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INVESTIGATION OF THE CHARACTERISTICS AND SOURCE
OF THE MAGNETIC RIDGE MAGNETIC ANOMALY,
COBAR, NSW

by

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ABSTRACT

The Magnetic Ridge magnetic anomaly, near Cobar, New South Wales, is one of a number of linear positive magnetic features whose axes coincide with lines of mineralisation. It can be traced for about 50 km, from 10 km south of Cobar to 20 km north of the CSA Mine. The CSA Mine is associated with a local magnetic anomaly on the axis of Magnetic Ridge. During 1978 and 1979, the Bureau of Mineral Resources examined the geological parameters controlling the geophysical characteristics of the Cobar area and its mineral deposits. Part of the project consisted of investigations into the sources of magnetic anomalies. To study the magnetic highs associated with lines of mineralisation near Cobar, BMR made airborne, carborne, and ground magnetic surveys, and a gravity survey across the Magnetic Ridge anomaly. Magnetic Ridge was found to comprise a broad anomaly interpreted as being caused by a tabular source in bedrock at 95 m depth, and many short-wavelength superimposed anomalies arising from near-surface magnetite accumulations. A vertical hole was drilled to test the interpreted depth to the top of the bedrock source and to determine the mineralogy and physical properties of the source. Resistivity, induced polarisation, and magnetic field measurements were made in the hole, and magnetic susceptibility, remanence, density, porosity, resistivity, and induced polarisation measurements, and copper and zinc assays were made on the drill core. The physical property measurements confirmed the magnetic interpretation and showed that over 85 per cent of the intensity of magnetisation in the source was due to remanence, which approximately parallels the Earth's present ambient magnetic field. The depth to the top of the bedrock source appears to be controlled by weathering, and the location of the source appears to be stratigraphically controlled. The other linear features with axes lying along lines of mineralisation may have similar sources to that of Magnetic Ridge. The sources of these features and other positive linear features not associated with mineralisation near Cobar should be drilled to determine their mineralogy and physical properties. Surveys with appropriate precision and operating parameters are recommended to test if a feature similar to Magnetic Ridge occurs over Elura, and to identify Magnetic Ridge beyond its presently known extremities.

INTRODUCTION

Most of the mines near Cobar lie along three separate lines, which have been called by Russell & Lewis (1965) the CSA Line (CSA lodes, Spotted Leopard mineralisation), the Western Line (Great Cobar, Dapville, and Gladstone lodes), and the Eastern Line (New Cobar, Chesney, New Occidental, The Peak, and Queen Bee lodes). Each of these lines is associated with a zone of distinct magnetic intensity, higher than that of surrounding areas, and, within the zones, local magnetic highs are often associated with the mines.

The zone of high magnetic intensity associated with the CSA line, passing just to the west of Cobar, is known locally as Magnetic Ridge. It is shown as a series of flexures in the 20 nT contours of the results of the 1957 BMR regional aeromagnetic survey of the COBAR 1:250 000 Sheet area, flown at an altitude of 150 m and flightline spacing 1.6 km (Fig. 1). Magnetic Ridge can be seen more clearly in the 10 nT contours of the results of a more detailed survey flown for Cobar Mines Pty Ltd, in which it is shown by a series of separate contour closures. It can be traced for about 50 km, from 10 km south of Cobar to 20 km north of the CSA Mine (Fig. 2).

During 1978 and 1979, the Bureau of Mineral Resources (BMR) examined the geological parameters controlling the geophysical characteristics of the Cobar area and its mineral deposits. Because known mineral deposits in the Cobar area are magnetic, the magnetic method plays a major role in exploration, and a large part of the project consisted of studies to understand the sources of magnetic anomaly types. Studies included investigation of the nature of surficial magnetic sources and their discrimination from bedrock magnetic sources, and the characteristics of magnetic anomalies over orebodies, in particular Elura. To complement these, a study was initiated into the characteristics of the magnetic highs associated with the lines of mineralisation, and their sources. In this study, BMR investigated the characteristics and source of a typical section of the Magnetic Ridge anomaly, 1.5 km north of Cobar. This investigation involved airborne, carborne, and ground magnetic surveys along line AD shown in Figure 2.

Following interpretation of the magnetic anomaly at this site, the source of the anomaly was investigated by a drillhole. The hole was continuously cored from 3 m to its total depth of 147.5 m. Magnetic susceptibility, remanence, density, porosity, resistivity, and induced polarisation (IP) measurements were made on the core, and down-hole resistivity, IP, and magnetic field measurements were made in the hole. The core was geologically logged, and analysed for copper and zinc content.

GEOLOGY

The oldest rocks in the region belong to the intensely deformed Girilambone Group, which with the Nymagee Igneous Complex forms basement to the Cobar Supergroup. The Cobar Supergroup is Early Devonian, and composed mainly of turbidite and shallow-water sediments with some terrestrial siltstones, felsic volcanics, and carbonates.

The generalised geology of the Cobar area is shown in Figure 3. The area in which the surveys were conducted is underlain by Cobar Supergroup rocks, which dip steeply, typically 50°-80°W, are strongly cleaved, and strike at about 345°. Units represented are:

Chesney Formation, the basal unit of the Cobar Supergroup, a turbidite facies, mainly greywacke, conglomerate, sandstone, and siltstone;

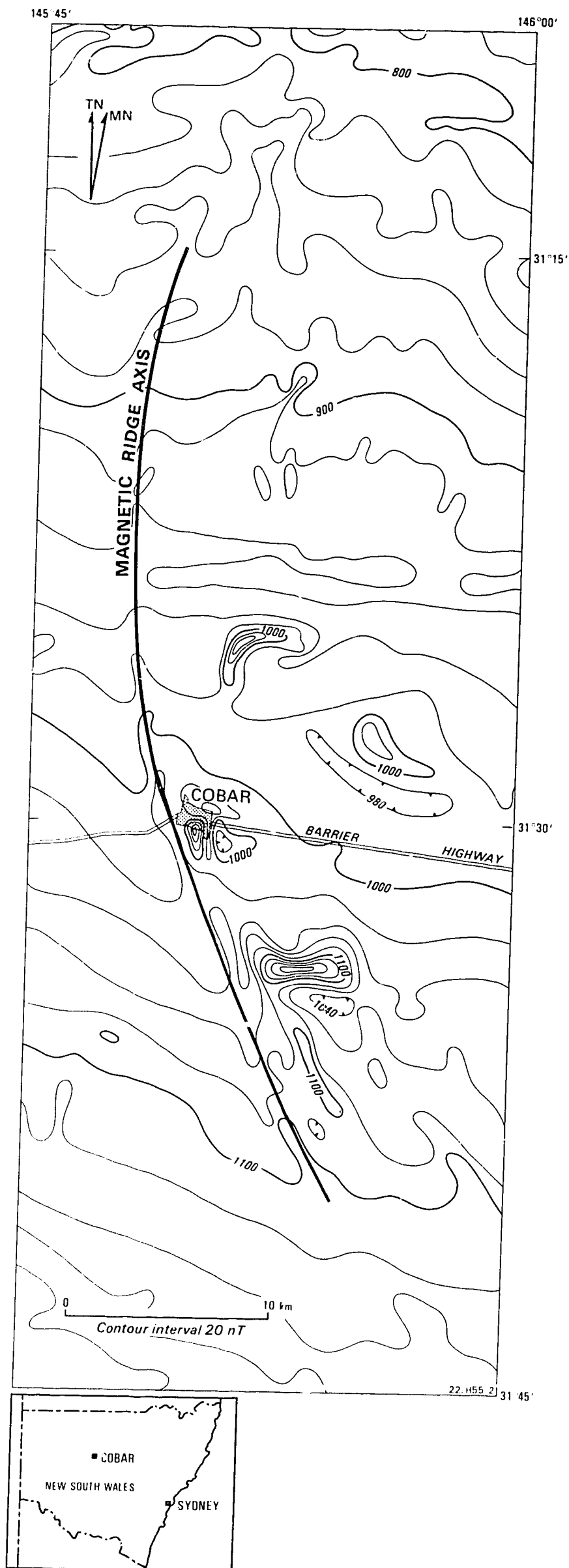


Figure 1. BMR regional aeromagnetic survey results, Cobar area.

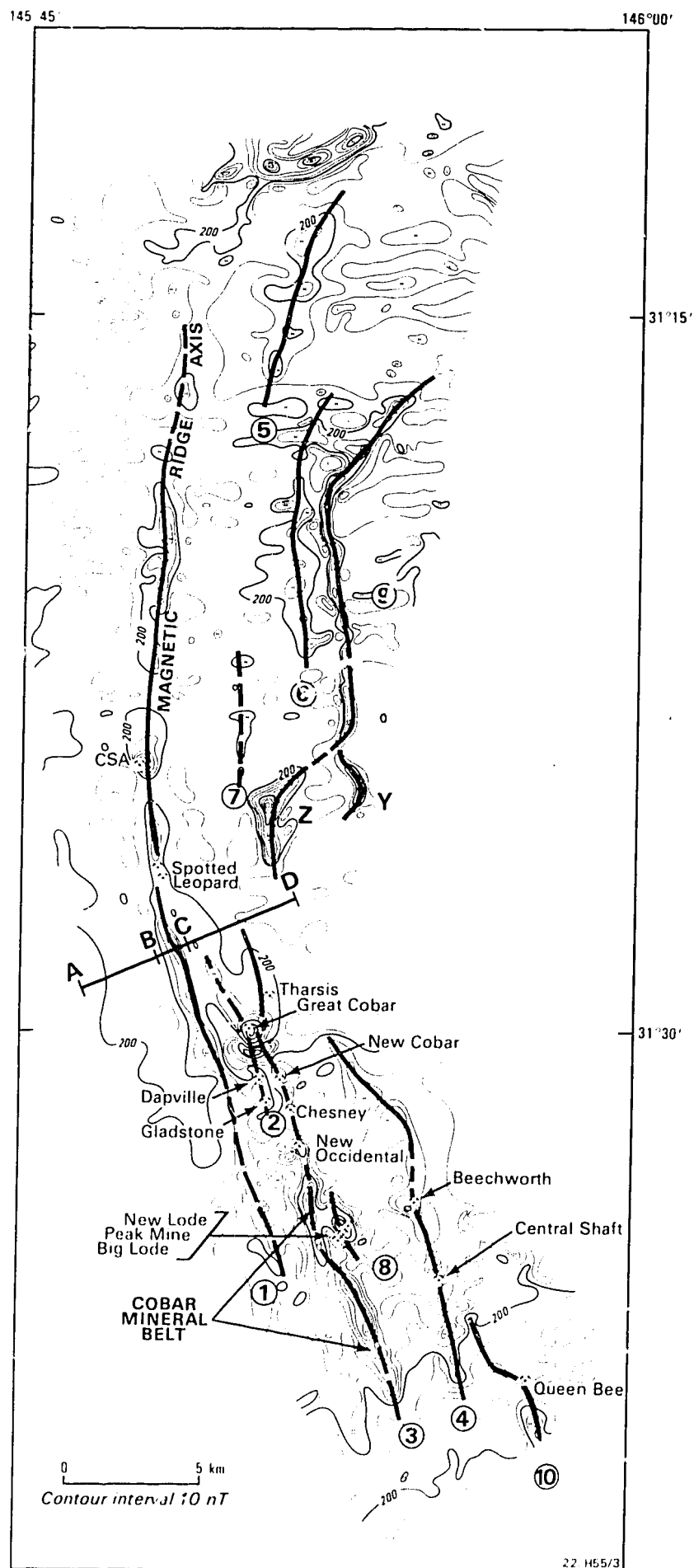


Figure 2. Aeromagnetic contour map over the Cobar area. The survey was flown at an altitude of 90 m with line separation of about 500 m.

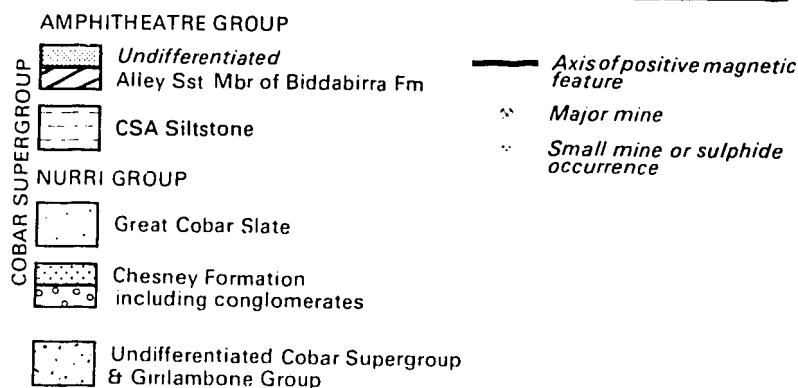
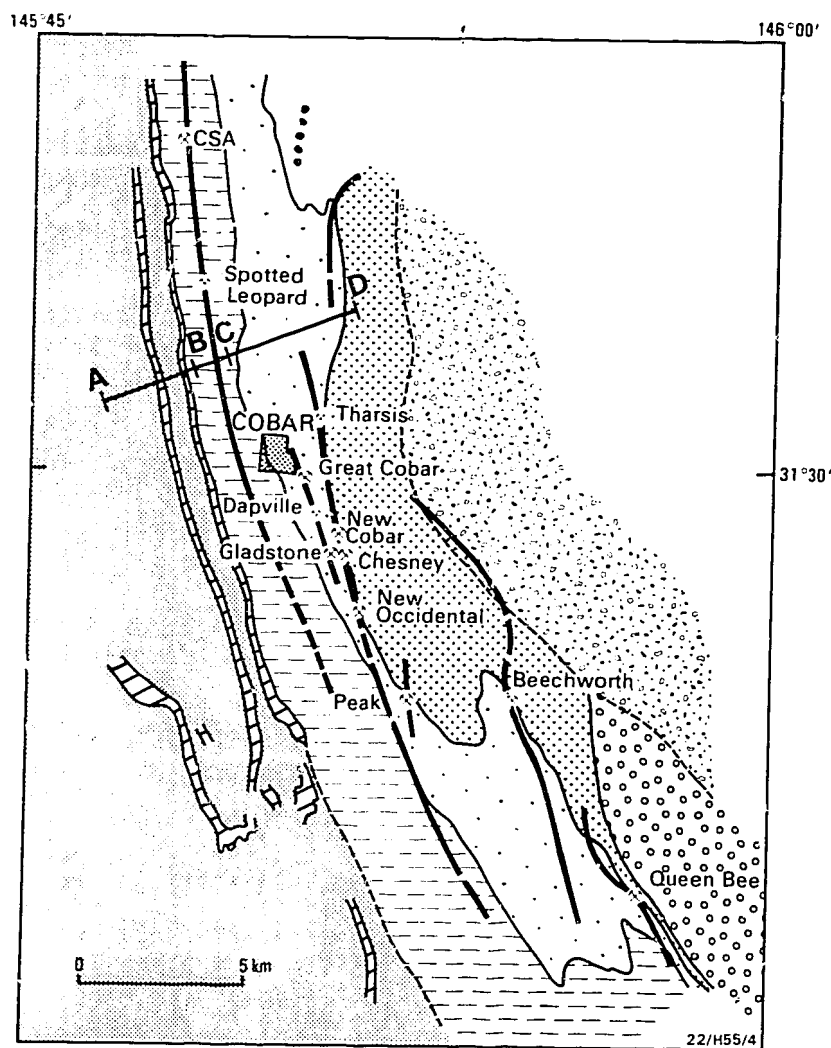


Figure 3. Geology of the Cobar mineral belt, showing survey line ABCD.
Map from Baker (1979); nomenclature from Pogson & Felton (1978) and Glen (1982).

Great Cobar Slate, a monotonous distal turbidite unit of quartz-sericite slate with minor silty interbeds and occasional coarse facies. Its outcrops are highly weathered and its boundaries are considered to be gradational (Baker & others, 1975).

CSA Siltstone, interbedded slate and siltstone with occasional greywacke beds. It grades up into undifferentiated shallow marine Amphitheatre Group.

Undifferentiated Amphitheatre Group, siltstone and quartzite with discontinuous quartzitic units, such as the Alley Sandstone Member of the Biddabirra Formation.

Mineralisation

All the significant mineral deposits in the Cobar area occur in the Cobar Supergroup and are preferentially located in the finer grained sediments. The

deposits are steeply pitching, flattened, pipe-like bodies, usually containing appreciable concentrations of pyrrhotite and/or magnetite. Typical ore mineral assemblages are: 10-12 per cent chalcopyrite-pyrrhotite in partly silicified siltstone, and massive sulphide veins; or siliceous, brecciated pyrite ore with chalcopyrite, pyrrhotite, and some sphalerite and galena. Other ore mineral assemblages are massive chalcopyrite-pyrrhotite, and pyrite and pyrrhotite containing irregular patches of sphalerite and galena (Brooke, 1975).

The presence of pyrrhotite or magnetite in the ore has resulted in substantial magnetic anomalies being generated by the orebodies. Hence, magnetic surveys have had an important role in the exploration of the area.

MAGNETIC SURVEYS

Regional aeromagnetic survey

Figure 2 shows the results of an aeromagnetic survey flown in 1959 over the Cobar mineral field and environs for Cobar Mines Pty Ltd, along east-west flight lines nominally 500 m apart at 90 m altitude. A number of long narrow magnetic highs are evident from the 10 nT contours. These highs broadly parallel the stratigraphy and can be identified trending northwards north of Cobar, and north-northwest south of Cobar. The longest, which passes 1 km west of Cobar, is Magnetic Ridge (feature 1), which has its maximum amplitude in the vicinity of Cobar, and weakens to the north and south.

To the north, Magnetic Ridge dies out just south of an area where the geological strike swings west (Adams & Schmidt, 1980; Fig. 2), and approaches the direction of the flight lines. It is possible that a high-precision detailed aeromagnetic survey in this area with flight lines perpendicular to geologic strike may permit Magnetic Ridge to be mapped further to the north than is shown in Figure 2.

The termination of the Magnetic Ridge trend in the south may result from masking by other anomalies or inadequate sensitivity of the survey or data presentation. If the last two are the case, a high-precision detailed survey and appropriate data presentation may reveal a southerly extension of Magnetic Ridge.

Features 2-8 (Fig. 2) have similar trends and shapes to Magnetic Ridge (feature 1) and contain local anomalies similar to those of Magnetic Ridge. Their amplitudes, except for those of features 6 and 7, which are weak, are similar to those of Magnetic Ridge. Feature 9 has a larger amplitude and appears more continuous than features 1-8 and anomalies in it appear more elongate.

Anomalies Y and Z, just south of feature 9 have comparatively large amplitudes, and, although elongate, are shorter than features 1-8 and also show larger variations in trend direction.

Associations with geology. The axis of Magnetic Ridge lies over rocks mapped as CSA Siltstone and approximately parallels their trend (Fig. 3), suggesting that the source of Magnetic Ridge could be stratigraphically controlled. Other magnetic features similar to Magnetic Ridge appear to be roughly parallel to the strike of mapped geological horizons or boundaries between units, but occur over rocks of the Chesney Formation and the Great Cobar Slate.

Associations with mineralisation. Most occurrences of mineralisation, and all the major mines in the Cobar area, are associated with magnetic anomalies superimposed on long narrow magnetic highs (Fig. 2). For example, magnetic anomalies A, B, C, D, and E (Fig. 2) are superimposed on magnetic trends east of Magnetic Ridge and coincide with mines. Magnetic Ridge contains local anomalies up to 120 nT amplitude. The largest is associated with the CSA mine, and a weaker anomaly of about 20 nT occurs near the Spotted Leopard mineralisation to

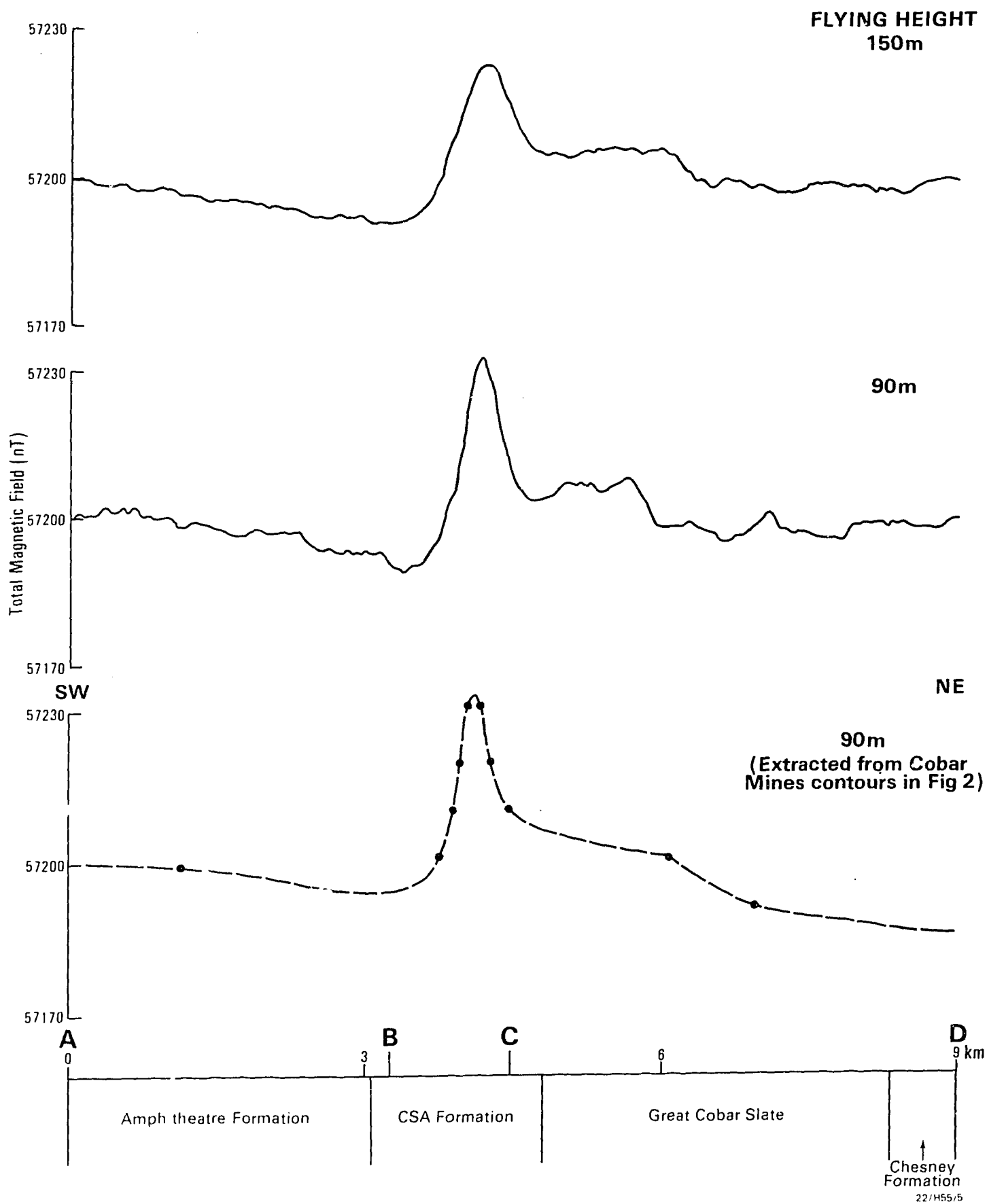


Figure 4. Aeromagnetic profiles flown by BMR across Magnetic Ridge at altitudes of 150 m and 90 m, profile from contour map, and geologic section.

the south. Significant mineralisation has not been reported with other local anomalies superimposed on Magnetic Ridge.

Multi-height aeromagnetic survey

BMR flew two magnetic traverses 150 m and 90 m above ground level across Magnetic Ridge between A and D (Fig. 2) to investigate the characteristics of the anomaly and its source at this location. The profiles, after removal of a regional gradient of 7 nT/km, decreasing to the east, are shown in Figure 4, together with a profile constructed from the contours shown in Figure 2.

All the aeromagnetic profiles show a complex anomaly. For example, at 90 m altitude, a 40 nT amplitude peak occurs in the west, and several minor 5-10 nT amplitude interfering peaks occur in the east, forming a plateau. At 150 m altitude the western peak is 30 nT amplitude.

Magnetic Ridge lies over the CSA Siltstone. The interfering anomalies immediately to its east lie over a mapped upper section of the Great Cobar Slate. Further to the east, in the profile recorded at 90 m altitude, a disturbance of about 5 nT can be recognised over the Great Cobar Slate, and some smaller, interfering disturbances occur over the basal part of the Great Cobar Slate and the upper part of the Chesney Formation. Only very low-amplitude disturbances (less than 3 nT at 90 m flying height) occur west of Magnetic Ridge, over rocks of the Amphitheatre Group.

Ground magnetic surveys

A traverse was surveyed between B and C over the distinct magnetic peak (Fig. 2) using a hand-held magnetometer and a carborne magnetometer system. For the hand-held magnetometer survey, a Geometrics G816 proton precession magnetometer was employed with the sensor 2 m above the ground, and stations were read at 5 m intervals. For the carborne magnetometer survey, a Landrover transported the electronic module of a Geometrics G803 proton precession magnetometer, and the sensor was carried 1.2 m above the ground 30 m behind the vehicle, to reduce magnetic effects from the vehicle and electromagnetic signals from its engine. The output from the magnetometer was recorded digitally on a tape recorder, together with distance information, and also was displayed on a chart recorder to permit monitoring of the data during acquisition. A sampling rate of one sample per second was used, giving a station interval of about 0.3 m for a traversing speed of 1 km/h.

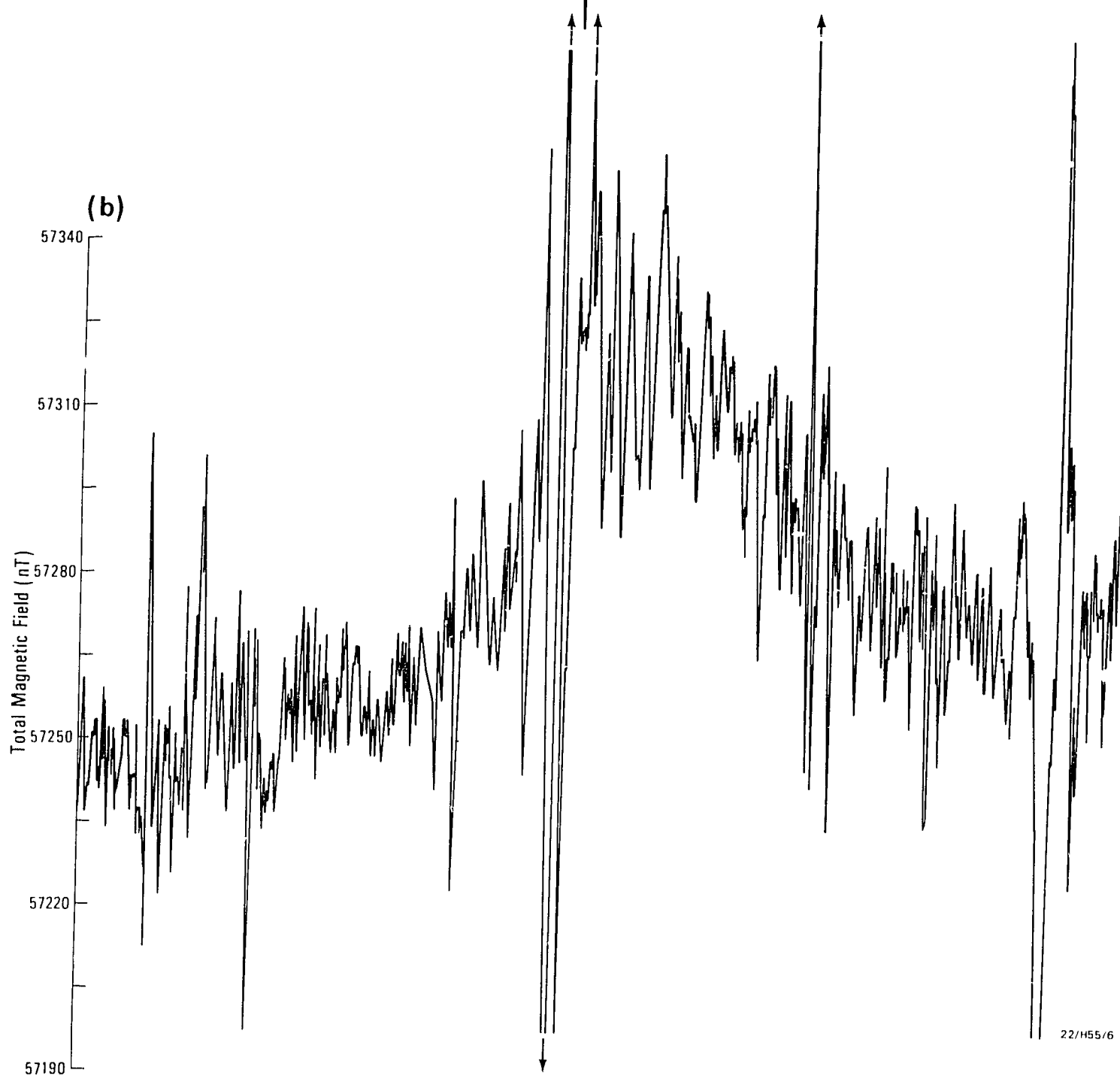
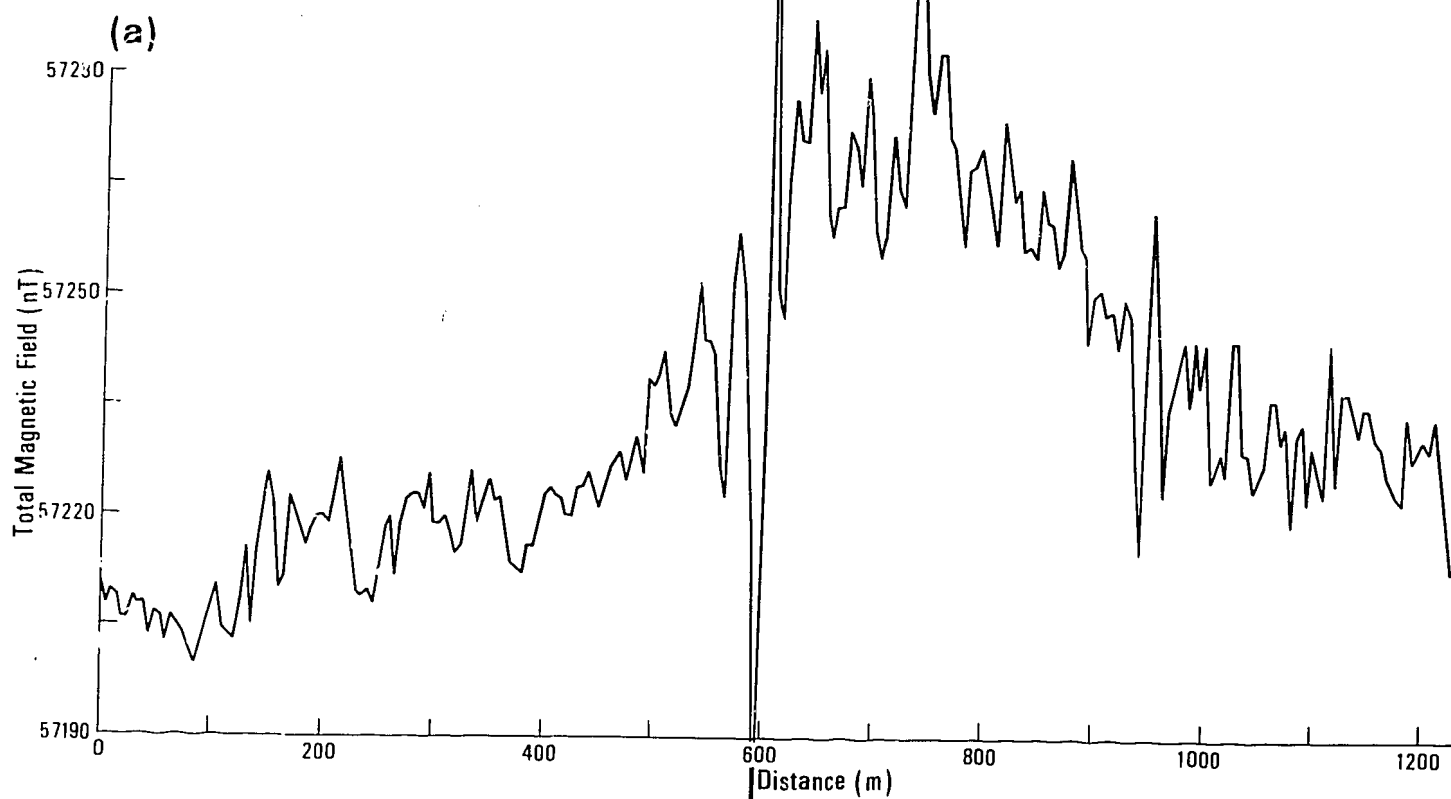
The results from both surveys show an anomaly of about 60 nT with a half-width of about 350 m (Fig. 5). Superimposed on this anomaly are many short-wavelength anomalies up to several hundred nT amplitude and averaging about 30 nT amplitude. These short-wavelength anomalies are more precisely detailed in the carborne data than in the more coarsely spaced hand-held data. They arise from near-surface sources, most probably remanently magnetised maghemite accumulations, which are common in the Cobar area. These anomalies can be removed by applying a low pass filter, which will reveal clearly the long-wavelength anomaly. Figure 5c shows the result of applying a filter to the carborne data to pass only signals with wavelengths of more than 100m.

Comparison of airborne and ground data

Both airborne profiles (Fig. 4) are much smoother and have a larger signal-to-noise ratio than the ground profiles (Fig. 5). Other airborne surveys near Cobar show that noise such as appears on the ground profiles across Magnetic Ridge generally only becomes noticeable on a airborne profiles recorded at less than 60 m altitude (Gidley, 1981).

Interpretation of magnetic data

The airborne and ground data for the Magnetic Ridge anomaly were interpreted with a non-linear least squares inversion computer program that



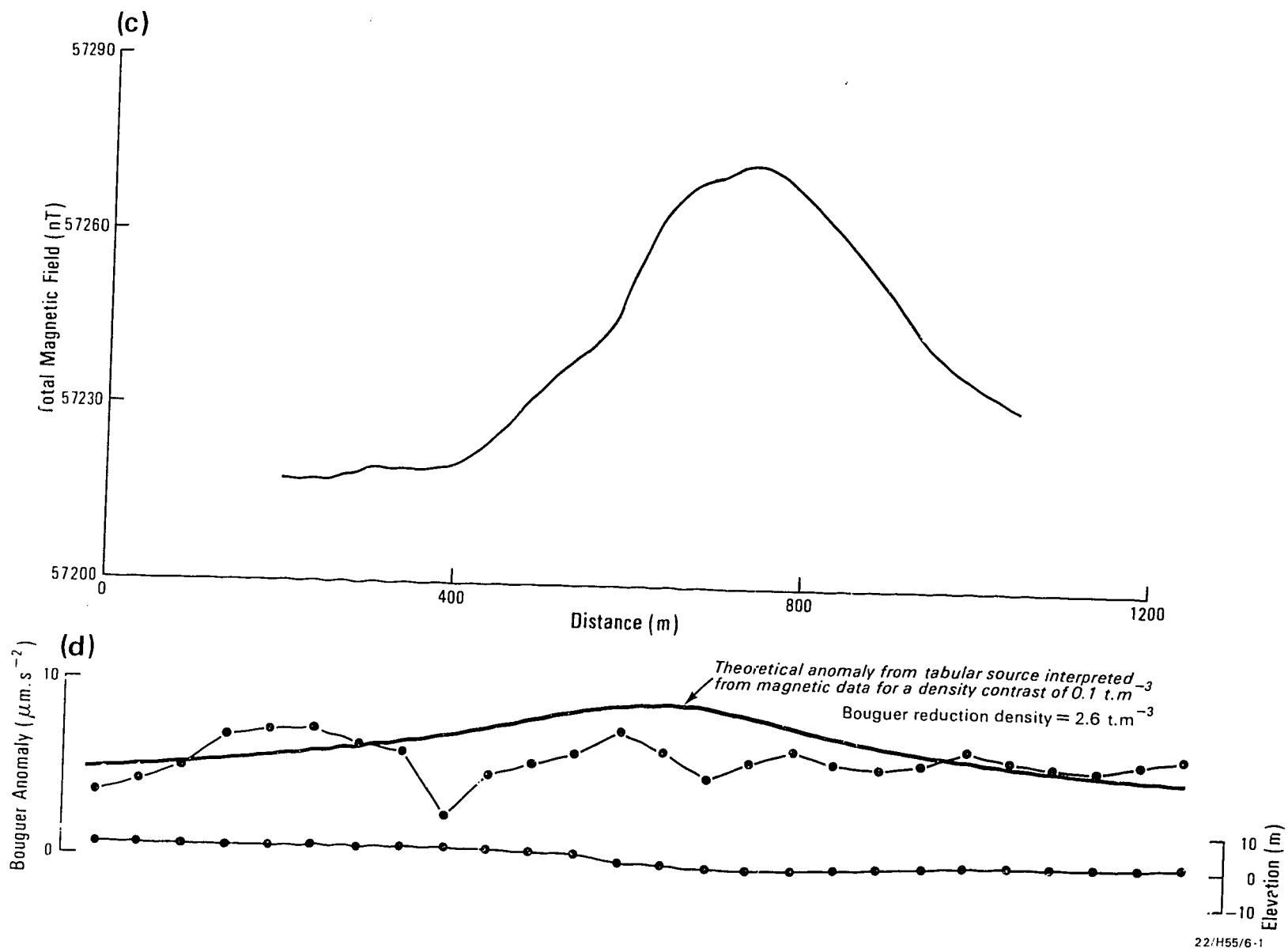


Figure 5. Total magnetic field ground profiles and gravity profile along line BC. (A) hand-held, (B) carborne, (C) carborne data filtered to remove wavelengths $< 100 \text{ m}$.

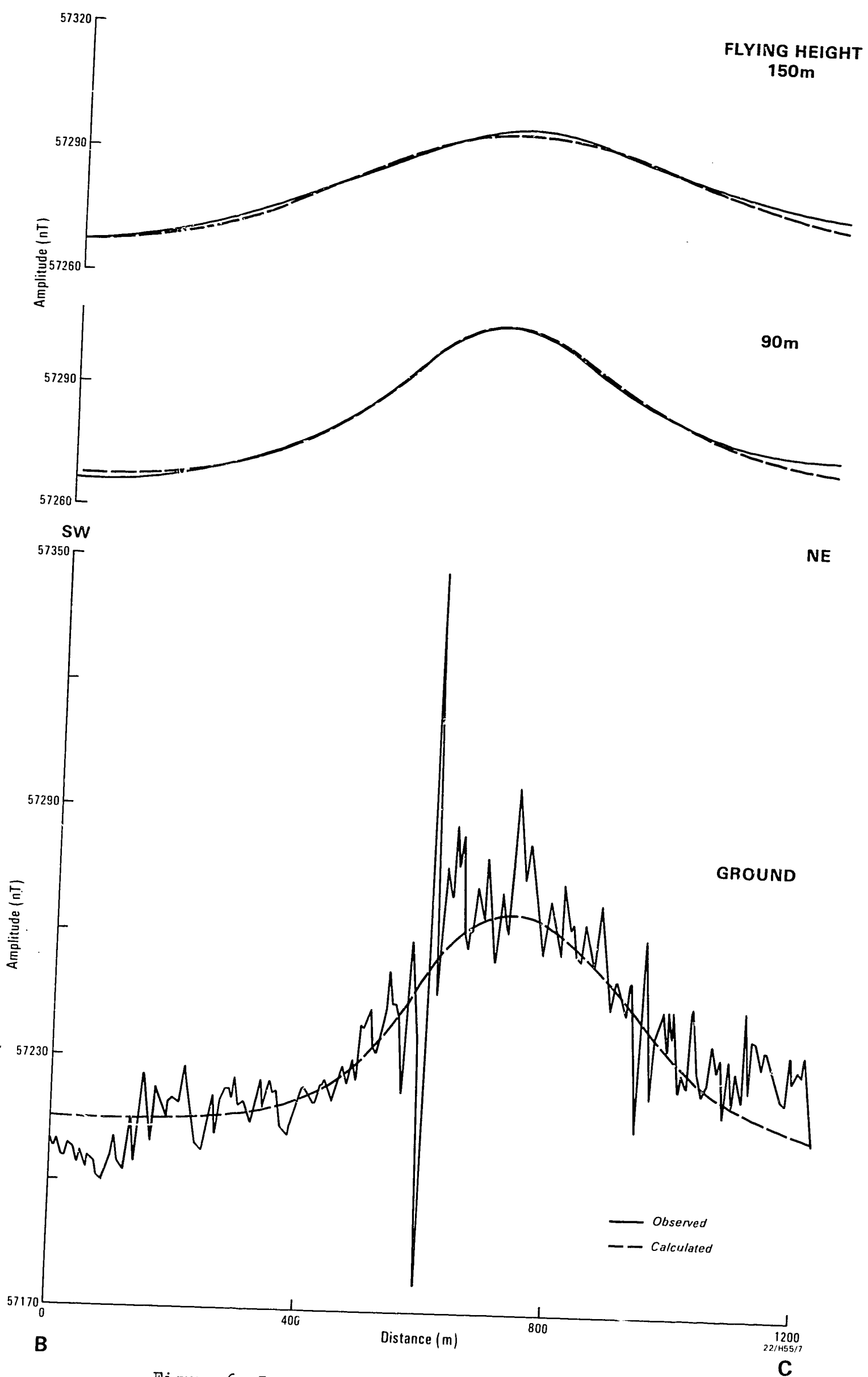


Figure 6. Interpretation profiles of Magnetic Ridge.

assumes that the source is tabular, has infinite strike length and depth, and is magnetised by induction only. The theoretical anomaly generated from the source interpreted from each profile, and the observed profiles are shown in Figure 6, and the interpretations summarised in Table 1.

Table 1. Interpreted parameters for tabular model source of Magnetic Ridge

Height of observations (m)	Dip	Depth to top (m)	Susceptibility (SI)	Thickness (m)	RMS error (nT)
150	88°W	95	0.0037	200	1.2
90	85°W	95	0.005	190	3.7
Ground level	83°W	90	0.005	180	20

The RMS error is the standard deviation between observed and theoretical values at each station, and gives a measure of the spread of the observed data about the theoretical values. The increase in RMS error with decreasing height mainly reflects increasing short-wavelength noise forming a wider envelope around the theoretical values. The short-wavelength noise is probably responsible for the slight differences in models interpreted from data recorded at different observation heights.

In the magnetic inversion process, a series of anomalies computed from a model source are compared with the observed anomaly, the values of the parameters describing the model being adjusted until the computed and observed anomalies are satisfactorily close. The values of the parameters are interrelated. A change in the value of one parameter can often be almost completely compensated for by a change in the value of one or more other parameters, so that the computed anomaly changes only slightly. For example, an increase in susceptibility may nearly compensate for a decrease in thickness. In addition, some parameters have a stronger effect on the theoretical anomaly than others, and hence are better estimates. Moderate changes in dip produce only small changes in the theoretical anomaly, whereas similar changes in depth produce large changes in the theoretical anomaly. Hence, the depth estimate is likely to be more accurate than the dip. The consistency in the final values of the parameters from inversions of data obtained at different heights, and the consistency of the dip estimates with the dip of the rocks in the area strengthen confidence in the results of the inversions.

GRAVITY SURVEY

Gravity measurements at intervals of 50 m between B and C disclosed only short-wavelength anomalies of 5 m/s^2 , which are unrelated to the source of the broad magnetic anomaly and are probably due to near-surface density variations generated by weathering (Fig. 5d).

Gravity modelling indicates that if the tabular source interpreted from the magnetic data had a density contrast of 0.1 t/m^3 with surrounding rocks, a peak would be generated near the centre of the traverse 4 m/s^2 greater than values at the ends. The absence of such a peak suggests that the density contrast between the source of the magnetic anomaly and the surrounding rocks is less than 0.1 t/m^3 .

DRILLING RESULTS

A hole was collared at 635 N on line BC and drilled vertically to 147.5 m depth to test the depth to the top and the mineralogy of the interpreted source. The hole was continuously cored below 3 m, and plastic casing inserted in the top 112 m to prevent caving. In-situ, resistivity and IP measurements were made below the plastic casing, vertical magnetic field measurements were made in the top 74 m, and magnetic susceptibility, remanence, density, porosity, resistivity, and IP measurements, and analyses of copper and zinc content were made on the core (Fig. 7).

Geological log

The area that surrounds the drillhole is covered with red soil and, although no rock crops out, it is assumed to overlie the CSA Siltstone. The top 3 m consists mainly of soil. Below 3 m siltstone and shale were intersected. Near the surface, the rocks are strongly weathered, but weathering decreases down-hole, and the core shows no visual evidence of weathering at 95 m, the approximate depth of the water table.

Studies of thin sections of fresh and slightly weathered core samples (A.N. Yeates, BMR, personal communication) show that the sequence intersected consists of thin interbeds and laminae of two distinct principal components: a detrital suspension-current siltstone, and an impure calcareous quartzite of chemical sedimentary origin.

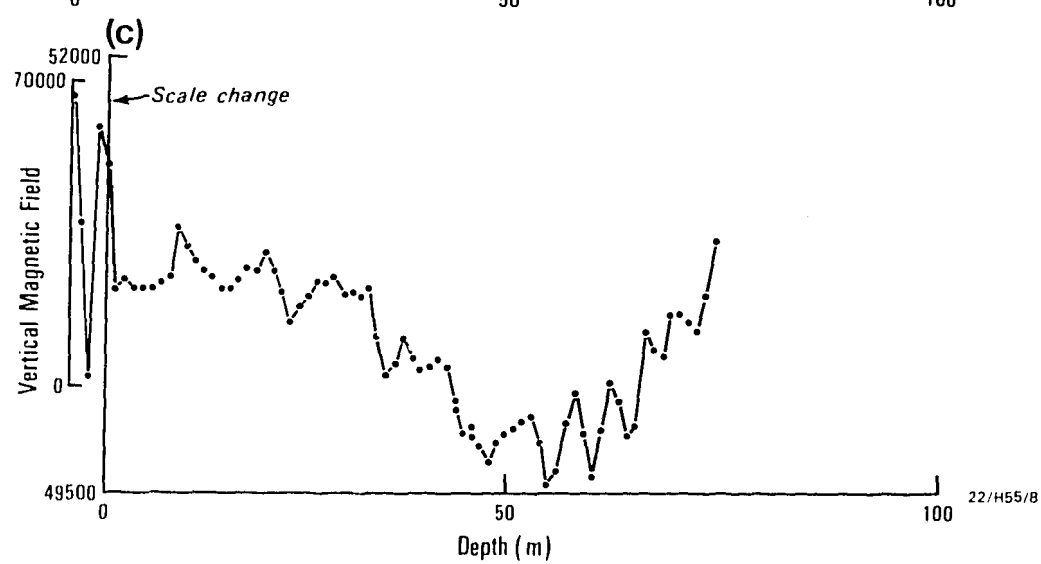
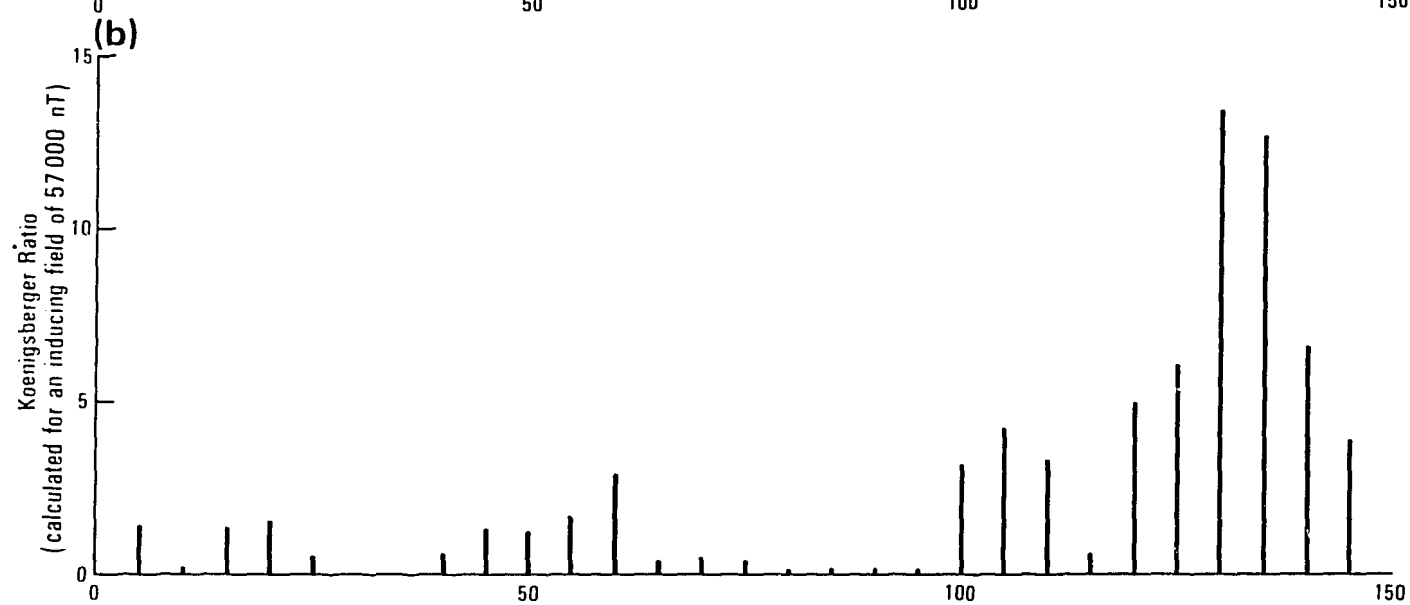
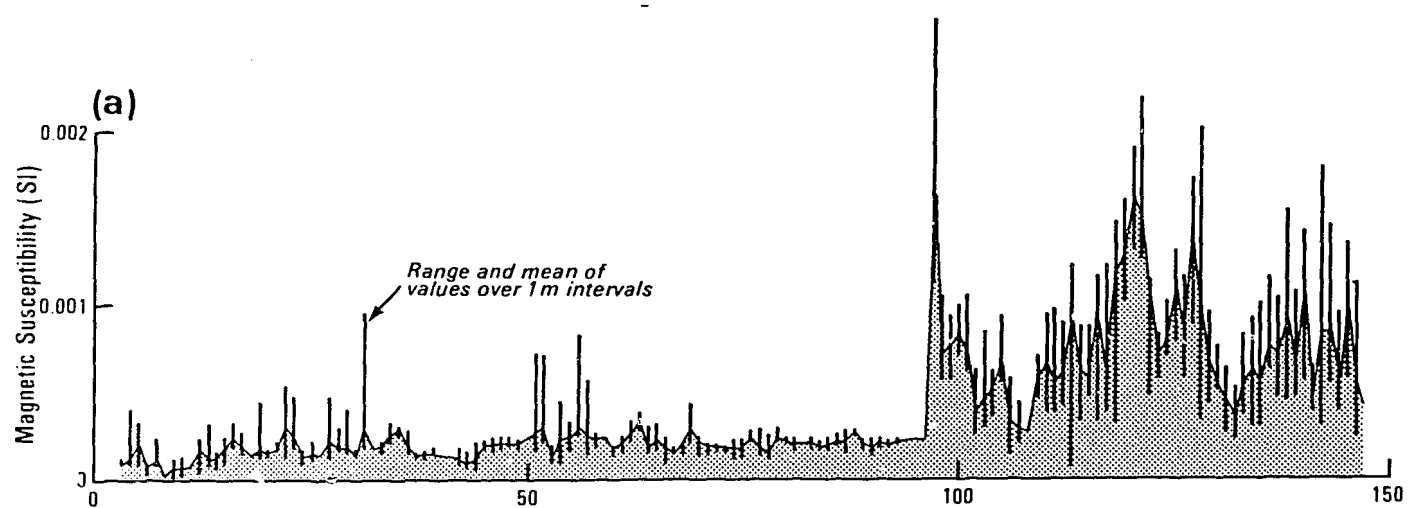
The siltstone component is composed partly of dispersed fine sand-sized to silt-sized clasts of strained and strain-free quartz plus discrete plates of detrital muscovite, which together form about 20 per cent of the rock. The remainder consists of mud partly resolvable as chlorite, sericite, and graphite, and rare magnetite, sphalerite, pyrrhotite, and pyrite. Variation in the proportions of the constituents, and graphite content define numerous laminations and thin bedding. Incipient slaty cleavage is defined by planar orientation of graphite particles, which make a slight angle to undeformed bedding. In some layers pyrrhotite is preferentially concentrated along this cleavage.

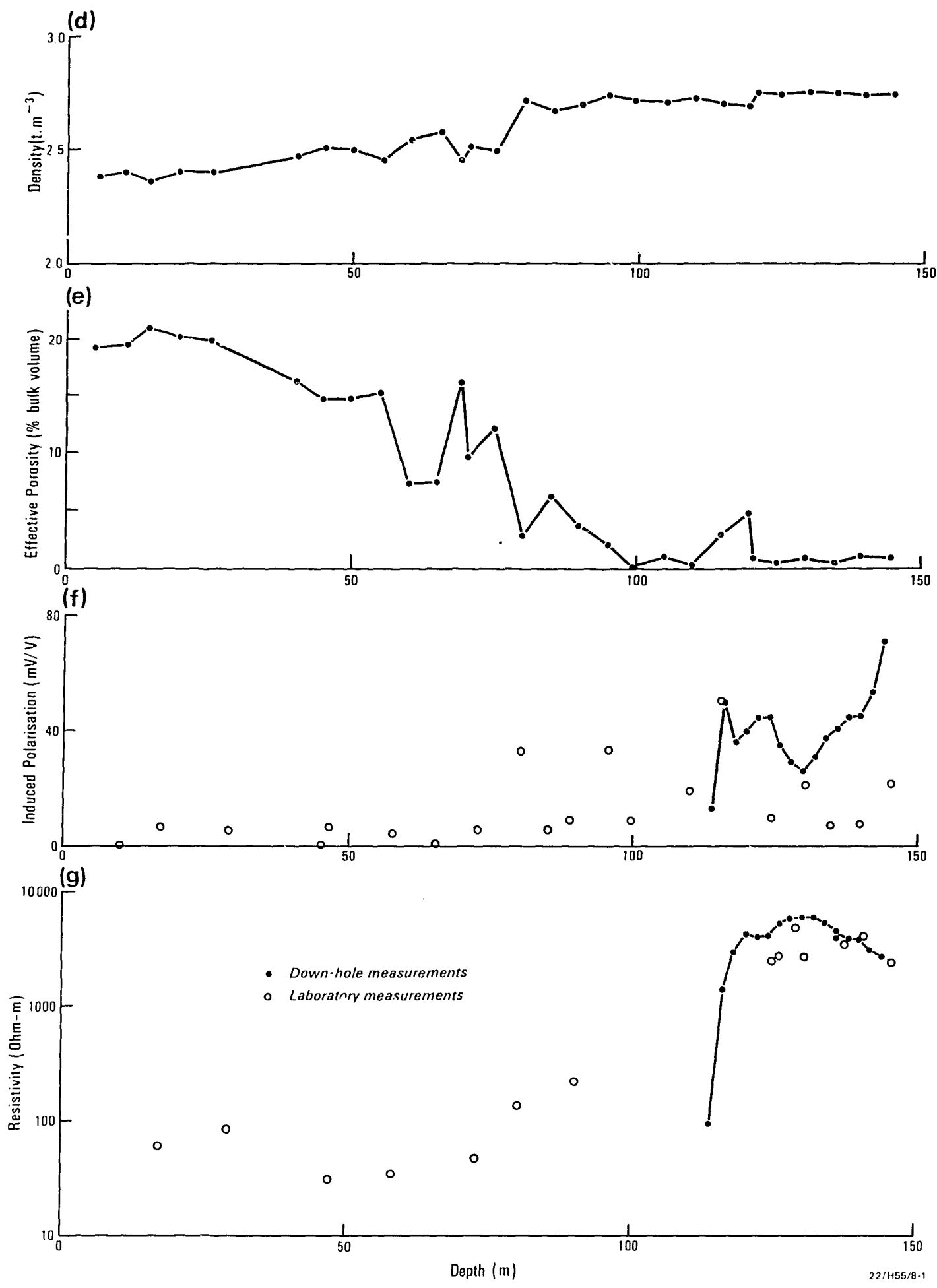
The calcareous quartzite component in its purest form consists mainly of lenticular lenses and bulbous micro-masses of strained quartz grains and calcite. The quartz grains lack a detrital texture and appear to have grown from former cherty silica. Detrital muscovite, zircon, and tourmaline, and rare sphalerite, pyrrhotite, and pyrite form accessory constituents; fine graphite and chlorite are common impurities. Their presence together with detrital muscovite indicates that, generally, some suspension-current sedimentation was superimposed on pulses of chemical sedimentation.

The calcareous quartzite layers appear to preferentially host large diagenetic pyrrhotite and cubes of pyrite throughout the intersected sequence. Modal counts on polished thin sections of core from below 95 m indicate up to 1 per cent pyrrhotite.

Geochemical analyses

The results of copper and zinc carried out on the core at approximately 5 m intervals of 5 m are shown in Figures 7h and 7i and summarised in Table 2.





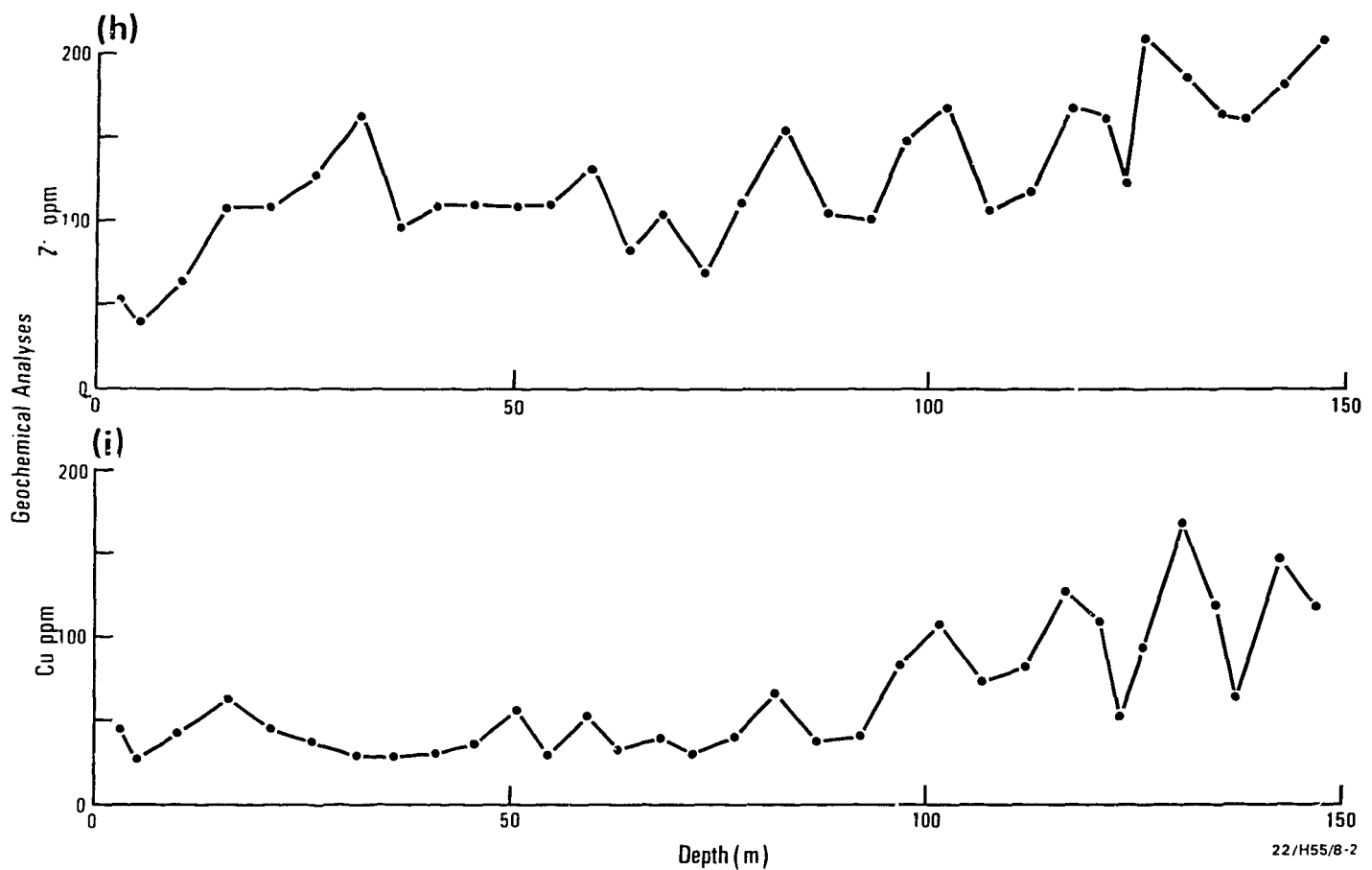


Figure 7. Drillhole logs. Note scale change on (c).

Table 2. Summary of copper and zinc assays

Depth interval (m)	Copper		Zinc	
	Range (ppm)	Mean (ppm)	Range (ppm)	Mean (ppm)
0-92.8	28-68	42	39-164	103
97-147.5	62-170	105	103-210	162

The copper and zinc logs are similar, and show a trend of values increasing with depth, indicating that even well below the water-table some copper and zinc are being removed by weathering.

Magnetic susceptibility

Magnetic susceptibility measurements were made on the core at intervals of 0.1 m with Bison 310A susceptibility meter and an external coil. The range and mean of values over 1 m intervals are plotted in Figure 7a.

From 0 to 96 m susceptibility is very low averaging 190×10^{-6} SI. From 97 m to the bottom of the hole it is higher, averaging 780×10^{-6} SI, and ranging up to 2640×10^{-6} SI.

The susceptibility contrast between core below and above 97 m probably results from the weathering of magnetic minerals (probably mainly pyrrhotite) to non-magnetic minerals above the water table.

Remanence

The magnitude of the permanent magnetism of core samples, and its direction relative to the horizontal, were measured on samples at 5 m intervals with a Digico Complete Results magnetometer. Remanence of samples from 100 m to the bottom of the hole averaged 46 times the strength of those of the top 95 m (Table 3). The large average Koenigsberger ratio (Fig. 7b) of 5.5 for samples from 100 m and below indicates that magnetisation arising from remanence is much larger than that arising from susceptibility.

Table 3. Remanent magnetic intensity

Depth interval (m)	Number of samples	Remanent intensity (ma/m)		Koenigsberger ratio	
		Range	Average	Range	Average
0-95	18	0.1-10.2	3.6	0.01-1.1	0.7
100-147.5	10	1.7-402.5	165.4	0.2-13.3	5.5

Figure 8 shows a stereographic plot of the measured inclinations of remanence. Angles from the horizontal are plotted inwards from the outside. Declinations are random as, owing to rotation of the core during sampling, the declination of the remanence could not be determined. Samples from the interval 0-95 m are seen to have random inclinations. Those from the interval 100 m to the bottom of the hole average -59° , close to that of the Earth's primary field (-63°).

On a regional and local scale, the shape of the Magnetic Ridge anomaly is consistent with that of an anomaly from a steeply dipping, purely inductively magnetised source. This consistency in shapes indicates that the remanence vector is approximately parallel to the Earth's present ambient field.

Magnetic effect of remanence and susceptibility combined

An effective susceptibility, k_e , can be defined as the susceptibility that would produce the same magnetisation as that from the remanence and susceptibility combined. As the remanence of the source of Magnetic Ridge is almost parallel to the Earth's magnetic field the effective susceptibility can be closely determined from addition of the effects of remanence and susceptibility. For core from below 97 m the effective susceptibility is 0.005 SI, which is close to the susceptibility interpreted for a solely inductively magnetised source.

Vertical magnetic field

Vertical magnetic field measurements (Fig. 7c) were made with a BMR-constructed down-hole fluxgate magnetometer at 1 m intervals down the drillhole to 74 m depth. Extremely high magnetic gradients recorded over small distances in the top 4 m indicate rapid vertical variation in magnetic properties near the near-surface maghemite accumulations. A low was recorded at 55 m depth.

Density

Saturated density (Fig. 7d) increases from less than 2.4 t/m^3 near the surface to 2.73 t/m^3 at 95 m. Below 95 m, saturated density is in the range $2.69\text{--}2.77 \text{ t/m}^3$.

Porosity

Effective porosity (Fig. 7e), defined as the percentage volume that interconnected pore spaces occupy, decreases from about 20 per cent near the surface to 2 per cent at 95 m. Below 95 m, porosity ranges from less than 0.1 per cent to 4.7 per cent. A break in the porosity and density logs at about 95 m

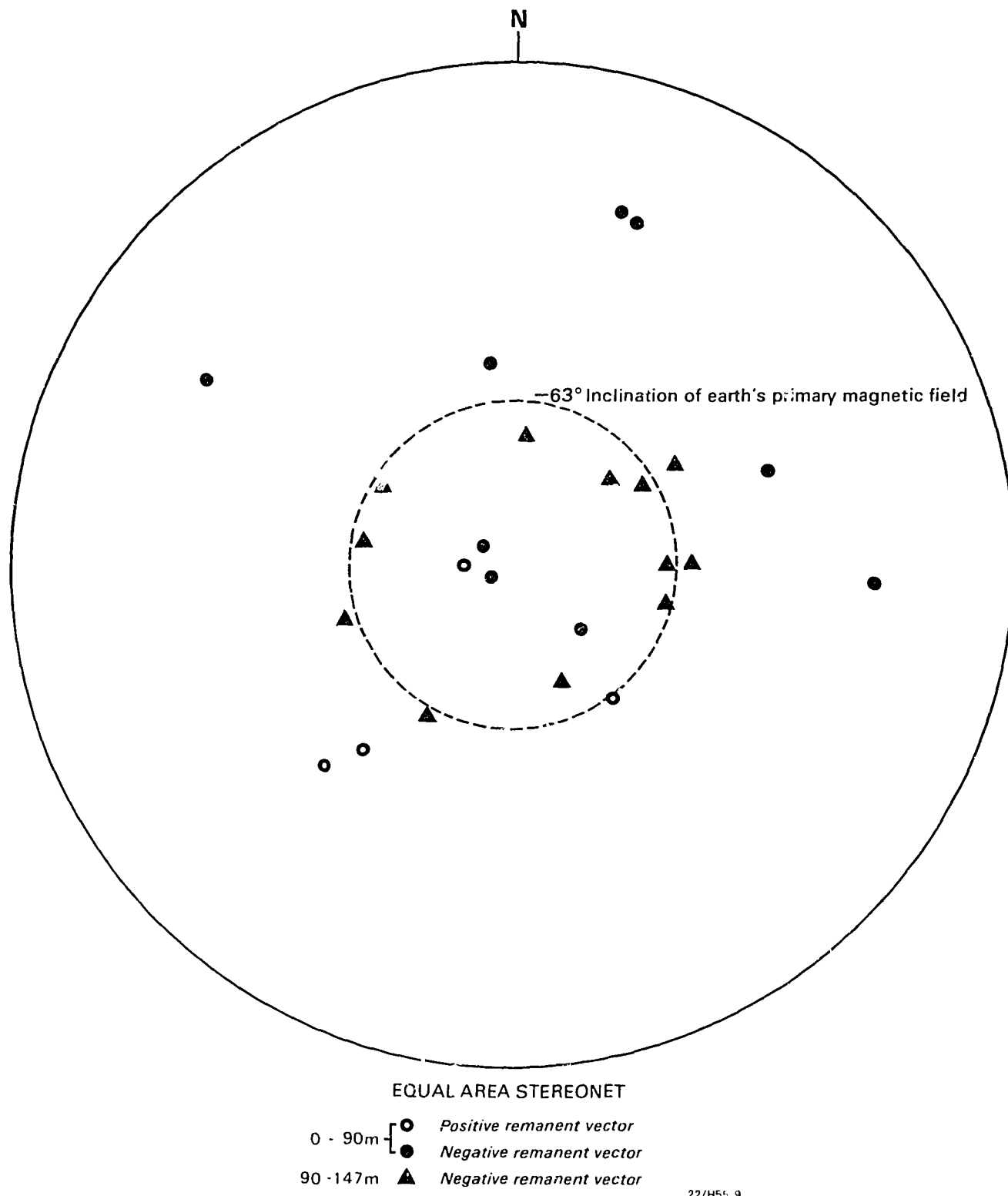


Figure 8. Stereonet plot of remanent magnetic vectors determined on Magnetic Ridge drill core.

(Fig. 7d, e) suggests that weathering, involving removal of substantial amounts of material, has taken place down to this depth.

The porosity log is similar to a mirror image of the density log; a plot of density against porosity (Fig. 9) indicates that they are approximately linearly related. The least squares line of best fit has the equation $\text{density} = 2.74 - 0.18 \times \text{porosity}$ (1). The correlation coefficient, r , is 0.98.

The substantial difference between the density of near-surface rocks, which are strongly weathered, and that of fresh rocks indicates that care must be

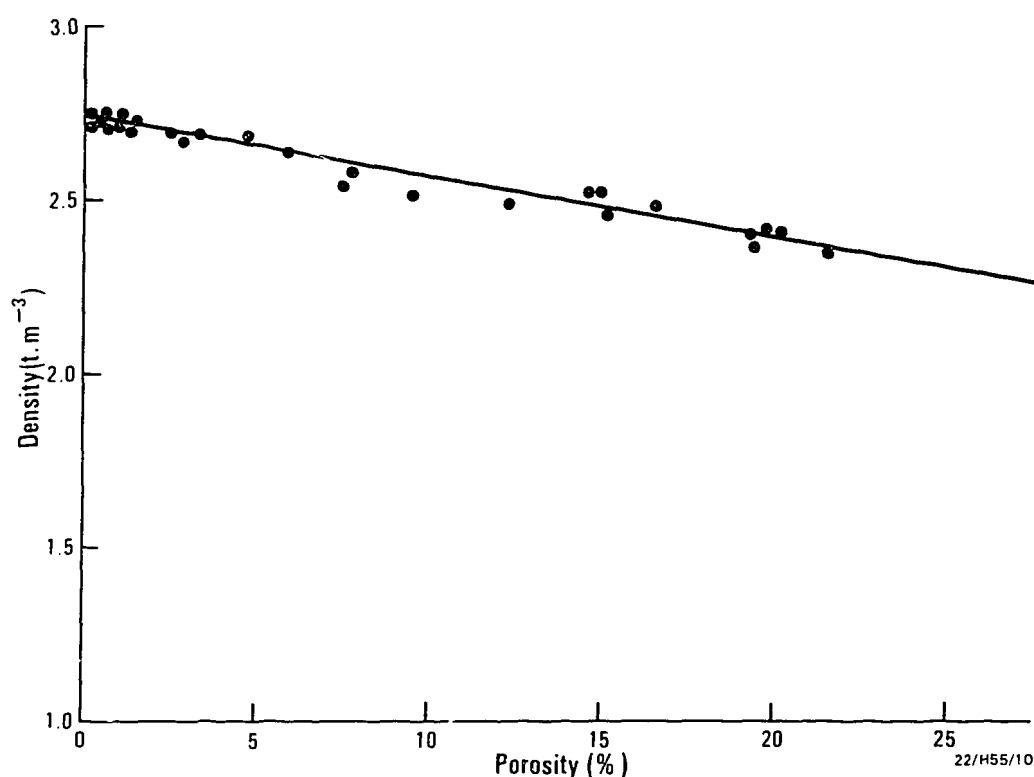


Figure 9. Density versus porosity plot for Magnetic Ridge drill core.

exercised in estimating the density of fresh rocks from measurements on surface or near-surface samples, as the near-surface samples may be less than 90 per cent the density of fresh rocks. Relations similar to (1) can be derived for other rock units and areas near Cobar to estimate the density of fresh rocks.

Electric logs

In-situ resistivity and IP measurements (Figs. 7g,h) were made below the plastic casing with a 3-array, in which a current electrode and two potential electrodes are lowered down the hole. A probe with an electrode spacing of 2 m was used, connected to a Hunttec 2.5 kW transmitter and a Scintrex IPR-8 receiver. Measurements were made in the time domain, using an 8s sample time.

Laboratory measurements were made with a 4-electrode cell on samples prepared as cylinders of 25 mm diameter. Chargeability was measured nominally at 780 ms after current turn-off (M3).

Comparison of the in-situ and laboratory measurements of resistivity (Table 4) and IP (Table 5) shows that some of the laboratory measurements appear to be less than measurements made in situ at equivalent depths. The effect may be due to a smaller volume of material being measured in the laboratory than in situ, effects of drilling on the laboratory sample, effects of borehole fluid on the in-situ measurements, and the differences in environment of the material during measurement.

Table 4. Resistivity measurements (ohm-m)

Depth interval (m)	Down-hole measurements			Laboratory measurements		
	Number	Range	Mean	Number	Range	Mean
0-80	0			5	31-84	51
80-118	3	94-2987	1494	2	116-203	165
120-147.5	13	2710-5915	4499	7	2066-3878	2669

Table 5. Induced polarisation measurements (mV/V)

Depth interval (m)	Down-hole measurements			Laboratory measurements		
	Number	Range	Mean	Number	Range	Mean
0-80	0			8	0-6	3
80-114	1		12.5	6	6-33	18
114-147.5	15	25-72	43	6	6-50	19

Resistivity. Apparent resistivity measured down-hole increases from about 90 ohm-m at 114 m to 4300 ohm-m at 120 m, the increase probably resulting from a decrease in weathering as depth increases. Below 120 m apparent resistivity is high, in the range 2700-5900 ohm-m.

The laboratory measurements indicate a large resistivity contrast between weathered rocks above 80 m (low resistivity) and fresh rocks below 120 m (high resistivity). The down-hole and laboratory measurements also show that these are separated by a transition zone of increasing resistivity with increasing depth.

Induced polarisation. The minimum down-hole IP measurement is 12.5 mV/V at 114 m - the shallowest depth readings were made at. Below 114 m chargeability is in the range 25-72 mV/V.

The laboratory measurements show that the rocks above 80 m have very low chargeability. Chargeability is generally higher below 80 m.

A transition zone of increasing values with increasing depths, similar to that observed in the resistivity measurements, was not apparent in the IP measurements below 80 m. This lack of evidence for a transition zone may be due partly to a chargeability of 33 mV/V being recorded at 80.2 m. This value, which may mask an increasing trend with depth, may be caused by a small concentration of polarisable material.

CONCLUSIONS

Magnetic Ridge in the area surveyed is clearly seen in aeromagnetic and ground magnetic surveys. The ground magnetic survey shows a broad anomaly on which are superimposed numerous short-wavelength anomalies, arising from accumulations of maghemite in the top few metres.

Interpretation of magnetic profiles recorded at different heights indicates that the source of the broad anomaly is a tabular-shaped body about 95 m deep, about 200 m thick, and having an average magnetisation equivalent to a susceptibility of about 0.005 SI. Physical property measurements on core from a drillhole sited to intersect the source indicate that over 85 per cent of the intensity of magnetisation is due to remanence that approximately parallels the Earth's present magnetic field. The measurements indicate that the effect of remanence and susceptibility is equivalent to a susceptibility of about 0.005 SI, confirming the interpretation of the profiles.

The depth to the top of the source of Magnetic Ridge appears to be controlled by weathering, which has substantially altered or removed magnetic minerals above 95 m. Effects of weathering are seen down to 150 m. Fresh core contains up to 1 per cent disseminated pyrrhotite - which is probably the main magnetic mineral - pyrite, and rare magnetite. Some sulphide crystals appear to have developed along cleavage planes.

Because Magnetic Ridge approximately parallels the mapped regional stratigraphy, its source appears to be conformable and stratigraphically controlled. Adjacent, interfering anomalies on the east might have sources similar to that of Magnetic Ridge, but containing a smaller percentage volume of magnetic minerals.

Magnetic Ridge and other similar features near Cobar delineate areas in which geological conditions have been favourable for mineralisation. No such feature has been reported associated with Elura. As the lack of such an associated feature would distinguish the Elura mineralisation from other mineralisation in the Cobar mineral belt, its presence or absence should be ascertained.

Magnetic Ridge and the features similar to it may be traced beyond their present known extent by careful analysis of data from high-resolution low-level aeromagnetic surveys with closely spaced lines, and from detailed ground surveys, such as carborne surveys. It is recommended that such delineation of Magnetic Ridge be attempted north and northwest of its present identified northern extremity. The surveys should test the proposition that Magnetic Ridge follows the strike of rocks shown by Adams & Schmidt (1980), which suggests that Elura may lie in a stratigraphic position similar to that of the CSA lodes.

Drilling should be carried out to determine whether other linear positive magnetic anomalies near Cobar have sources similar to that of Magnetic Ridge.

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