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Enriched lithosphere overprint on the isotope geochemistry of the CAMP-related Freetown Layered Complex (Sierra Leone)

Sara Callegaro (1), Andrea Marzoli (2), Hervé Bertrand (3), Janne Blichert-Toft (3), Laurie Reisberg (4), Giancarlo Cavazzini (5), Fred Jourdan (6), Joshua Davies (7), Urs Schaltegger (7), and Massimo Chiaradia (7)

(1) Centre for Earth Evolution and Dynamics (CEED), Oslo, Norway (sara.callegaro@geo.uio.no), (2) Dipartimento di Geoscienze, Università di Padova, Padova, Italy, (3) Laboratoire de Géologie de Lyon, Université Lyon 1 and Ecole Normale Supérieure de Lyon, Lyon, France, (4) Centre de Recherches Pétrographiques et Géochimiques, Université de Lorraine, Vandoeuvre-les-Nancy Cedex, France, (5) Istituto di Geoscienze e Georisorse, C.N.R., Padova, Italy. , (6) Department of Applied Geology, Curtin University, Bentley, Australia., (7) Département des Sciences de la Terre, Université de Genève, Genève, Switzerland

We present a geochemical and geochronological study of a mafic layered intrusion cropping out along the Atlantic coast of Sierra Leone – the Freetown Layered Complex (FLC). Geochronology (^{40}Ar/^{39}Ar on plagioclase: 201.7±0.7 and 202.3±2.3 Ma; U-Pb on baddeleyite: 198.794 ± 0.048/0.071/0.22 Ma) and crystal chemistry (high-TiO_2 pyroxene) demonstrate the connection between the FLC and the high-Ti magmatism of the Central Atlantic Magmatic Province (CAMP). Yet, Sr, Nd, Hf, Pb, and Os isotopes reveal an unusual signature for the FLC compared to most other CAMP occurrences previously studied. Particularly distinctive of the FLC rocks are their low ^{206}Pb/^{204}Pband high ^{207}Pb/^{204}Pb, suggesting involvement of an ancient component in the genesis of these magmas. Although some lower crustal assimilation is isotopically confirmed and also suggested by the presence of a granulite xenolith in one of the analysed rocks, this process alone cannot be responsible for the observed isotopic fingerprint of the FLC. We rather propose that the most straightforward way to confer the distinctive isotopic signature to the FLC is by hybridization of an upper asthenospheric melt with small volumes (1-3%) of highly enriched alkaline melts derived from the sub-continental lithospheric mantle, possibly lamproites. This scenario is also supported by the geodynamic setting of the FLC, emplaced within a Proterozoic mobile belt (Rokelide) and bordering an Archean craton (Man), as well as by the reported presence of lamproites and kimberlites in the area. Only high-Ti CAMP rocks found in regions once contiguous with Sierra Leone show similar isotopic compositions, though less extreme.