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K.A. PLUMB[2] and I.P. SWEET[2]

ABSTRACT

Stratigraphic correlations across the Murphy Tectonic Ridge are crucial to regional correlations between the Mount Isa and McArthur River areas. Recent work in the Westmoreland and surrounding areas has substantiated the earlier general correlations between the Mount Isa and McArthur River sequences. The Mount Isa and McArthur Groups, and their equivalents, remain prime prospecting targets for major lead-zinc deposits of the Mount Isa and H.Y.C. type. A prospective area for Redbank-type copper mineralization is suggested.

INTRODUCTION

Regional mapping of the McArthur Basin by the Bureau of Mineral Resources in the early sixties (Roberts, Rhodes & Yates, 1963; Smith & Roberts, 1963) revised the earlier correlations across the Murphy Tectonic Ridge by Carter, Brooks & Walker (1961). This, together with isotopic age determinations (McDougall et al., 1965), led to the proposal that the stratigraphic successions at Mount Isa and McArthur River, and their lead-zinc deposits, could be correlated (Dunn, Plumb, & Roberts, 1966). This correlation was developed in more detail by Plumb & Derrick (1974).

Remapping of the Mount Isa region at 1:100 000 scale, by joint parties of BMR and the Geological Survey of Queensland (GSQ), began in 1969, and was extended into the Westmoreland area in 1972. To date the Westmoreland 1:250 000 Sheet has been revised, and the Seigal Creek and Hedleys Creek 1:100 000 Sheets mapped (Fig. 1). Mapping will continue southwards to link eventually with the mapping proceeding northwards from Mount Isa.

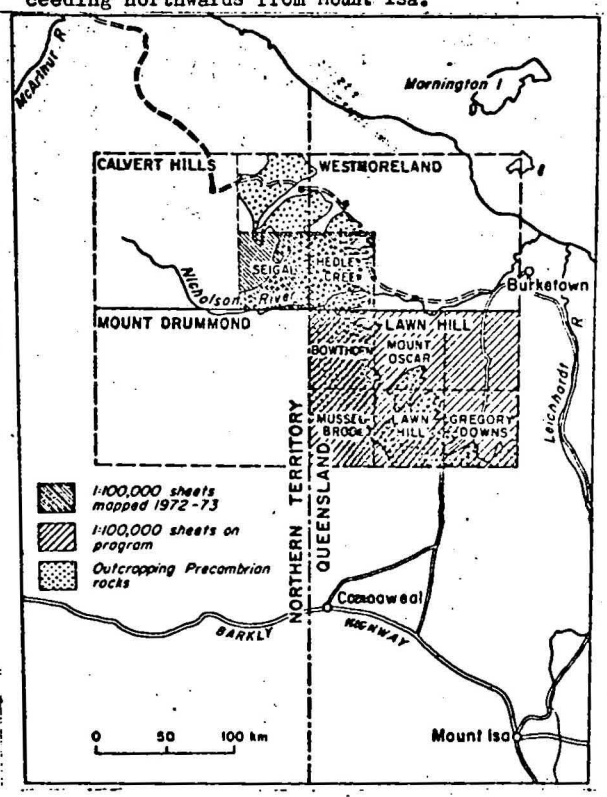

FIG. 1 - Index to Sheet areas

This paper assesses the significance of mapping across the Murphy Tectonic Ridge to regional correlations, particularly between McArthur River and Mount Isa.

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2. Geologist, Bureau of Mineral Resources.

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REGIONAL TECTONIC SETTING

The principal tectonic elements of the region (Fig. 2) are defined by Plumb & Derrick (1974).

The Murphy Tectonic Ridge is a basement inlier separating the McArthur Basin and Northwest Queensland Province, and formed a narrow barrier during sedimentation in them; the relationships across the ridge are crucial to correlations between McArthur River and Mount Isa.

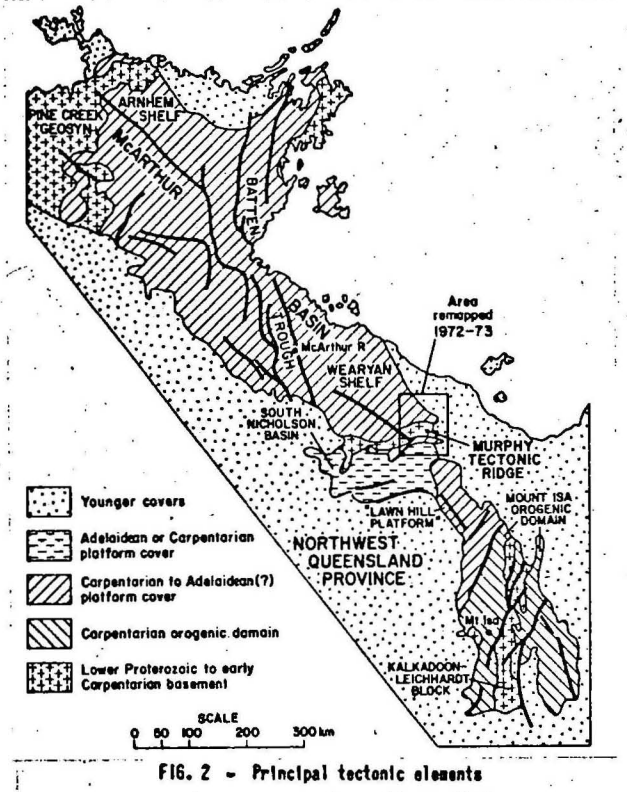


FIG. 2 - Principal tectonic elements

The Carpentarian Tawallah and McArthur Groups and the Adelaidean or Carpentarian Roper Group, and their stratigraphic equivalents, were deposited in the McArthur Basin. In the Northwest Queensland Province other equivalents of the Tawallah and McArthur Groups were deposited in the 'Lawn Hill Platform'* and Mount Isa Orogenic Domain, and were then deformed before the Roper Group equivalent (South Nicholson Group) was deposited in the South Nicholson Basin.

*Provisional name (Plumb & Derrick, 1974) pending completion of 1:100 000 mapping.

GEOLOGY

The stratigraphy of the Westmoreland area is summarized in Table 1 and relationships across the Murphy Tectonic Ridge illustrated in Figures 3 and 4.

MURPHY TECTONIC RIDGE

The four lower units mapped within the Cliffdale Volcanics comprise acid ignimbrites and minor tuff and lava; the upper unit is prominently flow-banded rhyolite and tuff.

The distinction between the Nicholson (pre-Cliffdale) and Norris (post-Cliffdale) Granites (Roberts et al., 1963) is no longer considered to be valid and the informal term 'Nicholson Granite Complex' is used pending completion of the work. The new field evidence suggests that all phases intrude the Cliffdale Volcanics, although poor outcrop obscures some relationships. Preliminary isotopic dating (see below) of the Nicholson Granite of Roberts et al. still suggests an age older than that of the volcanics.

WEARYAN SHELF (McARTHUR BASIN)

The stratigraphy of the Wearyan Shelf is little changed from that established by Roberts et al. (1963) and Yates (1963); the unit previously mapped as Peters Creek Volcanics in the McArthur Basin is now called Seigal Volcanics (see later).

The Westmoreland Conglomerate and Seigal Volcanics are the only units preserved on the Murphy Tectonic Ridge, and they thin dramatically across the Tin Hole Hinge Line (Fig. 4). Most of the younger units probably did not transgress the ridge. The Westmoreland Conglomerate has the characteristics of piedmont or alluvial fan deposits, and was locally derived from the exposed ridge.

TABLE 1

SUMMARY OF PRECAMBRIAN STRATIGRAPHY - WESTMORELAND AREA

Rock Unit and Symbol	Thickness in metres	Lithology	Remarks
SOUTH NICHOLSON BASIN			
SOUTH NICHOLSON GROUP			
Pe	500+	Quartz sandstone, micaceous siltstone; ferruginous sandstone & siltstone	Unconformable on all units of 'Lawn Hill Platform'
'LAWN HILL PLATFORM'			
Fielding Beds: 'Sandstone unit' Paf$_3$	170	Pebbly & silty sandstone; siltstone, shale, & dolomite	Local disconformity; pebbles of Paf$_2$ & Paf$_1$ in basal conglomerate
Fielding Beds: 'Siltstone unit' Paf$_2$	100	Grey & black dolomitic siltstone & shale; minor dolomite	Conformable on Paf$_1$
Fielding Beds: 'Dolomite unit' Paf$_1$	450	Oolitic & stromatolitic dolomite & chert; dolomitic siltstone & shale	Minor Pb. Conformable on Fish R. Fm.
Tawallah Group equivalent: Fish River Formation Ptf	180	Quartz sandstone, conglomeratic near base; micaceous siltstone	Unconformable on Peters Cr. Volc. & 'Westmoreland Cgl. equiv.'; transgresses Murphy Tectonic Ridge
Peters Creek Volcanics Ptp$_7$	200	Rhyolite	Rhyolites resemble Hobblechain Rhy. Mbr. Possible lava flows mapped between Ptp$_6$ & Ptp$_7$
Peters Creek Volcanics Ptp$_6$	330	Amygdaloidal basalt; minor tuff, sandstone, & conglomerate	
Peters Creek Volcanics Ptp$_5$	260	Flow-banded rhyolite; minor (?)intermediate volcanics	
Peters Creek Volcanics Ptp$_4$	80	Amygdaloidal basalt; minor sandstone	
Peters Creek Volcanics Ptp$_3$	0-200	Oolitic & sandy dolomite; dolomitic siltstone & shale; stromatolites	Lenses out westwards. Stromatolites & other rocks resemble those in Wollogorang Fm.
Peters Creek Volcanics Ptp$_2$	500	Massive rhyolite	
Peters Creek Volcanics Ptp$_1$	600	Amygdaloidal basalt; tuff; minor sandstone	Resembles Seigal Volc. Conformable on 'Westmoreland Cgl. equiv.'
'Westmoreland Conglomerate equivalent' Ptw	50	Feldspathic sandstone; pebbly & cobbly sandstone	Unconformably overlies basement rocks of Murphy Tectonic Ridge
WEARYAN SHELF (McArthur Basin)			
ROPER GROUP Pr	400	Micaceous, glauconitic, & quartz sandstone; micaceous & ferruginous siltstone	Unconformable on McArthur Gp. Nearest outcrop in Robinson River Sheet area
McARTHUR GROUP: Karns Dolomite Pak	100+	Silty, sandy & stromatolitic dolomite; chert; dolomitic siltstone	Only McArthur Gp unit on eastern Wearyan Shelf. Unconformable on Masterton Fm.
Packsaddle Microgranite Pgr		Porphyritic microgranite	Intrusive mass grading into extrusive Hobblechain Rhy. Mbr.
TAWALLAH GROUP: Masterton Formation: Undivided Ptm	200-450	Quartz & feldspathic sandstone; conglomerate	Overlies Hobblechain Rhy. Mbr or Gold Cr. Volc Mbr with apparent conformity; local angular unconformity near Redbank; conglomerates contain volcanic pebbles. Elsewhere sandstone overlies Wollogorang Fm., encloses Gold Cr. Volc Mbr northwest of Calvert Hills
Masterton Formation: Hobblechain Rhy. Mbr Pth	60+	Porphyritic rhyolite	Local unit developed north of Redbank
Masterton Formation: Gold Cr. Volc Mbr Ptg	180	Basalt, trachyte, tuff, agglomerate; tuffaceous & dolomitic sandstone	Base of Masterton Fm. in east; thins out to west where underlain & overlain by sandstone
Wollogorang Formation Pto	180	Silty & sandy dolomite; dolomitic siltstone & sandstone; stromatolites	Overlain by Masterton Fm.
Settlement Creek Volcanics Pts	150	Basalt, tuff, agglomerate; tuffaceous siltstone	
Aquarium Formation Ptq	170	Ferruginous, micaceous, glauconitic sandstone & siltstone; dolomitic siltstone	
Sly Creek Sandstone Ptl	170	Quartz sandstone; minor feldspathic sandstone	Overlies McDermott Fm. or Seigal Volc.
McDermott Formation Ptd	0-150	Silty, sandy & oolitic dolomite; dolomitic siltstone & sandstone; stromatolites	Absent adjacent to Murphy Tectonic Ridge
Seigal Volcanics Pts	1100	Basalt, agglomerate, tuff, tuffaceous siltstone	Previously mapped as Peters Cr. Volc. Reduced section overlies Murphy Tectonic Ridge
Carolina Sst. Mbr Ptc	60	Feldspathic sandstone	
Westmoreland Conglomerate Ptw	1300-1600	Quartz & arkosic sandstone & conglomerate; quartz & acid volcanic pebbles	Unconformably overlies basement rocks of Murphy Tectonic Ridge; thins dramatically onto Ridge
MURPHY TECTONIC RIDGE			
'Nicholson Granite Complex'		Porphyritic hornblende-biotite adamellite; even-grained muscovite granite	Several phases. Intrudes Murphy Met. Most (possibly all) phases intrude Cliffdale Volc. Norris Granite no longer recognized
Cliffdale Volcanics	4000+	Ignimbrite; subordinate acid lava; minor tuff	Five unnamed members. Unconformably overlain by Westmoreland Cgl. Intruded by granite
Murphy Metamorphics		Quartz-muscovite schist; metavolcanics; minor quartz-feldspar gneiss	Oldest rocks in area. Unconformably overlain by Cliffdale Volc. Intruded by 'Nicholson Gr. Cplx.'

'LAWN HILL PLATFORM'

The previously mapped units south of the Murphy Tectonic Ridge have been subdivided, but their nomenclature must remain informal pending further mapping.

Unconformities at the base of the 'Westmoreland Conglomerate equivalent' and Fish River Formation (Roberts et al., 1963) are confirmed, but the Fickling Beds are conformable on the Fish River Formation. Volcanic rocks and underlying conglomerate previously included in the Fish River Formation belong to the underlying Peters Creek Volcanics and 'Westmoreland Conglomerate equivalent'.

SOUTH NICHOLSON BASIN

No changes have been made to the stratigraphic relationships of the South Nicholson Group.

REVISED CORRELATIONS

The major correlations of Roberts et al. (1963) (Table 2) remain essentially valid, and are modified only at the more detailed level (Fig. 3).

TABLE 2

Previous correlations across Murphy Tectonic Ridge

(Roberts et al., 1963)

NORTH	SOUTH
Roper Gp	Sth Nicholson Gp
unconformity	
Karns Dol.	Fickling Beds
unconformity	
Masterton Fm	Fish R. Fm.
Wollogorang-McDermott Fms undivided	unconformity
Peters Ck. Volc.	Peters Ck. Volc.
Westmoreland Congl.	Westmoreland Congl.
unconformity	

The Peters Creek Volcanics in their type area (Carter et al., 1961) can no longer be directly correlated with the Seigal Volcanics; only the lower unit (Ptp_1) resembles the Seigal Volcanics. Acid and basic volcanics higher in

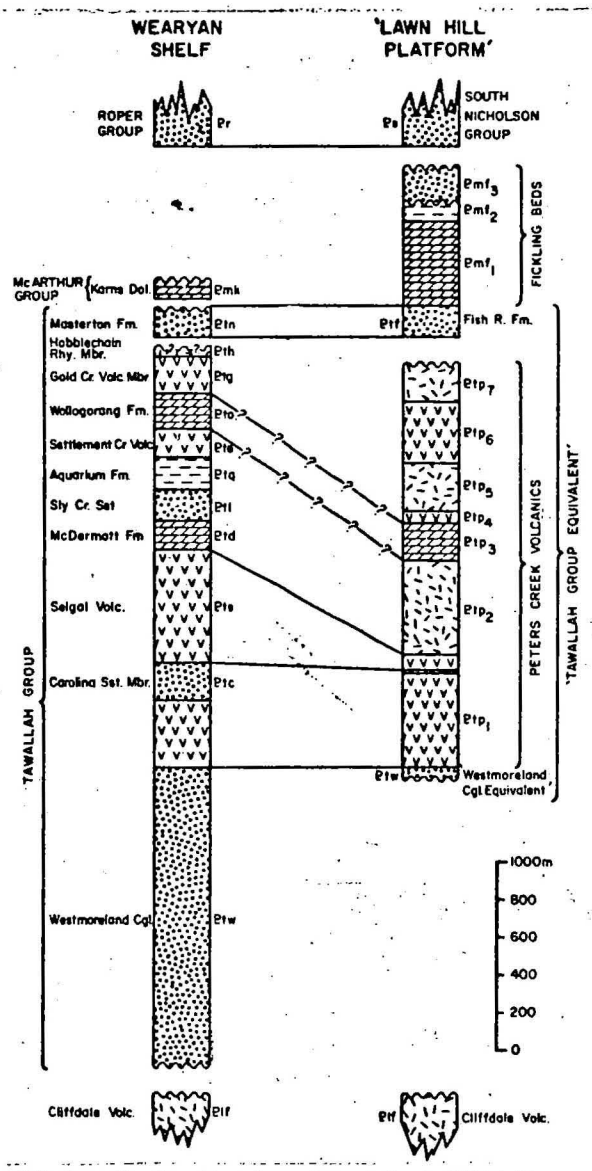
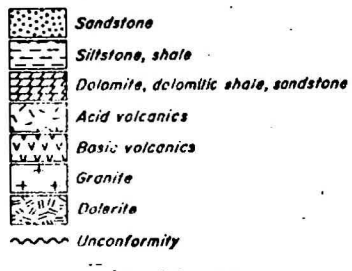


FIG. 3 - Stratigraphic columns, Carpentarian to (?)Adelaidean rocks, Westmoreland area



Legend figs 3-5

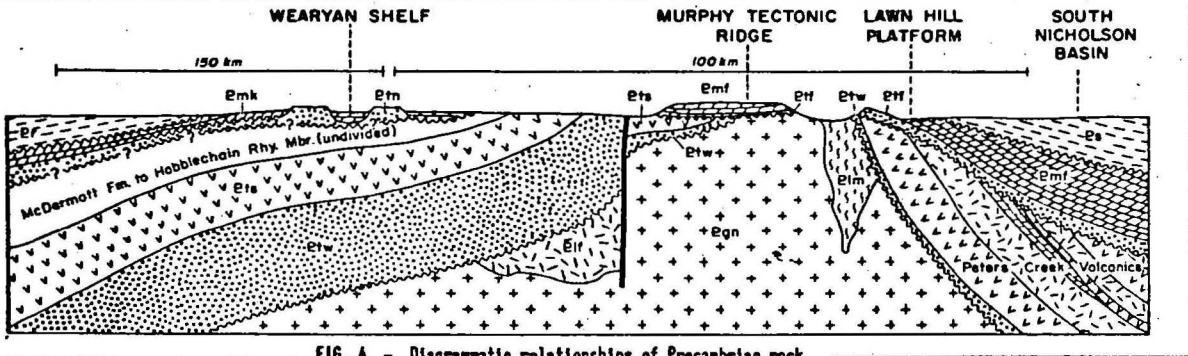


FIG. 4 - Diagrammatic relationships of Precambrian rock units, Westmoreland area

the Peters Creek Volcanics are very similar to those of the volcanic members of the Masterton Formation, and the carbonate unit (Btp_3) has many features in common with the Wollogorang Formation. No direct equivalents of the McDermott and Aquarium Formations or Sly Creek Sandstone are apparent in the south. The Peters Creek Volcanics are therefore considered to be the time equivalent of the complete Tawallah Group sequence between the Westmoreland Conglomerate and top of the Hobblechain Rhyolite Member (Fig. 3).

The sandstones of the Fish River Formation have always been recognized as possessing features characteristic of those in the Masterton Formation. Published work shows the Masterton Formation as a conformable sequence, but unpublished BMR data present evidence for an erosional break at the base of the sandstone at several widely spaced localities. Although this break may be more significant than formerly supposed, no redefinition of units is proposed at this stage.

Correlations between the Fickling Beds and McArthur Group, and between the Roper and South Nicholson Groups, are still valid. The unconformity below the Karns Dolomite is peculiar to the Wearyan Shelf.

REGIONAL CORRELATIONS

The lithostratigraphic successions in the McArthur Basin and the Northwest Queensland Province are similar (Fig. 5). This is the basis of the group-by-group correlations shown in Table 3, and isotopic age determinations have supported the hypothesis that the major changes in rock type reflect approximately isochronous events. Plumb & Derrick (1974) have made only minor modifications to the correlations of Dunn et al. (1966): the Tewinga Group may be slightly younger than the Cliffdale Volcanics, and it was suggested that deposition of the Mount Isa Group commenced slightly later than that of the McArthur Group to accommodate an unconformity associated with the emplacement of the Sybella Granite.

TABLE 3

General correlations between Mount Isa (present stratigraphic nomenclature) and McArthur River by Dunn et al., (1966) and Plumb & Derrick (1974)

McARTHUR RIVER	MOUNT ISA
Roper Gp	Sth Nicholson Gp
unconformity	
McArthur Gp	Mt Isa Gp
unconformity	
Tawallah Gp	Haslingden Beds
unconformity	
Cliffdale Volc.	Tewinga Gp

The correlations now proposed (Fig. 5) generally confirm those made earlier; the latest data suggest minor modifications to the detailed correlation of the Sybella Granite and the commencement of deposition of the Mount Isa

and McArthur Groups.

GEOCHRONOLOGY

A detailed assessment of most of the isotopic age determinations used to compile the absolute age controls in Figure 5 is given by Plumb & Derrick (1974).

The age of the base of the Carpentarian, as defined by Dunn et al. (1966), is provided by identical Rb-Sr isochrons of 1770 m.y. obtained from the Cliffdale Volcanics and granites (the old 'Norris Granite') intruding them (A.W. Webb AMDL Report An1814/73, unpublished). A less precise isochron of about 1845 m.y. from the old 'Nicholson Granite' needs confirmation by analysis of additional samples. A new Rb-Sr isochron of about 1575 m.y. (A.W. Webb, AMDL Report An2250/74, unpublished), which is based on additional sampling of the cogenetic Packsaddle Microgranite/Hobblechain Rhyolite Member, replaces the preliminary figure of 1600 m.y. in Plumb & Derrick (1974). The only data as yet available for younger units in the McArthur Basin are a minimum Rb-Sr mineral age of 1390 m.y. for glauconite from the Crawford Formation, and a minimum K-Ar mineral age of 1280 m.y. from dolerites intruding all units of the Roper Group (McDougall et al., 1965). Page (1974) has obtained a new Rb-Sr isochron of about 1720 m.y. for the Oenpelli Dolerite of western Arnhem Land, which is unconformably overlain by the Katherine River Group.

A program of isotopic dating of rocks in the Mount Isa region is not yet completed (R.W. Page, personal communication). A minimum Rb-Sr age of 1650-1700 m.y. has been obtained for part of the Tewinga Group and associated Kalkadoon Granite, but the results are complicated by the effects of regional metamorphism. Analysis of additional samples from new localities is in progress. Separate phases of Sybella Granite, both of which intrude all units of the Haslingden Beds, and are unconformably overlain by the Mingera Beds (Mount Isa Group equivalents), give good Rb-Sr isochrons of about 1645 m.y. and 1575 m.y.; a younger phase at about 1540 m.y. does not have demonstrable field relationships with the Mingera Beds. Several granites and metamorphic minerals which post-date the Mount Isa Group yield ages ranging from about 1400 m.y. to 1450 m.y.

STRATIGRAPHY

The apparent agreement in maximum age limits of the sedimentary successions, provided by the Oenpelli Dolerite and the preliminary age of the Tewinga Group (1100 km apart), suggest that sedimentation commenced about 1700 m.y. ago throughout the McArthur Basin, 'Lawn Hall Platform', and Mount Isa Trough, although deposition of the Westmoreland Conglomerate could have commenced earlier.

The reliability of the Sybella Granite isochrons makes it inescapable that a considerable gap in sedimentation accompanied its emplacement. The less precise isochron for the Hobblechain Rhyolite Member agrees with the younger (1575 m.y.) Sybella Granite phase, and would suggest that deposition of the Tawallah Group continued long after deposition of the Haslingden Beds ceased - a conclusion in agreement with the apparently minor time break above the Hobblechain Rhyolite Member.

The tentative correlations in Table 4 are based on a reconnaissance of the Lawn Hill area. From the generally accepted correlation of the Ploughed Mountain Beds with the Mount Isa Group (Carter et al., 1961; Plumb & Derrick, 1974), it is logical to correlate the Warrina Park Quartzite, at the base of the Mount Isa Group, with the Fish River Formation and, by corollary (Fig. 3), with the upper sandstone unit of the Masterton Formation. The Bone Creek Formation, at the base of the Mount Rigg Group in western Arnhem Land, has long been correlated with the Masterton Formation, and the Dook Creek Formation with the McArthur Group. The unconformity below the Mount Isa Group may be mappable

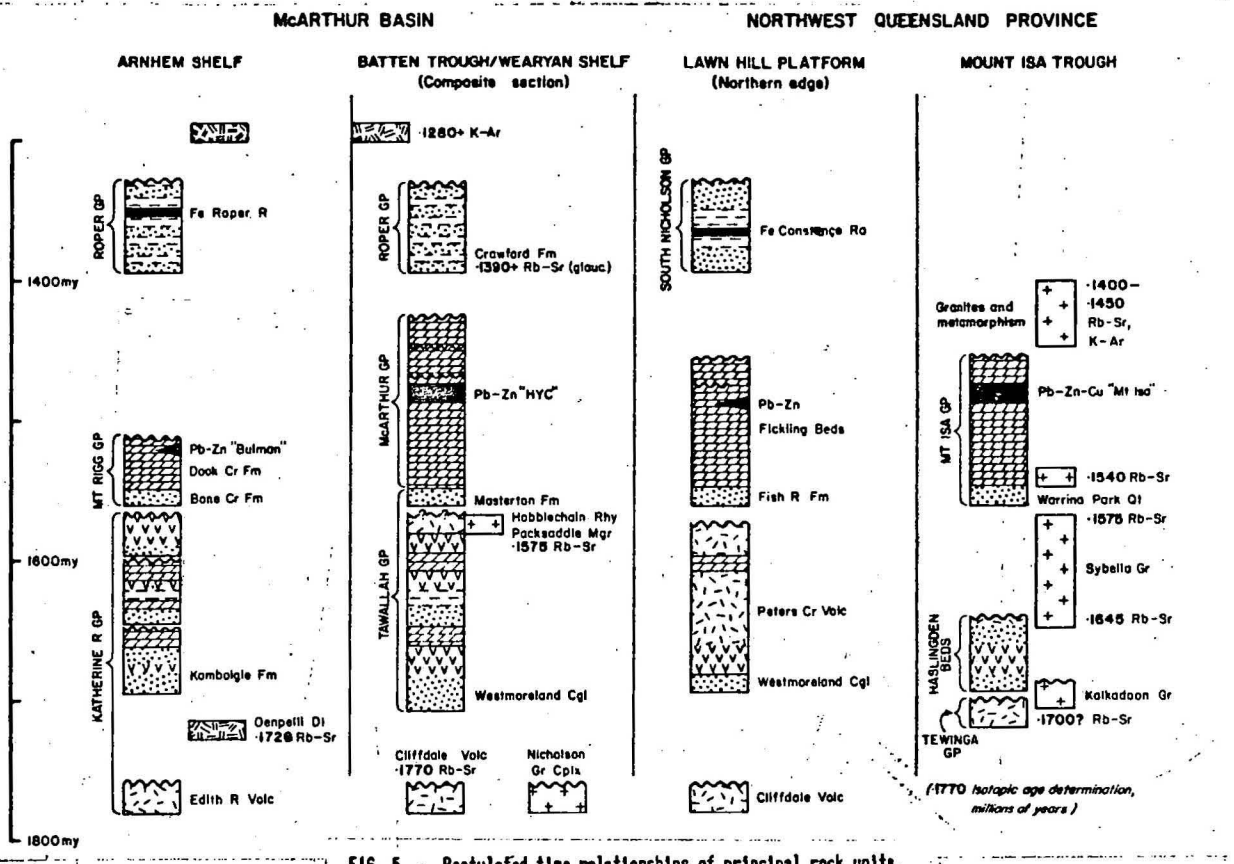


FIG. 5 - Postulated time relationships of principal rock units, McArthur Basin and Northwest Queensland Province

throughout the region.

TABLE 4

Tentative stratigraphic correlations within 'Lawn Hill Platform'

HEDLEYS CREEK SHEET AREA		LAWN HILL SHEET AREA	
Fickling Beds	'Sst. unit' (Pmf_3)	Lawn Hill Fm.	
	Local unconformity	'Sst. unit'	Ploughed Mountain Beds
	'Sltst. unit' (Pmf_2)	'Sh./Sltst. unit'	
	'Dol. unit' (Pmf_1)	'Dol. unit'	
Fish R. Fm.	unconformity	'Basal sst. unit'	unconformity
Peters Cr. Volc.		Myally Beds (?)	

The period of granite emplacement and deformation after deposition of the Mount Isa Group occupies a considerable span of time, and the isotopic age control of the Roper Group is consistent with the relationships here postulated. There is little structural break between the McArthur and Roper Groups, suggesting only a short time break, and the overall succession and thickness of beds in the McArthur Group, particularly if the lead-zinc orebodies are assumed to be isochronous, suggest a longer period of deposition for the McArthur Group than for the Mount Isa Group.

The overall correlations between the McArthur Basin and Northwest Queensland Province, proposed by Dunn et al. (1966) and Plumb & Derrick (1974), are therefore still valid. Detailed analysis, however, suggests that sedi-

mentation was more continuous in the Batten Trough of the McArthur Basin than it was in the Mount Isa Orogenic Domain, despite the greater overall thickness in the latter area; this is to be expected with the greater tectonic mobility at Mount Isa.

CONCLUSIONS

1. Although differing in minor detail, the recent work has validated the earlier general correlations made between the successions at Mount Isa and McArthur River and, by corollary, between the lead-zinc orebodies such as Mount Isa, Hilton, Lady Loretta, and H.Y.C.

2. The McArthur and Mount Isa Groups and their stratigraphic equivalents remain prime prospecting targets for lead and zinc. Particularly favourable are black-shale sequences about the middle of the groups, deposited in restricted depressions within linear troughs flanked by shallow shelves (Plumb, 1974; Plumb & Derrick, 1974).

3. The upper units of the Peters Creek Volcanics are a logical prospect for 'Redbank-type' copper deposits, particularly within volcanic domes.

ACKNOWLEDGEMENTS

The contribution to this study by the other members of the Westmoreland field party - J.E. Mitchell, Miss C.M. Gardner, and J.A. Ingram of BMR, and P.J. Slater of GSQ - is gratefully acknowledged.

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