University. The group was under the leadership of John K. Howard, of Boston. The other members were Amory Lawrence; Ernest Fox, geologist; Arthur Cleaves, paleontologist, and Lawrence Kilhan, biologist, all of Boston; Dr. W. G. Smillie, of the Harvard faculty; Henry Mallinckrodt, of St. Louis, and Dudley V. Talcott, of New Haven, owner of the schooner *Norkap,* on which they sailed from Isafyordur, Iceland, late in July. Under favorable weather conditions the voyage was made to Cape Brewster, southern gate-post of Scoresby Sound, whence the *Norkap* cruised north to Kaiser Franz Josef fiord after being unable to enter Davy Sound because of heavy ice packs off shore. For nearly three weeks several members of the party made a survey of musk-ox conditions, getting valuable data as to the size and conditions of the herds which form one of the outstanding life-groups in the Free Natural History Museum, and collecting birds and fossils. In the meantime, Mr. Dolan and Mr. Lawrence camped on the Strindberg Peninsula and centered their work on collecting specimens of foxes, arctic hares, barnacle geese and various birds, and Messrs. Mallinckrodt and Howard took a series of motion pictures of musk-oxen and polar bears. On one occasion the *Norkap* came dangerously near being destroyed by a huge iceberg which drifted to the ship's side in a half gale. Before it had a chance to crush the vessel, however, the anchor was lifted and a safe getaway was made. Late in August the expedition returned to Leith, Scotland, by way of Iceland, and sailed thence for this country.

ACCORDING to the Peking correspondent of the London *Times* the Nanking Government has engaged Dr. Sven Hedin to lead a small Chinese-Swedish survey expedition to Sinkiang (Chinese Turkestan). The object is to find motorable highways which would facilitate trade between the remote interior and the coast. Leaving Kueihua in mid-October, the party will travel westward by motor-car along the ancient silk route to Rome, the longest and, it is claimed, the oldest caravan route in the world. The return journey will be made by the Imperial road through Kansu, with Nanking as the destination. The survey will take eight months, and the highways when completed will be 2,000 miles long.

A GIFT of 3,646 acres of forest land has been made to the University of Idaho by the Forest Development Company of Lewiston for development of an experimental forest. The tract is on Moscow Mountain about twenty miles from the university and will be known as the Moscow Mountain Experimental Forest. While practically all the merchantable timber has been removed, undersized trees have been left intact on most of the area, so that natural regeneration will make replanting largely unnecessary. The forest will serve as a field laboratory for the training of forestry students and experimentation in methods of silvicultural management, as well as a game preserve and for recreational purposes.

DISCUSSION

NOTE ON THE LONG BEACH EARTHQUAKE

IN a recent number of SCIENCE[1] there appears "Notes on the Fall of Columns during the Long Beach Earthquake," by Dr. Thomas Clements. A little earlier a "Preliminary Report on the Long Beach Earthquake" was published by the present writer.[2] (More complete and thorough studies of this shock will appear in a future article, or articles, probably in the *Bulletin of the Seismological Society*). From its content it appears certain that Dr. Clements' article had been sent to publication before the appearance of the paper by the present writer.

Because the circulation of SCIENCE is very much larger than that of the *Bulletin of the Seismological Society,* among both men of science and non-professional readers, it seems desirable and perhaps necessary to comment here on Dr. Clements' article. In so doing it must be emphasized that it is desired to avoid over-positive and dogmatic statements. The phenomena developed by strong and destructive earthquakes are very complex, and thorough understanding of them is far from attained. There is no desire to put aside any valuable suggestion. Nevertheless, Dr. Clements' conclusions are not in harmony with ours and the discrepancies call for attention.

When, in 1857 and later, Mallet used overtoppled and fallen objects in the study of earthquakes he recognized waves of longitudinal vibration only. This view prevailed for a long time, implicitly longer than explicitly. Many such studies have been based upon it. Now, however, we recognize elastic waves of transversal vibration as well, and it is generally considered that these are the more destructive. This, perhaps, is not demonstrated; but it has been proved abundantly, especially in the last 30 years, that the amplitudes of the transversal waves are much larger than those of the longitudinal waves and that the periods of the transversal waves (though still very short) are longer. Besides these there are large-amplitude elastic surface waves—Love waves, so-called, with horizontal-transversal vibration, and Ray-

[1] SCIENCE, 78: 2014, 100–101, August 4, 1933.

[2] *Bulletin of the Seismological Society of America,* 23: 2, April, 1933.

leigh waves, in which the vibratory path is a vertical ellipse in the plane of the ray from the origin. All these waves have different speeds of propagation, and the groups of similar waves endure for greater or less intervals. The arrival and passage of these waves, in part separately and in part together, should produce a confused motion of the surface, with local changes from epoch to epoch. Also, there is no doubt of waves at the surface, especially in basins of loose, wet alluvium, which have been called quasi-elastic and quasi-gravitational. These have still different amplitudes, periods and speeds of propagation. In some instances it is known that objects which fall do so at different stages of the shaking. Therefore, it is an open question whether much can be learned from the study of overtoppled or thrown objects unless it is known that those considered fell at known instants, or during the predominant action of particular groups or kinds of waves.

However, accepting Dr. Clements' observations as carefully and critically made—it is clear that columns are as likely to fall under the action of transversal waves and Love waves as of longitudinal, and very probably more so. The Rayleigh waves may also cause their fall (in this case in the same directions as the longitudinal waves). Thus, if the action does not develop too great complexity, objects may be expected to fall not only toward or away from the source of the shaking, but also, possibly to a greater extent, in directions at right angles to radii from the origin. Such a tendency is discernible in the diagram published by Dr. Clements, although the spread indicated is fairly wide. As pointed out by Mr. Hugo Benioff, of this laboratory, if it is assumed that the directions corresponding to the maximum number of falls are determined by transversal movements, "the mean lines intersect at a point about 5 miles northeast of Long Beach (say 33° 49′ N., 118° 08′ W., approximately). The polygon of errors is smaller for this assumed epicenter and in addition the observations at Wilmington fit in very well, whereas with his (Dr. Clements') epicenter it was necessary to discard the Wilmington observations." It is not intended here to offer this new position as the preferred site for the chief epicenter, but merely to make it clear that the observations are susceptible of more than one interpretation.

As stated in the "Preliminary Report, etc.,"[2] the origin of the first motion is excellently determined within very narrow limits (2 to 5 kilometers, at most 5 miles) at 33° 34.5′ N. Lat., 117° 59′ W. Long., about 3½ miles southwest of Newport Beach and a very little farther from Balboa. A strong motion seismographic record written at Pasadena leaves practically no doubt that this was the source of the first motion of the main shock. Whether the fault-source developed and elongated significantly to the northwest immediately after the initial action is a matter which will be very thoroughly considered later in the more complete report. It may be that this will be found to be the case. At the present time, however, there is no evidence known to the writer to support the hypothesis that a minor shock originating off Newport Beach was followed immediately by a greater discrete shock originating some twenty miles to the northwest. The instrumental records appear to rule this out completely.

There is excellent evidence, supported by the detailed descriptions given in their reports, that many persons felt the arrival of the longitudinal waves followed after some seconds by the arrival of the transversal waves. Whether this will explain the personal impressions of "two distinct series of shocks, one following immediately upon the other," mentioned by Dr. Clements is, of course, uncertain.

It is true, as Dr. Clements states, that the shaking at Newport Beach and Balboa did not appear as violent as at Compton, for example. This will be the subject of discussion in the more complete report. However, there was much evidence of strong vertical shaking at Newport Beach and at Balboa; and there is abundant evidence in many places difficult to reconcile with an epicenter very near Compton. On the basis of much experience it may be stated that the nature and distribution of the effects of the shock are consistent with an epicenter off Newport Beach when the character of the ground throughout the area is taken into consideration.

It is further true, as Dr. Clements states, that there was no "tidal-wave" so-called. There were, however, reports of slight disturbance of the sea surface. The absence of a significant wave is of slight consequence. In the San Francisco earthquake of 1906, there was but little disturbance of the sea surface and no wave, properly speaking, although there is sound evidence that sidelong slipping of the San Andreas fault amounting to several feet (with little, or negligible, vertical offsetting) traversed a submarine course of many miles. For the Long Beach shock there is no evidence of any surface dislocation at all, whether submarine or subaerial. Shocks originating at sea without producing significant seismic sea waves are very common, even when the origins are near coastlines. In detail the cause, or causes, of seismic sea waves are not sufficiently well known, but they have not generally been considered due to vibration of the ground surface which forms the ocean floor.

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