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A meteoric water source for the formation of hyaloclastites at Minna Bluff, Ross Sea, Antarctica: A petrographic, geochemical and isotopic (Sr & O) investigation
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In situ Sr laser ablation analyses have confirmed a meteoric water source for the alteration minerals in hyaloclastite deposits at Minna Bluff; a 45 km-long peninsula in the southern Ross Sea. Geochemical analyses of complexly zoned minerals – zeolites (phillipsite and chabazite) and carbonates (calcite, LMC, HMC, dolomite and magnesite) - show significant chemical differences suggesting dynamic physiochemical conditions and multiple water generations. $^{87}\text{Sr}/^{86}\text{Sr}$ ratios for 6 carbonate samples are indistinguishable at 0.70327 ± 0.0002; comparable to the surrounding volcanic deposits, thus precipitation by seawater is untenable. Zeolite (Na + K)/Ca ratios show a wide range (< 1 to 150) compared to host rocks (< 1 to 15). Minor element (Sr, Fe, Mn)/Ca ratios in carbonates also show a greater range relative to the rocks. These variations can be explained by changing chemical and temperature gradients, water-rock interactions, and/or influxes of fresh water. Mg/Ca ratios in carbonate show a negative linear correlation as predicted for equilibrium at variable temperatures. $\delta^{18}\text{O}_{\text{SMOW}}$ values for carbonates range from -0.5 to 21.5‰. The occurrence of phillipsite and chabazite, which coexist with carbonate, suggest temperatures of formation between 50° and 100°C. Thus, $\delta^{18}\text{O}$ water values for carbonates were calculated within this range using local present-day meteoric waters values ($\delta^{18}\text{O} = -25\%$) adjusted for annual air temperature variations of ±5.0°C. Models indicate that the oxygen isotope values can be explained by meteoric water heated within predicted temperature ranges, except for magnesite. Heavier $\delta^{18}\text{O}$ magnesite values suggest considerable exchange between meteoric water and lava at low W/R ratios and/or evaporitic process. Establishing a single water source (i.e. meteoric) for the formation of hyaloclastite deposits at Minna Bluff (11.8-6.2 Ma) permits further evaluation and possible application towards our understanding of climate variability during the Middle to Late Miocene in the southern Ross Sea.