

Ultrasonic/Sonic Drilling and Coring Using Floating Head Mechanism

PI: Yoseph Bar-Cohen

NDEAA, JPL, 818-354-2610, yosi@jpl.nasa.gov

Investigators:

JPL: Stewart Sherrit and Benjamin Dolgin

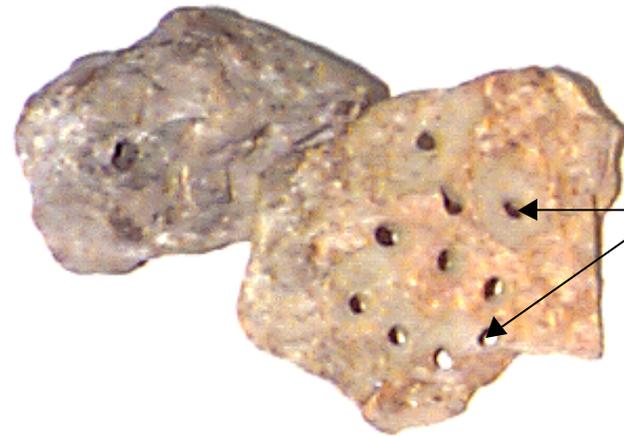
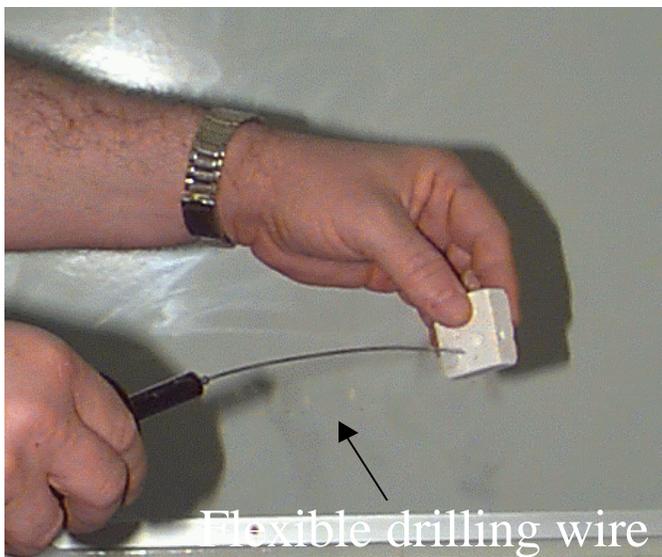
**Cybersonics: Thomas Peterson, Dharmendra Pal and
Jason Kroh**

June 1, 1999

Background

- **Coring and drilling as sample collection techniques were identified as critical technologies for Mars Exploration and Solar System Exploration Programs.**
 - **Sample Returns from Mars, Comets (CNSR), Venus, Titan**
- **A unique drilling/coring mechanism was developed jointly by JPL and Cybersonics.**
 - **Combines ultrasonic and sonic vibrations via hammering mechanism**
 - **Current medical applications: destruction of kidney stones (lithotripsy) and thrombi in arteries.**

FLEXIBLE GUIDEWIRE ULTRASONIC DRILLING



Ultrasonically drilled holes

Ultrasonic device used for medical applications was demonstrated to drill rocks.

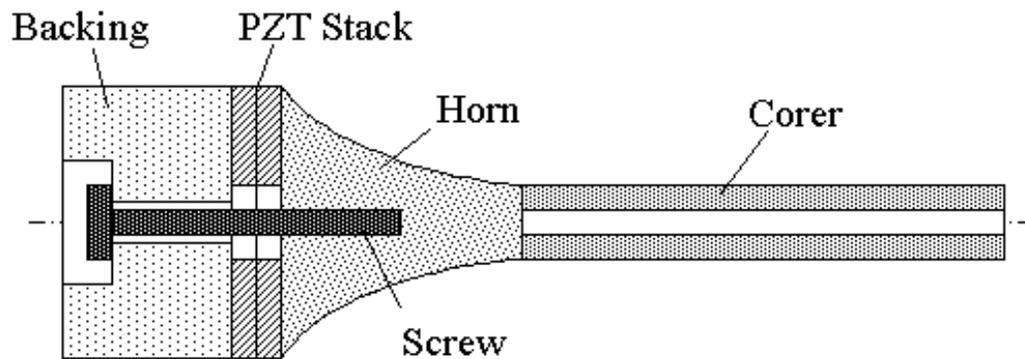
RELEVANCE TO IN-SITU PLANETARY EXPLORATION

- **The ultrasonic/sonic driller is effective on very hard rocks**
- **Can be based on an ultralight rover, lander in low gravity, or robotic arm with very low mechanical impact of its host.**
- **Potential of operating under extreme conditions from cryogenic temperature/ vacuum (e.g., comets, asteroids, Mars, moons) to extremely high temperatures/pressures (e.g., Venus).**

Ultrasonic Driller/Corer Using Low Axial Force

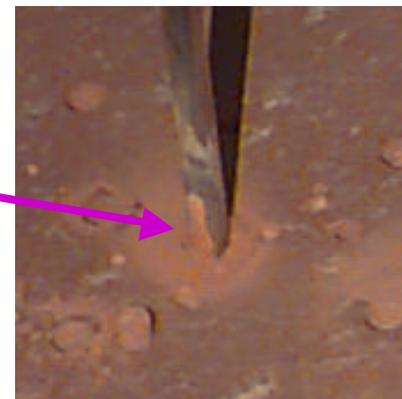


Coring bricks using the new Ultrasonic/Sonic Drilling Mechanism

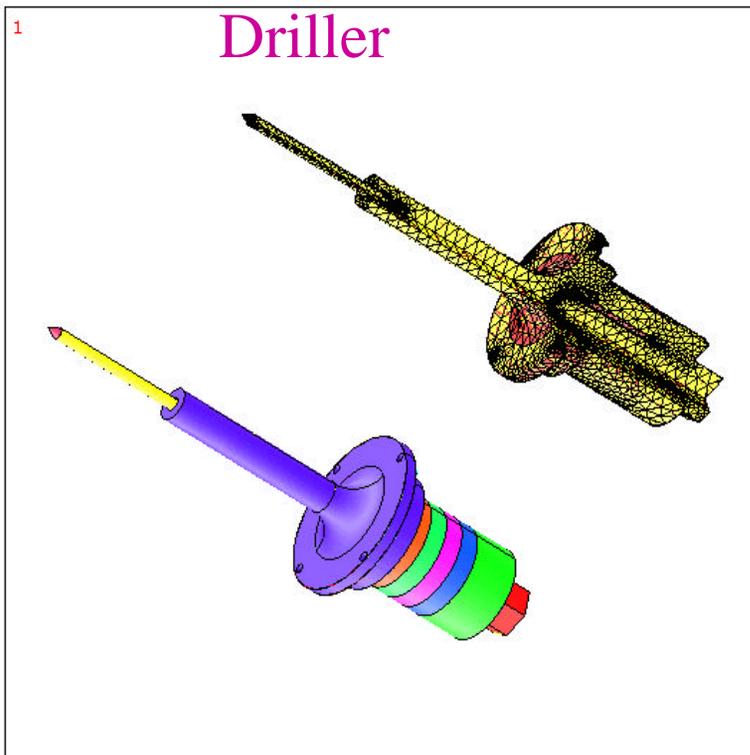


General view of the corer actuator and end effector

Self debris-extraction mechanism

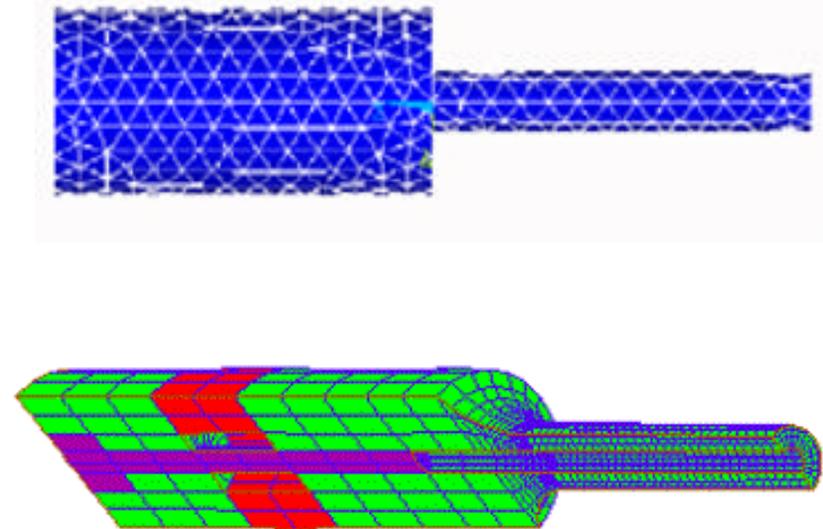


FEM of Ultrasonic Driller/Corer



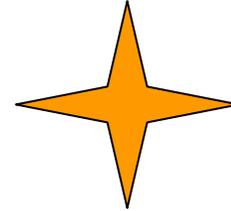
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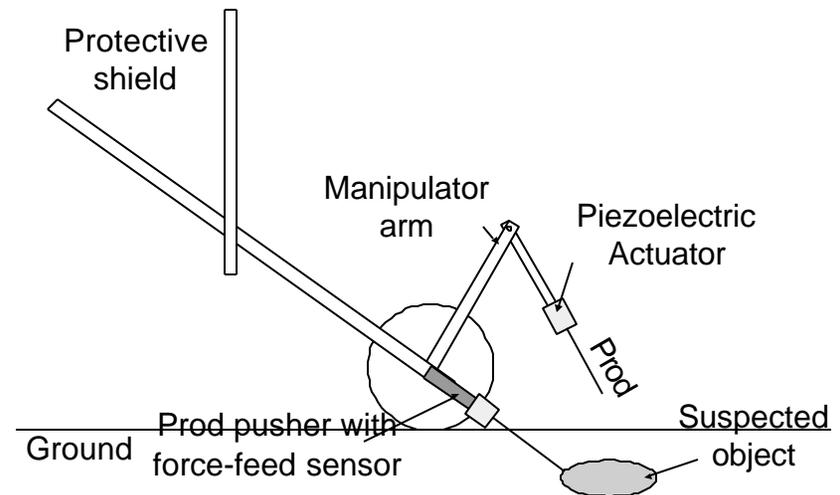
ADVANTAGES OF ULTRASONIC/SONIC DRILLER

- **Holes with various cross-sections for better microscopic viewing and analytical instruments access.**
- **Potential debris removal using guided wave on the end-effector**
- **Sensors integrated into the end-effector for in-situ gauging**
- **Harsh environments, including high/low temperatures, vacuum/pressure, and under water.**
- **No concern of bit dulling, no need for bit cleaning or sharpening**
- **Low impact on the host structure**
- **Very safe - During drilling the tip can be handled or guided even with a bare hand**
- **Can drill or core at an angle and is not sensitive to misalignment**



COMMERCIALIZATION POTENTIAL

- Medical application in orthopedic operations
- Effective grinder and marker, ceramic and semiconductor wafer machining
- Construction tools
- Potential consumer products (e.g., concrete drilling tool at Home Depot).
- Robotic drilling and hammering
- Land mine detection, manual and robotic, emulating manual prodding techniques



Summary

- A novel drilling and coring device, driven by a combination of sonic and ultrasonic vibration, was developed.
- The device drills soft and hard objects using low axial preload; it is expected to operate under extreme conditions.
- The device has numerous potential extraterrestrial applications.
- Significant potential for commercialization in construction, demining, drilling and medical fields.