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The Si isotope evolution of the crust recorded by ancient glacial diamictites

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An established archive for investigating the temporal evolution of continental crust is the chemical composition of ancient glacial diamictites [1-3]. Because silicon is the second most abundant element in the continental crust [4] and stable silicon isotopes are resistant up to granulite facies metamorphism [5], application of Si isotopes to glacial diamictites is a natural tool for evaluating primary signatures in the ancient crust and its subsequent evolution. Twenty-four composites of diamictites deposited during glaciations from the Mesoarchaean to Palaeozoic were analysed for silicon isotopes to establish, for the first time, the long-term secular Si isotope record of upper continental crust (UCC). Diamictites having Archaean and Palaeoproterozoic Nd model ages display larger Si isotope heterogeneity than those with younger model ages; some of the former have anomalously light Si isotopes, which we attribute to banded iron formation (BIF) in their provenance, as supported by high iron content of these samples. Some Palaeoproterozoic diamictites (with Archaean Nd model ages) have relatively heavy Si isotope signatures, inferred to result from tonalite-trondhjemite-granodiorite (TTG) contribution, evidenced by the abundant TTG clasts. By the Neoproterozoic (with Nd model ages ranging from 2.3 to 1.8 Ga), diamictite Si isotope compositions exhibit a range comparable to modern UCC. This reduced isotopic variability through time emphasises the decreasing importance of BIF and TTG in post-Archaean continental crust. The secular Si isotope evolution recorded by the diamictites provides an independent test of crustal growth models that infer the timing of craton stabilisation and onset of mobile-lid tectonism. Early Archaean UCC was heterogeneous, incorporating significant amounts of isotopically light BIF, but after the late Archaean emergence of stable cratons, coupled with atmospheric oxygenation that led to decreasing BIF formation, the UCC became increasingly homogeneous in Si isotopes. We infer this homogenisation occurred via reworking of preexisting crust, as supported by Archaean Nd model ages recorded in younger diamictites.

1. Gaschnig et al. (2014) *EPSL* 408, 87-99. 2. Tang et al. (2016), *Science* 351, 372-375. 3. Chen et al. (2020), *GCA* 278, 16-29. 4. Rudnick and Gao (2014), *Treatise on Geochem*. 2nd ed. 1-51. 5. Savage et al. (2013), *EPSL* 365, 221-231.