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Radon emanation of rock and soil samples: A tool for stratigraphy, geology, geophysical modelling and radon health hazard

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Radium-226, the mother of radon-222, with a half-life of 1600 years, is intrinsically present in all the rocks and soils in variable amount. However, a small part only of the radium atoms is able to produce radon atoms in the porous media of the rock allowing this radon to escape the rock media through the pore space. This fraction of radium is referred to as the radon source term in rocks or soils, and is usually called the effective radium concentration (EC_{Ra}). This parameter is expressed in Bq kg^{-1}, where C_{Ra} is the radium-226 concentration and E the emanation coefficient. Considering a sample, it is not possible to estimate its EC_{Ra} value *a priori*. Therefore, this parameter has to be measured in the laboratory. The method in the laboratory to obtain EC_{Ra} values is based on the measurement of the concentration of radon in the inner air of a hermetically sealed container in which one rock or one soil sample was previously placed. In order to measure this radon concentration, Lucas scintillation flasks were used, and their radon content counted by a photomultiplier (Stoulos *et al.*, *Journal of Environmental Radioactivity*, 2003). This method was compared in detail with another method using SSNTD (Solid-State Nuclear Track Detector). Detailed investigations have been carried out, including systematic effects such as the shape or volume of container, mass and preparation method of the sample, using a large number of rock, soil and building material samples (more than 800) collected in France and Nepal. Preliminary results will be given based on this data set. With such a large sample, some effects of intrinsic and external factors on the measurement technique and on the obtained results could also be accurately studied: the effect of atmospheric pressure, of the ambient temperature, or of the water content of the sample. EC_{Ra} measurements appear to be particularly useful for human health hazards study on a considered natural site, as well as for other applications. Indeed, some studies were performed in an overpopulated area, more precisely in the Kathmandu Basin, Nepal, where sediments from several terraces and scarps were sampled and analysed. In addition, EC_{Ra} values exhibit characteristic patterns, and therefore can be used for stratigraphy studies. Similarly, this parameter could be relevant in geological mapping, especially where it is not particularly easy to discriminate the diverse encountered layers, as in the Main Central Thrust (MCT) Zone of the Himalayan range. The measurement of effective radium concentration is also important to assess health hazard, and for detailed modelling of radon flux from the soil. Examples of such modelling will be given in the case of the high radon flux observed in geothermal areas of the Nepal Himalayas (Perrier *et al.*, *Earth and Planetary Science Letters*, 2009; Girault *et al.*, *Journal of Environmental Radioactivity*, 2009). Thus, these various results illustrate that it is useful to develop the knowledge of effective radium concentration in different natural and artificial media, both for practical and fundamental problems.