Hydrology and astrobiology on early Mars: Insights from hydrology in cold semiarid areas in central Aria, Mongolia

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The surface of current Mars is hyperarid and cold; however, early Mars would have been wetter and warmer in ~4 billion years ago as evidenced by the widespread occurrence of valley networks, lake deposits, and clay minerals. Despite of the geological and geochemical evidence for surface liquid water, climate models suggest that a long-term, wet and warm Mars is not sustainable. Instead, recent climate modeling and geochemical modeling have proposed relatively short-term semiarid climates for early Mars to explain the geological and geochemical observations (Wordsworth et al., 2015; Bishop et al., 2018; Fukushi et al., 2019). Although theoretical models are used to investigate past climates on Mars, hydrological cycles on early Mars remain poorly constrained based on geological evidence. Did groundwater supply sustain surface water? Was surface runoff required to support surface water? Was the water chemistry of the surface water same as that of groundwater? These questions remain unsolved due to lack of the constraints on groundwater chemistry and subsurface hydrological cycles on early Mars. In this regard, terrestrial analogs of saline lakes at semiarid climates may provide insights into the fluvial/lacustrine environments on early Mars.

Here, we report results of geological survey for subsaline closed-basin lakes in the Khangai and Gobi-Altai mountains transition zone in southern Mongolia. The Valley of the Gobi Lakes is semiarid, where evaporation predominates precipitation (Szuminska, 2016). The water source of the Valley of the Gobi Lakes replies largely on the supply from snow melting and permafrost degradation of the Khangai mountains. These characteristics of the climate, hydrology, and possibly biology may allow this area as a promising and unique terrestrial analog for closed-basin lake systems developed on semiarid early Mars.

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