Abdelzaher, M.
Seasonal variation of radon level and radon effective doses in the Catacomb of Kom EI-Shuqafa, Alexandria, Egypt
(2011) Pramana - Journal of Physics, 77 (4), pp. 749-757.

Abstract
Inhalation of radon has been recognized as a health hazard. In the present work radon concentration was measured, in the atmosphere of the archaeological place, namely Catacomb of Kom El-Shuqafa, in Alexandria, Egypt, which is open to the public, using time-integrated passive radon dosimeters containing LR-115 solid-state nuclear track detector. The measurements were performed throughout winter and summer. Seasonal variation of radon concentration, with the maximum in summer ranging from 243 to 574 Bq m-3 and minimum in winter ranging from 64 to 255 Bq m-3 was observed. Because of the variations of the catacomb ventilation system, the equilibrium factor between radon and its progeny ranges from 0.14 to 0.48. The tour guides are exposed to an average estimated annual effective dose ranging from 0.21 to 0.52 mSv y-1 and the visitors from 0.88 to 2.28 μSv y-1. The effective doses the catacomb workers are exposed to ranged from 0.20 mSv y-1 in winter to 4.65 mSv y-1 in summer which exceeds the lower bound of the recommended level (3-10 mSv y-1) (ICRP, 1993). © Indian Academy of Sciences.

Abe, K., Hieda, K., Hiraide, K., Hirano, S., Kishimoto, Y., Kobayashi, K., Koshio, Y., Liu, J., Martens, K., Moriyama, S., Nakahata, M., Nishiie, H., Ogawa, H., Sekiya, H., Shinozaki, A., Suzuki, Y., Takachio, O., Takeda, A., Ueshima, K., Umemoto, D., Yamashita, M., Hosokawa, K., Murata, A., Otsuka, K., Takeuchi, Y., Kusaba, F., Motoki, D., Nishijima, K., Tasaka, S., Fujii, K., Murayama, I., Nakamura, S., Fukuda, Y., Itow, Y., Masuda, K., Nishitani, Y., Takiya, H., Uchida, H., Kim, Y.D., Kim, Y.H., Lee, K.B., Lee, M.K., Lee, J.S.
Radon removal from gaseous xenon with activated charcoal
Nuclear Instruments and Methods in Physics Research, Section A: Accelerators, Spectrometers, Detectors and Associated Equipment, . Article in Press.

Abstract
Many low background experiments using xenon need to remove radioactive radon to improve their sensitivities. However, no method of continually removing radon from xenon has been described in the literature. We studied a method to remove radon from xenon gas through an activated charcoal trap. From our measurements we infer a linear relationship between the mean propagation velocity vRn of radon and vXe of xenon in the trap with vRn / vXe = (0.96 ± 0.10) × 10- 3 at -85 °C. As the mechanism for radon removal in this charcoal trap is its decay, knowledge of this parameter allows us to design an efficient radon removal system for the XMASS experiment. The verification of this system found that it reduces radon by a factor of 0.07, which is in line with its expected average retention time of 14.8 days for radon.

Agbalagba, E.O., Onoja, R.A.
Evaluation of natural radioactivity in soil, sediment and water samples of Niger Delta (Biseni) flood plain lakes, Nigeria
(2011) Journal of Environmental Radioactivity, 102 (7), pp. 667-671.

Abstract
This paper presents the findings of a baseline study undertaken to evaluate the natural radioactivity levels in soil, sediment and water samples in four flood plain lakes of the Niger Delta using a hyper pure germanium (HPGe) detector. The activity profile of radionuclides shows low activity across the study area. The mean activity level of the natural radionuclides 226Ra, 232Th and 40K is 20 ± 3, 20 ± 3 and 180 ± 50 Bq kg-1, respectively. These values are well within values reported elsewhere in the country and in other countries with similar environments. The study also examined some radiation hazard indices. The mean values obtained are, 76 ± 14 Bq kg-1, 30 ± 5.5 ηGy h-1, 37 ± 6.8 μSv y-1, 0.17 and 0.23 for Radium Equivalent Activity (Raeq), Absorbed Dose Rates (D), Annual Effective Dose Rates (Eff Dose), External Hazard Index (Hex) and Internal Hazard Index (Hin) respectively. All the health hazard indices are well below their recommended limits. The soil and sediments from the study area provide no excessive exposures for inhabitants and can be used as construction materials without posing any significant radiological threat to the population. The water is radiologically safe for domestic and industrial use. The paper recommends further studies to estimate internal and external doses from other suspected radiological sources to the population of the Biseni kingdom. © 2011.

Al Attar, L., Al-Oudat, M., Kanakri, S., Budeir, Y., Khalily, H., Al Hamwi, A.
Radiological impacts of phosphogypsum
(2011) Journal of Environmental Management, 92 (9), pp. 2151-2158.

Abstract
This study was carried out to assess the radiological impact of Syrian phosphogypsum (PG) piles in the compartments of the surrounding ecosystem. Estimating the distribution of naturally occurring radionuclides (i.e. 226Ra, 238U, 232Th, 210Po and 210Pb) in the raw materials, product and by-product of the Syrian phosphate fertilizer industry was essential. The data revealed that the concentrations of the radionuclides were enhanced in the treated phosphate ore. In PG, 226Ra content had a mean activity of 318Bqkg-1. The uranium content in PG was low, ca. 33Bqkg-1, because uranium remained in the phosphoric acid produced. Over 80% of 232Th, 210Po and 210Pb present partitioned in PG. The presence of PG piles did not increase significantly the concentration of 222Rn or gamma rays exposure dose in the area studied. The annual effective dose was only 0.082mSvy-1. The geometric mean of total suspended air particulates (TSP) ca. 85μgm-3. The activity concentration of the radionuclides in filtrates and runoff waters were below the detection limits (ca. 0.15mBqL-1 for 238U, 0.1mBqL-1 for 232Th and 0.18mBqL-1

for both of 210Po and 210Pb); the concentration of the radionuclides in ground water samples and Qattina Lake were less than the permissible limits set for drinking water by the World Health Organisation, WHO, (10, 1 and 0.1Bq L-1 for 238U, 232Th and both of 210Po and 210Pb, respectively). Eastern sites soil samples of PG piles recorded the highest activity concentrations, i.e. 26, 33, 28, 61 and 40Bqkg-1 for 226Ra, 238U, 232Th, 210Po and 210Pb, respectively, due to the prevailing western and north-western wind in the area, but remained within the natural levels reported in Syrian soil (13-32Bqkg-1 for 226Ra, 24.9-62.2Bqkg-1 for 238U and 10-32Bqkg-1 for 232Th). The impact of PG piles on plants varied upon the plant species. Higher concentrations of the radionuclides were recorded for grass in comparison to broad-leaved plants. Among the species that grow naturally on PG piles, Inula, Ecballium and Polygonium may be radionuclides accumulators. A determined effort is needed at a national level to achieve a common and coherent approach to regulate PG piles or to consider it a resource material rather than waste or residue.

Al-Jundi, J., Li, W.B., Abusini, M., Tschiersch, J., Hoeschen, C., Oeh, U.
Inhalation dose assessment of indoor radon progeny using biokinetic and dosimetric modeling and its application to Jordanian population
(2011) Journal of Environmental Radioactivity, 102 (6), pp. 574-580.

Abstract
High indoor radon concentrations in Jordan result in internal exposures of the residents due to the inhalation of radon and its short-lived progeny. It is therefore important to quantify the annual effective dose and further the radiation risk to the radon exposure. This study describes the methodology and the biokinetic and dosimetric models used for calculation of the inhalation doses exposed to radon progeny. The regional depositions of aerosol particles in the human respiratory tract were firstly calculated. For the attached progeny, the activity median aerodynamic diameters of 50 nm, 230 nm and 2500 nm were chosen to represent the nucleation, accumulation and coarse modes of the aerosol particles, respectively. For the unattached progeny, the activity median thermodynamic diameter of 1 nm was chosen to represent the free progeny nuclide in the room air. The biokinetic models developed by the International Commission on Radiological Protection (ICRP) were used to calculate the nuclear transformations of radon progeny in the human body, and then the dosimetric model was applied to estimate the organ equivalent doses and the effective doses with the specific effective energies derived from the mathematical anthropomorphic phantoms. The dose conversion coefficient estimated in this study was 15 mSv WLM-1 which was in the range of the values of 6-20 mSv WLM-1 reported by other investigators. Implementing the average indoor radon concentration in Jordan, the annual effective doses were calculated to be 4.1 mSv y-1 and 0.08 mSv y-1 due to the inhalation of radon progeny and radon gas, respectively. The total annual effective dose estimated for Jordanian population was 4.2 mSv y-1. This high annual effective dose calculated by the dosimetric approach using ICRP biokinetic and dosimetric models resulted in an increase of a factor of two in comparison to the value by epidemiological

study. This phenomenon was presented by the ICRP in its new published statement on radon. © 2011 Elsevier Ltd.

Alabdula'aly, A.I., Maghrawy, H.B.
Comparative study of different types of granular activated carbon in removing medium level radon from water
(2011) Journal of Radioanalytical and Nuclear Chemistry, 287 (1), pp. 77-85.

Abstract
Granular activated carbon (GAC) has proven its effectiveness in removing radon from water supplies. Laboratory and pilot plant studies were carried out using three different types of activated carbons (F-300, F-400, and HD-4000) to remove radon from water supply. From the experimental kinetic study, the data indicated that at least 6 h are needed to attain equilibrium between radon activity adsorbed onto carbon and its concentration in the aqueous phase. Also, it showed that HD-4000 has higher capacity for removing radon than the other two investigated carbons F-300 and F-400. The adsorption isotherms were satisfactorily explained by Freundlich equation. In the pilot plant study, the performance of the three activated carbons in removing radon at medium concentration (~111 Bq dm-3) was evaluated over 60 days of continuous water flow. Four empty-bed contact times (EBCTs) corresponding to four bed depths were continuously monitored and the corresponding steady state adsorption-decay constant values were calculated and the efficiency of each carbon was used to provide a facet for comparison. The γ-radiation exposure rate distribution throughout each GAC bed was measured and compared. This study, despite paucity of literature in this field, is useful for designing a GAC adsorption system for the removal of medium level radon concentration from water supplies. © 2010 Akadémiai Kiadó, Budapest, Hungary.

Alberigi, S., Pecequilo, B.R.S., Lobo, H.A.S., Campos, M.P.
Assessment of effective doses from radon levels for tour guides at several galleries of santana cave, southern brazil, with CR-39 detectors: Preliminary results
(2011) Radiation Protection Dosimetry, 145 (2-3), art. no. ncr054, pp. 252-255.

Abstract
Indoor radon concentrations have been measured in Santana cave, the most frequented cave of PETAR (High Ribeira River Tourist State Park), situated southern of Sao Paulo State, Brazil. The measurements were carried out with CR-39 detectors installed in four of the most frequently visited galleries. Preliminary results from November 2009 to June 2010 show radon concentrations varying from 1.9±0.1 to 8.4±0.6 kBq m-3. The total annual effective dose for all galleries was 3.32 mSv. The complete evaluation will be concluded by September 2010. © The Author 2011. Published by Oxford University Press. All rights reserved.

Ali, N., Khan, E.U., Akhter, P., Rana, M.A., Rajput, M.U., Khattak, N.U., Malik, F., Hussain, S.
Wet depositional fluxes of 210Pb- and 7Be-bearing aerosols at two different altitude cities of North Pakistan
(2011) Atmospheric Environment, 45 (32), pp. 5699-5709.

Abstract
The natural radionuclides 210Pb and 7Be have been widely used as tracers of aerosols for the study of pollution and atmospheric transport processes. The depositional fluxes of atmospheric 210Pb and 7Be-bearing aerosols in precipitation samples have been continuously measured from October 2006 to April 2010 at a high altitude city of Murree (33° 85' N, 73° 41' E, Alt.2300m a.s.l) and low altitude city of Islamabad (33° 38' N, 73° 09' E, Alt. 534m a.s.l), Pakistan, using a high resolution spectrometer. The specific activity values of 210Pb and 7Be measured in rain samples collected monthly from open lawn of Murree ranged from 2-87 mBq l-1 and 80-1680mBql-1 with their mean values of 30±11mBql-1 and 573±201mBql-1, respectively. Similarly the mean specific concentration values of 210Pb and 7Be in open lawn rain samples of Islamabad are 123±12mBql-1 and 442±321mBql-1 respectively. The specific concentrations of 210Pb and 7Be in throughfall samples collected at Murree site only are in the range from 5-34mBql-1 and 110-1177mBql-1 with the mean values of 17±6mBql-1 and 442±321mBql-1 respectively. The annual deposition fluxes of these radionuclides at Murree varied from 1 to 129Bqm-2y-1 and 17 to 2202Bqm-2y-1 in the open lawn rain samples and from 1 to 35Bqm-2y-1 and 9 to 975Bqm-2y-1 in throughfall samples respectively. Similarly the annual mean flux values of both radionuclides in open lawn rain samples of Islamabad are 1137Bqm-2y-1 and 3801Bqm-2y-1 respectively. Observed seasonal variations of deposition of 210Pb and 7Be are explained in terms of different environmental features. The role of plantation in the interception of radionuclides in throughfall samples is analyzed and discussed. The effect of the altitude on the deposition processes at the investigated site is studied using the comparison of present results with the relevant published results and analysis. © 2011 Elsevier Ltd.

Alifano, P., Nassisi, V., Siciliano, M.V., Talà, A., Tredici, S.M.
Unexpected photoreactivation of Vibrio harveyi bacteria living in ionization environment
(2011) Journal of Applied Physics, 109 (10), art. no. 104703, .

Abstract
Bacteria undergoing environmental effects is extremely interesting for structural, mechanistic, and evolutionary implications. Luminescent bacteria that have evolved in a specific ambient have developed particular responses and their behavior can give us new suggestions on the task and production of luciferina proteins. To analyze the UV interaction under controlled laboratory conditions, we used photoluminescent bacterial strains belonging to a new species evolutionarily close to Vibrio harveyi sampled from a

coastal cave with a high radon content that generates ionizing radiation. The survival of the bacterial strains was analyzed, in the light and in the dark, following a variety of genotoxic treatments including UV radiation exposure. The strains were irradiated by a germicide lamp. The results demonstrated that most of the strains exhibited a low rate of survival after the UV exposure. After irradiation by visible light following the UV exposure, all strains showed a high capability of photoreactivation when grown. This capability was quite unexpected because these bacteria were sampled from a dark ambient without UV radiation. This leads us to hypothesize that the photoreactivation in these bacteria might have been evolved to repair DNA lesions also induced by different radiation sources other than UV (e.g., x-ray) and that the luminescent bacteria might use their own light emission to carry out the photoreactivation. The high capability of photoreactivation of these bacteria was also justified by the results of deconvolution. The deconvolution was applied to the emission spectra and it was able to show evidence of different light peaks. The presence of the visible peak could control the photolysis enzyme.

AlSuhaibani, E.S.
Chromosomal aberration analysis among underground water wellworkers in Saudi Arabia (2011) Radiation Protection Dosimetry, 144 (1-4), art. no. ncq348, pp. 651-654.

Abstract
In the absence of permanent rivers or bodies of water, half of the Saudi Arabia domestic water consumption is provided through desalination. The other half is derived from groundwater. Groundwater from the Disi aquifer is already used for drinking water in parts of Jordan and, more extensively, in Saudi Arabia, where it is known as the Saq aquifer. Some of the geological analyses of the host sandstone aquifer rocks show 228Ra and 226Ra. The usefulness of chromosomal aberrations analysis as a bioindicator for ionising radiation effect was tested in underground water well workers of Saudi Arabia in this industry producing technologically enhanced naturally occurring radioactive material. The incidence of chromosomal aberrations was evaluated using the metaphase analysis method in the lymphocytes of peripheral blood of 10 persons working in underground water well. The age range of the workers was 25-40 y and their duration of service ranged from 3-7 y. For comparison, blood samples were also collected from 10 subjects (controls) who belonged to same age and socioeconomic status. Subjects in the both groups were non-smokers and non-alcoholics. Results showed that the mean frequencies of dicentrics and acentrics in underground water well workers are significantly higher than those in controls. The higher frequency of chromosomal aberration in lymphocytes of underground water well workers compared with controls could be due to the accumulative effect of radiation. The results of this study demonstrated that occupational exposure to radiation leads to a significant induction of cytogenetic damage in peripheral lymphocytes of workers engaged in underground water well.

Amin, Y.M., Nik, H.W.
Radiological monitoring of waste treatment plant
(2011) AIP Conference Proceedings, 1328, pp. 101-103.

Abstract
Scheduled waste in West Malaysia is handled by Concession Company and is stored and then is incinerated. It is known that incineration process may result in naturally occurring radioactive materials (NORM) to be concentrated. In this study we have measured three samples consist of by-product from the operation process such as slag, filter cake and fly ash. Other various environmental media such as air, surface water, groundwater and soil within and around the plant have also been analysed for their radioactivity levels. The concentration of Ra-226, Ac-228 and K-40 in slag are 0.062 Bq/g, 0.016 Bq/g and 0.19 Bq/g respectively. The total activity (Raeq) in slag is 99.5 Bq/kg. The concentration in fly ash is 0.032 Bq/g, 0.16 Bq/g and 0.34 Bq/g for Ra-226, Ac-228 and K-40 respectively resulting in Raeq of 287.0 Bq/kg. For filter cake, the concentration is 0.13 Bq/g, 0.031 Bq/g and 0.33 Bq/g for Ra-226, Ac-228 and K-40 respectively resulting in Raeq of 199.7 Bq/kg. The external radiation level ranges from 0.08 μSv/h (Administrative building) to 0.35 μSv/h (TENORM storage area). The concentration level of radon and thoron progeny varies from 0.0001 to 0.0016 WL and 0.0006 WL to 0.002 WL respectively. For soil samples, the activity ranges from 0.11 Bq/g to 0.29 Bq/g, 0.06 Bq/g to 0.18 Bq/g and 0.065 Bq/g to 0.38 Bq/g for Ra-226, Ac-228 and K-40 respectively. While activity in water, except for a trace of K-40, it is non-detectable. © 2011 American Institute of Physics.

Anjos, R.M., Juri Ayub, J., Cid, A.S., Cardoso, R., Lacerda, T.
External gamma-ray dose rate and radon concentration in indoor environments covered with brazilian granites
(2011) Journal of Environmental Radioactivity, 102 (11), pp. 1055-1061.

Abstract
Health hazard from natural radioactivity in Brazilian granites, covering the walls and floor in a typical dwelling room, was assessed by indirect methods to predict external gamma-ray dose rates and radon concentrations. The gamma-ray dose rate was estimated by a Monte Carlo simulation method and validated by in-situ measurements with a NaI spectrometer. Activity concentrations of 232Th, 226Ra, and 40K in an extensive selection of Brazilian commercial granite samples measured by using gamma-ray spectrometry were found to be 4.5-450 Bq kg-1, 4.9-160 Bq kg-1 and 190-2029 Bq kg-1, respectively. The maximum external gamma-ray dose rate from floor and walls covered with the Brazilian granites in the typical dwelling room (5.0 m × 4.0 m area, 2.8 m height) was found to be 120 nGy h-1, which is comparable with the average worldwide exposure to external terrestrial radiation of 80 nGy h-1 due to natural sources, proposed by United Nations Scientific Committee on the Effects of Atomic Radiation. Radon

concentrations in the room were also estimated by a simple mass balance equation and exhalation rates calculated from the measured values of 226Ra concentrations and the material properties. The results showed that the radon concentration in the room ventilated adequately (0.5 h-1) will be lower than 100 Bq m-3, value recommended as a reference level by the World Health Organization.

Annangi, P., Raja, A.
Lung partitioning for x-ray CAD applications
(2011) Progress in Biomedical Optics and Imaging - Proceedings of SPIE, 7963, art. no. 79631P, .

Abstract
Partitioning the inside region of lung into homogeneous regions becomes a crucial step in any computer-aided diagnosis applications based on chest X-ray. The ribs, air pockets and clavicle occupy major space inside the lung as seen in the chest x-ray PA image. Segmenting the ribs and clavicle to partition the lung into homogeneous regions forms a crucial step in any CAD application to better classify abnormalities. In this paper we present two separate algorithms to segment ribs and the clavicle bone in a completely automated way. The posterior ribs are segmented based on Phase congruency features and the clavicle is segmented using Mean curvature features followed by Radon transform. Both the algorithms work on the premise that the presentation of each of these anatomical structures inside the left and right lung has a specific orientation range within which they are confined to. The search space for both the algorithms is limited to the region inside the lung, which is obtained by an automated lung segmentation algorithm that was previously developed in our group. Both the algorithms were tested on 100 images of normal and patients affected with Pneumoconiosis. © 2011 SPIE.

Antovic, I., Antovic, N.M.
Determination of concentration factors for Cs-137 and Ra-226 in the mullet species Chelon labrosus (Mugilidae) from the South Adriatic Sea
(2011) Journal of Environmental Radioactivity, 102 (7), pp. 713-717.

Abstract
Concentration factors for Cs-137 and Ra-226 transfer from seawater, and dried sediment or mud with detritus, have been determined for whole, fresh weight, Chelon labrosus individuals and selected organs. Cesium was detected in 5 of 22 fish individuals, and its activity ranged from 1.0 to 1.6 Bq kg-1. Radium was detected in all fish, and ranged from 0.4 to 2.1 Bq kg-1, with an arithmetic mean of 1.0 Bq kg-1. In regards to fish organs, cesium activity concentration was highest in muscles (maximum - 3.7 Bq kg-1), while radium was highest in skeletons (maximum - 25 Bq kg-1). Among cesium concentration factors, those for muscles were the highest (from seawater - an average of 47, from sediment - an average of 3.3, from mud with detritus - an average of 0.8). Radium

concentration factors were the highest for skeleton (from seawater - an average of 130, from sediment - an average of 1.8, from mud with detritus - an average of 1.5). Additionally, annual intake of cesium and radium by human adults consuming muscles of this fish species has been estimated to provide, in aggregate, an effective dose of about 4.1 μSv y-1. © 2011 Elsevier Ltd.

Appleton, J.D., Miles, J.C.H., Young, M.
Erratum to "Comparison of Northern Ireland radon maps based on indoor radon measurements and geology with maps derived by predictive modelling of airborne radiometric and ground permeability data" [Sci. Total Environ. 409 (2011) 1572-1583]
(2011) Science of the Total Environment, 409 (20), p. 4496.

Appleton, J.D., Doyle, E., Fenton, D., Organo, C.
Radon potential mapping of the Tralee-Castleisland and Cavan areas (Ireland) based on airborne gamma-ray spectrometry and geology
(2011) Journal of Radiological Protection, 31 (2), pp. 221-235.

Abstract
The probability of homes in Ireland having high indoor radon concentrations is estimated on the basis of known in-house radon measurements averaged over 10km × 10km grid squares. The scope for using airborne gamma-ray spectrometer data for the Tralee-Castleisland area of county Kerry and county Cavan to predict the radon potential (RP) in two distinct areas of Ireland is evaluated in this study. Airborne data are compared statistically with in-house radon measurements in conjunction with geological and ground permeability data to establish linear regression models and produce radon potential maps. The best agreement between the percentage of dwellings exceeding the reference level (RL) for radon concentrations in Ireland (% > RL), estimated from indoor radon data, and modelled RP in the Tralee-Castleisland area is produced using models based on airborne gamma-ray spectrometry equivalent uranium (eU) and ground permeability data. Good agreement was obtained between the % > RL from indoor radon data and RP estimated from eU data in the Cavan area using terrain specific models. In both areas, RP maps derived from eU data are spatially more detailed than the published 10km grid map. The results show the potential for using airborne radiometric data for producing RP maps. © 2011 IOP Publishing Ltd.

Appleton, J.D., Miles, J.C.H., Young, M.
Comparison of Northern Ireland radon maps based on indoor radon measurements and geology with maps derived by predictive modelling of airborne radiometric and ground permeability data
(2011) Science of the Total Environment, 409 (8), pp. 1572-1583.

Abstract
Publicly available information about radon potential in Northern Ireland is currently based on indoor radon results averaged over 1-km grid squares, an approach that does not take into account the geological origin of the radon. This study describes a spatially more accurate estimate of the radon potential of Northern Ireland using an integrated radon potential mapping method based on indoor radon measurements and geology that was originally developed for mapping radon potential in England and Wales. A refinement of this method was also investigated using linear regression analysis of a selection of relevant airborne and soil geochemical parameters from the Tellus Project. The most significant independent variables were found to be eU, a parameter derived from airborne gamma spectrometry measurements of radon decay products in the top layer of soil and exposed bedrock, and the permeability of the ground. The radon potential map generated from the Tellus data agrees in many respects with the map based on indoor radon data and geology but there are several areas where radon potential predicted from the airborne radiometric and permeability data is substantially lower. This under-prediction could be caused by the radon concentration being lower in the top 30. cm of the soil than at greater depth, because of the loss of radon from the surface rocks and soils to air. © 2011.

Appleton, J.D., Cave, M.R., Miles, J.C.H., Sumerling, T.J.
Soil radium, soil gas radon and indoor radon empirical relationships to assist in post-closure impact assessment related to near-surface radioactive waste disposal
(2011) Journal of Environmental Radioactivity, 102 (3), pp. 221-234.

Abstract
Least squares (LS), Theil's (TS) and weighted total least squares (WTLS) regression analysis methods are used to develop empirical relationships between radium in the ground, radon in soil and radon in dwellings to assist in the post-closure assessment of indoor radon related to near-surface radioactive waste disposal at the Low Level Waste Repository in England. The data sets used are (i) estimated 226Ra in the <2mm fraction of topsoils (eRa226) derived from equivalent uranium (eU) from airborne gamma spectrometry data, (ii) eRa226 derived from measurements of uranium in soil geochemical samples, (iii) soil gas radon and (iv) indoor radon data. For models comparing indoor radon and (i) eRa226 derived from airborne eU data and (ii) soil gas radon data, some of the geological groupings have significant slopes. For these groupings there is reasonable agreement in slope and intercept between the three regression analysis methods (LS, TS and WTLS). Relationships between radon in dwellings and radium in the ground or radon in soil differ depending on the characteristics of the underlying geological units, with more permeable units having steeper slopes and higher indoor radon concentrations for a given radium or soil gas radon concentration in the ground. The regression models comparing indoor radon with soil gas radon have intercepts close to 5Bqm-3 whilst the intercepts for those comparing indoor radon with eRa226 from airborne eU vary from about 20Bqm-3 for a moderately permeable geological unit to about 40Bqm-3 for highly permeable limestone, implying unrealistically high

contributions to indoor radon from sources other than the ground. An intercept value of 5Bqm-3 is assumed as an appropriate mean value for the UK for sources of indoor radon other than radon from the ground, based on examination of UK data. Comparison with published data used to derive an average indoor radon: soil 226Ra ratio shows that whereas the published data are generally clustered with no obvious correlation, the data from this study have substantially different relationships depending largely on the permeability of the underlying geology. Models for the relatively impermeable geological units plot parallel to the average indoor radon: soil 226Ra model but with lower indoor radon: soil 226Ra ratios, whilst the models for the permeable geological units plot parallel to the average indoor radon: soil 226Ra model but with higher than average indoor radon: soil 226Ra ratios.

Armstrong, R.B.
Improving performance of geosynthetics for containment of volatile organic compounds through the use of ethylene vinyl alcohol (EVOH)
(2011) Geotechnical Special Publication, (211 GSP), pp. 2039-2048.

Abstract
The inclusion of ethylene vinyl alcohol (EVOH) copolymer by coextrusion into geosynthetic liners would greatly reduce diffusive migration of volatile organic compounds (VOC's). The primary function of a geosynthetic liner system in a geoenvironmental application is containment of liquids and vapor that should not migrate into the surrounding environment. Existing monolithic geomembranes comprised of polypropylene, polyethylene and polyvinylchloride are excellent hydraulic and heavy metal barriers, but are not good barriers to volatile organic compounds that pose a threat to soil, water and air quality. In a composite with polyethylene or polypropylene, EVOH would dramatically improve the capability of geosynthetics to control the diffusion of gases, hydrocarbons and solvents in applications ranging from waste landfills, secondary containment, radon and vapor intrusion barriers and brown field remediation. A comparison of the properties and performance of model geosynthetics incorporating EVOH showed that EVOH improves VOC barrier properties by several orders of magnitude without substantially affecting key form and functionality of existing geomembranes.

Ashry, A.H., Abou-Leila, M., Abdalla, A.M.
Measurement of radon permeability through polyethylene membrane using scintillation detector
(2011) Radiation Measurements, 46 (1), pp. 149-152.

Abstract
The permeability of Radon 222 through polyethylene membranes has been studied using activated charcoal technique. The permeability constant of Radon 222 through low-

density polyethylene, linear low-density Polyethylene and high density polyethylene samples has been measured. There is a considerable agreement between the values obtained by our method and the method suggested by W. Arafa [2002. Permeability of radon 222 through some materials. Radiat. Meas. 35, 207-211], and SSNTD technique suggested by A. Hafez and G. Somogyi [1986. Determination of radon and thoron permeability through some plastics by track technique. Int. J. Radiat. Appl. Instrum. Nucl. Track Radiat. Meas. 12 (1-6), 697-700]. In this work Radon permeability through different polyethylene membranes has been measured using three different methods, i.e. solid state nuclear track technique, W. Arafa [2002. Permeability of radon 222 through some materials. Radiat. Meas. 35, 207-211] method and our proposed method. In addition to this, in this study, the diffusion coefficient of radon in charcoal as well as solubility of Radon in polyethylene membrane has been taken into consideration.

Babai, K.S., Poongothai, S., Santhanam, R.
Measurement of radon levels in dwellings in and around Chennai city using SSNTD
(2011) European Journal of Scientific Research, 62 (1), pp. 6-13.

Abstract
Indoor radon studies have extensively been carried out in the dwellings of Chennai city, Tamil Nadu, India, using Solid-State Nuclear Track Detector (LR-115 type II). In the frame of this project, indoor radon concentration has been measured in 235 dwellings situated along the width and breadth of Chennai city. Measurements have been done on quarterly basis for one year in each dwelling. It was found that the indoor radon concentration in these dwellings varies from 21.6 to 139.3 Bq/m3. The radon concentration in all dwellings, irrespective of the seasons, is well below the ICRP recommended lower bound action level of 300 Bq/m3 . © EuroJournals Publishing, Inc. 2011.

Bai, Q., Fang, F., Li, X.
Study of correlation of fracture caused by coal mine production and radon concentration
(2011) Wutan Huatan Jisuan Jishu, 33 (2), pp. 175-178.

Abstract
Coal production in seam mining can easily lead fracture in overlying stratum link up to the surface cracks directly, which could cause combustion, loss of groundwater and so on. An important basis to effectively solve the problems is to grasp the characteristics of distribution of mining fracture in overlying stratum. Radon measurement is introduced into researching on fracture development of seam mining, and the correlation of fracture and radon concentration in seam mining is analyzed by experimental simulation.

Baíllo, A., Cuevas, A., Cuesta-Albertos, J.A.
Supervised Classification for a Family of Gaussian Functional Models
(2011) Scandinavian Journal of Statistics, 38 (3), pp. 480-498.

Abstract
In the framework of supervised classification (discrimination) for functional data, it is shown that the optimal classification rule can be explicitly obtained for a class of Gaussian processes with 'triangular' covariance functions. This explicit knowledge has two practical consequences. First, the consistency of the well-known nearest neighbours classifier (which is not guaranteed in the problems with functional data) is established for the indicated class of processes. Second, and more important, parametric and non-parametric plug-in classifiers can be obtained by estimating the unknown elements in the optimal rule. The performance of these new plug-in classifiers is checked, with positive results, through a simulation study and a real data example. © 2011 Board of the Foundation of the Scandinavian Journal of Statistics.

BaldIk, R., Aytekin, H., Erer, M.
Radioactivity measurements and radiation dose assessments due to natural radiation in Karabük (Turkey)
(2011) Journal of Radioanalytical and Nuclear Chemistry, 289 (2), pp. 297-302.

Abstract
In this work, the radionuclide activity concentrations of 226Ra, 232Th and 40K in surface soils and radon levels in dwellings of Karabük, Turkey were determined in order to evaluate the environmental radioactivity. Concentrations of 226Ra, 232Th and 40K radionuclides were determined using gamma spectrometry with using HPGe detector. The etch track detectors (CR-39) were used to determine the distribution of radon concentrations. The average activity concentrations for 226Ra, 232Th and 40K were found as 21.0, 23.5 and 363.5 Bq kg-1, respectively. The calculated average annual effective dose equivalent from the outdoor terrestrial gamma radiation from 226Ra, 232Th and 40K is 53.5 μSv y-1. The average radon concentration and annual effective dose equivalent of 222Rn in Karabük dwellings were obtained 131.6 Bqm-3 and 3.32 mSv y-1, respectively. The evaluated data were compared with the data obtained from different countries. © 2011 Akadémiai Kiadó, Budapest, Hungary.

Balek, V., Rao, T.N., Tryk, D.A., Fujishima, A.
Diffusion structural diagnostics of polycrystalline boron-doped diamond films
(2011) Thermochimica Acta, 524 (1-2), pp. 104-108.

Abstract
Emanation thermal analysis (ETA) has been used to characterize the thermal behavior of boron-doped diamond polycrystalline film samples prepared by microwave plasma-assisted chemical vapor deposition (MPCVD). The mobility of radon atoms in the diamond film samples was evaluated from the ETA results. From the diffusion structural diagnostics achieved by evaluating the ETA results it followed that the O-plasma treatment of the sample enhanced the mobility of radon atoms in the range of 50-200 °C, due to both structure disordering and removal of graphitic carbon. The structure disordering was suggested by the high-resolution XPS results. From the diffusion structural diagnostics data it followed that the annealing of the structure irregularities in the polycrystalline diamond films took place in the range of 250-450 °C, the annealing was more intense for the O-plasma-treated sample compared to the H-plasma-treated one, due mostly to the initially greater degree of structure irregularities. © 2011 Elsevier B.V.

Banerjee, K.S., Basu, A., Guin, R., Sengupta, D.
Radon (222Rn) level variations on a regional scale from the Singhbhum Shear Zone, India: A comparative evaluation between influence of basement U-activity and porosity
(2011) Radiation Physics and Chemistry, 80 (5), pp. 614-619.

Abstract
This paper is devoted to the comparative study of the radon flux vs. uranium content and radon flux vs. porosity for mineral samples from some typical Indian rocks (schists, quartzites, argillaceous quartzites, slates and granites) used as building materials, primarily around the Singhbhum Shear Zone, Jharkhand State. As the radon flux of any particular rock type was investigated with reference to its uranium activity and porosity, a good concordance of porosity on radon flux was observed. Such a significant influence of porosity on radon flux was also observed when different rock types were inter-compared. For example, granite that is commonly considered as typical source of indoor radon showed depleted level of radon flux when compared to most other rocks in the study area. In case of rocks such as slates and argillaceous quartzites, low porosity exhibited reduced radon flux in spite of their enhanced radioactive source content. It is concluded that it may not be advisable to utilize materials that are uranium depleted for construction purposes without giving importance to the materials' porosity. © 2011 Elsevier Ltd.

Baradaran-Ghahfarokhi, M., Faghihi, R., Karami, M., Siavashpour, Z., Owji, H.
The hazardous effects of interior wall materials and surfaces on indoor radon concentrations in Iranian houses
(2011) Iranian Red Crescent Medical Journal, 13 (9), pp. 530-532.

Abstract
Background: Radon gas, which emanates from thorium and uranium ore-bearing rocks

scattered throughout the surface soil and underground, can concentrate indoors and reach levels that represent a public health risk. According to the World Health Organization (WHO) and the US Environmental Protection Agency (EPA), radon is the second leading cause of the lung cancer worldwide. Due to the direct correlation between the lung cancer and radon exposure, it is important to directly, accurately, simply, and rapidly measure radon accumulation in Iranian dwellings built with various materials. Thus, the aim of this study was to measure the effects of these materials on ambient radon concentrations in Iran dwellings. Materials and Methods: We built a special chamber with interchangeable walls made with different materials and surfaces, including gypsum, wallpaper, oil paint, plastic paint, wall board, and Belka (a trademark for interior wall coating material composed of Cotton & Cellulose, mineral flakes, natural adhesive and Decorative additives). Radioactive lantern mantles were used to elevate the radon (220Rn) levels in the chamber. Chamber ventilation was designed to allow radon to accumulate, and active measurements were made with a Prassi portable radon gas surveyor (Tabesh Research Center, Shiraz University of Medical Sciences, Shiraz, IR Iran). Data were analyzed using the Mann-Whitney U test with a significance criterion of P = 0.05 with the Bonferroni correction. Results: The mean radon concentrations for wood and plastic paint were 869.0 ± 66.7 and 936.8 ± 60.6 Bq/m3, respectively while those for wallpaper and gypsum were 449.2 ± 101.7 and 590.9 ± 49.0 Bq/m3, respectively; both significantly lower than other materials. The mean radon concentrations for oil paint and Belka were 668.3 ± 42.3 and697.2 ± 136.7 Bq/m3, respectively. Conclusions: Individuals living in a house with interiors made of gypsum and covered with wallpaper receive an average annual radon dose smaller than people living in a house with interior wall coverings made of wall board or coated with plastic paint. Wallpaper and gypsum are suggested as the safest interior wall construction materials.

Barnet, I.
Indoor radon probability calculated from the Czech soil gas radon data in a grid net for the European Geogenic Radon Map construction: test of feasibility
(2011) Environmental Earth Sciences, pp. 1-5. Article in Press.

Abstract
The construction of the European Geogenic Radon Map in a proposed grid system 10 × 10 km requires the data test to derive the probability of exceeding the indoor action level 200 Bq m-3 from the geologically based data. The Czech Republic disposes both indoor and soil gas data sets to test the real probability to exceed 200 Bq m-3 from indoor radon measurements and to compare it with the probability calculated from soil gas radon concentrations. Comparison of real and calculated probability enables to delineate the areas, where under- or overestimation can be expected. The results of data processing show minor differences between processing the raw data in generalised polygons of geological units and in a grid net, when using the generalised geological characteristics of grid cells. © 2011 Springer-Verlag.

Barnet, I., Pacherová, P.
Impact of the deeper geological basement on soil gas and indoor radon concentrations in areas of Quaternary fluvial sediments (Bohemian Massif, Czech Republic)
(2011) Environmental Earth Sciences, 63 (3), pp. 551-557.

Abstract
The relationship of soil gas radon Rn222 and indoor radon was studied within the Quaternary fluvial sediments of the Czech Republic. The processing of data selection from the radon database of the Czech Geological Survey and indoor radon data (database of the National Radiation Protection institute) has proved the concentration dependence of radon in Quaternary fluvial sediments on deeper bedrock. The ArcGIS processing was accompanied by the field verification in five profiles, intersecting the granitoid Central Bohemian Plutonic Complex and its rim rock types. Both theoretical and experimental results show dependence of soil gas radon and indoor radon concentrations in Quaternary fluvial sediments on deeper geological basement, thus leading to the conclusion that the lateral transport of Quaternary sediments does not play such a dominant role in radon concentrations, as was thought previously. This fact will enable to determine precisely the radon index of Quaternary sediments (in the Czech radon mapping classified as an intermediate index) into three categories according to the lithology of their geological basement. © 2010 Springer-Verlag.

Barooah, D., Phukan, S., Baruah, R.
Study of radon exhalation rates using LR-115 (II) nuclear track detectors in coal-mining area of the foothills of Mokokchung District, Nagaland
(2011) Indian Journal of Pure and Applied Physics, 49 (10), pp. 665-668.

Abstract
The coal-mining area of the foothills of Mokokchung District, Nagaland bears significant geological features. Radon exhalation from ground plays an important role in enhanced indoor radon levels. Exhalation rates (mass and surface) from coal and soil samples of the area have been studied using LR-115 (II) nuclear track detectors. The mass and surface exhalation rates from coal samples varied in the range 9.7-16.2 mBq/kg/h and 323.5-538.6 mBq/m 2/h, respectively. The mass and surface exhalation rates from soil samples varied in the range 11.1-15.2 mBq/kg/h and 368.3-507.6 mBq/m 2/h, respectively. The study has revealed substantial presence of radionuclides in the coal and soil of the area.

Baskaran, M.
Po-210 and Pb-210 as atmospheric tracers and global atmospheric Pb-210 fallout: A Review
(2011) Journal of Environmental Radioactivity, 102 (5), pp. 500-513.

Abstract
Over the past □5 decades, the distribution of 222Rn and its progenies (mainly 210Pb, 210Bi and 210Po) have provided a wealth of information as tracers to quantify several atmospheric processes that include: i) source tracking and transport time scales of air masses; ii) the stability and vertical movement of air masses iii) removal rate constants and residence times of aerosols; iv) chemical behavior of analog species; and v) washout ratios and deposition velocities of aerosols. Most of these applications require that the sources and sink terms of these nuclides are well characterized.Utility of 210Pb, 210Bi and 210Po as atmospheric tracers requires that data on the 222Rn emanation rates is well documented. Due to low concentrations of 226Ra in surface waters, the 222Rn emanation rates from the continent is about two orders of magnitude higher than that of the ocean. This has led to distinctly higher 210Pb concentrations in continental air masses compared to oceanic air masses. The highly varying concentrations of 210Pb in air as well the depositional fluxes have yielded insight on the sources and transit times of aerosols. In an ideal enclosed air mass (closed system with respect to these nuclides), the residence times of aerosols obtained from the activity ratios of 210Pb/222Rn, 210Bi/210Pb, and 210Po/210Pb are expected to agree with each other, but a large number of studies have indicated discordance between the residence times obtained from these three pairs. Recent results from the distribution of these nuclides in size-fractionated aerosols appear to yield consistent residence time in smaller-size aerosols, possibly suggesting that larger size aerosols are derived from resuspended dust. The residence times calculated from the 210Pb/222Rn, 210Bi/210Pb, and 210Po/210Pb activity ratios published from 1970's are compared to those data obtained in size-fractionated aerosols in this decade and possible reasons for the discordance is discussed with some key recommendations for future studies.The existing global atmospheric inventory data of 210Pb is re-evaluated and a 'global curve' for the depositional fluxes of 210Pb is established. A current global budget for atmospheric 210Po and 210Pb is also established. The relative importance of dry fallout of 210Po and 210Pb at different latitudes is evaluated. The global values for the deposition velocities of aerosols using 210Po and 210Pb are synthesized. © 2010 Elsevier Ltd.

Baykara, O., Karatepe, S., Doğru, M.
Assessments of natural radioactivity and radiological hazards in construction materials used in Elazig, Turkey
(2011) Radiation Measurements, 46 (1), pp. 153-158.

Abstract
Building materials contain natural radionuclides (238U, 232Th and 40K) and therefore cause direct radiation exposure to the public. The radioactivity content of samples obtained from building materials produced in Elazig city, East Anatolian of Turkey, have been analyzed by gamma-ray spectrometry. However, radium equivalent activities, total and annual effective dose rate and external (gamma), internal (alpha) hazard indexes were calculated and radon concentration, radon specific exhalation rate and effective

radium content were measured. Also, indoor radon measurements carried out in each floor (uninhabited) of rough construction (newly construction). The specific concentrations of 238U, 232Th and 40K, from selected building materials, ranged from 3.5 to 114.1 Bq/kg, 1.6-20.7 Bq/kg and 201.4-4928.0 Bq/kg, respectively. The lowest of Raeq is 36.5 ± 1.8 Bq/kg calculated in bricks while the highest value is 405.2 ± 20.9 Bq/kg in gas concrete. The average indoor radon concentration is 364.3 Bqm-3, which is higher than the global mean value, in newly constructed floor.

Belchior, A., Gil, O.M., Almeida, P., Vaz, P.
Evaluation of the cytotoxicity and the genotoxicity induced by α radiation in an A549 cell line
(2011) Radiation Measurements, 46 (9), pp. 958-961.

Abstract
Exposure to radon and its progenies represents one of the greatest risks of ionizing radiation from natural sources. Nowadays, these risks are assessed by the extrapolation of biological effects observed from epidemiological data. In the present study, we made a dose response curve, to evaluate the in vitro response of A549 human lung cells to α-radiation resulting from the decay of a 210Po source, evaluated by the cytokinesis blocked micronuclei assay. The clonogenic assay was used to measure the survival cell fraction. As expected, the results revealed an increase of cellular damage with increased doses made evident from the increased number of micronuclei (MN) per binucleated cell (BN). Besides this study involving the biological effects induced by direct irradiation, and due to the fact that radiation-induced genomic instability is thought to be an early event in radiation carcinogenesis, we analyzed the genomic instability in early and delayed untargeted effects, by using the medium transfer technique. The obtained results show that unirradiated cells exposed to irradiated medium reveal a higher cellular damage in earlier effects when compared to the delayed effects. The obtained results may provide clues for the biodosimetric determination of radon dose to airway cells at cumulative exposures.

Belikov, V.T., Ryvkin, D.G.
Studying changes in the structural and dynamic characteristics of a disintegrating massif of rocks using radon concentration variations
(2011) Russian Journal of Nondestructive Testing, 47 (5), pp. 343-351.

Abstract
Experimental data on radon concentration variations were quantitatively interpreted on the basis of a proposed quantitative model that describes the process of the formation of high-amplitude radon anomalies. As a result, relative time variations in the structural

(porosity and specific inner surface) and dynamic (pressure) characteristics of a disintegrating massif of rocks were reconstructed.

Bender, M.L., Kinter, S., Cassar, N., Wanninkhof, R.
Evaluating gas transfer velocity parameterizations using upper ocean radon distributions (2011) Journal of Geophysical Research C: Oceans, 116 (2), art. no. C02010, .

Abstract
Sea-air fluxes of gases are commonly calculated from the product of the gas transfer velocity (k) and the departure of the seawater concentration from atmospheric equilibrium. Gas transfer velocities, generally parameterized in terms of wind speed, continue to have considerable uncertainties, partly because of limited field data. Here we evaluate commonly used gas transfer parameterizations using a historical data set of 222Rn measurements at 105 stations occupied on Eltanin cruises and the Geosecs program. We make this evaluation with wind speed estimates from meteorological reanalysis products (from National Centers for Environmental Prediction and European Centre for Medium-Range Weather Forecasting) that were not available when the 22Rn data were originally published. We calculate gas transfer velocities from the parameterizations by taking into account winds in the period prior to the date that 222Rn profiles were sampled. Invoking prior wind speed histories leads to much better agreement than simply calculating parameterized gas transfer velocities from wind speeds on the day of sample collection. For individual samples from the Atlantic Ocean, where reanalyzed winds agree best with observations, three similar recent parameterizations give k values for individual stations with an rms difference of □40% from values calculated using 222Rn data. Agreement of basin averages is much better. For the global data set, the average difference between k constrained by 222Rn and calculated from the various parameterizations ranges from -0.2 to +0.9 m/d (average, 2.9 m/d). Averaging over large domains, and working with gas data collected in recent years when reanalyzed winds are more accurate, will further decrease the uncertainties in sea-air fluxes.

Beraldin, J.A., Picard, M., Bandiera, A., Valzano, V., Negro, F.
Best practices for the 3D documentation of the Grotta dei Cervi of Porto Badisco, Italy (2011) Proceedings of SPIE - The International Society for Optical Engineering, 7864, art. no. 78640J, .

Abstract
The Grotta dei Cervi is a Neolithic cave where human presence has left many unique pictographs on the walls of many of its chambers. It was closed for conservation reasons soon after its discovery in 1970. It is for these reasons that a 3D documentation was started. Two sets of high resolution and detailed three-dimensional (3D) acquisitions were captured in 2005 and 2009 respectively, along with two-dimensional (2D) images.

From this information a textured 3D model was produced for most of the 300-m long central corridor. Carbon dating of the guano used for the pictographs and environmental monitoring (Temperature, Relative humidity, and Radon) completed the project. This paper presents this project, some results obtained up to now, the best practice that has emerged from this work and a description of the processing pipeline that deals with more than 27 billion 3D coordinates.

Berube, D.M., Cummings, C.L., Frith, J.H., Binder, A.R., Oldendick, R.
Comparing nanoparticle risk perceptions to other known EHS risks
(2011) Journal of Nanoparticle Research, 13 (8), pp. 3089-3099.

Abstract
Over the last decade social scientific researchers have examined how the public perceives risks associated with nanotechnology. The body of literature that has emerged has been methodologically diverse. The findings have confirmed that some publics perceive nanotechnology as riskier than others, experts feel nanotechnology is less risky than the public does, and despite risks the public is optimistic about nanotechnology development. However, the extant literature on nanotechnology and risk suffers from sometimes widely divergent findings and has failed to provide a detailed picture of how the public actually feels about nanotechnology risks when compared to other risks. This study addresses the deficiencies in the literature by providing a comparative approach to gauging nanotechnology risks. The findings show that the public does not fear nanotechnology compared to other risks. Out of 24 risks presented to the participants, nanotechnology ranked 19th in terms of overall risk and 20th in terms of "high risk." © 2011 Springer Science+Business Media B.V.

Bi, L., Tschiersch, J., Meisenberg, O., Wielunski, M., Li, J.L., Shang, B.
Development of a new thoron progeny detector based on ssntd and the collection by an electric field
(2011) Radiation Protection Dosimetry, 145 (2-3), art. no. ncr078, pp. 288-294.

Abstract
The importance of 220Rn (thoron) progeny for human exposure has been widely recognised in the past decades. Since no stable equilibrium factor was found between indoor thoron and its progeny, and the concentration of thoron progeny varies with time, it is necessary to develop detectors for long-term measurement that directly sample and detect thoron progeny. However, power supply of this kind of detectors has always been a problem. In this study, a set of device that is suitable for long-term measurement is introduced. A high-voltage electric field was formed for the collection of charged aerosols attached by 222Rn (radon) and thoron progenies on solid-state nuclear track detector. Impact from radon progeny could be eliminated with a shield of Al foil of appropriate thickness. Tests were made both in an experimental house and in a thoron

chamber in Helmholtz Zentrum München to determine the parameters and to verify the universality under different conditions.

Bijwaard, H., Dekkers, F., van Dillen, T.
Modelling lung cancer due to radon and smoking in WISMUT miners: Preliminary results
(2011) Radiation Protection Dosimetry, 143 (2-4), art. no. ncq469, pp. 380-383.

Abstract
A mechanistic two-stage carcinogenesis model has been applied to model lung-cancer mortality in the largest uranium-miner cohort available. Models with and without smoking action both fit the data well. As smoking information is largely missing from the cohort data, a method has been devised to project this information from a case-control study onto the cohort. Model calculations using 256 projections show that the method works well. Preliminary results show that if an explicit smoking action is absent in the model, this is compensated by the values of the baseline parameters. This indicates that in earlier studies performed without smoking information, the results obtained for the radiation parameters are still valid. More importantly, the inclusion of smoking-related parameters shows that these mainly influence the later stages of lung-cancer development.

Bikit, I., Mrda, D., Grujic, S., Kozmidis-Luburic, U.
Granulation effects on the radon emanation rate
(2011) Radiation Protection Dosimetry, 145 (2-3), art. no. ncr055, pp. 184-188.

Abstract
The radon emanation and the granulation effect on the emanation rate of several building materials (ceramic plates, sand, red brick and siporex brick) with different 226Ra concentrations were investigated. A ball mill was used to achieve different granulations of the materials. The particle size distributions were determined by a particle size analyser (Mastersizer 2000). The increase in the 222Rn concentration inside a closed chamber (volume ≈5.4 3 1023 m3) due to emanation from each material with different granulations was measured by an alpha spectrometer (RAD7). Thus, time-dependent curves for radon concentrations were obtained. The highest radon emanation coefficient (27 %) was obtained for the siporex sample with the smallest grain size (0.34 mm). For the ceramic pads, the granulation effect was negligible and the emanation coefficient was very low (~0.4 %). The strongest influence of granulation on the radon emanation rate was found for the siporex brick sample.

Birnbaum, L.S., Jung, P.
From endocrine disruptors to nanomaterials: Advancing our understanding of environmental health to protect public health
(2011) Health Affairs, 30 (5), pp. 814-822.

Abstract
Environmental health science is the study of the impact of the environment on human health. This paper introduces basic topics in environmental health, including clean air, clean water, and healthful food, as well as a range of current issues and controversies in environmental health. Conceptual shifts in modern toxicology have changed the field. There is a new understanding of the effects of exposure to chemicals at low doses, and in combination, and the impact on human growth and development. Other emerging topics include the role of epigenetics, or changes in genes and gene expression that can be brought about by chemical exposure; environmental justice; and potential effects of engineered nanomaterials and climate change. We review the important implications for public health policy and recommend a broad environmental health research strategy aimed at protecting and improving human health. © 2011 Project HOPE-The People-to-People Health Foundation, Inc.

Blanco, A.C., Watanabe, A., Nadaoka, K., Motooka, S., Herrera, E.C., Yamamoto, T.
Estimation of nearshore groundwater discharge and its potential effects on a fringing coral reef
(2011) Marine Pollution Bulletin, 62 (4), pp. 770-785.

Abstract
Radon (222Rn) measurements were conducted in Shiraho Reef (Okinawa, Japan) to investigate nearshore submarine groundwater discharge (SGDnearshore) dynamics. Estimated average groundwater flux was 2-3cm/h (maximum 7-8cm/h). End-member radon concentration and gas transfer coefficient were identified as major factors influencing flux estimation accuracy. For the 7-km long reef, SGDnearshore was 0.39-0.58m3/s, less than 30% of Todoroki River's baseflow discharge. SGDnearshore was spatially and temporally variable, reflecting the strong influence of subsurface geology, tidal pumping, groundwater recharge, and hydraulic gradient. SGDnearshore elevated nearshore nitrate concentrations (0.8-2.2mg/l) to half of Todoroki River's baseflow NO3--N (2-4mg/L). This increased nearshore Chl-a from 0.5-2μg/l compared to the typically low Chl-a (<0.1-0.4μg/l) in the moat. Diatoms and cyanobacteria concentrations exhibited an increasing trend. However, the percentage contributions of diatoms and cyanobacteria significantly decreased and increased, respectively. SGD may significantly induce the proliferation of cyanobacteria in nearshore reef areas. © 2011 Elsevier Ltd.

Bočarov, V., Čermák, P., Mamedov, F., Štekl, I.
First tests of multipurpose spectrometer
(2011) Nuclear Instruments and Methods in Physics Research, Section A: Accelerators, Spectrometers, Detectors and Associated Equipment, 633 (SUPPL. 1), pp. S43-S44.

Abstract
A new standalone compact spectrometer has been developed. It is based on the digital signal processor, sampling ADC and contains other components needed for spectra processing (i.e. RAM, Flash/ROM, real time clock, power supply block). Spectrometer is connected with a PC via high-speed USB 2.0 bus. It is designed as a multipurpose device, which is planned to be used for many applications such as measurements of Rn activities, energy of detected particles by CdTe pixel detector or for coincidence measurements. Results of the first spectroscopic tests (with AmPuCm alpha source, measurements of Rn progenies) are presented.

Bochicchio, F.
The newest international trend about regulation of indoor radon
(2011) Radiation Protection Dosimetry, 146 (1-3), art. no. ncr093, pp. 2-5.

Abstract
On the basis of recent epidemiological findings, many international and national organisations have revised their recommendations and regulations on radon exposure in dwellings and workplaces, or are in the process to do it. In particular, new recommendations and regulations were recently published (or are going to be) by World Health Organization, Nordic Countries, International Commission on Radiological Protection, International, Atomic Energy Agency (and the other international organisations sponsoring the International Basic Safety Standards), European Commission. Although with some differences, these new documents recommend lower radon concentrations in indoor air, especially in dwellings, compared with previous ones. Moreover, preventive measures in all new buildings are more and more considered as one of the most cost-effective way to reduce the radon-related lung cancers, compared with previous approach restricting preventive measures in radon-prone areas only. A comprehensive national action plan, involving several national and local authorities, is generally considered a necessary tool to deal with the many complex actions needed to reduce the risk from radon exposure in an effective way.

Boice Jr., J.D.
Lauriston S. Taylor Lecture: Radiation epidemiology-the golden age and future challenges
(2011) Health Physics, 100 (1), pp. 59-76.

Abstract
Epidemiology is the study of the distribution and causes of disease in humans. Studies of human populations exposed to ionizing radiation have been conducted for nearly 100 y during the "Golden Age of Radiation Epidemiology." Radiation epidemiology is now so sophisticated that human studies are the basis for radiation protection standards and for compensation schemes in response to claims of ill health from prior exposures. The studies of exposed human populations are very broad and include not only the Japanese atomic bomb survivors, but also patients given radiotherapy for cancer, patients treated with radiation for nonmalignant disease, patients given diagnostic radiation, persons with intakes of radionuclides, workers exposed to occupational radiation, and communities exposed to environmental sources of radiation. But there is more to be learned, and future knowledge may be advanced from new and continued occupational studies of the early radiation workers, atomic veterans, medically exposed patients, and populations living in areas of high natural background radiation. The interaction between radiation and underlying genetic susceptibilities is an important emerging area of research. It is indeed an honor to be included among the Lauriston S. Taylor Lecturers. Health Phys. 100(1):59 -76; 2011 © 2010 Health Physics Society.

Bonotto, D.M.
Natural radionuclides in major aquifer systems of the Paraná sedimentary basin, Brazil (2011) Applied Radiation and Isotopes, 69 (10), pp. 1572-1584.

Abstract
This paper describes the natural radioactivity of groundwater occurring in sedimentary (Bauru and Guarani) and fractured rock (Serra Geral) aquifer systems in the Paraná sedimentary basin, South America that is extensively used for drinking purposes, among others. The measurements of gross alpha and gross beta radioactivity as well the activity concentration of the natural dissolved radionuclides 40K, 238U, 234U, 226Ra, 222Rn, 210Po and 210Pb were held in 80 tubular wells drilled in 21 municipalities located at São Paulo State and its border with Mato Grosso do Sul State in Brazil. Most of the gross alpha radioactivity data were below 1mBq/L, whereas values exceeding the gross beta radioactivity detection limit of 30mBq/L were found. The radioelement solubility in the studied systems varied according to the sequence radon>radium>other radionuclides and the higher porosity of sandstones relatively to basalts and diabases could justify the enhanced presence of dissolved radon in the porous aquifer. The implications of the data obtained in terms of standards established for defining the drinking water quality have also been discussed. The population-weighted average activity concentration for these radionuclides was compared to the guideline value of 0.1mSv/yr for the total effective dose and discussed in terms of the choice of the dose conversion factors. © 2011 Elsevier Ltd.

Borgoni, R.
A Quantile Regression Approach to Evaluate Factors Influencing Residential Indoor Radon Concentration
(2011) Environmental Modeling and Assessment, 16 (3), pp. 239-250.

Abstract
Indoor radon concentrations depend on building characteristics such as building materials, ventilation and water supply. In this paper, a quantile regression approach is proposed to evaluate the effect of some buildings factors potentially influencing indoor radon concentration. Many of the considered factors, such as soil connection, age of construction and being a single family building, are found to have a statistically significant effect; however, this is far from being constant across the entire support of indoor radon concentration. A potential impact due to geological and geo-physical reasons is also found using the altitude of building locations as a surrogate variable. In addition, a clear local spatial effect is detected by a spatial autoregression approach. © 2011 Springer Science+Business Media B.V.

Borgoni, R., Tritto, V., Bigliotto, C., de Bartolo, D.
A geostatistical approach to assess the spatial association between indoor radon concentration, geological features and building characteristics: The case of Lombardy, Northern Italy
(2011) International Journal of Environmental Research and Public Health, 8 (5), pp. 1420-1440.

Abstract
Radon is a natural gas known to be the main contributor to natural background radiation exposure and second to smoking, a major leading cause of lung cancer. The main source of radon is the soil, but the gas can enter buildings in many different ways and reach high indoor concentrations. Monitoring surveys have been promoted in many countries in order to assess the exposure of people to radon. In this paper, two complementary aspects are investigated. Firstly, we mapped indoor radon concentration in a large and inhomogeneous region using a geostatistical approach which borrows strength from the geologic nature of the soil. Secondly, knowing that geologic and anthropogenic factors, such as building characteristics, can foster the gas to flow into a building or protect against this, we evaluated these effects through a multiple regression model which takes into account the spatial correlation of the data. This allows us to rank different building typologies, identified by architectonic and geological characteristics, according to their proneness to radon. Our results suggest the opportunity to differentiate construction requirements in a large and inhomogeneous area, as the one considered in this paper, according to different places and provide a method to identify those dwellings which should be monitored more carefully. © 2011 by the authors.

Breysse, J., Jacobs, D.E., Weber, W., Dixon, S., Kawecki, C., Aceti, S., Lopez, J.
Health outcomes and green renovation of affordable housing
(2011) Public Health Reports, 126 (SUPPL. 1), pp. 64-75.

Abstract
Objective. This study sought to determine whether renovating low-income housing using "green" and healthy principles improved resident health and building performance. Methods. We investigated resident health and building performance outcomes at baseline and one year after the rehabilitation of low-income housing using Enterprise Green Communities green specifications, which improve ventilation; reduce moisture, mold, pests, and radon; and use sustainable building products and other healthy housing features. We assessed participant health via questionnaire, provided Healthy Homes training to all participants, and measured ventilation, carbon dioxide, and radon. Results. Adults reported statistically significant improvements in overall health, asthma, and non-asthma respiratory problems. Adults also reported that their children's overall health improved, with significant improvements in non-asthma respiratory problems. Post-renovation building performance testing indicated that the building envelope was tightened and local exhaust fans performed well. New mechanical ventilation was installed (compared with no ventilation previously), with fresh air being supplied at 70% of the American Society of Heating, Refrigerating, and Air-Conditioning Engineers standard. Radon was,2 picocuries per liter of air following mitigation, and the annual average indoor carbon dioxide level was 982 parts per million. Energy use was reduced by 45% over the one-year post-renovation period. Conclusions. We found significant health improvements following low-income housing renovation that complied with green standards. All green building standards should include health requirements. Collaboration of housing, public health, and environmental health professionals through integrated design holds promise for improved health, quality of life, building operation, and energy conservation.

Briestensky, M., Thinova, L., Stemberk, J., Rowberry, M.D.
The use of caves as observatories for recent geodynamic activity and radon gas concentrations in the western carpathians and bohemian massif
(2011) Radiation Protection Dosimetry, 145 (2-3), art. no. ncr080, pp. 166-172.

Abstract
In recent years, many underground spaces such as caves and deep mines have been used to monitor geodynamic activity in the Western Carpathians and Bohemian Massif. In addition, long-term radon gas monitoring has also being undertaken in three of the caves. The observed radon concentrations have shown diurnal, seasonal and yearly variations. A significant correlation with external temperature has been registered. This pattern is considered to result from the movement of air caused by the contrast between the broadly constant internal and fluctuating external temperatures. The same seasonal effects have been observed in the record of active fault displacements at sites close to the surface. These seasonal effects lead to peak-to-peak massif dilation amplitude that affects the

overall trend of fault displacement. It is also noted that a significant decrease in this amplitude occurs with increasing depth beneath the surface. However, high variability has also been observed in both the radon concentration and fault displacement activity recorded. Many events have been registered that link these two geofactors.

Brown, J.M.C., Solomon, S., Tinker, R.A.
Development of an energy discriminate CR-39® nuclear track etch dosimeter for Radon-220 gas measurements
(2011) Journal of Environmental Radioactivity, 102 (10), pp. 901-905.

Abstract
An energy discriminate CR-39® nuclear track etch dosimeter for use in a 220Rn and 222Rn gas monitor has been developed and experimentally assessed. It utilises a thin film of Mylar® C to attenuate the alpha particle energies to allow only the damage tracks created by the 8.785 MeV alpha particles emitted from 212Po of the 232Th decay chain to be registered in the CR-39® plaque, allowing for the direct measurement of 220Rn gas concentrations. The dosimeter was developed through a combination of experimental investigations and theoretical simulations using the Monte Carlo ion transport modelling program Stopping and Range of Ions in Materials (SRIM 2008). A film thickness of 54 μm has been shown to attenuate all alpha energies less then 7.7 MeV. © 2010.

Bucci, S., Pratesi, G., Viti, M.L., Pantani, M., Bochicchio, F., Venoso, G.
Radon in workplaces: First results of an extensive survey and comparison with radon in homes
(2011) Radiation Protection Dosimetry, 145 (2-3), art. no. ncr040, pp. 202-205.

Abstract
Extensive radon surveys have been carried out in many countries only in dwellings, whereas surveys in workplaces are rather sparse and generally restricted to specific workplaces/activities, e.g. schools, spas and caves. Moreover, radon-prone areas are generally defined on the basis of radon surveys in dwellings, while radon regulations use this concept to introduce specific requirements in workplaces in such areas. This approach does not take into account that work activities and workplace characteristics can significantly affect radon concentration. Therefore, an extensive survey on radon in different workplaces have been carried out in a large region of Italy (Tuscany), in order to evaluate radon distribution in workplaces over the whole territory and to identify activities and workplace characteristics affecting radon concentration. The results of this extensive survey are compared with the results of the survey carried out in dwellings in the same period. The workplaces monitored were randomly selected among the main work activities in the region, including both public and industrial buildings. The survey

monitored over 3500 rooms in more than 1200 buildings for two consecutive periods of ~6 months. Radon concentration was measured by means of passive nuclear track detectors.

Bučinský, L., Biskupič, S., Jayatilaka, D.
Picture change error correction in the radial distributions of canonical orbital densities and total electron density of radon atom: The effect of the size of nucleus and the basis set limit
(2011) Theoretical Chemistry Accounts, 129 (2), pp. 181-197.

Abstract
The 2nd order Douglas-Kroll-Hess (DKH2) and the Infinite Order Two Component (IOTC) radial distributions of electron density of canonical Hartree-Fock (HF) orbitals of radon atom are presented. Furthermore, the total electron density is revisited. The picture change error (PCE) correction is investigated by analytical means. The point charge model of nucleus and the Gaussian nucleus model are employed. The basis set is extrapolated by means of including tight s and also p Gaussians within the original triple zeta basis set. It is found that the DKH1 PCE corrected DKH2 total electron and s orbital contact densities are negative for the point charge model of nucleus if tight enough s Gaussians are included in the basis set. It is shown that this failure is caused due to the missing terms of the second order Douglas-Kroll transformation for the DKH2 electron density. PCE is found the most striking in the DKH2/IOTC electron density of s orbitals close to the nucleus. The radial distributions of the 2-component p1/2 orbital densities are considerably affected by PCE at the nucleus as well. Furthermore, the PCE corrected DKH2/IOTC scalar p orbital densities have a non-zero value of electron density at nucleus and can be considered as an spin-orbit (SO) average of the p1/2 and p3/2 orbitals. The d and f orbitals are affected by PCE in the vicinity of the nucleus only little. The PCE corrected DKH2 and IOTC radial distributions of orbital densities are nodeless, which is completely in agreement with the radial distribution of the analytic or numeric DCH orbital densities. © 2011 Springer-Verlag.

Burian, I., Otahal, P., Vosahlik, J., Pilecka, E.
Czech primary radon measurement equipment
(2011) Radiation Protection Dosimetry, 145 (2-3), art. no. ncr041, pp. 333-336.

Abstract
The Authorized Metrological Centre (AMS) working by SUJCHBO (National Institute for Nuclear, Chemical and Biological Protection) ensures for the Czech Republic the metrological traceability for devices that measure the radon concentration and the energy equivalent radon concentration connected with the radon decay products (RnDP). The evaluation and the calibration of measuring devices for radon and RnDP require the stable conditions (first of all radon and the RnDP concentrations). The new AMS radon-

aerosol chamber in Kamenná consists of the walk-in testing chamber with a volume of 10 m3 and of the handling box with a volume of 0.3 m3. The design of the chamber allows measurement and a control of environmental parameters such as the temperature, the pressure of air inside and outside of the chamber, the relative humidity of air, the concentration and the size distribution of aerosol particles and the air velocity.

Burke, Ó., Murphy, P.
Regional variation of seasonal correction factors for indoor radon levels
(2011) Radiation Measurements, 46 (10), pp. 1168-1172.

Abstract
Radon levels measured for any duration less than one year are subject to seasonal variation. Such radon measurements must therefore be adjusted using an appropriate seasonal correction factor in order to estimate an annual average radon level. Radon mapping has shown that radon concentrations vary between regions within a country but there has been little work examining regional variation in the seasonality of radon levels. This paper investigates this regional variation in indoor radon seasonality in Ireland. Mean regional seasonal correction factors are estimated through Fourier decomposition and we find that there is significant regional variation in the computed seasonal correction factors. We conclude that the use of one national set of mean seasonal correction factors may not be appropriate in all countries.

Burke, Ó., Murphy, P.
The use of volunteer radon measurements for radon mapping purposes: An examination of sampling bias issues
(2011) Journal of Radiological Protection, 31 (3), pp. 319-328.

Abstract
National and regional radon surveys are used in many nations to produce maps detailing the spatial variation of indoor radon concentrations. National surveys which are designed to be representative use either a geographically-weighted or a population-weighted sampling scheme. Additionally, many countries collect a large number of data on indoor radon concentrations from volunteers who have chosen to have the indoor radon concentration measured in their own dwellings. This work examines the representativeness of volunteer-based samples in radon measurement and explores the effect of potential volunteer bias on radon mapping results. We also investigate the influence that media attention has on volunteer sampling of indoor radon concentrations. The result of our work indicates that volunteer measurements are biased due to over-sampling of high radon areas. Consequently such volunteer radon measurements should not be used for radon mapping purposes.

Burnett, J.L., Croudace, I.W., Warwick, P.E.
Pre-concentration of short-lived radionuclides using manganese dioxide precipitation from surface waters
(2011) Journal of Radioanalytical and Nuclear Chemistry, pp. 1-4. Article in Press.

Abstract
Rapid determination of 222Rn and 220Rn progeny (214Pb, 212Pb, 214Bi, 212Bi) is achievable using manganese dioxide (MnO2) precipitation with analysis by γ-spectrometry. This is of interest to environmental monitoring programmes that utilise gross activity methods to screen for anthropogenic radionuclides. The contribution from these naturally occurring radionuclides (NOR) varies, and is difficult to experimentally measure due to short half-lives (t1/2 = 19.9 m-10.64 h) and low environmental activity (<0.1 Bq L-1). The extraction efficiency of the technique is above 90%, and above 80% for other nuclides (232Th, 238U, 235U, 228Ac, 226Ra, 224Ra, 210Pb, 54Mn). Short-lived NOR have been measured at two surface water locations, and indicates elevated 214Bi activity of 4.0 ± 1.1 Bq L-1. © 2011 Akadémiai Kiadó, Budapest, Hungary.

Călin, M.R., Simion, C.A., Simionca, G.I., Călin, M.A., Druker, A.E.
The characterization of the radioactivity in the cacica salt mine
(2011) Romanian Reports on Physics, 63 (2), pp. 483-502.

Abstract
This paper presents the radioactive characterization (alfa-beta, gamma, radon and tritium) of the Cacica salt mine located in the Suceava county for speleotherapeutycal and medical purposes and for balneary and climatic tourism. The measurements have been made in situ and on samples of salt and water taken from the interior of the mine. These measurements were made as a part of a complex study from a radioactive, medical and biological point of view for an inovative use of the factors found in salt mines and caves that have a therapeutical potential in healthcare and balneoclimateric tourism.

Cai, B., Boulay, M., Cleveland, B., Pollmann, T.
Surface backgrounds in the DEAP-3600 dark matter experiment
(2011) AIP Conference Proceedings, 1338, pp. 137-146.

Abstract
DEAP-3600 is a dark matter experiment using 3.6 tons of liquid argon to search for Weakly Interacting Massive Particles (WIMPs), with a target sensitivity to the spin-independent WIMP-nucleon cross-section of 10 -46 cm2. The detector is designed to

allow for a three year background-free run with a 1-ton fiducial volume. We identify in this paper the potential sources of surface contamination. We require 238U and 232Th contaminations on the order of 10-12 g/g or less, a level achieved by the SNO experiment, and 210Pb not significantly out of equilibrium with 238U, i.e., 10-20 g/g or less 210Pb in the acrylic vessel or TPB wavelength shifter, which should be achievable with appropriate control of exposure to radon.

Calin, M.R., Calin, M.A.
Investigations on the presence and distribution of radon in the Cacica salt mine, Romania
(2011) Journal of Radioanalytical and Nuclear Chemistry, 288 (1), pp. 203-206.

Abstract
An important parameter for evaluating the possibilities of use of enclosed spaces (mines, caves, spas, etc.) for therapeutic purposes is the concentration of radon in different conditions of ventilation. The aim of this paper is to present the results of continuous radon gas measurement that were performed for ten days, at 20 min time intervals in different locations from Cacica salt mine (Romania) using a portable radon monitor. The average radon concentration was found to be between 96.5 ± 4.76 Bq/m3 and 20.5 ± 1.30 Bq/m3. These values are suitable for therapeutic applications and are useful for future experiments regarding the development of the radon therapy and speleotherapy in this salt mine. © 2010 Akadémiai Kiadó, Budapest, Hungary.

Calin, M.R., Calin, M.A.
System for air 222Rn activity concentration measurements based on ion-pulse ionization chamber detector
(2011) Journal of Radioanalytical and Nuclear Chemistry, 288 (1), pp. 109-114.

Abstract
This article presents the development, the testing and the efficiency estimation of a system for the monitoring of the atmospheric concentration of radon using a detector ionization chamber type in pulse mode for environmental measurements in which the measurement of the average value of the ionization current is completed with the recording of the impulses of the ionization current caused by the alpha disintegrations from the sensible volume of the detector. © 2010 Akadémiai Kiadó, Budapest, Hungary.

Calmet, D., Ameon, R., Beck, T., Bombard, A., Bourquin, M.N., Brun, S., De Jong, P., Forte, M., Fournier, M., Herranz, M., Jerome, S., Klett, A., Kwakman, P., Llaurado, M., Loyen, J., Michel, R., Nardoux, P., Richards, T., Schuler, C., Tokonami, S., Woods, M.
International standardisation work on the measurement of radon in air and water
(2011) Radiation Protection Dosimetry, 145 (2-3), art. no. ncr077, pp. 267-272.

Abstract
Radon is considered to be the main source of human exposure to natural radiation. As stated by the World Health Organization, the exposure due to the inhalation of indoor radon is much greater than the one via the ingestion of water as radon degasses from water during handling. In response to these concerns about the universal presence of radon, environmental assessment studies are regularly commissioned to assess the radon exposure of public and workers. The credibility of such studies relies on the quality and reliability of radon analysis as well as on the sample representativeness of the radiological situation. The standard-setting approach, based on consensus, seemed to lend itself to a settlement of technical aspects of potential comparison. At present, two Working Groups of the International Standardization Organization are focussing on drafting standards on radon and its decay products measurement in air and water. These standards, which aim for a set of rigorous metrology practices, will be useful for persons in charge of the initial characterisation of a site with respect to natural radioactivity as well as to those performing the routine surveillance of specific sites.

Canbazoğlu, C., Doğru, M., Çelebi, N., Kopuz, G.
Assessment of natural radioactivity in Elazi{dotless}ğ region, eastern Turkey
(2011) Journal of Radioanalytical and Nuclear Chemistry, pp. 1-6. Article in Press.

Abstract
In this study, the background radiation level of Elazi{dotless}ğ region was determined. Indoor radon measurements were made with CR-39 track detectors and a total of 208 houses were screened. Average radon concentration was 98 Bq/m3 and effective dose value was 2.48 mSv/year. Gamma radiation in air was measured with a plastic scintillator at 214 points. Average indoor and outdoor absorbed dose values were 105.8 and 85.4 nGy/h, respectively. Radioactivity levels of water and soil samples were calculated with gross alpha and gross beta methods. Average gross alpha and gross beta radioactivity concentrations were calculated, respectively, as 0.091 and 0.037 Bq/L for drinking waters and as 289.7 and 143.2 Bq/kg for surface soil.

Caresana, M., Ferrarini, M., Garlati, L., Parravicini, A.
Further studies on ageing and fading of CR39 PADC track detectors used as air radon concentration measurement devices
(2011) Radiation Measurements, 46 (10), pp. 1160-1167.

Abstract
PADC detectors are commonly used both as radon detectors and as personal dosemeters for neutron radiation. In both cases the measurement in workplace fields are

characterized by long term irradiations, lasting up to several months. During this period the detectors undergo to uncontrolled and unmonitored environmental conditions. In a recent work the same authors demonstrated that the environmental conditions, mainly temperature, can seriously affect the detector sensitivity. The temperature effect is to reduce the V ratio by decreasing the track etching velocity Vt. This causes a decrease in limit angle and efficiency. This paper describes the same ageing/fading test made with CR39 from a different supplier. In this case it seems that the temperature has a negligible effect, so no compensation algorithm is needed.

Carpentieri, C., Zunic, Z.S., Carelli, V., Cordedda, C., Ferrigno, G., Veselinovic, N., Bossew, P., Tollefsen, T., Cuknic, O., Vojinovic, Z., Bochicchio, F.
Assessment of long-term radon concentration measurement precision in field conditions (serbian schools) for a survey carried out by an international collaboration
(2011) Radiation Protection Dosimetry, 145 (2-3), art. no. ncr042, pp. 305-311.

Abstract
In an international collaboration, a long-term radon concentration survey was carried out in schools of Southern Serbia with, radon detectors prepared, etched and read-out in Italy. In such surveys it is necessary to evaluate measurement precision in field conditions, and to check whether quality assurance protocols were effective in keeping uncertainties under control, despite the complex organisation of measurements. In the first stage of the survey, which involves only some of the total number of municipalities, paired detectors were exposed in each monitored room in order to experimentally assess measurement precision. Paired passive devices (containing CR-39 detectors) were exposed for two consecutive 6-month periods. Two different measurement systems were used to read out CR-39s of the first and second period, respectively. The median of the coefficient of variation (CV) of the measured exposures was 8 % for 232 paired devices of the first 6-month period and 4 % for 242 paired devices of the second 6-month period, respectively. This difference was mainly due to a different track count repeatability of the two read-out systems, which was 4 and 1 %, respectively, as the median value of CVof repeated countings. The in-field measured precision results are very similar to the precision assessed in calibration conditions and are much lower than the room-to-room variation of radon concentration in the monitored schools. Moreover, a quality assurance protocol was followed to reduce extra-exposures during detector transport from Rome to schools measured and back.

Cartwright, I., Hofmann, H., Sirianos, M.A., Weaver, T.R., Simmons, C.T.
Geochemical and 222Rn constraints on baseflow to the Murray River, Australia, and timescales for the decay of low-salinity groundwater lenses
(2011) Journal of Hydrology, 405 (3-4), pp. 333-343.

Abstract
The distribution of 222Rn activities and major ion concentrations show that during low river flows characteristic of the recent drought conditions, the middle reaches of the Murray River, northern Victoria, were a predominantly gaining system at low river levels (May 2009, May 2010), and were variably gaining and losing at higher river levels (November 2009). The location of gaining and losing reaches are partially governed by the position of the river with respect to the edge of its floodplain; gaining reaches occur where the floodplain narrows or where the river is adjacent to the steep slopes at the floodplain margin. Cumulative inflows along this □350km stretch of the river estimated from 222Rn activities were 320-1500m3/day in November 2009 and 560-4300m3/day in May 2010. The relatively large uncertainty reflects the heterogeneous and poorly-constrained groundwater 222Rn activities. Major ion variations (notably Cl concentrations and Na/Ca ratios) correlate with 222Rn activities and may be used as indicators of groundwater inflows. Baseflow contributed <1% of the total water to this part of the river, and consequently has little impact on river water quality. Nevertheless the groundwater inflows remove water from low-salinity groundwater lenses that underlie the river and during the drought conditions these lenses were degrading. These reaches of the River Murray are an example of a system that transitioned from being dominantly losing to being variably gaining due to diminishing surface water flows. © 2011 Elsevier B.V.

Casanovas, R., Morant, J.J., López, M., Hernández-Girón, I., Batalla, E., Salvadó, M.
Performance of data acceptance criteria over 50 months from an automatic real-time environmental radiation surveillance network
(2011) Journal of Environmental Radioactivity, 102 (8), pp. 742-748.

Abstract
The automatic real-time environmental radiation surveillance network of Catalonia (Spain) comprises two subnetworks; one with 9 aerosol monitors and the other with 8 Geiger monitors together with 2 water monitors located in the Ebre river. Since September 2006, several improvements were implemented in order to get better quality and quantity of data, allowing a more accurate data analysis. However, several causes (natural causes, equipment failure, artificial external causes and incidents in nuclear power plants) may produce radiological measured values mismatched with the own station background, whether spurious without significance or true radiological values. Thus, data analysis for a 50-month period was made and allowed to establish an easily implementable statistical criterion to find those values that require special attention. This criterion proved a very useful tool for creating a properly debugged database and to give a quick response to equipment failures or possible radiological incidents. This paper presents the results obtained from the criterion application, including the figures for the expected, raw and debugged data, percentages of missing data grouped by causes and radiological measurements from the networks. Finally, based on the discussed

information, recommendations for the improvement of the network are identified to obtain better radiological information and analysis capabilities. © 2011 Elsevier Ltd.

Cases, R., Ros, E., Zúñiga, J.
Measuring radon concentration in air using a diffusion cloud chamber
(2011) American Journal of Physics, 79 (9), pp. 903-908.

Abstract
Radon concentration in air is a major concern in lung cancer studies. A traditional technique used to measure radon abundance is the charcoal canister method. We propose a novel technique using a diffusion cloud chamber. This technique is simpler and can easily be used for physics demonstrations for high school and university students. © 2011 American Association of Physics Teachers.

Catalano, R., Immè, G., Mangano, G., Morelli, D., Tazzer, A.R.
Indoor radon survey in Eastern Sicily
Radiation Measurements, . Article in Press.

Abstract
Inhalation of radon (Rn-222) and its progeny is one of the most significant sources of natural radiation exposure of the population. Nowadays, high radon exposures have been shown to cause lung cancer and many governments all over the world have therefore recommended that radon exposures in dwellings and indoor workplaces should be limited. Radon levels in buildings vary widely from area to area depending on local geology. This paper presents the results of a long-term survey of radon concentrations carried out from 2005 till 2010 in schools and dwellings of Eastern Sicily, using the solid-state nuclear track detector (SSNTD) technique. The investigated area shows medium-high indoor radon concentrations, higher than the Italian average of about 70 Bq/m3, with peaks of 500 Bq/m3 or more in buildings near active faults. Fortunately, only a small fraction of the measurements, about 1.5% of total, was found greater than EU and Italian action limits for indoor and workplaces. © 2011 Elsevier Ltd. All rights reserved.

Catherine, K.
Addressing environmental contaminants in pediatric practice
(2011) Pediatrics in Review, 32 (5), pp. 190-200.

Abstract
• Pediatricians are a trusted, desired, and important source of information on

environmental health topics. (8)(15) • It is well established that children are more vulnerable to environmental contaminants due to their rapid and ongoing growth and development and potential for higher exposures based on behavioral and physiologic differences. (16) • Evidence and consensus highlight the importance of the environmental history in identifying and reducing children's exposure to hazardous contaminants. (11)(16) • There is sufficient evidence that lead exposure is common among United States children and that concentrations below the current action level (BLL ≥10 µg/dL [0.48 µmol/L]) are associated with adverse effects on neurodevelopment and behavior. (1)(2)(3) • A joint federal advisory from the FDA and the EPA recommends reducing exposure to mercury by highlighting the importance of selecting fish that contain lower concentrations of methylmercury. (7) • Multiple studies identify risks in the indoor environment that reflect housing quality, choice of building sites, and exposures that include lead from paint or water, asbestos, radon, particulate matter, mold, pesticide use patterns, and carbon monoxide. (2)(3)(11)(13)(16).

Cevik, U., Kara, A., Celik, N., Karabidak, M., Celik, A.
Radon survey and exposure assessment in Karaca and Çal caves, Turkey
(2011) Water, Air, and Soil Pollution, 214 (1-4), pp. 461-469.

Abstract
Radon concentration and gamma activity concentration of naturally occurring radionuclides were determined and presented for two tourist caves (Karaca and Çal caves) in this study. These caves are reported to receive about 77,000 visitors during the summer season in 2007. It was seen that mean radon activity concentrations for the winter and summer seasons for the Karaca cave is 1,023 and 823 Bq/m3 and for the Çal cave is 264 and 473 Bq/m3. Mean 226Ra, 232Th, and 40K activity concentrations are found to be 43, 19, and 262 Bq/kg for the Karaca cave and 31, 27, and 460 Bq/kg for the Çal cave. Doses received by the cave guides due to radon were estimated to be 2.9 mSv/year for the winter season and 2.3 mSv/year for the summer season for the Karaca cave. Same values were estimated for the Çal cave, and the results were found to be 0.6 mSv/year for the winter season and 1.1 mSv/year for the summer season. Annual effective doses received by the visitors in both caves were estimated to be in the order of µSv/year because of the short exposure time comparing the cave guides. Although the reported values are below the recommended values, both groups are exposed to possible radiological risk during their stay inside the cave, since prolonged exposure to high radon concentration has been linked to lung cancer. © 2010 Springer Science+Business Media B.V.

Chahine, T., Schultz, B.D., Zartarian, V.G., Xue, J., Subramanian, S.V., Levy, J.I.
Modeling joint exposures and health outcomes for cumulative risk assessment: The case of radon and smoking

(2011) International Journal of Environmental Research and Public Health, 8 (9), pp. 3688-3711.

Abstract
Community-based cumulative risk assessment requires characterization of exposures to multiple chemical and non-chemical stressors, with consideration of how the non-chemical stressors may influence risks from chemical stressors. Residential radon provides an interesting case example, given its large attributable risk, effect modification due to smoking, and significant variability in radon concentrations and smoking patterns. In spite of this fact, no study to date has estimated geographic and sociodemographic patterns of both radon and smoking in a manner that would allow for inclusion of radon in community-based cumulative risk assessment. In this study, we apply multi-level regression models to explain variability in radon based on housing characteristics and geological variables, and construct a regression model predicting housing characteristics using U.S. Census data. Multi-level regression models of smoking based on predictors common to the housing model allow us to link the exposures. We estimate county-average lifetime lung cancer risks from radon ranging from 0.15 to 1.8 in 100, with high-risk clusters in areas and for subpopulations with high predicted radon and smoking rates. Ourfindings demonstrate the viability of screening-level assessment to characterize patterns of lung cancer risk from radon, with an approach that can be generalized to multiple chemical and non-chemical stressors.

Chambers, D.B., Stager, R.H.
Prediction of the variation in risks from exposure to radon at home or at work
(2011) Radiation Protection Dosimetry, 146 (1-3), art. no. ncr101, pp. 34-37.

Abstract
On the basis of a review of recent epidemiology, the ICRP recently issued a statement outlining a new approach to radon. The ICRP indicates that the Publication 65 dose conversion convention will be replaced using the dosimetric approach currently used for other radionuclides. Moreover, the ICRP indicates that the dose conversion factor is expected to increase by about a factor of 2. This paper independently examines the risks associated with exposure to radon and decay products through estimation of lifetime excess absolute risks per WLM for a variety of epidemiological risk projection models and baseline cancer and mortality rates. This paper suggests that current ICRP dosimetric models do not reflect the effect of smoking and suggest that basic risk estimates and dose conversion factors be based on risks to non-smoking populations with recognition that lifestyle choices, especially smoking, have a large effect on the risk from exposure to radon.

Chambers, S., Williams, A.G., Zahorowski, W., Griffiths, A., Crawford, J.
Separating remote fetch and local mixing influences on vertical radon measurements in the lower atmosphere
(2011) Tellus, Series B: Chemical and Physical Meteorology, 63 (5), pp. 843-859.

Abstract
Two-point radon gradients provide a direct, unambiguous measure of near-surface atmospheric mixing. A 31-month data set of hourly radon measurements at 2 and 50 m is used to characterize the seasonality and diurnal variability of radon concentrations and gradients at a site near Sydney. Vertical differencing allows separation of remote (fetch-related) effects on measured radon concentrations from those due to diurnal variations in the strength and extent of vertical mixing. Diurnal composites, grouped according to the maximum nocturnal radon gradient (ΔCmax), reveal strong connections between radon, wind, temperature and mixing depth on subdiurnal timescales. Comparison of the bulk Richardson Number (RiB) and the turbulence kinetic energy (TKE) with the radon-derived bulk diffusivity (KB) helps to elucidate the relationship between thermal stability, turbulence intensity and the resultant mixing. On nights with largeΔCmax,KB and TKE levels are low andRiB is well above the 'critical' value. Conversely, whenΔCmax is small,KB and TKE levels are high andRiB is near zero. For intermediateΔCmax, however,RiB remains small whereas TKE andKB both indicate significantly reduced mixing. The relationship between stability and turbulence is therefore non-linear, with even mildly stable conditions being sufficient to suppress mixing. © 2011 The Authors Tellus B © 2011 John Wiley & Sons A/S.

Charpak, G., Benaben, P., Breuil, P., Martinengo, P., Nappi, E., Peskov, V.
Results from prototypes of environmental and health alarm devices based on gaseous detectors operating in air in counting mode
(2011) Nuclear Instruments and Methods in Physics Research, Section A: Accelerators, Spectrometers, Detectors and Associated Equipment, 628 (1), pp. 187-189.

Abstract
We have developed and successfully tested two prototypes of detectors of dangerous gases based on wire-type counters operating in air in avalanche mode: one is for radon (Rn) detection whereas the other one is for the detection of gases with an ionization potential less than the air components. Due to the operation in pulse counting mode these prototypes have sensitivities comparable to (in the case of the Rn detector) or much higher than (in the case of the detector for low ionization gases) the best commercial devices currently available on the market. We believe that due to their high sensitivity, simplicity and low cost such new detectors will find massive applications. One of them, discussed in this paper, could be the on-line monitoring of Rn for the prediction of earthquakes.

Chauhan, R.P.
Radon exhalation rates from stone and soil samples of Aravali hills in India
(2011) Iranian Journal of Radiation Research, 9 (1), pp. 57-61.

Abstract
Background: The most popular building materials are soil bricks and different types of stones. Radon is released into ambient air from soil and stones due to ubiquitous uranium and radium in them, thus increasing the airborne radon concentration. The radioactivity in soils is related to radioactivity in the rocks from which the soil is formed. In the present investigation, the radon emanated from soil and stone samples collected from different locations of Aravali range of hills in the Haryana state of Northern India has been estimated. Materials and Methods: For the measurement of radon concentration emanated from these samples, alpha-sensitive LR-115 type II plastic track detectors have been used. The alpha particles emitted from the radon form tracks in these detectors. After chemical etching the track density of registered tracks is used to calculate radon concentration and exhalation rates of radon using required formulae. Results: The radon concentration in stone samples collected from Aravali range of hills varied from 729 Bq m-3 to 1958 Bq m-3 with an average of 1440 ± 134 Bq m-3 whereas it varied from 806 Bq m-3 to 1325 Bq m-3 with an average of 1040 ± 101 Bq m-3 in case of soil samples. Based upon the data, the mass and the surface exhalation rates of radon emanated from them have also been calculated. Conclusion: The measurements indicate normal to some higher levels of radon concentration emanated from the samples collected from Aravali range of hills of north India.

Chen, J., Ford, K., Whyte, J., Bush, K., Moir, D., Cornett, J.
Achievements and current activities of the Canadian radon program
(2011) Radiation Protection Dosimetry, 146 (1-3), art. no. ncr096, pp. 14-18.

Abstract
Based on new scientific information and broad public consultation, the Government of Canada updated the guideline for exposure to indoor radon and launched a multi-year radon program in 2007. Major achievements accomplished in the past 3 y and current activities underway are highlighted here. © Crown 2011.

Chen, J., Moir, D., Sorimachi, A., Tokonami, S.
Characteristics of thoron and thoron progeny in Canadian homes
(2011) Radiation and Environmental Biophysics, 50 (1), pp. 85-89.

Abstract
Naturally occurring isotopes of radon in indoor air are identified as the second leading cause of lung cancer after tobacco smoking. Radon-222 (radon gas) and radon-220 (thoron gas) are the most common isotopes of radon. While the radon equilibrium factor

is well established, the equilibrium factor between thoron progeny and thoron gas is still not well known. Thoron gas and progeny concentrations were determined in the lowest floors of 138 Canadian homes simultaneously. While thoron gas was only detectable in about 52% of the homes, thoron progeny concentrations were measured in every home surveyed. Thoron concentrations, thoron progeny concentrations, and the equilibrium factors varied widely and were log-normally distributed. With a 3 months simultaneous measurement of thoron and thoron progeny concentrations, the equilibrium factor was determined to be 0.024 with a geometric standard deviation of 2.7.

Chen, Y., Kuo, T., Fan, K., Liang, H., Tsai, C., Chiang, C., Su, C.
Radon measurements at IC-09 well of Chingshui geothermal field (Taiwan): A case study
(2011) Radiation Measurements, 46 (2), pp. 270-276.

Abstract
Radon concentration was monitored during the flow tests of well IC-09 at the Chingshui geothermal field. The radon concentration was found to increase from 54 ± 29 to 983 ± 65 Bq/m3 as a step function of production time, or cumulative production. The observed radon behavior can be explained by a radial composite model with the carbonate scales deposited in the skin zone near the well. The radius of skin zone near well IC-09 can be estimated with radon data at about 20 m using a plug flow model. Monitoring natural radon during the well flow tests is a helpful tracer to diagnose the formation damage near the well.

Cheng, W., Guan, Z., Su, Q., Ruan, X., Zhang, Z.
Precursory anomalies in Sichuan region before 2008 Wenchuan M s8.0 earthquake and their statistical analysis
(2011) Acta Seismologica Sinica, 33 (3), pp. 304-318.

Abstract
Various observation anomalies in Sichuan region before the 12 May 2008 Wenchuan Ms8.0 earthquake were studied. The abnormal items against all of observation items (or observation stations, measuring platforms, sites, well points, spring points) are the ratio of abnormal items (points), following are similar. On the mobile short leveling, the site and item ratios of existing medium to long-term trend anomalies are 0.28 and 0.20 respectively. On the mobile short baseline, the site and item ratios of existing medium-term trend anomalies are 0.13 and 0.13 respectively. On the ground tilt measurement, the station ratio of medium-term trend anomalies is 0.17, the abnormal item ratio is 0.13. On the groundwater level observation, the well point ratio of medium-term trend anomalies is 0.20. On the hot spring observation, the spring point ratio of short-term anomalies is 0.15. On the hot spring water-gas radon observation, the station and point ratio of short-

term anomalies is 0.08, the abnormal item ratio is 0.04. On the well water quality component observation, the station and point ratio of short-term anomalies is 0.02, the abnormal item ratio is 0.04. On the apparent resistivity, the station and items ratios of medium-term anomalies are 0.17 and 0.06 respectively. There have various observation means in the same station or site, we calculate the station or site number. There are 172 various stations or sites in Sichuan area before the Wenchuan Ms8.0 earthquake, and abnormal stations or sites ratio is 0.14, the site ratios of appearing mediumterm and short-term anomalies are 0.08 and 0.03 respectively. The total of various observation items are 335, the ratio of abnormal items is 0.09. The ratios of medium-term and short-term abnormal items are 0.06 and 0.01 respectively. It is clear that there are not obvious anomalies recorded by station or observation items before the earthquake. As for other observation means and data of observation items which are not involved in this paper, after researching, there have no abnormal items.

Choubey, V.M., Arora, B.R., Barbosa, S.M., Kumar, N., Kamra, L.
Seasonal and daily variation of radon at 10m depth in borehole, Garhwal Lesser Himalaya, India
(2011) Applied Radiation and Isotopes, 69 (7), pp. 1070-1078.

Abstract
Mostly accepted and widely reported radon (Rn222) measurements, a tool for earthquake precursor research, is a part of multi-parametric geophysical observation in the Garhwal Lesser Himalaya for earthquake related studies. Radon is being recorded continuously at an interval of 15min at 10m depth in a 68m deep borehole. Three years high resolution 15min data at 10m depth shows a complex trend and has a strong seasonal effect along with some diurnal, semi-diurnal and multi-day recurring trends. A well-defined seasonal pattern is prominent with a high emanation in summer and low values in winter accounting for about a 30% decrease in count values in winter when the atmospheric temperature is very low at this station located 1.90km above mean sea level. Diurnal, semi-diurnal and multi-day trends in this time-series are mainly observed during April-May and October-November. This is the period of spring and autumn when there is a high contrast in day-night atmospheric temperature. Hence the high fluctuation in Rn concentration is mainly caused by the temperature contrast between the air-column inside the borehole and the atmosphere above the earth's surface. © 2011 Elsevier Ltd.

Chun, S., Yoon, B.-R., Lee, K.-B.
Diagnostic flow metering using ultrasound tomography
(2011) Journal of Mechanical Science and Technology, 25 (6), pp. 1475-1482.

Abstract
For an accurate flow metering without considering the influences of flow control devices such as valves and elbows in closed conduits, velocity distribution in the cross-sectional

area must be integrated. However, most flow meters, including multi-path ultrasonic, electromagnetic or Coriolis mass flow meters, require assumptions on the fully-developed turbulent flows to calculate flow rates from physical quantities of their own concern. Therefore, a long straight pipe has been a necessary element for accurate flow metering because the straight pipe can reduce flow disturbances caused by flow control devices. To reduce costs due to the installation of long straight pipes, another flow metering technique is required. For example, flow rates can be estimated by integrating velocity distributions in the crosssection of conduits. In the present study, ultrasound tomography was used to find the velocity distribution in the cross-section of a closed conduit where flow was disturbed by a Coriolis mass flow meter or a butterfly valve. A commercial multi-path ultrasonic flow meter was installed in the pipeline to measure the line-averaged velocity distribution in the pipe flow. The ultrasonic flow meter was rotated 180° at intervals of 10° to construct line-averaged velocity distributions in Radon space. Flow images were reconstructed by using a backprojection algorithm (inverse Radon transform). Flow diagnostic parameters were defined by calculating statistical moments, i. e., average, standard deviation, skewness, and kurtosis, based on the normalized velocity distribution. The flow diagnostic parameters were applied to flow images to find whether the parameters could discern flow disturbances in the reconstructed velocity distribution.

Cinelli, G., Tondeur, F., Dehandschutter, B.
Development of an indoor radon risk map of the Walloon region of Belgium, integrating geological information
(2011) Environmental Earth Sciences, 62 (4), pp. 809-819.

Abstract
A radon risk map for the Walloon region of Belgium, based on the two databases available, has been calculated and is presented in this work. The data are organized into geological units. For each unit, an average logarithmic standard deviation is calculated, after correcting the higher variability of short term data. The region is divided with an 1-km grid. For each node, the local geological unit is determined, as well as the corresponding logarithmic standard deviation. The logarithmic mean is evaluated by smoothing the data belonging to the same geological unit as the node. Assuming a log-normal distribution, a map that shows for each node the predicted percentage of buildings with an indoor radon concentration above the Action level (400 Bq/m3) is constructed. This is the first radon risk map for this region that fully takes into account the geological information. © 2010 Springer-Verlag.

Clark, M.
[Get out, radon!]. [Dehors, le radon!]

(2011) Perspective infirmière : revue officielle de l'Ordre des infirmières et infirmiers du Québec, 8 (2), p. 10.

Clouvas, A., Xanthos, S., Takoudis, G.
Indoor radon levels in Greek schools
(2011) Journal of Environmental Radioactivity, 102 (9), pp. 881-885.

Abstract
Radon and gamma dose rate measurements were performed in 512 schools in 8 of the 13 regions of Greece. The distribution of radon concentration was well described by a lognormal distribution. Most (86%) of the radon concentrations were between 60 and 250 Bq m-3 with a most probable value of 135 Bq m-3. The arithmetic and geometric means of the radon concentration are 149 Bq m-3 and 126 Bq m-3 respectively. The maximum measured radon gas concentration was 958 Bq m-3. As expected, no correlation between radon gas concentration and indoor gamma dose rate was observed. However, if only mean values for each region are considered, a linear correlation between radon gas concentration and gamma dose rate is apparent. Despite the fact that the results of radon concentration in schools cannot be applied directly for the estimation of radon concentration in homes, the results of the present survey indicate that it is desirable to perform an extended survey of indoor radon in homes for at least one region in Northern Greece.

Compagno, A., Parlato, A., Rizzo, S., Tomarchio, E.
A chamber to test the response of radon detectors to changing environmental conditions
(2011) Radiation Protection Dosimetry, 145 (2-3), art. no. ncr073, pp. 312-315.

Abstract
Radon risk assessment is carried out by means of accurate measurements with active or passive instrumentation. All radon detectors must be calibrated and tested using a radon chamber containing a known concentration of radon produced by specific sources of 226Ra. Some chambers can also be used to test the response of detectors as a function of environmental conditions. In this case, a calibration curve can be inferred with respect to change in one of the considered parameters. For this aim, a new radon chamber was designed and realised to perform calibration and to study the detector response in a large range of variation of the environmental parameters (pressure, 700-1100 mbar; temperature, 5-508C; humidity, 10-90 %). The first experiments conducted to study the influence of environmental parameters on the detector response have shown flexibility and ease of use of the chamber.

Cooper, A.
Letter to the Editor
(2011) Journal of Environmental Radioactivity, 102 (4), p. 412.

Cooper, A.
Temperature calibration formula for activated charcoal radon collectors.
(2011) Journal of environmental radioactivity, 102 (4), p. 412.

Cooper, A., Le, T.N., Iimoto, T., Kosako, T.
Temperature calibration formula for activated charcoal radon collectors
(2011) Journal of Environmental Radioactivity, 102 (1), pp. 60-63.

Abstract
Radon adsorption by activated charcoal collectors such as PicoRad radon detectors is known to be largely affected by temperature and relative humidity. Quantitative models are, however, still needed for accurate radon estimation in a variable environment. Here we introduce a temperature calibration formula based on the gas adsorption theory to evaluate the radon concentration in air from the average temperature, collection time, and liquid scintillation count rate. On the basis of calibration experiments done by using the 25 m3 radon chamber available at the National Institute of Radiological Sciences in Japan, we found that the radon adsorption efficiency may vary up to a factor of two for temperatures typical of indoor conditions. We expect our results to be useful for establishing standardized protocols for optimized radon assessment in dwellings and workplaces.

Crockett, R.G.M., Holt, C.P.
Standardised Radon Index (SRI): A normalisation of radon data-sets in terms of standard normal variables
(2011) Natural Hazards and Earth System Science, 11 (7), pp. 1839-1844.

Abstract
During the second half of 2002, from late June to mid December, the University of Northampton Radon Research Group operated two continuous hourly-sampling radon detectors 2.25 km apart in the English East Midlands. This period included the Dudley earthquake (ML = 5, 22 September 2002) and also a smaller earthquake in the English Channel (ML = 3, 26 August 2002). Rolling/sliding windowed cross-correlation of the paired radon time-series revealed periods of simultaneous similar radon anomalies which occurred at the time of these earthquakes but at no other times during the overall radon monitoring period. Standardising the radon data in terms of probability of magnitude, analogous to the Standardised Precipitation Indices (SPIs) used in drought modelling,

which effectively equalises different non-linear responses, reveals that the dissimilar relative magnitudes of the anomalies are in fact closely equiprobabilistic. Such methods could help in identifying anomalous signals in radon - and other - time-series and in evaluating their statistical significance in terms of earthquake precursory behaviour. © 2011 Author(s).

Cuculeanu, V., Simion, F., Simion, E., Geicu, A.
Dynamics, deterministic nature and correlations of outdoor 222Rn and 220Rn progeny concentrations measured at Bacâu, Romania
(2011) Journal of Environmental Radioactivity, 102 (7), pp. 703-712.

Abstract
The long-term variation, nature and correlations of outdoor 222Rn and 220Rn progeny concentrations measured during the period 1994-2009 were investigated. The time series of data were obtained within the framework of the monitoring program performed by the Environmental Radioactivity Monitoring Station (ERMS) Bacâu, a component part of the National Environmental Radioactivity Survey Network (NERSN), coordinated by National Environmental Protection Agency (NEPA). The measuring method is based on the total beta measurements of atmospheric aerosol filters, using a low background total beta counter and (90Sr/Y) reference standard. Analysis of the time series of progeny concentrations in the low atmosphere makes evident different patterns of variation of these concentrations: diurnal, seasonal and annual. A possible relationship of progeny concentration increase with global warming is emphasized. In order to find the dominant frequency of the physical processes determining progeny concentration variability the power spectrum has been used. The deterministic nature of the time series of concentrations has been studied making use of the autocorrelation function and stationarity of the original data and of their phase randomized time series. Also, the correlations with meteorological parameters have been investigated using Pearson's correlation coefficient with corresponding level of significance. © 2011 Elsevier Ltd.

Cui, Z., Wang, L., Zheng, Y., Liu, Y., Yuan, H., Lu, L.
Distribution and characteristics of environmental radioactivity from typical natural mining sites in Chongqing, China
(2011) Research Journal of Chemistry and Environment, 15 (2), pp. 690-695.

Abstract
Chongqing city is rich of various unique mineral resources. Accompanying the useful minerals in the ores, a large number of natural radioactive elements exceed national standards. 20 typical mining areas, scattering in 11 districts of Chongqing Municipality, were taken as the survey objectives. The environmental radioactivities of Rn-222 in air and Ray-226, Th-232 and K-40 in soil around mining sites were measured and analyzed and the correlation between radioactive elements and their respective radioactivities were

investigated. The radioactivity of the radioactive elements was analyzed by comparing to the environment reference points, and the irradiation doses of Rn-222 to the public population around the mining areas were predicted as well. The results show that the environmental radioactivities of Rn-222 ranged from 8.29 to 617 Bq.m -3 and averaged at 83.55 Bq m-, much higher than the average value of the reference points 9.51 Bq/m-3. The specific activities of Ra-226 lay in the ranged from 4.08-758.29 Bq/kg and averaged at 81.25Bq/kg. Although the mean value of the specific activities of Ra-226 in the mining sites exceeded that of the reference points, 35.17Bq/kg, it was a few sites with apparently high radioactivity that contributed much to the high average value of the mining sites. In terms of Th-232, the specific activities of Th-232 in the mining sites averaged at 30.1 Bq/kg, which was lower than that of the reference points, 46.96Bq/kg. Similarly to Ra-226, environmental radioactivities of Th-232 in a few mining sites were apparently higher than those of the other mining sites. As to K-40, the specific activities in all the sampled sites were lower than the mean value of reference points, 686.80Bq/kg. And radioactivity of K-40 in soil around mining sites poses a relatively low environmental hazard to the public population. Therefore, much attention is required for the control of higher environmental radioactivity caused by Rn-222 in air, and Ray- 226 and Th-232 in soil around the mining sites in Chongqing.

Czarwinski, R., Crick, M.J.
Occupational exposures worldwide and revision of international standards for protection (2011) Radiation Protection Dosimetry, 144 (1-4), art. no. ncq449, pp. 2-11.

Abstract
United Nations Scientific Committee on the Effects of Atomic Radiation (UNSCEAR) has become the world authority on the levels and effects of ionising radiation. Since 1975, UNSCEAR has evaluated inter alia the level of occupational exposure worldwide. Based on revised questionnaires, more detailed information is now available. The results of the last evaluation (1995-2002) will be shown in the paper. Lessons learned from the responses by UN Member States will be given, as well as an outline of plans for data collection in future cycles. The requirements for protection against exposure to ionising radiation of workers, the public and patients are established in the International Basic Safety Standards for Protection against Ionising Radiation and for the Safety of Radiation Sources (BSS), published in 1996. As a result of a review of the BSS in 2006, the International Atomic Energy Agency (IAEA) started a process for the revision of these standards in 2007. International organisations including the joint sponsoring organisations of the BSS-IAEA, FAO, ILO, OECD/NEA, PAHO and WHO-as well as potential new joint sponsoring organisations of the revised BSS-the European Commission and UNEP-were involved from the beginning in the revision process. The paper also provides a summary of the status of the Draft Revised BSS and describes the new format. The paper focuses, in particular, on requirements for the protection of workers as well as recordkeeping requirements, which provide the legal basis for the collection of specific data; these data are of the type that can be used by UNSCEAR.

Da Silva, A.A.R., Valladares, D.L., Anjos, R.M., Velasco, H., Rizzotto, M., Yoshimura, E.M.
Assessment the health hazard from 222Rn in old metalliferous mines in San Luis, Argentina
(2011) Water, Air, and Soil Pollution, 218 (1-4), pp. 371-386.

Abstract
Radon levels in two old mines in San Luis, Argentina, are reported and analyzed. The radiation dose and environmental health risk of222Rn concentrations to both guides and visitors were estimated. CR-39 nuclear track detectors were used for this purpose. The values for the222Rn concentration at each monitoring site ranged from 0.43±0.04 to 1.48± 0.12 kBq m-3 in the Los Cóndores wolfram mine and from 1.8±0.1 to 6.0±0.5 kBq·m-3 in the La Carolina gold mine, indicating that, in this mine, the radon levels exceed up to four times the action level of 1.5 kBq m-3 recommended by the International Commission on Radiological Protection. The patterns of the radon transport process revealed that the La Carolina gold mine can be interpreted as a gas confined into a single tube with constant crosssection and air velocity. Patterns of radon activity, taking into account the chimney-effect winds, were used to detect tributary currents of air from shafts or larger fissures along the main adit of the Los Cóndores mine, showing that radon can be used as an important tracer of tributary air currents stream out from fissures and smaller voids in the rock of the mine. © Springer Science+Business Media B.V. 2010.

De Biase, C., Reger, D., Schmidt, A., Jechalke, S., Reiche, N., Martínez-Lavanchy, P.M., Rosell, M., Van Afferden, M., Maier, U., Oswald, S.E., Thullner, M.
Treatment of volatile organic contaminants in a vertical flow filter: Relevance of different removal processes
(2011) Ecological Engineering, 37 (9), pp. 1292-1303.

Abstract
Vertical flow filters and vertical flow constructed wetlands are established wastewater treatment systems and have also been proposed for the treatment of contaminated groundwater. This study investigates the removal processes of volatile organic compounds in a pilot-scale vertical flow filter. The filter is intermittently irrigated with contaminated groundwater containing benzene, MTBE and ammonium as the main contaminants. The system is characterized by unsaturated conditions and high contaminant removal efficiency. The aim of the present study is to evaluate the contribution of biodegradation and volatilization to the overall removal of benzene and MTBE. Tracer tests and flow rate measurements showed a highly transient flow and

heterogeneous transport regime. Radon-222, naturally occurring in the treated groundwater, was used as a gas tracer and indicated a high volatilization potential. Radon-222 behavior was reproduced by numerical simulations and extrapolated for benzene and MTBE, and indicated these compounds also have a high volatilization potential. In contrast, passive sampler measurements on top of the filter detected only low benzene and MTBE concentrations. Biodegradation potential was evaluated by the analysis of catabolic genes involved in organic compound degradation and a quantitative estimation of biodegradation was derived from stable isotope fractionation analysis. Results suggest that despite the high volatilization potential, biodegradation is the predominant mass removal process in the filter system, which indicates that the volatilized fraction of the contaminants is still subject to subsequent biodegradation. In particular, the upper filter layer located between the injection tubes and the surface of the system might also contribute to biodegradation, and might play a crucial role in avoiding the emission of volatilized contaminants into the atmosphere.

De Jong, P., Van Dijk, W., De Rooij, M.
Influence of the porosity on the 222RN exhalation rate of concrete
(2011) Health Physics, 100 (2), pp. 127-137.

Abstract
The composition of 23 concrete mixtures was varied in five separate series to evaluate the influence of porosity on the 222Rn exhalation rate. In each series, a range in porosities is obtained by varying (1) the amount of cement, (2) type of cement (Portland or blast furnace slag cement), (3) the amount of water at a fixed cement level, (4) addition of an air entraining agent, or (5) the amount of recycled aggregates. The porosities ranged from 1% to 16%. The 222Rn exhalation rate is normalized to the 226Ra activity concentration and expressed as the 222Rn release factor to eliminate the effect of differences in 226Ra activity concentrations among the various concrete mixtures. Since most 222Rn originates from the cement, a 222Rn release factor based on the amount of 226Ra introduced by the cements appeared to be more adequate. Although the methods to attain the porosities in the concrete mixtures differ widely, this cement-related factor corresponds well with the capillary porosity of the mixtures. Since the water-to-cement ratio of the fresh paste is a good indicator of the capillary porosity, this is the guiding factor in the fabrication of concretes low in 222Rn exhalation. The lower the water-to-cement ratio, the less capillary pore area will be available from which 222Rn can emanate from the mineral matrix into the pore system. The good correlation between the cement-based 222Rn release factor and literature data on the internal capillary pore area support the results of this study. Copyright © 2011 Health Physics Society.

De Weys, J., Santos, I.R., Eyre, B.D.
Linking groundwater discharge to severe estuarine acidification during a flood in a

modified wetland
(2011) Environmental Science and Technology, 45 (8), pp. 3310-3316.

Abstract
Periodic acidification of waterways adjacent to coastal acid sulfate soils (CASS) is a significant land and water management issue in the subtropics. In this study, we use 5-months of continuous radon (222Rn, a natural groundwater tracer) observations to link estuarine acidification to groundwater discharge in an Australian CASS catchment (Tuckean Swamp). The radon time series began in the dry season, when radon activities were low (2-3 dpm L -1), and the pH of surface water was 6.4. We captured a major rain event (213 mm on 2 March 2010) that flooded the catchment. An immediate drop in pH during the flood may be attributed to surface water interactions with soil products. During the post-flood stage, increased radon activities (up to 19.3 dpm L-1) and floodplain groundwater discharge rates (up to 2.01 m3 s-1, equivalent to 19% of total runoff) coincided with low pH (3.77). Another spike in radon activities (13.2 dpm L-1) coincided with the lowest recorded surface water pH (3.62) after 72 mm of rain between 17 and 20 April 2010. About 80% of catchment acid exports occurred when the estuary was dominated by groundwater discharging from highly permeable CASS during the flood recession. © 2011 American Chemical Society.

De With, G., De Jong, P.
Simulation of thoron and thoron progeny concentrations in the indoor environment
(2011) Journal of Building Physics, 35 (2), pp. 101-127.

Abstract
Thoron (220Rn) exhalation from building materials has become increasingly recognized as a potential source for radiation exposure in domestic houses. However, contrary to radon (222Rn), little is known about the exposure to thoron and its short-lived decay products. The purpose of this study is to estimate the concentration of thoron and its progeny products in a typical Dutch living room using computational fluid dynamics. The predicted thoron concentration is approximately 9 Bq m-3 using a best possible estimate of 14 Bq s-1 for the thoron exhalation from building materials. The concentration varies from 15 Bq m-3 near the building materials to 2.7 Bq m-3 in the center of the living room. The predicted concentrations of thoron's decay products 212Pb and 212Bi are 0.35 and 0.11 Bq m-3, respectively. The thoron exhalation is derived theoretically and is based on measured radon exhalation rates of the most commonly used building materials in the Netherlands. © 2011 The Author(s).

de With, G., de Jong, P.
CFD modelling of thoron and thoron progeny in the indoor environment
(2011) Radiation Protection Dosimetry, 145 (2-3), art. no. ncr056, pp. 138-144.

Abstract
Thoron (220Rn) exhalation from building materials has become increasingly recognised as a potential source for radiation exposure in residences. However, contrary to radon (222Rn), limited information on thoron exposure is available. The purpose of this study is to estimate the concentration of thoron and its progeny products in a typical Dutch living room using computational fluid dynamics. The predicted thoron concentration is ~9 Bq m-3 using a source term of 14 Bq s21 for the thoron exhalation from building materials. The concentration varies from 15 Bq m-3 near the building materials to 2.7 Bq m-3 in the centre of the living room. The mean effective dose from thoron progeny is calculated as 0.09 mSv y-1, with a total effective dose from radon and thoron progeny of 0.38 mSv y-1.

Deva Jayanthi, D., Maniyan, C.G., Perumal, S.
Assessment of indoor radiation dose received by the residents of natural high background radiation areas of coastal villages of Kanyakumari district, Tamil Nadu, India
(2011) Radiation Physics and Chemistry, 80 (7), pp. 782-785.

Abstract
Radiation exposure and effective dose received through two routes of exposure, viz. external and internal, via inhalation, by residents of 10 villages belonging to Natural High Background Radiation Areas (NHBRA) of coastal regions of Kanyakumari District and Tamil Nadu in India were studied. While the indoor gamma radiation levels were monitored using Thermo Luminescent Dosimeters (TLDs), the indoor radon and thoron gas concentrations were measured using twin chamber dosimeters employing Solid State Nuclear Track Detectors (SSNTDs, LR-115-II). The average total annual effective dose was estimated and found to be varying from 2.59 to 8.76 mSv.

Di Paolo, F., Plastino, W., Bella, F., De Vincenzi, M., Laubenstein, M., Povinec, P.P., Budano, A., Ruggieri, F.
Ground Gamma-ray survey by HPGe: Numerical simulations and comparison between field and laboratory measurements
(2011) Proceedings - 2011 7th International Conference on Natural Computation, ICNC 2011, 4, art. no. 6022594, pp. 2100-2103.

Abstract
A comparison between two methodologies for environmental gamma-ray spectrometry were carried out. Laboratory analyses on soil samples were used to test the accuracy of a hand-held portable instrument. Numerical simulations were performed to calibrate detectors and evaluate the actual response of the instrument in the field. Measurements were carried out in a volcanic area, in order to detect the presence of natural radionuclides such as 238U and 232Th chains daughters and 40K. Results show a good

agreement between the two methodologies. Some discrepancies are correlated to the presence of vegetation in the monitoring area, and can give a proxy to infer the presence of 222Rn degassing. © 2011 IEEE.

Dikii, N.P., Dovbnya, A.N., Lyashko, Y.V., Medvedev, D.V., Medvedeva, E.P., Uvarov, V.L., Achkasov, K.V.
Diffusion of sodium, potassium, calcium, manganese, and radon in tuff and clinoptilolite under leaching
(2011) Technical Physics, 56 (7), pp. 1018-1022.

Abstract
Nuclear physics methods are used to determine the diffusion coefficients of Na, Ca, Mn, K, and 222Rn in clinoptilolite (Sokirnitsa occurrence, Ukraine) and in natural tuff (Yucca Mountain, Nevada, United States) and in tuff irradiated by γ-quanta (Emax = 23 MeV) to a dose of 107 Gy at a leaching temperature of 37°C. The diffusion coefficients of sodium and potassium in clinoptilolite are found to differ considerably: 4 × 10-17 and 2 × 10-20 m2/s, respectively. This indicates the influence of aquacomplexes on the cation transfer. The diffusion coefficient of radon in these materials is determined: in clinoptilolite it equals 2.5 × 10-12 m2/s. © 2011 Pleiades Publishing, Ltd.

Dimitrova, I., Pressyanov, D., Georgiev, S., Yankov, P.
Logistic of surveys of retrospective radon concentrations by home-stored CDs/DVDs
(2011) Radiation Protection Dosimetry, 145 (2-3), art. no. ncr057, pp. 300-304.

Abstract
Recently, a method for rather precise retrospective 222Rn measurements, based on home-stored compact disks (CDs)/DVDs, has demonstrated a promising potential for wide application. In Bulgaria, pilot surveys have been initiated based on voluntarily provided CDs/DVDs. The results showed that large-scale surveys could be efficiently organised. However, several problems were identified and are discussed in the report. The first is the relatively small proportion of participants (30-50 %) that actually provided disks. Other addressed topics include the compatibility between results of different disks from one place, the accuracy of dating CDs/DVDs and the possibility for individual a posteriori calibration of each disk. The possibility to follow year-to-year variations by disks of different age is also discussed.

Dimitrova, I., Mitev, K., Pressyanov, D., Georgiev, S., Boshkova, T.
Measurement of 222Rn and 226Ra in water by absorption of radon in polycarbonates and

etching alpha-tracks
(2011) Radiation Measurements, 46 (1), pp. 119-126.

Abstract
This work describes a new method for measurement of the activity concentrations of 222Rn and 226Ra in water by exposure of a polycarbonate detector in the water and etching it for alpha-tracks. A theoretical model that gives the in-depth distribution of tracks inside polycarbonate detectors exposed in water is developed and used to optimize the method. The presented experimental results demonstrate the feasibility of the method for measurement of activity concentrations of both 222Rn and 226Ra in water. The lower detection limit is estimated at 0.06 kBq m-3 for 30 days exposure time and is achieved without preconcentration of the water or radiochemical separation of 226Ra. The method allows radon measurements directly in the water source, which could be carried simultaneously in a large number of points.

Dimova, N.T., Burnett, W.C., Speer, K.
A natural tracer investigation of the hydrological regime of Spring Creek Springs, the largest submarine spring system in Florida
(2011) Continental Shelf Research, 31 (6), pp. 731-738.

Abstract
This work presents results from a nearly two-year monitoring of the hydrologic dynamics of the largest submarine spring system in Florida, Spring Creek Springs. During the summer of 2007 this spring system was observed to have significantly reduced flow due to persistent drought conditions. Our examination of the springs revealed that the salinity of the springs' waters had increased significantly, from 4 in 2004 to 33 in July 2007 with anomalous high radon (222Rn, t1/2=3.8 days) in surface water concentrations indicating substantial saltwater intrusion into the local aquifer. During our investigation from August 2007 to May 2009 we deployed on an almost monthly basis a continuous radon-in-water measurement system and monitored the salinity fluctuations in the discharge area. To evaluate the springs' freshwater flux we developed three different models: two of them are based on water velocity measurements and either salinity or 222Rn in the associated surface waters as groundwater tracers. The third approach used only salinity changes within the spring area. The three models showed good agreement and the results confirmed that the hydrologic regime of the system is strongly correlated to local precipitation and water table fluctuations with higher discharges after major rain events and very low, even reverse flow during prolong droughts. High flow spring conditions were observed twice during our study, in the early spring and mid-late summer of 2008. However the freshwater spring flux during our observation period never reached that reported from a 1970s value of 4.9×106 m3/day. The maximum spring flow was estimated at about 3.0×106m3/day after heavy precipitation in February-March 2008. As a result of this storm (total of 173mm) the salinity in the spring area dropped from about 27 to 2 in only two days. The radon-in-water concentrations dramatically increased in

parallel, from about 330Bq/m3 to about 6600Bq/m3. Such a rapid response suggests a direct connection between the deep and the surficial aquifers. © 2011 Elsevier Ltd.

Dimova, N.T., Burnett, W.C.
Evaluation of groundwater discharge into small lakes based on the temporal distribution of radon-222
(2011) Limnology and Oceanography, 56 (2), pp. 486-494.

Abstract
In order to evaluate groundwater discharge into small lakes we constructed a model that is based on the budget of 222Rn (radon t1/2 5 3.8 d) as a tracer. The main assumptions in our model are that the lake's waters are wellmixed horizontally and vertically; the only significant 222Rn source is via groundwater discharge; and the only losses are due to decay and atmospheric evasion. In order to evaluate the groundwater-derived 222Rn flux, we monitored the 222Rn concentration in lake water over periods long enough (usually 1-3 d) to observe changes likely caused by variations in atmospheric exchange (primarily a function of wind speed and temperature). We then attempt to reproduce the observed record by accounting for decay and atmospheric losses and by estimating the total 222Rn input flux using an iterative approach. Our methodology was tested in two lakes in central Florida: one of which is thought to have significant groundwater inputs (Lake Haines) and another that is known not to have any groundwater inflows but requires daily groundwater augmentation from a deep aquifer (Round Lake). Model results were consistent with independent seepage meter data at both Lake Haines (positive seepage of 1.6 × 104 m3 d-1 in Mar 2008) and at Round Lake (no net groundwater seepage). © 2011, by the American Society of Limnology and Oceanography, Inc.

Dinis, M.L., Fiúza, A.
Using Monte-Carlo simulation for risk assessment: Application to occupational exposure during remediation works
(2011) Lecture Notes in Computer Science (including subseries Lecture Notes in Artificial Intelligence and Lecture Notes in Bioinformatics), 6046 LNCS, pp. 60-67.

Abstract
The aim of this study was to apply the Monte-Carlo techniques to develop a probabilistic risk assessment. The risk resulting from the occupational exposure during the remediation activities of a uranium tailings disposal, in an abandoned uranium mining site, was assessed. A hypothetical exposure scenario was developed and two different pathways were compared: internal exposure through radon inhalation and external through gamma irradiation from the contaminated tailings material. The input variables, such as the inhalation rate and the external exposure parameters, were considered as specific probabilistic distributions, each one characterized by its central tendency and dispersion parameters. Using the cumulative distribution function, a probabilistic value for each

variable can be generated using a single random number. Thus, this methodology allows performing a probabilistic risk assessment generating a risk distribution. © 2011 Springer-Verlag.

Distenfeld, C.
Radon measurement quality, how accurate is reasonable?
(2011) Health Physics, 101 (5 SUPPL. 3), pp. S148-S153.

Abstract
Until 2006, continuous radon monitoring devices, CR, could either be calibrated by reference to known quantities or by internal adjustments and or alignments. In 2007, a policy was advanced by the National Radon Safety Board and the National Environmental Health Association mandating internal adjustment and or alignment. Further, calibrations could only be performed by radon chamber persons authorized by the specific device manufacturer, which was a process that was impossible for many chamber operators to achieve. The paper serves to examine the technical validity for routine internal adjustments to Honeywell and Sun Nuclear (Sun Nuclear Corporation, 425A Pineda Court, Melbourne, FL 32940-7508) devices in contrast to the clear market controlling advantages of the policy. The purpose for making radon measurements is to assess risk. Comparing the uncertainties associated with risk to counting uncertainties of Honeywell and Sun Nuclear CR devices, less than 1% of model 1027 devices would have a calibration error exceeding 25%, and those devices, at this Radon Measurement Proficiency limit, would produce results that were more precise and accurate than the radon risk uncertainty. This was true for CR devices that have not been internally adjusted nor corrected in any way. It was concluded that internal adjustment or alignment better supported business principles than science. © by the Health Physics Society.

Du, N., Liao, L., Xiao, Y., Xiao, X., Zhao, Z., Lin, Y.
Determination of radon using solid state nuclear tracks wireless sensing method
(2011) Analytica Chimica Acta, 686 (1-2), pp. 121-125.

Abstract
The aim of this paper is to develop a solid state nuclear tracks (SSNTs) wireless magnetoelastic sensing method for the determination of radon. In this method, wireless sensors for detecting radon are fabricated by coating polymethyl methacrylate (PMMA) film on the surface of magnetoelastic foils. The magnetoelastic sensing technique has the unique characteristic of being able to wirelessly detect resonance frequency shifts of a magnetoelastic foil in response to differences in the mass of foil. When the sensor is exposed to the environment containing radon, the PMMA film on the sensor is attacked by alpha-particles emitted from radon, generating latent SSNTs. After the sensor is chemically etched, the latent SSNTs in the PMMA film are enlarged and the sensor loses a certain mass, resulting in a shift in resonance frequency of the sensor. Consequently,

the radon concentration can be determined by measuring the shift in resonance frequency. Under the conditions of the etchant concentration, etching temperature and etching time being 20% (w/w), 80°C and 18min, respectively, the linear range for the determination of radon is 1.20×105 to 3.60337199×106Bqm-3h with the detection limit of 20.3×103Bqm-3h. The method has been applied for the determination of radon in air samples with satisfactory results. © 2010 Elsevier B.V.

Duarte, V., González, Y., Cerrolaza, M.
Boundary element simulation of bone tissue
(2011) International Journal of Biomedical Engineering and Technology, 5 (2-3), pp. 211-228.

Abstract
Usually the mechanical condition and the induced electric signal are devoted to be part of the stimuli controlling the biophysical activity associate with healing and remodelling phenomena. The tissue differentiation theory proposed by Claes and Heigele (1999) has been numerically implemented using an poroelastic boundary element framework to characterises fracture healing, leading to a new poroelastic correlation between mechanical conditions and local tissue formation. This paper also presents the implementation of the piezoelectric boundary integral equation to further study the bone tissue behaviour. The results were in good agreement with those reported in previous works. © 2011 Inderscience Enterprises Ltd.

Dubčáková, R.
Eureqa: Software review
(2011) Genetic Programming and Evolvable Machines, 12 (2), pp. 173-178.

Abstract
The Eureqa software, also called the robot scientist was developed at the Computational Synthesis Lab at Cornell University by Dr. Hod Lipson. It uses symbolic regression for detecting equations and hidden mathematical relationships in raw data. The software was used to map the relationship between real measured values and values calculated according to manufacturer's manual. Radon measurements were taken in a house in the Czech Republic over 5 weeks. Five datasets of 26 measured values were obtained. The data was easily entered into Eureqa using its spreadsheet like interface. Next Eureqa requires the function set to be chosen, so addition, subtraction, multiplication and division, together with both Gaussian and exponential functions were chosen. Eureqa also supports parallel operation over multiple computers. Eureqa splits automatically training and validation dataset. The user can choose the amount of training or validation data or use the default settings.

Dubčáková, R., Praks, P., Moučka, L.
Statistical model of quality of radon measurements using electret ion chamber detectors (2011) Radiation Protection Dosimetry, 145 (2-3), art. no. ncr058, pp. 295-299.

Abstract
This paper presents a statistical model for estimating probability, which states that a quality of radon measurements using the electret ion chamber system RM-1 will be accurate. The quality of the electret measurement was modelled as a ratio between the reference radon concentration and values measured under real conditions with varied levels of indoor radon concentration and microclimate indoor conditions. It was stated that the accuracy tolerance of measured values is 20 % of the given refer- ence value. To estimate the uncertainty of the statistical model, the exact confidence limits for the estimated probabilities are computed. The statistical model was confirmed by an independent set of measurements. Moreover, the effect of absolute humidity on the quality estimation of electret detectors are also statistically analysed and discussed. The results of the statistical model confirm that the electret system is robust and suitable for estimation of radon concentration.

Dueñas, C., Fernández, M.C., Cañete, S., Pérez, M., Gordo, E.
Seasonal variations of radon and the radiation exposure levels in Nerja cave, Spain (2011) Radiation Measurements, 46 (10), pp. 1181-1186.

Abstract
222Rn concentrations in the air in Nerja cave (Spain) (3° 52′35″W 36° 43′50″N) were measured by continuous monitoring using Alpha-Guard, Genitron instrument equipment. The 222Rn measurements were carried out for a complete annual cycle in the different halls: Vestibule hall from July 2003 to June 2004, Ballet hall from July 2004 to June 2005 and Mirador hall from July 2005 to June 2006. Starting from the entrance of the cave we successively find the Vestibule hall, the Ballet hall and the Mirador hall. The range of 222Rn levels were of 8-627 Bq m-3 for the Vestibule hall, 28-575 Bq m-3 for the Ballet hall and 38-578 Bq m-3 for the Mirador. The aim of this study was to detect seasonal variation patterns of 222Rn concentrations. The seasonal variations of 222Rn concentrations are discussed in relation to various meteorological factors measured inside and outside the cave. The radiation exposure levels for workers and tourists with different equilibrium factors have been evaluated. The radiation exposure levels for workers and tourists only represent a low percentage of the exposure guides for the general population.

Dugan, H.A., Gleeson, T., Lamoureux, S.F., Novakowski, K.
Tracing groundwater discharge in a High Arctic lake using radon-222
(2011) Environmental Earth Sciences, pp. 1-8. Article in Press.

Abstract
In the High Arctic, groundwater fluxes are limited by the presence of continuous permafrost, although it has been hypothesized that there may be localized groundwater flow and hydraulic connectivity beneath large lakes, due to the presence of taliks, or large regions of unfrozen ground. However, due to the logistical difficulty of employing seepage meters and piezometers in deep, ice-covered lakes, relatively little is known about groundwater discharge to polar lakes. One method of assessing groundwater discharge is through the use of geochemical tracers. We conducted a pilot study to quantify groundwater discharge into a High Arctic lake using dissolved radon gas as a geochemical tracer. Lake water was collected in 15 L polyvinyl chloride (PVC) bags with minimal atmospheric interaction from a 25-m deep lake near Shellabear Point, Melville Island, Northwest Territories, Canada. Sample bags were aerated through a closed water loop for 60 min to allow sufficient radon to equilibrate in a coupled air circuit. Radon in air concentrations were measured on a Durridge RAD7 portable alpha spectrometer. The field trial in a remote setting and separate tests with groundwater samples collected from a temperate site demonstrate the utility of the methodology. The limited results suggest that radon levels in the lower water column are elevated above background levels following nival melt in the surrounding watershed. Although these results are insufficient to quantify groundwater discharge, the results suggest subsurface flow may exist, and further study is warranted. © 2011 Springer-Verlag.

El-Zaher, M.A.
Seasonal variation of indoor radon concentration in dwellings of Alexandria city, Egypt
(2011) Radiation Protection Dosimetry, 143 (1), art. no. ncq357, pp. 56-62.

Abstract
Inhalation of radon (222Rn) and daughter products are a major source of natural radiation exposure. Keeping this in view, seasonal indoor radon measurement studies have been carried out in 68 dwellings belonging to 17 residential areas in Alexandria city, Egypt. LR-115 Type 2 films were exposed for four seasons of 3 months each covering a period of 1 y for the measurement of indoor radon levels. Assuming an indoor occupancy factor of 0.8 and a factor of 0.4 for the equilibrium factor of radon indoors, it was found that the estimated annual average indoor radon concentration in the houses surveyed ranged from 45 ± 8 to 90 ± 13 Bq m-3 with an overall average value of 65 ± 10 Bq m-3. The observed annual average values are greater than the world average of 40 Bq m-3. Seasonal variation of indoor radon shows that maximum radon concentrations were observed in the winter season, whereas minimum levels were observed in the summer season. The season/annual ratios for different type of dwellings varied from 1.54 to 2.50. The mean annual estimated effective dose received by the residents of the studied area was

estimated to be 1.10 mSv. The annual estimated effective dose is less than the recommended action level (3-10 mSv y-1).

Fairchild, R., Tjong, L., Wright, T.
Automating radon solid state track detector measurements
Radiation Measurements, . Article in Press.

Abstract
CR-39 nuclear track detectors are routinely used for the passive measurement of radon exposure. A new measurement system for the semi-automated assessment of radon plaques has previously been developed. This system is based on the analysis of images obtained with a high-resolution optical scanner. The scanner operates in transparency mode and the nuclear tracks on both sides of the detector are assessed. Earlier testing has revealed inconsistencies in the results obtained by the system. It was found that dust spots, artefacts or other plaque damage within the area of interest are likely to be the cause of such problems. Quality control checks and procedures have been implemented to identify and correct for these problems. Following calibration and validation against the current manual counting method, the system will be suitable to implement for routine use. Crown Copyright © 2011.

Fanshawe, T.R., Diggle, P.J.
Bivariate geostatistical modelling: a review and an application to spatial variation in radon concentrations
(2011) Environmental and Ecological Statistics, pp. 1-22. Article in Press.

Abstract
We present a comprehensive review of multivariate geostatistical models, focusing on the bivariate case. We compare in detail three approaches, the linear model of coregionalisation, the common component model and the kernel convolution approach, and discuss similarities between them. We demonstrate the merits of the common component class of models as a flexible means for modelling bivariate geostatistical data of the type that frequently arises in environmental applications. In particular, we show how kernel convolution can be used to approximate the common component model, and demonstrate the method using a data-set of calcium and magnesium concentrations in soil samples. We then apply the model to a study of domestic radon concentrations in the city of Winnipeg, Canada, in which exposure was measured at two sites (bedroom and basement) in each residential location. Our analysis demonstrates that in this study the correlation between the two sites within each house dominates the short-range spatial correlation typical of the distribution of radon. © 2011 Springer Science+Business Media, LLC.

Farkas, Á., Hofmann, W., Balásházy, I., Szoke, I., Madas, B.G., Moustafa, M.
Effect of site-specific bronchial radon progeny deposition on the spatial and temporal distributions of cellular responses
(2011) Radiation and Environmental Biophysics, 50 (2), pp. 281-297.

Abstract
Inhaled short-lived radon progenies may deposit in bronchial airways and interact with the epithelium by the emission of alpha particles. Simulation of the related radiobiological effects requires the knowledge of space and time distributions of alpha particle hits and biological endpoints. Present modelling efforts include simulation of radioaerosol deposition patterns in a central bronchial airway bifurcation, modelling of human bronchial epithelium, generation of alpha particle tracks, and computation of spatio-temporal distributions of cell nucleus hits, cell killing and cell transformation events. Simulation results indicate that the preferential radionuclide deposition at carinal ridges plays an important role in the space and time evolution of the biological events. While multiple hits are generally rare for low cumulative exposures, their probability may be quite high at the carinal ridges of the airway bifurcations. Likewise, cell killing and transformation events also occur with higher probability in this area. In the case of uniform surface activities, successive hits as well as cell killing and transformation events within a restricted area (say 0.5 mm2) are well separated in time. However, in the case of realistic inhomogeneous deposition, they occur more frequently within the mean cycle time of cells located at the carinal ridge even at low cumulative doses. The site-specificity of radionuclide deposition impacts not only on direct, but also on non-targeted radiobiological effects due to intercellular communication. Incorporation of present results into mechanistic models of carcinogenesis may provide useful information concerning the dose-effect relationship in the low-dose range.

Fathabadi, N., Farahani, M.V., Amani, S., Moradi, M., Haddadi, B.
Evaluation of occupational exposure to naturally occurring radioactive materials in the Iranian ceramics industry
(2011) Radiation Protection Dosimetry, 145 (4), art. no. ncq441, pp. 400-404.

Abstract
Zircon contains small amounts of uranium, thorium and radium in its crystalline structure. The ceramic industry is one of the major consumers of zirconium compounds that are used as an ingredient at ~10-20 % by weight in glaze. In this study, seven different ceramic factories have been investigated regarding the presence of radioactive elements with focus on natural radioactivity. The overall objective of this investigation is to provide information regarding the radiation exposure to workers in the ceramic industry due to naturally occurring radioactive materials. This objective is met by collecting existing radiological data specific to glaze production and generating new data from sampling activities. The sampling effort involves the whole process of glaze

production. External exposures are monitored using a portable gamma-ray spectrometer and environmental thermoluminescence dosemeters, by placing them for 6 months in some workplaces. Internal routes of exposure (mainly inhalation) are studied using air sampling, and gross alpha and beta counting. Measurement of radon gas and its progeny is performed by continuous radon gas monitors that use pulse ionisation chambers. Natural radioactivity due to the presence of 238U, 232TH and 40K in zirconium compounds, glazes and other samples is measured by a gamma-ray spectrometry system with a high-purity germanium detector. The average concentrations of 238U and 232TH observed in the zirconium compounds are >3300 and >550 Bq kg-1, respectively. The specific activities of other samples are much lower than in zirconium compounds. The annual effective dose from external radiation had a mean value of ~0.13 mSv y-1. Dust sampling revealed the greatest values in the process at the powdering site and hand weighing places. In these plants, the annual average effective dose from inhalation of long-lived airborne radionuclides was 0.226 mSv. 222Rn gas concentrations in the glaze production plant and storage warehouse were found to range from 10 to 213 Bq m-3. In this study, the estimated annual effective doses to exposed workers were <1 mSv y-1.

Feldtkeller, E., Hammel, L., Brenneis, C., Song, I.-H., Rudwaleit, M.
Advice for patients diagnosed with ankylosing spondylitis. Results of a representative patient survey in Germany [Hinweise für patienten mit der diagnose ankylosierende spondylitis: Ergebnisse einer repräsentativbefragung der deutschen vereinigung morbus bechterew e.v.]
(2011) Zeitschrift fur Rheumatologie, 70 (5), pp. 431-437.

Abstract
Background: Following the diagnosis of a chronic disease like ankylosing spondylitis (AS), patients need extensive information on what to expect, how to behave and what they need to be aware of in particular in order to contribute to a favourable disease outcome.Methods: A questionnaire consisting of 82 questions regarding demographics, diagnosis, information received with the diagnosis, disease activity, function, quality of life, treatment, ability to work, smoking etc. was distributed to AS patients by rheumatologists in 51 hospitals and/or private practices. In addition, the questionnaire was sent to 3400 randomly selected members out of the 14,000 patient members of the German Ankylosing Spondylitis Society (Deutsche Vereinigung Morbus Bechterew, DVMB).Results: In all, 1068 DVMB members and 205 non-members responded to the survey. Almost all of these indicated that they had received at least one piece of information regarding what they should be particularly aware of, at the time of diagnosis. A total of 69% were informed about the need for daily exercise, 51% about the value of individual physiotherapy, 38% about the value of group physiotherapy, 37% about the need to maintain an upright posture, and 33% were recommended 3 weeks in a rehabilitation centre. Less than 30% were informed about appropriate sports, appropriate working conditions, suitable chairs, mattress, pillows etc., about the value of radon therapy or about joining a disease-specific patient organisation.To the question regarding

what patients meanwhile consider as most important, daily exercise (50%) and sufficient movement at work and leisure (55%) were reported most frequently. Other aspects regarded as important to patients included a flat, firm mattress (53%), avoiding large pillows (42%), keeping an upright posture at work (38%), appropriate sports (36%), and an upright posture also when not at work (34%).Of the DVMB members, 46% had participated in disease-specific standardised patient education, compared with only 31% of non-members ($p < 0.001$).

Feng, W., Chipperfield, M.P., Dhomse, S., Monge-Sanz, B.M., Yang, X., Zhang, K., Ramonet, M.
Evaluation of cloud convection and tracer transport in a three-dimensional chemical transport model
(2011) Atmospheric Chemistry and Physics, 11 (12), pp. 5783-5803.

Abstract
We investigate the performance of cloud convection and tracer transport in a global off-line 3-D chemical transport model. Various model simulations are performed using different meteorological (re)analyses (ERA-40, ECMWF operational and ECMWF Interim) to diagnose the updraft mass flux, convective precipitation and cloud top height. The diagnosed upward mass flux distribution from TOMCAT agrees quite well with the ECMWF reanalysis data (ERA-40 and ERA-Interim) below 200 hPa. Inclusion of midlevel convection improves the agreement at mid-high latitudes. However, the reanalyses show strong convective transport up to 100 hPa, well into the tropical tropopause layer (TTL), which is not captured by TOMCAT. Similarly, the model captures the spatial and seasonal variation of convective cloud top height although the mean modelled value is about 2 km lower than observed. The ERA-Interim reanalyses have smaller archived upward convective mass fluxes than ERA-40, and smaller convective precipitation, which is in better agreement with satellite-based data. TOMCAT captures these relative differences when diagnosing convection from the large-scale fields. The model also shows differences in diagnosed convection with the version of the operational analyses used, which cautions against using results of the model from one specific time period as a general evaluation. We have tested the effect of resolution on the diagnosed modelled convection with simulations ranging from 5.6° × 5.6° to 1° × 1°. Overall, in the off-line model, the higher model resolution gives stronger vertical tracer transport, however, it does not make a large change to the diagnosed convective updraft mass flux (i.e., the model results using the convection scheme fail to capture the strong convection transport up to 100 hPa as seen in the archived convective mass fluxes). Similarly, the resolution of the forcing winds in the higher resolution CTM does not make a large improvement compared to the archived mass fluxes. Including a radon tracer in the model confirms the importance of convection for reproducing observed midlatitude profiles. The model run using archived mass fluxes transports significantly more radon to the upper troposphere but the available data does not strongly discriminate between the different model versions. © 2011 Author(s).

Fernandes, P.C.P., Sousa, W.O., Julião, L.M.Q.C., Dantas, B.M.
Development and validation of a technique for the determination of 226Ra and 228Ra by liquid scintillation in liquid samples
(2011) Radiation Protection Dosimetry, 144 (1-4), art. no. ncq434, pp. 335-338.

Abstract
Radium isotopes are dispersed in the environment according to their physicochemical characteristics. Considering their long half-lives and radiological effects, 226Ra and 228Ra are very important issues in radiological protection. In Brazil, radium isotopes represent an exposure problem both in nuclear fuel cycle installations and in high natural radiation background areas. The experimental part of this work includes the development of a technique for the determination of 226Ra and 228Ra by liquid scintillation with potential application in biological samples. Radium was concentrated and then separated from other constituents of the sample by co-precipitation/precipitation with Ba(Ra)SO4. The precipitate was filtered and weighted to calculate the chemical yield. The filter containing the precipitate of Ba(Ra)SO4 was transferred to a scintillation vial. Two methods were used to prepare the sources. The first one consisted of the addition of water (8 ml), Instagel XF (8 ml) and UltimaGold (4 ml) in the vial containing the filter and the precipitate, forming a gel suspension. In the second method, the precipitate was dissolved with 0.2 M ethylene-diamine-tetra-acetic-acid solution (9 ml) and 11 ml of scintillation solution (Optiphase Hisafe 3) was added to the vial, forming an aqueous and an organic phase. The solutions obtained were counted in a low background scintillation spectrometry system (Quantulus) suitable for the detection and identification of both alpha and beta particles for the determination of 226Ra and 228Ra. The activity values of 226Ra and 228Ra calculated by the two methods are in good agreement with the reference values, indicating that both methods are suitable for the determination of 226Ra and 228Ra.

Fernandez-Cortes, A., Cuezva, S., Sanchez-Moral, S., Cañaveras, J.C., Porca, E., Jurado, V., Martin-Sanchez, P.M., Saiz-Jimenez, C.
Detection of human-induced environmental disturbances in a show cave
(2011) Environmental Science and Pollution Research, 18 (6), pp. 1037-1045.

Abstract
Purpose: We investigated the effects of human-induced disruption in a subterranean stable environment containing valuable Palaeolithic paintings and engravings (Ardales Cave, Southern Spain) using a double analytical approach. Methods: An environmental monitoring system was installed in the cave to record temperature, relative humidity, carbon dioxide (CO2) and radon (222Rn) concentrations in air. In the same stations, an aerobiological sampling was conducted to quantify the level of airborne microorganisms. Results: The combination of different methods allowed us to detect the extent of human-induced changes, confirming that these can be very hazardous in certain cave areas that

should be apparently outside the scope of human disturbances, either by their remoteness to the visitor entrance or by being briefly visited. Conclusions: The detection of evident anomalies in the environmental parameters and airborne microorganism concentration in the cave area housing the high density of paintings and engravings helps to control human disturbances and supports the direct application of this double approach for cave management purposes. © 2011 Springer-Verlag.

Fernandez-Cortes, A., Sanchez-Moral, S., Cuezva, S., Benavente, D., Abella, R.
Characterization of trace gases' fluctuations on a 'low energy' cave (Castañar de Íbor, Spain) using techniques of entropy of curves
(2011) International Journal of Climatology, 31 (1), pp. 127-143.

Abstract
Variations of carbon dioxide and radon content of cave air are presented as key parameters to assess the outgassing and isolation processes of a subterranean atmosphere. An exhaustive monitoring in the Castañar cave determined the temporal evolution of CO2 and 222Rn levels over a 12-month period, in order to characterise the mechanisms of these microclimatic processes. Concentrations of both gases show both seasonal variations and short-term fluctuations depending on several climatic factors: the air temperature difference between cave and exterior, cave air pressure, rainfall and anthropic factors including visits and duration of door opening. Over the course of an annual cycle, a cause-effect analysis has been conducted by stationary clustering of time series in terms of entropy of curves. Two opposing patterns of cave microclimate have been distinguished: (1) storage of trace gases in the cave reservoir during the cold-wet season, and (2) CO2 emissions during warm-dry season. The partial water filling of the porous system and fissures of the membranes covering the cave (host rock and soil) is determined by the external relative humidity (controlled by the external air temperature) as well as by rainfalls, which play a key role in confining the cave atmosphere. Copyright © 2009 Royal Meteorological Society.

Fijałkowska-Lichwa, L., Przylibski, T.A.
Short-term 222Rn activity concentration changes in underground spaces with limited air exchange with the atmosphere
(2011) Natural Hazards and Earth System Science, 11 (4), pp. 1179-1188.

Abstract
The authors investigated short-time changes in 222Rn activity concentration occurring yearly in two underground tourist facilities with limited air exchange with the atmosphere. One of them is Niedźwiedzia (Bear) Cave in Kletno, Poland - a natural space equipped with locks ensuring isolation from the atmosphere. The other site is Fluorite Adit in Kletno, a section of a disused uranium mine. This adit is equipped with a mechanical ventilation system, operated periodically outside the opening times (at night).

Both sites are situated within the same metamorphic rock complex, at similar altitudes, about 2 km apart. The measurements conducted revealed spring and autumn occurrence of convective air movements. In Bear Cave, this process causes a reduction in 222Rn activity concentration in the daytime, i.e. when tourists, guides and other staff are present in the cave. From the point of view of radiation protection, this is the best situation. For the rest of the year, daily concentrations of 222Rn activity in the cave are very stable. In Fluorite Adit, on the other hand, significant variations in daily 222Rn activity concentrations are recorded almost all year round. These changes are determined by the periods of activity and inactivity of mechanical ventilation. Unfortunately this is inactive in the daytime, which results in the highest values of 222Rn activity concentration at the times when tourists and staff are present in the adit. Slightly lower concentrations of radon in Fluorite Adit are recorded in the winter season, when convective air movements carry a substantial amount of radon out into the atmosphere. The incorrect usage of mechanical ventilation in Fluorite Adit results in the most unfavourable conditions in terms of radiation protection. The staff working in that facility are exposed practically throughout the year to the highest 222Rn activity concentrations, both at work (in the adit) and at home (outside their working hours). Therefore, not very well considered solution for the ventilation system not only does not prevent radioactive exposure of the staff, but can even increase it. The authors have also observed comparable characteristics of the annual patterns of 222Rn activity concentration changes in underground spaces and residential buildings situated in the same or similar climatic zones.

Fink, M., Kalpakcioglu, B., Bernateck, M., Gutenbrunner, C.
Is there evidence for balneotherapy in rheumatic diseases? [Gibt es Evidenz in der Balneotherapie rheumatologischer Erkrankungen?]
(2011) Aktuelle Rheumatologie, 36 (3), pp. 157-164.

Abstract
In many countries balneotherapy as a representative of classic naturopathy has a long tradition, and it is used among other indications for the treatment of rheumatic diseases. Inconsistent with the frequent use of this sedentary remedy is the small number of clinical studies to confirm its specific efficacy. Studies about the properties of balneotherapies for the treatment of rheumatic diseases are afflicted by methodological difficulties, for example, in the choice of suitable controls. Numerous studies published in the past decade, however, document the efforts to fulfill the demands of evidence-based medicine. Recent research indicates that patients with ankylosing spondylitis or rheumatoid arthritis will benefit from a radon speleotherapy for longer times (6 months), and patients with a fibromyalgia from thermal spa therapies (optionally complemented by mud packs). Apart from the aforementioned modalities and indications, randomised clinical studies in accordance with the criteria of evidence-based medicine are lacking. The present review gives methodological recommendations for further studies about other rheumatic diseases and treatment options, respectively.

Florea, N., Duliu, O.G.
Eighteen years of continuous observation of Radon and Thoron progenies atmospheric activity
Journal of Environmental Radioactivity, 104 (1), pp. 14-23. Article in Press.

Abstract
The eighteen years (1993-2010) of continuous observations of the activity concentrations of Radon (222Rn) and Thoron (220Rn) progenies within the atmosphere as recorded twice a day in Arad (Romania) are analyzed and discussed in correlation with air temperature, monthly precipitation and sky cloudiness.A detailed statistic analysis of all data revealed more peculiarities such as a systematically higher concentration in the morning compared to midday, a negative correlation between 220Rn and 222Rn activity concentrations and precipitation level, temperature and sky cloudiness. Both Morlet wavelet and power spectra confirmed the predominance of the one year periodicity, as well as the presence of some components with a periodicity of 7.2, 2.8, 1.5 and 1.2 years, more evident in the case of 220Rn. The possible influence of meteorological factors on both 222Rn and 220Rn progenies atmospheric activity concentrations are discussed. © 2011 Elsevier Ltd.

Fojtikova, I., Barnet, I., Marusiakova, M.
Radon index of a local administrative unit
(2011) Radiation Protection Dosimetry, 145 (2-3), art. no. ncr084, pp. 107-109.

Abstract
The determination of radon-prone areas is usually based on indoor radon data and on the prognosis of the occurrence of houses exceeding the action level. However, the sample of houses in the survey must be representative and large enough, which is not easy to fulfill. Despite this, the determination of localities with high radon risk is useful not only for planning of indoor radon surveys, but also mainly for predicting the risk in newly built houses. There exist two more sources of data that can be used when assigning radon-related index to territories: soil gas radon measurements and gamma dose rate maps, both having their own inaccuracies. An attempt has been made to combine Czech indoor radon data, soil gas radon data and gamma dose rate maps for municipalities, where available. The radon-related index has been constructed by means of statistical analysis (linear regression). The equations found can be used for predicting the radon risk of the municipalities where the data sets are not large enough.

Fojtikova, I., Rovenska, K.
Radon programmes and health marketing
(2011) Radiation Protection Dosimetry, 145 (2-3), art. no. ncr083, pp. 92-95.

Abstract
Being aware of negative health effects of radon exposure, many countries aim for the reduction of the radon exposure of their population. The Czech radon programme was commenced >20 y ago. Since then experts have gathered a lot of knowledge, necessary legislation has been enacted, tens of thousands of inhabitants have been offered free measurement and subsidy for the mitigation. Despite the effort, the effectiveness of the radon programme seems to be poor. Newly built houses still exhibit elevated radon concentrations and the number of houses mitigated is very low. Is it possible to enhance the effectivity of radon programme while keeping it on a voluntary basis? One possible way is to employ health marketing that draws together traditional marketing theories and science-based strategies to prevention. The potential of using marketing principles in communication and delivery of radon information will be discussed.

Ford, R., Chen, M., Chkvorets, O., Hallman, D., Vázquez-Jáuregui, E.
SNO+ scintillator purification and assay
(2011) AIP Conference Proceedings, 1338, pp. 183-194.

Abstract
We describe the R&D on the scintillator purification and assay methods and technology for the SNO+ neutrino and double-beta decay experiment. The SNO+ experiment is a replacement of the SNO heavy water with liquid scintillator comprised of 2 g/L PPO in linear alkylbenzene (LAB). During filling the LAB will be transported underground by rail car and purified by multi-stage distillation and steam stripping at a flow rate of 19 LPM. While the detector is operational the scintillator can be recirculated at 150 LPM (full detector volume in 4 days) to provide re-purification as necessary by either water extraction (for Ra, K, Bi) or by functional metal scavenger columns (for Pb, Ra, Bi, Ac, Th) followed by steam stripping to remove noble gases and oxygen (Rn, O2, Kr, Ar). The metal scavenger columns also provide a method for scintillator assay for ex-situ measurement of the U and Th chain radioactivity. We have developed "natural" radioactive spikes of Pb and Ra in LAB and use these for purification testing. Lastly, we present the planned operating modes and purification strategies and the plant specifications and design.

Fornalski, K.W., Dobrzyński, L.
Erratum: Pooled Bayesian analysis of twenty-eight studies on radon induced lung cancers (Health Physics (2011) 101 (265-273))
(2011) Health Physics, 101 (4), p. 485.

Fornalski, K.W., Dobrzyński, L.
Pooled bayesian analysis of twenty-eight studies on radon induced lung cancers
(2011) Health Physics, 101 (3), pp. 265-273.

Abstract
The influence of ionizing radiation of Rn and its progeny on lung cancer risks that were published in 28 papers was re-analyzed using seven alternative dose-response models. The risks of incidence and mortality were studied in two ranges of low annual radiation dose: 0-70 mSv per year (391 Bq m) and 0-150 mSv per year (838 Bq m). Assumption-free Bayesian statistical methods were used. The analytical results demonstrate that the published incidence and mortality data do not show that radiation dose is associated with increased risk in this range of doses. This conclusion is based on the observation that the model assuming no dependence of the lung cancer induction on the radiation doses is at least □90 times more likely to be true than the other models tested, including the linear no-threshold (LNT) model. Copyright © 2011 Health Physics Society.

Frank, H., Himmel, B., Ewald, H., Spann, F., Raiber, T.
Mobile Radon filtration system for closed rooms [Mobiles Radon-filtersystem für den einsatz in geschlossenen räumen]
(2011) Gefahrstoffe Reinhaltung der Luft, 71 (3), pp. 113-116.

Abstract
The aim of this project was the development of a transportable filtration system for immobilization of the radioactive noble gas Radon. The concentration of Radon and of its decay products should be decreased clearly. Different filter materials such as activated coals and highly porous silicates were tested for this Radon filtration system. The classification of the filter materials resulted from acoustical gas analytics for the inert sulfur hexafluoride (SF6) as a model gas. The different filter materials were tested and compared for loading and adsorption capacity with regard to the conditions of measurement like pressure, temperature, volume flow, degree of the compartment air exchange and SF6 concentration. This filtration system was finally proved with a natural Radon source. The equilibrium concentration of Radon could be decreased to 60%. It was shown that the relative air moisture and the temperature have a major influence on the results of measurements.

Fränkle, F.M., Bornschein, L., Drexlin, G., Glück, F., Görhardt, S., Käfer, W., Mertens, S., Wandkowsky, N., Wolf, J.
Radon induced background processes in the KATRIN pre-spectrometer
(2011) Astroparticle Physics, 35 (3), pp. 128-134.

Abstract

The KArlsruhe TRItium Neutrino (KATRIN) experiment is a next generation, model independent, large scale tritium β-decay experiment to determine the effective electron anti-neutrino mass by investigating the kinematics of tritium β-decay with a sensitivity of 200 meV/c2 using the MAC-E filter technique. In order to reach this sensitivity, a low background level of 10-2 counts per second (cps) is required. This paper describes how the decay of radon in a MAC-E filter generates background events, based on measurements performed at the KATRIN pre-spectrometer test setup. Radon (Rn) atoms, which emanate from materials inside the vacuum region of the KATRIN spectrometers, are able to penetrate deep into the magnetic flux tube so that the α-decay of Rn contributes to the background. Of particular importance are electrons emitted in processes accompanying the Rn α-decay, such as shake-off, internal conversion of excited levels in the Rn daughter atoms and Auger electrons. While low-energy electrons (<100 eV) directly contribute to the background in the signal region, higher energy electrons can be stored magnetically inside the volume of the spectrometer. Depending on their initial energy, they are able to create thousands of secondary electrons via subsequent ionization processes with residual gas molecules and, since the detector is not able to distinguish these secondary electrons from the signal electrons, an increased background rate over an extended period of time is generated.

Froňka, A., Jílek, K., Moučka, L., Brabec, M.
Significance of independent radon entry rate and air exchange rate assessment for the purpose of radon mitigation effectiveness proper evaluation: Case studies
(2011) Radiation Protection Dosimetry, 145 (2-3), art. no. ncr051, pp. 133-137.

Abstract
Two new single-family houses identified as insufficient with regard to existing radon barrier efficiency, have been selected for further examination. A complex set of radon diagnosis procedures has been applied in order to localise and quantify radon entry pathways into the indoor environment. Independent assessment of radon entry rate and air exchange rate has been carried out using the continuous indoor radon measurement and a specific tracer gas application. Simultaneous assessment of these key determining factors has turned out to be absolutely crucial in the context of major cause identification of elevated indoor radon concentration.

Froňka, A.
Indoor and soil gas radon simultaneous measurements for the purpose of detail analysis of radon entry pathways into houses
(2011) Radiation Protection Dosimetry, 145 (2-3), art. no. ncr052, pp. 117-122.

Abstract
Detailed knowledge of radon transport mechanisms from the subsoil into the indoor

environment is essential for the correct interpretation of results of short-term indoor radon measurements and for proper and effective design of radon mitigation systems. Radon transfer factor time variations have been studied based on simultaneous continuous indoor and soil gas radon measurements within the framework of complex radon diagnosis of individual buildings. In this context, the key influencing factors have been identified and analysed in order to provide satisfactory explanation on radon entry variations under different measurement conditions. Moreover, a new significant manner of radon entry into the indoor environment has been identified and will be discussed in detail.

Frutos, B., Olaya, M., Esteban, J.L.
Extraction systems as construction techniques to prevent the entry of radon gas in homes [Sistemas de extracción como técnicas constructivas para evitar la entrada de gas radón en las viviendas]
(2011) Informes de la Construccion, 63 (521), pp. 23-36.

Abstract
The health risk associated to high radon levels in living spaces leads to perform remedial actions in buildings with radon reduction techniques to reduce radon concentration down to acceptable levels. Within this type of solution, extraction systems, consisting in sumps buried in the ground and connected to the outside through pipes, have demonstrated a high effectiveness in reducing the flow of radon that penetrates into a building from the field. This article presents the results of effectiveness of 4 extraction solutions implemented in a module representative of a home, built in an area with high radon concentrations. Effectiveness is studied depending on the locations of the sumps, with centered or perimeter situation under the floor of the module, and with different types of expulsion of gas, natural convection or forced convection. The main conclusion include the high efficiency displayed by extraction system, with reduction ranges between 91% and 99%, with the exception of the system that use the sump buried by the outer perimeter of the module, and working by natural convection, which actually awarded only in the range of 53% to 58%.

Fucic, A., Fucic, L., Katic, J., Stojković, R., Gamulin, M., Seferović, E.
Radiochemical indoor environment and possible health risks in current building technology
(2011) Building and Environment, 46 (12), pp. 2609-2614.

Abstract
Tremendous work of civil and environmental engineering has been focused on development of sustainable buildings. From economical and ecological viewpoint, this approach is a significant step forward, but the microenvironment created in such living surroundings may present a complex radiochemical setting, which could be a threat to the

health of its occupants. This paper gives overview about levels of indoor radon, insight in risks related with radioactivity of fly ash and zircon, current application of nanoparticles and concrete additives in buildings and their possible impact on human health. As construction engineering is current producer of almost 50% of waste encouragement of incorporation of toxic and radioactive agents in buildings could in future demand redefinition of building construction waste as hazardous and special waste disposals. Collaboration between governmental and non-governmental bodies, manufacturers, scientific institutions, and chartered engineers is needed in order to find balance between quality of indoor air, and to enable maintaining of high health standards by application of non-toxic or non-carcinogenic building materials that meet energy efficiency, building structure stability and security requirements.

Gal, F., Michel, B., Gilles, B., Frédéric, J., Karine, M.
CO2 escapes in the Laacher See region, East Eifel, Germany: Application of natural analogue onshore and offshore geochemical monitoring
(2011) International Journal of Greenhouse Gas Control, 5 (4), pp. 1099-1118.

Abstract
Natural analogues studies have received growing interest during preceding years in a CCS perspective. There is a strong willing to deploy robust and reliable technologies to ensure the safety and integrity of CO2 underground storages. Here we present a dataset acquired in the Eifel volcanic district, using geochemical monitoring methods focussing on both dissolved and gaseous species. Onshore and offshore monitoring (Lake Laacher See) were performed to depict spatial behaviour of CO2 natural releases. Additional gaseous species, mainly helium and radon, were also monitored to better assess the shapes of gas vents, using methodologies that were learned from hydrological and tectonic applications. Lake water monitoring allowed the characterisation of the water body itself, in terms of lateral heterogeneities, to evaluate the impact of CO2 deep degassing near the bottom of the lake. The use of a dedicated sensor for monitoring in situ CO2 partial pressure did not provide more valuable information that was learned from more classical physico-chemical parameters. From those investigations, the usefulness of geochemical monitoring is still demonstrated, but the use of complementary approaches and methods is still needed to get a powerful set of techniques able to warn in case of leakages occurring from depth.

Gal, F., Joublin, F., Haas, H., Jean-prost, V., Ruffier, V.
Soil gas (222Rn, CO2, 4He) behaviour over a natural CO2 accumulation, Montmiral area (Drôme, France): Geographical, geological and temporal relationships
(2011) Journal of Environmental Radioactivity, 102 (2), pp. 107-118.

Abstract
The south east basin of France shelters deep CO2 reservoirs often studied with the aim of

better constraining geological CO2 storage operations. Here we present new soil gas data, completing an existing dataset (CO2, 222Rn, 4He), together with mineralogical and physical characterisations of soil columns, in an attempt to better understand the spatial distribution of gas concentrations in the soils and to rule on the sealed character of the CO2 reservoir at present time.Anomalous gas concentrations were found but did not appear to be clearly related to geological structures that may drain deep gases up to the surface, implying a dominant influence of near surface processes as indicated by carbon isotope ratios. Coarse grained, quartz-rich soils favoured the existence of high CO2 concentrations. Fine grained clayey soils preferentially favoured the existence of 222Rn but not CO2. Soil formations did not act as barriers preventing gas migrations in soils, either due to water content or due to mineralogical composition. No abundant leakage from the Montmiral reservoir can be highlighted by the measurements, even near the exploitation well. As good correlation between CO2 and 222Rn concentrations still exist, it is suggested that 222Rn migration is also CO2 dependent in non-leaking areas - diffusion dominated systems.

Gal, F., Gadalia, A.
Soil gas measurements around the most recent volcanic system of metropolitan France (Lake Pavin, Massif Central) [Mesure des gaz des sols autour du système volcanique le plus récent de France métropolitaine (lac Pavin, Massif Central)]
(2011) Comptes Rendus - Geoscience, 343 (1), pp. 43-54.

Abstract
Soil gas monitoring techniques (CO2, O2, 222Rn, 4He) are used in the geographical context of the recent volcanic system of Lake Pavin (Puy-de-Dôme), to get a better knowledge of local gaseous emissions, in order to establish whether or not this system can present evidence of reactivation. Concentrations up to 100% CO2 and 50ppm of helium are measured in a narrow geographical area (Escarot mofette), together with a magmatic origin for these gases. Radon activity in the mofette area is quite high, but does not show, compared to surrounding areas, enrichments as high as those measured for CO2 or helium. Hourly records of these radon activities, performed during several weeks, suggest the existence of pulsed radon exhalation in the mofette area. The period of this pulsation is around 40 days but its origin remains poorly understood. Apart from this mofette, no evidence of gas originating from depth is highlighted.

Galeriu, D., Melintescu, A., Stochioiu, A., Nicolae, D., Balin, I.
Radon, as a tracer for mixing height dynamics - an overview and RADO perspectives
(2011) Romanian Reports on Physics, 63 (1), pp. 115-127.

Abstract
This paper analyses the various existing experiments using the natural isotope Radon -

222 in estimating the planetary boundary layer (PBL) dynamics and particularly the regional pollutants mixing height. The paper will propose an instrumental set-up in frame of RADO project (Romanian 3D Atmospheric Observatory) based on meteorological tower instrumentation (standard meteo station with 30 and 60 m measuring levels) supplemented by eddy covariance for extensive studies and using well established relationships for assessing mixing height from surface measurement. This will include also daytime comparisons with MAP3D (Mesoscale Air Pollution 3D model) simulations in Bucharest-Magurele station area. Finally LIDAR observations for PBL height validation will be used for development of local Radon tracing function. Further potential development of RADO will be argued.

Gang, C., Ming, J.
Evaluation of Rn-safe around a uranium company in Southern China
(2011) 5th International Conference on Bioinformatics and Biomedical Engineering, iCBBE 2011, art. no. 5781643, .

Abstract
In order to determine exposure to natural sources of radiation for people in the vicinity of a southern China uranium company, six sites included a school, a hospital and four residential areas were investigated from september 2006 to march 2008. The surveys evaluated indoor radon concentrations and outdoor and indoor external gamma dose rates. Indoor radon concentrations were measured in 98 dwellings by means of nuclear track-etched detectors. The terrestrial gamma ray dose rate was measured outdoors and indoors at a total of 148 points and 85 points, respectively. The results show that the total mean annual effective doses for the six areas studied ranged from 3.6 to 5.9 mSv per year, which is between 1.8 and 2.8 times higher than the HengYang average value. Applying the BEIR VI model to the areas studied, the population-weighted average lifetime risk of lung cancer can get 1.9×10-4.

Gardner, W.P., Harrington, G.A., Solomon, D.K., Cook, P.G.
Using terrigenic 4He to identify and quantify regional groundwater discharge to streams
(2011) Water Resources Research, 47 (6), art. no. W06523, .

Abstract
We present a new technique for identifying and quantifying the discharge of long residence time, regional groundwater to rivers using naturally occurring tracers measured within the river. Terrigenic 4He and 222Rn, synoptically sampled along a 100 km reach in the Fitzroy River in northern Western Australia, are used to identify areas of groundwater inflow to the river and to distinguish shallow, local and deep, regional groundwater. Models of tracer transport in the river can be numerically optimized to

calculate total groundwater discharge and to separate regional and local discharge fractions. Discharge of regional groundwater composes close to 15% of the total groundwater discharge along the entire reach, varying spatially along the reach from 0% to 100% of total groundwater discharge. This method should be applicable in river systems where groundwater with elevated terrigenic helium could be discharging to the river. The ability to separate locally from regionally derived groundwater discharge has significant implications for calculating catchment water budgets, for predicting catchment response to changes in precipitation, and for sustainable management of the catchment.

Gattacceca, J.C., Mayer, A., Cucco, A., Claude, C., Radakovitch, O., Vallet-Coulomb, C., Hamelin, B.
Submarine groundwater discharge in a subsiding coastal lowland: A 226Ra and 222Rn investigation in the Southern Venice lagoon
(2011) Applied Geochemistry, 26 (5), pp. 907-920.

Abstract
Several recent studies have suggested that submarine groundwater discharge (SGD) occurs in the Venice lagoon with discharge rates on the same order or larger than the surface runoff, as demonstrated previously in several other coastal zones around the world. Here, the first set of 222Rn data, along with new 226Ra data are reported, in order to investigate the occurrence and magnitude of SGD specifically in the southern basin of the lagoon. The independent connection with the Adriatic Sea (at the Chioggia inlet), in addition to the relative isolation of the water body from the main lagoon, make this area an interesting case study. There is probably only minimal fresh groundwater flux to the lagoon because the surrounding aquifer is subsiding and mainly has a lower hydraulic head than seawater.The data show that the Ra and Rn activities are in slight excess in the lagoon compared to the open sea, with values on the same order as those observed in the northern and central basins. Taking into account the water exchange rate between the lagoon and adjacent seawater provided by previous hydrodynamic numerical modelling, it is shown that this excess cannot be supported at steady state by only riverine input and by diffusive release from the sediment interstitial water. High activities observed in groundwater samples collected from 16 piezometers tapping into the shallow aquifer over the coastal lowland substantiate that the excess radioactivity in the lagoon may indeed be due to the advection of groundwater directly into the lagoon bottom water through the sediment interface. However, the data show that the groundwater composition is extremely heterogeneous, with high Ra activities concentrated within a narrow coastal strip where the contact between fresh and saline water takes place, while Rn strongly decreases when approaching the lagoon shore across the 20km coastal plain. Assuming that the average groundwater activities measured in the coastal strip are representative of the SGD composition, a SGD flux of 7.7±3.5×105 and 2.5±2×106m3/d is calculated using a 226Ra and 222Rn budget, respectively, (i.e. about 1-3 times the surface runoff), substantially lower than in previous studies. The influence of all assumptions on SGD

estimates (groundwater heterogeneity, diffusive sediment flux, one-box versus multi-boxes model calculations) is discussed, and a sensitivity analysis of the influence of imperfect exchange and mixing at the lagoon outlets that affects the lagoon composition is provided. Finally, the results confirm that the SGD flux, calculated with these assumptions, is largely (□80%) composed of saline lagoon water circulating through the sediment under the lagoon margin, and that the fresh water discharge associated with SGD is at most a minor term in the lagoon hydrologic balance. © 2011 Elsevier Ltd.

Gavrilyuk, Yu.M., Gangapshev, A.M., Kuzminov, V.V., Panasenko, S.I., Ratkevich, S.S.
Monitoring the 222Rn concentration in the air of low-background laboratories by means of an ion-pulse ionization chamber
(2011) Bulletin of the Russian Academy of Sciences: Physics, 75 (4), pp. 547-551.

Abstract
A brief description of a setup based on a large-size air ion-pulse ionization chamber intended for monitoring the concentration of 222Rn in the air of laboratories is given. The sensitivity of the detector used for performing measurements with an air sample containing radon with a volume activity of 10 Bq m-3 makes it possible to attain 10% statistical accuracy in determining the area of a radon peak in a measurement time of 103 s. The results from long-term measurements of radon concentration in the air of ground-based and underground laboratories are presented. © 2011 Allerton Press, Inc.

Geng, B., Zhang, G.-H.
Design of detector assembly of the radon measure device
(2011) Hedianzixue Yu Tance Jishu/Nuclear Electronics and Detection Technology, 31 (5), pp. 568-571.

Abstract
It introduces a radon detector assembly of the radon measure device which bases on high voltage electrostatic diffuse approach. The radon is collected by a sampling air circuit which made of silicagel desiccator, double filter, high voltage electrostatic collecting decay chamber and micro-air pump. It detects the daughters of the radon which is in the high voltage electrostatic collecting decay chamber by Au-Si surface barrier detector and charge-sensitive preamplifier, and equips suitable peak hold circuit.

Ghosh, D., Deb, A., Sahoo, S.R., Haldar, S., Sengupta, R.
Radon as seismic precursor: New data with well water of Jalpaiguri, India
(2011) Natural Hazards, 58 (3), pp. 877-889.

Abstract
This paper reports the measurement of radon concentration in well water at the site of Jalpaiguri (26°32′N, 88°46′E) near the active fault zone of West Bengal, India. Radon concentration has been measured in well water with the help of solid-state nuclear track detectors (SSNTD). The study indicates a positive correlation between radon anomaly and earthquake. The data of radon content in well water have been compared with that in soil gas at the same site. © 2011 Springer Science+Business Media B.V.

Ghosh, D., Deb, A., Sengupta, R., Bera, S., Sahoo, S.R., Haldar, S., Patra, K.K.
Comparative study of seismic surveillance on radon in active and non-active tectonic zone of West Bengal, India
(2011) Radiation Measurements, 46 (3), pp. 365-370.

Abstract
Study of radon behaviour in soil or groundwater provides important information in case of seismic activity within the earth's crust. In a previous work, we have tried to correlate the occurrence of radon concentration anomalies in soil with incidents of earthquakes within the distance of 1000 km from the experimental site. The experiment was performed at Kolkata, West Bengal, India (22.53°N, 88.4°E) which is not located in an active fault zone. In extension of our study we have performed simultaneous measurement of radon in an active fault zone at Jalpaiguri (26.53°N, 88.76°E), West Bengal, India as well as in Kolkata - a non-active fault zone. The variation of radon concentration in soil gas was measured by SSNTDs [Solid State Nuclear Track-etch Detector(s)]. Interesting features of an anomalous fluctuation in radon concentration in both the seismic as well as non-seismic zones prior to any particular earthquake is reported.

Gillmore, G., Alizadeh Gharib, H., Denman, A., Phillips, P., Bridge, D.
Radon concentrations in abandoned mines, Cumbria, UK: Safety implications for industrial archaeologists
(2011) Natural Hazards and Earth System Science, 11 (5), pp. 1311-1318.

Abstract
This paper presents a number of surveys performed in a geographical area of the UK, part of which until recently was considered low radon risk. The Cumbrian region was identified by the Building Research Establishment (BRE) in its 1999 guide as an area without a significant radon problem in the built environment. The geology of the region, which includes the Northern Pennine Orefield is varied, but consists of granites, andesites, tuffs, carbonates, sandstones and shales. Mineralisation has taken place (mostly lead and copper ores) primarily along fault and fracture zones, one example being Copper Valley, northwest of Coniston village. This work quantifies the risk of exposure to radon

in a number of abandoned mine environments. High radon levels, up to 28 589 Bq m-3, have been measured in parts of one mine. This study demonstrates that industrial archaeologists (such as the Cumbrian Amenity Trust Mining History Society or CATMHS members) and explorers of abandoned mines can be at risk from radon exposure and it proposes a management scheme to allow industrial archaeologists to continue exploration whilst minimising the risk to health from radon. © Author(s) 2011.

Girault, F., Perrier, F.
Heterogeneous temperature sensitivity of effective radium concentration from various rock and soil samples
(2011) Natural Hazards and Earth System Science, 11 (6), pp. 1619-1626.

Abstract
Temporal variations of radon concentration, or spatial variations around geothermal systems, are partly driven by the effect of temperature on the radon source term, the effective radium concentration (ECRa). ECRa from 12 crushed rock and 12 soil samples from Nepal was measured in the laboratory using the radon accumulation method and Lucas scintillation flasks at three temperatures: 7, 22 and 37 C. For each sample and at each temperature, 5 or 6 measurements were carried out, representing a total of 360 measurements, with an ECRa average varying from 1.1 to 75 Bq kg-1. While the effect is small, ECRa was observed to increase with temperature in a significant and sufficiently reproducible manner. The increase was approximately linear with a slope (temperature sensitivity, TS) expressed in % C-1. We observed a large heterogeneity of TS with average values (range min-max) of 0.79 ± 0.05 (0.16-2.0) % C-1 and 0.61 ± 0.05 (0.10-2.0) % C -1, for rock and soil samples, respectively. While this range overlaps with the results of previous studies, our values of TS tend to be smaller. The observed heterogeneity implies that the TS, rather poorly understood, needs to be assessed by dedicated experiments in every case where it is of consequence for the interpretation. © Author(s) 2011.

Girault, F., Gajurel, A.P., Perrier, F., Upreti, B.N., Richon, P.
Radon emanation of heterogeneous basin deposits in Kathmandu Valley, Nepal
(2011) Journal of Asian Earth Sciences, 40 (2), pp. 595-610.

Abstract
Effective radium-226 concentration (ECRa) has been measured in soil samples from seven horizontal and vertical profiles of terrace scarps in the northern part of Kathmandu Valley, Nepal. The samples belong to the Thimi, Gokarna, and Tokha Formations, dated from 50 to 14ky BP, and represent a diverse fluvio-deltaic sedimentary facies mainly consisting of gravelly to coarse sands, black, orange and brown clays. ECRa was measured in the laboratory by radon-222 emanation. The samples (n=177) are placed in air-tight glass containers, from which, after an accumulation time varying from 3 to

18days, the concentration of radon-222, radioactive decay product of radium-226 and radioactive gas with a half-life of 3.8days, is measured using scintillation flasks. The ECRa values from the seven different profiles of the terrace deposits vary from 0.4 to 43Bqkg-1, with profile averages ranging from 12±1 to 27±2Bqkg-1. The values have a remarkable consistency along a particular horizon of sediment layers, clearly demonstrating that these values can be used for long distance correlations of the sediment horizons. Widely separated sediment profiles, representing similar stratigraphic positions, exhibit consistent ECRa values in corresponding stratigraphic sediment layers. ECRa measurements therefore appear particularly useful for lithologic and stratigraphic discriminations. For comparison, ECRa values of soils from different localities having various sources of origin were also obtained: 9.2±0.4Bqkg-1 in soils of Syabru-Bensi (Central Nepal), 23±1Bqkg-1 in red residual soils of the Bhattar-Trisuli Bazar terrace (North of Kathmandu), 17.1±0.3Bqkg-1 in red residual soils of terrace of Kalikasthan (North of Trisuli Bazar) and 10±1Bqkg-1 in red residual soils of a site near Nagarkot (East of Kathmandu). The knowledge of ECRa values for these various soils is important for modelling radon exhalation at the ground surface, in particular in the vicinity of active faults. Importantly, the study also reveals that, above numerous sediments of Kathmandu Valley, radon concentration in dwellings can potentially exceed the level of 300Bqm-3 for residential areas; a fact that should be seriously taken into account by the governmental and non-governmental agencies as well as building authorities.

Gomes, M.E.P., Neves, L.J.P.F., Coelho, F., Carvalho, A., Sousa, M., Pereira, A.J.S.C.
Geochemistry of granites and metasediments of the urban area of Vila Real (northern Portugal) and correlative radon risk
(2011) Environmental Earth Sciences, 64 (2), pp. 497-502.

Abstract
Radon concentration was evaluated in dwellings of the urban area of Vila Real (Northern Portugal). The area is mainly composed of Hercynian granites and Cambrian metasediments, and CR-39 passive detectors (n = 112) were used for the purpose. The results obtained in winter conditions suggest that the most productive geological unit is the Hercynian granite G1 (geometric mean of 364 Bq/m3), while Cambrian metasediments of the Douro Group show the lowest average indoor radon concentration (236 Bq/m3). The geological, geochemical and radiological data obtained suggest that the most effective control on the radon concentrations of the area is related with the uranium content of the rocks; indeed, the highest contents were observed in granite G1 (21 ppm) and the lowest in the metasediments (3 ppm). This is also confirmed by the results obtained for groundwater, where granites present the highest concentrations of dissolved radon (up to 938 Bq/l), uranium (5-18 ppb) and gross α activities (0.47-0.92 Bq/l). No important radiometric anomalies were found in relation with geological structures such as faults, veins and contacts, but a moderate increase of the uranium content can occur locally in such structures. Petrographic observations and SEM studies show that uranium is mainly contained within the rock in heavy accessory minerals (apatite, zircon,

monazite, xenotime), which reduces radon emanation. Notwithstanding, due to the high U contents granites show a significant potential to induce indoor radon concentrations in dwellings in excess of the recommended value of 400 Bq/m3. Overall, we can conclude that the region of Vila Real presents a moderate to high radon risk in dwellings and groundwater. © 2010 Springer-Verlag.

Gómez, D.P., Neves, L., Pereira, A., Neila, C.G.
Natural radioactivity in ornamental stones: An approach to its study using stones from Iberia
(2011) Bulletin of Engineering Geology and the Environment, 70 (4), pp. 543-547.

Abstract
Natural stones are commonly used both for interior and exterior construction but due to their mineralogy, some rocks (e.g.,granite) can generate a high amount of radon in the atmosphere. Several samples of commercial ornamental stones from Iberia were analyzed for radon. A correlation between natural radioactivity, mineralogy and geochemistry provides a useful indication of the possible hazards of using such rocks indoors. A high radon content in a rock should lead to both restrictions for its use as interior building stone and, if it has been used, implementation of a ventilation system to reduce any hazard. Such rocks as serpentinite, which do not seem to present any problem related to natural radioactivity, are recommended for interior use in preference to granitic rocks. © 2011 Springer-Verlag.

Grant, D., Hallin, A., Hanchurak, S., Krauss, C., Liu, S., Soluk, R.
Low radon cleanroom at the University of Alberta
(2011) AIP Conference Proceedings, 1338, pp. 161-163.

Abstract
A cleanroom laboratory designed to create and maintain a low concentration of radon in the air has been designed and is now under construction. We describe the clean room, the radon stripping system, and various radon monitoring tools. © 2011 American Institute of Physics.

Gregorič, A., Zidanšek, A., Vaupotič, J.
Dependence of radon levels in Postojna Cave on outside air temperature
(2011) Natural Hazards and Earth System Science, 11 (5), pp. 1523-1528.

Abstract
Postojna Cave is the largest of 21 show caves in Slovenia. The radon concentration there was measured continuously in the Great Mountain hall from July 2005 to October 2009

and ranged from about 200 Bq m-3 in winter to about 3 kBq m-3 in summer. The observed seasonal pattern of radon concentration is governed by air movement due to the difference in external and internal air densities, controlled mainly by air temperature. The cave behaves as a large chimney and in the cold period, the warmer cave air is released vertically through cracks and fissures to the colder outside atmosphere, enabling the inflow of fresh air with low radon levels. In summer the ventilation is minimal or reversed and the air flows from the higher to the lower openings of the cave. Our calculations have shown that the effect of the difference between outside and cave air temperatures on radon concentration is delayed for four days, presumably because of the distance of the measurement point from the lower entrance (ca. 2 km). A model developed for predicting radon concentration on the basis of outside air temperature has been checked and found to be successful.

Grossi, C., Vargas, A., Camacho, A., López-Coto, I., Bolívar, J.P., Xia, Y., Conen, F.
Inter-comparison of different direct and indirect methods to determine radon flux from soil
(2011) Radiation Measurements, 46 (1), pp. 112-118.

Abstract
The physical and chemical characteristics of radon gas make it a good tracer for use in the application of atmospheric transport models. For this purpose the radon source needs to be known on a global scale and this is difficult to achieve by only direct experimental methods. However, indirect methods can provide radon flux maps on larger scales, but their reliability has to be carefully checked. It is the aim of this work to compare radon flux values obtained by direct and indirect methods in a measurement campaign performed in the summer of 2008. Different systems to directly measure radon flux from the soil surface and to measure the related parameters terrestrial γ dose and 226Ra activity in soil, for indirect estimation of radon flux, were tested. Four eastern Spanish sites with different geological and soil characteristics were selected: Teruel, Los Pedrones, Quintanar de la Orden and Madrid. The study shows the usefulness of both direct and indirect methods for obtaining radon flux data. Direct radon flux measurements by continuous and integrated monitors showed a coefficient of variation between 10% and 23%. At the same time, indirect methods based on correlations between 222Rn and terrestrial γ dose rate, or 226Ra activity in soil, provided results similar to the direct measurements, when these proxies were directly measured at the site. Larger discrepancies were found when proxy values were extracted from existing data bases. The participating members involved in the campaign study were the Institute of Energy Technology (INTE) of the Technical University of Catalonia (UPC), Huelva University (UHU), and Basel University (BASEL).

Groves-Kirkby, C.J., Timson, K., Shield, G., Denman, A.R., Rogers, S., Phillips, P.S.
Lung-cancer reduction from smoking cessation and radon remediation: A preliminary cost-analysis in Northamptonshire, UK
(2011) Environment International, 37 (2), pp. 375-382.

Abstract
Domestic radon levels in parts of the United Kingdom are sufficiently high as to increase the risk of lung-cancer among residents. Public health campaigns in the county of Northamptonshire, a designated radon Affected Area with 6.3% of homes having average radon levels in excess of the UK Action Level of 200Bq m-3, have encouraged householders to test for radon and then, if indicated to be necessary, to carry out remediation in their homes. These campaigns have been only partially successful, since to date only 40% of Northamptonshire houses have been tested, and only 15% of those householders finding raised levels have proceeded to remediate. Those who remediate have been shown to have smaller families, to be older, and to include fewer smokers than the average population, suggesting that current strategies to reduce domestic radon exposure are not reaching those most at risk. During 2004-2005, the NHS Stop-Smoking Services in Northamptonshire assisted 2847 smokers to quit to the 4-week stage, the 15% (435) of these 4-week quitters remaining quitters at 1. year forming the subjects of a retrospective study considering whether smoking cessation campaigns contribute significantly to radon risk reduction. Quantitative assessment of the risk of lung-cancer among the study population, from knowledge of the individuals' age, gender, and smoking habits, together with the radon levels in their homes, demonstrates that smoking cessation programmes have significant added value in reducing the incidence of lung-cancer in radon Affected Areas, and contribute a substantially greater health benefit at a lower cost than the alternative strategy of reducing radon levels in the smokers' homes, while they remain smokers. Both radon remediation and smoking cessation programmes are very cost effective in Northamptonshire, with smoking cessation being significantly more cost effective, and these are potentially valuable programmes to drive health improvements through promotion of the uptake or environmental management for radon in the home. © 2010 Elsevier Ltd.

Gruber, E., Salama, E., Rühm, W.
Real-time measurement of individual occupational radon exposures in tombs of the Valley of the Kings, Egypt
(2011) Radiation Protection Dosimetry, 144 (1-4), art. no. ncq450, pp. 620-626.

Abstract
The active radon exposure meter developed recently at the German Research Center for Environmental Health (Helmholtz Zentrum München) was used to measure radon concentrations in 12 tombs located in the Valley of the Kings, Egypt. Radon concentrations in air between 50 ± 7 and 12 100 ± 600 Bq m-3 were obtained. The device was also used to measure individual radon exposures of those persons working as safeguards inside the tombs. For a measurement time of 2-3 d, typical individual radon

exposures ranged from 1800 ± 400 to 240 000 ± 13 000 Bq h m-3, depending on the duration of measurement and radon concentration in the different tombs. Based on current ICRP dose conversion conventions for workers and on equilibrium factors published in the literature for these tombs, individual effective dose rates that range from 1.5 ± 0.3 to 860 ± 50 μSv d21 were estimated. If it is assumed that the climatic conditions present at the measurement campaign persist for about half a year, in this area, then effective doses up to ~66 mSv could be estimated for half a year, for some of the safeguards of tombs where F-values were known. To reduce the exposure of the safeguards, some recommendations are proposed.

Gu, S., Zhang, H.
Study on extracting medium-term precursory anomalies from water radon and water level observation with wavelet analysis
(2011) Acta Seismologica Sinica, 33 (4), pp. 471-482.

Abstract
Noticing that the wavelet analysis possesses a characteristic of high resolution in time and frequency domain, this paper develops a method of extracting wavelet medium-term anomaly from water radon and water level observation. The extraction process includes, through research, deciding the objective earthquake expected to be predicted, selecting testing items and observation wells, extracting wavelet anomaly, identifying the property of the precursor anomaly, etc. (seven steps). With the methodology of extraction of wavelet anomaly, we have studied large amount of earthquake materials in North China, Sichuan and its vicinity, and Hainan. After analyzing the relation between the earthquakes and the anomaly of water level and radon, we provided the characteristic time distribution of wavelet anomalies in these three regions. Moreover, the advanced time of the wavelet anomaly can be regarded as an indicator for forecasting an earthquake. This indicator would be helpful in analyzing earthquake situation in practice.

Guiseppe, V.E., Elliott, S.R., Hime, A., Rielage, K., Westerdale, S.
A radon progeny deposition model
(2011) AIP Conference Proceedings, 1338, pp. 95-100.

Abstract
The next generation low-background detectors operating underground aim for unprecedented low levels of radioactive backgrounds. Although the radioactive decays of airborne radon (particularly 222Rn) and its subsequent progeny present in an experiment are potential backgrounds, also problematic is the deposition of radon progeny on detector materials. Exposure to radon at any stage of assembly of an experiment can result in surface contamination by progeny supported by the long half life (22 y) of 210Pb on sensitive locations of a detector. An understanding of the potential surface

contamination from deposition will enable requirements of radon-reduced air and clean room environments for the assembly of low background experiments. It is known that there are a number of environmental factors that govern the deposition of progeny onto surfaces. However, existing models have not explored the impact of some environmental factors important for low background experiments. A test stand has been constructed to deposit radon progeny on various surfaces under a controlled environment in order to develop a deposition model. Results from this test stand and the resulting deposition model are presented.

Guo, H.-P., Wei, P.-G., Sun, T., Wei, C.-M.
The electrostatic collection SSNTD's Monte Carlo method simulates and optimizes
(2011) Hedianzixue Yu Tance Jishu/Nuclear Electronics and Detection Technology, 31 (6), pp. 685-688.

Abstract
It designs a new type of the electrostatic collection SSNTD(Solid State Nuclear Track Detector), simulates and calculates the detecting process through a model build by Monte Carlo method, and quantitatively simulates the effects of electrostatic collection method improving detection efficiency. It makes the detector's potency achieve maximum by simulating and optimizing its size. It is indicated that the conversion fraction which is an optimized object approximately linear grows with the detector's diameter's growing, and when the detector's radius reaches 2 cm, the conversion fraction grows gradually, while when the detector's radius reaches about 3 cm, the conversion fraction doesn't grow, and has the dropping trend. It can conclude that when the detector's radius is about 3 cm, the detector has higher detection efficiency.

Guo, H.-P., Xu, Z.-L., Wang, H.-C.
Monitor and evaluation of the indoor radon of one residential quarters period II
(2011) Hedianzixue Yu Tance Jishu/Nuclear Electronics and Detection Technology, 31 (5), pp. 547-550.

Abstract
To obtain the indoor radon concentration level of one residential quarters period II, it measures the radon concentration by model PCMR-1 online monitor. It can find that the concentration scope of radon is 6.2~35.4 Bq·m-3, absolutely measures up the national standard. Through the analysis and evaluation of data. The source of radon will be known, and some measures can also be made to reduce radon concentration.

Gyorfi, T., Raics, P.
Investigation of environmental radioactivity of wine cellars, watercourse and industrial

waste
(2011) Applied Radiation and Isotopes, 69 (9), pp. 1235-1240.

Abstract
The aim of the investigations was to determine activity concentration of radioactive isotopes in soil samples collected from different provinces of Hungary.Earlier studies have proved that the 222Rn activity concentration is higher than permitted in some wine cellars. To investigate the reason for this phenomenon, the activity concentration of soil samples was measured.Analyzing 137Cs isotope activity in samples collected from the area of a watercourse it was possible to determine the silting-up rate.Activity concentrations were measured for red mud originating from an industrial disaster. © 2011 Elsevier Ltd.

Gyorfi, T., Raics, P.
Investigation of environmental radioactivity of wine cellars, watercourse and industrial waste
Applied Radiation and Isotopes, . Article in Press.

Abstract
The aim of the investigations was to determine activity concentration of radioactive isotopes in soil samples collected from different provinces of Hungary. Earlier studies have proved that the 222Rn activity concentration is higher than permitted in some wine cellars. To investigate the reason for this phenomenon, the activity concentration of soil samples was measured. Analyzing 137Cs isotope activity in samples collected from the area of a watercourse it was possible to determine the silting-up rate. Activity concentrations were measured for red mud originating from an industrial disaster. © 2011 Elsevier Ltd. All rights reserved.

Gyorfi, T., Csige, I.
Effect of atmospheric pressure variations on the 222Rn activity concentration in the air of a wine cellar
(2011) Journal of Radioanalytical and Nuclear Chemistry, 288 (1), pp. 229-232.

Abstract
We have measured the variation of atmospheric pressure and of 222Rn activity concentration in the air of a wine cellar with an AlphaGAURD type ionization chamber radon monitor. We have found that the 222Rn activity concentration varies inversely with pressure. To explain this behavior we have done model calculations. We have compared the results of model calculations with the results of experimental measurements, and we have found that the model is capable to reproduce some part of the variation of 222Rn activity concentration. © 2011 Akadémiai Kiadó, Budapest, Hungary.

Hajdu, S.I.
A note from history: Much overlooked causes of lung cancer
(2011) Annals of Clinical and Laboratory Science, 41 (1), pp. 97-101.

Hale, A.C., Tries, M.A.
Determination of 239Pu airborne concentration alpha correction factor for a zinc sulfide detector via ambient 222Rn progeny air sampling
(2011) Health Physics, 100 (2), pp. 201-209.

Abstract
This research empirically determined the 239Pu airborne concentration alpha correction factor for an ADM-300 zinc sulfide detection system via ambient 222Rn progeny air sampling using a RADeCO high volume air sampler. Radon progeny air samples were collected on a four inch glass fiber filter and evaluated on both a high purity germanium detector and the ADM-300 simultaneously using the three count method. These data were analyzed to obtain a loss fraction in the glass fiber filter for the 214Bi collected. The 214Bi response then was used to estimate a loss fraction for 239Pu. The 239Pu airborne concentration alpha correction factor for the ADM-300 detection system was found to be 445 ± 47 dpm ft3 cpm-1 m-3 as compared to a previously published correction factor of 500 dpm ft3 cpm -1 m-3.

Hamzah, Z., Saat, A., Kassim, M.
Determination of radon activity concentration in water using gamma spectrometry and liquid scintillation counter techniques
(2011) 3rd ISESEE 2011 - International Symposium and Exhibition in Sustainable Energy and Environment, art. no. 5977087, pp. 191-193.

Abstract
Naturally occurring radionuclides in water such as, 226Ra and 222Rn, emit gamma radiation through their decaying process which could reach to the human. The water samples were collected from, Kelantan, Perak and Pahang. At each sampling points, in situ measurement was done whereupon test were performed using GPS, LUDLUM rate meter, and HYDROLAB. Marinelli beakers and glass bottles were used to prepare the water samples. The samples were kept for a month to allow equilibrium between 226Ra, and 222Rn and its progenies to reach. The measurement was done using two different methods, and radon activities were ranged from (0.156-1.876 Bq/l).

Hanžek, B., Franić, Z., Branica, G.
Notable radiophysicists and radiochemists in Croatia by 1945 [Znameniti radiofizičari i radiokemičari u Hrvatskoj do 1945]
(2011) Arhiv za Higijenu Rada i Toksikologiju, 62 (3), pp. 279-290.

Abstract
Physicists and chemists were among the first potential victims of occupational exposure to ionising radiation and they were also the first to warn about the harmful effects of radiation on living organisms. This review presents the work of the first notable scientists in the field of radiation science in Croatia from the discovery of radiation (Henry Becquerel in 1896) to 1945. The beginning of radiation science and radiation protection in Croatia can be traced to the end of the 19th century. Our research of the archived material and literature not only gave a deeper insight to the life and work of some of these notable scientists, but also gave a glimpse of previously unknown facts and details important for the history and development of radiation science, radiation protection, as well as medical physics. Our research has shown that Croatian scientists not only kept pace with contemporary scientific knowledge but also made notable contributions from the very beginning.

Harley, N.H., Chittaporn, P., Marsicano, A.
Residential radon remediation: Performance over 17 years
(2011) Radiation Protection Dosimetry, 145 (2-3), art. no. ncr199, pp. 194-197.

Abstract
An exploratory radon measurement in 1990 identified 190 Bq m-3 in the basement of a newly built home in Central New Jersey. Subsequently, the owner had a sub-slab remediation system installed in the basement, i.e. PVC duct through the basement floor connecting to an exhaust fan venting to the house roof. Sequential radon measurements began in 1992 using the NYU alpha-track detector. The homeowner wanted to insure the long-term durability of this remedial system. Seventeen years of measurements show the system functioned properly and reduced an established baseline concentration of 370±8, 56±1 and 67±1 Bq m-3 for the basement, first and second floors, respectively, to an average of 19±4, 13±3 and 10±0.1 Bq m-3. The last measurement, 2007-2008, with a newer NYU detector measured both 222Rn (radon) and 220Rn (thoron). The basement thoron concentration was 1.5±0.9 Bq m-3 or about 8 % of the 222Rn value.

Hart, J.
Lung cancer in oregon
(2011) Dose-Response, 9 (3), pp. 410-415.

Abstract

Factors thought to be related to lung cancer include smoking, radon, and educational attainment. These factors were analyzed in the present ecological study for Oregon with correlation and linear regression statistics. A moderate, inverse, and statistically significant correlation was found with educational attainment while surprisingly, negligible and statistically insignificant correlations were found with smoking and radon. More rigorous research such as case-control study designs, are indicated to verify or refute these findings.

Hart, J.
Deadly radon in montana? a brief note
(2011) Dose-Response, 9 (2), pp. 293-295.

Hart, J.
Deadly radon in Montana? a rebuttal to dr. larsson
(2011) Dose-Response, 9 (2), pp. 299-300.

Hashemi, S.M., Negarestani, A.
Effective dose rate of radon gas in Jooshan hot spring of kerman province
(2011) Journal of Kerman University of Medical Sciences, 18 (3), pp. 279-285.

Abstract
Background & Aims: Human beings are constantly exposed to different radiations that have always been recognized as a health hazard. Radon -222 and its daughter products are major sources of natural radiations and a significant total inhalation dose is related to them. Hence, the measurement of radon activity in the environment has gained an increasing importance. In this study, with the measurement of radon concentration, the indoor radon activity level and radon effective dose rate in Jooshan hot spring were determined. Method: Concentration of radon gas inside the pool of Jooshan hot spring was measured using the active detector Rad7 type and the annual effective dose was estimated for individuals inhaling the indoor air of this pool for a specified period of time. Results: Concentration of indoor air radon gas was 98.3±4.9 Bq/m3 and for a person staying in the pool twice a week and each time for two hours, the annual effective dose rate, due to the inhalation of radon, equals to 0.06±0.003 mSv/y. Conclusion: Comparison of the obtained effective does with the standards of Environmental protection Agency and Health physics Society, it can be concluded that for individuals that normally use Jooshan hot spring pool, the resulted dose is in the recommended range.

Hassan, N.M., Ishikawa, T., Hosoda, M., Iwaoka, K., Sorimachi, A., Sahoo, S.K., Janik, M., Kranrod, C., Yonehara, H., Fukushi, M., Tokonami, S.
The effect of water content on the radon emanation coefficient for some building materials used in Japan
(2011) Radiation Measurements, 46 (2), pp. 232-237.

Abstract
Building materials used in Japan were collected from several companies and their radionuclide concentrations were measured. Fifteen granite samples with high activity concentrations were selected for the present study. To investigate the effect of water content on the radon emanation coefficient, the coefficient was measured under 3 different conditions (dry, normal, and wet). The emanation coefficients were then used to calculate the alpha equivalent dose (dose from indoor radon generated from building materials), assuming a simple room model. The radon emanation coefficient for the dry condition ranged from (3.7 ± 0.1)% to (27.2 ± 3.9)%, with an average value of (10.5 ± 1.4)%. The emanation coefficients were 2-5 times that size for the wet condition. Similarly, the alpha dose became larger, owing to its proportion to the emanation coefficient, indicating that water content in building materials is an important factor for the emanation coefficient as well as the radiation dose. The radon exhalation rate was also measured for the dry samples. Radon exhalation rate and radium concentration had a relatively low correlation (R2 = 0.40). However, the correlation between radon exhalation rate and "emanated radon concentration" (radium concentration × emanation coefficient) was much higher (R2 = 0.84). Therefore, emanated radon concentration could be a useful index for exhalation rate and alpha equivalent dose, but radium concentration in building materials alone is not.

Hassan, N.M., Tokonami, S., Fukushi, M.
A simple technique for studying the dependence of radon and thoron exhalation rate from building materials on absolute humidity
(2011) Journal of Radioanalytical and Nuclear Chemistry, 287 (1), pp. 185-191.

Abstract
Indoor radon and thoron concentrations were dominated with their exhalation rate from building materials. Thus, the evaluation of exhalation rate with highly precise is important. This paper presented a new technique to measure the dependence radon/thoron exhalation rate, from building materials used in Japan, on absolute humidity. The measurement technique consisted of a solid state alpha detector equipped a ventilation-type chamber and humidity control system in a flow through method. The exhalation rate of dried samples (Indian red granite and Japanese gray granite) was measured at various absolute humidity levels in the range of 1-20 g cm-3. It was found that exhalation rate increased exponential with increasing of absolute humidity for both samples. Furthermore, the dependence of radon emanation coefficient on building material's temperature was also studied using an accumulation chamber equipped with scintillation cell alpha detector. The emanation coefficient of dry sample increased proportionally

with increasing the material's temperature with a correlation factor of 0.88. © 2010 Akadémiai Kiadó, Budapest, Hungary.

Hauptmann, M., Richardson, D.B.
Flexible modeling of the cumulative effects of time-dependent exposures on the hazard
(2011) Statistics in Medicine, 30 (2), pp. 197-197.

Heidary, S., Setayeshi, S., Ghannadi-Maragheh, M., Negarestani, A.
Monitoring and measurement of radon activity in a new design of radon calibration chamber
(2011) Radiation Measurements, 46 (8), pp. 694-700.

Abstract
A new radon calibration chamber has been designed, constructed and tested to set various desired environmental parameters. The chamber is cubic with two trapezoid sides with a total volume size of 0.498 m3. The three parameters, temperature, humidity and flow are controlled in the range of 20-45 °C (±2 °C), 10-70% (±2.5%) and 0.2-10 m3/min (±0.1 m3/min) respectively. The chamber is equipped with a controllable speed centrifugal fan to achieve a desirably uniform radon flow rate. Many parts of this system are controlled and monitored with a PLC (Programmable Logic Control) and HMI (Human Monitoring Interface) software (Citect Scada). Finally a radon detector (Alpha-Guard) registers the activity parameter.

Heraud, J.A., Lira, J.A.
Co-seismic luminescence in Lima, 150 km from the epicenter of the Pisco, Peru earthquake of 15 August 2007
(2011) Natural Hazards and Earth System Science, 11 (4), pp. 1025-1036.

Abstract
The first photographs of Co-seismic Luminescence, commonly known as Earthquake lights (EQLs), were reported in 1968 in Japan. However, there have been documented reports of luminescence associated with earthquakes since ancient times in different parts of the world. Besides this, there is modern scientific work dealing with evidence of and models for the production of such lights. During the Peru 15 August 2007 MwCombining double low line8.0 earthquake which occurred at 06:40 p.m. LT, hence dark in the southern wintertime, several EQLs were observed along the Peruvian coast and extensively reported in the capital city of Lima, about 150 km northwest of the epicenter. These lights were video-recorded by a security camera installed at the Pontificia Universidad Catolica del Peru (PUCP) campus and time-correlated with seismic ground accelerations registered at the seismological station on campus, analyzed

and related to highly qualified eyewitness observations of the phenomena from other parts of the city and to other video recordings. We believe the evidence presented here contributes significantly to sustain the hypothesis that electromagnetic phenomena related to seismic activity can occur, at least during an earthquake. It is highly probable that continued research in luminescence and the use of magnetometers in studying electromagnetic activity and radon gas emanation detectors will contribute even more towards determining their occurrence during and probably prior to seismic activity.

Hoffman, F.O., Kocher, D.C., Apostoaei, A.I.
Beyond dose assessment: Using risk with full disclosure of uncertainty in public and scientific communication
(2011) Health Physics, 101 (5), pp. 591-600.

Abstract
Evaluations of radiation exposures of workers and the public traditionally focus on assessments of radiation dose, especially annual dose, without explicitly evaluating the health risk associated with those exposures, principally the risk of radiation-induced cancer. When dose is the endpoint of an assessment, opportunities to communicate the significance of exposures are limited to comparisons with dose criteria in regulations, doses due to natural background or medical X-rays, and doses above which a statistically significant increase of disease has been observed in epidemiologic studies. Risk assessment generally addresses the chance (probability) that specific diseases might be induced by past, present, or future exposure. The risk of cancer per unit dose will vary depending on gender, age, exposure type (acute or chronic), and radiation type. It is not uncommon to find that two individuals with the same effective dose will have substantially different risks. Risk assessment has shown, for example, that: (a) medical exposures to computed tomography scans have become a leading source of future risk to the general population, and that the risk would be increased above recently published estimates if the incidence of skin cancer and the increased risk from exposure to X-rays compared with high-energy photons were taken into account; (b) indoor radon is a significant contributor to the baseline risk of lung cancer, particularly among people who have never smoked; and (c) members of the public who were exposed in childhood to I in fallout from atmospheric nuclear weapons tests and were diagnosed with thyroid cancer later in life would frequently meet criteria established for federal compensation of cancers experienced by energy workers and military participants at atmospheric weapons tests. Risk estimation also enables comparisons of impacts of exposures to radiation and chemical carcinogens and other hazards to life and health. Communication of risk with uncertainty is essential for reaching informed consent, whether communicating to a larger community debating the tradeoffs of risks and benefits of an action that involves radiation exposure or communicating at the level of a physician and patient. Copyright © 2011 Health Physics Society.

Hofmann, H., Gilfedder, B.S., Cartwright, I.
A novel method using a silicone diffusion membrane for continuous 222Rn measurements for the quantification of groundwater discharge to streams and rivers
(2011) Environmental Science and Technology, 45 (20), pp. 8915-8921.

Abstract
222Rn is a natural radionuclide that is commonly used as tracer to quantify groundwater discharge to streams, rivers, lakes, and coastal environments. The use of sporadic point measurements provides little information about short- to medium-term processes (hours to weeks) at the groundwater-surface water interface. Here we present a novel method for high-resolution autonomous, and continuous, measurement of 222Rn in rivers and streams using a silicone diffusion membrane system coupled to a solid-state radon-in-air detector (RAD7). In this system water is pumped through a silicone diffusion tube placed inside an outer air circuit tube that is connected to the detector. 222Rn diffuses from the water into the air loop, and the 222Rn activity in the air is measured. By optimizing the membrane tube length, wall thickness, and water flow rates through the membrane, it was possible to quantify radon variations over times scales of about 3 h. The detection limit for the entire system with 20 min counting was 18 Bq m-3 at the 3σ level. Deployment of the system on a small urban stream showed that groundwater discharge is dynamic, with changes in 222Rn activity doubling on the scale of hours in response to increased stream flow.

Hofmann, W., Winkler-Heil, R.
Radon lung dosimetry models
(2011) Radiation Protection Dosimetry, 145 (2-3), art. no. ncr059, pp. 206-212.

Abstract
Two different modelling approaches are currently used to calculate short-lived radon progeny doses to the lungs: the semiempirical compartment model proposed by the International Commission on Radiological Protection and deterministic and stochastic airway generation models. The stochastic generation model IDEAL-DOSE simulates lung morphometry, transport, deposition and clearance of inhaled radionuclides, and cellular dosimetry by Monte Carlo methods. Specific dosimetric issues addressed in this paper are: (1) distributions of bronchial doses among and within bronchial airway generations; (2) relative contributions of radon progeny directly deposited in a given airway generation and those passing through from downstream generations to the bronchial dose in that generation; (3) distribution of bronchial doses among the five lobes of the human lung; (4) inhomogeneity of surface activities and resulting doses within bronchial airway bifurcations; (5) comparison of bronchial doses between non-smokers and smokers; (6) relative contributions of sensitive target cells in bronchial epithelium to lung cancer induction and (7) intra- and intersubject variations of bronchial doses.

Hosoda, M., Ishikawa, T., Sorimachi, A., Tokonami, S., Uchida, S.
Development and application of a continuous measurement system for radon exhalation rate
(2011) Review of Scientific Instruments, 82 (1), art. no. 015101, .

Abstract
A continuous measurement system, with a ventilation-type accumulation chamber, was developed for radon exhalation rate determination. A reasonable sampling flow rate for the measurement system was determined by comparing the values obtained by the system with those obtained by a grab sampling method. The sampling flow rate of passage through the scintillation cell from the accumulation chamber was varied from 0.05 to 2.0 l min-1. The difference in pressure between the inside and outside of the accumulation chamber increased as the sampling flow rate became large, and the estimated radon exhalation rate also increased with the sampling flow rate. From these results, a reasonable sampling flow rate was estimated to be less than 0.2 l min-1. © 2011 American Institute of Physics.

Hou, W.-S., Chen, G.-N., Zhuang, W.-M., Peng, Z.-L., Meng, F.-Q., Zhang, C.-B., Zhang, K.
Detection and activity estimation of quaternary fault in Xilingang area
(2011) Jilin Daxue Xuebao (Diqiu Kexue Ban)/Journal of Jilin University (Earth Science Edition), 41 (3), pp. 925-931.

Abstract
Ground penetration radar, luminescence dating and radon measurement were used to detect the Xilingang fault in Pearl River Delta. The results illustrate that during the Late Pleistocene epoch, at least two paroxysmal fault movements happened in the research area. The first movement happened about 40000 a ago, causing a block inclination of hanging wall, and an unconformity interface among the Quaternary strata; the slip of the fault reached to 5.5 m. The second paroxysmal movement, which happened 20000 a ago, causing the fault slip about 0.53 m. The peak value of radon on the fault is three times higher than the background value. All the evidences demonstrate that the Xilingang fault is active and has potential dange, therefore the conclusion that the faults located in the north of Pearl River Delta were non-active and steady should be changed.

Hu, D., Yang, W.-G., Song, J.-F.
International comparison of radon measurements using solid state nuclear track detectors
(2011) Hedianzixue Yu Tance Jishu/Nuclear Electronics and Detection Technology, 31 (7), pp. 794-797.

Abstract
It introduces the radon measurements international comparison using solid state track detectors among Zhejiang Environmental Radiation Monitoring Center (RMTC), Japan Chemical Analysis Center (JCAC) and National Institute for Radiological Protection of China CDC (NIRP). The results of the international comparison show that: Compared to the reference values, the measurements' relative deviations of detectors from 3 labs were 2%~22%, which were exposed in radon chambers with different radon concentration, while the measurements' relative deviations were 0.5%~13% when exposed in the environment. The measurement's relative deviations of RMTC were5%~13% in radon chambers and 0.5%~9% in the environment, the results met requirements of the relative standards both at home and abroad.

Hunter, N., Muirhead, C.R., Miles, J.C.H.
Two error components model for measurement error: Application to radon in homes
(2011) Journal of Environmental Radioactivity, 102 (9), pp. 799-805.

Abstract
In this paper, a simple model for analysing variability in radon concentrations in homes is tested. The approach used here involves two error components, representing additive and multiplicative errors, together with variation between-houses. We use a Bayesian approach for our analysis and apply this model to two datasets of repeat radon measurements in homes; one based on 3-month long measurements for which the original measurements were close to the current UK Radon Action Level (200 Bq m-3), and the other based on 6-month measurement data (from regional and national surveys), for which the original measurements cover a wide range of radon concentrations, down to very low levels. The model with two error components provides a better fit to these datasets than does a model based on solely multiplicative errors. © 2011 Elsevier Ltd.

Hussain, M., Winkler-Heil, R., Hofmann, W.
Lung dosimetry for inhaled long-lived radionuclides and radon progeny
(2011) Radiation Protection Dosimetry, 145 (2-3), art. no. ncr060, pp. 213-217.

Abstract
The current version of the stochastic lung dosimetry model IDEAL-DOSE considers deposition in the whole tracheobronchial (TB) and alveolar airway system, while clearance is restricted to TB airways. For the investigation of doses produced by inhaled long-lived radionuclides (LLR) together with short-lived radon progeny, alveolar clearance has to be considered. Thus, present dose calculations are based on the average transport rates proposed for the revision of the ICRP human respiratory tract model. The results obtained indicate that LLR cleared from the alveolar region can deliver up to two

to six times higher doses to the TB region when compared with the doses from directly deposited particles. Comparison of LLR doses with those of short-lived radon progeny indicates that LLR in uranium mines can deliver up to 5 % of the doses predicted for the short-lived radon daughters.

Hutchison, L.
The necessity of sharing how evidence-based medicine works.
(2011) Iowa medicine : journal of the Iowa Medical Society, 101 (4), p. 6.

Iashina, L.M., Shatrova, L.E., Zhdanova, K.S., Kuznetsova, T.A.
[The influence of radon baths on the lipid profile of patients with cardiovascular diseases and dyslipidemia].
(2011) Voprosy kurortologii, fizioterapii, i lechebnoĭ fizicheskoĭ kultury, (2), pp. 3-4.

Abstract
The present study included 82 patients at the age from 28 to 60 years (46 women and 36 men). Radiotherapy was given to 44 patients of whom 27 presented with cardiovascular diseases (CVD) and 17 with diseases of the locomotor apparatus (LA) and concomitant dislipoproteinemia (DLP). The control group was comprised of 38 subjects (27 with CVD and 11 with LA disease + DLP). The patients received radiotherapy every other day as a series of 8-9 radon baths (water temperature 36-37 degrees C) for 10-15 min each at a radon concentration of 20-40 nCi/l (total dose 1.2 mSv). The treatment caused a significant increase of serum cholesterol (CL) and high-density lipoproteide (HDLP) levels with simultaneous reduction of the atherogenicity index and a tendency towards a decrease in the levels of total cholesterol, cholesterol of low density lipoproteides (LDLP), and triglicerides. Clinically, the desired level of arterial pressure was reached in 77.2% of the patients.

Idriss, H., Salih, I., Sam, A.K.
Study of radon in ground water and physicochemical parameters in Khartoum state
(2011) Journal of Radioanalytical and Nuclear Chemistry, 290 (2), pp. 333-338.

Abstract
This study was conducted primarily to measure and map radon activity concentration in wells within water supply network of Khartoum State. Ground water samples were collected before and after autumn and analysed using low level γ-spectrometry equipped with HPGe-detector. Radon activity concentration was found in the range of 1.58-345.10 Bq/L with an average value of 59.20 ± 6.60 Bq/L. Upon comparing the radon concentration values obtained with EPA it was found they were far below the maximum

contaminant level of EPA with the exception five samples. Physicochemical water parameters were measured and no correlation was noted between radon concentration and these parameters. The overall annual effective dose for adults due to radon ingestion is less than WHO recommended reference dose level for most except 14 samples.

Iimoto, T., Kosako, T.
Discussion on framework of radon management strategy in various environments
(2011) Radiation Protection Dosimetry, 146 (1-3), art. no. ncr153, pp. 217-220.

Abstract
Activities on radon management strategy of international organisations (International Atomic Energy Agency, International Commission on Radiation Protection, etc.) should be carefully and continuously traced to discuss how to control radon in various environments, for example, dwellings, workplace, underground, caves, mines, hot springs, disposal facilities and so on. It is more reasonable in parallel to set radon reference level by effective dose criteria of Sv y. -1 as well as by radon concentration in air of Bq m. -3. How to investigate radon concentration in each environment, and how to make decisions on needed action for radiation protection from natural radon,-these should be discussed for each environmental situation on a case-by-case basis. International discussion as well as domestic discussion is continuously needed, not only among the radon specialists and regulators, but also including stakeholders who are the main users of regulation and guidance.

Imyanitov, N.S.
Application of a new formulation of the periodic law to predicting the proton affinity of elements
(2011) Russian Journal of Inorganic Chemistry, 56 (5), pp. 745-748.

Abstract
To illustrate the efficiency of a previously proposed new formulation of the Periodic Law, the proton affinities and gas-phase basicities of 20 elements in the p- and d-blocks were predicted. These properties were considered as a function of the total number of p- or d-electrons in an atom, rather than depending on the nuclear charge or the number of outer-shell electrons. The analysis was performed block by block separately. For p elements, the kainosymmetry and additional periodicity were taken into account. Equations were deduced and then used for predicting the proton affinities and gas-phase basicities of p 4-p 6 elements (Se, Te, Po, At, and Rn) and d 2-d 10 elements (Zr, Nb, Mo, Tc, Ag, Cd, Hf, Ta, W, Re, Os, Ir, Pt, Au, and Hg).

Iqbal, A., Baig, M.S., Akram, M., Khan, S.
Indoor radon concentration: Impact of geology in the 2005 Kashmir earthquake-affected Bagh area, Azad Jammu and Kashmir, Pakistan
(2011) Radioprotection, 46 (3), pp. 373-385.

Abstract
The early Miocene Murree Formation, late Miocene Nagri Formation and recent alluvium rock units are exposed in the sub-Himalayas of the Bagh area, State of Azad Jammu and Kashmir, Pakistan. The Bagh area was badly affected by the Kashmir earthquake of October 8th 2005 which, along the Muzaffarabad Fault, deformed both the hanging and footwall blocks. The cracks, joints, fissures and fractures in houses and bedrocks might have affected the emission of radon to the surface. Indoor radon concentration measurements were carried out in some dwellings of the Bagh area, Azad Kashmir, Pakistan. The measurements were based on passive integrative detection of radon using CN-85 plastic track detectors in box-type dosimeters. The radon concentration in dwellings was between 50 ± 11.6 Bq•m-3 and 167.1 ± 21.4 Bq•m -3with an overall average of 95.1 ± 15.8 Bq•m -3(geometric mean = 93.4 Bq•m-3). The average radon concentrations in pucka, semi-pucka and kucha houses were 97.6 ± 15.4 Bq•m-3, 89.7 ± 15.2 Bq•m-3 and 101.9 ± 15.9 Bq•m-3, respectively. The mean values of radon concentrations in the Nagri Formation, Murree Formation and recent alluvium lithology were 99.3 ± 15.8, 90.1 and 96.2 ± 15.5 Bq•m -3, respectively. The annual effective dose to the Bagh population was calculated as 2.38 ± 0.77 (1.33 ± 0.2 to 4.7 ± 0.5) mSv. The average radon (95.1 ± 15.8 Bq•m-3) concentration in dwellings for the inhabitants of the Bagh area was safe from radon-related health hazards and was within the recommended action level (ICRP publication 65 (1993) Protection against radon at home and at work, International Commission on Radiological Protection, Ann. ICRP 23(2)).The indoor radon values obtained in the present study are more than the world average of 40 Bq•m-3 (UNSCEAR (2000) United Nations Scientific Committee on the Effects of Atomic radiation, Report to the General Assembly, United Nations, New York).

Ishikawa, T., Hosoda, M., Sorimachi, A., Tokonami, S., Katoh, S., Ogashiwa, S.
Radiological characterization of commercially available "radon spa sources"
(2011) Journal of Radioanalytical and Nuclear Chemistry, 287 (3), pp. 709-713.

Abstract
Nowadays, artificial "radon spa sources" for home baths are commercially available. Although these sources could give a potential radiation exposure to the users, few studies have been reported on their radiological measurements. In the present study, five types of radon spa sources were collected and their radiological characterization was investigated. The followings were estimated for these samples: (1) radon emanation coefficients (dry and water-saturated conditions), (2) surface γ-ray dose rate, (3) surface count rates for α-

and β-rays, (4) activity concentrations of 226Ra, 232Th and 40K, and (5) concentrations of radon and thoron generated from the sources located in an air flow system. The activity concentrations were very high (except for one sample (named "sample B"), although radon emanation coefficient was low compared with soil. This leads to high concentrations of radon/thoron generated from the sample. The maximum surface γ-ray dose rate was observed for sample A (2.7 μGy h-1). If people stay very close to the sample for a long time, the exposure might be significant.

Ishimori, Y., Mitsunobu, F., Yamaoka, K., Tanaka, H., Kataoka, T., Sakoda, A.
Performance of the first Japanese large-scale facility for radon inhalation experiments with small animals
(2011) Radiation Protection Dosimetry, 146 (1-3), art. no. ncr100, pp. 31-33.

Abstract
A radon test facility for small animals was developed in order to increase the statistical validity of differences of the biological response in various radon environments. This paper illustrates the performances of that facility, the first large-scale facility of its kind in Japan. The facility has a capability to conduct approximately 150 mouse-scale tests at the same time. The apparatus for exposing small animals to radon has six animal chamber groups with five independent cages each. Different radon concentrations in each animal chamber group are available. Because the first target of this study is to examine the in vivo behaviour of radon and its effects, the major functions to control radon and to eliminate thoron were examined experimentally. Additionally, radon progeny concentrations and their particle size distributions in the cages were also examined experimentally to be considered in future projects.

Ismail, A.H., Jaafar, M.S.
Design new detection technique for deposition of radon's daughter onto human blood samples
(2011) 2011 IEEE International Conference on Imaging Systems and Techniques, IST 2011 - Proceedings, art. no. 5962165, pp. 229-231.

Abstract
Proper amount of radon gas (303.11KBq/m3) collected in a tight PVC container with the appropriate engineering dimension using two sources of Radium (5Ci). Complete blood test and the computer scanning for each piece of CR-39NTDs have done before and after exposure to radon concentration (22105.1Bq/m3). The results show that the present design has a good efficiency, an amount of the loss of radon concentration during the process of mixing blood component did not affect on the efficiency of exposure technique. Therefore, method of mixing blood component process was successful. As

well as, human blood exposure to radon gas (22105.1Bq/m3) makes thrombocytopenia, and no effect on red blood cell. Moreover, rate of radon-absorbed dose into the human blood samples is high at 20 minutes. © 2011 IEEE.

Ismail, A.H., Jaafar, M.S., Mustafa, F.H.
Histological study to estimate risks of radon inhalation dose on a lung cancer: In vivo
(2011) IFMBE Proceedings, 35 IFMBE, pp. 312-314.

Abstract
The aim of this study is to estimate risks of inhalation dose (543±26.87B/m3) of indoor radon gas on a lung cancer for the exposed Rabbits by using a histological method. For this purpose, new exposure technique equipped with the nuclear track detectors type CR-39 (CR-39NTDs) has been designed to expose the Rabbits for 90 days. To get an optimum time of exposure the make damage on the lugs, it has been classified into three times 30, 60 and 90 days. Radium-226 (4 pieces) are used as a source of radon inside the exposure chamber, thus, to estimate and get a real value of radon concentration, long (Dosimeter of CR-39NTDs) and short (RAD7) term measurements have been used. The results show that at 60 days of inhalation, Rabbit's lungs started to create spots of (damage cell) cancer, thus, at 90 day of exposure, increase of the cancer spots are increased obviously , and this is agreement with the principle of long of exposure create more damage. © 2011 Springer-Verlag.

Ismail, A.H., Jafaar, M.S., Houssein, H.A.A., Mustafa, F.H.
The impact of exposing human blood samples to the radon gas on the platelet count: Using new exposure technique
(2011) Biophysical Reviews and Letters, 6 (1-2), pp. 81-92.

Abstract
In the present technique, an amount of radon gas (2210 ± 5.1 Bq/m3) is collected in a tight PVC chamber equipped with two sources of radium (5 μCi). Blood samples and the pieces of CR-39NTDs are exposed (together) to a known radon concentration for different periods of exposure. Complete blood test and the computer scanning for each piece of CR-39NTDs before and after exposure are carried out. The results show a 95% retention of radon gas in the present technique during the exposure. Thus, the present technique is considered a better technique in terms of conservation of gas, because of the low rate of loss of the gas (4.915%), and this is the advantage of the present technique: keeping the concentration of gas during periods of exposure as much as possible. Deposition of the alpha particles, which are emitted from radon daughters, has reduced the number of platelets in both gender, and this is dependent on the energies of the alpha particles. Exposure time and the energy loss of the alpha particles within the target (blood and CR-39) through the atomic displacements are considered important parameters in the changes of platelet count. At 20-minute exposure time, the rate of absorption dose is

2.255 ± 0.11 μSv and the platelet count reduces rapidly.

Ismail, A.H., Jaafar, M.S.
Design and construct optimum dosimeter to detect airborne radon and thoron gas: Experimental study
(2011) Nuclear Instruments and Methods in Physics Research, Section B: Beam Interactions with Materials and Atoms, 269 (4), pp. 437-439.

Abstract
Aim of this work is to design and select optimum dimension of a radon and thoron dosimeter within the measure optimum value of the calibration factor, using CR-39 Nuclear Track Detectors (NTDs). The results show that the best dimension to detect and measure real values of airborne radon and thoron concentrations is 6 cm and 7 cm for diameter and height, respectively. Calibration factors (K) for radon and thoron at this dimension were 2.68 ± 0.03 cm and 0.83 ± 0.01 cm, respectively, and these factors relatively depend on the detector efficiency. Therefore, the efficiency of CR-39NTDs to register alpha particles and their effects on the calibration factor estimated. It is found that the calibration factor increased exponentially with detector efficiency. Moreover, detector efficiency was equal to 80.3 ± 1.23% at the optimum dosimeter.

Jacobson, D.R., Khan, N.S., Collé, R., Fitzgerald, R., Laureano-Pérez, L., Bai, Y., Dmochowski, I.J.
Measurement of radon and xenon binding to a cryptophane molecular host
(2011) Proceedings of the National Academy of Sciences of the United States of America, 108 (27), pp. 10969-10973.

Abstract
Xenon and radon have many similar properties, a difference being that all 35 isotopes of radon (195Rn - 229Rn) are radioactive. Radon is a pervasive indoor air pollutant believed to cause significant incidence of lung cancer in many geographic regions, yet radon affinity for a discrete molecular species has never been determined. By comparison, the chemistry of xenon has been widely studied and applied in science and technology. Here, both noble gases were found to bind with exceptional affinity to tris-(triazole ethylamine) cryptophane, a previously unsynthesized water-soluble organic host molecule. The cryptophane - xenon association constant, Ka = 42,000 ± 2,000 M-1 at 293 K, was determined by isothermal titration calorimetry. This value represents the highest measured xenon affinity for a host molecule. The partitioning of radon between air and aqueous cryptophane solutions of varying concentration was determined radiometrically to give the cryptophane - radon association constant Ka = 49,000 ± 12,000 M-1 at 293 K.

Jasaitis, D., Girgždys, A.
Influence of aerosol particle concentration on volumetric activities of indoor radon progeny [Aerozolio daleliu{ogonek} koncentracijos i{ogonek}taka radono skilimo produktu{ogonek} tū riniam aktyvumui patalpose]
(2011) Lithuanian Journal of Physics, 51 (2), pp. 155-161.

Abstract
The influence of aerosol particle concentration on changes of volumetric activities of radon short-lived decay products was investigated. Volumetric activities of radon short-lived products in accommodations under various living conditions were measured. Concentrations of aerosol particles in the air, equilibrium factors, and unattached fraction were determinated under normal living conditions and by increasing the concentration of aerosol particles in the air of the accommodations. An increase of radon short-lived decay products attached to aerosol particles was obtained during a candle or frankincence burn, in smokefilled compartments, or in steamy kitchen conditions, therefore larger volumetric activity of the alpha particles was registered. Negative correlation coefficient between unattached fraction and the radioactive equilibrium factor, as well as positive correlation coefficient between the radioactive equilibrium factor and aerosol particle concentration in the air of accommodations has been determined. Seasonal changes of the radioactive equilibrium factor are presented. © Lithuanian Academy of Sciences, 2011.

Jayaratne, E.R., Ling, X., Morawska, L.
Role of vegetation in enhancing radon concentration and ion production in the atmosphere.
(2011) Environmental Science and Technology, 45 (15), pp. 6350-6355.

Abstract
The role of ions in the production of atmospheric particles has gained wide interest due to their profound impact on climate. Away from anthropogenic sources, molecules are ionized by alpha radiation from radon exhaled from the ground and cosmic γ radiation from space. These molecular ions quickly form into "cluster ions", typically smaller than about 1.5 nm. Using our measurements and the published literature, we present evidence to show that cluster ion concentrations in forest areas are consistently higher than outside. Owing to the low range of alpha particles, radon present deep in the ground cannot directly contribute to the measured cluster ion concentrations. We propose an additional mechanism whereby radon, which is water-soluble, is brought up by trees and plants through the uptake of groundwater and released into the atmosphere by transpiration. We estimate that, in a forest comprising eucalyptus trees spaced 4 m apart, trees may account for up to 37% of the radon that is released from the ground during the middle of the day when transpiration rates are high. The corresponding percentage on an annual basis is 4.1%. Considering that 24% of the earth's land area is still covered in forests; these

findings have potentially important implications for atmospheric aerosol formation and climate. © 2011 American Chemical Society.

Jelle, B.P., Noreng, K., Erichsen, T.H., Strand, T.
Implementation of radon barriers, model development and calculation of radon concentration in indoor air
(2011) Journal of Building Physics, 34 (3), pp. 195-222.

Abstract
Norway has some of the highest concentrations of radon in indoor air in the world. Based on large-scale surveys by direct measurements of radon in indoor air it has been estimated that nearly 9% of the housing stock has an annual mean indoor radon concentration which is higher than the current action level of 200 Bq/m3. Preventive measures that focuses on saving energy and avoiding moisture problems in a cold climate, and by not introducing any specific measures to reduce the infiltration of radon and/or balanced ventilation of the indoor air, can lead to high indoor radon concentrations. It is of vital importance that the ground floor structure is as airtight as possible; both to reduce the infiltration of soil gas radon by using, for example, airtight and resistant membranes, and as a premise for other preventive measures to function, for example, sub-slab depressurization systems. Sufficient airtightness may be achieved by using a radon barrier towards the ground, for example, by avoiding perforations and ensuring sufficient airtightness in joints and feed-throughs. Various factors influencing the radon concentration in indoor air are discussed. Based on these factors a simplified but yet versatile and powerful model for calculating the radon concentration in indoor air is presented. Furthermore, the examples are depicted in selected 2 and 3D graphical plots for visualization. By incorporating various and realistic values in a spreadsheet version of the indoor radon concentration model, valuable information about the different parameters influencing the indoor radon level is gained. Hence, the presented model may be utilized as a tool for examining which preventive or remedial measures should be carried out in order to achieve an indoor level of radon below the reference level as set by the authorities. The radon transport into buildings might be dominated by diffusion, pressure driven flow or something in between depending on the actual values of the various parameters. The results of our work indicate that with realistic or typical values of the parameters, most of the transport of radon from the building ground to the indoor air is due to air leakage driven by pressure differences through the construction. © 2011 The Author(s).

Jílek, K., Marušiaková, M.
Results of the 2010 National radiation Protection Institute Intercomparison of radon and its short-lived decay product continuous monitors
(2011) Radiation Protection Dosimetry, 145 (2-3), art. no. ncr064, pp. 273-279.

Abstract
During the Sixth European Conference on Protection Against Radon at Home and at Work held in autumn 2010 in Prague, the first intercomparison of continuous radon and its short-lived decay product monitors was organised and held by the Natural Radiation Division of the National Radiation Protection Institute (NRPI) in Prague. Eight laboratories submitted eight continuous radon monitors, two electronic monitors, three passive integral systems based on charcoal and three continuous radon short-lived decay product monitors. The intercomparison included exposures to both the radon gas concentration and equivalent equilibrium radon concentration (EEC) under different ambient conditions similar to the ones in dwellings. In particular, the influence of the equilibrium factor F, unattached fraction of EEC fp and absolute air humidity were investigated. The results of the radon gas measurements were performed on a calibration level of about 8 kBq m-3. The results of all monitors were compared with the reference NRPI monitor.

Jiménez, M.A., Martín-Valdepeñas, J.M., García-Talavera, M., Martín-Matarranz, J.L., Salas, M.R., Serrano, J.I., Ramos, L.M.
Realistic retrospective dose assessments to members of the public around spanish nuclear facilities
(2011) Journal of Environmental Radioactivity, 102 (11), pp. 995-1007.

Abstract
In the frame of an epidemiological study carried out in the influence areas around the Spanish nuclear facilities (ISCIII-CSN, 2009. Epidemiological Study of The Possible Effect of Ionizing Radiations Deriving from The Operation of Spanish Nuclear Fuel Cycle Facilities on The Health of The Population Living in Their Vicinity. Final report December 2009. Ministerio de Ciencia e Innovación, Instituto de Salud Carlos III, Consejo de Seguridad Nuclear. Madrid. Available from: http://www.csn.es/images/stories/actualidad_datos/especiales/epidemiologico/epidemiological_study.pdf), annual effective doses to public have been assessed by the Spanish Nuclear Safety Council (CSN) for over 45 years using a retrospective realistic-dose methodology. These values are compared with data from natural radiation exposure. For the affected population, natural radiation effective doses are in average 2300 times higher than effective doses due to the operation of nuclear installations (nuclear power stations and fuel cycle facilities). When considering the impact on the whole Spanish population, effective doses attributable to nuclear facilities represent in average 3.5×10-5mSv/y, in contrast to 1.6mSv/y from natural radiation or 1.3mSv/y from medical exposures.

Jiránek, M., Kotrbata, M.
Radon diffusion coefficients in 360 waterproof materials of different chemical composition
(2011) Radiation Protection Dosimetry, 145 (2-3), art. no. ncr043, pp. 178-183.

Abstract
This paper summarises the results of radon diffusion coefficient measurements in 360 common waterproof materials available throughout Europe. The materials were grouped into 26 categories according to their chemical composition. It was found that the diffusion coefficients of materials used for protecting houses against radon vary within eight orders from 10-15 to 10-8 m2 s-1. The lowest values were obtained for bitumen membranes with an Al carrier film and for ethylene vinyl acetate membranes. The highest radon diffusion coefficient values were discovered for sodium bentonite membranes, rubber membranes made of ethylene propylene diene monomer and polymer cement coatings. The radon diffusion coefficients for waterproofings widely used for protecting houses, i.e. flexible polyvinyl chloride, high-, low-density polyethylene, polypropylene and bitumen membranes, vary in the range from 3×10-12to 3×10-11m2s-1.Tests were performed which confirmed that the radon diffusion coefficient is also an effective tool for verifying the air-tightness of joints.

Jones, D.G., Lister, T.R., Smith, D.J., West, J.M., Coombs, P., Gadalia, A., Brach, M., Annunziatellis, A., Lombardi, S.
In Salah gas CO2 storage JIP: Surface gas and biological monitoring
(2011) Energy Procedia, 4, pp. 3566-3573.

Abstract
Surface gas and biological monitoring were carried out in 2009 at the In Salah Gas project (Krechba, Algeria), where geological storage of CO2 has been underway since mid-2004. The CO2 is removed from produced natural gas and re-injected below the gas-water contact on the flanks of the reservoir. The biological work was the first such study undertaken at the site. Observations were made in: uplifted areas around the three CO2 injection wells, around the KB-5 well where breakthrough of CO2 from the KB-502 injector had occurred, around the KB-4 well and in a background area away from CO2 injection and gas production. Near ground atmospheric measurements were made with a mobile open path laser system, with soil gas and flux measurements in support of these and of a botanical and microbiological survey. Longer term monitoring was initiated for radon and other gases using buried probes and activated charcoal integrative collectors. Laser measurements appeared to show only natural variations, but interference from the vehicle exhaust, windblown dust and rain was apparent. Modifications are needed to overcome these problems. Natural variation of atmospheric CO2 needs to be better constrained to identify anomalous values. Soil gas concentrations and fluxes were very low but slightly higher values over the KB-5 well could indicate low-level leakage. This

is likely to be a legacy of breakthrough prior to the abandonment of the well. A variety of monocotyledonous and dicotyledenous plants was present, particularly in dry wadis or shallow depressions. The xerophytic flora and the microbial numbers were typical of such desert environments and the data provide baseline values since there were no indications of elevated CO2. There were analytical problems with the microbial activity determinations but it can be concluded that activities were low.

Jordan, T.H., Chen, Y.-T., Gasparini, P., Madariaga, R., Main, I., Marzocchi, W., Papadopoulos, G., Sobolev, G., Yamaoka, K., Zschau, J.
Operational earthquake forecasting: State of knowledge and guidelines for utilization (2011) Annals of Geophysics, 54 (4), pp. 319-391.

Abstract
Following the 2009 L'Aquila earthquake, the Dipartimento della Protezione Civile Italiana (DPC), appointed an International Commission on Earthquake Forecasting for Civil Protection (ICEF) to report on the current state of knowledge of short-term prediction and forecasting of tectonic earthquakes and indicate guidelines for utilization of possible forerunners of large earthquakes to drive civil protection actions, including the use of probabilistic seismic hazard analysis in the wake of a large earthquake. The ICEF reviewed research on earthquake prediction and forecasting, drawing from developments in seismically active regions worldwide. A prediction is defined as a deterministic statement that a future earthquake will or will not occur in a particular geographic region, time window, and magnitude range, whereas a forecast gives a probability (greater than zero but less than one) that such an event will occur. Earthquake predictability, the degree to which the future occurrence of earthquakes can be determined from the observable behavior of earthquake systems, is poorly understood. This lack of understanding is reflected in the inability to reliably predict large earthquakes in seismically active regions on short time scales. Most proposed prediction methods rely on the concept of a diagnostic precursor; i.e., some kind of signal observable before earthquakes that indicates with high probability the location, time, and magnitude of an impending event. Precursor methods reviewed here include changes in strain rates, seismic wave speeds, and electrical conductivity; variations of radon concentrations in groundwater, soil, and air; fluctuations in groundwater levels; electromagnetic variations near and above Earth's surface; thermal anomalies; anomalous animal behavior; and seismicity patterns. The search for diagnostic precursors has not yet produced a successful short-term prediction scheme. Therefore, this report focuses on operational earthquake forecasting as the principle means for gathering and disseminating authoritative information about time-dependent seismic hazards to help communities prepare for potentially destructive earthquakes. On short time scales of days and weeks, earthquake sequences show clustering in space and time, as indicated by the aftershocks triggered by large events. Statistical descriptions of clustering explain many features observed in seismicity catalogs, and they can be used to construct forecasts that indicate how earthquake probabilities change over the short term. Properly applied, short-term

forecasts have operational utility; for example, in anticipating aftershocks that follow large earthquakes. Although the value of long-term forecasts for ensuring seismic safety is clear, the interpretation of short-term forecasts is problematic, because earthquake probabilities may vary over orders of magnitude but typically remain low in an absolute sense (> 1% per day). Translating such low-probability forecasts into effective decision-making is a difficult challenge. Reports on the current utilization operational forecasting in earthquake risk management were compiled for six countries with high seismic risk: China, Greece, Italy, Japan, Russia, United States. Long-term models are currently the most important forecasting tools for civil protection against earthquake damage, because they guide earthquake safety provisions of building codes, performance-based seismic design, and other risk-reducing engineering practices, such as retrofitting to correct design flaws in older buildings. Short-term forecasting of aftershocks is practiced by several countries among those surveyed, but operational earthquake forecasting has not been fully implemented (i.e., regularly updated and on a national scale) in any of them. Based on the experience accumulated in seismically active regions, the ICEF has provided to DPC a set of recommendations on the utilization of operational forecasting in Italy, which may also be useful in other countries. The public should be provided with open sources of information about the short-term probabilities of future earthquakes that are authoritative, scientific, consistent, and timely. Advisories should be based on operationally qualified, regularly updated seismicity forecasting systems that have been rigorously reviewed and updated by experts in the creation,delivery, and utility of earthquake information. The quality of all operational models should be evaluated for reliability and skill by retrospective testing, and they should be under continuous prospective testing against established long-term forecasts and alternative time-dependent models. Alert procedures should be standardized to facilitate decisions at different levels of government and among the public. Earthquake probability thresholds should be established to guide alert levels based on objective analysis of costs and benefits, as well as the less tangible aspects of value-of-information, such as gains in psychological preparedness and resilience. The principles of effective public communication established by social science research should be applied to the delivery of seismic hazard information.

Joshi, M., Sapra, B.K., Kothalkar, P., Khan, A., Modi, R., Mayya, Y.S.
Implications of polarity of unipolar ionisers on reduction of effective dose attributable to thoron progeny
(2011) Radiation Protection Dosimetry, 145 (2-3), art. no. ncr063, pp. 256-259.

Abstract
Negative ionisers have been proved to be effective in reducing indoor particulates in general and activity concentrations due to radon and thoron (220Rn) decay products in workplace environments in particular. However, in comparison, there exist few studies on the effect of positive ions for mitigation. In the present work, particle and activity concentration reduction has been compared for three experimental conditions (two for

positive ions and one for negative) in an unoccupied room with elevated 220Rn levels. The negative ioniser configuration provided a better concentration reduction factor of 4.59 with smallest characteristic depletion time. A theoretical estimate of the dose reduction factor is found to be 3.96 and 3.74, respectively, for positive and negative ioniser configuration.

Jovanović, B., Nikezić, D.
Dependence of the probability of biological effects per hit, induced by radiation emitted by 222Rn, from alpha particle energies and the geometry of tracheobronchial tree
(2011) Journal of Radioanalytical and Nuclear Chemistry, 289 (3), pp. 939-944.

Abstract
Biological effects of radiation in terms of their effect on living cells are considered in this work. In dosimetry of the human lung exist the need to include the influence of the biological effects. The aim of this work is to calculate the probability of biological effects (transformation cell and production of lesion) per hit induced by alpha particle radiation on sensitive cells of human lung. Probability was calculated by applying the analytical model cylinder bifurcation (Nikezić et al., Int J Radiat Biol 79(3):175-180, 2003; Nikezić and Yu, Radiat Environ Biophys 42:49-53, 2003) which was created to simulate the geometry of human lung with the geometric distribution of cell nuclei in the airway wall of the tracheobronchial tree. This analytical model of the human traheobronchial tree represent the exstension of the ICRP66 model, and follows it as much as possible. Reported probabilities are calculated for various targets and alpha particle energies in order to show dependence of the probability of biological effects (transformation cell and production of lesion) per hit from alpha particle energies and the geometry of tracheobronchial tree for the human lung. © 2011 Akadémiai Kiadó, Budapest, Hungary.

Jovanović, B., Nikezić, D., Stevanović, N.
Applied mathematical modeling for calculating the probability of the cell killing per hit in the human lung
(2011) Journal of Radioanalytical and Nuclear Chemistry, pp. 1-7. Article in Press.

Abstract
The calculating the probability of the cell killing per hit, from radon progeny, requires the development of morphometric model of the human airway system. This study is focused on the different modeling concept. For example, several morphometric lung models have been published which differ in terms of airway structure and lung volume, there by affecting the particle deposition efficiencies. The present variety of modeling concepts suggests that the choice of specific modeling assumptions is as important for dose risk estimates as the choice of proper parameter values. The model of human lung analysed in the present study differ from those employed in the ICRP66 model, dose estimates will

consequently differ from ICRP66 predictions, because its included the area of the branching the cylinders (airways tube) in the human lung. A analytical model cylinder bifurcation was created to simulate the geometry of human lung with the geometric distribution of cell nuclei in the airway wall of the tracheobronchial tree. Reported probabilities are calculated for various targets and alpha particle energies in order to show dependence of the probability of cell killing per hit from alpha particle energies and the geometry of tracheobronchial tree for the human lung, created in this study.

Juarez, R., Zavala-Oseguera, C., Jimenez-Halla, J.O.C., Bickelhaupt, F.M., Merino, G.
Radon hydrides: Structure and bonding
(2011) Physical Chemistry Chemical Physics, 13 (6), pp. 2222-2227.

Abstract
Quantum chemical calculations, using gradient-correct density functional at the BP86 level in conjunction with TZ2P basis sets, have been carried out for the radon hydrides HRnY (with Y = F, Cl, Br, I, CCH, CN, and NC). The bonding in HRnY is studied using different bond ruptures, establishing the role of those stabilizing (and destabilizing) factors that prevent these species to be dissociated. Although all HRnY systems studied here are bound equilibrium structures, they are metastable species with respect to the HRnY → Rn + HY decomposition channel. However, the HRnY → H + Rn + Y reaction is endothermic. So, these results indicate the possibility to identify the radon hydrides in noble-gas matrices. © the Owner Societies.

Justus, A.L.
Prompt retrospective air sample analysis-a comparison of gross-alpha, beta-to-alpha ratio, and alpha spectroscopy techniques
(2011) Health Physics, 100 (2), pp. 191-200.

Abstract
The long-standing problem related to prompt analyses in continuous air sampling or monitoring has been the wellknown interference of the radon- and thoron-progeny codeposited on the filtration media with any potential suspect radionuclides. The solutions to this problem have been quite diverse, and have included, for example, simple gross-alpha screening, the use of beta-to-alpha ratios, and/or the use of alpha spectral analyses. In the context of week-long retrospective continuous air sampling, this paper will explain, in detail, the technical basis for the use of the simple gross-alpha screening, beta-to-alpha ratio, and alpha spectrometry techniques and demonstrate the efficacy (or lack thereof) of these methods with simple examples. Although the most sensitive analysis technique for week-long retrospective continuous air samples is no doubt a long-lived count performed typically after at least a four-day decay period, when necessary, certain prompt and semi-prompt techniques discussed here can approach a sensitivity that

is within about an order of magnitude of the long-lived count.

Jweda, J., Baskaran, M.
Interconnected riverine-lacustrine systems as sedimentary repositories: Case study in southeast Michigan using 210Pb and 137Cs-based sediment accumulation and mixing models
(2011) Journal of Great Lakes Research, 37 (3), pp. 432-446.

Abstract
Particle-reactive nuclides, such as 210Pb and 137Cs, serve as powerful chronometric tools in the investigations and reconstruction of historical contamination in coastal marine and lacustrine systems. Towards the first systematic establishment of sediment chronologies of river channel sediments, a set of seven sediment cores from Clinton River and Lake St. Clair riverine-lacustrine system were collected and analyzed for 210Pb, 226Ra, and 137Cs activities. Measured inventories of 210Pbxs and 137Cs were ~2 and ~9 times higher than that expected from atmospheric fallout. From the measured 210Pbxs/137Cs inventory ratios, erosional input of 137Cs was found to be significantly higher than that of 210Pb indicating that anthropogenic watershed disturbances have resulted in accelerated sediment erosion. Good agreement between accumulation rates using 210Pbxs and 137Cs using four different age models were obtained for four of the seven cores in the riverine-lacustrine environment. Average sediment mass accumulation rates, based on the 210Pbxs CFCS model, in the lower Clinton River (mean: 0.91gcm-2yr-1) were generally higher than those in Lake St. Clair (mean: 0.55gcm-2yr-1) due to a higher sediment flux and the unique riverine system characteristics. Sediment mixing coefficients, based on a 210Pbxs mixing model, were much higher in the river (mean: 64.9cm2yr-1) compared to the lake (mean: 4.7cm2yr-1), as was expected due to the frequency of perturbation and resuspension. Net accumulation of datable sediments in the Clinton River indicates that similar river channel deposits may act as repositories for the reconstruction of historical contamination and environmental changes. © 2011 International Association for Great Lakes Research.

Kaĭsinova, A.S., Osipov, I.S., Litvinova, M.A., Prosol'chenko, A.V.
[Magnetotherapy in the combined health resort-based treatment of irritated bowel syndrome].
(2011) Voprosy kurortologii, fizioterapii, i lechebnoĭ fizicheskoĭ kultury, (2), pp. 34-36.

Abstract
The authors describe a combined method for the treatment of irritated bowel syndrome with the use of magnetotherapy, drinking mineral waters, and radon baths. It was shown that prescription of preformed physical factors improves the psycho-emotional status of the patients due to normalization of the motor-evacuative function of the gastrointestinal

tract. The overall result of this therapeutic modality is the improvement of the quality of life of the patients.

Kamsali, N., Pawar, S.D., Murugavel, P., Gopalakrishnan, V.
Estimation of small ion concentration near the Earth's surface
(2011) Journal of Atmospheric and Solar-Terrestrial Physics, 73 (16), pp. 2345-2351.

Abstract
Atmospheric ions produced by radon gas exhalation from the Earth's surface can play a vital role in the electrification of atmosphere, especially during nights when the gases are trapped in a stable layer close to the surface. The measurements of concentration of radon and its progeny, air conductivity and aerosol size distribution made at Pune, India, have been analyzed. The concentrations of radon and its progeny show maxima during night and early morning hours, between 0500 and 0700. IST when atmosphere is more stable and mixing is low and start decreasing after sunrise and attain minima during 1000-1800. h when air is unstable. The diurnal variation of the ionization rate, calculated using the concentrations of radon and its progeny, follows the variations of concentrations of radon and its progeny. The ion-aerosol balance equations are solved to study the effect of aerosols on small ion concentration in the lower atmosphere. It has been found that during daytime when aerosol concentration is high, 20-30% reduction in small ion concentration can occur due to aerosols. The small ion concentration estimated using measured air conductivity is compared with small ion concentration estimated by solving ion-aerosol balance equations and both are found to be in good agreement with each other. © 2011 Elsevier Ltd.

Kapdan, E., Altinsoy, N., Karahan, G., Taskin, H.
Determination of the health hazards due to background radiation sources in the city of Adapazari, Northwestern Turkey
(2011) Isotopes in Environmental and Health Studies, 47 (1), pp. 93-100.

Abstract
Human body is exposed to ionising radiations both internally and externally by mainly high-energy cosmic ray particles incident on the earth's atmosphere and radioactive nuclides that originated in the earth's crust. The main objective of this study is to assess the health hazards due to environmental radiation sources in the city of Adapazari, one of the most important industrial cities of the country, Northwestern Turkey. For this purpose, natural radiation sources, external terrestrial radiations, cosmic radiations, and inhalation exposures have been investigated. The annual average external terrestrial radiation doses were determined as 0.08 and 0.35 mSv at outdoor and indoor atmospheres, respectively. The annual average cosmic radiation doses were found to be 0.08 and 0.05mSvfor directly ionising photon components and neutron components, respectively. The annual average inhalation exposure doses due to radon and thoron were

obtained as 1.42 and 0.19 mSv, respectively, in the region. The annual average effective dose due to natural radiation sources was determined as a total of 2.35 mSv with the predetermined ingestion radiation dose. The lifetime cancer risk due to the background ionising radiations has been determined as 0.9-2 for the residents of the Adapazari city, with the average lifespan of 70 years. The results of the effective doses due to background radiation sources in the region and the worldwide averages were discussed.

Kataoka, T., Teraoka, J., Sakoda, A., Nishiyama, Y., Yamato, K., Monden, M., Ishimori, Y., Nomura, T., Taguchi, T., Yamaoka, K.
Erratum to: Protective Effects of Radon Inhalation on Carrageenan-Induced Inflammatory Paw Edema in Mice
(2011) Inflammation, p. 1. Article in Press.

Kataoka, T., Teraoka, J., Sakoda, A., Nishiyama, Y., Yamato, K., Monden, M., Ishimori, Y., Nomura, T., Taguchi, T., Yamaoka, K.
Protective Effects of Radon Inhalation on Carrageenan-Induced Inflammatory Paw Edema in Mice
(2011) Inflammation, pp. 1-10. Article in Press.

Abstract
We assessed whether radon inhalation inhibited carrageenan-induced inflammation in mice. Carrageenan (1% v/v) was injected subcutaneously into paws of mice that had or had not inhaled approximately 2,000 Bq/m3 of radon for 24 h. Radon inhalation significantly increased superoxide dismutase (SOD) and catalase activities and significantly decreased lipid peroxide levels in mouse paws, indicating that radon inhalation activates antioxidative functions. Carrageenan administration induced paw edema and significantly increased tumor necrosis factor-alpha (TNF-α) and nitric oxide in serum. However, radon inhalation significantly reduced carrageenan-induced paw edema. Serum TNF-α levels were lower in the radon-treated mice than in sham-treated mice. In addition, SOD and catalase activities in paws were significantly higher in the radon-treated mice than in the sham-treated mice. These findings indicated that radon inhalation had anti-inflammatory effects and inhibited carrageenan-induced inflammatory paw edema. © 2011 Springer Science+Business Media, LLC.

Kataoka, T., Sakoda, A., Yoshimoto, M., Nakagawa, S., Toyota, T., Nishiyama, Y., Yamato, K., Ishimori, Y., Kawabe, A., Hanamoto, K., Taguchi, T., Yamaoka, K.
Studies on possibility for alleviation of lifestyle diseases by low-dose irradiation or radon inhalation
(2011) Radiation Protection Dosimetry, 146 (1-3), art. no. ncr189, pp. 360-363.

Abstract
Our previous studies showed the possibility that activation of the antioxidative function alleviates various oxidative damages, which are related to lifestyle diseases. Results showed that, low-dose X-ray irradiation activated superoxide dismutase and inhibits oedema following ischaemia-reperfusion. To alleviate ischaemia-reperfusion injury with transplantation, the changes of the antioxidative function in liver graft using low-dose X-ray irradiation immediately after exenteration were examined. Results showed that liver grafts activate the antioxidative function as a result of irradiation. In addition, radon inhalation enhances the antioxidative function in some organs, and alleviates alcohol-induced oxidative damage of mouse liver. Moreover, in order to determine the most effective condition of radon inhalation, mice inhaled radon before or after carbon tetrachloride (CCl4) administration. Results showed that radon inhalation alleviates CCl4-induced hepatopathy, especially prior inhalation. It is highly possible that adequate activation of antioxidative functions induced by low-dose irradiation can contribute to preventing or reducing oxidative damages, which are related to lifestyle diseases.

Kávási, N., Vigh, T., Kovács, T., Vaupotič, J., Jobbágy, V., Ishikawa, T., Yonehara, H.
Dose estimation and radon action level problems due to nanosize radon progeny aerosols in underground manganese ore mine
(2011) Journal of Environmental Radioactivity, 102 (9), pp. 806-812.

Abstract
One of the essential parameters influencing of the dose conversion factor is the ratio of unattached short-lived radon progeny. This may differ from the value identified for indoor conditions when considering special workplaces such as mines. Inevitably, application of the dose conversion factors used in surface workplaces considerably reduces the reliability of dose estimation in the case of mines. This paper surveyed the concentration of radon and its short-lived radon progeny and identified the unattached fraction of short-lived radon progeny. As well equilibrium factor during the month of August was calculated simultaneously at two extraction faces in a manganese ore mine. During working hours the average radon concentrations were 220 Bq m-3 and 530 Bq m-3 at Faces 1 and 2; the average short-lived progeny concentration was 90 Bq m-3 and 190 Bq m-3, the average equilibrium factors were 0.46 and 0.36, and the average unattached fractions were 0.21 and 0.17, respectively. The calculated dose conversion factor was between 9 and 27 mSv WLM-1, but higher values could also be possible.

Kávási, N., Kovács, T., Somlai, J., Jobbágy, V., Nagy, K., Deák, E., Berhés, I., Bender, T., Ishikawa, T., Tokonami, S.
Comparison of urinary excretion of radon from the human body before and after radon

bath therapy
(2011) Radiation Protection Dosimetry, 146 (1-3), art. no. ncr099, pp. 27-30.

Abstract
Theoretically, the human body absorbs radon through the lungs and the skin and excretes it through the lungs and the excretory organs during radon bath therapy. To check this theory, the radon concentrations in urine samples were compared before and after radon bath therapy. During the therapy, the geometric mean (GM) and the geometric standard deviation of the radon concentration in air and in the bath water were 979 Bq m-3, 1.58 and 73.6 Bq dm-3, 1.1, respectively. Since radon was detected in each urine sample (GM around 3.0 Bq dm-3), urinary excretion of radon was confirmed. The results of this study can neither reject nor confirm the hypothesis of radon absorption through the skin. A 15 times higher increment of inhaled radon level did not cause significant changes in radon of urine samples.

Kávási, N., Kobayashi, Y., Kovács, T., Somlai, J., Jobbágy, V., Nagy, K., Deák, E., Berhés, I., Bender, T., Ishikawa, T., Tokonami, S., Vaupotič, J., Yoshinaga, S., Yonehara, H.
Effect of radon measurement methods on doseestimation
(2011) Radiation Protection Dosimetry, 145 (2-3), art. no. ncr044, pp. 224-232.

Abstract
Different radon measurement methods were applied in the old and new buildings of the Turkish bath of Eger, Hungary, in order to elaborate a radon measurement protocol. Besides, measurements were also made concerning the radon and thoron short-lived decay products, gamma dose from external sources and water radon. The most accurate results for dose estimation were provided by the application of personal radon meters. Estimated annual effective doses from radon and its short-lived decay products in the old and new buildings, using 0.2 and 0.1 measured equilibrium factors, were 0.83 and 0.17 mSv, respectively. The effective dose from thoron short-lived decay products was only 5 % of these values. The respective external gamma radiation effective doses were 0.19 and 0.12 mSvy-1. Effective dose from the consumption of tap water containing radon was 0.05 mSvy-1, while in the case of spring water, it was 0.14 mSvy-1.

Kazkaz, K., Walsh, N.
Combining stochastics and analytics for a fast Monte Carlo decay chain generator
(2011) Nuclear Instruments and Methods in Physics Research, Section A: Accelerators, Spectrometers, Detectors and Associated Equipment, 654 (1), pp. 170-175.

Abstract

Various Monte Carlo programs, developed either by small groups or widely available, have been used simulate decays of radioactive chains, from the original parent nucleus to the final stable isotopes. These chains include uranium, thorium, radon, and others, and generally have long-lived parent nuclei. Generating decays within these chains requires a certain amount of computing overhead related to simulating unnecessary decays, time-ordering the final results in post-processing, or both. We present a combination analytic/stochastic algorithm for creating a time-ordered set of decays with position and time correlations, and starting with an arbitrary source age. Thus the simulation costs are greatly reduced, while at the same time avoiding chronological post-processing. We discuss optimization methods within the approach to minimize calculation time, and extension of the algorithm to include various source types.

Keefer, G.
Laboratory studies of lead removal from liquid scintillator in preparation for KamLAND's low background phase
(2011) AIP Conference Proceedings, 1338, pp. 175-178.

Abstract
The removal of Radon induced Lead from liquid scintillator was extensively studied in preparation for Kam-LAND's low background phase. This work presents the results from laboratory experiments performed at the University of Alabama and their implications for KamLAND and future low background experiments using carbon based liquid scintillator. It was observed that distillation was the most effective purification procedure and that one must consider a non-polar and non-ionic component of Lead in order to reach the levels of radio-purity required for these new class of ultra-low background experiments. © 2011 American Institute of Physics.

Kendall, G.M., Fell, T.P.
Doses to the red bone marrow of young people and adults from radiation of natural origin
(2011) Journal of Radiological Protection, 31 (3), pp. 329-335.

Abstract
Natural radiation sources comprise cosmic rays, terrestrial gamma rays, radionuclides in food and inhaled isotopes of radon with their decay products. These deliver doses to all organs and tissues including red bone marrow (RBM), the tissue in which leukaemia is thought to originate. In this paper we calculate the age-dependent annual RBM doses from natural radiation sources to young people and to adults at average levels of exposure in the UK. The contributions to dose are generally less complex than in the case of doses to foetuses and young children where it is necessary to take into account transfer of radionuclides across the placenta, intakes in mother's milk and changes in gut uptake in young infants. However, there is high uptake of alkaline earths and of similar elements in

the developing skeleton and this significantly affects the doses from radioisotopes of these elements, not just in the teens and twenties but through into the fifth decade of life. The total equivalent dose to the RBM from all natural sources of radiation at age 15 years is calculated to be about 1200 νSv a year at average UK levels, falling to rather less than 1100 νSv per year in later life; the gentle fall from the late teens onwards reflects the diminishing effect of the high uptakes of radioisotopes of the alkaline earths and of lead in this period. About 60% of the equivalent dose is contributed by the low linear energy transfer (LET) component. Radionuclides in food make the largest contribution to equivalent doses to RBM and much the largest contribution to the absorbed dose from high LET radiation (mainly alpha particles).

Khalilur, R., Hayashi, K., Shibuya, H.
Brachytherapy for tongue cancer in the very elderly is an alternative to external beam radiation
(2011) British Journal of Radiology, 84 (1004), pp. 747-749.

Abstract
Background: The result of curative treatment for very elderly patients with tongue carcinoma has not been reported to date. We retrospectively reviewed the results of brachytherapy in 125 the patients aged over 75 years. Methods: The results of brachytherapy in 125 patients, 75 years old or older, with Stage I or II squamous cell carcinoma of the oral tongue were reviewed. The 125 cases consisted of 31 Stage I and 94 Stage II cases; 67 patients were under 80 years old and 58 were over 80 years old. All patients were treated using low-dose-rate brachytherapy (198Au/222Rn: 59 cases; 192Ir: 38 cases; 226Ra/137Cs: 28 cases). Results: None of the patients stopped treatment during the course of brachytherapy. The 3 year and 5 year control rates of the primary lesions were both 86%. Post-brachytherapy neck node metastasis was diagnosed in 43 cases and radical neck dissection was performed for 24 cases (21 of the 24 cases were under 80 years old). As a result, the 7 year disease-specific survival (DSS) rate for patients aged under 80 years old was 70% and 41% for those over 80 years old (p=0.03). Conclusion: The brachytherapy for elderly patients with tongue cancer was safe, and the control of the primary lesion was almost the same as in younger patients. However, modalities available to treat neck node metastasis are limited. More conservative surgical approaches combined with post-operative irradiation may be advocated for neck node metastasis for elderly patients with tongue cancer.

Khan, A.H., Puranik, V.D.
Radon in the environment and in dwellings in a uranium mining area in eastern india: An overview
(2011) Radiation Protection Dosimetry, 145 (2-3), art. no. ncr061, pp. 198-201.

Abstract

Radon has been extensively studied in the Singhbhum Thrust Belt (STB) of eastern India where mining and processing of uranium ore has been in progress for over four decades. Emanation from the soil is the main natural source of environmental radon. Releases from mine and emanations from waste rocks and tailings are the technological sources. Rn studies in the environment, dwellings and ground waters in STB are reviewed in this paper.

Khan, M.S., Zubair, M., Verma, D., Naqvi, A.H., Azam, A., Bhardwaj, M.K.
The study of indoor radon in the urban dwellings using plastic track detectors
(2011) Environmental Earth Sciences, 63 (2), pp. 279-282.

Abstract
Radon and its progeny have been recognized as one of the major contributors to the natural radiation and health hazards in the human dwellings. Even lung cancer is expected if it is present in enhanced levels beyond maximum permissible limit. This paper reports the measurements of indoor radon and its progeny in the urban dwellings of the Etah district of Uttar Pradesh province in Northern India using the cellulose nitrate (LR-115 type-II) plastic track detectors. It is found that the values of radon concentration vary from 3.52 to 248.64 Bq m-3 with a standard deviation of 69.19. The values of radon progeny concentration vary from 0.38 to 26.88 mWL with a standard deviation of 7.48. The effective dose has been calculated and found to vary from 0.05 to 3.76 mSv year-1 with a standard deviation of 1.05. The lifetime fatality risk is found to vary from 0.04 × 10-4 to 2.90 × 10-4. The results have been compared with the results reported in the rural areas of the same district. © 2010 Springer-Verlag.

Khattak, N.U., Khan, M.A., Shah, M.T., Javed, M.W.
Radon concentration in drinking water sources of the Main Campus of the University of Peshawar and surrounding areas, Khyber Pakhtunkhwa, Pakistan
(2011) Journal of Radioanalytical and Nuclear Chemistry, 290 (2), pp. 493-505.

Abstract
Radon and its progenies in indoor environment have been identified as the main sources of radiation dose to the people from natural radioactive sources. Presence of radon in drinking water causes radiation related health hazards both through inhalation and ingestion. In this study 36 drinking water samples from taps, boreholes and deep tube wells within the Main Campus of the University of Peshawar and adjoining area were analyzed with RAD7 electronic device for radon content determination. These water samples have a mean, maximum and minimum radon value of 8.8 ± 0.8, 18.2 ± 1.0, and 1.6 ± 0.3 Bq L-1, respectively. Eleven drinking water samples analyzed have radon levels in excess of the EPA recommended maximum contaminant level (MCL) of 11.1 Bq L-1. These include 89% from tube wells, 8% from tap water, and 50% from shallow boreholes. Radon levels of about 31% of the total samples used by the inhabitants of the

study area are higher than the EPA advised level of 11.1 Bq L-1. The annual effective dose from radon in water due to its ingestion and inhalation per individual has also been estimated. The mean radon concentration and mean annual effective dose due to radon in water of this study have been compared with the mean radon concentration and mean annual effective dose of earlier investigators due to radon in water from different localities of India and Pakistan. The mean annual effective doses of all the samples are lower than the reference level of 0.1 mSv a-1 for drinking water of WHO and EU Council. It has been concluded that drinking water of the study area is generally safe as far as radon related health hazards are concerned with the exception of a few isolated cases. It has been found that radon levels within the region have a positive correlation with depth of the water sources.

Kim, Y., Chang, B., Park, H., Kim, C., Tokonami, S.
National radon survey in Korea
(2011) Radiation Protection Dosimetry, 146 (1-3), art. no. ncr094, pp. 6-10.

Abstract
To estimate annual average concentrations in Korean dwellings and the effective dose to the general public, nationwide surveys on radon were conducted in 1989, 1999-2013;2000 and 2002-2005. The total number of dwellings was about 5600. A survey of thoron and its decay products was also conducted in 2002-2005. In 2008-2009, a new radon survey in 1100 public buildings was conducted. The annual arithmetic (AM) and geometric (GM) means of indoor radon concentration in total were 62.1 ± 66.4 and 49.0 ± 1.9 Bq m-3, respectively. The annual AM and GM means of indoor thoron concentrations were 40.4 ± 56.0 and 10.7 ± 2.9 Bq m-3, respectively. The radon and thoron concentrations in detached houses were much higher than those in apartments. The locations of the high radon or thoron houses seem to be correlated with the concentrations of their parent nuclides in surface soil. The mean individual doses of radon and thoron were calculated to be 1.65 and 0.17 mSv y-1, respectively.

Kirchner, G.
210Pb as a tool for establishing sediment chronologies: Examples of potentials and limitations of conventional dating models
(2011) Journal of Environmental Radioactivity, 102 (5), pp. 490-494.

Abstract
For aquatic sediments, the use of 210Pb originating from the decay of atmospheric 222Rn is a well-established methodology to estimate sediment ages and sedimentation rates. Traditionally, the measurement of 210Pb in soils and sediments involved laborious and time-consuming radiochemical separation procedures. Due to the recent development of

advanced planar ('n-type') semi-conductors with high efficiencies in the low-energy range which enable the gamma-spectrometric analysis of the 46.5 keV decay line of 210Pb, sediment dating using this radionuclide has gained renewed interest.In this contribution, potentials and limitations of the 210Pb methodology and of the models used for estimating sediment ages and sedimentation rates are discussed and illustrated by examples of freshwater and marine sediments. Comparison with the use of 137Cs shows that the information which may be gained by these two tracers is complementary. As a consequence, both radionuclides should be used in combination for dating of recent sediments. It is shown that for various sedimentation regimes additional information from other sources (e.g. sediment lithology) may be needed to establish a reliable chronology. A strategy for sediment dating using 210Pb is recommended. © 2010 Elsevier Ltd.

Kleinschmidt, R., Black, J., Akber, R.
Mapping radioactivity in groundwater to identify elevated exposure in remote and rural communities
(2011) Journal of Environmental Radioactivity, 102 (3), pp. 235-243.

Abstract
A survey of radioactivity in groundwater (110 sites) was conducted as a precursor to providing a baseline of radiation exposure in rural and remote communities in Queensland, Australia, that may be impacted upon by exposure pathways associated with the supply, treatment, use and wastewater treatment of the resource. Radionuclides in groundwater, including 238U, 226Ra, 222Rn, 228Ra, 224Ra and 40K were measured and found to contain activity concentration levels of up to 0.71 BqL-1, 0.96 BqL-1, 108 BqL-1, 2.8 BqL-1, 0.11 BqL-1 and 0.19 BqL-1 respectively. Activity concentration results were classified by aquifer lithology, showing correlation between increased radium isotope concentration and basic volcanic host rock. The groundwater survey and mapping results were further assessed using an investigation assessment tool to identify seven remote or rural communities that may require additional radiation dose assessment beyond that attributed to ingestion of potable water. © 2010.

Kligerman, S., White, C.
Epidemiology of lung cancer in women: Risk factors, survival, and screening
(2011) American Journal of Roentgenology, 196 (2), pp. 287-295.

Abstract
OBJECTIVE. Lung cancer remains the leading cause of cancer mortality in both men and women. Tobacco use causes the vast majority of lung cancer in women but does not explain all cases, because about one in five women who develop lung cancer have never smoked. CONCLUSION. Environmental exposures, genetic predisposition, hormonal factors, and viral infection may all play a role in lung cancer in women. A better

understanding may provide an avenue to more effective screening, diagnosis, and therapy. © American Roentgen Ray Society.

Klusoň, J., Thinová, L.
Contribution of atmospherical radon to in-situ scintillation gamma spectrometry data
(2011) Applied Radiation and Isotopes, 69 (8), pp. 1143-1145.

Abstract
In-situ gamma spectrometry can be used for monitoring and determining natural and man-made radionuclide concentrations in the environment. The low detection limit of potential contaminants depends on the natural background variations, including variations in the atmospheric concentrations of radon and its decay products. The scintillation spectrometer response for atmospheric radon was simulated by the Monte Carlo method, and the results were compared with the experimental measurements over large water surfaces. The contributions of atmospheric radon to the natural background were assessed. © 2010 Elsevier Ltd.

Kovler, K.
Legislative aspects of radiation hazards from both gamma emitters and radon exhalation of concrete containing coal fly ash
(2011) Construction and Building Materials, 25 (8), pp. 3404-3409.

Abstract
Utilization of coal fly ash in concrete construction has clear environmental, technological and economical advantages. At the same time, fly ash is known to have enhanced concentrations of Naturally Occurring Radioactive Materials (NORM). Legislative issues related to the utilization of coal fly ash in concrete construction are analyzed. Different approaches implemented in standards regulating gamma radiation and radon emanation of concrete and other building materials are reviewed. Although radon exhalation rate of concrete containing coal fly ash can be sometimes slightly higher than that of the reference concrete, radon emanation coefficient is usually lower. In view of this, the standards regulating radioactivity of building materials, but not addressing radon emanation properly could be detrimental to the utilization of fly ash in concrete. At the same time, the evaluation of the excess dose caused by building materials for the radon pathway is complicated, and much more research work is required to justify the assumptions of the physical models in the future standards. © 2011 Elsevier Ltd. All rights reserved.

Kozak, K., Mazur, J., Kozłowska, B., Karpińska, M., Przylibski, T.A., Mamont-Cieśla, K., Grzaadziel, D., Stawarz, O., Wysocka, M., Dorda, J., Zebrowski, A., Olszewski, J.,

Hovhannisyan, H., Dohojda, M., Kapała, J., Chmielewska, I., Kłos, B., Jankowski, J., Mnich, S., Kołodziej, R.
Correction factors for determination of annual average radon concentration in dwellings of Poland resulting from seasonal variability of indoor radon
(2011) Applied Radiation and Isotopes, 69 (10), pp. 1459-1465.

Abstract
The method for the calculation of correction factors is presented, which can be used for the assessment of the mean annual radon concentration on the basis of 1-month or 3-month indoor measurements. Annual radon concentration is an essential value for the determination of the annual dose due to radon inhalation. The measurements have been carried out in 132 houses in Poland over a period of one year. The passive method of track detectors with CR-39 foil was applied. Four thermal-precipitation regions in Poland were established and correction factors were calculated for each region, separately for houses with and without basements. © 2011 Elsevier Ltd.

Kucukomeroglu, B., Yesilbag, Y.O., Kurnaz, A., Celik, N., Cevik, U., Celebi, N.
Radiological characterisation of Artvin and Ardahan provinces of Turkey
(2011) Radiation Protection Dosimetry, 145 (4), art. no. ncq442, pp. 389-394.

Abstract
Indoor radon concentration measurements were carried out and corresponding annual effective doses due to exposure to indoor radon were determined in Artvin and Ardahan provinces located in the eastern part of Turkey. The measurements were performed for four seasons in order to determine the seasonal fluctuations mostly observed in indoor environments. Indoor radon concentration values were observed to range from 21 to 321 Bq m-3 for the Artvin province and from 53 to 736 Bq m-3 for the Ardahan province. It was observed that minimum indoor radon concentration values were obtained in summer, while the highest ones were observed in winter. Indoor radon concentration values of the current study were compared with those of other provinces in Turkey. As elevated indoor radon concentrations are mostly correlated with high 238U activity concentrations in soil, a total of 57 and 33 soil samples were collected from the Artvin and Ardahan provinces, respectively, to determine 238U activity concentration as well as the concentration of 232TH and 40K-naturally occurring radionuclides. It was also observed that soil samples collected from the study areas contained 137Cs as an artificial radionuclide. © The Author 2010. Published by Oxford University Press. All rights reserved.

Kulich, M., Řeřicha, V., Řeřicha, R., Shore, D.L., Sandler, D.P.
Incidence of non-lung solid cancers in Czech uranium miners: A case-cohort study
(2011) Environmental Research, 111 (3), pp. 400-405.

Abstract

Objectives: Uranium miners are chronically exposed to radon and its progeny, which are known to cause lung cancer and may be associated with leukemia. This study was undertaken to evaluate risk of non-lung solid cancers among uranium miners in Příbram region, Czech Republic.Methods: A retrospective stratified case-cohort study in a cohort of 22,816 underground miners who were employed between 1949 and 1975. All incident non-lung solid cancers were ascertained among miners who worked underground for at least 12 months (n=1020). A subcohort of 1707 subjects was randomly drawn from the same population by random sampling stratified on age. The follow-up period lasted from 1977 to 1996.Results: Relative risks comparing 180. WLM (90th percentile) of cumulative lifetime radon exposure to 3. WLM (10th percentile) were 0.88 for all non-lung solid cancers combined (95% CI 0.73-1.04, n=1020), 0.87 for all digestive cancers (95% CI 0.69-1.09, n=561), 2.39 for gallbladder cancer (95% CI 0.52-10.98, n=13), 0.79 for larynx cancer (95% CI 0.38-1.64, n=62), 2.92 for malignant melanoma (95% CI 0.91-9.42, n=23), 0.84 for bladder cancer (95% CI 0.43-1.65, n=73), and 1.13 for kidney cancer (95% CI 0.62-2.04, n=66). No cancer type was significantly associated with radon exposure; only malignant melanoma and gallbladder cancer showed elevated but non-significant association with radon.Conclusions: Radon was not significantly associated with incidence of any cancer of interest, although a positive association of radon with malignant melanoma and gallbladder cancer cannot be entirely ruled out.

Kuo, T., Lin, C., Su, C., Liu, C., Lin, C.H., Chang, C., Chiang, C.
Correlating recurrent radon precursors with local earthquake magnitude and crust strain near the Chihshang fault of eastern Taiwan
(2011) Natural Hazards, 59 (2), pp. 861-869.

Abstract
The active Chihshang fault in the southern segment of longitudinal valley of eastern Taiwan is part of the suture boundary between the Eurasia plate and the Philippine Sea plate. Radon anomalies in groundwater were recorded prior to three major earthquakes-(1) 2003 Mw = 6.8 Chengkung, (2) 2006 Mw = 6.1 Taitung, and (3) 2008 Mw = 5.4 Antung. The epicenters were located 24, 52, and 13 km, respectively, from the radon-monitoring well (D1) in the Antung hot spring about 3 km southeast of the Chihshang fault. Prior to the three major earthquakes, radon decreased from background levels of 787 ± 42, 762 ± 57, and 700 ± 57 pCi/L to minima of 326 ± 9, 371 ± 9, and 480 ± 43 pCi/L, respectively. Based on the radon volatilization model and the rock dilatancy model, this paper correlates the observed radon minima with local earthquake magnitude and crust strain. The correlation is a useful means of forecasting local disastrous earthquakes in the southern segment of longitudinal valley of eastern Taiwan.

Kurnaz, A., Küçükömeroğlu, B., Çevik, U., Çelebi, N.
Radon level and indoor gamma doses in dwellings of Trabzon, Turkey
(2011) Applied Radiation and Isotopes, 69 (10), pp. 1554-1559.

Abstract
The seasonal variations of the indoor radon activity concentrations were determined in the 97 dwellings of Trabzon, Turkey. The annual average indoor radon activity concentration varied from 8 to 583Bq/m3. The average winter/summer ratio of radon activity concentrations was 3.62. The gamma activity concentrations in the soil samples were determined as 41, 38, 443 and 25Bq/kg for 226Ra, 232Th, 40K and 137Cs, respectively. The average gamma dose rate in air and the annual effective dose equivalent for outdoor occupancy were calculated as 63nGy/h and 77γSv/y, respectively. © 2011 Elsevier Ltd.

Kuźniak, M.
Acrylic purification and coatings
(2011) AIP Conference Proceedings, 1338, pp. 101-108.

Abstract
Radon (Rn) and its decay daughters are a well-known source of background in direct WIMP detection experiments, as either a Rn decay daughter or an alpha particle emitted from a thin inner surface layer of a detector could produce a WIMP-like signal. Different surface treatment and cleaning techniques have been employed in the past to remove this type of contamination. A new method of dealing with the problem has been proposed and used for a prototype acrylic DEAP-1 detector. Inner surfaces of the detector were coated with a layer of ultra pure acrylic, meant to shield the active volume from alphas and recoiling nuclei. An acrylic purification technique and two coating techniques are described: a solvent-borne (tested on DEAP-1) and solvent-less (being developed for the full scale DEAP-3600 detector). © 2011 American Institute of Physics.

La Delfa, S., Vizzini, F., Patanè, G.
Radon migration into different building types at medium and low south-eastern flank of Mt Etna (Sicily): connection with the volcanic activity
(2011) Environmental Earth Sciences, pp. 1-9. Article in Press.

Abstract
Indoor Radon concentrations have been carried out simultaneously at the villages of S. Venerina and Acireale, which are located on the south-eastern flank of Mt. Etna volcano. Both investigation sites are partially affected by the same fault system, which plays an important role in the dynamics of the volcano, especially before and during eruptive periods. Measurements were performed in the period from January 2006 until April 2006, just prior to an eruption which took place on 14th July 2006. Indoor Radon monitoring at

S. Venerina, was carried out at two buildings located nearby, characterized by a different type of construction. These buildings were chosen because they can be considered as representative of both the historical centre and the new neighbourhoods of the village. At the same time, a Radon active monitor was operating in-soil near the two aforesaid edifices. Cross-correlation analysis between the in-soil one with both the indoor S. Venerina Radon series indicated different temporal correlation, probably due to the different types of building foundations and constructive materials of their walls, both causing the different indoor accumulation. S. Venerina's indoor Radon values taken at the new building showed similar trends and the same anomalies as the ones recorded at Acireale. The simultaneous increase in indoor Radon concentration was observed at both sites from the last ten days of March, when a significant increase in the CO2 efflux was recorded. Increases in volcanogenic gases occurred very probably throughout an inflating state of the volcano during the pre-eruptive period, which caused the wide opening of the fractures. Lastly, variations in indoor Radon concentrations observed before an eruption, indicate the suitability of the investigated sites for in-soil Radon monitoring at a low altitude of the south-eastern flank of Mt. Etna. Moreover, in this place repeated and long period Radon indoor measurements should be carried out due to high potential indoor accumulation which depends from the volcanic activity, as this could constitute a serious danger to public health.

Landrigan, P.J., Espina, C., Neira, M.
Global prevention of environmental and occupational cancer
(2011) Environmental Health Perspectives, 119 (7), pp. A280-A281.

Larson, T., Östman, C., Colmsjö, A.
An automated multidimensional preparative gas chromatographic system for isolation and enrichment of trace amounts of xenon from ambient air
(2011) Analytical and Bioanalytical Chemistry, 400 (2), pp. 449-458.

Abstract
The monitoring of radioactive xenon isotopes is one of the principal methods for the detection of nuclear explosions in order to identify clandestine nuclear testing. In this work, a miniaturized, multiple-oven, six-column, preparative gas chromatograph was constructed in order to isolate trace quantities of radioactive xenon isotopes from ambient air, utilizing nitrogen as the carrier gas. The multidimensional chromatograph comprised preparative stainless steel columns packed with molecular sieves, activated carbon, and synthetic carbon adsorbents (e.g., Anasorb®-747 and Carbosphere®). A combination of purification techniques-ambient adsorption, thermal desorption, back-flushing, thermal focusing, and heart cutting-was selectively optimized to produce a well-defined xenon peak that facilitated reproducible heart cutting and accurate quantification. The chromatographic purification of a sample requires approximately 4 h and provides complete separation of xenon from potentially interfering components (such as water

vapor, methane, carbon dioxide, and radon) with recovery and accuracy close to 100%. The preparative enrichment process isolates and concentrates a highly purified xenon gas fraction that is suitable for subsequent ultra-low-level γ-, /γ-spectroscopic or high-resolution mass spectrometric measurement (e.g., to monitor the gaseous fission products of nuclear explosions at remote locations). The Xenon Processing Unit is a free-standing, relatively lightweight, and transportable system that can be interfaced to a variety of sampling and detection systems. It has a relatively inexpensive, rugged, and compact modular (19-inch rack) design that provides easy access to all parts for maintenance and has a low power requirement.

Larsson, L.S.
A response to: Deadly radon in Montana?
(2011) Dose-Response, 9 (2), pp. 296-298.

Lawson, I., Cleveland, B.
Low background counting at SNOLAB
(2011) AIP Conference Proceedings, 1338, pp. 68-77.

Abstract
It is a continuous and ongoing effort to maintain radioactivity in materials and in the environment surrounding most underground experiments at very low levels. These low levels are required so that experiments can achieve the required detection sensitivities for the detection of low-energy neutrinos, searches for dark matter and neutrinoless double-beta decay. SNOLAB has several facilities which are used to determine these low background levels in the materials and the underground environment. This proceedings will describe the SNOLAB High Purity Germanium Detector which has been in continuous use for the past five years and give results of many of the items that have been counted over that period. Brief descriptions of SNOLAB's alpha-beta and electrostatic counters will be given, and the radon levels at SNOLAB will be discussed. © 2011 American Institute of Physics.

Lazareva, E.V., Zhmodik, S.M., Melgunov, M.S., Petrova, I.V., Bryanskaya, A.V.
Redistribution of radionuclides between a microbial mat and a carbonate body at the Garga hot spring (Baikal Rift Zone)
(2011) Doklady Earth Sciences, 439 (2), pp. 1131-1137.

Abstract
The features of present deposits that form in the vicinity of hot springs can provide clues to the parameters of paleowaters in places of past hydrothermal activity marked by remnant carbonate and/or siliceous sinter. We investigated a large carbonate body at the

Garga hot spring developing in the Baikal zone of nitric hydrotherms in the Barguzin Rift Zone valley. The main focus was on the structure of the carbonate mound, as well as on the partitioning of radioactive elements between the cyanobacterial mat and the inorganic component of the body (the issue that has never been explored before). The cyanobacterial community of the Garga spring is an active biosorbent of 226Ra, 228Ra, 210Pb. The radionuclides accumulated by biosorption become preserved in minerals that form within the bacterial community. The reported data of mineral formation in the cyanobacterial mat along with the mineralogy and structure of the carbonate mound of the Garga spring have implications for the complex history of the Garga body. It has been produced jointly by precipitation from the venting thermal water (opal-calcite-fluorite-barite-celestine assemblage) and microbial metabolic activity (coarse calcite and thin black encrustation rich in Mn minerals).

Le, R., He, Z., Cai, S., Chen, J., Hong, J.
Error-analysis of correction method in radon measurement with activated charcoal according to the chinese standard of GB/T14582-1993
(2011) He Jishu/Nuclear Techniques, 34 (5), pp. 350-353.

Abstract
Radon detection by activated charcoal needs corrections according to exposure time and soak time (the duration from the end of collection time to the start time of measurement). The counts must be corrected by exposure-time adjustment factor t10.49 (where t1 is exposure time) and decay adjustment factor of e-(t1/2+t2)λRn(where t2 is soak time), which is widely used in China. In order to test the adjustment and check the adjustment errors, the counts of γ-rays at different exposure hours and soak hours are calculated using a calculation method. The calculation results show that the exposure time difference of (-12 h~+12 h) between measurement and calibration can cause exposure-time adjustment error of +5.0%~-3.9% and decay adjustment error of 4.4%-4.6%. The soak time can be adjusted according to exposure time, which does not cause any decay adjustment error. If the exposure time is less than 48 h, the soak time should be more than 3 h. If the exposure time is more than 72 h, the soak time can be less than 3 h.

LEE, J.Y.
Environmental issues of groundwater in Korea: implications for sustainable use
(2011) Environmental Conservation, pp. 1-11. Article in Press.

Abstract
SUMMARYGroundwater has been extensively exploited worldwide but is now confronted by a variety of problems, including groundwater depletion and contamination, that threaten its sustainable use as a clean water source. Groundwater is one of the major sources of water for domestic, agricultural and industrial uses, and provides 13% of the total annual water supply in Korea. Annual groundwater use has continuously increased

from 2.57 billion m3 in 1994 to 3.72 billion m3 in 2007, of which 48.1% was consumed for domestic purposes. However, due to imprudent groundwater development and inappropriate management, Korea has confronted some critical groundwater problems, including extensive water level decline and quality deterioration caused by petroleum hydrocarbons and chlorinated solvents. Among 193 national groundwater deep-monitoring wells nationwide, 62% showed decreasing water levels over the period 2004-2008. Soil and groundwater contamination by petroleum hydrocarbons was detected at a great number of military bases and public facilities, which drew national attention and complaints. The presence of high levels of radionuclides such as uranium and radon in groundwater has awakened controversy on their health effects. Increasing outbreaks of massive gastroenteritis were attributed to noroviruses in contaminated groundwater, and raised public health concerns. In addition, chlorinated solvents, especially trichloroethylene (TCE), have been frequently found in urban and industrial groundwaters, further adding to the burdens of environmental authorities. Consequently, these groundwater-related environmental issues have forced the Korean government and relevant authorities to urgently devise mitigation plans to secure a sustainable future use of groundwater resources. This paper provides details of the groundwater issues and implications for appropriate development and management.

Lee, K.Y., Cho, S.Y., Yoon, Y.Y., Jang, Y.N.
Determination of the radon emanation fraction from phosphogypsum using LSC
(2011) Journal of Radioanalytical and Nuclear Chemistry, pp. 1-4. Article in Press.

Abstract
A simple method for the determination of the radon emanation fraction was studied using a liquid scintillation counter. The radon activity of the gaseous phase in a closed container was measured 1 day and 35 days after sealing and used to calculate the radon emanation fraction. Radon leakage from the container was investigated using a 226Ra radioactive standard solution (SRM4967, NIST) to plot a radon growth curve. The method was applied to materials that typically contain a high level of radium, such as phosphogypsum, phosphate fertilizer and a rock sample. The effect of temperature on the radon emanation fraction from the materials was investigated at 0, 10, 20, 30 and 40 °C. It was found that there is a linear correlation (R2 = 0.746 - 0.946) between temperature and the emanation fraction. Within the temperature range, the radon emanation fractions were 0.241-0.466 for phosphogypsum, 0.225-0.351 for phosphate fertilizer and 0.154-0.351 for the rock sample. © 2011 Akadémiai Kiadó, Budapest, Hungary.

Lee, M., Bhang, H.C., Kim, S.C., Kim, S.K., Lee, S.-J., Li, J., Myung, S.S., Kim, Y., Kim, H.J.
Radon environment in the Korea invisible mass search experiment and its measurement
(2011) Journal of the Korean Physical Society, 58 (4), pp. 713-718.

Abstract
The level of radioactivity from 222Rn in the air has to be monitored to control systematic effects on the background level at the KIMS (Korea Invisible Mass Search) dark matter search experiment. We designed and constructed a radon detector using a silicon photodiode that collects 218Po and 214Po daughter ions electrically and detects their α decays. Results for the detector calibration with a standard radon source, as well as the dependence of the α-particle detection efficiency on the humidity, are presented. The radioactivity of radon at the YangYang underground laboratory is measured and continuously monitored.

Lehnert, A.L., Thompson, K.H., Kearfott, K.J.
Application of an equilibrium-based model for diffusion barrier charcoal canisters in a small volume non-steady state radon chamber
(2011) Health Physics, 100 (2), pp. 138-147.

Abstract
Radon in indoor air is often measured using activated charcoal in canisters. These are generally calibrated using large, humidity- and temperature-controlled radon chambers capable of maintaining a constant radon concentration over several days. Reliable and reproducible chambers are expensive and may be difficult to create and maintain. This study characterizes a small radon chamber in which 222Rn gas is allowed to build up over a period of several days for use in charcoal canister calibration and educational demonstrations, as well as various radon experiments using charcoal canisters. Predictive models have been developed that accurately describe radon gas kinetics in the charcoal canisters. Three models are available for kinetics in the small chamber with and without radon-adsorbing charcoal canisters. Presented here are both theoretical and semi-empirical applications of this equilibrium-based model of radon adsorption as applied to canisters in the small chamber. Several charcoal canister experiments in the small chamber with an equilibrium-based model of radon adsorption applied are reported. Results show that it is necessary to include a continuous radon monitor in the chamber during canister exposures, as the radon removal rate is highly variable. Furthermore, the presence of the canisters significantly decreases the amount of radon in the small chamber, especially when several canisters are present. It was found that canister response in the small chamber is largely consistent with the equilibrium-based model for both applications, with average errors of 1% for the theoretical application and -4% for the semi-empirical approach. Copyright © 2011 Health Physics Society.

Leonard, B.E., Thompson, R.E., Beecher, G.C.
Human lung cancer risks from radon - part I- influence from Bystander effects - a microdose analysis
(2011) Dose-Response, 9 (2), pp. 243-292.

Abstract
Since the publication of the BEIR VI report in 1999 on health risks from radon, a significantamount of new data has been published showing various mechanisms that mayaffect the ultimate assessment of radon as a carcinogen, at low domestic and workplaceradon levels, in particular the Bystander Effect (BE) and the Adaptive Response radio-protection(AR). We analyzed the microbeam and broadbeam alpha particle data of Miller etal. (1995, 1999), Zhou et al. (2001, 2003, 2004), Nagasawa and Little (1999, 2002), Hei etal. (1999), Sawant et al. (2001a) and found that the shape of the cellular response toalphas is relatively independent of cell species and LET of the alphas. The same alpha particletraversal dose response behavior should be true for human lung tissue exposure toradon progeny alpha particles. In the Bystander Damage Region of the alpha particleresponse, there is a variation of RBE from about 10 to 35. There is a transition regionbetween the Bystander Damage Region and Direct Damage Region of between one andtwo microdose alpha particle traversals indicating that perhaps two alpha particle "hits"are necessary to produce the direct damage. Extrapolation of underground miners lungcancer risks to human risks at domestic and workplace levels may not be valid.

Leonardo, L., Mazzilli, B.P., Damatto, S.R., Saiki, M., Barros de Oliveira, S.M.
Assessment of atmospheric pollution in the vicinity of a tin and lead industry using lichen species Canoparmelia texana
(2011) Journal of Environmental Radioactivity, 102 (10), pp. 906-910.

Abstract
This paper examines the viability of using Canoparmelia texana lichen species as a bioindicator of air pollution by radionuclides and rare earth elements (REEs) in the vicinity of a tin and lead industry. The lichen and soil samples were analyzed for uranium, thorium and REEs by instrumental neutron activation analysis. The radionuclides 226Ra, 228Ra and 210Pb were determined either by Gamma-ray spectrometry (GRS) (soils) or by radiochemical separation followed by gross alpha and beta counting using a gas flow proportional counter (lichens). The lichens samples concentrate radionuclides (on the average 25-fold higher than the background for this species) and REEs (on the average 10-fold higher), therefore they can be used as a fingerprint of contamination by the operation of the tin industry.

Leuraud, K., Schnelzer, M., Tomasek, L., Hunter, N., Timarche, M., Grosche, B., Kreuzer, M., Laurier, D.
Radon, smoking and lung cancer risk: Results of a joint analysis of three European case-control studies among uranium miners
(2011) Radiation Research, 176 (3), pp. 375-387.

Abstract
A combined analysis of three case-control studies nested in three European uranium miner cohorts was performed to study the joint effects of radon exposure and smoking on lung cancer death risk. Occupational history and exposure data were available from the cohorts. Smoking information was reconstructed using self-administered questionnaires and occupational medical archives. Linear excess relative risk models adjusted for smoking were used to estimate the lung cancer risk associated with radon exposure. The study includes 1046 lung cancer cases and 2492 controls with detailed radon exposure data and smoking status. The ERR/WLM adjusted for smoking is equal to 0.008 (95% CI: 0.0040.014). Time since exposure is shown to be a major modifier of the relationship between radon exposure and lung cancer risk. Fitting geometric mixture models yielded arguments in favor of a sub-multiplicative interaction between radon and smoking. This combined study is the largest case-control study to investigate the joint effects of radon and smoking on lung cancer risk among miners. The results confirm that the lung carcinogenic effect of radon persists even when smoking is adjusted for, with arguments in favor of a sub-multiplicative interaction between radon and smoking. © 2011 by Radiation Research Society.

Lezhnin, V.L., Polzik, E.V., Kazantsev, V.S., Zhukovsky, M.V., Pakholkina, O.A.
A multifactorial assessment of carcinogenic risks of radon for the population residing in a Russian radon hazard zone
(2011) Archive of Oncology, 19 (1-2), pp. 3-8.

Abstract
Background: Results of numerous epidemiologic studies of carcinogenic effects of indoor radon conducted in different countries in the past 40 years remain controversial. To assess the contribution of the residential radon exposure in the development of lung cancer in the population of the Russian region with a high radon hazard we conducted a cancer epidemiology study based on a multifactorial analysis. Methods: The study was conducted in the town of Lermontov situated in the area with high background radon concentrations and lung cancer rates of the Caucasian Mineral Water Region of Russia. High indoor radon levels were found in the houses of urban residents, mostly employed by the mining and chemical enterprise. The cohort consisted of 122 lung cancer cases and 208 controls. Each of 330 study participants was characterized by a set of 23 indices reflecting known lung cancer risk factors. We also collected data on occupational and residential radon exposure of all subjects. Results: The analysis of a combined effect of 23 different lung cancer risk factors based on pattern recognition methods showed that the contribution of the non-occupational radon exposure was only about 2% whereas that of the occupational radon exposure equaled 15%. Conclusion: Our findings showed that the effect of the residential radon exposure on the lung cancer rate was 15-20 times weaker than the effects of the main risk factors such as smoking, occupational hazards, chronic lung diseases, social and household factors, etc., although for the population of

Lermontov this factor was 2-3 times stronger than that found in the Ural towns of Russia.

Li, H., Zhang, L., Guo, Q.
Behaviours and influence factors of radon progeny in three typical dwellings
(2011) Journal of Radiological Protection, 31 (1), pp. 135-140.

Abstract
To investigate the behaviours and influence factors of radon progeny in rural dwellings in China, site measurements of radon equilibrium factor, unattached fraction and some important indoor environmental factors, such as aerosol concentration, aerosol size distribution and ventilation rate, were carried out in three typical types of dwellings, and a theoretical study was also performed synchronously. Good consistency between the results of site measurements and the theoretical calculation on equilibrium factor F and unattached fraction fp was achieved. Lower equilibrium factor and higher unattached fraction in mud or cave houses were found compared to those in brick houses, and it was suggested by the theoretical study that the smaller aerosol size distribution in mud or cave houses might be the main reason for what was observed. The dose conversion factor in the mud houses and the cave houses may be higher than that in brick houses. © 2011 IOP Publishing Ltd.

Liang, P., Li, Y.
The design of measurement and control system of the radon detection instrument based on MCU
(2011) Proceedings of 2011 International Conference on Electronic and Mechanical Engineering and Information Technology, EMEIT 2011, 8, art. no. 6023936, pp. 4027-4029.

Abstract
The design of measurement and control system of the radon detection instrument, which used for geological prospecting and environmental monitoring, is introduced in this paper. This paper includes the present research situation of the radon detection instrument, the software and hardware design, the focus is the data processing software design which based on the fourth language Delphi. The data processing software includes the data serial communication, the data acceptance, the data display, the data storage, the curve drawing, the database management and so on. © 2011 IEEE.

Lin, C., Kuo, T., Fan, K., Chen, Y., Su, C., Tong, L., Lee, C., Hu, K., Liu, C., Liang, H., Tsai, C., Chiang, C.

Characterization of well skin using buildup test and radon as a tracer
(2011) Journal of Petroleum Science and Engineering, 78 (2), pp. 201-207.

Abstract
Pressure buildup tests are often used to determine the reservoir permeability and skin factor to quantify formation damage. However, no quantitative method is currently available for calculating the reduced permeability of the skin zone. With the help of radon measurements during the flow period preceding the buildup test, it is possible to calculate both the radius and the altered permeability in the damaged zone based on a radial composite model. © 2011.

Lindemann, S., Simgen, H., Zuzel, G.
Behaviour of 222Rn at cryogenic temperatures
(2011) AIP Conference Proceedings, 1338, pp. 156-160.

Abstract
The behaviour of radon in a cryogenic environment is still not well known. Therefore, measured radon emanation rates at room temperature cannot be translated directly to cryogenic conditions. In this work we present a table-top experiment that provides a direct way of determining the behaviour of 222Rn in cryogenic argon and helium at liquid argon temperature. We observe an increased emanation rate of 222Rn atoms to liquid argon compared to the rate observed to helium at room temperature. We also find that 222Rn atoms stick to cold metal surfaces when emanated to helium at liquid argon temperature but partly distribute in the liquid when emanated to cryogenic argon. Concluding, we give possible interpretations of the observations. © 2011 American Institute of Physics.

Liu, H.-Z., Chen, H.-J., Cao, H., Hu, Y.-H.
Influence of aerosol upon radon concentration of radon chamber
(2011) Hedianzixue Yu Tance Jishu/Nuclear Electronics and Detection Technology, 31 (7), pp. 772-774+830.

Abstract
On the basis of theoretical analysis, the influence on the radon concentration of radon chamber by the experiment of filling the radon chamber with aerosol, and the absorption of radon daughter on aerosol under the condition of different radon concentration and aerosol concentration was described. The results of experiment showed that: Aerosol did not affect the stability of the radon concentration of the radon chamber, but different aerosol concentration will change the combination state of radon daughter, thus it will affect the diffusion coefficient of radon daughter, so it will affect the results of the measure of the gross measuring instrument.

Liu, L.-Y., Zhao, X.-L., Huang, S., Wu, R.-Y., Zhao, Y.-H.
Methods and technology status of 222Rn/220Rn joint measurement
(2011) Hedianzixue Yu Tance Jishu/Nuclear Electronics and Detection Technology, 31 (2), pp. 248-250+254.

Abstract
222Rn/220Rn is a radioactive gas full of everywhere on Earth, the study of 222Rn/220Rn has been an important issue in radiation protection and environmental protection. At present, the accurate measurement of 222Rn is already built up, but the measurement standards of 220Rn concentration has not been fully established yet. The joint measurement of 222Rn/220Rn concentration can be mainly divided into double membrane spectroscopy, delay method using scintillation cells, parallel measurement using solid state nuclear track detector, activated carbon filter paper method and electrostatic collection method. At home and abroad 222Rn/220Rn co-measuring instrument mainly includes FD-129 222Rn/220Rn detector, LR-115 solid state nuclear track detectors, RAD7 radon monitor, and so on.

López, F.A., Gázquez, M., Alguacil, F.J., Bolívar, J.P., García-Díaz, I., López-Coto, I.
Microencapsulation of phosphogypsum into a sulfur polymer matrix: Physico-chemical and radiological characterization
(2011) Journal of Hazardous Materials, 192 (1), pp. 234-245.

Abstract
The aim of this work is to prepare a new type of phosphogypsum-sulfur polymer cements (PG-SPC) to be utilised in the manufacture of building materials. Physico-chemical and radiological characterization was performed in phosphogypsum and phosphogypsum-sulfur polymer concretes and modeling of exhalation rates has been also carried out. An optimized mixture of the materials was obtained, the solidified material with optimal mixture (sulfur/phosphogypsum. =1:0.9, phosphogypsum dosage. =10-40. wt.%) results in highest strength (54-62. MPa) and low total porosity (2.8-6.8%). The activity concentration index (I) in the PG-SPC is lower than the reference value in the most international regulations and; therefore, these cements can be used without radiological restrictions in the manufacture of building materials. Under normal conditions of ventilation, the contribution to the expected radon indoor concentration in a standard room is below the international recommendations, so the building materials studied in this work can be applied to houses built up under normal ventilation conditions.Additionally, and taking into account that the PG is enriched in several natural radionuclides as 226Ra, the leaching experiments have demonstrated that environmental impact of the using of SPCs cements with PG is negligible.

Lozano, R.L., San Miguel, E.G., Bolívar, J.P.
Assessment of the influence of in situ 210Bi in the calculation of in situ 210Po in air aerosols: Implications on residence time calculations using 210Po/210Pb activity ratios
(2011) Journal of Geophysical Research D: Atmospheres, 116 (8), art. no. D08206, .

Abstract
The long-lived daughter products of 222Rn (210Pb, 210Bi, and 210Po) in the atmosphere have been utilized to obtain residence time and transport time scale of atmospheric aerosols. Residence times obtained using 210Bi/210Pb consistently yielded lower residence times compared to 210Po/210Pb pair. This is widely attributed to the extraneous sources of 210Po. However, one additional source that has been overlooked is the decay from 210Bi. Most of the published data that reports residence time of aerosols based on 210Po/210Pb pair do not report corrections in 210Po activities due to its in-growth from 210Bi. In this work, we quantitatively evaluate the effect of initial 210Bi concentrations in the atmospheric aerosol filters at the time of collection on the production rates of 210Po and how that could affect the residence time calculated using 210Po. In particular, we estimate the deviation of in situ 210Po activities from the measured 210Po activities for two limiting extreme cases: (1) neglecting the initial 210Bi concentrations and (2) assuming secular equilibrium between 210Bi and 210Pb. The residence times under these scenarios have been calculated. Our results show that neglecting the value of the initial 210Bi concentration in air can lead to significant differences between the in situ 210Po activity and measured 210Po, and thus affect the residence time calculations of the aerosols. Therefore, 210Bi should be determined when 210Po measurements are carried out in air, and 210Bi/210Pb pair should be utilized better than 210Po/210Pb one in order to estimate aerosol residence time.

Lubenau, J.O., Mould, R.F.
The radium bank of Grand Junction, Colorado [Bank radu w Grand Junction w stanie Kolorado]
(2011) Nowotwory, 61 (1), pp. 81-83.

Abstract
The existence in the early years of the 20th century is described of what was a commercial bank specifically set up to deal in radium. This was sited in Grand Junction, Colorado and existed in 1913 but the year of its closure is not known. The only reference to this Bank in the literature, as far as can be ascertained, was in the August 1913 issue of the Technical World Magazine [1] of Chicago, where it was described as "Radium Banking - a New Business". Radon water therapy is also described as well as a case history of the treatment of liver cancer. In 1910 Radium Banks were reported n Paris and London with future plans for Berlin and New York.

Madas, B.G., Balásházy, I.
Mutation induction by inhaled radon progeny modeled at the tissue level
(2011) Radiation and Environmental Biophysics, pp. 1-18. Article in Press.

Abstract
The observable responses of living systems to ionizing radiation depend on the level of biological organization studied. Understanding the relationships between the responses characteristic of the different levels of organization is of crucial importance. The main objective of the present study is to investigate how some cellular effects of radiation manifest at the tissue level by modeling mutation induction due to chronic exposure to inhaled radon progeny. For this purpose, a mathematical model of the bronchial epithelium was elaborated to quantify cell nucleus hits and cell doses. Mutagenesis was modeled considering endogenous as well as radiation-induced DNA damages and cell cycle shortening due to cell inactivation. The model parameters describing the cellular effects of radiation are obtained from experimental data. Cell nucleus hits, cell doses, and mutation induction were computed for the activity hot spots of the large bronchi at different exposures. Results demonstrate that the mutagenic effect of densely ionizing radiation is dominated by cell cycle shortening due to cell inactivation and not by DNA damages. This suggests that radiation burdens of non-progenitor cells play a significant role in mutagenesis in case of protracted exposures to densely ionizing radiation. Mutation rate as a function of dose rate exhibits a convex shape below a threshold. This threshold indicates the exhaustion of the tissue regeneration capacity of local progenitor cells. It is suggested that progenitor cell hyperplasia occurs beyond the threshold dose rate, giving a possible explanation of the inverse dose-rate effect observed in the epidemiology of lung cancer among uranium miners.

Madas, B.G., Balásházy, I., Farkas, A., Szoke, I.
Cellular burdens and biological effects on tissue level caused by inhaled radon progenies
(2011) Radiation Protection Dosimetry, 143 (2-4), art. no. ncq522, pp. 253-257.

Abstract
In the case of radon exposure, the spatial distribution of deposited radioactive particles is highly inhomogeneous in the central airways. The object of this research is to investigate the consequences of this heterogeneity regarding cellular burdens in the bronchial epithelium and to study the possible biological effects at tissue level. Applying computational fluid and particle dynamics techniques, the deposition distribution of inhaled radon daughters has been determined in a bronchial airway model for 23 min of work in the New Mexico uranium mine corresponding to 0.0129 WLM exposure. A numerical epithelium model based on experimental data has been utilised in order to quantify cellular hits and doses. Finally, a carcinogenesis model considering cell death-induced cell-cycle shortening has been applied to assess the biological responses. Present computations reveal that cellular dose may reach 1.5 Gy, which is several orders of magnitude higher than tissue dose. The results are in agreement with the histological

finding that the uneven deposition distribution of radon progenies may lead to inhomogeneous spatial distribution of tumours in the bronchial airways. In addition, at the macroscopic level, the relationship between cancer risk and radiation burden seems to be non-linear.

Máduar, M.F., Campos, M.P., Mazzilli, B.P., Villaverde, F.L.
Assessment of external gamma exposure and radon levels in a dwelling constructed with phosphogypsum plates
(2011) Journal of Hazardous Materials, 190 (1-3), pp. 1063-1067.

Abstract
Phosphogypsum, a fertilizer industry by-product, is being worldwide stockpiled, posing environmental concerns. Since this material contains natural radionuclides in significant concentrations, its use as a building material has radiological implications. In order to confirm the feasibility of the use of a new material mainly composed by phosphogypsum, an experimental house was built, having some of its rooms entirely lined with this material. Measurements of samples of phosphogypsum plates from different origins resulted in values of 0.2 to 2.6 for the external radiation index, thus justifying a more detailed investigation. In this paper, the application of a previously developed computational model to forecast external doses indoors is described. A comprehensive radiological evaluation is being performed, including measurement of the external gamma exposure and radon concentrations in one of the rooms of the house. The results show that the annual increment in the effective dose to an inhabitant of the house will remain below the 1. mSv limit for every reasonable scenario.The radon measurements were carried out over a period of 18months, in order to determine the long-term average levels of the indoor radon concentrations. The results obtained are below 200Bqm-3, the recommended investigation level for radon. © 2011 Elsevier B.V.

Mahat, R.H., Jojo, P.J., Pereira, C.E., Amin, Y.M.
Seasonal variation of indoor radon concentration in the tropics: Comparative studies between Kuala Lumpur, Malaysia and Kerala, India
(2011) AIP Conference Proceedings, 1328, pp. 107-109.

Abstract
The radiation dose received by man from indoor radon and its progeny is the largest at more than 50% of total dose received. The seasonal variation of indoor radon concentration in Kerala, India and Kuala Lumpur, Malaysia were studied. The Southwest coast of the Kerala state in India is known to have very high levels of natural background radiation owing to the rare earths rich monazite sand available in large amount. Kuala Lumpur, Malaysia used to be a famous tin mining area where it was done using open cast system. One-year measurements of radon concentration in houses were done for these

two regions. It was found that there is considerable seasonal variation in the levels of radon in Kerala but the variation in Kuala Lumpur is only less than 10%.

Mahmood, A., Tufail, M.
Measurement of radon concentration for assessment of the radiological hazard in the Chakwal coalmines of the Salt Range, Pakistan
(2011) Journal of Radiological Protection, 31 (3), pp. 353-367.

Abstract
Radon and its progeny are prevalent everywhere on the lithosphere especially in the mining environment. Coal exists in the Salt Range that passes through Pakistan. The aim of the present study was to measure radon concentration and assess the associated radiological hazard in the coalmines developed in that portion of the Salt Range which passes through the district of Chakwal in Pakistan. Among the various coalmines in the coalfield, five were selected for radon survey. A passive integrated technique consisting of SSNTDs (solid state nuclear track detectors) was employed for the measurement of radon concentration in these coalmines. Box type dosimeters containing CN-85 detectors were placed for three months at six locations in every selected coalmine. After removing the dosimeters, the CN-85 detectors were etched in alkaline solution to enlarge the alpha tracks in the detectors and counted under an optical microscope. The track densities were converted to radon concentration. The average concentration of radon in the coalmines varied in the range 50-114 Bqm-3. Radon exhalation rates from the samples of coal and shale collected from the coalmines were determined to be respectively 934 (830-1010) and 1302 (1020-1580) mBqm-2h-1. The radiation dose and corresponding health risk for the mine workers were also estimated. © 2011 IOP Publishing Ltd.

Mamedov, F., Čermák, P., Smolek, K., Štekl, I.
Measurement of radon diffusion through shielding foils for the SuperNEMO experiment
(2011) Journal of Instrumentation, 6 (1), art. no. C01068, .

Abstract
An apparatus developed for the measurement of radon diffusion through thin foils for the SuperNEMO project is presented. The goal of the SuperNEMO collaboration is to construct a new generation detector for the search for neutrinoless double-beta decay ($0\nu\beta\beta$) with 100 kg of enriched isotope as the source. At present, the collaboration is carrying out R&D in order to suppress significantly intrinsic background including that caused by radon. The description of the apparatus, data analysis method, as well as the results obtained in the measurement of radon diffusion through several types of thin foils, glue and sealant suitable for shielding in the SuperNEMO detector are discussed. © 2011 IOP Publishing Ltd and SISSA.

Manea, C., Podina, C., Crutu, G., Pordea, I., Popescu, M., Iuescu, M.
Radiological risk assessement by deteraiining the additional effective dose received by the population in ciudanovita mining area (Banat - Romania)
(2011) Revista de Chimie, 62 (10), pp. 986-991.

Abstract
This paper is a study of radioactive pollution of a former uranium mining area which is now decommissioned. By measuring activity concentrations of radionuclides ofU, Ra, Th and Rn in surface water, soil and air and debit ydose at external irradiation, there were calculated the radiological risk coefficients for people in the population. It comes out that in the area of a uranium ore deposit there is a major radiological hazard area and therefore that area cannot be inhabited, while in the vicinity of a waste dump resulting from the processing of uranium ore extracted in previous years, the area partly inhabited at present, there is a much lower radiological risk but still a significant one that cannot be neglected.

Markovic, V.M., Stevanovic, N., Nikezic, D.
Doses from beta radiation in sensitive layers of human lung and dose conversion factors due to 222Rn/220Rn progeny
(2011) Radiation and Environmental Biophysics, 50 (3), pp. 431-440.

Abstract
Great deal of work has been devoted to determine doses from alpha particles emitted by 222Rn and 220Rn progeny. In contrast, contribution of beta particles to total dose has been neglected by most of the authors. The present work describes a study of the detriment of 222Rn and 220Rn progeny to the human lung due to beta particles. The dose conversion factor (DCF) was introduced to relate effective dose and exposure to radon progeny; it is defined as effective dose per unit exposure to inhaled radon or thoron progeny. Doses and DCFs were determined for beta radiation in sensitive layers of bronchi (BB) and bronchioles (bb), taking into account inhaled 222Rn and 220Rn progeny deposited in mucus and cilia layer. The nuclei columnar secretory and short basal cells were considered to be sensitive target layers. For dose calculation, electron-absorbed fractions (AFs) in the sensitive layers of the BB and bb regions were used. Activities in the fast and slow mucus of the BB and bb regions were obtained using the LUNGDOSE software developed earlier. Calculated DCFs due to beta radiation were 0.21 mSv/WLM for 222Rn and 0.06 mSv/WLM for 220Rn progeny. In addition, the influence of Jacobi room parameters on DCFs was investigated, and it was shown that DCFs vary with these parameters by up to 50%.

Marocchi, M., Righi, S., Maria Bargossi, G., Gasparotto, G.
Natural radionuclides content and radiological hazard of commercial ornamental stones: An integrated radiometric and mineralogical-petrographic study
(2011) Radiation Measurements, 46 (5), pp. 538-545.

Abstract
Twenty samples of natural building materials commonly employed as ornamental stones in the international market have been investigated for natural radioactivity. External (gamma), as defined and used by the European Commission, and internal (alpha) hazard indexes were calculated and radon specific exhalation rate and emanation fraction were measured. The radiological investigation was complemented by an integrated mineralogical-petrographic and rock characterization approach. The most common radioactive accessory minerals occurring in the investigated samples are apatite, zircon and allanite, with minor monazite, thorite, thorianite, REE and Zr-oxides. Significant correlations with total activity concentration have been observed for K2O, Th and Ce concentrations. The emanation fraction is also influenced by both total porosity and porosity distribution. Radon exhalation rate and emanation fraction are very variable ranging from 0.0011 to 0.64 Bq kg-1 h-1 and from 0.2 to 62%, respectively. Most of the materials have radiological hazard indexes that do not exceed the European Commission limit values when used as ornamental or paving or flooring stones. However, three volcanic (Tufo Giallo Riano, Tufo Grigio Riano and Peperino Viterbese) samples could cause significant exposure both from excess radon indoor concentration (>200 Bq m3) and from gamma radiation (>1 mSv y-1) when used as structural materials. This study further indicates that limit values for hazard indexes based on natural activity concentration and Rn emanation should take into account the lithological properties and use of the materials.

Marschalko, M., Yilmaz, I., Fojtová, L., Kubečka, K., Bednárik, M., Stalmachová, B., Závada, J., Arencibia, O.
Implementation of selected geobarriers for the landscape planning purposes in Slezska Ostrava (Czech Republic)
(2011) Scientific Research and Essays, 6 (22), pp. 4798-4807.

Abstract
This article deals with the analysis of engineering-geological zones, flood lands and radon hazard. The main reason of the study is the insufficient use of engineering-geological data for land planning and designing activities of competent authorities. The applied method makes use of the possibilities of geographical information systems, terrain research, documentation and study of archives. The research is localized in the selected area of the city of Ostrava affected by former mining of black coal. An appreciable factor for the characterization of engineering-geological conditions in the monitored areas is an analysis of potential flooding of the current and future development. The potential danger characterized by the 100-years flood concerns 5.2% of the studied area, while 18.1% of this area is currently built up and the rest are fields

and meadows (28.3%) and forests (24.8%). This implies that neither people nor state administration respected the natural conditions in the interest area. For future developers, investors, building offices, it is also important to pay more attention to the radon hazard because of health safety for the future users of the environment. It can be orientation determined, based on the radon hazard maps that can be used along with other specific purpose maps, especially the map of engineering-geological zoning for the foundation engineering needs. The significance of the radon hazard evaluation in the form of maps permits consideration of this geo-factor further during the selection of places of future constructions. In the study area there are two categories of radon index, that is, one is medium and one transient, while the medium category is bound to the indiscriminate flysch sediments zone and the rest falls in the category with a transient radon index. Based on the observed orientation map category, vital attention must be paid to the implementation of measures preventing radon leaks from the bedrock (special insulation of foundations, etc.).

Marušiaková, M., Gregor, Z., Tomášek, L.
A review of exposures to radon, long-lived radionuclides and external gamma at the Czech uranium mine
(2011) Radiation Protection Dosimetry, 145 (2-3), art. no. ncr065, pp. 248-251.

Abstract
This paper presents the results of the personal exposure monitoring conducted in the Rŏń uranium mine in the Czech Republic. In this mine, which has been operated since the late 1950s, personal ALGADE dosemeters have been used since 1998. A group of 600 miners employed during the period 2000-09 has been analysed. Annual exposures to radon decay products, long-lived alpha emitters and external gamma radiation are described. These components play an essential role in the estimation of the total effective dose. The dependence of the exposures on the type of mining job is also assessed. © The Author 2011. Published by Oxford University Press. All rights reserved.

Marušiaková, M., Hůlka, J.
Estimates of the annual average indoor radon concentration in telecí in the Czech republic
(2011) Radiation Protection Dosimetry, 145 (2-3), art. no. ncr066, pp. 145-149.

Abstract
Indoor radon concentrations are subject to diurnal and seasonal variations. In order to obtain an unbiased estimate of the annual mean radon concentration, measurements made over periods less than 12 months have to be adjusted accordingly. In this paper, hourly radon measurements from one uninhabited rural house in Telecí in the Czech Republic have been analysed. The data were collected over a period of 1 y. The behaviour of the radon concentration with time and its relationship with the outdoor temperature, wind

speed and atmospheric pressure have been studied. Different estimates of the annual mean radon concentration based on short-term continuous measurements have been assessed.

Maver Modec, P., Korun, M., Martelanc, M., Vodenik, B.
A comparative study of the radon-induced background in low-level gamma-ray spectrometers
Applied Radiation and Isotopes, . Article in Press.

Abstract
The radon-induced background of ten, high-resolution, germanium, gamma-ray spectrometers was analyzed. In the analysis the apparent activity was introduced, which is defined as the peak count rate normalized with respect to the emission probability and the detection probability. On the basis of its energy and time dependence, the contributions to the background count rates due to the radiation penetrating the shield and the radiation due to the contamination of the air with radon daughters were determined.

McCoy, C., Viso, R., Peterson, R.N., Libes, S., Lewis, B., Ledoux, J., Voulgaris, G., Smith, E., Sanger, D.
Radon as an indicator of limited cross-shelf mixing of submarine groundwater discharge along an open ocean beach in the South Atlantic Bight during observed hypoxia
(2011) Continental Shelf Research, 31 (12), pp. 1306-1317.

Abstract
Hypoxic conditions (dissolved oxygen (DO)<2 mgl-1) have been documented in the nearshore coastal waters of Long Bay, South Carolina, United States of America, during summer months over the past several years. Hypoxia was documented in August 2009 in the nearshore (<500m offshore) for ten consecutive days and four days in September 2009 corresponding with spring tides. This study measured radon activities of shallow beachface groundwater and nearshore bottom waters to estimate mixing rates and submarine groundwater discharge (SGD) in the nearshore waters of central Long Bay. Statistical analyses demonstrate significant correlations between high bottom water radon activities, low DO, and cooler bottom water temperatures during hypoxic conditions. Elevated radon activities during hypoxia were significantly influenced by upwelling favorable conditions which severely limited cross-shelf mixing. Model results indicate mixing of nearshore and offshore waters was limited by up to 93% (range: 43-100%) relative to non-hypoxic conditions. Data suggests previously overlooked natural phenomena including limited cross-shelf mixing and SGD can significantly influence nearshore water quality.

McErlean, A., Ginsberg, M.S.
Epidemiology of Lung Cancer
(2011) Seminars in Roentgenology, 46 (3), pp. 173-177.

McGee, L.E., Beier, C., Smith, I.E.M., Turner, S.P.
Dynamics of melting beneath a small-scale basaltic system: A U-Th-Ra study from Rangitoto volcano, Auckland volcanic field, New Zealand
(2011) Contributions to Mineralogy and Petrology, 162 (3), pp. 547-563.

Abstract
The Auckland volcanic field is a Quaternary monogenetic basaltic field of 50 volcanoes. Rangitoto is the most recent of these at ~500 year BP and may mark a change in the behaviour of the field as it is the largest by an order of magnitude and is unusual in that it erupted magmas of alkalic then subalkalic basaltic composition in discrete events separated by ≤50 years. Major and trace element geochemistry together with Sr-Nd and U-Th-Ra isotopes provides the basis for modelling the melting conditions that brought about the eruption of two chemically different lavas with very little spatial or temporal change. Sr-Nd isotopes suggest that the source for both eruptions is similar with a slight degree of heterogeneity. The basalts show high 230Th-excess compared with comparable continental volcanic fields. We show that the alkalic basalts give evidence for lower degrees of partial melting, higher amounts of residual garnet, a longer melting column and lower melting and upwelling rates compared with the subalkalic basalts. The low upwelling rates (0.1-1.5 cm/year) modelled for both magmas do not suggest a plume or major upwelling in the mantle region beneath Auckland; therefore, we suggest localised convection due to relict movement from the active subduction system situated 400 km to the southeast. A higher porosity for the initial alkalic basalt is based on 226Ra-excesses, suggesting movement of melt by two different porosities: the initial melt travelling in fast high porosity channels from greater depths preserving a high 230Th-excess and the subsequent subalkalic magma travelling from a shallower depth through lower porosity diffuse channels preserving a high 226Ra-excess; this creates a negative array in (226Ra/230Th) versus (230Th/238U) space previously only seen in mid ocean ridge Basalt data. This mechanism suggests the Auckland volcanic field may operate by the presence of discrete melt batches that are able to move at different depths and speeds giving the field its erratic spatial and temporal pattern of eruptions, a type of behaviour that may have implications for the evolution of other continental volcanic fields worldwide.

McLaughlin, J., Murray, M., Currivan, L., Pollard, D., Smith, V., Tokonami, S., Sorimachi, A., Janik, M.
Long-term measurements of thoron, its airborne progeny and radon in 205 dwellings in

Ireland
(2011) Radiation Protection Dosimetry, 145 (2-3), art. no. ncr067, pp. 189-193.

Abstract
Long-term (circa 3 months) simultaneous measurements of indoor concentrations of thoron gas, airborne thoron progeny and radon were made using passive alpha track detectors in 205 dwellings in Ireland during the period 2007-09. Thoron progeny concentrations were measured using passive deposition monitors designed at the National Institute of Radiological Sciences (NIRS), Japan, whereas thoron gas concentrations were measured using Raduet detectors (Radosys, Budapest). Radon concentrations were measured in these dwellings by means of NRPB/SSI type alpha track radon detectors as normally used by the Radiological Protection Institute of Ireland (RPII). The concentration of thoron gas ranged from <1 to 174 Bq m-3 with an arithmetic mean (AM) of 22 Bq m-3. The concentration of radon gas ranged from 4 to 767 Bq m-3 with an AM of 75 Bq m-3. For radon, the estimated annual doses were 0.1 (min), 19.2 (max) and 1.9 (AM) mSv y-1. The concentration of thoron progeny ranged from <0.1 to 3.8 Bq m-3 [equilibrium equivalent thoron concentration (EETC)] with an AM of 0.47 Bq m&-3 (EETC). The corresponding estimated annual doses were 2.9 (max) and 0.35 (mean) mSv y-1. In 14 or 7% of the dwellings, the estimated doses from thoron progeny exceeded those from radon.

Meisenberg, O., Tschiersch, J.
Thoron in indoor air: Modeling for a better exposure estimate
(2011) Indoor Air, 21 (3), pp. 240-252.

Abstract
Only recently, the radioactive gas thoron (220Rn) and its decay products have been regarded as significant health risk in the indoor environment. This is because of new findings of increased thoron concentrations in traditional mud dwellings and considerations leading toward reduced action levels for natural airborne radionuclides. A model which describes the sources and sinks of thoron and its decay products should help to assess the indoor exposure. This work presents an extensive depiction of the influences of indoor conditions on the occurrence of these radionuclides. Measurements were performed in an experiment room and in mud dwellings in China and India. Mud even with an average 232Th concentration was identified as a significant thoron source. The spatial distribution of the decay products proved to be homogeneous, which is in contrast to thoron gas. The prominent contribution of the unattached and attached decay product 212Pb to the exposure was elaborated. The theoretically derived impact of air exchange and aerosol concentration, which determines the proportion of unattached decay products, could be confirmed. Transfer coefficients of the model were determined. The thoron model with these transfer coefficients predicts annual doses of almost 2mSv for dwellers of traditional Chinese and Indian mud buildings, confirming the potential health impact of thoron.

Méndez, D., Alshanqeety, O., Warner, K.E., Lantz, P.M., Courant, P.N.
The impact of declining smoking on radon-related lung cancer in the United States
(2011) American Journal of Public Health, 101 (2), pp. 310-314.

Abstract
Objectives. We examined the effect of current patterns of smoking rates on future radon-related lung cancer. Methods. We combined the model developed by the National Academy of Science's Committee on Health Risks of Exposure to Radon (the BEIR VI committee) for radon risk assessment with a forecasting model of US adult smoking prevalence to estimate proportional decline in radon-related deaths during the present century with and without mitigation of high-radon houses. Results. By 2025, the reduction in radon mortality from smoking reduction (15 percentage points) will surpass the maximum expected reduction from remediation (12 percentage points). Conclusions. Although still a genuine source of public health concern, radoninduced lung cancer is likely to decline substantially, driven by reductions in smoking rates. Smoking decline will reduce radon deaths more that remediation of high-radon houses, a fact that policymakers should consider as they contemplate the future of cancer control.

Meslin, P.Y., Sabroux, J.C., Bassot, S., Chassefière, E.
Experimental study of radon production and transport in an analogue for the Martian regolith
(2011) Geochimica et Cosmochimica Acta, 75 (9), pp. 2256-2270.

Abstract
The suggestion that radon could be used as a radioactive tracer of regolith-atmosphere exchanges and as a proxy for subsurface water on Mars, as well as its indirect detection in the Martian atmosphere by the rover Opportunity, have raised the need for a better characterization of its production process and transport efficiency in the Martian soil. More specifically, a proper estimation of radon exhalation rate on Mars requires its emanation factor and diffusion length to be determined. The dependence of the emanation factor as a function of pore water content (at 267 and 293K) and the dependence of the adsorption coefficient on temperature, specific surface area and nature of the carrier gas (He, He+CO2) have been measured on a Martian soil analogue (Hawaiian palagonitized volcanic ash, JSC Mars-1), whose radiometric analysis has been performed. An estimation of radon diffusion lengths on Mars is provided and is used to derive a global average emanation factor (2-6.5%) that accounts for the exhalation rate inferred from the 210Po surface concentration detected on Martian dust and from the 214Bi signal measured by the Mars Odyssey Gamma Ray Spectrometer. It is found to be much larger than emanation factors characterizing lunar samples, but lower than the emanation factor of the palagonite samples obtained under dry conditions. This result probably reflects different degrees of aqueous alteration and could indicate that the

emanation factor is also affected by the current presence of pore water in the Martian soil. The rationale of the " radon method" as a technique to probe subsurface water on Mars, and its sensitivity to soil parameters are discussed. These experimental data are useful to perform more detailed studies of radon transport in the Martian atmosphere using Global Climate Models and to interpret neutron and gamma data from Mars Odyssey Gamma Ray Spectrometer. © 2011 Elsevier Ltd.

Milić, G., Yarmoshenko, I.V., Jakupi, B., Kovacević, M., Žunić, Z.S.
Indoor radon measurements in Kosovo and Metohija over the period 1995-2007
(2011) Radiation Measurements, 46 (1), pp. 141-144.

Abstract
The paper deals with the results of the investigations of indoor radon measurements in more than 300 rural and urban dwellings in Kosovo and Metohija. All measurements were carried out using CR-39 solid state nuclear track detectors by similar protocols and within two series in 1990-s and in 2000-s, in 34 settlements divided by 9 regions, thus covering significant part of Kosovo. For most of measured points the adjustment for seasonal variation was necessary and had been conducted. Highest average values of indoor radon concentrations were found in rural settlements of Lipljan and Vitina regions, 512 and 452 Bq/m3, respectively. Combined analysis allows indoor radon concentration of 220 Bq/m3 to be suggested as representative estimate for Kosovo, while additional data appear. Observed pattern of indoor radon seasonal variation and difference of radon levels between ground and upper floors suggest soil radon as primary source of indoor radon and significance of convection type radon entry. © 2010 Elsevier Ltd. All rights reserved.

Minina, V.I., Druzhinin, V.G., Golovina, T.A., Larin, S.A., Mun, S.A., Akhmat'ianova, V.R., Bakanova, M.L., Glushkov, A.N.
[Spread of carcinogenic and mutagenic effects in the population of Gornaia Shoria].
(2011) Gigiena i sanitariia, (2), pp. 35-38.

Abstract
Mutagenic and carcinogenic effects were studied in the population of Gornaya Shoria, Kemerovo Region. The carcinogenic effects were evaluated on the basis of the data given by the Kemerovo regional cancer registry over 1990-2008. The standardized cancer morbidity index in Gornaya Shoria (342 per 100,000 population) exceeded the average index in the Kemerovo Region (286 per 100,000) in the same period. The mutagenic effects were estimated on the basis of the monitoring data on the frequency and spectrum of chromosomal aberrations in the peripheral blood lymphocytes of the dwellers of Gornaya Shoria for the 1992-2009 period. The mean level of chromosomal aberrations (5.31%) in the residents of Gornaya Shoria was found to be greater than the regional background mutation rate (2.86%) ($p < 0.001$). The values of individual aberration types

(chromatid and chromosomal breaks, as well as chromosome-type exchange aberrations) were significantly higher in the dwellers of Gornaya Shoria than those in the basic control group. The revealed high mutagenic load in the inhabitants of Tashtagol District, Kemerovo Region, allows this area to be assigned to high genetic risk ones.

Miotliński, K., Dillon, P.J., Pavelic, P., Cook, P.G., Page, D.W., Levett, K.
Recovery of injected freshwater to differentiate fracture flow in a low-permeability brackish aquifer
(2011) Journal of Hydrology, 409 (1-2), pp. 273-282.

Abstract
A low-permeability weathered siltstone-sandstone aquifer containing brackish water was investigated to measure recoverability of injected freshwater with the aim of determining the significance of secondary porosity in contributing to groundwater flow and transport. Examination of the core, borehole geophysics, Radon-222, electromagnetic flowmeter (EMF) profiles and step-drawdown pumping tests did not identify whether fractures contribute to groundwater flow. A number of injection and recovery tests lasting from 3. days to 3. months using potable water showed a large degree of mixing with native groundwater. Withdrawal greater than 12-17% of the injected volume resulted in recovered water containing more native groundwater than injected water. A finite element solute transport model was set up to reproduce the observed salinity in recovered water. Without the inclusion of discrete fractures in the model it was not possible to get a fit between the observed and modelled salinity of recovered water within a realistic range of dispersivity values. The model was subsequently verified by using data from long-term injection and recovery trials. This evaluation of mixing conclusively demonstrated that the aquifer behaved as a fractured rock aquifer and not as an aquifer with primary porosity alone. Therefore, aquifer storage and recovery can be a very useful hydrogeological method to identify the occurrence of fracture flow in aquifers where there is a measurable concentration difference between the injected water and ambient groundwater. © 2011.

Misdaq, M.A., Ouguidi, J.
Concentrations of radon, thoron and their decay products measured in natural caves and ancient mines by using solid state nuclear track detectors and resulting radiation dose to the members of the public
(2011) Journal of Radioanalytical and Nuclear Chemistry, 287 (1), pp. 135-150.

Abstract
Alpha- and beta-activities per unit volume of air due to radon (222Rn), thoron (220Rn) and their progenies were measured in the air of natural caves and ancient mines as well as inside different reference atmospheres by using CR-39 and LR-115 type II solid state nuclear track detectors (SSNTDs). In addition, the radon concentration was continuously

measured inside one of the studied caves by using the SSNTDs' method and AlphaGuard counter. Equilibrium factors between radon and its daughters and between thoron and its progeny were evaluated in the studied atmospheres. Alpha-activities due to 218Po and 214Po short-lived radon decay products were determined in different compartments of the respiratory tract of members of the public. The committed equivalent doses due to the 218Po and 214Po radon short-lived progeny were evaluated in different tissues of the respiratory tract of the visitors of the considered caves and ancient mines. Annual effective doses due to radon progeny from the inhalation of air by the visitors of the studied caves and ancient mines were evaluated.

Moder, A., Foisner, W., Hitzl, W., Fagerer, N., Ritter, M., Kullich, W.
Pain, functional capacity, analgetic consumption, mental state and days of employees illness in the year prior to and post combined radonthermaltherapy [Schmerz, Krankenstnde, Befindlichkeit, Medikamentenverbrauch und Funktionsverbesserung im Jahr vor und nach einer kombinierten Radonthermalkur]
(2011) Physikalische Medizin Rehabilitationsmedizin Kurortmedizin, 21 (5), pp. 215-219.

Abstract
Purpose: Aim of this prospective intervention-study is to assess the impact of combined Radon/physical therapy on patients with degenerative spine syndrome in terms of pain, functional capacity, analgetic consumption, mental state and days of employees illness 12 months prior to as well as post therapy. Methods: 222 patients treated with a combined Radon/physiotherapy within an inpatient cure participated in the study. After a baseline survey, questionnaires concerning pain, disabilities, mental state and medication were replied by the participants prior to, and immediately post therapy as well as 3, 6 and 12 months later. Concomitantly, sick leave days 12 months prior to and post therapy were assessed. Results: The average pain intensity at the surveys (enquiries) 3, 6 and 12 months post therapy was significantly reduced compared to baseline levels. The improvement of functional capacity was significant up to 6 months after therapy. The fraction/percentage of patients that didnt consume analgetics during 12 months post therapy was higher than before therapy. Sick leave days were significantly reduced during the year post therapy compared to the year prior to intervention. Approximately 29% of the patients improved their mental state until one year after completing the therapy. Conclusion: Summing up, combined Radon/physiotherapy clearly demonstrates a medium to long-term improvement in the main patients relevant outcomes. © Georg Thieme Verlag KG Stuttgart New York.

Mollberg, N., Surati, M., Demchuk, C., Fathi, R., Salama, A.K., Husain, A.N., Hensing, T., Salgia, R.

Mind-mapping for lung cancer: Towards a personalized therapeutics approach
(2011) Advances in Therapy, 28 (3), pp. 173-194.

Abstract
There were over 220,000 people diagnosed with lung cancer and over 160,000 people dying of lung cancer during 2010 alone in the United States. In order to arrive at better control, prevention, diagnosis, and therapeutics for lung cancer, we must be able to personalize the approach towards the disease. Mind-mapping has existed for centuries for physicians to properly think about various "flows" of personalized medicine. We include here the epidemiology, diagnosis, histology, and treatment of lung cancer - in particular, non-small cell lung cancer. As we have new molecular signatures for lung cancer, this is further detailed. This review is not meant to be a comprehensive review, but rather its purpose is to highlight important aspects of lung cancer diagnosis, management, and personalized treatment options. © Springer Healthcare 2011.

Mollo, S., Tuccimei, P., Heap, M.J., Vinciguerra, S., Soligo, M., Castelluccio, M., Scarlato, P., Dingwell, D.B.
Increase in radon emission due to rock failure: An experimental study
(2011) Geophysical Research Letters, 38 (14), art. no. L14304, .

Abstract
Radon anomalies are commonly observed prior to dynamic failure in the crust and are interpreted as cracking of the medium, thus attracting considerable attention in understanding the precursory phenomena of earthquakes and volcanic activity. In this study we have compared the starting radon emissions from low porosity crystalline lava (phonolite) samples with those from damaged and failed samples. The damaged sample was loaded up to just beyond the end of the linear elastic phase, as evidenced by the output of AE energy, the increase in total porosity and a decrease in P-wave and S-wave velocity relative to the intact sample. Whereas, the failed sample showed deformation behaviour characteristically brittle with increasing values of AE output and porosity as the sample approached macroscopic failure. Radon measurements have evidenced that dilatational microcracking of deformed sample produced no significant variation in radon emanation with respect to the intact sample. In contrast, after macroscopic failure, radon emanation drastically increased. Therefore, major finding from this study is that, in the case of low porosity and relatively high strength crystalline lavas, the development of a macroscopic fracture provides new large exhaling surface resulting in a substantial increase in radon emission rate. Copyright 2011 by the American Geophysical Union.

Morelli, D., Immè, G., Altamore, I., Cammisa, S., Giammanco, S., La Delfa, S., Mangano, G., Neri, M., Patanè, G.
Radionuclide measurements, via different methodologies, as tool for geophysical studies on Mt. Etna

(2011) Nuclear Instruments and Methods in Physics Research, Section A: Accelerators, Spectrometers, Detectors and Associated Equipment, 652 (1), pp. 911-914.

Abstract
Natural radioactivity measurements represent an interesting tool to study geodynamical events or soil geophysical characteristics. In this direction we carried out, in the last years, several radionuclide monitoring both in the volcanic and tectonic areas of the oriental Sicily. In particular we report in-soil Radon investigations, in a tectonic area, including both laboratory and in-site measurements, applying three different methodologies, based on both active and passive detection systems. The active detection devices consisted of solid-state silicon detectors equipped in portable systems for short-time measurements and for long-time monitoring. The passive technique consisted of solid-state nuclear track detectors (SSNTD), CR-39 type, and allowed integrated measurements. The performances of the three methodologies were compared according to different kinds of monitoring. In general the results obtained with the three methodologies seem in agreement with each other and reflect the tectonic settings of the investigated area. © 2011 Elsevier B.V.

Mostafa, A.M.A., Tamaki, K., Moriizumi, J., Yamazawa, H., Iida, T.
The weather dependence of particle size distribution of indoor radioactive aerosol associated with radon decay products
(2011) Radiation Protection Dosimetry, 146 (1-3), art. no. ncr097, pp. 19-22.

Abstract
This study was performed to measure the activity size distribution of aerosol particles associated with short-lived radon decay products in indoor air at Nagoya University, Nagoya, Japan. The measurements were performed using a low pressure Andersen cascade impactor under variable meteorological conditions. The results showed that the greatest activity fraction was associated with aerosol particles in the accumulation size range (100-1000 nm) with a small fraction of nucleation mode (10-100 nm). Regarding the influence of the weather conditions, the decrease in the number of accumulation particles was observed clearly after rainfall without significant change in nucleation particles, which may be due to a washout process for the large particles.

Moura, C.L., Artur, A.C., Bonotto, D.M., Guedes, S., Martinelli, C.D.
Natural radioactivity and radon exhalation rate in Brazilian igneous rocks
(2011) Applied Radiation and Isotopes, 69 (7), pp. 1094-1099.

Abstract
This paper reports the natural radioactivity of Brazilian igneous rocks that are used as dimension stones, following the trend of other studies on the evaluation of the risks to the

human health caused by the rocks radioactivity as a consequence of their use as cover indoors. Gamma-ray spectrometry has been utilized to determine the 40K, 226Ra and 232Th activity concentrations in 14 rock types collected at different quarries. The following activity concentration range was found: 12.18-251.90Bq/kg for 226Ra, 9.55-347.47Bq/kg for 232Th and 407.5-1615.0Bq/kg for 40K. Such data were used to estimate Raeq, Hex and Iγ, which were compared with the threshold limit values recommended in literature. They have been exceeded for Raeq and Hex in five samples, where the highest indices corresponded to a rock that suffered a process of ductile-brittle deformation that caused it a microbrecciated shape. The exhalation rate of Rn and daughters has also been determined in slabs consisting of rock pieces -10cm-long, 5cm-wide and 3cm-thick. It ranged from 0.24 to 3.93Bq/m2/h and exhibited significant correlation with eU (=226Ra), as expected. The results indicated that most of the studied rocks did not present risk to human health and may be used indoors, even with low ventilation. On the other hand, igneous rocks that yielded indices above the threshold limit values recommended in literature may be used outdoors without any restriction or indoors with ample ventilation.

Mowlavi, A.A., Fornasier, M.R., Binesh, A., Denaro, M.d.
Indoor radon measurement and effective dose assessment of 150 apartments in Mashhad, Iran
(2011) Environmental Monitoring and Assessment, pp. 1-4. Article in Press.

Abstract
Environmental monitoring and indoor radon measurement are important for public health, to estimate the cancer risk of respiratory system and, if necessary, to suggest proper methods that reduce indoor radon level. In this research, indoor radon concentration in the air has been measured in 150 apartments in Mashhad city. The result demonstrates about 94.7% of apartments have radon concentration less than 100 Bq/m3, taken by WHO as the action level, and 5.3% have the concentration higher than this level. As well as, annual radon dose has been assessed using the equation for annual effective dose calculation introduced by United Nations Scientific Committee on the Effects of Atomic Radiation. © 2011 Springer Science+Business Media B.V.

Mullerová, M., Holý, K., Bulko, M.
Results of outdoor radon monitoring in Bratislava and Nováky
(2011) Radiation Protection Dosimetry, 145 (2-3), art. no. ncr068, pp. 325-328.

Abstract
Measurements of radon activity concentration (RAC) were made in two localities of Slovakia. The first one is located on the campus of Comenius University in Bratislava, where radon has been monitored since 1991. The second area is situated in the city of Nováky (midwest Slovakia, ~150 km from Bratislava). The localities have a different

orography. RAC was measured continuously by large-volume scintillation chambers. The outdoor air was sampled at a height of 1.5 m above the ground. Time courses of RAC in both localities have a similar character. The correlation coefficients between RAC in Bratislava and Nováky was quite high (R2 5 0.45). However, RACs in Nováky were found out to be about two times higher (~12.1 Bq m-3) than in Bratislava.

Musavi Nasab, S.M., Negarestani, A., Mohammadi, S.
Modeling of the radon exhalation from water to air by a hybrid electrical circuit
(2011) Journal of Radioanalytical and Nuclear Chemistry, 288 (3), pp. 813-818.

Abstract
A new model based on electric circuit theory has been introduced for modeling the radon exhalation from water to air in a sample bottle. Comparing the differential equations for radon exhalation from water to air and a hybrid electrical circuit shown that the volume of water or air, radon concentration, radon flux and solubility coefficient (dependent on temperature of water) are equivalent with capacitance, voltage across of capacitor, current and voltage gain, respectively. Then by using a hybrid electrical model total radon transfer velocity from water to air and time variation of water radon concentration in our experimental setup has been obtained. Also the variations of air radon concentration with temperature, volume of water and volume of air is obtained. The results show a good agreement with those in literatures. © 2011 Akadémiai Kiadó.

Najam, L.A., Al-Jomaily, F.M., Al-Farha, E.M.
Natural radioactivity levels of limestone rocks in northern Iraq using gamma spectroscopy and nuclear track detector
(2011) Journal of Radioanalytical and Nuclear Chemistry, 289 (3), pp. 709-715.

Abstract
The activity concentration of radionuclides, such as 238U, 226Ra and 40K of limestone rocks in northern Iraq was measured using gamma spectroscopy. The radionuclide activities were obtained and discussed. CR-39 nuclear track detector was used to measure the radon exhalation rates as well as the effective radium contents of these samples and are found to correspond with uranium concentration values measured by NaI(Tl) detector in the corresponding limestone rocks samples. The absorbed gamma dose rates in air due to the presence of 238U, 226Ra, 40K and cosmic ray contribution varied between 105.3 and 223.11 nGy/h. The annual effective dose of each sample has been calculated. The correlation between activities of 226Ra, 222Rn exhalation rates and 238U is explained. Results show a symmetrical distribution of activity concentrations of primordial of radionuclides in selected samples. The values of all studied radionuclides are considered to be a typical level of natural background and compared with results of similar investigations carried out else where. © 2011 Akadémiai Kiadó, Budapest, Hungary.

Nassiri, P., Ebrahimi, H., Shalkouhi, P.J.
Evaluation of radon exhalation rate from granite stone
(2011) Journal of Scientific and Industrial Research, 70 (3), pp. 230-231.

Abstract
This study evaluates radon exhalation rate from 10 different granite stones, used for building construction in Iran. Radon exhalation rate ranged from non-detectable to 0.6 Bq m-2 h-1. Six samples had exhalation rate above detectable level. A significant statistical relationship between radon exhalation rate with 226Ra and 232Th indicated that 226Ra and 232Th were responsible for radon exhalation from granite stones.

Neri, M., Giammanco, S., Ferrera, E., Patanè, G., Zanon, V.
Spatial distribution of soil radon as a tool to recognize active faulting on an active volcano: The example of Mt. Etna (Italy)
(2011) Journal of Environmental Radioactivity, 102 (9), pp. 863-870.

Abstract
This study concerns measurements of radon and thoron emissions from soil carried out in 2004 on the eastern flank of Mt. Etna, in a zone characterized by the presence of numerous seismogenic and aseismic faults. The statistical treatment of the geochemical data allowed recognizing anomaly thresholds for both parameters and producing distribution maps that highlighted a significant spatial correlation between soil gas anomalies and tectonic lineaments. The seismic activity occurring in and around the study area during 2004 was analyzed, producing maps of hypocentral depth and released seismic energy. Both radon and thoron anomalies were located in areas affected by relatively deep (5-10 km depth) seismic activity, while less evident correlation was found between soil gas anomalies and the released seismic energy. This study confirms that mapping the distribution of radon and thoron in soil gas can reveal hidden faults buried by recent soil cover or faults that are not clearly visible at the surface. The correlation between soil gas data and earthquakes depth and intensity can give some hints on the source of gas and/or on fault dynamics.

Nikolov, J., Todorovic, N., Forkapic, S., Bikit, I., Mrdja, D.
Radon in drinking water in Novi Sad
(2011) Proceedings of World Academy of Science, Engineering and Technology, 76, pp. 307-310.

Abstract
Exposure to radon occurs when breathing airborne radon while using water: showering, washing dishes, cooking, and drinking water that contain radon. The results of radon

activity measurements in water from public drinking fountain in city of Novi Sad, Serbia is presented in this paper. Radon level in some samples exceeded EPA (Environmental Protection Agency) recommendation for maximum contaminant level (MCL) for radon in drinking water of 11.1 Bq/l.

Noori, H., Ranjbar, A.H.
Radon health hazards of some rocks of Iranian origin, frequently used as building stones (2011) Journal of Radioanalytical and Nuclear Chemistry, 290 (1), pp. 183-186.

Abstract
Radon exhalation rate from various types of stones, used inside the living buildings, is a major factor for evaluation of the environmental radon level. To verify the significance and lethal impacts of this unknown and obscure source of radiation upon the people around the world, the exhaled radon gas concentrations from the rocks, granodiorite, granite, limestone and aragonite, and the effect of their block sizes on the exhalation rate, have been studied. The block samples, collected from their ores, were transferred to plastic containers in which the CR-39 detectors could properly be placed and air tightened, for concentration measurements. The results show the radon concentration of 7.4 ± 0.8, 6.6 ± 0.6, 0.08 ± 0.02 and 0.09 ± 0.02 kBq m-3 for granodiorite, granite, limestone and aragonite, respectively. The corresponding annual dose values in a closed environment are: 186 ± 20, 166 ± 15, 2.5 ± 1 and 2 ± 1 mSv y-1. These absorbed dose values indicate that granodiorite and granite when used inside the buildings could increase the risk of various cancers while aragonite and limestone have much lower risks and are recommended for use inside the buildings. The former ones when used in the closure areas remedial action should be implemented. The results do not show obvious dependence between the rock size of the samples and their radon exhalation rate. © 2011 Akadémiai Kiadó, Budapest, Hungary.

Null, K.A., Corbett, D.R., DeMaster, D.J., Burkholder, J.M., Thomas, C.J., Reed, R.E.
Porewater advection of ammonium into the Neuse River Estuary, North Carolina, USA Estuarine, Coastal and Shelf Science, . Article in Press.

Abstract
Radon-222 (222Rn) and ammonium (NH4+) were measured in interstitial water of the Neuse River Estuary (NRE), North Carolina, USA to determine the advective flux of NH4+ from sediments to the overlying water column. Porewater samples were collected over an annual cycle from multi-level piezometers installed in nearshore sites. NH4+ concentrations in sandy environments of the NRE were 10-fold higher than concentrations in the overlying water column. Shallow porewaters exhibited seasonal variations in NH4+ concentrations, which resulted in temporal changes in NH4+ flux from the sediment. Submarine groundwater discharge (SGD) was measured indirectly by

using 222Rn as a tracer and directly via seepage meters. Discharge rates were variable depending upon the sampling location and season. The mean SGD was 9.1 ± 1.5 cm d-1 with a maximum SGD during spring at a rate of 13.6 cm d-1 based on 222Rn porewater distribution. High porewater NH4+ concentrations in sandy nearshore sediments contributed NH4+ to the overlying water via groundwater discharge as an advective process. The overall mean NH4+ flux was 11.2 ± 2.0 mmol NH4+ m-2 d-1. Seasonal trends in groundwater seepage rates and NH4+ concentration suggest that groundwater is an important mechanism advecting nutrients from porewaters to surface waters, which is comparable to riverine NH4+ discharge. SGD N:P ratios (NH4+ as N) were >16:1, indicating that SGD is an important contributor of inorganic N for phytoplankton growth and may influence the NRE toward a less N-limited system. The data from this study will advance current understanding about the role of NH4+ in the progressive eutrophication of shallow estuarine ecosystems.

O'Brien, K.E., Goodwin, T.A., Risk, D.
Radon soil gas in the Halifax Regional municipality, Nova Scotia, Canada
(2011) Atlantic Geology, 47, pp. 112-124.

Abstract
Naturally occurring radon222 is found in measurable quantities in soil gas across Nova Scotia. Next to smoking, exposure to radon is the leading cause of lung cancer. This study identifies relationships between the permeability and composition of the soil, and the geology of the respective bedrock types within Halifax Regional Municipality (HRM). Over 280 radon soil gas samples from 60 sites were collected and analyzed using protocols developed for the North American Soil Geochemical Landscapes Project. This study focused on soil developed on glacial till over three major bedrock types: the Cambrian-Ordovician Goldenville and Halifax groups, and Devonian granite of South Mountain Batholith. All samples contained radon soil gas. Fine-grained leucomonzogranite samples returned the highest mean radon concentration of 51.0 kBq m-3, followed by coarse-grained leucomonzogranite (50.2 kBq m-3), monzogranite (44.3 kBq m-3), slate (36.1 kBq m-3), and metasandstone and Lawrencetown till, respectively 22.5 kBq m-3 and 19.4 kBq m-3. Analysis of the permeability readings was done in four major till types in HRM: granite (3.27 × 10-12 m2), metasandstone (5.84 × 10-12 m2), and slate facies (5.20 × 10-12 m2) of the Beaver River Till (BRT), and Lawrencetown Till (1.18 × 10-12 m2). The soil radon potential index (SRP), which is used to correlate soil gas and permeability readings with indoor radon potential, was applied to data collected for the HRM study area, where over 40% of Nova Scotia's population resides. The SRP index results show the granite facies of BRT returning the highest mean value of 34.5, followed by the slate facies (27.2) and metasandstone facies (15.1) of the BRT, and Lawrencetown Till (9.1). 1D soil-gas modeling demonstrated that it is unlikely that bedrock radon transport from depth alone can contribute to the concentrations measured at 60 cm; the overlying tills must also be producing radon. © Atlantic Geology, 2011.

Obed, R.I., Ademola, A.K., Vascotto, M., Giannini, G.
Radon measurements by nuclear track detectors in secondary schools in oke-ogun region, nigeria
(2011) Journal of Environmental Radioactivity, 102 (11), pp. 1012-1017.

Abstract
Radon measurements were performed in secondary schools in the Oke-Ogun area, South-west, Nigeria, by solid state nuclear track detectors (SSNTDs). About seventy CR-39 detectors were distributed in 35 high schools of the Oke-Ogun area. The CR-39 detectors were exposed in the schools for 3 months and then etched in NaOH 6 N solution at 90 °C for 3 h. The tracks were counted manually at the microscope and the radon concentration was determined at the Radioactivity Laboratory, Department of Physics, University of Trieste, Trieste, Italy. The overall average radon concentration in the surveyed area was 45 ± 27 Bq m-3. The results indicate no radiological health hazard. The research also focused on parameters affecting radon concentrations such as the age of the building in relation to building materials and floor number of the classrooms. The results show that radon concentrations in ground floors are higher than in upper floors. © 2011 Elsevier Ltd.

Olszewska-Wasiolek, M.A., Arnold, B.W.
Radioactive disequilibria in the saturated zone transport model and the biosphere model for the Yucca mountain repository - The case of Radon-222
(2011) 13th International High-Level Radioactive Waste Management Conference 2011, IHLRWMC 2011, 2, pp. 767-772.

Abstract
In the saturated zone transport model for the Yucca Mountain repository, the transport of the long lived radionuclides is explicitly modeled, while the concentrations of the short-lived decay products are inferred from the concentrations of their respective parent radionuclides. When assessing dose from 226Ra and its decay products, it is important to consider radioactive disequilibrium between the concentrations of 226Ra in the groundwater and the concentrations of its short-lived decay product, 222Rn caused by the preferential sorption of 226Ra on mineral grains in the aquifer. This paper discusses behavior of radon in the groundwater, 222Rn transfer to indoor and outdoor air, and the resulting transport and exposure pathways for the groundwater enriched in 222Rn. The processes considered include the buildup of radon decay products in the soil, the transfer of radon from groundwater to outdoor and indoor air, and the consequent radionuclide transfer to other environmental media, such as plants and animal products. The increased concentrations of radon and its decay products in the environmental media (water, soil, air, crops, animal products, and fish) result in additional exposure pathways that should be taken into account when evaluating the dose to the receptor. It is concluded that the

unsupported 222Rn can have a significant effect on the dose from 226Ra and its decay products.

Olszewski, J., Skubalski, J.
Radon concentrations in selected residential buildings in the city of łódź [Ste{ogonek}żenie radonu w wybranych budynkach mieszkalnych na terenie miasta łodzi]
(2011) Medycyna Pracy, 62 (1), pp. 31-36.

Abstract
Background: Radon and its decay products in the atmosphere are the most important contributors to human exposure from natural sources. In Poland, the total annual effective dose from indoor radon is 1.36 mSv. Material and Methods: Over the past twenty years, the measurements of radon concentration in the building indoor air were performed three times by the Nofer Institute of Occupational Medicine, Łódź, with the use of track detector CR-39 enclosed in NRPB cassette. Those measurements were taken in the ground floor of each building. Results: The average annual radon concentration was 89 Bq/m3 in 1998/1999; 75 Bq/m3 in 2008/2009; and 52 Bq/m3 in 2005. Conclusions: Assuming that a human spends at home about 5000 hours per annum and using suitable conversion factors, the dose from radon the inhabitants under study are exposed to varies from 0.9 to 1.1 mSv and it is lower than average dose for the Polish population. © Instytut Medycyny Pracy im. prof. J. Nofera w Łodzi.

Patra, P.K., Houweling, S., Krol, M., Bousquet, P., Belikov, D., Bergmann, D., Bian, H., Cameron-Smith, P., Chipperfield, M.P., Corbin, K., Fortems-Cheiney, A., Fraser, A., Gloor, E., Hess, P., Ito, A., Kawa, S.R., Law, R.M., Loh, Z., Maksyutov, S., Meng, L., Palmer, P.I., Prinn, R.G., Rigby, M., Saito, R., Wilson, C.
TransCom model simulations of CH4 and related species: Linking transport, surface flux and chemical loss with CH4 variability in the troposphere and lower stratosphere
(2011) Atmospheric Chemistry and Physics Discussions, 11 (7), pp. 18767-18821.

Abstract
A transport model intercomparison experiment (TransCom-CH4) has been designed to investigate the roles of surface emissions, transport and chemical loss in simulating the global methane distribution. Model simulations were conducted using twelve models and four model variants and results were archived for the period of 1990-2007. The transport and removal of six CH 4 tracers with different emission scenarios were simulated, with net global emissions of 513 ± 9 and 514 ± 14 Tg CH4 yr-1 for the 1990s and 2000s, respectively. Additionally, sulfur hexafluoride (SF6) was simulated to check the interhemispheric transport, radon (222Rn) to check the subgrid scale transport, and methyl chloroform (CH3CCl3) to check the chemical removal by the tropospheric hydroxyl radical (OH). The results are compared to monthly or annual mean time series

of CH4, SF6 and CH 3CCl3 measurements from 8 selected background sites, and to satellite observations of CH4 in the upper troposphere and stratosphere. Most models adequately capture the vertical gradients in the stratosphere, the average long-term trends, seasonal cycles, interannual variations and interhemispheric gradients at the surface sites for SF 6, CH3CCl3 and CH4. The vertical gradients of all tracers between the surface and the upper troposphere are consistent within the models, revealing vertical transport differences between models. We find that the interhemispheric exchange rate (1.39 ± 0.18 yr) derived from SF6 is faster by about 11 % in the 2000s compared to the 1990s. Up to 60 % of the interannual variations in the forward CH4 simulations can be explained by accounting for the interannual variations in emissions from biomass burning and wetlands. We also show that the decadal average growth rate likely reached equilibrium in the early 2000s due to the flattening of anthropogenic emission growth since the late 1990s. The modeled CH4 budget is shown to depend strongly on the troposphere-stratosphere exchange rate and thus to the model's vertical grid structure and circulation in the lower stratosphere. The 15-model median CH4 and CH3CCl3 atmospheric lifetimes are estimated to be 9.99 ± 0.08 and 4.61 ± 0.13 yr, respectively, with little interannual variability due to transport and temperature as noted by the ± 1 σ.

Peano, G., Vigna, B., Villavecchia, E., Agnesod, G.
Radon exchange dynamics in a Karst system investigated by radon continuous measurements in water: First results
(2011) Radiation Protection Dosimetry, 145 (2-3), art. no. ncr053, pp. 173-177.

Abstract
In 2008 the underground Karst Laboratory of Bossea Cave started research on radon exchange dynamics between bedrock, cave waters (main collector and percolations) and indoor underground atmosphere. Radon air concentrations, normally high, increase more and more during the collector's floods. An explanation of this is a radon-water solubilisation process more effective in flood events, because of a greater rock-water contact surface. Radon is then carried by water into the cave and released into the air. To verify this, continuous measurements of radon concentration are needed not only in the air, but also in the waters of the cave. So a new device for continuous radon monitoring in water was tested, connected to the AlphaGuard radon monitor. For the first 6 months of 2010, for different sections of the cave, the correlations between radon in the air, radon in the waters and the collector's stream flow fluctuations were presented and discussed.

Pereira, A.J.S.C., Barbosa, S.M., Neves, L.J.P.F., Aumento, F.
Soil-gas radon monitoring in an active granite quarry from central Portugal
(2011) Natural Hazards and Earth System Science, 11 (7), pp. 1845-1849.

Abstract
Seven soil-gas radon monitoring stations were placed along the active front of a granite quarry in Canas de senhorim, Central Portugal, recording continuously for 81 days. Important differences in the radon concentration were found between stations, with average values comprised between 102 and 2982 Bqm-3, which can be explained by the local presence of uranium anomalies in the regional lateorogenic Hercynian granite, usually associated with faults. One of the boreholes exhibits large radon anomalies lasting for several days, and two, contrary to the others, show a clear daily periodic behaviour, with minima around 19:00 LT and maxima around 07:00 LT. The different patterns observed in stations placed at such a short distance (<100 m) has no clear explanation and deserves further investigation. Data analysis shows no evidence of soil-gas radon concentration changes during explosions carried out at the quarry. This is likely to result from the absence of a progressive stress field affecting the rock, as typically occurs before an earthquake. © Author(s) 2011.

Pereira, C.E., Vaidyan, V.K., Sunil, A., Byju, S.B., Jose, R.M., Jojo, P.J.
Radiological assessment of cement and clay based building materials from southern coastal region of Kerala
(2011) Indian Journal of Pure and Applied Physics, 49 (6), pp. 372-376.

Abstract
Building materials are one of the potential sources of indoor radioactivity because of the naturally occurring radio nuclides in them. External as well as internal exposures are the two pathways of radiation dose imparted to the human beings from the building materials. Natural clay is the main raw material for the production of bricks and tiles. In the present study, samples of cement, bricks, floor and wall tiles have been analyzed for the primordial radio nuclides namely, uranium, thorium and potassium using gamma ray spectrometry. Radon exhalation rates of these materials were also measured. Among the samples analyzed, the minimum radium equivalent activity was found in bricks (66.08 Bqkg-1) and the maximum was found in cement (225.46 Bqkg-1). External gamma dose, effective dose equivalent, internal and external hazard indexes resulting from the radio nuclides were also determined. The radon exhalation rates from building materials were found to vary between 10.5±2.8 and 82.8±8.2 mBqh-1m-2.

Perrot, F.
Low radioactive techniques in SuperNEMO: Status of the radon R&D
(2011) AIP Conference Proceedings, 1338, pp. 130-136.

Abstract
Radon is a well-known source of background with respect to the search for neutrinoless double beta decay (0νββ), due to the high Q β value of one of its daughter nucleus 214Bi.

Radon has been observed and reduced down to 6.5 mBq/m3 in the NEMO-3 experiment which is looking for the 0vββ process in 100Mo and in six other isotopes. The SuperNEMO project, a next-generation double beta decay experiment which will also use a tracko-calorimeter technique, has been in an R&D phase since 2006. The goal is to reach a sensitivity of T 1/2(0v)>1026 y corresponding to an effective Majorana neutrino mass of 0.05-0.1 eV with 100 kg of 82Se. Such a sensitivity requires in particular to improve the radon radiopurity down to 0.1 mBq/m 3 in the tracking chamber.

Persson, B.R.R., Holm, E.
Polonium-210 and lead-210 in the terrestrial environment: A historical review
(2011) Journal of Environmental Radioactivity, 102 (5), pp. 420-429.

Abstract
The radionuclides 210Po and 210Pb widely present in the terrestrial environment are the final long-lived radionuclides in the decay of 238U in the earth's crust. Their presence in the atmosphere is due to the decay of 222Rn diffusing from the ground. The range of activity concentrations in ground level air for 210Po is 0.03-0.3 Bq m-3 and for 210Pb 0.2-1.5 Bq m-3. In drinking water from private wells the activity concentration of 210Po is in the order of 7-48 mBq l-1 and for 210Pb around 11-40 mBq l-1. From water works, however, the activity concentration for both 210Po and 210Pb is only in the order of 3 mBq l-1. Mosses, lichens and peat have a high efficiency in capturing 210Po and 210Pb from atmospheric fallout and exhibit an inventory of both 210Po and 210Pb in the order of 0.5-5 kBq m-2 in mosses and in lichens around 0.6 kBq m-2. The activity concentrations in lichens lies around 250 Bq kg-1, dry mass.Reindeer and caribou graze lichen which results in an activity concentration of 210Po and 210Pb of about 1-15 Bq kg-1 in meat from these animals. The food chain lichen-reindeer or caribou, and Man constitutes a unique model for studying the uptake and retention of 210Po and 210Pb in humans. The effective annual dose due to 210Po and 210Pb in people with high consumption of reindeer/caribou meat is estimated to be around 260 and 132 μSv a-1 respectively. In soils, 210Po is adsorbed to clay and organic colloids and the activity concentration varies with soil type and also correlates with the amount of atmospheric precipitation. The average activity concentration levels of 210Po in various soils are in the range of 20-240 Bq kg-1.Plants become contaminated with radioactive nuclides both by absorption from the soil (supported Po) and by deposition of radioactive fallout on the plants directly (unsupported Po). In fresh leafy plants the level of 210Po is particularly high as the result of the direct deposition of 222Rn daughters from atmospheric deposition. Tobacco is a terrestrial product with high activity concentrations of 210Po and 210Pb. The overall average activity concentration of 210Po is 13 ± 2 Bq kg-1. It is rather constant over time and by geographical origin.The average median daily dietary intakes of 210Po and 210Pb for the adult world population was estimated to 160 mBq day-1 and 110 mBq day-1, corresponding to annual effective doses of 70 μSv a-1 and 28 μSv a-1, respectively. The dietary intakes of 210Po and 210Pb from vegetarian food was estimated to only 70 mBq day-1 and 40 mBq day-1 corresponding to annual effective

doses of 30.6 μSv a-1 and 10 μSv a-1, respectively. Since the activity concentration of 210Po and 210Pb in seafood is significantly higher than in vegetarian food the effective dose to populations consuming a lot of seafood might be 5-15 fold higher.

Plastino, W., Panza, G.F., Doglioni, C., Frezzotti, M.L., Peccerillo, A., De Felice, P., Bella, F., Povinec, P.P., Nisi, S., Ioannucci, L., Aprili, P., Balata, M., Cozzella, M.L., Laubenstein, M.
Uranium groundwater anomalies and active normal faulting
(2011) Journal of Radioanalytical and Nuclear Chemistry, 288 (1), pp. 101-107.

Abstract
The ability to predict earthquakes is one of the greatest challenges for Earth Sciences. Radon has been suggested as one possible precursor, and its groundwater anomalies associated with earthquakes and water-rock interactions were proposed in several seismogenic areas worldwide as due to possible transport of radon through microfractures, or due to crustal gas fluxes along active faults. However, the use of radon as a possible earthquake's precursor is not clearly linked to crustal deformation. It is shown in this paper that uranium groundwater anomalies, which were observed in cataclastic rocks crossing the underground Gran Sasso National Laboratory, can be used as a possible strain meter in domains where continental lithosphere is subducted. Measurements evidence clear, sharp anomalies from July, 2008 to the end of March, 2009, related to a preparation phase of the seismic swarm, which occurred near L'Aquila, Italy, from October, 2008 to April, 2009. On April 6th, 2009 an earthquake (Mw = 6.3) occurred at 01:33 UT in the same area, with normal faulting on a NW-SE oriented structure about 15 km long, dipping toward SW. In the framework of the geophysical and geochemical models of the area, these measurements indicate that uranium may be used as a possible strain meter in extensional tectonic settings similar to those where the L'Aquila earthquake occurred.

Ponomarev, E.A., Cherneva, N.V., Firstov, P.P.
Formation of a local atmospheric electric field
(2011) Geomagnetism and Aeronomy, 51 (3), pp. 402-408.

Abstract
We have estimated the variations in the atmospheric electrostatic field (AEF, EZ(0)) strength in the surface layer caused by variations in conductivity due to radon influences, cosmic ray intensity, changes in the balance of light and heavy ions during sunset and sunrise, and under the effect of the ionospheric electric current potential on the AEF potential. It is shown that the air conductivity varies due to ionization under the effect of radon emanations and is determined by the radon e-xhalation and turbulent diffusion of the surface air layer, while the cosmic ray intensity affects the surface air conductivity

through changes in the ion recombination conditions. A decrease in the air conductivity due to a decrease in the cosmic ray intensity (Forbush decrease) also decreases EZ(0), while a decrease in radon fluxes results i-n an increase in EZ(0). We have estimated the effect of illumination conditions on the AEF due to variations in the relative concentration of heavy and light ions under the influence of photodetachment and photoattachment processes. The work has been done on the basis of data received from the Paratunka observatory (Kamchatka).

Poortinga, W., Bronstering, K., Lannon, S.
Awareness and Perceptions of the Risks of Exposure to Indoor Radon: A Population-Based Approach to Evaluate a Radon Awareness and Testing Campaign in England and Wales
Risk Analysis, . Article in Press.

Abstract
The current study aimed to evaluate the locally directed radon roll-out program that was conducted between 2001 and 2005 in England and Wales to increase radon awareness and testing rates. A representative sample of 1,578 residents aged 16 and older were interviewed who lived in radon-affected areas of 15 local authorities in England and Wales that were eligible for participation in the program. The study systematically sampled across participating and nonparticipating local authorities, "actionable" and "nonactionable" radon-affected areas, and geographic regions with different campaign histories (Wales, Southwest England, and the rest of England). As a multistage sampling strategy was used, the data were analyzed from a multilevel perspective. This study found that participants living in participating local authorities had higher levels of awareness and were more likely to have tested their home for radon than participants living in nonparticipating local authorities. Similar results were found for participants living in "actionable" areas as compared to those living in "nonactionable" radon-affected areas. The study further found that radon awareness and testing rates were the highest in Southwest England and the lowest in Wales. This study suggests that the radon roll-out program has been effective in raising awareness and testing rates, and that ongoing domestic radon campaigns in Southwest England may have raised radon awareness and testing in these areas, showing important reinforcement effects of multiple risk communication campaigns.

Popa, M.E., Vermeulen, A.T., Van Den Bulk, W.C.M., Jongejan, P.A.C., Batenburg, A.M., Zahorowski, W., Röckmann, T.
H2 vertical profiles in the continental boundary layer: Measurements at the Cabauw tall tower in the Netherlands
(2011) Atmospheric Chemistry and Physics, 11 (13), pp. 6425-6443.

Abstract

In-situ, quasi-continuous measurements of atmospheric hydrogen (H 2) have been performed since October 2007 at the Cabauw tall tower station in the Netherlands. Mole fractions of H2, CO and several greenhouse gases are determined simultaneously in air sampled successively at four heights, between 20 and 200 m above ground level. 222Rn measurements are performed in air sampled at 20 and 200 m. This H2 dataset represents the first in-situ, quasi-continuous long-term measurement series of vertical profiles of H2 in the lower continental boundary layer. Seasonal cycles are present at all heights in both H2 and CO, and their amplitude varies with the sampling height. The seasonality is evident in both the baseline values and in the short term (diurnal to synoptic time scales) variability, the latter being significantly larger during winter. The observed H2 short term signals and vertical gradients are in many cases well correlated to other species, especially to CO. On the other hand, H2 has at times a unique behaviour, due to its particular distribution of sources and sinks. Our estimation for the regional H2 soil uptake flux, using the radon tracer method, is (1.89 ± 0.26) × 10 5 g/(m2 h), significantly smaller than other recent results from Europe. H2/CO ratios of the traffic emissions computed from our data, with an average of 0.54 ± 0.07 mol:mol, are larger and more variable than estimated in some of the previous studies in Europe. This difference can be explained by a different driving regime, due to the frequent traffic jams in the influence area of Cabauw. The H2/CO ratios of the large scale pollution events have an average of 0.36 ± 0.05 mol:mol; these ratios were observed to slightly increase with sampling height, possibly due to a stronger influence of soil uptake at the lower sampling heights. © 2011 Author(s).

Popa, M.E., Vermeulen, A.T., Van Den Bulk, W.C.M., Jongejan, P.A.C., Batenburg, A.M., Zahorowski, W., Röckmann, T.
H2 vertical profiles in the continental boundary layer: Measurements at the Cabauw tall tower in the Netherlands
(2011) Atmospheric Chemistry and Physics Discussions, 11 (2), pp. 5589-5639.

Abstract
In-situ, quasi-continuous measurements of atmospheric hydrogen (H 2) have been performed since 2007 at the Cabauw tall tower station in the Netherlands. Mole fractions of H2, CO and several greenhouse gases are determined simultaneously in air sampled successively at four heights, between 20 and 200 m above ground level. 222Rn measurements are performed in air sampled at 20 and 200 m. This H2 dataset represents the first in-situ, quasi-continuous measurement series of vertical profiles of H2 in the lower continental boundary layer. From the three-year long time series, we characterize the main features and variability patterns of H2 and CO on various time scales; the time series is too short to justify an attempt to determine multi-annual trends. Seasonal cycles are present in both H2 and CO, and their amplitude varies with the sampling height. The seasonality is evident in both the "baseline" values and in the short term (diurnal to synoptic time scales) variability, the latter being significantly larger during winter. The observed H2 short term signals and vertical gradients are in many cases well correlated to other species, especially to CO. On the other hand, H2 has at times a behaviour which

differentiates it from all the other species measured, due to its particular distribution of sources and sinks, that is, with the main source in our area (anthropogenic emissions) and the main sink (soil uptake) both near ground level. The local to regional soil sink of H2 is observable as H2 depletion at the lower sampling levels in some of the stable nights, although the signals at Cabauw are smaller than observed at other stations. Positive vertical gradients are another consequence of the soil uptake. Our estimation for the regional H2 soil uptake flux, using the radon tracer method, is (-1.89 ± 0.26) × 10-5 g/(m2h), significantly smaller than other recent results from Europe. Local soil and weather characteristics might be responsible for the very low soil uptake of H2. Our result could also be biased by the absence of radon flux estimates that could reliably approximate the fluxes during the relevant time intervals in our study domain. H2/CO ratios of the traffic emissions computed from our data, with an average of 0.54 ± 0.07 mol:mol, are larger and more scattered than estimated in some of the previous studies in Europe. This difference can be explained by a different driving regime, due to the frequent traffic jams in the influence area of Cabauw. In contrast, the H2/CO ratios of the large scale pollution events, with an average of 0.36 ± 0.05 mol:mol, are very similar to results of previous studies; these ratios were observed to slightly increase with sampling height, possibly due to a stronger influence of soil uptake at the lower sampling heights.

Potiriadis, C., Koukouliou, V., Seferlis, S., Kehagia, K.
Assessment of the occupational exposure at a fertiliser industry in the northern part of Greece
(2011) Radiation Protection Dosimetry, 144 (1-4), art. no. ncq309, pp. 668-671.

Abstract
In the northern part of Greece, close to the city of Kavala, a phosphoric acid production industry has operated since 1965. The raw material used is the phosphate rock imported from the foreign countries. During industrial processes, naturally occurring radioactive materials (NORM) deposits exist in many facilities in the industry, causing increased levels of radiation exposure. Additionally, increased levels of NORM concentrations are also detected in the waste material of the production process, the phosphogypsum. According to the Greek Regulations for Radiation Protection (no. 216B, 5/3/2001), which is in accordance with the 96/29/EURATOM 31/5/1996, the action levels concerning the effective dose to workers at workplaces due to natural radiation sources are 1 mSv y-1. Work activities where the corresponding doses exceed 6 mSv y-1 are under the control of the Greek Atomic Energy Commission (GAEC). The mean yearly radon concentration action level at workplaces is 400 Bq m-3, while the corresponding concentration limit is 3000 Bq m-3, respectively. GAEC, according to its constitutional law, is the responsible organisation to enforce and to implement the law by means of in situ surveys and laboratory measurements. The first inspection of the area was performed in 2002 and the first measures were proposed. Periodic inspections were performed every 2 y in order to extend the operation licensing of the industry. In this work a dose assessment of the workers based on in situ and laboratory measurements is presented. In order to assess the

doses to the workers the external and the internal doses are estimated.

Povinec, P.P., Burnett, W.C., Beck, A., Bokuniewicz, H., Charette, M., Gonneea, M.E., Groening, M., Ishitobi, T., Kontar, E., Liong Wee Kwong, L., Marie, D.E.P., Moore, W.S., Oberdorfer, J.A., Peterson, R., Ramessur, R., Rapaglia, J., Stieglitz, T., Top, Z.
Isotopic, geophysical and biogeochemical investigation of submarine groundwater discharge: IAEA-UNESCO intercomparison exercise at Mauritius Island
Journal of Environmental Radioactivity, 104 (2), pp. 24-45. Article in Press.

Abstract
Submarine groundwater discharge (SGD) into a shallow lagoon on the west coast of Mauritius Island (Flic-en-Flac) was investigated using radioactive (3H, 222Rn, 223Ra, 224Ra, 226Ra, 228Ra) and stable (2H, 18O) isotopes and nutrients. SGD intercomparison exercises were carried out to validate the various approaches used to measure SGD including radium and radon measurements, seepage rate measurements using manual and automated meters, sediment bulk conductivity and salinity surveys. SGD measurements using benthic chambers placed on the floor of the Flic-en-Flac Lagoon showed discharge rates up to 500 cm/day. Large variability in SGD was observed over distances of a few meters, which were attributed to different geomorphological features. Deployments of automated seepage meters captured the spatial and temporal variability of SGD with a mean seepage rate of 10 cm/day. The stable isotopic composition of submarine waters was characterized by significant variability and heavy isotope enrichment and was used to predict the contribution of fresh terrestrially derived groundwater to SGD (range from a few % to almost 100%). The integrated SGD flux, estimated from seepage meters placed parallel to the shoreline, was 35 m3/m day, which was in reasonable agreement with results obtained from a hydrologic water balance calculation (26 m3/m day). SGD calculated from the radon inventory method using in situ radon measurements were between 5 and 56 m3/m per day. Low concentrations of radium isotopes observed in the lagoon water reflected the low abundance of U and Th in the basalt that makes up the island. High SGD rates contribute to high nutrients loading to the lagoon, potentially leading to eutrophication. Each of the applied methods yielded unique information about the character and magnitude of SGD. The results of the intercomparison studies have resulted a better understanding of groundwater-seawater interactions in coastal regions. Such information is an important pre-requisite for the protection and management of coastal freshwater resources.

Pressyanov, D., Georgiev, S., Dimitrova, I., Mitev, K., Boshkova, T.
Determination of the diffusion coefficient and solubility of radon in plastics
(2011) Radiation Protection Dosimetry, 145 (2-3), art. no. ncr069, pp. 123-126.

Abstract

This paper describes a method for determination of the diffusion coefficient and the solubility of radon in plastics. The method is based on the absorption and desorption of radon in plastics. Firstly, plastic specimens are exposed for controlled time to referent 222Rn concentrations. After exposure, the activity of the specimens is followed by HPGe gamma spectrometry. Using the mathematical algorithm described in this report and the decrease of activity as a function of time, the diffusion coefficient can be determined. In addition, if the referent 222Rn concentration during the exposure is known, the solubility of radon can be determined. The algorithm has been experimentally applied for different plastics. The results show that this approach allows the specified quantities to be determined with a rather high accuracy-depending on the quality of the counting equipment, it can be better than 10 %.

Pressyanov, D., Mitev, K., Dimitrova, I., Georgiev, S.
Solubility of krypton, xenon and radon in polycarbonates. Application for measurement of their radioactive isotopes
(2011) Nuclear Instruments and Methods in Physics Research, Section A: Accelerators, Spectrometers, Detectors and Associated Equipment, 629 (1), pp. 323-328.

Abstract
Bisphenol-A polycarbonates have a high absorption ability for noble gases that can be employed for sampling and measurement of radioactive isotopes of these gases. In this report the solubility of krypton, xenon and radon in the specified polycarbonates is determined by measurement of 85Kr, 133Xe and 222Rn absorbed in polycarbonate specimens. The found solubility is used to develop a general methodology for measurement of radioactive noble gases in air and water. The methodology is tested in pilot measurements of 133Xe in air under real conditions. The results demonstrate sufficient potential for practical applications.

Pressyanov, D.S.
Modeling response of radon track detectors with solid absorbers as radiators
(2011) Radiation Measurements, 46 (3), pp. 357-361.

Abstract
Recently, a new radon monitor, based on the combination of plastic radon absorber/radiator and an alpha-track detector, has been proposed. In this report a theoretical model of its response is described. The modeling is performed for two widely used track detectors: CR-39 and Kodak Pathe LR-115 type II. Theoretical estimates of the response for various designs of such monitors are obtained and comparison with available experimental data is made. The results demonstrate the feasibility of this approach for practical applications.

Przylibski, T.A., Zebrowski, A., Karpińska, M., Kapała, J., Kozak, K., Mazur, J., Grzadziel, D., Mamont-Cieśla, K., Stawarz, O., Kozłowska, B., Kłos, B., Dorda, J., Wysocka, M., Olszewski, J., Dohojda, M.
Mean annual 222Rn concentration in homes located in different geological regions of Poland - first approach to whole country area
(2011) Journal of Environmental Radioactivity, 102 (8), pp. 735-741.

Abstract
The paper presents the results of year-long measurements of radon (222Rn) concentration inside 129 buildings in Poland in relation to the geological conditions of their foundation. The authors took into account the division of the country into tectonic units, as well as the lithology of the rocks forming the bedrock of these buildings. As expected, the highest value of mean annual 222Rn concentration (845Bq/m3) was recorded in a building situated in the area of the Sudetes, while the highest geometric mean (characteristic of the expected log-normal data distribution) was calculated based on measurements from buildings located within the East-European craton, in the area of Mazury-Podlasie monocline, where it reached 231Bq/m3. Such results reflect geological conditions - the occurrence of crystalline rocks (especially U- and Ra-enriched granites and orthogneisses) on the surface in the Sudetes, and of young post-glacial sediments containing fragments of Scandinavian crystalline rocks, also enriched with U and Ra, in the area of Mazury-Podlasie monocline. However, the least expected result of the investigations was finding out that, contrary to the hitherto widespread belief, none of the major tectonic units of Poland can be excluded from the list of those containing buildings with mean annual 222Rn concentration exceeding 200Bq/m3. The mean annual concentration of radon for all the buildings were much higher than the mean concentration value (49.1Bq/m3) of indoor radon in Poland quoted so far. These results cast a completely new light on the necessity to perform measurements of radon concentration in residential buildings in Poland, no more with reference to small areas with outcrops of crystalline rocks (especially the Sudetes, being the Polish fragment of the European Variscan belt), but for all the major tectonic units within Poland. © 2011 Elsevier Ltd.

Pulinets, S., Ouzounov, D.
Lithosphere-Atmosphere-Ionosphere Coupling (LAIC) model - An unified concept for earthquake precursors validation
(2011) Journal of Asian Earth Sciences, 41 (4-5), pp. 371-382.

Abstract
The paper presents a conception of complex multidisciplinary approach to the problem of clarification the nature of short-term earthquake precursors observed in atmosphere, atmospheric electricity and in ionosphere and magnetosphere. Our approach is based on the most fundamental principles of tectonics giving understanding that earthquake is an

ultimate result of relative movement of tectonic plates and blocks of different sizes. Different kind of gases: methane, helium, hydrogen, and carbon dioxide leaking from the crust can serve as carrier gases for radon including underwater seismically active faults. Radon action on atmospheric gases is similar to the cosmic rays effects in upper layers of atmosphere: it is the air ionization and formation by ions the nucleus of water condensation. Condensation of water vapor is accompanied by the latent heat exhalation is the main cause for observing atmospheric thermal anomalies. Formation of large ion clusters changes the conductivity of boundary layer of atmosphere and parameters of the global electric circuit over the active tectonic faults. Variations of atmospheric electricity are the main source of ionospheric anomalies over seismically active areas. Lithosphere-Atmosphere-Ionosphere Coupling (LAIC) model can explain most of these events as a synergy between different ground surface, atmosphere and ionosphere processes and anomalous variations which are usually named as short-term earthquake precursors. A newly developed approach of Interdisciplinary Space-Terrestrial Framework (ISTF) can provide also a verification of these precursory processes in seismically active regions.The main outcome of this paper is the unified concept for systematic validation of different types of earthquake precursors united by physical basis in one common theory.

Puskin, J.S.
Deadly radon in montana?
(2011) Dose-Response, 9 (3), p. 442.

Quattrocchi, F., Galli, G., Gasparini, A., Magno, L., Pizzino, L., Sciarra, Voltattorni, N.
Very slightly anomalous leakage of CO2, CH4 and radon along the main activated faults of the strong l'Aquila earthquake (Magnitude 6.3, Italy). Implications for risk assessment monitoring tools & public acceptance of CO2 and CH4 underground storage
(2011) Energy Procedia, 4, pp. 4067-4075.

Abstract
The 2009-2010 L'Aquila seismic sequence is still slightly occurring along the central Apenninic Belt (August 2010), spanning more than one year period. The main- shock (Mw 6.3) occurred on April 6th at 1:32 (UTC). The earthquake was destructive and caused among 300 casualties. The hypocenter has been located at 42.35 °N, 13.38° at a depth of around 10 km. The main shock was preceded by a long seismic sequence starting several months before (i.e., March, 30, 2009 with Mw 4.1; April, 5 with Mw 3.9 and Mw 3.5, a few hours before the main shock). A lot of evidences stress the role of deep fluids pore-pressure evolution-possibly CO2 or brines - as occurred in the past, along seismically activated segments in Apennines. Our geochemical group started to survey the seismically activated area soon after the main-shock, by sampling around 1000 soil gas points and around 80 groundwater points (springs and wells, sampled on monthly basis still ongoing), to help in understanding the activated fault segments geometry and

behaviour, as well as leakage patterns at surface (CO2, CH4, Radon and other geogas as He, H2, N2, H2S, O2, etc.), in the main sector of the activated seismic sequence, not far from a deep natural CO2 reservoir underground (termomethamorphic CO2 from carbonate diagenesis), degassing at surface only over the Cotilia-Canetra area, 20 km NW from the seismically activated area. The work highlighted that geochemical measurements on soils are very powerful to discriminate the activated seismogenic segments at surface, their jointing belt, as well as co-seismic depocenter of deformation. Mostly where the measured "threshold" magnitude of earthquakes (around 6), involve that the superficial effects could be absent or masked, our geochemical method demonstrated to be strategic, and we wish to use these methods in CO2 analogues/ CO2 reservoir studies abroad, after done in Weyburn. The highlighted geochemical - slight but clear anomalies are, in any case, not dangerous for the human health and keep away the fear around the CO2-CH4 bursts or explosions during strong earthquakes, as the L'Aquila one, when these gases are stored naturally/industrially underground in the vicinity (1-2 km deep). These findings are not new for these kind of Italian seismically activated faults and are very useful for the CO2-CH4 geological storage public acceptance: Not necessarily (rarely or never) these geogas escape abruptly from underground along strongly activated faults.

Rafique, M., Rahman, S.U., Akram, M., Matiullah
Estimation of concentration and exposure doses due to radon by using CR-39 plastic track detectors in the residences of Sudhnuti, Azad Kashmir, Pakistan
(2011) Environmental Earth Sciences, pp. 1-8. Article in Press.

Abstract
This paper presents the results of indoor radon concentration measurements in 120 dwellings of district Sudhnuti of Azad Kashmir. Measurements were taken with CR-39 passive alpha track detector. CR-39 based box type radon detectors were installed in a bedroom and living rooms of each house. The detectors were retrieved after exposing to indoor radon for period of 6 months and then etched in 6 M NaOH at 80°C for 16 h, the observed track densities were converted in to the indoor radon concentration. Indoor radon concentration varied from 20 ± 12 to 170 ± 4 Bq m-3 for the houses of the district Sudhnuti. Arithmetic mean (AM), geometric mean (GM) and geometric standard deviations (GSD) were found to be 82 ± 6, 77 ± 6 and 1.51, respectively. The minimum value of weighted average radon concentration was recorded in one of the house of Mang town, whereas the maximum value was found in the Pattan Sher Khan region. Doses due to indoor radon exposure vary from 0.50 ± 0.31 to 4.28 ± 0.11 mSv year-1 AM, GM and GSD. of mean effective doses were found to be 2.06 ± 0.13, 1.95 ± 0.18 and 1.51, respectively. According to the recommendations made by the Health Protection Agency, UK (200 Bq m-3) all the houses surveyed are within the safe limits. © 2011 Springer-Verlag.

Rafique, M., Rahman, S.U., Mahmood, T., Rahman, S., Matiullah
Assessment of seasonal variation of indoor radon level in dwellings of some districts of Azad Kashmir, Pakistan
(2011) Indoor and Built Environment, 20 (3), pp. 354-361.

Abstract
Measurements of indoor radon concentrations in 200 dwellings of four districts of Azad Kashmir have been carried out using CR-39-based radon dosimeters. Indoor radon levels were calculated for four seasons (i.e. spring, summer, autumn and winter) in Muzaffarabad, Hattian, Neelum and Poonch districts. Maximum value of radon concentration (398 ± 2 Bq•m -3) has been found in Muzaffarabad district (in bedrooms) and minimum value (23 ± 9 Bq•m-3) is reported for Hattian district (in living rooms). Elevated values of radon levels have been found in winter, whilst lower values are observed in summer season. Seasonal correction factors calculated for spring, summer, autumn and winter seasons were found to be 1.02 ± 0.91, 0.86 ± 0.77, 0.98 ± 0.92 and 1.14 ± 1.04, respectively. Measured values for winter/spring, winter/summer and winter/autumn radon ratios were found as 1.11 ± 1.28, 1.33 ± 1.21 and 1.15 ± 1.17. Radon doses have been calculated and yearly mean effective dose has been found 2.52 ± 1.22 mSv, which is less than the lower limit of the recommended action level 3-10 mSv.

Rafique, M., Rahman, S.U., Rahman, S., Nasir, T., Matiullah
Radiation doses due to indoor radon exposure, before and after the 2005 earthquake, in dwellings of Muzaffarabad and the Jhelum Valley, Azad Kashmir, Pakistan
(2011) Indoor and Built Environment, 20 (2), pp. 259-264.

Abstract
Radiation doses from indoor radon exposure, before and after the 2005 earthquake, have been assessed from measurements taken in the city of Muzaffarabad and Jhelum valley, Azad Kashmir, Pakistan. Indoor radon concentration was measured in dwellings in Muzaffarabad city and the Jhelum valley after the devastating 2005 earthquake using CR-39 based radon box type detectors which were exposed to indoor radon for 60 days. After processing, the observed track densities were related to the indoor radon concentrations using a calibration factor of 0.0092 tracks cm-2 hr-1 = 1 Bq m-3 of 222Rn and compared with already published data obtained before the earthquake. The post-earthquake weighted average indoor radon concentration ranged from 65 Bq m-3 to 398 Bq m-3 for the dwellings of state capital city of Azad Kashmir where pre-earthquake values were in the range of 89Bq m-3 to 167 Bq m -3. In the Jhelum valley, post-earthquake indoor radon concentrations varied from 81 to 509 Bq m-3 and 64 to 456 Bq m-3 in the bedrooms and kitchens, respectively while pre-earthquake radon concentration for Jhelum valley ranges from 86 to 236 Bqm -3 and 62 to 208 Bqm -3 in the bedrooms and kitchens, respectively. The post earthquake indoor radon concentration levels and hence radiation doses have been found higher than those of pre-earthquake values.

Rafique, M., Rahman, S.U., Mahmood, T., Rahman, S., Matiullah, Rehman, S.U.
Radon exhalation rate from soil, sand, bricks, and sedimentary samples collected from Azad Kashmir, Pakistan
(2011) Russian Geology and Geophysics, 52 (4), pp. 450-457.

Abstract
Experimental results concerning the radon exhalation rate from samples of building materials which were collected from the districts of Muzaffarabad and Neelum Valley, Azad Kashmir, Pakistan are presented. The study aims at assessing the contribution of building materials towards the total indoor radon exposure to the inhabitants of the studied area. In this context, samples of building materials, namely, soil, sand, gravel aggregates, and bricks were collected from different parts of the districts of Muzaffarabad and Neelum Valley. After processing, the samples were placed in plastic containers and box type radon detectors were installed in it at heights of 25 cm above the surface of the samples. The containers were then hermetically sealed. After 80 days of exposure to radon, CR-39 detectors were etched in 25% NaOH at 80°C for 16 h and counted under an optical microscope. The measured track densities were related to radon concentrations. Radon exhalation rate from soil, gravel aggregates, sands, and bricks varied from 171 ± 11 to 344 ± 11, 168 17 to 322 ± 11, 366 ± 8 to 649 ± 8 and 184 ± 14 to 231 14 mBq m-2 h-1, respectively. Present data have been compared with the published data for other parts of the world. © 2011.

Ramachandan, T.V., Sathish, L.A.
Nationwide indoor 222rn and 220rn map for india: A review
(2011) Journal of Environmental Radioactivity, 102 (11), pp. 975-986.

Abstract
Considering the role of radon in epidemiology, an attempt was made to make a nation-wide map of indoor 222Rn and 220Rn for India. More than 5000 measurements have been carried out in 1500 dwellings across the country comprising urban and nonurban locations. The solid state nuclear track detectors based twin cup 222Rn/220Rn discrimination dosimeters were deployed for the measurement of indoor 222Rn, 220Rn and their progeny levels. The geometric means of estimated annual inhalation dose rate due to indoor 222Rn, 220Rn and their progeny in the dwellings was 0.94 mSvy-1 (geometric standard deviation 2.5). It was observed that the major contribution to the indoor inhalation dose was due to indoor 222Rn and its progeny. However, the contribution due to indoor 220Rn and its progeny was not trivial as it was found to be about 20% of the total indoor inhalation dose rates. The indoor 222Rn levels in dwellings was significantly different depending on the nature of walls and floorings. © 2011 Elsevier Ltd.

Ramachandran Dr., T.V.
Background radiation, people and the environment
(2011) Iranian Journal of Radiation Research, 9 (2), pp. 63-76.

Abstract
All living organisms are exposed to ionizing radiation comprising cosmic rays coming from outer space, terrestrial nuclides occurring in the earth's crust, building materials, air, water and foods and in the human body itself. The exposures are constant and uniform for all individuals everywhere including the dose from ingestion of 40K in food. Cosmic rays are, more intense at higher altitudes, and the levels of uranium and thorium in soils are elevated in localized areas. Exposures also vary as a result of human activities and practices. In particular, building materials of houses and the design and ventilation systems strongly influences the indoor levels of the radioactive gas radon and its decay products, which contributes the doses through inhalation. Component of the sources of exposures to Indian population has been assessed based on the data generated. Total contribution from the natural sources to the Indian population works out to 2.3 mSv/y as against the global value of 2.4 mSv/y. Estimated modified source including mining of heavy metals, coal fired power plants, mining of phosphate rocks and its use as fertilizers, production of natural gas, gas mantles and luminescent dial and air travel contribution to the background radiation to the Indian population works out to be 1.2 × 10-3 mSv/y; atmospheric weapon tests contributes about 0.045 mSv/y, medical exposure contributes about 0.048 mSv/y and exposure due to nuclear power production contributes about 5.0 × 10-5 mSv/y to the background radiation. Brief review and comparison of the dose rates arising from natural and man made sources to the Indian population is given.

Ramola, R.C., Prasad, G., Gusain, G.S.
Estimation of indoor radon concentration based on radon flux from soil and groundwater
(2011) Applied Radiation and Isotopes, 69 (9), pp. 1318-1321.

Abstract
The indoor radon concentration was estimated based on the radon flux in soil and groundwater. The indoor radon concentration in Budhakedar area of Garhwal Himalaya, India is estimated to be 3.0-131.4Bq/m3 in summer and 4.6-92.4Bq/m3 in winter. Based on the available data from study area, the calculated value of diffusion coefficient for the soil ranges from 0.1×10-2 to 3.0×10-2cm2s-1 in the summer season and 0.1×10-2 to 0.4×10-2cm2s-1 in the winter season. The calculated value of diffusion flux in the study area is found to vary from 0.1×10-2 to 16.1×10-2Bqm-2s-1 in summer season and 0.1×10-2-12.2×10-2Bqm-2s-1 in winter season. The formulation was tested by comparing the results of radon values from two different seasons of a year. © 2011 Elsevier Ltd.

Ramola, R.C.
Survey of radon and thoron in homes of Indian Himalaya
(2011) Radiation Protection Dosimetry, 146 (1-3), art. no. ncr095, pp. 11-13.

Abstract
Measurements of radon, thoron and their progeny were carried out in some houses from Garhwal and Kumaun Himalayas of India using a LR-115 plastic track detector. The measurements were made in various residential houses of the area at a height of 2.5 m above the ground level using a twin chamber radon dosemeter, which can record the values of radon, thoron and their progeny separately. The concentrations of radon and thoron in these homes were found to vary from 11 to 191 and 1 to 156 Bq m-3, respectively. The equilibrium factor between radon and progeny varies from 0.02 to 0.90, with an average of 0.26 for the region. The resulting dose rate due to radon, thoron and their decay products was found to vary from 0.02 to 0.84 μSv h-1 with an arithmetic mean of 0.27 μSv h-1. A detailed analysis of the distribution of radon, thoron and their decay products inside a house is also reported. The observed dose rates due to radon, thoron and progeny were found somewhat higher but well below the international recommendations.

Rana, B.K., Tripathi, R.M., Meena, J.S., Sahoo, S.K., Topno, R., Shukla, A.K., Puranik, V.D.
Assessment of radon concentration and external gamma radiation level in the environs of Narwapahar uranium mine, India and its radiological significance
(2011) Journal of Radioanalytical and Nuclear Chemistry, 290 (2), pp. 347-352.

Abstract
In the environs of uranium mining, milling and processing facilities and in the uranium mineralized terrain, a little higher ambient radon concentration and gamma radiation level may be expected in comparison with natural background. The present study gives a brief account of atmospheric radon concentration, gamma absorbed dose rate and radiation dose received by the members of public in the vicinity of Narwapahar uranium mine. The ambient radon concentration in the air in the study area was found to vary from 5 to 107 Bq m-3 with geometric mean of 24 Bq m-3 and geometric standard deviation of 1.74 Bq m-3. The measured gamma absorbed dose rate in air at 1 m above the ground ranged from 87 to 220 nGy h-1 with an overall arithmetic mean of 128 ± 18.5 nGy h-1. The mean annual effective dose received by the members of public from inhalation of radon and its progeny and external gamma exposure was estimated to be 0.32 mSv year-1, which is comparable to other reported values elsewhere.

Rand, E.T., Bangay, J.C., Bianco, L., Dunlop, R., Finlay, P., Garrett, P.E., Leach, K.G., Phillips, A.A., Sumithrarachchi, C.S., Svensson, C.E., Wong, J.
Geant4 developments for the radon electric dipole moment search at TRIUMF
(2011) Journal of Physics: Conference Series, 312 (SECTION 10), art. no. 102013, .

Abstract
An experiment is being developed at TRIUMF to search for a time-reversal violating electric dipole moment (EDM) in odd-A isotopes of Rn. Extensive simulations of the experiment are being performed with GEANT4 to study the backgrounds and sensitivity of the proposed measurement technique involving the detection of γ rays emitted following the β decay of polarized Rn nuclei. GEANT4 developments for the RnEDM experiment include both realistic modelling of the detector geometry and full tracking of the radioactive β, γ, internal conversion, and x-ray processes, including the γ-ray angular distributions essential for measuring an atomic EDM.

Rau, W.
Radon diffusion measurement in polyethylene based on alpha detection
(2011) AIP Conference Proceedings, 1338, pp. 164-167.

Abstract
We present a method to measure the diffusion of Radon in solid materials based on the alpha decay of the radon daughter products. In contrast to usual diffusion measurements which detect the radon that penetrates a thin barrier, we let the radon diffuse into the material and then measure the alpha decays of the radon daughter products in the material. We applied this method to regular and ultra high molecular weight poly ethylene and find diffusion lengths of order of mm as expected. However, the preliminary analysis shows significant differences between two different approaches we have chosen. These differences may be explained by the different experimental conditions. © 2011 American Institute of Physics.

Reddy, D.V., Nagabhushanam, P.
Groundwater electrical conductivity and soil radon gas monitoring for earthquake precursory studies in Koyna, India
(2011) Applied Geochemistry, 26 (5), pp. 731-737.

Abstract
Hourly monitoring of electrical conductivity (EC) of groundwater along with groundwater levels in the 210. m deep boreholes (specially drilled for pore pressure/earthquake studies) and soil Rn gas at 60. cm below ground level in real time, in the Koyna-Warna region (characterized by basaltic rocks, >1500. m thick, and dotted with several sets of fault systems), western India, provided strong precursory signatures

in response to two earthquakes (M 4.7 on 14/11/09, and M 5.1 on 12/12/09) that occurred in the study region. The EC measured in Govare well water showed precursory perturbations about 40. h prior to the M 5.1 earthquake and continued further for about 20. h after the earthquake. In response to the M 4.7 earthquake, there were EC perturbations 8. days after the earthquake. In another well (Koyna) which is located 4. km north of Govare well, no precursory signatures were found for the M 4.7 earthquake, while for M 5.1 earthquake, post-seismic precursors were found 18. days after the earthquake. Increased porosity and reduced pressure head accompanied by mixing of a freshwater component from the top zone due to earthquakes are the suggested mechanisms responsible for the observed anomalies in EC. Another parameter, soil Rn gas showed relatively proportional strength signals corresponding to these two earthquakes. In both the cases, the pre-seismic increase in Rn concentration started about 20. days in advance. The co-seismic drop in Rn levels was less by 30% from its peak value for the M 4.7 earthquake and 50% for the M 5.1 earthquake. The Rn anomalies are attributed to the opening and closing of micro-fractures before and during the earthquake. On line monitoring of these two parameters may be useful to check the entire chemistry change due to earthquake which may help to forecast impending earthquakes.

Ren, H.W., Liu, Y.W., Yang, D.Y.
A preliminary study of post-seismic effects of radon following the Ms 8.0 Wenchuan earthquake
Radiation Measurements, . Article in Press.

Abstract
The observation data for radon from national geochemical observation points have been collected and analyzed following the Ms 8.0 Wenchuan earthquake on 12th May, 2008 and a post-seismic effect of radon was observed. It has provided the most abundant record since the radon observation network had been set up in china. In this paper, the behaviour of the post-seismic effects of radon gas and water radon is reported. The results were obtained that observation points recording post-seismic effects of radon release were distributed mainly along the extended line of Longmenshan faults, and located on the boundary faults of regional tectonic blocks (Category II) and inside some tectonic blocks (Category II). The pattern of variation in radon emission observed was largely in the form of rising steps. A comparison was made with the variation of water level and flow observed simultaneously with radon measurement, to investigate a dynamic link with post-seismic radon with underground water conditions. This study confirmed a response of radon concentration to the seismic wave, and also raised other scientific issues, such as the dynamic association between geochemical composition of underground water and medium parameter variation of aquifers under dynamic loading, which may support the study of the mechanism of earthquake precursors of radon.

Reponen, M., Moore, I.D., Pohjalainen, I., Kessler, T., Karvonen, P., Kurpeta, J., Marsh, B., Piszczek, S., Sonnenschein, V., Äyst, J.
Gas jet studies towards an optimization of the IGISOL LIST method
(2011) Nuclear Instruments and Methods in Physics Research, Section A: Accelerators, Spectrometers, Detectors and Associated Equipment, 635 (1), pp. 24-34.

Abstract
Gas jets emitted from an ion guide have been studied as a function of nozzle type and gas cell-to-background pressure ratio in order to obtain a low divergent, uniform jet over a distance of several cm. The jet has been probed by imaging the light emitted from excited argon or helium gas atoms. For a simple exit hole or converging-diverging nozzle, the jet diameter was found to be insensitive to the nozzle shape and inlet pressure. Sonic jets with a FWHM below 6 mm were achieved with a background pressure larger than 1 mbar in the expansion chamber. The measurements are supported by the detection of radioactive 219Rn recoils from an alpha recoil source mounted within the gas cell. A Laval nozzle produced a well-collimated supersonic jet at low background pressures with a FWHM of □6mm over a distance of 14 cm. Direct Pitot probe measurements, on-axis, revealed a non-uniform pressure distribution in the gas jet of the Laval nozzle, supporting the visual observations. All measurements are motivated by the requirement of a good geometrical overlap between atoms and counter-propagating laser beams in the gas cell-based Laser Ion Source Trap (LIST) project. Computational fluid dynamics gas flow simulations were initiated to guide the future development of the gas jet system.

Richardson, D.B., MacLehose, R.F., Langholz, B., Cole, S.R.
Practice of epidemiology: Hierarchical latency models for dose-time-response associations
(2011) American Journal of Epidemiology, 173 (6), pp. 695-702.

Abstract
Exposure lagging and exposure-time window analysis are 2 widely used approaches to allow for induction and latency periods in analyses of exposure-disease associations. Exposure lagging implies a strong parametric assumption about the temporal evolution of the exposure-disease association. An exposure-time window analysis allows for a more flexible description of temporal variation in exposure effects but may result in unstable risk estimates that are sensitive to how windows are defined. The authors describe a hierarchical regression approach that combines time window analysis with a parametric latency model. They illustrate this approach using data from 2 occupational cohort studies: studies of lung cancer mortality among 1) asbestos textile workers and 2) uranium miners. For each cohort, an exposure-time window analysis was compared with a hierarchical regression analysis with shrinkage toward a simpler, second-stage

parametric latency model. In each cohort analysis, there is substantial stability gained in time window-specific estimates of association by using a hierarchical regression approach. The proposed hierarchical regression model couples a time window analysis with a parametric latency model; this approach provides a way to stabilize risk estimates derived from a time window analysis and a way to reduce bias arising from misspecification of a parametric latency model.

Richon, P., Perrier, F., Koirala, B.P., Girault, F., Bhattarai, M., Sapkota, S.N.
Temporal signatures of advective versus diffusive radon transport at a geothermal zone in Central Nepal
(2011) Journal of Environmental Radioactivity, 102 (2), pp. 88-102.

Abstract
Temporal variation of radon-222 concentration was studied at the Syabru-Bensi hot springs, located on the Main Central Thrust zone in Central Nepal. This site is characterized by several carbon dioxide discharges having maximum fluxes larger than 10 kg m-2 d-1. Radon concentration was monitored with autonomous Barasol™ probes between January 2008 and November 2009 in two small natural cavities with high CO2 concentration and at six locations in the soil: four points having a high flux, and two background reference points. At the reference points, dominated by radon diffusion, radon concentration was stable from January to May, with mean values of 22 ± 6.9 and 37 ± 5.5 kBq m-3, but was affected by a large increase, of about a factor of 2 and 1.6, respectively, during the monsoon season from June to September. At the points dominated by CO2 advection, by contrast, radon concentration showed higher mean values 39.0 ± 2.6 to 78 ± 1.4 kBq m-3, remarkably stable throughout the year with small long-term variation, including a possible modulation of period around 6 months. A significant difference between the diffusion dominated reference points and the advection-dominated points also emerged when studying the diurnal S1 and semi-diurnal S2 periodic components. At the advection-dominated points, radon concentration did not exhibit S1 or S2 components. At the reference points, however, the S2 component, associated with barometric tide, could be identified during the dry season, but only when the probe was installed at shallow depth. The S1 component, associated with thermal and possibly barometric diurnal forcing, was systematically observed, especially during monsoon season. The remarkable short-term and long-term temporal stability of the radon concentration at the advection-dominated points, which suggests a strong pressure source at depth, may be an important asset to detect possible temporal variations associated with the seismic cycle. © 2010 Elsevier Ltd.

Robu, E., Maringer, F.J., Garavalia, M., Picini, L.
Influence of exposure geometry on the response of cr39 ssnt radon detectors
(2011) Romanian Reports on Physics, 63 (2), pp. 376-382.

Abstract
A number of about 130 solid state nuclear track detectors (SSNTD) of CR39 type were exposed in controlled conditions in a Radon Exposure Calibration chamber. The purpose of the work was to study the dependence of the response of the detector to the exposure conditions. Identically shaped CR39 detectors were placed in open cylindrical cups of various geometries (height and diameter). For each geometry the side surface of the detector cup was coated with three materials, paper, plastic and aluminum. The effect of the coating of the detector cup on the plate-out of the radon decay products, as well as on the detector response was investigated for each geometry of the detector cup. The dependence of the response on the geometry of the cup was also studied.

Röttger, A., Honig, A.
Recent developments in radon metrology: New aspects in the calibration of radon, thoron and progeny devices
(2011) Radiation Protection Dosimetry, 145 (2-3), art. no. ncr047, pp. 260-266.

Abstract
Due to the importance of reliable measurements of radon activity concentration, one of the past developments in metrology was applied to the field of radon, thus meeting two basic needs: (1) the harmonisation of metrology within the scope of the mutual recognition arrangement, an arrangement drawn up by the International Committee of Weights and Measures for the mutual recognition of national standards and of calibrations issued by national metrology institutes and (2) the increased demands of the European Atomic Energy Community (EURATOM) directive, transferred into national radiation protection regulations with regard to natural radioactivity and its quality-assured measurements. This paper gives an overview of typical technical procedures in the radon-measuring technique group of PTB, covering all aspects of reference atmospheres (primary standards) for radon, thoron and their respective progenies.

Rovenska, K., Jiránek, M.
1st international comparison measurement on assessing the diffusion coefficient of radon
(2011) Radiation Protection Dosimetry, 145 (2-3), art. no. ncr079, pp. 127-132.

Abstract
Radon diffusion coefficient is a material parameter which is usually used in the radon mitigation measures design. There are different approaches used for radon diffusion coefficient measurement and assessment. The International comparison measurement which was jointly organised by National Radiation Protection Institute and Faculty of Civil Engineering CTU Prague in 2009 and 2010 has registered 11 laboratories from all over the world. Three sets of samples of polyethylene damp-proof membranes were sent

to these laboratories for measurement. Till today, the organisers received only five sets of results. The results showed a great variability among laboratories involved.

Royse, K.R.
The Handling of Hazard Data on a National Scale: A Case Study from the British Geological Survey
(2011) Surveys in Geophysics, 32 (6), pp. 753-776.

Abstract
This paper reviews how hazard data and geological map data have been combined by the British Geological Survey (BGS) to produce a set of GIS-based national-scale hazard susceptibility maps for the UK. This work has been carried out over the last 9 years and as such reflects the combined outputs of a large number of researchers at BGS. The paper details the inception of these datasets from the development of the seamless digital geological map in 2001 through to the deterministic 2D hazard models produced today. These datasets currently include landslides, shrink-swell, soluble rocks, compressible and collapsible deposits, groundwater flooding, geological indicators of flooding, radon potential and potentially harmful elements in soil. These models have been created using a combination of expert knowledge (from both within BGS and from outside bodies such as the Health Protection Agency), national databases (which contain data collected over the past 175 years), multi-criteria analysis within geographical information systems and a flexible rule-based approach for each individual geohazard. By using GIS in this way, it has been possible to model the distribution and degree of geohazards across the whole of Britain.

Ruyters, S., Mertens, J., Vassilieva, E., Dehandschutter, B., Poffijn, A., Smolders, E.
The red mud accident in Ajka (Hungary): Plant toxicity and trace metal bioavailability in red mud contaminated soil
(2011) Environmental Science and Technology, 45 (4), pp. 1616-1622.

Abstract
The red mud accident of October 4, 2010, in Ajka (Hungary) contaminated a vast area with caustic, saline red mud (pH 12) that contains several toxic trace metals above soil limits. Red mud was characterized and its toxicity for plants was measured to evaluate the soil contamination risks. Red mud radioactivity (e.g., 238U) is about 10-fold above soil background and previous assessments revealed that radiation risk is limited to indoor radon. The plant toxicity and trace metal availability was tested with mixtures of this red mud and a local noncontaminated soil up to a 16% dry weight fraction. Increasing red mud applications increased soil pH to maximally 8.3 and soil solution EC to 12 dS m-1. Shoot yield of barley seedlings was affected by 25% at 5% red mud in soil and above. Red mud increased shoot Cu, Cr, Fe, and Ni concentrations; however, none of these

exceed toxic limits reported elsewhere. Moreover, NaOH amended reference treatments showed similar yield reductions and similar changes in shoot composition. Foliar diagnostics suggest that Na (>1% in affected plants) is the prime cause of growth effects in red mud and in corresponding NaOH amended soils. Shoot Cd and Pb concentrations decreased by increasing applications or were unaffected. Leaching amended soils (3 pore volumes) did not completely remove the Na injury, likely because soil structure was deteriorated. The foliar composition and the NaOH reference experiment allow concluding that the Na salinity, not the trace metal contamination, is the main concern for this red mud in soil.

Saad, A.F., El-Namrouty, A.A., Solyman, S., Atwa, S.T.
Scanning aged CR-39 SSNTDs with etched alpha tracks by using transmitted laser light
(2011) Journal of the Korean Physical Society, 58 (4), pp. 701-705.

Abstract
The optical track scanning method is based on the measurement of laser light transmission through CR-39 solid state nuclear track detectors (SSNTDs). Etched tracks in CR-39 SSNTDs are used to examine the degree of linear correlation between the tracks observed using an optical microscope and those measured by using the laser light transmission (LLT) method. The intensity of the light transmitted through the etched tracks was measured using a photodiode. The present investigation clearly indicates that the results from the LLT method depend on track density and alpha energy, as well as the etching and storage conditions of the detector material. In addition, the transmittance of laser light through the etched CR-39 detectors aged at room temperature is found to be relatively small compared with that of those kept in a freezer. This technique was tested on the overlap of tracks in SSNTD radon dosimetry by using a standard exposure. The results show that the radon dose can be rapidly estimated.

Sabaris, T.P.P., Bonotto, D.M.
Sedimentation rates in Atibaia River basin, São Paulo State, Brazil, using 210Pb as geochronometer
(2011) Applied Radiation and Isotopes, 69 (1), pp. 275-288.

Abstract
The constant initial concentration (CIC) of unsupported/excess 210Pb model was successfully used to assess 210Pb data of nine sediment cores from Atibaia River basin, São Paulo State, Brazil. The 210Pb-based apparent sediment mass accumulation rates ranged from 47.7 to 782.4mg/cm2yr, whereas the average linear sedimentation rates between 0.16 and 1.32cm/yr, which are compatible with the calculated sediment mass fluxes, i.e. a higher sediment mass accumulation rate yielded a higher linear sedimentation rate. The higher long-term based accumulation rate tended to be found in topographically softer regions. This occurs because the sediments are preferentially

transported in topographically steeper regions instead of being deposited. Anthropic activities like deforestation possibly interfered with the natural/normal sedimentation processes, which increased in accordance with modifications on the channel drainage. The radionuclide geochronology as described in this paper allows determination of sedimentation rates that are compatible with values estimated elsewhere. The adoption of an appropriate factor generated from previous laboratory experiments resulted in a successful correction for the 222Rn-loss from the sediments, bringing the estimate of the parent-supported (in-situ produced) 210Pb to reliable values required by the CIC model.

Sabol, J., Jurda, M., Gregor, Z., Navrátil, L.
Assessment of the total effective dose of miners in the underground Rožná Uranium Mine in the Czech Republic during the period 2004-2009
(2011) Radiation Protection Dosimetry, 144 (1-4), art. no. ncq334, pp. 615-619.

Abstract
The paper discusses the situation in the Czech Republic regarding past and present uranium mining activities with emphasis on the evaluation of the exposure of underground miners in the Rožná Uranium Mine, which is currently the only active mine in the country and practically in the entire European Union. The total effective dose has been summarised taking into account all three major components, namely radon short-lived decay products, long-lived alpha emitters in ore dust and penetrating external gamma radiation. The average and maximum values of the effective dose as well as the collective effective dose of underground miners are also presented. The purpose of the paper is to document the miners' exposures during a period of 6 years in a uranium mine where conditions including the ore grade and methods of mining showed recently some changes that may affect the individual components of the total effective dose. © The Author 2010. Published by Oxford University Press. All rights reserved.

Sac, M.M., Harmansah, C., Camgoz, B., Sozbilir, H.
Radon monitoring as the earthquake precursor in fault line in Western Turkey [Bati{dotless} türkiye fay hatti{dotless}nda deprem ïzleyicisi olarak radon monitörü]
(2011) Ekoloji, (79), pp. 93-98.

Abstract
Variations in radon concentrations near the earth's surface can provide important information about seismic activities. Continuous monitoring of radon concentrations is one of the important steps in predicting earthquake mechanisms. This study monitored the radon concentration of an active tectonic zone in western Turkey. Four sampling stations in the seismic area, of the Tuzla fault line, were selected for radon monitoring. The online radon monitoring system was placed at Cumali{dotless} station. Concurrently, the radon concentrations in the soil gas were continuously measured using

LR-115 nuclear track detectors and an online radon measurement system. Data obtained from Bogazici University Kandilli Observatory and Earthquake research Institute was incorporated in the analysis to correlate with the collected radon concentration. The radon concentrations were measured using solid-state nuclear track films (LR-115) in the soils of thermal water fields, which varied from 40 track cm-2 week-1 to 1580 track cm-2 week-1. Comparison of the radon concentration found using the above described techniques reveals that there is a linear correlation between the radon emission rate and the seismic activities in the area under investigation.

Saeed, I., Anderson, J.
Cancer of the lung: Staging, radiology, surgery
(2011) Surgery, 29 (5), pp. 221-226.

Abstract
Primary lung cancer is the leading cause of cancer-related deaths in industrialized countries. Despite advances in treatment, the overall 5-year survival remains poor due to the advanced stage of disease at presentation. Smoking remains the main risk factor being responsible for around 85% of all cases. The most important distinction is that between non-small cell lung cancer (NSCLC) and small cell lung cancer (SCLC). Surgeons primarily deal with NSCLC (SCLC is an aggressive tumour that usually presents with systemic disease). NSCLC has a number of histological subtypes. Patient evaluation aims to establish the cell type of the tumour, determine the stage of the disease, and to determine fitness for surgery. Staging of NSCLC is based on the tumour/node/metastasis (TNM) classification. Procedures used to diagnose or stage lung cancer can include chest X-ray, chest computed tomography (CT) scan, combined positron emission tomography/CT, CT or transbronchial guided needle biopsy, and mediastinoscopy amongst others. Surgery is the only established method for 'curing' NSCLC. However, only a quarter of patients have resectable disease at presentation. Surgical resection can be performed using a variety of procedures including lobectomy, pneumonectomy or wedge resections. The 5-year survival of patients with stage I lung cancer following surgical resection is 51-60%.

Sahagia, M., Luca, A., Watjen, A.C., Antohe, A., Ivan, C., Stanga, D., Varlam, C., Faurescu, I., Toro, L., Noditi, M., Cassette, P.
Results obtained in measurements of Rn-222 with the Romanian standard system
(2011) Romanian Journal in Physics, 56 (5-6), pp. 682-691.

Abstract
This paper presents the following results: (i) Realization of the metallic radon standard system; (ii) Quantitative extraction of radon from the radium source; (iii) Absolute standardization by liquid scintillation counting and relative measurements of radon activity, by using the HPGe gamma spectrometry method and the reentrant ionization

chamber. The final purpose of the work is to calibrate adequately the secondary standard systems, for using them in the measurement of the working standards, glass vials containing standard gas radon, in order to assure the traceability. A method for modelling of the radon transport in various matrices was also elaborated, with reference to the simulation of the radon detectors containing active charcoal. It will be validated experimentally, with radon gas standards.

Sahagia, M., Luca, A., Wtjen, A.C., Antohe, A., Ivan, C., Varlam, C., Faurescu, I., Cassette, P.
Establishment of the 222Rn traceability chain with the Romanian standard system
(2011) Nuclear Instruments and Methods in Physics Research, Section A: Accelerators, Spectrometers, Detectors and Associated Equipment, 631 (1), pp. 73-79.

Abstract
This paper presents the results obtained in the establishment of the upper level of the traceability chain, primary and secondary 222Rn measurements, with the standard system realized at IFIN-HH, Romania. The following subjects are presented: (i) the principle of establishing the traceability chain; (ii) the setting up of the final metallic system for the radon standardization and the experimental method; (iii) results obtained in the realization of the traceability chain, by absolute radon standardization with the liquid scintillation counting method (LSC) and relative measurements of activity, using the HPGe gamma-ray spectrometry method and the CENTRONIC IG12/20A ionization chamber, and its validation. The final purpose of the work is to calibrate adequately the secondary standard systems, HPGe spectrometer and ionization chamber, for using them in the measurement of the working standards, various types of recipients containing radon gas, prepared in the laboratory with the radon system.

Sahoo, B.K., Sapra, B.K., Gaware, J.J., Kanse, S.D., Mayya, Y.S.
A model to predict radon exhalation from walls to indoor air based on the exhalation from building material samples
(2011) Science of the Total Environment, 409 (13), pp. 2635-2641.

Abstract
In recognition of the fact that building materials are an important source of indoor radon, second only to soil, surface radon exhalation fluxes have been extensively measured from the samples of these materials. Based on this flux data, several researchers have attempted to predict the inhalation dose attributable to radon emitted from walls and ceilings made up of these materials. However, an important aspect not considered in this methodology is the enhancement of the radon flux from the wall or the ceiling constructed using the same building material. This enhancement occurs mainly because of the change in the radon diffusion process from the former to the latter configuration.

To predict the true radon flux from the wall based on the flux data of building material samples, we now propose a semi-empirical model involving radon diffusion length and the physical dimensions of the samples as well as wall thickness as other input parameters. This model has been established by statistically fitting the ratio of the solution to radon diffusion equations for the cases of threedimensional cuboidal shaped building materials (such as brick, concrete block) and one dimensional wall system to a simple mathematical function. The model predictions have been validated against the measurements made at a new construction site. Thismodel provides an alternative tool (substitute to conventional 1-D model) to estimate radon flux from a wall without relying on 226Ra content, radon emanation factor and bulk density of the samples. Moreover, it may be very useful in the context of developing building codes for radon regulation in new buildings.

Saïdou, Bochud, F.O., Baechler, S., Moïse, K.N., Merlin, N., Froidevaux, P.
Natural radioactivity measurements and dose calculations to the public: Case of the uranium-bearing region of Poli in Cameroon
(2011) Radiation Measurements, 46 (2), pp. 254-260.

Abstract
The objective of this work is to carry out a baseline study of the uranium-bearing region of Poli in which lies the uranium deposit of Kitongo, prior to its impending exploitation. This study required sampling soil, water and foodstuffs representative of the radioactivity exposure and food consumption patterns of the population of Poli. After sampling and radioactivity measurements were taken, our results indicated that the activities of natural series in soil and water samples are low. However, high levels of 210Po and 210Pb in foodstuffs (vegetables) were discovered and elevated activities of 40K were observed in some soil samples. All components of the total dose were assessed and lead to an average value of 5.2 mSv/year, slightly higher than the average worldwide value of 2.4 mSv/year. Most of this dose is attributable to the ingestion dose caused by the high levels of 210Po and 210Pb contained in vegetables, food items which constitute an important part of the diet in Northern Cameroon. Consequently, bringing uranium ore from underground to the surface might lead to an increased dose for the population of Poli through a higher deposition of 222Rn decay products on leafy vegetables.

Sakoda, A., Ishimori, Y., Yamaoka, K.
A comprehensive review of radon emanation measurements for mineral, rock, soil, mill tailing and fly ash
(2011) Applied Radiation and Isotopes, 69 (10), pp. 1422-1435.

Abstract
To our knowledge, this paper is the most comprehensive review to cover most studies,

published in the past three decades at least, of radon emanation measurements. The radon emanation fraction, a possibility of radon atoms generated in a material escaping from its grains, has been widely measured for a variety of materials. The aim of this review is to organize a huge number of such data accumulated. The representative values of the emanation fraction for minerals, rocks, soils, mill tailings and fly ashes were derived to be 0.03, 0.13, 0.20, 0.17 and 0.03, respectively. Current knowledge of the emanation processes was also summarized to discuss their affected factors. © 2011 Elsevier Ltd.

Salameh, B., Abu-Haija, O., Ajlouni, A.-W., Abdelsalam, M.
Radiation doses due to indoor radon concentration in Tafila district, Jordan
(2011) Research Journal of Environmental Toxicology, 5 (1), pp. 71-75.

Abstract
In this study, measurements of the indoor radon concentration level using solid state nuclear track detectors inside dwellings were performed in the fall 2008. Fifty two detectors (type CR-39) were distributed in four sites in Tafila district, Jordan. The study sites were located in an area that has the most important phosphate mines and hot spa springs. After three months of the detector exposure, the detectors were etched in a 30% KOH solution at 70°C for 9 h. The Alpha track density was determined by means of an optical microscope. Radon concentrations were found to vary from region to region, ranging from 23.85 to 29 Bq m-3 with a mean value of 27.30 Bq m-3. Tafila city region was found to have the highest and the lowest radon concentration with a mean value of 28.77 Bq m-3. According to the findings of this study, the residents of the four sites may receive on the average an annual radon effective dose 0.665 mSv y-1, which is below the annual effective dose recommended by the International Commission on Radiological Protection (ICRP). © 2011 Academic Journals Inc.

Samet, J.M.
Radiation and cancer risk: A continuing challenge for epidemiologists
(2011) Environmental Health: A Global Access Science Source, 10 (SUPPL. 1), art. no. S4, .

Abstract
This paper provides a perspective on epidemiological research on radiation and cancer, a field that has evolved over its six decade history. The review covers the current framework for assessing radiation risk and persistent questions about the details of these risks: is there a threshold and more generally, what is the shape of the dose-response relationship? How do risks vary over time and with age? What factors modify the risk of radiation? The example of radon progeny and lung cancer is considered as a case study, illustrating the modeling of epidemiological data to derive quantitative models and the coherence of the epidemiological and biological evidence. Finally, the manuscript

considers the need for ongoing research, even in the face of research over a 60-year span.

Samsudin, S.S., Mokhtar, N., Arof, H., Ibrahim, F., Iwahashi, M.
Blind user indoor environment mapping system for self-localization
(2011) 2011 IEEE 3rd International Conference on Communication Software and Networks, ICCSN 2011, art. no. 6014943, pp. 497-500.

Abstract
This paper described blind user indoor environment mapping system for self-localization via webcam camera. The method used is based on robot navigation systems which capture and build panorama map of the floor. The map is then incrementally update its position as it moves throughout an environment. Image registration techniques are applied to measure translation distance and rotation angle between consecutive frames. We used Phase only correlation (POC) method to matched image differs only by a translation. For rotated image, RI-POC and Radon Transform is used to recovered rotation. The accuracy of these two methods for rotated image is compared for best result.

Samuelsson, C.
Exerpts from the history of alpha recoils
(2011) Journal of Environmental Radioactivity, 102 (5), pp. 531-533.

Abstract
Any confined air volume holding radon (222Rn) gas bears a memory of past radon concentrations due to 210Pb (T1/2 = 22 y) and its progenies entrapped in all solid objects in the volume. The efforts of quantifying past radon exposures by means of the left-behind long-lived radon progenies started in 1987 with this author's unsuccessful trials of removing 214Po from radon exposed glass objects. In this contribution the history and different techniques of assessing radon exposure to man in retrospect will be overviewed. The main focus will be on the implantation of alpha recoils into glass surfaces, but also potential traps in radon dwellings will be discussed. It is concluded that for a successful retrospective application, three crucial imperatives must be met, i.e. firstly, the object must persistently store a certain fraction of the created 210Pb atoms, secondly, be resistant over decades towards disturbances from the outside and thirdly, all 210Pb atoms analysed must originate from airborne radon only.For large-scale radon epidemiological studies, non-destructive and inexpensive measurement techniques are essential. Large-scale studies cannot be based on objects rarely found in dwellings or not available for measurements.

Sánchez, A.M., Poncela, L.S.Q.
Radon: Risks and applications
(2011) Nuclear Physics News, 21 (3), pp. 17-22.

Santos, I.R., Burnett, W.C., Misra, S., Suryaputra, I.G.N.A., Chanton, J.P., Dittmar, T., Peterson, R.N., Swarzenski, P.W.
Uranium and barium cycling in a salt wedge subterranean estuary: The influence of tidal pumping
(2011) Chemical Geology, 287 (1-2), pp. 114-123.

Abstract
The contribution of submarine groundwater discharge (SGD) to oceanic metal budgets is only beginning to be explored. Here, we demonstrate that biogeochemical processes in a northern Florida subterranean estuary (STE) significantly alter U and Ba concentrations entering the coastal ocean via SGD. Tidal pumping controlled the distribution of dissolved metals in shallow beach groundwater. Hourly observations of intertidal groundwaters revealed high U and low Ba concentrations at high tide as a result of seawater infiltration into the coastal aquifer. During ebb tide, U decreased and Ba increased due to freshwater dilution and, more importantly, biogeochemical reactions that removed U and added Ba to solution. U removal was apparently a result of precipitation following the reduction of U(VI) to U(IV). A significant correlation between Ba and dissolved organic carbon (DOC) in shallow beach groundwaters implied a common source, likely the mineralization of marine particulate organic matter driven into the beach face by tidal pumping. In deeper groundwaters, where the labile organic matter had been depleted, Ba correlated with Mn. We estimate that net SGD fluxes were -163 and +1660μmolm-1d-1 for U and Ba, respectively (or -1 and +8μmolm-2d-1 if a 200-m wide seepage area is considered). Our results support the emerging concept that subterranean estuaries are natural biogeochemical reactors where metal concentrations are altered relative to conservative mixing between terrestrial and marine endmembers. These deviations from conservative mixing significantly influence SGD-derived trace metal fluxes.

Santos, I.R., Lechuga-Deveze, C., Peterson, R.N., Burnett, W.C.
Tracing submarine hydrothermal inputs into a coastal bay in Baja California using radon
(2011) Chemical Geology, 282 (1-2), pp. 1-10.

Abstract
Hydrothermal fluid fluxes into deep ocean environments can be obtained from heat balance approaches. However, in shallow systems, hydrothermal heat fluxes can be masked by solar heating. In this paper, we use radon (222Rn) as a naturally occurring geochemical tracer to map the location of hydrothermal fluid inputs, as well as low-temperature groundwater discharges, and quantify fluxes into Concepcion Bay, Baja

California, Mexico. This fault-bound bay contains intertidal seeps with salinities ranging from 5.3 to 25.6, temperatures reaching 64°C, and nitrate reaching 900μM. The bay is subject to natural eutrophication and frequent red tide events. A detailed 222Rn survey around the 100-km perimeter of Concepcion Bay allowed us to map the location of enhanced submarine groundwater inputs. Moorings at three contrasting coastal sites indicated that radon concentrations were higher at low tide and during the winter. Modeled hydrothermal fluid inputs ranged between 0.4cm/day in the middle of the bay and 43.9cm/day at the largest hydrothermal coastal seep site. Apparently, faults allow meteoric water to be heated and serve as conduits for its subsequent discharge through permeable marine sediments. When conservatively extrapolated to the entire bay using weighted distributions, these fluxes are estimated at 17.5 m3/s, a flow much higher than local ephemeral rivers. About 42% of the fluxes described consisted of fresh groundwater with the remaining made up of recirculated seawater. New nitrogen inputs associated with groundwater pathways are estimated to directly account for at least 15% of the local primary productivity. Our combined spatial survey/time series strategy can be very useful to quantify hydrothermal fluid inputs in particular at vent sites where a temperature signal in shallow surface waters is difficult to be observed.

Santos, I.R., Glud, R.N., Maher, D., Erler, D., Eyre, B.D.
Diel coral reef acidification driven by porewater advection in permeable carbonate sands, Heron Island, Great Barrier Reef
(2011) Geophysical Research Letters, 38 (3), art. no. L03604, .

Abstract
Little is known about how biogeochemical processes in permeable sediments affect the pH of coastal waters. We demonstrate that seawater recirculation in permeable sands can play a major role in proton (H+) cycling in a coral reef lagoon. The diel pH range (up to 0.75 units) in the Heron Island lagoon was the broadest ever reported for reef waters, and the night-time pH (7.69) was comparable to worst-case scenario predictions for seawater pH in 2100. The net contribution of coarse carbonate sands to the whole system H + fluxes was only 9% during the day, but approached 100% at night when small scale (i.e., flow and topography-induced pressure gradients) and large scale (i.e., tidal pumping as traced by radon) seawater recirculation processes were synergistic. Reef lagoon sands were a net sink for H+, and the sink strength was a function of porewater flushing rate. Our observations suggest that the metabolism of advection-dominated carbonate sands may provide a currently unknown feedback to ocean acidification. Copyright 2011 by the American Geophysical Union.

Santos, I.R., Eyre, B.D.
Radon tracing of groundwater discharge into an Australian estuary surrounded by coastal acid sulphate soils
(2011) Journal of Hydrology, 396 (3-4), pp. 246-257.

Abstract
Widespread sulphidic deposits have accumulated in tropical coastal floodplains throughout the world. Sulphidic soils oxidize when floodplains are drained for urban and agricultural development. As a result, large amounts of sulphuric acid may be released to nearby waterways. Macropores may create excellent conditions for groundwater flow in coastal acid sulphate soils (CASS). An automated radon (222Rn) measurement system was used to quantify groundwater inputs into a tidally-dominated estuary that is known to be influenced by acid discharges from CASS (Richmond River Estuary, Australia). A high resolution radon survey along a 120-km long segment of the tidal river identified two areas of preferential groundwater inputs. Intensive time series measurements in one of those areas (the Tuckean Broadwater) demonstrated that groundwater inputs are highly variable over hourly and seasonal time scales and inversely related to surface water pH. Elevated radon concentrations (up to 12dpm/L) and low pH (as low as 3.3) were observed in surface waters at low tide a few weeks after a large rain event. These results demonstrate that acidic waters are entering the estuary via tidally-modulated groundwater flow pathways. Groundwater discharge rates into drains in the Tuckean Swamp were estimated from a dual-assumption radon mass balance to be 0.09-0.16 and 0.56-0.89m3s-1 during the dry and wet season, respectively (or 6-10 and 37-59cm/day if the area is taken into account). While surface runoff increased only 2-fold in the wet season relative to the dry season, groundwater discharge rates increased □6-fold. Since groundwater can be a major driver of surface water quality, radon can be useful in CASS monitoring and management efforts. © 2010 Elsevier B.V.

Sarra, A., Nissi, E., Palermi, S.
Residential radon concentration in the Abruzzo region (Italy): a different perspective for identifying radon prone areas
(2011) Environmental and Ecological Statistics, pp. 1-29. Article in Press.

Abstract
Indoor radon is an important risk factor for human health. Indeed radon inhalation is considered the second cause of lung cancer after smoking. During the last decades, in many countries huge efforts have been made in order to measuring, mapping and predicting radon levels in dwellings. Various researches have been devoted to identify those areas within the country where high radon concentrations are more likely to be found. Data collected through indoor radon surveys have been analysed adopting various statistical approaches, among which hierarchical Bayesian models and geostatistical tools are worth noting. The essential goal of this paper regards the identification of high radon concentration areas (the so-called radon prone areas) in the Abruzzo Region (Italy). In order to accurately pinpoint zones deserving attention for mitigation purpose, we adopt spatial cluster detection techniques, traditionally employed in epidemiology. As a first step, we assume that indoor radon measurements do not arise from a continuous spatial process; thus the geographic locations of dwellings where the radon measurements have been taken can be viewed as a realization of a spatial point process. Following this

perspective, we adopt and compare recent cluster detection techniques: the simulated annealing scan statistic, the case event approach based on distance regression on the selection order and the elliptic spatial scan statistic. The analysis includes data collected during surveys carried out by the Regional Agency for the Environment Protection of Abruzzo (ARTA) in 1,861 random sampled dwellings across 277 municipalities of the Abruzzo region. The radon prone areas detected by the selected approaches are provided along with the summary statistics of the methods. Finally, the methodologies considered in this paper are tested on simulated data in order to evaluate their power and the precision of cluster location detection.

Sathish, L.A., Nagaraja, K., Ramachandran, T.V.
The spatial and volumetric variations of radon in Bangalore Metropolitan, India
(2011) International Journal of Physical Sciences, 6 (18), pp. 4348-4360.

Abstract
Radon levels have been measured in houses at ten different locations of Bangalore City, India. The study was focused on the basis of quality of construction, age of building and room volume. Solid state nuclear track detectors were used for measuring the concentrations. The average spatial values of 222Rn and 220Rn concentrations were found to be 33.4 ± 6.1 and 21.6 ± 2.5 Bqm-3, respectively. However, the volumetric concentrations were ranged between 4.0 and 93.0 Bqm-3. The annual dose rate due to 222Rn, 220Rn and their progenies for the population in the studied location ranged from 0.5 to 3.5 mSvy-1. It is alarming that the dwellers of lower volumes receive a relatively higher dose rate and the result shows significant radiological risk. The magnitude and its effects of doses are discussed in detail. ©2011 Academic Journals.

Sathish, L.A., Nagaraja, K., Ramanna, H.C., Sundareshan, S.
Volumetric Variations of Indoor Radon and Thoron
(2011) Arabian Journal for Science and Engineering, 36 (4), pp. 671-676.

Abstract
The volumetric variations of indoor radon and thoron were measured in rooms ranging in volume from 30-310 m3 in different dwellings at various locations in Bangalore, India. The rooms selected were similar in quality of construction, age, type of walls, and type of floor. Twin cup plastic track detectors were installed in the rooms of 42 dwellings to record indoor 222Rn and 220Rn levels. Higher concentrations were observed in rooms with lower volumes than in rooms with higher volumes. The 222Rn and 220Rn concentrations in the dwellings ranged from 4.0-93.0 Bq m-3, whereas the concentrations of their daughter products ranged from 0.01-2.5 mWL. When the room volume increased tenfold, the concentration of 222Rn reduced by 23% and that of 220Rn reduced by 13%, provided all other conditions remained the same. The concentrations did not increase linearly with the volumes of the rooms. The annual effective exposure dose rate because

of 222Rn, 220Rn and their daughter products ranged from 0.1-0.4 mSv year-1 with a mean of 0.2 ± 0.1 mSv year-1. © 2011 King Fahd University of Petroleum and Minerals.

Sathish, L.A., Nagaraja, K., Nagesh, V., Sundareshan, S.
Survey of indoor concentrations of radon and thoron in homes in Bangalore, India
(2011) Indoor and Built Environment, 20 (2), pp. 278-283.

Abstract
Due to the legislation and general concern of radiation levels in dwellings in India, there is a need to continuously monitor the indoor concentrations of radon and Thoron in different geographical areas of Bangalore, which could be of great significance to exposure to occupants, particularly in living places. This paper presents the 222Rn and 220Rn concentrations measured in houses in 10 different locations in Bangalore. The data was continuously obtained for a period of 2 years since 2007, covering more than 150 dwellings. The arithmetic mean values of 222Rn and 220Rn were found to be 35.0 and 21.5 Bqm-. The effective dose rate received by the population in the study area ranged between 0.1-0.5 mSv y-1, the arithmetic mean concentration was 0.2±0.03mSv y-1. The result shows no significant radiological risk for the inhabitants. © SAGE Publications 2010.

Sava, P.C., Vlad, I.
Efficient wide-azimuth angle decomposition for reverse-time migration
(2011) Society of Petroleum Engineers - 73rd European Association of Geoscientists and Engineers Conference and Exhibition 2011 - Incorporating SPE EUROPEC
2011, 3, pp. 1716-1720.

Abstract
Extended common-image-point-gathers (CIP) contain all the necessary information for decomposition of reflectivity as a function of the reflection and azimuth angles at selected locations in the subsurface. This decomposition operates after the imaging condition applied to wavefields reconstructed by any type of wide-azimuth migration method, e.g. using downward continuation or time reversal. The reflection and azimuth angles are derived from the extended images using analytic relations between the space-lag and time-lag extensions. The transformation amounts to a linear Radon transform applied to the CIPs obtained after the application of the extended imaging condition. If information about the reflector dip is available at the CIP locations, then only two components of the space-lag vectors are required, thus reducing computational cost and increasing the affordability of the method. Applications of this method include the study of subsurface illumination in areas of complex geology where ray-based methods are not usable, and the study of amplitude variation with reflection and azimuth angles if the subsurface subsurface illumination is sufficiently dense. Migration velocity analysis

could also be implemented in the angle domain, although an equivalent implementation in the extended domain is cheaper and more effective.

Savović, S., Djordjevich, A., Tse, P.W., Nikezić, D.
Explicit finite difference solution of the diffusion equation describing the flow of radon through soil
(2011) Applied Radiation and Isotopes, 69 (1), pp. 237-240.

Abstract
Radon diffusion through soil and into air is investigated. The solution of the relevant diffusion equation is given using the explicit finite difference method. Results from a two-medium model (soil-air) are compared to those from a simplified single-medium model (soil alone). The latter are an underestimate in early stages of the diffusion process. Later on, the two models match closely and either one can be used at equilibrium conditions to calculate radon diffusion, estimate indoor radon concentration and assess health hazards. © 2010 Elsevier Ltd.

Savović Svetislav, S., Djordjevich, A., Tse, P.W., Krstić, D.
Radon diffusion in an anhydrous andesitic melt: A finite difference solution
(2011) Journal of Environmental Radioactivity, 102 (2), pp. 103-106.

Abstract
Radon-222 diffusion in an anhydrous andesitic melt was investigated. The melts were glass discs formed artificially from melted volcanic materials. Solutions of the relevant diffusion equations were done by the explicit finite difference method. Results were compared to analytical solutions reported in the literature and good agreement was found. We have shown that the explicit finite difference method is effective and accurate for solving equations that describe 222Rn diffusion in andesitic melts, which is especially important when arbitrary initial and boundary conditions are required. © 2010 Elsevier Ltd.

Savoy, L., Surbeck, H., Hunkeler, D.
Radon and CO2 as natural tracers to investigate the recharge dynamics of karst aquifers
(2011) Journal of Hydrology, 406 (3-4), pp. 148-157.

Abstract
This study investigated the use of radon (222Rn), a radioactive isotope with a half-life of 3.8days, and CO2 as natural tracers to evaluate the recharge dynamics of karst aquifer under varying hydrological conditions. Dissolved 222Rn and carbon dioxide (CO2) were measured continuously in an underground stream of the Milandre test site, Switzerland.

Estimated soil water 222Rn activities were higher than baseflow 222Rn activities, indicating elevated 222Rn production in the soil zone compared to limestone, consistent with a 226Ra enrichment in the soil zone compared to limestone. During small flood events, 222Rn activities did not vary while an immediate increase of the CO2 concentration was observed. During medium and large flood events, an immediate CO2 increase and a delayed 222Rn activity increase to up to 4.9Bq/L and 11Bq/L, respectively occurred. The detection of elevated 222Rn activities during medium and large flood events indicate that soil water participates to the flood event. A soil origin of the 222Rn is consistent with its delayed increase compared to discharge reflecting the travel time of 222Rn from the soil to the saturated zone of the system via the epikarst. A three-component mixing model suggested that soil water may contribute 4-6% of the discharge during medium flood events and 25-43% during large flood events. For small flood events, the water must have resided at least 25days below the soil zone to explain the background 222Rn activities, taking into account the half-life of 222Rn (3.8days). In contrast to 222Rn, the CO2 increase occurred simultaneously with the discharge increase. This observation as well as the CO2 increase during small flood events, suggests that the elevated CO2 level is not due to the arrival of soil water as for 222Rn. A possible explanation for the CO2 trend is that baseflow water in the stream has lower CO2 levels due to gas loss compared to water stored in low permeability zones. During flood event, the stored water is more rapidly mobilised than during baseflow with less time for gas loss. The study demonstrates that 222Rn and CO2 provides value information on the dynamics of groundwater recharge of karst aquifer, which can be of high interest when evaluating the vulnerability of such systems to contamination. © 2011.

Schmidt, C., Hanfland, C., Regnier, P., van Cappellen, P., Schlüter, M., Knauthe, U., Stimac, I., Geibert, W.
228Ra, 226Ra, 224Ra and 223Ra in potential sources and sinks of land-derived material in the German Bight of the North Sea: Implications for the use of radium as a tracer (2011) Geo-Marine Letters, 31 (4), pp. 259-269.

Abstract
Activities of the naturally occurring radium nuclides 228Ra, 226Ra, 224Ra and 223Ra were determined in waters of the open German Bight and adjacent nearshore areas in the North Sea, in order to explore the potential use of radium isotopes as natural tracers of land-ocean interaction in an environment characterised by extensive tidal flats, as well as riverine and groundwater influx. Data collected at various tidal phases from the Weser Estuary (228Ra: 46.3 ± 4.6; 226Ra: 17.1 ± 1.1; 224Ra: 26.1 ± 8.2 to 36.5 ± 6.1; 223Ra: 1.8 ± 0.1 to 4.0 ± 0.4), tidal flats near Sahlenburg (228Ra: 39.3 ± 3.8 to 46.0 ± 4.5; 226Ra: 15.5 ± 1.5 to 16.5 ± 1.7; 224Ra: 34.3 ± 2.2 to 85.3 ± 6.3; 223Ra: 3.6 ± 0.5 to 8.0 ± 1.2), freshwater seeps on tidal flats near Sahlenburg (228Ra: 42.1 ± 4.1; 226Ra: 21.3 ± 2.2; 224Ra: 5.1 ± 0.9; 223Ra: 2.6 ± 1.3) and also in permanently inundated parts of the North Sea (228Ra: 23.0 ± 2.3 to 28.2 ± 2.8; 226Ra: 8.2 ± 0.8 to 11.8 ± 1.2; 224Ra: 3.1 ± 1.0 to 10.1 ± 0.9; 223Ra: 0.1 ± 0.02 to 0.9 ± 0.05; units: disintegrations per minute per 100 kg water sample) reveal that, except for the fresh groundwater, the potential end-

members of nearshore water mass mixing have quite similar radium signatures, excluding a simple discrimination between the sources. However, the decreasing activities of the short-lived 224Ra and 223Ra isotopes recorded towards the island of Helgoland in the central German Bight show a potential to constrain fluxes of land-derived material to the open North Sea. The largest source for all radium isotopes is generally found on the vast tidal flats and in the Weser Estuary. Future work could meaningfully combine this so-called radium quartet approach with investigations of radon activity. Indeed, preliminary data from a tidal flat site with fresh groundwater seepage reveal a 222Rn signal that is clearly lower in seawater.

Schubert, M., Brueggemann, L., Knoeller, K., Schirmer, M.
Using radon as an environmental tracer for estimating groundwater flow velocities in single-well tests
(2011) Water Resources Research, 47 (3), art. no. W03512, .

Abstract
Naturally occurring radon-222 was evaluated for its use in estimating groundwater flow velocities using single-well tests. Investigations were carried out for four different well scenarios, which revealed the advantages and limitations of the approach. On one hand, it was shown that radon is useful as an environmental tracer because of (1) the low costs of the method, (2) the avoidance of any artificial tracer injection into the aquifer, (3) the immediate availability of results, and (4) the need for only a single monitoring well. On the other hand, several potential sources of error were identified, including poor sampling, inadequate hydraulic connection of the well because of a clogged screen, and an unsuitable well diameter resulting in excessively long or short well water residence times. The practical approach is supported by in-depth theoretical considerations. General recommendations are presented concerning the use of radon as an environmental tracer for groundwater flow assessment. Copyright 2011 by the American Geophysical Union.

Schubert, M., Schmidt, A., Müller, K., Weiss, H.
Using radon-222 as indicator for the evaluation of the efficiency of groundwater remediation by in situ air sparging
(2011) Journal of Environmental Radioactivity, 102 (2), pp. 193-199.

Abstract
A common approach for remediation of groundwater contamination with volatile organic compounds (VOCs) is contaminant stripping by means of in situ air sparging (IAS). For VOC stripping, pressurized air is injected into the contaminated groundwater volume, followed by the extraction of the contaminant-loaded exhaust gas from the vadose soil zone and its immediate on-site treatment. Progress assessment of such remediation measure necessitates information (i) on the spatial range of the IAS influence and (ii) on temporal variations of the IAS efficiency. In the present study it was shown that the

naturally occurring noble gas radon can be used as suitable environmental tracer for achieving the related spatial and temporal information. Due to the distinct water/air partitioning behaviour of radon and due to its straightforward on-site detectability, the radon distribution pattern in the groundwater can be used as appropriate measure for assessing the progression of an IAS measure as a function of space and time. The presented paper discusses both the theoretical background of the approach and the results of an IAS treatment accomplished at a VOC contaminated site lasting six months, during which radon was applied as efficiency indicator.

Seidel, C., Baumgartner, A., Ringer, W., Gräser, J., Friedmann, H., Kaineder, H., Maringer, F.J.
Soil gas radon measurements in a region of the Bohemian Massif: Investigations in the framework of an Austrian pilot study
(2011) Radiation Protection Dosimetry, 145 (2-3), art. no. ncr089, pp. 329-332.

Abstract
Soil gas radon measurements are carried out in a pilot study in three municipalities in Upper Austria. The selected municipalities are characterised by a high radon potential. Sixty measuring sites-well distributed over the region and over the different geological areas-were selected. Additionally, the permeability of the soil was determined where the soil gas samples were taken and at various sites where soil samples were analysed by gamma spectrometry. Long-term soil-gas radon concentration measurements are carried out at several sites to study the long-term behaviour of radon activity concentration in soil, the influence of meteorological parameters and seasonal variations. The final goal of the project is to correlate the collected data with geological data and indoor radon concentration. First results of this ongoing study are presented and discussed.

Seiler, R.
Physical setting and natural sources of exposure to carcinogenic trace elements and radionuclides in Lahontan Valley, Nevada
Chemico-Biological Interactions, . Article in Press.

Abstract
In Lahontan Valley, Nevada, arsenic, cobalt, tungsten, uranium, radon, and polonium-210 are carcinogens that occur naturally in sediments and groundwater. Arsenic and cobalt are principally derived from erosion of volcanic rocks in the local mountains and tungsten and uranium are derived from erosion of granitic rocks in headwater reaches of the Carson River. Radon and 210Po originate from radioactive decay of uranium in the sediments. Arsenic, aluminum, cobalt, iron, and manganese concentrations in household dust suggest it is derived from the local soils. Excess zinc and chromium in the dust are probably derived from the vacuum cleaner used to collect the dust, or household sources

such as the furnace. Some samples have more than 5 times more cobalt in the dust than in the local soil, but whether the source of the excess cobalt is anthropogenic or natural cannot be determined with the available data. Cobalt concentrations are low in groundwater, but arsenic, uranium, radon, and 210Po concentrations often exceed human-health standards, and sometime greatly exceed them. Exposure to radon and its decay products in drinking water can vary significantly depending on when during the day that the water is consumed. Although the data suggests there have been no long term changes in groundwater chemistry that corresponds to the Lahontan Valley leukemia cluster, the occurrence of the very unusual leukemia cluster in an area with numerous 210Po and arsenic contaminated wells is striking, particularly in conjunction with the exceptionally high levels of urinary tungsten in Lahontan Valley residents. Additional research is needed on potential exposure pathways involving food or inhalation, and on synergistic effects of mixtures of these natural contaminants on susceptibility to development of leukemia.

Seiler, R.L.
210Po in Nevada Groundwater and Its Relation to Gross Alpha Radioactivity
(2011) Ground Water, 49 (2), pp. 160-171.

Abstract
Polonium-210 (210Po) is a highly toxic alpha emitter that is rarely found in groundwater at activities exceeding 1 pCi/L. 210Po activities in 63 domestic and public-supply wells in Lahontan Valley in Churchill County in northern Nevada, United States, ranged from 0.01 ± 0.005 to 178 ± 16 pCi/L with a median activity of 2.88 pCi/L. Wells with high 210Po activities had low dissolved oxygen concentrations (less than 0.1 mg/L) and commonly had pH greater than 9. Lead-210 activities are low and aqueous 210Po is unsupported by 210Pb, indicating that the 210Po is mobilized from aquifer sediments. The only significant contributors to alpha particle activity in Lahontan Valley groundwater are 234/238U, 222Rn, and 210Po. Radon-222 activities were below 1000 pCi/L and were uncorrelated with 210Po activity. The only applicable drinking water standard for 210Po in the United States is the adjusted gross alpha radioactivity (GAR) standard of 15 pCi/L. 210Po was not volatile in a Nevada well, but volatile 210Po has been reported in a Florida well. Additional information on the volatility of 210Po is needed because GAR is an inappropriate method to screen for volatile radionuclides. About 25% of the samples had 210Po activities that exceed the level associated with a lifetime total cancer risk of 1× 10-4 (1.1 pCi/L) without exceeding the GAR standard. In cases where the 72-h GAR exceeds the uranium activity by more than 5 to 10 pCi/L, an analysis to rule out the presence of 210Po may be justified to protect human health even though the maximum contaminant level for adjusted GAR is not exceeded. Journal compilation © 2010 National Ground Water Association. No claim to original US government works.

Senal, M.I.S., Jacinto, G.S., San Diego-McGlone, M.L., Siringan, F., Zamora, P., Soria, L., Cardenas, M.B., Villanoy, C., Cabrera, O.
Nutrient inputs from submarine groundwater discharge on the Santiago reef flat, Bolinao, Northwestern Philippines
(2011) Marine Pollution Bulletin, 63 (5-12), pp. 195-200.

Abstract
Submarine groundwater discharge (SGD) on the reef flat of Bolinao, Pangasinan (Philippines) was mapped using electrical resistivity, 222Rn, and nutrient concentration measurements. Nitrate levels as high as 126μM, or 1-2 orders of magnitude higher than ambient concentrations, were measured in some areas of the reef flat. Nutrient fluxes were higher during the wet season (May-October) than the dry season (November-April). Dissolved inorganic nitrogen (DIN=NO3+NO2+NH4) and soluble reactive phosphorus (SRP) fluxes during the wet season were 4.4 and 0.2mmolesm-2d-1, respectively. With the increase population size and anthropogenic activities in Bolinao, an enhancement of SGD-derived nitrogen levels is likely. This could lead to eutrophic conditions in the otherwise oligotrophic waters surrounding the Santiago reef flat. © 2011 Elsevier Ltd.

Shang, B., Cui, H.-X., Wu, Y.-Y., Bi, L., Cao, J.-S., Liu, J.-X., Zhang, Q.-Z.
Study on 220Rn equilibrium factor in China traditional dwellings
(2011) Yuanzineng Kexue Jishu/Atomic Energy Science and Technology, 45 (6), pp. 756-762.

Abstract
The spatial distribution and seasonal variation of 220Rn concentration (CTn) and its progeny concentration (Cp,Tn) in China traditional dwellings constructed with soil were studied. The results show that the spatial distribution of CTn appears a significant concentration gradient, and decreases exponentially from the distance of source (bare walls or ground), while there is a good linearity and repeatability. The seasonal variation of CTn displays maximum value in autumn and minimum value in winter. The seasonal variation of Cp,Tn comparing with CTn and Cp,Rn is similar, and its spatial variation can be ignored. Therefore, fixing the distance of 220Rn form source, there is a definite relationship between CTn and Cp,Tn. 220Rn equilibrium factors FTn respectively are 0.003±0.001 and 0.017±0.014 at the distances of 2.5 cm and 20 cm from wall. The Cp,Tn results of actual measurement in traditional houses are in good agreement with the calculated values by using FTn. The measurement to 220Rn gas is more easily achieved comparing with 220Rn progenies. The introduction of FTn provides a simple and reliable method for assessment of 220Rn exposure.

Shashkov, A.G., Zolotukhina, A.F., Fokin, L.R.
Generalization and calculation of the thermal diffusion factor of binary hydrogen-

containing gaseous mixtures
(2011) Journal of Engineering Physics and Thermophysics, 84 (1), pp. 39-48.

Abstract
The results of generalization of experimental data on the thermal diffusion factor αT of hydrogen-containing gaseous mixtures within the framework of similarity theory have been given. The calculated relation which makes it possible to predict the thermal diffusion factor of hydrogen-containing mixtures of nonpolar gases with a limited body of data on the substance has been obtained. The αT values of mixtures of hydrogen with inert gases, including radon Rn, and with N2, SiH4, and GeH4 in the temperature interval 100-1500 K have been calculated. © 2011 Springer Science+Business Media, Inc.

Silva, H.G., Bezzeghoud, M., Reis, A.H., Rosa, R.N., Tlemĉani, M., Araújo, A.A., Serrano, C., Borges, J.F., Caldeira, B., Biagi, P.F.
Atmospheric electrical field decrease during the M =4.1 Sousel earthquake (Portugal)
(2011) Natural Hazards and Earth System Science, 11 (3), pp. 987-991.

Abstract
In this paper, we report the observation of a significant decrease of the vertical component of the atmospheric electrical field in the Évora region (Portugal) during the M =4.1 Sousel earthquake of 27 March 2010. The epicentre of the earthquake was 52 km from the observation site, which falls within the theoretical earthquake preparation radius. A simple interpretation based on hypothetical radon emissions is presented, and future experiments required to elucidate these observations are outlined. To our knowledge, this is the first reported observation of a decrease of the atmospheric electrical field preceding an earthquake. © 2011 Author(s).

Simgen, H.
Low background aspects of GERDA
(2011) AIP Conference Proceedings, 1338, pp. 149-155.

Abstract
The GERDA experiment operates bare Germanium diodes enriched in 76Ge in an environment of pure liquid argon to search for neutrinoless double beta decay. A very low radioactive background is essential for the success of the experiment. We present here the research done in order to remove radio-impurities coming from the liquid argon, the stainless steel cryostat and the front-end electronics. We found that liquid argon can be purified efficiently from 222Rn. The main source of 222Rn in GERDA is the cryostat which emanates about 55 mBq. A thin copper shroud in the center of the cryostat was implemented to prevent radon from approaching the diodes. Gamma ray screening of radio-pure components for front-end electronics resulted in the development of a pre-

amplifier with a total activity of less than 1 mBq 228Th. © 2011 American Institute of Physics.

Singh, B., Singh, S., Bajwa, B.S., Singh, J., Kumar, A.
Soil gas radon analysis in some areas of Northern Punjab, India
(2011) Environmental Monitoring and Assessment, 174 (1-4), pp. 209-217.

Abstract
The radon concentration levels in soil samples from 39 locations of Northern Punjab are measured using AlphaGUARD (PQ 2000 PRO Model) of Genitron instruments, Germany. The radon concentration in soil varies from 0.3 to 35.8 kBq/l. The minimum value of radon is observed in Talwandi Choudhrian and is maximum for Nushera Dhala. The soil gas radon is correlated with soil temperature, pressure, and humidity to observe the effect of these parameters on radon release. The soil gas radon values in the study area are compared with that obtained in groundwater. The results are also compared with the available radon data for other parts of Punjab and Himachal Pradesh. © 2010 Springer Science+Business Media B.V.

Sobakin, P.I., Chevychelov, A.P., Dyachkovskii, A.P.
Radon migration in landscapes of the Elkon Uranium Ore region, Southern Yakutia
(2011) Russian Journal of Ecology, 42 (3), pp. 252-255.

Somlai, J., Hakl, J., Kávási, N., Szeiler, G., Szabó, P., Kovács, T.
Annual average radon concentration in the show caves of Hungary
(2011) Journal of Radioanalytical and Nuclear Chemistry, 287 (2), pp. 427-433.

Abstract
Radon can accumulate in underground areas such as show caves. Repairmen and tourist guides working in such caves may thus be exposed to significant radiation doses. Therefore, it is necessary to measure the radon concentration to estimate the exact radiation dose caused by radon. Considering that the radon concentration in caves usually shows significant seasonal fluctuations, the monthly change of radon concentration was studied for 1 year in nine show caves opened to the public in Hungary. Despite the fact that all of the caves were formed in karst rocks, the annual average radon concentration levels were rather different between each other (541-8287 Bq m-3). The significant monthly fluctuation of the radon concentration indicates that the annual average radon concentration in caves can only be accurately obtained by year-long measurements. © 2010 Akadémiai Kiadó, Budapest, Hungary.

Song, G., Wang, X., Chen, D., Chen, Y.
Contribution of 222Rn-bearing water to indoor radon and indoor air quality assessment in hot spring hotels of Guangdong, China
(2011) Journal of Environmental Radioactivity, 102 (4), pp. 400-406.

Abstract
This study investigates the contribution of radon (222Rn)-bearing water to indoor 222Rn in thermal baths. The 222Rn concentrations in air were monitored in the bathroom and the bedroom. Particulate matter (PM, both PM10 and PM2.5) and carbon dioxide (CO2) were also monitored with portable analyzers. The bathrooms were supplied with hot spring water containing 66-260 kBq m-3 of 222Rn. The results show that the spray of hot spring water from the bath spouts is the dominant mechanism by which 222Rn is released into the air of the bathroom, and then it diffuses into the bedroom. Average 222Rn level was 110-410% higher in the bedrooms and 510-1200% higher in the bathrooms compared to the corresponding average levels when there was no use of hot spring water. The indoor 222Rn levels were influenced by the 222Rn concentrations in the hot spring water and the bathing times. The average 222Rn transfer coefficients from water to air were 6.2 × 10-4-4.1 × 10-3. The 24-h average levels of CO2 and PM10 in the hotel rooms were 89% and 22% higher than the present Indoor Air Quality (IAQ) standard of China. The main particle pollutant in the hotel rooms was PM2.5. Radon and PM10 levels in some hotel rooms were at much higher concentrations than guideline levels, and thus the potential health risks to tourists and especially to the hotel workers should be of great concern, and measures should be taken to lower inhalation exposure to these air pollutants. © 2011 Elsevier Ltd.

Sroor, A., Dawood, N.
Evaluation of radiation level and radon exhalation rate of rock samples from Mahd Ad Dahab mine in Saudi Arabia
(2011) Radiation Effects and Defects in Solids, 166 (4), pp. 305-312.

Abstract
Mahd Ad Dahab mine is the largest and oldest gold mine in the middle East, situated in the western region of Al-Madina Al-Munawara in Saudi Arabia. By using a high-resolution gamma-ray spectroscopy system, various radionuclides in about 20 rock samples, collected from four different locations of the Mahd Ad Dahab mine, have been identified quantitatively based on their characteristic spectral peaks. The activity concentrations of the natural radionuclides uranium (238U), thorium (232Th), and potassium (40K) as well as some radiological parameters were measured in the rock samples. The activity concentration of uranium was found to vary from 7.94 to 38.52Bq/kg, thorium from 3.14 to 17.79Bq/kg and potassium activity from 93.51 to 175.83Bq/kg. The radon emanation coefficient of the rock samples was estimated. It ranged between 0.48 and 0.55. Moreover, the radium equivalent activity in the samples

ranged between 19.3 and 77.49Bq/kg, which is lower than the allowed maximum value for worker safety. The external and internal hazard indices and gamma-radiation hazard index were found not to exceed the permissible limits. © 2011 Taylor & Francis.

St-Amant, N., Whyte, J.C., Rousseau, M.-E., Lariviere, D., Kurt Ungar, R., Johnson, S.
Radiostrontium and radium analysis in low-level environmental samples following a multi-stage semi-automated chromatographic sequential separation
(2011) Applied Radiation and Isotopes, 69 (1), pp. 8-17.

Abstract
Strontium isotopes, 89Sr and 90Sr, and 226Ra being radiotoxic when ingested, are routinely monitored in milk and drinking water samples collected from different regions in Canada. In order to monitor environmental levels of activity, a novel semi-automated sensitive method has been developed at the Radiation Protection Bureau of Health Canada (Ottawa, Canada). This method allows the separation and quantification of both 89Sr and 90Sr and has also been adapted to quantify 226Ra during the same sample preparation procedure. The method uses a 2-stage purification process during which matrix constituents, such as magnesium and calcium that are rich in milk, are removed as well as the main beta-interferences (e.g., 40K, 87Rb, 134Cs, 137Cs, and 140Ba). The first purification step uses strong cation exchange (SCX) chromatography with commercially available resins. In a second step, fractions containing the radiostrontium analytes are further purified using high-performance ion chromatography (HPIC). While 89Sr is quantified by Cerenkov counting immediately after the second purification stage, the same vial is counted again after a latent period of 10-14 days to quantify the 90Sr activity based on 90Y ingrowth. Similarly, the activity of 226Ra, which is separated by SCX only, is determined via the emanation of 222Rn in a 2-phase aqueous/cocktail system using liquid scintillation counting. The minimum detectable concentration (MDC) for 89Sr and 90Sr for a 200min count time at 95% confidence interval is 0.03 and 0.02Bq/L, respectively. The MDC for 226Ra for a 100min count time is 0.002Bq/L. Semi-annual intercomparison samples from the USA Department of Energy Mixed Analyte Performance Evaluation Program (MAPEP) were used to validate the method for 89Sr and 90Sr. Spiked water samples prepared in-house and from International Atomic Energy Agency (IAEA) were used to validate the 226Ra assay. © 2010.

Steinitz, G., Piatibratova, O., Kotlarsky, P.
Possible effect of solar tides on radon signals
(2011) Journal of Environmental Radioactivity, 102 (8), pp. 749-765.

Abstract
Large temporal variations of radon (222Rn) are often encountered in air in the geologic environment, at time scales from diurnal to annual. Interpretations as to the nature of these variations, unique to 222Rn, often invoke either above surface atmospheric

variations, or the influence of subtle active geodynamic processes. So far the eventual geophysical drivers of the variation of 222Rn as well as its specific qualities enabling this temporal variation are not known. New insight on the temporal variation of 222Rn is gained by experimental simulation in confined air. Two short laboratory experiments, and one external experiment lasting over 3 years, were performed inside closed canisters and using natural and commercial 222Rn sources. Internal and external gamma and alpha detectors recorded variations of the radiation, up to around 20% of the equilibrium level. Radon signals of different time scale occurred with: a) periodic annual and semi-annual signals; b) non-periodic multi-day signals; c) periodic daily signals. Similar, related, inversely-related and dissimilar temporal patterns were manifested in the measured time series of the different sensors. Diurnal periodicity was dominated by the solar tide components S1, S2 and S3, exhibiting unlike relative amplitudes and different phases at the different sensors. A compound association occurs among the amplitudes and phases of the diurnal and seasonal periodicities of the daily 222Rn signal, linking the periodic phenomena to the rotation of earth around its axis and around the sun. 222Rn variation patterns in the frequency-time domain cannot be driven by the corresponding atmospheric variation patterns. These results, obtained under static and isolated conditions, are in disagreement with the expected radioactive equilibrium and its spatially uniform expression within and around the experimental volume. The external influence which drives the daily signals evolving from 222Rn inside the canister is non-atmospheric and seemed to be from a remote source and traversed a 5-cm thick lead shield. The similarities with observations on 222Rn signals from upper crustal levels imply that such an external influence, possibly as a component of solar irradiance, drives the 222Rn signals to a depth of at least 100 m. New combined prospects for the research are indicated in terms of the radioactive behavior of 222Rn in air and in terms of an above surface geophysical driver for this behavior.

Stephens, B., Carter, E.M., Gall, E.T., Earnest, C.M., Walsh, E.A., Hun, D.E., Jackson, M.C.
Home energy-efficiency retrofits
(2011) Environmental Health Perspectives, 119 (7), pp. A283-A284.

Abstract
In the February 2011 issue of EHP, Manuel (2011) took an important look at some potential adverse health implications of home energy retrofits. Here, we further discuss the complexity of possible indoor environmental concerns and encourage incorporation of comprehensive homeowner education campaigns in weatherization programs.

Stojanovska, Z., Januseski, J., Bossew, P., Zunic, Z.S., Tollefsen, T., Ristova, M.
Seasonal indoor radon concentration in FYR of Macedonia
(2011) Radiation Measurements, 46 (6-7), pp. 602-610.

Abstract
This paper presents the results of the seasonal indoor radon concentration measurements in dwellings in all regions of the Former Yugoslav Republic (FYR) of Macedonia. The measurements were made in 437 dwellings using CR-39 track detectors over four successive three-month periods (winter, spring, summer and autumn) throughout 2009. The results of analysis of variance showed statistically significant differences between indoor radon concentrations in different seasons. The geometric mean values and geometric standard deviations of indoor radon concentrations in winter, spring, summer and autumn were obtained to be: 115 Bq m-3 (2.02), 72 Bq m-3 (1.97), 46 Bq m-3 (1.95), 92 Bq m-3 (2.02), respectively. The geometric mean values of spring, summer and autumn to winter ratios were found to be: 0.63 (1.50), 0.40 (1.81), and 0.80 (1.58), respectively. The results of the analysis of the variance showed statistically significant differences among the indoor radon measurements for the regions in different seasons. The influence of the factors linked to building characteristics in relation to radon measurements in different seasons was examined. The factors which enable a differentiation into subgroups (significance level p < 0.05) are the floor level, basement and building materials.

Taguchi, S., Law, R.M., Rödenbeck, C., Patra, P.K., Maksyutov, S., Zahorowski, W., Sartorius, H., Levin, I.
TransCom continuous experiment: Comparison of 222Rn transport at hourly time scales at three stations in Germany
(2011) Atmospheric Chemistry and Physics, 11 (19), pp. 10071-10084.

Abstract
Fourteen global atmospheric transport models were evaluated by comparing the simulation of 222Rn against measurements at three continental stations in Germany: Heidelberg, Freiburg and Schauinsland. Hourly concentrations simulated by the models using a common 222Rn-flux without temporal variations were investigated for 2002 and 2003. We found that the mean simulated concentrations in Heidelberg are related to the diurnal amplitude of boundary layer height in each model. Summer mean concentrations simulated by individual models were negatively correlated with the seasonal mean of diurnal amplitude of boundary layer height, while in winter the correlation was positive. We also found that the correlations between simulated and measured concentrations at Schauinsland were higher when the simulated concentrations were interpolated to the station altitude in most models. Temporal variations of the mismatch between simulated and measured concentrations suggest that there are significant interannual variations in the 222Rn exhalation rate in this region. We found that the local inversion layer during daytime in summer in Freiburg has a significant effect on 222Rn concentrations. We recommend Freiburg concentrations for validation of models that resolve local stable layers and those at Heidelberg for models without this capability.

Tai, P., Yu, E., Koul, R., Dubey, A.
Lung cancer epidemiology - A global view
(2011) Current Respiratory Medicine Reviews, 7 (5), pp. 305-312.

Abstract
Smoking, air pollution and radon exposure are causally related to lung cancer. This review analyzes trends of smoking habits by age, sex and ethnicity and their correlation with incidence and mortality of lung cancer. Unfortunately the use of tobacco by adolescents is on the rise. Most developed countries are still showing the rising trend of mortality in female smokers. In Asia, cigarette smoking has become a major health risk with one in three of all cigarettes in the world today are smoked in China. Estimated one hundred million young (< 29 years old) Chinese smokers will eventually die from lung cancer. In Central and South America, occupational risk with exposure to respiratory carcinogens in Brazil correlated with increasing lung cancer incidence. In Chile an analysis revealed a trend in lung cancer odd ratios with increasing concentration of arsenic in drinking water. In Uruguay, in addition to tobacco consumption, diet with low consumption of plant foods, or high consumption of red meat, total fat and cholesterol contributed to a higher risk of lung cancer development. Although many Western governments and health authorities now try to persuade people not to smoke, and in some developed countries tobacco consumption has already begun to fall, promotion of cigarette sales in the third world has intensified. Adenocarcinoma has become the most common histological type recently. Research from various disciplines including radiation therapy, chemotherapy, and surgery are on-going to improve the relative dismal prognosis of lung cancer.

Talati, J.J., Agha, R., Agha, M., Rosin, R.D.
Reducing the need for surgeons by reducing pollution-derived workload: Is there a role for surgeons?
(2011) International Journal of Surgery, 9 (6), pp. 444-450.

Abstract
The need for additional surgical workforce personnel is likely to increase dramatically at a rate beyond our capacity to train them. As surgical training programmes cannot be rapidly expanded, this paper explores an alternative solution to the quandary, a reduction of the disease burden by a war on pollution. Highlighting the role of pollutants in increasing the surgical workload, it identifies potential roles for surgeons in the battle against pollution and draws attention to the need to research out agents which could protect humans against their carcinogenic effects.

Tan, Y., Xiao, D.
A novel algorithm for quick and continuous tracing the change of radon concentration in environment
(2011) Review of Scientific Instruments, 82 (4), art. no. 043503, .

Abstract
Several measurements of the radon concentration are performed by RAD7 in the University of South China. We find that 30-40 min is needed for RAD7 for tracing the concentration of the standard radon chamber. There are two reasons. The first is that the sufficient time of air cycle is needed for the radon concentration in internal cell of RAD7 equal to that of the environment; and the second is that the sufficient decay time is needed for the 218Po concentration in internal cell of RAD7 equal to that of the radon. We used a zeroth order approximation to describe the evolution of the environment radon concentration, and obtained a novel algorithm for quick and continuous tracing the change of radon concentration. The corrected radon concentration obtained through this method is in good agreement with the reference value. This method can be applied to develop and improve the instruments for tracing the change of radon concentration quickly. © 2011 American Institute of Physics.

Tan, Y., Xiao, D.
Revision for measuring the radon exhalation rate from the medium surface
(2011) IEEE Transactions on Nuclear Science, 58 (1 PART 2), art. no. 5671519, pp. 209-213.

Abstract
The radon exhalation rate from the medium surface is commonly derived using a scheme involving a radon detector and an accumulation chamber. The accumulation chamber accumulates the radon gas to make its concentration level inside the chamber detectable by the radon detector in the scheme. The common calculation method for deriving the exhalation rate is based on an assumption that the radon concentrations in the detector's internal cell and that in the accumulation chamber become equal with sufficient accumulation time. However, based on our recent experiments, this method tends to underestimate the actual exhalation rates as generated by our simulation facility. To correct this, we develop a new method for computing the exhalation rate based on the non-equilibrium concept. This paper presents the new method. © 2011 IEEE.

Teng, Y.-G., Zheng, J.-Q., Tuo, X.
Application of radon-detection for groundwater exploration in qingyuanshan of quanzhou region
(2011) Wutan Huatan Jisuan Jishu, 33 (1), pp. 75-78.

Abstract

Radon-detection is an effective geophysical radiometry. Because of the difference of structures between fractured rock and base-rock body, the abnormity of the concentration of radon could reflect the state of fractures, and could be used to analyze the extent of opening, connectedness, and the crashing extent of fractures. It can be made use of in exploration of groundwater, and describing of the fractures character. Combining with the geological data, it could accurately be the base of exploration of groundwater resource. Here, for the aim of groundwater-rich zones, radon-detection was applied in exploration of fracture groundwater resource in Qingyuan mountain in Quanzhou, east-southern China. And the results shown that there was two obvious faults named F1 and F2, with the direction of North-West-West and NorthWest in Qingyuan mountain. Combining with the geological data, F1 fault was engendered from orogeny, and F2 fault was original from invading of granitoids and tectonic activity, they were an ideal reserving space of groundwater. And the extending of the faults was 2. 5 km - 3. 0 km, water catchment area was more than 13 km2 with 211 × 104 m3/a of precipitation recharge, the storage of fracture groundwater was about 5.1 × 10 8m3.

Thinova, L., Rovenska, K.
Radon dose calculation methodology for underground workers in the Czech Republic
(2011) Radiation Protection Dosimetry, 145 (2-3), art. no. ncr071, pp. 233-237.

Abstract
The project focused on classifying the level of irradiation from natural ionising radiation sources for workers in publicly accessible caves and in caves used for speleotherapy, with applicability to other underground workplace. A correct and accurate procedure (and calculation) is defined for determining the effective dose that workers are exposed to in caves, based on the results of integral measurements of radon volume activity and on the length of time spent by workers in the caves. A review was made of various approaches for evaluating lung irradiation found in the literature. Experimental measurements of cave atmosphere characteristics (continuous measurement of radon volume activity, continuous and integral measurements of radon decay products, interior climatic parameters and aerosol spectra) were the main sources for the methodology.

Thinova, L., Fronka, A., Rovenska, K.
A pilot study of the dependence of radon concentration on the tectonic structures, using simple geophysical methods
(2011) Radiation Protection Dosimetry, 145 (2-3), art. no. ncr070, pp. 159-165.

Abstract
It is well known that there are great variations in radon concentrations in the soil gas on building sites. The concentration may sometimes vary by more than two orders of magnitude. The tectonic structure of the bedrock is one of the factors that influence the

intensity of the radon outflow. The simple ARES geophysical method [automatic resistivity system-main unit with standard accessories, multi-electrode cable sections (MCS5)-eight electrodes per 5 m spacing] was used in various modes (Schlumberger, Dipole-Dipole and Pole-Dipole arrays) for in situ tectonic structure determination. The radon concentration in the soil gas was measured using the same network as for the resistivity measurements. The radon measurements were also followed up by in situ gamma spectrometry measurements. The behaviour of the radon concentration in the soil gas was correlated with the detected tectonic non-homogeneities. This pilot study opened up new questions for future analysis.

Thomas, J., Jílek, K.
Evaluation and comparison of measurements of unattached and attached radon progeny in the radon chamber of PTB braunschweig (Germany) with NRPI praha (Czech Republic)
(2011) Radiation Protection Dosimetry, 145 (2-3), art. no. ncr081, pp. 316-319.

Abstract
On the case of a parallel metrological measurement of unattached and attached concentrations of radon progeny, the evaluation by an inversion of the Jacobi-Porstendörfer room model indicates a real overestimation of the concentration of RaA (218Po). © The Author 2011. Published by Oxford University Press. All rights reserved.

Thomas, K.J., Mei, D.-M., Heise, J., Durben, D., Salve, R.
Radon monitoring and early low background counting at the Sanford Underground Laboratory
(2011) AIP Conference Proceedings, 1338, pp. 81-87.

Abstract
Radon detectors have been deployed underground at the Sanford Underground Laboratory at the site of the former Homestake Mine in Lead, SD. Currently, no radon mitigation measures are in place in the underground environment, and the continuing evolution of the facility ventilation systems has led to significant variations in early airborne radon concentrations. The average radon concentration measured near the primary ventilation intake for the 4850-ft level (Yates shaft) is 391 Bq/m3, based on approximately 146 days of data. The corresponding average radon concentration near the other main ventilation intake for the 4850-ft level (Ross shaft) is 440 Bq/m3 based on approximately 350 days of data. Measurements have also been collected near the 1250-ft level Ross shaft, with average radon concentrations at 180 Bq/m 3. Secondary factors that may increase the baseline radon level underground include the presence of iron oxide and moisture, which are known to enhance radon emanation. The results of the current radon monitoring program will be used for the planning of future measurements and any

potential optimization of ventilation parameters for the reduction of radon in relevant areas underground.

Thompson, K.H., Zak, T., Ambers, S.D., Fetterley, J.A., Kearfott, K.J.
An intercomparison study of simultaneous radon measurements using two separate radon screening tests under as-deployed conditions
(2011) Health Physics, 100 (SUPPL.1), pp. S13-S20.

Abstract
Short-term measurements using activated-charcoal based devices remain a popular screening method for radon in indoor air. For this study, two charcoal-based radon detectors were compared for simultaneous measurements in as-deployed conditions. Oneradon detector, obtained and analyzed by a commercial vendor, consisted of nominally 12.8 g of activated charcoal in a cardboard packet. The second measurement system used metal canisters containing 76 g of activated charcoal with counting performed in the investigators' laboratory. Three hundred pairs of tests were distributed in southeast Michigan during the winter. For the comparison of simultaneous radon measurements, participants were instructed to place pairs of tests within 20 cm of each other and open and close the devices at the same time, with suggested deployment time of 5-6 d. Results showed that the radon concentration distributions were lognormal for both sets of data and that there was good correlation between cardboard packet and metal canister results in as-deployed conditions. Health Phys. 100(Supplement 1):S13-S20; 2011 © by the Health Physics Society.

Thompson, R.E.
Epidemiological evidence for possible radiation hormesis from radon exposure: A case-control study conducted in Worcester, MA
(2011) Dose-Response, 9 (1), pp. 59-75.

Abstract
Data from a case-control study of lung cancer and residential radon exposure conducted in Worcester County, Massachusetts, are presented. Lung cancer risk was estimated using conditional logistic regression models that controlled for demographic, smoking, and occupational exposure covariates. Preliminary exploratory analyses using lowess smoothing revealed a non-linear association between exposure and the log odds of lung cancer. Radon exposure was considered by using linear spline terms in order to model this nonlinearity. The best fit of this linear spline model to these data predicted a shift from a positive to a negative slope in the log-odds of lung cancer at a radon concentration of 70 Bq m-3. A statistically significant decrease in cancer risk with increased exposure was found for values ≤157 Bq m-3 normalized to the reference exposure of 4.4 Bq m-3, the lowest radon concentration measured(adjusted odds ratio (AOR) [95% CI] = 0.42 [0.180, 1.00], p = 0.049). This result is consistent with those reported elsewhere that

considered radon exposure with cubic spline terms (Thompson, RE et al. 2008). Furthermore, this model predicts an AOR that is numerically less than 1.0 for radon exposures up to 545 Bq m-3 versusthe above baseline, reference exposure. © 2011 University of Massachusetts.

Todorovic, N., Forkapic, S., Bikit, I., Mrdja, D., Veskovic, M., Todorovic, S.
Monitoring for exposures to tenorm sources in Vojvodina region
(2011) Radiation Protection Dosimetry, 144 (1-4), art. no. ncq414, pp. 655-658.

Abstract
TENORM are found in a wide variety of waste materials, some raw mineral ores and in some consumer products (in trace amounts) where molecules of radionuclides may be bound to specific minerals used in the manufacturing process and can result in increases in radiation exposures to workers and the public. The aim of this paper is to understand this problem and to develop effective ways to protect humans and the environment from harmful exposure to the radiation in TENORM materials in the Vojvodina region. The results of measurement of indoor radon concentration in schools and kindergartens and dose-rate and gamma-spectrometry measurements of the workplace with TENORM materials are presented.

Tollefsen, T., Gruber, V., Bossew, P., De Cort, M.
Status of the european indoor radon map
(2011) Radiation Protection Dosimetry, 145 (2-3), art. no. ncr072, pp. 110-116.

Abstract
Since 2006 a European map of indoor radon (Rn) concentration is in the making. So far 20 countries have contributed with national data, allowing a fair coverage of parts of Europe. This paper presents the current (September 2010) state of the map, discusses its rationale, presents some statistical findings and addresses a few problems which arose during the work. It also briefly presents the European Atlas of Natural Radiation project, of which the Rn map will be part, and further, planned maps of environmental natural radioactivity.

Tomasek, L.
Interaction of radon and smoking among czech uranium miners
(2011) Radiation Protection Dosimetry, 145 (2-3), art. no. ncr048, pp. 238-242.

Abstract

The study is based on a case-control study nested within a cohort study (11 000 miners and 1074 lung cancers). The controls were individually matched by year of birth and attained age. Smoking data were collected in person or from relatives of deceased subjects or from medical files. The study resulted in 850 cases of lung cancer with smoking data. The linear dependence of lung cancer relative risk (RR) on radon exposure adjusted for smoking was not substantially different from analyses when smoking was ignored and reflected mainly the risk among smokers. However, the excess RR per unit exposure among never smokers (70 cases) was substantially higher in comparison with that in smokers, reflecting differences in lung morphometry and clearance. The RRs from combined effects are substantially lower than the risk derived from the multiplicative model, but somewhat higher than those from the additive model. The work was supported by the Czech Ministry of Health (IGA NS 10596).

Tommasino, L., Tokonami, S.
Four passive sampling elements (quatrefoil)-II. Film badges for monitoring radon and its progeny
(2011) Radiation Protection Dosimetry, 145 (2-3), art. no. ncr050, pp. 284-287.

Abstract
The four passive samplers (quatrefoil) already described in a parallel paper, make it possible to obtain thin radiation sources, useful for alpha and beta counting by any passive and real-time detector. In the present paper, the applications of this quatrefoil for measuring radon gas by etch-track detectors will be described. In the case of radon measurements, different solids have been identified, with radon-sorption partition coefficients related to air from 1 to 2000. Uniquely compact radon badges can be obtained by using a layer of these solids facing an alpha track-etch detector. These radon badges make it possible to overcome most of the shortcomings of existing passive monitors. Moreover, these badges show promise for studying the radon solubility of polymer films.

Tommasino, L., Tokonami, S.
Four passive sampling elements (quatrefoil)- I. Monitoring radon and its progeny by surface-contamination monitors
(2011) Radiation Protection Dosimetry, 145 (2-3), art. no. ncr049, pp. 280-283.

Abstract
Four passive sampling elements (quatrefoil) have been recently developed, which transform airborne radionuclides into surface-bound radionuclides. These samplers, once exposed, result in thin radiation sources that can be detected by any realtime or passive detector. In particular, by using a large collecting-area sampler with a low surface density

(g cm2), it is possible to measure radon and its decay products by beta surface-contamination monitors, which are rarely used for these applications. The results obtained to date prove that it is finally possible to carry out the measurements of radon (and its decay products) indoors, in soil and in water simply by a Pancake Geiger-Muller counter. Emphasis will be given to those measurements, which are difficult, if not impossible, to carry out with existing technologies.

Tommasone, F.P., De Francesco, S., Cuoco, E., Verrengia, G., Santoro, D., Tedesco, D.
Radon hazard in shallow groundwaters II: Dry season fracture drainage and alluvial fan upwelling
(2011) Science of the Total Environment, 409 (18), pp. 3352-3363.

Abstract
222Rn concentrations have been measured in a well located on the edge of a large Pleistocene-Holocene fan and belonging to the shallow pyroclastic aquifer of the Pietramelara Plain, southern Italy. The aim of this study has been both to characterise the hydrological inputs that determine the influx of 222Rn to the shallow aquifer and to understand the correlations between 222Rn, major ions, physical-chemical parameters and rainfall. Results obtained from the time series indicate that the studied well shows a 222Rn variability that is inconsistent with a mechanism of pure hydrological amplification, such as described in Radon hazard in shallow groundwaters: Amplification and long term variability induced by rainfall (De Francesco et al., 2010a). On the contrary, in this well hydrological amplification appears to be mainly tied to the upwelling of alluvial fan waters, rich in radon, in response to pistoning from recharge in the carbonate substrate. This upwelling of alluvial fan waters occurs during almost the whole period of the annual recharge and is also responsible of the constant increase in 222Rn levels during the autumn-spring period, when both the water table level and weekly rainfall totals drop. Furthermore, a rapid delivery mechanism for 222Rn likely operates through fracture drainage in concomitance with the very first late summer-early autumn rains, when rainfall totals appear largely insufficient to saturate the soil storage capacity. Results obtained from this study appear to be particularly significant in both radon hazard zoning in relation to the shallow aquifer and possibly also for indoor radon, owing to possible shallow aquifer-soil-building exchanges. Moreover, both the spike-like events and the long wave monthly scale background fluctuations detected can also have potential significance in interpreting 222Rn time series data as seismic and/or volcanic precursors. Finally, 222Rn has proved to be an excellent tracer for hydrological inputs to the shallow aquifer when combined with major ions, physical-chemical data and geological and geomorphological controls. © 2011 Elsevier B.V.

Tondeur, F., Ródenas, J., Querol, A., Ortiz, J., Juste, B.
Indoor radon measurements in the city of Valencia
(2011) Applied Radiation and Isotopes, 69 (8), pp. 1131-1133.

Abstract
The indoor radon risk in Valencia (Spain) was studied more than twenty years ago in two surveys using different methodologies and leading to contradictory results. We report here on new indoor radon measurements with the charcoal canister technique, which confirm the low average level of indoor radon in the city, with a geometrical mean of 24Bq/m3 and an arithmetic mean of 27Bq/m3. © 2010 Elsevier Ltd.

Torok, S., Hegedus, B., Laszlo, V., Hoda, M.A., Ghanim, B., Berger, W., Klepetko, W., Dome, B., Ostoros, G.
Lung cancer in never smokers
(2011) Future Oncology, 7 (10), pp. 1195-1211.

Abstract
Lung cancer in never smokers (LCINS) is the seventh leading cause of death among solid tumors. The main risk factor for lung cancer is smoking; however, approximately 15% of lung cancer patients have never smoked. LCINS is more frequent in women, irrespective of geographical location, nevertheless, the highest incidence has been found in South-East Asia. The histological incidence of adenocarcinoma is higher in the group of never smokers than squamous cell carcinoma. There is a familial clustering of lung cancer that is more pronounced in never smokers, where the family history was associated with an increased risk. Genome-wide association studies identified certain chromosomal aberrations in LCINS. Furthermore, the oncogenic mutation pattern is distinct in nonsmoking patients: activating mutations of EGFR or anaplastic lymphoma kinase are more frequent. The etiology of LCINS includes several environmental factors as well, such as environmental tobacco smoke, viral and hormonal factors, a variety of pulmonary diseases and certain occupational exposures. It is now established that EGFR-tyrosine kinase inhibitor treatment (erlotinib and geftinib) in lung cancer is more effective in LCINS, owing to the higher incidence of EGFR mutation in nonsmokers. Despite the growing body of information on LCINS in recent years there is a need to further investigate the pathogenesis of this particular lung cancer. Future studies on LCINS should try to tackle the issues of prevention, early diagnosis and the exploration of novel therapeutic targets to combat lung cancer disease. © 2011 Future Medicine Ltd.

Truta-Popa, L.A., Hofmann, W., Fakir, H., Cosma, C.
The effect of non-targeted cellular mechanisms on lung cancer risk for chronic, low level radon exposures.
(2011) International journal of radiation biology, 87 (9), pp. 944-953.

Abstract
The goal of the present study was to investigate the effect of non-targeted mechanisms on the shape of the lung cancer risk function at chronic, low level radon exposures relative to direct cellular radiation effects. This includes detrimental and protective bystander effects, radio-adaptive bystander response, genomic instability and induction of apoptosis by surrounding cells. To quantify the dependence of these mechanisms on dose, analytical functions were derived from the experimental evidence presently available. Alpha particle intersections of bronchial target cells during a given exposure period were simulated by a Transformation Frequency-Tissue Response (TF-TR) model, formulated in terms of cellular hits within the cycle time of the cell and then integrated over the whole exposure period. In general, non-targeted effects like genomic instability and bystander effects amplify the biological effectiveness of a given radiation dose, while induction of apoptosis and adaptive response will decrease the risk values. While these observations are related to the absolute number of lung cancer cases, normalization to the epidemiologically observed risk at 0.675 Gy suggests that the effect of such mechanisms on the shape of the dose-response relationship may be different. Indeed, genomic instability and adaptive response cause a substantial reduction of the risk at low doses, while induction of apoptosis and detrimental bystander effects slightly increase the risk. Predictions of lung cancer risk, including these mechanisms, exhibit a distinct sublinear dose-response relationship at low exposures, particularly for very low exposure rates. However, the relatively large error bars of the epidemiological data do not currently allow the prediction of a statistically significant deviation from the Linear - No Threshold (LNT) assumption.

Truta-Popa, L.-A., Hofmann, W., Cosma, C.
Prediction of lung cancer risk for radon exposures based on cellular alpha particle hits (2011) Radiation Protection Dosimetry, 145 (2-3), art. no. ncr082, pp. 218-223.

Abstract
To explore the role of the multiplicity of cellular hits by radon progeny alpha particles for lung cancer incidence, the number of single and multiple alpha particle hits were computed for basal and secretory cells in the bronchial epithelium of human airway bifurcations. Hot spots of alpha particle hits were observed at the branching points of bronchial airway bifurcations. The effect of single and multiple alpha particle intersections of bronchial cells during a given exposure period, selected from a Poisson distribution, on lung cancer risk were simulated by a transformation frequency-tissue response model, based on experimentally observed cellular transformation and survival functions. Calculations of lung cancer risk at low radon exposure levels suggest that single hits produce a linear-dose response relationship, while the superposition of single and increasing multiple hits at higher exposure levels may also be approximated by a quasi-linear dose-effect curve. The simulations predict a carcinogenic enhancement effect for radon progeny accumulations at bifurcation branching sites, which may increase

current risk estimates.

Tsabaris, C., Patiris, D.L., Karageorgis, A.P., Eleftheriou, G., Papadopoulos, V.P., Georgopoulos, D., Papathanassiou, E., Povinec, P.P.
In-situ radionuclide characterization of a submarine groundwater discharge site at Kalogria Bay, Stoupa, Greece
Journal of Environmental Radioactivity, . Article in Press.

Abstract
In-situ underwater gamma-ray spectrometer KATERINA was used for continuous measurements of radon progenies (214Pb, 214Bi), thoron progeny (208Tl) and 40K in submarine groundwater discharge (SGD) sites at Kalogria Bay, SW Peloponnesus (Greece). The spectrometer was deployed attached on measuring platform along with two conductivity - temperature data loggers while underwater battery packs supplied the system for acquisition periods up to 25 days. The radionuclide time series together with salinity data were obtained for spring (wet) and summer (dry) seasons. The 40K activity concentrations correlated well with salinity of the emanating groundwater. Although the 214Bi and 208Tl activities showed usually similar trends anticorrelating with salinity, in some cases 208Tl did not follow the 214Bi record due to changes in the dynamics of the groundwater aquifer. As the half-life of 220Rn is very short (55.6 s), its concentration in SGD may depend on the distance from its origin to the monitoring point. The observed temporal variations of 214Bi and 208Tl confirmed advantages of continuous in-situ monitoring of SGD in coastal areas.

Tsabaris, C., Patiris, D.L., Lykousis, V.
KATERINA: An in situ spectrometer for continuous monitoring of radon daughters in aquatic environment
(2011) Nuclear Instruments and Methods in Physics Research, Section A: Accelerators, Spectrometers, Detectors and Associated Equipment, 626-627 (SUPPL.), pp. S142-S144.

Abstract
The detection system KATERINA has been used in the National Laboratory of Gran Sasso (close to L' Aquila) in Italy for short term continuous monitoring of radon daughter concentrations in a groundwater path. The system was immersed in an water tank which was supplied with groundwater discharged from the mountain of Gran Sasso. The system offers quantitative results using calibration parameters obtained by reference sources and appropriate system efficiency simulation. Measurements were performed in two periods (December 2005 and November 2007) exhibiting almost constant radon level 2.8 Bq/l in the first period, while in the second period it increased up to 6.8 Bq/l. This gradual enhancement of radon background level could be attributed to the increase of

microseismicity that occurred from late of 2007 till April 2009.

Tse, L.A., Yu, I.T.-S., Qiu, H., Au, J.S.K., Wang, X.-R.
A case-referent study of lung cancer and incense smoke, smoking, and residential radon in Chinese men
(2011) Environmental Health Perspectives, 119 (11), pp. 1641-1646.

Abstract
Background: Burning incense generates large amounts of air pollutants, many of which are confirmed or suspected human lung carcinogens. Objectives: We conducted a population-based case-referent study to examine the effect of incense smoke exposure on lung cancer risk among Chinese males and explored the joint effect of cigarette smoking and exposure to residential radon. Methods: We recruited 1,208 male lung cancer incident cases and 1,069 community referents from 2004 to 2006 and estimated their lifetime exposures to incense smoke and other residential indoor air pollutants based on self-reported information collected during interviews. We performed unconditional multivariable logistic regression analysis to estimate the odds ratio (OR) for lung cancer associated with exposure to incense smoke after adjusting for possible confounders. We conducted stratified analyses by smoking status and exposures to incense burning and residential radon and explored the potential additive-scale interactions. Results: We observed an association between incense exposure and lung cancer that was limited primarily to smokers. Cigarette smoking and high cumulative incense exposure at home appeared to have a synergistic effect on lung cancer (compared with never-smokers who never used incense, the OR for lung cancer for smokers who used incense ≥ 60 day-years = 5.00; 95% confidence interval: 3.34, 7.51). Power was limited, but we also found preliminary evidence suggesting that radon exposure may increase risk among smokers using incense. Conclusion: Our study suggests that exposure to incense smoke in the home may increase the risk of lung cancer among smokers and that exposure to radon may further increase risk.

Turner, M.C., Krewski, D., Chen, Y., Pope III, C.A., Gapstur, S., Thun, M.J.
Radon and lung cancer in the American Cancer Society Cohort
(2011) Cancer Epidemiology Biomarkers and Prevention, 20 (3), pp. 438-448.

Abstract
Background: Case-control studies conducted in North America, Europe, and Asia provided evidence of increased lung cancer risk due to radon in homes. Here, the association between residential radon and lung cancer mortality was examined in a large-scale cohort study. Methods: Nearly 1.2 million Cancer Prevention Study-II participants were recruited in 1982. Mean county-level residential radon concentrations were linked to study participants according to ZIP code information at enrollment [mean (SD) = 53.5

Bq/m3 (38.0)]. Cox proportional hazards regression models were used to obtain adjusted HR and 95% CI for lung cancer mortality associated with radon. Potential effect modification by cigarette smoking, ambient sulfate concentrations, and other risk factors was assessed on both the additive and multiplicative scales. Results: Through 1988, 3,493 lung cancer deaths were observed among 811,961 participants included in the analysis. A significant positive linear trend was observed between categories of radon concentrations and lung cancer mortality (P = 0.02). A 15% (95% CI, 1-31) increase in the risk of lung cancer mortality was observed per 100 Bq/m3 increase in radon. Participants with mean radon concentrations above the EPA guideline value (148 Bq/m3) experienced a 34% (95% CI, 7-68) increase in risk for lung cancer mortality relative to those below the guideline value. Conclusions: This large prospective study showed positive associations between ecological indicators of residential radon and lung cancer. Impact: These results further support efforts to reduce radon concentrations in homes to the lowest possible level. ©2011 AACR.

Turunen, J., Ihantola, S., Peräjärvi, K., Pöllänen, R., Toivonen, H., Hrnecek, E.
Collection and behaviour of radon progenies on thin Mylar foils
(2011) Radiation Measurements, 46 (6-7), pp. 631-634.

Abstract
Thin Mylar foils are often used to protect detectors from contamination. However, these foils can be electrostatically charged, possibly leading to their contamination with airborne radon progenies. In the present work, the collection and behaviour of radon progenies on Mylar foils was investigated in detail using alpha spectrometry. The radon progenies collection rate of a small Mylar foil (3 cm2) is equivalent to an air sampler with a flow rate of approximately 0.1 m3/h. It was demonstrated that such contamination may jeopardise the validity of the entire analysis if not interpreted correctly.

Udovičić, V., Aničin, I., Joković, D., Dragić, A., Banjanac, R., Grabež, B., Veselinović, N.
Radon time-series analysis in the underground low-level laboratory in Belgrade, Serbia
(2011) Radiation Protection Dosimetry, 145 (2-3), art. no. ncr074, pp. 155-158.

Abstract
Measurements of radon concentration in the underground low-level laboratory in Belgrade, Serbia with a discrete sampling (T52 h) have been performed. From July 2008 to July 2010, the time-series analysis was carried out. Also, the simultaneous measurements of meteorological parameters (temperature, atmospheric pressure and relative humidity) in the laboratory were done. The simultaneous monitoring of these parameters shows the correlation between temporal variations of radon concentration and meteorological parameters. Also, the radon time-series analysis has been used to study

the possible correlation between the anomalous behaviour of the radon concentration and the local seismicity.

Valmari, T., Mäkeläinen, I., Reisbacka, H., Arvela, H.
Finnish radon situation analysed using national measurement database
(2011) Radiation Protection Dosimetry, 145 (2-3), art. no. ncr075, pp. 101-106.

Abstract
Radiation and Nuclear Safety Authority (STUK) maintains the national indoor radon measurement database in Finland. The analysis of the database material supplements information on radon situation collected by random sampling surveys. The 92 000 dwellings in the database are not a representative sample of the Finnish housing stock. However, the bias is compensated by calculating radon parameters in 1-km2 cells and weighting the cells by the number of dwellings in the cell. Both the database material and a recent random sampling survey show that radon concentrations in new Finnish houses have been decreasing since the 1990s. This positive trend is clearly stronger in radon-prone areas where preventive measures are nowadays commonly implemented in new construction. The changeover to mechanical supply and exhaust ventilation together with the increase in crawl-space foundations has also contributed to the decrease in the concentrations. © The Author 2011. Published by Oxford University Press. All rights reserved.

Van der Graaf, E.R., Limburg, J., Koomans, R.L., Tijs, M.
Monte Carlo based calibration of scintillation detectors for laboratory and in situ gamma ray measurements
(2011) Journal of Environmental Radioactivity, 102 (3), pp. 270-282.

Abstract
The calibration of scintillation detectors for gamma radiation in a well characterized setup can be transferred to other geometries using Monte Carlo simulations to account for the differences between the calibration and the other geometry. In this study a calibration facility was used that is constructed from bricks of well-known activity concentrations of 40K and of radionuclides from the 238U- and 232Th-series. Transfer of the calibration was attempted to a Marinelli beaker geometry with the detector inside a lead shield and to an in situ application with the detector positioned on a sand bed. In general this resulted in good correspondence (within 5-10%) between the activity concentrations derived using the transferred calibration and activities that were derived by independent measurements. Some discrepancies were identified that were attributed to coincident summing in the natural decay series and interference of radon. © 2010 Elsevier Ltd.

Van Dillen, T., Dekkers, F., Bijwaard, H., Kreuzer, M., Grosche, B.
Lung cancer from radon: A two-stage model analysis of the WISMUT cohort, 1955-1998
(2011) Radiation Research, 175 (1), pp. 119-130.

Abstract
A biologically based two-stage carcinogenesis model is applied to epidemiological data for lung cancer mortality in a large uranium miner cohort of the WISMUT company (Germany). To date, this is the largest uranium miner cohort analyzed by a mechanistic model, comprising 35,084 workers among whom 461 died from lung cancer in the follow-up period 19551998. It comprises only workers who were first employed between 1955 and 1989 and contains information on annual exposures to radon progeny. We fitted the model's free parameters, including the average growth time of one malignant cell into a lethal tumor. This lag time has an extraordinary value of 13 to 14 years, larger than that previously used or found in miner studies. Even though cohort-wide information on smoking habits is limited and the calendar-year dependence of tobacco smoke exposure was only implicitly accounted for by a birth cohort effect, we find good agreement between the modeled (expected) and empirical (observed) lung cancer mortality. Model calculations of excess relative lung cancer death risk agree well with those from the descriptive, BEIR VI-type exposure-age- concentration model for WISMUT miners. The large variety of exposure profiles in the cohort leads to a well-determined mechanistic model that in principle allows for an extrapolation from occupational to indoor radon exposure.

Vasidov, A., Salikhbaev, U.S., Kist, A.A., Radyuk, R.I.
Measurement of the volume activity of radon in uranium waste zones
(2011) Atomic Energy, 109 (5), pp. 333-336.

Abstract
The accumulation and behavior of radon in the home, school, preschool and other buildings during the summer and winter are investigated and an assessment is made of the dose load on the residents of the settlements located next to the uranium wastes. Methods of active and passive measurement of the volume activity of radon were used to accomplish this. The results of measurements of the radon activity in rooms are presented, the radon dose loads on the population are evaluated, and the radon-dangerous sections are indicated.

Vaupotič, J., Žvab Rožič, P., Barišić, D.
Environmental aspect of radon potential in terra rossa and eutric cambisol in Slovenia
(2011) Environmental Earth Sciences, pp. 1-7. Article in Press.

Abstract
Terra rossa and eutric cambisol soils were surveyed in Slovenia. At both sites, 6-13 boreholes were drilled in a regular 24 m × 24 m square grid. Soil samples from various depths were taken for gamma spectrometric analysis, and radon in soil gas was measured at a depth of 80 cm using an AlphaGuard instrument. The following ranges of activity concentration (Bq kg-1) were obtained for 238U, 226Ra, 228Ra, 40K and 137Cs: in terra rossa, 64-74, 70-84, 45-49, 293-345, 20-30 and, in eutric cambisol, 55-80, 132-147, 50-57, 473-529, 106-272. Radon activity concentrations in both soils ranged from about 100 kBq m-3 to 370 kBq m-3. © 2011 Springer-Verlag.

Vázquez, B.F., Adán, M.O., Quindós Poncela, L.S., Fernandez, C.S., Merino, I.F.
Experimental study of effectiveness of four radon mitigation solutions, based on underground depressurization, tested in prototype housing built in a high radon area in Spain
(2011) Journal of Environmental Radioactivity, 102 (4), pp. 378-385.

Abstract
The present paper discusses the results of an empirical study of four approaches to reducing indoor radon concentrations based on depressurization techniques in underground sumps. The experiments were conducted in prototype housing built in an area of Spain where the average radon concentration at a depth of 1 m is 250 kBq m-3.Sump effectiveness was analysed in two locations: underneath the basement, which involved cutting openings into the foundation, ground storey and roof slabs, and outside the basement walls, which entailed digging a pit alongside the building exterior. The effectiveness of both sumps was likewise tested with passive and forced ventilation methods. The systems proved to be highly efficient, lowering radon levels by 91-99%, except in the solution involving passive ventilation and the outside sump, where radon levels were reduced by 53-55%. At wind speeds of over 8 m/s, however, passive ventilation across an outside sump lowered radon levels by 95% due to a Venturi effect induced drop in pressure. © 2011 Elsevier Ltd.

Vázquez-López, C., Zendejas-Leal, B.E., Golzarri, J.I., Espinosa, G.
A survey of 222Rn in drinking water in mexico city
(2011) Radiation Protection Dosimetry, 145 (2-3), art. no. ncr062, pp. 320-324.

Abstract
In Mexico City there are more than 22 millions of inhabitants (10 in the metropolitan area and 12 in the suburban zone) exposed to drinking water. The local epidemiological authorities recognised that exposure to radon contaminated drinking water is a potential health hazard, as has been considered worldwide. The United States Environmental Protection Agency has proposed a limit of 11.1 Bq l1 for the radon level in drinking

water. In Mexico a maximum contamination level of radon in drinking water has not yet even considered. In this work, a 222Rn study of drinking water in Mexico City has revealed a range of concentrations from background level to 3.8 Bq l1. 222Rn was calculated using a portable degassing system (AquaKIT) associated with an AlphaGUARD measuring system. Samples from 70 wells of the water system of the south of the Valley Basin of Mexico City and from houses of some other political administrative divisions of Mexico City were taken.

Veloso, B., Nogueira, J.R., Cardoso, M.F.
Lung cancer and indoor radon exposure in the north of Portugal - An ecological study
Cancer Epidemiology, . Article in Press.

Abstract
Background: Indoor radon exposure is a well documented environmental factor as a leading cause of lung cancer. Objectives: The aim of this study was to assess the risk of lung cancer and estimate the number of deaths due to indoor radon exposure in the north of Portugal, between 1995 and 2004. Methods: The sixth Biological Effects of Ionizing Radiation Committee (BEIR VI) preferred models were applied to estimate the risk of developing lung cancer induced by indoor radon exposure, by age and level of exposure, and calculated the number of lung cancer deaths attributable to this exposure. Lung cancer mortality data were granted by the North Regional Health Administration and indoor radon concentrations resulted from a national survey conducted by the Portuguese Environmental Agency. The smoking habit was accounted with two methods. A submultiplicative interaction between smoking and indoor radon exposure was considered. Results: Depending on the model applied and the method used to account for the smoking habit, the estimated number of lung cancer deaths attributed to indoor radon exposure, in northern Portugal, ranges from 1565 to 2406, for the period between 1995 and 2004. This indicates that of the 8514 lung cancer deaths observed, from 18 to 28% could be associated with indoor radon exposure. Conclusions: This was the first study realized in Portugal on the impact of indoor radon exposure in lung cancer mortality. The application of the BEIR VI models led to a high number of lung cancer deaths due to indoor radon exposure.

Vidic, A., Ilić, Z., Deljkič, D., Adrović, F.
Exposure of workers in Tusnica coal mine
(2011) Radiation Protection Dosimetry, 144 (1-4), art. no. ncq310, pp. 672-674.

Abstract
The aim of this paper is to identify potential exposure of the workers in the coal mine Tusnica. The results of the investigation showed increased activity of brown coal up to 1060±88 Bq kg-1 for 238U, 976±30 Bq kg-1 for 226Ra and 118±31 Bq kg-1 for 232Th.

Dose rate measurements ranged from 0.07 to 0.25 μSv h-1. The annual effective dose, taking into account external exposure to ambient gamma radiation and internal exposure due to inhalation of the resuspended dust, would be 1.6 mSv a-1. The results presented lead to the conclusion that Tusnica coal mine contains brown coal with significant radioactivity, indicating that the working hours in the area should be regulated and the use of respiratory protective equipment is obligatory.

Vives i Batlle, J., Smith, A., Vives-Lynch, S., Copplestone, D., Pröhl, G., Strand, T.
Model-derived dose rates per unit concentration of radon in air in a generic plant geometry
(2011) Radiation and Environmental Biophysics, pp. 1-17. Article in Press.

Abstract
A model for the derivation of dose rates per unit radon concentration in plants was developed in line with the activities of a Task Group of the International Commission on Radiological Protection (ICRP), aimed at developing more realistic dosimetry for non-human biota. The model considers interception of the unattached and attached fractions of the airborne radon daughters by plant stomata, diffusion of radon gas through stomata, permeation through the plant's epidermis and translocation of deposited activity to plant interior. The endpoint of the model is the derivation of dose conversion coefficients relative to radon gas concentration at ground level. The model predicts that the main contributor to dose is deposition of 214Po α-activity on the plant surface and that diffusion of radon daughters through the stomata is of relatively minor importance; hence, daily variations have a small effect on total dose. © 2011 Springer-Verlag.

Vojtko, R., Beták, J., Hók, J., Marko, F., GajdoÅ, V., Rozimant, K., MojzeÅ, A.
Pliocene to Quaternary tectonics in the Horná Nitra Depression (Western Carpathians)
(2011) Geologica Carpathica, 62 (4), pp. 381-393.

Abstract
The Horná Nitra Depression is an Upper Miocene-Quaternary intramontane sedimentary basin. This N-S elongated half-graben structure is rimmed from the west by the marginal Malá Magura fault which is the most distinctive fault in the Horná Nitra Depression, traditionally considered as an active fault during the neotectonic phase. This dislocation is attended by contrasting landforms and their parameters. The low S-index of about 1.10, at least two generations of well-preserved faceted slopes along this fault, and longitudinal river valley profiles point to the presence of a low-destructed actual mountain front line, which is typical for the Quaternary active fault systems. Comparison with known normal fault slip rates in the world makes it possible to set an approximate vertical slip rate between 0.3-1.1 m • kyr-1. The present-day fault activity is considered to be normal, steeply dipping towards the east according to structural and geophysical data. The NNW-

SSE present-day tectonic maximum horizontal compressional stress SH and perpendicular minimum horizontal compressional stress Sh was estimated in the Horná Nitra region. The Quaternary activity of the Malá Magura fault is characterized by irregular movement. Two stages of important tectonic activity along the fault were distinguished. The first stage was dated to the Early Pleistocene. The second stage of tectonic activity can by dated to the Late Pleistocene and Holocene. The Malá Magura fault is permeable for gases because the soil atmosphere above the ca. 150 meters wide fault zone contains increased contents of methane and radon.

Voltaggio, M., Spadoni, M.
Direct determination of half-life of 214Pb by gamma spectrometry and comparison with previous indirect measurements
(2011) Applied Radiation and Isotopes, 69 (4), pp. 705-710.

Abstract
A new value of half-life of 214Pb was determined using 214Pb-enriched radioactive sources made of polyurethane foam filters treated with Rn-enriched water. Measurements based on cumulative gamma rays countings yielded a value of 27.06 (7)min. This result is 0.17min longer than the most recent value measured by indirect methods reported in the scientific literature (Martz et al., 1991). The difference between these two measurements is caused by beta recoil whose effects in glass substrates had been neglected. © 2011 Elsevier Ltd.

Walsh, L., Dufey, F., Möhner, M., Schnelzer, M., Tschense, A., Kreuzer, M.
Differences in baseline lung cancer mortality between the German uranium miners cohort and the population of the former German Democratic Republic (1960-2003)
(2011) Radiation and Environmental Biophysics, 50 (1), pp. 57-66.

Abstract
A previous analysis of the radon-related lung cancer mortality risk, in the German uranium miners cohort, using Poisson modeling techniques, noted internal (spontaneous) rates that were higher on average than the external rates by 16.5% (95% CI: 9%; 24%). The main purpose of the present paper is to investigate the nature of, and possible reasons for, this difference by comparing patterns in spontaneous lung cancer mortality rates in a cohort of male miners involved in uranium extraction at the former Wismut mining company in East Germany with national male rates from the former German Democratic Republic. The analysis is based on miner data for 3,001 lung cancer deaths, 1.76 million person-years for the period 1960-2003, and national rates covering the same calendar-year range. Simple "age-period-cohort" graphical analyses were applied to assess the main qualitative differences between the national and cohort baseline lung cancer rates. Some differences were found to occur mainly at higher attained ages above 70 years. Although many occupational risk factors may have contributed to these observed age

differences, only the effects of smoking have been assessed here by applying the Peto-Lopez indirect method for calculating smoking attributability. It is inferred that the observed age differences could be due to the greater prevalence of smoking and more mature smoking epidemic in the Wismut cohort compared to the general population of the former German Democratic Republic. In view of these observed differences between external population-based rates and internal (spontaneous) cohort baseline lung cancer rates, it is strongly recommended to apply only the internal rates in future analyses of uranium miner cohorts.

Wang, J., Meisenberg, O., Chen, Y., Karg, E., Tschiersch, J.
Mitigation of radon and thoron decay products by filtration
(2011) Science of the Total Environment, 409 (19), pp. 3613-3619.

Abstract
Inhalation of indoor radon (222Rn) and thoron (220Rn) decay products is the most important source of exposure to ionizing radiation for the human respiratory tract. Decreasing ventilation rates due to energy saving reasons in new buildings suggest additional active mitigation techniques to reduce the exposure in homes with high radon and thoron concentrations but poor ventilation. Filtration techniques with HEPA filters and simple surgical mask material have been tested for their potential to reduce the indoor exposure in terms of the total effective dose for mixed radon and thoron indoor atmospheres. The tests were performed inside an experimental room providing stable conditions.Filtration (at filtration rates of 0.2h-1 and larger) removes attached radon and thoron decay products effectively but indoor aerosol as well. Therefore the concentration of unattached decay products (which have a higher dose coefficient) may increase. The decrease of the attached decay product concentrations could be theoretically described by a slowly decreasing exponential process. For attached radon decay products, it exhibited a faster but weaker removal process compared to attached thoron decay products (-70% for attached radon decay products and -80% for attached thoron decay products at a filtration rate of 0.5h-1 with an HEPA filter). The concentration of unattached thoron decay products increased distinctly during the filtration process (+300%) while that of unattached radon decay products rose only slightly though at a much higher level (+17%). In the theoretical description these observed differences could be attributed to the different half-lives of the nuclides. Considering both effects, reduced attached and increased unattached decay product concentrations, filtration could significantly decrease the total effective dose from thoron whereas the overall effect on radon dose is small. A permanent filtration is recommended because of the slow decrease of the thoron decay product concentrations. © 2011 Elsevier B.V.

Wang, N., Xiao, L., Li, C., Liu, S., Huang, Y., Liu, D., Peng, M.
Distribution and characteristics of radon gas in soil from a high-background-radiation

city in China
(2011) Journal of Nuclear Science and Technology, 48 (5), pp. 751-758.

Abstract
A soil survey using a portable radon monitor employing semiconductor alpha spectroscopy has been performed on a large scale to determine the distribution of radon in soil in Zhuhai City, Guangdong Province. The survey with 469 sample sites covered an area of more than 100 km2. The average soil radon concentrations at a depth of 0.6m were 55:94 ± 58:54 kBqm-3 in the Zhuhai Urban Area (ZUA) and 7:14 ± 8:75, 37:64 ± 25:92, and 151:25 ± 196:23 kBqm-3, respectively, in the Quaternary sediment, mixtures of sediment and weather grain of granite, and weathered granite in Doumen District. The areas with high radon potential were located within areas of biotitic granites and new developing industrial districts, as indicated by a strong correlation between the radioactivity level and geological lithology. The mean radon concentration in ZUA is about ten times higher than those in Guangzhou City, Quanzhou City, and Jinjiang City. The results show that the Zhuhai area has a higher radon potential, and protective measures against radon should be considered.

Wang, Q., Qu, J., Zhu, W., Zhou, B., Cheng, J.
An experimental study on radon adsorption ability and microstructure of activated carbon
(2011) Nuclear Science and Engineering, 168 (3), pp. 287-292.

Abstract
The radon adsorption ability of four samples of coconut shell-based activated carbons has been investigated by measuring the dynamic adsorption coefficient (DAC) of each activated carbon in a radon room. The findings obtained have shown that DACs are dramatically different even when the surfaceareas are near. Nitrogen adsorption and X-ray photoelectron spectroscopy analysis are used to study the microstructure of the four samples. The results have shown that micropores with diameters between 0.5 and 0.8 nm play themost important role in radon adsorption on activated carbons. Oxygen on thepore surface influences radon adsorption because of the polarity molecular adsorption on oxygen groups.

Wang, X.
Radon anomaly analysis of engineering slopes
(2011) Advanced Materials Research, 261-263, pp. 1161-1166.

Abstract
For various engineering slopes, due to unloading relaxation of the rock mass or sliding disintegration of the slope, the cracks inside the slope will open by different extent, thus when measuring radon content, different parts of the slope will have different radon

content anomaly. Through analyzing radon content anomaly, information as the landslide boundary and structure zoning of the slope rock mass, etc can be obtained. Landslide boundaries and rock mass structure zoning and other information can be identified because of radon anomalies analysis. Through radon anomalies analysis on two projects, landslide boundary identification and zoning on bank-slope adit rock mass structure, it has proved that radon anomalies analysis could be well used as a complementary method to provide more analysis data and thus provide objective scientific basis for slope stability study. The analysis method used is simple, easy to operate, and low in cost. In the analysis, it shall be noted that removing interference from groundwater, desiccant humidity should be excluded.

Weber, M.
A study of radon background in the XENON100 experiment
(2011) AIP Conference Proceedings, 1338, pp. 208-213.

Abstract
The XENON100 Dark Matter experiment has recently published first results from an analysis of 11.2 live days of data, setting an upper limit on the spin-independent WIMP-nucleon elastic scattering cross section of 3.4 × 10-44 cm2 at 55GeV/c2 and 90% confidence level. This article focuses on one specific background component of the XENON100 detector by presenting two independent methods of measuring the 222Rn concentration during operation phase. A first estimate of radon activity is derived for the 11.2 days analysis, proving the feasibility of on-line radon monitoring. Remaining systematic uncertainties are discussed. © 2011 American Institute of Physics.

Weinstein, Y., Yechieli, Y., Shalem, Y., Burnett, W.C., Swarzenski, P.W., Herut, B.
What is the role of fresh groundwater and recirculated seawater in conveying nutrients to the coastal ocean?
(2011) Environmental Science and Technology, 45 (12), pp. 5195-5200.

Abstract
Submarine groundwater discharge (SGD) is a major process operating at the land-sea interface. Quantifying the SGD nutrient loads and the marine/terrestrial controls of this transport is of high importance, especially in oligotrophic seas such as the eastern Mediterranean. The fluxes of nutrients in groundwater discharging from the seafloor at Dor Bay (southeastern Mediterranean) were studied in detail using seepage meters. Our main finding is that the terrestrial, fresh groundwater is the main conveyor of DIN and silica to the coastal water, with loads of 500 and 560 mol/yr, respectively, per 1 m shoreline. Conversely, recirculated seawater is nutrient-poor, and its role is mainly as a dilution agent. The nutrient loads regenerated in the subterranean estuary (sub-bay sediment) are relatively small, consisting mostly of ammonium (24 mol/yr). On the other

hand, the subterranean estuary at Dor Bay sequesters as much as 100 mol N/yr per 1 m shoreline, mainly via denitrification processes. These, and observations from other SGD sites, imply that the subterranean estuary at some coastal systems may function more as a sink for nitrogen than a source. This further questions the extent of nutrient contributions to the coastal water by some subterranean estuaries and warrants systematic evaluation of this process in various hydrological and marine trophic conditions.

Weissmann, G.
Fukushima Daiichi and Icarus: The human factor in a meltdown (Sv=1J/kg.w)
(2011) FASEB Journal, 25 (6), pp. 1777-1780.

Williams, A.G., Zahorowski, W., Chambers, S., Griffiths, A., Hacker, J.M., Element, A., Werczynski, S.
The vertical distribution of radon in clear and cloudy daytime terrestrial boundary layers
(2011) Journal of the Atmospheric Sciences, 68 (1), pp. 155-174.

Abstract
Radon (222Rn) is a powerful natural tracer of mixing and exchange processes in the atmospheric boundary layer. The authors present and discuss the main features of a unique dataset of 50 high-resolution vertical radon profiles up to 3500 m above ground level, obtained in clear and cloudy daytime terrestrial boundary layers over an inland rural site in Australia using an instrumented motorized research glider. It is demonstrated that boundary layer radon profiles frequently exhibit a complex layered structure as a result of mixing and exchange processes of varying strengths and extents working in clear and cloudy conditions within the context of the diurnal cycle and the synoptic meteorology. Normalized aircraft radon measurements are presented, revealing the characteristic structure and variability of three major classes of daytime boundary layer: 1) dry convective boundary layers, 2) mixed layers topped with residual layers, and 3) convective boundary layers topped with coupled nonprecipitating clouds. Robust and unambiguous signatures of important atmospheric processes in the boundary layer are identifiable in the radon profiles, including "top-down" mixing associated with entrainment in clear-sky cases and strongly enhanced venting and subcloud-layer mixing when substantial active cumulus are present. In poorly mixed conditions, radon gradients in the daytime atmospheric surface layer significantly exceed those predicted by Monin-Obukhov similarity theory. In two case studies, it is demonstrated for the first time that a sequence of vertical radon profiles measured over the course of a single day can consistently reproduce major structural features of the evolving boundary layer.

Wójcik, M., Zuzel, G., Majorovits, B.
Removal of the long-lived 222Rn daughters from steel and germanium surfaces
(2011) AIP Conference Proceedings, 1338, pp. 224-228.

Abstract
Removal of the long-lived 222Rn daughters (210Pb, 210Bi and 210Po) from stainless steel and germanium surfaces was investigated. As cleaning technique etching was applied to samples in a form of discs exposed earlier to a strong radon source. Reduction of the 210Pb activity was tested using a HPGe spectrometer, for 210Bi a beta spectrometer and for 210Po an alpha spectrometer was used. According to the conducted measurements all the isotopes were removed very efficiently from germanium. Results obtained for stainless steel were worse but still better than those achieved for copper. © 2011 American Institute of Physics.

Wu, H., Liu, Q., Yang, B., Yuan, X., Wang, L.
A scheme for measuring emanation factors of radon from building materials' top-surface
(2011) He Jishu/Nuclear Techniques, 34 (3), pp. 209-212.

Abstract
This work derived the relationship of the emanation factor and the radon that released from building materials based on the equation of balance for each phase of radon in unbroken building materials, and calculated the emanation factor of the radon that released from the top-surface of the building materials by measuring the concentration curve of radon in the equipment at intervals. The radon attenuation in air-filled pores of building materials is taken into account. The measuring results are more accurate after the calculation of leakage rate of the equipment by measuring the concentration of the pre-injected radon in the equipment at intervals. A high accurate measuring formula for short time is also obtained for the existing of "back-diffusion" in long time measuring, which can accurately fit the experimental data within ± 4%.

Wu, H.-X., Liu, Y.-J., Yang, B., Qiu, G.-X., Liu, Q.-C.
Evaluation of dose arising from 222Rn, decay products of 222Rn and 220Rn to staff from a certain nuclear power plant
(2011) Hedongli Gongcheng/Nuclear Power Engineering, 32 (4), pp. 122-126.

Abstract
The staff of the plant was grouped based on their work ranges. The annual effective dose resulted from radon and the decay products of 222Rn/220Rn is studied by measuring radon concentration with double filter membrane method and by measuring the concentration of 222Rn/220Rn short life radioactive decay products with five-count method. Based on the results, specific protection measures are proposed for high radon

areas. The study results show that the monitoring data for all areas except the spent fuel pool was smaller than the recommended values by ICRP.

Wu, J., Gao, X., Zeng, J., Xu, J., Yang, X., Lou, K.
The bacterial community structures in xinjiang fault belt spring analyzed by PCR-DGGE
(2011) Shengtai Xuebao/ Acta Ecologica Sinica, 31 (2), pp. 506-512.

Abstract
Seismic fault belt is a main passageway of various kinds of gas and geochemistry elements, where are important zone for matters, energy and information transfer between lithosphere and atmosphere. Microbes living in the belt effected intensively by the hydrogeochemical changes caused by earth crust movement. The 10th spring of Urumq originates from Bogeda mountain of Tianshan mountain range, and the groundwater runoff in seismic fault belt. The spring water contains various geochemistry elements, such as sulfide, methane, hydrogen, radon, sulfide, methane, carbon dioxide, helium, fluorine and hydrarg et al, many of which may potentially act as electron donors capable of supporting chemolithotrophy-based primary production. In order to reveal the impact of hydrogeochemical changes to bacterial community in seismic fault belt spring water, thirty-one samples of spring water collected from October 12th to November 11th and their corresponding geochemial parameters were determined. Of them, ten samples were used for bacterial dynamic changing monitoring. The planktonic communities were collected by microporous membrane filtration and then total DNA were extracted by SDS-enzymatic disruption method. The V3 region of the 16S rDNA gene of those samples was analyzed by PCR-DGGE (Denaturing Gradient Gel Electrophoresis) and different bands were excised for sequencing. The DGGE fingerprints combined with hydrogeochamical parameters were analyzed by CCA (Canonical correspondence analysis). The results showed that B16 (Uncultured bacterium) and epsilon proteobacterium were positive correlate to Fluorine fluctuation and clustered as group one and two, respectively; B1 (Flavobacterium), Pseudomonas aeruginosa, B10 (Uncultured bacterium) and Staphylococcus saprophyticus were positive correlate to sulfide change; Thiomicrospira arctica,B3 (Flavobacterium)aand Staphylococcus arlettae were positive correlated to hydrogen content. The result indicated that bacterial communities in seismic fault belt spring water could response sensitively to hydrogeochemical parameter changes, and this may provide a novel means for crust movement monitoring and earthquake forecast.

Wysocka, M., Kotyrba, A.
Radon mapping with the support of geophysical methods
(2011) Journal of Mining Science, 47 (3), pp. 330-337.

Abstract
The goals of presented studies were to find out whether or not radon risk can be

correlated with mininginduced transformation of subsurface layers of a rock mass, to check whether results of chosen geophysical methods can support radon risk mapping. Investigations were conducted in Upper Silesian Region in Poland. The results of previous studies have shown that radon levels depend on geological structure and on the mining-induced transformations taking place in a rock mass, influencing radon migration ability. Geophysical methods such as electrical resistivity profiling (PE), electrical resistivity sounding (VES) and gravimetric survey allowed to analyze geological conditions to a depth up to 50 m. On the basis of the results of mentioned above investigations sites which are likely or not to be a radonprone areas were distinguished. Investigations such as measurements of radon in soil gas its exhalation and concentrations in buildings were curried out.

Xia, Y., Conen, F., Haszpra, L., Ferenczi, Z., Zahorowski, W.
Evidence for Nearly Complete Decoupling of Very Stable Nocturnal Boundary Layer Overland
(2011) Boundary-Layer Meteorology, 138 (1), pp. 163-170.

Abstract
Concentrations of 222Rn at 0.1 m and 6.5 m height above ground level and 222Rn flux density were measured during nights characterized by strong cooling, light winds and clear sky conditions in the Carpathian Basin in Hungary. A very stable boundary layer (vSBL) formed on 14 nights between 15 August and 3 September 2009. On 12 nights, an estimated 72% (s.d.20%) of 222Rn emitted from the surface since sunset was retained within the lowest 6.5 m above the ground until sunrise the following morning. On two nights an intermittent increase in wind speed at 9.4 m height was followed by a rise in temperature at 2.0 m height, indicating a larger atmospheric motion that resulted in 222Rn at 0.1 m around sunrise being the same as around the preceding sunset. It does not seem to be rare in a large continental basin for a vSBL to be nearly completely decoupled from the atmosphere above for the entire period from sunset to sunrise. © 2010 Springer Science+Business Media B.V.

Xu, Y.-H., He, L.-F., Tang, F.-D.
Calibration of the radon monitor and result analysis
(2011) Hedianzixue Yu Tance Jishu/Nuclear Electronics and Detection Technology, 31 (3), pp. 324-326.

Abstract
Radon monitor is the most useful method for measuring radon concentration in the air, but the response of the monitor changes due to the different environments. The standard radon measurement system at Shanghai Institute of Measurement and Testing Technology (SIMT) dose calibration for the radon monitors regularly. When taking the

data of the samples from 2008 to 2009, the results shows, about 1/3 of the samples, their inherent errors of the correction factors are over ±10%, and the yearly fluctuation over 5%, which means, for the high confidence on the radon concentration measurement results, the regular calibration of the radon monitor is necessary and needed.

Xueref-Remy, I., Messager, C., Filippi, D., Pastel, M., Nedelec, P., Ramonet, M., Paris, J.D., Ciais, P.
Variability and budget of CO2 in Europe: Analysis of the CAATER airborne campaigns-Part 1: Observed variability
(2011) Atmospheric Chemistry and Physics, 11 (12), pp. 5655-5672.

Abstract
Atmospheric airborne measurements of CO2 are very well suited for estimating the time-varying distribution of carbon sources and sinks at the regional scale due to the large geographical area covered over a short time. We present here an analysis of two cross-European airborne campaigns carried out on 23-26 May 2001 (CAATER-1) and 2-3 October 2002 (CAATER-2) over Western Europe. The area covered during CAATER-1 and CAATER-2 was 4° W to 14° E long; 44° N to 52° N lat and 1° E to 17° E long; 46° N to 52° N lat respectively. High precision in situ CO2, CO and Radon 222 measurements were recorded. Flask samples were collected during both campaigns to cross-validate the in situ data. During CAATER-1 and CAATER-2, the mean CO2 concentration was 370.1 ± 4.0 (1-σ standard deviation) ppm and 371.7 ± 5.0 (1-σ) ppm respectively. A HYSPLIT back-trajectories analysis shows that during CAATER 1, northwesterly winds prevailed. In the planetary boundary layer (PBL) air masses became contaminated over Benelux and Western Germany by emissions from these highly urbanized areas, reaching about 380 ppm. Air masses passing over rural areas were depleted in CO2 because of the photosynthesis activity of the vegetation, with observations as low as 355 ppm. During CAATER-2, the back-trajectory analysis showed that air masses were distributed among the 4 sectors. Air masses were enriched in CO2 and CO over anthropogenic emission spots in Germany but also in Poland, as these countries have part of the most CO2-emitting coal-based plants in Europe. Simultaneous measurements of in situ CO2 and CO combined with back-trajectories helped us to distinguish between fossil fuel emissions and other CO2 sources. The ΔCO/ΔCO2 ratios (R<2 Combining double low line 0.33 to 0.88, slopes Combining double low line 2.42 to 10.37), calculated for anthropogenic-influenced air masses over different countries/regions matched national inventories quite well, showing that airborne measurements can help to identify the origin of fossil fuel emissions in the PBL even when distanced by several days/hundreds of kms from their sources. We have compared airborne CO2 observations to nearby ground station measurements and thereby, confirmed that measurements taken in the lower few meters of the PBL (low-level ground stations) are representative of the local scale, while those located in the free troposphere (FT) (moutain stations) are representative of atmospheric CO2 regionally on a scale of a few hundred kilometers. Stations located several 100 km away from each

other differ from a few ppm in their measurements indicating the existence of a gradient within the free troposphere. Observations at stations located on top of small mountains may match the airborne data if the sampled air comes from the FT rather than coming up from the valley. Finally, the analysis of the CO 2 vertical variability conducted on the 14 profiles recorded in each campaign shows a variability at least 5 to 8 times higher in the PBL (the 1-σ standard deviation associated to the CO2 mean of all profiles within the PBL is 4.0 ppm and 5.7 ppm for CAATER-1 and CAATER-2, respectively) than in the FT (within the FT, 1-σ is 0.5 ppm and 1.1 ppm for CAATER-1 and CAATER-2, respectively). The CO2 jump between the PBL and the FT equals 3.7 ppm for the first campaign and 0.3 ppm for the second campaign. A very striking zonal CO2 gradient of about 11 ppm was observed in the mid-PBL during CAATER-2, with higher concentrations in the west than in the east. This gradient may originate from differences in atmospheric mixing, ground emission rates or Autumn's earlier start in the west. More airborne campaigns are currently under analysis in the framework of the CARBOEUROPE-IP project to better assess the likelihood of these different hypotheses. In a companion paper (Xueref-Remy et al., 2011, Part 2), a comparison of vertical profiles from observations and several modeling frameworks was conducted for both campaigns.

Xueref-Remy, I., Bousquet, P., Carouge, C., Rivier, L., Ciais, P.
Variability and budget of CO2 in Europe: Analysis of the CAATER airborne campaigns-Part 2: Comparison of CO2 vertical variability and fluxes between observations and a modeling framework
(2011) Atmospheric Chemistry and Physics, 11 (12), pp. 5673-5684.

Abstract

Our ability to predict future climate change relies on our understanding of current and future CO2 fluxes, particularly on a regional scale (100-1000 km). CO2 regional sources and sinks are still poorly understood. Inverse transport modeling, a method often used to quantify these fluxes, relies on atmospheric CO2 measurements. One of the main challenges for the transport models used in the inversions is to properly reproduce CO2 vertical gradients between the boundary layer and the free troposphere, as these gradients impact on the partitioning of the calculated fluxes between the different model regions. Vertical CO2 profiles are very well suited to assess the performances of the models. In this paper, we conduct a comparison between observed and modeled CO2 profiles recorded during two CAATER campaigns that occurred in May 2001 and October 2002 over Western Europe, as described in a companion paper. We test different combinations between a global transport model (LMDZt), a mesoscale transport model (CHIMERE), and different sets of biospheric fluxes, all chosen with a diurnal cycle (CASA, SiB2 and ORCHIDEE). The vertical profile comparison shows that: 1) in most cases the influence of the biospheric flux is small but sometimes not negligible, ORCHIDEE giving the best results in the present study; 2) LMDZt is most of the time too diffuse, as it simulates a too high boundary layer height; 3) CHIMERE better reproduces the observed gradients between the boundary layer and the free troposphere, but is sometimes too variable and

gives rise to incoherent structures. We conclude there is a need for more vertical profiles to conduct further studies to improve the parameterization of vertical transport in the models used for CO2 flux inversions. br> Furthermore, we use a modeling method to quantify CO2 fluxes at the regional scale from a chosen observing point, coupling influence functions from the transport model LMDZt (that works quite well at the synoptic scale) with information on the space-time distribution of fluxes. This modeling method is compared to a dual tracer method (the so-called Radon method) for a case study on 25 May 2001 during which simultaneous well-correlated in situ CO2 and Radon 222 measurements have been collected. Both methods give a similar result: a flux within the Radon 222 method uncertainty (35%), that is an atmospheric CO2 sink of '4.2 to 4.4 gC mg-2 day 1. We have estimated the uncertainty of the modeling method to be at least 33% on average, and even more for specific individual events. This method allows the determination of the area that contributed to the CO2 observed concentration. In our case, the observation point located at 1700 m a.s.l. in the north of France, is influenced by an area of 1500-700 km2 that covers the Benelux region, part of Germany and western Poland. Furthermore, this method allows deconvolution between the different contributing fluxes. In this case study, the biospheric sink contributes 73% of the total flux, fossil fuel emissions for 27%, the oceanic flux being negligible. However, the uncertainties of the influence function method need to be better assessed. This could be possible by applying it to other cases where the calculated fluxes can be checked independently, for example at tall towers where simultaneous CO 2 and Radon 222 measurements can be conducted. The use of optimized fluxes (from atmospheric inversions) and of mesoscale models for atmospheric transport may also significantly reduce the uncertainties.

Yamazawa, H.
Present and future studies on environmental radioactivity in Japan
(2011) Radiation Protection Dosimetry, 146 (1-3), art. no. ncr171, pp. 283-286.

Abstract
In this paper, recent studies on environmental radioactivity are briefly reviewed. Considering the growing dependency on nuclear energy in Asia, emphasis has been given to 14C cycle at the ground surface including rice paddy fields and to long-range atmospheric transport of natural and anthropogenic radioactive materials. Studies on the dynamic behaviour of 14C are being carried out and some important experimental results are becoming available for models of 14C migration in rice paddy. Long-range atmospheric transport models have been improved substantially by using sophisticated physical models and simulation techniques to improve emergency preparedness. Although our knowledge on radon flux distribution in Asia has been improved and radon has become a more reliable atmospheric tracer, we still need more intensive measurements of exhalation flux and atmospheric concentration of radon and radium content in soil.

Yan, R., Jiang, C.-S., Zhang, L.-P.
Study on critical slowing down phenomenon of radon concentrations in water before the Wenchuan Ms8. 0 earthquake
(2011) Chinese Journal of Geophysics (Acta Geophysica Sinica), 54 (7), pp. 1817-1826.

Abstract
In recent years, critical slowing down phenomenon have shown great potentials on the aspects of disclosing whether or not a complex dynamic system is tend to critical cataclysm. Based on the concepts of critical slowing down, the observed data of radon concentrations in water were processed in this article. Take radon concentration observation data at Longmen Mountain fault zone and nearby regions before the Wenchuan Ms8. 0 earthquake on May 12, 2008 as an example, the autocorrelation coefficients and variances which can characterize critical slowing down have been calculated separately. The result indicated that radon data at different station had obviously critical slowing down phenomenon before the Wenchuan Ms8. 0 earthquake, which indicated that critical slowing down phenomenon is a possible early warning signal for strong earthquakes. The introduction and study on critical slowing down theory into precursory data processing have practical significances and important scientific values to thoroughly understand precursor mechanism, to determine the stage of precursory anomalies and to enhance earthquake prediction level.

Yang, M.
A current global view of environmental and occupational cancers
(2011) Journal of Environmental Science and Health - Part C Environmental Carcinogenesis and Ecotoxicology Reviews, 29 (3), pp. 223-249.

Abstract
This review is focused on current information of avoidable environmental pollution and occupational exposure as causes of cancer. Approximately 2% to 8% of all cancers are thought to be due to occupation. In addition, occupational and environmental cancers have their own characteristics, e.g., specific chemicals and cancers, multiple factors, multiple causation and interaction, or latency period. Concerning carcinogens, asbestos/silica/wood dust, soot/polycyclic aromatic hydrocarbons [benzo(a) pyrene], heavy metals (arsenic, chromium, nickel), aromatic amines (4-aminobiphenyl, benzidine), organic solvents (benzene or vinyl chloride), radiation/radon, or indoor pollutants (formaldehyde, tobacco smoking) are mentioned with their specific cancers, e.g., lung, skin, and bladder cancers, mesothelioma or leukemia, and exposure routes, rubber or pigment manufacturing, textile, painting, insulation, mining, and so on. In addition, nanoparticles, electromagnetic waves, and climate changes are suspected as future carcinogenic sources. Moreover, the aspects of environmental and occupational cancers are quite different between developing and developed countries. The recent follow-up of occupational cancers in Nordic countries shows a good example for

developed countries. On the other hand, newly industrializing countries face an increased burden of occupational and environmental cancers. Developing countries are particularly suffering from preventable cancers in mining, agriculture, or industries without proper implication of safety regulations. Therefore, industrialized countries are expected to educate and provide support for developing countries. In addition, citizens can encounter new environmental and occupational carcinogen nominators such as nanomaterials, electromagnetic wave, and climate exchanges. As their carcinogenicity or involvement in carcinogenesis is not clearly unknown, proper consideration for them should be taken into account. For these purposes, new technologies with a balance of environment and gene are required. Currently, various approaches with advanced technologiesgenomics, exposomics, etc.have accelerated development of new biomarkers for biological monitoring of occupational and environmental carcinogens. These advanced approaches are promising to improve quality of life and to prevent occupational and environmental cancers.

Yang, P.
Lung cancer in never smokers
(2011) Seminars in Respiratory and Critical Care Medicine, 32 (1), pp. 10-21.

Abstract
Lung cancer in never smokers (LCINS) has lately been recognized as a unique disease based on rapidly gained knowledge from genomic changes to treatment responses. The focus of this article is on current knowledge and challenges with regard to LCINS expanded from recent reviews highlighting five areas: (1) distribution of LCINS by temporal trends, geographic regions, and populations; (2) three well-recognized environmental risk factors; (3) other plausible environmental risk factors; (4) prior chronic lung diseases and infectious diseases as risk factors; and (5) lifestyles as risk or protective factors. This article will also bring attention to recently published literature in two pioneering areas: (1) histological characteristics, clinical features with emerging new effective therapies, and social and psychological stigma; and (2) searching for susceptibility genes using integrated genomic approaches. © Georg Thieme Verlag KG Stuttgart. New York.

Yokoyama, S., Mori, N., Shimo, M., Fukushi, M., Ohnuma, S.
Measurement of radon concentration in water using the portable radon survey meter
(2011) Radiation Protection Dosimetry, 146 (1-3), art. no. ncr098, pp. 23-26.

Abstract
A measurement method for measuring radon in water using the portable radon survey meter (RnSM) was developed. The container with propeller was used to stir the water samples and release radon from the water into the air in a sample box of the RnSM. In this method, the measurement of error would be <20 %, when the radon concentration

in the mineral water was >20 Bq l-1.

Yoshimoto, S., Tsuchihara, T., Ishida, S., Masumoto, T., Imaizumi, M.
Groundwater flow and transport and potential sources of groundwater nitrates in the Ryukyu Limestone as a mixed flow aquifer in Okinawa Island, Japan
(2011) Paddy and Water Environment, 9 (4), pp. 367-384.

Abstract
We investigated the groundwater flow and the transport and potential source of groundwater nitrates in the typical karst setting of the Ryukyu Limestone aquifer in the southern part of Okinawa Island, Japan. Analysis of groundwater hydrographs indicated that this is a "mixed flow" aquifer with the coexistence of slow diffuse flow in the matrices and rapid conduit flow in the caves and caverns. This relationship is indicated by the travel time of groundwater flow: 70 days in the matrices of the aquifer and 6 days through the caves and caverns. The conduit flow system was also confirmed by the distribution of relatively low concentrations of 222Rn near caverns. The sampling sites were categorized into upland field (UF) type and residential area (RA) type according to the land-use ratio on the upstream side with a 600-m influential radius, and cave and cavern (CC) type according to the hydrogeologic setting near two large caverns, even though the CC type should be categorized as the UF type from the viewpoint of land use. Cross plots of NO3-N versus SO42- showed that the predominant source of UF groundwater nitrates was chemical fertilizer. A difference was observed in average δ15N values between UF (8. 9‰) and RA (10. 0‰). On the other hand, the average δ15N value for CC (10. 5‰) was similar to that for RA, indicating that CC nitrates were not related to the surrounding land use. This phenomenon is considered as evidence that CC groundwater nitrates were carried by rapid groundwater flow through caves and caverns from residential areas located higher upstream compared to the influential areas. According to previous studies, animal and human waste was considered the predominant sources of RA and CC groundwater nitrogen. The contribution ratio of chemical fertilizer (RCF) was calculated using mass balance equations under assumed predictability. There was a relatively high correlation between the rate of upland areas and of residential areas and RCF. Average RCF for UF, RA and CC was 41, 27, and 25%, respectively. © 2011 Springer-Verlag.

Yu, K.N., Nikezic, D.
Long-term determination of airborne radon progeny concentrations using LR 115 solid-state nuclear track detectors
Radiation Measurements, . Article in Press.

Abstract
This paper described the establishment of lognormal distributions for the Jacobi room

model parameters with a view to improve an existing method for long-term passive measurements of the equilibrium factor using LR 115 solid-state nuclear track detectors, namely, through the proxy equilibrium factor (Fp) method. Fp is defined as (C1 + C3)/C0 where C0, C1 and C3 are the concentrations of 222Rn, and the airborne concentrations of 218Po and 218Po (or 214Bi), respectively. The studied Jacobi room model parameters included the ventilation rate λv, the aerosol attachment rate λa, the deposition rate λdu of unattached progeny and the deposition rate λda of attached progeny. The lognormal distributions generated more realistic distributions for the equilibrium factor F and the unattached fraction fp of the potential alpha energy concentration, and a much tighter relationship between F and Fp, when compared with the traditionally used uniform distributions. With the new relationship between F and Fp, the accuracy of the Fp method to determine F from Fp is significantly improved.

Yver, C., Schmidt, M., Bousquet, P., Ramonet, M.
Measurements of molecular hydrogen and carbon monoxide on the Trainou tall tower (2011) Tellus, Series B: Chemical and Physical Meteorology, 63 (1), pp. 52-63.

Abstract
We present 2 yr (October 2008 to September 2010) of in situ measurements of molecular hydrogen (H2) and carbon monoxide (CO) sampled at the tall tower of Trainou, France (47.96°N, 02.11°E, 131 masl, sampling height: 50, 100 and 180 m). Radon-222 (222Rn) measurements were added in May 2009. Background seasonal cycles, based on afternoon values, exhibit an amplitude of 45 and 60 ppb for H2 and CO, respectively, for the three different heights (50, 100 and 180 m above ground). The vertical gradient also shows seasonal variations with a maximum (during the night) of 20 and 45 ppb for H2 and CO, respectively. We also observe diurnal cycles for H2 and CO for the three different heights. In the afternoon, the mixing ratios at the three different heights are similar and are comparable with maritime background stations, such as Mace Head (Ireland). The diurnal cycle of 222Rn follows the boundary layer height variations, with maximum values in the morning. Throughout the year but especially in summer and autumn, the H2 mixing ratio shows nighttime depletion, with the lowest values at 06:00 UTC, due to soil uptake and the low boundary layer height. Using a simple box approach and the Radon-Tracer-Method, the H2 deposition velocity is calculated for the catchment area of Trainou. We find a mean value for the H2 deposition velocity of 2.6 ± 0.9 10-2 cm s-1. During wintertime, H2 and CO are sometimes strongly correlated leading to a H2/CO ratio around 0.25. This ratio is lower than the ratio from traffic emissions, thus highlighting the mixing of sources in this area.

Zafrir, H., Haquin, G., Malik, U., Barbosa, S.M., Piatibratova, O., Steinitz, G.
Gamma versus alpha sensors for Rn-222 long-term monitoring in geological

environments
(2011) Radiation Measurements, 46 (6-7), pp. 611-620.

Abstract
The behavior of alpha silicon diodes, gamma crystal scintillators and ionization chamber detectors employed for long-term radon monitoring in geological media was studied and a comparison of the efficiency and sensitivity, the capability to resolve signal to noise, background, stability, and reliability of their long-term measurements is presented. An understanding of the qualities of monitoring techniques is necessary for determining suitability to the characteristics of the individual monitoring site and what exactly they will measure: radon in an air cavity, in porous media or in water. The experimental layout was located inside the Amram Mountain research tunnel near Elat (Gulf of Aqaba), within a closed room in the tunnel core. This enabled monitoring natural temporal radon variations under fairly stable internal conditions, at a high-resolution sampling rate of once every several minutes. In an interval of several days, all the sensors responded simultaneously to the same eventual radon variations. An ionization chamber device, the AlphaGUARD designed with a long-time stable calibration factor and an inherent QA-System, was used as reference calibration of the different radon detectors. The results indicate that the higher sensitivity of 2-4 orders of magnitude exhibited by gamma sensors even with narrow dimensions (1" × 3" BGO detector) are preferred for long-term radon monitoring in comparison to the solid-state alpha detectors and ionization chambers.

Zhang, K., Feichter, J., Kazil, J., Wan, H., Zhuo, W., Griffiths, A.D., Sartorius, H., Zahorowski, W., Ramonet, M., Schmidt, M., Yver, C., Neubert, R.E.M., E.-G. Brunke
Radon activity in the lower troposphere and its impact on ionization rate: A global estimate using different radon emissions
(2011) Atmospheric Chemistry and Physics, 11 (15), pp. 7817-7838.

Abstract
The radioactive decay of radon and its progeny can lead to ionization of air molecules and consequently influence aerosol size distribution. In order to provide a global estimate of the radon-related ionization rate, we use the global atmospheric model ECHAM5 to simulate transport and decay processes of the radioactive tracers. A global radon emission map is put together using regional fluxes reported recently in the literature. Near-surface radon concentrations simulated with this new map compare well with measurements.

 Radon-related ionization rate is calculated and compared to that caused by cosmic rays. The contribution of radon and its progeny clearly exceeds that of the cosmic rays in the mid-and low-latitude land areas in the surface layer. During cold seasons, at locations where high concentration of sulfuric acid gas and low temperature provide potentially favorable conditions for nucleation, the coexistence of high ionization rate may help enhance the particle formation processes. This suggests that it is probably worth investigating the impact of radon-induced ionization on aerosol-climate interaction in global models.

Zhang, K., Feichter, J., Kazil, J., Wan, H., Zhuo, W., Griffiths, A.D., Sartorius, H., Zahorowski, W., Ramonet, M., Schmidt, M., Yver, C., Neubert, R.E.M., Brunke, E.-G.
Radon activity in the lower troposphere and its impact on ionization rate: A global estimate using different radon emissions
(2011) Atmospheric Chemistry and Physics Discussions, 11 (1), pp. 3251-3300.

Abstract
The radioactive decay of radon and its progeny can lead to ionization of air molecules and consequently influence aerosol size distribution. In order to provide a global estimate of the radon-related ionization rate, we use the global atmospheric model ECHAM5 to simulate transport and decay processes of the radioactive tracers. A global radon emission map is put together using regional fluxes reported recently in the literature. The near-surface radon concentrations simulated with this new map compare well with measurements. Radon-related ionization rate is calculated and compared to that caused by cosmic rays. The contribution of radon and its progeny clearly exceeds that of the cosmic rays in the mid-and low-latitude land areas in the surface layer. In winter, strong radon-related ionization coincides with low temperature in China, USA, and Russia, providing favorable condition for the formation of aerosol particles. This suggests that it is probably useful to include the radon-induced ionization in global models when investigating the interaction between aerosol and climate. © 2011 Author(s).

Zhang, L., Guo, Q.
Observation and analysis of atmospheric radon in Qingdao, China
(2011) Journal of Radiological Protection, 31 (1), pp. 129-134.

Abstract
To investigate the levels and behaviours of the atmospheric radon concentration in Qingdao, a continuous measurement was carried out and recorded hourly over a three-year period from September 2006 to August 2009. Levels and variations were studied on the basis of 16 817 data points, and the trends of diurnal and seasonal variations were also analysed. The average concentration of atmospheric radon over the three years was 5.00 3.01Bqm-3. The average diurnal pattern of radon concentration showed that the daily maximum appears in the early morning, and the daily minimum in the late afternoon, which is driven by the atmospheric stability. The annual pattern features a maximum around December and a minimum around June, which correlates with the origin of air mass brought by the monsoon. © 2011 IOP Publishing Ltd.

Zhang, W., Chow, Y., Meara, J., Green, M.
Evaluation and equity audit of the domestic radon programme in England
(2011) Health Policy, 102 (1), pp. 81-88.

Abstract
The UK has a radon programme to limit the radon risk to health. This involves advice on protective measures in new buildings, technical guidance on their installation, encouragement of radon measurements and remediation in existing dwellings in high radon areas. We have audited the radon programme at the level of individual homes to identify factors that influence the likelihood of remediation. 49% of the householders responded to our survey and 30% of the respondents stated that they had done some remediation to reduce the indoor radon levels. We found that householders with higher incomes and higher socio-economic status are more likely than others to remediate. Householders are less likely to remediate if they have one of the following: living in a property with a high radon concentration, current smokers in the dwelling, being unemployed or an unskilled worker, long length of time living in that property or elderly (65+ years) living by themselves. Householders appeared to be more likely to remediate if they considered the information on radon and its risk to be very clear and useful. This emphasises the importance of communication with householders. © 2010 Elsevier Ireland Ltd.

Zhang, Y., Gao, F., Ping, J., Zhang, X.
A synthetic method for earthquake prediction by multidisciplinary data
(2011) Natural Hazards, pp. 1-11. Article in Press.

Abstract
China Metropolitan area around Beijing is one of the earthquake test sites in Continental China. Through more than 20 years of hard work, abundant seismic, geological, geophysical and geochemical data have been obtained, and the variation of seismic, geophysical and geochemical parameters was recorded before several strong earthquakes and some moderate earthquakes in this area. In this paper, we chose 19 high qualified observatory parameters in this area to establish a multidisciplinary system for earthquake forecast, including apparent resistivity, ground water level, ground-level, tilt, radon content in groundwater, volumetric strain, Hg content in groundwater, low frequency electric signal. We calculate the synthetic information by a simple algorithm. The procedure is: firstly, we detect the abnormal intervals of the observatory data by some data analysis methods such as filtering, differencing, etc.; secondly, we endow the value of 1 to the abnormal intervals and 0 to other intervals and produce a new time series of data set of the ith parameter; thirdly, we compose the value of the new time series of 19 observatory parameters and obtain the normalized value as called synthetic information. The result shows that there are high correlations between the high synthetic information and the earthquakes with $M \geq 5.0$ in this area. The earthquakes almost occurred several days to several months after the peak value of the synthetic information. This synthetic

method might be taken for a short-term prediction method for M ≥ 5.0 earthquakes in this area.

Zhou, C., Zhao, F.
Environmental radioactivity survey in an abandoned uranium mine
(2011) He Jishu/Nuclear Techniques, 34 (4), pp. 278-282.

Abstract
In this paper, we report the environmental radioactivity survey in an abandoned uranium mine in China. The air gamma ray absorption dose rate was measured. Radionuclides in uranium mine slag, soil, water, sediment and biological samples, were analyzed. Radon in the air was monitored. The annual radiation dose of the residents in the uranium mine region was assessed. All the work was conducted in line with national standards of China. The survey results show that the radioactive pollution in the region should be disposed immediately. According to the characteristics of the uranium mining pollution sources, we propose some reasonable ways of radiation protection and disposal.

Zhou, J.-B., Wang, L., Tong, Y.-F.
Performance and applied research of a new type detecting system for radon and α energy spectrum machine
(2011) Hedianzixue Yu Tance Jishu/Nuclear Electronics and Detection Technology, 31 (7), pp. 823-826.

Abstract
Paper analyzes the process of the decay of the 222Rn and 220Rn, and introduces the alpha ray spectrometer based on the nuclear spectrum technology and embedded system technology, using semi-conductor detector. It determined the parameters by comparing results of a few kinds of test. By analyzing measuring method and calibration method involved, paper believes that machine is able to meat the requirements of the continuous and instantaneous radon measurement and alpha measurement. It is also can be used to measure thorium and radon in soil, water, and air.

Zhukovsky, M., Onishchenko, A., Varaksin, A., Vasilyev, A.
The influence of radon measurement errors on the uncertainties of epidemiological case-control studies
(2011) Radiation Protection Dosimetry, 145 (2-3), art. no. ncr090, pp. 243-247.

Abstract
To analyse the influence of the parameters of case and control groups and uncertainties of radon concentration assessments on the dose-effect dependence, a special computer

program was designed. The influence of measurement errors on the uncertainties of radon case-control analysis is demonstrated on examples of hypothetical case and control groups with sizes from 250-500 to 7000-14 000 members. The modelling was conducted using a Monte Carlo technique for different values of measurement uncertainties. The random errors of radon assessment affect both the numerical value of the slope coefficient b of the linear dependence of relative risk of lung cancer incidence on indoor radon concentration and the accuracy of this value. The extrapolation of the dependence of the slope coefficient b on the total (initial plus additional) random error of radon concentration assessment is suggested for the assessment of an unbiased value of the slope coefficient β.

Zielinski, R.A., Al-Hwaiti, M.S., Budahn, J.R., Ranville, J.F.
Radionuclides, trace elements, and radium residence in phosphogypsum of Jordan
(2011) Environmental Geochemistry and Health, 33 (2), pp. 149-165.

Abstract
Voluminous stockpiles of phosphogypsum (PG) generated during the wet process production of phosphoric acid are stored at many sites around the world and pose problems for their safe storage, disposal, or utilization. A major concern is the elevated concentration of long-lived 226Ra (half-life = 1,600 years) inherited from the processed phosphate rock. Knowledge of the abundance and mode-of-occurrence of radium (Ra) in PG is critical for accurate prediction of Ra leachability and radon (Rn) emanation, and for prediction of radiation-exposure pathways to workers and to the public. The mean (±SD) of 226Ra concentrations in ten samples of Jordan PG is 601 ± 98 Bq/kg, which falls near the midrange of values reported for PG samples collected worldwide. Jordan PG generally shows no analytically significant enrichment (< 10%) of 226Ra in the finer (< 53 μm) grain size fraction. Phosphogypsum samples collected from two industrial sites with different sources of phosphate rock feedstock show consistent differences in concentration of 226Ra and rare earth elements, and also consistent trends of enrichment in these elements with increasing age of PG. Water-insoluble residues from Jordan PG constitute <10% of PG mass but contain 30-65% of the 226Ra. 226Ra correlates closely with Ba in the water-insoluble residues. Uniformly tiny (< 10 μm) grains of barite (barium sulfate) observed with scanning electron microscopy have crystal morphologies that indicate their formation during the wet process. Barite is a well-documented and efficient scavenger of Ra from solution and is also very insoluble in water and mineral acids. Radium-bearing barite in PG influences the environmental mobility of radium and the radiation-exposure pathways near PG stockpiles. © 2010 US Government.

Zölzer, F., Skalická, Z.F., Havránková, R., Hon, Z., Navrátil, L., Rosina, J., Škopek, J.
Enhanced frequency of micronuclei in lymphocytes from current as opposed to former

uranium miners
(2011) Journal of Applied Biomedicine, 9 (3), pp. 151-156.

Abstract
Micronuclei can be used as markers of past radiation exposure, but few pertinent studies have dealt with alpha radiation. Here we report on micronuclei in lymphocytes from uranium miners, comparing some that are currently active and others that retired 15-20 years ago. Their radiation exposure is assumed to come mainly from radon and its decay products in the air breathed at the work place. Current miners showed a greater micronucleus frequency than former miners. This can be attributed to their recent radiation exposure, while the lower frequency in the former miners probably results from the disappearance of potentially micronucleus containing lymphocytes from the peripheral blood, which is known to occur with a half-life of about one year. For current miners there is a significant correlation between micronucleus frequency and effective dose received over the last 12 months. The dose at which a doubling of the micronucleus frequency is observed is around 10 mSv. This is a much smaller dose than would usually be expected to be detectable with this test, and raises a number of questions about the induction of micronuclei by alpha radiation from radon and its decay products.

13th International High-Level Radioactive Waste Management Conference 2011, IHLRWMC 2011
(2011) 13th International High-Level Radioactive Waste Management Conference 2011, IHLRWMC 2011, 1, 1155 p.

Abstract
The proceedings contain 171 papers. The topics discussed include: a vision of next generation performance assessment models; preliminary performance assessment for deep borehole disposal of high-level radioactive waste; the NEA international project on reversibility and retrievability - overview and findings; impacts associated with early transfer of SNF from pool storage to dry storage; railway accident analyses for spent nuclear fuel transportation packages; technical lessons to learn in disposal of spent nuclear fuel and high-level waste; compartment marine ecosystem model for prediction of the radionuclide transport; atmospheric chemistry impacts on the corrosion environments of waste packages; radioactive disequilibria in the saturated zone transport model and the biosphere model for the Yucca mountain repository - the case of Radon-222; and development of a long-term spent fuel integrity demonstration methodology.

13th International High-Level Radioactive Waste Management Conference 2011, IHLRWMC 2011
(2011) 13th International High-Level Radioactive Waste Management Conference 2011, IHLRWMC 2011, 2, 1155 p.

Abstract
The proceedings contain 171 papers. The topics discussed include: a vision of next generation performance assessment models; preliminary performance assessment for deep borehole disposal of high-level radioactive waste; the NEA international project on reversibility and retrievability - overview and findings; impacts associated with early transfer of SNF from pool storage to dry storage; railway accident analyses for spent nuclear fuel transportation packages; technical lessons to learn in disposal of spent nuclear fuel and high-level waste; compartment marine ecosystem model for prediction of the radionuclide transport; atmospheric chemistry impacts on the corrosion environments of waste packages; radioactive disequilibria in the saturated zone transport model and the biosphere model for the Yucca mountain repository - the case of Radon-222; and development of a long-term spent fuel integrity demonstration methodology.

Radon: Radioactivity for pain [Radon: Radioaktive Strahlung bei Schmerzen]
(2011) Pharmazeutische Zeitung, 156 (17), .