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Oxygen fugacity heterogeneity in the ridge mantle caused by recycling of wedge mantle residue

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The oxygen fugacity, a measure of the chemical potential of oxygen, plays significant role in both the geophysical and geochemical properties of the mantle. The direct measurement of Fe^{3+}/Fe_{toal} ratio of the mid-ocean ridge basaltic (MORB) glasses, by X-ray absorption near-edge structure (XANES), could provide essential information of the redox state in the upper mantle. Using this tecqniue, the previous works have shown that the Fe^{3+}/Fe_{toal} of the global MORBs without influence from the mantle plume span a narrow range around 0.14±0.01[1,2]. Recently, components derived from ancient arc mantle have been suggested to be present in the oceanic ridge mantle [3], while its effect on the mantle oxygen fugacity remains unknown.

Here, we report the new XANES results for the Southwestern India Ocean Ridge (48-52ºE) basaltic glasses, with high H_2O/Ce ratios (mostly >400, and up to 1000), high δD and relatively low Ce/Pb ratios, features attributed to the presence of depleted mantle wedge residue in their mantle sources[3]. Our results show that the Fe^{3+}/Fe_{toal} ratios are from 0.12 to 0.15. The Fe^{3+}/Fe_{toal} ratios are positively correlated with trace elemental concentrations, but not with La/Sm and Sm/Yb. The negative correlations between Fe^{3+}/Fe_{toal} ratios and δD, H_2O/Ce, and the calculated water contents in the mantle sources indicate that the more reduced components were derived from the recycled arc mantle residue. This indicates that, although the mantle wedge could be largely oxidized by the derivates from the subducting slab[4], the depleted mantle wedge residue after melt extraction would be rather reduced, and the recyling of such mantle wedge has limited power to oxidize the mantle and could potentially reduce it.

[1] Cottrell, E., & Kelley, K. A. (2011). Earth and Planetary Science Letters, 305(3-4), 270-282.

[2] Zhang, H. L. et al. (2018). Chemical Geology, 479, 166-175.

[3] Liu et al., (2022). Earth and Planetary Science Letters, Accepted.

[4] Brounce et al. (2021) Geochemistry, Geophysics, Geosystems, 22(6), e2021GC009823.