Spirit Rover Switches to Backward Drives

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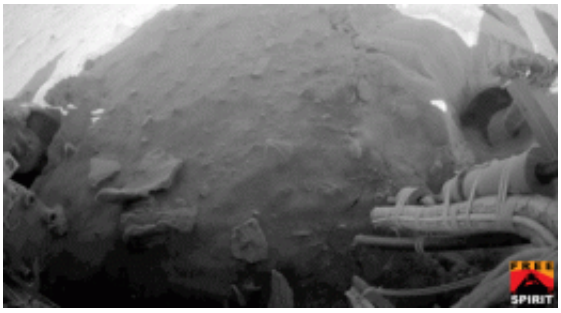

This two-frame animation aids evaluation of NASA's Mars Exploration Rover Spirit during a drive on the rover's 2,147th Martian day, or sol (Jan. 16, 2010). Click "Enlarge" for animation.

(PhysOrg.com) -- The rover team has begun driving Spirit backward as next technique for attempting to extricate the rover from the sand trap where it is embedded. The first two backward drives produced about 6.5 centimeters (2.6 inches) of horizontal motion and lifted the rover slightly.

Spirit performed the first backwards drive (toward the south) on Sol 2045 (Jan. 14, 2010). Until then, all drives since extrication attempts began two months earlier had been with forward driving, with Spirit facing northward.

The rover first entered its present location driving backward in April 2009. The backward driving in recent days includes the additional technique of steering the wheels side-to-side before performing each

step. The hypothesis for the wheel steering is two-fold. The process clears out material in front of the wheel and allows material to slough off the face of the wheel trench and provide traction under the wheel.

Also, the flat surface of the wheel's side "kicks" against loose material, like a swimmer's frog kick or breast stroke, to provide some push. This Sol 2045 drive included enough wheel rotations to move the rover backward about 30 meters (98 feet) in six steps of 5 meters (16 feet) each, if the rover were in a situation with good traction. However, as Spirit is in a sand trap, the drive moved the rover backward a total of just over 3 centimeters (1.2 inches) and raised it in altitude just over 1 centimeter (0.4 inch). This is the first time the rover has climbed since extrication attempts began.

Northerly tilt also improved by just over a degree. The explanation here is that the rover's rear wheels are climbing, raising the back of the rover. Images from the rear hazard avoidance camera confirm this. A tilt toward the north would be favorable for energy production in the coming Martian winter, as it would gain more sunshine on the solar array .

A second backward drive was commanded on Sol 2047 (Jan. 16, 2010). It was also six steps of 5 meters backward with the steering "frog kicks." The rover moved about 3.5 centimeters (1.4 inches) backward and climbed 0.3 centimeters (0.1 inch). However, this time the northerly tilt deteriorated by over a degree, undoing the prior drive's improvement. The explanation here is that the rover yawed counterclockwise, swinging the angled solar arrays away from north. But the rear wheels continued to climb, suggesting that the middle wheels are gaining traction. The rover is now about 3.5 centimeters (1.4 inches) south of the point where it started extrication two months ago, meaning the backward driving has already covered all of the distance achieved with forward driving and then some. Spirit is still down about 3 centimeters (1.2 inches) in altitude

since extrication started. It is important to remember that the right-rear wheel is still non-functional, along with the right-front wheel.

On Sol 2050 (Jan. 19, 2010), Spirit was commanded to drive further backwards. Partway through the drive, the rover's left middle wheel stalled. Activities planned for coming sols include getting more diagnostic information about that wheel stall. Even with four working wheels, Spirit would have a very difficult path to extrication. And the rover needs a much better northerly tilt to assure winter survival.

As for other techniques to consider for extrication, the rover team has examined the two options that would use the robotic arm: pushing with it and re-sculpting the terrain by the left-front wheel. The assessment of pushing with the arm reveals that only about 30 newtons of lateral force could be achieved, while a minimum of several hundreds of newtons would be needed to move the rover. Further, such a technique risks damaging the arm and preventing its use for high-priority science from a stationary rover. The other technique of re-sculpting the terrain and perhaps pushing a rock in front of or behind the left-front wheel is also assessed to be of little to no help and, again, risks the arm. There is also a large risk of accidentally pushing the rock into the open wheel and jamming.

Provided by JPL/NASA