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DEPARTMENT OF NATIONAL DEVELOPMENT

BUREAU OF MINERAL RESOURCES, GEOLOGY AND GEOPHYSICS

RECORDS 1958 No. 86

SEISMOLOGICAL RESULTS OBTAINED FROM THE SNOWY MOUNTAINS EXPLOSIONS OF DECEMBER 1956 and FEBRUARY 1957

by

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C O N T E N T S

I L L U S T R A T I O N

A B S T R A C T

Provisional interpretation of results from three seismological stations set up by the Bureau of Mineral Resources to record the large explosions in the Snowy Mountains area in December, 1956 and February, 1957, indicates :-

(a) the existence of a granitic layer with a P wave velocity of 5.9 km/sec. and an S wave velocity of 3.55 km/sec.,

(b) that the velocity of P waves below the Mohorovicic discontinuity is 8.0 km/sec., and

(c) the depth to the Mohorovicic discontinuity is at least 35 km.

1. INTRODUCTION

On 23rd December 1956 and 10th February 1957, about 70 tons of explosives were detonated south of Adaminaby, New South Wales, by the Snowy Mountains Hydro-electric Authority. Recordings of seismic waves generated by the explosions were obtained from seismographs operated by the Bureau of Mineral Resources at Melbourne Observatory, the Warragamba dam site in New South Wales, and at a site about 10 miles south-east of Whitfield, Victoria. This report includes a summary of the data obtained and subsequent preliminary interpretation of the data.

Mountainous country, with peaks up to 6,000 feet, surrounds the explosion points and extends to Warragamba and Whitfield and to within 30 miles of Melbourne.

2. RESULTS

Details of the explosion times and positions are given in Table 1 and the station positions in Table 2. Seismic phases, travel times, and the epicentral distance of each station are shown in Table 3.

A Benioff seismograph was in operation at the Melbourne Observatory and records of the two detonations were obtained by the short-period seismographs. The amplitude of the phases was not large, but the magnification could not be increased beyond about 60,000 (at 1 c/s) because of vibrations due to traffic. The timing accuracy of the first recording was considerably less than that for the second, as time checks were not made during the weekend, at the time of the first.

Willmore seismographs were used at the stations at Warragamba and near Whitfield. Magnification of this instrument is about 30,000 at 0.1 c/s.

3. INTERPRETATION OF RESULTS

Interpretation of the records is only tentative, as it is not possible to draw accurate time/distance charts from such limited data. Fig. 1 is a plot of all i (impetus or sharp) phases, and of e (emerso) phases recorded on more than one component.

The results of the two Melbourne records A and B (see Table 3) were combined. There was a discrepancy of 0.3 seconds between the times of the Pn phase on these records; the major part of the discrepancy is attributed to record A, as the time mark accuracy on record B was known to be approximately $\pm$ 0.1 sec.

The Melbourne phases in Fig. 1 are plotted at the mean distance for the two explosions. The travel times are weighted means of the two travel times, and an allowance is made for the small differences in distance. When a phase was recorded for only one explosion, the travel time plotted incorporates a small correction for distance.

An examination of the very limited data suggests that:

(a) The Pg velocity is 5.9 km/sec

(b) The Pn velocity is 8.0 km/sec

(c) The Sg velocity is 3.55 km/sec

(d) The depth to the Mohorovicic discontinuity is probably about 35 km. The discontinuity may be deeper but is unlikely to be very much shallower.

These interpretations may need modification in future - particularly the velocities assumed for the granitic layer, in which wave velocities are probably higher at greater depths.

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4. FUTURE PROGRAMME

Other recordings were made from these explosions by officers of the Snowy Mountains Hydro-electric Authority and the Australian National University. These include recordings at locations near Benambra (epicentral distance about 100 km) and Moss Vale (200 km). Results of these have not yet been published. These could be expected to record the Pg and Pn phases respectively as first arrivals.

If any explosions are planned in the future, it is recommended that the Willmore seismograph should be set up at a point approximately half-way between Melbourne and Whitfield, say near Marysville, at an epicentral distance of about 300 km. This should pick up the Pn phase as a first arrival, and provide data for more accurate estimation of the Pn velocity in the south-west direction.

If a prospecting-type seismograph is available, it should be set up near Mitta Mitta or Benambra in order to record a reflection from the Mohorovicic discontinuity. This reflection should be of large amplitude at such a distance. Alternative stations 10 miles east of Seymour or at Yarra Glen should also provide interesting data and would be more convenient operationally.

TABLE 1 - EXPLOSION TIMES AND POSITIONS

EXPLOSION	LATITUDE	LONGITUDE	TIME (E.S.T.)
A	36° 08' 13"	148° 37' 43"	23rd Dec. 1956 12. 19. 49. 6
B	36° 07' 36"	148° 36' 48"	10th Feb. 1957 13. 00. 54. 5

TABLE 2 - STATION POSITIONS

STATION	LATITUDE	LONGITUDE	RECORDED EXPLOSION
Melbourne Observatory	37° 49' 53"	144° 58' 24"	A and B
Near Whitfield	36° 52.7'	146° 32.6'	B
Warragamba	33° 53' 30"	150° 36' 20"	B

TABLE 3 - SEISMIC PHASES AND TRAVEL TIMES

STATION - Melbourne Observatory

EPICENTRAL DISTANCE - 375.2 km

RECORD A

Phase	Travel Time		
	Vertical	N - S	E - W
	Seconds	Seconds	Seconds
i Pn	55.1		
e	63.7	63.7	
i Pg	64.2		
e			65.0

TABLE 3 (CONT.) - SEISMIC PHASES AND TRAVEL TIMES

Phase	Travel Time		
	Vertical	N - S	E - W
	Seconds	Seconds	Seconds
e	71.0		
e	84.0		
e Sn		95.0	95.8
i Sg	105.0	105.0	104.5
e	106.0		
e			107.0
i		108.0	
e	116.0		

STATION - Melbourne Observatory

EPICENTRAL DISTANCE - 374.7 km

RECORD B

Phase	Travel Time		
	Vertical	N - S	E - W
	Seconds	Seconds	Seconds
i Pn	54.7		
i	55.5		
e Pg	64.4		
e	103.3		
e Sg	104.3		104.3
i		106.8	106.8
e	107.8		108.0
e			109.8
e	111.7		

TABLE 3 (CONT.) - SEISMIC PHASES AND TRAVEL TIMES

STATION - Near Whitfield - Victoria

EPICENTRAL DISTANCE - 203.0 km

Phase	TRAVEL TIME			REMARKS
	Vertical	Transverse Horizontal	Longitudinal Horizontal	
	Seconds	Seconds	Seconds	
e Pn	33.3	33.4	33.4	
i	33.8	33.8		
i (Pg)	34.4	34.4		
e			34.9	
e		35.3		
i	35.7			
e		51.2		

TABLE 3 (CONT.) - SEISMIC PHASES AND TRAVEL TIMES

Phase	TRAVEL TIME			REMARKS
	Vertical	Transverse Horizontal	Longitudinal Horizontal	
	Seconds	Seconds	Seconds	
e		56.2	56.0	Timing accuracy approximately ± 0.2 seconds.
i Sg	57.6	57.6	57.7	
i	59.4	59.4	59.4	

STATION - Warragamba - New South Wales

EPICENTRAL DISTANCE - 307.6 km.

PHASE	Travel Time VERTICAL COMPONENT	REMARKS
e Pn	47.7	Timing accuracy ± 0.3
i	51.1	
i	51.8	
e	82.7	
i Sg	85.1	

FIG. 1

TRAVEL TIME — Seconds

108
104
100
96
92
88
84
80
76
72
68
64
60
56
52
48
44
40
36
32
28
24
20
16
12
8
4

Sg 3·55

Pg 5·88 kms/sec

Pn 8·02 kms/sec

⊙ impulsive phases

⨯ emergent phases recorded on more than one component

SEISMOLOGICAL RESULTS OBTAINED FROM THE SNOWY MOUNTAINS EXPLOSIONS

PROVISIONAL TIME TRAVEL CURVES FOR SOUTH EASTERN VICTORIA

20 40 60 80 100 120 140 160 180 200 220 240 260 280 300 320 340 360 380 400

WHITFIELD

WARRAGAMBA

MELBOURNE

EPICENTRAL DISTANCE — Kilometres

Geophysical Section, Bureau of Mineral Resources, Geology and Geophysics

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