

# Different types of fan-shaped sedimentary deposits on Earth, on Mars, and in the laboratory

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## AIM

Five different types of large fan-shaped deposits have previously been identified on Mars. Most of these types of fan-shaped deposits occur naturally on Earth, but are not very well observed or preserved due to vegetation and erosion, respectively. We have formed almost all of these deposits in the laboratory (except for alluvial fans). Here we would like to point out some analogies between the various cases.

## BACKGROUND

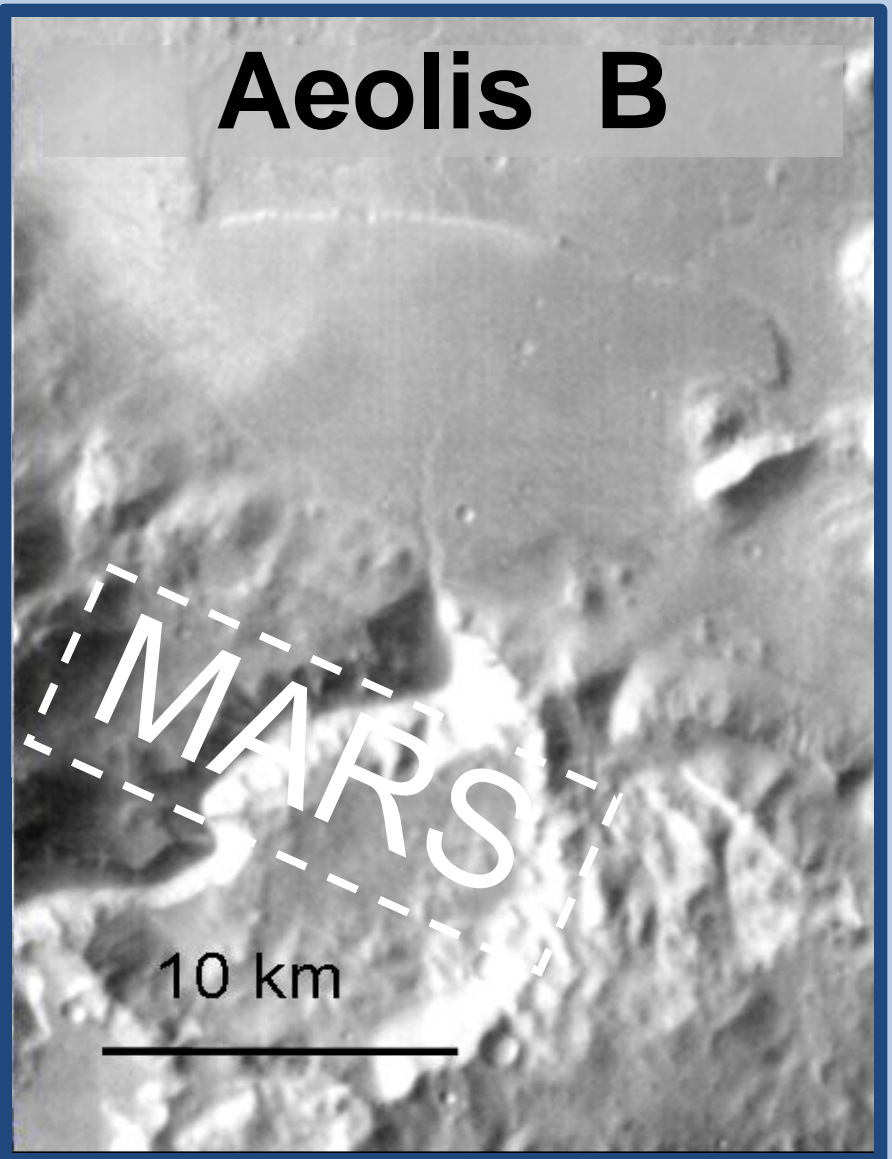
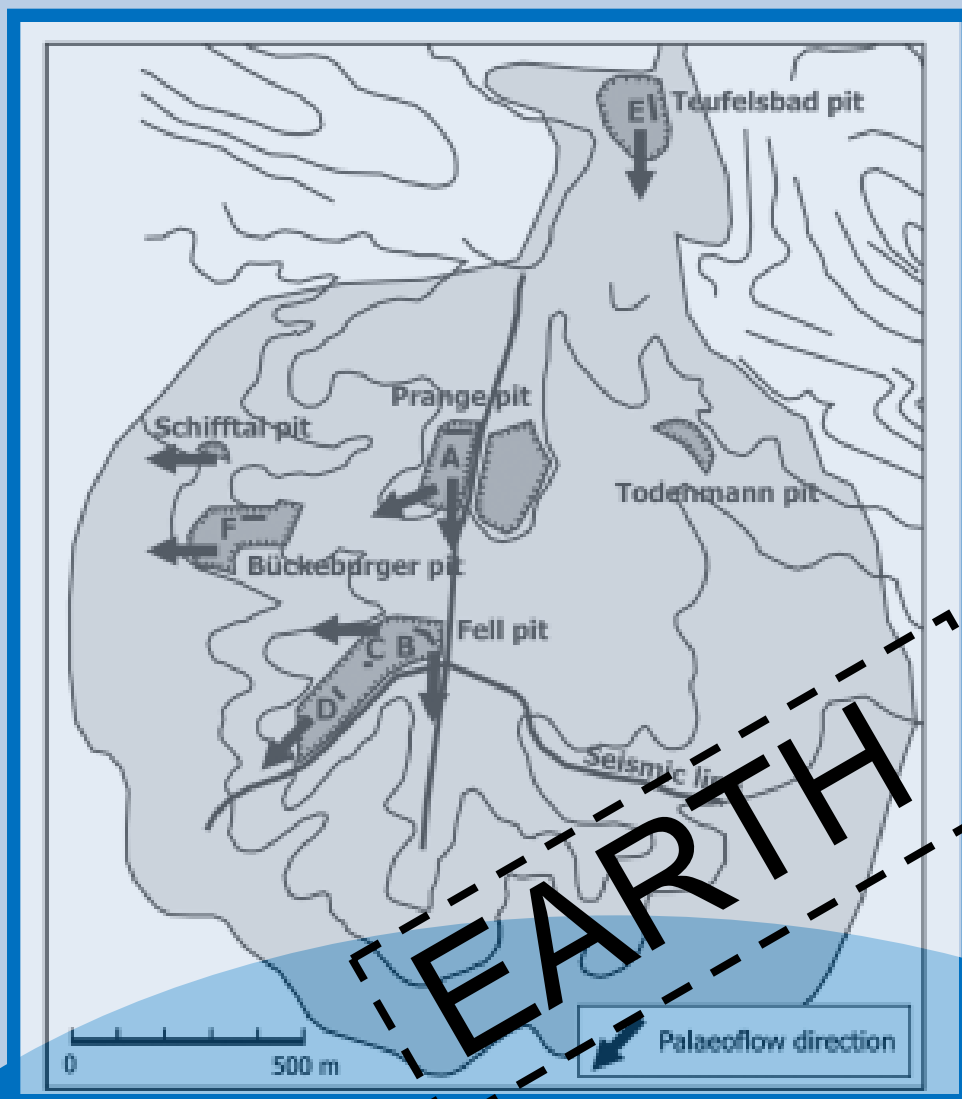
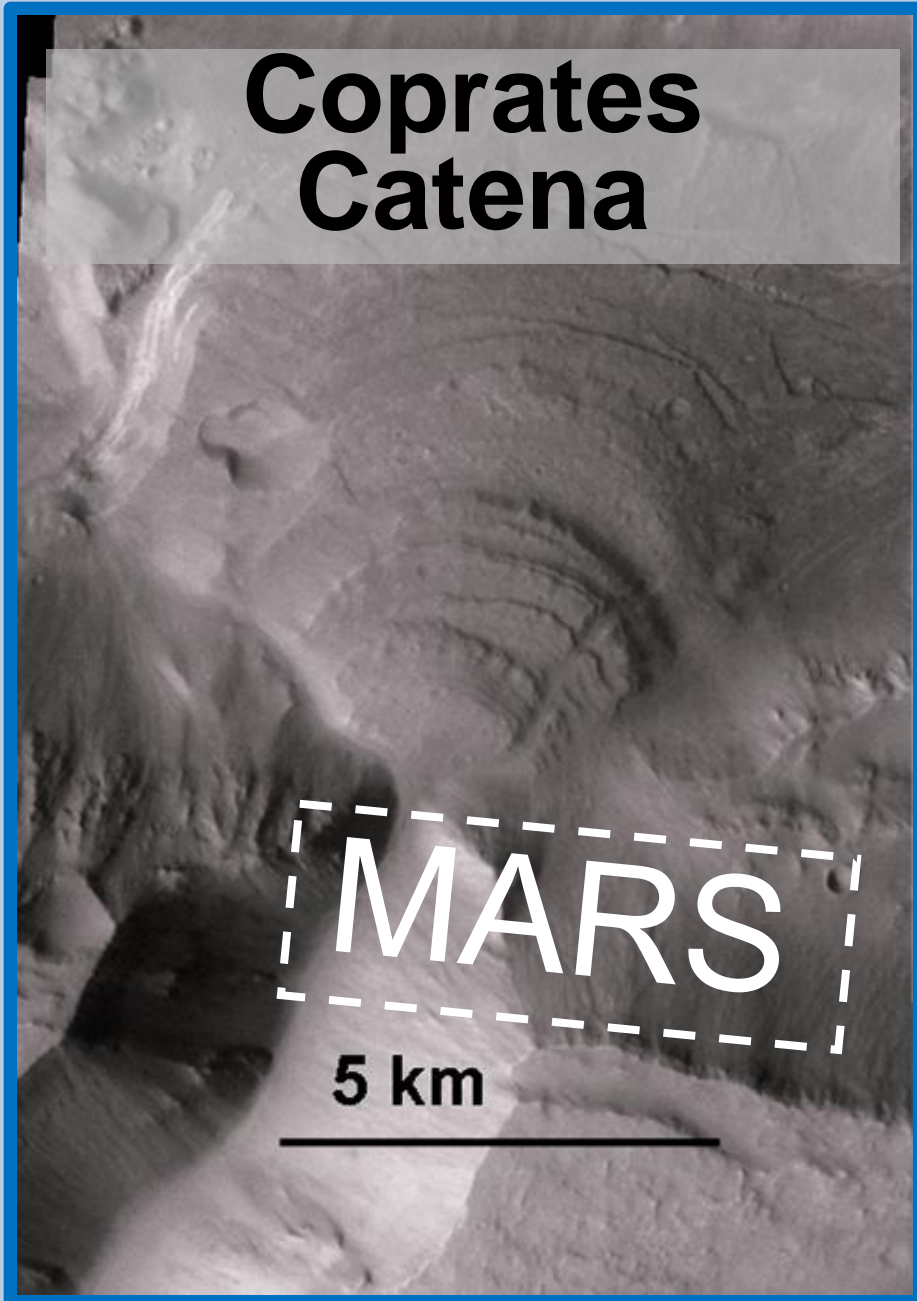
Martian fan-shaped deposits show architectural elements similar to those of terrestrial analogues. Terrestrial analogues are hard to study from aerial imagery alone due to observation and preservation issues (mainly related to vegetation, precipitation, and erosion). However, it is recognised that different morphological types of fan-shaped deposits occur (or did occur) naturally on Earth. Fan morphology is related to upstream and downstream conditions such as water discharge and flow duration; sediment flux and properties; as well as basin size and water level. We have varied these parameters in the laboratory (see another abstract for this meeting), we have seen that various types of fan-deposits are merely different phases of development of the same system.

## TYPES OF DEPOSITS

We present examples on Earth, Mars and from the laboratory of five different types of large fan-shaped deposits. Note that these deposits are not formed at the same scale, however, the general resemblance in morphology is striking. Furthermore, we observe that we can explain the formation of different types of Martian sedimentary deposits by referring to terrestrial or laboratory analogues. Below are our descriptions for the five Martian types:

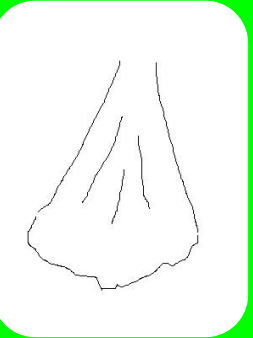
- **Alluvial Fans:** Large, relatively low-gradient, fluvial dominated fans with classic conical shapes with short and steep or absent feeder channels.
- **Smooth Deltas:** Semi-circular, flat-topped, Gilbert-type deltas with steep fronts indicating sheet-flow conditions and with long feeder channels suggesting bed-load dominated transport.
- **Branched Deltas:** Bird-foot shaped, branched deltas indicating channelized-flow conditions and with medium to long feeder channels.
- **Stepped Deltas:** Terraced deltas with clear fronts or frayed toe-sets, as well as short feeder channels.
- **Sliding Deltas?:** A variety of terraced deltas with less well-developed steps, but rather drapes (difference is more evident in profile than in plan view) – we see this in the laboratory and have found at least one candidate for this type on Mars!

Note: Alluvial fans are formed where there is NO ponding water (as opposed to deltas) and hence there is no interaction with the water level!



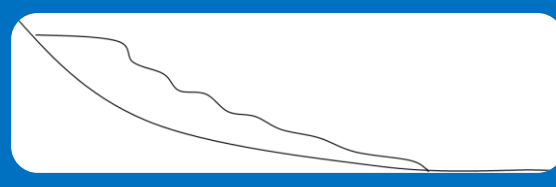
### Alluvial Fans

Inferred Processes – Fluvial flows; but significant post-depositional aeolian erosion  
Water Level – Little or no ponding water in basin  
Feeder Channels – Absent or short and steep

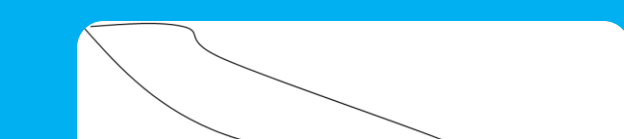


### Stepped Deltas

Inferred Processes – Fluvial flow  
Water Level – Rapidly Rising  
Feeder Channels – Mainly short and steep



### Rising Water Level



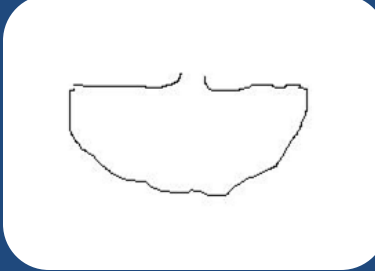
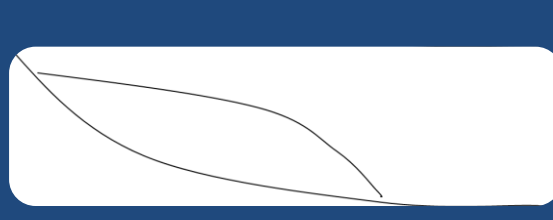
### Sliding Deltas

Inferred Processes – Fluvial flow  
Water Level – Slowly Rising  
Feeder Channels – Mainly Short and steep



### Smooth Deltas

Inferred Processes – Sheet-like fluvial flow  
Water Level – Steady at basin breach level  
Feeder Channels – Varies in length

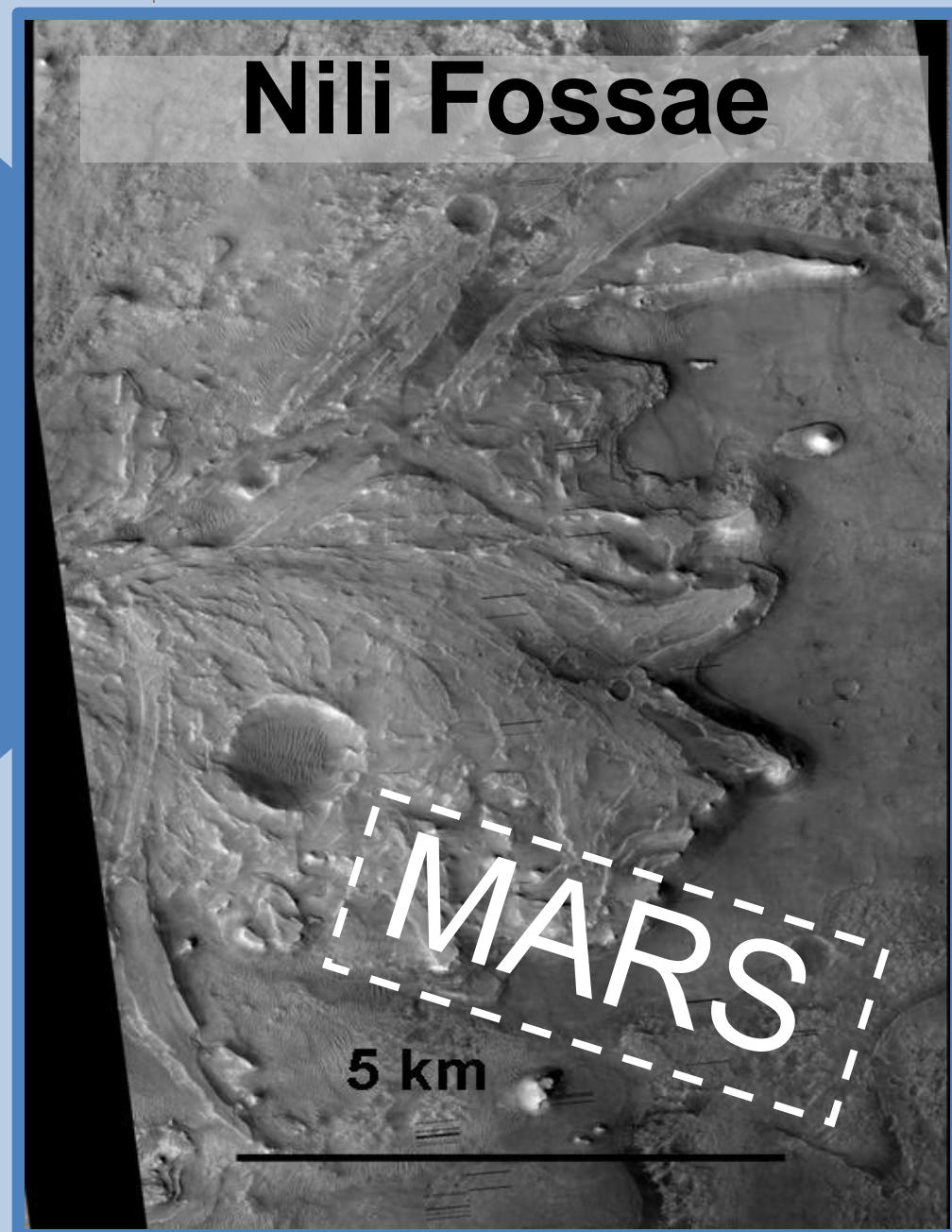


### Constant or Falling Water Level

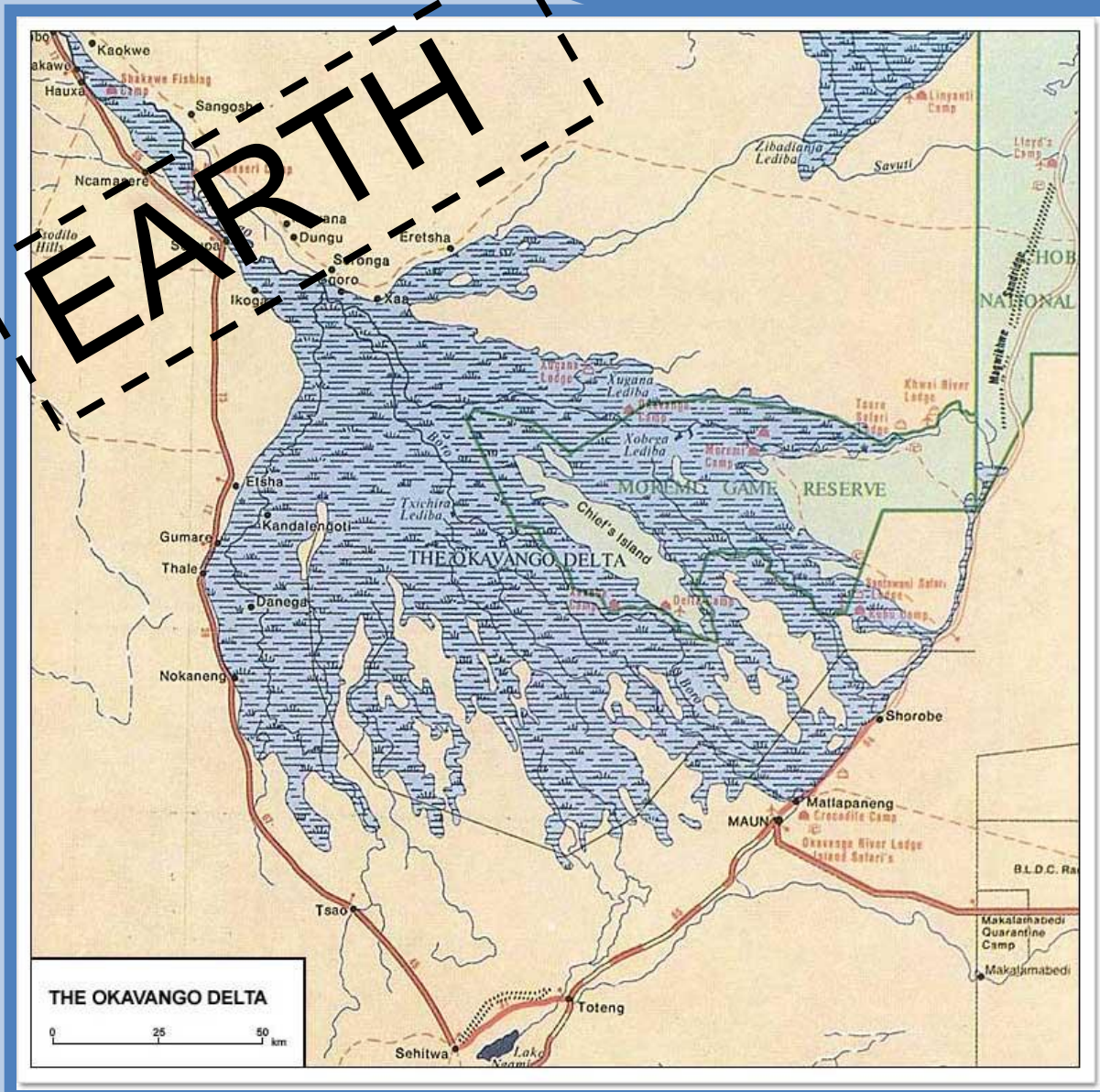
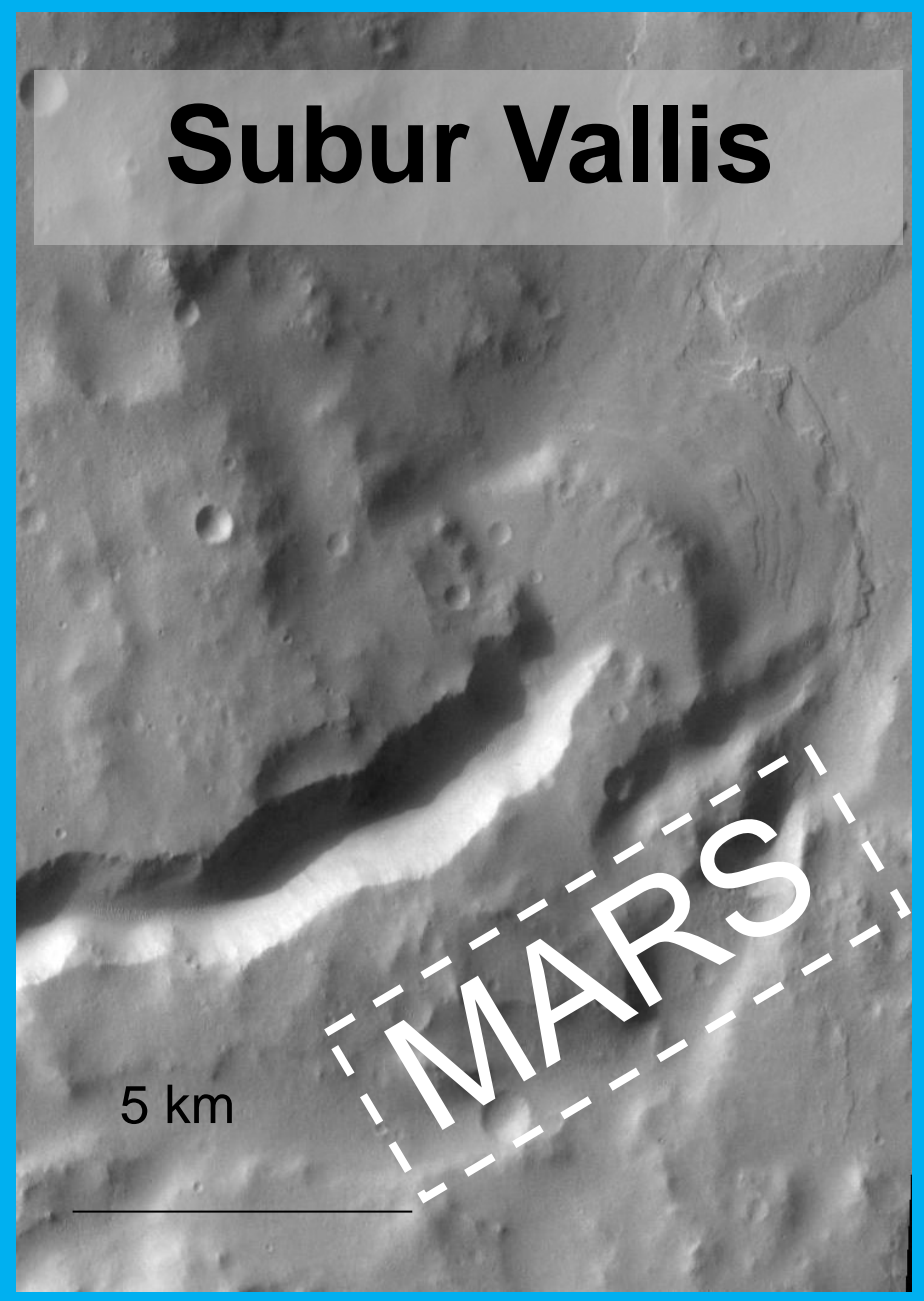


### Branched Deltas

Inferred Processes – Channelized fluvial flow  
Water Level – Steady at basin breach level  
Feeder Channels – Long and shallow



### Subur Vallis



Increase in Time

## SUMMARY

- Different morphological types of fan-shaped deposits exist on Earth and Mars, and we can re-create some of these in the laboratory
- Different types of these deposits might indicate different types of processes and possibly different types of climatic (regional or global) conditions during formation
- The location of the water level (absent in the case of alluvial fans), plays a significant role in the morphology of the fan and can perhaps indicate the stage of development of the system
- The degree of branching seems to be a function of both *discharge* and *sediment mobility* (a function of grain size); deltas can be dominated by sheet-flow or channelized flow
- Relationships exist between the different “end-member” types of deltas shown here and overlap between types does occur.



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