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Picrites and Ferropicrites: Mantle heterogeneity in a continental flood basalt setting

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Picrites and ferropicrites from the early-Cretaceous Parana-Etendeka Large Igneous Province are primary mantle melts associated with the initial impact of the proto-Tristan mantle plume, and subsequent break-up of the South Atlantic. They are a rare example of primitive asthenospheric melts originating from beneath thick continental lithosphere. As their source melting regime is constrained at high pressures, these samples provide an excellent opportunity to identify a melt component from a more fusible (pyroxenite) source. We also look at a ferropicrite from Dronning Maud Land (the Karoo Province), Antarctica.

Ferropicrite is rare on Earth's surface and is exclusively associated with continental flood basalt provinces. It is thought to be similarly primitive and high-pressure as peridotite-derived picrite, though with a more enriched trace element composition, greater FeO concentration and reduced Al_2O_3. Although phenocrysts have lower forsterite contents ($<Fo_{85}$) than expected from primary mantle melts, their high temperatures and high Ni contents suggest this is due to a high melt Fe rather than low melt Mg. This contrasts with the Etendeka picrites, which represent normal high-pressure melting of peridotite mantle.

To explore the possibility that ferropicrite melts are derived from a pyroxenite source, we use the incompatible trace element geochemistry of olivine-hosted melt inclusions. These allow us to explore melt composition prior to most fractionation and contamination processes, as well as increase the sample size of these rare melts. It is often thought that mantle melts on continental crust will be complicated by contamination. However, in these samples, both whole-rock isotope and melt-inclusion trace element geochemistry indicate relatively little contamination. Trace elements in ferropicrite melt inclusions can be highly enriched and show fractionated HREEs, indicating high pressure melting of an enriched, fusible source, which may be garnet pyroxenite; we explore this possibility through trace element modelling.

Although rare at Earth's surface, ferropicrite is of key importance in the debate around mantle recycling. As the melt is dense, it may in fact be more common in the deep plumbing system of continental flood basalts.