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NEW ENGLAND, NEBINE RIDGE AND MURRUMBIDGEE BATHOLITH CRUSTAL SURVEYS, 1984: OPERATIONAL REPORT

By

R.Bracewell and D.M.Finlayson

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ABSTRACT

This is a record of three refraction profiling surveys undertaken by BMR in 1984, one in the New England Fold Belt, Northern NSW in April, a second over the Nebine Ridge, Queensland in June, and a third along the Murrumbidgee Batholith near Canberra. The aim of the investigations was to delineate crustal structures within the New England Fold Belt and Nebine Ridge, and test drilling and recording techniques near Canberra in hard-rock areas.

The surveys used a total of 17 BMR shots and 4 blasts from Ravensworth coal mine as energy sources to make seismic recordings at 149 sites in the combined surveys. The seismic traverse ran for 300 km north-south in the New England survey, 96 km east-west normal to strike over the Nebine Ridge, and for about 100 km north-south along the Murrumbidgee Batholith.

This record describes the field work and equipment used, and tabulates the station and shot data. No interpretation is given here: the Record is merely a document of the seismic operations to supplement the interpretation reports and for reference.

CONTENTS

TABLES

Table 2c has been omitted from the hardcopy of record 1985/3.

FIGURES

1. INTRODUCTION

In April and June 1984 the BMR undertook deep seismic refraction and wide angle reflection investigations of the crust in the New England Fold Belt and Nebine Ridge regions. They were the first such surveys to be carried out in those areas.

The survey used 16 BMR shots as sources and, in addition, blasts at Ravensworth colliery were used for the New England study. 33 portable field seismographs were deployed along 396 km of traverse. The positions of traverses for both surveys are shown in Fig. 1.

In February-March 1984, prior to the New England Survey, some estimate of BMR's drilling capabilities in hard-rock areas was required. A preliminary survey was therefore conducted on the Murrumbidgee Batholith near Canberra involving one shot.

NEW ENGLAND

This survey is the first deep seismic investigation of the New England Fold Belt and will provide a useful constraint on our understanding of its tectonic development and a comparison of the crustal structure with other regions of the Australian continent. In particular, comparisons with the adjacent Lachlan Fold Belt will be used to investigate trends in crustal growth with time.

Seismic velocities derived for the crust and upper mantle will be used in the interpretation of proposed vertical reflection profiles across the Fold Belt, and for improving the location of earthquakes within the central block.

The survey line shown in Fig. 2 follows, approximately, the New England Highway from near Warwick in the north to Woolbrook in the south. It lies wholly within the Wooloomin-Texas Block (Zone B) and crosses the Permian intrusives of the New England Batholith, Tertiary volcanics including basalt and dolerite around Guyra, Carboniferous sediments around Armidale and back into the New England Batholith around Woolbrook.

NEBINE RIDGE

This survey aims to investigate the deep crustal structure of the Nebine Ridge by correlating wide angle reflection and deep refraction data with the coincident, vertical-reflection profiling obtained by the BMR reflection crew (Fig. 3).

The Nebine Ridge is located between the Eromanga and Surat Basins. The surface expressions of the basement ridge form the Maranoa anticline. Sediments of the Rolling Downs and Injune Creek groups unconformably overlie the basement rock.

MURRUMBIDGEE BATHOLITH

Because of the extensive hard-rock areas in the New England region, it was decided to assess BMR's capacity to drill shot holes in such areas. A test drillhole was put down on Booroomba Station near Tharwa, into the exposed granite of the Murrumbidgee Batholith. It was also decided to record the shot along the length of the Batholith and onto the Berridale Batholith southwest of Cooma (Fig. 4).

2. SEISMIC SURVEY PLANNING AND DESIGN

NEW ENGLAND

Clive Collins of the BMR visited the proposed survey area in December 1983. He returned in February 1984 with Doug Finlayson with the purpose of:

1) Reconnoitring the survey area;

2) Determining shot site positions: owners of suitable sites were contacted and access for the BMR drilling crew was arranged;

3) Determining the suitability of selected sites for seismograph stations.

4) Arranging with Ravensworth open-cut coal mine to deploy a seismograph for monitoring mine blasts. The mine had been used as an energy source in previous surveys and was known to be effective.

The line was 300 km long. For recording purposes it was divided into two equal sections, giving an average station interval of 4.8km with 33 seismographs.

The shots were sited at the northern and southern ends of the line with one in the centre. Two offset sources were used; a BMR shot 100 km north of the line and the Ravensworth open cut coal mine 150 km to the south. This configuration of sources and receivers provided a reversed 400 km traverse with intermediate shots providing shorter-range upper crustal data (Fig. 2).

NEBINE RIDGE

The survey was planned to coincide with the 1984 BMR reflection survey from Charleville to Toowoomba. The shot holes were drilled and loaded by the reflection drilling crew as they traversed the survey area. The same survey line and station pegs were used as for the reflection survey.

The seismic traverse crosses normal to the strike of the Nebine Ridge. The spatial layout of recorders and shots was designed to facilitate wide angle reflection and deep refraction investigations over approximately 75 km of subsurface (Fig. 3).

The survey was also designed to tie in with the vertical reflection and expanded spread reflection investigations undertaken by the reflection crew. The expanded spread was centred about peg 2333.

MURRUMBIDGEE BATHOLITH

The shot on Booroomba Station was on the Murrumbidgee Batholith. Recording was conducted southward along the Batholith and onto the Berridale Batholith. The survey objective was to determine structure in the batholith in a reconnaissance experiment. Three of the recording stations were set up as 3-component stations to establish more clearly the S-wave structure.

3. SEISMIC RECORDING OPERATIONS

NEW ENGLAND

(See Table 1a for recording station data).

There were 4 survey personnel, each with 8 or 9 recorders plus a shot timing unit. The line was divided into northern and southern sections, each section taking about 5 days to complete. Each person had to deploy his seismographs after obtaining permission from the land owner. The sites were located within 1 km diameter areas as indicated on a 1:100000 topographic map. Land use in the survey area is mainly for sheep grazing, fodder crops and fruit growing. Consequently, access and communications were good though they deteriorated as the line passed through areas of high relief with deep valleys in the north.

63 sites were occupied by portable field seismographs programmed to operate from 0700 to 1800 each day. Three Tandberg and one Akai recorders failed to operate satisfactorily. The tape transport failures (see comments in Table 1a) were mainly due to damp weather. Moisture on the stationary tape overnight caused it to stick to the rubber idler wheel. On start up at 0700 hr the tape would wrap round the idler instead of being taken up by the spool. Other failures were either electronic in nature or due to low battery voltage.

During deployment of the northern section of the line the weather deteriorated; rain and wind persisted for a few days. This held up operations as wind-generated microseismic noise was unacceptably high.

NEBINE RIDGE

(See Table 1b for recording station data).

Land use in the survey area is for sheep and cattle grazing. The terrain is flat and covered with medium to dense forest. The survey line ran east-west, approximately 70 km south and parallel to the Warrego Highway. As it ran mainly along existing fence lines access was good. Unfortunately heavy rain in the second week reversed this situation and delayed survey completion by one week. The situation was aggravated by only one vehicle having a winch.

Mitchell served as survey base camp, although, during continuous operation, survey personnel set up camp along their designated section of the line. 65 sites were occupied by recorders throughout the survey. The line was divided into 2 sections:

A -- Peg 2333 to 2909 (inclusive).
B -- Peg 1757 to 2333 (inclusive).

33 sets occupied each section giving a recorder interval of 1.5 km or 18 pegs. Each section was 48 km long (Fig. 3).

After deployment of seismographs in the first section heavy rain fell for a day effectively cutting off access to the sets. After a few days spent locating shots it was dry enough to drive in and switch the sets on. The first 6 shots were fired the next day.

The deployment of sets and shot firing along the second section went according to plan. Only offset sources at 144 km and 96 km were fired into this section.

NEBINE RIDGE DFS-4 RECORDING OF WIDE-ANGLE SHOTS.

It was arranged for the BMR reflection crew to record the shots of the first spread on their DFS 4 recording system. Their spread was located between pegs 3577 and 3624. The shot firer sent a radio message to the observer giving him the proposed firing time plus a suitable start up delay appropriate to the distance between the shot and recording spread.

NEBINE RIDGE EXPANDING SPREAD EXPERIMENT

(See Table 1c for recording station data)

Eight seismographs were deployed to record the shots of the Nebine Ridge expanding spread and the production shots for the CDP profiling over the same time period (15 - 23 May). The purpose of the experiment was twofold: firstly to compare records of the expanding spread shots on refraction instruments with those recorded on the DFS-4 using the arrays of geophones routinely deployed for the CDP profiling; secondly to obtain supplementary information about the underlying structure using recordings of the production shots on the refraction seismographs.

The refraction recorders were deployed at locations 2183,2195,2206,2218,2229, 2241,2252 and 2264 (1 km apart) to record the expanding spread shots to the east of the mid-point of the expanding spread (location 2333). The refraction equipment was then deployed at pegs 2402,2414,2425,2437,2448,2460,2471 and 2483 to record the expanding spread shots at the mid-point and to the west of the mid-point. About 75 of the production shots and all of the 19 shots of the expanding spread were recorded at the two separate deployments of the refraction instruments.

In a second experiment seven refraction seismographs were deployed at five locations, separated by 1 km over a period two weeks (30 May to 13 June). At two locations (3154 and 3178) two recorders were deployed ; one used a vertical component seismometer and the other an array of 16 vertical component geophones. There were two objectives of this experiment. The first was to compare records on the usual refraction equipment with those obtained on the refraction recorders attached to the geophone array configuration normally used in CDP profiling. The second objective was to determine the distance range over which the CDP production shots could be recorded.

MURRUMBIDGEE BATHOLITH CRUSTAL SURVEY

(See Table 1d for recording station data).

Recording stations were established at approximately 5 km intervals southward from the shot on Booroomba Station (Fig. 4). 21 sites were set up, three of them with 3 seismometers set up in a 3-component configuration (vertical, horizontal along the axis of recording, horizontal across the axis of recording).

4. RECORDING EQUIPMENT

Four types of equipment were used (Table 3);

1) 6 - Precision Instrument 4 channel (PI) FM tape recorders;
2) 15 - Akai, 4 channel FM tape recorders;
3) 12 - Tandberg 4 channel FM tape tape recorders;
4) Shot timing equipment consisting of a BMR seismic amplifier (TAM 5), Hellige Heloscripter He 16 chart recorder and a Labtronics radio receiver to provide VNG time signals.

Details of the deployment of recorders are contained in Tables 1a,b,c,d. The BMR FM tape recorders are described by Finlayson & Collins (1980).

5. SHOTS

NEW ENGLAND

(See Table 2a for New England shot data)

BMR crews drilled the shots, 2 each at Warwick, Deepwater and Woolbrook and an offset shot at Oakey, 100 km to the north of Warwick. The details of these shots are given in Table 2a. The offset source was received by the first deployment of recorders. Each deployment received shots from Warwick, Deepwater and Woolbrook. Useful blasts were also detected from Ravensworth during the first and second deployments.

BMR shots were drilled in patterns with a minimum distance of 10m between holes and 100 m between shots. Holes were drilled to depths of 40 to 60 m and loaded with up to 150 kg of explosive, ensuring that not less than 15 m of stemming remained above the charge.

The Ravensworth open cut colliery owned by Costain Australia Ltd, regularly blasts sandstone, shale, and conglomerate overburden and coal. This energy source was known to be useful for seismic recording from the 1980 BMR Lachlan Fold Belt study (Finlayson and others, 1980). Up to 120 tonnes of explosive are used in blasting mainly during the 11.30-12 noon lunch break and at the end of the day shift at 4.30 pm.

An Akai recorder was located at the mine site to monitor mine blasts. Surface velocities could be estimated from previous surveys so it was not necessary to time any blasts with the portable shot timing equipment. The mine monitor was disturbed during the first week by kangaroos. The seismometer was uprooted and seismic cable severed in places. However, recording was restored just prior to the shots on 5 April.

The motor of the mine monitor (set 11) was not operating correctly. Consequently, good records are not available. The records used to determine times were severely distorted and times may not be accurate. Hence other shots from the Hunter Valley that were recorded at Cooney Observatory have also been listed in Table 2a. These may be of use when it comes to interpreting data because in many cases the recordings are better than those known to have been fired at Ravensworth.

NEBINE RIDGE

(See Table 2b for Nebine Ridge shot information).

The sources at pegs 1757, 2909, 2333, 3053, 3341 and 3197 were shot into the first spread of recorders (pegs 2333 to 2909) . Shots at 3509 and 4061 were recorded by receivers between pegs 1757 and 2333 during the second deployment. The subsurface coverage this gives is shown in Fig 3. Shot holes were drilled in patterns with a minimum of 10 m between holes and 30 m between shots at the same peg.

MURRUMBIDGEE BATHOLITH

Various attempts were made to drill shot holes directly into the Murrumbidgee Batholith exposed at the surface on Booroomba Station near Tharwa. A BMR Mayhew 1000 drilling rig was used, fitted with an air hammer and button bits. After several attempts over a few days the experiment was abandoned. It became obvious that with drilling rates of about 5 m per day any attempt to drill shot holes was going to take a long time and be prohibitively expensive.

Eventually a shothole was drilled in river gravel and alluvium next to the granite outcrop. The shot data are as follows:

Latitude; 35 deg 28.88 min south, Longitude 149 deg 00.50 min east,
Hole depth; 32 m Charge size; 100 kg Elevation; 730 m
Shot time; 14 h 40 m 33.38 s EST on 2 March.

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6. SURVEYING

NEW ENGLAND

It was a simple task to pin-point station sites onto 1:100 000 topographic maps and scale the latitudes and longitudes off these back in Canberra. The co-ordinates had an estimated accuracy better than 100m.

NEBINE RIDGE
The line had previously been surveyed for the BMR reflection crew and all pegs were left intact. The peg interval was 83.333 metre. Latitudes and longitudes were determined from this detailed survey work.

MURRUMBIDGEE BATHOLITH

The same surveying procedures were followed as for the New England survey described above.

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TABLE 1a

NEW ENGLAND CRUSTAL SURVEY 1984, RECORDING STATION DATA.

Station No.	Set No.	Latitude deg min	Longitude deg min	Elev m	Time on d h m	Time off d h m	Gain db	
01	12	28 17.20	151 57.50	510	09 12 56	11 12 36	90	
02	05	28 20.33	151 55.90	600	09 12 28	11 11 52	90	
03	27	28 24.83	151 56.40	810	09 11 45	11 11 08	90	
04	13	28 27.50	151 54.79	820	09 10 47	11 10 33	90	
05	17	28 30.22	151 56.05	920	09 10 17	22 09 58	90	Day 22 should read 11
06	06	28 33.20	151 55.74	920	09 09 48	11 09 25	90	VNG failure for small period before 11 09 25
07	33	28 35.92	151 56.03	920	09 09 20	11 08 37	90	Radio and clock channel noisy.
08	26	28 38.10	151 56.33	840	09 08 40	11 08 12	90	
09	30	28 40.92	151 56.60	840	08 10 30	11 13 16	90	Radio interference on seismic channel.
10	19	28 43.38	151 55.76	810	08 11 55	11 12 27	90	
11	14	28 47.31	151 55.68	980	08 14 05	11 11 40	90	Motor oscillating : not digitized.
12	02	28 49.43	151 57.28	880	08 15 55	11 10 50	90	Noisy recorder : not digitized.
13	24	28 50.86	151 55.01	890	08 17 04	11 10 17	90	Tape transport failure.
14	25	28 53.82	151 57.02	920	07 15 07	11 09 32	90	Clock poor. High frequency noise in places.
15	01	28 58.00	151 55.58	830	07 14 07	11 08 49	90	
16	18	29 01.13	151 55.98	825	07 12 37	11 08 07	90	
17	23	29 03.22	151 55.10	930	08 10 01	11 08 04	90	Radio interference on seismic channel.
18	21	29 05.49	151 55.72	1040	08 11 30	11 10 00	90	
19	04	29 09.50	151 54.78	910	08 12 43	11 09 25	90	Noisy site. VNG fault at 11 09 15.
20	20	29 12.06	151 52.92	520	08 15 02	11 11 20	90	
21	15	29 13.17	151 54.77	540	08 07 00	11 13 58	90	
22	32	29 17.70	151 54.30	790	08 07 00	11 12 59	90	
23	03	29 19.60	151 54.98	960	07 10 48	11 14 46	90	10 minutes slow (i.e. reading 11 14 50
24	22	29 22.79	151 54.22	950	08 07 00	11 15 36	90	at 11 15 00).
25	29	29 23.97	151 53.13	960	09 14 10	11 12 45	90	
26	09	29 27.88	151 54.48	990	09 13 12	11 11 35	90	Tape transport inoperative at pick up. On day 10 recorder switches on at 10 16 25.
27	28	29 30.22	151 52.31	1030	09 12 35	11 11 00	90	
28	08	29 32.90	151 51.85	1110	09 12 40	11 10 30	90	Motor oscillating during shots 07 and 08.
29	16	29 36.00	151 51.93	1020	09 11 40	11 09 55	90	

TABLE 1a (continued)

Station No.	Set No.	Latitude deg min	Longitude deg min	Elev m	Time on d h m	Time off d h m	Gain db	
30	07	29 39.42	151 53.89	1190	09 10 30	11 09 16	90	No VNG at 11 09 16
31	05	29 41.21	151 51.48	1090	09 08 22	11 08 40	90	
31	10	29 41.21	151 51.48	1090	04 14 18	06 07 53	90	
32	13	29 43.12	151 50.60	1020	04 12 56	06 08 26	90	
33	12	29 45.68	151 49.81	1070	04 11 15	06 08 57	90	
34	26	29 48.15	151 48.44	1120	04 09 49	06 09 37	90	Tape transport fault.
35	17	29 51.38	151 48.20	1180	04 08 08	06 10 10	90	
36	33	29 54.43	151 45.08	1150	03 16 46	06 11 01	90	Motor oscillating during shots 02,03,04 and 05
37	06	29 56.80	151 44.12	1160	03 14 56	06 11 33	90	
38	27	29 59.90	151 43.52	1370	03 13 45	06 12 13	90	
39	18	30 01.89	151 43.51	1330	04 13 32	08 23 13	90	2 days 10 hours fast.Therefore only shot 1 is within the recording period.
40	01	30 03.88	151 42.79	1360	04 14 40	06 13 53	90	
41	25	30 07.33	151 41.50	1290	04 11 18	06 12 17	90	
42	14	30 09.36	151 40.24	1310	04 09 43	06 11 36	90	
43	30	30 12.05	151 38.82	1310	03 17 54	06 10 55	90	
44	02	30 14.28	151 38.31	1320	03 16 36	06 10 19	90	
45	24	30 16.69	151 37.36	1300	03 14 53	06 09 21	90	Machine failure.
46	19	30 20.16	151 36.90	1290	03 13 22	06 08 24	90	
47	20	30 22.92	151 35.25	1260	04 15 50	06 08 25	90	
48	31	30 24.86	151 34.04	1152	04 14 26	06 09 50	90	
49	21	30 26.93	151 35.58	1160	04 13 15	06 10 32	90	
50	04	30 29.73	151 32.37	1090	04 12 01	06 12 15	90	Reading 1 hour fast,i.e. 04 12 01 is 04 11 01
51	23	30 32.30	151 30.60	1020	04 09 12	06 12 20	90	Machine failure. Oscillating motor.
52	15	30 35.58	151 30.48	1050	03 16 38	06 13 05	90	
53	32	30 36.92	151 29.21	1040	03 15 13	06 13 33	90	
54	03	30 40.32	151 28.27	1040	03 13 28	06 14 27	90	Running 10 minutes slow
55	22	30 43.28	151 27.51	1040	03 12 25	06 15 03	90	Low channel noisy.
56	07	30 45.71	151 26.46	1060	04 09 35	06 07 58	90	
57	29	30 48.38	151 25.18	1080	04 10 48	06 08 38	90	

TABLE 1a (continued)

Station No.	Set No.	Latitude deg min	Longitude deg min	Elev m	Time on d h m	Time off d h m	Gain db	
58	08	30 51.15	151 25.37	1090	04 12 20	06 09 25	90	
59	16	30 53.14	151 24.42	1040	03 16 40	06 10 00	90	
60	10	30 55.80	151 23.22	1090	03 15 25	06 10 34	90	
61	28	30 57.36	151 23.72	1000	03 13 00	05 17 16	90	
62	09	30 59.82	151 23.38	930	03 11 45	05 16 49	90	Tape transport inoperative at pick up.
63	11	32 26.06	151 02.23	124	02 17 25	05 11 00	90	Seismometer uprooted 05 11 00,cable severed.
63	11	32 26.06	151 02.23	124	05 11 53	12 09 26	90	Ravensworth mine monitor.

TABLE 1b

NEBINE RIDGE CRUSTAL SURVEY 1984 , RECORDING STATION DATA

Peg No.	Stn. No.	Set No.	Latitude deg min	Longitude deg min	Time on d h m	Time off d h m	Gain db	
1757	01	33	26 50.32	146 26.06	26 08 53	27 11 18	96	
1775	02	17	26 50.34	146 26.97	26 09 24	27 10 52	96	
1793	03	12	26 50.43	146 27.86	26 09 42	27 10 35	96	
1811	04	13	26 50.56	146 28.75	26 09 53	27 10 20	96	
1829	05	27	26 50.69	146 29.65	26 10 03	27 10 05	96	
1847	06	06	26 50.81	146 30.55	26 10 14	27 09 50	96	
1865	07	26	26 50.94	146 31.44	26 10 26	27 09 36	96	
1883	08	05	26 51.07	146 32.33	26 10 33	27 09 23	96	
1901	09	19	26 51.20	146 33.23	26 12 54	27 09 07	96	
1919	10	01	26 51.39	146 34.10	26 12 22	27 08 38	96	
1937	11	30	26 51.48	146 35.00	26 11 39	27 11 28	96	
1955	12	02	26 51.57	146 35.90	26 11 13	27 11 10	96	Tape tangled around capstan.
1973	13	25	26 51.67	146 36.80	26 10 40	27 10 41	96	
1991	14	14	26 51.76	146 37.70	26 10 12	27 10 25	96	
2009	15	24	26 51.85	146 38.60				
2027	16	18	26 51.94	146 39.50	26 09 15	27 09 45	96	
2045	17	09	26 52.03	146 40.40	26 08 51	27 08 27	96	
2063	18	29	26 52.26	146 41.26	26 09 19	27 08 43	96	
2081	19	10	26 52.60	146 42.08	26 09 46	27 09 00	96	
2099	20	08	26 52.93	146 42.91	26 10 14	27 09 30	96	
2117	21	28	26 53.27	146 43.73	26 10 42	27 09 50	96	
2135	22	07	26 53.60	146 44.56	26 11 18	27 10 39	96	
2153	23	16	26 53.93	146 45.39	26 11 44	27 10 56	96	
2171	24	11	26 54.26	146 46.22	26 12 30	27 11 27	96	
2189	25	15	26 54.45	146 47.09	25 14 07	27 08 43	96	
2207	26	04	26 54.57	146 47.99	25 13 27	27 09 08	96	
2225	27	31	26 54.69	146 48.88	25 12 39	27 09 26	96	
2243	28	23	26 54.82	146 49.78	26 08 30	27 09 42	96	
2261	29	20	26 54.93	146 50.68	26 08 22	27 09 54	96	
2279	30	21	26 55.05	146 51.57	26 08 14	27 10 17	96	

TABLE 1b (continued)

Peg No.	Stn. No.	Set No.	Latitude deg min	Longitude deg min	Time on d h m	Time off d h m	Gain db	
2297	31	22	26 55.16	146 52.47	25 14 50	27 10 38	96	
2315	32	32	26 55.28	146 53.37	25 15 17	27 10 52	96	
2333	33	03	26 55.32	146 54.27	25 15 30	27 11 12	96	for shots 8 & 9.
2333	34	03	26 55.32	146 54.27	21 14 22	24 12 06	96	for shots 1 - 7.
2351	35	21	26 55.40	146 55.17	21 13 30	25 09 55	96	12v supply low at pick up.
2369	36	20	26 55.49	146 56.07	21 13 10	25 06 28	96	Clock is 3 hour slow.
2387	37	22	26 55.58	146 56.97	21 11 35	24 16 30	96	
2405	38	32	26 55.68	146 57.87	21 10 43	24 16 15	96	
2423	39	04	26 55.77	146 58.77	21 10 18	24 15 48	96	
2441	40	31	26 55.87	146 59.67	21 09 59	24 15 23	96	
2459	41	23	26 55.96	147 00.57	21 09 43	24 15 03	96	
2477	42	15	26 56.01	147 01.48	21 08 34	24 14 02	96	
2495	43	16	26 56.10	147 02.37	21 08 33	25 09 59	96	
2513	44	11	26 56.19	147 03.27	21 08 42	25 10 20	96	
2531	45	07	26 56.23	147 04.17	21 09 10	25 10 59	96	
2549	46	28	26 56.30	147 05.07	21 09 30	25 11 51	96	
2567	47	08	26 56.40	147 05.97	21 09 47	25 12 15	96	
2585	48	10	26 56.50	147 06.87	21 10 10	25 12 37	96	
2603	49	29	26 56.60	147 07.77	21 10 42	25 13 24	96	
2621	50	09	26 56.65	147 08.67	21 11 16	25 13 47	96	
2639	51	18	26 56.70	147 09.58	22 12 34	25 15 39	96	
2657	52	02	26 56.75	147 10.48	22 12 23	25 15 12	96	
2675	53	30	26 56.80	147 11.39	22 12 39	25 14 43	96	
2693	54	24	26 56.86	147 12.29	22 13 16	25 13 58	96	
2711	55	14	26 56.91	147 13.20	22 13 54	25 13 17	96	
2729	56	25	26 56.95	147 14.10	22 15 30	25 12 51	96	Seismometer disturbed by cattle.
2747	57	01	26 57.01	147 15.01	22 14 13	25 12 25	96	
2765	58	19	26 57.05	147 15.91	22 14 22	25 11 24	96	
2783	59	33	26 56.83	147 16.78	22 14 43	25 11 57	96	Seismometer cable chewed;aerial disturbed.
2801	60	26	26 56.62	147 17.65	21 11 12	25 08 46	96	One minute fast.

TABLE 1b (continued)

Peg No.	Stn. No.	Set No.	Latitude deg min	Longitude deg min	Time on d h m	Time off d h m	Gain db	
2819	61	12	26 56.65	147 18.56	21 11 21	25 09 10	96	
2837	62	27	26 56.81	147 19.44	21 11 48	25 09 34	96	
2855	63	13	26 57.00	147 20.32	21 12 10	25 10 00	96	
2873	64	06	26 57.08	147 21.22	21 12 32	25 10 20	96	One minute fast
2891	65	05	26 57.16	147 22.13	21 12 36	25 10 38	96	
2909	66	17	26 57.24	147 23.03	21 14 47	24 15 52	96	
DFS-4 seismic spread (48 channels)								
3577			26 58.58	147 56.52	western-most channel			
3624			26 58.83	147 58.87	eastern-most channel			

TABLE 1c

NEBINE RIDGE EXPANDING SPREAD EXPERIMENT, RECORDING STATION DATA.

Peg No.	Stn. No.	Set No.	Latitude deg min	Longitude deg min	Time on d h m	Time off d h m	Gain db	
2183	01	18	26 54.42	146 46.90	15 10 00	17 18 10	96	
2195	02	14	26 54.49	146 47.39	15 10 41	17 17 54	96	
2206	03	24	26 54.56	146 47.94	15 11 19	17 17 36	96	
2218	04	02	26 54.65	146 48.54	15 12 33	17 17 14	96	
2229	05	25	26 54.72	146 49.08	15 13 08	17 16 57	96	
2241	06	01	26 54.80	146 49.68	15 13 44	17 16 37	96	
2252	07	30	26 54.87	146 50.23	15 14 50	17 16 12	96	
2264	08	19	26 54.95	146 50.83	15 15 35	17 15 46	96	17 15 46 reading 28 16 46 at pick up.
2402	09	18	26 55.66	146 57.72	20 11 15	23 13 08	96	
2414	10	14	26 55.72	146 58.32	20 11 58	23 12 41	96	
2425	11	24	26 55.78	146 58.87	20 12 49	23 12 19	96	
2437	12	02	26 55.85	146 59.47	20 13 29	23 11 56	96	
2448	13	25	26 55.90	147 00.02	20 14 40	23 11 35	96	Geophone string run over by drilling rig.
2460	14	01	26 55.97	147 00.62	20 15 13	23 10 01	96	Tape wrapped around capstan.
2471	15	30	26 56.00	147 01.17	20 15 55	23 10 24	96	
2483	16	19	26 56.04	147 01.78	20 16 42	23 10 52	96	
3130	17	01	26 57.82	147 34.11	30 13 49	32 08 09	96	Rigs drilling nearby.
"	"	"	"	"	35 13 34	39 18 40	96	
"	"	"	"	"	40 08 10	40 18 01	96	
"	"	"	"	"	44 07 52	44 16 21	96	
3142	18	24	26 57.83	147 34.72	30 12 01	32 08 27	96	
"	"	"	"	"	36 09 24	39 18 30	96	
"	"	"	"	"	40 08 23	40 17 51	96	
"			"	"	44 08 06	44 16 32	96	
3142	18	25	26 57.83	147 34.72	30 12 05	32 08 24	96	
"	"	"	"	"	36 09 37	39 18 34	96	
"	"	"	"	"	40 17 53	40 17 53	96	
"	"	"	"	"	44 08 11	44 16 34	96	
3154	19	19	26 57.84	147 35.32	30 10 45	32 08 40	96	

TABLE 1c (continued)

Peg No.	Stn. No.	Set No.	Latitude deg min	Longitude deg min	Time on d h m	Time off d h m	Gain db
"	"	"	"	"	35 14 13	39 18 21	96
"	"	"	"	"	40 08 43	40 17 41	96
"	"	"	"	"	44 08 23	44 16 44	96
3166	20	02	26 57.83	147 35.93	30 16 00	32 08 55	96
"	"	"	"	"	35 14 39	39 18 02	96
"	"	"	"	"	40 09 01	40 17 26	96
"	"	"	"	"	44 08 49	44 17 06	96
3166	20	14	26 57.83	147 35.93	30 15 56	32 08 58	96
"	"	"	"	"	35 14 33	39 18 00	96
"	"	"	"	"	40 09 06	40 17 24	96
"	"	"	"	"	44 08 45	44 17 05	96
3178	21	30	26 57.79	147 36.53	30 16 38	32 09 06	96
"	"	"	"	"	32 09 06	35 14 50	96
"	"	"	"	"	35 14 50	39 17 30	96
"	"	"	"	"	40 09 20	40 17 16	96
"	"	"	"	"	44 09 04	44 17 16	96

TABLE 1d

MURRUMBIDGEE BATHOLITH SURVEY, RECORDING STATION DATA

Statn. No	Set No	Latitude deg mins	Longitude deg mins	Elev m	Time on d h m	Time off d h m	Gain db	Comments
1	29	35 32.98	149 02.54	1383	30 13 02	31 15 57	90	
2	33	35 34.60	149 01.57	680	31 11 19	31 16 32	90	
3	20	35 37.45	149 00.90	940	01 13 29	02 16 41	90	North- South component.
3	18	"	"	940	01 13 51	02 16 42	90	East-West component.
3	07	"	"	940	29 14 51	31 17 04	90	Vertical component.
4	09	35 40.03	148 59.08	920	29 15 52		90	No tape drive.
5	19	35 42.12	148 59.72	920	01 15 55	02 14 46	?	East-West component.Seismometer replaced.
5	16	"	"	920	01 16 24	02 14 44	96	North-South component.
5	02	"	"	920	29 16 25	31 15 08	96	Vertical Component.
6	11	35 43.96	148 58.89	1000	30 17 26	31 17 41	96	
7	12	35 47.35	148 57.70	1130	30 14 13	31 15 39	96	East-West component.
7	06	"	"	1130	30 14 56	31 15 51	96	North-South component.
7	01	"	"	1130	30 14 41	31 15 48	96	Vertical component.
8	15	35 49.77	148 57.39	1150	30 16 01	31 16 53	96	
9	25	35 51.99	148 54.17	1200	29 15 45	31 17 20	96	
10	28	35 54.18	148 53.63	1587	29 14 00	31 16 17	96	
11	30	35 57.92	148 54.10	1000	29 17 20	31 18 09	96	
12	23	36 01.93	148 53.67	1060	29 16 37	34 12 25	84	
13	26	36 04.17	148 53.05	1150	29 15 21	34 12 53	84	
14	05	36 06.62	148 54.28	1160	29 13 54	34 13 21	96	
15	27	36 08.13	148 53.00	1200				
16	24	36 11.00	148 51.22	1230	29 10 47	34 14 18	84	
17	03	36 13.65	148 49.56	1160	29 16 41	34?	96	Disturbed by cattle.
18	04	36 16.36	148 48.18	1040	29 15 43	34 10 51	96	Tape ran out.
19	14	36 18.35	148 50.36	920	29 13 52	34 11 17	96	Tape ran out.
20	13	36 20.53	148 51.39	880	29 12 49	34 12 22	96	
21	10	36 23.44	148 51.05	900	29 10 30	34 11 47	96	Tape ran out.

TABLE 2a

NEW ENGLAND CRUSTAL SURVEY 1984, SHOT INFORMATION

Shot No.	Location	Time d h m s	Size t	Latitude deg min	Longitude deg min	Elevation m
01	Woolbrook	04 16 14 33.10	1.0	30 59.80	151 23.38	930
02	Deepwater	05 09 40 02.54	0.53	29 27.87	151 54.50	990
03	Oakey	05 10 00 10.21	2.7	27 23.02	151 43.68	400
04	Ravensworth	05 11 52 46.88	32.4	32 26.39	151 02.55	124
05	Ravensworth	05 11 53 17.59	44.3	32 26.69	151 02.64	124
06	Warwick	05 16 11 10.15	2.23	28 17.25	151 57.79	520
07	Ravensworth	10 11 37 03.46	18.9	32 26.39	151 02.64	124
08	Ravensworth	10 13 20 52.65	28.2	32 26.70	151 02.60	124
09	Woolbrook	10 16 46 34.32	1.82	30 59.80	151 23.38	930
10	Warwick	10 17 05 10.11	1.0	28 17.25	151 57.79	520
11	Deepwater	10 17 11 06.67	0.53	29 27.87	151 54.50	990

	Time at set 11 d h m s	Time at Cooney(C) h m s	C-11 s	S-P(Cooney) s
04 Ravensworth	05 11 52 47.00	small shot	-	-
05 Ravensworth	05 11 53 17.82	11 53 50.0	32.18	
12 Hunter Valley	05 12 29 16.96	12 29 48.4	31.44	27.0
13 Hunter Valley	05 13 01 01.88	13 01 36.2	34.32	27.5
14 Hunter Valley	05 13 11 39.76	13 12 10.4	30.64	27.5
15 Hunter Valley	10 11 09 52.12?	11 10 27.2	35.08	30.2?
16 Hunter Valley	10 11 33 30.50	11 34 04.0	33.5	27.8
07 Ravensworth	10 11 37 03.64	Poorly recorded		
17 Hunter Valley	10 12 59 18.78	12 59 52.0	33.22	27.8
08 Ravensworth	10 13 20 52.90	13 21 28.0	35.10	28.2

Note: In the lower part of the Table there are listed the times of all Ravensworth and Hunter Valley shots recorded at Cooney Observatory. The exact location of the Hunter Valley shots is not known but the data are included in case they may be useful at a later stage.

TABLE 2b

NEBINE RIDGE CRUSTAL SURVEY 1984, SHOT INFORMATION

Shot No.	Location (Peg No.)	Time d h m s	Size kg	Latitude deg min	Longitude deg min
01	1757	22 15 55 09.78	400	26 50.32	146 26.06
02	2909	23 10 00 10.07	150	26 57.24	147 23.03
03	2333	23 10 20 10.14	150	26 55.32	146 54.27
04	3053	23 15 30 10.07	150	26 57.82	147 30.25
05	3341	23 16 45 09.69	300	26 57.53	147 44.72
06	3197	23 17 00 10.10	300	26 57.70	147 37.48
07	3509	23 17 30 10.29	400	26 58.23	147 53.12
08	3509	26 13 08 09.59	700	26 58.23	147 53.12
09	4061	26 16 42 10.15	1000	26 58.88	148 20.66

TABLE 3

RECORDING EQUIPMENT, NEW ENGLAND AND NEBINE RIDGE CRUSTAL SURVEYS 1984.

Set Nos	Recorder Type	Seismometer Type	Amplifier Type	Clock	Polarity (see Note)
1 to 9	Akai	Willmore Mk.III	TAM 5	NCE 3	Mass down Signal down
10 to 15	"	Willmore Mk.II	TAM 5	NCE 3	"
16 to 21	Precision Instrument	Willmore Mk.II	TAM 5	NCE 3	"
22 to 27	Tandberg	Willmore Mk.II	Geotech	NCE 3	"
28 to 33	Tandberg	SIE 2 Hz (New England Survey)	Geotech	NCE 3	"
" "		Willmore Mk.III (Nebine Ridge Survey)			

Note: 1) Mass down applies for an impusive P-wave arrival.
2) Signal down refers to the trace played back from tape through the Siemens analogue recorder.

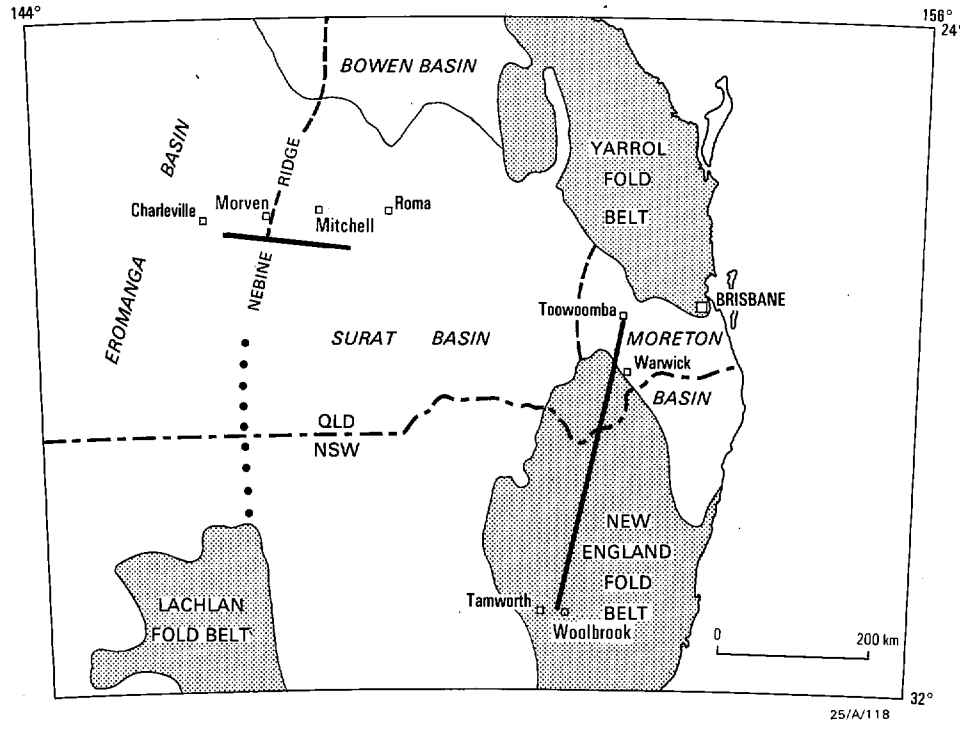

Fig.1 Recording traverses, Nebine Ridge/New England region

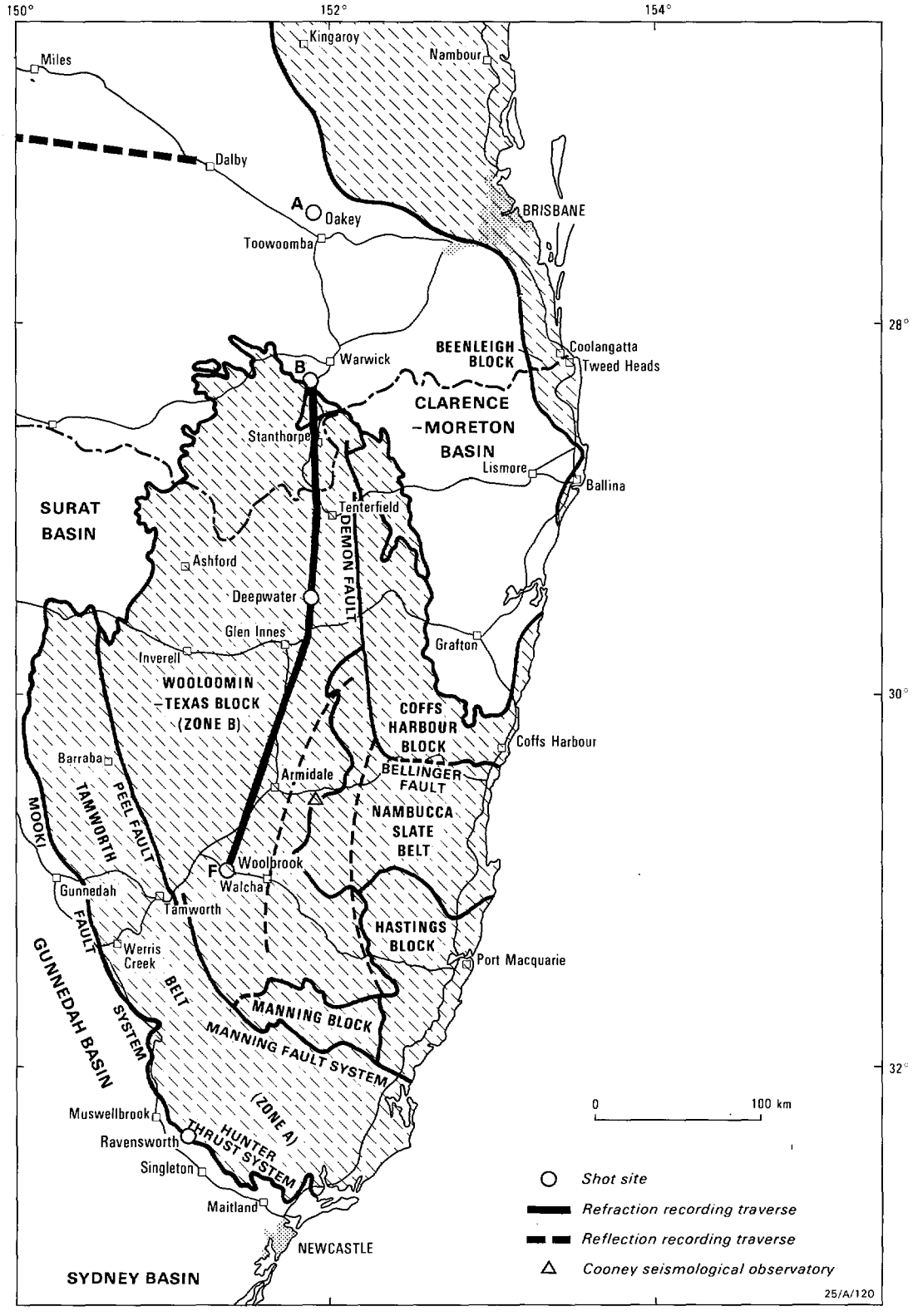

Fig. 2 Geology and survey design, New England

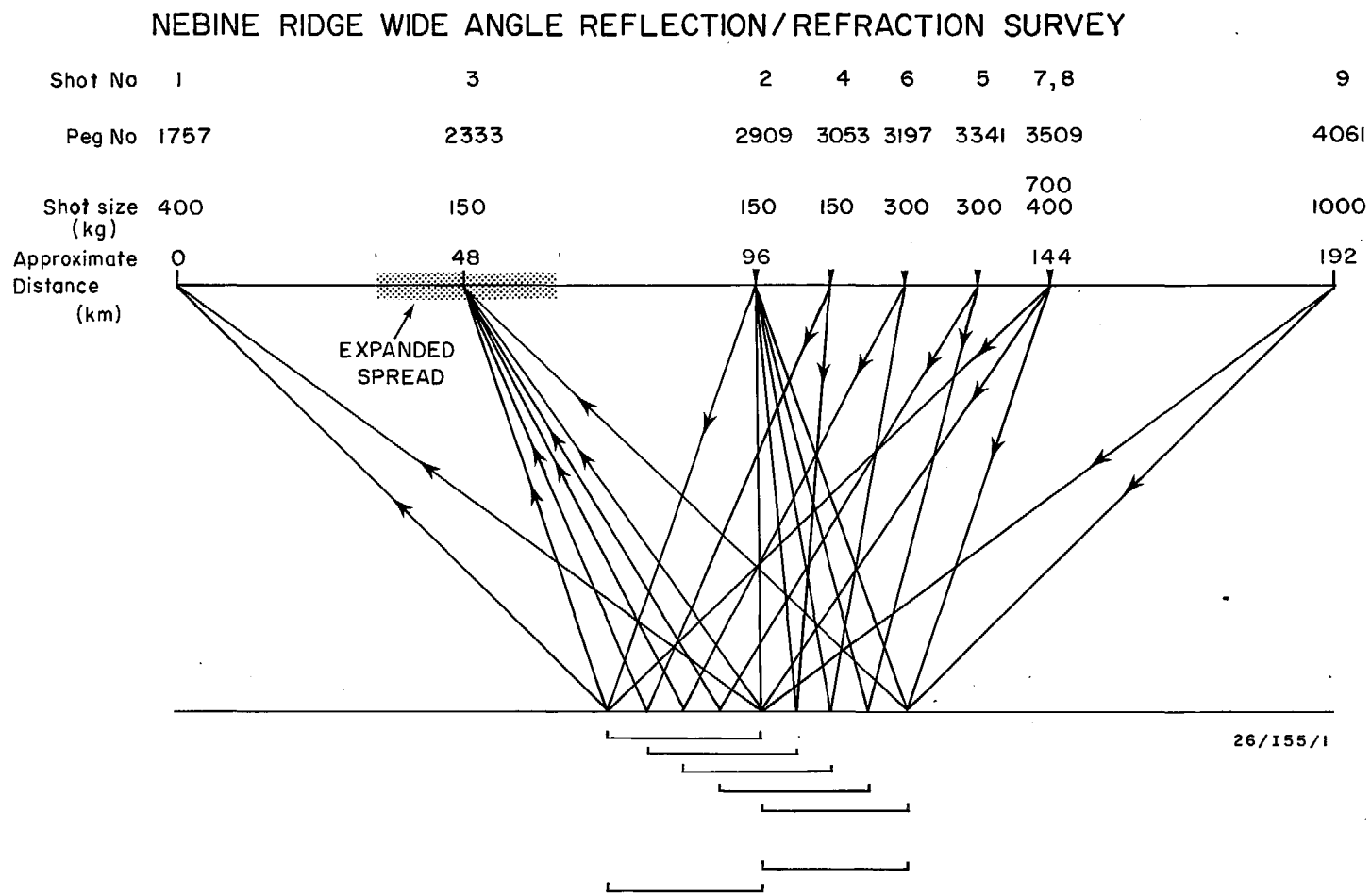

Fig.3 Nebine Ridge ray path design

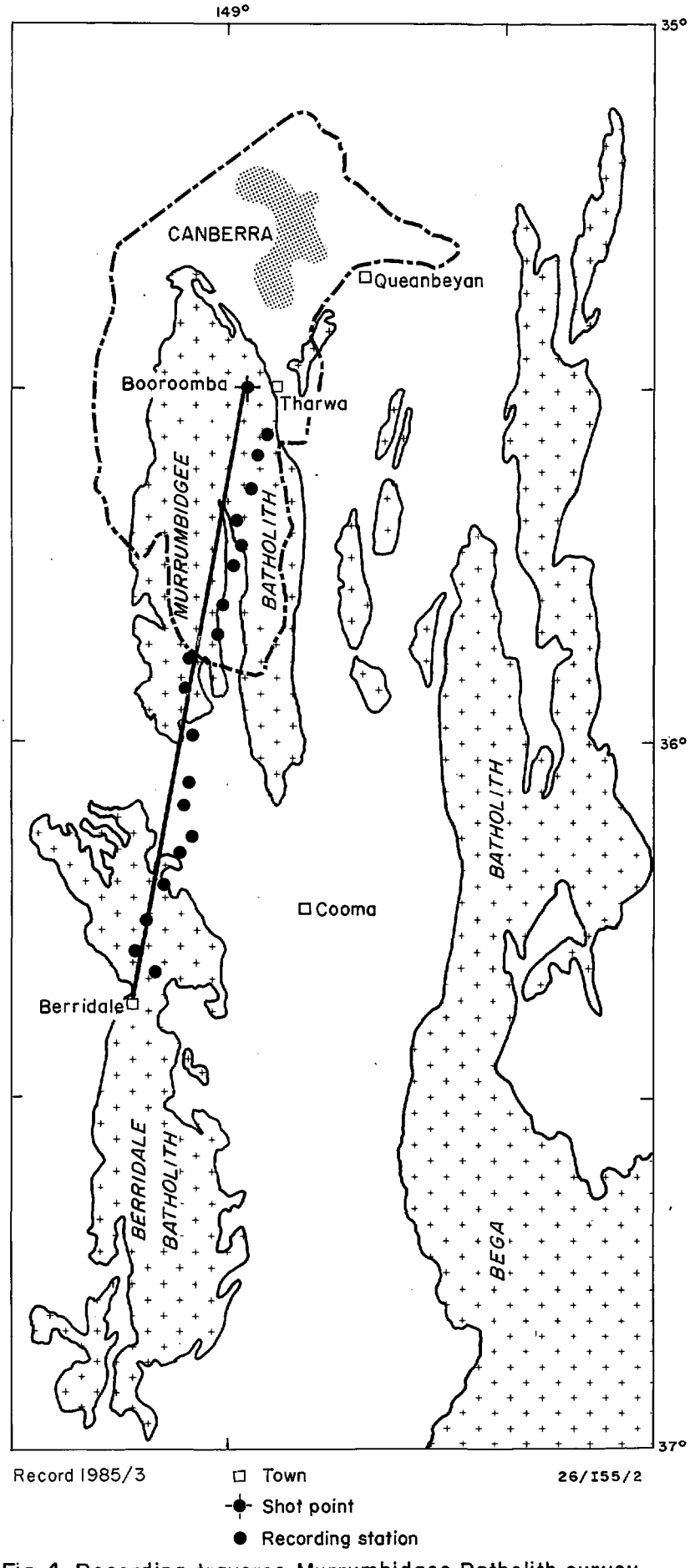

Fig.4 Recording traverse, Murrumbidgee Batholith survey