In-situ Rock Probing Using The Ultrasonic/Sonic Driller/Corer (USDC)

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ABSTRACT

Ability of in-situ sampling and analysis are important capabilities to allow meeting the major objectives of future NASA's planetary exploration missions. The development of an ultrasonic device that can serve as a probe, sampler and sensors platform for in-situ analysis is currently underway at JPL. The device is based on the novel Ultrasonic/Sonic Driller/Corer (USDC) technology, which was co-developed by the Non-Destructive Evaluation and Advanced Actuator laboratory (NDEAA, http://ndeaa.jpl.nasa.gov/), JPL, and Cybersonics. This sampling technology requires low axial force, thereby overcoming one of the major limitations of planetary sampling in low gravity using conventional drills. This device allows the design of an effective tool that is compact, low mass and uses low power. To assure effective use of power for drilling/coring rocks in-situ probing is needed to allow selecting rocks with the highest probability of containing information (biological markers, water, etc.). While the major function of the USDC is sampling, drilling and coring, it also has great potential to serve as a probing device. The USDC imparts elastic waves into the sampled medium offering a sounding method for geophysical analysis similar to the ones used by the oil industry. Also, the characteristic of the piezoelectric actuator, which drives the USDC, is affected by the medium to which it is coupled. Using various piezoelectric wafer configurations, we are conducting a series of experiments to measure the elastic wave velocity, scattering, impedance and the shift in resonance frequency. We are testing various rocks to determine their characteristics. Preliminary results are encouraging. We are currently investigating methods of minimizing the effect of surface roughness, geometry and sample dimensions on the data.