Mechanics/Machinery

Method for Cleanly and Precisely Breaking Off a Rock Core Using a Radial Compressive Force

This technique can be used by civil engineers in rock, ground, and concrete coring and sampling.

NASA's Jet Propulsion Laboratory, Pasadena, California

The Mars Sample Return mission has the goal to drill, break off, and retain rock core samples. After some results gained from rock core mechanics testing, the realization that scoring teeth would cleanly break off the core after only a few millimeters of penetration, and noting that rocks are weak in tension, the idea was developed to use symmetric wedging teeth in compression to weaken and then break the core at the contact plane. This concept was developed as a response to the break-off and retention requirements.

The wedges wrap around the estimated average diameter of the core to get as many contact locations as possible, and are then pushed inward, radially, through the core towards one another. This starts a crack and begins to apply opposing forces inside the core to propagate the crack across the plane of contact.

The advantage is in the simplicity. Only two teeth are needed to break five varieties of Mars-like rock cores with limited penetration and reasonable forces. Its major advantage is that it does not require any length of rock to be attached to the parent in order to break the core at the desired location. Test data shows that some rocks break off on their own into segments or break off into discs. This idea would grab and retain a disc, push some discs upward and others out, or grab a segment, break it at the contact plane, and retain the portion inside of the device. It also does this with few moving parts in a simple, space-efficient design.

This discovery could be implemented into a coring drill bit to precisely break off and retain any size rock core.

This work was done by Megan Richardson and Justin Lin of Caltech for NASA's Jet Propulsion Laboratory. Further information is contained in a TSP (see page 1). NPO-47444

Praying Mantis Bending Core Breakoff and Retention Mechanism

This mechanism has application in sampling cores for analytical tests of geological materials.

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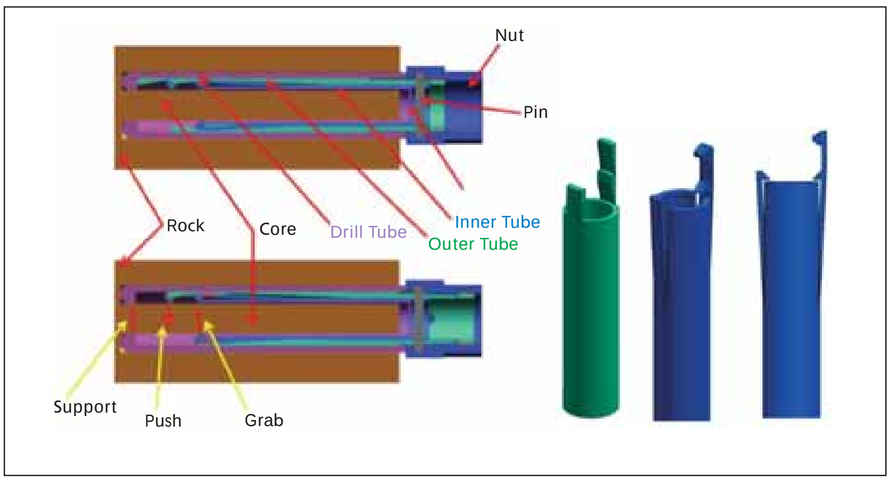
Sampling cores requires the controlled breakoff of the core at a known location with respect to the drill end. An additional problem is designing a mechanism that can be implemented at a small scale, yet is robust and versatile enough to be used for a variety of core samples.

The new design consists of a set of tubes (a drill tube, an outer tube, and an inner tube) and means of sliding the inner and outer tubes axially relative to each other. Additionally, a sample tube can be housed inside the inner tube for storing the sample. The inner tube fits inside the outer tube, which fits inside the drill tube. The inner and outer tubes can move axially relative to each other. The inner tube presents two lamellae with two opposing grabbing teeth and one pushing tooth. The pushing tooth is offset axially from the grabbing teeth. The teeth can move radially and their motion is controlled by the outer tube. The outer tube presents two lamellae with radial extrusions to control the inner tube lamellae motion. In breaking the core, the mechanism creates two support points (the grabbing teeth and the bit tip) and one push point. The core is broken in bending. The grabbing teeth can also act as a core retention mechanism.



The **Praying Mantis Core Breakoff Mechanism** design assembly (left), and (right) the outer (green) and inner tubes (blue).

The praying mantis that is disclosed herein is an active core breaking/retention mechanism that requires only one additional actuator other than the drilling actuator. It can break cores that are attached to the borehole bottom as