Along-arc geochemical variations in northern Cascade intermediate lavas: crustal processes, slab melting, or mantle heterogeneity?

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As an end-member 'hot' subduction zone [1] and host to the termination of a subducting slab, the northern Cascade arc (Garibaldi Volcanic Belt, GVB) is a unique setting to examine intermediate magma genesis and the implications for evolution of the continental crust. Two isotopically distinct mantle components in GVB basalts indicates toroidal flow of deep mantle around the slab edge and into the arc mantle source [2], which could lead to unusually hot conditions and melting of the slab edge.

We present new high precision Sr-Nd-Hf-Pb isotope and trace element data for lavas from the GVB volcanic centres of Glacier Peak, Garibaldi, Cayley and Meager. In isotopic plots, GVB lavas broadly define mixing curves between northern Cascadia Basin sediment [3] and Juan de Fuca MORB. GVB lavas are more isotopically depleted than High Cascade lavas [2] and have elevated Sr/Y, suggesting the possibility of a slab melt component. However, only one lava (Enostuck at Mt. Garibaldi) has the requisite high Dy/Yb of a slab melt. Mt. Baker [4] and Glacier Peak have typical 'arc' trace element signatures and display a continuum in isotopic and trace element compositions from basalts to dacites, implying a genetic link between the mafic and silicic series and a single mantle source. Conversely, lavas of Garibaldi, Cayley and Meager indicate two isotopically distinct mantle sources, producing separate alkalic and subalkalic magmatic lineages. The subalkalic lineage displays a continuum between mafic and silicic, but with higher $^{87}Sr/^{86}Sr$, $\square_{Hf}$, $^{208}Pb/^{204}Pb$ and $^{207}Pb/^{204}Pb$ for a given $^{206}Pb/^{204}Pb$ and lower $\square_{Nd}$ than the alkalic lineage. Alkalic basalts have OIB-like trace element compositions [2], while more evolved alkalic lavas show trace element and isotope compositions indicative of crustal contamination. Despite the GVB's hot thermal regime, slab melts are uncommon and 'adakitic' signatures are mainly a consequence of crustal contamination.

[1] Syracuse et al. (2010) Phys Earth Planet Int 183. [2] Mullen & Weis (2015) EPSL 414. [3] Carpentier et al. (2014) Chem Geol 382. [4] Mullen & McCallum (2014) J Pet 55(2).