INTERPRETATION OF RECORDS OBTAINED FROM THE NEW MEXICO ATOMIC BOMB TEST, JULY 16, 1945

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Records obtained at the following stations were available for interpretation of ground and air waves produced by the New Mexico atomic bomb test:

	Distance	*Courtesy of:*
Tucson	437 km.	U. S. Coast and Geodetic Survey
Pierce Ferry	740 km.	Dr. Carder, Lake Mead Seismological Stations, Bureau of Reclamation, National Park Survey, and U. S. Coast and Geodetic Survey
Overton	793 km.	
Boulder City	806 km.	
Palomar	965 km.	Stations of the California Institute of Technology
Riverside	1010 km.	
Mt. Wilson	1072 km.	
Pasadena	1083 km.	
Haiwee	1085 km.	
Tinemaha	1136 km.	

Unfortunately, the time of the explosion is known only within about ± 15 seconds.

Plotting of all data revealed that the first longitudinal wave through the ground (Pn) was recorded only at Tucson, Palomar, and Riverside. From the times of arrival, given below, the apparent velocity of this wave was found as follows:

Riverside-Tucson.....7.99 km/sec.
Palomar-Tucson.....8.04 km/sec.

These results agree, within the limits of error, with the value of 8.06 km/sec. found for southern California earthquakes. Thus it is possible to calculate the origin time, using for each of the three stations the travel times for zero depth (Gutenberg-Richter, 1939, p. 97).

Station	*Distance*	*Observed time*	*Travel time from tables*	*Origin time (GCT)*
Tucson	437 km.	11:30:26.3	1:04	11:29:22
Palomar	965 km.	11:31:32	2:11	11:29:21
Riverside	1010 km.	11:31:38	2:16	11:29:22

The $\overline{P}$ wave through the "granitic" layer was recorded at Tucson at 11:30:38. Supposing that the velocity of this wave was about the same as in California (5.58 km/sec.), its travel time would have been 78.3 seconds. This would give an origin time of 11:29:20. The agreement is very good, considering the fact that the travel time of Pn depends on the depth of the Mohorovičić layer. An origin time of 11:29:21 was used in the following calculations. It is probably correct within two seconds and is within the interval considered as probable from the direct observations.

A clear impulse was recorded at Tucson 3 seconds after Pn; it may correspond to "Px" in earthquakes (Gutenberg, 1944, p. 158).

The beginning of the S waves was not very clear, as is true in earthquake records from corresponding distances, and their amplitudes were relatively small. The following travel times (min:sec.) were measured:

Tucson	2:05
Pierce Ferry	3:30 and 3:40!
Overton	4:00
Boulder City	3:53
Palomar	5:02
Riverside	4:47
Mount Wilson	5:11

They correspond to SySy, Sy, or $\overline{S}$ in earthquakes (Gutenberg, 1944, pp. 153–155). No unusual waves were obvious.

Several distinct groups of sound waves were recorded. The direct sound waves (*a*) give the following velocities:

Station	*Distance*	*Observed travel time*	*Velocity*
Tucson	437 km.	1303 sec.	336 m/sec.
Pierce Ferry	740 km.	2134 sec.	347 m/sec.
Overton	793 km.	2265 sec.	350 m/sec.
Palomar	965 km.	2679 sec.	360 m/sec.
Riverside	1010 km.	2956 sec.	342 m/sec.
Mount Wilson	1072 km.	2972 sec.	361 m/sec.

These waves were usually small, and the beginning of the group was uncertain at several stations. The velocities agree within reasonable limits with what is to be expected under the various meteorological conditions, especially temperature, wind velocity, and wind direction. Besides, the possibility must be considered that waves have traveled partly in the ground and a part of their path through the air.

The other groups of waves cannot be interpreted with confidence, as the gaps between the source and the first station, Tucson, and also between Tucson and the next station, Pierce Ferry, are too great. It is not unlikely that some of the stations have recorded the direct wave through the stratosphere (*b*), which follows normally the direct wave along the ground after roughly one minute (Gutenberg, 1939), and its reflections from the ground (*c*, *d*). The following are the time intervals:

Station	*Time intervals in minutes and seconds:* *b–a*	*c–a*	*d–a*
Tucson		2:08	
Pierce Ferry	1:06	2:09	
Overton	1:00	2:00	2:57
Palomar		2:31	
Riverside	1:11		3:00
Mount Wilson		2:23	3:29

Finally, there is at all stations a group which usually carries the largest amplitudes. At Pasadena the motion on the microbarograph was so abrupt and so large that the light spot disappeared, and this wave was also recorded on the strain seismograph (but not on other instruments), indicating that the hill in which the instrument tunnel is situated was compressed by this airwave. The beginning of this group is not always very clear. The observed times are given below, together with calculated values, supposing that the wave had a uniform velocity of 301 m/sec. and started at the time of the explosion. The difference between the observed values and the calculated values are within the range of possible errors. At Overton a smaller beginning (given in the table) is followed by a stronger movement at 44:36 which gives a difference of +42 seconds and may well correspond to the beginning which has been read at Palomar. It is probable that there were real deviations from the average apparent velocity assumed for the calculations, and there may also have been a delay due to the time needed for the impulse to reach the level in which the energy was propagated and to come back to the ground. The data available are not sufficient to decide this question.

Station	*Distance*	*Travel time*		*Difference in seconds*
		Observed	*Calculated*	
Tucson	437 km.	24:18	24:12	+ 6
Pierce Ferry	740 km.	40:13	40:58	−45
Overton	793 km.	43:38	43:54	−16
Boulder	806 km.	44:47	44:37	+10
Palomar	965 km.	54:05	53:26	+39
Riverside	1010 km.	56:22	55:55	+27
Mount Wilson	1072 km.	59:15	59:21	− 6
Pasadena	1083 km.	59:53	59:58	− 5
Haiwee	1085 km.	60:07	60:04	+ 3

The low apparent velocity of 301 m/sec. seems to exclude the possibility that this is a wave reflected at the surface of the earth. It may correspond to the sound wave recorded by barographs after the explosion of Krakatoa, which circled the whole earth three times with an average velocity of about 313 m/sec. (305 m/sec. westward, 320 m/sec. eastward). The conclusion drawn previously by the author that this wave has traveled rather high up in the atmosphere corresponding to the low velocity (and temperature of −30°) may also hold in the present case where the temperature corresponding to the "average" wave velocity is about −50°C.

References

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