MAGMA-CRYOSPHERE INTERACTIONS ON MARS - AN EXPERIMENTAL INVESTIGATION OF PHYSICAL PROCESSES

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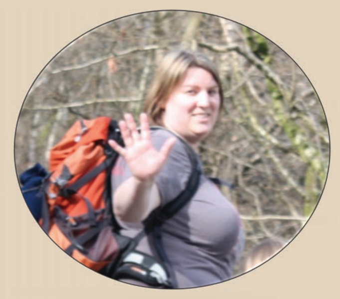
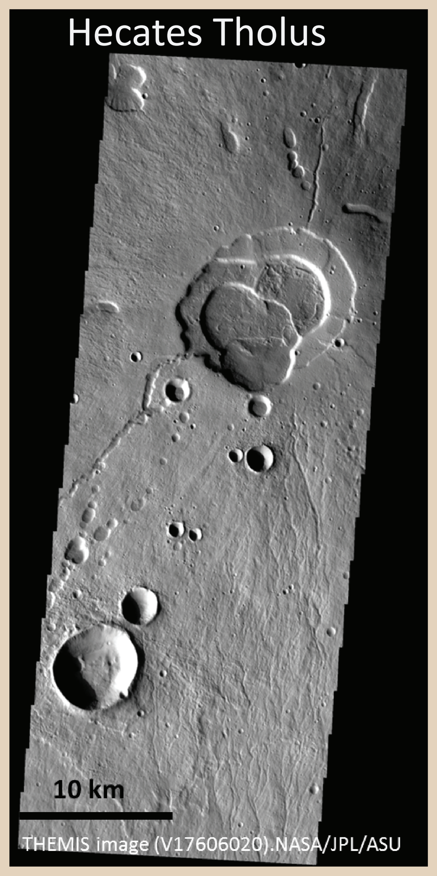
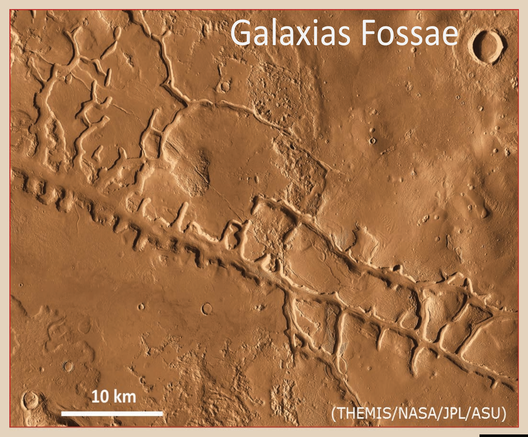
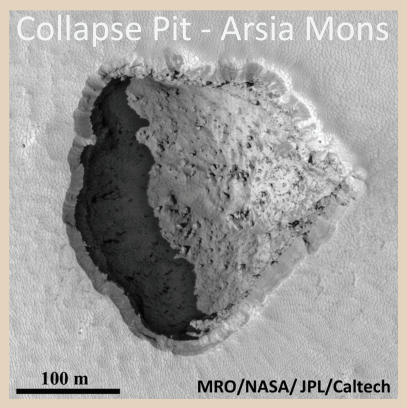
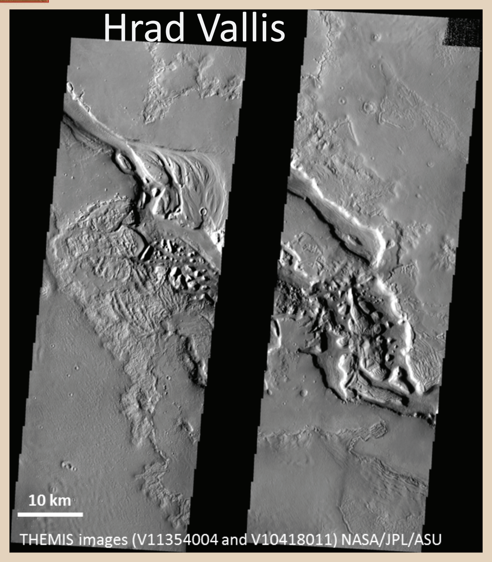


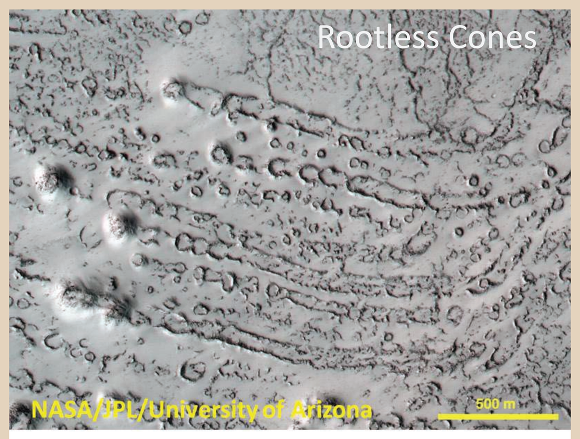


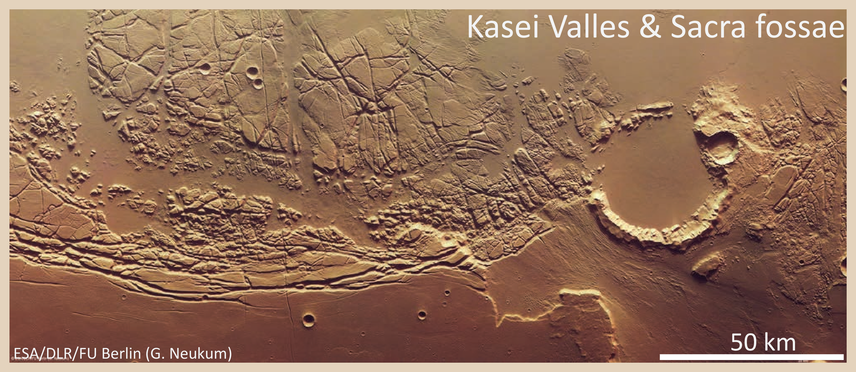




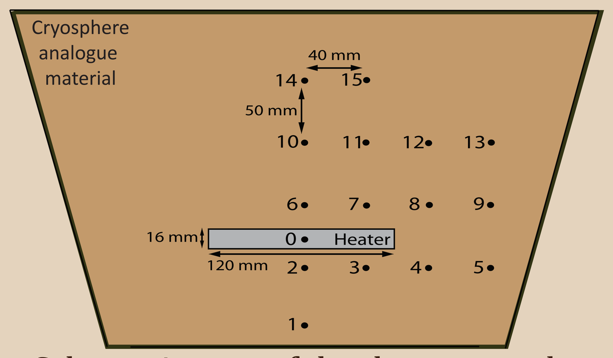
1) Landforms on Mars thought to have been influenced by magma-cryosphere interactions (MCI).



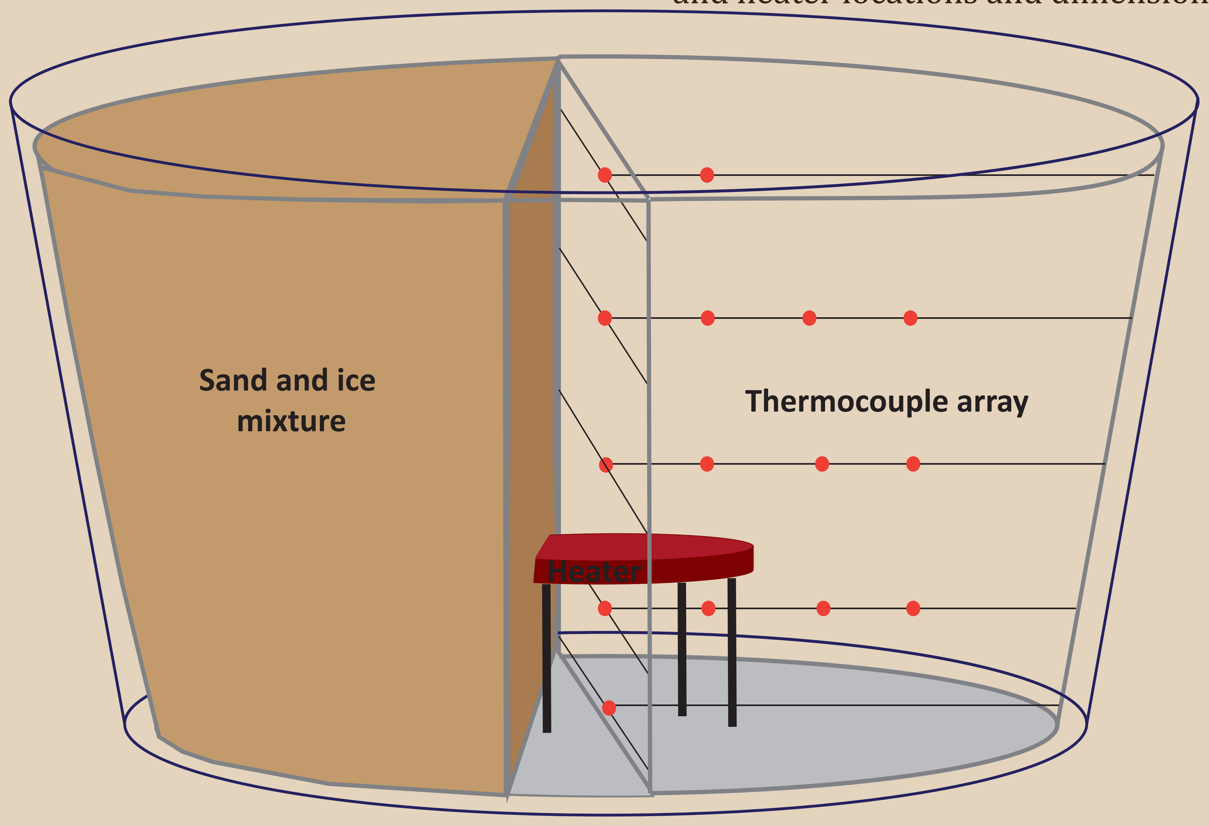




2) A series of laboratory experiments to investigate the range of thermal and physical processes which take place during MCI were conducted.

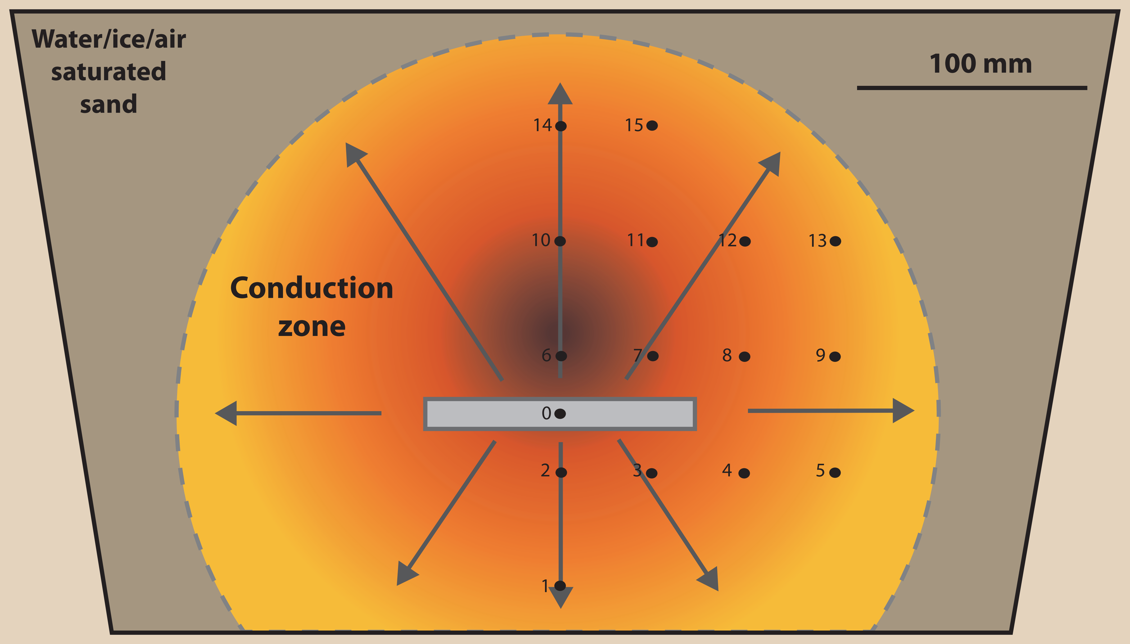


Schematic map of the thermocouple and heater locations and dimensions

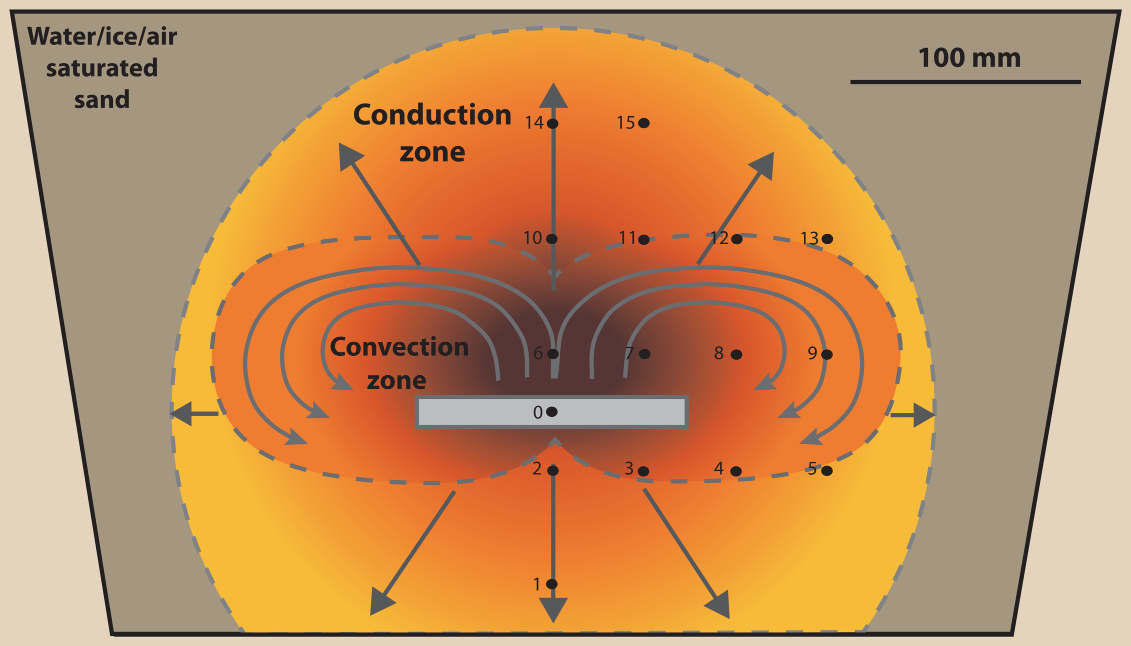


A 3D schematic cut-through of our experimental equipment. The heater is supported centrally on legs. Thermocouples are suspended by an insulating frame.

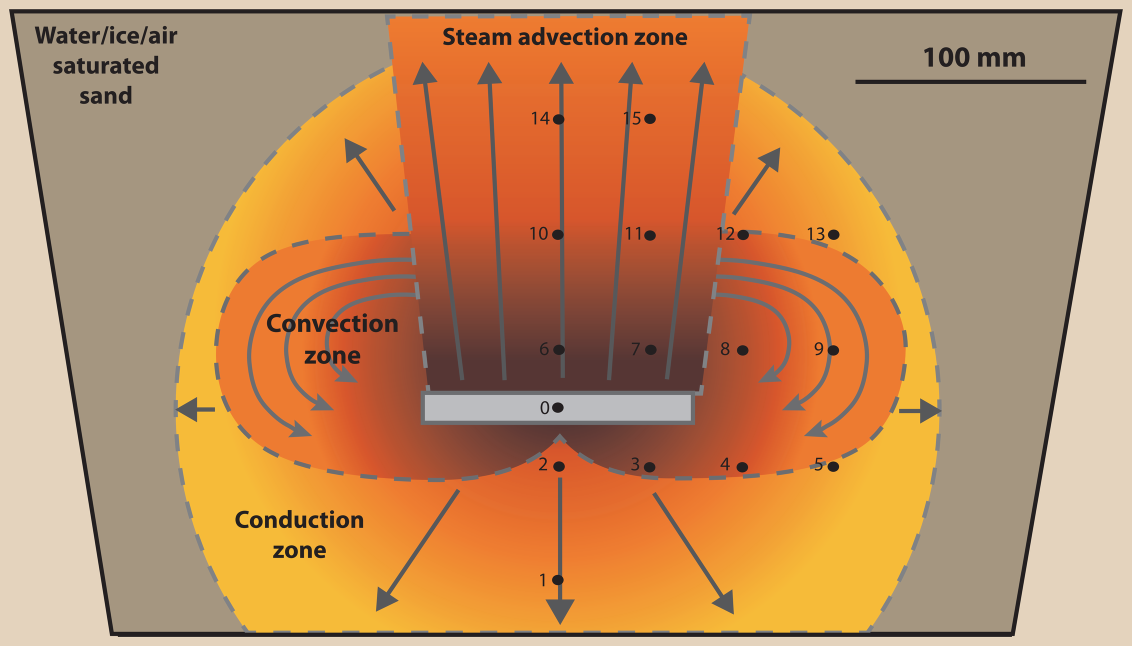
3) Three key heat-transfer mechanisms were identified.



At low heat transfer rates into the simulated cryosphere heat transport was dominated by conduction, and a near-radial pattern of temperature changes with time was observed.



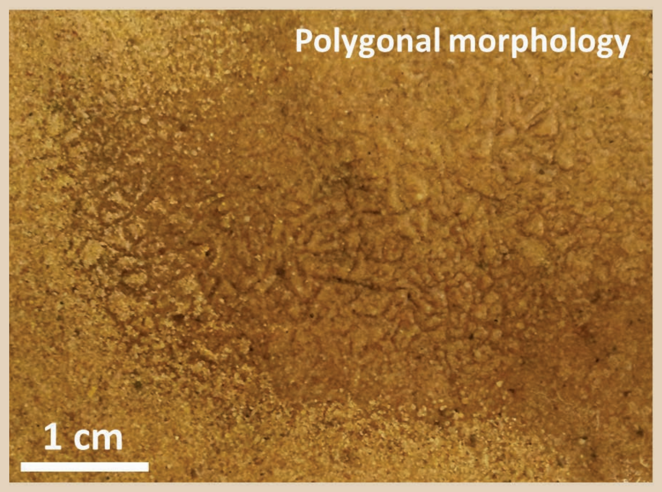
At greater heating rates, hindered convection of liquid water and wet steam at temperatures up to 100 °C occurs in a region close to the heater. This region extends to greater distances laterally than vertically. At suffcently great distances from the heat source conduction replaces convection as the dominant heat transfer mode.

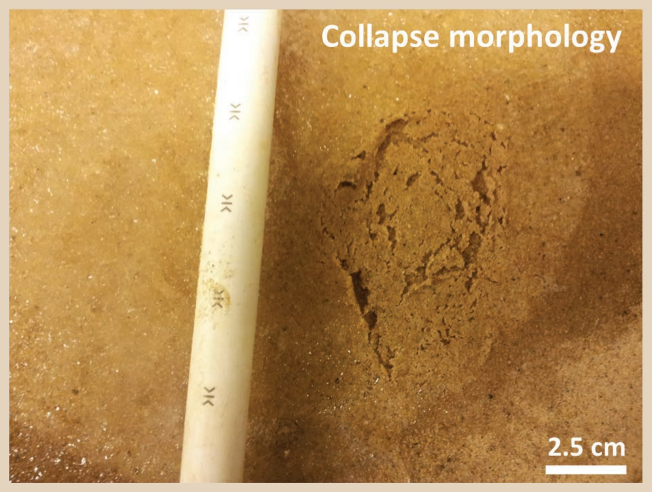


As temperatures exceed 100 °C near the heater dry steam is produced. The steam advects heat almost directly upward above the heater with the other two regimes being present where the temperatures are lower

4) Experimental data demonstrated that resultant surface morphology was highly dependent upon the heat-transfer mechanism/s which caused the cryosphere analogue to melt. In addition, for collapse to occur there must be a loss of support from below.

Grain-Supported Experiments



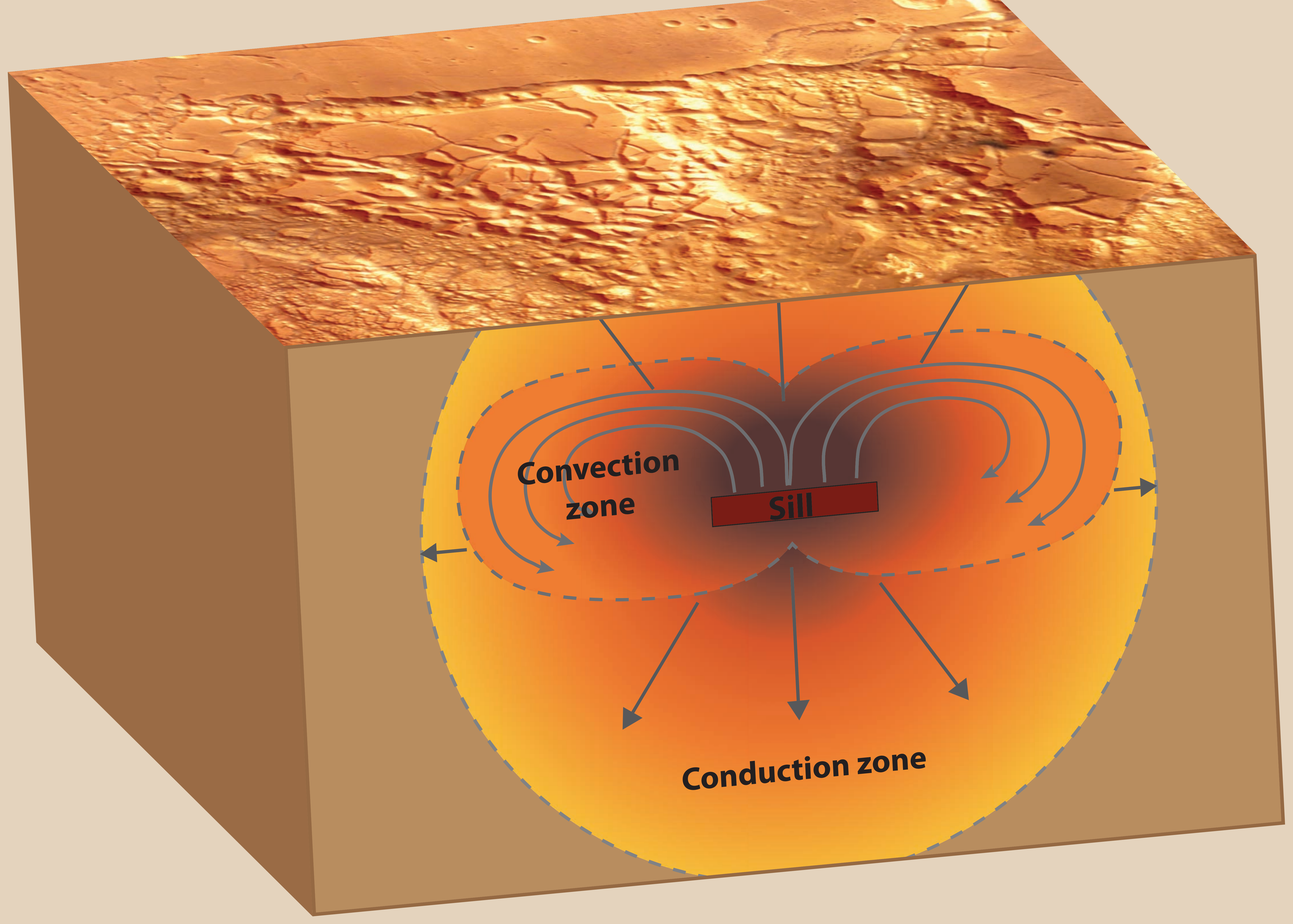


In grain-supported experiments surface morphology formed due to the 10 % reduction in volume when ice changes phase to liquid water.

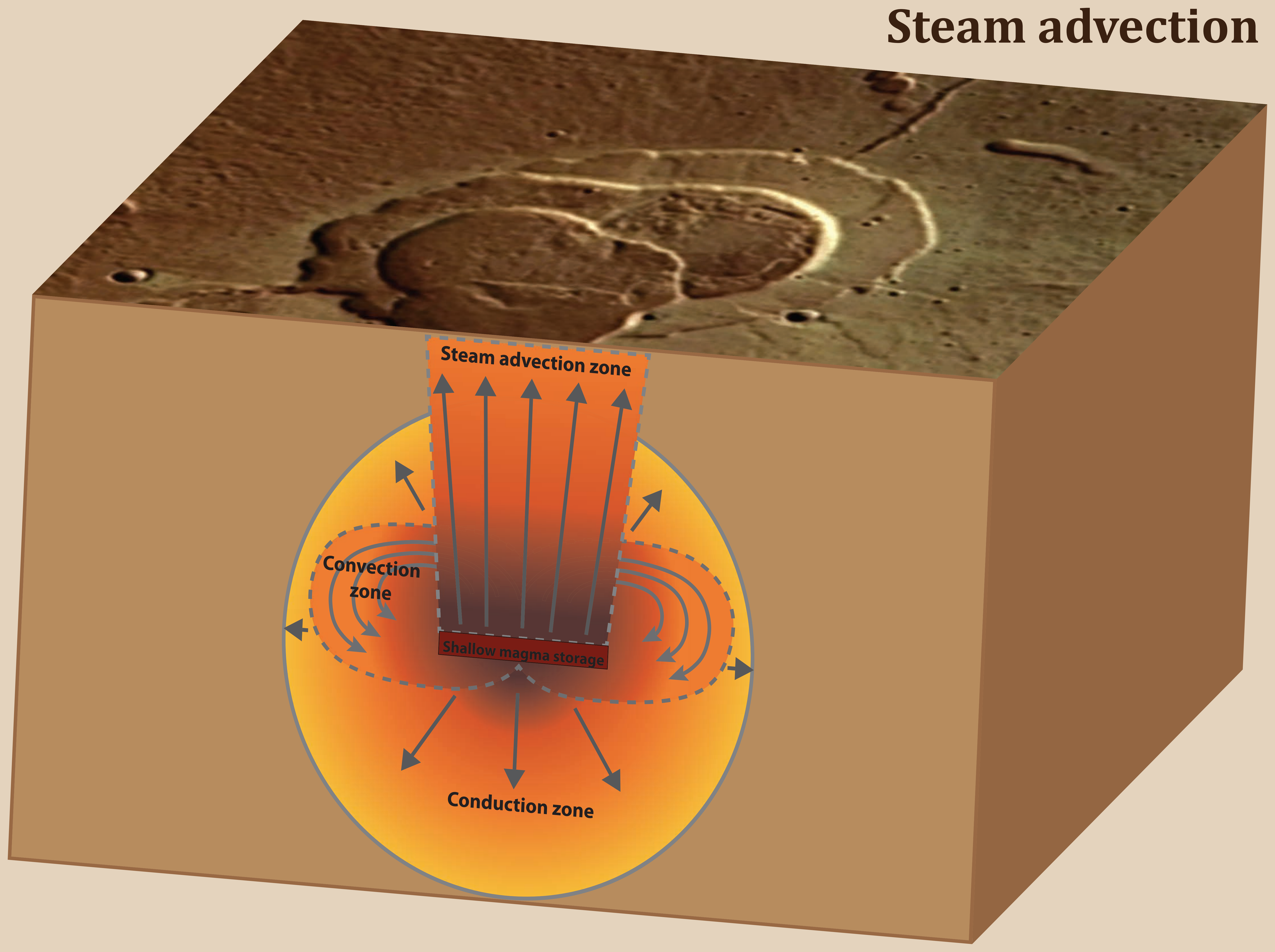
Ice-Supported Experiments

In ice-supported experiments surface collapse ocurred. The morphology of this collapse structure was dependent upon the dominant heat-transfer mechanism during the experiment.

Convection and conduction



Steam advection



3D schematic cross-sections of a sill intruded into cryosphere and the potential resultant morphology.

5) Our experimental observations provide insight into the range of plausible heat-transfer processes operating as an intrusion is emplaced within the cryosphere and cools with time. A key parameter for sill-like intrusions is likely to be the ratio of the horizontal extent of the intrusion to the depth of its top below the surface.

Conclusions:

- If conduction and convection are the dominant heat-transfer mechanisms and steam advection is only minimally active at the surface then the area of surface modification may extend to significantly greater horizontal distances than the size of the intrusion and may exhibit a greater range of textures. Image: ESA/DLR/FU Berlin (G. Neukum).
- If the influence of a steam advection zone extends to the surface, any surface disruption or subsidence will be similar in size to that of the heat-source. Image: ESA/DLR/FU Berlin (G. Neukum).