EARTH SCIENCES

The Yellowstone mantle plume

Seismic studies in the last few years have shown evidence that the dramatic thermal activity in Yellowstone National Park is due to the presence beneath Yellowstone of a large mantle plume—an upward extension of heat and material from the earth's mantle. A new study now for the first time charts the presence of the plume to depths beyond 200 kilometers and indicates a need to revise the previous model for the feature (SN: 12/21&28/74, p. 392).

The new evidence comes from observations made from 17 seismic stations deployed in a fan configuration centered at Regina, Saskatchewan, that recorded seismic waves produced by a 6.3-magnitude underground nuclear test last October in Nevada. Some of the P waves recorded from the explosion had passed horizontally through the Yellowstone plume, at depths of 200 and 400 kilometers. By observing the differences in travel times of waves that passed through different segments of the plume, David M. Hadley, Gordon S. Stewart and John E. Ebel of the California Institute of Technology's Seismological Laboratory have been able to chart a vertical cylindrical structure with a high-velocity core and a low-velocity collar. The diameter of the low-velocity collar is 250 ± 30 km at a depth of 200 km and at least 300 km at a depth of 400 km. The center of the structure is shifted about 40 km northwest from the center of the Yellowstone caldera. In addition, the structure appears to be slightly asymmetrical; its southeast shoulder is somewhat broader than its northwest shoulder.

The observations, the authors say in the Sept. 24 SCIENCE, are consistent with a chemical mantle plume beneath Yellowstone proposed recently by Don L. Anderson of Caltech. In his model, conduits through the mantle contain residuals from the differentiation of the primitive earth. The chemical plume is enriched in the oxides of calcium, aluminum and titanium and in the elements uranium and thorium. This assemblage would give higher seismic velocities than normal crustal material. The area around it would have lower velocities due to thermal perturbations from the radioactive decay of the uranium and thorium, and this would be the low-velocity collar observed.

Below 200 km, the new data fit the hypothesis of a chemical plume but not that of the previously proposed thermal plume. Either type of plume adequately explains the effects above 200 km: both would cause extensive melting.

Life within rocks

Colonies of one-celled blue-green algae have been found living beneath the surface of rocks found on mountain slopes above the dry valleys of Antarctica, E. Imre Friedmann and Roseli Ocampo of Florida State University report in the Sept. 24 SCIENCE. Examination of the orthoquartzite rocks showed a dark green zone of algae about 1 to 2 millimeters beneath the rock surface in a layer about 1.5 millimeters thick running parallel to the surface. The rocks are porous, and the algae grow in the air spaces between rock particles. The rock is transparent enough to allow light into the algae zone. This "peculiar and protected physical niche" provides favorable conditions for the microbes to prevail in the Antarctic cold.

Although similar endolithic algae have been found in hot deserts like the Negev and the Sinai, this is the first report of them in Antarctica. The finding, the authors say, also constitutes the first record of primary producers (photosynthetic plants) in the Antarctic cold desert ecosystem away from lakes, streams and seepage areas.

The authors suggest that future searches for life on Mars should concentrate not just on the soil, as Viking is doing, but also on the interiors of exposed rocks.

PHYSICAL SCIENCES

A big fat neutron star

According to a recent suggestion by Barry Lasker of Cerro Tololo Inter-American Observatory, the pulsar in the constellation Vela seems to be visible as a bluish object of about 24th magnitude. Most astrophysicists suppose that pulsars are neutron stars, and in this case the emitted light is believed to be thermal radiation from its surface.

This identification allows George Greenstein of Amherst College and Jeffrey E. McClintock of the Massachusetts Institute of Technology to place limits on the size of the neutron star (ASTROPHYSICAL JOURNAL LETTERS, 208:L 41). From the color, distance and assumed radius one can calculate the temperature of the star. Assuming 10 kilometers, the radius that most neutron-star students might pick, gives a temperature so high that the Vela object would have to emit six times the X-ray flux it is known to emit. Using the X-ray spectrum as a constraint on the temperature gives a radius that certainly exceeds 45 kilometers and may exceed 95.

Such a large radius for a neutron star indicates a low mass. This means that arguments that prohibit low-mass neutron stars will have to be discarded if Greenstein and McClintock are correct. Also, a low-mass neutron star cannot have a solid core, so the starquake theory that explains sudden changes in the Vela pulsar's rotation rate will have to be given up.

A superheavy nuclear doughnut

The recently reported discovery of several superheavy chemical elements in samples of ancient mica (SN: 6/26/76, p. 404) has handed nuclear theorists something of a problem. The inclusion of these elements in ancient minerals seems to indicate lifetimes comparable to that of the earth. Theorists had not expected some of these elements, especially element 126, for which the evidence is strongest, to be that stable.

On the testimony of more than one nuclear theorist, the most probable number of neutrons for an element with 126 protons is 228. In the Sept. 13 PHYSICAL REVIEW LETTERS C. Y. Wong of Oak Ridge National Laboratory presents calculations intended to check the long term stability of such a nucleus. Assuming a spherical shape for the nucleus, Wong finds it unstable against fission, and alpha decay.

These deficiencies can be rectified by assuming a toroidal shape, which changes the balance of forces so as to reassure stability. But this is an odd shape for an undisturbed nucleus, so Wong proposes an experimental way to find out: The toroid shape reduces the necessary number of neutrons to 202, so a determination of element 126's mass should tell the tale.

Historical search for solar neutrinos

The continuing failure of the attempts of Raymond R. Davis Jr. to detect the flux of neutrinos that ought to come from the sun's thermonuclear energy-producing reactions has sparked a number of suggestions for changes in the experiment. Most of the proposals are to replace the chlorine that Davis uses with detectors that would be more sensitive to neutrinos.

All these would be ongoing experiments recording neutrinos as they arrive. In the Sept. 17 SCIENCE Melvin S. Freedman and seven others from Argonne National Laboratory propose a search for a historic record. Neutrinos arriving in thallium deposits produce lead 205, and studying the amount of that in old thallium deposits could give a historical record of solar neutrino flux. This would be especially useful if at the moment we are in a time when the sun's neutrino-producing mechanisms are for some reason shut off, as a number of observers have suggested in view of Davis's negative result.