550·34 (85 : 81)

A note on the sense of the first PKP motion for the Peru-Brazil border earthquake of 19 August 1961

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(*Received 16 March 1962*)

ABSTRACT. The seismograms at some Indian stations appear to indicate opposite sense of the first PKP motions for the Peru-Brazil border earthquake of 19 August 1961. The PKP motions are impulsive and seem to arrive simultaneously on all the components of the records. In order to avoid any doubt about the relation between the trace and ground displacements, seismograms of the same earthquake from instruments having optico-mechanical registration are also presented.

Nuttli (1960) observed that the Montana earthquake of 18 August 1959 exhibited a most unusual phenomenon concerning the sense of the first motion of the P wave at St. Louis and Florissant. The present observations are in respect of the exhibition of an unusual phenomenon concerning the sense of the first motion of the PKP wave at Poona, Bombay, Delhi and Shillong on account of the Peru-Brazil border earthquake of 19 August 1961 at $05^h\ 09^m\ 49{\cdot}5^s$ GMT. The epicentre and other particulars of the earthquake as given by the U.S.C.G.S. are as follows —

Epicentre $10°{\cdot}7$ S and $71°{\cdot}0$ W

Focal depth—649 km

Mag. 7 (Pas) $7\frac{3}{4}$—8 (Berk)

On account of unusually great depth of focus of 650 km, the first PKP motions are very well recorded by instruments of divergent design and construction and the initial first PKP motions are exceptionally impulsive. The present observations are different from those of Nuttli (1960) in this respect that the opposite sense of the first PKP motion has been exhibited by the different components of the instruments of the same or similar design. At Poona the short period Sprengnether vertical ($T_0 = 1{\cdot}6$ sec, $T_g = 1{\cdot}6$ sec) has recorded downward ground movement and Wood-Anderson ($T = 4{\cdot}0$ s) has recorded initial ground movement towards west both indicating dilatation at $05^h\ 28^m\ 21^s$; whereas the Milne-Shaw seismograph ($T_0 = 12$ sec) has recorded initial ground motion towards north indicating a compression at $05^h\ 28^m\ 21^s$. At Colaba (Bombay) the initial ground movements recorded by the two horizontal component Milne-Shaw ($T_0 = 12$ sec both) seismographs are south and east at $05^h\ 28^m\ 12^s$. The south movement corresponds dilatation whereas the east movement corresponds to compression.

At Delhi both short period Benioff ($T_0 = 1{\cdot}0$ sec, $T_g = 0{\cdot}2$ sec) and long period Press-Ewing ($T_0 = 15$ sec, $T_g = 90$ sec) vertical seismographs have recorded downward ground motion indicating dilatation. The long period Press-Ewing ($T_0 = 15$ sec, $T_g = 75$ sec) and the Sprengnether horizontal have recorded initial ground motion towards west

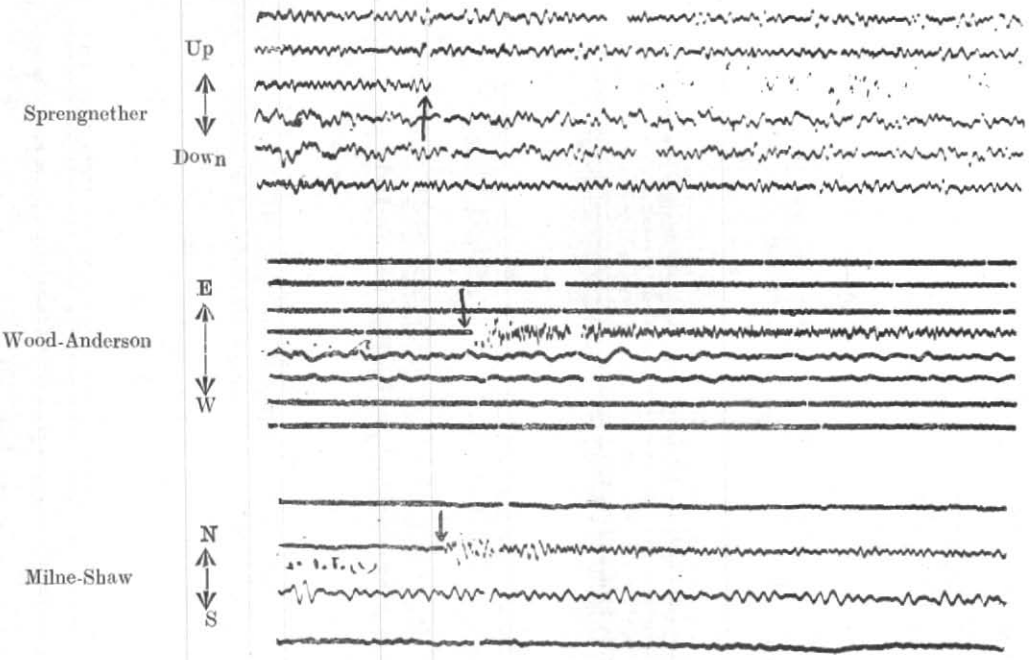
Sprengnether
Up
Down
Wood-Anderson
E
W
Milne-Shaw
N
S

Fig. 1

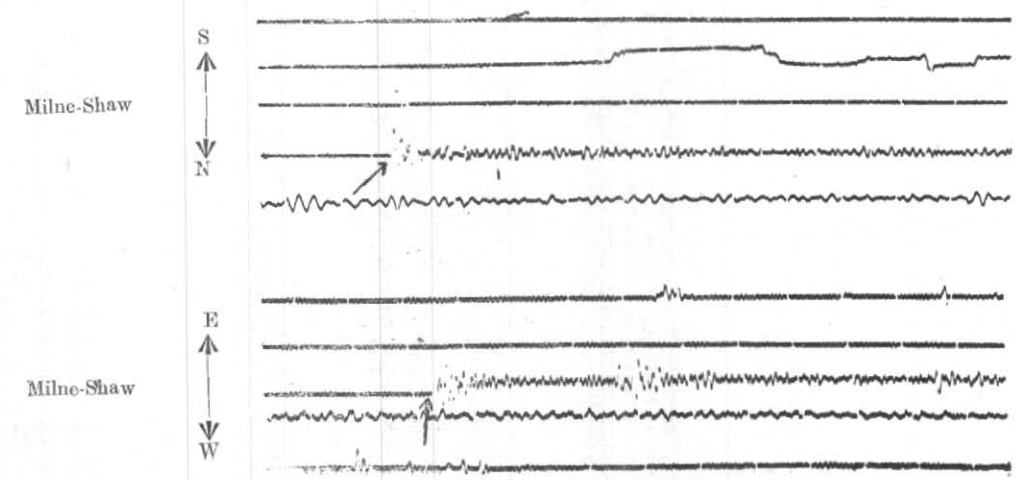
Milne-Shaw
S
N
Milne-Shaw
E
W

Fig. 2

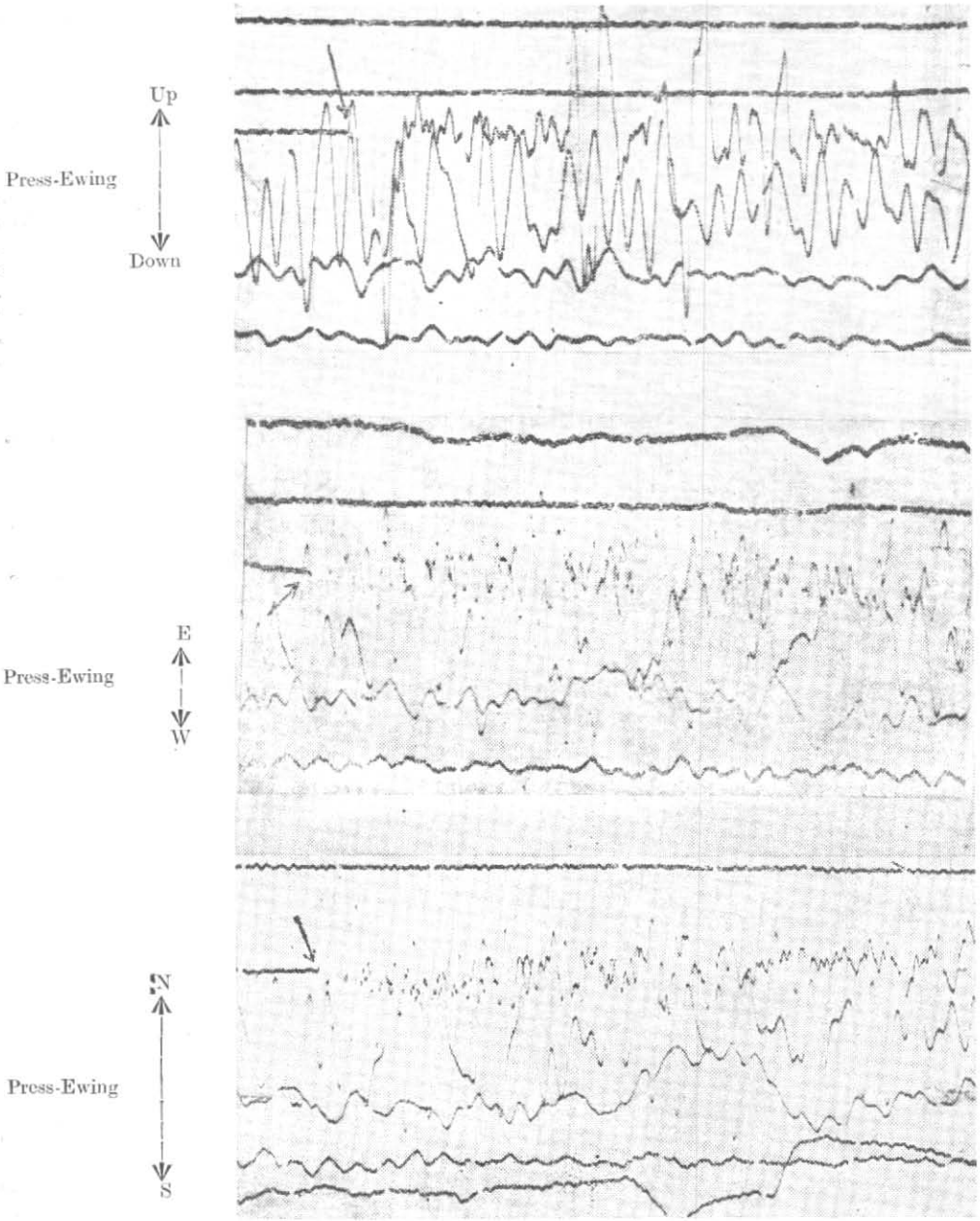

Fig. 3

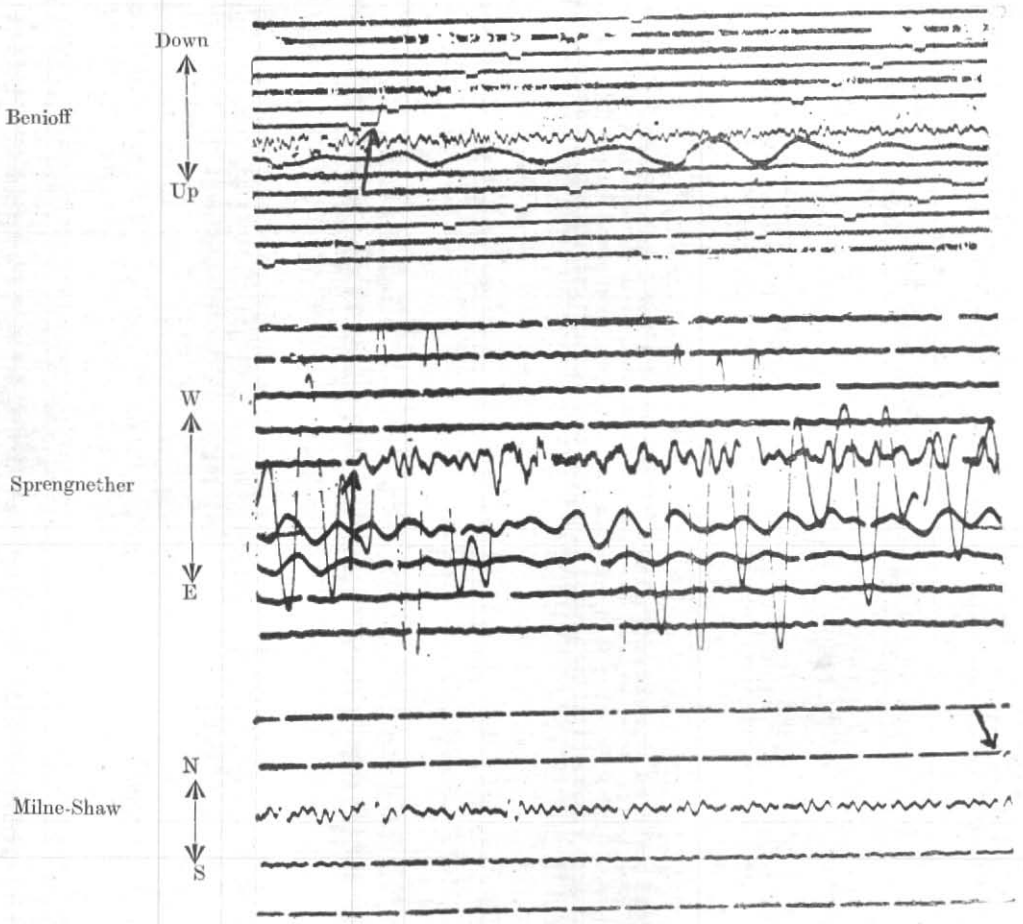

Fig. 4

indicating dilatation whereas the long period Press-Ewing (T_0=15 sec, T_g=85 sec) and Milne-Shaw (T_0=12 sec) have recorded an initial ground motion towards north indicating compression. At the Central Seismological Observatory, Shillong the short period Benioff vertical (T_0=1·0 sec, T_g=0·18 sec) has recorded a ground movement downwards and the Sprengnether horizontal (T_0=T_g=6·8 sec) has recorded initial ground movement towards west both indicating dilatation; whereas the Milne-Shaw (T_0=12 sec) has recorded a clear movement towards north indicating a compression.

Fig. 1 shows the portion of the Poona seismograms for the Peru-Brazil border earthquake. The first PKP motion on the short period vertical component Sprengnether is down. The ground movement in Wood-Anderson is west and in Milne-Shaw it is north. The times of incidence of PKP waves on three instruments are simultaneously at $05^h\ 28^m\ 21^s$ GMT.

Fig. 2 shows the portion of the Colaba (Bombay) seismograms for the above earthquake. The first PKP motions recorded by the Milne-Shaw seismograph are towards south and east. The times of incidence

of PKP waves on two instruments are simultaneously at $05^h\ 28^m\ 12^s$ GMT.

Fig. 3 shows the portion of the Delhi seismograms for the above earthquake. The first PKP motion recorded by the long period Press-Ewing seismograph is down, west and north. The times of incidence of PKP waves are simultaneously at $05^h\ 28^m\ 20^s$ GMT which agrees well with the time of incidence in the short period Benioff vertical at $05^h\ 28^m\ 21^s$ GMT. The records of the Milne-Shaw and Sprengnether horizontal and Wood-Anderson (double component) would indicate impulsive initial motion at $05^h\ 28^m\ 13^s$. The direction of the ground movement agrees remarkably well but the time of incidence differs by about 7 sec. The clearness of the recorded initial motion together with its agreement in the sense go to suggest that the discrepancy in the time of incidence is on account of the difference in the performance of the time keepers coupled to different instruments.

Fig. 4 shows the portion of the Shillong seismograms for the above earthquake. The first PKP motion recorded by the short period Benioff Vertical is down and the initial motion recorded by the Sprengnether microseismograph is towards west, both indicating dilatation. On the other hand the recorded movement in Milne-Shaw is towards north indicating a compression. The time of incidence of PKP wave on all these instruments are simultaneously at $05^h\ 28^m\ 38^s$.

The consequence of the observation of a different sense as recorded by the seismographs of similar design at the same instant may be rather significant in the study of the earthquake mechanism. The above unusual sense of initial PKP motion observed at several observatories could not be explained as an error in the convention used in going from trace motion to ground motion. The possibility that there was change in the galvanometer connection in the case of the instruments having galvanometric registration during the period when the earthquake of 19 August 1961 was recorded is also ruled out because the same observations are available from instruments, at the same station, having optico-mechanical registration where there is no chance of similar mistakes.

No attempt will be made to explain the above observations on the opposite sense of the initial PKP motions recorded in different components of the seismographs of the same or similar design. It would be interesting to learn if the similar phenomenon occurred at other distances and/or azimuths for this earthquake. The study of the fault plane solution from the distribution of P and PKP initial motions of the Peru-Brazil earthquake of 19 August 1961 might also indicate interesting results on the nature of the earthquake mechanism and the related fault movements at such a great depth of 650 km.

REFERENCE

Nuttli, O. 1960 *Bull. seismol. Soc. Amer.*, **50**, pp. 211-215.