

Radon risk and their geological controle in the region of Amarante (Northern Portugal)

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Amarante is located in the border of an extensive tardi-tectonic massif, formed by Hercynian granites. Around Amarante city, two types of the granitic rocks occur: AT1 is a coarse-grained, porphyritic, bi>mu (biotite>muscovite) and AT2 is granite with medium-grained, bi>mu, porphyritic. Other units are metamorphic rocks of Silurian and Devonian in Aboim village. Representative samples of granitic rocks unaltered and with different degrees of alteration were studied. The variations of SiO₂, TiO₂, Fe₂O_{3t}, MgO, V, Zr, Sr, Ba, U, Fe/(Fe+Mg), their subparallel REE of two unaltered granites suggest a relation by crystal fractionation; and AT2 is the most differentiated granite. The average uranium content of the AT2 granite was found to be 18 ppm, higher than the crustal average, subsequently showing a high radon potential. Accessory minerals from granites were studied through SEM suggesting that, U and Th are mainly concentrated in zircon, monazite, uraninite, thorite and thorianite. In three geological units was evaluated a radioactive background with gamma-ray portable spectrometers and in the granitic rock a gamma ray flux of 289 ηGy/h measured in direct contact with the rock was observed; a lower flux of 155 ηGy/h was observed for metamorphic rocks that also outcrop in the area. An important measured system of fractures with tardi-hercynian directions affects the studied area. Some fractures that crosscut the Amarante granite show a moderate degree of uranium enrichment (26 ppm), with gamma ray fluxes up to 420 ηGy/h.

The indoor radon concentrations, during the winter, were measured in 73 dwellings with CR39 passive detectors. The highest radon levels occur in 35 dwellings and built over the granite AT2 (geometric mean of 430 Bq/m³), which also shows the highest uranium. Buildings from Aboim village show the lowest U contents and consequent lowest radon levels. Fourteen representative samples of groundwater were analysed for Rn, gross α and β. Groundwater related with AT2 has the highest radon (up to 2295 Bq/l) and the highest gross α (up to 0, 83 Bq/l) allowed by Portuguese legislation. Overall, we can conclude that the area of Amarante city presents a moderate to high radon risk and the area of Aboim presents low to moderate radon risk.

Nitrogen fixation through early Earth history

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Nitrogen is an essential part of many of the chemical compounds, such as proteins and nucleic acids, which are the basis of all life forms. However, N₂ cannot be used directly by biological systems to build the chemicals required for growth and reproduction. Before its incorporation into a living system, N₂ must first be combined with hydrogen. This process of reduction of N₂, commonly referred to as *nitrogen fixation* may be accomplished chemically or biologically. In this paper we present a study of the evolution of nitrogen fixation through Earth history between 3.4 and 0.5 Gyr ago and its effects on the geophysical Earth system.