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Platinum, palladium and gold depletion in boninitic arc magmas during fractional crystallization - what is the role of immiscible fluids?

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Fresh glassy samples of boninite lavas and their differentiates from the Tofua arc, the Fonualei rifts, and the Mangatolu rift-rift-rift triple junction, at the north end of the Tonga-Kermadec arc-backarc system, were dredged during the Northern Tonga Vents (NoToVe) cruise by RV Southern Surveyor in 2004. Major, trace, and chalcophile elements were analysed by XRF, ICPMS, and NiS fire assay with ICPMS finish at ANU and the Geoscience Laboratory of the Ontario Geological Survey. Boninite lavas from volcanoes A, F and L in the main Tofua arc and from the Mangatolu rift-rift-rift triple junction, and tholeiitic basalts from the Fonualei rifts, show extreme enrichment in platinum group elements (PGE; Ir, Ru, Rh, Pt, Pd) and Au. Concentrations of the chalcophile elements decrease steadily with increasing concentration of incompatible lithophile elements within each suites due to removal of a phase concentrating all of the PGE and Au during fractional crystallization. The depletion trends are not coupled to the appearance and disappearance of major fractionating mineral phases, including magnetite, in the magmas. Modeling indicates that if fractionation of an immiscible sulfide phase was responsible for the observed depletions in PGE and Au, the bulk sulfide/silicate partition coefficient must have been on the order of 500 to 1000, far below accepted values. More probably, the magmas were continuously saturated with an aqueous fluid phase into which chalcophile elements were partitioned moderately strongly. The results imply that fluids derived from fractionating boninitic magmas have high potential to generate hydrothermal deposits enriched in PGE and Au. We also suggest that models for large scale PGE transport by orthomagmatic fluids in

cooling layered intrusions are supported by the present results.