Earth Sciences

Stefi Weisburd reports from Austin, Tex., at the meeting of the Seismological Society of America

Quake depths differ in eastern U.S.

When seismologist Gilbert Bollinger first came to Virginia Polytechnic Institute and State University in Blacksburg 18 years ago, there were less than 10 seismic stations covering the entire southeastern United States—far too few to pinpoint the depth of an earthquake. Today, with 136 stations in place, scientists have "a dense enough network and several years of monitoring, so that for the first time in the Southeast we have some idea of how deep earthquakes are," he says. And these depths, Bollinger has recently found, appear to be distributed in an unusual pattern.

In studying the 216 best-defined quakes recorded since 1977, Bollinger and his co-workers discovered that their depths differ in two regions. In one, the Valley and Ridge and Blue Ridge (VRBR) provinces, the 90 percent depth—the level above which 90 percent of quakes occur—is 20 kilometers below the surface. In contrast, the 90 percent depth in the Piedmont and Coastal Plain (PICP) provinces to the east is only 13 km.

Scientists believe that the 90 percent depth marks the transition between upper brittle rocks and lower ductile rocks; below this depth the warmer crust is thought too pliable to fracture and cause earthquakes. The temperature of this transition zone in most other places is about 350°C ± 100°C. From heat flow measurements in bore holes, Bollinger's group estimated that the 20-km VRBR rocks fall within this range but the PICP rocks at 13 km are at only 150°C, indicating that the crust there is somehow different from that in other regions.

The most likely explanation is that the PICP rock types are different from others. "But what that means," says Bollinger, "we just don't know right now." One possibly significant aspect of the findings is that the PICP depths lie above the Appalachian décollement—a dividing fault between rocks that were thrust up on the existing crust at least 200 million years ago during the building of the Appalachian Mountains. The VRBR 90 percent depths, however, fall below the décollement in crustal rocks that are probably similar to those in other regions.

Henry Hasegawa from Energy, Mines and Resources in Ottawa also noted at the meeting that similar relationships between heat flow and earthquake depth have been found for two regions in eastern Canada.

Seismicity in sync with the sun?

The 11-year cycle in the number of sunspots, as well as the underlying flip of the sun's magnetic field every 22 years, has been tied to many phenomena on earth, including global climate, the production of carbon-14 and the planet's rotation rate. Now Charles Bufe of the U.S. Geological Survey in Reston, Va., suggests that earthquakes — at least those that rumble in Parkfield, Calif.—be considered for this list too.

The timing of Parkfield earthquakes has been remarkably regular; the last six events with magnitudes 5.5 or higher occurred about every 22 years with the exception of one quake in 1934 that came 10 years ahead of schedule (SN: 4/13/85, p. 228). After comparing the Parkfield record to solar activity over the last century and a half, Bufe found that the Parkfield quakes all fell within 2.4 years of sunspot minima. The probability of producing such a pattern randomly, says Bufe, is less than 1 in 100. Most of the quakes were also in sync with the cycle of the solar magnetic field. Moreover, the 1934 quake, Bufe notes, happened to follow a period of unusually low sunspot activity.

Bufe cautions that the similarity in the Parkfield quake and solar cycles in no way proves that the sun can trigger earthquakes and no one has proposed any possible mechanisms linking the two. But if there is a real link it's clear that it would be very complex, involving changes in the magnetic fields between the sun and earth, changes in the earth's atmosphere and rotation, and changes in the motion of and stresses between the plates that cover the globe.

Environment

Pesticides: How low will they go?

Pesticides are designed to stay in the top several feet of soil, where they can destroy the weeds and crop pests for which they were formulated. Also residing here are microorganisms that are counted upon to ultimately degrade these toxic chemicals into benign compounds. But new field research by William Jury of the University of California at Riverside shows that the conventional laboratory-scale tests greatly underestimate how much pesticide will flow through the upper soil unchanged. This could explain much pesticide contamination of groundwater.

Working with the herbicide napropamide, and later with four other commonly used pesticides, Jury followed manufacturers' instructions for pesticide use on his 1-acre sandy field in a commercial grape-growing area. He irrigated the soil as usual. Two weeks later he took 20 core samples. Though the pesticide should not have penetrated more than 8 inches, all cores showed that 20 percent of it had traveled—unchanged—to depths of at least 6 feet.

In upcoming tests he hopes to uncover why these pesticides behave so differently in field and laboratory conditions. He suspects that although the pesticides normally show a magnetlike attraction for soil, some compound or mineral in the soil *water* may hold an even stronger attraction for them. If so, as the water seeped down it would carry along that fraction of the pesticide it had been able to bind up.

More on leukemia and electrical workers

Three years ago, Washington State epidemiologist Samuel Milham Jr. reported a provocative study linking death from leukemia with employment in professions that suggested possible exposures to high electric and magnetic fields (SN: 8/21/82, p. 123). Two additional suggestions of such a link now appear in the April 6 LANCET.

The first involves a study of 546 men in New Zealand who were identified as leukemia patients between 1979 and 1983. Each was matched, based on age and year of cancer registration, with four other men from that nation's cancer registry. The study found a significant excess of leukemias among those electrical workers who had been employed as electronic equipment assemblers (4 cases where only 0.5 cases would have been expected) and radio and television repairers (7 cases where only 1.5 cases were expected). The number of cases involved was too small to permit an investigation of risks for specific leukemia types, according to N.E. Pearce and his colleagues at the Department of Community Health, Wellington Clinical School and National Health Statistics Centre in Wellington, New Zealand. However, they conclude, the findings do suggest that electrical workers are at increased risk of developing the cancer.

The second report is by Milham, who works with the Department of Social and Health Services in Olympia, Wash. Responding to an amateur radio operator's request, he investigated what proportion of male members of the American Radio Relay League—amateur radio operators—died from leukemia. Focusing on deaths occurring between 1971 and 1983, he obtained death certificates for 95 percent of the 296 deceased Washington members and 86 percent of the 1,642 deceased California members. Of the total of 24 leukemias identified in this way, 16 were of the myeloid class (originating in a type of white blood cells called granulocytes) — nearly triple the 5.7 deaths that would have been expected from these leukemias.

Acknowledging that this excess might be attributable to chance, Milham does point out that three other recent studies in the United States and United Kingdom have "revealed a tendency toward a relative increase in the acute myelogenous type of leukemia in electrical workers." In his study, 11 of the 16 myeloids were of the acute form — almost a tripling of the 3.8 cases that would have been expected.