



ESSA

Seismographs monitor all earthquakes, but better instrumentation is needed.

A similar correlation was found at the Rangely oil field in northwestern Colorado, the site of a secondary recovery operation involving the injection of water under pressure.

Similarly, underground nuclear explosions in Nevada have caused numerous small earthquakes close to the test sites (SN: 2/23/69, p. 153).

In addition to providing new insight into the mechanisms of earthquakes, these discoveries provide a potential means for modifying or controlling them. In some cases fluid injections or small explosions may gradually release built-up strain in a series of minor, harmless quakes. Conversely, in regions where high subterranean pore pressure increases the danger of quakes, as when reservoirs are filled, extraction of fluids could act as a safety valve. A U.S. Geological Survey project now underway at Rangely uses pumps at four wells to reduce fluid pressure in the earthquake focal region.

Scientists at the NCER are concentrating their field work on fault zones in California and Nevada, and the physical and chemical nature of rocks and their behavior under stress are being studied in laboratories. The faults are mapped and identified by type and movements. A network of seismometers continuously records shocks along the faults.

As a result of these studies, says Dr. Pakiser, NCER scientists now have a good working knowledge of the mechanism of earthquakes in California. He estimates that within three to five years they will have sufficient scientific knowledge to make predictions of specific earthquakes. But, cautions Dr. Eaton, this does not mean prediction can be effected operationally. The theoretical

knowledge cannot be used without an adequate monitoring system.

The consensus seems to be that an adequate prediction system would entail the monitoring, with the greatest possible sensitivity, of all possible indicators foretelling the occurrence of earthquakes—ground tilt, strain, seismic activity, fluctuations in the magnetic field, as well as periodic measurements of rock stress in drill holes and of physical properties that are stress-dependent.

Once the recent history of a fault is established as background, says Dr. Eaton, phenomena such as magnetic field variations can be used as specific indicators of impending quakes.

Dr. Pakiser believes, though the scientists haven't yet reached a point where a warning system could be developed, "We are at a right stage to make a real move forward in the whole field of earthquake prediction."

What remains for the California seismologists, he says, is to estimate how near the breaking point the San Andreas Fault is. One way to find out, he believes, would be to inject fluids into an area under very controlled conditions and increase the pressure just to the point where tiny tremors occur. The researchers could then extrapolate to find the amount of stress needed to trigger a major quake.

But much remains to be done. Right now, says Dr. Pakiser, the recurrence interval for the San Andreas Fault can be estimated as anywhere from 200 to 50 years. The last major quake along the fault was in 1906. "On the basis of present knowledge, we can't say for sure whether the next major quake is 14 years overdue or we have 136 years to wait." □

films OF THE WEEK

HYDROLOGY. 8mm, color, silent, series of 12 film loops. Explain the action of water in a variety of geological conditions. Titles include: Water Cycle in the Ocean, Water Cycle on Land, How Rivers Receive Water, Laminar and Turbulent Flow, Dry Channel and Flood Flow in Rivers, Wind Set-up on Lakes, Turbidity Currents on Lakes, Cross-channel Flow in Rivers, Flow in Meandering Rivers, Movement of Groundwater, Surface and Sub-surface Streams, and Influence of Rock Structures. Audience: elementary, junior high. Purchase \$20 each or series of 12 for \$240 from BFA Educational Media, Dept. SN, 2211 Michigan Ave., Santa Monica, Calif. 90404.

JOURNEY INTO SELF. 16mm, b&w, sound, 47 min. Film is a documentary of an intensive basic encounter group. Eight total strangers from various parts of the country meet for the first time in front of the cameras to share some of the most intimate contacts of their lives. The group is led by Drs. Carl Rogers and Richard Farson, two of the country's foremost psychologists. The film focuses on four group members, and contains highlights of the most emotional moments of their interaction. Audience: psychologists, psychology students, general. Purchase \$250 or rental \$60 from Western Behavioral Sciences Institute, Dept. SN, Film Library, 1150 Silverado, La Jolla, Calif. 92037.

THE KINGFISHER. 16mm, color, sound, 15 min. Shows several members of this family of birds whose distribution is worldwide, and then explores in detail the life-cycle of the European or Common Kingfisher. The two adult birds live along a small river. They mate in early spring, and set about digging a nest in the bank above the river. The nest with the hatched fledglings is seen in a cut-away shot which allows the viewer to watch the growth and feeding of the baby birds. When the young birds emerge from the nest, they must learn the difficult art of diving and catching a fish. Those who reach maturity must search out new home grounds since the food supply is not adequate for more than one adult pair. Next year, a new generation of kingfishers will appear. Audience: general. Purchase \$190 from Act Films, Dept. SN, 35 West 45th St., New York, N.Y. 10036.

THE LASER. 16mm, color, English soundtrack, 25 min. The laser is a light source which is coherent in both space and in time. The film shows the basic notions of time coherence and space coherence by means of simple models such as coupled pendulum circuits. Once these notions have been established, it is shown that Einstein's discovery, in 1917, of stimulated emission, makes it possible to imagine a light emission medium as a circuit of coupled oscillators, on the condition that population reversal can be brought about. When this is done, a feedback system must be created in order to obtain an auto-oscillator; it is the laser. Applications also shown. Audience: technical. Rental \$6.00 from Society French American Cultural Services and Educational Aid, Dept. SN, 972 Fifth Ave., New York, N.Y. 10021.

Listing is for readers' information of new 16mm and 8mm films on science, engineering, medicine and agriculture for professional, student and general audiences. For further information on purchase, rental or free loan, write to distributor.

*Correction: We are informed that purchase and loan information about the film *Ground Water: The Hidden Reservoir*, noted in the Jan. 16 issue, should be directed to John Wiley & Sons, Inc., Educational Services Dept., 605 3rd Ave., New York, N.Y. 10016*