# Mineral depositions via mixing of surface water and groundwater on early Mars

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There is a variety in mineralogy in lacustrine deposits on early Mars[1,2]. This includes silica-rich deposits/fracture halos, clay mineral (Fe/Mg saponite)-rich deposits, and sulfate deposits in sedimentary rocks of Gale Crater[2]. This diversity would reflect changes in water chemistry of lakes, possible due to changes in sources of water[3,4] and redox environments[5]; however, the details of the causative mechanisms are largely unknown. Here, we suggest that the variety in mineralogy would have been caused by mixing of two distinct water sources (i.e., groundwater and surface water) with different chemistry on early Mars. Upon warming events[5], surface ice with sulfuric acid frost would have become molten[3], forming an acidic surface water with high levels of $SO_4$, Mg, and Fe. This acidic water would have been supplied to lakes via surface runoff. On the other hand, alkaline groundwater[4] with high concentrations of $SiO_2$, Al, and Ca would have upwelled to the surface at topographic lows (e.g. deep crater floor). Through mixing of these waters at different fractions in lakes, a variety of mineral deposits, such as silica, clay minerals, and sulfate, would have been generated. We report experimental results on mineral precipitation at low temperatures via mixing laboratory analogs of surface water and groundwater on early Mars. We aim to investigate whether simple mixing of two water sources can generate a variety in mineral deposits and to determine threshold pH and chemical compositions of water sources for silica, clay minerals, and sulfate precipitations.

1: Ehlmann & Edwards (2014) Annu. Rev. Earth Planet. Sci. 42:291; 2: Hurowitz et al. (2017) Science 356, eaah6849; 3: Fukushi et al. (2019) Nat. Comms. 10:4896; 4: Kikuchi & Shibuya (2021) Minerals 11, 341; 5: Wordsworth et al. (2021) Nat. Geosci. 14, 127

 