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Ballistic landslides on comet 67P/Churyumov–Gerasimenko

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Introduction:

The slow ejecta (i.e., with velocity lower than escape velocity) and landslides are similar. Both are forms of gravity movement. After landing, ejecta may be still moving like a 'regular' landslide. On the other hand, the motion of landslides may include free fall without contact with the ground

Observations of comets 9P/Tempe 1 and 67P/Churyumov – Gerasimenko revealed existence of various forms of mass motion [1, 2, 3]. We compare here landslides of matter from Imhotep (in the lobe Body) and from Hathemit (in the lobe Head) depressions.

Model of ejection

A simple model of processes leading to the formation of slow ejecta is assumed [3]. The phase transition heats a certain underground volume [4, 5, 6]. It leads to vaporization of volatiles. Eventually a cavity is formed. If the pressure in the cavity exceeds some critical value then the crust could be crushed and its fragments will be ejected in the space. Note that the initial velocity of ejecta are usually approximately perpendicular to the physical surface. This assumption was used successfully in [6].

Results

We found that ejecta with the velocity 0.3 m s^{-1} (or lower) land close to the starting point for both considered depressions. Ejecta faster than 0.5 m s^{-1} have complex trajectories and may land far from the starting point. For the velocity 0.7 m s^{-1} (and higher) some of ejecta did not land during modeling even for Imhotep.

In [6] we have found that ejecta from Hathemit fall in a wide belt mainly on the one hemisphere. For ejecta from Imhotep there is no such pattern.

The fate of the ejecta after landing depends on many factors: the friction coefficient, the inclination of the place of landing, the vector of velocity, etc. However, often the motion is determined by small scale details. Note that the sliding grain must overcome the worst obstacle on the landing surface.

Conclusions and future plans

Determining places of deposition of the material ejected from Imhoteb or Hatmelib will allow to determine the composition of the comet's interior under these regions without the need for drilling. This would be particularly important for future missions to the comet.

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