Could some craters on Mars have acid water origins? D.A. LaClair[1] and K.C. Benison[2], [1] Department of Geology, Central Michigan University, 314 Brooks Hall, Mt. Pleasant, MI, 48858; star_spacecadet@yahoo.com, [2] Department of Geology, Central Michigan University, 314 Brooks Hall, Mt. Pleasant, MI, 48858; benis1kc@cmich.edu

Introduction: Physical sedimentology experiments using a 39% concentration of sulfuric acid have produced three distinct features, which are similar to features seen on Mars. However, these sedimentary features could not be created using pure water in the laboratory. These three features include deeply-incised, narrow channels, cracks that run parallel to the flow direction, and circular depressions that are concentrated along the toes of alluvial fans. These circular depressions, which form syndepositionally, are likely produced by the release of trapped air or possibly by gases escaping to the surface. They closely resemble impact crater features, though they are on a significantly smaller scale [1].

Background: Clark (2-5) first proposed the possibility that sulfuric acid could exist on Mars. This theory was based on the elemental composition of Mars' surface fines with their unusual abundances of sulfur, the lack of carbonates, as well as the physical characteristics of a 39% sulfuric acid solution . A 39% sulfuric acid solution, based on its freezing point, would be stable on Mars' surface today.

Burns (6,7) noted that some minerals and chemical compositions from the Martian surface indicate that Mars likely has experienced long-term oxidative weathering such as in Australia, perhaps due to acid saline meltwaters (6,7). Recently, a mineralogical and chemical similarity has been demonstrated between data returned from Mars and shallow, acid saline lake systems in modern Western Australia and the Permian of the midcontinent of the U.S. (8).

Our physical sedimentology experiments have shown that many of the surface features seen on Mars, which have historically been attributed to creation by water [9], could have been created by a 39% sulfuric acid solution [1]. Such features produced only during acid runs that resemble features on Mars include deeply incised, narrow channels and valleys, surface cracks that run parallel to the flow direction, and "crater" air bubbles, which are circular depressions that tend to form along the edges of alluvial fans or along the base of slopes [1].

Martian Analogs: The Martian surface is pockmarked with numerous impact craters. Many are large complex craters, but many more are smaller (<1km) in diameter. In some regions on the planet there are debris flows that contain concentrations of circular depressions along the toe of the flows (Fig. 1). These features have been interpreted to be impact craters, however, they greatly resemble the "crater" air bubbles produced during physical sedimentology experiments performed in terrestrial lab conditions [1]. They also resemble pockmark structures seen on Earth, found typically in ocean settings [10].

Terrestrial Analogs: There are numerous examples of terrestrial crater-like features produced by various processes. They range in size from raindrop imprints (mm-scale) [10] to pockmark structures (10m-700m) [7]. Non-impact related crater-like features seen on Earth are typically rimless and some can even have a central peak, which closely resembles the central peak seen in large, complex impact structures [10,11]. They can be created by biological process or by abiological processes in different environmental settings. Subsurface organisms can create crater-like features by respiration or burrowing [9]. Crater-like features can also be created as water or gas escapes to the surface during periods of heavy fluidized sedimentation or by the release of gases under pressure [11].

Conclusions: Although it is likely that most craters on Mars were formed by meteorite impacts, alternate theories should be considered a possibility for some of the smaller craters. Craters concentrated along the toes of alluvial fans may possibly be a result of acid water deposition, similar to those created in physical sedimentology experiments. This would mean a drastic reconsideration for Mars' interpreted surface age, which is based on crater density counts of the planet's surface.

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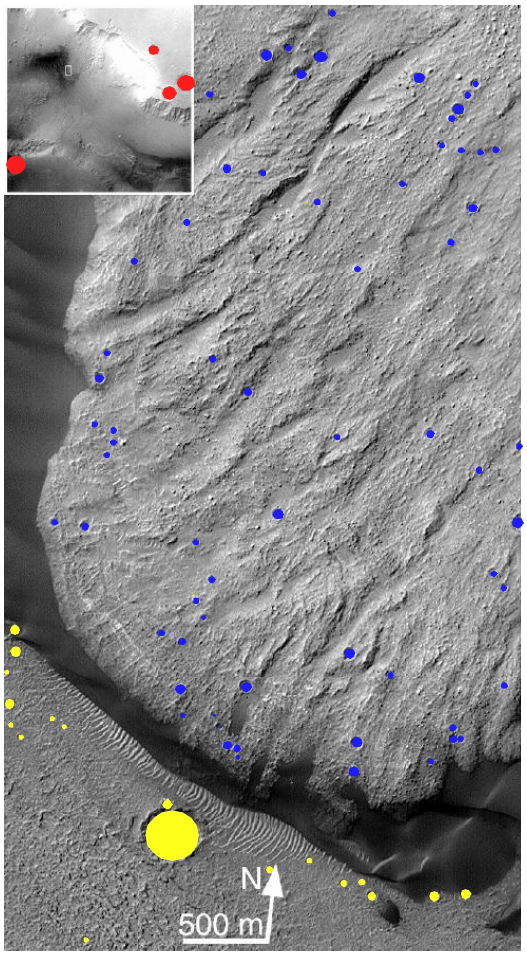

Figure 1: Debris flow deposit in Ganges Chasm. Red dots indicate large impact structures, blue dots show crater-like features on debris flow, and yellow dots show crater-like features on chasm floor. (Modified from MSSS/NASA)