Parameters affecting the depth of redox melting beneath ridges

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The f_{O2}-depth profile of Earth's mantle sets the depth at which diamond in upwelling mantle oxidizes to form carbonated melts (DCO3), reducing iron in the process [1]. Estimates of MORB-source f_{O2} based on spl-oxybarometry [2] and $Fe^{3+}/\Sigma Fe$ in MORB glasses [3] anchor the f_{O2}-depth profile. Upper mantle f_{O2} decreases with depth as Fe_2O_3 in garnet is diluted by increasing modal garnet [4]. We present a petrological model of the mantle f_{O2}-depth profile to predict the depth of melt initiation in the sub-ridge mantle.

We have augmented a model of the f_{O2}-depth profile of adiabatically upwelling mantle first presented by Stagno *et al.* [5], kindly provided by D. Frost. Empirical fits to experimental data and a chemical mass balance produce phase compositions along constant $Fe^{3+}/\Sigma Fe$ isopleths that can be used to calculate f_{O2} through the grt-ol-opx oxybarometer [5]. Differences in bulk $Fe^{3+}/\Sigma Fe$, potential temperature, and bulk composition may each lead to variation in the depth of intersection with the DCO3 of >50 km. A surprising result is that more refractory compositions begin redox melting at greater depth (Fig. 1), opposite the effect of fertility during silicate partial melting.

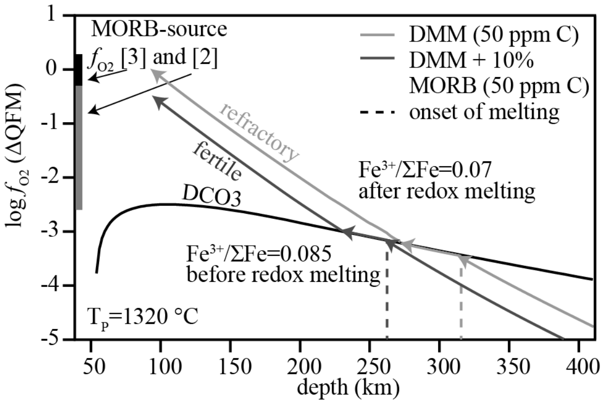

Fig.1. Model compositions with the same bulk $Fe^{3+}/\Sigma Fe$.

The refractory composition is more oxidized due to lower modal proportion of garnet. This leads to intersection with the DCO3 and initiation of carbonated melting at greater depth.

[1] Stagno and Frost (2010) *Earth Planet. Sci. Lett.* **300**, 72-84 [2] Bryndzia and Wood (1990) *Am. J. Sci.* **290**, 1093-1116 [3] Cottrell and Kelley (2011) *Earth Planet. Sci. Lett.* **305**, 270-282 [4] Ballhaus (1995) *Earth Planet. Sci. Lett.* **132**, 75-86 [5] Stagno *et al* (2013) *Nature* **493**, 84-88