Diagnostic Morphology for Martian Groundwater Outflows from Flume Experiments

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Introduction
- There are many channels on Mars, but climate conditions were different than on Earth.
- Different sources of water have been proposed for Mars, including groundwater as main source for channel formation [1,2,3].
- Knowledge on groundwater-induced channels is minimal due to limited occurrence on Earth.
- We aim to extend the knowledge on related processes and resulting morphology for these systems from scaled flume experiments.

Aims
- Experimental setup consists of a flume of 6 m long x 4 m wide and 1.20 m deep.
- Simulation of seepage from sub-surface groundwater level from a distant source using a constant head tank.
- Seepage from a local source (e.g. melt or precipitation) was simulated by rain simulators.
- Pressurized aquifer release using a subsurface drainage pipe with forced discharge, at:
  - sub-lithostatic pressure (only seepage)
  - super-lithostatic pressure (sediment lifted by water pressure)
- Data: time-lapse imagery and laser-scanned DEMs.

Methods

Pressurized Groundwater
- Converging flow upstream: feather-shaped head.
- Deposition of lobes after first overflow due to infiltration in unsaturated substrate (sieve deposits).
- No morphology left by actual seepage process.
- Not found on Mars without pits or chaos (see next).

Super-lithostatic Pressure
- Pit formation: emergence of channels
- Flow from source area carved by emerging groundwater.
- Converging flow features disconnected from source area.

Local Infiltration
- Surface runoff: Seepage zonesaturated sediment

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Conclusions
- Different sources of groundwater for channel formation produce distinct types of valleys and channels.
- Groundwater sapping:
  - Produces theater-shaped valley heads.
  - Flow piracy occurs when the water source is distant, this focusses flow and enhances development of a few channels.

Key Features
- Different sizes of valleys due to flow piracy.
- Theater-shaped valley heads due to mass wasting processes.
- Valley depth relates to groundwater level.
- Further developed valleys are deeper as groundwater level is deeper upstream.

Upcoming papers
- Paper on these experiments (and others): formative timescales, diagnostic morphology and hydrological modeling.
- Interpretation of Martian morphology.
- Morphodynamical modeling of these systems.

References

LPSC 2013: abstract 1899

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Martian River and delta morphodynamics

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Converging flow: Seepage from a local source (e.g. melt or precipitation) was simulated by rain simulators.

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Seepage Zone

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Unsaturated Sediment

• Pressurized groundwater release:
  - Results in channel head with converging flow features.
  - Downstream lobate deposits on unsaturated sediment.
  - Super-lithostatic pressure breaks surface and forms pits in the source area.