Geophysical Research Abstracts
Vol. 12, EGU2010-2133-2, 2010
EGU General Assembly 2010


# Radiometric surveys in underground environment

Massimo Bochiolo, Paolo Chiozzi, Massimo Verdoya, and Vincenzo Pasquale

Dipartimento Territorio Risorse, Settore di Geofisica, Università di Genova, Viale Benedetto XV 5, I-16132 Genoa, Italy (massimo.bochiolo@unige.it)

Due to their ability to travel through the air for several metres, gamma-rays emitted from natural radioactive elements can be successfully used in surveys carried out both with airborne and ground equipments. Besides the concentration of the radio-elements contained in rocks and soils and the intrinsic characteristics of the gamma-ray detector, the detected count rate depends on the solid angle around the spectrometer. On a flat outcrop, ground spectrometry detects the radiation ideally produced by a cylindrical mass of rock of about two metres in diameter and thickness of about half a meter. Under these geometrical conditions, the natural radioactivity can be easily evaluated. With operating conditions different from the standard ones, such as at the edge of an escarpment, the count rate halves because of the missing material, whereas in the vicinity of a rock wall the count rate will increase. In underground environment, the recorded count rate may even double and the in situ assessment of the concentration of radio-elements may be rather difficult, even if the ratios between the different radio-elements may not be affected.

We tested the applicability of gamma-ray spectrometry for rapid assessment of the potential hazard levels related to radon and radiation dose rate in underground environment. A mine shaft, located in a zone of uranium enrichment in Liguria (Italy), has been investigated. A preliminary ground radiometric survey was carried out to define the extent of the ore deposit. Then, the radiometric investigation was focussed on the mine shaft. Due to rock mass above the shaft vault, the background gamma radiation can be considered of negligible influence on measurements. In underground surveys, besides deviations from a flat geometry, factors controlling radon exhalation, emanation and stagnation, such as fractures, water leakage and the presence of ventilation, should be carefully examined.

We attempted to evaluate these control factors and collected a set of rock samples along the mine shaft to compare in situ results with high resolution gamma-ray analysis in the laboratory. The comparison points to a systematic overestimation (on the average, by a factor of two) of the uranium, thorium and potassium concentrations obtained with the portable apparatus. The bias between laboratory and field is slightly smaller for potassium and could be due only to deviation from standard geometric conditions. The largest differences occur in uranium concentrations, probably due also to the influence of the activity deriving from radon stagnation. The calculated radon flux depends on the radium specific activity, which, under the assumption of secular radioactive equilibrium, can be easily inferred from the uranium concentration, and the specific exhalation coefficient. Measurements of specific exhalation coefficient are difficult and only few studies have examined unaltered rocks in details. We estimated the values of this parameter by considering the degree of fracturing, width of fissures and evidence of percolating groundwater. In general, the coefficient increases from the entrance, where rocks are more massive, towards the shaft bottom, where closely spaced open fissures, often filled with percolating groundwater, might boost exhalation. As a whole, both potential radon flux and radiation dose values are relevant to radio protection rules.