# Radon in dwellings and groundwater of the Vila Real urban area (Northern Portugal)

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In the urban area of Vila Real there are several different types of granitic rocks: medium-grained, porphyritic, mu>bi (muscovite>biotite) (G1), coarse-grained, mu>bi (G2), fine to medium-grained mu>bi (G3) and fine to medium-grained bi>mu (G4), as well as autochthonous metasedimentary rocks and local sedimentary cover. These geological units have been evaluated for their radioactive background with gamma-ray portable spectrometers, which showed important differences in their uranium contents. The uranium concentration correlates well with indoor radon concentrations measured in 121 dwellings with CR-39 passive detectors. The highest radon levels occur in dwellings built over the granite G1 (geometric mean of 364 $Bq.m^{-3}$), which also shows the highest U contents, and the lowest radon levels occur in dwellings built over metasediments, with the lowest U contents. SEM studies indicate that U is mainly concentrated in accessory minerals, like zircon, monazite and xenotime.

Ten representative samples of surface water and groundwater were analysed for Rn, gross $\alpha$, gross $\beta$ and U. All parameters are highly variable in groundwater, and present low values in superficial water (public supplies and streams). Groundwater from the G1 granite has the highest concentrations of dissolved radon (128 to 938 $Bq.l^{-1}$) and uranium (5 to 15 ppb), emphasizing the role of the primary uranium content of the rock as a source of radionuclides. Groundwater of terrace sediments over granites also show some radon potencial, however with low values of other dissolved radionuclides.

# Geochemical evolution in compacted MX-80 bentonite: Simulation of the conditions in a HLW repository

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The study was developed in the framework of nuclear waste disposal in deep geological formations, which consist on the storage of the waste protected by a system of geological and engineered barriers. One of these engineered barriers may be formed by compacted bentonite blocks. The bentonite was chosen as sealing material because of their expansive capability, low permeability, high retention capacity and plasticity. In the deep storage, the thermal effect due to the waste disintegration and the hydraulic conditions caused by the water circulation in the host rock will affect the clay barrier performance.

## Material and Methods

The bentonite used was the MX-80. This clay comes from Wyoming (USA), and has been selected in many disposal concepts as sealing material (Sweden, Finland, Germany, France). It is composed mainly by montmorillonite (65-82%) and it also contains quartz (4-12%) and feldspars (5-8%). The MX-80 is supplied in the form of powder homoionised to sodium.

To study the behaviour of the MX-80 bentonite at repository conditions, an infiltration test under thermal gradient was designed. The bentonite was compacted at dry density 1.7 $g/cm^3$ at a water content of 17% in two blocks 100 mm length and 70 mm diameter, that were piled up inside a cylindrical cell. At the bottom of the bentonite column a plane heater was set at 140°C, while hydration with deionised water took place by the upper part. The test was running for 496 days, and afterwards, it was dismantled and the bentonite was analysed.

## Results

Water content, density, soluble salts and exchangeable cations were mesured in 10 sections along the column. Although the total water intake during the test was very low, there has been an important redistribution of water inside the clay, which has also affected the dry density pattern. Along the bentonite column, disolution and precipitation phenomena took place, as well as cationic exchange process in the montmorillonite interlayer. Towards the heater, sodium was replaced by calcium in the exchange complex.