A NEW FLUVIAL ANALOG FOR THE RIDGE-FORMING UNIT, NORTHERN SINUS MERIDIANI/ SOUTHWEST ARABIA TERRA, MARS. M. J. Wilkinson[1], C. C. Allen[2], D. Z. Oehler[2], and M. R. Salvatore[3] [1]Jacobs Engineering, PO Box 58447, Houston, TX 77258, jwilkin1@ems.jsc.nasa.gov , [2]NASA - Johnson Space Center, Houston, TX 77058, [3]Pennsylvania State University, University Park, PA 16802.

Introduction: The origin of the Noachian ridge-forming rock unit, which outcrops widely in Sinus Meridiani and SW Arabia Terra (10N–2S, 10W–8E), is enigmatic [1]. Fracture fill and fracture hardening have been proposed to explain the characteristic long narrow ridges [2, 3], as has the filling of giant polygonal troughs [1]. We suggest that a fluvial origin explains many of the observed features. A terrestrial analog for the ridge-forming unit may be the fluvial *megafan*, a feature recorded mainly in India and South America [e.g. 4, 5], but whose significance is only now becoming appreciated [6]—possibly because megafans have been difficult to recognize due to their size and overprinting by younger features such as sand dunes. Several megafan characteristics, especially (i) channel patterns, (ii) the very large areas covered by megafan channels (commonly 10^{4-5} km^2), and (iii) the regional/basin scale, fit characteristics of the ridge-forming unit well.

Terrestrial megafans: Megafans are partial cones of sediment with low slopes (<1°). The cone apex lies at the point where the formative river exits a confined upland valley (the erosional sector), and enters the neighboring depositional basin. Here the river is *unconfined* by valley slopes. This is the aggrading megafan sector (Fig. 1). The formative river lays down tracts of sediment (channel, levee, overbank) that radiate from the apex.

A global population of >150 megafans has been mapped on all continents, mainly from handheld imagery originally acquired from the Space Shuttle, between ~55N and 55S. Megafans achieve radii of hundreds of km (minimum radius arbitrarily set at 100 km in our study) and occur in many modern continental basins.

Channels. Because megafans are depositional fluvial features, their surfaces are dominated by active and inactive stream channels, unconfined by valley slopes. With active sedimentation, distributary and tributary channel relationships are common. Straight, sinuous, contorted and braided stream habits are all encountered. Active major and minor stream courses cross inactive channels.

When developed laterally along a mountain front, contiguous megafan surfaces occupy vast areas, e.g. 1.2 x 10^6 km^2 in central South America. The net result—of significance here—is that the prime geomorphic element is a network of crossing channels of different size covering the megafan surface(s).

Inverted ridges on megafans. Many desert megafans display relict river channels which appear as ridges standing several meters above the surrounding terrain (termed *inverted landscapes*). Subsequent erosion has lowered the intervening, less indurated inter-channel material. Terrestrial inverted landscapes have been mentioned as possible analogs for the ridge-forming unit of Sinus Meridiani [1]. Good examples are the Omani megafans in the Arabian peninsula [e.g. 7]. A tight pattern of crossing channels of different size is their most striking feature (Fig. 2).

Regional setting of megafans. Two characteristics of megafans apply to this analysis: (i) Unlike alluvial fans, the radius of megafans is controlled by the width of the accommodating basin. Large basins acquire large megafans. (ii) Sets of megafans form in continental basins of all tectonic types—even at the foot of topographically low uplands, as seen in Africa and Australia.

Features of the Ridge-forming Unit:

Features suggestive of channels. Excluded from our analysis were features overtly related to impact craters (rims, radial fractures, ejecta). Many of the remaining intercrater features appear to accord with channel patterns encountered on megafan plains (Fig. 3): (i) the prominent ridge-like features are straight to sinuous, of widely variable width; (ii) tributary and distributary relationships; (iii) crossing relationships; (iv) braids; (v) lateral migration of channels; (vi) twinning of ridges (suggestive of indurated stream banks in many deserts).

Regional setting of the ridge-forming unit. Valleys cut into rocks of the southern highlands have long been known. The valleys slope north towards Sinus Meridiani, and extend as far as the foot (north margin) of the southern highlands in the Meridiani region, along a distance of hundreds of km [8].

The location of the ridge-forming rock unit *immediately downstream of the terminations of these valleys* specifically suggests the following parallel with the megafan analog: north-flowing rivers which eroded the valleys deposited sediment upon entering the lowland. The ridge-forming unit, persuasively argued to be a layered sedimentary unit [1, 9], may be the depositional equivalent of the eroded mass. The mean orientation of the longer and more prominent ridges appears to be markedly NNW—i.e. generally away from the southern highlands. The *regional extent* of the ridge-forming unit over areas of 10^4 km^2 is suggestive of deposition on contiguous megafans, fed by drainages in the adjacent southern highlands. Terrestrial megafans can prograde hundreds of km from the source upland. Similarly, if fluvial systems emplaced the ridge-forming unit, this could explain the distribution of the unit up to hundreds of km from the uplands. The location of the ridge-forming unit accords with fluid flows from the Southern Highlands towards the low Northern Plains.

Conclusions: The ridge-forming unit of the Sinus Meridiani/Southwestern Arabia Terra intercrater plains shows many similarities to terrestrial megafans, including its great extent, ridge patterns that are reminiscent of channel habits in megafans, inverted ridge morphology, a NNW trend away from the Southern Highlands, and its setting immediately downstream of a valleyed upland and between the Southern Highlands and Northern Plains. This analogy supports the concept that the ridge-forming unit was fluvially emplaced.

References: [1] Edgett K. S. (2005) *Mars, 1,* 5–58. [2] Arvidson R. E. et al. (2003) *JGR, 108(E12)*, 20 pp. [3] Ormö J. et al. (2004) *Icarus 171*, 295–316. [4] Geddes A. (1960) *Trans., Inst. Brit. Geographers*, *28,* 253–276. [5] Iriondo M. H. (1984) *Quaternary of South America 2*, 51–78. [6] Wilkinson, M. J. et al. (2007) *Eos Trans. AGU, 88(52), Fall Meet. Suppl.,* Abstract P12C-03. [7] Maizels J. K. (1987) *Geol. Soc. (London) Spec. Pub., 35*, 31–50. [8] Carr M. H. (2006) *The Surface of Mars*, CUP, 307 pp. [9] Edgett K. S. et al. (2002) *Geophys. Res. Lett. 29,* 2179.

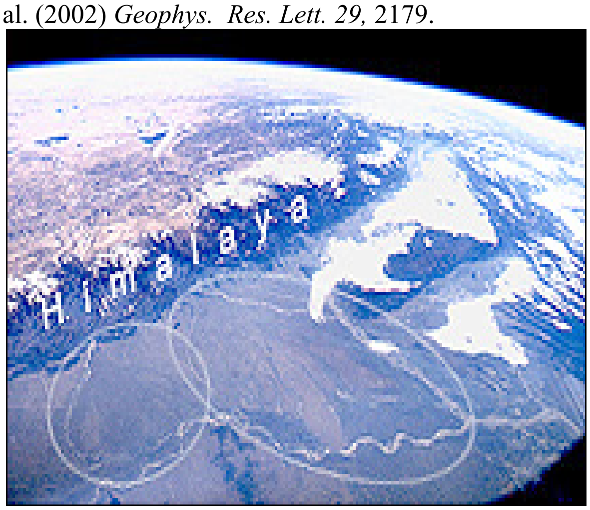

Figure 1. Between the Himalaya and the Ganges (across bottom of image), rivers generate large fans of sediment—the Kosi River megafan (left oval) is 170 km in radius, the neighboring Tista River megafan (right oval) 350 km in radius (Space Shuttle image STS27-39-27).

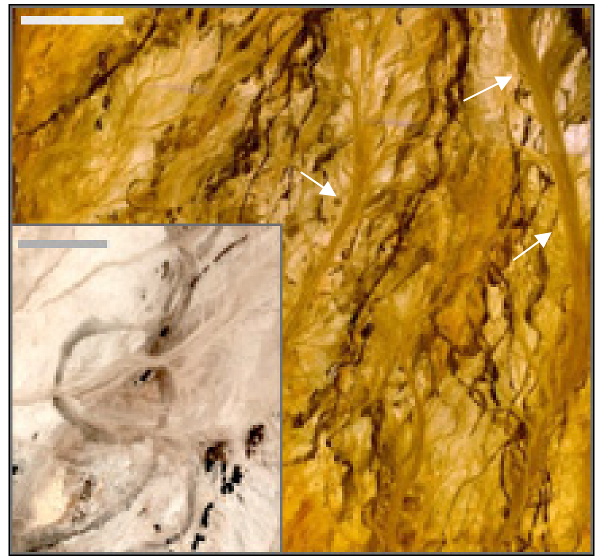

Figure. 2. All darker, sinuous lines are raised stream channels on a megafan surface in Oman; lighter lines are modern channels (arrows); flow diverges from an apex to the north outside the top of the view. Much of the flat fan surface is dominated by raised channels (image center 22.25N 57.85E; scale bar 5 km). *Inset:* darker lines in the image are raised channels, some straight, some meandering. Channels cross one another at several points (image center 22.25N 57.75E; scale bar 1 km; image courtesy of Google Earth).

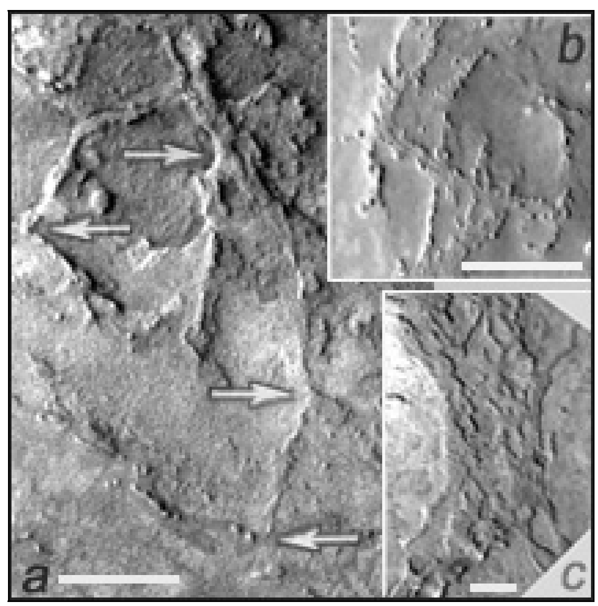

Figure. 3. Straight to sinuous ridges in these examples suggest fluvial channels, as do the following: a—tributary and distributary relationships (arrows; THEMIS visible image V19870003); b—several N-S-oriented ridges crossed by a wide NNW-SSE-oriented ridge (V17736028); c—braid-like feature (V4369006). Scale bars: 2 km.