# The magmatic plumbing of volcanic plateaus: Petrogenetic and economic implications

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Magmas in continental or oceanic plateaus result from the partial melting of an upwelling, sub-lithosphere source. The geometry of this source may be far more complicated than that of a classic cylindrical or mushroom shaped mantle plume, but a static source within or below the lithosphere cannot produce a sufficiently large volume of hot magma, erupted within a short period of time. Magmas of alkaline affinity interact little with the crust during their ascent because dissolved and subsequently exolved volatiles reduce the density of the magma and drive it to the surface without being trapped at density barriers at the base of or within the crust. Tholeiitic magmas, on the other hand, ascend through a complex series of lower to mid crustal magma chambers where they evolve and interact with the crust. Primary picritic magma fractionally crystallizes, assimilates its wall rocks and is homogenized to produce the uniform, evolved, siliceous flood basalts that make up to bulk of most volcanic plateaus. In the upper crust, particularly in the sediment piles that underlie most plateaus, the magma passes through a hugely complex network of sills, such as those beneath the Karoo or Siberian provinces. Further magma-crust interaction takes place in the sills. Very few magmas escape this interaction — the "continental" geochemical signature in most flood basalts results mainly from crustal interaction and is not inherited from a mantle source.

The assimilation of granitic or sedimentary rocks by magmas of the Siberian province led to the segregation of magmatic sulfides and the formation of the large and rich Ni-Cu-PGE deposits of Noril'sk-Talnakh region. The ore-forming process was triggered by the assimilation of evaporite at very shallow levels in the sediment pile. The dynamics of magma flow and the extent and mechanism of wall-rock assimilation was influenced by the structure and rheology of the sediments, particularly their degree of consolidation and lamination, features related to the depth below the surface at the time of intrusion.

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# A HIMU source in metasomatised continental lithosphere

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Late Cretaceous-Quaternary continental basalts from the Chatham and Antipodes Islands, New Zealand, are characterized by trace element and isotopic affinity with oceanic HIMU basalts. The alkaline basalts have trace element (Ce/Pb 28-36, Ba/Nb 4-7, La/Yb$_n$ 12-28) and isotopic ($^{87}$Sr/$^{86}$Sr 0.7029-0.7034, $^{206}$Pb/$^{204}$Pb 19.8-20.8) signatures that indicate low-degree melts (~3%) of garnet periodotite. Negative K-anomalies on spidergrams reflect residual amphibole ± phlogopite in the source. The inversion of trace elements reveal enriched mantle (1-4 x PM) and heterogeneity due to differences in the proportions of hydrous and anyhdrous minerals.

Calculated melt segregation pressures of ~4.3 GPa (Chatham) and ~5.2 GPa (Antipodes) are equivalent to depths of ~130 km and ~160 km. Pressures calculated for individual episodes of volcanism on Chatham Island show that the depth of melting has varied little (±0.15 GPa) in ~80 Ma. Temperatures at the top of the asthenosphere are often defined to be ~1300˚C, which for much of SW Pacific, would occur at shallow levels (~50-80 km). In this case, the continental geotherms would resemble the asthenosphere adiabat with major melting and generation of tholeiitic and not alkalic basalts. Lithospheric thickness estimates of 100-150 km based on geophysical data suggest that low velocity zones (<~100-150 km) reflect melt/volatile sources with the lithopshere (Finn et al., in press). Melting within the lithopshere is also supported by the fact that Chatham Island has drifted ~3000 km (~65˚S to 44˚S) in ~85 Ma without significant change in depth or melt composition.

New Zealand was part of the eastern margin of Gondwana, juxtaposed to Australia, Tasmania and Antarctica in the Cretaceous. Cenozoic alkaline magmatism on each fragment has been linked to ancient metasomatised sources. The timing of metasomatism is constrained between 500 and 200 Ma, coincident with subdution and distribution of HIMU volcanism. We propose that subduction-related metasomatism modified the continental lithosphere and contributed to the HIMU signature (cf. Stein et al., 1997).

## References

Finn C.A., Müller R.D. & Panter K.S., (in press), *Geochem. Geophys. Geosyst.* 6, doi:10.1029/2004GC000723.

Stein M., Navon O., & Kessel R., (1997), *Earth Planet. Sci. Lett*. 152, 75-91.