Interpreting diagenesis in the Marinoan-age Wilsonbreen Fm. using carbonate clumped isotopes

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Rare, synglacial carbonate deposits from the Wilsonbreen Formation in Svalbard provide an opportunity to probe the climate and environmental conditions during the Marinoan Snowball Earth episode. However, such conclusions hinge on the preservation of these proxies through lithification and burial. Carbonate clumped isotopes have the potential to yield information on both surface temperatures and fluid $\delta^{18}O$ values from this unique period in geologic history, though their sensitivity to post-burial alteration also makes them useful for interpreting the extent and mode of carbonate diagenesis. In this study, we analyzed samples of carbonate (calcite and dolomite) from throughout the Wilsonbreen Fm., from multiple locations in NE Svalbard, for their $\delta^{13}C$, $\delta^{18}O$, and clumped isotopic composition (Δ_{47}) in order to reconstruct temperature and fluid $\delta^{18}O$ composition of the precipitating fluid and access covariation between geochemical proxies, lithofacies, mineralogy, and sample location. We find reconstructed temperatures ranging from <25°C to >100°C and fluid $\delta^{18}O$ values ranging from –5‰ to +10‰. There is no substantial trend in values across locations, with the exception of higher temperatures in the most southern sections, consistent with higher burial temperatures inferred from other studies. The relationship between temperature and fluid $\delta^{18}O$ for the majority of samples is consistent with solid-state reordering or low water-rock recrytallization as the dominant mode of alteration. Trends among dolomite samples with high mineral $\delta^{18}O$ values (>5‰) are less clear. Dolomite samples tend to record lower temperatures on average than calcites do, consistent with differences in reordering kinetics between the two minerals. We also observe variations in the measured Δ_{47} value based on the volume of CO_2 analyzed, suggesting that any clumped isotope measurements must be made at consistent volumes of CO_2 in order to obtain accurately values; this is critical for samples of low carbonate content (<50 wt%). Minimal evidence for high water-rock recrystallization suggests that previous isotopic measurements may be reflecting primary fluid compositions and original surface conditions from during the Marinoan Snowball Earth episode.