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On the suction drill as an effective tool to get rid of bore debris in a narrow deep borehole

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Abstract

In this experimental study a novel method for the removal of bore debris from narrow and deep boreholes is described. The idea is to use a constant flow of inert gas (e.g. N_2) to transport the fine bore debris produced by a drill head to the surface and thereby clear the bore hole from the solid material. A theoretical study [1] has previously predicted that it should be possible to construct a system able to transport particles in the micrometer to millimeter range along the vertical direction over many meters – without consuming unreasonable amounts of gas.Such a system could be of great interest for drilling and sampling on the Moon, Mars and small bodies.

In order to verify this statement experimentally, a series of laboratory tests was performed. The experimental setup consists of the following main components: (i) a gas regulation system allowing accurate measurement and control of the inlet gas flux and (ii) a device representing the suction drill. The "drill" consists of a 45 cm long Plexiglas sheath within which a central metal tube leads gas to the bottom of a (simulated) borehole, where it is diverted through thin outlet openings to flow back up the tube, driving out debris particles as it does so. Experiments with two particular sample materials were performed, namely (i) glass beads with a size range of 0.25 mm - 0.50 mm and (ii) the standardised lunar analog material JSC-1A, which is a milled basaltic lava with an average particle size of about 0.1 mm.

In both cases the suction mechanism under vacuum worked very well and the theoretical predictions were largely confirmed. Similar results were obtained for JSC-1A samples and glass beads, although in case of the lunar analog material adhesive forces among the irregular particles might hinder the transport. The conclusion from our experiments is that suction of particles from deep bore holes is an effective method and needs rather moderate resources of gas supply. Thus it may be better suited for planetary lander missions than other, more traditional systems as auger drills or corers and therefore can be recommended as part of a drilling system to be installed on a lunar or planetary lander.

References

[1] Kömle N.I., Weiss P., and Yung K.L.: Considerations on a suction drill for lunar surface drilling and sampling. Acta Geotechnica 3, 201-214 (2008)