Introduction: The Apollo lunar EVAs demonstrated success in many different ways – trained crew observations, sample documentation, experiment deployment, and roving vehicle operation to name a few. Drilling into the lunar regolith, however, was not an unequivocal success. Although heat-flow probes were successfully employed on Apollo 15 and 17 and deep drill cores were returned on Apollo 15, 16 and 17, the cores were obtained only at the cost of significant physical effort and exploration time. Although the rotary percussive drill system used by Apollo astronauts penetrated into the lunar regolith with reasonable efficiency, extraction of the drill core stem proved to be very difficult on all three missions.

The Problem: The problem with drill stem extraction probably lies in two aspects of the geotechnical character of the regolith. First of all, even though it is a heterogeneous mixture of particle sizes, the regolith is very closely packed and provides little or no space for sideways particle movement during drilling. The fluted design of the outer wall of the drill stem (figure 1) provided a path for the drill cuttings to move upward and out of the way of down-hole movement. Secondly, the regolith contains numerous jagged particles large enough to catch on the flutes during extraction but too large to be easily pushed into the densely packed walls of the drill hole. As the fluted drill stem begins to move upward, some of these larger particles catch on the flutes and work to retard that upward movement. This will be a problem whether robotic or human energy is available for extraction.

The Solution: A potential solution would be to employ flutes that can be retracted into the drill stem wall so that the outer drill stem wall becomes a smooth surface. Alternatively, a gas-flow system might be devised to removed cuttings during drilling, allowing a smooth wall to be used on the outer drill stem.

Figure 1 Apollo deep drill stem showing outer spiral flutes.