ART. XXVI.—*Preliminary Report on the Messina Earthquake of December 28, 1908;* by FRANK A. PERRET, K.I.C., former Honorary Assistant at Royal Vesuvian Observatory.

As special representative of the American Consulate, the writer sailed from Naples on Dec. 30, arriving at the Straits at daybreak of the 31st.* He remained eight days and the scientific observations and photographs were chiefly confined to Messina and its environs, Reggio and Villa San Giovanni having been inspected only from the sea during a visit of the U.S.S. "Scorpion" to the Calabrian coast. The present report must, therefore, be considered as preliminary in its nature and limited by the extraordinary conditions incident to life in destroyed cities under martial law, and in a state of siege.

Before proceeding to a detailed account of the observations, it may be well to present a summary of the principal facts:

For several weeks preceding the earthquake a number of more or less severe shocks were felt in the neighborhood of the Straits, the most important occurring on Nov. 5 and Dec. 10. Exactly twenty-four hours before the great event, i. e. at 5.20 A. M. of Dec. 27th, the seismograph at the Messina Observatory registered an important earth movement.

Etna and Stromboli were unusually active on Dec. 25th, but neither showed sympathetic action at the time of the earthquake nor immediately after.

The earthquake occurred at 5.20 A. M. of Dec. 28, 1908 (cf. fig. 1). The macroseismic duration was about 32 seconds.

The epicentrum was apparently at the northern entrance of the Straits or a little to the E. and N. of this.

The intensity within the megaseismic area was between the 9th and 10th grade of the Mercalli scale, and fell off rapidly with increasing distance from the epicentrum, indicating a centrum at no great depth, possibly 15 kilometers or less.

The destructive area extends to and beyond Palmi on the north and to Ali on the south, say twenty miles in either direction.

The isoseismals will show an elliptical form with the major axis lying N. and S. or, more precisely, from E. of N. to W. of S.

Within the megaseismic area free surface waves were produced, and their forms, preserved in the stone pavement of the Messina embankment, were photographed by the writer.

* The cost of this seismologic study is being paid from a fund generously and promptly subscribed by friends of the Massachusetts Institute of Technology and by the Volcanic Research Society of Springfield, Mass.

The event occurred on a steep barometric gradient, the mercury rising 5^{mm} during the night to a maximum at 9.00 A. M. of the 28th and then falling 10^{mm} in the course of the day. The moon was nearing its quadrature position of the 29th and had just passed its perigee, these conditions producing the

FIG. 1.

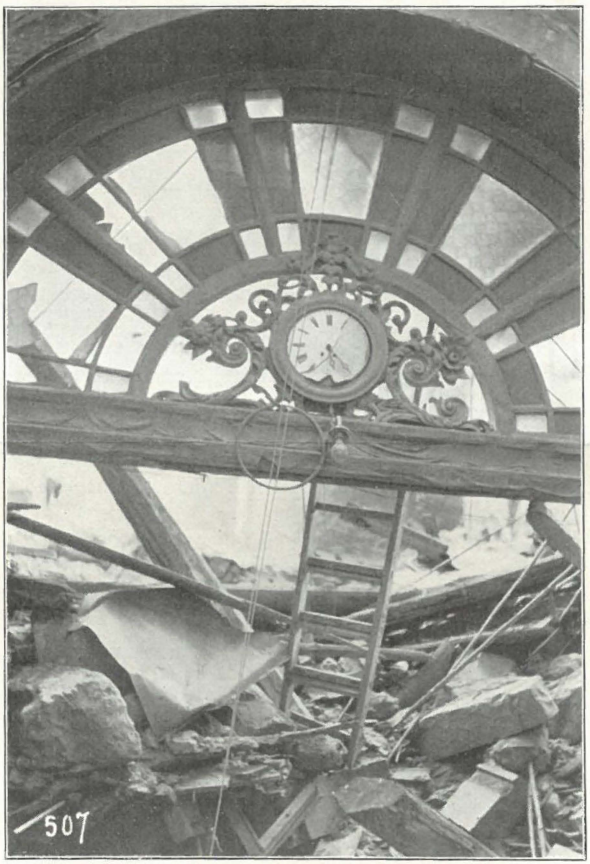

FIG. 1. Office of the Hotel Trinacria, clock stopped at 5.23.

"Terrestrial Maximum" of Dec. 28th on the writer's astro-seismic curve for 1908.* This combination was preceded by three very favorable luni-solar positions during the month of December, and this fact had led the writer to expect some

*Science, Aug. 28, 1908.

important volcanic or seismic event before the close of the year.

At the moment of the earthquake the moon was near the nadir and the sun just below the eastern horizon.

The earth movement resulted in a sea wave which arrived at Messina two or three minutes after the shock and at Villa San Giovanni several minutes later. It reached the point of Schisò (Naxos) in 35 minutes and Malta in 115 minutes. It was also registered by the mareograph at Ischia, the greatest rise (22^{cm}) occurring at 2.30 P. M. and the intervals between crests being 12 minutes. The height of the wave at Messina

FIG. 2.

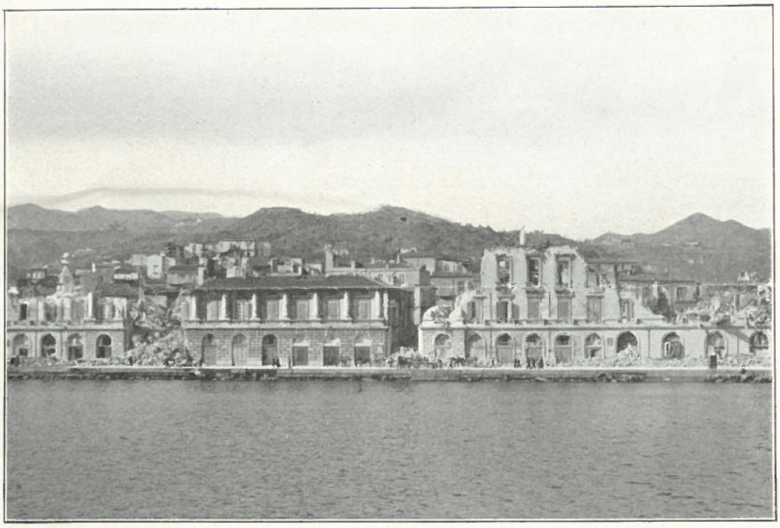

FIG. 2. View along water-front, showing relative stability of low buildings.

seems not to have exceeded three meters; at Reggio it was somewhat greater and reached its maximum on the coast below Taormina. In all cases the wave was noteworthy only by its development on reaching shallow water—a small, low free-board ferry-boat with passengers aboard having been in the Straits at the time and suffering no inconvenience beyond the difficulty of landing at the damaged and submerged ferry-slips.

The earthquake is described as having been preceded for a few seconds by a singing sound like a far-away wind storm which rapidly drew nearer and became a rumble and a roar when the earth movement began.

Nearly all the after-shocks observed by the writer were accompanied by sound phenomena.

Observers at Taormina report having seen luminous effects on the horizon in the direction of Messina immediately before the earthquake, but at Messina all was dark. The sea appeared luminous, possibly because of having been converted into foam by the vibrations. There is no doubt of luminous effects having been observed immediately before and during other earthquakes in this region—that of 1905 being accompanied by a strong red glow upon the mountain tops.

FIG. 3.

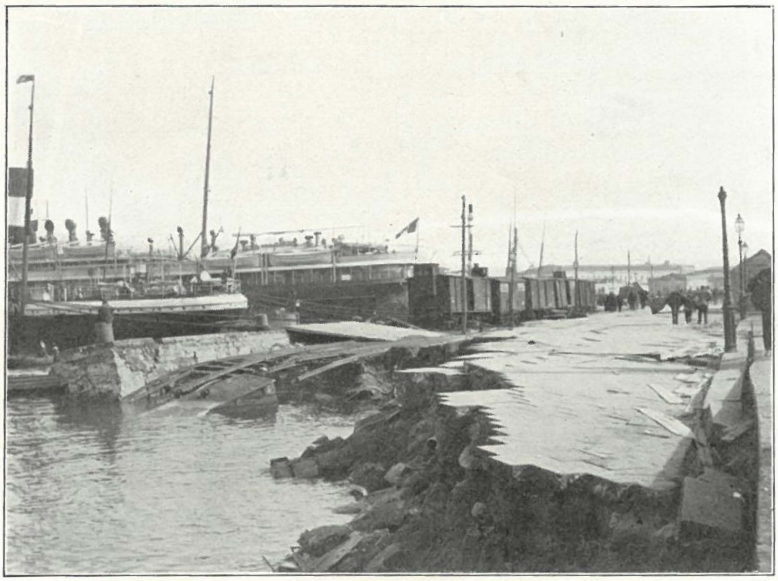

FIG. 3. Collapse of the embankment.

The Messina seismograph recorded a part of the movement.

The loss of life and property was enormous owing to the "rubble" construction of the buildings.

As has often been noted, those buildings which presented their diagonal to the direction of the earth movement resisted better than those whose faces paralleled or right angled the motion, and those on loose or sloping ground suffered most.

In Messina the general direction or "throw" of the movement was from N.E. to S.W., and the same was the case at Villa San Giovanni.

There seems to be no evidence of a geological sinking. The sea has advanced in places as much as one hundred meters, but

this is evidently due to the downslip of loose material into deep water. The Messina embankment, built of lava blocks on made ground, has collapsed under the influence of the earth vibration and the sea wave, but the relative insignificance of its fall is shown by the perfectly upright walls of houses not twenty feet away.

Unless subsequent soundings shall demonstrate the contrary, it does not seem that any great physical changes have taken

FIG. 4.

FIG. 4. Partial collapse of the embankment.

place upon the earth's surface in consequence of the earthquake. That of 1783 resulted in considerable downfalls along mountain ranges, the formation of lakes by the sinking of plains and the production of crevasses. In the present case these latter are limited to insignificant fissures.

The earthquake was lightly felt at Naples and more strongly on the island of Capri.

Properly constructed houses in Calabria withstood the shock.

Entering the Straits at daybreak of the 31st, I observed that the famous rock of Scylla, which, together with the lighthouse (Faro di Messina) on the opposite point and several of the Lipari Islands, was reported as having disappeared, stood in its accustomed place. The lighthouse also was standing, but the lantern at the top had been slightly displaced toward the east. The first view of Messina from the sea did not give

FIG. 5.

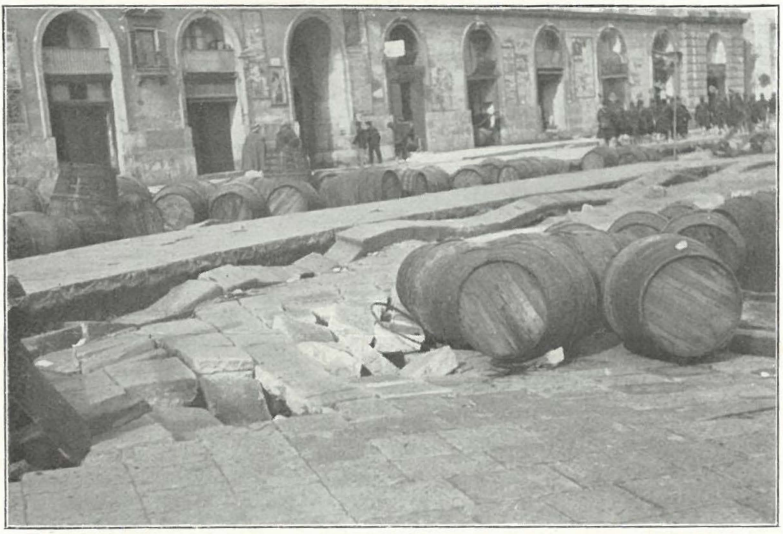

FIG. 5. Free surface wave-forms retained by curb stones of the embankment.

the impression of a complete disaster. A considerable portion of the façades of the line of buildings along the quay—the famous "Palazzata"—remained standing as well as a number of one or two-storied houses, but a nearer view showed that there was practically nothing back of the façades and that these houses were damaged, although still standing (fig. 2).

On going ashore it was easily seen that the embankment had collapsed from the sliding down into the deep harbor of its insecure foundations (figs. 3, 4). All along the quay a critical eye could detect signs of the free surface wave, and in one spot the curb had become detached from the sidewalk and retained admirably the full wave form into which it had been thrown. (See fig. 5.) The average distance from crest to crest of these waves was two meters and the height from trough to crest

(double amplitude) was 30^{cm}. In other places the wave was of flatter form, i. e., height 16^{cm}, crest to crest 6 M.

The "rubble" construction of the buildings was apparent all along the quay, broken arches of the "Palazzata" revealing the small round stones set in mortar of poor quality (figs. 6, 7).

FIG. 6.

FIG. 6. Showing rubble construction.

A conspicuous exception was seen in the building occupied by the French Consulate, the walls of which were fairly thick and built of tiling or thin brick, its chief defect being the weakness of the floors and its height of four stories (fig. 8). The relative stability of these walls was shown by a seven-foot pier glass which was not even cracked. The American Consulate building had collapsed to a compact heap of mortar and stone.

The general direction of the earth movement was well shown by the wreck of the Maurolico monument in the Villa Mazzini (fig. 9). This has fallen due S.W. and, having been symmetrical and standing on a level plain, it gave as fair an index as could be obtained. The same general direction was

FIG. 7.

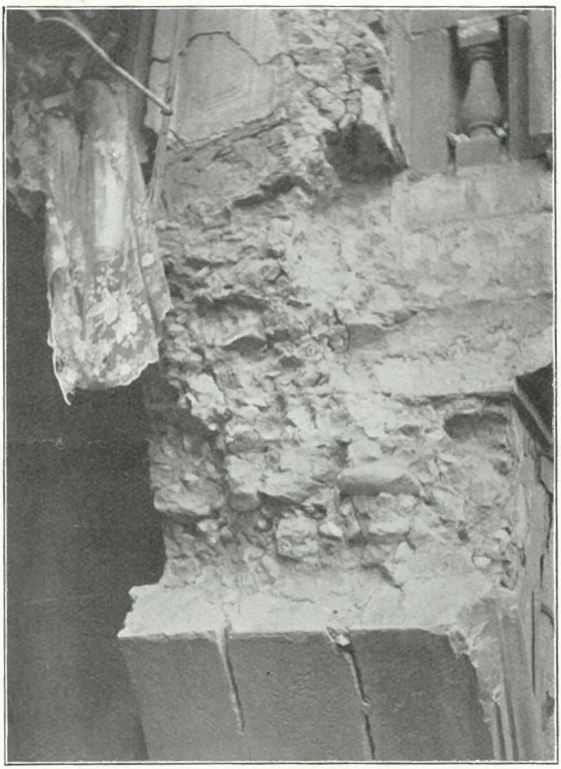

FIG. 7. Broken arch of the Palazzata showing rubble construction.

observed just outside the city, where the top of a tall stack had been snapped off and fallen S.S.W. (fig. 10). Two other single column monuments on the hills west of the city had also fallen S.W. At Villa San Giovanni a tall stack was tilted S.W. Although in Japan it is generally found that such objects fall inward or toward the epicentrum, this was not the case here, the most probable explanation being that, owing to the slight depth of the centrum and the nearness of the city to the epi-

centrum, there was a very pronounced vertical component at the beginning of the earth movement which, in combination with the horizontal motion, threw the objects in the direction of the movement instead of tripping their bases and causing them to fall inward. This will be more evident to the reader

FIG. 8.

FIG. 8. Ruin of French Consulate. Walls fairly thick and well built but floors weak and house too high for this type of construction.

from an inspection of the photograph of the Maurolico monument, the dome of which has been thrown to a distance of five meters from the center, which would scarcely have been the case if it had fallen under the impact of horizontal motion. The lantern of the Faro forms a case of displacement toward the epicentrum.

The principal after-shocks observed by the writer were the following:

Jan. 2,— 8.14 A. M.—½ sec., weak.
9.40 P. M.—½ sec., strong, threw down walls.
11.42 P. M.—two weak shocks ½ sec. apart.
Jan. 3,— 3.55 A. M. } weak, brief duration.
4.56 A. M. }
7.24 A. M. }
Jan. 5,—12.10 noon—¾ sec., strong ; several weak shocks two to three minutes later.
5.05 P. M. } unimportant.
9.50 P. M. }
Jan. 6,— 9.00 A. M. } unimportant.
10.00 A. M. }

FIG. 9.

FIG. 9. The Maurolico Monument in the Villa Mazzini ; this has fallen due S.W.

Jan. 7,— 5.00 A. M.—strong, brief duration.
6.28 P. M.—5 sec., strong, threw down walls, followed by a replica.
Several shocks during the night and the early morning of Jan. 8th.

This should not be taken as a complete record of all shocks occurring during the time nor can the relative intensity be depended upon as accurate, the various observations having been made on shore, on shipboard and in the ruins. The need of a good, portable seismograph was never better illustrated than by this event, as all the instruments in the neighbourhood were destroyed. It would have been possible to take a portable

instrument down to Messina from Naples and to have thus obtained a complete record of all after-shocks.

Of those indicated above three are deserving of special mention. That of Jan. 2, at 9.40 P. M., occurred when the writer was standing on the deck of a steamer moored to the embankment. The impression was that of a submarine explosion—a loud report and a sharp vertical movement. These, however,

FIG. 10.

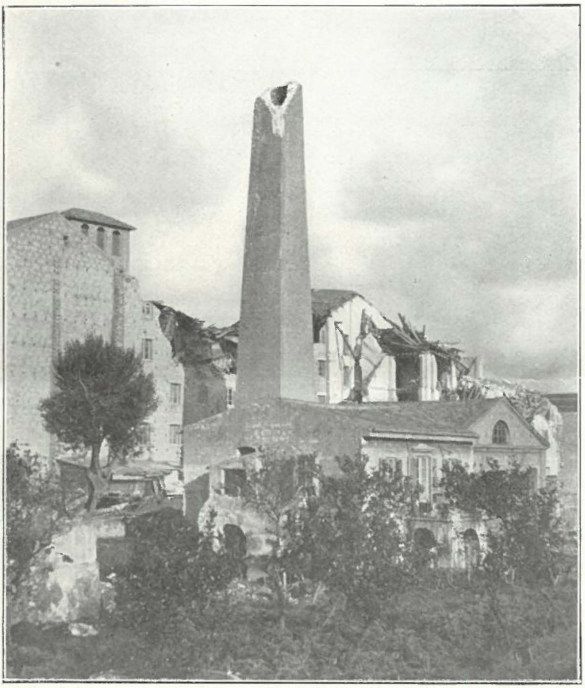

FIG. 10. Tall stack ; top snapped off and fallen S.S.W.

were partly due to the iron hull of the ship receiving the impact from the water. In from three to five seconds was heard the crash of falling walls within the city and smouldering fires blazed up anew. This shock is *reported* to have snapped the anchor tips of the British cruiser "Exmouth," which was carried two miles to the southward by a twelve-knot current through the Straits.

At ten minutes past noon of the 5th another strong shock of the same general nature occurred, but this was felt on shore

only as a horizontal wave motion. It was followed by several weaker movements.

At 6.28 P. M. of Jan. 7, a shock lasting fully five seconds formed the most interesting of those observed. The duration was such as to give ample time to study the phenomenon and it was impossible to avoid the conviction that the originating movement at the centrum had a duration not greatly inferior to that of the observed effect. This is contrary to the accepted ideas of the day regarding earthquake generation and a discussion of the subject may be reserved for a future paper, but

FIG. 11.

FIG. 11. Fronts fallen from houses, lying East and West.

the writer feels in duty bound to record the impression in the belief that no honest observation is without value.

This shock was experienced when on board the U. S. S. "Scorpion" and the man on watch reported having "seen" the earthquake pass through the city from N. to S. When interrogated he could give no more definite information, but it is evident that the earth waves had produced a visible undulation of the buildings and walls along the water front. Many walls fell and the shock was followed by another not as strong. A number of shocks occurred during the night and in the early morning of the 8th.

As to the cause of these Calabrian earthquakes, the writer inclines to the opinion of Mercalli, viz.: that they are due to the movements of deep-seated magma and belong, therefore,

to the type which he denominates "inter-volcanic." In their nature they are, of course, tectonic, and I often permit myself to ask if the primal cause of all tectonic earthquakes may not yet be found in magmatic intrusion, the fact of their non-occurrence in the immediate neighborhood of active volcanic vents and of their prevalence in the steeply folded portions of the earth's surface constituting, in my opinion, an argument for, and not against, the hypothesis.

FIG. 12.

FIG. 12. North end of Quay.

At all events, this portion of the Italian peninsula lying, as it does, between the Tyrrhenian and Ionian deeps and subject to the upheaval revealed by the Quaternary terraces of the Aspromonte, must be considered as one of the most pronouncedly seismic areas of the globe. This being the case, it is idle and harmful to encourage the hope that this region will not be subject in the future, as it has been in the past, to frequent and severe earthquakes. Rather should it be impressed upon both government and people that, sooner or later, these are certain to occur and that the proper construction of houses to withstand their effects is an absolute necessity. Only thus, with the active prosecution of the study of prediction, may we

hope to avoid future repetitions of the recent great disaster, and ample means should, therefore, be provided for putting earth-science on a world-wide basis and bringing it thus to at

FIG. 13.

FIG. 13. Wreck of a tall, poorly constructed building.

least a par with astronomy. A glance at a list of the volcanic and seismic catastrophes of the last eighteen years will suffice to show that few other lines of scientific investigation can vie with this in importance to the human race.

Vomero, Naples, Italy.