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Were ancient granitoid compositions influenced by contemporaneous atmospheric and hydrosphere oxidation states?Were ancient granitoid compositions influenced by contemporaneous atmospheric and hydrosphere oxidation states?

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A fundamental shift in the nature of granitoids occurs at approximately the Archean-Proterozoic boundary. Archean crust is dominated Na-rich tonalite-trondhjemite-granodiorites (TTGs), whereas post-Archean granitoids are characterized by K-rich granodiorite-granite (GG). Due to the HREE depletion commonly found in TTGs indicating the presence of residual garnet, many researchers have proposed that the difference in Na/K is related to the deeper melting depth of the TTG parental liquids. Here I present a compilation of the relevant experimental data, documenting that no correlation exists between the Na/K of derivative felsic liquids and the pressure of partial melting/fractional crystallization. Instead, the Na/K ratio of the felsic liquid best correlates with the Na/K ratio of the source. This implies that in Archean time the source material of TTG rocks must have been Na/K enriched relative to the modern. Modern granitoids are dominantly formed in a supra subduction zone environment, where a feedback loop exists between subducted materials (oceanic crust and sediments) and arc magmatism. Sea-floor weathering and the Na/K of the altered oceanic crust strongly depends on f(O_2) conditions during alteration, which likely changed with earth history. During alteration under oxidized condition K2O is fixated due to the formation of celadonite (K-Mica), wheres during anoxic condition saponite (Na-Smectite) is the stable alteration mineral. I propose that the rise of oxygen at 2600–2400 Ma triggered associated changes in f(O_2) seafloor alteration conditions. The change in the dominant seafloor alteration mineral from reduced to oxidized causes a change in the nature of the arc magma source and provides a possible explanation for the observed transition from TTGrocks in the Archean to the GG-granitoids in post-Archean times.