

short period Sprengnether Vertical Seismograph has been in continuous use at Poona for more than 6 years. A short period Benioff Vertical Seismograph was also installed at Chatra in Nepal by the India Meteorological Department at the request of the Central Water and Power Commission. This instrument has also been successfully functioning there for over six years.

Until now the exact time of origin and location of the nuclear blasts was kept a closely guarded secret, but the United States Atomic Energy Commission, at the specific request of the seismologists, has recently issued a circular giving the exact location and origin times (correct to 0.1 sec) of fifteen atomic explosions conducted by them during 1954 (Operation Castle), 1956 (Operation Redwing) and 1957 (Operation Plumb-bob). The tests in the first two series were carried on in the Eniwetok proving ground and the third series in Nevada. On receipt of the above information, the records obtained in India from the seismological observatories mentioned above were examined, and it was found that out of 10 explosions conducted during the first two series, 9 were well recorded by one or more of the three sensitive seismographs. Explosions carried under the operation plumbbob during 1957 in Nevada were not recorded at all by any of the observatories. This is not due to lack of sensitivity of the seismographs but due to the fact that the distance of Nevada from the Indian stations falls within the shadow zone of the primary waves. The *P* waves of even large earthquakes are not expected to be well recorded at these critical distances.

550.341 : 539.17  
SEISMIC RECORDING IN INDIA OF  
NUCLEAR TEST EXPLOSIONS

A large number of nuclear test explosions have been conducted by U.S.A., U.S.S.R. and U.K. during the last few years. While a few of these tests were exploded in the air, a fairly good number were exploded either under water or on ground. The latter two types generated seismic waves which could be recorded by sensitive seismographs at long distances. In India, a sensitive Benioff Vertical Seismograph is in continuous operation at the Central Seismological Observatory, Shillong since 1954 and another

The times of arrival of the primary waves from the nuclear blasts as recorded at the Indian seismological observatories, along with other particulars, are given in Table 1, which also gives the calculated distances in degrees of arc of the shot point from the observatory, and the calculated travel times according to Jeffreys and Bullen's Tables (1948), after taking the ellipticity correction into account. In col. 8, are given the

TABLE 1

Shot name and (Type)	GMT Date and Origin time (h m s)	Geographical Co-ordinates (°) (') (")	Station	Distance in degrees Δ	Observed travel time (min) (sec)	Calculated travel time (min) (sec)	O—C (sec)
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
BRAVO (Ground)	28-2-54 18-45-00.0	Lat. 11 41 27 Long. 165 16 25	Shillong	70.187	Recorded but failure of time marks		
			Poona	87.675	12-49.9	12-52.4	-2.5
			Chatra	74.284	Record not available		
ROMEO (Barge)	26-3-54 18-30-00.4	Lat. 11 41 27 Long. 165 16 23	Shillong	70.187	Record not available		
			Poona	87.675	12-49.4	12-52.4	-3.0
			Chatra	74.284	11-39.6	11-41.3	-1.7
KOON (Ground)	6-4-54 18-20-00.4	Lat. 11 29 48 Long. 165 22 03	Shillong		Record not available		
			Poona		Do.		
			Chatra		Do.		
UNION (Barge)	25-4-54 18-10-00.7	Lat. 11 39 59 Long. 165 23 14	Shillong	70.300	11-16.1	11-17.7	-1.6
			Poona	87.791	12-51.2	12-53.0	-1.8
			Chatra	74.334	Record not available		
YANKEE (Barge)	4-5-54 18-10-00.1	Lat. 11 39 56 Long. 165 23 13	Shillong	70.298	11-15.1	11-17.1	-2.6
			Poona	87.791	12-50.8	12-53.0	-2.2
			Chatra	74.400	11-40.8	11-42.0	-1.2
NECTOR (Barge)	13-5-54 18-20-00.4	Lat. 11 40 14 Long. 162 11 47	Shillong	67.420	10-58.3	10-59.9	-1.6
			Poona	Not recorded or record obscured by strong microseisms			
			Chatra	71.551	11-25.0	11-25.3	-0.3*
ZUNI (Ground)	27-5-56 17-56-00.3	Lat. 11 29 48 Long. 165 22 09	Shillong	70.350	11-16.7	11-18.0	-1.3
			Poona	Not recorded or record obscured by strong microseisms			
			Chatra	74.455	Records not available		
APACHE (Barge)	8-7-56 18-06-00.2	Lat. 11 40 17 Long. 162 12 01	Shillong	67.423	10-57.6	11-00.0	-2.4
			Poona	Not recorded or record obscured by strong microseisms			
			Chatra	71.552	11-24.5	11-25.3	-0.8
NAVAJO (Barge)	10-7-56 17-56-00.3	Lat. 11 39 48 Long. 165 23 14	Shillong	70.302	11-15.5	11-17.7	-2.2
			Poona	Not recorded or record obscured by strong microseisms			
			Chatra	74.400	11-40.6	11-42.0	-1.4
TEWA (Barge)	20-7-56 17-46-00.0	Lat. 11 40 26 Long. 165 20 22	Shillong	70.253	11-15.6	11-17.4	-1.8
			Poona	Not recorded or record obscured by strong microseisms			
			Chatra	74.350	11-40.7	11-41.7	-1.0

\*Rotation of drum not uniform

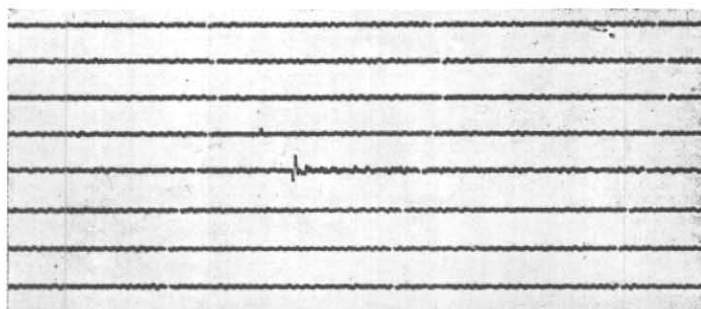


Fig. 1

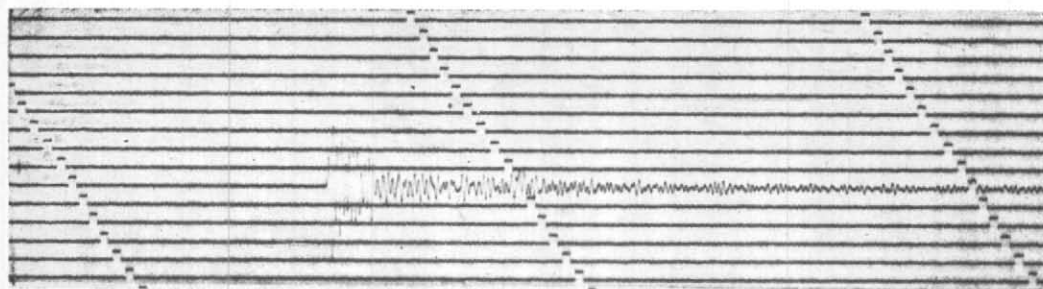


Fig. 2

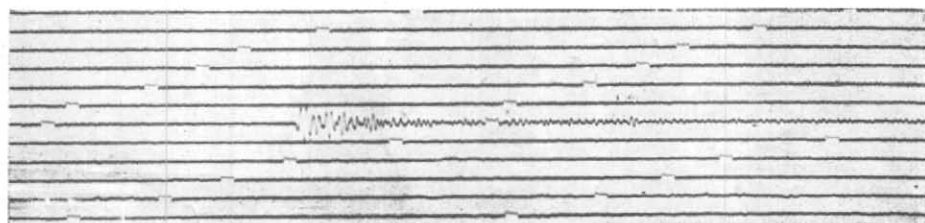


Fig. 3

residuals (observed—calculated travel times) for each station. travel earlier by 2.4 seconds.

It is significant to note that for nearly all the stations and all the shots, the observed times are 0.8 seconds to 3.0 seconds earlier than those given in Jeffreys and Bullen's Tables. For distances of the order of  $70^\circ$  the observed times appear to be on the average 1.6 seconds earlier while for a distance of the order of  $88^\circ$  the observed times are

Records obtained at Poona (for the shot BRAVO), Chatra (for ROMEO) and Shillong (for NAVAJO) are reproduced in Figs. 1, 2 and 3 respectively.

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#### REFERENCE

Jeffreys, H. and Bullen, K. E.

1948

*Seismological Tables*