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Novel insights into the volatile content of arc magmas recorded in the deep roots of Kohistan arc

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Water cycled between the crust and mantle affects the geophysical, rheological, and geochemical properties of minerals and melts, particularly at subduction zones where water is returned from surface reservoirs to the mantle. To constrain the H_2O content of arc magmas, previous studies have relied on measuring extrusive products and mineral-hosted melt inclusions; yet these methods have inherent limitations, which may obfuscate the full range of H_2O in arc magmas. Here we use secondary ion mass spectrometry to analyze H_2O concentrations in pyroxenes from two suites of lower arc cumulate rocks from the Kohistan paleo-arc (NW Pakistan) to evaluate the H_2O content of the melts from which the cumulates crystallized. Pyroxenes were found to retain their primary water abundances and record two distinct parental melts: one H_2O-poor (<1 wt.%), the other H_2O-rich (>4 wt.%). Extensive crystal fractionation of the latter led to the formation of super-hydrous andesitic to dacitic melts (~12–20 wt.% H_2O), predicted petrologically yet rarely if ever observed. Foundering of water-rich lower arc roots can deliver water fluxes comparable to eclogitized subducted oceanic crust, which underpins the importance of foundering in global volatile cycling.