EARTHQUAKE STUDY IN SOUTHERN CALIFORNIA, 1948

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This continues the previous report by GUTENBERG and RICHTER [1947].

S. K. Chakrabarty of Bombay was in residence at Pasadena for most of 1948. In October, 1948, E. E. Ingram of the National University, Dublin, arrived for an academic year of study and research. A. Deo-Rojo of Cartuja, Spain, W. Heiskanen of the Isostatic Institute, Helsinki, and R. Stoneley of Cambridge, England were also visitors for more or less extended periods, and provided much valuable material for discussion and investigation.

Ivan Tolstoy spent several days searching the seismograms for evidence of SOFAR waves originating from submarine earthquakes. Several small examples were found. A much larger one has since been identified on records of the earthquake of January 23, 1938, off Hawaii.

B. Gutenberg attended the Oslo meeting of the International Geophysical Union. A paper on earthquakes and structure of the Earth's crust was presented to a joint meeting of several Associations. He also presented a paper, Unexplained Phases in Seismograms, which has been submitted to the Bulletin of the Seismological Society of America. Three groups of waves, following P after about five, ten, and 20 sec on seismograms of deep-focus earthquakes recorded at Huancayo, are possibly waves transformed from longitudinal to transverse at depths of roughly 40, 80, and 150 km. Others may be reflected at a depth between 900 and 1000 km, where there may be a sudden small decrease in velocity.

A paper by C. F. Richter on the history and applications of the magnitude scale was read at Oslo by B. Gutenberg and will appear in the proceedings.

Other contributions in course of publication are:

By S. K. Chakrabarty: The theory of electromagnetic seismographs, submitted to the Bulletin of the Seismological Society of America. This paper arose from experience and discussions in connection with the testing of a Benioff instrument destined for use in India.

By S. K. Chakrabarty and C. F. Richter: The Walker Pass earthquakes and structure of the southern Sierra Nevada, also submitted to the Bulletin of the Seismological Society of America. The principal earthquake of March 15, 1946 is assigned a depth of 21 km, with an epicenter definitely within the Sierra block. The epicenters of aftershocks scatter about this, with no definite alignment. Some of the aftershocks are better suited by the more usual depth of 18 km. The effect of the "shadow" of the root of the Sierra Nevada appears on the records at Tinemaha, to the north.


H. Benioff is continuing his investigations on the relation of earthquake and aftershock sequences to rock creep. On the basis of the elastic rebound theory, the fault rock strain relief which produces an earthquake is proportional to the square root of the energy. Consequently in a sequence derived from a single fault system the square root of the energy of each shock represents a strain release (or increase) increment, and a plot of the accumulated sum of such increments against time represents the creep curve of the fault rock. The energy is derived from the magnitudes of the shocks determined by Gutenberg and Richter. In the case of aftershock sequences, it has been found that...
the creep curves exhibit either simple compression elastic creep release characteristics or com­
pression elastic creep release followed by shear elastic creep release.

The magnitude data for the earthquake sequences have been taken from tabulations by Guten­
berg and Richter in their forthcoming book. Study of a number of these sequences occurring in all
the active regions of the world has revealed that most of them form creep series. Many types of
creep are represented, such as constant velocity, exponential velocity, elastic and elastic flow. In­
dividual sequences may have linear extents of 20° to 30° of latitude as in the case of the South Amer­
can and Tonga sequences and the evidence strongly suggests that they behave as single mechanical
units. The very deep focus Tonga sequence exhibits elastic creep which continued some 25 years,
thus demonstrating that at depths of 650 km rock masses can support creep stresses for many years.

Instrumental development under Benioff may be summarized as follows:

In the older standard models of the variable reluctance seismographs the transducers were as­
sembled with silicon steel laminations which had not been heat treated. Recent experiments have
demonstrated that heat treatment of the laminations, after punching, greatly improves the damping
characteristics of the pendulum and at the same time reduces hysteresis effects to negligible qua­
tities.

Work is progressing on a group of moving coil electromagnetic pendulum seismographs having
short period galvanometer film recorders for semi-permanent seismograph stations. One unit is
already in service with paper recording at Desert Hot Springs.

A modified Michelson tide gauge is being constructed for the measurement of a secular tilt.
This instrument uses a twenty-meter glass tube half filled with mercury. At either end the tube
enters a three inch cylindrical container in which a pool of mercury is formed. The ground tilt is
determined by measuring the relative height of the two pools of mercury. This measurement is
accomplished electrically by comparing the electrostatic capacities of the two condensers formed
by the pool surfaces and fixed metallic plates mounted above each pool.

A device is being constructed for observing the creep behaviour of rock samples subjected to
compression and shear stress simultaneously.

A study of microseisms is being supported and sponsored by the Geophysical Research Direc­
torate of the Cambridge Field Station, AMC, U. S. Air Force.

S. T. Martner has completed a thesis on observations of seismic waves reflected at the Earth's
core. The observed amplitudes of PcP are found to be larger than those calculated, especially in
the horizontal components. Amplitudes of ScS agree more closely with those calculated, assuming
zero rigidity for the core. A similar investigation for P' and other waves through the core has been
initiated by M. E. Denison. The amplitude ratio of P/P is being investigated by H. M. Mooney, the
type of motion in S-waves in seismograms of local shocks by Dehlinger, and of teleseisms by Ingram.

B. F. Howell, Jr. has completed a thesis on ground vibrations near explosions. He finds that
several types of surface waves can be identified at short distances; one of these has the properties
of Rayleigh waves, with forward orbital motion of the displaced particle, while another has retro­
grade motion (as observed by Leet).

In cooperation with J. P. Buwalda, the field geology of the area of the Manix earthquake of 1947
is being investigated for the purpose of interpreting the instrumental findings. This has been much
facilitated by a beautiful series of air photographs supplied by the Army Air Force.

On December 4, 1948, at about 23:43:17 GCT, an earthquake of magnitude 6.6-6.7 originated
near 33°55' N, 116°28' W, probably on the San Andreas fault or the closely adjacent Mission Creek
fault. Field parties led by F. E. Lehner operated a portable seismometer unit at four localities with­
in a few miles of the epicenter, beginning within eight hours. A few days later a temporary station
for continuous recording with a Benioff vertical instrument was established at Desert Hot Springs,
the nearest community, with the cooperation of Mrs. L. Johnson and the local Chamber of Com­
merce. The station coordinates are: 33°57.7' N, 116°30.0' W, h = 335 meters. A number of aftershocks
were recorded simultaneously at this station and by the portable unit at another nearby location.
The data on the entire shock group are unusually copious, and should yield exceptionally good results
on depth of focus, wave velocities, and crustal structures. The nearest points of observation, includ­
ing Desert Hot Springs, show the unusually short apparent S-P interval of 1 1/2 sec or less commen-
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observed in similar circumstances, which is not yet satisfactorily explained. Other points only a few kilometers farther away show a true S-P of three to four seconds.

On May 21, 1948, at 15:38:20 GCT a shock of magnitude 4.8 occurred at 33.0°N, 123.5°W. This is far off the coast beyond the steep submarine slopes which mark the edge of the continental topography. Only two similar shocks are known, in 1933 and 1940, from widely separated epicenters. It is possible that these three epicenters are actually outside the continental structures and in the Pacific basin but the boundary in this sector is not precisely known.

Two shocks of magnitude 7 3/4 or over occurred during 1948; on January 24, 17th, in the Philippines (M = 8) and on September 8, 15th, in the Tonga Islands (M = 7 3/4).

The Laboratory has undertaken to report data for large earthquakes through the communication channels of the United States Navy for use in preparing warning of possible destructive tsunamis. This warning service operated on the occasion of the shock of September 8, 1948.

Routine bulletins for teleseisms and the larger local shocks have been prepared through June 1948. Reports giving epicenters and origin times for the smaller local shocks have been issued through September 1948. Provisional readings for the Pasadena station are being circulated by air letter to a short list of addresses, chiefly those of stations which are similarly reporting their data in exchange.

A special issue of Engineering and Science Monthly, published by the California Institute of Technology Alumni Association, contained articles describing the activities of the Division of the Geological Sciences. Those describing seismological work are included in the following list of publications:


Reference


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