



Ultrasonic/Sonic Driller/Corer (USDC) as a subsurface sampler and sensors platform for planetary exploration applications

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The search for existing or past life in the Universe is one of the most important objectives of NASA's mission. For this purpose, effective instruments that can sample and conduct in-situ astrobiology analysis are being developed. In support of this objective, a novel Ultrasonic/Sonic Driller/Corer (USDC) based device has been developed to probe and sample rocks, ice and soil. The USDC is driven by an ultrasonic piezoelectric actuator that impacts a coring or drilling bit at sonic frequencies through the use of an intermediate free-mass. The USDC can produce both core and powdered cuttings, operate as a sounder to emit elastic waves and serve as a platform for sensors. For planetary exploration, this mechanism has the important advantage of requiring low axial force, virtually no torque, and can be duty cycled for operation at low average power. This low axial load advantage overcomes a major limitation of planetary sampling in low gravity environments or when operating from lightweight robots and rovers. The low power operation produces a minimum temperature rise allowing for control of the sample integrity and allowing identification of the possible biological markers of the acquired sample. The development of the USDC is being pursued on various fronts ranging from analytical modeling to mechanisms improvements while seeking a wide range of applications. While developing the analytical capability to predict and optimize its performance, efforts are made to enhance its capability to drill at higher power, and high speed. Taking advantage of the fact that the bit does

not require rotation and that it may be designed to be subjected to minute displacements, sensors (e.g., thermocouple and fiberoptics) were integrated into the bit to examine the borehole during drilling. The sounding effect of the drill was used to emit elastic waves in order to evaluate the surface characteristics of rocks. In this paper, the status of the latest USDC development and applications will be reviewed.