

The Auto-Gopher – A Wireline Rotary-Percussive Sampler for deep subsurface planetary exploration

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ABSTRACT

For the “Search for Life” part of the NASA’s solar system exploration objectives, it is vital to be able to acquire samples from subsurface regions on planetary bodies that potentially contain extinct or extant biosignatures. To enable the required capability, a wireline deep rotary-percussive corer called Auto-Gopher was developed. The Auto-Gopher can operate as an effective sampling tool reaching great depths (many tens of meters) and is significant to future NASA in-situ exploration mission concepts that would address the important questions of whether life once existed or exists elsewhere in the solar system. The main target for this development effort is Mars although the drill would also be suitable to potential subsurface exploration of Europa and Titan. On Europa, much like Mars, the surface is bombarded with radiation that will destroy fragile biomarkers that may be indicative of life in the Europa Ocean, potentially the largest liquid water repository in the solar system.

The percussive action provides effective material fracturing and the rotation provides efficient cuttings removal. To increase the drill’s penetration rate, the percussive and rotary motions are operated simultaneously. To maximize the penetration rate, the lessons learned suggested the need to use a combination of rotation and hammering. This capability was implemented and tested as the Auto-Gopher-1 deep drill which was demonstrated to reach 3-meter deep in gypsum. Currently, the second generation wireline system is being developed, called Auto-Gopher-2, and it is integrated in a single drilling unit to execute all the necessary functions and to include the drive electronics. To maximize the probability of success, the coring mechanism is being replaced with a full face drill head and an auger. The integrated wireline drill functions include cutting removal, retention and delivery in addition to drilling. In this paper, the Auto-Gopher-2, its predecessors and their capability will be described and discussed.