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U and Th variability along a deep borehole in the Beiras Granite (Almeida, central Portugal)

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The Beiras Granite, of late Hercynian age, occurs in central Portugal and has been object of several studies to evaluate its potential for deep geothermal projects. Most of the mineralogical and geochemical characteristics are similar to the granites of Cornwall, that were extensively studied for this purpose, namely at the Rosmanowes site. Radiogenic heat production, resulting from the presence of radiogenic elements (U, Th and K) in the rocks, can provide a significant contribution to the local heat flow. Understanding the variability of these elements with depth is of great importance for the development of numerical models of the possible geothermal reservoirs. In this work we report the results obtained for U and Th concentrations in a deep borehole with 1.000 meters carried out in the Beiras Granite, close to Almeida (central Portugal). A total of 128 samples were studied from the borehole, distributed between a depth of 200 meters up to 1000 meters. The analysis of the samples were carried out in the Laboratory of Natural Radioactivity of the University of Coimbra, using a Ortec gamma-ray Digibase system with a 3” NaI(Tl) detector. U was estimated from the activity of Bi-214 and Th from the activity of Tl-208, assuming secular equilibrium.

The results obtained were first considered in two groups, since part of the granite in the borehole shows a variable degree of episienitization (Group I with no alteration, n=94; Group II vith visible alteration, n=34). The average results for the two Groups for U were 14.6 and 13.4 ppm and for Th 17.8 and 16.2 ppm, respectively. There is no statistical difference between the two groups for both elements. U shows a higher variability than Th, as a result of a few measurements with higher values (up to three times the average) that occur randomly along the borehole. These are likely related with increased uranium mobility in fractured zones. Both U and Th do not show any relation with depth along the borehole. We can conclude that radiogenic heat production can be estimated with a good degree of confidence from the results obtained in the borehole, that show a higher uranium content than previously observed from superficial samples. These results also provide good indications regarding the geothermal potential of the Beiras granite.