COMMONWEALTH OF AUSTRALIA
DEPARTMENT OF NATIONAL DEVELOPMENT
BUREAU OF MINERAL RESOURCES,
GEOLOGY AND GEOPHYSICS

RECORDS 1959, No. 63

A SEISMIC INVESTIGATION OF THE FENTON FAULT AT BARNES FLOW, CANNING-FITZROY BASINS, KIMBERLEY DIVISION, W.A.

by

K. R. VALE and E. R. SMITH

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ABSTRACT.

The Fenton Fault, one of the major tectonic lines in the Canning and Fitzroy Basins, has always presented a major problem to geologists seeking to determine its true nature and significance. The investigation described in this report was intended to contribute towards a solution of the problem. This investigation included a seismic reflection traverse across the Fault in the area of Barnes Flow, near where previous gravity and airborne magnetic traverses had crossed it, together with refraction traverses on each side of and across the fault.

The results of previous surveys are discussed, and show that the gravity meter is a most useful tool for the further investigation of the Fenton Fault. However, unless new and effective treatment of results can be devised, it is of doubtful value in investigating folding within the Fitzroy Basin, though this does not necessarily detract from its value for regional surveys. The airborne magnetometer on the other hand, is not a reasonable tool for investigating the Fault.

It is concluded that the Fenton Fault at Barnes Flow is a normal fault, downthrown to the north-east, with a throw probably exceeding 10,000 feet. The thickness of the sedimentary section on the north side of the Fault near Barnes Flow probably exceeds 16,000 feet. On the south side a velocity of over 20,000 ft/sec. was recorded from a depth of 5,500 feet. This probably indicates the depth to basement at this point. On the south side of the Fault at Jurgurra Creek the sedimentary section appears to be about 7,000 feet thick.

The conclusion that basement is relatively shallow to the south of the fault could be tested by drilling. The rig used should be capable of drilling to at least 6,000 feet to ensure that the 20,000 ft/sec. refractor may be penetrated and identified.

1. INTRODUCTION

The location of the Fenton Fault is shown on Plate 2. It can be followed from the vicinity of Sandfly Yard and Jurgurra Creek, through Moulamen Hill, Mt. Arthur, Barnes Flow and Mt. James.

The first extensive mapping of the Fenton Fault was carried out by Wade in 1934. Later investigators, including Dr. F. Reeves (1951) have given it a lot of attention during their investigations in the Fitzroy and/or southern Canning Basins. During the past few years, it has been mapped in comparative detail from surface geology and crossed by geophysical traverses (airborne magnetometer, gravity and seismic), by geological and geophysical parties of the Bureau of Mineral Resources and of the West Australian Petroleum Pty.Ltd. The investigations have not, in general, been carried more than a few miles to the south-west of the known part of the Fenton Fault, because of masking of the geology and difficulty of access caused by the sand dunes of the north-west desert.

The investigation described in this report was planned to give information on:-

(a) The nature of the faulting (e.g. normal or reverse fault).

(b) The throw of the Fault.

(c) The thickness of the sedimentary section and the attitude of bedding on each side of the fault.

(d) The suitability of gravity and airborne magnetometer techniques for further investigation of the Fault.

The investigation has produced positive answers to each of the above questions in spite of the party having insufficient explosives to complete the refraction work.

The seismic party comprised E.R. Smith (party leader), M.J. Goodspeed, and about twenty others, including a surveying team from the Department of Interior, Perth, and a drilling team from the Petroleum Technology Section of the Bureau. Shooting commenced on 4th July, 1955 and was concluded on 23rd July, 1955.

2. GEOLOGY

The Fenton"Fault" has always presented a major problem to geologists in the Canning and Fitzroy Basins. It is one of the major tectonic lines in the area, and by definition is the southern margin of the Fitzroy Basin. (Guppy, et al, 1958, p.7). In some places a fault plane can be seen at the surface, in other places it can be traced by noting the variation in vegetation growing on opposite sides, It can be followed in this manner from Sandfly Yard on Jurgurra Creek through Moulamen Hill, Mt. Arthur, Barnes Flow, Mt. James to Mt. Fenton, and more recent geological and gravity evidence suggests that it extends at least a further 100 miles to the south east. Various theories concerning the nature and significance of the Fenton Fault have been put forward. These may be summed up in the form of the following four postulates:-

(1) That the fault is entirely downthrown on the north-east side; that it is the line along which a mobile Fitzroy Basin broke away from a more stable shelf now underlying the southern Canning Basin and that there has been much greater sedimentation in the Fitzroy Basin than in the remainder of the Canning Basin (Schneeberger, 1950).

(2) That the Fault is hinged at one or more places, and that the conditions postulated in (1) above may be applicable in part, but not in general, to the southern Canning Basin (Guppy et al, 1958).

(3) That, although the Fault may show considerable movement in some parts, such movement may be relatively local, or associated with narrow horsts, and will not have had very much influence on the sedimentary history of the two parts of the basin (Condon, verbal communication, 1955).

(4) A fourth interpretation is suggested by Condon and Casey (1958). They suggest that, although faulting has been established in places along the Fenton Fault line, it may not be the dominant structure, but a secondary feature representing the surface trace of an underlying unconformity or subsurface "high".

A comprehensive discussion of the geology of the Fitzroy Basin is given by Guppy et al (1958). The Fenton Fault is discussed and the suggestion made that "its history could be similar to the Pinnacle Fault with a consequent important effect on environmental conditions and disposition of sedimentation during the Palaeozoic. Outcrops along the Fault are restricted to the Permian and Mesozoic. There has undoubtedly been considerable movement along some sections of the fault and practically no movement in others. For example, between Nerrima Creek and Mount Fenton the fault plane has been studied at a number of localities and dips to the north at 50° to 60° with considerable displacement".

"In general it can be stated that the fault has a throw to the north, with a variable displacement, in Permian rocks. There is a possibility of a reversal of throw towards Nerrima Creek".

"Mesozoic beds have been faulted along the Fenton Fault with a downthrow of 140 feet to the south-west".

It is pointed out that "the area to the south of the Fenton Fault is unknown geologically owing to the cover of Mesozoic sediments and the total lack of sub-surface information. It does seem probable that Permian transgression took place across the Fenton Fault but it is suggested that this transgression was of very limited extent".

From the above observations of Guppy et al, the importance of a sounder knowledge of the Fenton Fault, with a view to assessing the oil prospects of the Canning Basin, can be realised. Quite a lot has already been learnt, particularly from gravity work, but some of the conclusions based on gravity, appear to be at variance with those based solely on magnetic and seismic. The fault at Barnes Flow is well established by surface geology. It showed a very pronounced gravity anomaly (about 18 mg.), but no significant magnetic anomaly. It was considered likely that the seismic method would be able to give a definite indication of:-

(a) The position of the fault plane.

(b) The dip of the fault plane.

(c) The throw of the fault.

(d) The thickness of the sedimentary section and the attitude of bedding on each side of the Fault.

3. OTHER GEOPHYSICAL SURVEYS.

Previous geophysical surveys which have investigated the Fenton Fault include:-

1. Gravity survey (1952 BMR) which crossed the Fault at Mt. James, Barnes Flow, Mt. Density, 3 miles north-west of Mt. Arthur, and Jurgurra Creek (Wiebenga and van der Linden 1953).

2. Seismic survey (1953 Seismograph Service Ltd. under contract to West Australian Petroleum Pty.Ltd.) which crossed the Fault near Jurgurra Creek. (Unpublished).

3. Airborne Magnetometer survey (1954 BMR) comprising 14 traverses, four of which crossed the Fault near Jurgurra Creek, 4½ miles north-east of Camelgooda Hill, 3 miles south-east of Barnes Flow and 31 miles south-east of Barnes Flow. (Unpublished).

For the purpose of this report we shall consider only that work which relates to Barnes Flow and Jurgurra Creek. The unpublished BMR work will appear at a later date. There is no present intention to publish the S.S.L. work but West Australian Petroleum Pty.Ltd. has kindly granted permission for a copy of the relevant section to be included in this report. This is shown along with corresponding gravity and magnetic profiles on Plate 3.

The S.S.L. seismic section clearly indicates the existence of the Fault near shot points 8 and 9. Unfortunately the quality of the reflections is poor and it is not possible to draw any conclusions on the dip of the fault plane or the throw of the fault. Some refraction work would probably have furnished information on the throw of the fault, but the seismic party did not have the time available for such work. Four points stand out from the section. These are:-

1. On the south-west side of the Fault the sedimentary section probably exceeds 7,000 feet.

2. On the south-west side of the Fault an unconformity is suggested at about 5,000 feet. Above this the section is more or less flat, but below it the beds dip at approximately 6°.

3. Two reflections below 5,000 feet on the south-west side, though unreliable by themselves, show a flattening of dip that may be an indication of drag associated with down-thrown movement on the south-west side.

4. The reflections on the north-east side are of poor quality and of no use for estimating even a reasonable minimum value for the thickness of section. They do, however, indicate that down to a depth of approximately 3,000 feet the beds are dipping to the south-west at approximately 15°.

There are several possible interpretations of the Bouguer anomaly across the assumed location of the Fault. There are lower gravity values on the south side than on the north side. This indicates that there is unlikely to be downthrow to the north. On the other hand the gravity gradient is small and if the downthrow is to the south then it would appear to be small. The gravity gradient could quite well be explained by an unconformity, or the basement, dipping relatively gently to the south. It is reasonable to conclude therefore that the gravity results at Jurgurra Creek are not in contradiction to the seismic results. The magnetic profile at Jurgurra Creek shows no strong features and no conclusions can be drawn from it. If the throw of the fault is small then a more or less featureless profile would be expected.

The drilling of the Jurgurra Creek Scout Bore in November 1955 contributed to the investigation of the Fault (Henderson, 1956). The object was to determine what lay under the Mesozoic sediments south-west of the "Fenton Fault". It was thought that a small amount of Alexander Formation would be encountered before the Jurgurra Sandstone was penetrated. It was expected that the latter formation would be of considerable thickness, and possibly underlain by other Mesozoic formations. However, the bore established that the Jurassic formations mapped in the Edgar Ranges do not extend as far north as the bore site, the Upper Noonkanbah Formation being identified at a depth of 15 feet. Poole Sandstone was identified below the Noonkanbah, and the hole probably bottomed in the Grant Formation at 1450-1680 feet. The bore hole confirms the lack of major displacement on the "Fenton Fault" north-west of Moulamen Hill.

The gravity and magnetic profiles across the Fault near Barnes Flow are shown on Plate 4. Wiebenga interpreted the gravity profile as indicating a throw of 7,000 feet on the north side of the fault. This is in good qualitative agreement with the interpretation of the seismic results. On the other hand the positive anomaly on the south side of the Fault and the steadily decreasing values north-east along the traverse away from the Fault can not be interpreted in terms of the seismic results which show strong dips to the south-west. It has been concluded from this that the gravity method is most useful for investigating large scale faulting in this area but is of doubtful value for the investigation of structure within the sediments. It is possible that the gravity profile is reflecting an increase in thickness of sediments to the north-east but the seismic results are unable to confirm this.

The magnetic profile is featureless and it would appear that the airborne magnetometer is of doubtful value for investigating the Fenton Fault near Barnes Flow. Elsewhere in the Canning Basin it has proved useful in indicating some of the large scale structures and particularly in giving spot estimates of depth of basement. Such estimates of depth to basement are randomly scattered.

4. SEISMIC PROCEDURES.

The programme of work called for:-

(a) Reflection traverse commencing 5 miles north of the surface line of the Fault and continuing, more or less at right angles to the Fault, as far south as practicable.

(b) Refraction traverse parallel to the fault on the upthrown side to record and estimate the depth of any high velocity refractor or refractors that it may be possible to record on another traverse on the downthrown side.

(c) Refraction traverse parallel to the fault on the downthrown side to record and estimate the depth of any suitable high speed refractor that may have been recorded on the upthrown side.

(d) Refraction traverse across the fault to see if it would be possible to measure the throw on any particular refractor and obtain evidence on the location of the fault plane.

As it turned out, (b) above was shot more or less at right angles to the Fault along the reflection traverse in order to save surveying. This was possible because the beds were practically horizontal. In the case of (c) above, the section proved to be too thick to record a high velocity refractor that had been recorded on the upthrown side. A greater effort, if time and explosives had been available, might have resulted in recording this refractor. However, enough was learnt to make the actual recording of the refractor of small practical value. (d) above proved to be of little practical value because the throw of the fault was too great. It did give some evidence of the location of the fault plane on one particular refractor.

The reflection and refraction techniques used have been described in other reports dealing with areas within the Fitzroy Basin (Vale, Smith and Garrett, 1953, and Smith, 1955).

5. RESULTS

Reflection cross-sections at Barnes Flow are shown on plate 4 and refraction time-distance curves on plate 5.

On traverse B there is a remarkable difference in the number and distribution of reflections on either side of the Fenton Fault. Numerous reflections were recorded on the north-eastern part of the traverse between shot points 425 and 443; they are particularly numerous to depths of 8,000 to 9,000 ft. and in significant numbers to depths of about 16,000 ft. With the exception of some doubtful reflections and those believed to be connected with the Fenton Fault, these reflections have a component of dip along the traverse to the south-west. Near the surface the dips are of the order of 6° and increase with depth to approximately 25° at 16,000 ft.

In the section between shot points 439 to 445 are shown groups of reflections and isolated reflections with a steep north-easterly component of dip. These are believed to be connected with the Fenton Fault.

On the south-western end of the traverse from shot points 446 to 465 very few reflections were recorded. They are relatively numerous at a depth of approximately 3,000 ft. Below this only a few isolated reflections were recorded, which it is currently believed, are of no significance. It is not uncommon to record such isolated reflections apparently from within a basement complex. They may derive from seismic velocity variations within the basement complex or from shears or even surface irregularities to one side of the traverse.

On traverse C which is normal to traverse B, numerous reflections were recorded to depths of over 16,000 ft. The dips are flat which indicates that traverse C is more or less parallel to the strike of the sediments and therefore the dips recorded on traverse B are true dips.

Most of the information sought by the survey appears to be fairly clearly shown on the reflection section. It is believed that all those reflections shown dipping steeply to the north-east under shot points 439 and 445 are representative of, and come from within, the fault zone. The position and dip of these reflections have been computed assuming the conventional curved path theory and using the linear velocity function $V = 8,600 + .6D$. The geological map shows the traverse cutting the fault between SPs 444 and 445. This, however, could be in slight error as the exact position of the fault on the surface relative to the traverse was not determined. A study of the first refraction arrivals for the shot points near the fault reveals a sharp break in the slope of the time-distance curves at the mid-point between SPs 445 and 446. This is assumed to be the point at which the fault crops out. The upper surface of the fault zone may be anywhere between those reflections that are believed to come from within the fault zone and those which are coming from the sedimentary section abutting it to the north (see plate 4) but it is considered most likely that it will be close to those from within the fault zone.

A line has been drawn on the section, which it is believed represents the front face of the fault. This is shown dipping to the north-east at an angle of 45° between depth of 4,500 and 15,000 feet. Above 4,500 feet a dip of about 72° is indicated. A suggested explanation for this apparent steeper dip is that it may be a secondary development of the fault, the displacement of the basement rocks being the primary development. The displacement of the basement rocks may even be more of the nature of a downwarp than simple faulting and was possibly caused by sediment loading in a more mobile basin area on the north side of the present fault. At times such as when the primary faulting (or warping) was quiescent, the basin would fill and the sediments overlap on the southern side. Subsequent movement of the primary fault or compaction of the thicker sediments on the north side, would cause rupture of the overlapping sediments which may have occurred on a more vertical plane.

The structure appears to be a normal fault, downthrown to the north, although the fault may grade into a monoclinal fold of the basement rocks at depth. The reflections suggest that the thickness of sediments on the north side of the fault may exceed 16,000 feet, but on the south side only about 3,000 feet of sediments are indicated. However, the refraction work indicates that 5,500 feet would be a more reasonable value for the thickness on the south side.

The reflection cross-section shows more or less horizontal bedding on the south side of the Fault compared to the dips on the north side and this is confirmed by the refraction work. However, a small anticlinal reversal is indicated under shot points 448 and 449. This is possibly a drag fold associated with the fault.

On the north side of the fault, a short reflection cross traverse (Traverse C) through SP 435 indicates that the main traverse (Traverse B) was shot more or less across the strike, so the dips recorded should be approximately true dips. All reliable dips on the north side are to the south-west and they increase with depth. There is some evidence of drag close to the fault but beyond the influence of this the dips range from about 6° near the surface to about 15° at 8,000 feet and about 25° at 16,000 feet. There is no recognisable unconformity within the section. These dips really apply to the southern flank of the Nerrima Dome, and show that, if the rocks are petroliferous, there would be drainage towards the dome from the southern side. The increasing dip with depth suggests that the fault was active throughout the period of deposition of the sediments.

A velocity of 14,600 ft/sec. was recorded from a depth of approximately 2,700 feet on the south side of the Fault. A previous refraction survey on the Nerrima Dome (Vale et al. 1953) had recorded a velocity of 14,500 ft/sec. at a depth of 4,000 feet and also a velocity of 16,000 ft/sec. at 7,000 feet. These refractors deepen towards the Fault, as shown by the reflection cross section, and minimum depths for them adjacent to the Fault on the north side are 9,000 feet and 13,000 feet respectively. Correlation of the refractor on the south side of the Fault with either one of these refractors gives possible throws for the Fault of 6,300 feet or 10,300 feet respectively. Correlation with the deeper refractor is favoured, as it can be expected that, under the lesser thickness of overburden, the velocity of this refractor would be considerably less than 16,000 ft/sec. thus bringing it more into line with the 14,600 ft/sec. recorded on the south side.

An attempt to record either of these refractors adjacent to the Fault on the north side was unsuccessful, due to poor energy being received at the geophones at the large shot to geophone distances required, in spite of charges of 300 lb. being used.

A velocity of over 20,000 ft/sec. was recorded from a depth of approximately 5,500 feet on the south side of the Fault. The only other place in the Kimberleys where a velocity of this order has been recorded by the Bureau is on the north side of the Pinnacle Fault. Here a similar velocity was recorded from a formation, below the Ordovician rocks, which test drilling has shown to belong to the Pre-Cambrian basement complex. It seems reasonable to correlate the high velocity rock on the upthrow side of the Fenton Fault with that on the upthrow side of the Pinnacle Fault and to assume that in this case also, it is a part of the Pre-Cambrian basement. If this assumption is accepted, and a minimum of 16,000 feet of section on the north side is assumed, then we arrive at a minimum throw for the fault of 10,500 feet, which is in good agreement with the estimate of 10,300 feet given above.

The results of the refraction shots across the Fault are also shown on Plate 5. It is difficult to interpret these definitely in terms of certain refractors. However, it is likely that the change in slope of the time-distance curves in each direction is related to the Fault, and this then locates the Fault approximately below SP 445, which is in qualitative agreement with the position as deduced from the first break velocities and the reflection section.

6. CONCLUSIONS

The following conclusions are drawn from the results of this survey and the other geophysical surveys referred to in the text:-

(1) The Fenton Fault at Barnes Flow is a normal fault.

(2) It has a throw which probably exceeds 10,000 feet.

(3) The 16,000 ft/sec. refractor recorded at 6,000 to 7,000 feet at Nerrima, is too deep to be recorded on the north side of the fault without special effort, but a refractor which possibly represents the same geological horizon lies at about 2,500 feet depth on the south side.

(4) A refractor with a seismic velocity of at least 20,000 ft/sec. and recorded from an estimated depth of 5,500 feet on the south side of the Fault near Barnes Flow possibly correlates with a refractor of similar velocity recorded on the north side of the Pinnacle Fault at Prices Creek. This probably represents the basement complex and may be taken as the bottom of the sedimentary section on the south side of the Fault.

(5) The thickness of the sedimentary section on the north side of the Fault near Barnes Flow probably exceeds 16,000 feet.

(6) The dips at 8,000 feet on the north side of the Fault at Barnes Flow are of the same order as those at 2-3000 feet depth on the north side at Jurgurra Creek viz. about 15°.

(7) On the south side of the Fault at both Jurgurra Creek and Barnes Flow there is a more or less flat lying section down to 5,000 feet. It is currently believed that this is the entire sedimentary section at Barnes Flow, but at Jurgurra Creek it is underlain unconformably by a section of more than 2,000 feet of sediments with a component of dip of about 6° to the north-east.

(8) Conclusions (6) and (7) may be summarized by stating that at both Barnes Flow and Jurgurra Creek the fault has beds dipping steeply to the south-west abutting it on the north side and relatively flat lying beds abutting it on the south side.

(9) The gravity meter is a reasonably reliable tool for further qualitative investigation of the nature of and estimates of the throw of the Fenton Fault. Care should be exercised before quantitative estimates of section and throw are accepted.

(10) The airborne magnetometer has doubtful value for further specific investigation of the Fenton Fault. Its use may be limited to random spot estimates of depth to basement.

(11) The seismograph is a useful tool for spot checking the conclusions that may be drawn from further gravity investigation of the Fenton Fault. It is, however, essential that both reflection and refraction methods be used.

(12) Reservations must be held on the above remarks concerning the applicability of the various methods. These are:-

(a) Changes in the type of sediment and basement rocks along the Fault may alter the conclusions regarding the applicability of the gravity and magnetic methods. For example, quite definite magnetic anomalies have been associated with known faulting in the Stansmore Ranges.

(b) Even after all geophysical methods have been tried, the estimates of thickness of sediments on each side of the Fault and the throw of the Fault are far from precise.

(c) For precise information, the only known technique is drilling but even here the basement on the north side of the Fault is likely to be beyond practical limits.

7. RECOMMENDATIONS

One of the important conclusions of this survey which has implication as far as the regional geology is concerned, can be tested by a bore on the south side of the Fenton Fault at Barnes Flow. A favourable location would be between shot points 448 and 449 on the indicated structural reversal. The rig used should be capable of drilling to at least 6,000 feet in order to ensure that the 20,000 ft/sec. refractor may be penetrated and identified. Such a test bore would undoubtedly penetrate the Permian section, including any Grant Formation (the 14,600 ft/sec. layer probably lies at or somewhere near the base of the Grant) and would reveal any Carboniferous, Devonian and Ordovician sediments that may be present. Proof of the presence of Devonian and/or Ordovician sediments at this locality would be of the utmost importance. However it must be kept in mind that failure to record either Devonian or Ordovician rocks here cannot be taken as positive evidence that these rocks do not exist or are of limited extent in either the southern Canning or Fitzroy Basins because of the possibility that the history of the relative highness of the basement may have been such that these rocks were either not deposited here or else were subsequently eroded, whereas, in surrounding areas, they may have been both deposited and retained. On the other hand, if these rocks should be detected, then that would represent positive evidence that they extend for considerable distances east and south of areas where they are already known. If present on the south side of Barnes Flow, they may be of a shallower water facies than those that may be encountered further into either of the two sub-basins.

8. ACKNOWLEDGMENT

The authors wish to acknowledge the kind permission of the West Australian Petroleum Pty.Ltd., to make use of the seismic section across the Fenton Fault which was produced by a seismic party under contract to them.

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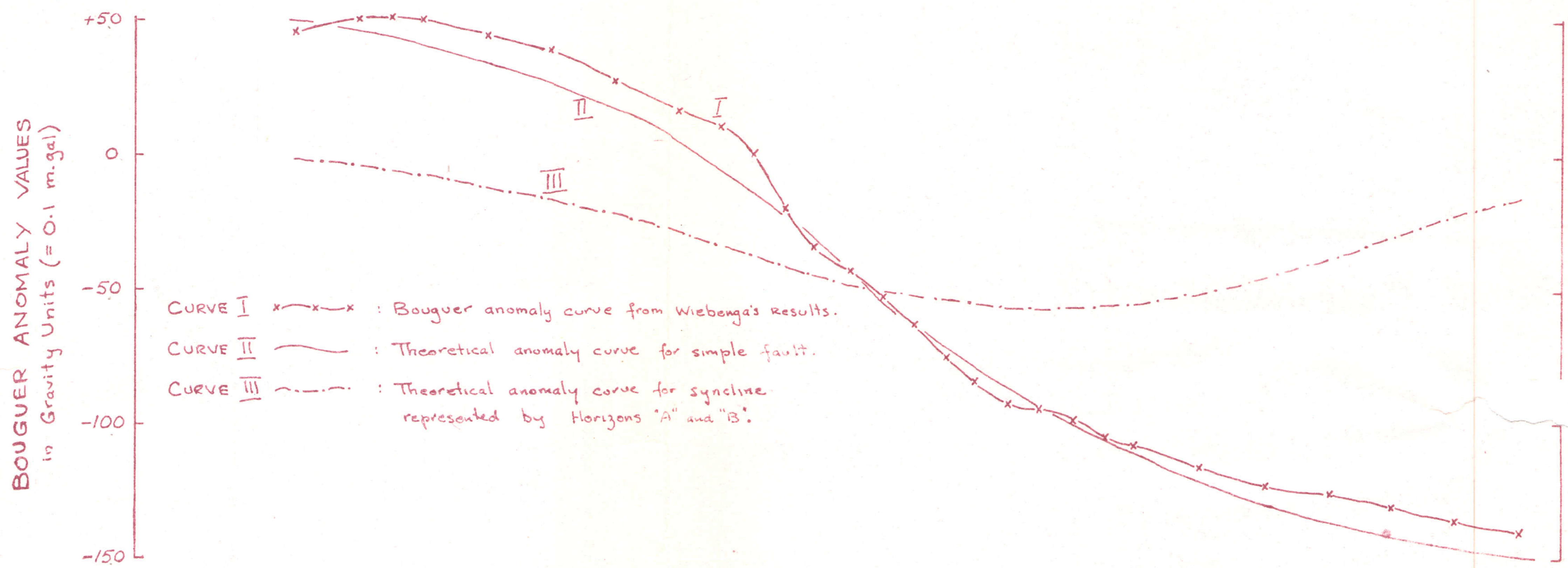

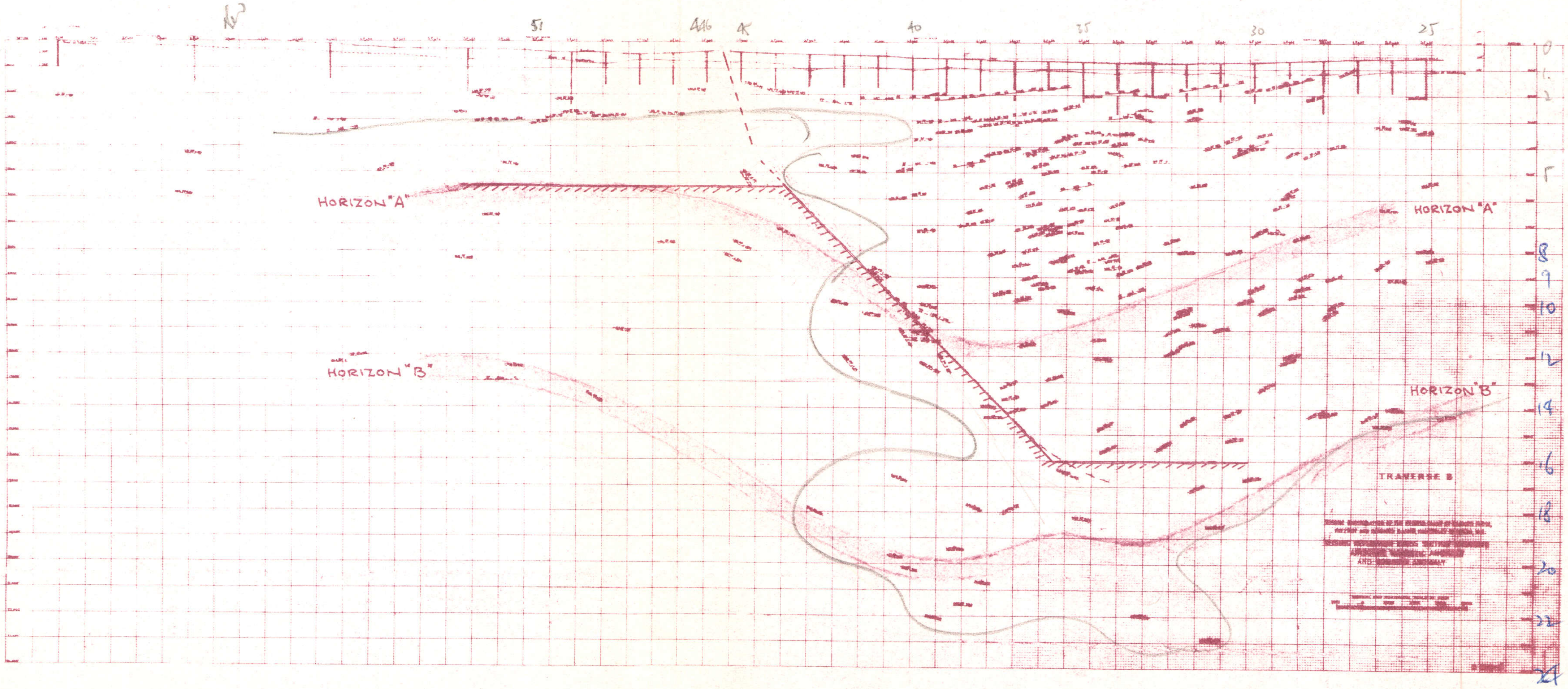

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To Accompany Records 1959, No. 63

APPENDIX

A FURTHER STUDY OF THE GEOPHYSICAL RESULTS OBTAINED ACROSS THE FENTON FAULT AT BARNES FLOW.

by A.G. MORTON.

In the preceding report the authors have interpreted the seismic results obtained at Barnes Flow as indicating a normal fault downthrown to the north east. M.A. Condon, in a personal communication to K.R. Vale (2nd July, 1958) suggested an alternative interpretation. He considers that the seismic profile may be interpreted to indicate a depositional anticline and syncline with a steep zone in the flank between them, the steep zone possibly being related to a scarp in the basement.

In Condon's interpretation he has accepted the isolated deep reflection shown on the cross section beneath the south-western part of Traverse B as indicating a deep sedimentary section and has drawn by inspection two phantom horizons shown as Horizon A and Horizon B respectively. On the other hand Vale and Smith have on the basis of the refraction results assumed that these isolated deep reflections are coming from within the basement complex or represent other seismic energy not related to sedimentary section.

In the opinion of the writer the seismic results could be considered to fit either of these postulates within reasonable limits. It was thought however that the gravity results obtained in the same area might be used to resolve this ambiguity. The two alternative possibilities were therefore represented by simple geometric figures, and theoretical gravity anomalies corresponding to them were calculated. The results of this study are illustrated on the figure opposite, and discussed below.

From the gravity results obtained by Wiebenga (B.M.R. Record 1953/64) Bouguer anomaly values were determined along a line coinciding with the seismic traverse. These values are represented by Curve I on the upper portion of the figure. On the lower portion of this figure the seismic cross-section (Plate 4) has been reproduced on a reduced scale. On this has been drawn a simple geometric shape to represent the normal fault postulated by Vale and Smith. Taking a density contrast of 0.20 used by G. Neumann (Minute to K. Vale, 29.8.58), theoretical gravity anomaly values were calculated for this simple shape and plotted on the upper portion of the figure (Curve II).

It will be seen that the theoretical anomaly (Curve II) very nearly fits the observed gravity values (Curve I), the most significant difference being that, over the middle portion, curve I is slightly steeper than Curve II. Even closer agreement would be obtained if the angle of the fault were increased from the value of 45° depicted on the seismic section to about 60°. A discrepancy of this magnitude in estimating the dip of the fault plane is not considered unreasonable bearing in mind the factors involved in migrating the steeply dipping reflections.

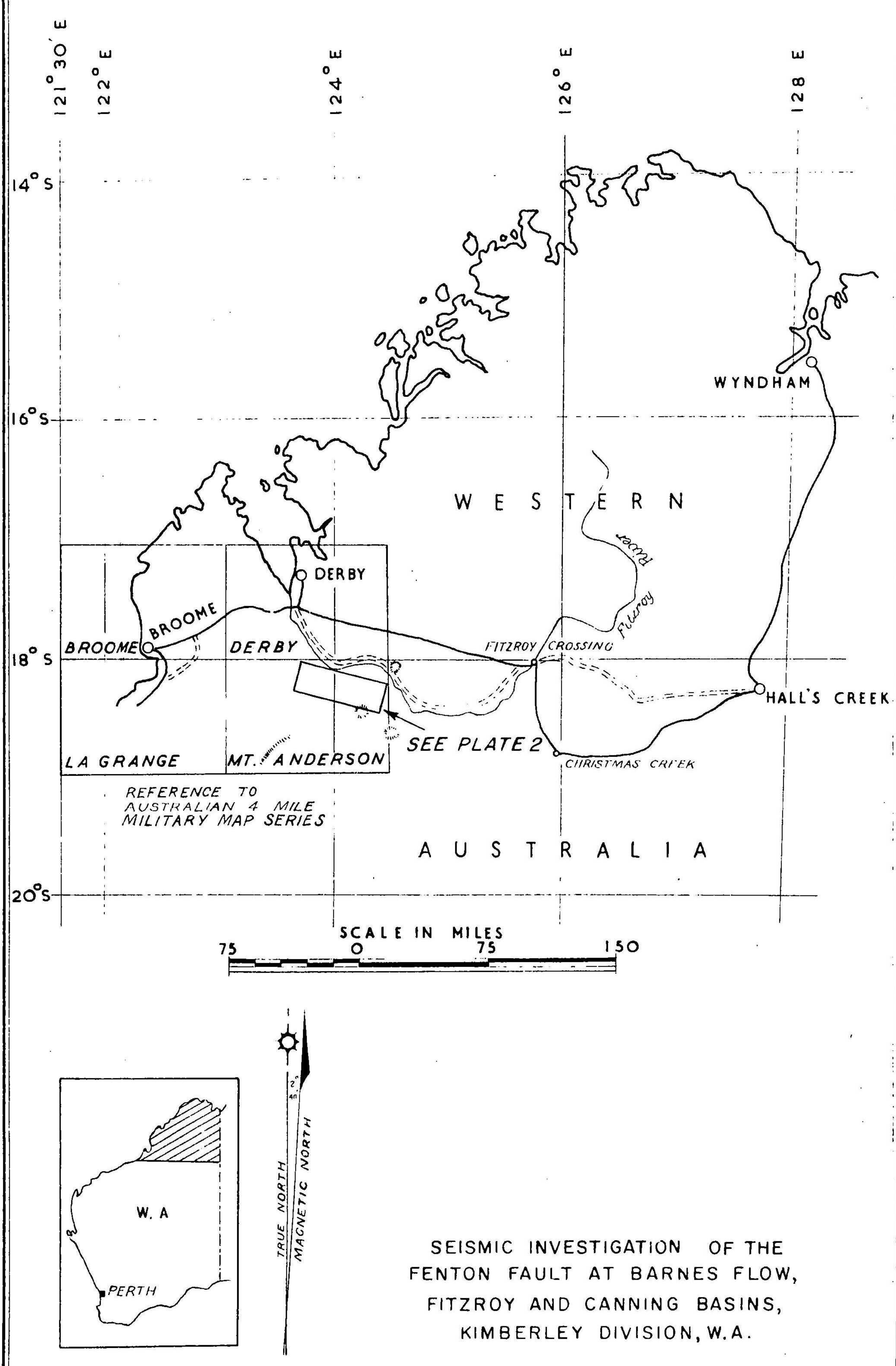
Referring again to the figure, the alternative interpretation of the seismic cross-section has also been depicted on the lower part of the figure. Horizons "A" why so small?

and "B" illustrate the syncline postulated by Condon. Horizon "A" possibly represents the base of the Grant formation. On the south side of the "fault", horizon "A" corresponds approximately to the high velocity refractor referred to in the report. This is assumed by Condon to be a Devonian or Ordovician limestone or dolomite. Assuming a density contrast of .12 between this and the overlying sediments, and a further small (.08) density contrast across horizon "B", the theoretical gravity anomaly resulting from this configuration has been calculated, and is shown as Curve III in the figure. This curve clearly does not agree with the observed gravity results (Curve I). It would be modified to a limited extent by adding the effect of a deep basement scarp but could not reasonably approach the near coincidence shown by Curve II.

Thus, in the writer's opinion, the gravity results obtained across the Fenton Fault at Barnes Flow support the existence of a normal fault as postulated in the preceding report. They do not support the alternative theory of supratenuous folding.

As a final comment some mention should perhaps be made of the results obtained in the Frome Rocks No.1 bore recently drilled by the West Australian Petroleum Pty.Ltd. This bore, which is located near Jurgurra Creek on a north westerly extension of the Fenton Fault Line is reported in the press as having encountered salt bearing formations at 2263 feet. This section persisted down to 4000 feet, at which depth the hole was abandoned. As mentioned above, the seismic refraction results at Barnes Flow indicated a high velocity (20,000 ft/sec) refractor at a depth of 5,500 feet. Vale and Smith suggest that this probably represents a basement complex; Condon believes it to be a limestone or dolomite. Perhaps in the light of the Frome Rocks bore, a third possibility should be considered, namely that it may represent a salt section.

PLATE I



SEISMIC INVESTIGATION OF THE
FENTON FAULT AT BARNES FLOW,
FITZROY AND CANNING BASINS,
KIMBERLEY DIVISION, W.A.

LOCALITY MAP

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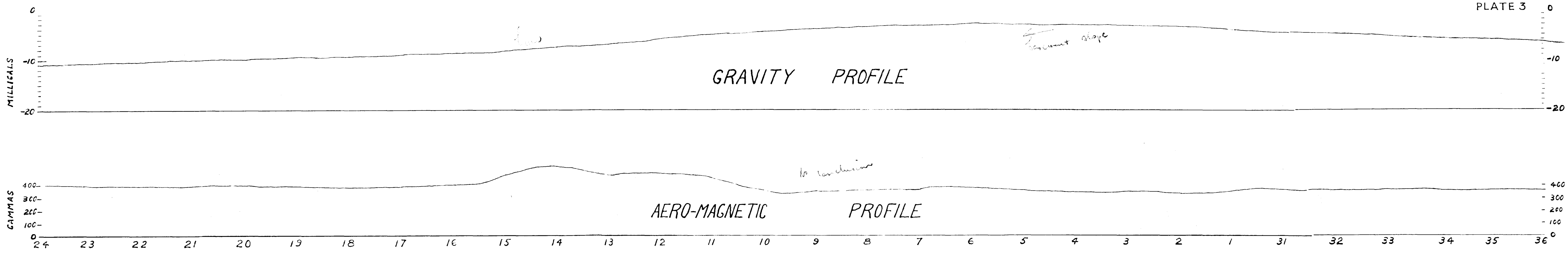
PLATE 2
SEISMIC INVESTIGATION OF THE FENTON FAULT AT BARNES FLOW,
FITZROY AND CANNING BASINS, KIMBERLEY DIVISION, W.A.
GEOLOGICAL SKETCH MAP
S.S.L. SEISMIC AND B.M.R. SEISMIC AND MAGNETIC TRAVERSES
ACROSS THE FENTON FAULT
Geology from B.M.R. Map WA 3E-13
SCALE IN MILES
2 0 2 4 6 8
FL. 7R B.M.R. Aeromagnetic Flight Line 1954 from Map G 169-3
SSL Seismic Traverse (1953)
B.M.R. " "
CHARLES KNOB
CAMELGOODA HILL
Yellagoodine Native Well
MOULAMEN HILL SOUTH
MT. ARTHUR
MT. JAMES
Big (Green) Spring
Barnes Flow (Big)
Little Flow
Dry Corner
Tutu
Blue Mud
Eldorado Yard
Victory
Sandfly Yard
Old Yard
Sook
Moffats
Ruins
Nerrima No 1
"Freney" Quarters
McLarty
McAlear
Roebuck Branding Yards
B.M.R. 1
JURGURRA CREEK
FL. 6R
FL. B
FL. 7R
FL. 8R
FL. D
Traverse
1952
1953
1955
Geophysical Section, Bureau of Mineral Resources, Geology and Geophysics
G258-2

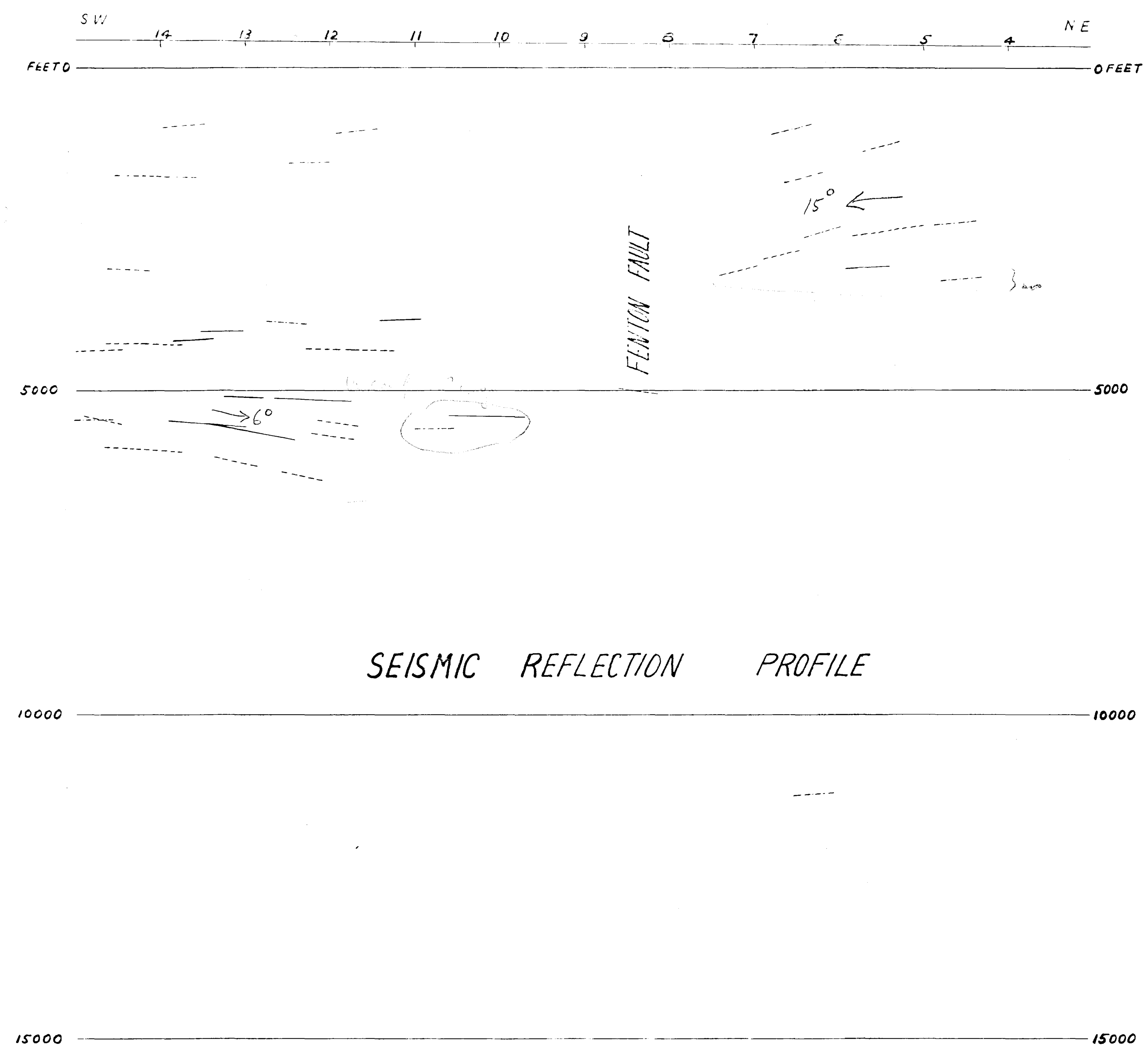


GRAVITY DATA BY BMR 1952 AND 1953
PROFILE SHOWS A BOUGER ANOMALY

MAGNETIC DATA BY BMR 1954
TOTAL MAGNETIC INTENSITY WAS CONTINUOUSLY
RECORDED BY AN AN-ASQ/1 AIRBORNE MAGNETOMETER
OPERATING AT AN ALTITUDE OF 1500 FEET ABOVE GROUND

SEISMIC REFLECTION PROFILE BY SEISMOGRAPH SERVICE LTD.
THIS PROFILE IS PART OF THE RESULTS OF A SURVEY
CARRIED OUT BY S.S.L. FOR WEST AUSTRALIAN PETROLEUM PTY. LTD.
AND IS PUBLISHED BY COURTESY OF WEST AUSTRALIAN PETROLEUM PTY. LTD.

NUMBERS REFER TO S.S.L. SHOT-POINTS 1320 FEET APART.



SEISMIC INVESTIGATION OF THE
FENTON FAULT AT BARNES FLOW,
FITZROY AND CANNING BASINS,
KIMBERLEY DIVISION, W.A
JURGURRA

SEISMIC REFLECTION CROSS SECTION
SHOWING MAGNETIC ANOMALY
AND BOUGUER ANOMALY

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PLATE 4
POSSIBLE POSITION OF FRONT FACE OF FAULT
TRAVERSE C
TRAVERSE B
AEROMAGNETIC PROFILE
BOUGUER ANOMALY PROFILE
SEISMIC INVESTIGATION OF THE FENTON FAULT AT BARNES FLOW,
FITZROY AND CANNING BASINS, KIMBERLEY DIVISION, W.A.
SEISMIC REFLECTION CROSS SECTION SHOWING
AIRBORNE MAGNETIC ANOMALY
AND BOUGUER ANOMALY
VERTICAL AND HORIZONTAL SCALE IN FEET
1000 0 1000 2000 3000 4000
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PLATE 5

SEISMIC INVESTIGATION OF THE FENTON FAULT AT BARNES FLOW,
FITZROY AND CANNING BASINS, KIMBERLEY DIVISION, W.A.

TIME-DISTANCE CURVES FOR REFRACTION TRAVERSE B

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