Generation of high-K granites at the Archaean - Proterozoic boundary.

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ABSTRACT

The Archaean crustal provinces of the world are dominated by the rocks of the Tonalite-Trondhjemite-Granodiorite (TTG) series and account for 50% of the exposed Archaean crust. Towards the end of Archaean, however, TTG magmatism was replaced by the generation of high-K granites which continued into the Proterozoic and Phanerozoic. The late Archaean (~2.65 Ga) high-K granites of the Tanzania Craton some of which intrude the greenstone sequence of northern Tanzania are compared with the early Proterozoic (~ 1.92 - 1.96 Ga) high-K granites from the Ubendian belt of southwestern Tanzania. Granites from both late Archaean and early Proterozoic crustal terranes are pink in colour, and are composed of K-feldspar, plagioclase, quartz, biotite, less hornblende with minor phases including sphene, zircon and chlorite. It is in the Proterozoic granites that muscovite and tourmaline become important phases. The compositional similarities of the high-K granites from both late Archaean and early Proterozoic terranes include high SiO2 (> 70 wt %), high K2O (≥ 4.0 wt %) which leads to K2O/Na2O ratio of > 1, Al2O3 contents lower than those of TTG (< 15 wt %) and low MgO < 1.2 wt % and Ni (< 20 ppm). Trace element compositions reveal that, the high-K granites from both crustal terranes show comparable concentrations of Y, MREE and HREE, and display the negative Eu anomaly (Eu/Eu* = 0.5 - 0.6 on average). The major compositional differences between them are discerned in the most incompatible elements. High-K granites from the Proterozoic terrane consistently show higher concentrations of Zr, Hf, Th, Ba, Sr, K and ΣREE than their late Archaean counterparts. On the basis of the observed compositional similarities and differences, the key trace element ratios employed to distinguish the two magmas involve an incompatible element and middle to heavy REE (i.e. Zr/Sm, Zr/Y, Zr/Nb, Ba/Nb, Th/Ta) as well as the K2O/Na2O ratio. These ratios are a reflection of the primary petrogenetic feature inherent from the source rocks. The field relationships and geochemical features of the high-K granites from both crustal terranes are consistent with their derivation from partial melting at pressures and depths where plagioclase was a residual phase. Whereas the generation of the high-K granites in the Archaean would require partial melting of the juvenile igneous rocks including the TTG and greenstones that were emplaced in previous 10 to 20 Ma, those in the Proterozoic would require partial melting of the more evolved crustal rocks including the Archaean rocks. The generation of high-K granitic magmas at the Archaean-Proterozoic boundary marked a transition from growth of the Neoarchaean continental crust through the addition of juvenile mantlederived material to intra-crustal recycling of pre-existing material. It also marked the final stages of the stabilization of the Archaean Cratons worldwide

Keywords

K granites**;** Proterozoic