Heat Production and changes in the composition of the bulk crust

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A key aspect of the evolution of the continental crust is how the bulk composition has changed with time, and we explore how heat flow data constrain the composition of the bulk continental crust of different ages. A review of the geochemistry of rocks from the Superior craton indicates that heat production was largely controlled by magmatic processes. Plutonic rocks are characterised by slightly higher heat production than volcanic rocks with similar SiO_2 contents. Nonetheless both exhibit a range of heat production at low SiO_2, and then a gradual increase in heat production at higher SiO_2. The sediments sampled heat production on average 30% higher than that in the volcanic rocks with similar SiO_2. Heat production increases with Rb/Sr, and it decreases with increasing present day Nd isotope ratios, that primarily reflect variations in Sm/Nd in the different crustal suites. Broadly similar trends of increasing heat production with differentiation are also observed in the Andes, but the age corrected Superior data are displaced to higher heat production values at similar SiO_2 contents. Overall the variations in heat production in the Superior Province are largely determined by the magmatic processes responsible for generating the observed range in bulk rock compositions.

The differentiation index DI expresses the heat production in surface rocks normalized to the bulk crustal heat production in different areas. Crustal provinces with "moderate" values of heat prod (consistent with juvenile crust) tend to be weakly differentiated (DI values close to 1). DI values increase with the mean crustal heat production, and with decreasing geological age, and increased crustal reworking. Provinces with heat production in the range 0.3-0.85 μWm^{-3} have values broadly consistent with the values inferred for juvenile crust, whereas those with heat production values > 2 μWm^{-3} are consistent with increased crustal differentiation/reworking.