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Cratons radioactivity, crustal growth, paleogeotherms and metallogenic provinces

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The heat flux at the surface of the Archean and Proterozoic cratons corresponds to the heat coming from the mantle transferred by conduction through the lithospheric mantle and continental crust added to the heat produced in the continental crust by the radiogenic decay of U, Th, K, the heat producing elements (HPE). In turn, the average distribution of HPE of Archean and Proterozoic cratons is calculated using the 1D heat equation. The boundary conditions are determined using estimates of the surface heat flux and of the current thickness of the continental crust and lithospheric mantle.

The initial average concentration of U, Th, K at the time of the craton's formation is calculated using the decay constants of the HPE. The results indicate that for a given time period, the average concentration of the various cratons are significantly different. This suggests either that the primitive mantle source of this crust was heterogeneous or that the processes leading to the formation of this primitive crust were distinct. This also provides a basis for the identification of metallogenic provinces.

The HPE content of cratons decreases with time owing to radiogenic decay. However, the comparison of cratons formed at different time periods indicates that older cratons are relatively more enriched than younger ones. This is in support of an early formation of the continental crust leaving a progressively depleted mantle reservoir.

The high paleogeotherms calculated for Archean cratons at the time of their formation indicate that they were partially molten for at least half of their thickness. The evolution of their paleogeotherms show that they cooled slowly and that their lower part remained partially molten until the Proterozoic. A slow crystallization provides an explanation for the large range of ages typically displayed by cratons without invoking multiple tectonic events or mantle plumes.