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Record 1981/50

McARTHUR BASIN RESEARCH

JANUARY-JUNE, 1981

K.A. Plumb (Co-ordinator)

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Contents

PRINCIPAL RESULTS

1) Further evaporite relicts, after anhydrite, have been identified within the Wollogorang Formation, and may be compared with identical nodules within the HYC Pyritic Shale Member.

2) Interpretation of seismic refraction data indicates velocity gradients, rather than a clearly layered structure, in the lower crust and upper mantly beneath the McArthur Basin. The structure resembles that of other Precambrian shields, and differences in deep crustal structure are found to the east and west of the Emu Fault Zone.

3) New methods of data analysis have placed greater constraints then previously on geological interpretations of MT data. Interpretations across the Bauhinia Shelf are in close agreement with both surface geology and seismic refraction.

4) Both Roper and Tawallah Group rocks are interpreted to extend as far west as Daly Waters, thinning suddenly westwards in that vicinity. McArthur Group rocks are absent from the western part of the Bauhinia Shelf.

5) Preliminary modelling of depth to magnetic basement indicates derivation from several sources, both within the basin sequence and various levels within the basement. Further interpretation is required for valid modelling of the basement configuration.

PUBLICATIONS

The following papers have been published:

COLLINS, C.D.N., 1981. Crustal seismic investigations in northern Australia, 1979: operational report. Bureau Mineral Resources, Australia, Record 1981/2.

PLUMB, K.A., DERRICK, G.M., NEEDHAM, R.S., & SHAW, R.D., 1981. The Proterozoic of Northern Australia. In, D.R. HUNTER (Editor), PRECAMBRIAN OF THE SOUTHERN HEMISPHERE. Developments in Precambrian Geology, 2. Elsevier, pp.205-307.

PLUMB, K.A., DERRICK, G.M., & WILSON, I.H., 1980. Precambrian geology of the McArthur River-Mount Isa Region, Northern Australia. In, R.A. HENDERSON & P.J. STEPHENSON (Editors), THE GEOLOGY AND GEOPHYSICS OF NORTHEASTERN AUSTRALIA. Geological Society of Australia, Queensland Division, pp.71-88.

The following publications are with editors or in press:

CULL, J.P., SPENCE, A.G., MAJOR, J.A., KERR, D.W., & PLUMB, K.A., in press. The 1978 McArthur Basin magneto-telluric survey. Bureau Mineral Resources, Australia, Record 1981/1.

CULL, J.P., SPENCE, A.G., & PLUMB, K.A., in prep. The 1979 McArthur Basin magneto-telluric survey. Bureau Mineral Resources, Australia, Record.

JACKSON, M.J., 1981. The Masterton Sandstone - a mid-Proterozoic intracratonic clastic unit. 5th Australian Geological Convention, Geological Society of Australia, Abstracts (in press).

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GEOLOGY

M.J. Jackson (Task Leader), K.J. Armstrong

SEDIMENTOLOGICAL STUDIES

Wollogorang Formation

Petrological studies of thin sections from surface specimens confirm the widespread presence of evaporite relicts, first seen in subsurface core specimens from Mount Young 2. The most common relicts in outcrop are small quartz and chalcedony nodules, up to 2 mm in diameter. In thin section they comprise an outer rim of small interlocking quartzose spherules and a core of euhedral equant megaquartz crystals, separated by a zone of radially or concentrically extinguishing fibrous chalcedony. Minute remnants of anhydrite, within the megaquartz cores, indicate that these nodules were formerly anhydrite.

Identical nodules have been noted, from nodular dolomites in the HYC Pyritic Shale Member at McArthur River, by Croxford and Jephcott (AIMM Proceedings, 243), indicating an evaporite environment for the deposition or diagenesis of at least part of this formation as well.

General

The following lectures were presented:

1. 'Syngenetic mineralization in the Wollogorang Formation, McArthur Basin, Northern Territory', to the Baas Becking Symposium on 3 March;

2. 'The Sedimentology of the Wollogorang Formation', to CCAE Geology School on 15 April;

3. 'The Wollogorang Formation - a potential host for McArthur River-type base-metal deposits', to the BMR Symposium on 6 May.

GEOPHYSICS

SEISMIC REFRACTION SURVEY (C.D.N. Collins)

Interpretation of the deep crustal refraction data recorded during 1979, between Daly Waters and HYC, and between Borroloola and Westmoreland, has been carried out, and reports on the results are in progress. The interpretation of near-surface structures was discussed in the report for July-December, 1980 (Record 1981/20). Substantial differences between the travel-time curves, from the two traverses recorded in 1979, are due mainly to lateral variations in these near-surface structures.

The characteristic features of arrivals from the middle and deep crust, and from the upper mantle, are a lack of obvious wide-angle reflection branches and first arrivals with fairly uniform amplitudes, and a more or less continuous travel-time curve. These suggest gradients in the velocity-depth curve, rather than sharply-defined layering. Lateral variations in the upper crustal structure (Record 1981/20) make it difficult to apply modelling techniques, such as synthetic seismograms, which require lateral homogeneity. The deeper layers are assumed to fulfil this requirement, at least within each traverse.

The following layered model, for the traverse west of the Emu Fault, may be interpreted from the data, within the limitations discussed above. The "basement" to the 4.62 km/s layer at Daly Waters lies at a depth of 4.3 km and has a velocity of about 5.8-5.9 km/s. It remains substanitally constant, or with perhaps a slight increase, to a depth of 18 km, where it increases gradually to 6.94 km/s at 24 km. A further increase takes place within a gradient zone between 30 and 34 km, to a velocity of 7.52 km/s, and again between 42 to 52 km, from 7.52 to 8.55 km/s. This very high velocity is based on poor data, recorded only at the furthest recording sites.

The data quality is better on the eastern traverse, with some evidence of later arrivals. Below the "basement" of 6.04 km/s. the velocity remains constant or increases slightly to a depth of 15 km, where it increases to reach 6.47 km/s at 16.5 km depth. It increases again within a gradient zone between 21 and 24 km, to 6.81 km/s, and increases from then on in a non-linear manner to about 7.4 km/s at 35 km depth. Below this, there is a gradual increase to 8.1 km/s at 52 km depth. Again the lower crust and upper mantle structures are not well defined, because they are only recorded at the furthest stations.

No significant low-velocity zones were interpreted within the crust, which accords with crustal models of other Precambrian shield areas. There is, however, a significant difference to the Western Australian Shield, where strong reflections are recorded. The lower velocity upper crust of the western traverse, as compared to the east, is balanced by a higher velocity lower crust and, perhaps, upper mantle. There is thus no overall effect in the regional gravity to support crustal differences between the two traverses, which may be evident from the seismic data.

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<u>MAGNETO-TELLURICS</u> J.P. Cull (Task Leader), A.G. Spence

In 1979, seventeen MT sites were occupied along a 200 km traverse across the Bauhinia Shelf, to complement the results obtained during 1978. The data were initially compiled as individual graphic representations of rotated tensor apparent resistivities, and phase curves for each orthogonal component, together with tensor rotation angle versus frequency. This new data processing has placed far greater constraints on interpretative models than previous analyses, and the geological interpretations so obtained are in excellent agreement with the constraints of surface geology. Final reports on the 1978 and 1979 surveys are in progress.

A preliminary examination of the resistivity plots at each site reveals marked differences associated with the major structural units of the Bauhinia Shelf. A predominant 2D feature is indicated by diverging components of apparent resistivity. This observation is emphasised when the data is presented as 2D pseudosections constructed from the individual plots, and severe limits must be imposed on 1D inversion. Actual resistivities for each stratigraphic unit cannot be readily resolved, because of anisotropy related to steeply-dipping structures, and correlations can only be based on relative values.

Isotropic data at each end of the traverse were inverted in a 1D analysis revealing well defined resistivity contrasts. The Roper Group appears to be characterised by values in the range 20-50 ohm m. However very low values (< 10 ohm m) have been detected at shallow depth in the region of the Limmen Bight River. These values suggest the presence of an aquifer sequence, such as the Abner Sandstone, which tends to mask any response from deeper layers. Even so, there is some indication of high values (> 1000 ohm m) at depths near 3 km below the Limmen Bight River, which are attributed to McArthur Group rocks which are not detected, either by MT or exposed stratigraphic sections, farther west.

Resistivity contrasts near Daly Waters and eastwards along the Carpentaria Highway are again reasonably consistent, but differ markedly from results in the Limmen Bight River area. In particular, there is no indication of the low resistivity aquifer sequence, and deeper features can be resolved with greater precision. Basement values appear to be less than 1000 ohm m, with maximum depths of 9.5 km along the highway westwards from Tanumbirimi homestead, decreasing abruptly to 6.0 km at Daly Waters. There is no indication of more resistive layers at shallow depth, and so the McArthur Group appears to be absent. The most significant resistivity contrast at shallow depth appears to correlate with the Roper/Tawallah Group boundary, at about 2.0 km below Daly Waters. A similar boundary has been detected by seismic refraction techniques, and the major features are identical. There is an abrupt increase in depth from 2.0 to 4.5 km immediately east from Daly Waters, with a gradual return to shallower depths towards the east from there.

Data from the structurally complex central sites are highly variable; orthogonal components diverge and continuity between sites cannot be readily detected; consequently, 1D inversion may not be appropriate. However, major features have been identified in models generated by 2D inversion. An isolated resistive block has been identified, again at shallow depth, in the Limmen Bight River region. This block has been attributed to

McArthur Group rocks, but its western extent remains obscure. Steeply dipping zones of high conductivity have been detected, which obscure details in other more resistive units.

AEROMAGNETICS I. Zadoroznyj

Processing and compilation of all the airborne data collected during 1977 and 1978 was completed during 1980. The results are now available, for all the 1:250 000 Sheets covering the McArthur Basin, as maps of magnetic intensity contours, radiometric contours, and stacked profiles.

Modelling of the depth to magnetic basement has been carried out across the whole of the basin using iterative magnetic inversion programs, and contour maps have been compiled at 1:1 million scale. A preliminary report on this study is nearing completion.

These initial results are difficult to interpret geologically, and contribute little at this stage to the interpretation of the basin's structure. The magnetic anomalies are derived from several sources, ranging from volcanics within the basin sequence down to sources deep within the basement. In some examples, model depths of up to 15 km have been obtained from areas of exposed high-grade metamorphic basement.

Further interpretation is required to identify the source of the anomalies; in particular, to recognise those which can contribute to valid modelling of the basement configuration. This second phase of interpretation is expected to commence in late 1981 and be completed in early 1982.