



## INTRODUCTION

The Phase 1 interpretation of newly acquired, or augmented, gravity and magnetic data within the D'Entrecasteaux Region of Southern Tasmania has indicated (i) a number of features which seem to be related to dolerite feeders and (ii) relatively high bulk contrasts for the dolerite sheets (0.002 cgs minimum).

The interpretation has been reported by Leaman (1987).

Many of the implied feeders were in areas where no detail had ever been recorded about the character of the dolerite. Only mapping by Leaman (1972) notes relevant features and that by Farmer (1981) is quite deficient in this respect. Thus in order to calibrate and confirm the implications of the interpretation each region was visited and the local dolerite inspected.

This report records the results of these inspections.

## OBSERVATIONS

Feeders were inferred in the general region of Nierrina-Red Hill, Grove, Mt. Mangana, Howrah, Ridgeway, Dennes Point, Bruny Main Road, Grey Mountain, Cremorne, Garden Island Creek, Nine Pin Point and at other sites further west and south. In order to test the veracity of the interpretation and the reality of inferred contrasts only those sites closest to Hobart and Bruny Island were reviewed. Any region could have been selected for control purposes.

Leaman (1972, 1975) proposed feeders near Nierrina-Red Hill, Howrah and Cremorne on the basis of other evidence (petrological, textural, structural and gravimetric) and it is no surprise to find these sites identified. The magnetic data, however, specifies the precise location of the major differentiated and depth extended column which is the feeder system and is not misled by surface distribution or local structure. Thus the Howrah feeder centre is located SSW of Howrah and the Cremorne centre a little south of Lauderdale. The Nierrina-Red Hill system is compound but the well known granophyres all lie close to pipe axes.

Leaman (1972, 1975) also proposed feeders near Mt. Nelson and east of Huonville. The new data and interpretation shows that the Huonville system is located a little west of Grove but there is no feeder on Mt. Nelson east of the Southern Outlet. This conflict was noted by Leaman (1987) but it can be explained. The petrological characters sought lie between Ferntree and Ridgeway and it is clear that the centre of the Nelson-Wellington intrusions lies in this region. The gravimetric shift to the east is generated by the contrast with Tertiary units and structures along the Derwent and is not related to the Nelson dolerite.

The interpretation was provided on the basis of these correlations.

Several other sites have been reviewed to assess the predictive reliability of the interpretation. These include the region of Upper Garden Island Creek, Nine Pin Point-Verona Sands, North Bruny Island and Mt. Mangana. In all cases coarse pegmatitic differentiates and granophyres, either as local injections or accumulations, were observed within the peak response zone. The nearness of contacts or sheet margins is not systematic and this material can occur within 10m of an intrusive boundary, but its presence is critical. There is no doubt that the magnetic data defines these zones and the feeder axes which accompany them.

On North Bruny Island the exposure near Sadgrove Point is intrusive and near, if not part of, a feeder arm. The main feeder system on North Bruny is, as suggested by the position of the magnetic anomaly, located west and south of Barnes Bay township. An accessory feeder is located south of Dennes Point. Granophyres were observed at all sites. Textural and magnetic properties change rapidly and systematically to both east and west of these sites.

Investigation on South Bruny Island was somewhat restricted but it is clear that a feeder lies on the western face of Mt. Mangana as suggested by the magnetics. It was not precisely located, being off ready access routes, but the local systematic changes in magnetic properties and texture certainly support its existence.

An array of sites was then selected for susceptibility measurement. The interpretation has implied that the minimum effective contrast for dolerite sheets in this region is of the order of 0.002 cgs with some as high as 0.004 and feeder systems in the range 0.003 to 0.004 cgs. The latter estimate must be very approximate since only the most basic geometries were applied. Were these values reasonable?

Some extant data was collated and new observations acquired. These results are summarised in the table. The range in values is not shown; only the median for a particular site. Where values may have been biased by variable textures or weathering and two families are indicated, two results are shown.

Magnetisation data is only available for projects directed at palaeomagnetic or research objectives. This is unfortunate and magnetometer methods could be more generally applied in order to provide estimates of the Koenigsberger ratio (K).

The table implies quite low susceptibility values generally for the Jurassic dolerites; generally of the order of 0.001 cgs or less. Where magnetisations are known these are significantly more than any induced magnetisation implied by the susceptibility and the Koenigsberger ratio is rarely less than 1.

This has significant ramifications for the use of the results in modelling and interpretation.

The following discussion illustrates the means of assessing the Koenigsberger ratio and its conversion into practical implications as a contrast controlling aspect of the rock's properties.

Calculation of Koenigsberger ratio.

Ratio of Magnetisation and Induced magnetisation

$$K = J/kF$$

where J = rock magnetisation, k = susceptibility, F = magnetic field

if J = 0.00163 Gauss (emu)

F = 63000 gammas

= 0.63 Oe

k = 0.00224

0.00163

$$\text{then } K = \frac{0.00163}{0.00224 \times 0.63} = 1.2$$

Consider some of the issues of units and effective contrast.

Observed susceptibility : 0.00224 cgs = 0.028 SI

Observed magnetisation : 0.00163 emu = 1.63 A/m

Koenigsberger ratio : 1.2

In a field of 63000 gammas (nT) the resultant (magnetisation) effect is

$$\frac{63000 \times 0.00224 + 0.00163}{100000} = 0.00304 \text{ Oersted}$$

100000

The equivalent susceptibility (or contrast) is

$$0.00304/0.63 = 0.0048 \text{ cgs}$$

Thus, for a rock with a Koenigsberger ratio of little more than 1, the effective contrast could be more than double the observed susceptibility.

Could be, since the calculation presumes maximisation of the vector. Review of those samples for which vector orientations are known shows that the Declination scatter is centred on the present field and the Inclination, whether normal or reversed, is within 5 degrees of the present field. This means that for the predominantly normal condition the above calculation is representative and only a 10 to 20% overstatement of the actual full vector calculation. The general conclusion and application is valid and indicates that the measured susceptibility of a piece of dolerite should be, at least, doubled for modelling purposes and that the effect of detailed variations in remanence can be ignored once this has been done.

Where the remanent magnetisation is reversed, and opposes the inducing field, there is an equivalent reduction and for values of  $K > 1$  the result may be a strong negative response. As far as is known this condition is relatively unusual but insufficient full property determinations have yet been made of the huge

volume of dolerite in Tasmania to be certain.

Table 1 presents estimated effective contrasts where these can be estimated on the basis of measurements. In all other cases, where only susceptibility data is available, the reader should generally consider the contrast to be at least double the observed value.

This conclusion should be supported by more complete observations but it is not suggested that expensive sampling and laboratory methods are generally necessary. Enough control of this type exists to reliably use field magnetometer determinations. These require rough shaping of the rock sample, crude orientation - basically up or down, and measurement of the change induced in the magnetometer head by the specimen placed up or down at a measured distance. These observations yield two equations for the variables susceptibility and magnetisation and both, with the orientation of the magnetisation, can be estimated.

#### CONCLUSIONS

Inspection of dolerite sites identified by significant magnetic anomalies has confirmed that each represents the locus of intrusion or is very close to the feeding centre. This may be judged on petrographic evidence.

Assessment of the magnetic properties of the dolerite at those sites and elsewhere has demonstrated that the effective minimum contrast for the dolerite is of the order of 0.002 cgs irrespective of the susceptibility value determined. Thick sheets present higher values due to the increased proportion of medium and coarse-grained more magnetic components. Pegmatitic, granophyric accumulations near the feeders may lead to bulk values in excess of 0.005 cgs.

#### REFERENCES

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TABLE 1  
SUMMARY OF DOLERITE MAGNETIC PROPERTIES

Site	Coordinates (E,N)	cgs units		K	Note	Contrast
		Susc (k)	Magnetis (I)			
1	525000, 5257400	0.00042	0.00033	1.2	f-m	0.0009
2	526100, 5253500	0.00224	0.00163	1.2	f-m	0.0048
3	535500, 5256800	0.00039	0.00415	16.9	m-c	0.007
4	520500, 5225600	0.00084	0.00258	4.9	m-c	0.005
5	516400, 5220100	0.00014	0.00006	0.7	f	0.00022
6	502000, 5229100	0.00041	0.00030	1.2	f-m	0.0009
7	503800, 5233000	0.00073	0.00105	2.3	m	0.0024
8	504400, 5234500	0.00035	0.00064	2.9	f-m	0.0013
9	519400, 5244800	0.00005	0.00015	4.8	f	0.00028
10	506500, 5219500	-	0.00043	-	var	-
11	506500, 5219500	-	0.00084	-	var	-
12	506500, 5219500	-	0.00451	-	var	-
13	506500, 5219500	-	0.0116	-	var	-
14	519700, 5220200	0.00024	0.0014	9.3	m	0.0025
15	519550, 5219950	0.0024	0.0012	0.8	m	0.0043
16	520550, 5224400	0.00048	0.00024	0.8	m	0.00086
17	520550, 5224400	0.00034	0.0012	5.6	m	0.0022
18	522700, 5220300	0.00059	0.0011	3.0	m	0.0024
19	525300, 5223400	>0.00032	0.00018	0.9	f	0.0006
20	524700, 5223650	0.0	0.00001	-	f	-
21	522850, 5222900	>0.0044	0.007	2.5	gra	0.015
22	523600, 5219550	0.00156	0.0011	1.1	c	0.0032
23	523450, 5217000	0.00016	0.00004	0.4	f	0.00027
24	521250, 5224500	0.0	0.0019	-	c	-
25	521200, 5224350	0.0	0.002	-	c	-
26	519500, 5219900	0.00012	-	-	f	-
27	521000, 5214150	0.0016	-	-	c	-
28	525300, 5237400	0.00006	-	-	f	-
29	519700, 5227800	0.0015	-	-	m-c	-
30	524700, 5222000	0.00016	-	-	m	-
31	525000, 5222700	0.001	-	-	gra	-
32	526500, 5222200	0.0002	-	-	f-m	-
33	529500, 5222600	0.0012	-	-	c	-
34	530200, 5222100	0.0011	-	-	c-gra	-
35	519400, 5203000	0.0008	-	-	m	-
36	519400, 5201600	0.0003	-	-	f-m	-
37	520300, 5197400	0.0005	-	-	f-m	-
38	521500, 5197700	0.0008	-	-	m-c	-
39	522700, 5199000	0.0007	-	-	m-c	-
40	523400, 5199000	0.0001	-	-	f-m	-
41	524000, 5198750	0.0001	-	-	f	-
42	524300, 5198600	0.0002	-	-	f-m	-
43	528600, 5198600	0.0001	-	-	m-c	-
44	524000, 5205250	0.0011	-	-	m-c	-
45	530500, 5215600	0.0014	-	-	gra	-
46	530300, 5223600	0.0006	-	-	c	-
47	530500, 5224800	0.0009	-	-	c-gra	-
48	530500, 5225500	0.0011	-	-	c	-
49	529100, 5228800	0.001	-	-	gra	-
50	529250, 5224500	0.0019	-	-	c-gra	-
51	529100, 5224000	0.0015	-	-	c	-

Site	Coordinates (E,N)	Susc (k)	Magnetis (I)	K	Note	Contrast
52	524000,5223200	0.0003	-	-	f-m	-
53	524800,5247500	0.0001	-	-	f	-
54	525800,5242800	0.001	-	-	c	-
55	527000,5234200	0.0007	-	-	c	-
56	527400,5232900	0.001	-	-	m-c	-
57	518500,5230200	0.0016	-	-	gra	-
58	519700,5227900	0.0015	-	-	gra	-
59	520500,5224400	0.0014	-	-	c	-
60	516800,5220300	0.0015	-	-	c	-
61	512000,5219300	0.0007	-	-	m	-
62	508500,5217000	0.0004	-	-	m	-
63	511200,5212800	0.0003	-	-	f-m	-
64	512200,5212200	0.0001	-	-	f-m	-
65	511500,5210400	0.001	-	-	m-c	-
66	512000,5208700	0.0018	-	-	m-c	-
67	514500,5208250	0.0006	-	-	m-c	-
68	516500,5208100	0.0005	-	-	m	-
69	518400,5208250	0.0007	-	-	m	-
70	520600,5216300	0.0009	-	-	m-c	-
71	519700,5237600	0.002	-	-	c-gra	-
72	518500,5239300	0.0003	-	-	m	-
73	517000,5241100	0.0002	-	-	f-m	-
74	517000,5241100	0.0018	-	-	f-m	-
75	540800,5251500	0.0001	-	-	f	-
76	540800,5251500	0.0025	-	-	c-gra	-
77	529700,5252800	0.0	-	-	f	-
78	528700,5252800	0.0003	-	-	f-m	-
79	528900,5253850	0.002	-	-	c	-
80	528700,5254500	0.002	-	-	c	-
81	533500,5251000	0.0015	-	-	m-c	-
82	533500,5251000	0.004	-	-	m-c	-

## Sources

Irving (1956) Sites 1-9

Francombe (1978) Sites 14-29

D.E. Leaman Sites 30-

Robertson &amp; Hastie (1962) Sites 10-13

## Grain size code

f fine

m medium

c coarse

gra granophyre