Potential carbon sequestration in perchlorate brines on Mars: Experimental studies

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Perchlorates have been widely detected across the surface of Mars including site locations between 4.5°S and 68°N [1-3]. Perchlorates can lower the freezing temperature of liquid water down to -70°C facilitating the existence of both temporary brines (e.g., thin water films) on Mars' surface and permanent large brines in the subsurface over the entire history of Mars. Although these perchlorate brines might have been a potential sink of the atmospheric CO_2 on Mars, the interaction between $CO_{2(g)}$ and perchlorate brines is poorly understood.

In this study, we present several experiments to simulate the interaction between the $CO_{2(g)}$ and Mg, Ca, Na-perchlorate solutions in a closed system at a pCO_2 of 4 mbar and four temperatures (i.e., 30, 4, -15 and -33°C). The interaction between the $CO_{2(g)}$ and Mg, Ca, Na-perchlorate solutions was traced by measuring the carbon isotope composition of the CO_2 ($\delta^{13}C_{CO_2}$) and its concentration in the head space above perchlorate solution using the Gas Bench II system coupled with a Finnigan™ MAT 253.

The $\delta^{13}C_{CO_2}$ value of CO_2 in the headspace above the perchlorate brines evolved from the starting $\delta^{13}C_{CO_2}$ at zero reaction time to a lower constant value which decreases with decreasing temperature. At all temperatures, the CO_2 above the $MgCl_2O_8$ brines possess the lowest $\delta^{13}C_{CO_2}$ value. The decrease in the $\delta^{13}C_{CO_2}$ value was also associated with a decrease in the CO_2 fraction in the headspace suggesting that CO_2 was trapped in the brines. We interpret the decrease in the $\delta^{13}C_{CO_2}$ value as an indication of the carbonate precipitation in the brines, especially in the $MgCl_2O_8$ brines. Carbonate formation in brines is consistent with the low amounts of carbonate in Martian dust, Martian sediments and Martian meteorites. Moreover, subsurface brines on Mars can provide long term subsurface storage of carbon.

[1] Glavin D.P. et al. (2013) *JGR, 118*, 1955–1973. [2] Hecht M.H. et al. (2009) *Science, 325*, 64–67. [3] Navarro-González, R. et al. (2010) *JGR, 115*, E12010.