

## A Preliminary Note on the Catastrophic Chilean Earthquake of January 25, 1939

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THE great circum-Pacific seismic belt which passes through Chile began to exhibit unusual activity in November last and there occurred about half a dozen large or very large earthquakes in the Pacific, to the east of Japan and to the South of Alaska. The disastrous Chilean earthquake of January 25, 1939, appears to be the last of this series and is no doubt, the most catastrophic (in point of destruction of human life and property) of all the earthquakes that have occurred since the Quetta earthquake of the 30th May 1935.

Seismological data for the Chilean earthquake have so far been received here from Kew, Neuchatel, Basel, Zurich, Chur, Stuttgart, Hamburg, Perth, Riverview, Cape Town, Hongkong, Dehra Dun, Hyderabad, Agra and Calcutta. The original seismograms from the last three stations are also available. Except Kew and Cape Town all the stations have recorded the first movement as emergent, while Kew, Zurich, Chur and Hamburg report  $eP_1'$  in addition to P. An analysis of the P and  $P_1'$  residuals using Gutenberg and Richter's tables<sup>1</sup> show that these data are in satisfactory agreement with the epicentre  $36^\circ.3$  S. and  $72^\circ.2$  W. This is about 20 miles to the north of Chillan. The time of origin of the shock is obtained as  $25^d\ 3^h\ 32^m\ 12^s$  G.M.T.

### FOCAL DEPTH

The problem of the depth of focus of the shock appears to present some difficulty. In the opinion of some,<sup>2</sup> the shock was of normal focal depth but Kew estimates the depth at about 75 km. In the Bombay E component a clear phase is recorded 18 secs. after  $eP_1'$ . If this be taken as  $pP_1'$  a value of about 60 km. is obtained for the depth. The phase corresponding to 18 secs. is also clear in the Agra E component. Other clear phases, which are identifiable in all the seismograms from Agra, Bombay, Calcutta and Hyderabad, have been recorded at 28–31 secs. and 45–47 secs. respectively from the beginning. Assuming these to be  $pP'$  and  $sP'$  respectively, a value of 100 km. for the depth is obtained from each of these phases.

Therefore these appear to suggest a depth between 60 and 100 km.

Another phase, namely, SKKS, is exceptionally clear in the Agra and Bombay records and is fairly so in the Calcutta and Hyderabad seismograms. Comparing the observed travel times of SKS and SKKS with Jeffrey's calculated times<sup>3</sup> we get the following values for the depth. Kew: SKS—50 km. and a sSKS (assumed here as SKKS)—50 km.; Neuchatel SKS—50 km.; SKKS at Agra, Bombay, Calcutta and Hyderabad—70, 60, 40 and 50 km. respectively. The mean of these values is 55 km.

We can also examine the question of the depth of focus from the macroseismic data, for, the focal depth of a shock is related to the radius of the area shaken by it and its maximum intensity. From the available data, Gassmann's formula gives 46 km. while Blake's formula 58 km. for the focal depth of this earthquake. The degree of reliability of the results obtained from Gassmann and Blake's empirical relations can be gauged from the fact that they give 12 and 6 km. respectively for the depth of focus of the Quetta earthquake (May 1935) while seismological evidences from a recent study of this shock made at Colaba pointed to a depth definitely less than 10 km. It thus appears probable that the depth of the Chilean earthquake was near about 60 km.

### ENERGY

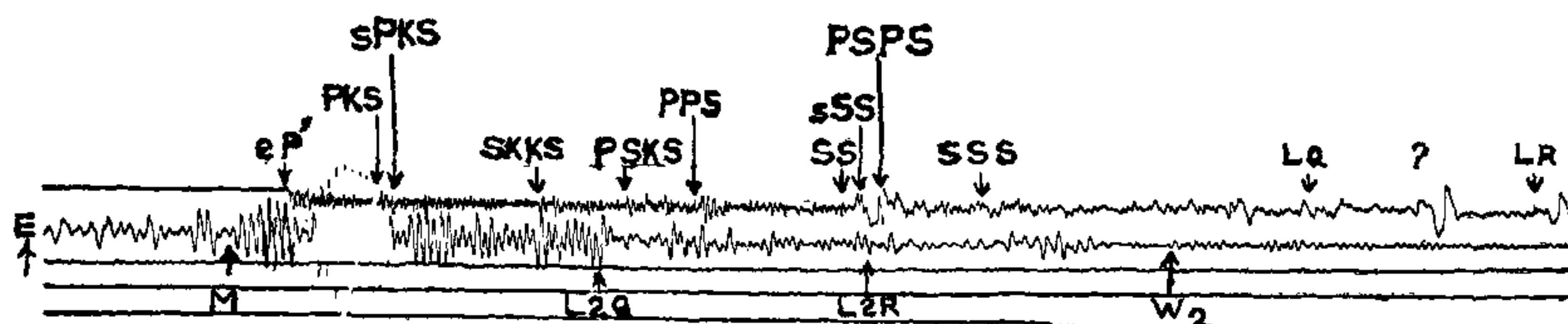
From the horizontal maximum amplitudes of the ground as recorded at C. Town (N,E), Kew (N,E), Bombay (N,E), Hyderabad (N,E), Hongkong (N,E), Agra (E) and Calcutta (N) we get 7.5 as the mean value of the magnitude of this shock which gives  $10^{22}$  ergs as the lower limit of its energy.<sup>4</sup> In the case of the Quetta earthquake the lower limit was found to be  $10^{21}$  ergs. Thus the energy of the Chilean earthquake, as manifested on the surface, was 10 times as great as that of the Quetta earthquake. Fortunately for the survivors, however, the former occurred at an abnormal depth. Had it been as shallow as the Quetta earthquake it would have produced much greater destruction which might have equalled that

<sup>1</sup> *Gerl. Beitr. Geophys.*, 1934, **43**, 82; *M.N.R.A.S., Geophys. Suppl.*, 1938, **4**, 370.

<sup>2</sup> *Nature*, 1939, **143**, 230

<sup>3</sup> *Publ. Bur. Centr. Seimol. Int.*, A, 14.

<sup>4</sup> *Gerl. Beitr. Geophys.*, 1936, **47**, 122–24.



Seismogram of the Chilean earthquake of January 25, 1939, recorded at Bombay

$\Delta = 144.7$  Milne-Shaw, E.-W.

caused by some of the severest earthquakes of the world.

The E-W component of the seismogram of this earthquake as recorded at Bombay is reproduced above. The various phases that

have been recognised have been marked on it.  $L_Q$  and  $L_R$  refer to Love and Rayleigh waves respectively. These have also been well recorded at most of the stations for which data are available.

## On *Coeloplana* sp. discovered by Prof. W. M. Tattersall at Krusadai Island, Marine Biological Station, Gulf of Manaar\*

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### 1. INTRODUCTION

THE genus *Cœloplana* was constituted by Kowalevsky, a Russian Naturalist, for a form he discovered in the Red Sea near the City of Tor in 1880, apparently because it combined cœlenterate and planarian characters. No less than nine species of *Cœloplana* have been recorded after the discovery of *Cœloplana metschnikowii*. They are:—

- (1) *Cœloplana willeyi*, Abbot, 1901—Misaki, Japan.
- (2) *C. mitsukurii*, Abbot, 1901—Misaki, Japan.
- (3) *C. bocki*, Komai, 1920—Misaki, Japan.
- (4) *C. gonactena*, Kremf, A. 1920—Coast of Annam.
- (5) *C. astericola*, Th. Mortensen, 1927—Amboina and Kei Islands.
- (6) *C. duboscqui*, Dawydoff, 1930—Gulf of Siam.
- (7) *C. agniæ*, Dawydoff, 1930—Coast of Annam.
- (8) *C. echinicola*, Tanaka, H. 1932—Japan.
- (9) *C. bannwarthi*, Krumbach, Th. 1933—Gulf of Suez.

Prof. W. M. Tattersall, of the University College, Cardiff, Wales, delegate to the Silver Jubilee Session of the Indian Science

Congress last year, visited the Krusadai Island Biological Station to study its fauna. On 7th February 1938, while examining certain sea-weeds, chiefly *Halimeda opuntia* collected from the Galaxea Reef lying to the east of Krusadai, he came across a specimen of *Cœloplana*. Unfortunately, he could not continue his observations as he had booked his passage and was due to leave for Colombo the next morning.

The work, therefore, of observing the habits and describing and identifying the Krusadai form was very kindly entrusted to us by the Professor and what facts we were able to collect within the short time at our disposal form the subject of this paper. The large number of species of *Cœloplana* recorded since 1880 made it impossible to settle the identity of the species to which the Krusadai *Cœloplanæ* belonged or to say definitely if they constituted a species new to science within the short time at our disposal.

As the sequel will show, it is likely that in our material—a dozen specimens†—is included more than one species of *Cœloplana*. For the present, therefore, we content ourselves with alluding to Krusadai *Cœloplanæ* in this paper rather than to particular Species.

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† The one discovered by Prof. Tattersall broke to pieces when he attempted to kill it with cold corrosive.