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Experimental simulation of geomorphological evolution of cometary surfaces using volatile-rich analog materials

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The morphologic development of sublimating cometary surfaces is investigated in our study using analog laboratory experiments on Earth. The focus lies on the evolution of different morphologies, taking into account parameters such as the composition of the sample material and variable insolation flux. Different sample compositions and geometries are prepared to model the interaction of volatile-dust mixtures with vacuum conditions. We aim to study the appearance of morphologic features, such as fractures and debris, developing by insolation and sublimation.

Important questions to answer are:

- Under which insolation and compositional conditions do cracks form in the sample material?
- Under which insolation and compositional conditions do cliffs collapse and are larger debris particles formed?
- Under given environmental conditions, how long do morphologic features remain on the surface?
- How do sublimating volatiles support the process of dust transport?
- What are the time scales of activity under given environmental conditions?

Initial investigations were conducted using cometary analogue materials. These materials are mixtures of water-ice and silica-dust particles with a diameter of few microns and in different mixing ratios. The water-ice particles are produced by freezing mist with liquid nitrogen and the silica-dust consists of angular particles of comparable size. To determine the tensile strength of the different ice-dust mixtures a series of Brazilian Disc Tests was performed. In this test, small cylinders of sample material are exposed to pressure until fracturing. The derived tensile strength can be used to determine the cohesion of the ice-dust mixtures and allows the vapour pressure that is required to entrain particles by sublimating volatiles to be estimated.

In our upcoming experiments, sample mixtures of variable particle sizes and water-ice/silica-dust ratios will be shaped into various morphologies, such as a cliff, pits or boulders and placed into a vacuum sublimation chamber. During insolation, the water-ice sublimates and the altering sample morphology will be observed and analysed with cameras. Additional monitored processes will be:

- mass loss during different phases of varying insolation
- lateral extent of mass movements
- the evolution of the temperature inside the sample material.