Picrite-basalt associated to Ethiopian-Yemeni CFB and their relevance to mantle plume processes

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The Oligocene Northern Ethiopian-Yemeni LIP, represented by a CFB plateau extending ca. 700 km in diameter, is characterized by a well-defined zonal arrangement with increasing plume-related physico-chemical features of erupted magmas, such as thermal regime, incompatible element enrichment and specific Sr-Nd-Pb-He isotopic fingerprint, from the periphery to the central plateau area [1]. Two CFB volcanic piles in the Lalibela district (Northern Ethiopia, ca. 2 km thick) and in the Manakhah section (Northern Yemeni plateau, ca. 1 km thick) which erupted close to the Oligocene Afar plume axis, are similarly characterized by very high-Ti transitional basalts and picrites (HT2, [1] [2]) that account for ca. 13% (40,000 km^3) of the total Ethiopian-Yemeni CFB lavas. These magmas are characterized, in addition to the extremely high TiO_2 content (3-6 wt%) by a high MgO content (mostly between 8 and 18 wt%), and show striking compositional analogies with those from the Karoo province and the Siberian meimechites [3] [4]. Petrological modelling based on whole rock FeO-MgO and Ol composition [5] indicates that some of picrites (MgO 16-17 wt%) are near-primary magmas with olivine phenoscrysts up to Fo 90.4. Calculation shows that the primary melts have picrite composition MgO 19.8-20.7 wt% and were generated by polybaric melting in the pressure range 3-4 GPa at a potential temperature of 1570°C. Together with high-MgO lavas from Hawaii and Gorgona, these are the highest temperatures of any OIB and LIP lavas. The available data suggest that HT2 magma sources necessarily require the involvement of specific high-Ti (and Fe) deep-seated sublithospheric components which were entrained and remobilized by the rising plume.

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