Ultrasonic Drilling and Coring

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Participants:

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Cybersonics: Thomas Peterson, Dharmendra Pal and Jason Kroh

NASA Space Mechanisms Working Group
Video Conference, December 15, 1998

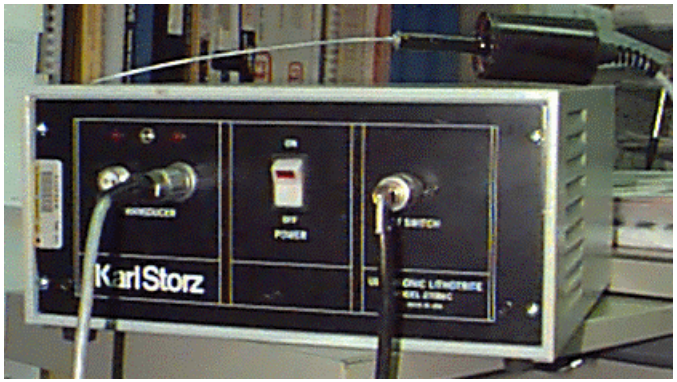
Background

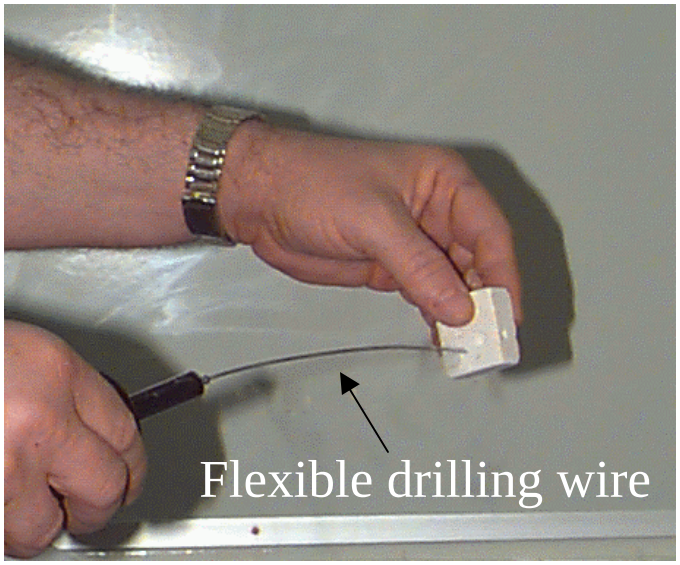
- Mars Sample Return, Cometary Sample Return and the Solar Exploration Initiative identified coring, drilling and sample collection capability as critical technologies.

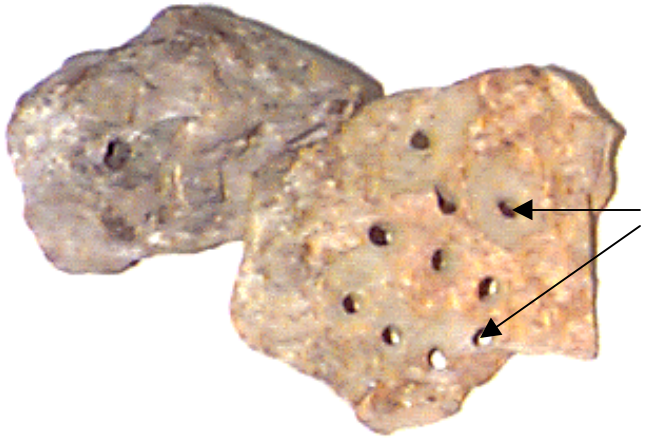
- An ultrasonic drill, developed initially for destruction of kidney stones (lithotripsy), was studied.
  - The study was triggered by a development at Cybersonics using flexible guided wire as a means of destroying blockages in arteries.
  - Potential for rover mount with minimum torque impact was considered.
  - A Phase-I contract was awarded to Cybersonics to demonstrate miniaturization of the ultrasonic device for drilling hard rocks using low axial force while consuming low power (<5 Watts).

- A novel method was developed for effective drilling and coring using a combination of ultrasonic and sonic vibrations.

FLEXIBLE GUIDEWIRE ULTRASONIC DRILLING







- Ultrasonic device demonstrated to drill rocks.
- Tungsten carbide flexible wire is guided in arteries to destroy blockages.

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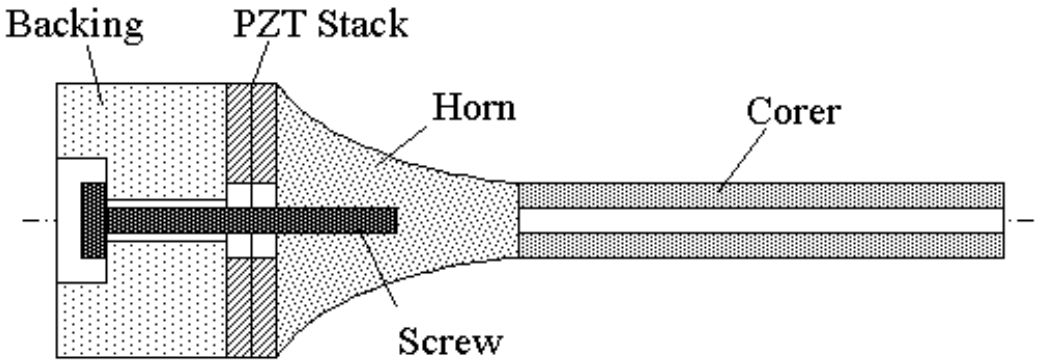
Relevance to in-situ planetary exploration

- The developed ultrasonic device offers effective drilling mechanism for very hard rocks from an ultralight rover, lander or robotic arm with *low axial load*.

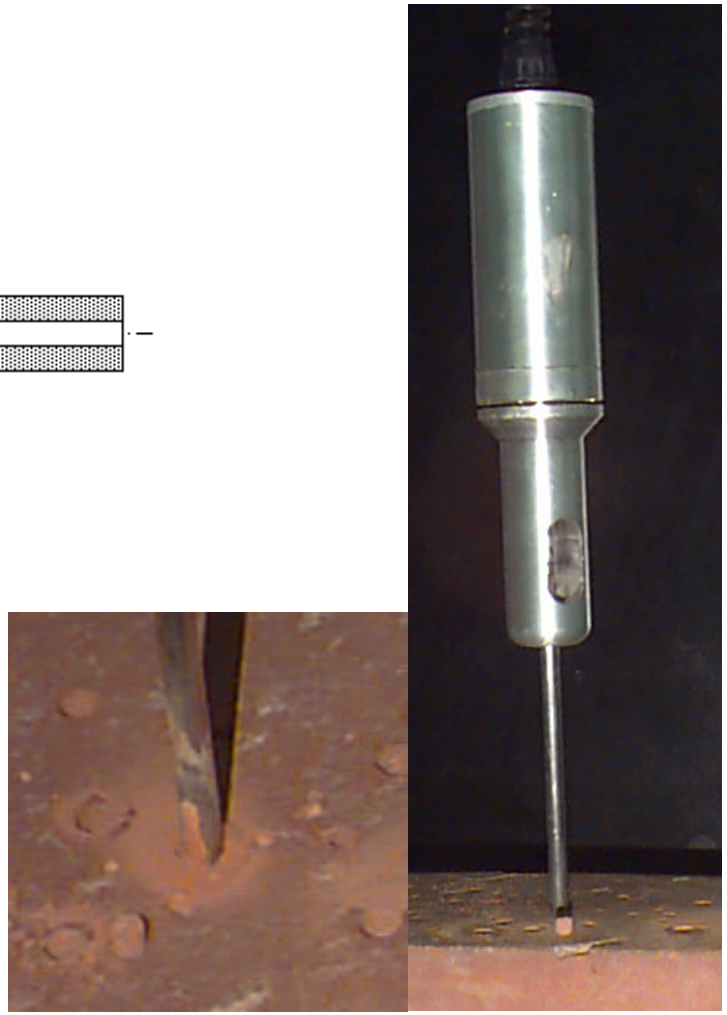
- Potential of operating under extreme conditions from cryogenic temperature/ vacuum (e.g., comets, Mars) and extremely high temperatures/pressures (e.g., Venus).

Ultrasonic Driller

Ultrasonic Corer

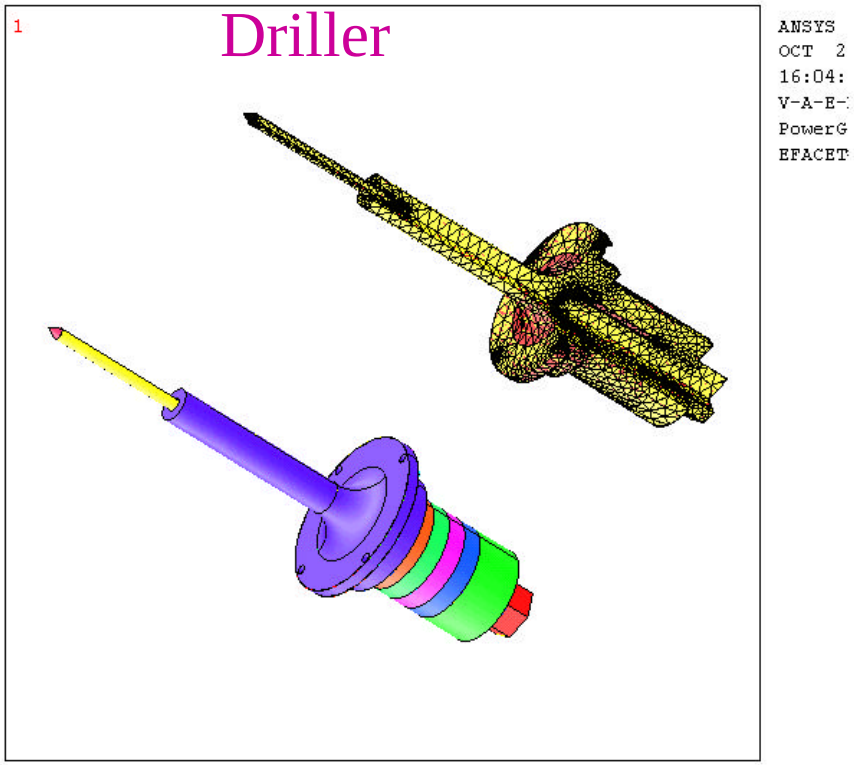


General view of the corer actuator and end effector

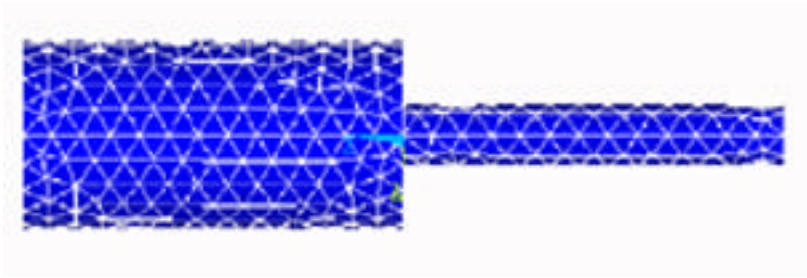


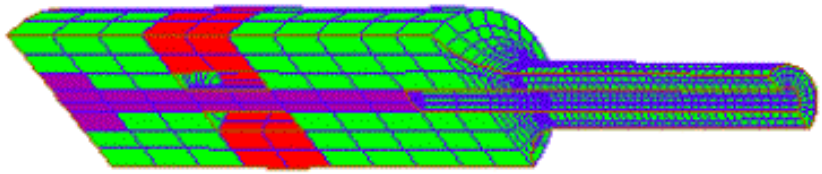
FEM of Ultrasonic Driller/Corer

Driller



Corer





Commercialization potential

- Medical application to orthopedic operations and others
- Construction tools
- Robotic drilling and hammering
- Potential consumer product (e.g., concrete drilling tool at Homedepot).
- Effective grinder and marker, ceramic machining, etc.

Summary

- A novel drilling and coring device, driven by a combination of sonic and ultrasonic vibration, was developed.
- The device is applicable to soft and hard objects using low axial load and potentially operational under extreme conditions.
- The device has numerous potential planetary applications.
- Significant potential for commercialization in construction, demining, drilling and medical technologies.