Distribution of uranium and other trace elements in an aplite dyke from Fornos de Algodres area (Northern Central Portugal)

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A uranium-rich aplite dyke from the Fornos de Algodres area (Northern Central Portugal), located in the Beira uraniferous province, is the focus of our study. This dyke intruded in Hercynian granitic rocks is greatly altered showing evidence of spheroidal weathering, consisting mainly of yellowish residual clay with boulders of less altered aplite. The main aim of this work is to investigate the distribution of U and other trace elements in the aplite, considering the variation within the vertical profile, samples showing different degree of alteration, different size fractions, and in different concentric shells of decayed aplite formed during spheroidal weathering. The goal of this work is to better comprehend the geochemical behavior of uranium concerning its distribution in U-enriched rocks and its mobility and redistribution during weathering of granitic rocks.

The chemical and mineralogical composition was determined for the whole rock of eleven samples of aplite and for the various grain-size fractions (2 mm-63 µm, 63-20 µm, 20-2 µm and <2 µm) of four of the samples distributed along a vertical profile (2 samples of residual clay and 2 samples of soil). The chemical investigation was performed by instrumental neutron activation analysis (INAA), using the Portuguese Research Reactor at ITN (Sacavém), whereas the mineralogy was studied by X-ray diffraction (XRD), using a Philips X'Pert Pro diffractometer. An in situ gamma-ray measurement was undertaken using a NaI (2"x2") portable detector to obtain concentrations of the three primordial radionuclides (K, Th and U) that are primarily responsible for terrestrial gamma radiation.

The mineralogical composition is similar for all samples, varying mainly the proportion of the mineral phases. They are essentially composed by quartz and potassium feldspar, which clearly identifies the origin of aplite as granitic. Anatase is common and abundant, except in the two soil samples, and the phyllosilicates observed are mainly of vermiculite, kaolinite, illite and rarely smectite and gibsite.

Concentrations of uranium vary from 5 to 80 ppm in the studied samples. The higher concentrations of U are found in the: i) more altered samples, ii) coarse fraction (2 mm-63 µm) and clay fraction (<2 µm) of residual clays and just in clay fraction of soil samples, and iii) core of the rounded boulders of aplite formed through spheroidal weathering. The higher concentration of U in levels where clay fraction is more abundant, suggests that U is mainly adsorbed/incorporated on clay minerals. The geochemical behavior of U is generally accompanied by a similar distribution pattern of lanthanides.

The obtained results for the studied aplite from Fornos de Algodres area show that the uranium suffered processes of mobilization, transport and deposition.

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