



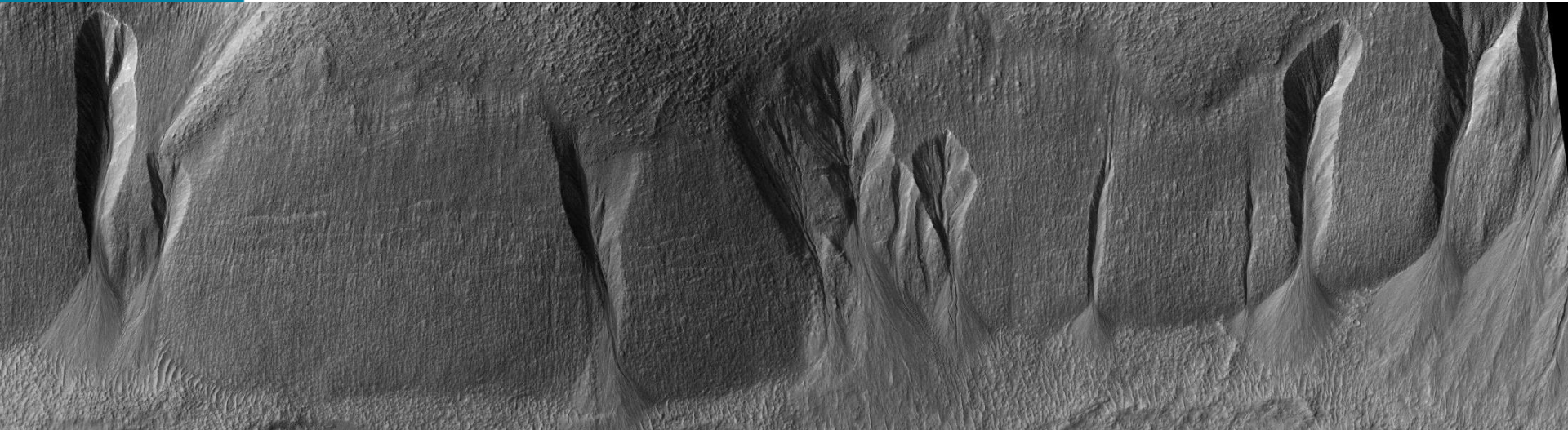
Universiteit Utrecht  
Faculty of *Geosciences*

*Martian*

Research group  
**River and delta morphodynamics**

# Gully formation on Mars

## Subsurface as the key to the surface



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Dario Ventra, Ernst Hauber, Susan Conway & Maarten Kleinhans



# How did they form?

- Fluvial flows → water >>> sediment
- Debris flows → 20-60% water by volume
- Dry flows → no water

→ No terrestrial analog  
for CO<sub>2</sub>-driven flows

500 m

# Problem definition

“Morphometric analyses of Martian debris-flow-dominated formation, with a debris-morphological observation to (11)

“Previous have shown that debris flows show on Mars, despite the fact that m evidence for debris-flow dominated gully fans is rare (Johnsson et al., 2014)

So what's going on?



# Debris-flow morphology

Lobes

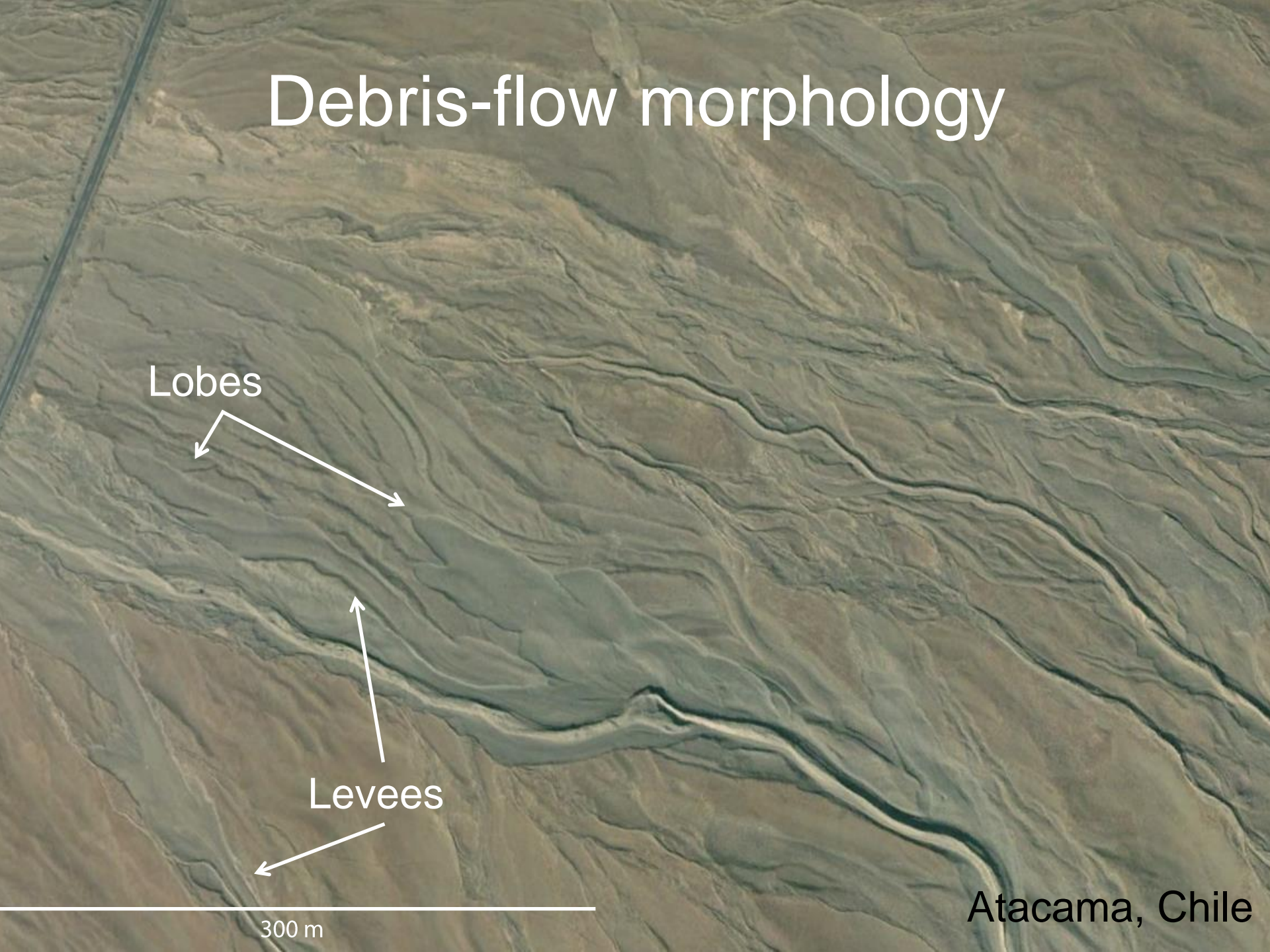


Levees



300 m

Atacama, Chile





# Hanaskogdalen, Svalbard



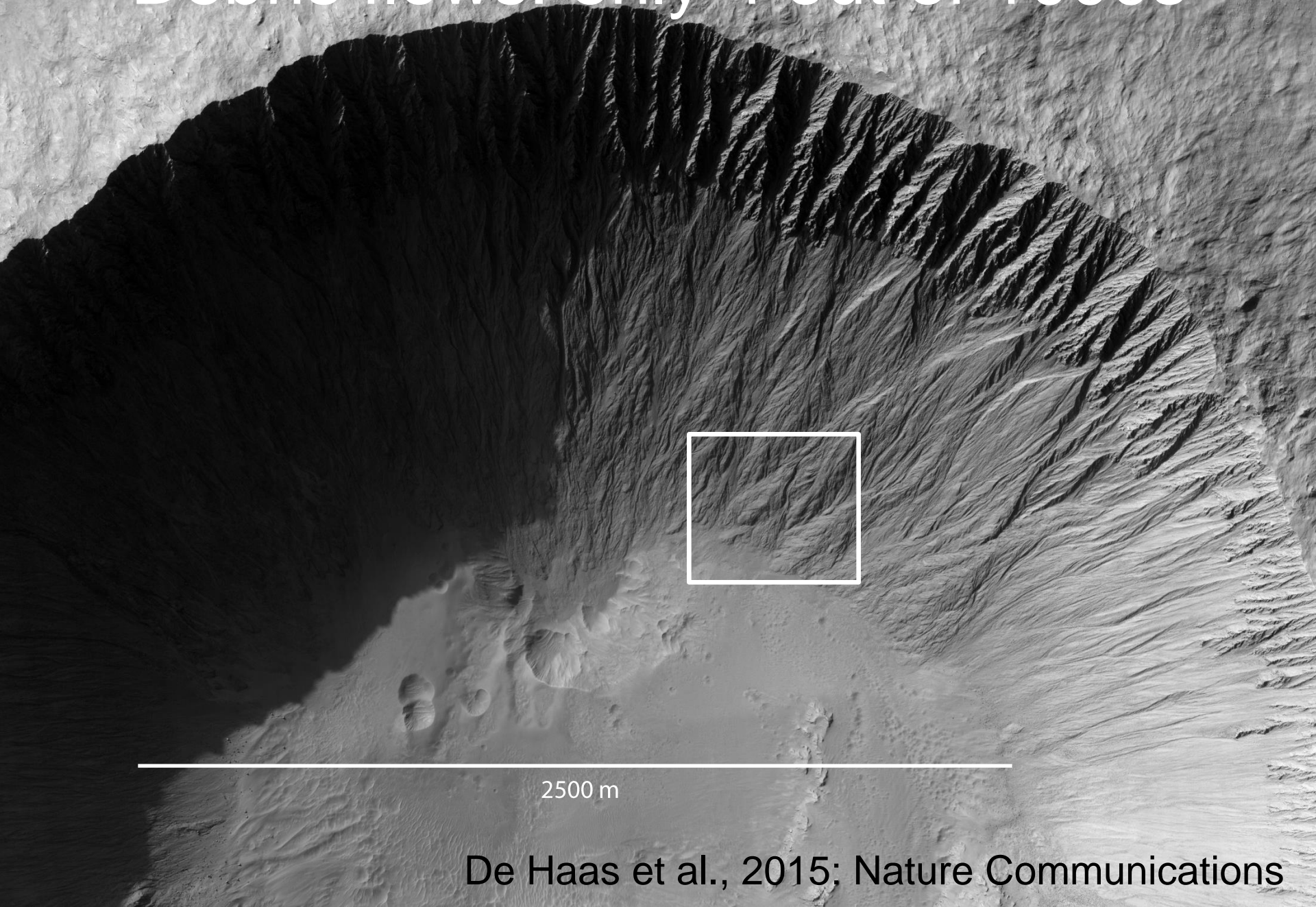
De Haas et al., 2015: Earth Science Reviews





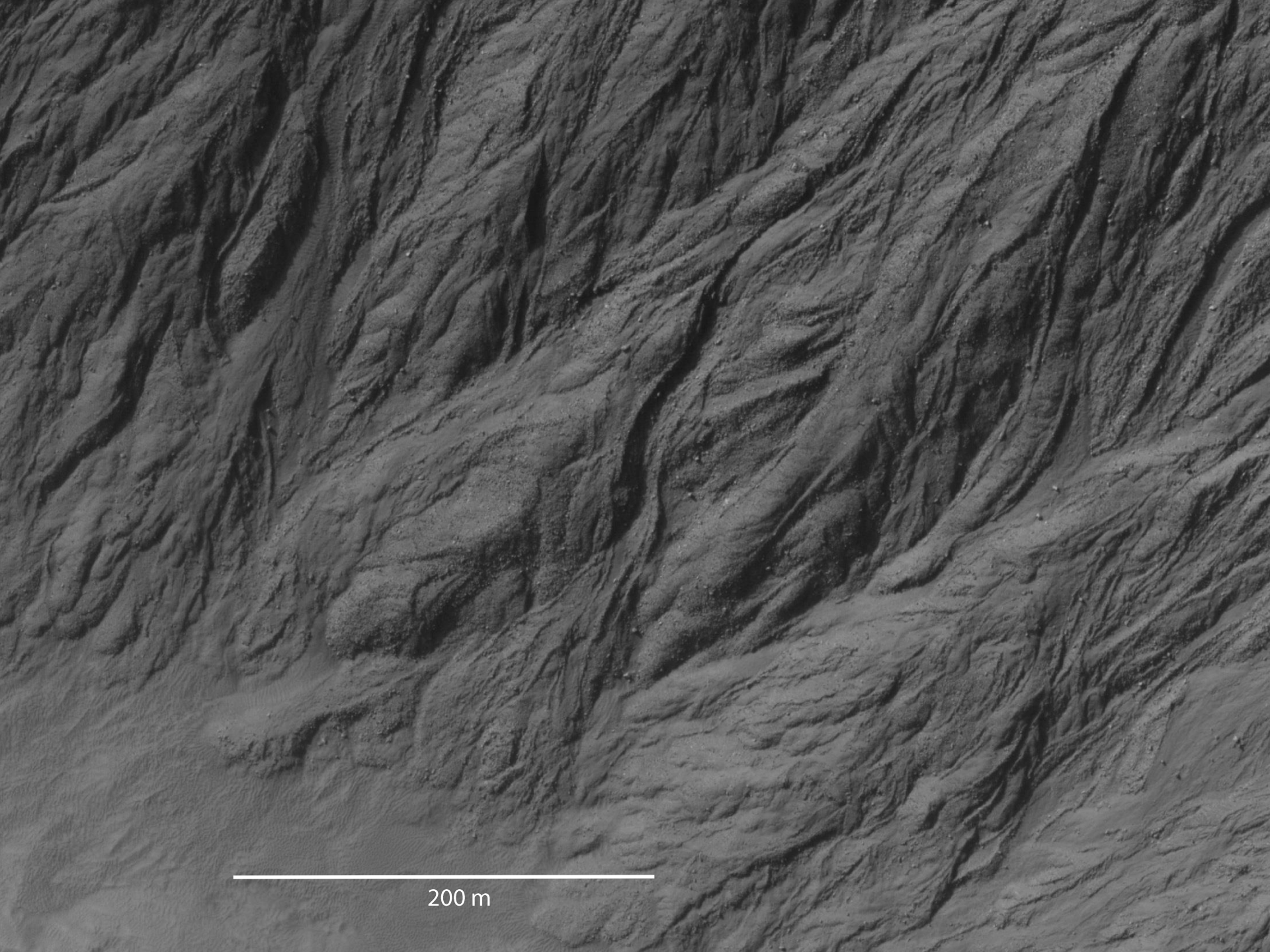


# Debris flows: only 4 out of 1000s



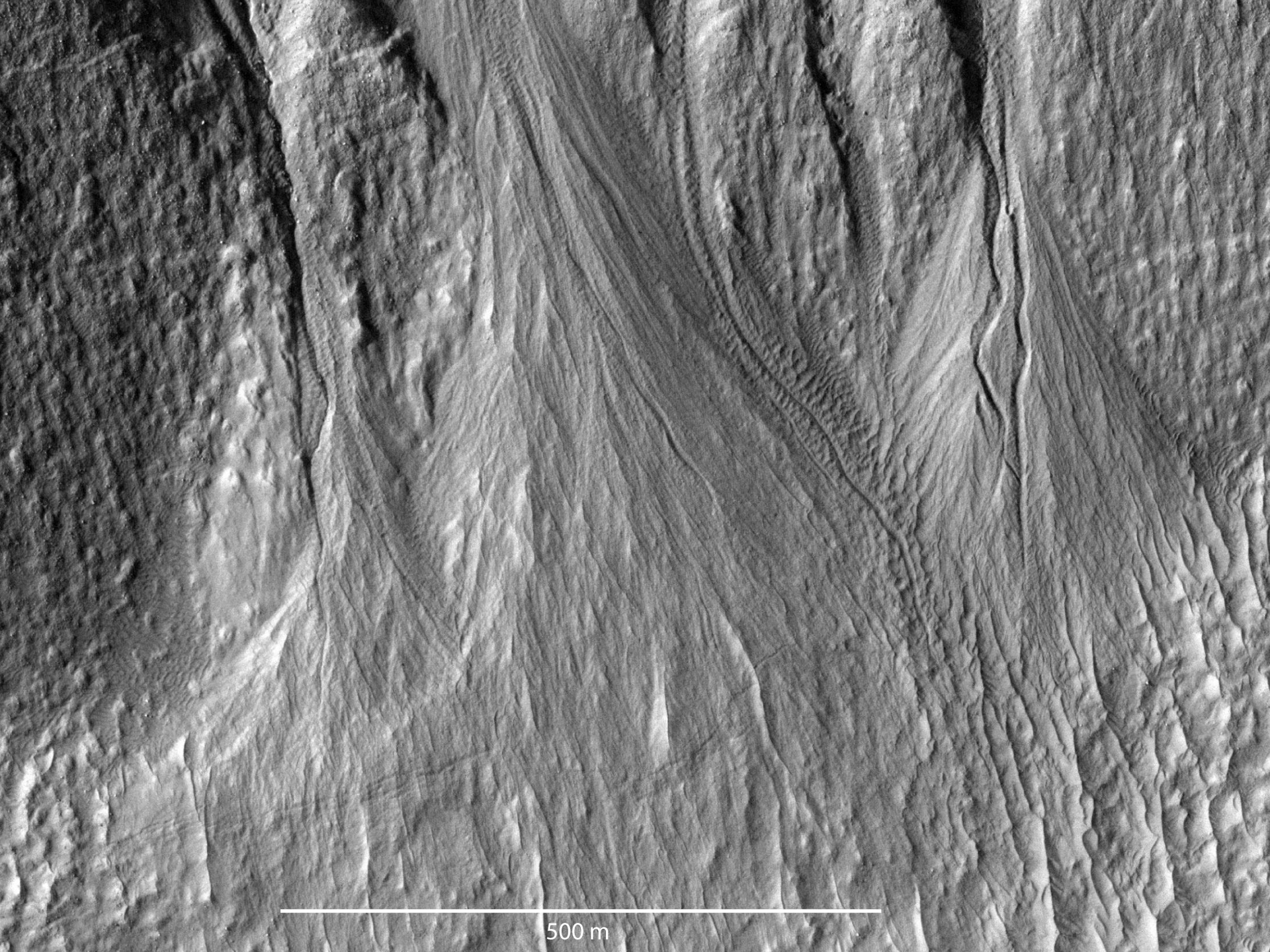
2500 m

De Haas et al., 2015: Nature Communications

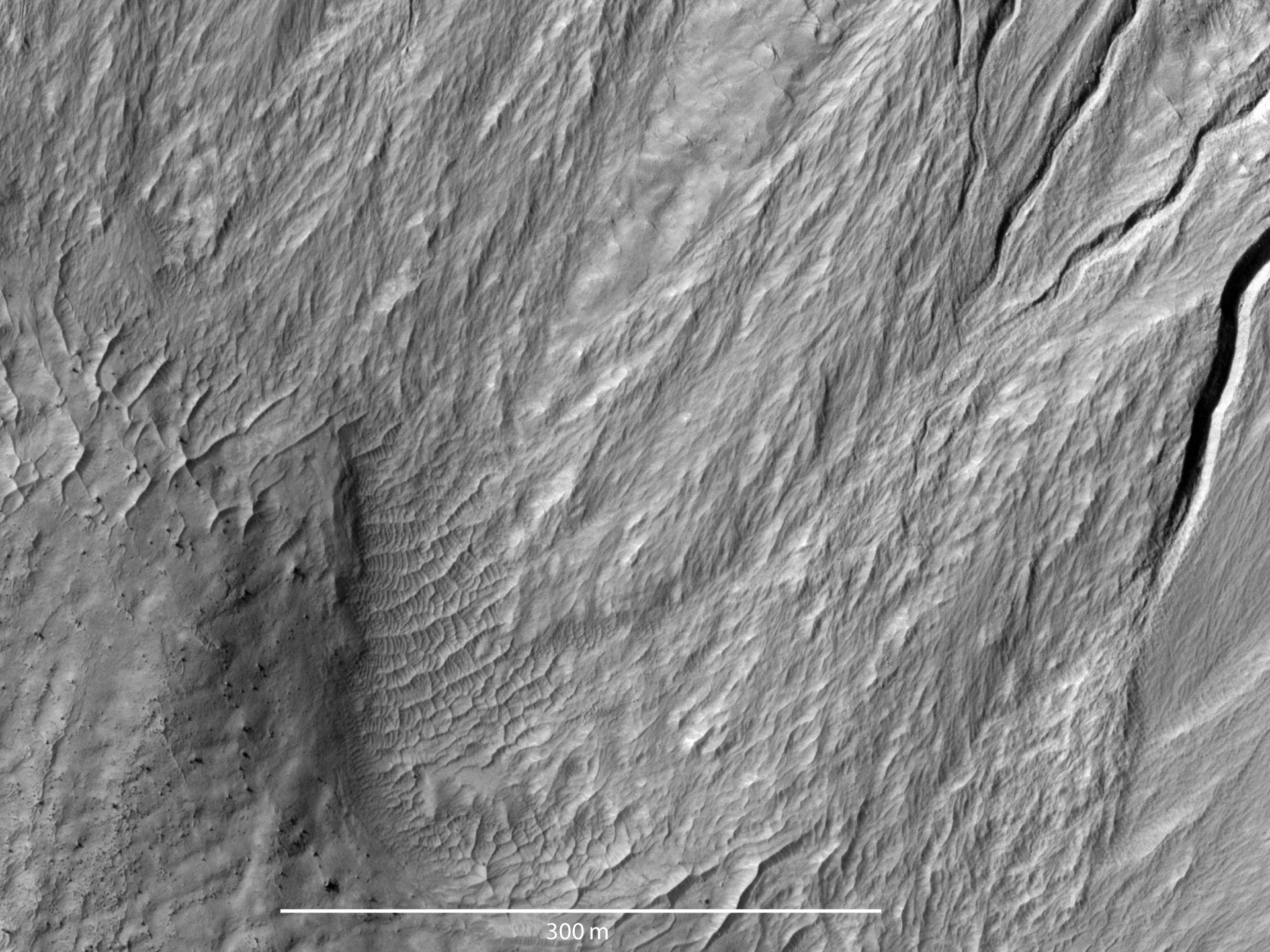


200 m



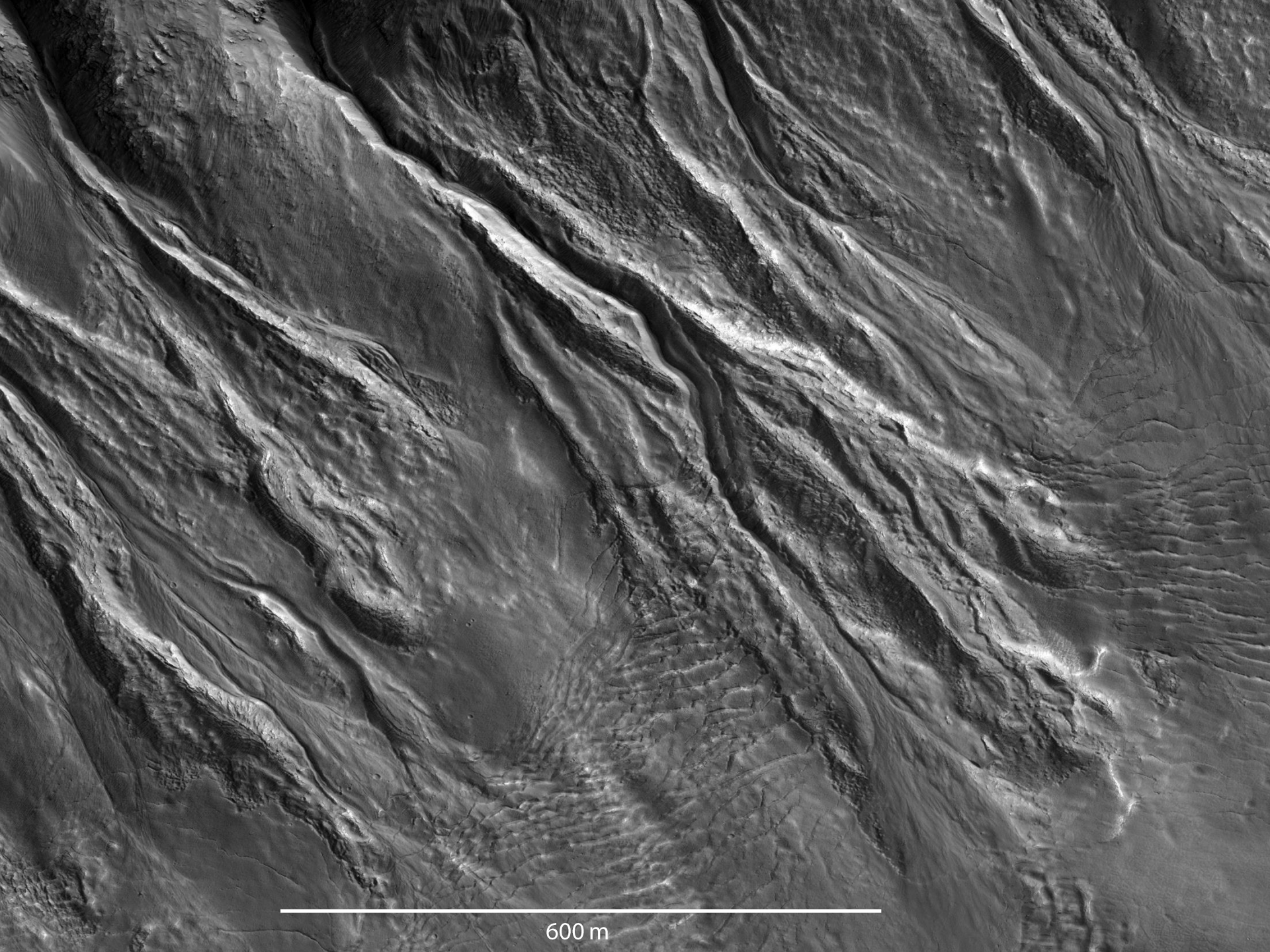


500 m



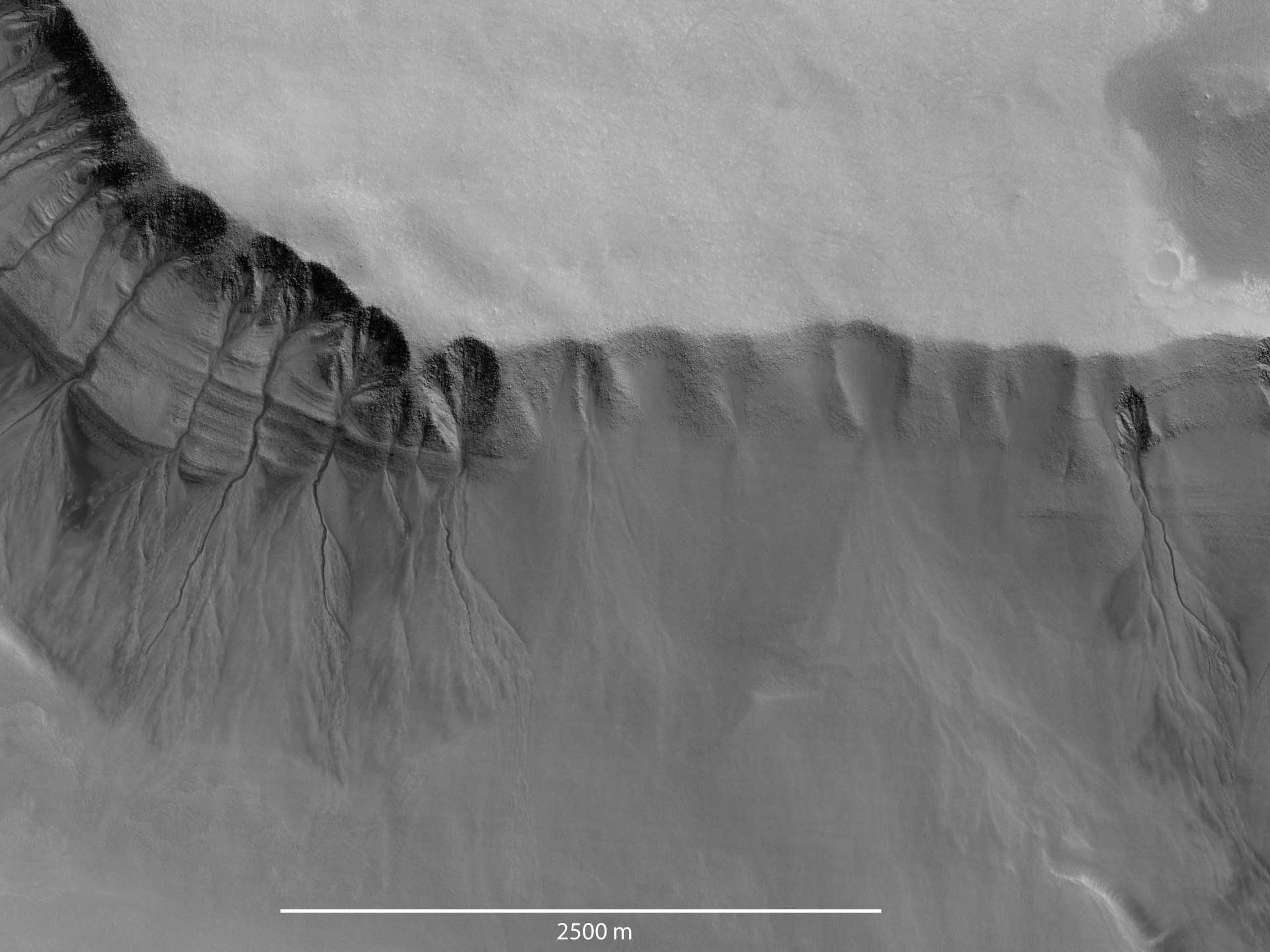
300 m





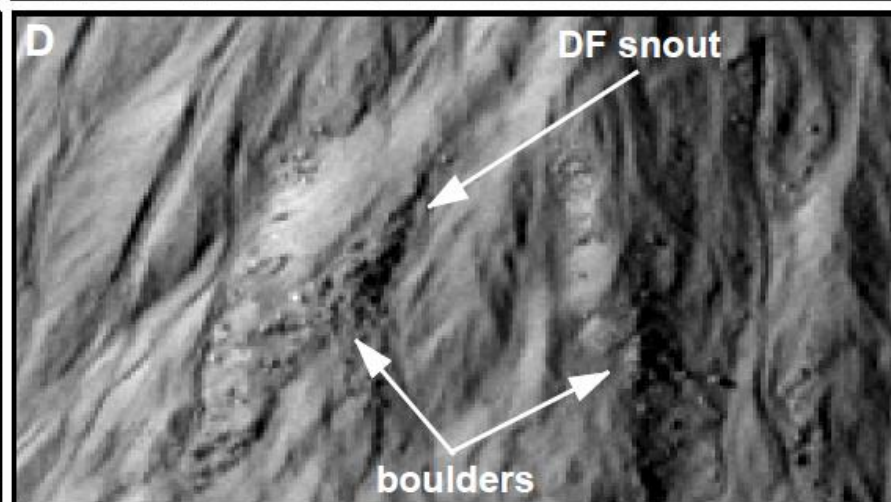
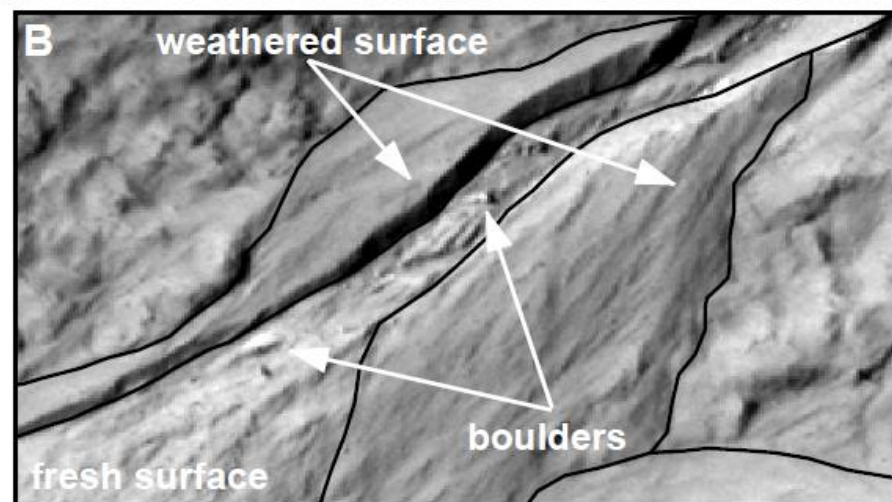
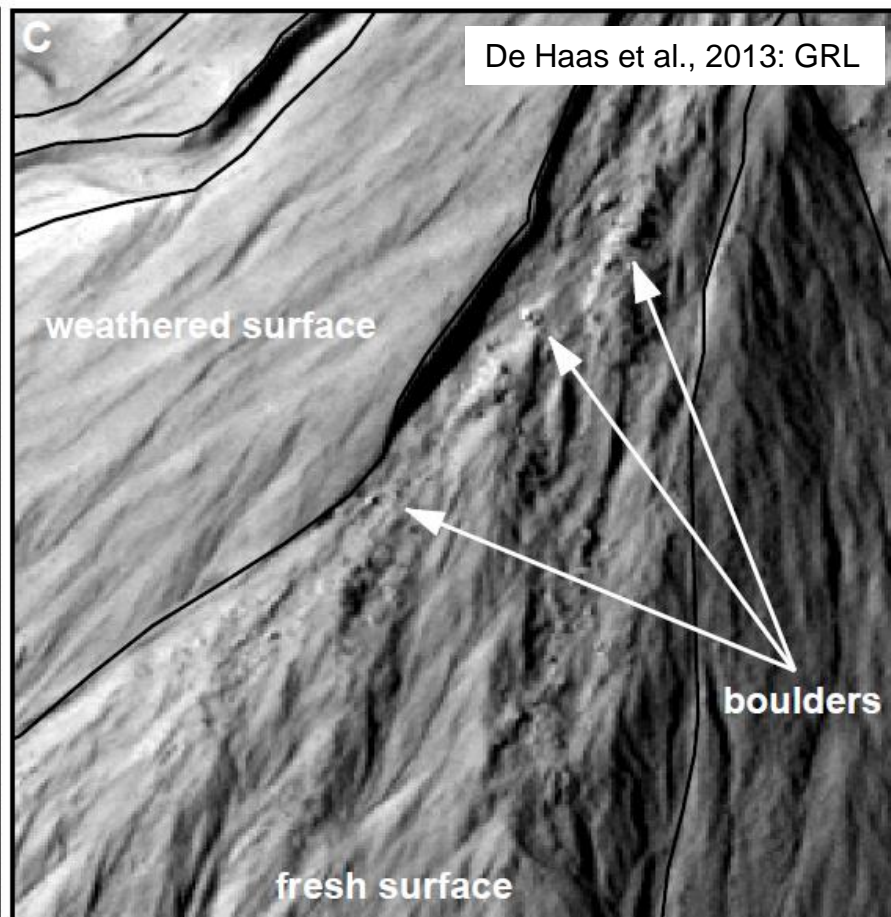
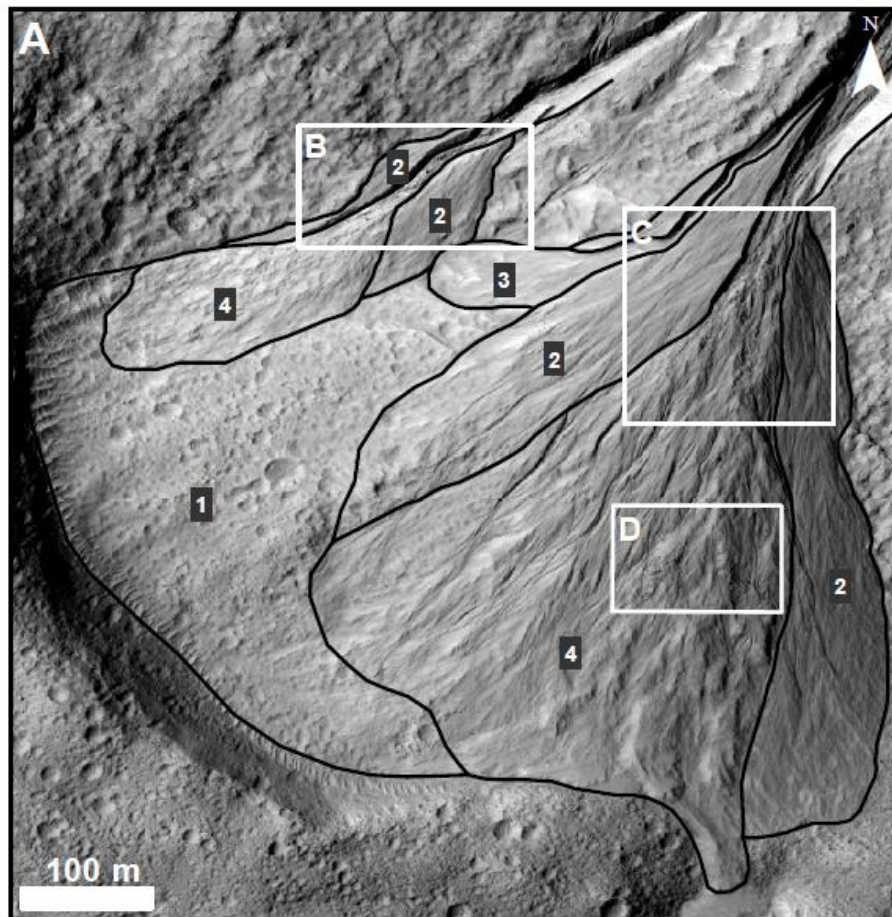
600 m





2500 m









Nevada, USA (Blair & McPherson, 2009)



Panamint valley, USA





# Subsurface as the key to the surface







Atacama, Chile



Atacama, Chile





Death valley, USA







Atacama, Chile



Atacama, Chile

Fining upwards

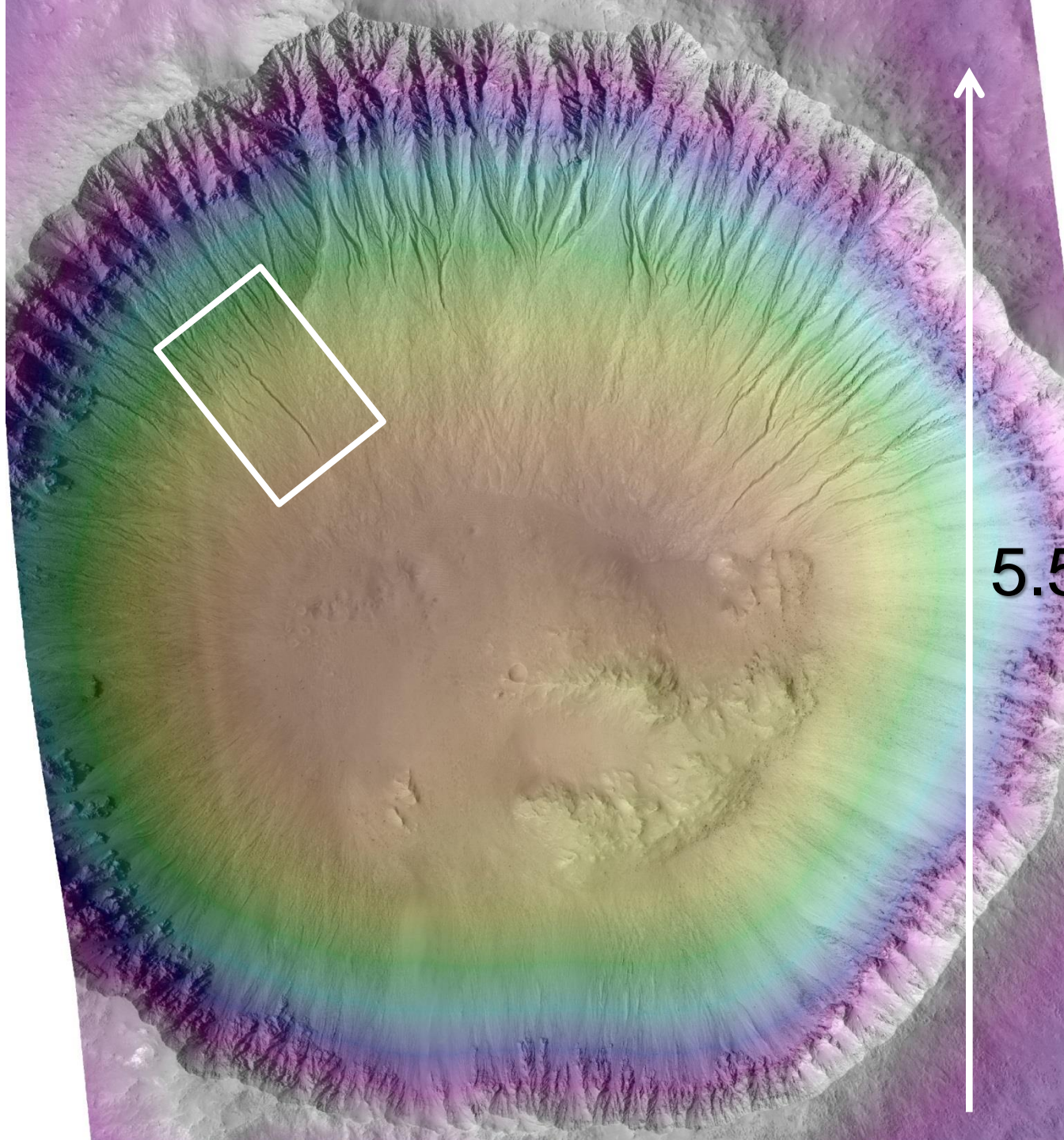




Atacama, Chile

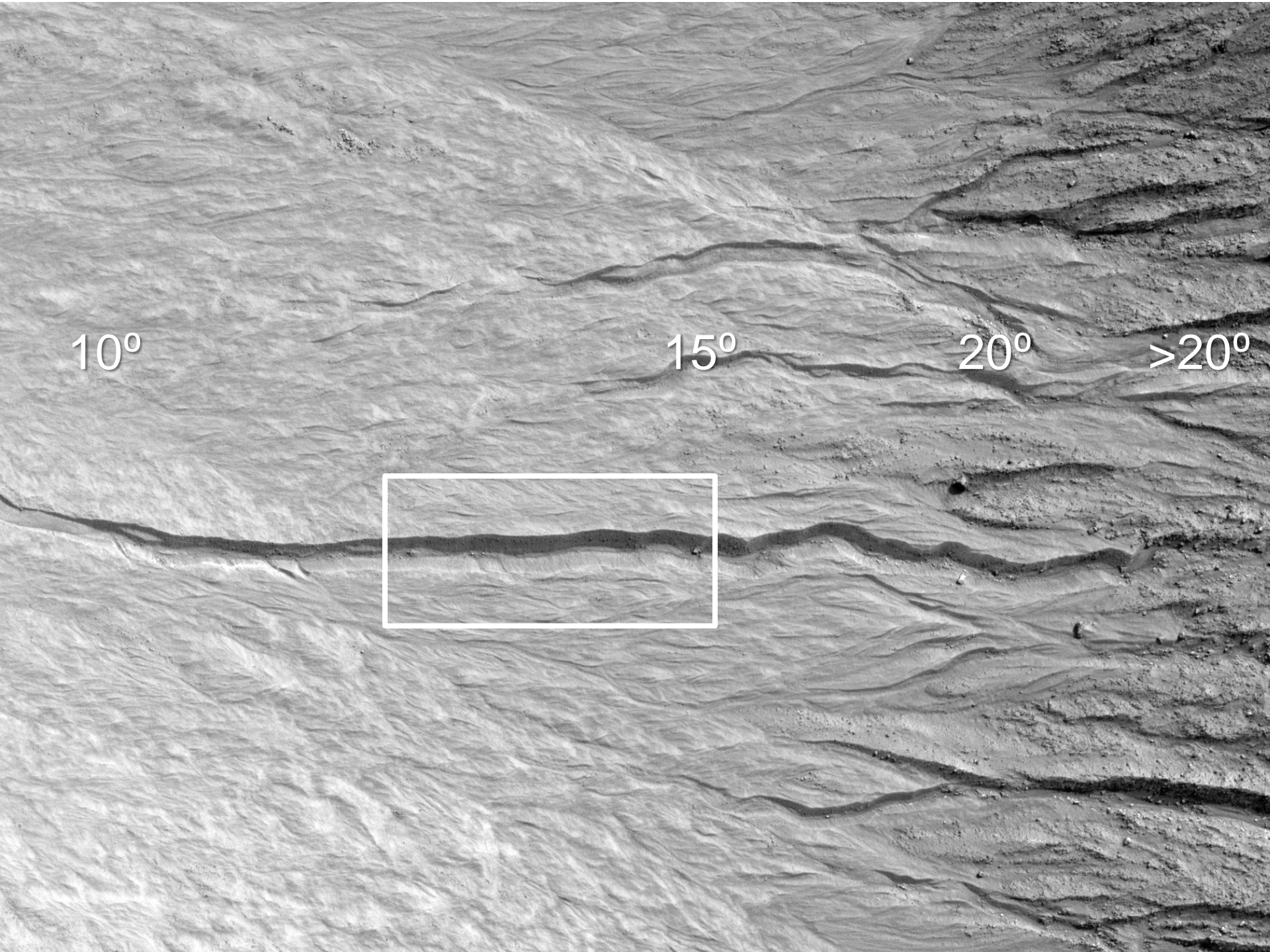




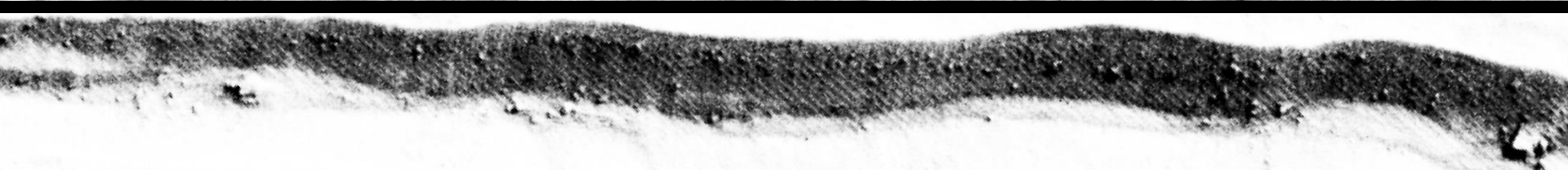
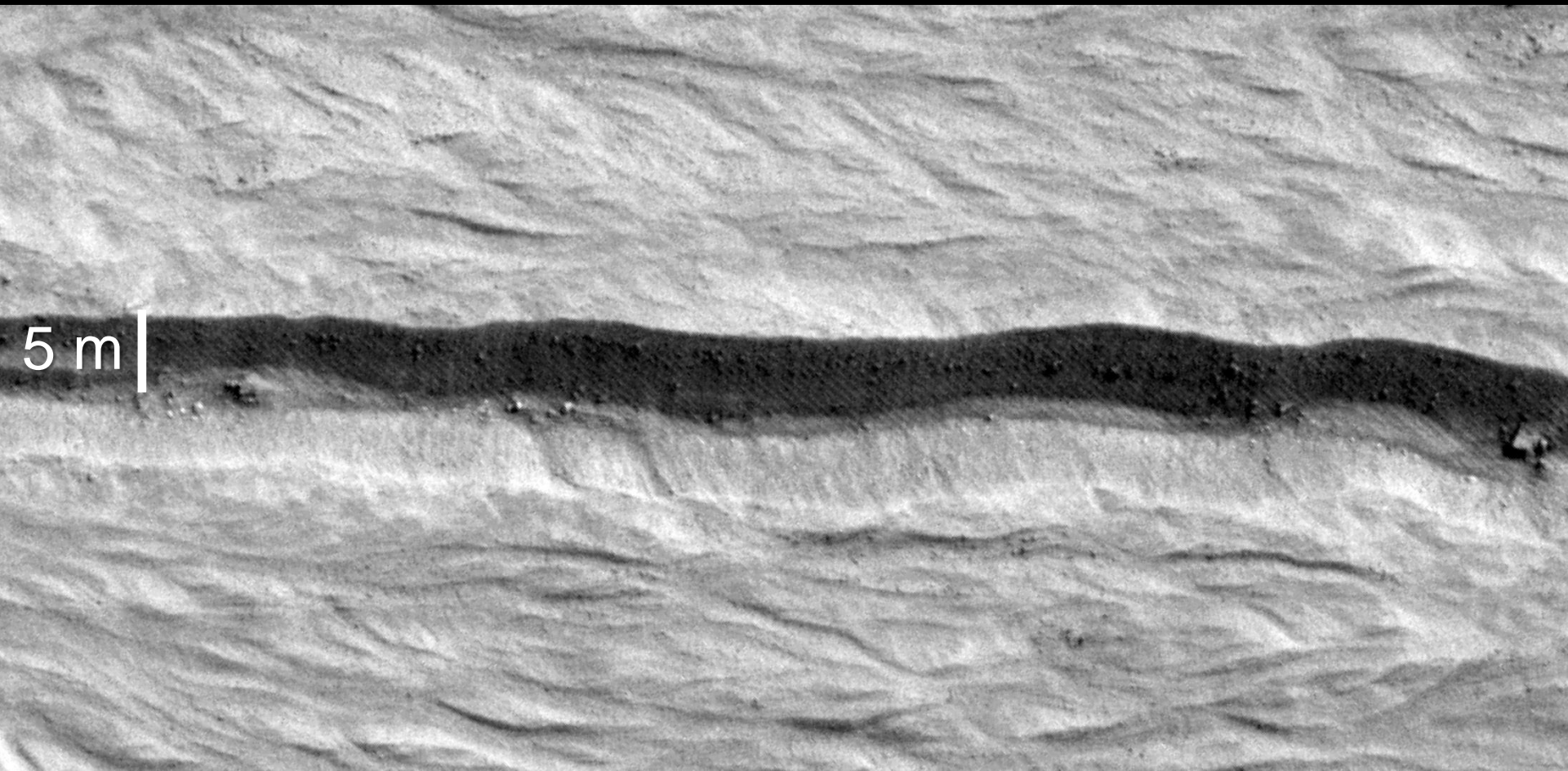


5.5 km

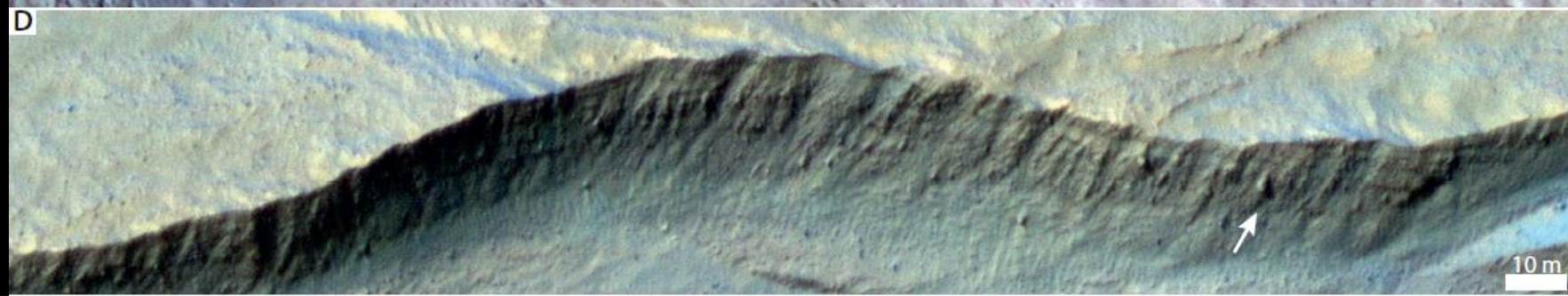
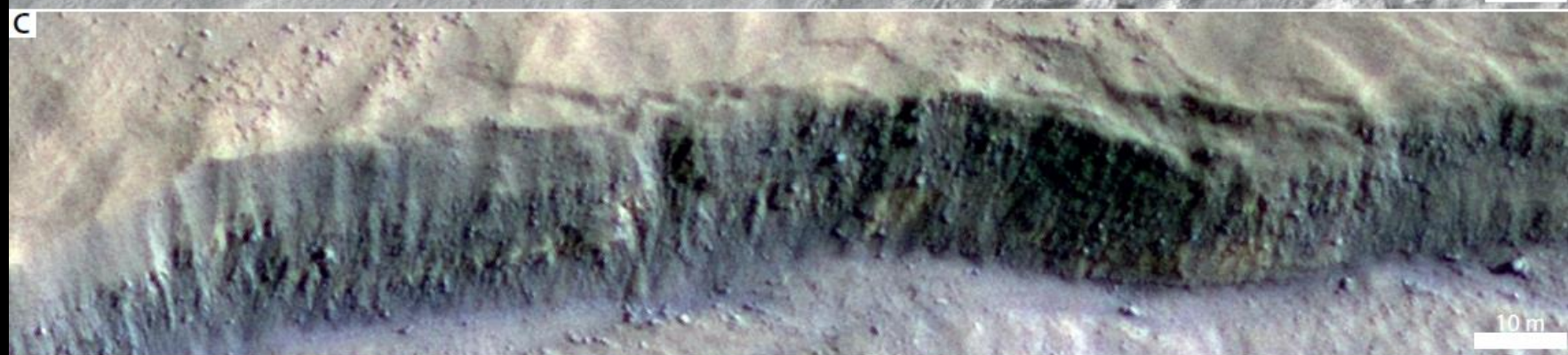
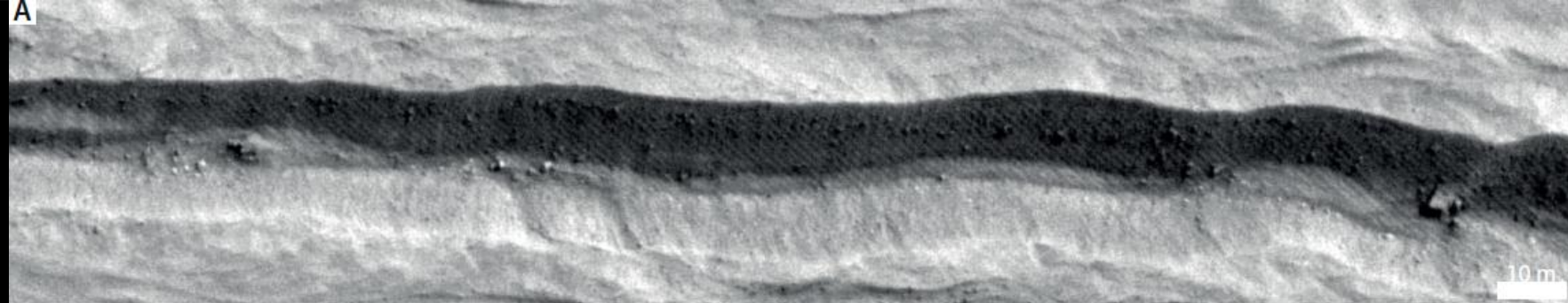






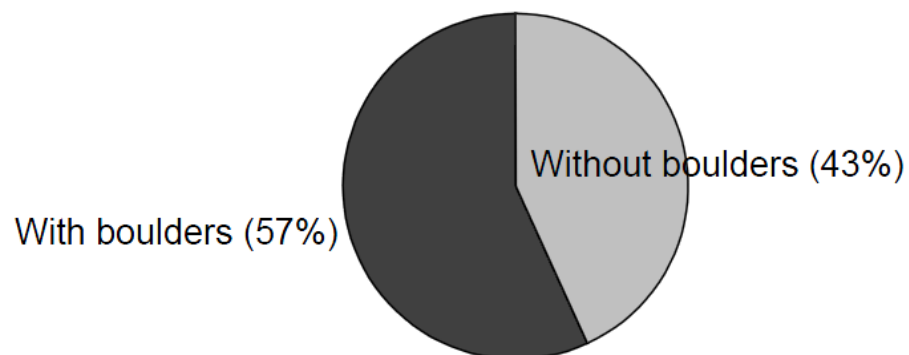




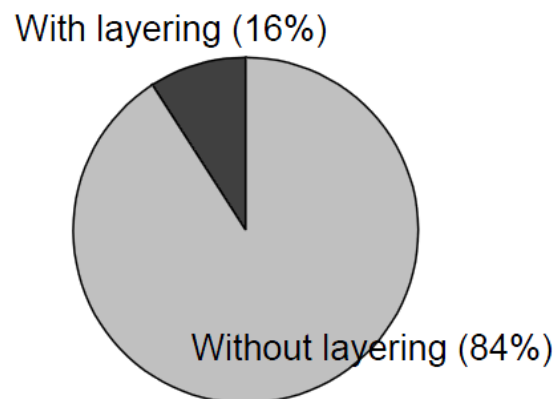




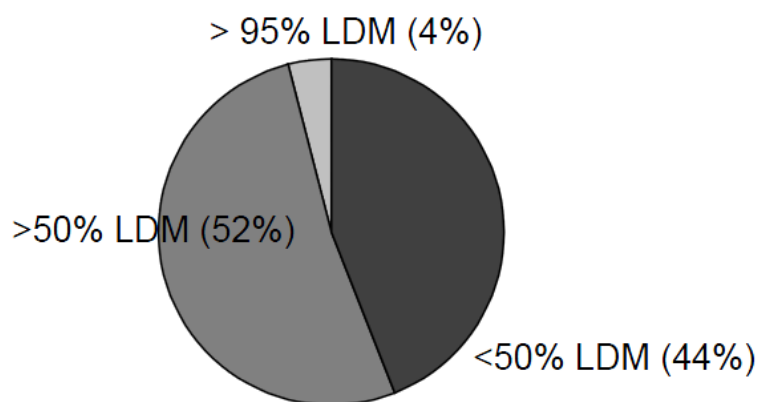
A. Boulders in outcrops



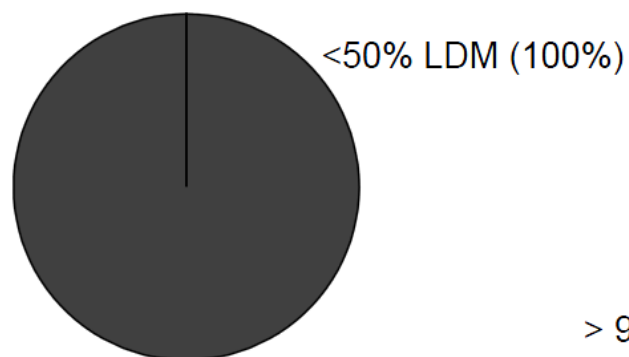
B. Layering in outcrops



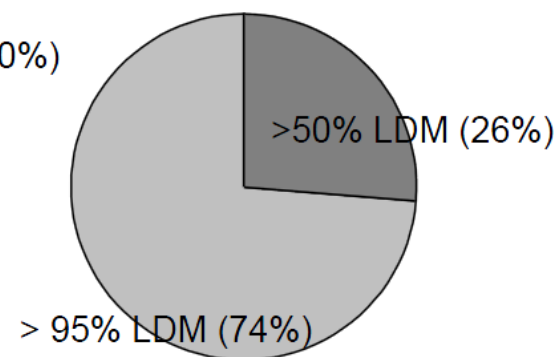
C. Catchment characteristics of outcrops with boulders



D. Catchment characteristics of outcrops with layering



E. Catchment characteristics of outcrops without boulders/layering





# Conclusions

- Martian gullies mainly formed by debris flows
- So only little liquid water needed!
- Surface morphology modified

De Haas et al., 2015: Icarus