Oyxgen fugacity at the base of the Talkeetna arc, Alaska

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Arc volcanic rocks are characterized by higher magmatic oxygen fugacities (f_{O2}s) (+1 to +5 ΔFMQ [log units above the fayalite-magnetite-quartz buffer]) than MORBs (~FMQ). The mechanisms producing elevated f_{O2}s in arc volcanics is controversial as they may be due to 1) a source region oxidized by melts or fluids from the subducting slab; 2) intra-crustal processes (e.g., assimilation or fractionation); or 3) shallow level and eruptive processes (e.g., degassing). Most studies investigating the f_{O2}s of arc magmas focus on volcanic rocks, which may be influenced by some or all of the above processes, making it difficult to identify the origin of their elevated f_{O2}s. Here we take a different approach by constraining the f_{O2}s at the base of an arc (~ 1 GPa). Studied samples include lherzolites, wehrlites, and dunites from the Tonsina, Eklutna, and Red Mountain areas of the Jurassic Talkeetna arc of Alaska and are either a) residual mantle or b) ultramafic cumulates. We analyzed the major and minor element chemistry of olivine, orthopyroxene, clinopyroxene, and spinel from 15 samples and implement the olivine-spinel-orthopyroxene oxybarometer[1], olivine-spinel Fe-Mg exchange thermometer[2], and two-pyroxene thermometer[3]. Spinels Fe^{3+}/Fe^{T} ratios were corrected using an external set of spinel standards characterized by Mössbauer spectroscopy[4]. Fe^{3+}/Fe^{T} ratios in cores of spinel grains from all samples are 0.20-0.53 and calculated f_{O2}s range from +0.8-2.2 ΔFMQ. Subsolidus processes do not appear to have signficantly affected calculated f_{O2}s as supported by: 1) homogeneous cores and lack of compositional zoning in the majority of spinels and 2) no variation in f_{O2}s over a wide range of equilibration temperatures (1210-700ºC). Our results indicate that the sub-arc mantle wedge and parental arc melts to the cumulates at the base of the Talkeetna arc had magmatic f_{O2}s above that of MORBs, suggesting that the oxidized nature of arc magmas may be due, at least in part, to contribution of subducted oxidized material to their source region.

[1] Ballhaus, Berry, & Green (1991), *Contrib. Min. Petrol.* 107, 27-40. [2] Li, Kornprobst, Vielzeuf, & Fabries (1995), *Chinese J. of Geochem.* 14, 68-77. [3] Putirka (2008), *Rev. in Min. Geochem.* 69, 61-120. [4] Wood & Virgo, (1988), *Geochim. Cosm. Acta* 53, 1277-1291.