

Regional geophysics of the Alberton – Mangana goldfield, northeast Tasmania

M. J. ROACH

Centre for Ore Deposit and Exploration Studies, University of Tasmania

ABSTRACT

Gold mineralisation in the Alberton–Mangana goldfield occurs within quartz veins hosted by the Siluro-Devonian Mathinna Beds. The distribution of gold occurrences defines a clear NNW-trending lineation which passes through the centre of a corridor of Mathinna Beds sediments separating the Devonian Scottsdale and Blue Tier batholiths. Regional geophysical data has been used to define the gross structure of the goldfield, in particular the form of the adjacent granitoid intrusions and their relationship to gold occurrences.

GEOLOGY

The Alberton–Mangana goldfield is situated in northeast Tasmania approximately 60 km east of Launceston (fig. 1). The geology of the region is shown in Figure 2.

Gold mineralisation is hosted by the Mathinna Beds, a thick succession of regionally metamorphosed sandy turbidites. Structural and stratigraphic relationships within the succession are poorly defined. Deformation in the Early Devonian produced moderate to tight folding with fold axes trending NNW.

Large-scale granitic intrusions closely followed the regional deformation. The Alberton–Mangana goldfield lies within a corridor of Mathinna Beds which separates the Scottsdale and Blue Tier batholiths. The batholiths are composite bodies, each consisting of a number of discrete plutons with characteristic mineralogy, geochemistry and physical properties. The timing of the mineralisation with respect to the regional deformation and the granitic intrusions is unknown.

Thin sequences of flat-lying Permo-Triassic sediments unconformably overlie the Mathinna Beds. These are intruded by Jurassic dolerite sills which form the resistant caps of the isolated topographic high points. The topography is rugged, rising to in excess of 1500 m on the Ben Lomond plateau. Tertiary basalt flows are present in the north of the area around Alberton and Ringarooma.

The Alberton–Mangana Goldfield here refers to the general region comprising, from north to south, the Alberton, Mt Victoria, Dans Rivulet, Mathinna, Tower Hill and Mangana Goldfields. These areas are discussed separately in reports by Twelvetrees (1900, 1904, 1907a, 1907b), Finucane (1935), and Nye and Blake (1938). A synthesis of the geology of the region was carried out by Threader (1967).

MINERALISATION

Gold mining in the region commenced with the discovery of alluvial gold near Mangana in 1852 and reached a peak of activity in the early 1870s, rapidly declining thereafter. By 1900 the majority of mines in the area were closed. Little mining activity has taken place since the 1930s.

Gold mineralisation occurs within discrete quartz veins, silicified shear zones and faults which range from less than one centimetre up to several metres in thickness. Low-grade disseminated mineralisation is uncommon. Mineralised quartz veins are generally steeply dipping and may be locally either concordant or discordant to bedding and cleavage within the regionally metamorphosed Mathinna Beds sedimentary rocks. On a regional scale, the locations of known gold occurrences form a prominent NNW-trending lineation, sub-parallel to the regional bedding trend. This alignment of prospects is suggestive of a major controlling structural feature, which is thought to be a dextral wrench fault system (Taheri and Findlay, 1992). Over much of its length the lineation has a pronounced negative topographic expression. The concentration of prospects around Mathinna and Alberton are inferred to fall within dilatational regions within this shear.

Gold occurs both free and in close association with arsenopyrite, pyrite, galena and sphalerite. The total sulphide content of the quartz reefs is low, typically less than 3%. Gold grades are highest in vein samples which contain several sulphide phases. The majority of veins, while rich in gold, were limited in strike and depth extent, and as a result are not readily suited to modern mining methods. Little modern systematic exploration has been conducted within the goldfield.

The largest mine in the goldfield was the New Golden Gate Mine at Mathinna, which worked a quartz reef system to a depth of 600 m and produced 7895 kg of gold from ore with an average grade of 25 g/t (Williams *et al.*, 1989).

GEOPHYSICS

Regional magnetic and gravity datasets were used to provide some constraints on the gross structure of the goldfield. Measurements of the physical properties of rocks from the study area were made both in the field and from available drill core samples. These results are shown in Table 1.

From a geophysical perspective the Devonian granitic rocks may be subdivided into three main classes:

- Low density, non-magnetic granites and adamellites typical of the bulk of the Blue Tier and Scottsdale batholiths;
- Medium density, non-magnetic granodiorites such as the southern portion of the Blue Tier batholith and zones within the Pyengana Granodiorite;
- High density, strongly magnetic hornblende granodiorite represented by the bulk of the Pyengana pluton.

The Mathinna Beds in the study area are effectively non-magnetic and have a density similar to the magnetic component of the Pyengana pluton. The Mathinna Beds, the granites and adamellites are all non-magnetic, and it is not possible to distinguish between these lithologies based on regional magnetic data alone. An interpretation involving a synthesis of magnetic and gravity data is required in order to confidently predict the subsurface distribution of the various lithologies. The gravity and magnetic data in this case are clearly complimentary.

An aeromagnetic survey of the entire Alberton–Mangana goldfield was conducted in 1989 by the Tasmania Department of Mines (Richardson, 1989). An image of this dataset is shown in Figure 3*. A qualitative interpretation of the features shown in this image is presented as Figure 4.

High-frequency, high-amplitude anomalies result from Tertiary basalt flows (Tb) and from Jurassic dolerite sills (Jd). The low-amplitude linear anomalies in the southeast portion of the survey area are inferred to be caused by thin flows of Tertiary basalt beneath a cover of Quaternary alluvium. Portions of the exposed Pyengana pluton are strongly magnetic, however other zones within the pluton's mapped boundaries are apparently non-magnetic. The differences in physical properties between these two components of the Pyengana pluton have been confirmed by the mapping of Capp (1991).

The long-wavelength, low-amplitude, rounded magnetic anomalies in areas of Mathinna Beds outcrop are interpreted to result from subsurface bodies of granodiorite with physical properties similar to the magnetic portion of the exposed Pyengana pluton. These bodies flank both the Scottsdale and Blue Tier Batholiths. There is no systematic relationship between the distribution of magnetic granodiorite and the sites of known gold mineralisation.

Granodiorite in the Alberton area appears to directly underlie the gold deposits, at a depth of less than one kilometre. This interpretation is supported by the presence of thick porphyry dykes in the workings of a number of mines in the Alberton goldfield (Twelvetrees, 1904). The proximity of underlying granodiorite may also account for the predominance of arsenopyrite within mineralised veins at Alberton, compared to veins at Mathinna and Mangana which are dominated by pyrite and galena (Nye and Blake, 1938).

Gravity stations are sparsely and irregularly distributed throughout the goldfield. Two lines of closely-spaced stations were measured to supplement the existing data. One line passes through Mathinna and the other to the south of Mt Victoria. Topography is rugged and access limited to much of the area. Terrain corrections are high, ranging from 0.5 to 8.1 mGal.

A residual Bouguer anomaly map of the Alberton–Mangana area is shown in Figure 5. The map was derived using the modified MANTLE91 version of the Tasmanian regional gravity field (Leaman and Richardson, 1989). Large negative anomalies are associated with the Scottsdale and Blue Tier batholiths. The magnitude of these anomalies (-25 mGal) is consistent with a thickness of 8–9 km of granite with a density of 2.61 t/m^3 . A relative positive anomaly of up to 10 mGal is associated with the Mathinna Beds corridor. The Mathinna Beds and the Pyengana pluton have the same density (2.75 t/m^3) and hence there is no gravimetric expression of the contact between these two units.

MODELLING

Two-dimensional forward modelling of gravity and magnetic data was carried out for a series of east-west sections crossing the goldfield. All modelling was conducted using magnetic data continued to a constant altitude of 1500 metres. This was necessary because of the large variation in terrain clearance in the raw magnetic data caused by the rugged topography. The important features of the major magnetic anomalies are preserved in the continued dataset.

The magnitude of the gravity anomaly associated with the Mathinna Beds corridor and the Pyengana pluton is low, given the relatively high density contrast with the surrounding granite (0.13 t/m^3). This immediately places constraints on the maximum thickness of the combined package of sediments and granodiorite. It implies that the entire goldfield must be underlain by a large volume of low-density granite. The maximum implied thickness of the Mathinna Beds, assuming the measured densities, is less than three kilometres.

Model sections for two lines are given in Figures 6 and 7. The locations of these sections are shown in Figure 4. Line 1 (fig. 6) extends from the Scottsdale batholith across the Mathinna Beds and Pyengana pluton to the Blue Tier batholith. The positive gravity anomaly on this line clearly results from the combination of the Mathinna Beds and the dense granodiorite. The magnetic anomaly reflects the irregular distribution of the magnetic granodiorite component. The modelled thickness of Mathinna Beds is 1.6 km, while the Pyengana pluton appears to have a maximum thickness of 2.5 kilometres.

Line 2 (fig. 7) passes from the Scottsdale batholith over Mathinna Beds outcrop, crossing two inferred granodiorite bodies. Detailed modelling of the eastern granodiorite suggests a minimum depth of approximately 200 m to the top of the body. Contact metamorphism of the Mathinna Beds is apparent on the surface above the anomaly maximum (Capp, 1991), however a 500 m hole drilled in 1991 by the Department of Mines on the western flank of the anomaly did not intersect granodiorite.

The granodiorite bodies appear to be less than one kilometre in thickness and roughly tabular in form. The upper surface of the granodiorite is constrained by the magnetic data, while the gravity profile determines the location of the contact with the underlying granite. It is probable that the granite has intruded and assimilated the granodiorite. This interpretation is consistent with the observed field relationships to the north, where the Pyengana pluton has been intruded by the younger Poimena granite.

* Figure 3 is located in the pocket at the rear of this bulletin.

SUMMARY AND CONCLUSIONS

Regional geophysical data has been used to place some constraints on the gross structure of the goldfield. The resolution of the data precludes an investigation of the local signature of individual deposits.

Gravity data implies that low-density granitic rocks underlie the entire goldfield. The maximum calculated thickness of Mathinna Beds is 2.6 kilometres. Magnetic data suggests the presence of a number of subsurface bodies of strongly magnetic hornblende granodiorite. There is no clear spatial relationship between these granodiorite bodies and the known gold occurrences.

Mineralisation is structurally controlled on both a regional and a local scale. The identification of favourable structural environments for mineralised vein development is the most important aspect of exploration for gold in the Alberton-Mangana area. The importance of the underlying granitoid intrusives in the formation of the gold deposits, either in the form of the direct input of fluid or as heat sources driving the hydrothermal systems, is as yet unknown.

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Table 1

Physical properties of the major rock types exposed within the Alberton-Mangana goldfield.

	Lithology	Density (t/m ³)		Susceptibility (x10 ⁻³ SI)	
		Range	Value	Range	Value
Tertiary	Basalt	2.80 - 2.90	2.85	Variable	>10
Jurassic	Dolerite	2.70 - 2.85	2.80	Variable	10
Permian	Sediments	2.25 - 2.50	2.40	0.00 - 0.02	0.00
Blue Tier Batholith	Granite	2.59 - 2.63	2.61	0.02 - 0.15	0.05
Scottsdale Batholith	Granite	2.59 - 2.65	2.62	0.02 - 0.20	0.12
Pyengana Pluton	Granodiorite	2.74 - 2.75	2.75	3.0 - 10.0	8.0
	Granodiorite	2.70 - 2.73	2.71	0.15 - 0.30	0.22
Mathinna Beds	Metasediments	2.55 - 2.80	2.74	0.06 - 0.32	0.15

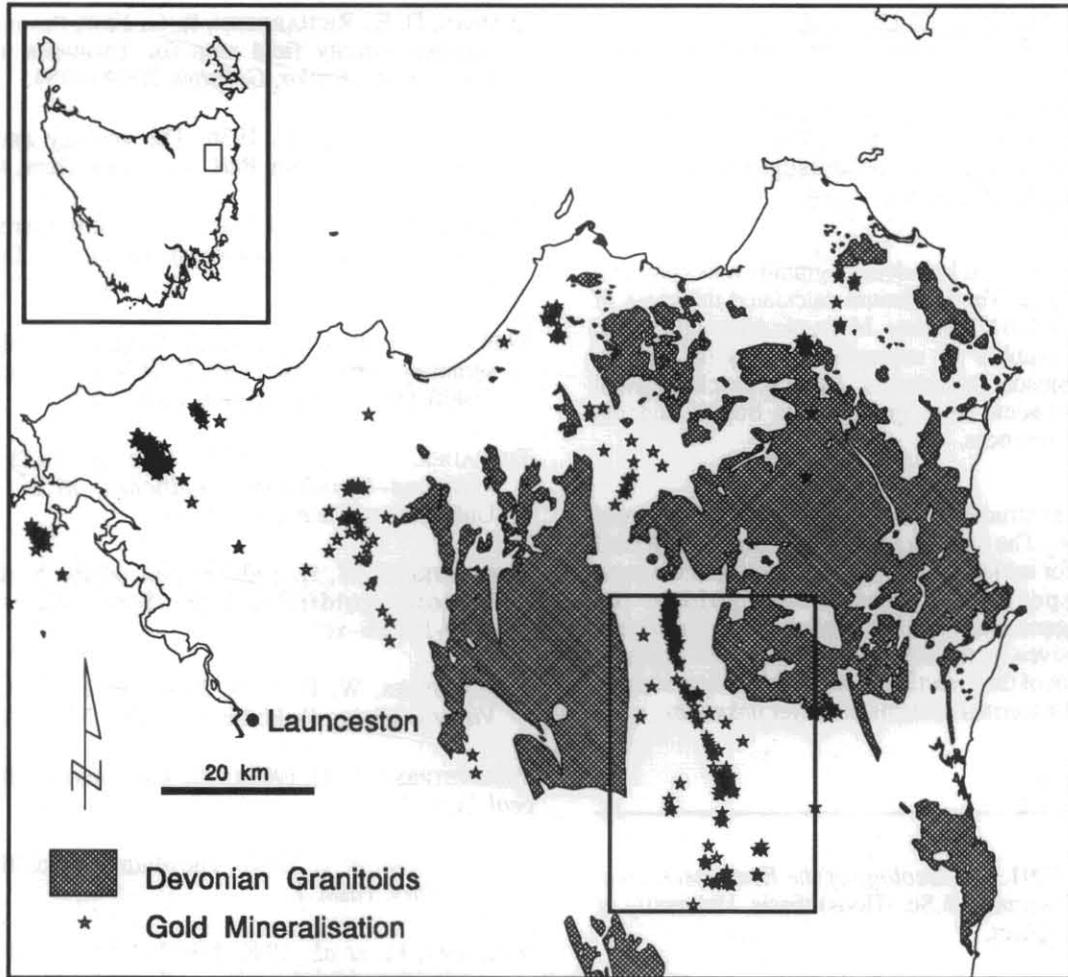
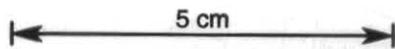


Figure 1

Locality diagram showing the boundaries of the Alberton–Mangana goldfield, the distribution of Devonian granitic rocks, and gold mineralisation locations from the Tasmania Department of Mines MIRLOCH database.



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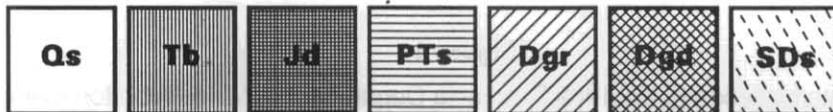
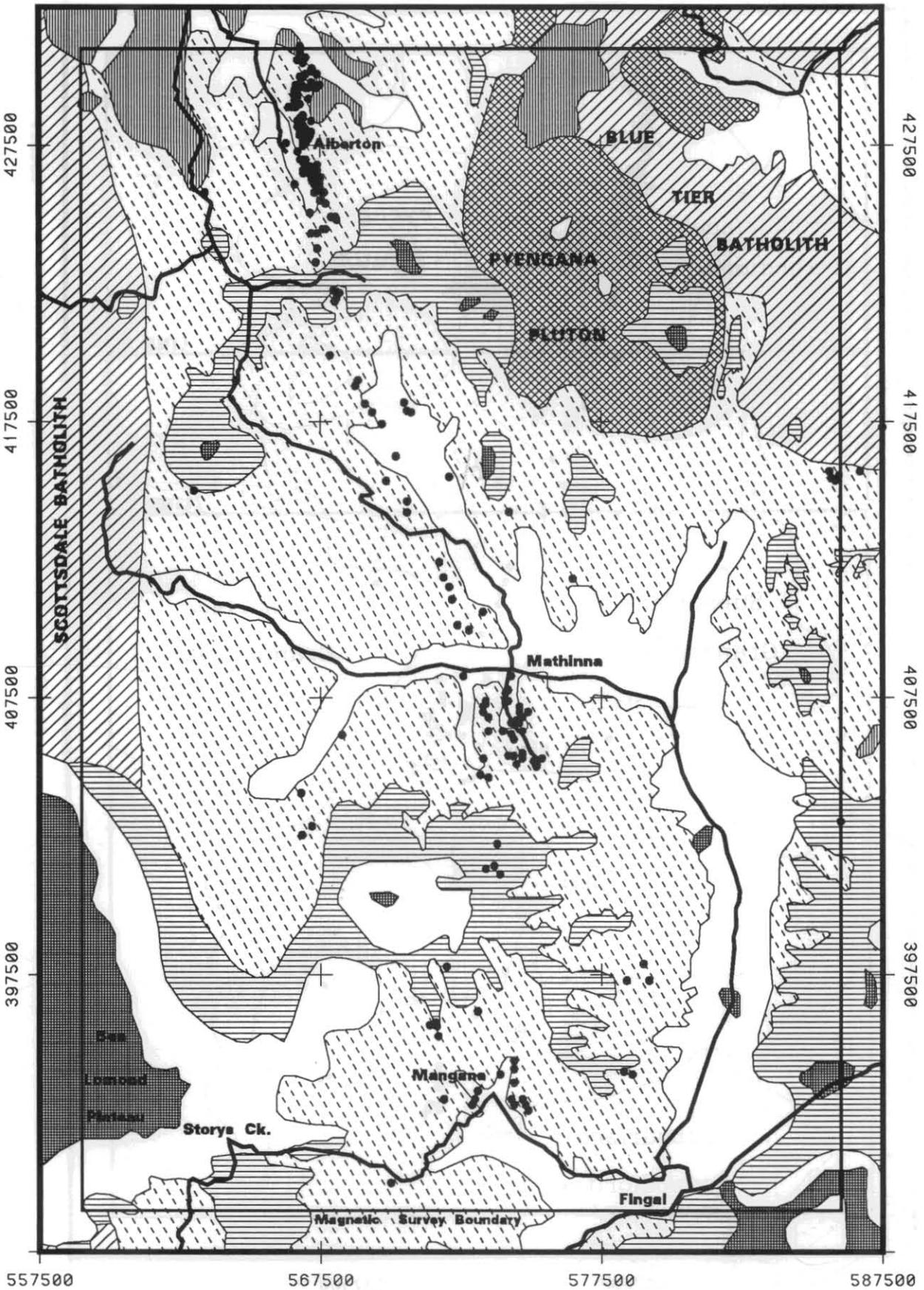
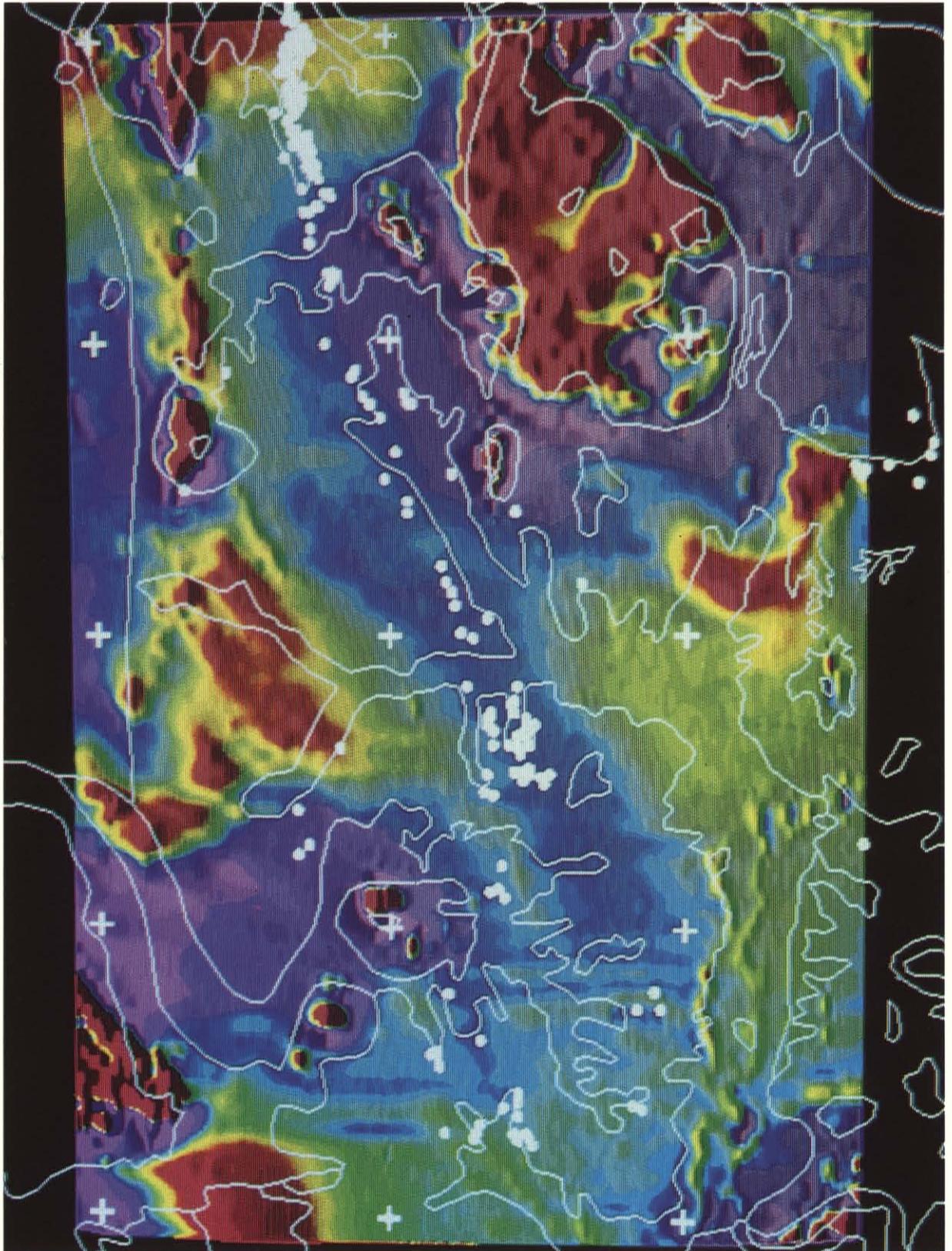


Figure 2. Geology of the Alberton–Mangana goldfield. Mineralised locations from the MIRLOCH database are shown as black dots. (1:200 000, AMG grid).

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Figure 3.
(M. J. ROACH — *Alberton-Mangana goldfield*)

1989 Tasmania Department of Mines Alberton-Mangana aeromagnetic survey, with geology and gold occurrence locations overlaid. Gold mineralisation data from Tasmania Department of Mines MIRLOCH data base. The image is approximately 27 × 42 km with a 10 km grid.

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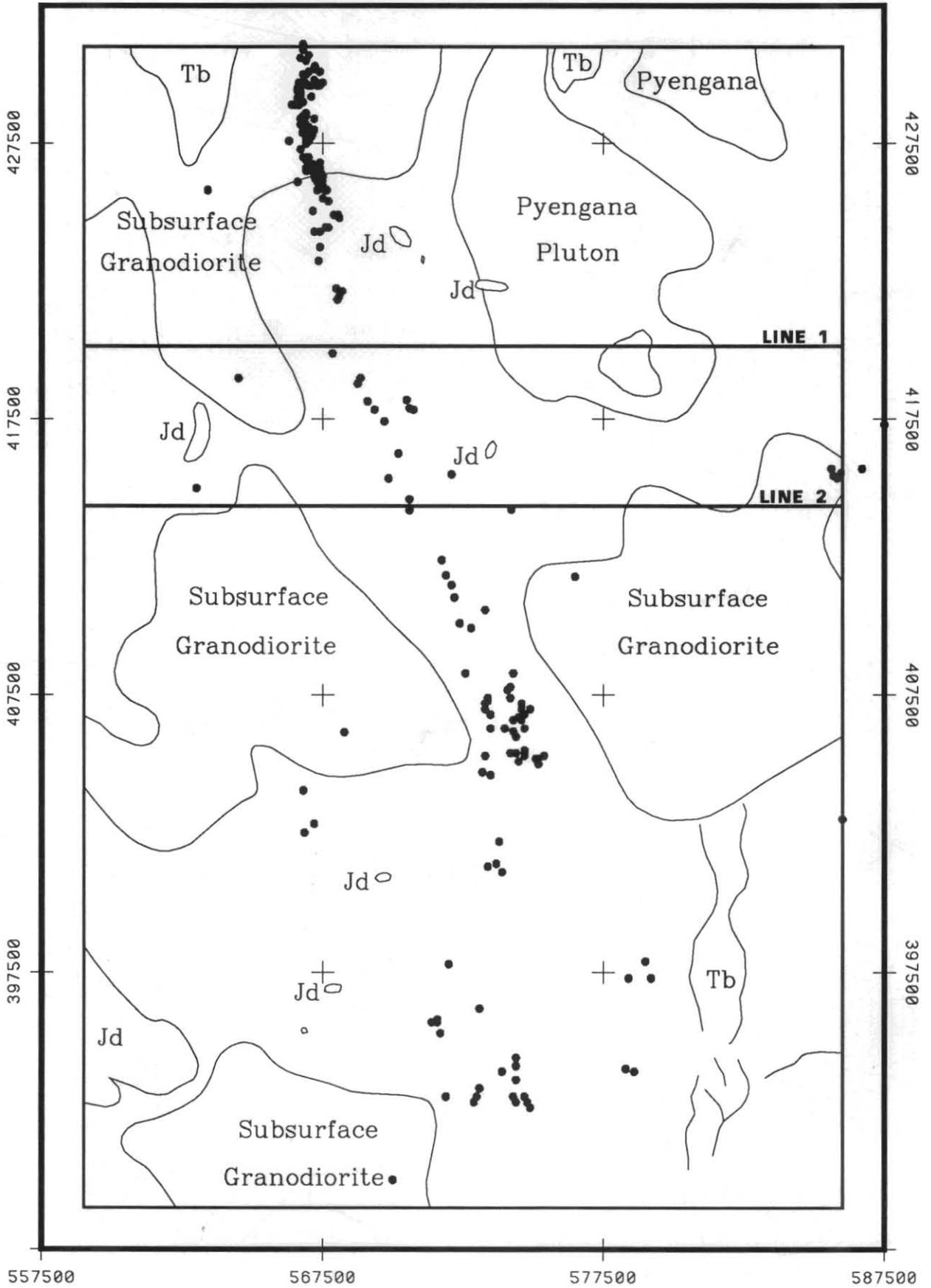


Figure 4

Qualitative interpretation of the 1989 Tasmania Department of Mines Alberton-Mangana aeromagnetic survey shown in Figure 3. (1:200 000, AMG grid).

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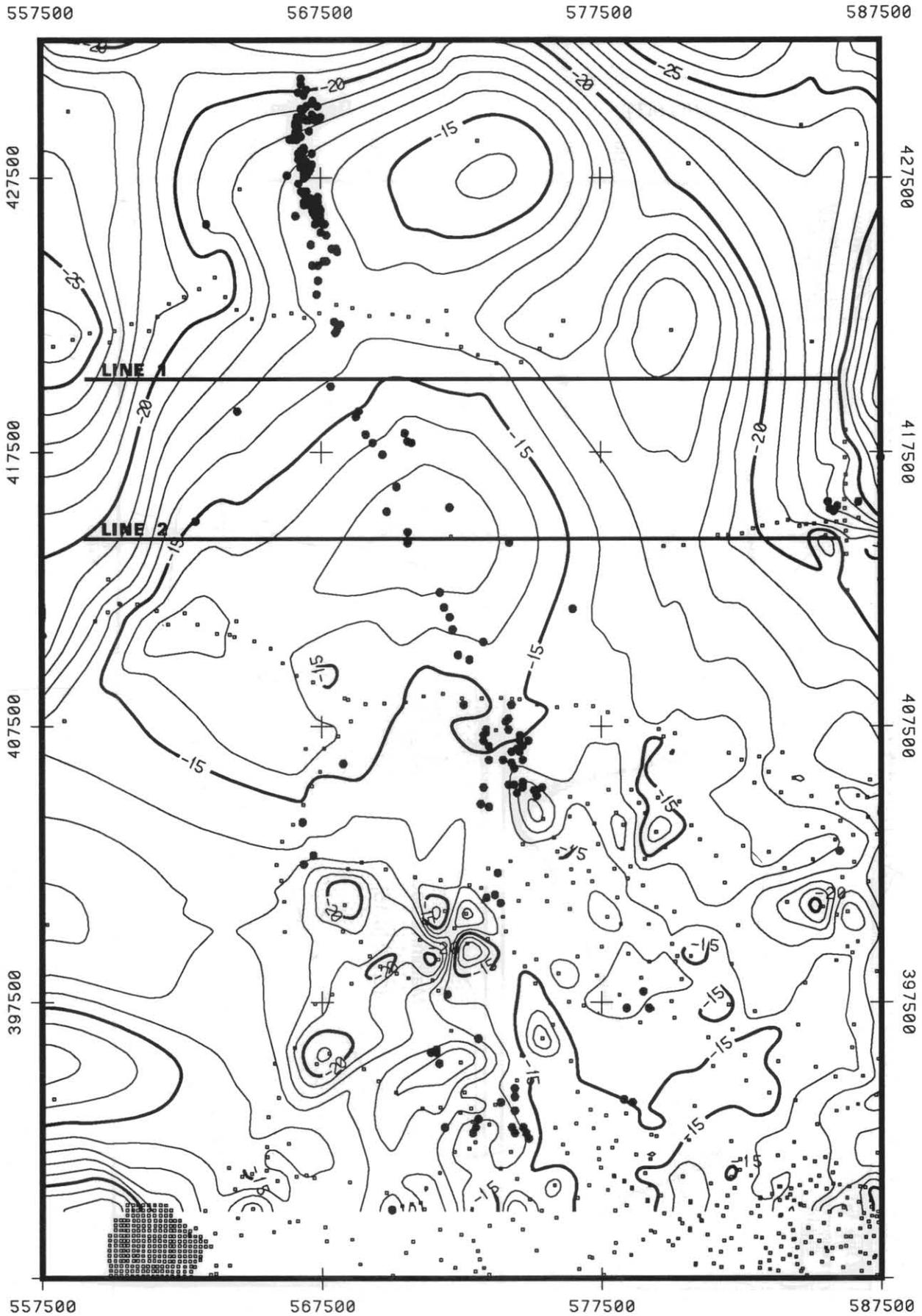


Figure 5

Residual Bouguer anomaly map of the Alberton-Mangana goldfield. Bouguer reduction density 2.67t/m^3 , Mantle91 regional field removed (Leaman and Richardson, 1989). Small squares show the locations of gravity stations. (1:200 000, AMG grid).

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2D GRAVITY AND MAGNETICS MODEL

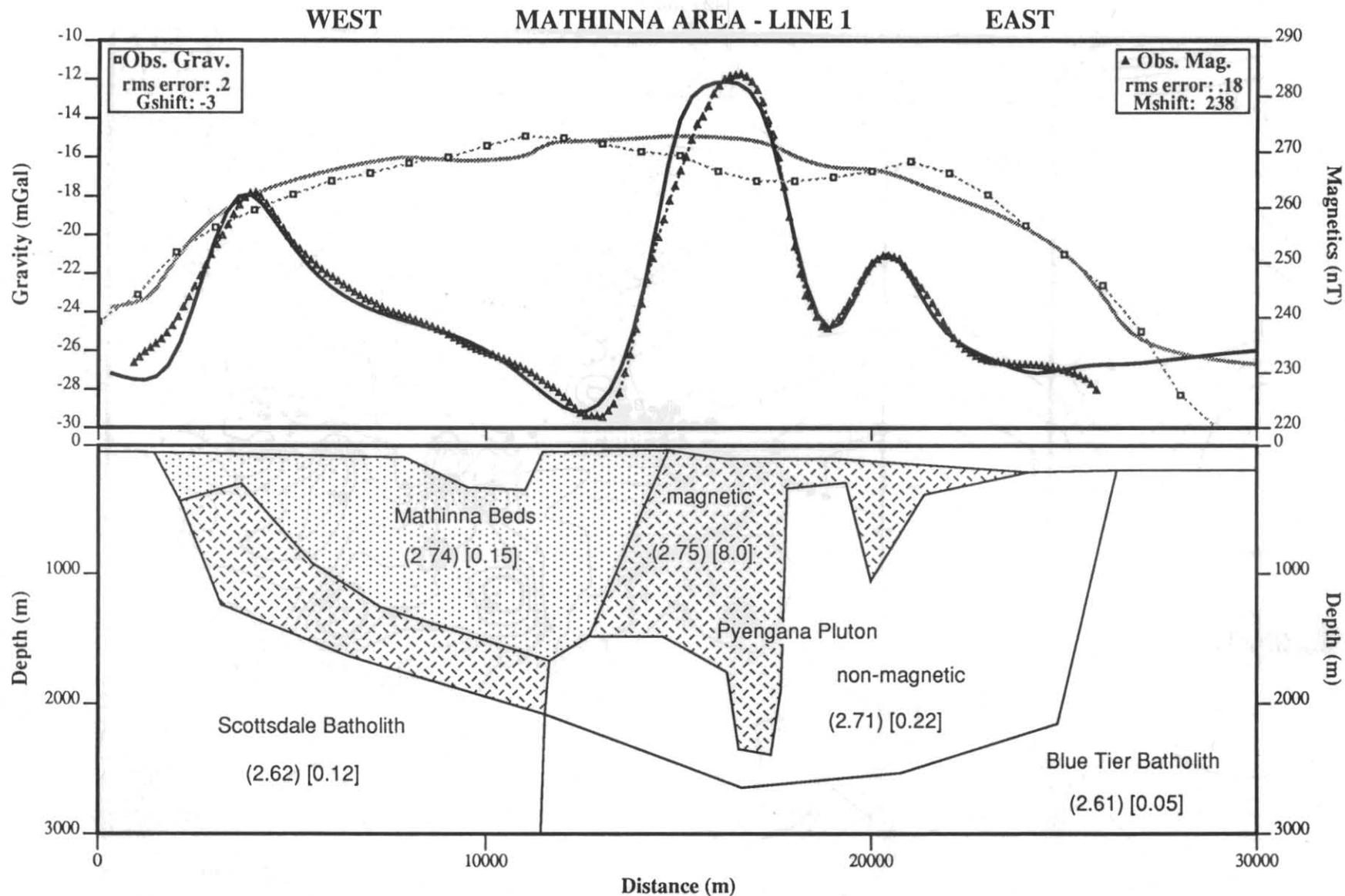


Figure 6. Two-dimensional gravity and magnetics model section crossing the Pyengana pluton. Values in curved brackets are densities (t/m^3); values in square brackets are magnetic susceptibilities [$\times 10^{-3}$ SI]. Location of the section is shown in Figures 4 and 5.

