Narrow Low Velocity Zones

When there are narrow low velocity zones in the refractor, this minimum perturbation approach is essential. Even in the absence of undetected layers, the appropriate migration distance for the definition of lateral velocity variations is not a simple function of overburden and approximate bedrock velocities (Sjogren, 1984; Palmer, 1986).

The benefits of variable migration have been demonstrated with targets which are reasonably deep in relation to the detector spacing (Palmer, 1980, pp. 59–81). However, it is still generally considered that migration is not necessary for very shallow refractors. The data and processed data in the accompanying figures dispute such a proposition. Even though the refractor is only about 10 m deep, the use of a 3 m detector interval, as well as the GRM velocity analysis technique, has resulted in precise definition of a narrow low velocity zone. The zone corresponds with a fault mapped in a coal mine below, and with a topographic depression.

Conclusions

Narrow low velocity zones are most effectively delineated with the seismic refraction method using a refractor velocity analysis technique employing migration. Such targets are not easily defined with reflection methods.

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THREE DIMENSIONAL REFRACTION METHODS

Derecke Palmer

The Requirements

Most methods for interpreting seismic refraction data assume that the seismic traverse is oriented in the direction of any lateral changes in depth or seismic velocity. This assumption treats the subsurface as two dimensional and greatly reduces the complexity of interpretation.

However, there are often situations where two dimensional methods are not applicable. The line orientation may be inappropriate because of insufficient regional geological control, or because of access constraints. If the seismic profile is not orthogonal to the contacts between lateral variations in refractor velocity, then refraction in the horizontal plane occurs, and the measured seismic velocities are higher than the true seismic velocities (see Sjogren, 1984, p. 168).

Alternatively, the target may in fact be three dimensional. This applies to seismic velocity as well as geometry. In particular, seismic velocity anisotropy, caused by foliation, jointing, etc. (Bamford and Nunn, 1979; Crampin *et al.* 1980) is common, and its measurement in the horizontal plane would be of considerable geological value.

Possibly the earliest three dimensional refraction method was fan shooting (Nettleton, 1940, p. 277; Dix, 1956, p. 31; McGee and Palmer, 1967, p. 5–8). A modern development is tomographic imaging (Mason, 1981; Worthington *et al.* 1983). Limitations of this approach are that it assumes an isotropic rock mass and that it ignores refraction effects, and so velocity inhomogeneities less than about 15% are not fully accommodated.

Three dimensional refraction methods offer the opportunity to overcome the limitations of treating the subsurface geometry as two dimensional. However it is also probably necessary to resolve any ambiguities between velocity inhomogeneities and horizontal anisotropy.

Wavefront Reconstruction in the Refractor

One approach which accommodates irregular geometries, velocity inhomogeneities of any magnitude, and anisotropy, is reconstruction of the horizontally propagating wavefronts in the refractor (Palmer, 1986). The following are the major features of the method.

A number of lines, usually parallel, is set out, and arrival times from each shot are recorded on all detectors. Shots are located so that a standard, in-line profile interpretation can be carried out on each line. This allows computation of time-depths at each detector position. These time-depths are then subtracted from arrival times for all shots, including shots sited on other lines, to produce travel times from each shot to a point on the refractor below each detector. The corrected arrival times for each shot are plotted on a plan of the survey lines and then contoured to produce wavefronts in the refractor.

The seismic velocity is obtained from the distance along the normal between the wavefronts, divided by the time increment (Palmer, 1986, chapter 2).

Data from localities at Foybrook and Mt. Bulga will demonstrate the method, its potential and its problems.

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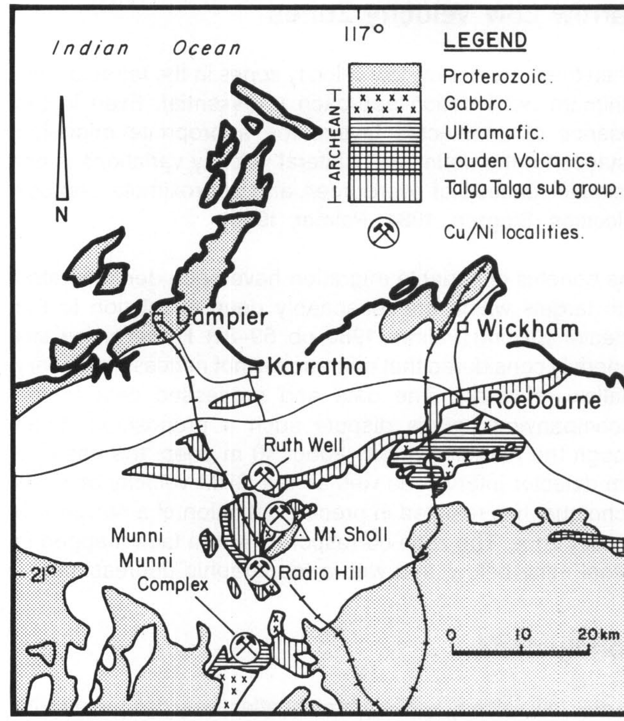
THE RADIO HILL NI-CU MASSIVE SULPHIDE DEPOSIT A GEOPHYSICAL CASE HISTORY

W. S. Peters, M. de Angelis

Introduction

The Radio Hill Ni–Cu deposit is situated approximately 30 km south of Karratha in Western Australia (Fig. 1). It was originally located by Westfield Minerals (WA) N.L. in 1972 as an aeromagnetic anomaly with coincident weak Ni–Cu soil geochemistry in an area of no outcrop. Between that time and 1978 various geophysical surveys and drilling failed to locate significant mineralisation. Between 1981 and 1986 geophysical surveys and drilling by Teck Explorations Limited and Samim Australia Pty Ltd located a significant Ni-Cu sulphide deposit. Table 1 summarises the geophysical surveys carried out over the area.



REGIONAL GEOLOGY & LOCATION MAP

FIGURE 1
Regional geology and location map.

TABLE 1
Geophysical survey summary

METHOD	YEAR	COMMENTS
Aeromagnetic	1968	U.S. Steel : 400m Line spacing.
Ground Magnetic	1972	Whim Creek - Westfield Minerals : 120m x 30m Grid.
Turam	1972	" " " " : 120m x 30m Grid.
Crone P.E.M.	1978	" " " " : Two Lines only.
Aeromagnetic	1981	Teck Explorations : 50m Line Spacing.
Sirotem	1982	" " : Offset 100m Loops. 100m x 50m Grid.
Ground Magnetic	1984	Samim Australia : 50m x 10m Grid.
Applied Potential	1984	" " : 50m x 25m Grid.
EM 37	1984	" " : 50m x 50m Grid.
Downhole Sirotem	1985	" " : 12 Holes, 7 TX Loops.
Gravity	1986	" " : Two Lines only.

Geology

The deposit is hosted within one of several layered mafic/ultramafic intrusions emplaced in the Archaean sequence of the western Pilbara Block (Figs 1, 2). The sequence has been invaded regionally by granite gneiss and intruded by granite plugs, the layered mafic/ultramafic bodies, and basic igneous rocks. Proterozoic basalts overlie the sequence and the area is extensively intruded by younger dolerite sills and dykes (Cooya Pocya Dolerite). Several major lineaments and faults have been identified from Landsat and aeromagnetics.