well as broken cores, and it also acts as a core retention device. The cores are broken at the bottom of the sample tube with a clean cut. The invention uses a core bending principle and does not induce additional axial load on the drill/robotic arm.

This invention is potentially applicable to sample return and *in situ* missions to planets such as Mars and Venus, moons such as Titan and Europa, and comets. It is also applicable to terrestrial applications like forensic sampling and geological sampling in the field.

This work was done by Mircea Badescu, Stewart Sherrit, Yoseph Bar-Cohen, Xiaoqi Bao, and Randel A. Lindemann of Caltech for NASA's Jet Propulsion Laboratory. Further information is contained in a TSP (see page 1). NPO-47356

Scoring Dawg Core Breakoff and Retention Mechanism

NASA's Jet Propulsion Laboratory, Pasadena, California

This novel core break-off and retention mechanism consists of a scoring dawg controlled by a set of two tubes (a drill tube and an inner tube). The drill tube and the inner tube have longitudinal concentric holes. The solution can be implemented in an eccentric tube configuration as well where the tubes have eccentric longitudinal holes. The inner tube presents at the bottom two control surfaces for controlling the orientation of the scoring dawg. The drill tube presents a sunk-in profile on the inside of the wall for housing the scoring dawg. The inner tube rotation relative to the drill tube actively controls the orientation of the scoring dawg and hence its penetration and retrieval from the core. The scoring dawg presents a shaft, two axially spaced arms, and a tooth. The two arms slide on the control surfaces of the inner tube. The tooth, when rotated, can penetrate or be extracted from the core.

During drilling, the two tubes move together maintaining the scoring dawg completely outside the core. After the desired drilling depth has been reached the inner tube is rotated relative to the drill tube such that the tooth of the scoring dawg moves toward the central axis. By rotating the drill tube, the scoring dawg can score the core and so reduce its cross sectional area. The scoring dawg can also act as a stress concentrator for breaking the core in torsion or tension. After breaking the core, the scoring dawg can act as a core retention mechanism.

For scoring, it requires the core to be attached to the rock. If the core is broken, the dawg can be used as a retention mechanism. The scoring dawg requires a hard-tip insert like tungsten carbide for scoring hard rocks. The relative rotation of the two tubes can be controlled manually or by an additional actuator. In the implemented design solution the bit rotation for scoring was in the same direction as the drilling. The device was tested for limestone cores and basalt cores. The torque required for breaking the 10-mm diameter limestone cores was 5 to 5.8 lb-in. (0.56 to 0.66 N-m).

This work was done by Mircea Badescu, Stewart Sherrit, Yoseph Bar-Cohen, Xiaoqi Bao, and Paul G. Backes of Caltech for NASA's Jet Propulsion Laboratory. Further information is contained in a TSP (see page 1). NPO-47355

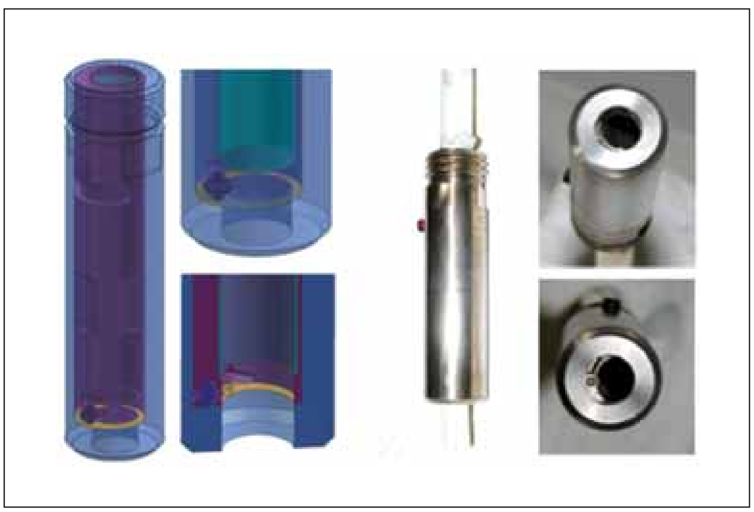
Rolling-Tooth Core Breakoff and Retention Mechanism

The mechanism has applications in analytical tests of geological materials.

NASA's Jet Propulsion Laboratory, Pasadena, California

Sampling cores requires the controlled breakoff of the core at a known location with respect to the drill end. An additional problem is designing a mechanism that can be implemented at a small scale that is robust and versatile enough to be used for a variety of core samples. This design consists of a set of tubes (a drill tube and an inner tube) and a rolling element (rolling tooth). An additional tube can be used as a sample tube. The drill tube and the inner tube have longitudinal holes with the axes offset from the axis of each tube. The two eccentricities are equal. The inner tube fits inside the drill tube, and the sample tube fits inside the inner tube.

While drilling, the two tubes are positioned relative to each other such that the sample tube is aligned with the drill tube axis and core. The drill tube includes teeth and flutes for cuttings removal. The inner tube includes, at the base, the rolling element implemented as a wheel on a shaft in an eccentric slot. An additional slot in the inner tube and a pin in the drill tube limit



The **Rolling-Tooth Design** of the core breakoff and retention mechanism (left), and the assembled parts (right).