BALDWIN HILLS INJECTIONS

Oil and earth movements

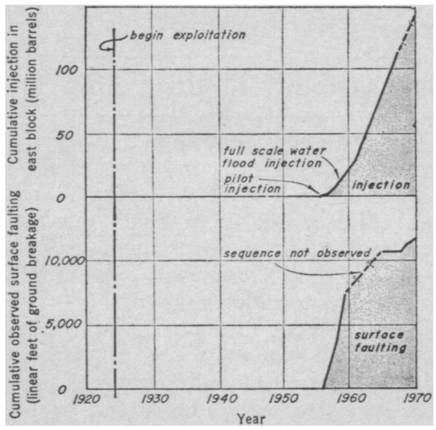
Various events of the past few decades are making it increasingly apparent that any tampering with the geologic structure of the earth may produce unforseen and unwanted consequences. One such type of tampering is the practice now widely used by oil companies of injecting fluids into near-depleted oil fields to flush out remaining oil. These injections have been shown to be responsible for a series of earth tremors at Rangely, Colo. (SN: 4/17/71, p. 263). Now, two California scientists are presenting strong evidence that such operations were responsible for a 1963 disaster in Los Angeles.

On Dec. 14 of that year, a wall of the Baldwin Hills Reservoir in metropolitan Los Angeles gave way, spilling some 250 million gallons of water on the communities below. A square mile of homes was inundated with mud and debris; five lives were lost. The toll might have been greater had not recognition of the imminent failure of the wall permitted several hours for evacuation.

There is no doubt that the disaster was the result of a sudden displacement along a fault underlying the reservoir which ruptured the structure's clay lining. What set off the earth displacement, say geologist Douglas H. Hamilton and engineer Richard L. Meehan, was fluid injections at a neighboring oil field. The Inglewood oil field lies across the main fault of a network of fractures that lie under the Baldwin Hills. The wells extend down among these fractures. The field was discovered in 1924 and rapidly exploited. In 1957, the Standard Oil Co. began a full-scale program of water flooding for secondary recovery. Meanwhile, engineers of the Los Angeles Department of Water and Power discovered that the ground was subsiding in the Inglewood area and that the changes in elevation defined a bowl-shaped area, the outline of which appeared to coincide with the outline of the Inglewood oil field.

There have been two basic explanations offered for the deformation that ruptured the reservoir. One is that it is purely of tectonic origin. Proponents of this theory point out that movement now occurring along known active faults is the same as always. But Hamilton and Meehan point out that displacement along subsidiary faults generally occurs in response to greater displacements along the principal fault, yet large displacements have occurred on the subsidiary faults of the Inglewood network with no evidence of related creep, rupture or crustal strain along the main fault.

The second theory is that the simple withdrawal of some 67,000 acre-feet of oil, water and sand from the field would produce ground subsidence and surface rupturing on the edge of the subsidence bowl. The objections to this theory are that ground rupturing was not directly observed during the decades of oil removal prior to 1957 and that almost all the rupturing has occurred in one limited sector of the bowl circumference.



Science

Injections and ruptures: A close tie.

Hamilton and Meehan propose instead, in the April 23 SCIENCE, a modification of the subsidence theory which, they say, eliminates these flaws. Their theory is that injection of fluid into the ground under pressures only slightly greater than normal hydrostatic pressure (the pressure due to the weight of water at higher levels) will reduce or eliminate shearing resistance (such as friction) between two planes of a potential fault.

The two researchers have found a clear correlation between fluid injections at the Inglewood oil field and ground movements. In fact, they point out, all recorded episodes of fault movement since 1957 have occurred after one or more actions or events: initiation of injection in nearby wells, increases in fluid pressure, or problems such as loss of fluid injected. "The sequence of events suggests that the injection caused or contributed to the movement."

The mechanical behavior of systems consisting of solid particles with fluid-filled voids—such as an oil field—are well defined. It is an established principle that a decrease in fluid pressure produces an increase in stress and therefore a decrease in the volume of the solid part of the system. This principle, the researchers say, provides a reliable theoretical basis for predicting crustal settlements caused by changes in total stress or fluid pressures, and can be applied in reverse to injection of fluids.

Injection pressures in the Baldwin Hills area were high enough, the scientists believe, to markedly reduce or, in some areas, eliminate shear resistance along preexisting fault surfaces, and even create new fracture surfaces. The weakened zones must have been initially confined to the immediate vicinity of the injection wells, but as new injectors were put into operation, larger areas became affected.

Fault activations at Inglewood and Rangely demonstrate some of the mechanically predictable consequences of fluid injections, the researchers conclude, and these consequences should be considered before such operations are begun. "Experience in the Baldwin Hills suggests that, although fluid injection operations may be carried out for beneficial purposes, the effects of such injection on the geologic fabric can be serious and far-reaching." □

LONG-SOUGHT GOAL

Accelerator for Japan

In the development of particle physics Asian physicists have made important contributions in both theory and experiment. When they have been experimenters, however, they have had to do their work far from home, in the United States, western Europe or the Soviet Union. Non-Soviet Asia lacks a particle accelerator of what might be called the world high-energy class.

Japanese physicists have been especially prominent in particle physics. Japan is the richest and technologically most advanced nation in eastern Asia. For years Japanese physicists have talked about building a large national accelerator, mentioning energies as high as 40 billion electron-volts (GeV).

Now the Japanese are building one. It will not be nearly as energetic as the most optimistic scientists had hoped. It will be a proton synchrotron that will begin at 8 GeV and later be able to go to 12 GeV. Considering the present international financial climate for high-energy physics, this is a respectable effort. It compares favorably with the largest national accelerators of such countries as Great Britain, France and West Germany though it is much smaller than the latest United States and European international projects, which go to the hundreds of billions of electron-volts.

The National Laboratory for High Energy Physics, as it is called, will be built on a 200-hectare site near the projected Tsukuba Science City, located near Mount Tsukuba not far from Tokyo. The estimated total cost will be $24 million, and construction is expected to be completed by 1974. The laboratory will be directed by Dr. S. Suwa and will be open to physicists from universities and research institutes throughout Japan. It will also be a center for the promotion of international collaboration in high-energy physics on behalf of Japan. □