Proposal for a Planetary Geology and Geophysics Initiative on Lunar Drilling

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Scientific drilling is critical to the development of planetary science and technology. As the Moon is the cornerstone for deep space exploration, lunar drilling will become an important task in the near future. However, research into the scientific objectives and required technologies for lunar drilling is lagging behind deep space exploration strategy and planning. Compelling reasons for speeding up lunar drilling research include but are not limited to the following:

- There have been great advances in the conceptual understanding of various lunar processes since the Apollo era, mainly on the basis of reinterpretation of Apollo data, numerical modeling, and remote sensing from Clementine, Lunar Prospector, and Smart 1. Drilling will provide a unique opportunity for a direct verification of those new conceptual models.
- Borehole drilling is the only means of directly measuring the heat flow from the interior of the Moon. So far the only in situ lunar heat flow measurements were made from shallow boreholes at two Apollo landing sites. Deep boreholes in diverse geological settings are needed in order to obtain a globally representative value of lunar heat flow.
- The subsurface of the Moon may comprise important clues to deepening our understanding of the terrestrial climate change. Lunar drilling will enable application of borehole thermometry to reconstruct a solar radiation history. Isotope ratios in the lunar regolith core samples may shed light on the variability of the solar and cosmic particle flux that affects Earth's atmosphere.
- Deep drilling will offer great opportunities for paleoregolith/rock sampling, stratigraphic analysis, and better detection of seismic signals that illuminate the deep structure of the Moon. Core samples can provide insight into planetary impact and volcanism processes, and allow for a better assessment of the Helium-3 deposits.
- Borehole drilling is necessary for the design of a sustainable lunar base and mining activities. It can lead us to a better understanding of the distribution of water and other resources. From a geotechnical point of view, a drilling program can provide us with information about regolith/rock properties such as stiffness and strength that are essential for manufacture of construction material and design of mining equipment.
- The Moon is the most realistic testbed for deep space exploration technologies. Lunar drilling provides a platform for testing deep drilling techniques to be later used on Mars. Although the motivations for drilling on different planetary bodies might somehow differ, our ability to drill on Mars will be greatly strengthened by what we learn from our drilling experience on the Moon.

A lunar drilling program will be both scientifically and technologically challenging. This proposed PGG initiative is to focus primarily on the scientific aspects of lunar drilling. It is aimed to stimulate the exchange of ideas and to foster international collaboration on lunar drilling through workshops and special sessions at relevant conferences. We will promote multidisciplinary research to maximize the value of a lunar drilling program. The outcome of this initiative will contribute to the development of future lunar mission concepts.

The participants of this initiative will include David Beaty (NASA JPL), Robert Cahalan (NASA Goddard), Ronald Creel (SAIC), Ian Crawford (Birkbeck College, London), Dana Crider (Catholic Univ.), Youssef Hashash (Univ. Illinois), Shaopeng Huang (Univ. Michigan), Ramesh Malla (Univ. Connecticut), Wendell Mendell (NASA Johnson), Jeffrey Plescia (Applied Physics Lab / JHU), Yasuyuki Saito (ISAS/JAXA), Mark Wieczorek (Institut de Physique du Globe de Paris), Allen Wilkinson (NASA Glenn).