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Characterization of mantle/crust chemical transfer during the formation of Neoproterozoic oceanic crust (Bou Azzer and Sirwa ophiolites, Moroccan Anti-Atlas)

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We present here a petrological and geochemical study of Neoproterozoic ophiolitic relics from the Moroccan Anti-Atlas orogenic belt. They comprise two main complexes: (i) the Khzama ophiolite (in the Sirwa window) to the west and (ii) the Aït Ahmane ophiolite to the east (in the Bou Azzer inlier). Ultramafic lithologies are dominant in both complexes. They consist essentially in serpentinites associated with rare chromite pods and pyroxenites. They are in tectonic contact with the mafic units of the sequences comprising isotropic and layered metagabbros and metabasalts. These ophiolitic units have been dated at 762 Ma, from a plagiogranite dyke cutting across the Khzama assemblage (U-Pb on zircons; dating on metagabbroic baddeleyite from Aït Ahmane are in progress). The precursors of Aït Ahmane and Khzama serpentinites are spinel harzburgites associated with minor dunitic lenses, both entirely serpentinized. Bulk rock composition shows low contents in incompatible major and trace elements ($Al2O_3$: 0.2-1.3 wt.% and Ti 3-38 ppm) and in HREE ([Yb]N<0.4), attesting of a highly refractory protolith. This is in agreement with high Cr# (0.44-0.81) and rather low Mg# (0.25-0.73) ratios of Cr-spinels cores in serpentinites from the two complexes. Cr-spinels from Aït Ahmane serpentinites also display very low TiO_2 contents (<0.1 wt.%) consistent with a highly depleted precursor. Interestingly, Cr-spinels from the Khzama serpentinites are characterized by higher TiO_2 contents (0.12-0.23 wt.%), reflecting prior-serpentinization melt/rock interactions. Whole-rock trace elements data show that the Aït Ahmane and Khzama harzburgites are residues after a high degree of partial melting, similar to peridotites from the IBM forearc region. Their REE compositions can be modeled by 20 to 32% partial melting in an open-system hydrous dynamic model using an already depleted mantle source. Their flat to U-shaped REE patterns characterized by marked LREE enrichments compared to the residue expected for such high melting degrees could be explained by subsequent melt-rock interactions (up to 5-7 % of slab-derived fluids). Metabasaltic rocks are tholeiitic with variable subduction zone signature marked by variable LILE/HFSE ratios. Their highly positive εNd values at 760 Ma (+6.3 to +8.8) attest that they form from a juvenile mantle-derived input. Their REE contents fit with aggregated fractional melts derived from 21 to 28% of partial melting of spinel harzburgite. These geochemical signatures for the Moroccan Anti-Atlas ophiolitic units, from mantle rocks to the overlying crustal magmatic units, confirm a supra-subduction zone for the genesis and evolution of the ophiolite with multiple stages of melting and variable overprint of slab-derived fluxes on the magmagenetic center.