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ON THE DEPTH OF FOCUS OF THE DELHI EARTHQUAKE OF 27 AUGUST 1960

An earthquake shock of moderate intensity originated near New Delhi on 27 August 1960. The epicentre etc, determined by United States Coast and Geodetic Survey, are as follows—

Epicentre—Lat. 28·2°N, Long. 77·4°E (India)

Origin time—H=15 h 58 m 59.2 s

Focal depth—h=109 km (approx.)

The magnitude of the shock as determined at Shillong is about 6 in the Richter-Gutenberg scale. The shock was well recorded at different Indian observatories and the shock was also felt at New Delhi and other places near the epicentre. The shock was also followed by several minor aftershocks.

The attention of the writer was drawn to this earthquake because it rocked the Indian Capital and caused some minor damages to the private and public buildings at the Capital. From the microseismic effects like the localised damage and aftershock sequence it was natural to conclude that the above earthquake must have originated from a shallow focus. This conclusion is supported by the past seismic history of a region because the past earthquakes originating in the Himalayan boundary fault zones have generally shallow depth of focus. Earthquake shocks having intermediate depth of focus originate mostly from the extreme northwestern part (west of Long. 65°E) and extreme eastern part (east of Long. 90°E). Of course, the

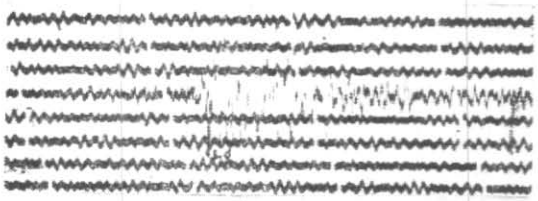

FIG. 1

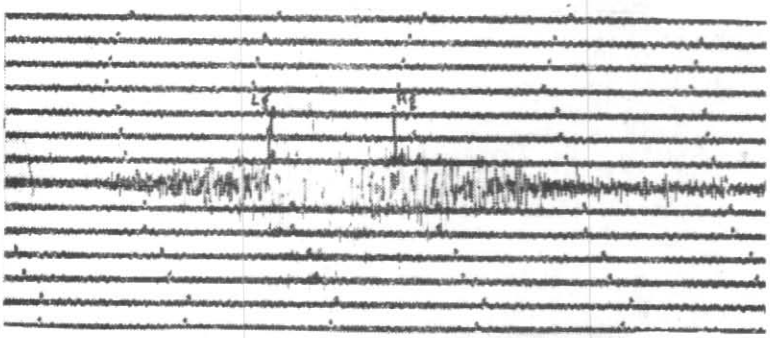

FIG. 2

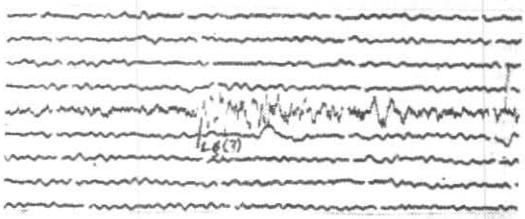

FIG. 3

FIG. 4

Fig. 1. **Record of Colaba Sprengnether microseismograph of 27 August 1960**
$T_o = T_g = 7{\cdot}4$ sec. Damping critical. $\triangle = 1130$ km

Fig. 2. **Record of Poona Sprengnether short period vertical of 27 August 1960**
$T_o = T_g = 1{\cdot}6$ sec. Damping critical. $\triangle = 1150$ km

Fig. 3. **Record of Madras Sprengnether microseismograph of 27 August 1960**
$T_o = T_g = 7{\cdot}5$ sec. Damping critical $\triangle = 1680$ km

Fig. 4. **Record of Calcutta Milne-Shaw Seismograph**
$T_o = 7{\cdot}8$ sec. $\triangle = 1220$ km

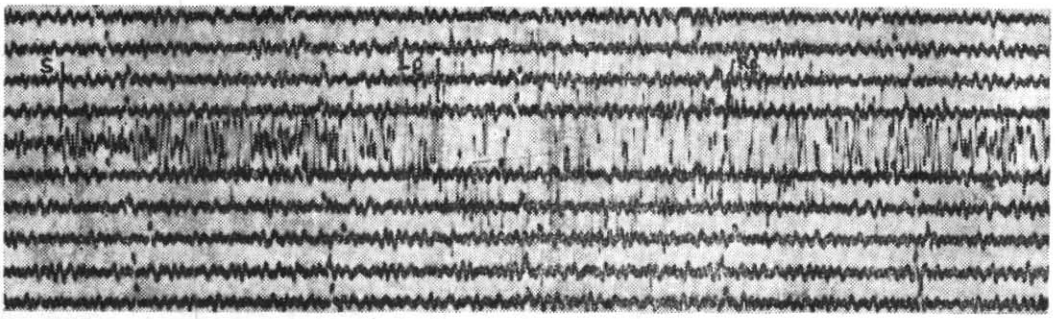

Fig. 5. Record of Poona Sprengnether short period vertical of 29 July 1960 (Δ = 1950 km)

above findings are mostly from microseismic observations because with the network of seismological observatories in and near India it is not possible to determine accurately depths of shallow and intermediate earthquakes from microseismic data. Accordingly it was a great surprise when an approximate depth of focus of 109 km was indicated in the United States Coast and Geodetic Survey epicentre card.

On examination of the records it was noticed that the *Lg*-phase is well recorded in many observatories. Earthquakes frequently excite *Lg* waves inspite of their depth beneath the surface. However, the relative amplitudes of the *Lg* waves recorded during the above earthquake are so large that a source near the granitic layer in the crust is strongly suggested. Theoretical calculations will show as the depth of the source is increased relative excitation of the shorter period waves diminishes much more rapidly than the longer period waves. Moreover, the waves in the shorter period range suffer greater attenuation possibly by absorption or by scattering. Oliver and Ewing (1958) have pointed out that the *Lg* waves which constitute short period spectrum in the continental surface waves due to natural earthquakes could be explained as normal mode propagation in higher modes through the surface and near surface layers. It is, therefore, quite likely that shallow surface disturbances could excite short period surface waves effectively and higher mode might be of effectively greater importance when the source is particularly shallow.

We shall reproduce some of the records of the *Lg* waves observed at different observatories in India (Figs. 1–5).

Inspite of strong microseismic back ground which is apparent from the very appearance, *Lg* phases are quite prominent in all the records. The phase is not so well developed in the Madras record and this could be explained from the consideration of the intervening cross mountain ranges. In other observatories, the phase is very well developed and we shall have to find an explanation of the same from the consideration of the mechanism at the earthquake focus. Oliver and Ewing (1958) have rightly observed that the relative excitation of the various types of surface waves may ultimately provide detailed information on conditions at the focus. The strong excitation of the *Lg* waves on account of Delhi earthquake goes to show that the focal depth of 109 km determined by United States Coast and Geodetic Survey is apparently very high. Bath (1954) has actually tabulated various reasons when no *Lg* has been recorded and the focal depth greater than normal is one of the reasons. Another is that no reliable readings are possible when microseisms are strong. The fact that *Lg* waves are so strongly excited that these are well recorded inspite

of microseismic back ground goes to suggest very shallow depth. The above conclusion of the author is supported by the observation of localised damage and the aftershock sequence mentioned earlier. This is also corroborated by the general appearance of the earthquake records of the shock. The amplitudes of the initial P and S motion are so small that a focus near the surface is strongly suggested. The initial P motion recorded in Shillong ($\triangle = 1490$ km), Short Period Benioff vertical is also very feeble.

The author likes to conclude this communication by reproducing below the record of the *Lg* waves on account of an earthquake originating in Assam-Bhutan border (epicentre Lat. 26·9° N and Long. 90·3°E) on 29 July 1960. The origin time of the shock was H=10 h 42 m 41·6 s, the approximate focal depth h =11 km only. The focal depth of this earthquake in relation to the amplitudes of the *Lg* waves was discussed by the author in his earlier communication (Saha 1961). The above earthquake also originates from the Himalayan boundary fault zone.

B. P. SAHA

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Shillong
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