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Mobile Chalcophile Element Subduction Fluxes in a Continental Arc Setting

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There is a well-established link between the formation of economically viable chalcophile-rich ore deposits and continental arc volcanism however, the distribution of these deposits between different arc regions can be sporadic [1]. We lack understanding of the magmatic processes and conditions which predispose some continental arc systems to be associated with chalcophile-rich ore deposits [2]. Within the chalcophile element group, there is a subset of mobile elements whose behaviour is less well understood (e.g. W, Sb) and whose absence from published continental arc datasets is notable. We investigate two volcanic systems in the Trans Mexican Volcanic Belt, Popocatépetl Volcano in the east, and Colima Volcano in the west. This barren continental arc is used to constrain subduction mechanisms and processes affecting mobile chalcophile element enrichment and distribution.

Element compositional data collected, using recently developed LA-ICP-MS protocols, from Holocene aged mineral hosted melt inclusions reveal distinct compositional differences between the two regions. Popocatépetl inclusion data show MgO content up to 2 wt.% and SiO2 content between 60 wt.% and 80 wt.%. In contrast, Colima inclusions have more primitive compositions with MgO up to 10 wt.% and SiO2 as low as 42 wt.% in addition to high K_2O (>8 wt.%) in alkaline cinder cones erupted close to the main vent. We demonstrate that Pb, Sb, Tl and W are subduction mobile across the eastern and western arc segments and are more enriched in Popocatépetl inclusions relative to Colima. Decreasing Cu concentrations show that sulphide saturation has occurred for all compositional ranges. Th/Nb ratios show a dominant slab melt component in the east. In contrast, Colima inclusion Ba/Nb ratios indicate a dominant fluid subduction component in the western arc sector. Tl and Sb behave similarly to Th suggesting mobilisation further from the subduction trench in the eastern sector, whereas W, Pb and Bi share similar controls on their mobility to Ba and indicate mobilisation closer to the trench in the western sector. The variability of mobile element slab fluxes highlights arc-scale heterogeneities.

[1] Sillitoe (1997), Aust. J. Earth Sci. 44, 373-388.
[2] Jenner (2017), Nat. Geosci. 10, 524-529.