HYPERARID FANS IN THE ATACAMA DESERT ARE AN INTERESTING ANALOG TO MARTIAN FANS. E. R. Kraal[1]
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Introduction: The Atacama Desert has been used as a planetary analog in the search for extremophiles [1], testing rovers and remote sensing equipment [2] as well as other processes [e. g. 3, 4]. In addition, the Atacama Desert, Chile is a hyperarid environment filled with sedimentary fans [e. g. 5]. These fans are useful analogs to the hundreds of fans that have been discovered on the Martian surface [e. g. 6-8].

Atacama Desert, Chile: Filling a series of North-South trending valleys, the Atacama Desert stretches from ~10° to 27° South bound on the East by the rising High Andes and the Altiplano and on the West by the Pacific Ocean and Peru-Chile Oceanic Trench. Sheltered by the rain shadow of the High Andes and with the local atmosphere cooled and stabilized by the northward flowing Humbolt Current, hyperarid conditions have dominated this landscape for 10 – 15 million years [e. g. 9]. Though ephemeral streams flow occasionally, often spring fed by precipitation on the Altiplano, and there have been some long-period climatic variations, the landscape is largely devoid of vegetation and surface features are considered to be ancient. Playas, sedimentary fans, and active tectonic features dominate the landscape. Currently the dominant geomorphic process is wind erosion, which sculpts the previously formed fluvial features.

Martian Fans: Sedimentary fans have been identified across the Martian surface and have been classified by various researchers as ranging from deltas to alluvial fans [6-8]. It is unclear what climate conditions contributed to the formation of these fans; in addition, different climates may have been responsible for forming different populations of fans. Clearly, however, there must have been flowing surface water to transport and deposit particles into sedimentary fans. It is likely, given the lack of extensive weathering products like clay, that surface exposure to water was limited (in time and/or space). Therefore, many of these Martian fans may have formed under conditions similar to the hyperarid ones found in the Atacama Desert, Chile.

Atacama Desert as an Analog: The fans in the Atacama Desert serve as useful analogs for many reasons (Figure 1 A-F). First of all, the fans formed under conditions of sporadic precipitation over areas with generally low surface water tables (Fig. 1A). The fans experience transitions from pluvial to fluvial to debris flow environments (Fig 1B, F). The overall persistent hyperarid conditions limit the development of vegetation and clays and the consequent cohesive effects these can have on sedimentary bodies in humid depositional systems (Fig B.) Eolian processes play an important role in the Atacama Desert, eroding previously formed fluvial features, covering up sediment deposits, and modifying surface grain sizes (Fig B-E.)

Summary: Fans located in the hyperarid Atacama Desert serve as valuable, accessible analogs for processes that may have been important in forming the Martian fan population. The variety of sedimentary fans in the Atacama Desert correlates well with those hypothesized to have formed on Mars. The environment has many important similarities and future work will aim to quantify these similarities to provide meaningful insights into the hydrologic, climatic, and geomorphic conditions required for Martian fan formation.

References: [1] Cabrol, et al. (2007) *JGR* doi:10.1029/2006JG000298 [2] Piatek et al. (2007) *JGR* doi:10.1029/2006JG000317. [3] Heldman et. Al. (2008) *LPSC XXXIX*, #2214 [4] Cabrol, et al. (2001) *JGR* doi: 10.1029/1999JE001181 [5] Hartley et al. (2005) in Alluvial Fans…,95-115. [6] Irwin et al. (2005) *JGR* doi:10.1029/2005JE002460 [7] Moore and Howard (2005) *JGR* doi:10.1029/2004JE002352 [8] Kraal et al. (2008) 2007, doi:10.1016/j.icarus.2007.09.028 [9] Hartley and Chong (2002) Geology, v. 30, 43-46.

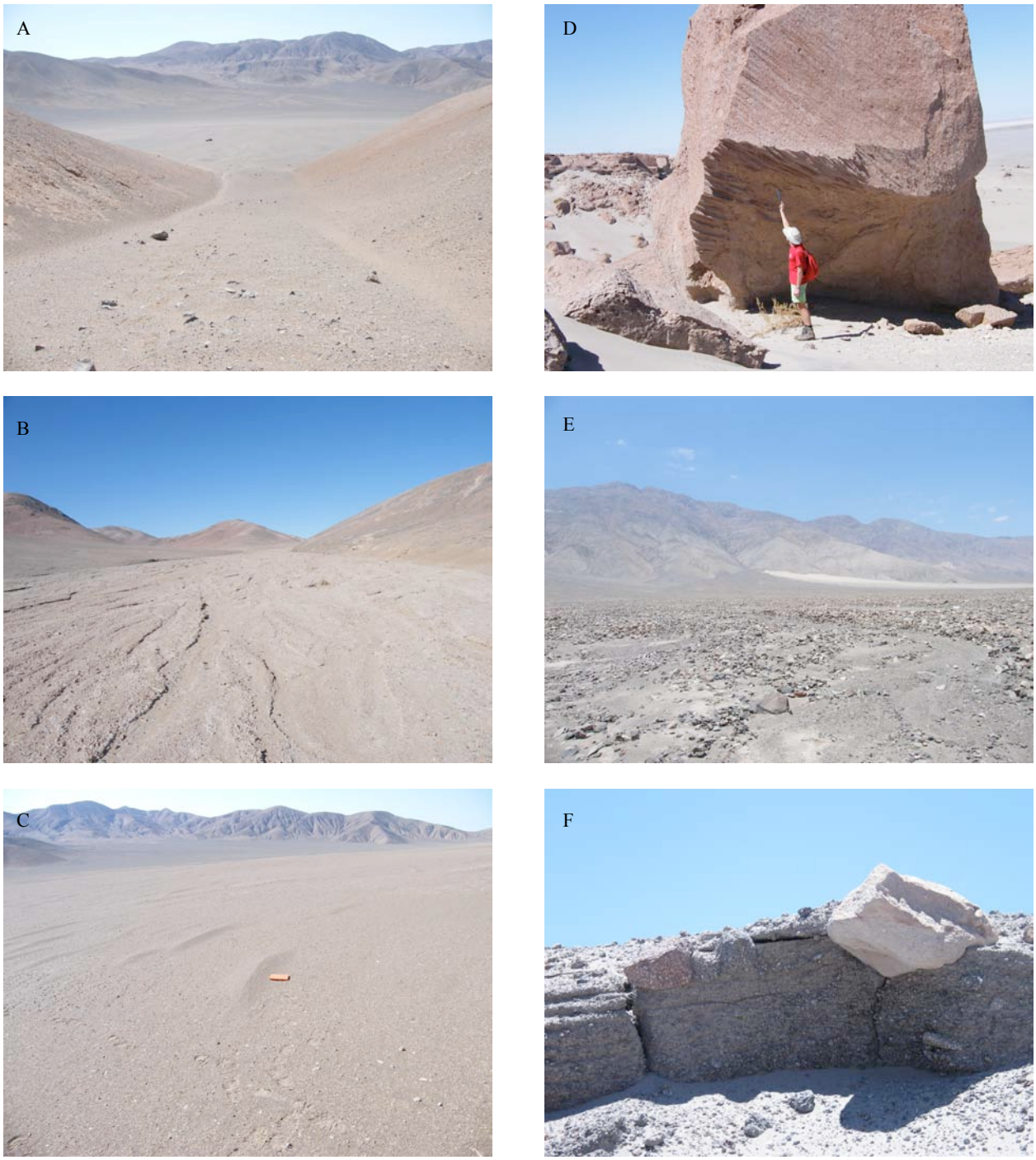

Figure 1: Images of hyperarid alluvial fans in the Atacama Desert, Chile.
A) Looking down the apex of an alluvial fan into a valley near Iquique, Chile filled with a bahada of alluvial fan aprons. Truck for scale. B) The most active portion of an alluvial fan with small braiding and channel depths of a few centimenters. C.) Surface of an alluvial fan following eolian erosion and deposition. Small ripples cover the surface (field notebook for scale), the active braided channels have been removed, and the grain size distribution has been modified. D.) Eolian erosion is extensive, as evidenced by the winnowing and scour marks over 4 meters up this large boulder. E.) A dune field encroaches on an alluvial fan forming along the coastal mountains just north of Antifogasta, Chile. F.) The fans have experienced transitions between fluvial processes (evidenced by the smaller grain sizes) and boulder transporting (white boulder is ~1 m) debris flows, photo taken near San Pedro de Atacama, Chile. (all photographs by E. Kraal)