targeting drillholes. A correlation between gold grades and apparent susceptibility at Bounty and Mount Martin suggests that, in some cases, susceptibility measurements can be used as a guide to ore. In deposits containing komatiitic volcanic rocks, such as Queen Margaret and Mount Martin, the susceptibility meter can be used as an effective mapping tool, particularly where facing evidence is required to interpret complex structures.

Magnetic and Electrical Signatures of the Granny Smith Gold Deposits, Western Australia

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Abstract

Gold deposits at Granny Smith occur along a shear between a granodiorite intrusion and epiclastic sedimentary units. Three ore zones, Goanna, Granny and Windich, were identified by CSR in 1987, during exploration that included ground magnetic and induced polarisation surveys. Magnetic data were useful in helping to map intrusive rocks, banded iron-formations and less magnetic sedimentary horizons, and some faults. Although magnetite is a minor alteration mineral in the granodiorite, the mineralised zones do not give identifiable magnetic responses. Dipole-dipole induced polarisation surveys also gave valuable, and complementary, mapping information. At Granny, carbonaceous shale in the hangingwall and weakly polarisable footwall granodiorite masked any induced polarisation signal that the mineralisation may have produced. Drillhole measurements showed that oxidised mineralisation is not anomalously polarisable, whereas fresh mineralisation is moderately polarisable (some pyrite accompanies gold). Despite the lack of a direct induced-polarisation anomaly from Granny, the IP surveys delineated the deeply weathered mineralised shear north of Granny, which contributed to the discovery of Goanna. Electromagnetic measurements have also been used effectively for resistivity mapping.

IRON

Magnetic Properties and Magnetic Signatures of BIFS of the Hamersley Basin and Yilgarn Block, Western Australia

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Abstract

Magnetite-rich banded iron-formations (BIFs) exhibit characteristic magnetic properties, including strong anisotropy. Interpretation of the geological structure of BIF units from the associated magnetic anomalies is complicated by anisotropy of susceptibility and, frequently, by remanent magnetisation. The timing of remanence acquisition relative to folding exerts a crucial influence on the form of the anomalies. Neglect of susceptibility anisotropy and remanence can lead to large errors in interpreted dips and thicknesses of BIF units. The effective susceptibility of BIFs parallel to bedding exceeds the susceptibility normal to bedding, typically by a factor of 2 to 4. Bedding-parallel susceptibilities of magnetite-rich BIFs are typically 0.5 to 2.0 SI (0.05-0.16 G/Oe). Remanence directions in BIFs usually lie close to the bedding plane. Koenigsberger ratios (Q) of BIFs vary widely, but characteristic values can often be determined for individual units. Q values in the range 1 to 2 are common. The magnetisations of the haematite-rich supergene-enrichment iron ores are much lower than those of their BIF precursors.

Magnetic properties of outcropping BIFs are usually greatly modified by weathering, which substantially decreases the bulk susceptibility, the degree of anisotropy and the remanence intensity. Deeper and more intense weathering of BIFs is encouraged by faulting and can be associated with reduced magnetic response over intensely faulted zones.

The remanence of BIFs from the Hamersley Basin is carried by late diagenetic to low-grade metamorphic magnetite after primary haematite. At Wittenoom and Paraburdoo, the remanent magnetisation of Brockman Formation BIFs is pre-folding, whereas in an area of higher metamorphic grade, the Turner Syncline, the remanence of the BIFs is probably post-folding. Aeromagnetic signatures over the Turner Syncline clearly reflect anisotropy and remanence.

Anisotropy and remanence effects are also evident in observed magnetic signatures over Archaean BIFs in the Yilgarn Block. Magnetic property measurements on samples from the Mount Magnet area and elsewhere confirm the high anisotropy and strong remanent magnetisations of these rocks.

Geophysics and Iron Ore Exploration: Examples from the Jimblebar and Shay Gap-Yarrie Regions, Western Australia

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Abstract

Aeromagnetic and downhole logging data have been acquired for iron ore deposits at Jimblebar and Shay Gap-Yarrie in the Pilbara region of Western Australia. The Jimblebar deposits are from the Archaean-Early Proterozoic Hamersley Group and the Shay Gap-Yarrie deposits are from the Archaean Gorge Creek Megasequence.

Aeromagnetic data are used to assist in regional mapping and generation of exploration targets. In structurally complex areas, a very close line-spacing may be necessary to provide data of sufficient resolution. Careful processing is necessary to reduce the large dynamic range of the data, caused by highly magnetic banded iron-formation (BIF), so that subtle features may be seen. Deposits display both structural and stratigraphic controls which may be evident in aeromagnetic data. In addition, the iron enrichment process alters magnetite within the parent BIF to haematite, which may give rise to subdued responses in aeromagnetic data. The application of the aero-

magnetic technique to exploration at Yarrie was an integral part of the discovery of the Y2 deposit.

Downhole natural gamma logging is used as an in-hole stratigraphic mapping tool. In the Jimblebar area, the stratigraphy, comprising interbedded oxide BIF and silicate iron formation (shale) macrobands, is very regular. As a result, it is generally possible for gamma ray logging to identify the strata intersected in drillholes to within a several metres, even where they are complexly deformed. Hence natural gamma logging can play an important role in resolving complex structural problems. At Shay Gap-Yarrie, gamma logging does not show the stratigraphic discrimination seen in the Jimblebar area, because the stratigraphy in the Shay Gap region is not as laterally consistent. However, gamma logging is still useful for general delineation of rock types.

Density logging is used for a variety of applications, including confirmation of ore grades, bulk density estimates for resource calculation, and geotechnical studies. At Shay Gap-Yarrie, back-scattered gamma density logging is used downhole to determine the density of iron ore, an important parameter in resource calculations. Frequent calibration of the probe with known reference samples is critical.

URANIUM

Geophysical Signature of the Kintyre Uranium Deposit, Western Australia

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Abstract

Kintyre is an unconformity-related, vein-style uranium deposit estimated to contain 36,000 t of U3O8. The deposit, located 70 km south of Telfer, was discovered during heliborne follow-up of 214Bi channel anomalies detected by an airborne magnetic and radiometric survey. Ground inspection of the strongest anomaly identified outcropping secondary uranium-silicate mineralisation. Drilling beneath the mineralised outcrop intersected the Kintyre ore lens, with the best hole containing 71 m at 5.94 kg/t U3O8. Since then, six additional ore lenses have been discovered and these make up the Kintyre deposit.

A wide range of airborne, ground and borehole geophysical techniques has been applied to the evaluation of the deposit in an attempt to locate additional ore lenses and to determine a geophysical signature for use in regional exploration. Two types of geophysical signature have been determined for the deposit; that of the mineralised zones and that of the host unit.

The deposit has an anomalous 214Bi channel radiometric response coupled with elevated counts in the potassium channel. Induced polarisation surveys have shown that a distinct, high apparent resistivity and high chargeability response coincides with the Kintyre mineralisation.

The ore is hosted by a lithological package which contains variable amounts of magnetite, leading to a moderate- to high-amplitude, inhomogeneous magnetic response. A density contrast detectable by gravity surveying has been noted between the host sequence and surrounding rocks. Electrical surveys have shown that the host unit is resistive relative to the rest of the host sequence and other rocks in the area.

TITANIUM

Geophysical Signature of the Balla Balla Titaniferous Magnetite Deposit, Western Australia

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Abstract

The Balla Balla titaniferous magnetite deposit is situated about 120 km southwest of Port Hedland, in the Archaean Pilbara Craton of Western Australia. The titaniferous magnetite, and associated vanadium, occurs as layers within a mafic intrusion. A detailed gravity survey was conducted over the deposit. After band-pass filtering, residual gravity highs (about 10 gu) associated with mineralisation were defined. A ground magnetic survey was also conducted over the deposit. Positive magnetic anomalies (about 4000 nT) were interpreted to be due to more massive areas of mineralisation. Offsets between these anomalies allowed faults to be mapped. Elementary modelling of the magnetic data indicates that remanent magnetisation is responsible for a significant part of the observed magnetic anomalies. Ground electromagnetic data (VLF) and resistivity data were moderately successful in mapping the contact between the mafic intrusion and underlying granitic rocks, and confirmed the location of faults inferred from the magnetic data. Induced polarisation data show that the mineralisation is chargeable.

DIAMONDS

Geophysical Signature of the Argyle Lamproite Pipe, Western Australia

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Abstract

The Argyle lamproite diatreme is located close to the eastern margin of the Halls Creek Mobile Zone, in the East Kimberley, 120 km south of Kununurra. The pipe was discovered by the Ashton Joint Venture during reconnaissance gravel sampling of the East Kimberley in late 1979. The Argyle diatreme is intruded into Revolver Creek Formation and Carr Boyd Group Proterozoic sedimentary rocks. The diatreme is an elongate body 2 km long and oriented approximately north-south, with widths varying from 150 to 500 m. It is composed dominantly of pyroclastic rocks.

A range of geophysical techniques have been used over the Argyle pipe, partly to assist in prospect evaluation but mainly to test their suitability for locating lamproite diatremes in adjacent areas. Airborne and ground magnetic and electromagnetic methods were used with varying degrees of success and a limited borehole logging programme carried out. None of the methods produced a definitive response over the Argyle pipe. Results indicate that the Argyle pipe is, at best, weakly magnetic, mainly in the northern bowl area, and weakly conductive, making it a very difficult target to locate using geophysical exploration techniques. Severe topographic problems which affected both airborne and ground survey results compounded the inherent problem of locating a subtle geophysical response.