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RECORD No. 1966/106

GRAVITY INVESTIGATION OF THE THICKNESS OF BASALT COVER IN THE EINASLEIGH 1:250,000 MAP AREA,

QUEENSLAND 1960

by

W.J. LANGRON

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SUMMARY

A gravity traverse was made across an extensive lava flow in the Einasleigh district, North Queensland, in an attempt to measure variations in thickness of the basalt cover. The survey failed in this respect, but the gravity results clearly show the presence of two plugs of dense material located at the foci of volcanic activity. The principal gravity feature is due to a huge mass of Permian granite beneath the basalt cover.

The relation between the gravity results and other points of geology is discussed.

1. INTRODUCTION

During the course of regional gravity measurements along the east coast of Australia (Flavelle, 1966), gravity stations were occupied at intervals of one mile over a section of traverse between the Lynd Homestead and the northern border of the Einasleigh 1:250,000 map area. This station spacing was adopted to investigate the thickness of basalt, which covers a large part of the area. The investigation was made at the request of the Geological Branch of the BMR, which was carrying out geological mapping in this region.

The location of the traverse is shown in Plate 1.

2. GEOLOGY

The geology of the Einasleigh map area is discussed by White (1963) and the geological map of the area forms the basis of Plate 1. The subject of Cainozoic basalts in the area is discussed specifically by Best (1959).

About one third of the area bounded by the Einasleigh sheet is covered by basalt. The basalt is mainly effusive and was extruded through many vents. One hundred and twelve volcanoes have been located, and most of these lie within the McBride Basalt Province. The maximum thickness of the basalt is not known; it is at least 375 feet and possibly 2000 feet.

The volcanic activity continued through from the upper Miocene to Recent, and probably into historical time. The youngest basalt flow is the Kinrara Flow and both the crater and the flow have all their structures perfectly preserved.

The basalts for the most part coalesced and overlapped and so built a large plateau that completely buried the pre-basalt topography. The pre-Miocene rocks consist mainly of sediments within the Palaeozoic Tasman Geosyncline; these sediments have been folded and faulted and intruded by granites of at least two ages. There are extensive outcrops of granite in the area. Schists, gneisses, serpentinites, and amphibolites of Proterozoic and Archean age also crop out in the area.

3. DISCUSSION OF GRAVITY RESULTS

To assist in the interpretation of the gravity data the Bouguer anomaly values for stations along the traverse have been calculated using density values of 1.9, 2.2, 2.67, and 2.0 g/cm^3 in the Bouguer correction factor. The four gravity profiles together with a plot of the elevation along the traverse are shown in Plate 2.

Much of the traverse is located along the top of a ridge, which in parts rises to over 3000 feet; thus for many stations along the northern portion of the traverse the terrain corrections could be quite large and the final Bouguer anomaly values along this portion of the traverse could be greater than is indicated.

There are two features that are immediately obvious on first inspection of Plate 2. The first of these is that the four gravity profiles are very similar in shape and mean slope, thus suggesting that over a fairly wide range of rock density there is no single value for incorporation in the Bouguer correction.

The second feature of note is that over two sections of the traverse, between H34 and H59 and between H89 and H102, the trend of the gravity profiles follows the trend of the topography. Between H59 and H89, the trend of the gravity profiles is contrary to that of topography. The gravity 'low' in the central portion of the traverse is explained by the presence of a huge mass of Permian granite beneath the basalt cover. The author (1966) has shown a clear correlation between other gravity 'lows' and outcropping granite along traverse BN, which in part crosses the Einasleigh sheet. If we assume the granite body in question to be a vertical cylinder with a diameter of 30 miles, lying 500 feet below the surface, and if we assume a density contrast of 0.20 g/cm^3 between it and surrounding (metamorphic) rocks, then for the observed gravity anomaly of 18 milligals we could postulate a depth to the base of the cylinder of 1.4 miles. If the density contrast were 0.30 g/cm^3 then the depth would be about 1.1 miles. The centre of this granite mass is beneath H74. These depth figures can be regarded as minimum values; it is likely that the diameter of the cylindrical body taken for purposes of calculation is less than 30 miles, although the gravity results indicate that the boundaries of the granite beneath the basalt cover are at H59 and H89 approximately.

If the 'regional' effect were to be removed from the gravity profiles over this granite province then two distinct residual anomalies would be apparent. These anomalies are located about H67 and H79; both are due to high density bodies, most likely basic plugs. The anomaly at H79 is located over the highest (basalt) topographic feature and can be considered to be the main volcanic plug, the top of which is very near the surface. It is the centre of the Undara crater and system of lava tunnels and volcanic foci located about the gravity anomaly. The feature at H67 is interpreted as due to a volcanic plug that does not reach so close to the surface as the basic body at H79. This view is supported by geological mapping; there are no craters in the immediate vicinity of H67. The nearest craters could be apophyses of the main body below H67.

The flow lava produces no obvious effect on the gravity profiles. The density of this continental olivine basalt probably varies greatly; mostly the lava is weathered and vesicular and its density would not exceed that of the granite. The possibility that there is a sufficient thickness of basalt of sufficiently low density to make a significant contribution to the central gravity 'low' is not supported by the gravity evidence.

Between H34 and H59 the gravity profiles indicate the presence of a deep-seated high-density structure. There is little change in the amplitude of the anomaly on all profiles thus indicating a deep source for the anomaly. There is no rock type exposed at the surface of sufficient density to account for the gravity anomaly. One must therefore postulate some sort of sub-crustal doming with possibly magnetic differentiation associated with the introduction of the Permian granite to explain the gravity feature.

Irregularities in the gravity profiles between H51 and H59 are probably due to metamorphism and differentiation in the zone marginal to the granite body.

Correlation between the gravity profiles and elevation along the northern end of the traverse (H89-H102) is not so pronounced as on the southern portion of the traverse. It would appear that the traverse here enters near-surface Archean gneisses and schists that have a density higher than that of the granite. The small anomaly feature at H98 is located on a local topographic 'high'; it will also be noted that the anomaly disappears with an increase in the density value used in the Bouguer correction factor. Hence it is concluded that the gravity anomaly is due to a small body of high density lying close to the surface. Such a rock type is serpentinite or amphibolite, which, it is noted, occurs in association with an Archean outcrop to the east of the traverse.

4. CONCLUSIONS

Although the gravity results do not assist in determining the variation in thickness of the basalt cover, they have assisted in clarifying the geology along this traverse. That the granite body is as extensive as is suggested from the gravity interpretation is supported by the widespread occurrence of granite in outcrop and the presence of 'windows' of granite near to the traverse.

The prediction of two plugs of dense (basic) material is made with a considerable degree of confidence. The explanations offered for gravity effects obviously due to deep-seated causes are, as is usual in such instances, largely conjectural.

5. REFERENCES

BEST, J.G.	1959	Cainozoic basalts on the Einasleigh 4-mile sheet, North Queensland. <u>Bur. Min. Resour. Aust. Rec.</u> 1959/117.
FLAVELLE, A.J.	1966	Gravity meter measurements between pendulum stations, eastern Australia 1959-1960. <u>Bur. Min. Resour. Aust. Rec.</u> 1966/45.
LANGRON, W.J.	1966	Regional gravity traverses, north Queensland 1963. <u>Bur. Min. Resour. Aust. Rec.</u> 1966/94.
WHITE, D.A.	1963	Einasleigh, Qld., 1:250,000 geological series, sheet E/55-9. <u>Bur. Min. Resour. Aust. Explan. Notes.</u>

APPENDIX

Operational details

Staff: Geophysicist J. van Son

Vehicle: One International station waggon (C84289) equipped with Western elevation meter 204.

Duration of survey: 10-16th May, 1960.

This investigation was included in the course of a regional gravity survey between Melbourne (Victoria) and Cairns (Queensland).

Instrument: Worden gravity meter, serial No. 260, with calibration factor 0.108 mgal/scale division was used for this work. The meter was calibrated on the Ferntree Gully - Kallista Range in February 1960 and on the Melbourne Calibration Range in July 1960. Meter drift was determined by reading stations in the sequence 1, 2, 3, 4, 5, 6, 1, 6, 7, etc.

During the survey, quite severe tapping of the meter was required to release the beam from the stops. Such action did not appear to affect the accuracy of the readings.

In general, drift of the meter was satisfactory.

Elevations: Benchmarks of the Queensland Department of Main Roads were used. All elevations are referred to Queensland State Datum.

Plotting: The co-ordinates of the stations were obtained by reference to the R.A.S.C. compilation for Einasleigh. All stations were picked on airphotos so that station positions can be upgraded when final base maps become available.

Tie stations: The observed gravity values of all stations have been adjusted to the May 1965 Isogal' values for BMR pendulum stations No. 52 at Cairns and No. 53 at Hughenden.

Bouguer anomalies: The Bouguer anomalies were calculated using densities of 1.9, 2.2, 2.67, and 3.0 g/cm^3 in the Bouguer correction.

Gravity data files: (Stored in the BMR Gravity Group)

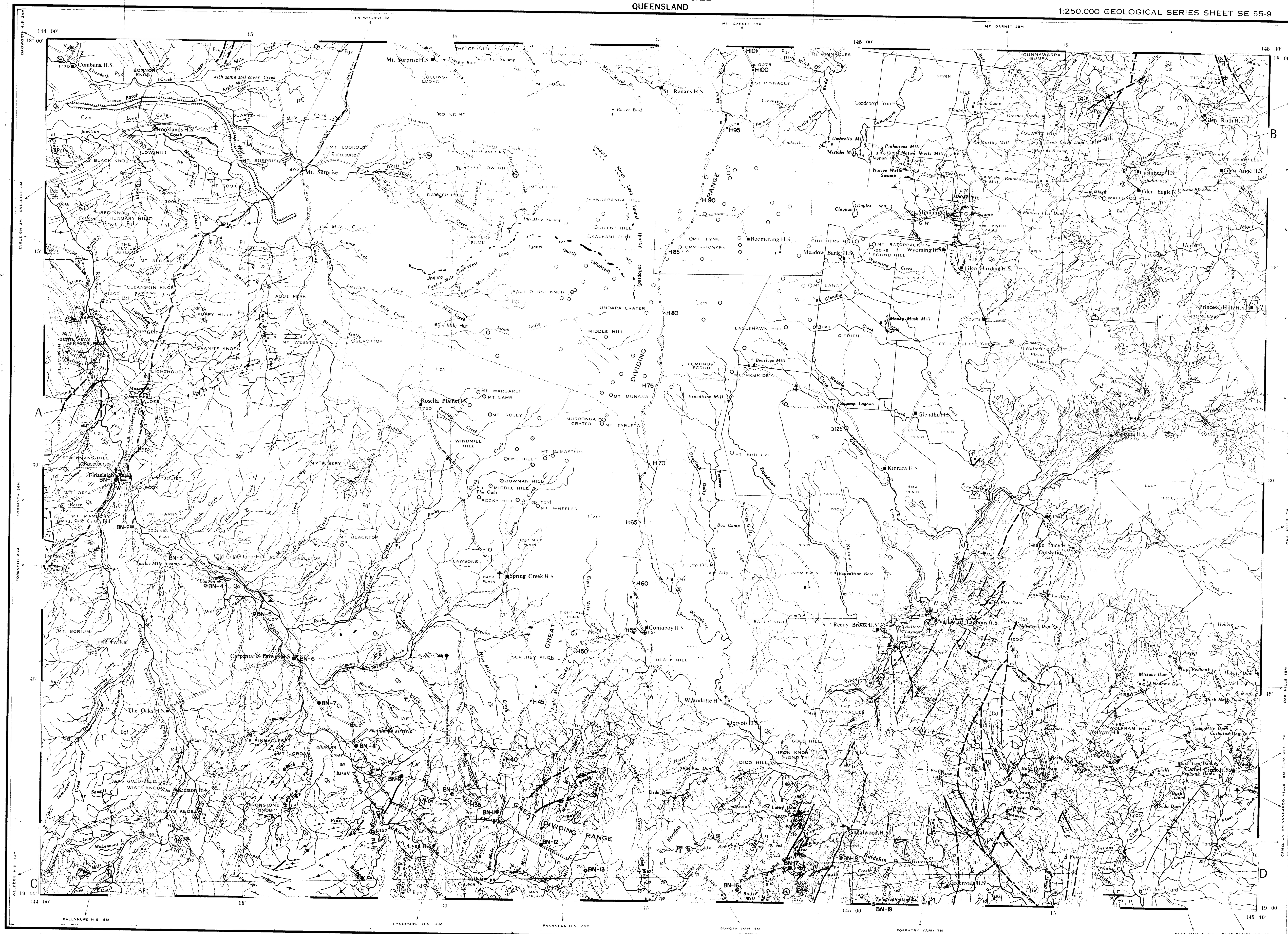
No. 6003.1	:	Level data and station descriptions
6003.21	:	Gravity field sheets
6003.22	:	Gravity drift plots
6003.3	:	Final elevations
6003.4	:	Gravity calculation sheets.

EINASLEIGH
QUEENSLAND

AUSTRALIA 1:250,000

1:250,000 GEOLOGICAL SERIES SHEET SE 55-9

PLATE I



Reference

- Geological boundary
- Fault, showing relative horizontal movement
- Anticline, showing plunge
- Syncline
- Where location of boundaries, faults and folds is approximate, line is broken; where inferred, queried; where concealed, boundaries and folds are dotted; faults are shown by short dashes
- Strike and dip of strata
- Vertical strata
- Overturned strata
- Strike and dip of foliation
- Vertical foliation
- Strike and dip of cleavage
- Vertical cleavage
- Strike and dip of joints
- Dip 15° — 45°, Trend lines, Joint pattern } Air photo interpretation
- Plunge of folds
- Dyke: a - aplite, d - dolerite, p - pegmatite, q - quartz, r - rhyolite
- Volcanic vent
- Macrofossil locality
- Plant fossil locality
- Mine
- Ag Silver, Au Gold, Cr Chromium, Cu Copper, D Diatomite, Mi Mica, Mn Manganese, Ni Nickel, Pb Lead, Sn Tin, W Wolfram } Circle around mineral symbol indicates unexploited deposit.
- Highway
- Vehicle track
- Telephone line
- Railway and station
- Fence
- Dam
- Swamp
- • B Water bore
- • S Spring
- • W Well
- Windpump
- ■ H.S. Homestead
- Landing ground
- E20 Survey station with reference number
- • 350' Barometric spot height in feet ; datum mean sea level

Reference

CAINOZOIC	QUATERNARY		Qa	Alluvium
			Qs	Soil
	RECENT	Kinrara Basalt	Qrk	Olivine basalt
			Cz	Conglomerate, sandstone, shale, claystone
			Czl	Laterite and lateritic soil
	PLIOCENE TO PLEISTOCENE ?		Czb	Basalt
			Czs	Silicified quartz sand ('Billy')
		Chudleigh Basalt	Czc	Olivine basalt
		McBride Basalt	Czm	Iddingsitized olivine basalt
MESOZOIC	CRETACEOUS		K	Undifferentiated sandstone, conglomerate and shale
UPPER PALAEOZOIC			Pzu	Undifferentiated rhyolite, rhyolite-porphyry, quartz porphyry
	PERMIAN (-TRIASSIC?)	Tiger Hill Microgranite	Pgt	Grey microgranite
		Elizabeth Creek Granite	Pge	Pink massive granite
		Lochaber Granite	Pgl	Pink granite with rhyolite-porphyry hood
		Butlers Igneous Complex	Pb	Granite with rhyolite-porphyry hood and trachyte plug
		Newcastle Range Volcanics	Pn	Ignimbrite, rhyolite, pyroclastics. Basal sedimentary lenses
		Herbert River Granite	Pg	Grey porphyritic biotite granite
	CARBONIFEROUS ?	Sunday Creek Volcanics	Cs	Ignimbrite, rhyolite
PALAEOZOIC	DEVONIAN	Boiler Gully Complex		Serpentinized peridotite. Gabbro, microdiorite, diallagite
		Gray Creek Complex	Dg	Serpentinite, pyroxenite, gabbro and amphibolite
				Dolerite. Roof pendants of jasper and chert
	UPPER SILURIAN TO LOWER DEVONIAN	Perry Creek Formation	S-Dp	Quartz sandstone, quartz siltstone, shale. Limestone and conglomerate lenses
		Kangaroo Hills Formation	S-Dk	Quartz sandstone, quartz siltstone, shale with greywacke and greywacke conglomerate lenses
		Mt. Garnet Formation	S-Dm	Greywacke, limestone and arkose conglomerates
	SILURIAN	Pelican Range Formation	Sp	Clayey quartz sandstone, quartz siltstone and shale
		Greenvale Formation	Sg	Clayey quartz siltstone, shale, lenses of quartz greywacke, and greywacke
	LOWER SILURIAN	Wairuna Formation	Slw	Quartz siltstone, shale, claystone, quartz sandstone
PRECAMBRIAN	PROTEROZOIC?	Dumbano Granite	Bgu	Grey biotite granite with pink porphyritic feldspar
		Forsayth Granite	Bgf	Grey porphyritic biotite granite
		Dido Granodiorite	Bgd	Grey hornblende-biotite granite
		McKinnons Creek Granite	Bgm	Cream-pink muscovite granite
		Cobbold Dolerite	Bd	Dolerite, locally metamorphosed to gabbro and amphibolite
		Sandalwood Serpentinite	Bss	Serpentinite with chlorite, talc and tremolite
		Paddys Creek Formation	Bp	Bedded quartz phyllite and quartzite
		Lucky Creek Formation	Bl	Actinolite schist, quartz-chlorite-epidote schist, quartz-albite-hornblende schist, marble, calc-silicate hornfels, calcareous greywacke
	UNDIFFERENTIATED		pC	Undifferentiated garnet-mica schist, mica schist and quartzite
	ARCHAEAN?	Einasleigh Metamorphics	Ae	Gneiss, migmatite, garnet-mica-sillimanite schist, garnet quartzite. Marble lens
		Hall's Reward Metamorphics	Ah	Mica schist, quartz-mica schist, garnet-mica schist, quartzite and migmatite
		Stenhouse Creek Amphibolite	A	Banded amphibolite with marble lenses

∘ H60, ◎ BN-2 } Gravity station

Compiled and published by the Bureau of Mineral Resources, Geology and Geophysics, Department of National Development, in conjunction with the Geological Survey of Queensland. Topographic base compiled and drawn by Royal Australian Survey Corps, with amendments by the Division of National Mapping, Department of National Development. Aerial photography by the Royal Australian Air Force; complete vertical coverage at 1:50,000 scale.
Transverse Mercator Projection

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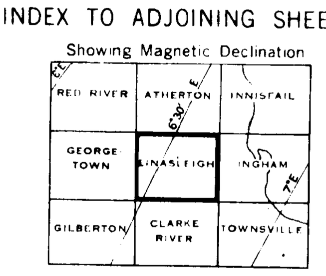
Showing Magnetic Declination

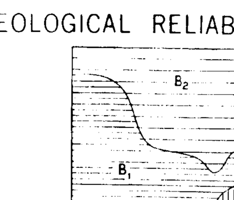


Scale 1 : 250,000

MILES

KILOMETRES

GEOLOGICAL RELIABILITY DIAGRAM

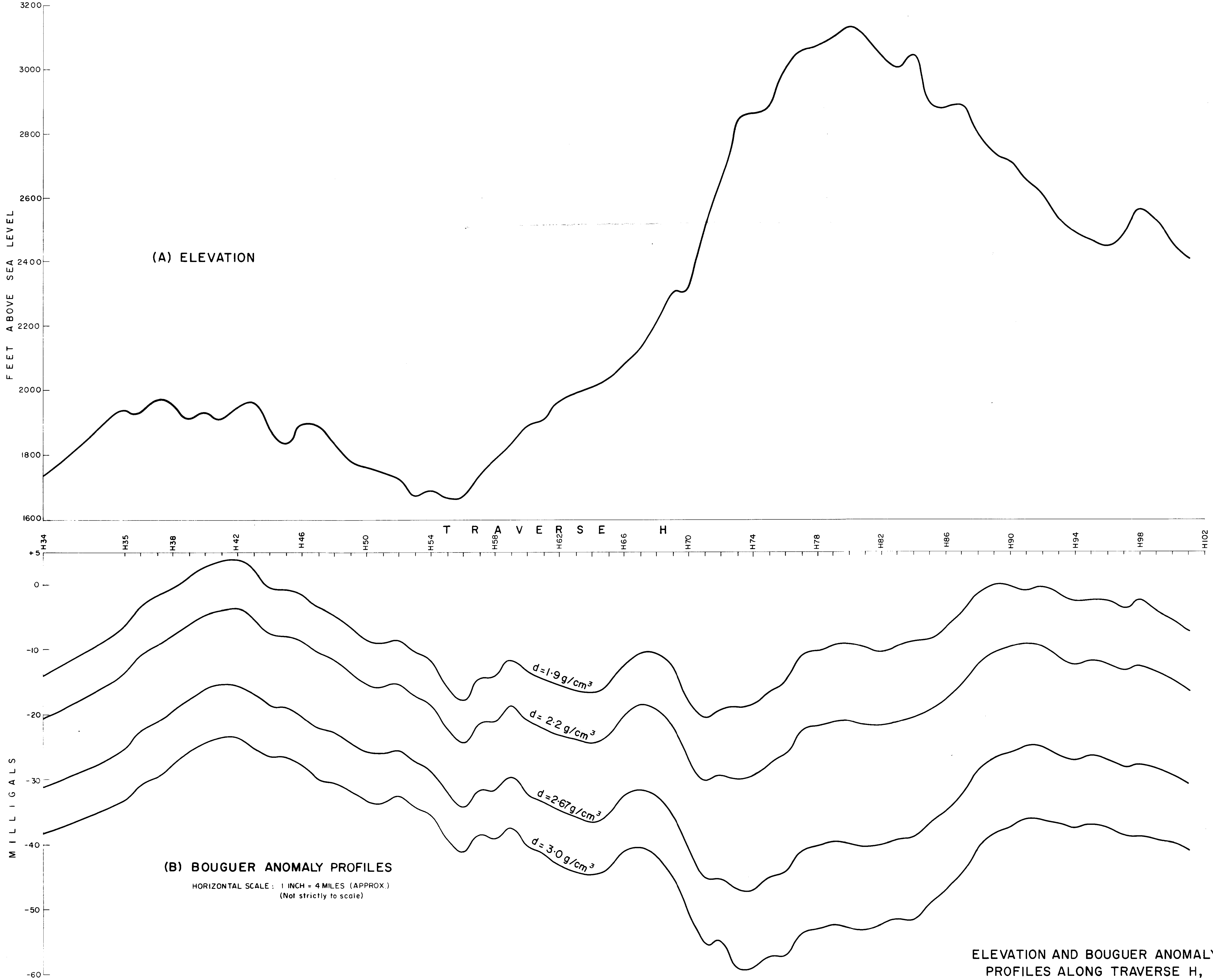


A Detailed mapping
B_1 Detailed reconnaissance, numerous traverses and air-photo interpretation
B_2 Reconnaissance, traverses and air-photo interpretation

Geology, 1956-58, by: D. A. White, J. G. Best, C. D. Branch, K. Hughes, D. H. Wyatt, W. E. Bush, D. H. Green, J. B. Firman.
Compiled May 1959 by: D. A. White.
Drawn 1962 by: Mercury Press Pty. Ltd.

TRAVERSE PLAN AND GEOLOGY

Gravity investigation of the thickness of basalt cover in the EINASLEIGH sheet area, Queensland 1960



ELEVATION AND BOUGUER ANOMALY PROFILES ALONG TRAVERSE H, EINASLEIGH, QUEENSLAND 1960

Geophysical Branch, Bureau of Mineral Resources, Geology and Geophysics E55/B2-35

TO ACCOMPANY RECORD NO. 1966/106