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Measuring CO_2 Exchange over the Hydromagnesite-Magnesite Playas in Atlin, B.C.

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The hydromagnesite-magnesite playas in Atlin, BC, are an important site for demonstrating carbonate mineral stability at the Earth's surface [1]. The playas represent a natural analogue for carbon capture and storage *via ex-situ* carbon mineralization. Additionally, Power *et al.* (2014) suggested that the playas degas CO_2 during carbonate mineral precipitation from the Mg-HCO_3 rich groundwater. The complex interactions between minerals, fluids and the atmosphere make Atlin an ideal site to test methods for measuring CO_2 fluxes in a predominantly abiotic geologic setting. Eddy covariance (EC) and dynamic closed chamber (DCC) systems, combined with meteorological sensors, were co-located to directly quantify rates and characterize processes governing the CO_2 flux across the playa-atmosphere interface. Data were collected continuously over 27 days in August 2020 and 12 days in 2021. The results from the DCC method show distinct diurnal oscillation of CO_2 fluxes, with average daytime fluxes of +0.17±0.36 μmol m^{-2} s^{-1} and nighttime fluxes of -0.24±0.32 μmol m^{-2} s^{-1} (positive upward and negative downward). The near-zero flux measured via the DCC method indicates minimal net exchange of carbon across the playa-atmosphere interface. These observations imply that DCC-measured CO_2 fluxes are governed predominantly by changes in CO_2 solubility in alkaline porewater related to diurnal temperature fluctuations and variations in CO_2 concentrations in ambient air above the ground surface. However, the EC data show a continuous positive flux averaging +1.39 μmol m^{-2} s^{-1} (2020) and +1.11 μmol m^{-2} s^{-1} (2021). The net flux of CO_2 measured by EC is from a source undetected by the DCC (i.e. CO_2 imported laterally from surrounding forests or released through preferential pathways in the playa). The use of two flux measurement methods reveals the importance of the scale and location at which CO_2 flux processes occur at this site and the necessity of cross-validation between methods. These findings provide insights for the larger-scale application of these methods for monitoring and verification of *ex-situ* carbon mineralization at enhanced weathering sites.

[1] Power, I. M. *et al.* A depositional model for hydromagnesite-magnesite playas near Atlin, British Columbia, Canada. *Sedimentology* **61**, 1701–1733 (2014).