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Constraints on the formation of Earth's early continental crust from B isotopes

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The continental crust appears to have undergone rapid growth and compositional maturation 3.2-2.8 Gyr ago. This change is now recorded in various geochemical datasets and may have had drastic effects on the Earth system, including the cycle of oxygen and important nutrients [1,2]. Its causes are nevertheless unknown. A direct link to the development of modern-style global plate tectonics is proposed [1,3]. Indeed, much of the crust made during this time comprises juvenile tonalite-trondhjemite-granodiorite (TTG) complexes, which may represent arc analogs. This interpretation is nevertheless contentious [4,5,6] and the implied occurrence of Archean global plate tectonics remains the subject of debate [6]. To progress in this field, we used B isotope analysis in conjunction with age dating and trace-element analysis on Archean TTG samples from various cratons to trace their magmatic provenance. All samples show a moderate to strong 11B depletion characteristic of crustal melting, regardless of whether rocks adhere to the high- or low-pressure TTG series. These observations indicate that the investigated TTGs did not form in subduction zones or primitive equivalents thereof, but instead were produced by partial melting of thickened mafic crust. This primitive mechanism dominated crustal growth and differentiation before 2.8 Ga and may have preconditioned the lithosphere for large scale plate burial as seen in the modern Earth.

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