

11. Magnetic anomalies, Derwent Estuary and Storm Bay

D.E. Leaman

A major magnetic anomaly, or series of anomalies has long been known to exist west of Betsey Island in the northern portion of Storm Bay (chart AUS 171). Volume II of the *Australian Pilot* (First edition, 1918; Fifth edition, 1969) describes features 3.2 km at 300° true from the Iron Pot Light and extending for some distance in a NNW direction. The later edition puts the area boundary somewhat to the south and west. Compass deflections of 17 to 26° have been recorded.

It is possible that Matthew Flinders in the *Norfolk* (1798) also crossed some of the anomalies in Storm Bay. His route north of Betsey Island and south of the Iron Pot is such that an unsteady compass might be expected (compare 1918 edition of *Australian Pilot*, p.371, line 13). He does mention, in the introduction to *A Voyage to Terra Australis in the Investigator* (1814 ed), small deviations.

The presence of a large magnetic disturbance in this area has always appeared geologically enigmatic since few rocks could produce such an effect and most of those capable of it are unlikely to be present. In order to verify the existence of such an anomaly, gain an estimate of its size and distribution and fix its position traverses were sailed across the Derwent Estuary and the northern part of Storm Bay. The coverage is not exhaustive but several anomalous areas have been located (fig. 15).

EQUIPMENT

A fluxgate magnetometer with a sensitivity of 10 nanoteslas (nT) and capable of operating in vertical or horizontal positions was positioned in a gimbal at sea level in a wooden boat. The location of the magnetometer was fixed after consideration of boat motions and magnetic effects from the engine (astern). The magnetometer was most sensitive to vertical motions.

No special navigation equipment was carried and courses were sailed on various landmark transits. With careful choice of transits and compass checking it was possible to pinpoint positions within 60 m.

RESULTS

Profiles of the major anomalies located as well as the position of anomalous areas are presented in Figures 15 and 16. The broken line indicates the limits of the present survey. It will be noticed that reports of a further anomaly north-west of Betsey Island have not been checked. Anomalies less than 300 nT are not indicated in Figure 15 but were recorded east and west of the Tinderbox Channel.

Five NE-SW traverses and one NW-SE traverse across the principal anomaly are shown in Figure 16. In each case the vertical component of the anomaly is asymmetrical and has a peak value of 11,000-12,000 nT. The anomaly diminishes rapidly to the south, but is elongate in a NNW direction. A smaller anomaly was recorded to the NW. No anomalies were located in the region of the chart marking and the features recorded appear to be distinct and separate. The main anomaly occurs in 19 m of water which is 3-6 m shallower than surrounding areas. This suggests that the anomaly feature is exposed on the bay floor and is more resistant to erosion. Chart 171 indicates a 20 m contour in the region of the anomaly. Other anomalies may be smaller due to a cover of bay silts. Away from the main features there are no deviations and the records are very 'flat'.

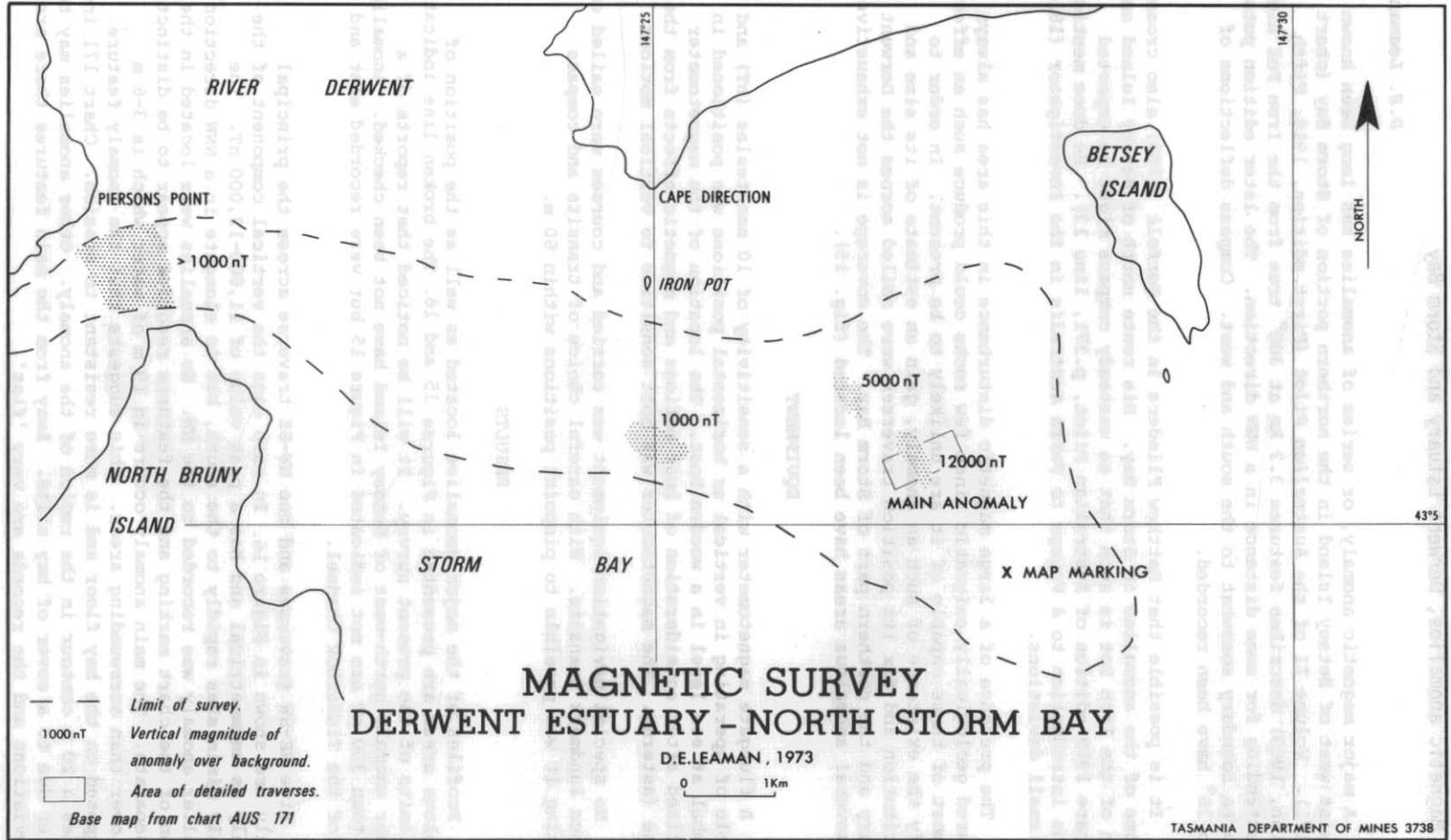


Figure 15.

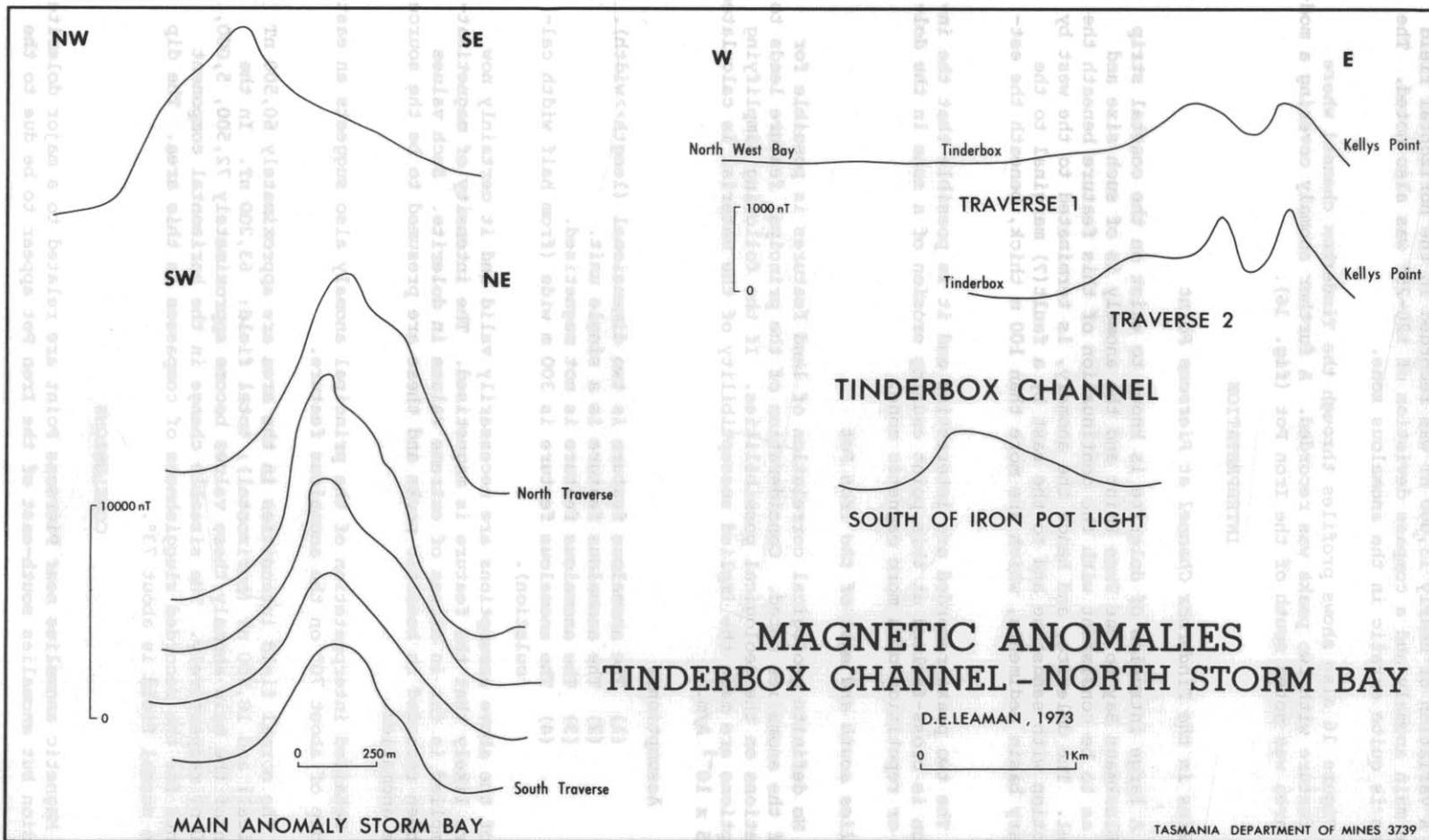
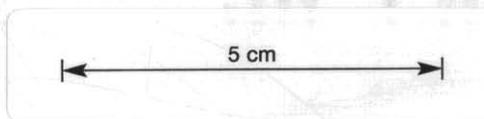


Figure 16.



A variation of nearly 13,000 nT was recorded in the horizontal field at the main anomaly and a compass deviation of $\pm 20-25^\circ$ was also noted. The compass is quite erratic in the anomalous zone.

Figure 16 also shows profiles through the Tinderbox channel where broad feature with two peaks was recorded. A further anomaly covering a moderate area was noted south of the Iron Pot (fig. 16).

INTERPRETATION

Anomalies in the Tinderbox Channel at Piersons Point

A large intrusion of dolerite is known to exist on the coastal strip from Blackmans Bay to One Tree Point and the anomaly is of such size and shape as to be consistent with the continuation of this feature beneath the channel. The dolerite, and hence the anomaly, is terminated to the west by a junction with sandstone and to the east by a fault(?) marginal to the Tertiary basin sediments, which are more than 100 m thick, beneath the estuary.

The two peaks recorded are interesting and it is possible that the intrusion is cross-faulted at this point causing erosion of a zone in the dolerite or repetition of a more magnetic zone.

Anomalies south and east of the Iron Pot

No definite geological correlation of land features is possible for any of the anomalies noted. Consideration of the principal feature leads to limitations on the geological possibilities. If the following simplifying assumptions are made the implied susceptibility of the material is calculated at 125×10^{-1} A/m.

Assumptions:

- (1) The anomalous feature is two dimensional (length \gg width).
- (2) The anomalous feature is a single unit.
- (3) The anomalous feature is not magnetised.
- (4) The anomalous feature is 300 m wide (from half width calculation).

None of the above assumptions are necessarily valid and it certainly now appears likely that the feature is magnetised. The intensity of magnetisation implied is far in excess of extreme values in dolerite. Such values have been recorded in basaltic necks and these are presumed to be the source of the anomalies.

Detailed interpretation of the principal anomaly also suggests an eastward dip of about 70° on the anomalous feature.

The normal field intensities in the area are approximately 60,500 nT (vertical) and 18,300 nT (horizontal); total field: 63,200 nT. In the region of the main anomaly these values become approximately 72,500, 5,000, 72,700 nT respectively. The sizeable change in the horizontal component accounts for the recorded sluggishness of compasses in this area. The dip of the normal field is about 73° .

CONCLUSIONS

Magnetic anomalies near Piersons Point are related to a major dolerite intrusion but anomalies south-east of the Iron Pot appear to be due to the

presence of basalt necks. Seismic surveys or grab sampling of the bay floor would help to confirm the presence of basalt. The main anomaly is related to a rise in the bay floor and this variation in relief, or lack of silt cover, may be the reason for the increased anomaly in this zone. Further surveys will be required to assess anomalies claimed to exist north of Betsey Island.

[28 May 1973]

In order to avoid damage, yet realizing that the human body is itself very sensitive to small vibrations, an arbitrary limit on particle velocity has been imposed, this being a fraction of what has been accepted in Aust- ralis and overseas as causing damage. There has been considerable debate in the literature as to what the damage threshold is and how it should be defined. In some cases there has been a detailed analysis of the explosives, building damage and vibration characteristics during a construction programme. However, since there has been no direct correlation, or description, of rock type, rock quality, structural properties or seismic data it is never possible to simply or directly apply the information elsewhere. In the author's view the data reported and contained in typical vibration engineering practice is incomplete since it lacks a time origin and full wave analysis. All re- cords are arbitrary and based on a neglect of geological considerations.

This arbitrary approach has often led to unexplained and unexpected results. A programme of test blasting is needed to establish vibration data for Tasmanian rocks in order to obtain predictable results. This report presents a summary of the results obtained in preliminary tests aimed at establishing guidelines for the investigation.

EQUIPMENT

OTSA seismograph: This instrument is normally used for shallow ref- raction surveys and is capable of recording records up to 1 second with up to 12 traces. Impact time and 10 ms timing lines are provided on the record. In the past no more than 2 channels were used so as to provide an uncluttered record of the full waveform.

Bison 1570B enhancement seismograph equipped with wide range geophones: The instrument is capable of displaying a detailed waveform over various time ranges (25-500 ms) as well as providing a time base which permits mark- ing and identification of any wave character. The time origin is also pro- vided. It is possible to examine the effects of coherent interference using the enhancement property of the instrument.

Major driving an oceanic weight: This device was used to impart a range of vibration frequencies to the soil. It is capable of operating from 15-100 Hz. It was possible to pick the resonant frequency using the OTSA seismograph.

DEFINITIONS

Amplitude of an oscillatory motion, A, is the maximum displacement of the oscillating particle from its equilibrium position.