Mars brine attacks! Accelerated dissolution rates and unique reaction products in high salinity brines.

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Mars is a salty world, as evidenced by widespread sulfate and Cl-rich phases in Mars meteorites delivered to Earth, as well as soils and sedimentary rocks observed by landers, rovers, and orbiters. These salts allow liquid water at or near the surface due to lower freezing temperatures and vapor pressures, resulting in thermodynmic stability and/ or slow evaporation rates. Indeed, melting/ evaporation/deliquescence of salty water likely forms recurring slope lineae and causes fluctuations in atmospheric water vapor. This suggests briny, near-surface waters on Mars may have been active throughout the Amazonian, providing environments for both inorganic chemical weathering and potential biologic processes on Mars. Since most natural waters on Earth are comparatively dilute ($\leq$3.5 wt% salt in seawater), we know relatively little about how minerals react with brines.

Here we compare results from >100 mineral dissolution experiments aimed at measuring sulfate, carbonate, clay, pyroxene, and feldspar mineral dissolution rates in sulfate, chloride, and perchlorate brines. Most dissolution rates slowed as salinity increased, particularly in near-saturated brines, likely due to low water activity in these systems. However, in some cases mineral dissolution rates accelerated with increased salinity, suggesting cation and anion chemistry can also play a significant role in dissolution mechanisms. In particular, Fe-bearing mineral (jarosite and siderite) dissolution rates increased in chloride brines, while pyroxene dissolution rates increased in sulfate brines. In some cases, increased dissolution rates in brines may be driven by secondary mineral precipitation. Faster apparent calcite dissolution in near-satruated $MgCl_2$ brine may be due to Ca-Mg exchange, resulting in dolomite precipitation. Likewise, jarosite dissolution in in $CaCl_2$ brine yielded anhydrite, gypsum, and abundant akaganeite. These experiments demonstrate that brine-mineral interactions cannot be directly extrapolated from behaviors observed in more dilute solutions.