Earth Sciences

Weekday pollution winds way to desert

Mother nature has her own natural periods — sunsets, lunar months, and the equinoxes. But the weekly cycle that guides our lives is an artificial one, dreamed up by humans. Atmospheric scientists are exploiting this unnatural cycle to study how Los Angeles pollution travels into the distant desert.

Warren H. White from Washington University in St. Louis and colleagues monitored summertime levels of methylchloroform (1,1,1-trichloroethane) in the air at four stations: one located inside the Los Angeles basin, one on a mountain pass near L.A., a third atop a Nevada mountain and a fourth about 20 kilometers from the mouth of the Grand Canyon in Arizona. Used by many industries as an electronics solvent, methylchloroform depletes the ozone layer and contributes to global warming. Because no natural source produces this chemical, scientists can use it to trace the path of human-made pollution.

In all four locations, White's groups found that methylchloroform levels followed a workweek cycle — high for five days, then low for two — suggesting that most emissions come from the workplace rather than the general activities of an urban population.

Though concentrations dropped in the L.A. region on Saturday and Sunday, similar lows in the levels measured at the Nevada and Arizona stations did not show up until Monday and Tuesday, the researchers report in the July GEOPHYSICAL RESEARCH LETTERS. That implies it takes one or two days for the pollution to rise out of the L.A. basin and travel the 400 km to the Arizona station. By studying details of the seven day cycle, researchers also hope to learn how much the polluted L.A. air mixes with clean air as it travels from the city, out to the desert.

First look at the base of the plates

Geophysicists have long used explosions to study what lies below Earth's surface. By sending seismic waves down into the ground and measuring the reflected waves that return, they can see structures within Earth's lithospheric plates, which form the hard outer shell of the planet. Now for the first time, researchers have succeeded in looking at the deepest section of the plates — opening up new possibilities for understanding how plate tectonics really works.

A team of researchers headed by J.E. Lie at the University of Oslo in Norway collected data with the research vessel, *Mobil Search*. The ship carried a large air gun and towed hundreds of microphones strung out along a 4.5-kilometer-long streamer. As it plied the waters south of Norway, the ship shot off the air gun and recorded the reflected waves — a technique called seismic-reflection profiling.

In the July 12 NATURE, Lie's group reports finding several abnormally reflective patches located at depths of 100 to 110 km. They cannot yet tell what the "reflectors" represent, but in the shallower portion of the plates, reflectors usually signify faults or interfaces between two different types of rock.

The lithospheric plates include both the crust and the uppermost section of the mantle. Profiling work on land, using vibrating trucks, has rarely detected features in the mantle. But a British ocean experiment has recently detected significant mantle structures. Pushing the bounds of profiling even deeper, the Norwegians report they can see reflectors at the lowest mantle portion of the lithosphere.

"If it is correct, this is a first time, extraordinary result," comments John Mutter of the Lamont-Doherty Geological Observatory in Palisades, N.Y. Mutter, who leads Lamont's research effort in seismic profiling, says geophysicists studying plate tectonics have had to infer how the lower portion of the lithosphere behaves when plates collide or stretch. Now they have a means of testing those inferences.

Space Sciences

Did volcanism scar Mars' canyons?

There are many signs of volcanism visible on Mars, from peaks and ridges to huge "shields" formed by slowly oozing flows of magma. Less research, however, has explored for signs of volcanism on the floors of a huge canyon complex known as the Valles Marineris, according to Baerbel K. Lucchitta of the U.S. Geological Survey in Flagstaff, Ariz. Only volcanism, she says, can so easily account for the variety of surface features within this canyon array, which stretches some 4,500 kilometers across the planet's northern hemisphere — a span as great as the contiguous United States is wide.

Photos taken by two Viking spacecraft, some as early as 1976, show many dark patches on Valles Marineris' floors. Some of the patches follow fault-lines that could have been generated by volcanic stresses. Elsewhere, Lucchitta identified surface deposits with "lobate" (curved) boundaries that appear to have resulted from flowing, molten lava. Valley-floor features that appear to have emerged from nearby craters also evoke volcanic origins, she says.

These apparently volcanic, valley-floor deposits vary from "thin dust to several kilometers" in thickness, Lucchitta says. And in the August ICARUS, she suggests they seem to represent "the last major event in the history of the Valles Marineris" — possibly occurring as recently as one billion years ago, barely a fifth of the planet's approximate age.

The dark material largely covering the valley floors reflects as little as 5 percent of the sunlight falling on it, Lucchitta says. Some dark patches show "feathery edges" that "may include explosive volcanic vents," she observes. The patches' crispness of detail, lack of any apparent dust cover, and visibility atop landslides all suggest "they are young."

Lighter-colored areas with about three times the reflectivity of the dark patches occur in smaller numbers within the canyons. Though their source is more difficult to identify, she notes they do occur near some craters that "may well be volcanic in origin."

Lucchitta also describes what she calls "mottled material" — dark and light — in a canyon known as Candor Chasma. Its origin is harder to identify, but an observed "dearth" of meteor impact craters within it indicates the material is young, she says, suggesting it was deposited at about the same time as the darker material.

Scientists with the International Astronomical Union named the canyons Valles Marineris, or Mariner Valleys, after the Mariner 9 spacecraft that began the process of photographing them in 1971.

Mapping below the seas of Titan

When the Voyager 1 spacecraft passed Saturn's big moon Titan in 1980, its scientific instruments successfully probed all the way down to the surface. Titan's dense atmosphere, however, prevented photography of the terrain, leaving unresolved whether its surface consists of rock, ice or a liquid ocean.

Now two scientists note that a radar scheduled to probe Titan as part of the U.S. Cassini mission in 2002 could map the surface even if it lies at the bottom of an ocean.

Possible coverings for Titan's surface include water ice, a thick layer of organic sediments and an ocean of liquid methane, ethane and nitrogen, according to W. Reid Thompson and Steven W. Squyres of Cornell University in Ithaca, N.Y. The radar NASA is considering including in Cassini's instrument package has a 13.6-centimeter wavelength — one capable of penetrating ocean-sediment and sediment-ice boundaries, they write in the August ICARUS. "Hence," they maintain, "such a sounding mode may offer prospects for investigating the geology of Titan even if the surface . . . is covered locally or globally by a deep ocean."