ten year budget of $218 million, exclusive of engineering research.

The National Academy of Engineering, for its part, produced in 1969 a report devoted to the engineering aspects of earthquakes, *Earthquake Engineering Research*, which proposed the expenditure of $38 million a year over a ten year period for those aspects alone. The report, produced by a committee chaired by Dr George W. Housner, of CalTech, urged the setting up of a panel to coordinate research carried out by the various government agencies and universities, and suggested that the National Science Foundation should assume the lead in directing the research effort.

1969 was a good year for reports about earthquakes and two more were to erupt before the year was out. *Toward Reduction of Losses from Earthquakes*, issued by the committee on the Alaska earthquake of the National Academy of Sciences, presented in summary form the main recommendations deduced from study of the 1964 earthquake. These included the call for more research into the development of earthquake resistant structures, earthquake forecasting and loss reduction, as well as for improved arrangements for gathering seismic data. A second report, produced by the committee on seismology of the National Academy of Sciences, repeated the plea for a national ten-year effort in seismology, the major part of which, it says, should be devoted to research on earthquake hazards and earthquake prediction and control (*Seismology: Responsibilities and Requirements of a Growing Science*). The committee envisaged that federal support of seismology, then running at about $10 million a year, should increase to $35 million by fiscal year 1971, and then to £50 million and above, making a round total of $500 million over the decade of the 1970s. Earthquake-related items in this imagined budget included $175 million to be devoted to prediction and prevention of earthquakes (exclusive of engineering), $55 million for instrumentation and observation and some $40 million for studying the physics of earthquake processes, making a total of some $270 million.

The chief difference between NAS and NAE reports of 1969 and the OST report of 1965 was that the latter proposed a ten year budget of $218 million for geophysical and other research, and $60 million for engineering research, while the former reports proposed sums of $270 million and $380 million respectively for these two categories of research. Perhaps because all these reports had only a token effect on federal expenditures, the most recent government effort in this direction avoids all mention of money and merely repeats the same list of recommendations.

Earthquake Hazard Reduction, issued last September by the Office of Science and Technology, is the report of a task force chaired by Karl V. Steinbrugge. The report counts earthquake prediction and control as benefits likely to accrue after a ten year research programme: projects likely to reap immediate reward include requiring all federal buildings to be of earthquake resistant design and preparing better seismicity maps. Applied research on earthquake engineering is deemed likely to yield fruits 5 to 10 years after commencement. The OST invited federal agencies to submit their comments on the Steinbrugge report, which were due in last month, but has taken no further action.

All six government reports prepared in the last six years have had less tangible effect than the utterances of the young clairvoyante, who predicted in 1968 that a catastrophic earthquake the following April would cause California to slip into the ocean; she at least produced a sharp increase in the airline reservations for flights out of California in March. It remains to be seen whether last week's earthquake will give any greater credence to the warnings of seismologists. But one thing seems certain: another report will be called for.

SEISMOLOGY

California Quakes Again

by our Geophysics Correspondent

THE most recent seismicity maps of the Earth show the San Andreas fault and its parallel neighbours as remarkably patchy features. For the most famous and most studied fault system in the world does not reveal itself by a regular chain of earthquakes along its thousand kilometre length, but by some regions of high seismicity interspersed with others of little or no activity. Future prospects in these quiet zones are obviously a very important matter and the evidence so far

Latest Lunar Seismology

LATEST reports are that the Apollo 14 seismometers are performing well and revealing very similar phenomena to those recorded by the Apollo 12 seismic package. The latter is still operating satisfactorily over a year after its installation (and beyond its nominal lifetime) and recorded the impact of the Saturn IVB rocket on the Moon. Again the extraordinary seismic records were seen with discernible compressional and shear waves and then the build-up and long ringing decay in energy over a space of two or three hours. The LEM impact was aimed between the two instruments and fills in two further points on a lunar travel time curve which is now quite well populated with impacts from LEMs and rockets. Starting from laboratory determinations of compressional velocity as a function of pressure for collected Moon rocks, it is possible to predict a velocity-depth function for the Moon which tallies remarkably well with the inferences from travel-time data now available.

The first part of the active seismic experiment—obtaining surface seismic velocities by thumping the ground in the vicinity of the Apollo 14 seismometers also appears to have worked well and yielded very low velocities (less than 100 metres/sec) for P-waves in the first few metres. The more spectacular experiment—the firing of mortars which land at distances between the thumper range and those of the impacts—has yet to be started.

The source of the ringing is still uncertain. Recent geophysical meetings have spawned an inordinate number of (often ill-informed) explanations. The front-runner at the present, however, seems to be this. The Moon rocks are assumed to have a combination of two properties not observed together on Earth—a high Q, or low absorption of seismic energy, and a heterogeneity sufficient to scatter seismic waves strongly. The incoherent but long lasting signal is the result—akin to the long rumble of thunder scattered by inhomogeneities in the atmosphere.

Meanwhile natural seismic activity continues to be recorded by the Apollo 12 instruments, and it is hoped that the addition of the second set of triaxial instruments will help to pin down the source of this activity. There are some intriguing facets. The peak of the activity seems definitely correlated with the lunar month—a correlation never satisfactorily pinned to any Earthly seismicity. In addition the events are carbon copies of each other—the traces tally wiggle for wiggle over extended periods. This in conjunction with the incoherence between different components of the ground motion is a very strong restraint on the location of the events. Experience in similar situations on Earth with heterogeneous media and scattering has shown how extremely sensitive the seismic signal is to the location of the source. Moving the source a few metres may change the whole pattern. Are the Moon events that close to one another? At the moment, it looks like it, in which case some form of venting would be the most obvious candidate.