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Laboratory experiments to explore the sediment transport capacity of carbon dioxide sublimation under martian conditions

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Every spring, the solid carbon dioxide deposited over the martian high latitudes sublimates. Several, unusual surface features, including dark spots and flows on sand dunes, as well as recent activity in martian gullies, have been associated with this CO_2 sublimation. Water and/or brines have also been proposed as potential agents for these events, but the timing of these phenomena suggest CO_2 sublimation is more likely. However, the exact mechanism by which CO_2 sublimation moves sediment is not fully understood, and this understanding is required to validate the CO_2 hypothesis. Here we present the results of the first ever laboratory simulations of this process under martian conditions, and show that significant quantities of loose sediment can be transported. The centrepiece of the apparatus is a 1m diameter, 2m long Mars simulation chamber, housed at The Open University, UK. JSC Mars-1A regolith simulant was formed into a slope, inside a box, $\sim$30 cm long, 23 cm wide by 12 cm deep. The box is constructed of coiled, copper tubing to allow cooling of the regolith by liquid nitrogen. The experimental procedure consists of four stages: 1) establishment of a dry atmosphere in the chamber, 2) cooling the regolith sufficiently to support condensation of CO_2 frost at reduced pressure, 3) introduction of cooled CO_2 gas above the regolith to deposit as frost, and 4) video recording the surface evolution under radiant heating ($\sim$100 mins). Two High Definition digital video cameras were mounted above the box and image pairs taken from the videos were then used to create digital elevation models (DEMs) in Agisoft Photoscan at regular intervals. In our initial experiments we performed four experimental runs where the slope was set at or near the angle of repose ($\sim$30°). In each case we observed mass wasting events triggered by the sublimation of the deposited CO_2 over the whole duration of the insolation. The highest levels of activity occurred in the first third of the run (approx. 30 mins); however, activity was detected, with sporadic peaks, throughout each run. The total volume of regolith moved ranged from 164 to 216 cm3 over the four experimental runs (an average of 0.3-0.4 cm depth over the whole surface).