Simulating Fine-grained Alluvial Fan Sedimentation

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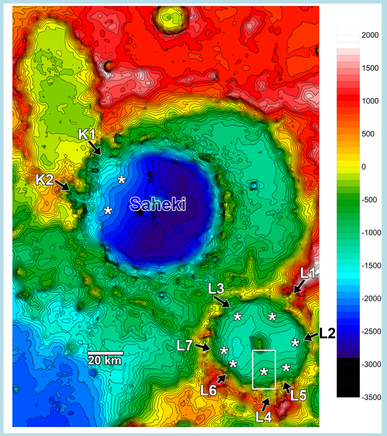
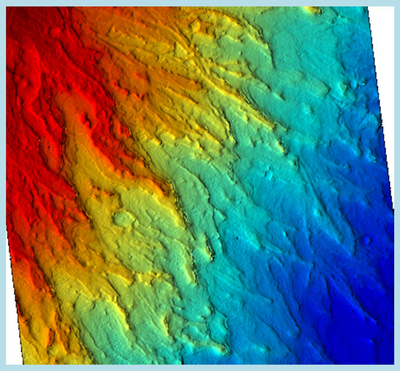
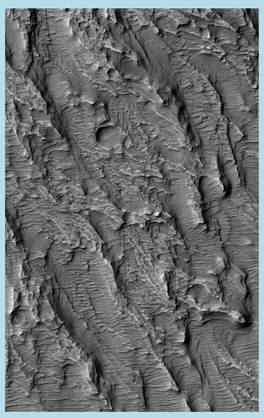
Part I: Motivation - Martian Alluvial Fans



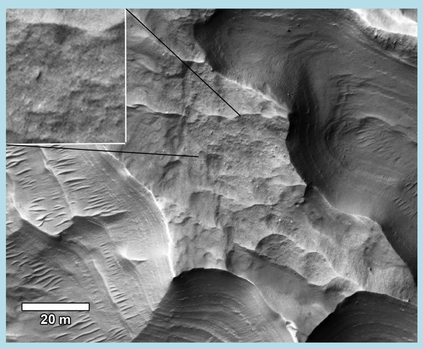
- Large alluvial fans occur in interior of 50-75 km-diameter craters
- Sourced from eroded crater rims
- Up to 45 km long, 850 m deep at apex, ~550 km^3 fan volume
- Gentle slope – 0.03



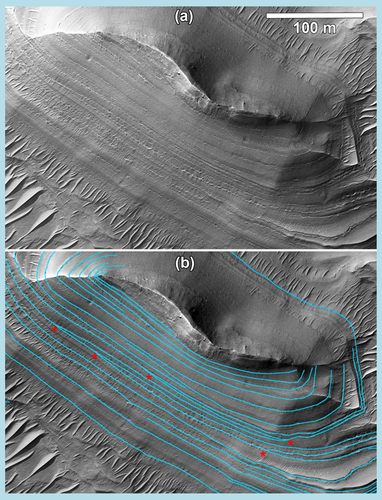
Expressed as inverted ridges



- Aeolian erosion of interbedded fine deposits leaves gravel channels in relief
- Granule ripples derived from eroded sediment
- Ridges typically ~40 m wide, but wide splays are interspersed

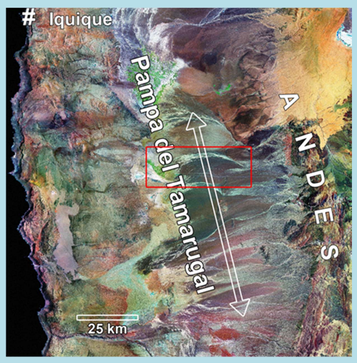


- HiRISE camera (0.25 m/pixel) reveals gravel covering inverted ridges
- Scalloped surface due to wind scour



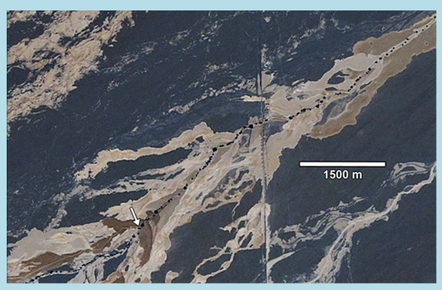
- Fine-grained deposits exposed on flanks of inverted ridges
- Readily wind-eroded
- Layers conformable with fan slope
- Interpreted as overbank mudflow deposits
- Plenty of layer pinch-outs (diastems)

Part II:Terrestrial Analog – Atacama Desert Fans

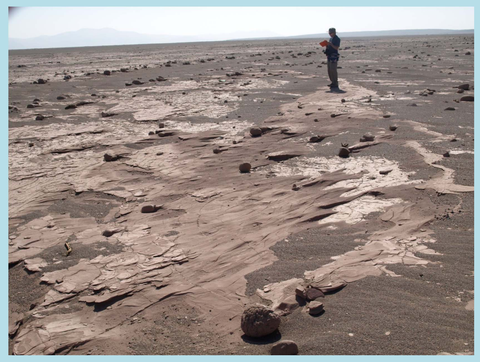


- Fans sourced from Andes
- No precipitation directly on fans
- Unusual in fine-grained nature of deposits and extensive wind erosion

- Typical distributary channel with muddy overbank deposits

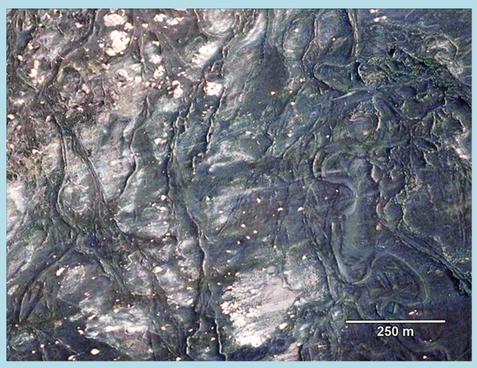


- Overbank mud deposits in two modes:
- Relatively symmetric deposits flanking distributary channel
- Long breakout flows (up to 1 km long)
- Avulsions occur as channel aggrades



- Dark areas are older muddy deposits partially stripped by wind erosion, leaving granule ripples

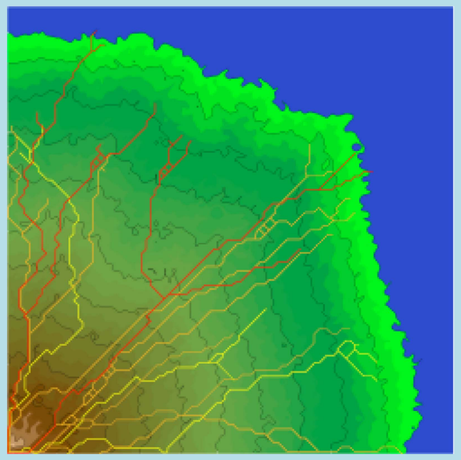
- Upstream feeder channel showing coexistence of mudflows with gravel bed



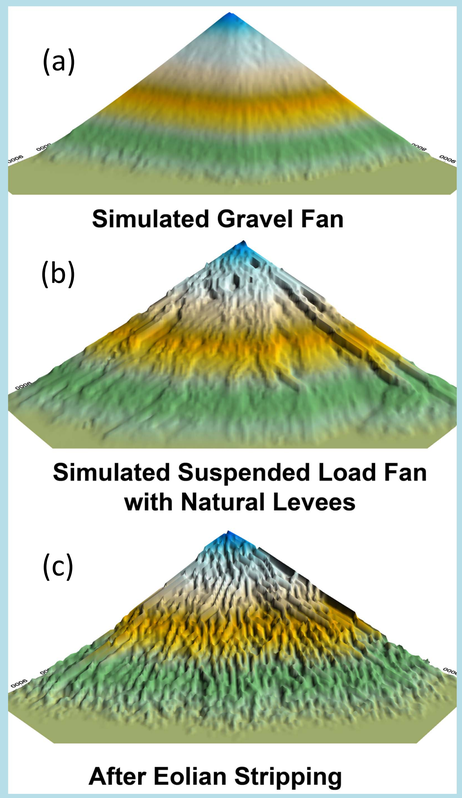
- Aeolian stripping of overbank deposits leaves distributaries in inverted relief
- But height of inverted channels (1-2 m much less than on martian fans (up to 70 m)

Part III: Modeling Fine-Grained Fans

- Model based on *Sun et al*. (2001) fan-delta model
- Flow through multiple interconnected distributaries, with flow proportional to gradient
- Bedload similarly distributed
- Overbank deposition modeled as negative exponential with distance from feeding channel
- Avulsions depend upon lateral gradients compared to downstream
- Model keeps track of 3D stratigraphy (Stacked cells in which proportion of bedload to suspended load is tracked)



Colors show multiple generations of distributaries



- Simulation with gravel only (a) produces a well-behaved fan with frequent avulsions
- Adding suspended load deposition has proved to be problematic (so far) (b)
- Distributaries tend to get locked in place and aggrade with few avulsions
- "Holes" in fan surface tend to develop that receive negligible deposition
- We have a wind-erosion algorithm that erodes overbank sediment but leaves distributary bedload, producing inverted channels.(c)

FUTURE

- Add in breakout flows
- Thoroughly root out fleas, cockroaches, and termites
- Add in broader splay deposits found of martian fans
- Develop quantitative morphological statistics to compare simulated, martian & analog fans