REPORT OF THE ADVISORY COMMITTEE IN SEISMOLOGY[1]

The report of the Advisory Committee for the year ending June 30, 1927, is necessarily brief in content and transitional in character. Development work in the laboratory has been more or less interrupted throughout the year by the confusion of dismanteling the equipment at the Mount Wilson Observatory and removing it to the new Seismological Laboratory provided by the California Institute of Technology. The equipment of the various sub-stations about Pasadena and the adjustment of new apparatus therein has been going on throughout the year, but the continuous daily record of tremors is still tentative and inadequate because of the lack of a proper minute-to-minute time service through which to compare them. Progress in the San Francisco Bay region, which has been greatly stimulated through the personal efforts of Mr. Willis of this Committee, is also passing through similar transitional operations, and Mr. Willis is now absent on a journey around the world in the interest of general seismology. However, these activities are in themselves adequate evidence of progress even though we must wait for tangible results from them until the next and following years.

FAULT ZONE GEOLOGY

The Committee continues to be indebted to the United States Geological Survey for active co-operation in the detailed study of the fault zones of southern California. Dr. Levi F. Noble, whose splendid report on the San Andreas Fault last year was the major item of progress reported by this Committee, is continuing his studies to the south of Cajon Pass in the same thorough manner as heretofore. A further report, of equal interest with the first, may therefore be anticipated from Dr. Noble in the near future. Geological studies in the interest of seismology about the San Francisco Bay region have been more or less interrupted because of the absence of Mr. Willis in the Orient.

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[1] Reprinted from *Year Book No. 26,* 1926–1927, of the Carnegie Institution of Washington.

TRIANGULATION AND PRECISE LEVELING

The United States Coast and Geodetic Survey is continuing its work in those portions of California which are particularly subject to earth movements. The system of triangulation through which horizontal displacements may be detected is now nearly completed, following the lines heretofore described in detail in these reports. It is our belief that the fault zones of California are now adequately covered by this triangulation net and that slow displacements or local disruption can be accurately located through these fixed points and appropriate local measurements.

During the past winter the entire triangulation net west of the Mississippi River has been subjected to a careful scrutiny with reference to the appropriate distribution of closing errors in areas surveyed at different times. When this readjustment is completed it is believed that all errors in the location of fixed triangulation points will be reduced to a minimum. This Committee is particularly interested in this readjustment of values because of considerable displacements discovered in the zone to the southwest of the San Andreas rift which reach their maximum in the vicinity of Santa Barbara and which were at first believed to indicate strains in that region sufficient to account for the Santa Barbara earthquake of two years ago. Control measurements have since shown this conclusion to be improbable. These strains, however great they may eventually be proved to be, apparently had nothing to do with this earthquake. It appears to have been entirely local and no displacement due to it which reaches to the main fault zone has been shown. Until these adjusted values are known, however, the absolute value of the displacements detected is still uncertain. Of the progress of the recalculation, Major C. V. Hodgson, Acting Chief of the Division of Geodesy, reports as follows:

> The adjustment of the triangulation reobserved in the earthquake region of California has been delayed in order that the final readjusted values in the western part of the United States could be used for comparison. The readjusted positions of the junction stations have now been obtained and the work of adjusting the connecting loop is now in progress. No comparison between the old and the new work can be made until the adjusted values throughout the loop have been obtained. It is hoped that the adjustments may be finished in the course of two months and then the two lists of positions, resulting from the old work and the new, will be prepared for comparison. Dr. William Bowie, Chief of the Division of Geodesy of the United States Coast and Geodetic Survey, expects to prepare a discussion of the data compared, after his return from the meeting of the International Geodetic and Geophysical Union to be held in Prague, in September 1927. This discussion and the conclusions drawn will be issued in a publication of the United States Coast and Geodetic Survey and it should appear some time this coming winter.

The present program of the Coast and Geodetic Survey contemplates a net-work of precise levels in the southern California fault zone through which vertical positions may also be established in sufficient number to permit the ready detection of vertical movement in this region. Dr. Noble's report of last year furnished abundant evidence of such movements throughout the recent geological history of the region. Of the two-year leveling program of the Geodetic Survey in southern California about half is finished; the northern region about Mount Whitney still remains to be completed as soon as the condition of the mountain trail permits.

PUBLICATIONS

Continuing the administration of the special grant of $5,000 provided by the Carnegie Corporation of New York in aid of seismological publication, eight reports of current seismologic research, including Professor Byerly's full account of the Montana Earthquake of June 28, 1925, have been published in the *Bulletin of the Seismological Society of America* at the expense of the grant. The total amount expended was $1,301.75, the balance remaining on July 1, 1927, is $339.29.

LABORATORY WORK[2]

At the end of June 1926, it was expected that the new Seismological Laboratory at Pasadena would become available within a very short time. Unforeseen contingencies led to one delay after another, so that authorization to take possession of the building and enter upon fitting it up was not given until the middle of December 1926. These delays, coming in sequence, seriously handicapped the work of experimentation and instrument development which had reached a stage where good progress was dependent upon facilities provided for in the new quarters, but not available in the old. And since the delays came unexpectedly, one after another, the straight-forward work of earthquake registration was affected adversely, since from week to week it appeared undesirable to initiate new routine or set up new experimental apparatus at the old quarters, about to be vacated, to replace experimental apparatus which had been discontinued and dismanteled there. For several months registration was at low ebb. Conduct of work in the new location was begun early in January 1927, and this has gone on, increasing as facilities permitted, up to the date of this report. Work was continued in the old quarters at the Mount Wilson Observatory Office, decreasing in amount as the facilities at the new building became available, until the middle of April 1927, when the transfer of all work to the new quarters was completed, except for some experimental registration which will be continued at the Observatory Office for an indefinite time.

The new Seismological Laboratory is situated a little over a mile due west of the business center of Pasadena from which it is separated by a high, narrow

[2] Extracted from the report of H. O. Wood, Research Associate in Seismology.

ridge of weathered granitic rock, east of which is the wide, deep channel of the Arroyo Seco, cut in the coarse, unconsolidated outwash material which forms the piedmont slope at the south base of the San Gabriel Mountains. East of this channel stands a relatively narrow fringe of residences and nondescript structures, before the busy center is reached. North, west, and south of the Laboratory is residential property and the grounds of the Annandale Golf Club. It is expected that the station will be reasonably free from traffic and town disturbances.

Six seismometers have been put in operation at the Seismological Laboratory—three short-period, torsion-suspension, local-earthquake instruments (including the vertical-component); two long-period, torsion-suspension, horizontal-component distant-earthquake instruments; and a compressed flat-spring vertical-component instrument of moderately long period which is under test in an early experimental stage. However, until better facilities for time-keeping and time-marking become available the operation of these instruments will not be on a good routine basis. Moreover, in addition to the absence of good time-keeping, instruments of this character require considerable time for settling down and need repeated adjustments before they operate in a quite satisfactory way. This period has not wholly elapsed at this date of writing.

During the year under report the instrumental and auxiliary equipment has been completed and installed, except for vertical-component seismometers, at the secondary stations at La Jolla, Santa Barbara, and Riverside. The instrumental equipment for a secondary station at the Observatory on Mount Wilson is now in an advanced stage of construction.

The work of equipping the station at Riverside was begun in August 1926. Unforeseen needs developed and some time was required to supply them. The installation and preliminary adjustment were completed in October 1926. Since then the station has been operating satisfactorily, except for time-keeping and time-marking.

It may be remarked in passing that, utilizing the data of the station at Riverside in combination with the data of the instruments at Pasadena, we already have been able in one instance to locate the origins of one group of small shocks upon the so-called Whittier fault, in good agreement with macroseismic data reported verbally and in the press. The Whittier fault was not previously known to be active, though this had been strongly suspected. Notwithstanding this, it must be stated that the study of the Santa Barbara group of shocks, of the Imperial Valley group which occurred in January 1927, and, in fact, of this Whittier fault group as well, makes it clear that for very precise location of shock-origins the formulas heretofore in use must be improved. It is too early to make a definite statement, but preliminary studies indicate that the hypothesis in regard to the structure of the earth crust advanced recently by Jeffreys is in closer accord with our recent instrumental findings than the older hypotheses advanced by Wiechert and his students, and by A. Mohorovičić and his son.

Instruments were installed at the new secondary station at Santa Barbara during April 1927. This was done very soon after the electric wiring of the station was completed, making the station shelter available for use. This instrumental equipment has not yet settled down into good routine operation and there is no adequate arrangement for keeping and marking time at Santa Barbara.

The installation of instruments in the room provided for this purpose at The Scripps Institution of Oceanography at La Jolla was undertaken early in May 1927. The room set aside at La Jolla for seismometers was available in one sense much earlier than the beginning of our program of work, and piers designed for our use were constructed in it some time ago; however, owing to the size and shape of the room a relatively complex pier housing was required and experience had to be gained before this could be planned intelligently. As early as practicable this housing was designed and as soon as it was completed and the electric wiring installed the instrumental apparatus was set up. This apparatus is not yet in good operation and adequate provision for the keeping and marking of time at La Jolla has not been made.

Since the submission of our last report the establishment of a secondary station on Mount Wilson, previously discussed, has been authorized and the shelter constructed. As soon as the instrumental equipment can be completed the apparatus will be installed there. This station also will be defective for a time in respect to time-keeping and marking.

As previously stated in these reports—the ideal method of marking time at the various stations of the network is to have all marked by the same identical clock by wire circuits, or, since this is impracticable on account of cost and not perfect in practical respects, by radio time signals sent out once a minute and received and marked automatically on the records at all places. To do this is a task of no small magnitude and it is not certain whether it can be done within permissible limits of cost. Nevertheless, it is pleasing to be able to report that considerable progress in this direction has been made during the year under report. This will be followed up vigorously in the ensuing months. If, however, this should fail, we have an alternative plan for very accurate time-keeping and time-marking, at less cost than usual for such service—timing to be checked at each station several times a day by radio time signals sent out from Annapolis, Mare Island, and other stations.

Depending to some extent upon the solution (permanent or temporary) of the time-keeping and time-marking problem, it is expected confidently that the primary station at Pasadena and the four secondary stations at Riverside, Santa Barbara, La Jolla, and Mount Wilson will be in satisfactory operation within a comparatively short time.

Relatively brief experience with a very short period torsion-suspension vertical-component seismometer indicates that this is a fairly satisfactory instrument for the recording of local earthquakes which are not vanishingly feeble.

Nevertheless the general problem of the vertical-component seismometer, with long or moderately long free period, bristles with difficulties. Several methods are still under consideration for the development of instruments with longer free periods, sensitive to the weak accelerations of teleseismic motion. Dr. J. A. Anderson and Dr. Sinclair Smith have experimented with a vacuum-suspension device, with a compressed flat-spring suspension device (now being tested), and with a double-spring suspension device which will be tested later. A small vertical-component seismometer constructed at the Geophysical Laboratory under the direction of Dr. F. E. Wright has been given careful table tests which show that it will require temperature control or temperature compensation to make it stable enough for practical use.

After repeated attempts, a low-pressure capillary nitrogen glow lamp has been developed which operates with more than sufficient brilliancy with relatively low power consumption. It apparently has long life. If inexpensive means can now be found for producing and suitably controlling interruptions in current we will obtain thus one solution for a seismometer lamp which will write a line of intensely exposed dots, overlapping to form a continuous but not greatly overexposed line in ordinary running, but spaced apart at short intervals to indicate the course of large excursions in the case of strong disturbances of the seismometer.

RECOMMENDATIONS

It is recommended that provision be made:

1. For further experimental work on vertical-component instruments for the stations already designated.
2. For the further study of minute-to-minute time signals for simultaneous record at all of the stations.
3. For further experimental work in the study of cumulative stresses (tilt mechanism).
4. For two additional branch stations at appropriate points to be selected.

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