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Recycling of ancient and variably depleted mantle recorded in the Bay of Island ophiolites

YUJIAN WANG[1], JAMES MUNGALL[2] AND JINGAO LIU[1]

[1]China University of Geosciences (Beijing)

[2]Carleton University

Presenting Author: YujianWang@cugb.edu.cn

Long term melt extraction and subducting the lithosphere back to the mantle lead to highly heterogeneous mantle. Mounting evidence have identified the existence of variably depleted mantle domains, but the evolution and length scales of these components remain elusive. Here we present elemental and Re-Os isotopic study of mantle peridotites from Bay of Island ophiolites, western Newfoundland. Geochemical variations combined with alphaMELTS modeling demonstrate that lherzolites that experienced adiabatic decompression beneath mid-ocean-ridges and porphyroclastic harzburgites that underwent a second-stage flux melting induced by influx of sediment fluids account for the generation of Early Ordovician non-arc and arc rocks within the ophiolites (Fig. 1). These peridotites exhibit unradiogenic prior-obduction $^{187}Os/^{188}Os$ ratios (0.1192 to 0.1253), which yield Proterozoic Re-depletion model ages of 610 to 1460 Ma (Fig. 2). The variably depleted mantle domains have been preserved in the asthenospheric mantle for hundreds of million years before they were sampled by upwelling mantle via rising plume or passive advection along mid-ocean ridges during the Iapetus opening (as early as 750 Ma). It suggests that the chemical heterogeneity of the upper mantle on spatial scales could range from kilometers to the size of ocean basins and hence great caution must be taken when dealing with depleted mantle reservoirs.

Fig. 1 (a) Plot of $(Er/Yb)_N$ versus anhydrous Al_2O_3 of bulk rocks with alphaMELTS simulated trends; (b) Plot of Plot of $(Sm/Yb)_N$ versus Yb_N of clinopyroxenes with alphaMELTS simulated trends

Fig. 2 Osmium isotope evolution versus time (Ga) illustrating the Re-depletion model ages for different lithologies. Also shown is the osmium isotope evolution of Primitive Upper Mantle (PUM).