MARS-ANALOGUE ALLUVIAL FANS IN THE CHILEAN ATACAMA DESERT. A. M. Morgan[1], M. C. Palucis[2], R. M. E. Williams[1], A. D. Howard[1], D. E. H. Hobley[3], J. M. Moore[4], R. A. Craddock[5], [1]Planetary Science Institute, Tucson, AZ, amorgan@psi.edu, [2]Dept. of Earth Sciences, Dartmouth College, Hanover, NH, [3]School of Earth and Environmental Sciences, Cardiff University, Wales, UK, [4]NASA Ames Research Center, Moffett Field, CA, [5]National Air and Space Museum, Smithsonian Institution, Washington, DC.

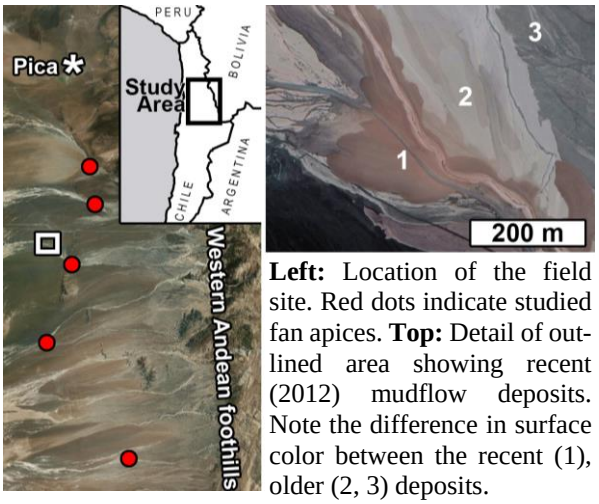
Introduction: Large alluvial fans on Mars offer compelling evidence that surface runoff persisted, at least episodically, into the Hesperian or Amazonian periods. This era has generally been thought to be cold and dry, and characterizing the climatic environment that permitted fan formation can offer insight into Mars' potential late-stage habitability. Here we describe ongoing field work at a suite of large alluvial fans in northern Chile which we believe to be the closest process and morphologic analogue to the martian alluvial fans.

Alluvial fans on Earth: Alluvial fans are sedimentary landforms found at the base of mountain fronts where a channel emerges onto a valley floor. Lateral spreading of flow and reduction in slope force the deposition of sediment, over time building up a fan. As a depositional feature in close proximity with its sediment source, alluvial fans preserve a record of environmental change during the transport and deposition of sediment. In addition, alluvial fans are often the only record of fluvial activity in arid regions since the limited available runoff may not reach main fluvial channels [1-2].

Alluvial fans on Mars: We [3-5] have identified several patterns in surface features and morphology: **(1)** martian alluvial fans are large (tens of km in length) and gently sloped (<5°); **(2)** martian alluvial fan surfaces have branching ridges that radiate downslope from the fan apex. These have been inferred to be the former channel network now expressed in inverted topographic relief following aeolian removal of more erodible overbank sediments [3–5]; and **(3)** martian alluvial fans were deposited by a bimodal transport and deposition regime. Many of the exposed ridges contain bedform features such as scroll bars [e.g., 4,6,7], consistent with channelized fluvial flow. However, HiRISE images reveal meter-thick (though image resolution limits detection of finer-scale bedding) layers indicative of the deposition of fine-grained sediment in broad sheets [6].

Alluvial fans in the Pampa de Tamarugal, Chile: These characteristic observational patterns of martian alluvial fans are distinctive from most terrestrial examples and represent processes inconsistent with common conceptual models of alluvial fan sedimentation [e.g., 1-2]. Terrestrial alluvial fans are generally classified as either debris flow or fluvial flow dominated [e.g. 7], rather than resulting from both sediment-gravity and fluid-gravity processes, as appears to be the case for the martian fans. Like their typical martian counterparts, alluvial fans in the Chilean Atacama Desert are exceptionally large (average area of ~200 km^2 and relief of .5 km). They share a dominantly fine-grained composition, similar gentle gradient, reworking of inactive fan surfaces by aeolian processes, and sediment and runoff sources almost exclusively from mountainous uplands. As with the martian alluvial fans, the dominant flow regime is bimodal, with channels transporting cobble- to boulder- sized bedload and layered fine-grained mudflows that extend laterally from the channel [6].

Ongoing work: Our field work aims to address three hypotheses regarding fan formation on Mars: (1) There is a predictable relationship between the sediment and water discharge with the subsequent flow rheology, (2) Ridges on inactive portions of the alluvial fans represent the formerly active channel network and can be used to infer paleoflow conditions, and (3) Overbank mudflow deposits constitute the bulk of fan sediment, but channelized fluvial flow creates a channel network responsible for delivering this sediment across the fan. Developing and applying new conceptual models of fan sedimentation to the martian fans, we will be able to place hard constraints on the paleohydrologic conditions during the time of martian alluvial fan formation.



Left: Location of the field site. Red dots indicate studied fan apices. **Top:** Detail of outlined area showing recent (2012) mudflow deposits. Note the difference in surface color between the recent (1), older (2, 3) deposits.

References: [1] Blair T.C. & McPherson J.G. (2009) *Geomorph. of Desert Env.* [2] Stock J.D. (2013) *Treat. on Geomorph.*, vol. 9. [3] Moore J.M. & Howard A.D. (2005) *JGR* 110(E4) [4] Morgan A.M. et al. (2019) *LPSC* 50, #3256. [5] Wilson et al. (2021) *GRL* 48(4). [6] Morgan A.M. et al. (2014) *Icarus* 229. [7] Blair T.C. (1999) *Sediment.* 46.