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Formation of the Continental Crust

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The emerging bank of U-Pb and Hf isotope analyses of zircons in granitoids and sediments provides an intriguing record of growth of the continental crust. In the first Hadean stage, recorded only in Jack Hills zircons, a single enriched source, or many enriched sources of near-identical composition, repeatedly melted to produce the granitoids that formed the first continental crust. The Hf isotope record shows little juvenile input from the mantle, a pattern very different from the post-Hadean record, and very surprising for this stage of Earth history when the mantle should have produced abundant magmas. Two non-exclusive explanations are proposed: 1) the source was abundant KREEPy oceanic crust that yielded granitoid magma in subduction zones until it was exhausted; 2) the enormous contents of heat-producing isotopes in the earliest granitoids maintained temperatures near the solidus and facilitated repeated short-term reworking.

The Archean and Proterozoic U-Pb zircon record is dominated by pronounced peaks that are variously interpreted as periods of accelerated crustal growth or periods of enhanced survival potential linked to the assembly of supercontinents. Analysis of the Hf isotope data, particularly those from granitoids, shows that the peaks are populated by abundant zircons whose positive epsilon-Hf values match those of subduction-zone mantle. They provide evidence of massive input of juvenile crust. Drawing a parallel with Cretaceous periods of enhanced LIP emplacement linked to accelerated plume activity, and enhanced granitic magmatism linked to accelerated subduction, we defend the hypothesis that the Precambrian peaks record periods of accelerated crustal growth.