Unravelling arc mantle using trace element and isotopic "intelligence" from the Middle-Late Triassic Stikine arc

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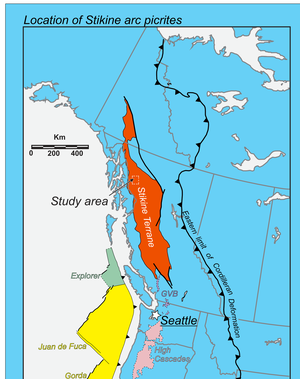
Summary

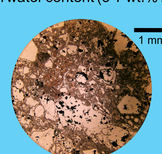
Near-primary, Middle-Late Triassic, volatile-rich picritic tuff gives insight into the trace element and isotopic composition of the mantle wedge beneath the Stikine terrane of the North American Cordillera. The most mobile isotopes (Pb) suggest ≤2% addition of molten subducted sediment to the depleted asthenospheric mantle wedge. The least mobile isotopes (Hf) are similar to modern E-MORB presently erupted at the southern end of the Explorer Ridge and suggest that enriched domains in the northeastern Pacific mantle may be long-lived (≥222

Location of Stikine arc picrites

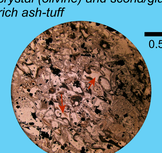


Background

The Stikine terrane of the North American Cordillera (Fig. 1) experienced a period of arc building and extensive mineralization during the Middle to Late Triassic. Volumetrically minor (<100 m-thick), olivine-phyric picritic tuff was deposited near the base of the Triassic volcanic arc at ≥222 Ma. The ultramafic composition of the tuff (MgO =21-33 wt.%) reflects, in part, accumulation of 20-65% olivine.Despite greenschist-facies metamorphic overprint, the tuff shows well-preserved primary textures, including euhedral pseudomorphed olivine, frothy devitrified lapilli groundmass, and cuspate glass shards with bubble-wall morphologies. The tuff was emplaced as result of violent exsolution of magmatic volatiles from oxidized ($logfO_2$ ~FMQ+1) and relatively cool (≤1200 °C) picritic (MgO ~16 wt.%) parent saturated in olivine (Fo_{91}) and chromite (Milidragovic et al., 2016). The relatively low temperature of the picritic magma is attributed to its high water content (5-7 wt.% H_2O).

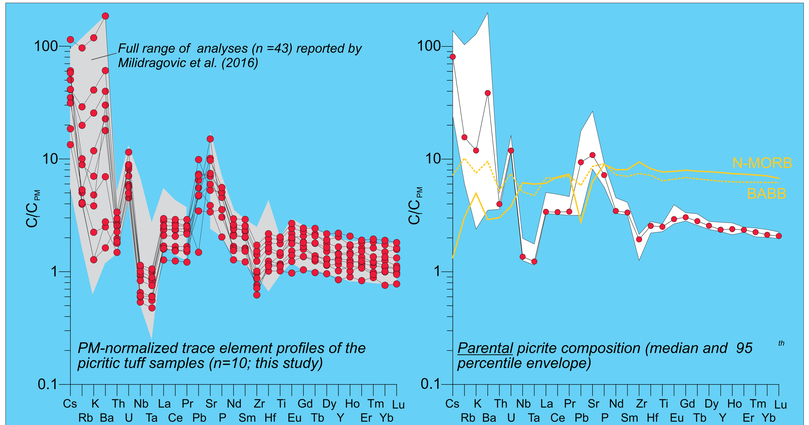


crystal (olivine) and scoria/glass-rich ash-tuff



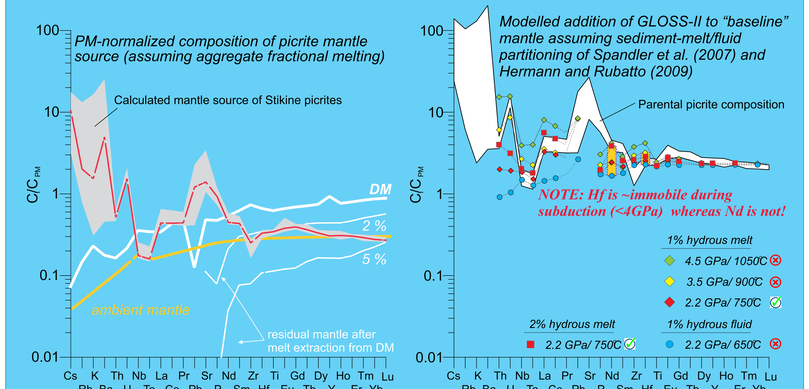
partially palagonitized cuspate glass shards in ash-tuff

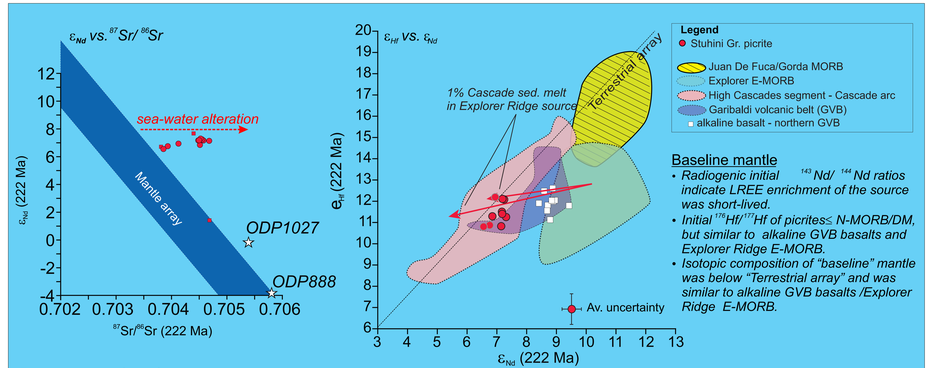
olivine-rich scoriaceous lapillus



Trace element geochemistry

Picritic tuff of Stikine terrane has a calc-alkaline trace element character (relative Nb-Ta depletion, La/Yb =2-3), typical of arc magmas. The abundance of MREE/HREE in the calculated parental picrite (corrected for olivine accumulation), is lower than that of MORB and back-arc basin basalts (BABB) and requires an ambient asthenospheric mantle source that was depleted relative to Earth`s model depleted mantle (DM). The calculated ambient mantle composition requires prior extraction of a relatively low-degree melt from DM (F ≤0.05). The relative enrichment in LREE and depletion in HFSE of the parental picrite magma requires addition of 1-2% sediment melt, generated at 2.2-3.5 GPa, to ambient mantle.



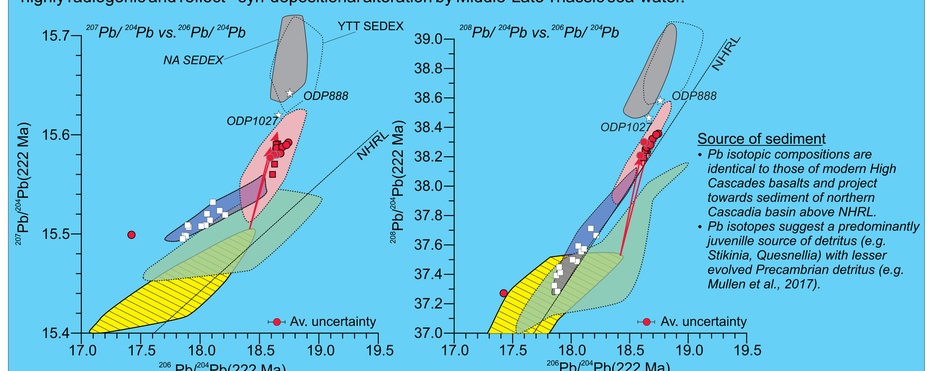


Baseline mantle

- *Radiogenic initial $^{143}Nd/^{144}Nd$ ratios indicate LREE enrichment of the source was short-lived.*
- *Initial $^{176}Hf/^{177}Hf$ of picrites≤ N-MORB/DM, but similar to alkaline GVB basalts and Explorer Ridge E-MORB.*
- *Isotopic composition of "baseline" mantle was below "Terrestrial array" and was similar to alkaline GVB basalts /Explorer Ridge E-MORB.*

Isotope geochemistry

Contrasting mobility of isotopic systems during subduction (see previous panel) allows us to characterize both the "baseline" mantle and subducted crust component in the mantle source of Stikine terrane picrites. Hf is immobile and therefore representative of the "baseline" mantle, whereas Pb is highly mobile and largely inherited from the subducted ocean floor. The behaviour of Nd is intermediate between these two isotopic systems. $^{87}Sr/^{86}Sr$ ratios of the picritic tuff are highly radiogenic and reflect ~syn-depositional alteration by Middle-Late Triassic sea-water.



Source of sediment

- *Pb isotopic compositions are identical to those of modern High Cascades basalts and project towards sediment of northern Cascadia basin above NHRL.*
- *Pb isotopes suggest a predominantly juvenille source of detritus (e.g. Stikinia, Quesnellia) with lesser evolved Precambrian detritus (e.g. Mullen et al., 2017).*

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