Geochemical variability within the lithospheric mantle beneath the Adelaide Fold Belt, South Australia

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Kimberlites in South Australia

The Adelaide Fold Belt hosts one of the largest kimberlite provinces in Australia. More than one hundred diamondiferous and non-diamondiferous kimberlites have been discovered in the Southern Flinders Ranges region, ~200 km north of Adelaide. The kimberlites, which commonly occur as northwest-trending dykes, sills, or pipe-like stuctures, contain abundant mantle-derived xenocrysts, including garnets, clinopyroxenes, orthopyroxenes, Cr-spinels, and ilmenites. The major- and trace-element compositions of these minerals have been used to reconstruct spatial variations in the structure and geochemical history of the mantle lithosphere beneath kimberlites in the Eurelia/Orroroo, Franklyn, and Monk Hills areas.

Results

The xenocryst populations from all kimberlites are dominated by peridotitic parageneses; eclogitic minerals are rare or absent. Although compositional ranges of the xenocryst populations are rather similar within each area, variations on a regional scale do exist. Garnets from the Franklyn area, for example, are characterized by more Ti-rich compositions, when compared to the other areas, and a lack of garnets with sinusoidal REE patterns. Regional differences also exist in the compositional ranges of spinels xenocrysts and the absence and presence of ilmenites.

Geothermobarometry based on single clinopyroxenes indicates a regional gethermal gradient of ~45 mW/m^2, which is in stark contrast to previous estimates for the lower crust in this region.

Conclusions

The geochemical variations in the lithospheric mantle are likely caused by variable degrees of metasomatism and/or different styles of metasomatism. Regional changes in the thickness of the lithosphere may also exist, and these factors together may explain the diamond potential of the kimberlites.

Variations of the Eocene climate reflected in the isotopic composition of fossil resins from the Northwest Territories, Canada

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Middle Eocene conifer resins have been analyzed for their C and H isotopic compositions, as well as spectral characteristics using FTIR. The resins were recovered from an unlithified peat sequence that forms part of the infill of the Giraffe kimberlite crater in the Lac de Gras field, Northwest Territories, Canada. Based on the presence of well-preserved macrofossils and FTIR spectra of fossil and modern resins, it is believed that the fossil resins were produced by *Metasequoia glyptostroboides*.

Results

The FTIR spectra indicate that all resins are chemically identical with only minor variations in redox history that is unlikely to influence isotopic composition. Throughout the sequence, resins are extremly variable with respect to δD and $\delta^{13}C$, ranging from -374 to -286‰ (δD vs SMOW) and -27 to -20‰ ($\delta^{13}C$ vs PDB), respectively. Variability is broadly mimicked by both isotopic systems, implying pervasive biogeochemical changes in the ecosystem. Based on a constant fractionation factor for hydrogen between resin and water (~200‰, Nissenbaum & Yakir, 1995), very light H-isotopic compositions are inferred for the Eocene waters accessed by these trees (-174 to -86‰).

Conclusions

Extreme co-isotopic variability of Eocene conifer resins, coupled to highly-depleted δD values, are indicative of short-lived climatic/hydrological variability in the Canadian low Arctic, in keeping with recent results from biomarkers in cores from the Arctic Ocean (Pagani *et al*., 2005). This challenges the notion of stable Middle Eocene climates at northern latitudes.

References

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