Hydromagnesite-magnesite playas: A model for carbon storage

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Hydromagnesite-magnesite playas (hectare-scale) are found near the town of Atlin, British Columbia, Canada. The playas were first described in 1916 by Young [1] and, most recently, characterized in the context of a biogeochemical model for CO_2 sequestration by Power et al. [2,3]. The weathering of ultramafic bedrock results in Mg-rich groundwaters that discharge into topographic lows where microbial, geochemical and physical processes mediate carbonate precipitation. The playas may be thought of as a natural repository of CO_2. Although magnesite [$MgCO_3$] is the most stable Mg-carbonate mineral, its precipitation is kinetically inhibited as a consequence of the strong hydration of Mg^{2+} ions [4]. As a result, the playas consist of a complex assemblage of hydrated Mg-carbonate mineral phases.

Aragonite [$CaCO_3$], dypingite [$Mg_5(CO_3)_4(OH)_2 \cdot 5H_2O$], and nesquehonite [$MgCO_3 \cdot 3H_2O$] may precipitate directly from surface and ground waters, which undergo diagenesis post-deposition. Playa sediments at depth (up to ~3 m) were collected along a transect (90 m) at 5 and 10 m intervals. The sediments are mainly composed of hydromagnesite [$Mg_5(CO_3)_4(OH)_2 \cdot 4H_2O$], but also contain magnesite. The abundance of magnesite at the surface ranges from 7 to 40 wt.% across the playa. The water table (~1 m depth) coincides with a hard crust containing up to 10 wt.% lansfordite [$MgCO_3 \cdot 5H_2O$]. Below ~1 m, the abundance of magnesite typically increases and may be up to 87 wt.% with hydromagnesite being the remainder. The Mg-carbonate sediments overlay Ca-carbonate sediments containing aragonite and dolomite [$CaMg(CO_3)_2$], which overlay glaciolacustrine sediments. Electron microscopy shows that magnesite forms as a distinct mineral phase and does not show intergrowth with hydromagnesite (Figure 1); meaning that it likely does not form from dehydration of hydromagnesite. The current focus is on understanding the geochemical conditions of low-temperature magnesite formation, which has implications for the long-term storage of anthropogenic CO_2 as Mg-carbonate minerals.
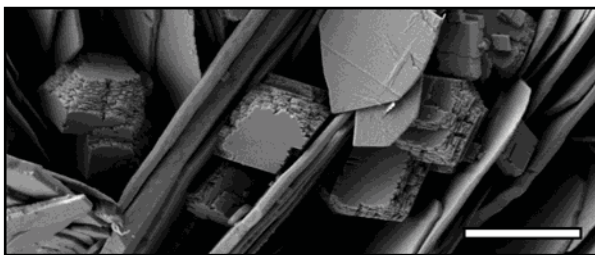

Figure 1: Low-temperature magnesite (rhombohedral crystals) forming between hydromagnesite plates (1 μm scale bar).

[1] Young (1916) *GSA Report*, 50-61. [2] Power *et al.* (2009) *Chem. Geol.* **206**, 302-316. [3] Power *et al.* (2007) *Geochem. Trans.* **8**:13 [4] Hänchen *et al.* (2008) *Chem. Eng. Sci.* **63**, 1012-1028.

Records of atmospheric Pb deposition along the St. Lawrence Valley, Quebec

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Ombrotrophic peat bogs provide reliable historical records of atmospheric metal deposition, in particular lead [1]. To date, most studies were carried out in Europe and served to document various periods of anthropogenic activities. In contrast, records of atmospheric metal deposition in North America are still scarce. The objective of this study was to reconstruct the recent history of atmospheric metal deposition (Pb, As, Cd, Ni and Zn) along the St. Lawrence Valley (SLV).

Cores (50 to 100-cm long) were collected in four peat bogs along the SLV. They were sub-sampled at 1 to 5-cm intervals and analyzed for their trace metal contents (Pb, As, Cd, Ni and Zn). Here, we present the vertical distributions of Pb and its stable isotopes (204, 205, 206, 207) in the four cores. Core chronologies were established using ^{210}Pb for the surface horizons and ^{14}C for the deeper sections. Regional, natural background metal concentrations and isotopic signatures were established from the analysis of samples taken from the bottom of the bogs. When the latter were not available, values from the upper continental crust (UCC) values were used [2]. Variations from these values within the cores were compared to the isotopic composition of North American major lead-bearing ores (used for the synthesis of gasoline additive) and modern aerosol for U.S. and Canada (1994-1999).

Preliminary results show that anthropogenic Pb concentrations increased sharply from the start of the 19th through the 20th century to reach a maximum between 1940-1970. The age and amplitude of this peak vary spatially along the SLV and, in some cases, can be associated with specific anthropogenic activities (e.g. smelting) or the convergence of different air masses. Since the 60's, lead concentrations have decreased rapidly, following the ban on leaded gasoline, but they have not reached pre-anthropogenic levels. Results show that the southwestern SLV has been more impacted by anthropogenic Pb.

Stable lead isotopes analyses are ongoing and will help discriminate between different anthropogenic and natural sources of atmospheric Pb at the study sites.

[1] Shotyk *et al.* (1996) *Earth Planet Sci Lett*. **145**, 1-7.
[2] Wedephol (1995). *Geochim. et Cosmochim. Acta* **59**(7), 1217-1232.