Edwin Kite

Title: Mars and the problem of planetary habitability

Abstract:

It is not known whether Earth's long-term climate stability is rare or common. Kepler data suggest many Earth-radius habitable-zone planets lie within reach of JWST. The fraction of these that are habitable depends on the unknown processes that regulate long-term environmental stability. Mars' sedimentary record is the only known archive of a major planetary habitability transition. No rivers flow on today's Mars, but rovers and orbiters have found >3 Ga-old sedimentary rocks, dry rivers and paleolakes, and aqueous minerals. The nature of the early wet era, the processes that allowed surface liquid water, and the cause of climate deterioration are all unknown.

In this talk, I will use a snowmelt model (ISEE-Mars) to understand the global environmental context of sedimentary rock formation on Mars. Greenhouse models struggle to maintain annual mean temperatures 273K on Early Mars, making snowmelt an attractive candidate water source for sedimentary-rock cementation. Snowmelt predicts that Mars never had a stable multibar atmosphere, consistent with results from our new paleobarometer. The "Curiosity" rover is currently exploring the moat encircling a 5km-high sedimentary rock mound in Gale Crater. This moat-and-mound pattern is common in Mars craters and canyons, but its origin is unknown. I will set out the evidence that moats and mounds grew together, shaped by slope winds down the crater and mound flanks. If time allows, I will discuss (rare) fluvial sediments that are anomalously recent. Results from a mesoscale model show these deposits may record transient, localized conditions, rather than a global return to wet conditions. Taken together, data and models hint at an early Martian climate comparable to the Antarctic Dry Valleys. The "Curiosity" rover will soon be in a position to test this hypothesis.

In combination, we now have the tools and the data to recover quantitative information about trends, rhythms and aberrations in Early Mars habitability. Billion-year-baseline time series from Mars and Earth are complementary to “snapshots” of exoplanet climates ... and both will be needed to develop a science of habitability on planets-in-general.

Cheers,
- Edwin