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BOISE STATE PHYSICIST HELPS UNRAVEL MYSTERY OF DEATH VALLEY'S SAILING STONES

Nestled high in the craggy mountains of Death Valley National Park, Racetrack Playa, a seasonally dry lake bed, is home to one of the longest-standing mysteries in earth science.

Dark, dolomite rocks, ranging from pebbles to boulders weighing hundreds of pounds, are scattered across the playa like a natural Zen garden. Extending out from many of the stones are shallow furrows in the playa's clay surface, some running parallel to others for hundreds of feet. Previous studies suggest that, about three out of five years, the rocks slide on the playa in the winter, when seasonal rains make its surface muddy. But even though scientists have visited the playa for decades, the sailing stones had never been observed in motion.

Until now.

In 2007, with permission from the National Park Service, Ralph Lorenz, a planetary scientist at Johns Hopkins University's Applied Physics Lab, and Brian Jackson, an assistant professor in Boise State University's Department of Physics, began deploying time-lapse cameras and weather-monitoring instrumentation to determine the conditions that drive the rocks, and perhaps even see them in motion.

Over its entire 2.8-mile by 1.3-mile surface, Racetrack Playa exhibits only 1.5 inches of relief, and so explanations for the rock motion typically invoke wind. However, winds approaching hurricane speeds, much stronger than observed, are required to overcome friction and move the largest stones.

Collected over six years, the time-lapse imagery from Lorenz and Jackson's cameras showed large winter storms often buried Racetrack Playa in snow, which would then melt to form mirror-smooth ponds that frequently re-froze. This ice probably reduced the friction and even formed floes that could push or buoy the sailing stones, allowing very light winds to move them. These results corroborated previous suggestions that conditions were best for rock motion in the winter. But after six years, Lorenz and Jackson had not seen any.

"The last suspected movement was in 2006, and so rocks may move only about one millionth of the time," said Lorenz. "There is also evidence that the frequency of rock movement, which seems to require cold nights to form ice, may have declined since the 1970s due to climate change."

But everything changed this winter, when a research team including Lorenz and Jackson and led by Richard Norris of Scripps Institution of Oceanography finally observed the rocks in motion.

"Science sometimes has an element of luck," Norris said. "We expected to wait five or 10 years without anything moving, but only two years into the project, we just happened to be there at the right time to see it happen in person."

Last December, members of the team visited Racetrack Playa and discovered a shallow pond less than 3 inches deep, with many rocks encased in thin ice floes two-tenths of an inch thick. Shortly

before noon, the ice floes began breaking up, and 10 mile-per-hour winds propelled some rocks at a snail's pace, only inches per second. Some rocks remained in motion for only a few seconds, while others moved for 16 minutes. The researchers also observed trails formed in the playa's muddy surface by ice floes. Frequently observed, such rockless trails had long been taken as evidence that tourists (illegally) took the trail-forming rocks.

The team's observations confirm that, aside from their unusual journey, there's nothing special about the sailing stones themselves. Instead, their motion results from the convergence of atypical meteorological conditions: the right combination of water and ice to push the rocks while leaving their keels to drag in the playa's surface, along with sufficient winds.

Is the mystery of the sliding rocks finally solved?

"We have seen that even in Death Valley, famous for its heat, floating ice is a powerful force driving rock motion," said Norris. "But we have not seen the really big [rocks] move out there does that work the same way?"

Added Jackson: "For decades, the enigma of Racetrack Playa's sailing stones has captured the public's imagination — living rocks that move, unseen, on their own. However, climate change may prevent the unusual meteorological conditions that allow rock motion, and so, a little like the polar ice caps, the sailing stones may fade into the past."

The team reports their work in two new papers, one led by Norris and published in the Aug. 27 PLOS ONE, and the other led by Lorenz and submitted to Earth Surface Dynamics.

For videos, images and links to the publications, visit <http://www.racetrackplaya.org>.

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