SEDIMENT PREDICTION THROUGH BASIN ANALYSIS: An example from Acidalia Planitia.

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Introduction: Basin analysis is used on Earth to predict amount, age, and types of sediments likely in locations having limited subsurface data. Regional geology, aerial photography, and satellite data are the main tools for this type of analysis. We have used a similar approach for predicting sediment accumulations in Acidalia Planitia, Mars [1] and have applied that to interpretation of high-albedo mounds from the region.

We have incorporated Mars Orbiter Laser Altimeter (MOLA) data to assess the regional setting of Acidalia with regard to sources of sediments, catchment area, and depositional sites. We have coupled this with the mapping of the Acidalia mounds and with details of their geomorphology from Context Camera (CTX) and High Resolution Imaging Science Experiment (HiRISE) images. We used Compact Reconnaissance Imaging Spectrometer for Mars (CRISM) data, thermal inertia, and regional gravity to help constrain our interpretations and our model of sedimentation.

Results: Chryse and Acidalia Planitiae (Fig. 1) have been proposed to be remnants of impact basins, formed ~4 Ga ago [2]. Together, they comprise an embayment [3] that was the focal point for sediment deposition from Hesperian outflow channels (Fig. 1).

Chryse is the proximal portion of that embayment. Channel deposits within Chryse are illustrated in Fig. 1. Acidalia is interpreted as the distal portion of the embayment. This is supported by occurrence of streamlined islands near the NE end of the Chryse Basin suggesting that water from the Hesperian floods spilled over into Acidalia [4-5]. In this distal position, Acidalia would have received the finer-grained fraction of sediments deposited during Hesperian flooding.

Within Acidalia, there are abundant high-albedo mounds. Mapping demonstrates 18,000+ of these and shows their spatial distribution to correspond to the southern portion of the Acidalia impact basin [1, 6]. HiRISE data add morphological detail that best supports an analog of terrestrial mud volcanism [1]. CRISM responses are consistent with this interpretation, as are estimates of thermal inertial and regional gravity [1].

Summary and Conclusions: Basin analysis suggests that Acidalia Planitia was the depocenter for accumulation of fine-grained sediments delivered by the Hesperian outflow channels. This is a unique setting on Mars in which especially large quantities of fluids and muds would have been concentrated. We propose that the profusion of mounds in Acidalia is a consequence this unique setting.

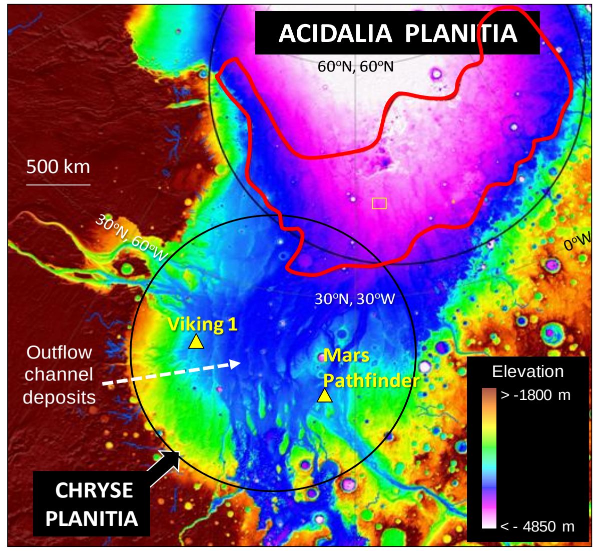

Fig. 1. Chryse-Acidalia embayment on stretched MOLA topography (polar projection). Black circles show proposed impact basins [2]. Red outline is area in which tens of thousands of mounds have been mapped.

The catchment area for the Chryse-Acidalia embayment includes a large portion of the Highlands. If organic materials were present in that catchment, they could have been carried with flood waters to the Chryse-Acidalia embayment. Since organics tend to be deposited - and preserved - with fine-grained sediments, buried sediments in Acidalia could contain remnants of such organic materials and these could include biosignatures of possible microbial life on Mars.

The basin analysis approach has resulted in new insight into the depositional history of Acidalia and that, in turn, has provided a regional context which supports comparison of the Acidalia mounds to mud volcanoes. Since mud volcanoes transport minimally-altered materials from depth to the surface, mud volcanoes in Acidalia may offer a means of tapping samples from deep zones that would otherwise be unreachable. Such samples may contain organic or mineralogical signatures of potential astrobiological significance [7]. Thus, the mounds in Acidalia may provide a new class of exploration target for Mars.

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