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Mechanisms controlling the Mg isotope composition of hydromagnesite-magnesite playas near Atlin, British Columbia, Canada

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The alkaline playas near Atlin, British Columbia, Canada are likely one of the few surface environments on Earth where contemporaneous formation of hydromagnesite and magnesite occurs at temperatures that do not exceed 15 °C. This environment offers a unique opportunity to examine the impact of different formation mechanisms on Mg isotope compositions of Mg-carbonate minerals at low temperature. In this study, we report the Mg isotope composition of ultramafic bedrock, Mg-carbonate sediments, and both surface and ground waters in this geological setting. The composition of hydromagnesite suggests a Rayleigh-type distillation effect on the fluid Mg isotope ratios in unsaturated sediment above the water table. Through this mechanism of formation, hydromagnesite is progressively depleted in ^{24}Mg obtaining $\delta^{26}Mg$ values as high as +1.14‰ near the sediment surface. In contrast, magnesite formation is characterized by enrichment of the solid phase in ^{24}Mg. The apparent Mg isotope fractionation factor during magnesite formation at ~ 10°C ranges between ~ 0.7±0.1‰ and 1.8±0.1‰. The distinct Mg isotope composition of hydromagnesite in comparison to magnesite supports magnesite formation occurring by precipitation from the fluid, or dissolution-reprecipitation, rather than solid-phase transformation from a hydrous Mg-carbonate precursor. Overall, the results provide insights on low temperature Mg-carbonate mineral formation that has implications for long-term storage of CO_2.