A STUDY OF EARLY S MOTION

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Earthquake waves which are propagated through the earth may be divided into two general classifications, longitudinal and transverse waves, which are referred to as P and S waves, respectively. These waves cause disturbances at great distances from the focus of the shock, and such disturbances are recorded by seismographs. The trace of the motion due to the arrival of the S wave often has a rather indeterminate beginning and the exact moment of arrival is not easily ascertained. This study was undertaken in order to help clarify the nature of this early S motion.

Many authors have mentioned the apparent confusion associated with the onset of the S phase and have attributed it to several causes. It is often noted that considerable motion may still be registering from the longitudinal waves which arrived ahead of S, and some authors suspect that the incoming S waves may give rise to refracted P waves upon striking discontinuities at depth. Others have suggested that possible polarization of the S motion results in two types of waves, one polarized parallel to the plane of propagation and the other polarized normal to this plane. It is thought that such polarized waves could arrive at different times and with different amplitudes at a particular station.

In the present investigation, a detailed particle motion study was made of 88 phases from 53 shocks. Magnification of the records was obtained by projecting them with an opaque projector onto rectangular coordinate paper. The enlarged trace was then copied and the various points on the east-west trace matched with those at corresponding times on the north-south trace. The amplitudes of the two displacements at each point were then plotted on coordinate paper to give the position of the earth particle at the station at a particular time.

The data obtained in the study were presented in figures, charts, and in particle motion diagrams which were included as an appendix.

The conclusions to be drawn from the study may be summarized as follows:

(1) The eS motion, or "curtsey" as Byerly called it, is usually transverse and then definitely part of the S phase. On many traces the small eS motion does not appear, the first motion of the S

phase being well defined and relatively large. On the small percentage of traces where the azimuth of the first motion associated with the S phase is parallel to the ray azimuth, and thus perhaps longitudinal in nature, the azimuth of the main S motion is also parallel to the ray azimuth and the data are inconclusive. Of the fifty-three earthquakes studied, only one exception to this was found. There is no definite pattern to the occurrence of eS; it does not appear to be related to epicentral distance, depth of focus or geographical region.

(2) There is evidence that refracted longitudinal phases, resulting from S waves striking discontinuities at moderate depths, do precede the S phases in enough strength to be recorded on some seismograms. These longitudinal phases are not as important as some authors have suggested, however, and have less amplitude than previous calculations might lead us to expect.

(3) Although there appears to be some evidence to support the hypothesis that the early S motion is a result of polarization which has caused SH waves to arrive ahead of SV waves, there is no apparent pattern to such occurrences and the data are inconclusive.

(4) In the application of Neumann's method for determination of the direction of faulting, the

azimuth of the main S motion does not appear to be the best choice for A_{ss} if the motion is predominately SV. Choice of the azimuth of the smaller early motion, as suggested by Walsh (1951), might be better if this motion is definitely present as part of the S phase and if its azimuth can be reasonably ascertained.