EARTHQUAKE CONTROL

Search for safety valves

The time when earthquakes can be predicted with reasonable accuracy may eventually come (SN: 2/20/71, p. 131). But prediction would be only a partial solution to the threat these upheavals present to populated and developed regions. The ideal solution would be to control or prevent them.

The possibility that earthquakes might be mitigated first suggested itself to seismologists when the filling of Lake Mead was accompanied by numerous local tremors. Quakes have similarly accompanied the injection of water under high pressure to drive out remaining oil at the Rangely oil field in northwestern Colorado.

Studies at Rangely, conducted by scientists at the National Center for Earthquake Research in Menlo Park, Calif., to test theories about earthquake modification, were described this week at the annual meeting of the American Geophysical Union in Washington. The experiments have an eventual goal of learning how stored-up strains in the earth may be relieved slowly.

Since 1969 earthquakes in the Rangely vicinity have been precisely located by a network of 14 stations that telemeter data to Menlo Park. Principal seismic activity occurs at depths of between one and four kilometers along a vertical fault that cuts across the field. Epicenters are concentrated on the southern margin of the field. The fault motion, the scientists report, appears to be right-lateral strike-slip. This means the two sides of the fault move horizontally with respect to one another, and to an observer standing on one side of the fault the other side would appear to be moved to the right.

Dr. James D. Byerlee studied the mechanical behavior of Weber sandstone, the type of rock in which the Rangely earthquakes occur, to determine its behavior as a function of confining pressure and water pore pressure. The laboratory experiments show that sudden stick-slip motion can occur during sliding both on fault surfaces and on surfaces cut by a saw, but that Weber sandstone is much more stable than other rock types. Most of the movement observed between two surfaces was by stable sliding, rather than the stick-slip motion that produces violent tremors. "This suggests that fault creep [gradual movement] may be an important mechanism at the Rangely oil field."

Another NCER scientist, James H. Dieterich, investigated computer modeling of earthquake stimulation by fluid injection. Two- and three-dimensional models have been developed to describe ground deformations associated with earthquakes on an existing fault. Friction values from laboratory experiments were inserted into the models. When subjected to a uniform rate of tectonic loading, the model generates a sequence of earthquakes that vary in magnitude and occur at different locations on the fault. For the simulated earthquakes, drops in stress, variations of magnitude with rupture length and other parameters were in good agreement with field observations for real earthquakes.

Dieterich simulated earthquakes caused by fluid injections at Rangely by allowing friction to vary with time and location on the fault as a function of changes in fluid pressure. At a constant rate of injection, the model shows that earthquakes become less frequent with time but increase in magnitude.

Four injection wells straddle the seismically active zone and pumps have been installed at the wells. Beginning last Nov. 10, fluid was withdrawn from the region through these four wells. Pressures in adjacent observation wells, according to Drs. C. B. Raleigh, J. H. Healy, J. P. Bohn of NCER and J. D. Bredehoeft of the U.S. Geological Survey's Water Resources Division, had dropped by as much as 800 pounds per square inch by Jan. 15 of this year.

Before backflowing began, there were two centers of earthquake activity in the vicinity of the four wells, one located at a distance from them and the other directly beneath. When water was withdrawn through the wells, earthquake activity beneath them was reduced significantly.

The researchers hypothesize that reduction in fluid pressure in the reservior would curtail earthquake occurrence because of an increase in the effective normal stress on the fault surfaces. They will test this hypothesis by reinjecting fluid to determine if earthquake activity again increases with rising pore pressure. They hope that continued experiments will identify an important safety valve for earthquakes triggered by fluid injections and even for quakes along such dangerous faults as the San Andreas in California. □

HODGKIN'S DISEASE

Pushing for a total cure

Some form of cancer will attack one of every four persons in the United States sometime during his life. Such statistics have made finding a cure for cancer a major goal of the 1970's. In December the Yarborough panel (SN: 12/19/70, p. 459) proposed the creation of a National Cancer Authority and an all-out attack on the disease. In his subsequent State of the Union Message President Nixon took up the call by announcing that he would ask Congress for an extra $100 million in fiscal 1972 to fund a bolstered effort to find a cure for cancer (SN: 1/30/71, p. 80).

The advances made in cancer research during the past 40 years (SN: 1/2/71, p. 12) indicate that now would be a good time for this extra Governmental boost. Cancer research is in full swing and is making considerable headway in certain areas. The added impetus should produce results.

However, there are many forms of the disease and a variety of treatments. Knowing exactly where to apply the impetus is crucial. With some forms of cancer one answer might be the coordinated, big-team approach, in contrast to having hundreds of independent researchers, each pursuing his own path.

A team approach to the cure of Hodgkin's disease is achieving success in 75 percent of the cases treated in some large medical centers. This disease is a form of cancer that attacks the body's lymphatic system. It usually begins in the neck and spreads throughout the body in four stages. Ten years ago it was considered an incurable and fatal disease. Now patients treated in the early stages may expect a 90 percent chance of a five-year cure, and for those making it to five years, a 95 percent chance of total cure.

The team approach that has been achieving this high rate of success was explained in detail by a panel of physicians speaking at an American Cancer Research seminar for science writers last week in Carefree, Ariz.

The first step in treating the disease involves proper diagnosis of the exact stage it is in. "Until recently, staging was based on inadequate information," says Dr. Henry Rappaport, pathologist at the University of Chicago. Two new dianostic techniques have changed this: lymphangiography, which enables the physician to see whether lymph nodes deep in the body are diseased, and surgical exploration of the abdomen, which permits a direct look at the diseased organs as well as a laboratory study of them and any others that might be affected.

Once the exact stage of the disease is known, the proper treatment can be applied. In the first and second stages radiation therapy is most effective. In the third stage radiation and chemotherapy can be used. In the fourth stage radiation cannot be used because of the risk of destroying vital tissues surrounding the diseased areas. Therefore, chemotherapy alone is used

These treatments, however, have not always been as effective as they are today. Dr. Henry Kaplan, a pioneer in radiation therapy from Stanford University, has helped to develop megavolt radiation therapy for Hodgkin's disease.