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DEPARTMENT OF  
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## BUREAU OF MINERAL RESOURCES, GEOLOGY AND GEOPHYSICS

Record 1973/64

### REGIONAL GEOLOGY OF THE ALLIGATOR RIVER URANIUM PROVINCE, NORTHERN TERRITORY, AUSTRALIA

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by

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## SUMMARY

A variety of Lower Proterozoic rocks ranging from little-altered metasediments to high-grade gneiss and granitoid rocks, overlain by the Carpentarian Kombolgie Formation, comprise the Alligator River uranium province. The metamorphism took place during orogenesis and migmatization of eugeosynclinal sediments in late Lower Proterozoic time; the Nanambu and Nimbuwah Complexes are exposed parts of the orogen. The highest grade granitoid rocks (sillimanite - orthoclase-amphibolite facies) are believed to be of migmatitic origin because of their association with the migmatites and lit-par-lit gneisses of the complexes.

The grade of metamorphism decreases gradually towards the margins of the complexes, and passes into greenschist facies rocks. West of the East Alligator River they can be correlated with the Lower Proterozoic sedimentary succession of the Mount Evelyn Sheet area to the south (the South Alligator Group).

The South Alligator Group approximately delineates the margin of the eugeosyncline. Miogeosynclinal conditions prevailed to the west, where Goodparla Group type rocks were deposited (including Mount Partridge Formation).

Although fieldwork is as yet incomplete, a clear association between uranium mineralization and the margins of the complexes has emerged. It seems possible that uranium in the Lower Proterozoic sedimentary pile was moved and concentrated during orogenesis and granitization, although final reconcentration and relocation may have taken place more recently.

## INTRODUCTION

A Bureau of Mineral Resources (BMR) field party began detailed mapping of the Alligator River uranium province in June 1971. Geological maps at 1:100 000 scale are being produced, and the genesis of the uranium mineralization is being investigated. Progress reports have been prepared by Needham & Smart (1972) and Needham, Smart, & Watchman (1973a, 1973b). Approved changes in stratigraphic nomenclature are listed in the appendix to this paper.

The province (Fig. 1) consists of a broad belt of Lower Proterozoic rocks adjacent to the northwestern margin of the Arnhem Land Plateau; these are masked by younger Proterozoic and Mesozoic units to the east and north. Earlier workers considered that the rocks east of Cannon Hill and Magela Creek were basement Archaean (Myra Falls Metamorphics), marginal to a Lower Proterozoic 'Pine Creek Geosyncline' to the west, and that the Nanambu and Nimbuwah Complexes probably formed part of this basement, or were younger intrusive granites within it (Walpole et al., 1968). We now consider that the 'Archaean' rocks are metamorphic equivalents of the Lower Proterozoic sediments, and that Lower Proterozoic deposition extended at least as far east as Maningrida. The Nanambu and Nimbuwah Complexes were formed by orogenesis of sediments deposited within a eugeosyncline, whose western margin is approximately delineated by the South Alligator Group (composed of the Koolpin Formation and Fisher Creek Siltstone). Miogeosynclinal conditions prevailed farther west, over the area previously regarded as the 'Central Trough' of the 'Pine Creek Geosyncline'.

The Lower Proterozoic rocks of the uranium province are generally lower to upper greenschist facies; the grade of metamorphism increases to upper greenschist facies close to the Complexes, and passes into almandine amphibolite facies within them.

### LOWER TO UPPER GREENSCHIST FACIES METAMORPHICS

West of the East Alligator River metamorphic rocks of the lower to upper greenschist facies can be correlated with the miogeosynclinal succession. Arkose and feldspathic quartzite with minor schist and conglomerate are correlated with the Mount Partridge Formation; quartzite, carbonate rock, and minor schist with the Koolpin Formation and Gerowie Chert; and a monotonous sequence of phyllite and quartz-muscovite schist with the Fisher Creek Siltstone. Regionally these units dip southeast, but are locally concordant with the margins of the Nanambu Complex owing to updoming during orogenesis and migmatization.

East of the East Alligator River, higher metamorphic grades and extensive isoclinal folding prevent correlation with unmetamorphosed units; therefore the name Myra Falls Metamorphics is retained. Near Oenpelli Mission the Myra Falls Metamorphics consist mostly of pelitic schist (probably equivalent to the Fisher Creek Siltstone); towards the east they grade into arenite and arenaceous schist, and still farther east, near Nabarlek, into pelitic schist and quartz-mica schist.

### NANAMBU AND NIMBUWAH COMPLEXES

*where?*  
*don't*  
*begin*  
Petrologically the Complexes are very similar, and are probably part of the same orogen. The Nimbuwah Complex is composed of a core of foliated and nonfoliated homogeneous granitoid rocks surrounded by a wide belt of heterogeneous migmatites. The migmatite belt is surrounded by lit-par-lit augen gneisses which grade outwards into upper and lower greenschist facies metamorphics. The Nanambu Complex mostly comprises lit-par-lit and augen gneisses with only minor migmatite and foliated granitoid rock, and is therefore regarded as a lower-grade equivalent of the Nimbuwah Complex; the apparent lower metamorphic grade of the Nanambu Complex is probably attributable to its being less deeply eroded than the Nimbuwah Complex.

*Nanambu? - N. - ...? both?*

The granitoid rocks are medium to coarse-grained and commonly porphyritic; they consist of quartz, plagioclase, orthoclase, and biotite, with or without hornblende. Both feldspars are usually clouded by fine-grained deuteritic alteration products, probably clinozoisite or epidote. Accessory minerals are chlorite and apatite. The migmatites display a diversity of penetration fabrics, and contain feldspar (plagioclase, microcline, and orthoclase), hornblende, biotite, quartz, and minor muscovite, tourmaline, apatite, and chlorite. The augen gneiss has a similar composition to the migmatite, and formed by crystal growth during metamorphism ('blastesis') rather than by post-crystallization deformation. The lit-par-lit gneiss is composed of quartz-feldspar bands within quartz-biotite-chlorite (+ garnet) schist. Metamorphic grade determination of the granitoid core and migmatite belt is complicated by the apparent absence of index mineral assemblages.

*No*  
The absence of muscovite and microcline and the presence of orthoclase, however, suggest that sillimanite-orthoclase amphibolite conditions were reached (Winkler, 1965, pp. 103-4).

*always present!*

### INTRUSIVE ROCKS

Intrusives in the province are an alkali/basalt, probably pre-orogenic, which crops out within the Nanambu Complex, and a post-orogenic tholeiitic dolerite (the Oenpelli Dolerite\*) which occupies a series of ellipsoidal basins extending from the King River to Jim Jim Creek. Within the Nimbuwah Complex the Oenpelli Dolerite is partly hybridized; this may indicate that it was intruded before the Complex completely cooled. Unaltered and undeformed phonolite dykes - some containing nepheline - crop out near Mudginberri Homestead (the Mudginberri Phonolite\*) and west of the Goomadeer River (the Maningkorri Phonolite\*); they may represent the last phase of igneous activity in the Lower Proterozoic.

Widespread narrow felsite, aplite, and pegmatite dykes intrude the Nanambu and Nimbuwah Complexes, and appear to be older than the phonolites, being late-stage anatectic rocks.

### CARPENTARIAN AND YOUNGER UNITS.

The Kombolgie Formation is an extensive, almost flat-lying sequence of medium to coarse-grained sandstone with minor conglomerate and siltstone beds. In places it is divided into upper and lower sandstone units by the interbedded basaltic Nungbalgarri Volcanic Member. The regional unconformity at the base of the formation is well exposed at the base of the Arnhem Land escarpment, a sheer cliff marking the western margin of the Kombolgie Formation.

Mesozoic shallow marine to freshwater siltstone and sandstone cover the northern and northwestern parts of the uranium province. Outcrop of Lower Proterozoic units is confined to incised creek banks and isolated hills and ridges; the remainder of the area is covered by Cainozoic sand, alluvium, and laterite.

Isotopic dating is under way to help interpret the geological history of the province. During 1972 the BMR also conducted airborne magnetic and radiometric surveys over the province (Horsfall, 1973, in prep.), carried out a brief ground gravity survey (Wronski, 1973, in prep.), and mapped the Mesozoic and younger geology of Cobourg Peninsula to the north (Hughes & Senior, 1973a, 1973b, in prep.).

\* Name reserved by Territories Stratigraphic Nomenclature Subcommittee, but not yet approved.

Our knowledge of the geology of the province is as yet incomplete; field work will continue until 1974. However, we already recognize an association between mineralization and the margins of the Complexes. Thus mineralization may have been concentrated, during orogenesis, from the Lower Proterozoic sedimentary pile, although relocation of the deposits may have been finally concentration and relocation more recently, as suggested by dating of mineralization at Nabarlek (Cooper, 1972; Hills & Richards, 1972).

## APPENDIX

The following changes in stratigraphic nomenclature have been approved by the Territories Stratigraphic Nomenclature Subcommittee.

### NANAMBU GRANITE TO NANAMBU COMPLEX

**REASONS** The Nanambu Granite was described as a 'garnetiferous granite' by Condon & Walpole (1955), and as 'leucocratic garnetiferous granite and gneissic granite' by Walpole et al., (1968). In fact it consists of migmatite, leucogneiss, gneissic granite, augen gneiss, schist, basic amphibolite, and quartzite, the whole constituting a mantled migmatite dome; therefore we propose the name Nanambu Complex.

**TYPE LOCALITY AND NAME:** Walpole et al. noted that the Nanambu Granite 'cropped out between the South Alligator and East Alligator Rivers'. The name was first published by Condon & Walpole, and was 'derived from Nanambu Creek, which flows into Woolwonga Swamp at about latitude 12°42'S, longitude 132°41'E.

We do not wish to change the derivation of the name. The type locality we propose is 4 km south along Nanambu Creek from its headwaters, terminating in the vicinity of Cubbarnby Spring.

**EXTENT:** The Nanambu Complex crops out in three areas or 'masses' between the South Alligator and East Alligator Rivers in the Alligator River 1:250,000 Sheet area.

**AGE:** Lower Proterozoic, being formed by migmatization of Lower Proterozoic sediments.

### TO FORMALIZE THE NAME NIMBUWAH COMPLEX

**REASONS:** The unit was first named the Nimbuwah Granite by Dunn (1962), but was modified to Nimbuwah Complex by Rix (1965) when 'it was found to include both gneissic and massive granitic rocks'. We now recognize the Complex to be an extensive mantled migmatite dome composed of diatectic (granitic) and metatectic (banded or differentiated) migmatites, gneiss, schist, basic amphibolite, and quartzite. Therefore we should like to retain the name Nimbuwah Complex, but alter its description, and take this opportunity to formalize the name.

*now part  
of Lahill?*

TYPE LOCALITY AND NAME: The name is derived from Nimbuwah Rock, a prominent pinnacle consisting of Kombolgie sandstone overlying Nimbuwah Complex rocks. We should like to register the type area as the hill situated at lat.  $12^{\circ}9'40''\text{S}$ , long.  $133^{\circ}35'30''\text{E}$ , where there are extensive exposures of diatectic and metatectic migmatites, intruded by phonolite and felsite dyke rocks.

EXTENT: The Nimbuwah Complex crops out east of the East Alligator River, mostly north of the Arnhem Land escarpment; it continues east to the vicinity of Nungbalgarri Creek, where it is overlain by rocks of the Adelaidean Wessel Group. It continues north to the coast, and is masked by Kombolgie Formation and Mesozoic strata at the base of Cobourg Peninsula.

AGE: Lower Proterozoic, being formed by migmatization of Lower Proterozoic sediments.

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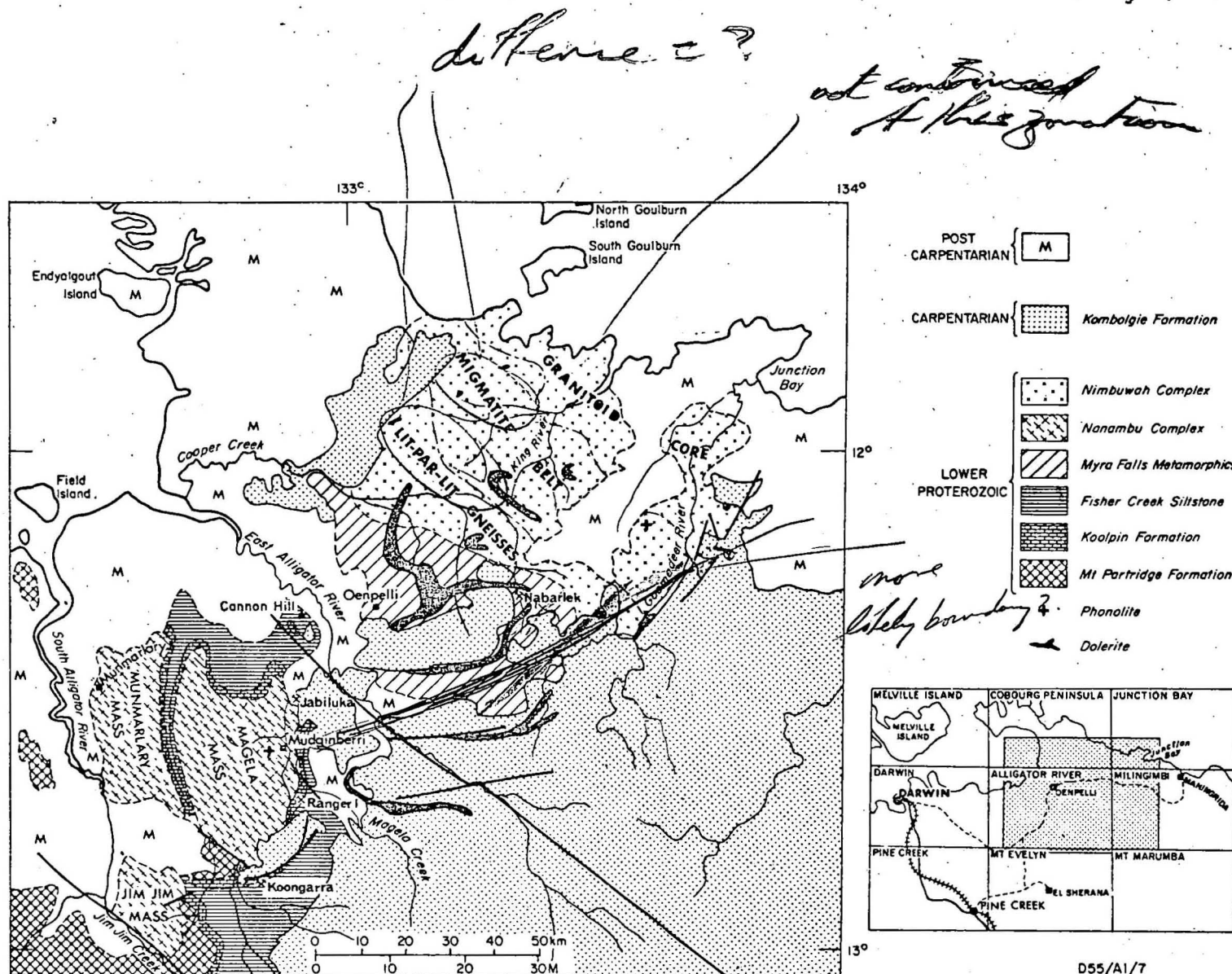


FIG 1-GENERALIZED GEOLOGICAL MAP, ALLIGATOR RIVER URANIUM PROVINCE

To accompany Record 1973/64