RADIOGENIC HEAT PRODUCTION IN THE CENTRAL FENNOSCANDIAN SHIELD - COMPARATIVE MATERIAL FOR THE BRAZILIAN SHIELD

[1]KUKKONEN, I.T. and [1]LAHTINEN, R. [1] Geological Survey of Finland, P.O. Box 96, FIN-02151 Espoo, Finland

We use the results of a geochemical survey (1150 outcrop samples) for heat production studies in a E-W oriented band (120 km x 500 km), located approximately between latitudes 62° and 63°N in Finland, the central part of the Fennoscandian Shield. The study area covers formations from the Archaean granite-greenstone terrain in the east to Palaeoproterozoic autochtonous and allochtonous covers to the west of it, as well as Palaeoproterozoic mobile belts, major granitoid areas and schist belts in central and western Finland. In this study we review the (volumetric) radiogenic heat production rates as calculated from the U, Th and K total analyses and densities of the samples, and the relations of heat production values with major tectonic setting, lithological type, major composition and petrophysical properties of the rocks. The aim is to find out whether the heat production rate shows any systematic variation with these factors.

Generally, there is an increase in heat production rates from the Archaean to Proterozoic rocks in E-W direction but this trend is relatively weak and often overrun by lithological variations. The arithmetic means are 1.2 μW m^{-3} in the Archaean domain, 1.4 μW m^{-3} in the Höytiäinen autochtonous Proterozoic domain, 1.2 μW m^{-3} in the Suvasvesi domain characterized by allochtonous Proterozoic cover, 1.1 μW m^{-3} in the Proterozoic Raahe-Ladoga mobile belt, 1.3 μW m^{-3} in the Proterozoic Rantasalmi-Haukivuori domain, 1.6 μW m^{-3} in the Central Finland Granitoid Complex and 1.5 μW m^{-3} in the Bothnian Schist belt. The standard deviations of the arithmetic mean values are considerable and attain values of about 40-115 % of the means. All distributions overlap.

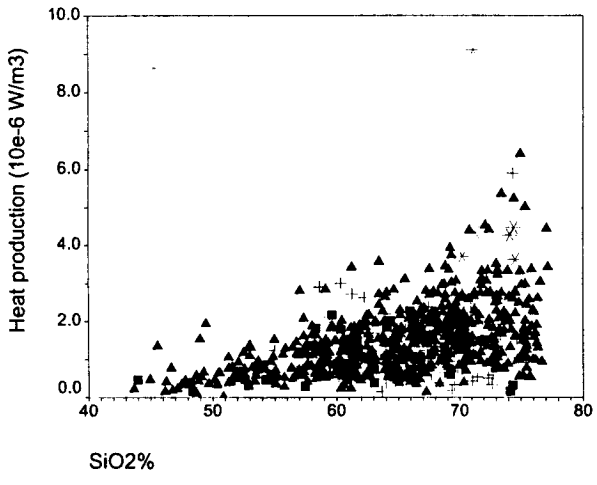

Fig. 1. Heat production rate vs. SiO_2 content in igneous rocks.

The heat production rate of igneous rocks (mainly granitoids) and metavolcanites show a weak positive correlation with SiO_2, whereas metasediments show a negative or no correlation (Figs. 1 and 2). The heat production rates of igneous rocks and metavolcanites show negative correlations with density but in the metasediments the correlation is positive. This can be attributed to the affection of heat producing elements in the pelitic (mica-rich) rock types which have low SiO_2 but high density. Generally, heat production shows only a very weak variation with P-wave velocity.

Variations within the igneous and metavolcanic rocks are influenced by the source material composition which is controlled by the tectonic setting for the mantle-derived component and the 'maturity' of the crust for the crust-derived component. The geochemical character and tectonic type of a granitoid is more decisive for heat production levels than the geological age (Achaean vs. Proterozoic).

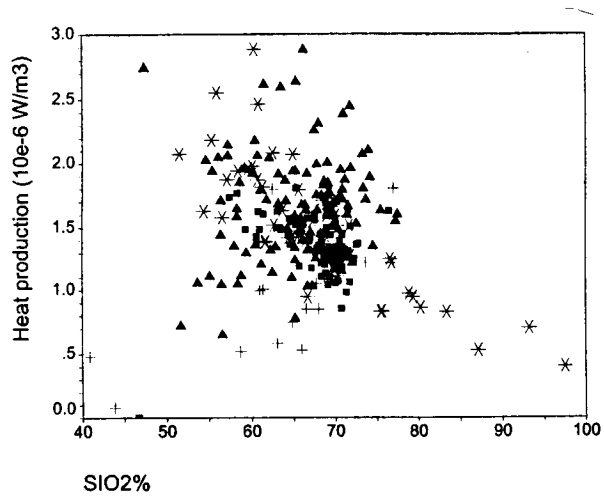

Fig. 2. Heat production rate vs. SiO_2 content in metasedimentary rocks.

The results obtained so far suggest that there is no simple way to determine the heat production levels of a shield terrain, and that crustal heat production models must include careful consideration of the evolutionary history of the area under study. Heat production is a relatively heterogeneous variable influenced by many factors, and no good correlations could be found with composition, density or P-wave velocity. Further, relating heat flow density measurements in 12 boreholes in the study area with the present results on heat production on the borehole sites, indicated that heat flow density increases with increasing heat production rate, but no distinct linear relationship is observed.