Patton tank marks suggest long recovery

In 1940, General George S. Patton hastily trained tank crews in California's Mojave Desert. With World War II under way, the fragility of desert life probably never appeared in his scope.

However, the tanks' treads damaged the ecosystem there, and 50 years later, the tracks are still visible, says Jayne Belnap of the U.S. Geological Survey who is in Moab, Utah. A new analysis by Belnap and Steven Warren of the U.S. Army Construction Engineering Research Laboratories in Champaign, Ill., suggests that it may take more than 1,000 years for some of this damaged area to recover completely.

Today, Army tank and bomber crews continue to train in arid areas of California, and people in four-wheel-drive vehicles whiz across the Mojave for fun. Once the crucial top layer of desert soil is disturbed, dust storms and gullies form more readily, more sediment runs off into reservoirs, and less vegetation is available for native animals to eat, says Kimball T. Harper, a retired botanist who studied desert soils at Brigham Young University in Provo, Utah.

Belnap's estimated recovery rate, the first to be calculated for such a dry desert area, is surprisingly low, Harper says. Belnap described her research at this week's annual meeting of the Ecological Society of America in Baltimore.

Desert soil is vulnerable because it is alive with organisms called cyanobacteria—better known as blue-green algae—Belnap told SCIENCE NEWS. These form a lattice that binds soil particles together. They also produce nutrients used by plants. Once this network is disrupted, it has difficulty growing back. Because of their tiny size, each only a few micrometers across, cyanobacteria are vulnerable to destruction even by rolling sand grains, she says.

Precise dating of the original disturbance is usually a challenge for scientists studying the recovery of soils. In this case, Belnap documented the date of Patton's presence. She says the site is so remote that it is unlikely that recreational motorists have driven over the tank tracks more recently.

She compared two different types of damaged terrain—shrub-covered patches and more open areas—to undamaged land nearby. In 58 years, only about 6 percent of the open patches had regained their surface layers of moss and lichen, indicating recolonization by cyanobacteria. In contrast, there was greater, and sometimes full, recovery in shrubby areas, where the soil receives more shade, moisture, and protection from disturbance.

However, open patches make up about two-thirds of the total area Belnap studied. Typically, estimates of recovery rates represent an average over an entire site, which in this case would yield a recovery time of 220 years. But that figure is misleading because cyanobacteria might need 1,000 years to recolonize the open areas fully, Belnap says.

Deserts may be the best place for tank exercises, but such use comes with a cost, she says. "If it hasn't recovered in 200 years, maybe we're talking about a nonsustainable use."

As damaging as tanks may seem, studies in other deserts show that four-wheel-drive vehicles actually cause more destruction, Belnap says. A tank's treads distribute its weight over a larger surface, so overall the impact is lessened.

Other researchers are examining whether disturbed desert areas could be "reseeded" with cyanobacteria. Army funds are supporting a study by Jeffrey R. Johansen of John Carroll University in Cleveland aimed at processing laboratory-grown cyanobacteria into flakes that could be dropped from airplanes. The Army also funded Belnap's research.

Warren/Inset: Belnap

Treads left by Patton's tanks endure. (Inset) Electron microscope image of cyanobacteria filaments binding soil particles.

Warren says that treatment with cyanobacteria could also be useful in nations where grazing and farming are encroaching on deserts. —*J. Brainard*

Ultracold atoms: New gravity yardstick?

The laboratory feat of laser-cooling atoms to near absolute zero is verging on its first commercial application.

A prototype of a novel, laser-cooled device for measuring gravity, described in the Aug. 3 PHYSICAL REVIEW LETTERS, promises to be a boon for oil exploration, geophysical measurements, and military uses, says Mark A. Kasevich, the Yale University physicist leading the U.S. Navy–funded development team. "I think there's a possibility for a basic science idea to have an impact technologically," he says.

Nobel prize-winning techniques developed in the 1980s to slow, and thus cool, atoms by zapping them with laser-generated photons have led to stunning advances in physics, including the creation of Bose-Einstein condensates, which are ultracold clusters of atoms sharing one quantum state (SN: 7/25/98, p. 54). The only practical gadget to emerge from the field, however, has been a better atomic clock, attractive only to a few time-standard labs, says Steven L. Rolston at the National Institute of Standards and Technology in Gaithersburg, Md.

The newer instrument determines gravity's gradient, or change in strength with position, by comparing the gravitational acceleration of two clouds, each made up of millions of cesium atoms. The clouds are cooled to 3 microkelvins and spaced a meter apart. Observing interference within each cloud's quantum-mechanical wave behavior yields a precise measurement of gravity at that position.

"It's beautiful work," Rolston says. "It's nice to see something showing some true practicality."

Measurement of gravity-gradient changes over an area can reveal subsurface irregularities in mass, which may represent underwater mountains or subterranean oil deposits. The Navy already uses precision-machined electromechanical gravity gradiometers to help submarines navigate without noisy sonar. In recent years, it has made the once-classified instruments available to civilian geologists.

The quantum-mechanical gradiometer has yet to surpass electromechanical instruments in sensitivity. Its advantage lies in its remarkable stability, derived from using fundamental properties of atoms and fixed laser frequencies as references, Kasevich says. In contrast, electromechanical gradiometers require periodic calibration because their components are vulnerable to temperature change and other influences.

Gravity surveyors would welcome an instrument whose measurements didn't drift, says Richard O. Hansen of Pearson, deRidder and Johnson, a geophysics consulting company in Lakewood, Colo. The quantum-mechanical design is "gorgeous," he says, but he cautions that a field-deployable version must maintain its laboratory performance while remaining small, light, and inexpensive.

Ultimately, the quantum-mechanical gradiometer should achieve a 10-fold to 100-fold edge in sensitivity over electromechanical versions, Kasevich says. On the other hand, he acknowledges that it has so far passed only a "proof of principle" test, with its first field trials anticipated within a year. —*P. Weiss*