Radiogenic Heat Production Rates of Subsurface Crystalline Rocks Calculated from Core Gamma-ray Logging Data, Bohemian Massif, Austria – First Results

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The radiogenic heat production (RHP) rate of magmatic and metamorphic rock of the Austrian part of the Bohemian Massif (Lower and Upper Austria) has been calculated from core gamma logs using the formula published by Bücker & Rybach (1; A µW/m³ = 0.0158*(GR[API]-0.8). This formula has been developed to calculate radiogenic heat production from gamma ray (GR) well-logs. In this work it was tested if applying the formula on core gamma logs would deliver meaningful results, especially for old wells where no GR-log coverage of basal crystalline intervals is available. The challenges are that core-GR logging will normally deliver lower API readings than compared to well-log GR so all values have to be considered to represent minimum RHP rates. Furthermore, core diameter and core preservation influence results. The analyzed lithologies include gneiss (55.6m, 52%), granites (28.3m, 27%), quartzites (2.8m/3%) and phyllite-schists (19.7m/19%). In total 106.4m of cores from 31 wells have been analyzed with a data acquisition point every 10cm resulting in 1064 data points. Depths of analyzed core intervals range from 187m to 6028m. The ranges for average and maximum RHP are listed in table 1.

Rock Type	Lithology	Lower Average RHP	Upper Average RHP	Lower Maximum RHP	Upper Maximum RHP	N
		µW/m³	µW/m³	µW/m³	µW/m³	
Metamorphite	Gneiss	0.52	2.84	0.79	7.65	556
Metamorphite	Schist-phyllite	0.49	2.82	0.68	4.43	197
Metamorphite	Quartzite	1.01	1.99	1.35	3.57	28
Magmatite	Granite	0.72	2.22	1.00	2.86	283

The average RHP ranges for gneiss and schists are quite comparable whereas maximum RHP readings in gneiss can reach up to 7.65µW/m³ compared to 4.43µW/m³ in schists. Quartzite exhibit lower RHP readings. Radiogenic heat production averages in granites ranges between 0.72 to 2.22µW/m³ with maximum calculated production rates of 2.86µW/m³. The highest core GR readings have been measured in metamorphic rocks, especially gneiss and schists and can be attributed to concentrations of coarse mica crystals, fracture planes and occurrences of coarse K-feldspar crystals. Granites exhibit lower GR readings; here high GR readings seem to be more linked to K-feldspar. The core observations are also approved by mineralogical analyses where high core GR in granites and gneiss correspond to high amounts of K-feldspar whereas high core GR in schists is linked to muscovite and clay mineral contents. The calculated average RHP rates for metamorphic rocks (gneiss, schists) are in good agreement with ranges of published data (2). For granites the calculated average RHP rates are at the lower end when compared to published data (2; 3) or significantly lower when compared to GR-measurements obtained on the German parts of the Bohemian Massif (4). It is our interpretation that the differences are mainly caused by the lower API values obtained from core-GR when compared to well-GR. When taking this into account core-GR API can be used as to identify crystalline rocks with potentially high RHP rates in the subsurface. In the next phases of this project, it is planned to GR-derived RHP with RHP calculated from chemical composition analyses of drill cores and cuttings.

References:

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