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Insights into arc fluid budgets from Mariana melt inclusions

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The transport of water from the subducting slab to the Mariana arc controls the transport of many elements and triggers melting within the mantle wedge. A fundamental aim of this study is to constrain the composition of hydrous fluids and their budget within the Mariana arc subduction factory. We present new volatile data from olivine-hosted melt inclusions in recently-erupted tephras from several Mariana volcanoes. H_2O, CO_2, S, F and Cl abundances have been determined by SIMS [1]. Melt inclusions from Pagan, Guguan and Agrigan volcanoes show a wide range of CO_2 concentrations (e.g. Pagan: 5-570 ppm; Guguan 2-216 ppm; Agrigan: 3-670 ppm). Likewise, water contents of melt inclusions also show significant variability; however, we note systematic differences in H_2O between the 3 volcanoes, with Agrigan having the highest average water contents (up to 5.6 wt. % H_2O) and Pagan showing the lowest range (0.5-3.4 wt. % H_2O). These water contents are consistent with prior work on smaller populations of inclusions [2,3]. Using the solution model of Dixon et al. [4], H_2O and CO_2 contents constrain the pressure (depth) of inclusion entrapment. We find that inclusions from Agrigan were trapped at much greater depths (up to ~9.1km) than inclusions from Guguan (up to 4.4 km) or Pagan (up to 3.7 km). Assuming that the highest concentration samples best represent the volatile composition of the undegassed sub-arc melt, we estimate absolute output fluxes along the arc for SO_2 (4.1 Mmol/yr/km of arc), CO_2 (2.0 Mmol/yr/km of arc) and H_2O (409 Mmol/yr/km of arc), using a magma production rate of 47 km^3/Ma/km arc [5]. In the case of CO_2 and H_2O these output flux estimates represent 10.4 % and 335 %, respectively, of the sedimentary inputs [6]. The excess water can be reconciled if we consider inputs from the altered oceanic crust, which, given the age of the subducting crust are likely to dominate the input. In order to balance the water budget, we require an input from the altered oceanic crust of ~ 4×10^{11} mol H_2O/yr.

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1.2.24

Volatiles in melt inclusions from the Central American Volcanic Arc: Insights into subduction-zone volatile cycling

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Melt inclusions trapped in high Fo olivine phenocrysts may capture primary volatile contents of primitive arc melts. Here we present results from studies of melt inclusions from the Central American Volcanic Arc (CAVA) in Nicaragua (Nic) and Costa Rica (CR). These study areas were chosen to represent two very different subduction environments with respect to subducting crustal input and slab dip, that are expected to play a significant role in the cycling of volatiles through the arc.

Melt inclusions from Nic have been analyzed in olivines covering a range of compositions (Fo_{70-87}). H_2O shows a general increase with decreasing Fo of the host olivine, reflecting incompatible behavior during differentiation from 1–3 wt. %.in samples from $Fo_{>85}$ to ~ 5% in some of the more evolved samples. Chlorine shows a similar trend from <1000 to >2000 ppm. Some of the more mafic samples have S contents >2000 ppm and the more evolved samples are lower in S suggesting degassing during fractionation. Only very primitive melt inclusions in olivine with Fo_{84-90} have been analyzed thus far from CR. H_2O contents are much higher in CR (~3-5 wt. %) than in the primitive samples from Nic. F also extends to higher concentrations in CR (<850 ppm) than in Nic (~200 ppm). Comparison of the major element data from whole rock lavas and melt inclusions with experimental melting studies indicates that the Nicaraguan melts with higher FeO and lower SiO_2 (both at similar MgO contents) could have formed at greater depths and temperatures in the presence of less water than the Costa Rican melts with higher SiO_2 and lower FeO..

Based on our preliminary data on volatile contents of primitive melt inclusions and estimates of the amount of magma erupting through the CAVA we attempt to calculate fluxes of volatiles from the mantle wedge (and ultimately the subducting slab) to the surface in the volcanic. We calculate fluxes (kg/yr*km arc) of 1 x 10^6 H_2O, 5 x 10^4 Cl, 8 x 10^4 S and 1x 10^4 F in Nic and of 5 x 10^6 H_2O, 8 x 10^4 Cl, 1 x 10^5 S and 6 x 10^4 F in CR. In addition to limited volatile data these results are sensitive to uncertanties in the flux of magma through the volcanic arc.