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Drilling investigations of geophysical anomalies and Cainozoic deposits, Fingal – Mathinna area: Preliminary report

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Abstract

Six diamond-drill holes were drilled in the Fingal–Mathinna area in 1991 by the then Tasmania Department of Mines to investigate unexplained aeromagnetic anomalies and to provide stratigraphic information. Five relatively shallow (100–200 m deep) holes were drilled largely in Cainozoic units, and one deep (504 m) hole was drilled in Mathinna Beds, for a total of 1160 metres. The main geological results were:

- (a) a large magnetic anomaly centred on a spur of Golden Ridge [EQ83651438] is due to magnetic zones within the Mathinna Beds, caused by magnetite probably deposited during hydrothermal alteration.
- (b) a small intense anomaly near Upper Esk [EQ63061149] is due to a small pipe-like basaltic diatreme of probable Tertiary age, which explosively disrupted the Mathinna Beds country rock and is now completely concealed by alluvium.
- (c) a series of elongate, sinuous anomalies extending along the floor of the South Esk River valley for 13 km to the north of Fingal are due to Tertiary dolerite-clast conglomerates, probably deposited in channels of the meandering ancestral South Esk River.
- (d) a large negative anomaly about 4 km north of Fingal is due to Tertiary basalt lying within the conglomerate.

Further detailed work on the core is required to fully assess the stratigraphic, geophysical, geochronological and economic implications.

INTRODUCTION

Late in 1990 the Regional Geological Mapping Section of the then Geological Survey Branch received a request from the Drilling Section of the Department of Mines to devise a diamond-drilling programme in northeast Tasmania. As the regional geologists were then engaged in mapping the Alberton 1:50 000 scale map sheet (McClenaghan *et al.*, 1993) and had recently produced the adjoining Ben Lomond 1:50 000 scale map sheet (Calver *et al.*, 1988), it was decided to take this opportunity to investigate several unexplained aeromagnetic anomalies in the region. These

anomalies had appeared on the Department's 500 m line spacing aeromagnetic survey which was flown in 1989. The drilling would also obtain stratigraphic data on lowland Cainozoic, potentially auriferous, rock and sediment units.

Possible drill sites were selected and field inspection of geological and logistic aspects was undertaken. In some cases, ground proton-precession magnetometer traverses were done to pinpoint anomalies.

Ultimately six holes were drilled (fig. 1), comprising five relatively shallow (100–200 m) holes largely in Cainozoic units, and one deep (504 m) hole in Mathinna Beds.

A second deep hole, planned near Chinamans Corner [EQ636201], was not drilled. During 1991 the Department's drillers were offered redundancies, with the majority eventually accepting. The Drilling Section was disbanded completely in early 1993.

The locations of the holes were not surveyed because of lack of funds. However the quoted co-ordinates are thought to be accurate to within 50 metres. All holes were vertical at the collar.

Detailed logging, petrography, geochemistry etc. on the core is still proceeding as work programmes permit. Thus the following should be regarded as preliminary notes.

1. BROOKS CREEK DRILL HOLE [EQ83651438, Brilliant 1:25 000 map]

This hole was designed to investigate a large asymmetric magnetic anomaly of >61 815 nT, about 60 nT above background, centred on a spur of Golden Ridge near EQ836150. On the Alberton map sheet and the adjoining St Helens sheet (McClenaghan *et al.*, 1987) the area is shown as Mathinna Beds, and the anomaly centre is about 1.6 km from the contact of the essentially non-magnetic Haleys New Country adamellite pluton and outside the mapped contact aureole. To ease access in the steep terrain, the hole was sited south of the anomaly centre, on the south bank of Brooks Creek and in State Forest.

Advice from geophysicists R. Richardson (Department of Mines) and M. Roach (1991) (University of Tasmania

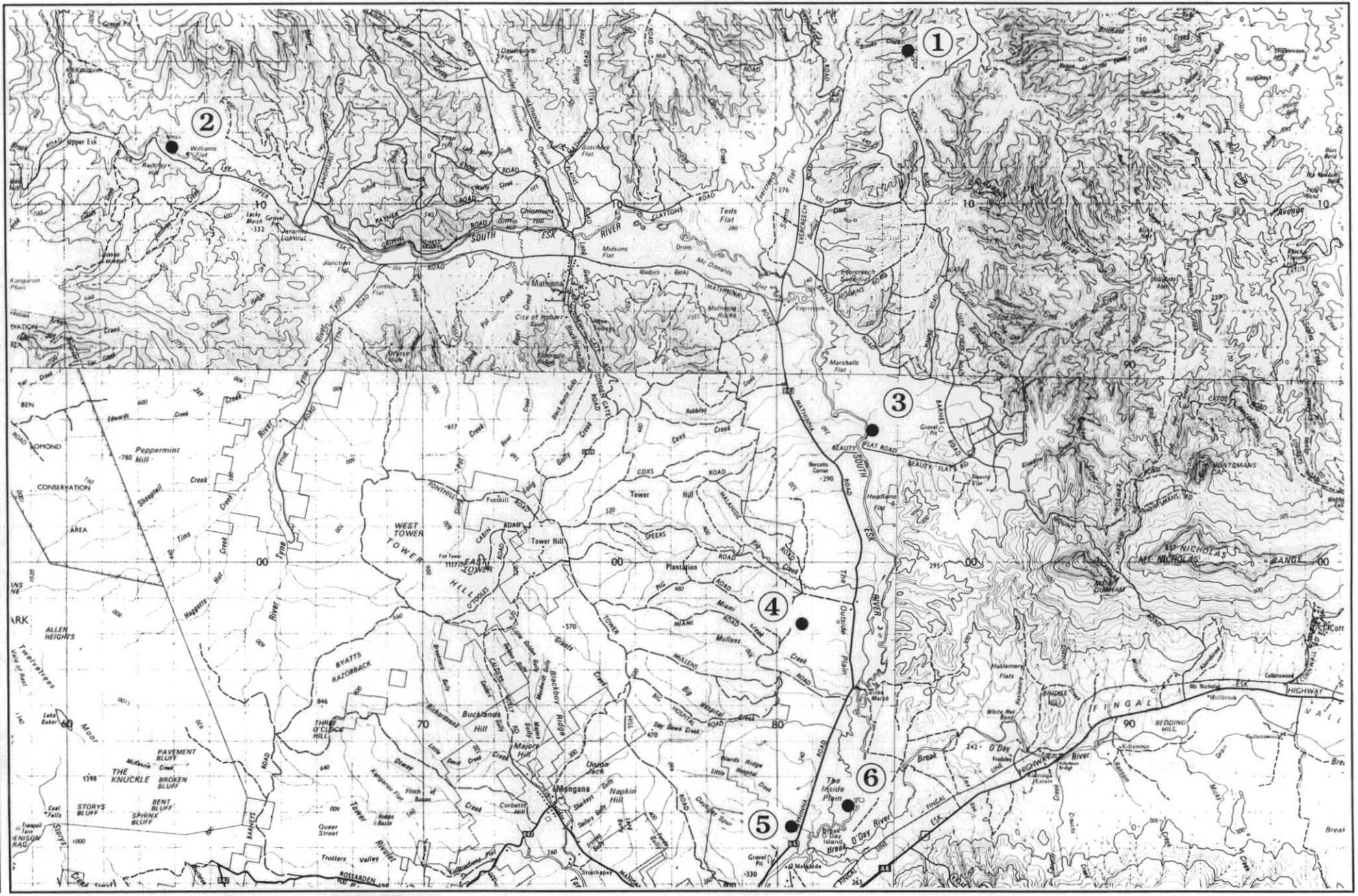


Figure 1. Location of drill holes

5 cm

Ph. D. student) was that the likely source of the anomaly was magnetic granodiorite (similar to that of the Pyengana pluton about 5 km to the northeast), at depths of no more than a few hundred metres. However the hole reached a depth of 504 m without encountering any granodiorite, and a decision was made to terminate drilling.

The core consists of an apparently monotonous turbidite sequence of interbedded pale-medium grey quartzarenite and subordinate medium-dark grey lutite, typical of the Mathinna Beds apart from the subhorizontal bedding.

Roach noted that two strongly magnetic ($X = 10 \times 10^{-3}$ SI units) intervals were present, between about 15–40 m and at about 115–225 m depth. The remainder of the core is essentially non-magnetic ($X = 0.1 \times 10^{-3}$ SI units approximately). Detailed scrutiny shows that the magnetic/non-magnetic boundary is sharp, cross-cuts bedding, and has characteristics suggestive of an alteration front. Elsewhere in northeastern Tasmania magnetic zones in the Mathinna Beds, although rare, are known from the Lisle and Gladstone areas, where they appear parallel to bedding (M. Roach, *pers. comm.*).

Minor euhedral pyrite is present within the hole. Quartz veins are present mainly below about 325 metres.

Petrographic and x-ray diffraction studies by R. S. Bottrill (Mineral Resources Tasmania) confirmed the presence of magnetite in the magnetic intervals. Quartz, white mica, chlorite, plagioclase, porphyroblastic apatite, minor biotite, and occasionally hematite, calcite and kaolinite were also noted. A positive correlation between magnetic susceptibility and illite crystallinity is attributed to temperature effects, probably hydrothermal alteration, depositing magnetite.

Further investigation of this drill hole, which has important implications for the interpretation of magnetic surveys and possibly for ore deposit models in northeast Tasmania, is proceeding as time and staff availability permit.

2. UPPER ESK DRILL HOLE [EQ63061149, Saddleback 1:25 000 map]

The purpose of this hole was to determine the source of a small intense positive magnetic anomaly located on a flight line on the 1989 aeromagnetic survey near Redclay Hill, about 3 km ESE of Upper Esk. On the aeromagnetic survey the anomaly is apparently about 60 nT above local background. However, field inspection with a hand-held proton-precession magnetometer indicated an even more intense and localised anomaly with a centre of 66 140 nT (about 4000 nT above background) locatable to within a few metres. The anomaly width at half maximum is only about 60 m, and in east-west profile there is a shoulder about 40 m east of the centre. On the basis of this data R. Richardson (*pers. comm.*) estimated the source to be a narrow (40 m width) body with a top about 15 m below the surface, and a high susceptibility suggestive of either basalt or dolerite, although part of the anomaly may be due to remnant magnetisation.

The anomaly is located on Mr F. J. Cook's property "Conroys Gap", in a flat paddock about 100 m from the south bank of the South Esk River, in an area mapped on

the Alberton map sheet as Quaternary river alluvium. Tough grey siltstone with quartz veins, assigned to the Mathinna Beds, crops out on the opposite river bank about 180 m north of the anomaly. A few hundred metres to the southwest, weathered brown, well-cleaved micaceous siltstone float also assigned to the Mathinna Beds occurs on Redclay Hill.

A vertical drillhole was collared directly over the anomaly centre. A summary log is:

- 0–c.7 m: Poor recovery, mainly river boulders.
- c.7–c.19 m: Poor recovery, sandy clay and fragments of deeply weathered breccia.
- c.19 m–140 m: Pyroclastic breccia. Matrix-supported with angular to sub-rounded clasts (<1 mm to 100 mm) of Mathinna Beds lithologies in a dark grey-green to black basaltic matrix. Clasts become more abundant and generally larger with depth. Magnetic susceptibility about 12×10^{-3} SI units. Subvertical contact at base.
- 140–198 m: Mathinna Beds, mainly dark grey well-cleaved lutite. Magnetic susceptibility about $0.2–0.8 \times 10^{-3}$ SI units.

The body is a basaltic diatreme of probable Tertiary age, occurring as a subvertical pipe-like body, which disrupted the Mathinna Beds country rock probably explosively. The hole eventually veered into the wall rocks at a depth of 140 metres. Further study of the core, including a petrographic search for heavy minerals (especially those indicative of high pressures), is warranted. The diatreme has no present surface expression, being entirely concealed beneath alluvium.

3. PEBBLE PLAIN DRILL HOLE [EQ82650368, Dublin Town 1:25 000 map]

The purpose of this hole was to investigate the Cainozoic deposits in the vicinity of the site of the former Beauty Flat bridge, about 14 km north of Fingal. Just south of this locality, the alluvial plain of the South Esk River becomes relatively narrow (circa 2 km), with Mathinna Beds rocks mapped on slightly higher ground both to the east and west, while to the north the plain broadens somewhat. Tertiary basalt (olivine nephelinite, unpublished data of J. L. Everard) crops out on the east bank of the river over a distance of about 500 m north of the bridge site, between EQ825035 and EQ825030, and similar basalt is mapped from float about 1 km to the ENE, also on the Ben Lomond 1:50 000 scale geological map sheet. More basalt occurs in a broad tongue further east, as shown on the adjoining St Marys 1:50 000 scale geological map sheet (Turner *et al.*, 1984), but this basalt is a tholeiite (Everard, 1987). The 1989 aeromagnetic survey suggests that the feeder for this latter basalt is located nearby at EQ853045. The surface boundary between the two basalt types roughly coincides with the boundary between the Ben Lomond/ St Marys map sheets near EQ835040 but outcrop is too poor and the terrain too flat to allow any relative age relationship to be established by field observations. Both types of basalt are

associated with siliceous gravel and sand of inferred Tertiary age. A small outcrop of Mathinna Beds basement occurs on the opposite (west) bank of the river at the bridge site [EQ823032].

It was thought that a substantial thickness of Tertiary deposits might be present in this area, particularly if one or both of the basalts had dammed the precursor of the South Esk River in Tertiary times. Two east-west ground traverses, each of about 500 m, with a proton-precession magnetometer suggested that the olivine nephelinite flow near its river exposure is only 200–300 m wide and passes east laterally into the Tertiary gravel.

The hole was drilled about 160 m east of the river bank over the (negative) magnetic anomaly attributed to the olivine nephelinite. The site is in a fairly flat paddock on the "Pebble Plain" property of Mr C. D. Loane. Basement was reached at a depth of only 26.3 metres.

A summary log is:

- 0–25.3 m: Basalt, massive, dark grey, fresh, $X = 3 \times 10^{-3}$ SI units.
- 25.3–26.3 m: Sandy brown clay.
- 26.3–104 m: Mathinna Beds — grey-green lutite becoming grey at depth. Bedding at $30\text{--}60^\circ$ to core axis. $X = 0.1 \times 10^{-3}$ SI units.

4. PIG ROAD DRILL HOLE [EP80639832, St Marys 1:25 000 map]

The aim of this hole and the Little Hospital Creek hole (see below), both on the "Malahide" estate, was to determine the source of a somewhat sinuous linear positive anomaly, or chain of anomalies, extending in a north-south direction for about 13 km along the western side of the South Esk valley subparallel to the present river, from just north of Fingal to west of the Beauty Flat bridge site. The Pig Road hole was sited near a high of about 61 780 nT (25 nT above local background) on this magnetic ridge, which is clearly apparent on the 1989 aeromagnetic survey. Topographically, the site is at the base of low foothills, composed of Mathinna Beds, flanking the valley. Dolerite talus is mapped in the vicinity on the Ben Lomond map sheet, and the hole was collared on a rocky knoll, bearing several large, rather weathered, disoriented dolerite boulders up to two metres across, partly buried in soil. As the nearest *in situ* Jurassic dolerite outcrops are about 10 km to the west at Tower Hill, the 'talus' may be a very old, perhaps lag, deposit. About 1200 m of ground magnetometer traverses confirmed a generally positive, but very irregular, anomaly in the vicinity.

A summary log of the hole is:

- 0–14 m: Soil and deeply-weathered dolerite boulders.
- 14–63.5 m: Conglomerate, clast-supported, with well-rounded cobble-sized clasts, dominantly of dolerite.

- 63.5–109.4 m: Mathinna Beds, mainly pale grey arenite with subordinate interbedded darker grey lutite.

The conglomerate is interpreted as a lithified river cobble deposit, and the sinuous linear anomaly as the trace of a Tertiary channel of the ancestral South Esk River (see also Little Hospital Creek drill hole). The clasts of Jurassic dolerite account for the magnetic response.

5. LITTLE HOSPITAL CREEK DRILL HOLE [EP80529256, St Marys 1:25 000 sheet]

This hole investigated the source of another positive magnetic anomaly, about 20 nT above local background on the 1989 survey, which forms a knoll on the sinuous magnetic ridge extending for 13 km north of Fingal, on which the Pig Road drill hole was also sited. The hole was sited in a flat paddock just west of the Fingal–Mathinna main road, in an area mapped as older alluvium of river terraces on the Ben Lomond 1:50 000 scale geological map sheet. A small area of dolerite 'talus' (or lag?) is shown about 300 m south of the site. Mathinna Beds rocks crop out at the base of hills about 500 m to the west.

A summary log of the hole is:

- 0–c.2 m: Medium-brown, gritty dolerite-derived soil.
- c.2–c.14 m: Mainly dolerite fragments — broken core.
- 14–73 m: Conglomerate, clast-supported. Well-rounded cobbles of mainly dolerite, with subordinate Mathinna Beds lithologies, in a brown coarse sandy matrix. Interval (0.4 m thick) of flaser coal and poorly-lithified sandstone near 49 metres.
- 73–136 m: Mathinna Beds. Mainly well-cleaved medium-grey lutite, quartz veins present.

As for the Pig Road hole, the magnetic anomaly is attributed to the dolerite-clast conglomerate, thought to represent a Tertiary river channel deposit. A more recent, higher resolution aeromagnetic survey flown in 1993 shows more clearly a complex system of sinuous, braided and branching anomalies extending along the South Esk valley floor to the north of Fingal. These are strongly suggestive of a meandering river system.

6. INSIDE PLAIN DRILL HOLE [EP81989303, St Marys 1:25 000 map]

This hole investigated a large double-centred negative magnetic anomaly, about 40 nT below background, located about 4 km north of Fingal on the west bank of the South Esk River just above its confluence with the Break O'Day River. The locality, also on the "Malahide" estate, lies on swampy, flood-prone river flats, mapped as Quaternary stream alluvium and swamp deposits on the Ben Lomond 1:50 000 scale map sheet. A percussion drilling programme by the Anglo American Corporation (Mellor, 1982) showed that the alluvium in the vicinity is underlain by "carbonaceous grey clay, gravel including dolerite

boulder beds, and minor conglomerate and lithic sandstone" of probable Tertiary age. Some of these holes bottomed in Mathinna Beds basement. Older alluvium on river terraces and dolerite 'talus' (possibly Tertiary lag deposits) are mapped within 2 km of the anomaly. Ground investigations showed that the nearest bedrock exposure is cleaved Mathinna Beds lutite on the river bank about 1 km to the north at EP825947 (not shown on the Ben Lomond map). Mathinna Beds rocks also crop out on low hills 2 km to the west, and Permian sedimentary rocks a similar distance to the south, east, and northeast.

About 1350 m of ground traverses with a proton-precession magnetometer were conducted across the anomaly. These confirmed a broad undulating negative anomaly with a minimum about 200 nT below background, elongated in a NNE-SSW direction.

A summary log of the hole, collared about 50 m west of the river bank and 70 m SSW of a low knoll, is:

- 0–0.7 m: Soil, clayey, light-brown.
- 0.7–5.5 m: River pebbles, mostly quartzarenite and vein quartz.
- 5.5–(?)11.4 m: Clay, silty clay and sandy clay.
- (?)11.4–17.5 m: No core except for 150 mm of lateritic ironstone.
- 17.5–34.2 m: Sandy clay, clay and minor intervals (<15 mm) of coal.
- 34.2–37.2 m: River pebbles and cobbles, of quartzarenite, vein quartz and conglomerate as below.
- 37.2–55.2 m: Conglomerate, clast supported, pebble to boulder-sized clasts of Jurassic dolerite, quartzarenite and other Mathinna Beds lithologies, subordinate vein quartz, rare granitoid, rare basalt.
- 55.2–61.7 m: Basalt, massive to slightly vesicular or amygdaloidal, fine grained.
- 61.7–64.7 m: Basaltic breccia, with about 30% intermixed clayey to silty sediment. Finely acicular zeolite (natrolite) in voids.
- 64.7–75.0 m: Basalt, as above.
- 75.0–84.2 m: Conglomerate as above, but with a higher proportion of dolerite clasts relative to Mathinna Beds clasts.
- 84.2–108.8 m: Mathinna Beds; interbedded lutite and arenite. Bedding variable; steep and overturned to subhorizontal and right way up.

The magnetic anomaly is attributed to the basalt (X typically $1-5 \times 10^{-3}$ SI units) which petrographically is a basanite or olivine nephelinite, similar to that cropping out 10 km to the north at Beauty Flat. A feeder may exist at this

locality with flows extending northward (upstream but at a very low gradient in terms of present drainage) to the latter locality. A Tertiary age for the basalt is highly likely. As the anomaly is negative, it must be largely due to remnant magnetisation, implying basalt extrusion at an epoch of reversed geomagnetic polarity. A sample of the basalt has been submitted for chemical analysis, but results are not yet available.

The dolerite-clast dominated conglomerate, occurring both above and below the basalt, is interpreted as a Tertiary river channel deposit. Although its magnetic susceptibility is similar to the basalt, the dolerite clasts are likely to be magnetically disoriented. Therefore the unit is unlikely to possess significant remnance and cannot account for a negative anomaly. A series of sinuous linear positive magnetic anomalies, aligned roughly north-south along the valley axis in this vicinity, suggests meandering river channels, consistent with this interpretation of the conglomerate.

The grey clay lying above the conglomerate is of uncertain age, although the presence of ironstone and minor coal suggests that a Tertiary rather than Quaternary age is more likely. Samples have been taken by S. M. Forsyth for palynological study but results are not yet available.

Further study of this hole has the potential to substantially improve our understanding of the age of post-Jurassic deposits and processes in northeast Tasmania. A radiometric date on the basalt could have implications for the Tertiary geomagnetic and palynological time scales.

Fossil Tertiary placers may conceivably be present in the conglomerates. Therefore assaying the conglomerates in this hole, and in the Pig Road and Little Hospital Creek holes, for gold might be worthwhile.

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