# Mars: Geochemical cycling on a once habitable world

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What governs whether large-scale planetary habitability is sustained through time? Lakes, valley networks, and chemically open-system weathering once existed on Mars. Groundwaters at temperatures ranging from just above freezing to hydrothermal have also left a rich mineralogical record. The suite of aqueous environments preserved in Mars' rock record – similar in diversity to Earth's – ranges in pH, temperature, redox, and chemical species, varying in space and time. Was there life in these habitable environments? What sustained liquid water against freezing? What dictated environmental variability? And what drove long term environmental change? With >50% of the surface rock record that is well-preserved from the first two billion years of its evolution, Mars is a linchpin in understanding the geochemical processes driving terrestrial planet evolution and habitability. Here I will discuss the variability in geochemical environments with liquid water and the consequences of aqueous alteration of the Martian crust on the composition of the atmosphere. Additionally, I will identify some key stratigraphies where a combination of focused in situ analyses and/or sample return can search for past Martian life and answer many unresolved questions about the timing and nature of early Martian habitats.