Phase equilibria and geochemical constraints on the petrogenesis of high-Ti picrite from the Paleogene East Greenland flood basalt province

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Phase equilibrium experiments have been performed on an extremely high-Ti (5.4 wt.% TiO_2) near-primitive picrite from the base of the Paleogene (~55 Ma) East Greenland Flood Basalt Province. This sample has a low An content, a steep REE profile and is enriched in incompatible trace elements. Near-liquidus phase relations were determined over the pressure range of 1 atm, 1 to 1.5 GPa and at temperatures from 1094 to 1400°C. They provide an important constraint on the petrogenesis of these lavas. High-Ti picritic glasses are multi-saturated with respect to olivine (Ol) + orthopyroxene (Opx) at pressures about 1 GPa but have only Ol or Opx on the liquidus at lower and higher pressures, respectively. This indicates the primitive melt was last equilibrated with its mantle source at relatively shallow pressure (~1 GPa). Melting probably started at 2-3 GPa and the picritic melt was produced by 15-30% melting of the mantle source. Such a degree of partial melting requires a mantle with a high potential temperature (1480-1530˚C). Relatively low CaO content and high FeO/MnO ratios of the most primitive East Greenland picrites, the high Ni content of olivine phenocrysts and the presence of low-Ca pyroxene (i.e., pigeonite) at high pressure in experiments all suggest a major component of garnet pyroxenite in the mantle source The high degree of enrichment in incompatible elements is suggested to result from melting of a metasomatized mantle. Based on geochemical modelling, we propose that the mantle source contains 5% Ti-enriched amphibole and that moderate partial melting (15-20%) of this source can produce the high Ti picritic lavas of East Greenland.