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Crust-mantle interaction in the Archean Abitibi Greenstone Belt, Canada: geochemical diversity and petrogenesis of the Deloro assemblage volcanic rocks

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The Abitibi greenstone belt in eastern Canada is one of the largest Neoarchean greenstone belts in the world. The belt consists of E-W trending successions of folded volcanic and sedimentary rocks and intervening domes of intrusive rocks. Of the seven sub-alkaline volcanic assemblages that have been defined in the Abitibi, the 2734–2724 Ma Deloro assemblage is second in areal extent and contains the largest number of volcanogenic massive sulfide (VMS) deposits, making it an interesting assemblage to study crust-mantle interactions and the causes of VMS fertility.

This study utilizes a large dataset (n=2420) of whole-rock geochemistry for mafic to felsic volcanic rocks to understand their petrogenesis. Principal Component Analysis shows that Ti, Th, and Yb are the primary contributors to the dataset's variation. Guided partly by k-means cluster analysis, the dataset has been divided into 10 geochemical groups reflecting tholeiitic to calc-alkaline and basaltic to rhyolitic characteristics. A least altered subset of the data is used to study major element patterns. The trends between these geochemical groups are consistent with variable degrees of closed- and open-system differentiation (e.g., mixing, fractional crystallisation and assimilation). This interpretation is being explored with thermodynamically-constrained major and trace element modelling using the Magma Chamber Simulator (MCS). Thus, we can constrain the variations in magma water content and differentiation pressure that contributed to the diversity of Deloro magma compositions (particularly with respect to major element trends) and quantify the different degrees of assimilation and crystallisation in the geochemical groups (reflected by variations in ratios such as Th/Yb, Th/Nb, Yb/Ti and Zr/Ti). Future work will evaluate partial melting in the lower to upper crust as a direct source of some felsic magmas. By building a picture of the magmatic processes that created the Deloro assemblage, our ongoing investigation seeks to provide insight into the geological context into which the associated VMS deposits developed.