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Record 1976/43

BMR ROTARY-PERCUSSION AND AUGER DRILLING IN THE CAHILL AND EAST ALLIGATOR 1:100 000 SHEET AREAS, ALLIGATOR RIVERS REGION, 1972-3

by

R.S. Needham

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SUMMARY

Details of rotary-percussion and auger drilling by BMR in the East Alligator and Cahill 1:100 000 Sheet areas during 1972-3 are given, together with results of subsequent petrological and geochemical studies.

Fresh material was obtained from the Nanambu Complex (leucocratic gneiss, biotite gneiss, granite), 'Koolpin Formation equivalent' (biotite gneiss, schist, amphibolite, carbonate rocks), Fisher Creek Siltstone(?) (metagreywacke), Zamu Complex (amphibolite), and Mudginberri Phonolite. This material allowed approximate projection of Archaean and Lower Proterozoic units under younger strata in the northern half of the East Alligator Sheet area, where the thickness of Cainozoic and Mesozoic cover was found to range up to 77 m. The distribution of the Lower Proterozoic units generally agrees with that indicated by aeromagnetic patterns, on which the positions of the holes were based. The Mesozoic sequences that were intersected comprised interfingering parts of the Darwin Member (thicker in the west) and the Marligur Member (thicker in the east) of the Cretaceous Bathurst Island Formation.

The Lower Proterozoic metasedimentary rocks are retrogressed amphibolite-grade rocks with a complex structural and metamorphic history: compositional layering defines S1, which is cross-cut by S2 defined by the orientation of muscovite flakes and some differentiated layering; S2 is succeeded by S3 defined by biotite flakes. S3 is most probably coincident with the 1800 m.y. regional metamorphism. The Lower Proterozoic igneous rocks generally have been recrystallized, probably by the same regional event. The Adelaidean Mudginberri Phonolite is unaltered, signifying the absence of significant metamorphic events since its emplacement.

Comprehensive silicate and trace-element analyses of samples have been made. In major elements, the leucocratic gneiss and granite of the Nanambu Complex are chemically distinct and tightly grouped. Nanambu Complex basic gneiss and schist, and 'Koolpin Formation equivalent' schist and gneiss together form a diversely scattered group. Mylonite intersected in one hole was chemically determined as being derived from the leucocratic group. Major-element analyses tend to support field evidence for the genesis of four amphibolite specimens - two para-amphibolites and two ortho-amphibolites. Trace-element analyses indicate, however, that only one amphibolite is of sedimentary parentage.

Auger drilling proved the existence of infolded belts of 'Koolpin Formation equivalent' within Nanambu Complex rocks, but failed to obtain bedrock from an area believed to be underlain by dolerite east of Ranger 1.

No economically significant metal values were detected in the samples analysed.

INTRODUCTION

This Record describes the results of rotary-percussion drilling (1972-3) and auger drilling (1973) by the Bureau of Mineral Resources in the East Alligator and Cahill 1:100 000 Sheet areas in the Alligator Rivers Uranium Field. Auger drilling by BMR in these areas during 1971 has been described by Needham & Smart (1972). Auger drilling in the Oenpelli 1:100 000 Sheet area and in the extreme northeast of the East Alligator 1:100 000 Sheet area (northeast of the East Alligator River) has been described by Needham et al. (1975).

LOCATION

The Alligator Rivers Uranium Field is 200 km east of Darwin in the Northern Territory. It covers the Alligator River 1:250 000 Sheet area and parts of adjoining sheets to the south and northeast. The East Alligator and Cahill 1:100 000 Sheet areas lie in the centre of the uranium field, between the East Alligator and South Alligator Rivers (Fig. 1). The positions of rotary-percussion holes and auger traverses described in this report are shown in Figures 2 and 3.

AIMS

The East Alligator and Cahill 1:100 000 Sheet areas were mapped at semi-detailed scale (1:100 000) in 1971-72. The stratigraphy of the rock units encountered in the drilling is shown in Table 1. The areas are underlain by a large mantled gneiss dome (the Nanambu Complex, formed by migmatization of Archaean basement rocks and overlying Lower Proterozoic sediments), which is surrounded by metamorphosed Lower Proterozoic sediments (Needham & Smart, 1972; R.W. Page, pers. comm.). Metamorphosed Zamu Complex dolerite intrudes the Archaean and Lower Proterozoic units. Most of the area is blanketed by superficial deposits; most exposures are of weathered rock in incised creek banks. North of Munmarlary homestead thick Cainozoic and Mesozoic deposits cover Lower Proterozoic strata.

The drilling program was designed to obtain fresh rock from poorly exposed and deeply weathered areas, in order to map concealed rock units. Some of the drill holes and auger traverses were designed specifically to locate the margins of the Nanambu Complex; these drill and traverse sites were chosen with the help of aeromagnetic patterns interpreted, from the results of a BMR airborne survey, (Horsfall & Wilkes, 1975) as marking the margins of the Nanambu Complex. Other specific targets were: dolerite below black soil (Auger Traverse 7); phonolite dykes (Cahill 3 and 5); and carbonate below a ferruginous silicified capping (Cahill 7).

TABLE 1. STRATIGRAPHIC TABLE OF UNITS ENCOUNTERED IN 1972-73 DRILLING PROGRAMS

UNIT	LITHOLOGY	RELATIONSHIPS	AGE
Marligur Member	medium sandstone, clayey sandstone, minor coarse or unconsolidated sand	) mutually interfingering; unconformable over older units	Cretaceous (Aptian)
Darwin Member	siltstone, fine sandstone	)	
Mudginberri Phonolite	phonolite	intrudes Nanambu Complex as dykes up to 1 m thick	Adelaidean (1340 m.y.)
	MAJOR UNCONFORMITY		
	REGIONAL METAMORPHISM AND DEFORMATION (including metamorphic accretion of some material onto Archaean basement to form Nanambu Complex mantled gneiss dome).		Lower Proterozoic
Zamu Complex	metadolerite, amphibolite	intrudes older units as sills	Lower Proterozoic
Fisher Creek Siltstone	metagreywacke	transitionally overlies 'Koolpin Formation equivalent'	Lower Proterozoic
'Koolpin Formation Equivalent'	biotite gneiss, schist, amphibolite, carbonate rock	probably unconformable in places over Nanambu Complex	Lower Proterozoic
Nanambu Complex	leucocratic gneiss, biotite gneiss, granite, schist	contains Archaean granite and gneiss, and metamorphosed partly differentiated Lower Proterozoic material	Archaean-Lower Proterozoic (2520-1800 m.y.)

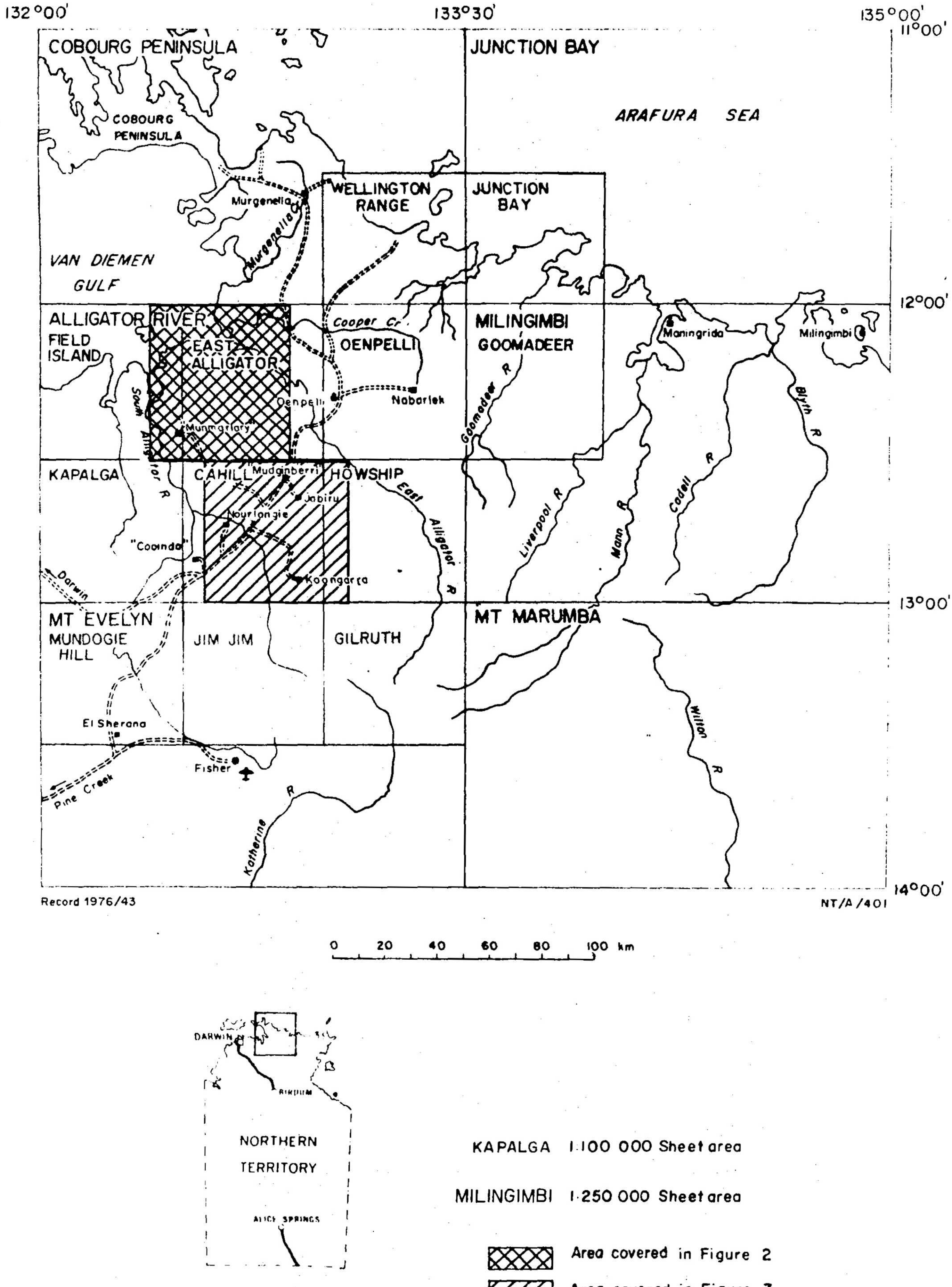

Fig. 1 General locality map.

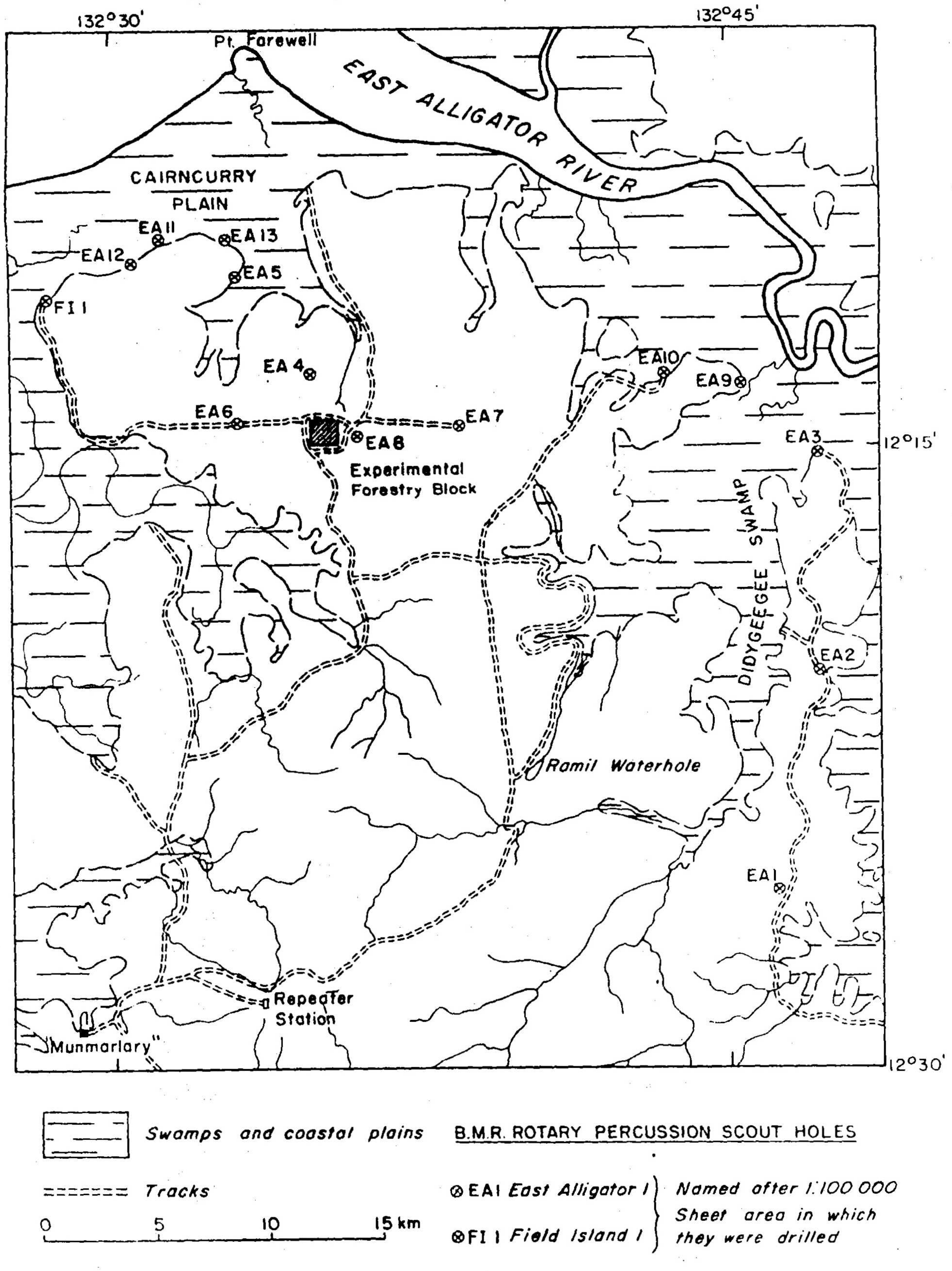

Fig. 2 Location of scout drill holes drilled by B.M.R. in the East Alligator and Field Island 1:100 000 Sheet areas during 1973

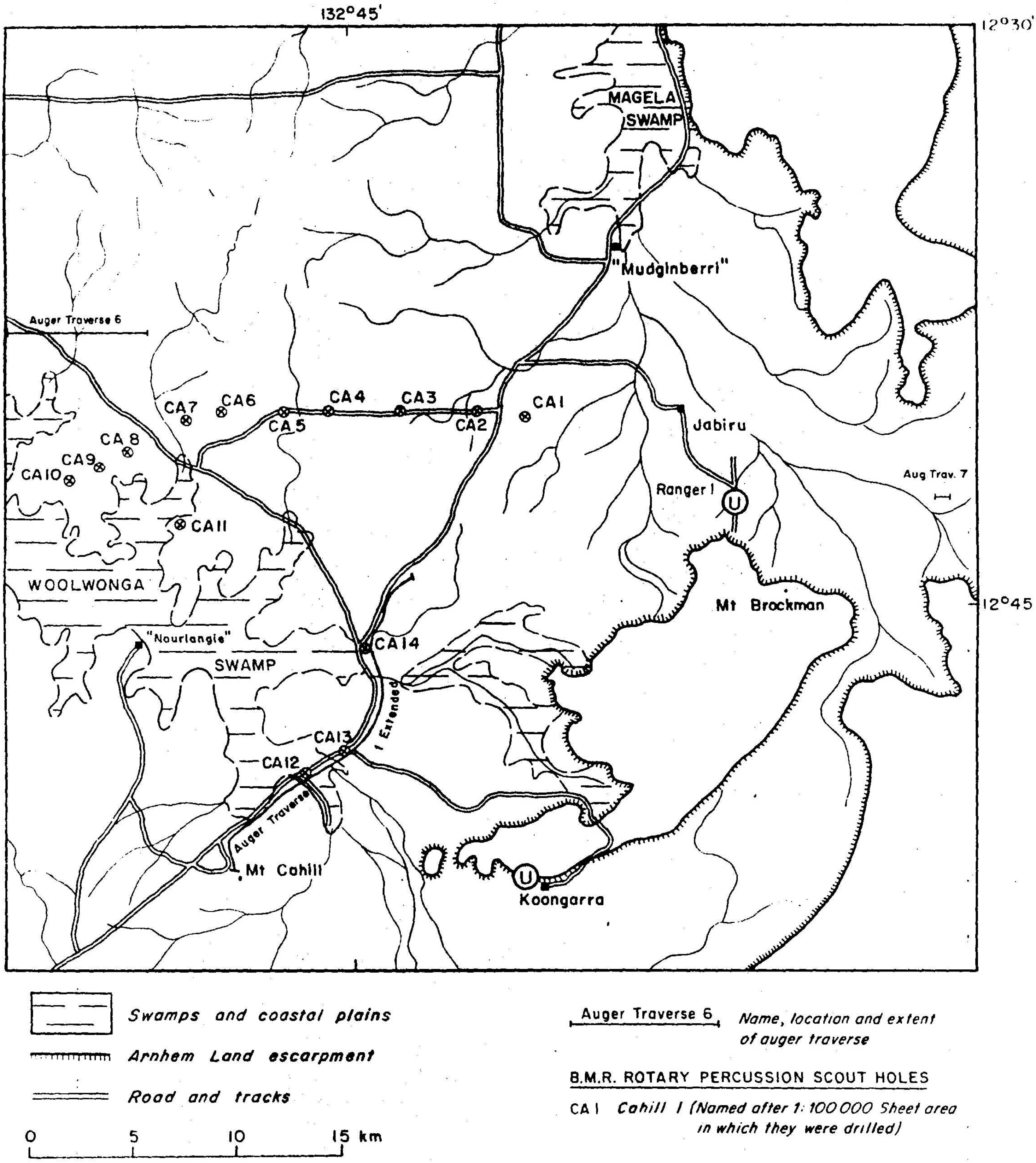

Fig. 3 Location of Auger Traverses drilled by B.M.R. in 1973, and scout drill holes drilled in 1972 and 1973, in the Cahill 1:100 000 Sheet area

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EQUIPMENT AND METHODS

All drilling was done by BMR staff. Auger holes were drilled by a Gemco 120 trailer-mounted auger rig. Rotary-percussion holes were drilled by a Mayhew 1000 rig. Target depth was 30 feet (9.1 m) for auger holes and 200 feet (61 m) for rotary-percussion holes. Generally 10 feet (3.05 m) of core was taken at the bottom of each rotary-percussion hole.

Bottom-hole samples were taken from the auger holes. Samples at intervals of 10 feet were taken during rotary-percussion drilling. All core and cuttings are stored at the BMR Fyshwick Core and Cuttings Laboratory, A.C.T.

Auger holes were radiometrically probed using an EMI Type 239 ratemeter coupled to a geiger tube. Readings in counts per second were taken at 2-foot intervals. Rotary-percussion holes were logged by the BMR Geophysical Branch using a Widco Porta-logger. Where possible, gamma-ray, self-potential, and resistance logs were run, but collapse in many of the holes prevented logging. Selected core samples were thin-sectioned for detailed petrographic study. Forty-eight core samples were analysed for both major and trace elements by BMR (analyst, J. Pyke); a further forty-seven samples of rotary-percussion cuttings were analysed for trace elements only (analyst, J. Pyke). Two core samples were analysed for carbonate by AMDEL.

The analytical results obtained in this work are to be used in a comprehensive geochemical study of the regional geology and mineralization of the Alligator Rivers Uranium Field; this is being undertaken by J. Ferguson of BMR. The data referred to in this report are on file at BMR in computer-ready form as magnetic tape.

Major element analysis

The method outlined by Norrish & Hutton (1969) was used; USGS standards and BMR secondary standards were applied as checks on the analysis of SiO_2, TiO_2, Al_2O_3, total Fe as Fe_2O_3, MnO, MgO, Na_2O, K_2O, and P_2O_5. The samples were mixed in the ratio 1:5.06 with a flux of lithium tetraborate, lithium carbonate, and lanthanum oxide, fused, and pressed into a glass disc.

Trace-element analysis

The samples of crushed rock were analysed using a Philips PW1210 X-ray spectrometer fitted with a Torrens TE108 automatic sample changer. Synthetically prepared standards were used throughout, and were checked against USGS rock standards. The method of Norrish & Chappell (1967) was used for converting count rates to element concentrations. Dead-time corrections were made automatically by the spectrometer. Empirical interfering-element corrections were applied to U (corrected for Rb interference), Ba(Ce), As(Pb), Y(Rb), Zr(Sr), and V(Ti). Mass-absorption coefficients for the Rb Kx wavelength were obtained from the Mo Compton peak. The Fe-Kx mass-absorption coefficients were calculated from the Fe_2O_3 concentration in the samples. Non-linear background corrections were made using 'specpure' Al_2O_3 and SiO_2.

Carbonate analysis

The samples were analysed under AMDEL scheme F10/1, using wet chemical techniques. Calcium was analysed as CaO, magnesium as MgO, and CO_2, total iron, and acid-insoluble content were determined.

RESULTS

ROTARY-PERCUSSION DRILLING

Eleven holes totalling 1062' (323.7 m) were drilled in the Cahill Sheet area in 1972, and core totalling 254'6" (77.6 m) was obtained. A further seventeen holes totalling 3227'6" (983.7 m) were drilled in the East Alligator, Cahill, and Field Island Sheet areas in 1973; core totalling 63'6" (19.3 m) was obtained.

Of the holes drilled in the Cahill Sheet area, most were drilled along an east-west line from the flood plain of the South Alligator River to the Darwin-Oenpelli road, north of Woolwonga Swamp (Fig. 3). Nine holes intersected leucogneiss, biotite gneiss, schist, and granite of the Nanambu Complex; two of these holes penetrated dykes of Mudginberri Phonolite intruding Nanambu Complex (Cahill 3 and 5), and one intersected amphibolite tentatively ascribed to the Zamu Complex (Cahill 4). Five holes in the Cahill Sheet area intersected 'Koolpin Formation equivalent' rock types, namely marble (either massive beds which are vuggy in places, or thin beds interlayered with quartz-biotite schist), chloritic quartz-biotite schist, schistose chloritic or garnetiferous calcite-veined amphibolite, mica schist, and biotite-feldspar gneiss; the presence of infolded belts of 'Koolpin Formation equivalent' dividing the Magela, Munmarlary and Jim Jim Masses of the Nanambu Complex, as proposed by Needham and Smart (1972), has thus been verified. Amphibolite intersected in Cahill 12 is ascribed to the Zamu Complex, and the weathered schist overlying it is ascribed to the 'Koolpin Formation equivalent' on the basis of its texture and biotite content, which are generally more characteristic of the 'Koolpin Formation equivalent' than of the Nanambu Complex.

Most of the holes drilled in the East Alligator Sheet area were located in the northwestern part of the Sheet area; East Alligator drill holes 1-3 were put down on a northerly-trending line in the central part of the Sheet area south of the East Alligator River estuary (Fig. 2). The holes were all in areas devoid of any pre-Cainozoic rock exposure, and were positioned with reference to magnetic patterns thought to indicate subsurface belts of 'Koolpin Formation equivalent' within the Nanambu Complex. Eight holes penetrated biotite gneiss, chlorite-biotite-quartz schist, pelitic schist, or chlorite-epidote-biotite schist of the 'Koolpin Formation equivalent'; one of them also intersected biotite calc-silicate schist (East Alligator 13). By and large the subsurface distribution of 'Koolpin Formation equivalent' indicated by magnetics was substantiated. Four holes penetrated Nanambu Complex leucogneiss, biotite schist and gneiss, augen gneiss, and granite (East Alligator 1, 4, 7, 8), and East Alligator 9 intersected mylonite indicating a probable extension of the Bulman Fault under the

East Alligator River flood plain. Chemical analysis indicated that the mylonite was derived from a leucocratic rock type of the Nanambu Complex.

The northwest part of the East Alligator Sheet area is occupied by extensive Mesozoic and Cainozoic sediments. Eight of the holes drilled in the Sheet area intersected Mesozoic sediments, between 10 and 80 m thick, comprising interfingering sandstone and siltstone members of the Bathurst Island Formation (Fig. 26; Hughes, in prep.). In places the Cainozoic cover is as much as 76 m thick. The greatest depth to pre-Mesozoic basement was in East Alligator 7, where 5 m of Cainozoic sand and 77 m of Mesozoic mudstone, sandstone, and siltstone covered Nanambu Complex granite.

One hole drilled in the Field Island Sheet area (Field Island 1) intersected quartz-biotite-epidote-albite schist. Similar rocks were found in the upper part of the 'Koolpin Formation equivalent' and in the Fisher Creek Siltstone, in the Jim Jim and Cahill Sheet areas during the 1974 BMR drilling program (P.G. Stuart-Smith & I.G. Hone, pers. comm.). The schist is tentatively assigned to the Fisher Creek Siltstone.

All the metasedimentary Lower Proterozoic rocks appear to be of amphibolite grade, and some specimens contain garnet, staurolite, or hornblende. Most of the rocks however show evidence of retrogressive metamorphism; biotite and chlorite commonly replace garnet and rutile needles are exsolved from biotite in some specimens. Textures in several of the metasedimentary rocks (e.g. 73121450) indicate a complex structural and metamorphic history. In specimen 73121450, a psammo-pelitic schist from East Alligator 3, early compositional layering is represented by quartz-rich and quartz-poor bands. Muscovite flakes cross-cut the layering, and define an early metamorphic foliation. A late foliation is defined by crenulations of the early foliation and by the orientation of biotite flakes. The event which produced the late foliation is believed to be related to regional amphibolite-grade metamorphism that affected the whole of the Alligator Rivers region; this has been isotopically dated at about 1800 m.y. (R.W. Page, pers. comm.). Most of the rocks have been retrogressed to middle greenschist facies.

The Lower Proterozoic igneous rocks are mostly recrystallized to some degree, probably by the 1800-m.y. event. The Mudginberri Phonolite is the only rock type in which there is no evidence of alteration, indicating that no significant metamorphic event has taken place since its emplacement at about 1340 m.y. (R.W. Page, pers. comm.).

Geophysical Results

Nine of the 28 holes drilled were logged by the gamma-ray, self-potential, and resistance methods, and a further eight holes solely by the gamma-ray method. The remaining holes were not logged, either due to early collapse of the holes or malfunction of the logging equipment. Many of the logs did not reach full depth owing to partial collapse of the holes.

Five of the gamma-ray logs recorded peaks of radioactivity in excess of 0.02 mR/h (milliroentgens/hour) above background. Three of the peaks represented near-surface or weathered-zone concentrations in Cainozoic, Mesozoic, or Lower Proterozoic material (East Alligator 9 and 13; Cahill 2), and two represented concentrations in fresh Nanambu Complex rocks at the bottom of the hole (East Alligator 8, a peak of 0.05 mR/h above background in augen and banded gneiss; Cahill 9, a peak of 0.03 mR/h above background in biotite gneiss and feldspathic biotite schist). The highest peak recorded was 0.06 mR/h in Cahill 2, in the weathered zone of the Nanambu Complex.

The gamma logs were not effective in defining lithological boundaries, although generally values are higher in Lower Proterozoic rocks than in Mesozoic and Cainozoic rocks.

The only radioactive mineral found was in core from East Alligator 1, where an opaque radioactive mineral with dark pleochroic haloes is contained in biotite in orthogneiss of the Nanambu Complex. Radioactivity was subsequently found to be due to uranium.

Geochemical results

Forty-seven specimens of Nanambu Complex gneiss, schist and granite, 'Koolpin Formation equivalent' gneiss, schist, carbonate rock, and amphibolite, Fisher Creek Siltstone(?) metagreywacke, Mudginberri Phonolite, Zamu Complex amphibolite, and a mylonite were analysed for major and trace elements. Two of the carbonate rocks were also submitted for analysis. One core sample of Mesozoic orthoquartzite was also analyzed for major elements. Forty-seven cuttings of Mesozoic and Cainozoic rocks were analysed for trace elements. The Mesozoic sediments consisted of consolidated and unconsolidated sandstone, and siltstone and mudstone. Cainozoic specimens consisted of unconsolidated sand, gravel, lateritic gravel, silt, and clay. The Mesozoic and Cainozoic samples were taken from East Alligator 5 and 7 which contained the best intersections of Mesozoic strata, including both the Marligur and Darwin Members of the Bathurst Island Formation. Eight samples near the base of the holes contained admixed Lower Proterozoic material.

Major elements determined were SiO_2, TiO_2, Al_2O_3, total Fe as Fe_2O_3, MnO, MgO, CaO, Na_2O, K_2O, and P_2O_5. Trace elements determined were U, Th, Y, Rb, Zr, Nb, Sr, Pb, As, Ba, Ce, Cu, Zn, Ni, Cr, V, and Sn (Ba and Ce were not sought in the Mesozoic and Cainozoic samples). Analytical results are tabulated in Appendices 2, 3, and 4, where detection limits are also given. The analytical method is described in the Introduction. All samples were crushed in a tungsten carbide vessel.

Major-element results are synthesized in Figures 27 and 28 (ACF and AKF plots, and a plot of alkalis versus silica). Nanambu Complex leucogneiss, augen gneiss, and granitoid rocks plot as a separate group (indicated by dashed line), being relatively high in alumina and silica, and lower in calcium and iron than other rock types. Biotite gneiss of the Nanambu Complex, and biotite gneiss and schist of the 'Koolpin Formation equivalent' plot as a diversly scattered group in which the constituent rock types are chemically indistinguishable.

On field evidence alone, the four amphibolites are divided into two igneous and two sedimentary types. Their major-element chemistry is similar, except that the two which appear to be para-amphibolites have a higher SiO_2 content. One of these (74121345) is very low in CaO and is also characteristically different from the remaining amphibolites in trace element chemistry (Appendix 3), indicating that it is probably the only true para-amphibolite of the group.

The presence of mylonite in East Alligator 9 probably indicates a northwesterly extension of the Bulman Fault. The rock plots consistently with Nanambu Complex leucocratic gneissic and granitic rocks, and was obviously derived from such a rock type.

Specimens 74121339 and 74121342 from Cahill 6 and 7 were submitted for partial analysis, and results are given in Appendix 1. Cahill 6 carbonate rock contains about 53 percent dolomite, 12 percent calcite, and some tremolite. Cahill 7 carbonate rock is composed of about 37 percent magnesite, minor dolomite or calcite (about 2 percent), and tremolite or talc.

The Nanambu Complex consists of both leucocratic and melanocratic rocks, and the trace-element contents of the two groups conform with their major-element chemistry. The leucocratic group is generally low in V, Cr, Ni, Zn, and sometimes Cu, whereas the melanocratic group is much higher in these elements. Chromium probably best illustrates this grouping, leucocratic rocks containing less than 30 ppm and melanocratic rocks more than 160 ppm. The vanadium content parallels this distribution, ranging up to 10 ppm in the leucocratic group, and between 70-200 ppm in the other. The trace-element chemistry of the 'Koolpin Formation equivalent' is broadly the same as that of the melanocratic group of the Nanambu Complex.

One of the amphibolites, 74121345, from Cahill 11 is enriched in Th, Y, Zr, Nb, Ba, Ce, and V, and depleted in Ni relative to the others, indicating that it is most probably of sedimentary origin, whereas the remainder are probably of igneous parentage. The interbanded relationship of amphibolite (specimen 73121465) with basic gneiss in Cahill 13 at first suggested that the amphibolite belonged to the 'Koolpin Formation equivalent'. However, trace and major-element geochemistry indicate that it was derived from an igneous parent (Zamu Complex).

No significantly high metal values were found. The highest uranium value was 50 ppm in 73121445 (Nanambu Complex, orthogneiss) from East Alligator 1, where radioactive inclusions with pleochroic haloes were noted in biotite. Otherwise uranium values are less than 10 ppm in the Nanambu Complex and 'Koolpin Formation equivalent', and less than 5 - mainly not detected - in all other rock types. Lead ranges up to 50 ppm in the Nanambu Complex and 'Koolpin Formation equivalent', and is about 20 ppm in the amphibolites. The highest copper content is 150 ppm in one amphibolite; all other values are below 100. Zinc values range widely in most rock types, the highest values of up to 160 ppm being in the phonolites. The nickel content also ranges widely, the highest values being in Nanambu Complex biotite gneiss (420 ppm). The highest tin value was 15 ppm in quartzo-feldspathic gneiss of the Nanambu Complex.

Analyses of Mesozoic and Cainozoic units tested the stratigraphic sections in east Alligator 5 and 7 for possible concentrations of uranium. Secondary enrichment of the metal in any part of the sequence may have encouraged exploration for uranium in the post-Proterozoic sediments. However, no concentration of uranium was evident from the results obtained. The yttrium content near the surface ranges up to 20 ppm, and the zirconium content near the surface is as much as 420 ppm. Values up to 335 ppm Zr were found in parts of the Mesozoic sequence. Base-metal values were generally at or near the lowest detection level.

AUGER DRILLING

Fifty eight auger holes were drilled along three traverse lines (Fig. 3). Traverse 1 Extended followed the Oenpelli road from Mount Cahill, northeast for 22.5 km with holes spaced every 0.8 km. The traverse continued a line of auger holes drilled in 1971 from the Jim Jim Creek crossing along the Oenpelli road to Mount Cahill (Needham & Smart, 1972). The extension of auger holes was planned to test the sub-surface extent of the 'Koolpin Formation equivalent' in an area occupied mainly by Nanambu Complex. Holes 1-4 penetrated sandstone of the 'Koolpin Formation equivalent'. The remainder of the traverse penetrated largely Nanambu Complex leucogneiss and detected

Quaternary sand accumulations more than 10 m thick (specified total depth of drilling) along the courses of major creeks. (Subsequently, rotary-percussion hole Cahill 13 intersected probable 'Koolpin Formation equivalent' below the Quaternary deposits of Nourlangie Creek). The traverse consisted of 28 holes with an aggregate depth of 637'6" (194.3 m). Details are tabulated in Appendix 5.

Traverse 6 was a northeasterly line of auger holes drilled over a corridor of 'Koolpin Formation equivalent' rocks dividing the Magela and Munmarlary Masses of the Nanambu Complex (Needham & Smart, 1972), 14 km north of Nourlangie Camp. The traverse intersected a diversity of rock types considered to be 'Koolpin Formation equivalent' with associated high radiometric values. Lithological descriptions of the cuttings were mislaid in Darwin in the aftermath of Cyclone Tracy (Dec., 1974). What information is known is tabulated in Appendix 6. Twenty-six holes with an aggregate depth of 633' (193 m) were drilled.

Traverse 7 comprised four holes drilled to test a body of subcropping dolerite 9 km east of Ranger 1 orebody; all failed to penetrate Cainozoic cover and therefore yielded no basement rock chips. Details are tabulated in Appendix 7. Aggregate depth of holes was 116' (35.4 m).

CONCLUSIONS

The scout-drilling technique has been most successful in the Alligator Rivers area. The shallow holes, drilled to fresh rock where a short core is taken, are invaluable in providing information in areas covered by Cainozoic or Mesozoic material. The cores are generally fresher than any rock exposures, and have been used for thin-section studies and geochemical and geochronological work.

The rotary-percussion holes have defined boundaries of the Nanambu Complex in the East Alligator and Cahill Sheet areas, and have largely confirmed aeromagnetic interpretation of the area. Some difficulties were encountered during the drilling program - for example, recognition of the stratigraphic position of biotite gneiss was difficult when only a single core specimen was recovered as similar rock occurs in both the Nanambu Complex and 'Koolpin Formation equivalent'.

The rotary-percussion holes drilled in the East Alligator Sheet area passed through weathered Mesozoic sediments overlying the Lower Proterozoic basement. No determinate plant fragments or spores were found in the samples examined, but Hughes (pers. comm.; in prep.) correlates argillaceous and fine sandstone beds in the section with the Darwin Member of the Bathurst Island Formation, and fine to coarse quartzose sandstone with the Marligur Member of the same formation. Within the East Alligator Sheet area the two members interfinger (Fig. 26).

The usefulness of auger drilling is confined to areas of relatively thin regolith or Cainozoic sand cover. Penetration below about 15 m with the Gemco 120 in all but the softest sediments is slow, and cuttings from below the water table are seldom definitive; therefore effective use of the auger drill is really confined to areas of Cainozoic cover less than 10 m thick, where weathered Lower Proterozoic material can be intersected above the water table (generally 10-15 m below surface).

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APPENDIX 1. ROTARY-PERCUSSION DRILLING RESULTS.

Holes: East Alligator 1-13, Field Island 1, Cahill 1-14. (In Figures 4-25, cored intervals are indicated by a thick vertical bar to the right of each graphic log, in the geophysical logs, values increase to the right).

East Alligator 1   BMR Index no. 2245

Location: East Alligator 1:100 000 Sheet area. 132°46'15" 12°25'30"

Access: Mudginberri station track from Oenpelli road to Didygeegee Swamp via Ranger 2 prospect.

Commenced 6/7/73, 10.20 a.m. Completed 6/7/73, 4.20 p.m.

Air drilling: 0-25'

Water drilling: 25'-98'9"

Coring: 98'-98'9"

Total depth: 98'9"

	0-8'	Grey-light brown sandy soil
	8-17'	Light brown clayey sand
CAINOZOIC	17-22'	White sandy clay
	22-40'	Brown quartz sand, clayey, micaceous.
	40-50'	White-buff-brown clay and clayey sand, and quartz sand.
		Weathered to fresh muscovite-quartz-feldspar gneiss.
NANAMBU	50-60'	Fresh leucogneiss, weathered mica schist.
COMPLEX	60-98'9"	Banded biotite-quartz-feldspar augen gneiss, and leucogneiss with minor muscovite. Foliation 20° to core normal.

Thin-section description:

Sample no. 73121445.   Depth: 98'

QUARTZO-FELDSPATHIC ORTHOGNEISS

Quartz + Albite + K feldspar (originally orthoclase but now largely inverted to microcline and minor muscovite). Biotite flakes include pleochroic haloes and dark pleochroic rims produced by a late-stage radioactive opaque mineral.

Silicate and trace-element analysis (results tabulated in Appendices 2 and 3):

Sample no. 73121445 Depth: 98'

East Alligator 2 BMR Index No. 2246

Location: East Alligator 1:100 000 Sheet area. 132°46'30", 12°30'30".

Access: Mudginberri station track to Didygeegee Swamp via Ranger 2 prospect. One hundred metres west of track where track leaves edge of Magela Swamp and heads into thick timber.

Commenced 9/7/73, 11.35 a.m. Completed 11/7/73, 2.00 p.m.

Air drilling: 0-15'

Water drilling: 15-203'

Coring: 190-203'

Total depth: 203'

	0-10'	laterite, quartz fragments, red soil.
	10-20'	grey-white clay
	20-40'	large quartz fragments, grey-white clayey sand.
CAINOZOIC	40-50'	red-yellow-grey clayey sand, minor quartz fragments
	50-60'	grey-white clayey sand.
	60-70'	grey-white clayey sand, fragments of weathered rock.
	70-90'	red-grey clay, ferruginous rock fragments.
____________	90-110'	grey-green-white clay, fragments of weathered possible chlorite schist.
	110-140'	green-pale yellow clay, micaceous, fragments of possible kaolinized feldspar.
	140-180'	weathered feldspar quartz mica schist.
	180-190'	large flakes biotite and quartz, with small garnets.
KOOLPIN FORMATION EQUIVALENT	190-192'	garnet-biotite-quartz-feldspar-muscovite augen gneiss, schistose. Augen composed of chloritized mica, quartz and garnet, Garnets restricted to augen. Crenulated foliation 0° to core normal.
	192'-194'	finely banded amphibolite, feldspathic bands 0.5 mm wide, continuous. Amphibole prisms, average 2 mm long. Planar foliation 10° to core normal.

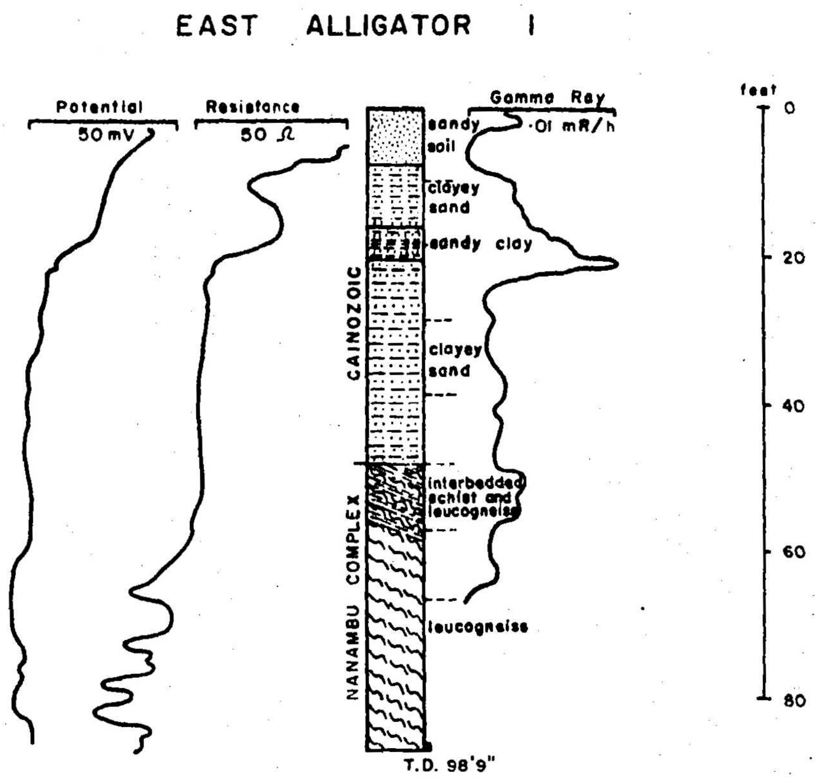

Fig. 4 Graphic lithological and geophysical logs of East Alligator I

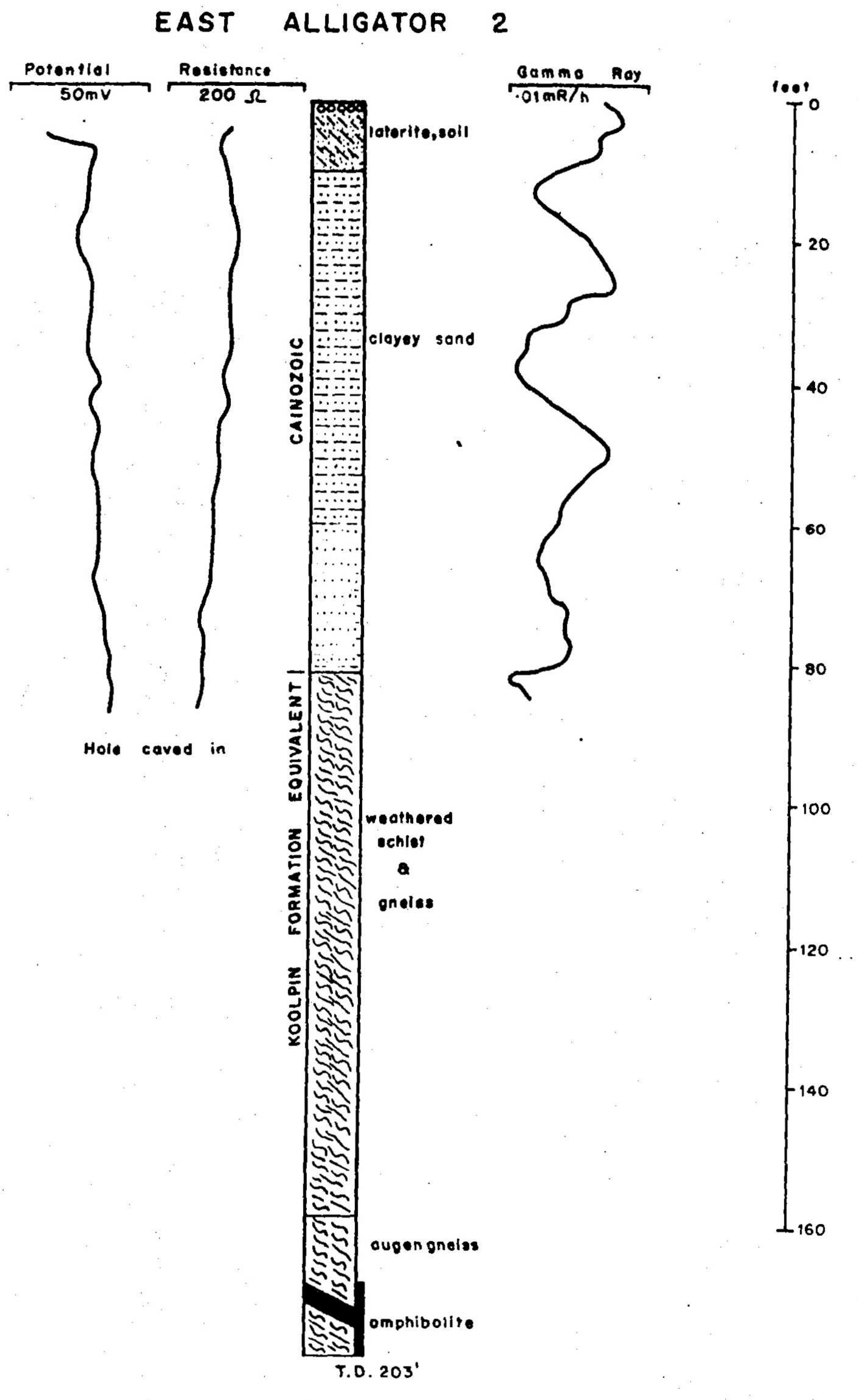

Fig. 5 Graphic lithological and geophysical logs of East Alligator 2

194-195'2"	fine grey foliated quartz-feldspar-biotite gneiss, massive.
195'2"-203'	finely banded feldspar-biotite gneiss, occasional feldspar-rich bands 2 mm wide; parallel to foliation, 10^o to core normal. Cleavage at 45^o to core normal marked by fine feldspar-rich bands up to 1 mm wide.

Thin-section descriptions:

Sample No. 73121446 PELITIC SCHIST Depth: 190'6"

Garnet + staurolite + biotite + muscovite + quartz + chlorite.

Garnet, staurolite and biotite (now mostly chloritized), relics of an earlier metamorphism, are now enveloped by later muscovite.

Sample No. 73121447 AMPHIBOLITE Depth: 193'9"

Hornblende + quartz + white mica (possibly margarite and/or paragonite after plagioclase) + opaque minerals + minor chloritized biotite.

A well foliated rock.

Sample No. 73121448 PSAMMO-PELITIC SCHIST Depth: 196'6"

Quartz + biotite + muscovite + strongly altered plagioclase + chlorite (after biotite) + minor zircon.

Well foliated, fine-grained.

Sample No. 73121449 PSAMMO-PELITIC SCHIST Depth: 200'

Biotite + highly altered plagioclase + chlorite + muscovite.

Fine-grained and well foliated.

Silicate and trace-element analysis (results tabulated in Appendices 2 and 3)

Sample no.	Depth:
73121446	190'6"
73121447	193'9"
73121448	196'6"
73121449	200'

East Alligator 3 BMR Index No. 2247

Location: East Alligator 1:100 000 Sheet area. 132°46'36", 12°15'15".

Access: Mudginberri station track to Didygeegee Swamp via Ranger 2 prospect. Continue north onto edge of East Alligator River flood plain. Follow edge of timbered area to its northernmost point.

Commenced: 12/7/73, 9.30 a.m. Completed: 13/7/73, 3.10 p.m.

Air drilling: 0-15'

Water drilling: 15'-268'7"

Coring: 260-268'7"

Total depth: 268'7"

	0-20'	red-grey clayey sand.
	20-30'	red-yellow-green clay, quartz fragments.
CAINOZOIC	30-170'	red-yellow-white sandy clay, occasional quartz fragments.
	170-220'	yellow-red clay, quartz fragments.
	220-250'	quartz fragments, minor clay.
	250-260'	quartz fragments, green gneissic chips.
	260-265'7"	very fine chloritized biotite schist. Foliation indistinguishable. Well marked cleavage 35° to core normal.
	265'7"-268'7"	finely banded biotite gneiss. Fine foliation 35° to core normal cuts compositional banding 5° to core normal (same sense).
?KOOLPIN FORMATION EQUIVALENT		Minor displacements of compositional banding along narrow (2 mm) iron-stained quartz-filled faults. Veined by quartz at 266' for 6"

Thin-section descriptions:

Sample No. 73121461 PELITIC SCHIST Depth: 263'

Biotite + muscovite + quartz.

There is a poorly developed crenulated foliation defined by the preferred orientation of muscovite flakes. Biotite flakes are oriented randomly.

Sample No. 73121450 PSSAMO-PELITIC SCHIST Depth: 267'

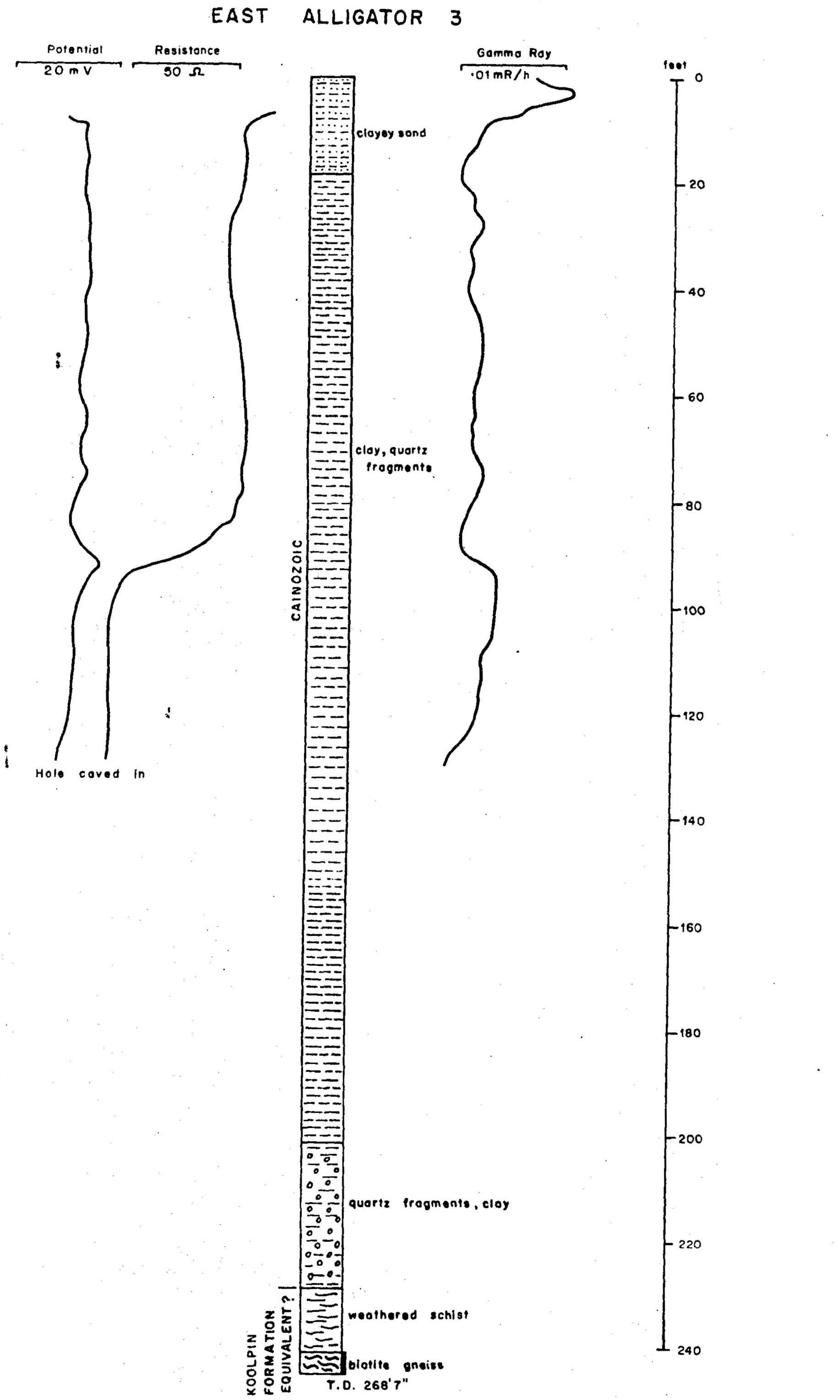

Fig. 6 Graphic lithological and geophysical logs of East Alligator 3

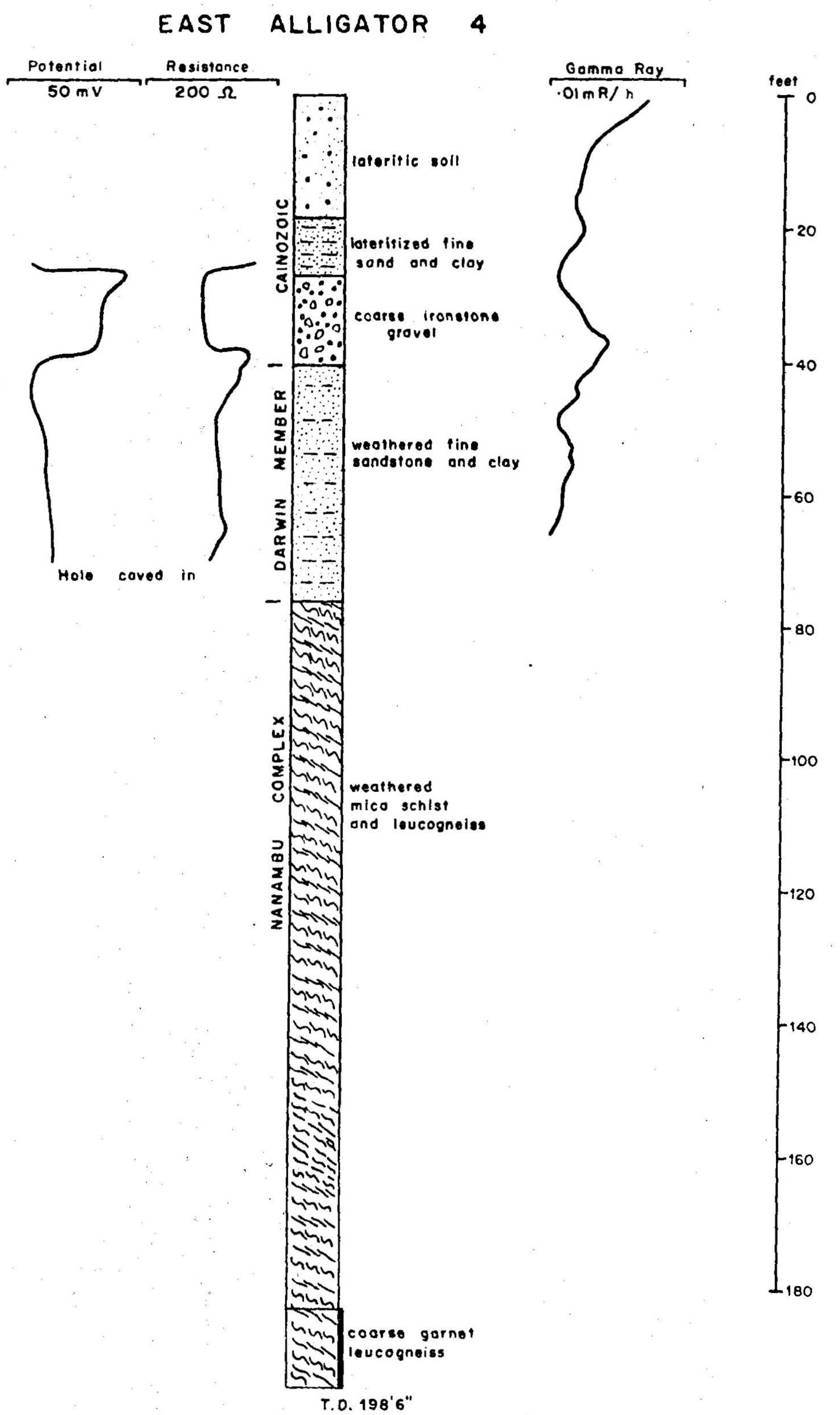

Fig. 7 Graphic lithological and geophysical logs of East Alligator 4

Quartz + muscovite + biotite + chlorite.

The effects of two metamorphic events have been clearly preserved:

(1) Early compositional layering (S1) represented by the two major bands in the slide.

(2) Early foliation (S2), defined by the orientation of muscovite flakes, which cross-cuts the gross lithological layering. Some differentiated layering parallel to S2 is evident.

(3) Late foliation (S3) defined by the axial planes of crenulations in S2 (especially in the quartz-rich band) and the preferred orientation of biotite flakes in the less quartz-rich band. Clusters of biotite flakes replace garnet. Chlorite occurs parallel to both foliations but is more common in S2. Biotite is much more common in S3.

Silicate and trace element analysis (results tabulated in Appendices 2 and 3):

Sample no. 73121450 Depth: 267'

East Alligator 4 BMR Index No. 2248

Location: East Alligator 1:100 000 Sheet area, 132°35'15", 12°13'30"

Access: Munmarlary station track north to experimental forestry block. About 1.5 km north from northwest corner of forestry block.

Commenced: 19/7/73, 9.30 a.m. Completed 24/7/73, 4.30 p.m.

Air drilling: 0-20'

Water drilling: 20-198'6"

Coring: 185'-198'6"

Total depth: 198'6"

	0-20'	red-brown lateritic soil
CAINOZOIC	20-30'	lateritized very fine sand and white clays, pisolitic in part.
	30-50'	coarse ironstone gravel.
Bathurst Island Formation-Darwin	50-80'	weathered white fine sandstone, clay.
Member	80-170'	weathered mica schist, quartz fragments.
NANAMBU	170-185'	weathered mica schist, leucogneiss.
COMPLEX	185-198'6"	garnet-muscovite-quartz-feldspar leucogneiss, very coarse fractures, muscovite books filling fractures. Rare biotite blebs, with associated garnet. Fracturing 70° to core normal.

Thin-section description:

Sample No. 73121451 QUARTZO-FELDSPATHIC GNEISS Depth: 186'

Quartz + oligoclase + muscovite + biotite + garnet.

Biotite and garnet (both minor) are remnants of an earlier metamorphism.

Silicate and trace-element analysis (results tabulated in Appendices 2 and 3):

Sample no. 73121451 Depth 186'

East Alligator 5 BMR Index No. 2249

Location: East Alligator 1:100 000 Sheet area, 132°33', 12°10'30"

Access: Munmarlary station track to experimental forestry block, then west on graded line to edge of South Alligator River flood plain. Follow tree line to north and east.

Commenced: 18/9/73, 3.10 p.m. Completed 19/9/73, 2.30 p.m.

Air drilling: 0-15'

Water drilling: 15-190'9"

Coring: 188'-190'9"

Total depth: 190'9"

	0-5'	red-grey clay, fine sand.
CAINOZOIC	5-30'	white-grey clay, quartz gravel.
	30-50'	very fine sand, white silt.
DARWIN MEMBER	50-70'	weathered white very fine sandstone.
?MARLIGUR MEMBER	70-100'	fine to medium poorly consolidated quartzose sandstone.
DARWIN MEMBER	100-110'	white siltstone, very fine sandstone.
MARLIGUR MEMBER	110-120'	coarse to granular quartzose sandstone.
DARWIN MEMBER	120-140'	soft white to brown clays, weathered mudstone.
KOOLPIN	140-170'	clays, chips of weathered schist.
FORMATION	170-188'	weathered schist.
EQUIVALENT	188-190'9"	chlorite-biotite-quartz schist, altered along fractures 90° and 10° to core normal. Crenulated foliation 10° to core normal.

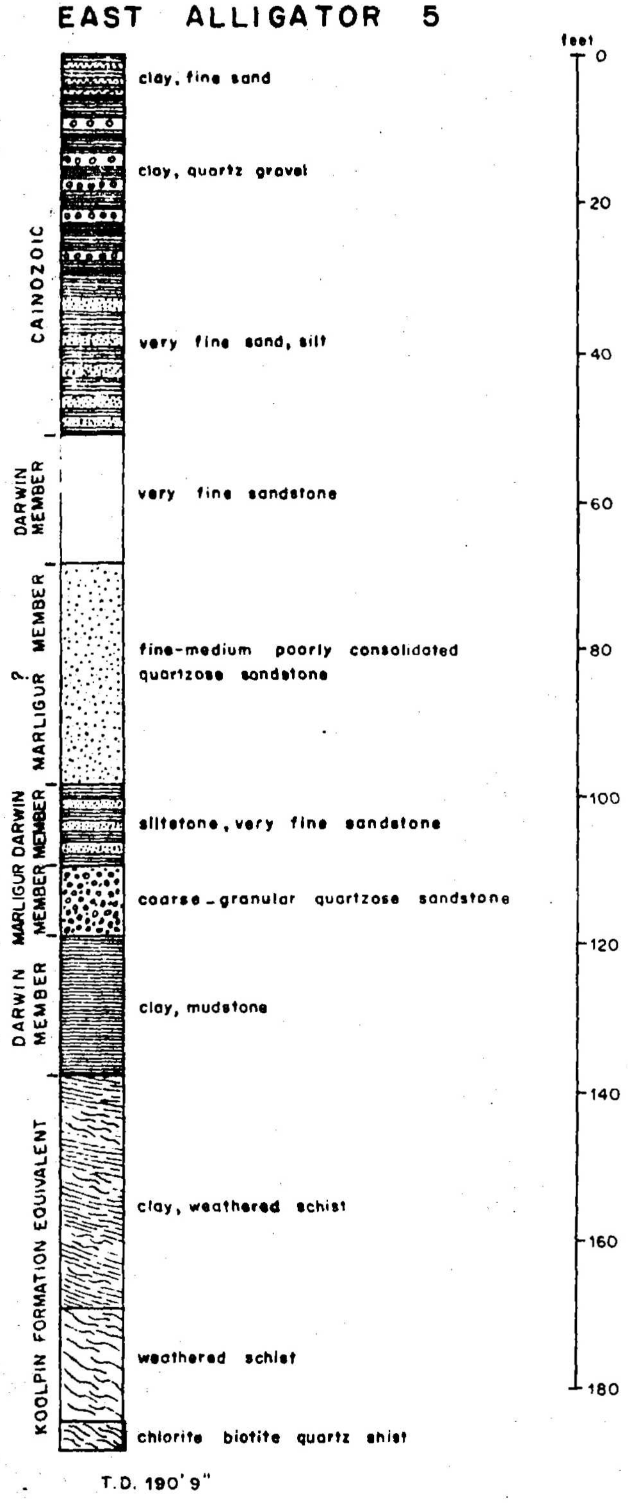

Fig. 8 Graphic lithological log of East Alligator 5

Thin-section description:

Sample No. 73121452 PELITIC SCHIST Depth: 190'

Biotite + altered plagioclase + muscovite + quartz.

Biotite appears to be a relic of an early metamorphism. This rock is very weakly foliated.

Trace-element analysis (results tabulated in Appendix 4):

Sample no.	74127070	Depth:	0-10'
	74127071		10-20'
	74127072		20-30'
	74127073		30-40'
	74127074		40-50'
	74127075		50-60'
	74127076		60-70'
	74127077		70-80'
	74127078		80-90'
	74127079		90-100'
	74127080		100-110'
	74127081		110-120'
	74127082		120-130'
	74127083		130-140'
	74127084		140-150'
	74127085		150-160'
	74127086		160-170'
	74127087		170-180'

Silicate and trace-element analysis (results tabulated in Appendices 2 and 3):

Sample no. 73121452 Depth: 190'

East Alligator 6 BMR Index No. 2250

Location: East Alligator 1:100 000 Sheet area, 132°33', 12°14'30"

Access: Munmarlary station track to forestry experimental block; about 3.2 km west from northwest corner of forestry block.

Commenced: 20/9/73, 2.30 p.m. Completed 21/9/73, 12 noon.

Air drilling: 0-25'

Water drilling: 25-179'

Coring: 177-179'

Total depth: 179'

	0-20'	brown very fine sand.
	20-50'	red clayey sand
CAINOZOIC	50-90'	red-orange coarse quartz sand.
	90-100'	pallid quartz gravel and fine sand.
BATHURST ISLAND	100-120'	white silicified mudstone.
FORMATION -	120-140'	white clays, weathered mudstone.
DARWIN MEMBER	140-170'	yellow clays and grey sandy mudstone.
KOOLPIN	170-177'	green clay, schist fragments.
FORMATION EQUIVALENT	177-179'	fine massive black quartz-biotite gneiss, minor pyrite. Foliation 80° to core normal.

Thin-section description:

Sample No. 73121453 QUARTZO-FELDSPATHIC BIOTITE GNEISS
Depth: 179'

Quartz + K-feldspar + rare oligoclase + biotite + epidote.

A fine grained, biotite-rich rock which resembles 73121456.

Silicate and trace-element analysis (results tabulated in Appendices 2 and 3):

Sample no. 73121453 Depth 179'

East Alligator 7 BMR Index No. 2251

Location: East Alligator 1:100 000 Sheet area, 132°39', 12°14'

Access: Munmarlary station track to experimental forestry block, 5.5 km east of northeast corner of forestry block, along cut line.

Commenced: 21/9/73, 1.30 p.m. Completed 25/9/73, 10.30 a.m.

Air drilling: 0-50'

Water drilling: 50-287'

Coring: 286-287'

Total depth: 287'

CAINOZOIC	0-15'	red lateritized sand.
	15-20'	yellow silicified mudstone
DARWIN MEMBER	20-30'	yellow fine sandstone
	30-60'	fine sandstone and white siltstone.
	60-90'	weathered argillaceous fine sandstone.

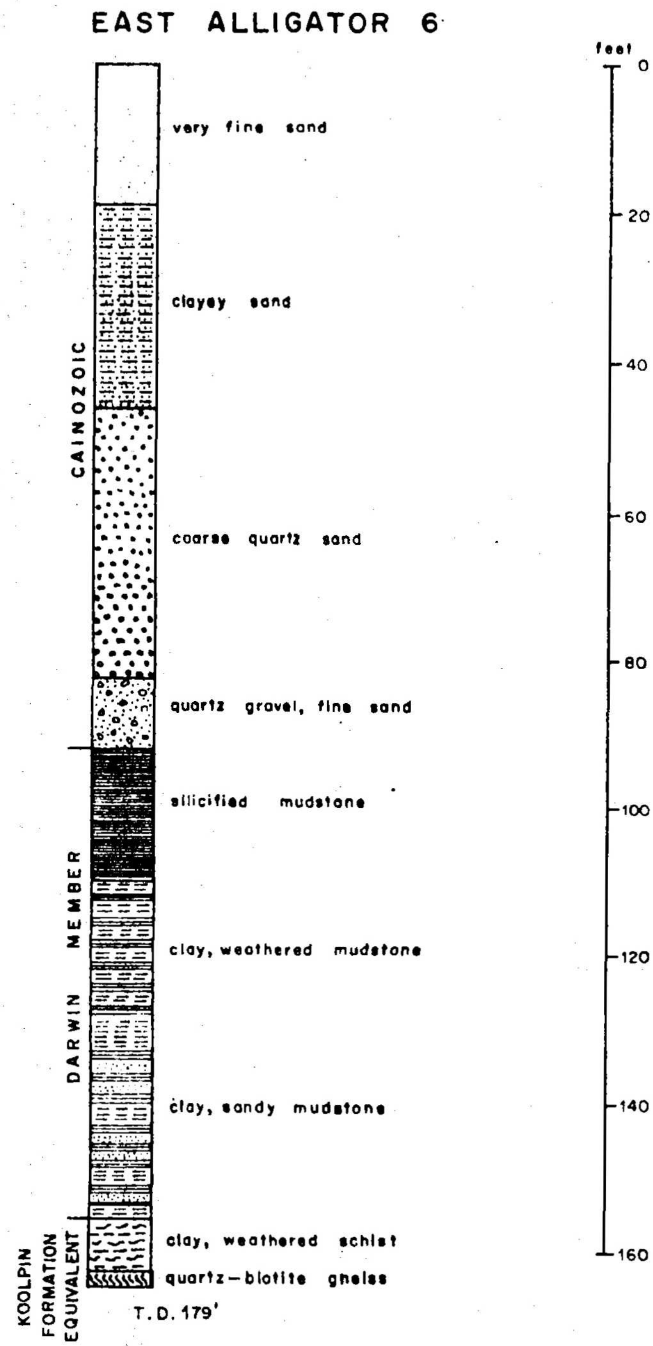

Fig. 9 Graphic lithological log of East Alligator 6

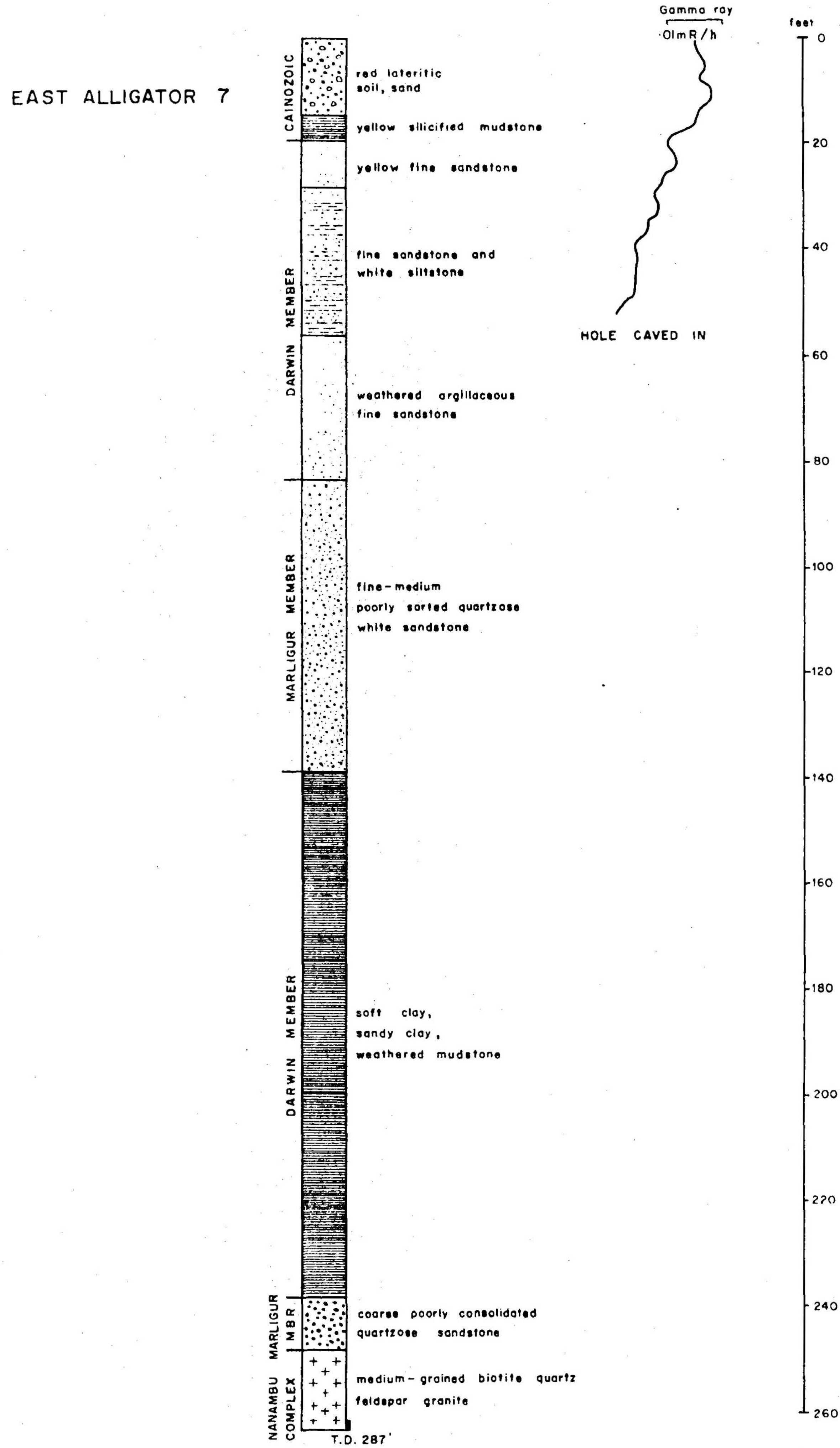

Fig. 10 Graphic lithological and radiometric log of East Alligator 7

MARLIGUR MEMBER	90-150'	fine to medium, poorly sorted, quartzose white sandstone.
DARWIN MEMBER	150-260'	soft clay, sandy clay and weathered mudstone.
MARLIGUR MEMBER	260-270'	coarse poorly consolidated quartzose sandstone.
NANAMBU	270-286'	coarse quartz sand, micaceous; fragments of weathered granite.
COMPLEX	286-287'	medium-grained granite, faint foliation 25° to core normal.

Thin-section description:

Sample no. 73121454 PARTLY RECRYSTALLIZED ADAMELLITE Depth: 286'

Orthoclase (mostly recrystallized to microcline) + albite (moderately sericitized) + biotite (partly chloritized) + minor muscovite.

Palynological description: Depth: 15-20': Barren; indeterminate plant fragments.

Trace-element analyses (results tabulated in Appendix 4):

Sample no.	74127106	Depth:	0-10'
	74127107		10-20'
	74127108		20-30'
	74127109		20-40'
	74127110		40-50'
	74127111		50-60'
	74127112		60-70'
	74127113		70-80'
	74127114		80-90'
	74127115		90-100'
	74127116		100-110'
	74127117		110-120'
	74127118A		120-130'
	74127118B		130-140'
	74127119		140-150'
	74127120		150-160'
	74127121		160-170'
	74127122		170-180'
	74127123		180-190'
	74127124		190-200'
	74127125A		200-210'
	74127125B		210-220'
	74127126		220-230'
	74127127		230-240'
	74127128		240-250'
	74127129		250-260'
	74127130		260-270'
	74127131		270-280'
	74127132		280-290'

Silicate and trace-element analysis (results tabulated in Appendices 2 and 3):

Sample no. 73121454 Depth: 286'

East Alligator 8 BMR Index No. 2252

Location: East Alligator 1:100 000 Sheet area. 132°36', 12°14'30"

Access: Munmarlary station track to experimental forestry block. About 1.5 km east of forestry block.

Commenced: 25/9/73, 1.00 a.m. Completed 25/9/73, 5.10 p.m.

Air drilling: 0-30'

Water drilling: 30-203'9"

Coring: 203-203'9"

Total depth: 203'9"

	0-15'	red-brown sand
CAINOZOIC	15-20'	red-brown clay
	20-40'	mottled fine sand and ironstone gravel
	40-50'	brown quartz-rich sand
	50-60'	mottled fine sandstone
	60-70'	poorly consolidated fine argillaceous sandstone.
DARWIN MEMBER	70-80'	weathered very fine sandstone and white siltstone.
	80-90'	light grey micaceous mudstone.
	90-100'	poorly consolidated quartzose sandstone.
MARLIGUR	100-130'	poorly consolidated well sorted and rounded sandstone.
MEMBER	130-150'	poorly consolidated leached sandy mudstone, micaceous in part.
DARWIN	150-160'	very fine argillaceous sandstone, micaceous in part.
MEMBER	160-170'	mottled soft clays and weathered micaceous mudstone.
NANAMBU COMPLEX	170-190'	green-yellow clayey sand, micaceous gneissic granitoid fragments.
	190-203'	micaceous gneissic granitoid chips.
	203-203'9"	muscovite-biotite-quartz-feldspar banded gneiss, tending to augen gneiss. Coarse. Foliation 50° to core normal.

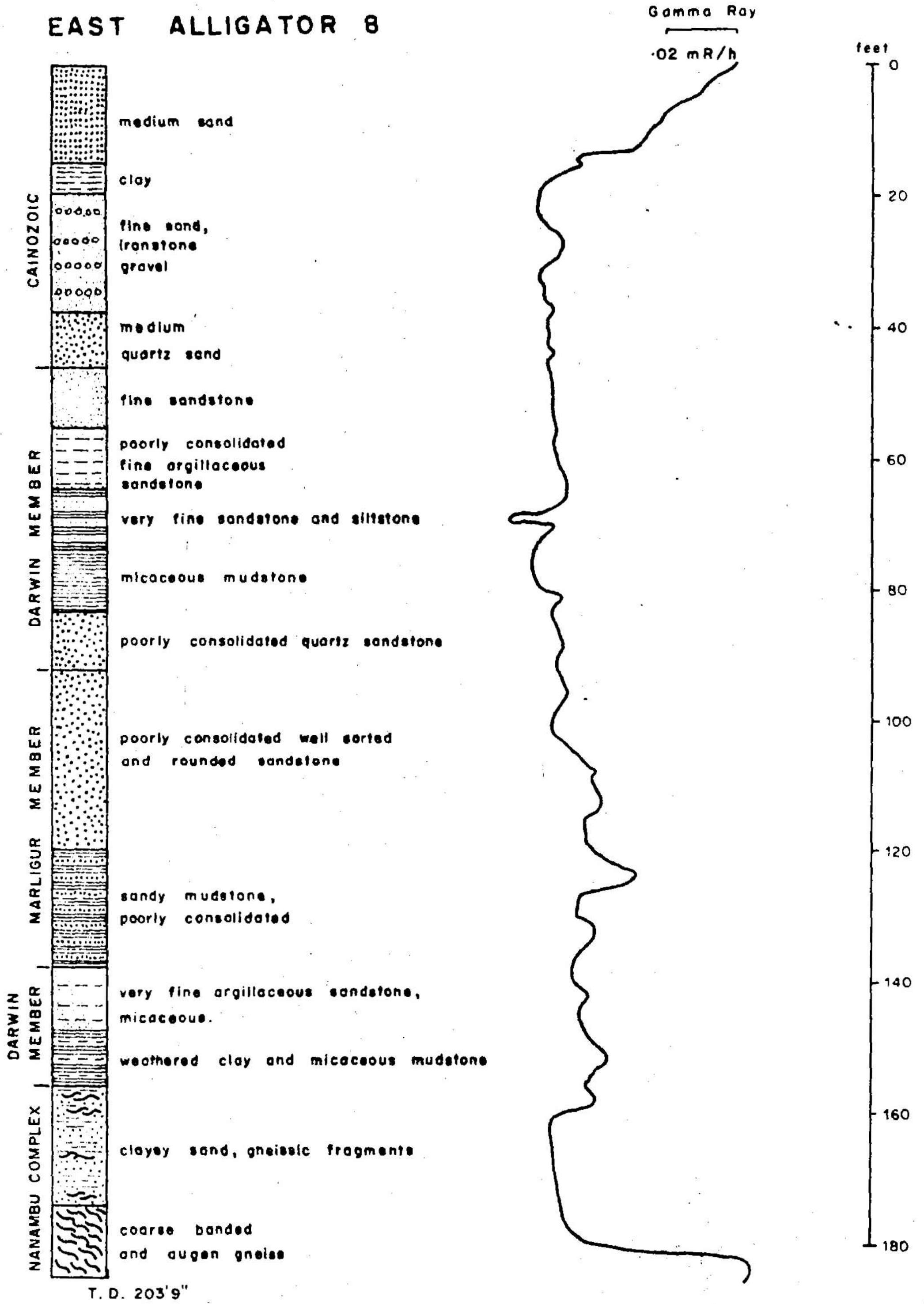

Fig. 11 Graphic lithological and radiometric log of East Alligator 8

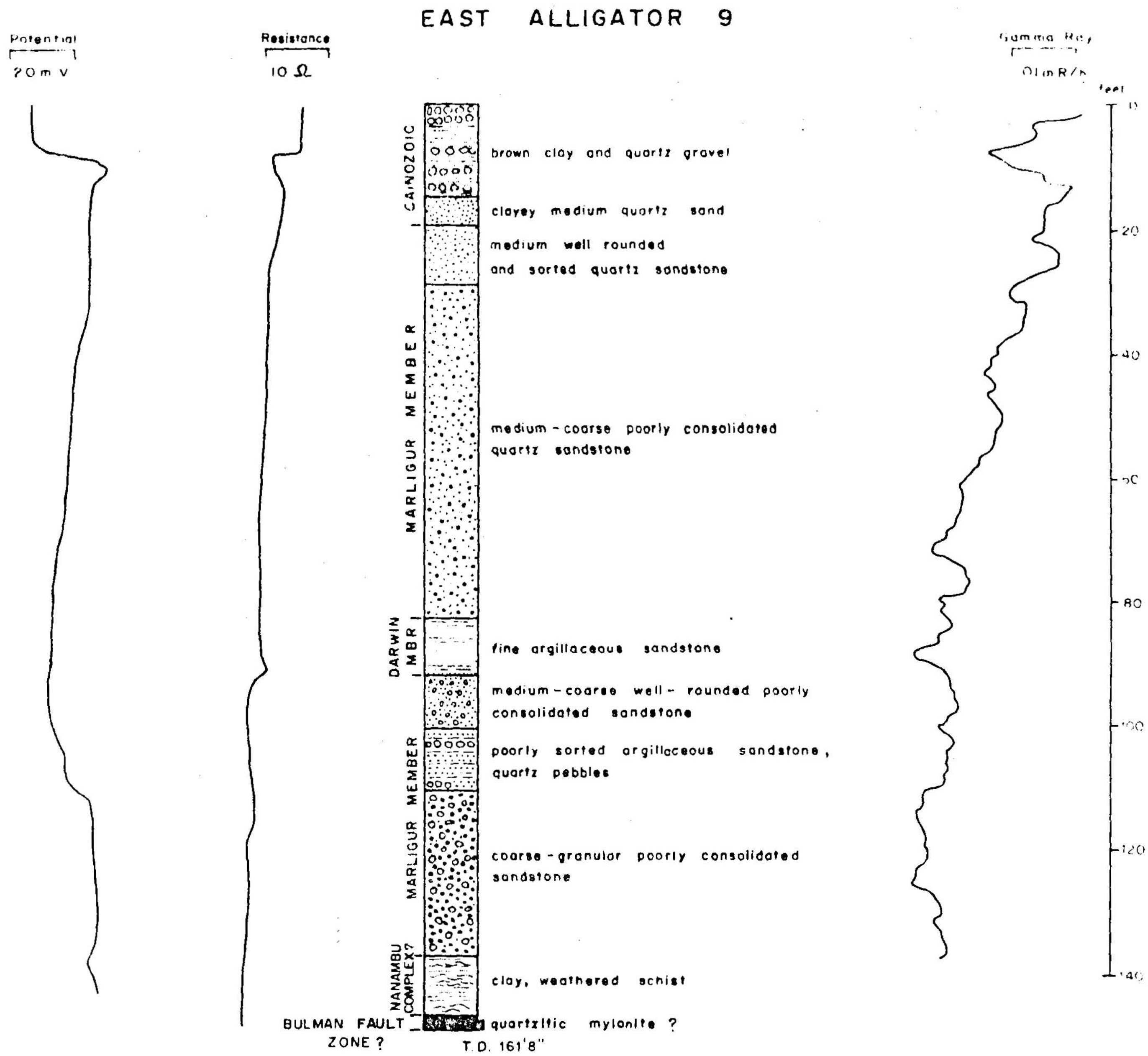

Fig. 12 Graphic lithological and geophysical logs of East Alligator 9

Thin-section description:

Sample No. 73121455 QUARTZO-FELDSPATHIC ORTHO? GNEISS
Depth: 203'6"

Orthoclase (mostly recrystallized to microcline) + albite + quartz + biotite + muscovite.

Silicate and trace-element analysis (results tabulated in Appendices 2 and 3):

Sample no. 73121455 Depth: 203'6"

East Alligator 9 BMR Index No. 2253

Location: East Alligator 1:100 000 Sheet area. 132°45'30", 12°13'.

Access: Munmarlary station track to Ramil Waterhole, north to East Alligator River flood plain on vehicle track; follow edge of flood plain to easternmost tip of timbered country.

Commenced: 16/9/73, 10.30 a.m. 26/9/73, 4.00 p.m.

Air drilling: 0-10'

Water drilling: 10'-161'8"

Coring: 160-161'8"

Total depth: 161'8"

CAINOZOIC	0-15'	brown clay and quartz gravel
	15-20'	quartz sand with clay matrix
MARLIGUR MEMBER	20-30'	weathered medium to well sorted and rounded quartzose sandstone.
	30-90'	weathered medium to coarse poorly consolidated quartzose sandstone.
DARWIN MEMBER	90-100'	fine argillaceous sandstone.
	100-110'	medium to coarse well rounded poorly consolidated sandstone.
MARLIGUR MEMBER	110-120'	white leached poorly sorted argillaceous sandstone with quartz pebbles.
	120-150'	coarse to granular poorly consolidated sandstone.
NANAMBU COMPLEX?	150-160'	large quartz chips, yellow clay, weathered to fresh green schist.
	160-161'	quartz vein, weathered cherty quartzite.
BULMAN FAULT ZONE	161-161'8"	pyritic grey cherty quartzite, minor biotite, hackly fracture. Banded at 90° to core normal.

Thin-section description:

Sample No. 73121456 PROBABLE MYLONITE Depth: 161'8"

Quartz + albite + ?microcline + biotite + muscovite + chlorite.

Silicate and trace-element analysis (results tabulated in Appendices 2 and 3):

Sample no. 73121456 Depth: 161'8"

East Alligator 10 BMR Index No. 2254

Location: East Alligator 1:100 000 Sheet area. 132°42'30", 12°13'.

Access: Munmarlary station track to Ramil Waterhole, north along vehicle track to East Alligator River flood plain. Hole situated at tree line where track emerges from timbered country onto flood plain.

Commenced: 17/9/73, 8.00 a.m. Completed 28/9/73, 12 noon.

Air drilling: 0-15'

Water drilling: 15-278'

Coring: 275-178'

Total depth: 278'

	0-5'	black soil
	5-15'	brown fine sand
	15-40'	mottled soft clay and gravel
	40-90'	yellow soft clay
CAINOZOIC	90-100'	pallid sandy clay
	100-102'	very hard silicified sandstone
	103-130'	yellow to brown clay
	130-170'	yellow clay and gravel
	170-210'	yellow-green clay
KOOLPIN	210-240'	green soft clay, ?weathered schist.
FORMATION EQUIVALENT	240-275'	chips of dark green schist, green-yellow clay.
	275-278'	crumbly weathered jointed chlorite schist.

East Alligator 11 BMR Index No. 2255

Location: East Alligator 1:100 000 Sheet area. 132°31', 12°10'.

Access: Munmarlary station track to experimental forestry block, then west along graded line from northwest corner of block to South Alligator River flood plain. Follow edge of plain north and northeast.

EAST ALLIGATOR 10

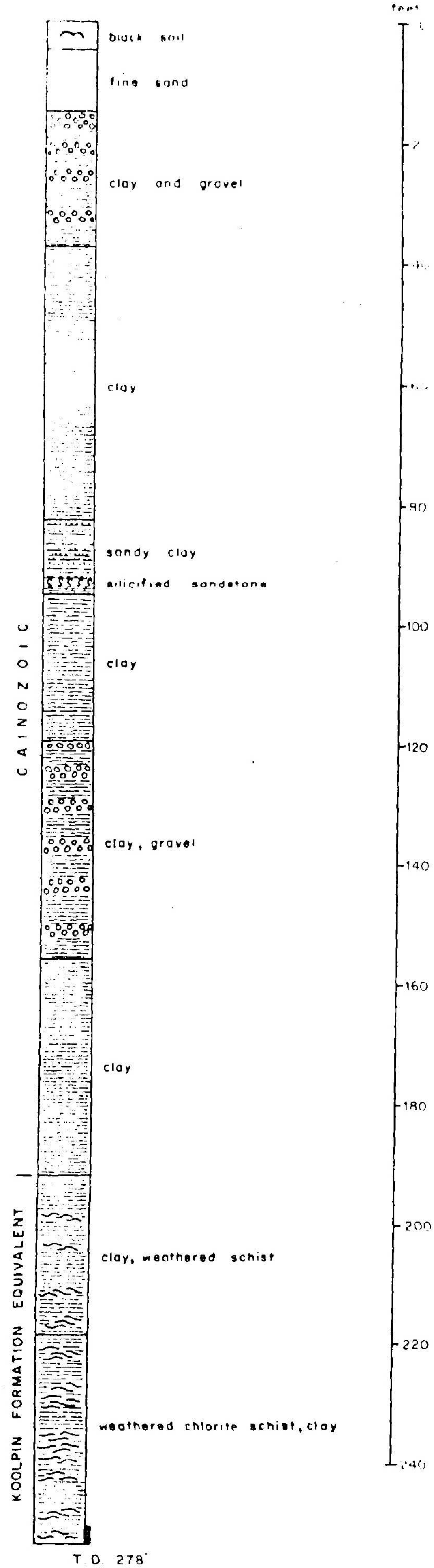

Fig. 13 Graphic lithological log of East Alligator 10

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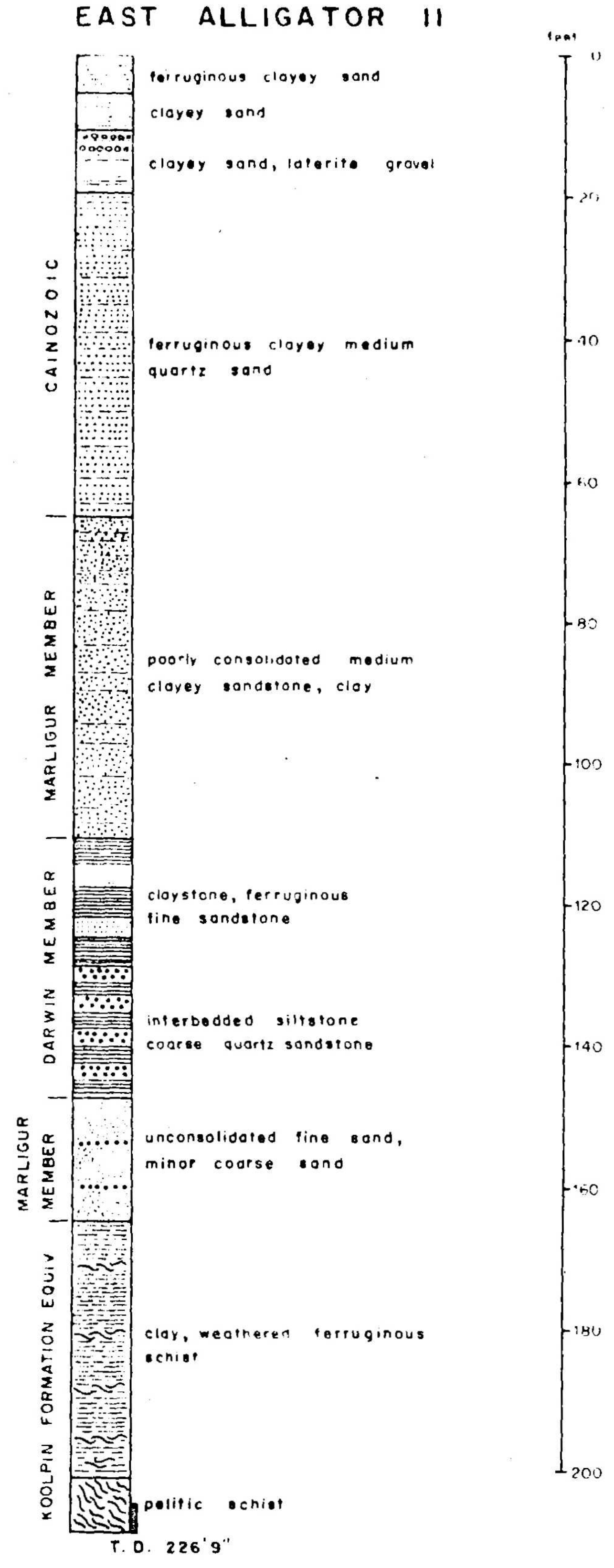

Fig. 14 Graphic lithological log of East Alligator II

Commenced: 1/10/73, 2.45 p.m. Completed 2/10/73, 4.00 p.m.

Air drilling: 0-15'

Water drilling: 15-226'9"

Coring: 224-226'9"

Total depth: 226'9"

	0-5'	clayey ferruginized brown-white sand.
	5-10'	grey clayey sand
CAINOZOIC	10-20'	brown and white clayey sand, laterite gravel
	20-70'	ferruginous medium quartz sand, yellow clay matrix
MARLIGUR MEMBER	70-90'	poorly consolidated medium-grained clayey sandstone, yellow clay.
	90-120'	white clayey poorly consolidated medium-grained sandstone.
DARWIN MEMBER	120-140'	brown claystone, ferruginous clayey fine sandstone.
	140-160'	pink siltstone, bands of coarse quartz sandstone.
MARLIGUR MEMBER	160-180'	unconsolidated fine yellow quartz sand, minor coarse sand.
	180-220'	green clay, weathered ferruginous schist fragments.
KOOLPIN	220-224'	quartz-chlorite schist chips.
FORMATION EQUIVALENT	224-226'9"	graphitic-chlorite-biotite amphibolite, minor pyrite. Faint foliation 80° to core normal, well-marked cleavage 65° to core normal.

Thin-section description:

Sample No. 73121457 PELITIC SCHIST Depth: 226'

Greenish biotite + plagioclase + quartz + epidote.

Some biotite clots may be after garnet. Rutile needles exsolved from biotite also suggest retrogression.

Silicate and trace-element analysis (results tabulated in Appendices 2 and 3):

Sample No. 73121457 Depth: 226'

East Alligator 12 BMR Index no. 2256

Location: East Alligator 1:100 000 Sheet area, 132°30'30", 12°10' 30".

Access: Munmarlary station track to experimental forestry block, then west to South Alligator River flood plain.

Commenced: 3/10/73, 10.00 a.m. Completed 3/10/73, 4.10 p.m.

Air drilling: 0-50'

Water drilling: 50-241'

Coring: 236-241'

Total depth: 241'

	0-1'	grey humic soil.
	1-10'	red-brown clayey sand.
CAINOZOIC	10-20'	red-brown ferruginous clayey sand and quartz gravel, white-yellow clay.
	20-50'	yellow-white clayey sand.
	50-80'	yellow clay, clayey sand.
DARWIN MEMBER	80-100'	poorly consolidated fine clayey sandstone.
MARLIGUR MEMBER	100-110'	ferruginous medium-grained sandstone.
DARWIN MEMBER	110-180'	white clayey fine sandstone, poorly consolidated.
	180-200'	red-yellow claystone, minor fine sand.
	200-210'	vein quartz fragments, blue-green clay.
KOOLPIN	210-220'	brown-blue-grey clay.
FORMATION	220-236'	quartz-chlorite schist fragments.
EQUIVALENT	236-241'	finely layered biotite-quartz gneiss or amphibolite, rare garnets, rare pyrite. Layering 50° to core normal.

Thin-section description:

Sample No. 73121458 EPIDOTE-BIOTITE SCHIST Depth: 239'

Epidote + chlorite + biotite + albite + quartz. Clots of chlorite appear to have replaced garnet.

Silicate and trace-element analysis (results tabulated in Appendices 2 and 3):

Sample no. 73121458 Depth: 239'

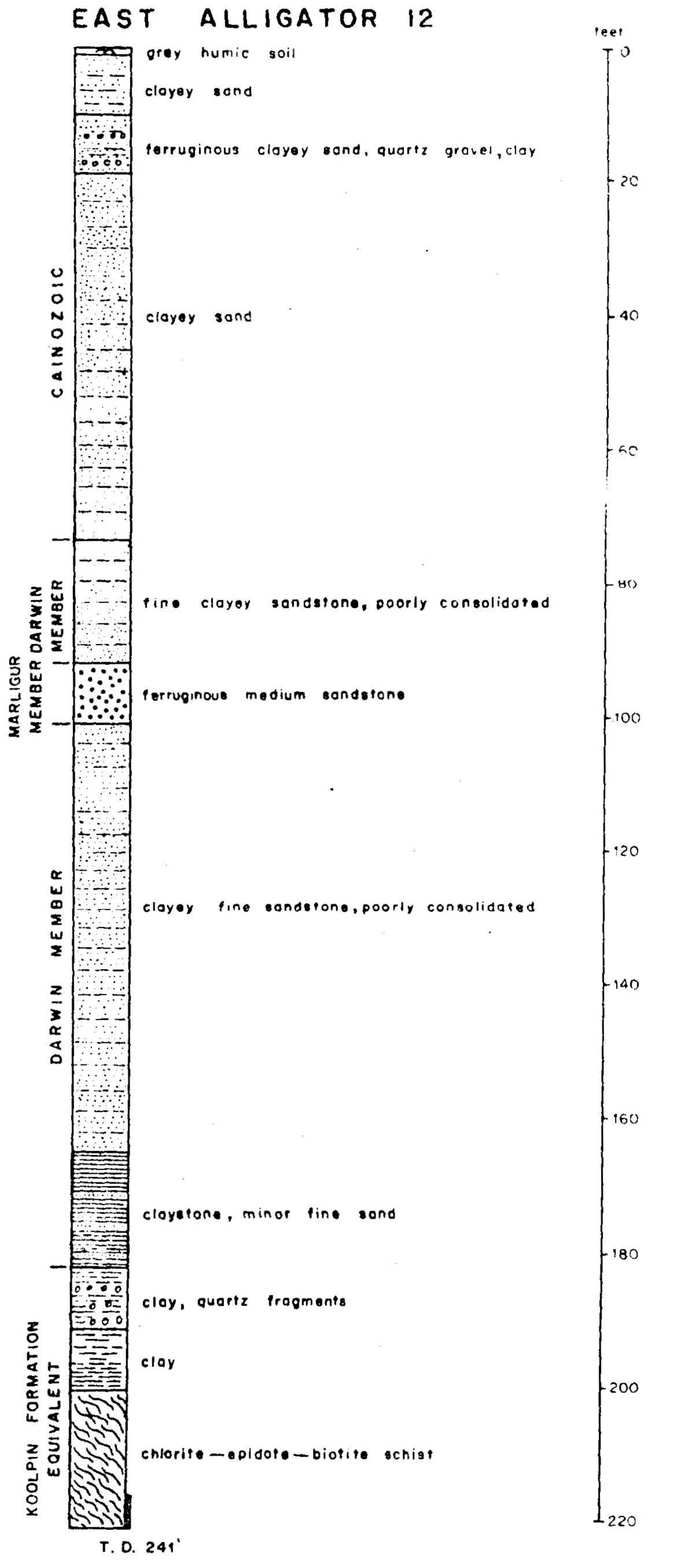

Fig. 15 Graphic lithological log of East Alligator 12

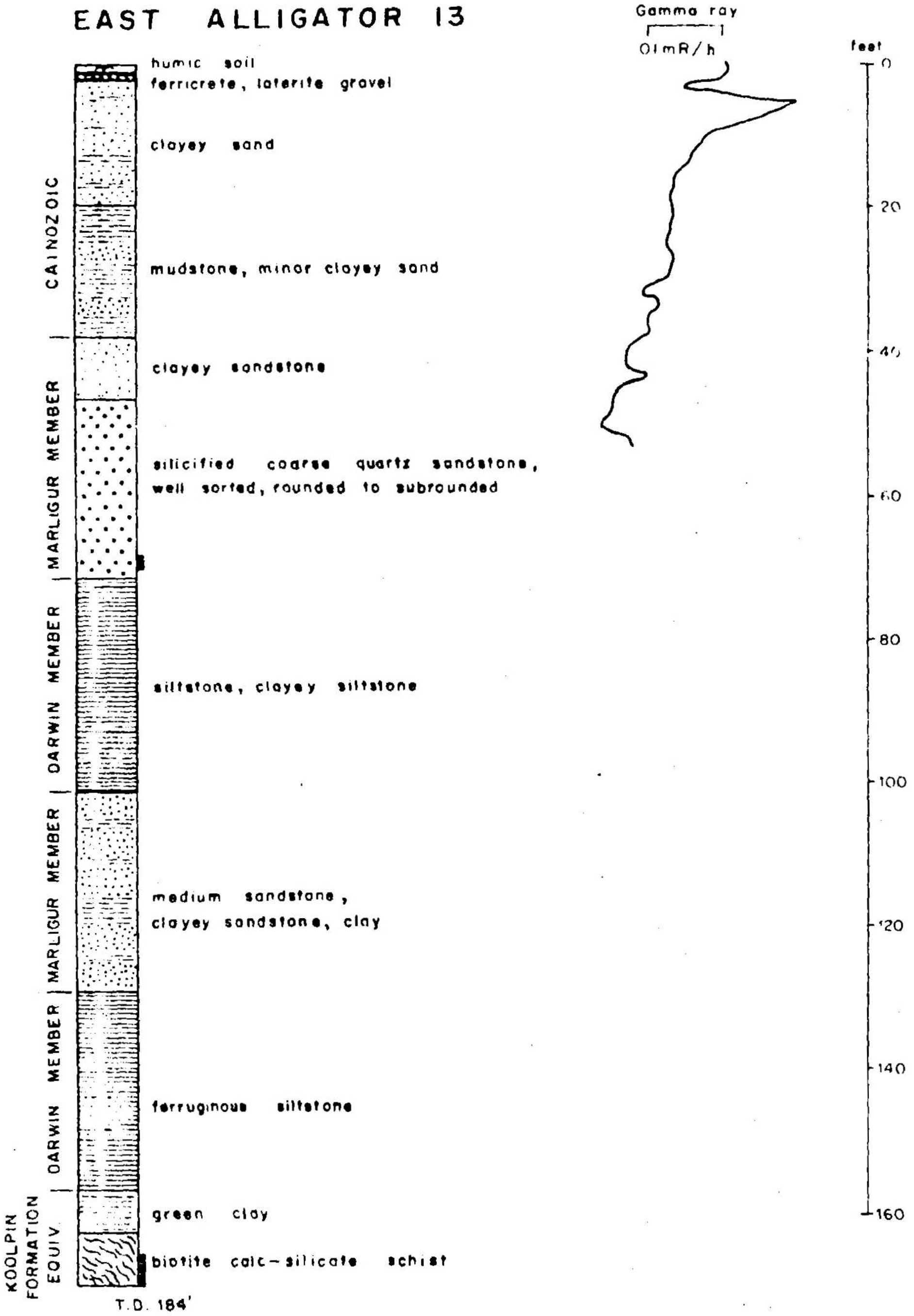

Fig. 16 Graphic lithological log of East Alligator 13

East Alligator 13 BMR Index No. 2257

Location: East Alligator 1:100 000 Sheet area, 132°32'30", 12°09'30"

Access: Munmarlary station track to experimental forestry block, follow graded line running west from northwest corner of the block to the South Alligator River flood plain. Follow edge of timbered country north and northeast.

Commenced: 4/10/73, 9.10 a.m. Completed 5/10/73, 1.00 p.m.

Air drilling: 0-20'

Water drilling: 20-184'

Coring: 74-74'6", 180-184'

Total depth: 184'

	0-1'6"	grey humic soil
CAINOZOIC	1'6"-3'	ferricrete, laterite gravel
	3-20'	yellow-white clayey sand
	20-40'	yellow mudstone, minor clayey sand
	40-50'	clayey white sandstone
MARLIGUR MEMBER?	50-76'	silicified coarse grained quartz sandstone; iron-stained along fractures and some bedding planes; well sorted, rounded to subrounded. Bedding horizontal. Cuttings retained as yellow quartz sand. Very hard drilling.
DARWIN MEMBER	76-110'	siltstone, fine white-pink clayey sandstone
MARLIGUR MEMBER	110-140'	ferruginous yellow porous medium sandstone, clayey sandstone, clay.
DARWIN MEMBER	140-170'	yellow-white mottled ferruginous siltstone.
KOOLPIN	170-176'	green clay
FORMATION EQUIVALENT	176-184'	chlorite-biotite-quartz gneissic schist. Planar foliation 15° to core normal. Locally crenulated. Radiating aggregate of white barite prisms on foliation plane (XRD determination).

Thin-section descriptions:

Sample No. 73121459 ORTHOQUARTZITE Depth: 74'

Well rounded, moderately well-sorted grains of quartz cemented by amorphous isotropic material (probably opaline silica). One or two well-rounded tourmaline grains.

Sample No. 73121460 BIOTITE CALC-SILICATE SCHIST Depth: 184'

Biotite + actinolite + oligoclase + quartz + epidote. Much biotite is presen in rolled-out clots which may be derived from retrogressive alteration of garnets.

Silicate and trace-element analysis (results tabulated in Appendices 2 and 3):

Sample no. 73121459 Depth: 74'
73121460 Depth: 184'

Palynological description: Depth: 74'

Barren. Indeterminate plant fragments.

Field Island 1 BMR Index No. 2261

Location: Field Island 1:100 000 Sheet area, 132°29', 12°10'.

Access: Munmarlary station track to experimental forestry block. West along graded line from northwest corner of block to South Alligator River flood plain. Follow edge of timbered country north for 6.5 km.

Commenced: 19/9/73, 3.00 p.m. Completed 20/9/73, 1.15 p.m.

Air drilling: 0-15'

Water drilling: 15-217'

Coring: 214-217'

Total depth: 217'

	0-5'	yellow-brown sandy soil
CAINOZOIC	5-10'	pallid clayey sand
	10-70'	brown clayey sand
	70-80'	fine clayey sand and quartz gravel.
	80-90'	brown clay
DARWIN MEMBER,	90-130'	fine argillaceous sandstone
BATHURST	130-140'	white clay; weathered mudstone.
ISLAND	140-150'	fine argillaceous sandstone.
FORMATION	150-200'	mottled sandy clay and light brown mudstone.
FISHER CREEK	200-210'	green clay, vein quartz fragments.
SILTSTONE?	210-214'	green clay, mica schist fragments.
	214-217'	quartz-mica schist, minor pyrite; planar foliation 45° to core normal, compositional banding 45° to core normal with 15° difference in strike direction.

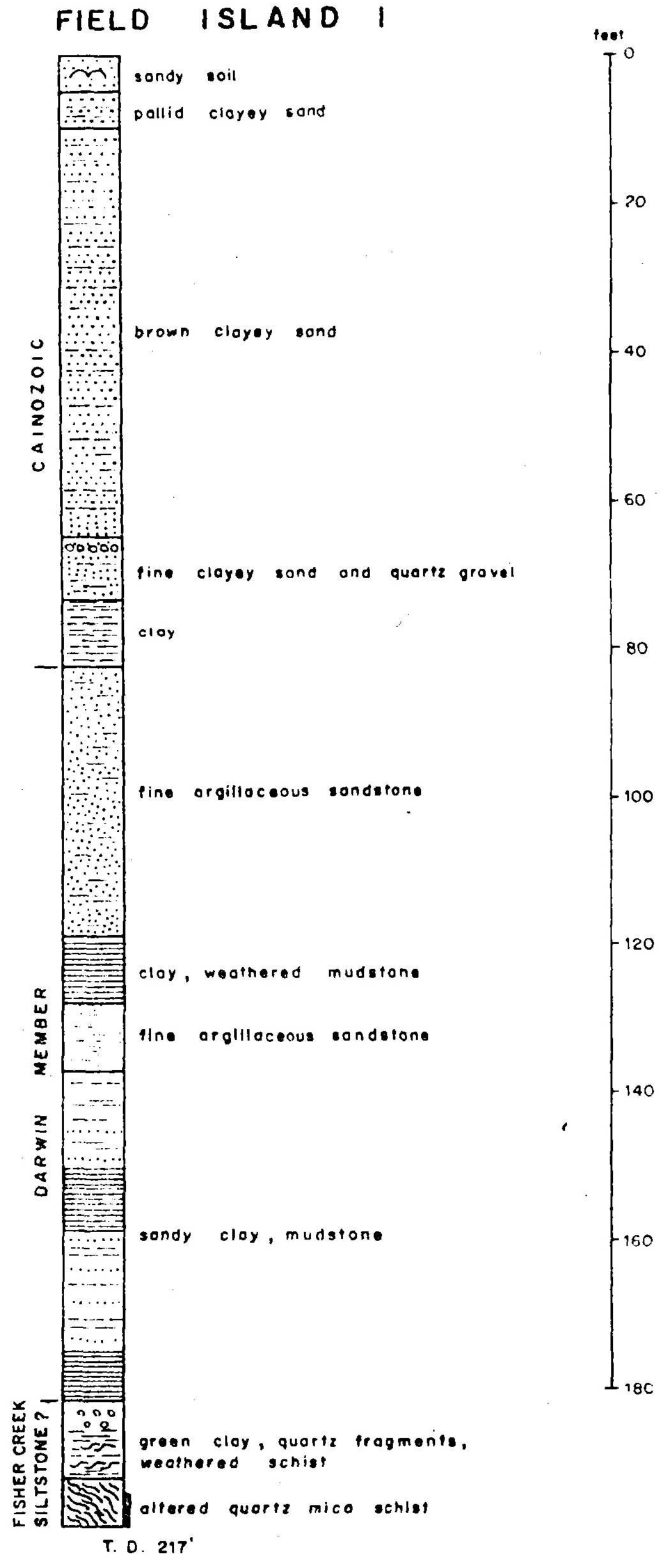

Fig. 17 Graphic lithological log of Field Island 1

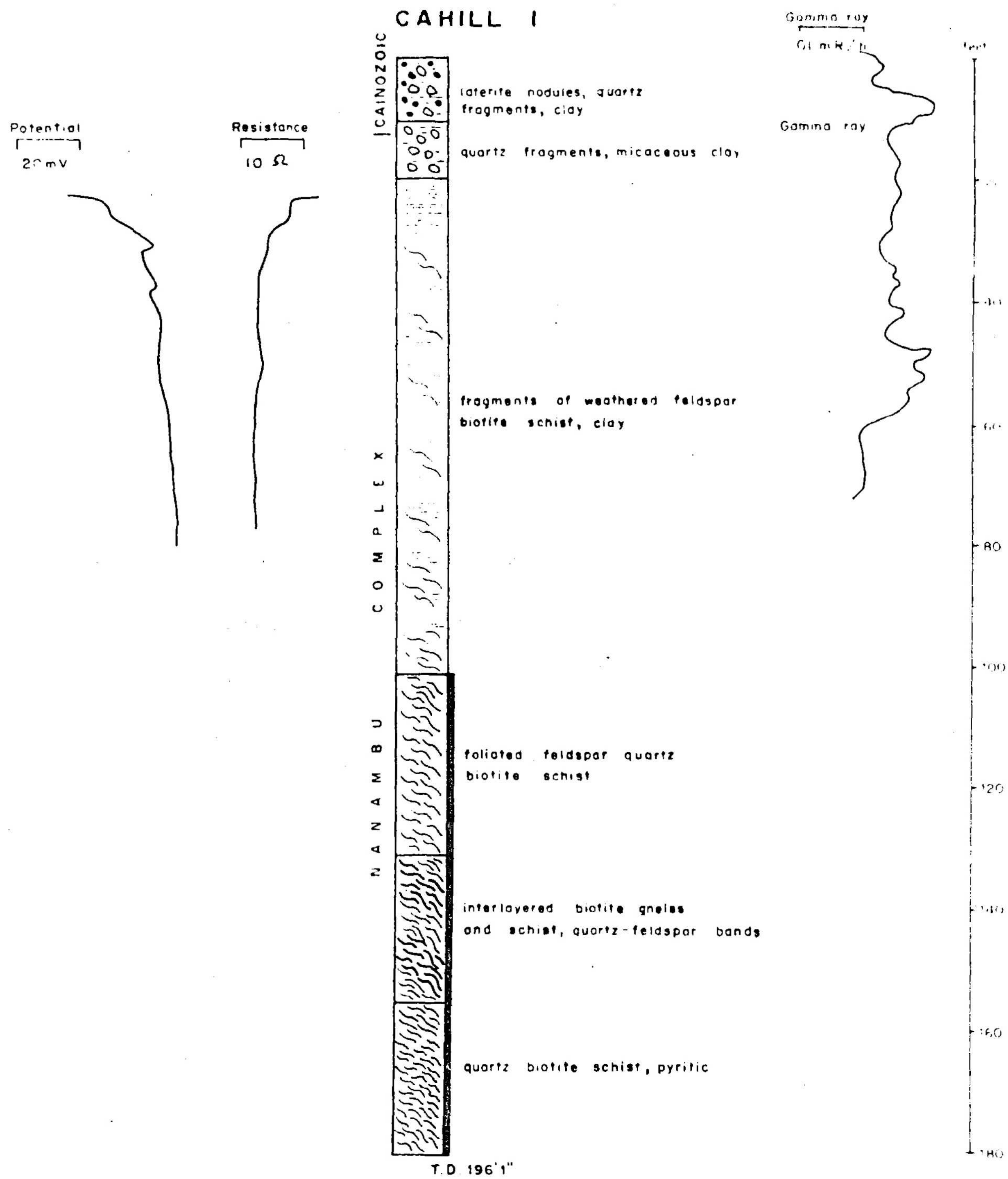

Fig. 18 Graphic lithological and geophysical log of Cahill 1

Thin-section description:

Sample No. 73121462 ?METAGREYWACKE Depth: 214'6"

Albite + epidote + greenish biotite + quartz + leucoxene + magnetite + very minor chlorite.

Silicate and trace-element analysis (results tabulated in Appendices 2 and 3):

Sample no. 73121462 Depth: 214'6"

Cahill 1 BMR Index No. 2234

Location: Cahill 1:100 000 Sheet area, 132°51', 12°38'45".

Access: 1.3 km (0.8 miles) east along Mudginberri boundary fence line '5JHS' from Darwin-Oenpelli road.

Commenced 12/6/72. Completed 19/6/72.

Coring: 110-196'1"

Total depth: 196'1"

CAINOZOIC	0-10'	laterite nodules, quartz fragments, white clay.
	10-20'	quartz fragments, clay with biotite flakes.
	20-110'	fragments of feldspathic quartz biotite schist.
	110-142'	foliated feldspar-quartz-biotite schist. Schistosity 20°-55° to core normal. Cubic pyrite crystal aggregates and disseminated pyrite from 120'.
NANAMBU	142-143'4"	banded quartz-biotite-feldspar gneiss and biotite gneiss and biotite schist. Foliation 50° to core normal.
	143'4"-144'	quartz-feldspar-biotite schist, foliation 50° to core normal, minor shearing.
	144-146'	biotite gneiss.
	146-154'6"	quartz-feldspar-biotite schist, quartz vein 4" wide at 150'; minor shearing.
COMPLEX	154'6"-156'	lenticular pods of biotite in biotite gneiss; foliation 50° to core normal.
	156'-158'	biotite schist, banded by quartz-feldspar bands, veined by fine quartz veins.
	158-170'	biotite gneiss, minor biotite schist; biotite is orientated along fractures in the gneiss which run normal to the foliation.

170-175'6"	disorientated quartzose gneiss fragments in contorted quartz-biotite schist. Minor pyrite at 165'. Minor chlorite in veins parallel to foliation and in cross-cutting fractures.
175'6"-191'1"	quartz-biotite schist, quartz veins up to 1" thick, minor chlorite, pyrite, ?garnet.

Silicate and trace-element analysis (results tabulated in Appendices 2 and 3):

Sample no.	74121310	Depth:	164'
	74121312		180'
	74121316		124'
	74121319		140'
	74121321		157'

Cahill 2 BMR Index No. 2235

Location: Cahill 1:100 000 Sheet area, 132°49', 12°38'35".

Access: 1.5 km west of Oenpelli road along Woolwonga track. 150 m south of track.

Commenced: 20/6/72. Completed 24/6/72.

Coring: 93'8"-168'6"

Total depth: 168'6".

CAINOZOIC	0-14'	laterite nodules, iron-stained angular quartz fragments.
	14-40'	chloritic muscovitic mud, minor biotite, angular quartz fragments.
	40-80'	weathered biotite-muscovite-quartz-feldspar schist, chloritic in part.
	80-93'8"	fresh quartz-biotite schist and muscovite-quartz-feldspar schist.
	93'8"-120'	granulitic biotite-quartz-chlorite gneiss; minor quartz-feldspar and quartz-chlorite-biotite bands, coarser and more leucocratic. Foliation 90° to core normal.
NANAMBU	120-120'3"	pegmatoid quartz-feldspar band or vein.
	120'3"-124'6"	biotite-quartz-chlorite gneiss, granulitic, numerous narrow quartz-feldspar bands, minor quartz veining. Foliation 70°-90° to core normal.

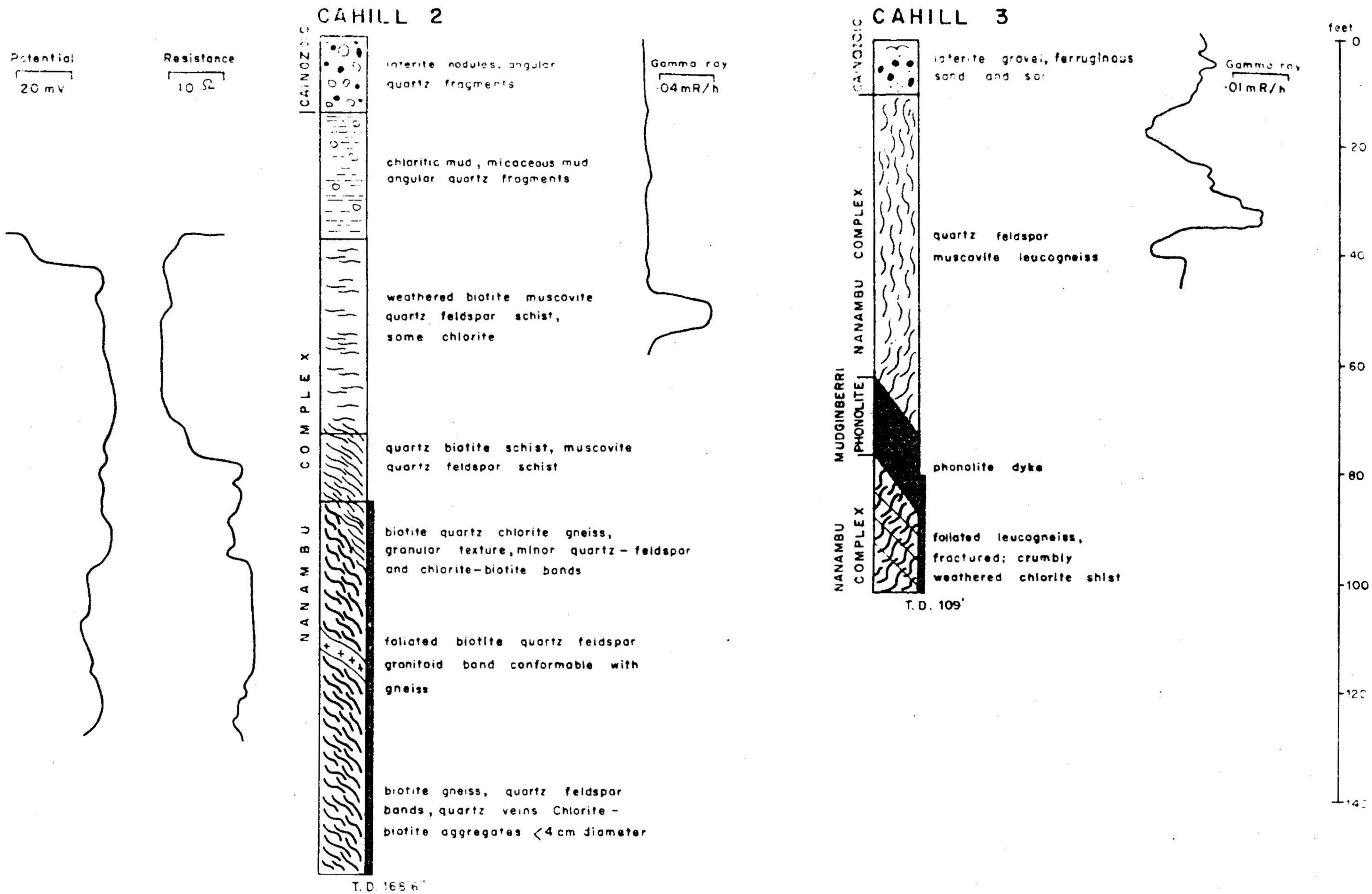

Fig. 19 Graphic lithological and geophysical logs of Cahill 2 and 3

COMPLEX	124'6"-126'	foliated biotite-quartz-feldspar granitoid band parallel to foliation of enclosing gneisses.
	126-137'	biotite gneiss, quartz-feldspar bands and quartz veins. Aggregates of chlorite and biotite increase in size to 1½" at 137' and give the rock a brecciated appearance. Foliation 40° to core normal.
	137-168'6"	biotite gneiss, aggregates of chlorite and biotite grow across foliation. 1½" quartz vein at 142'.

Silicate and trace-element analysis (results tabulated in Appendices 2 and 3):

Sample no.	74121323	Depth:	117'
	74121324		125'
	74121325		136'
	74121328		164'

Cahill 3 BMR Index No. 2236

Location: Cahill 1:100 000 Sheet area, 132°46'20", 12°38'25".

Access: About 5 km west of Oenpelli-Darwin road along Woolwonga track 15 m north of track.

Commenced: 26/6/72. Completed 30/6/72.

Coring: 83-109'

Total depth: 109'

CAINOZOIC	0-10'	laterite gravel, ferruginous sand and soil.
NANAMBU COMPLEX	10-70'	quartz-feldspar-muscovite leucogneiss.
MUDGINBERRI PHONOLITE	70-84'	phonolite dyke.
	84-97'	foliated leucogneiss, strongly fractured; minor schist bands.
NANAMBU	97-101'	chlorite schist, crumbly and weathered; fault zone?
COMPLEX	101-109'	quartz-rich gneiss, strongly fractured; poor recovery.

Silicate and trace-element analysis (results tabulated in Appendices 2 and 3):

Sample no.	74121329	Depth:	83'
	74121330		85'
	74121331		99'

Cahill 4 BMR Index No. 2237

Location: Cahill 1:100 000 Sheet area, 132°44'50", 12°38'45".

Access: 8 km west of Darwin-Oenpelli road along Woolwonga track. 20 m north of track.

Commenced: 3/7/72. Completed 8/7/72.

Coring: 40-48'; 65-66'3".

Total depth: 66'3".

CAINOZOIC	0-5'	laterite gravel
	5-10'	ferruginous soil and quartz gravel
	10-40'	weathered leucogneiss fragments, vein quartz chips.
NANAMBU	40-48'	medium-grained leucogranite with some gneissic bands, rare biotite.
COMPLEX	48-65'	gneiss and vein-quartz fragments
ZAMU COMPLEX?	65-66'3"	amphibolite, quartz-biotite gneiss; pyrite on foliation planes.

Silicate and trace-element analysis (results tabulated in Appendices 2 and 3):

Sample no. 74121332	Depth:	47'
74121333		65'
74121334		66'

Cahill 5 BMR Index No. 2238

Location: Cahill 1:100 000 Sheet area. 132°43'20", 12°39'45".

Access: On Woolwonga Reserve northern perimeter fenceline, 400 m west of Little Banyan Creek, 15 m north of fence.

Commenced: 10/7/72. Completed 13/7/72.

Coring: 48-56'

Total depth: 56'

NANAMBU	0-20'	fine fragments of biotite, quartz and feldspar - gneiss?
COMPLEX	20-35'	muscovite-quartz-feldspar gneiss fragments.
	35-45'	biotite quartz and feldspar chips and small fragments quartz-feldspar gneiss.
MUDGINBERRI PHONOLITE	45-48'	phonolite fragments.

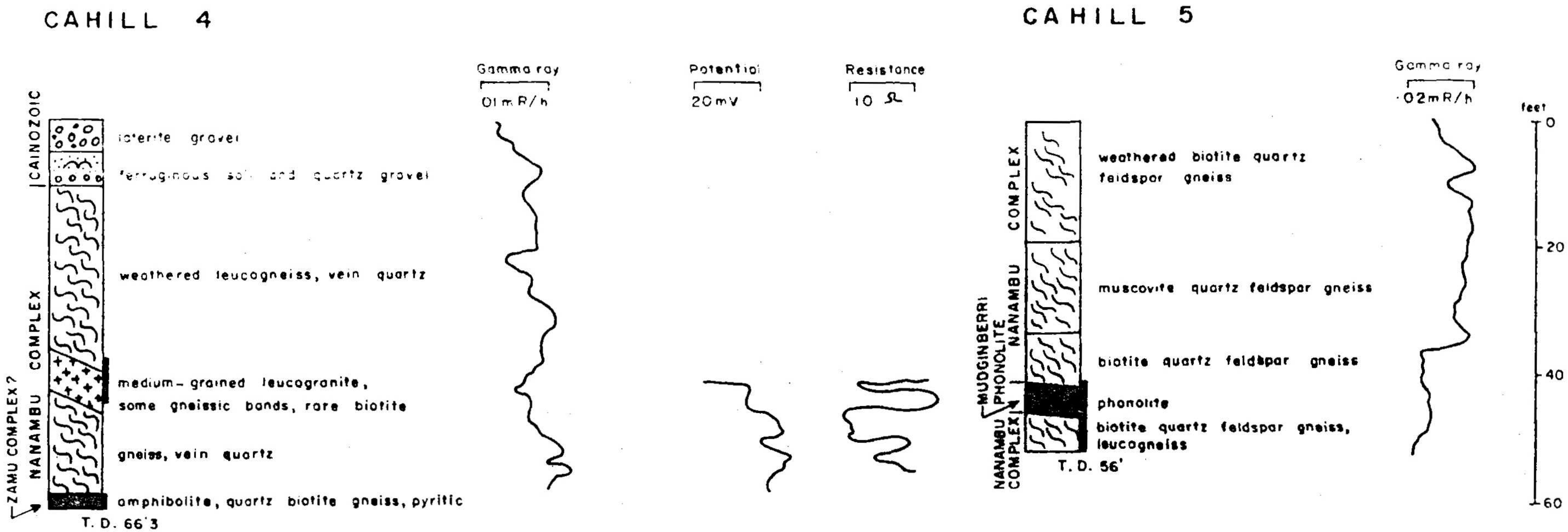

Fig. 20 Graphic lithological and geophysical logs of Cahill 4 and 5

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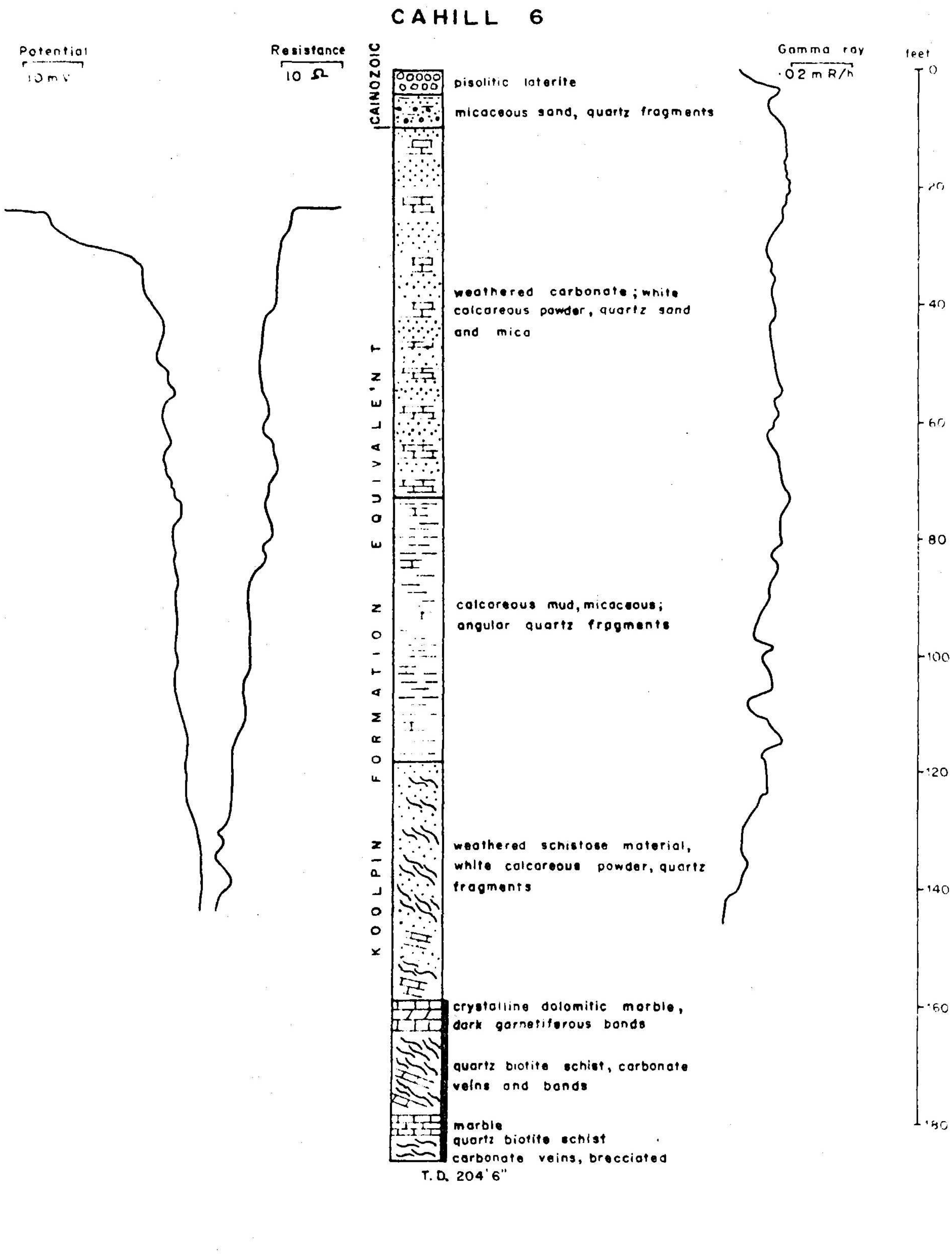

Fig. 21 Graphic lithological and geophysical logs of Cahill 6

NANAMBU	48-48'1"	quartz-biotite gneiss.
COMPLEX	48'1"-51'	porphyritic dark green phonolite. Coarse angular aggregates pink feldspar up to 1 cm, black laths amphibolite up to 0.5 cm in dark green cryptocrystalline matrix.
MUDGINBERRI PHONOLITE		
	51-53'	interbedded muscovite-quartz-feldspar leucogneiss and biotite-quartz-feldspar gneiss.
NANAMBU	53-53'6"	biotite-quartz-feldspar gneiss.
COMPLEX	53'6"-56'	biotite-quartz-feldspar gneiss, bands of quartzite and quartz-feldspar rock.

Silicate and trace element analysis (results tabulated in Appendices 2 and 3):

Sample no.	73121335	Depth 49'
	74121336	51'
	74121337	54'
	74121338	56'

Cahill 6 BMR Index No. 2239

Location: Cahill 1:100 000 Sheet area. 132°41'40", 12°39'40".

Access: On Woolwonga Reserve northern perimeter fenceline, 3.2 km west of Cahill 5. 20 m north of fenceline.

Commenced: 14/7/72. Completed: 19/7/72.

Coring: 171-204'6"

Total depth: 204'6"

CAINOZOIC	0-5'	pisolites, quartz fragments.
	5-10'	white sand, quartz fragments, mica flakes
	10-80'	white calcareous powder, quartz sand and mica (?altered biotite)
	80-130'	calcareous carbonate mud, mica flakes and angular quartz fragments
KOOLPIN FORMATION EQUIVALENT	130-175'	green chloritic biotite books and weathered schistose material with marked foliation, minor white powder and quartz fragments
	171-171'8"	crystalline marble, dark bands contain garnet
	177'8"-198'2"	quartz-biotite schist, minor veins and bands of carbonate

198'2"-199'9" dolomitic marble and carbonate-banded quartz-biotite schist

199'9"-204'6" quartz-biotite schist cut by thin carbonate veins; slightly brecciated

Silicate and trace-element analysis (results tabulated in Appendices 2 and 3):

Sample no.	74121339	Depth:	171'
	74121340		177'9"
	74121341		204'6"

Partial analysis (Analyst: AMDEL ref: 3547/75):

Sample no. 74121339

Acid-soluble CaO	Acid-soluble MgO	CO_2	Total Iron as Fe	Acid-insoluble
30.3%	13.3%	36.7%	0.23%	17.4%

Cahill 7 BMR Index No. 2240

Location: Cahill 1:100 000 Sheet area. 132°40'50", 12°39'45".

Access: 1.5 km north of Woolwonga track, 4.7 km east of Munmarlary road, within Woolwonga Reserve. West side of ridge and 30 m from it.

Commenced: 20/7/72. Completed: 24/7/72.

Cored: 31-33'8".

Total depth: 33'8".

KOOLPIN FORMATION	0-25'	quartz, chert, and white chalky material containing talc and powdered carbonate
EQUIVALENT	25-31'	cavity
	31-33'8"	crystalline pale yellow-white magnesite, minor quartz veins and bands.

Silicate and trace-element analysis (results tabulated in Appendices 2 and 3):

Sample no. 74121342 Depth: 32'

Partial analysis (Analyst AMDEL ref: 3547/75):

Sample no. 74121342

Acid-soluble CaO	Acid-soluble MgO	CO_2	Total Iron as Fe	Acid-insoluble
0.35%	17.7%	18.0%	0.39%	59.7%

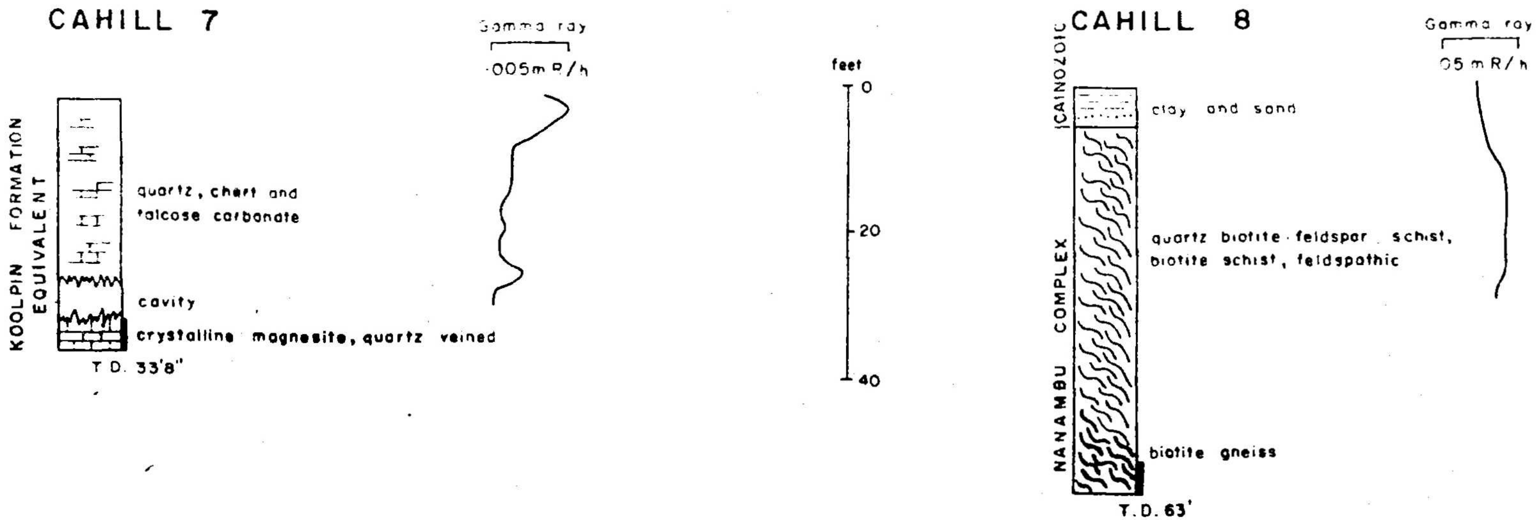

Fig.22 Graphic lithological and radiometric logs of Cahill 7 and 8

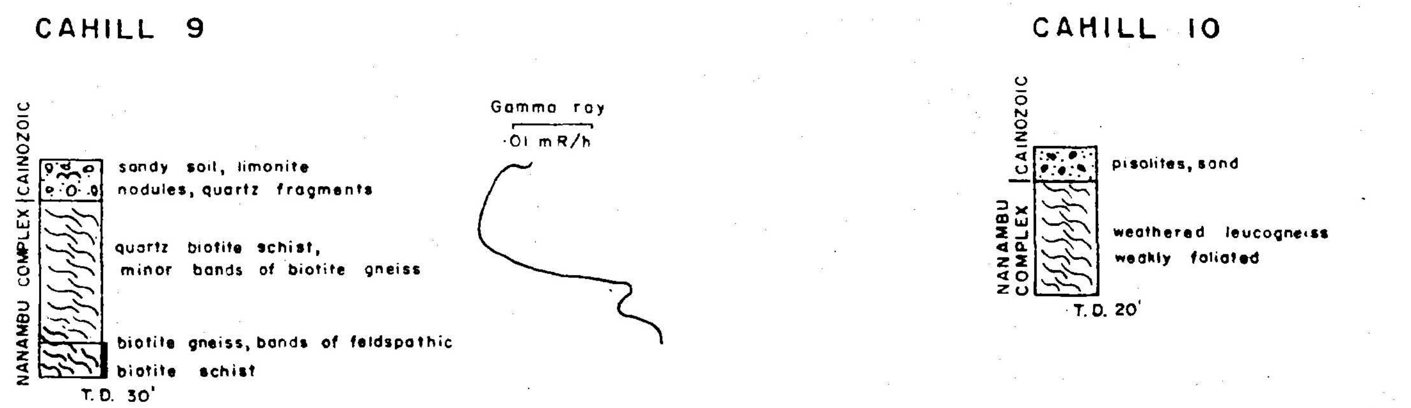

Fig. 23 Graphic lithological and radiometric logs of Cahill 9 and 10

Cahill 8 BMR Index No. 2241

Location: Cahill 1:100 000 Sheet area. 132°39'35", 12°40'30".

Access: 2.5 km west of Munmarlary road, 5 km south of Woolwonga Reserve northern boundary.

Commenced: 25/7/72. Completed 26/7/72.

Cored: 55-63'

Total depth: 63'

CAINOZOIC	0-5'	red-brown clay and sand
NANAMBU COMPLEX	5-50'	quartz-biotite-feldspar schist, biotite schist, feldspathic schist
	60-63'	biotite gneiss

Silicate and trace-element analysis (results tabulated in Appendices 2 and 3):

Sample no. 74121343 Depth: 62'

Cahill 9 BMR Index No. 2242

Location: Cahill 1:100 000 Sheet area. 132°38'50", 12°41'10".

Access: 3.5 km west of silicified dolomite outcrop at Woolwonga track/Munmarlary road junction, at head of minor creek.

Commenced: 27/7/72. Completed 27/7/72.

Coring: 26-30'

Total depth: 30'

CAINOZOIC	0-5'	red sandy soil, limonite nodules, quartz fragments
NANAMBU COMPLEX	5-26'	quartz-biotite schist, minor bands of biotite gneiss
	26-30'	biotite gneiss, bands of feldspathic biotite schist.

Silicate and trace-element analysis (results tabulated in Appendices 2 and 3);

Sample no. 74121344 Depth: 29'

Cahill 10 BMR Index No. 2243

Location: Cahill 1:100 000 Sheet area. 132°38'45", 12°41'30".

Access: 5.5 km west-southwest of Munmarlary road/Woolwonga track junction, 100 m east of quartzite ridge.

Commenced: 28/7/72. Completed 28/7/72.

Coring: NIL (rig broken-down, with slipping clutch)

Total depth: 20'

CAINOZOIC	0-5'	pisolites, sand
NANAMBU COMPLEX	5-20'	weathered leucogneiss chips, fragments of vein quartz, clay, feldspar and muscovite, faintly foliated.

Cahill 11 BMR Index No. 2244

Location: Cahill 1:100 000 Sheet area. 132°40'40", 12°42'40".

Access: 2.7 km along shooters' track starting 2.1 km south of Woolwonga track junction on Munmarlary road.

Commenced: 28/7/72. Completed 29/7/72.

Cored: 100-109'2"

Total depth: 109'2"

CAINOZOIC	0-5'	red sandy soil, quartz gravel
	5-20'	white, green-brown mica, quartz fragments, clay
	20-40'	vein-quartz fragments, biotite flakes and white feldspathic clay
KOOLPIN	40-45'	large muscovite flakes up to 5 mm, vein quartz (pegmatite?).
FORMATION	45-95'	chloritic green-black quartz-biotite schist or altered amphibolite
EQUIVALENT	95-100'	quartz amphibolite, fresh
	100-103'8"	quartz-biotite amphibolite, homogeneous with marked foliation at 45° to core normal marked with black/white colour banding; minor quartz veins up to 2 mm
	103'8"-109'2"	banded quartz-biotite amphibolite, pink garnet-rich bands, green ?epidote-chlorite bands; calcite and quartz veined, minor local brecciation

Silicate and trace-element analysis (results tabulated in Appendices 2 and 3);

Sample no. 74121345	Depth: 106'
74121346	109'

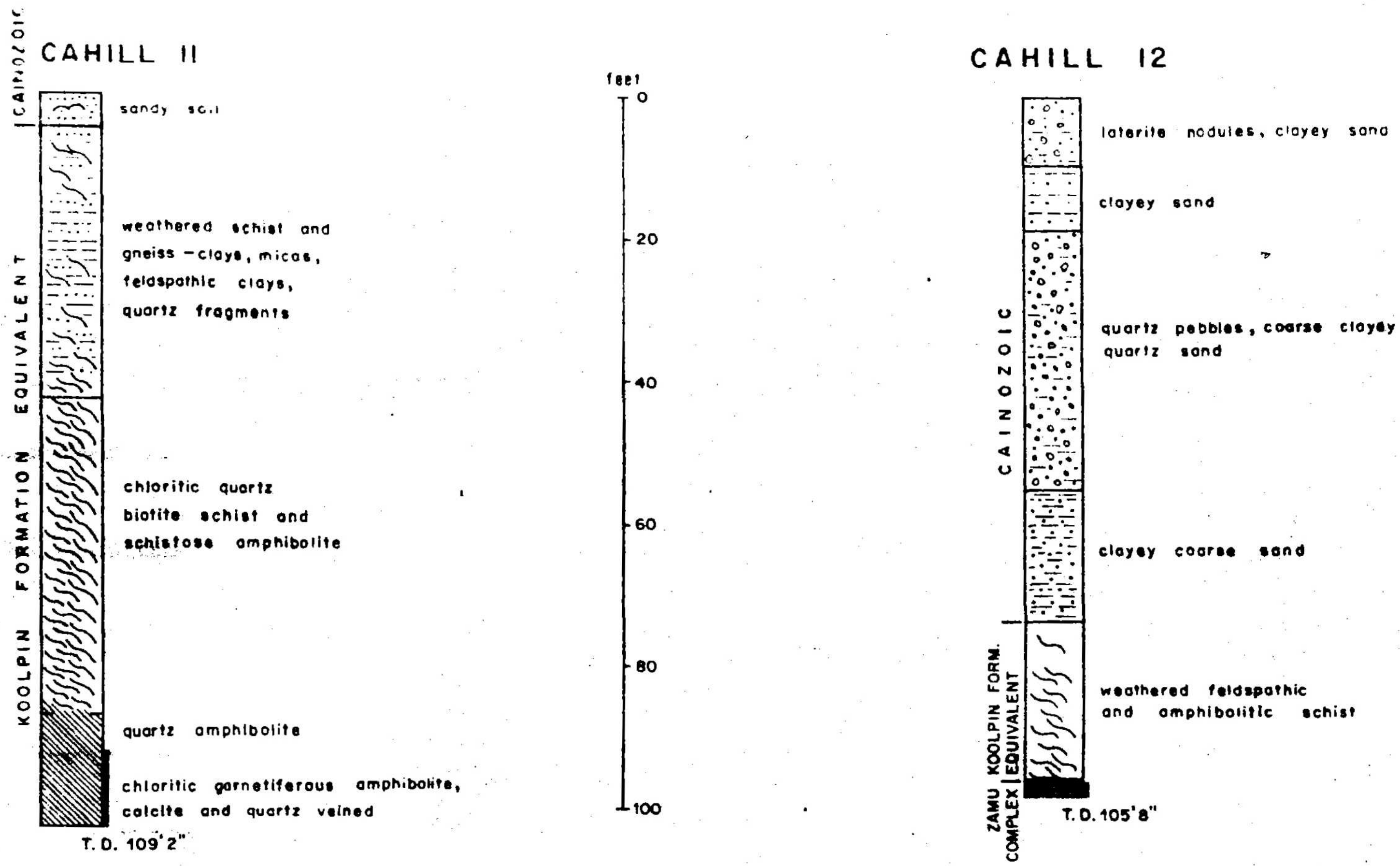

Fig. 24 Graphic lithological logs of Cahill 11 and 12

Cahill 12 BMR Index No. 2258

Location: Cahill 1:100 000 Sheet area. 132°44', 12°49'30".

Access: 15 m west of Darwin-Oenpelli road, at Muriella Park junction.

Commenced: 8/10/73, 11.00 a.m. Completed 9/10/73, 10.00 a.m.

Coring: 105-105'8"

Total depth: 105'8"

	0-10'	laterite nodules, grey clayey sand.
CAINOZOIC	10-20'	clayey sand
	20-60'	quartz pebbles, coarse clayey quartz sand.
	60-80'	yellow-brown clayey coarse sand.
KOOLPIN FORMATION EQUIVALENT	80-105'	weathered biotite schist.
ZAMU COMPLEX	105-105'8"	coarse feldspathic amphibolite, slightly weathered, chloritized along fractures. Foliation 40° to core normal.

Thin-section description:

Sample No. 73121463 AMPHIBOLITE (?METAGABBRO) Depth: 105'

Actinolite + heavily saussuritized and sericitized plagioclase + epidote + chlorite + sphene + prehnite + quartz.

Veins are filled with chlorite, prehnite and epidote.

Silicate and trace-element analysis (results tabulated in Appendices 2 and 3):

Sample no. 73121463 Depth: 105'

Cahill 13 BMR Index No. 2259

Location: Cahill 1:100 000 Sheet area. 132°44'30", 12°49'.

Access: 75 m south of junction of Koongarra road and Darwin-Oenpelli road.

Commenced: 9/10/73, 10.30 a.m. Completed 9/10/73, 3.15 p.m.

Coring: 115-117'

Total depth: 117'

CAINOZOIC	0-10'	laterite nodules, quartz fragments, clay.
	10-40'	white-green clays, weathered schist.
KOOLPIN	40-110'	weathered biotite-muscovite schist.
FORMATION	110-115'	biotite-quartz-feldspar gneiss.
EQUIVALENT AND INTERLAYERED ZAMU COMPLEX	115-117'	interbanded gneiss and coarsely banded amphibolite; bands of quartz and feldspar; amphibole prisms up to 5 mm. Chloritized along fractures. Foliation 70° to core normal.

Thin-section description:

Sample No. 73121465 AMPHIBOLITE Depth: 116'

Green hornblende + quartz + an aggregate of two unknown minerals (one with a high double refraction and the other with low), partly replacing plagioclase.

Silicate and trace-element analysis (results tabulated in Appendices 2 and 3):

Sample no. 73121465 Depth: 116'

Cahill 14 BMR Index No. 2260

Location: Cahill 1:100 000 Sheet area. 132°46', 12°46'30".

Access: Alongside Darwin-Oenpelli road, 35 m southeast of Munmarlary road junction.

Commenced: 9/10/73, 3.30 p.m. Completed 10/10/73, 11.30 a.m.

Coring: 65-67'6"

Total depth: 67'6"

CAINOZOIC	0-5'	laterite nodules
	5-20'	white feldspar chips, large muscovite flakes, coarse graphic quartz intergrowths, clayey coarse sand.
NANAMBU	20-65'	weathered coarse leucogneiss fragments.
COMPLEX	65-67'6"	biotite-quartz-feldspar leucogneiss, occasional garnets in biotite clusters; very coarsely banded, foliation 40° to core normal.

Thin-section description:

Samples No. 73121466 QUARTZO-FELDSPATHIC ORTHOGNEISS Depth: 65'6"

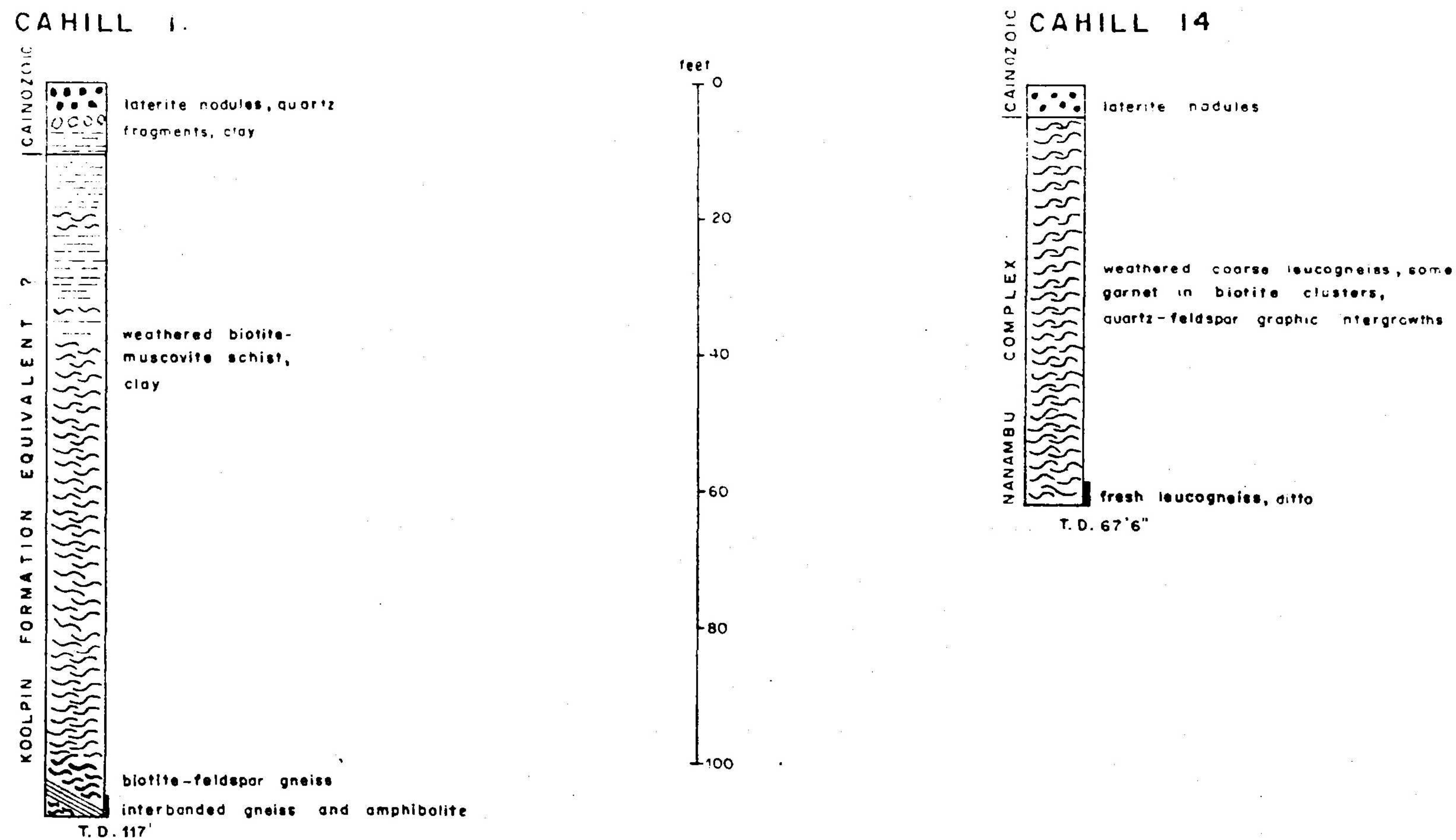

Fig. 25 Graphic lithological logs of Cahill 13 and 14

Microcline + strongly sericitized plagioclase (now albite) + quartz + partly chloritized albite.

Silicate and trace-element analysis (results tabulated in Appendices 2 and 3):

Sample no. 73121466 Depth: 65'6"

APPENDIX 2

ROTARY-PERCUSSION DRILLING: SILICATE ANALYSES OF PRE-MESOZOIC ROCKS (Analyst, J. Pyke, BMR)

	7312-1445	1446	1447	1448	1449	1450	1451	1452	1453	1454	1455	1456	1457	1458	1459*	1
SiO_2	74.04	60.71	52.50	59.96	68.28	60.09	75.11	66.00	66.35	75.03	73.10	73.47	54.17	54.18	96.47	51
TiO_2	0.21	0.59	1.15	0.79	0.52	0.56	0.01	0.41	0.55	0.23	0.14	0.19	0.60	0.73	0.03	0
Al_2O_3	13.60	20.32	13.49	15.89	13.54	17.92	14.93	13.96	15.57	13.71	14.06	13.11	14.64	15.81	0.15	14
Fe_2O_3	1.36	5.59	14.79	7.86	4.89	7.39	0.20	5.71	4.10	1.10	1.28	2.02	9.08	10.07	2.15	9
MnO	0.01	0.03	0.22	0.07	0.05	0.06	0.01	0.30	0.07	0.01	0.01	0.01	0.08	0.13	0.00	0
MgO	0.36	3.00	5.49	3.77	2.19	2.59	0.02	1.90	1.78	0.26	0.17	0.76	7.14	4.85	0.00	9
CaO	0.91	0.20	8.05	1.15	1.76	0.64	0.61	0.97	2.57	0.41	0.71	0.40	1.42	6.21	0.00	4
Na_2O	3.60	0.51	0.66	1.13	2.02	0.97	6.03	2.35	4.29	3.99	3.25	5.23	1.56	3.56	0.05	2
K_2O	4.36	4.62	1.33	5.27	3.80	4.52	1.22	3.66	3.36	4.90	5.66	3.34	4.39	1.78	0.02	3
P_2O_5	0.06	0.12	0.13	0.21	0.15	0.15	0.15	0.19	0.18	0.11	0.11	0.06	0.35	0.27	0.02	0
Loss	0.54	4.52	1.99	3.13	2.00	3.44	1.38	3.65	0.92	0.89	0.69	1.09	6.08	1.60	0.46	2
Total	99.06	100.20	99.78	99.23	99.20	99.23	99.66	99.10	99.74	100.63	99.17	99.67	99.50	99.20	99.35	99

* Mesozoic orthoquartzite

APPENDIX 2 (Contd.)

	7312 1462	1463	1465	1466	7412-1310	1312	1316	1319	1321	1323	1324	1325	1328	1329	1
SiO_2	58.47	49.51	56.14	73.64	75.53	61.86	51.75	50.20	67.69	54.63	60.62	59.83	58.59	50.77	77
TiO_2	0.72	0.52	0.66	0.08	0.13	0.67	0.92	0.49	0.33	0.83	0.66	0.60	0.69	1.67	0
Al_2O_3	16.25	17.59	13.40	13.93	12.75	14.72	13.34	10.16	16.81	15.15	14.01	13.85	14.34	15.77	12
Fe_2O_3	7.85	8.73	9.76	1.52	1.33	8.82	9.63	10.36	2.09	8.73	6.56	5.75	7.91	9.63	0
MnO	0.10	0.14	0.17	0.02	0.01	0.14	0.17	0.19	0.04	0.13	0.09	0.09	0.12	0.20	0
MgO	4.00	6.70	6.27	0.65	1.01	4.85	11.59	16.30	1.56	7.18	5.88	4.89	5.92	2.19	0
CaO	3.63	11.46	8.49	0.44	2.27	2.14	5.04	7.33	2.31	5.69	2.60	4.58	5.01	4.31	0
Na_2O	3.37	1.76	1.10	2.74	4.76	3.26	2.86	1.30	7.28	3.33	2.77	2.83	2.35	4.91	4
K_2O	3.05	0.56	0.81	6.31	0.84	2.31	1.64	1.71	1.12	2.58	3.07	2.85	3.61	4.53	5
P_2O_5	0.35	0.07	0.06	0.09	0.06	0.13	0.41	0.21	0.16	0.29	0.19	0.18	0.29	0.55	0
Loss	1.70	2.78	2.94	1.07	0.74	1.00	1.71	2.30	1.44	1.16	2.90	3.64	0.79	4.56	0
Total	99.48	99.82	88.81	100.49	99.44	99.89	99.07	100.56	100.83	99.70	99.37	99.09	99.63	99.09	100

APPENDIX 2 (Contd.)

	7412 1331	1332	1333*	1334	1335	1336	1337	1338	1339	1340	1341	1342	1343	1344	1345	13
SiO_2	78.22	76.95	50.60	50.83	49.80	62.74	48.71	55.83	11.84	59.54	53.50	40.41	75.06	74.10	55.19	54.
TiO_2	0.05	0.03	1.30	1.19	1.28	0.48	0.70	0.53	0.03	0.61	0.66	0.00	0.23	0.06	1.93	0.
Al_2O_3	11.70	12.96	18.24	14.36	17.66	14.15	11.90	16.42	0.78	13.94	15.74	0.04	14.13	14.09	12.86	9.
Fe_2O_3	0.70	0.54	7.86	14.88	7.51	5.95	11.16	6.91	0.49	6.01	7.69	0.61	1.12	0.40	14.42	31.
MnO	0.01	0.01	0.22	0.17	0.21	0.08	0.19	0.10	0.03	0.05	0.12	0.05	0.02	0.01	0.20	0.
MgO	0.16	0.08	1.27	6.26	1.22	3.84	12.75	6.73	18.40	5.96	5.31	36.79	0.39	0.06	4.29	2
CaO	0.11	0.84	3.51	8.02	3.45	3.11	5.82	3.75	31.79	0.41	3.20	0.14	0.63	0.51	6.66	2
Na_2O	4.43	4.69	4.48	2.35	9.63	3.04	0.81	2.87	0.04	0.09	0.96	0.04	3.66	3.71	1.39	0
K_2O	4.06	3.74	3.32	0.61	3.23	3.24	3.51	3.13	0.18	5.09	5.97	0.00	5.71	5.87	1.05	0
P_2O_5	0.03	0.07	0.20	0.13	0.19	0.25	0.27	0.39	0.11	0.08	0.07	0.00	0.06	0.10	0.32	0
Loss	0.74	0.56	0.30	1.12	5.00	2.33	3.38	3.13	36.36	8.14	6.42	21.57	+0.06	0.60	1.17	+1
Total	100.21	100.47	91.29	99.91	99.18	99.21	99.20	99.79	100.06	99.92	99.63	99.63	100.96	99.52	99.48	99

* Average values from 3 determinations

APPENDIX 3

ROTARY-PERCUSSION DRILLING: TRACE-ELEMENT ANALYSES OF PRE-MESOZOIC ROCKS (p.p.m.)

(Analyst, J. Pyke, BMR)

(Detection limits: U=2 Th=2 Y=2 Rb=2 Zr=2 Nb=2 Sr=2 Pb=2 As=2 Ba=3 Ce=3 Cu=2 Zn=2 Ni=2 Cr=2 V=2 Sn=2
ND=not detected)

	7312-1445	1446	1447	1448	1449	1450	1451	1452	1453	1454	1455	1456	1457	1458	1460
U	50	ND	ND	3	ND	5	ND	ND	ND	6	7	5	ND	ND	ND
Th	31	19	4	15	16	18	10	14	11	35	46	28	6	ND	10
Y	8	21	23	18	17	18	3	22	8	5	11	21	7	10	11
Rb	120	196	56	210	148	167	51	146	115	207	250	59	130	38	73
Zr	116	68	52	67	111	35	11	ND	ND	112	144	76	13	3	ND
Nb	8	15	3	14	11	13	20	11	7	13	19	13	3	4	6
Sr	98	44	59	91	133	76	96	203	341	60	73	79	198	581	531
Pb	39	13	2	19	21	20	16	26	13	29	32	15	6	8	14
As	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	18	ND	ND	ND
Ba	372	639	260	995	677	977	219	2052	2164	303	353	759	1065	1000	1856
Ce	16	8	ND	ND	65	10	18	52	55	18	34	77	64	22	11
Cu	5	12	9	31	31	97	6	24	20	6	ND	864	96	68	89
Zn	21	15	108	97	60	116	ND	76	68	80	35	24	74	86	105
Ni	4	27	41	34	22	31	ND	57	25	15	2	16	141	42	157
Cr	18	108	102	96	66	97	6	141	118	6	3	18	760	115	923
V	3	88	283	106	71	98	ND	63	60	4	4	12	127	171	143
Sn	ND	4	ND	3	2	5	15	ND	ND	2	2	3	ND	ND	ND

APPENDIX 3 (Contd.)

	7412-1332	1333	1334	1335	1336	1337	1338	1339	1340	1341	1342	1343	1344	1345	1346
U	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Th	ND	ND	ND	7	6	ND	4	ND	14	13	ND	30	12	13	10
Y	ND	ND	15	4	12	11	10	ND	7	13	ND	4	ND	54	11
Rb	74	63	17	63	124	124	122	7	227	204	ND	116	102	42	12
Zr	12	5	40	81	11	21	32	2	15	ND	ND	112	27	189	42
Nb	ND	ND	7	54	8	10	8	ND	9	9	ND	6	2	15	8
Sr	67	65	157	589	294	156	479	125	31	75	ND	113	137	80	9
Pb	23	23	6	18	14	5	13	2	14	25	ND	35	29	9	ND
As	ND	ND	ND	ND	ND	ND	ND	2	ND	ND	2	ND	ND	ND	ND
Ba	230	219	256	830	594	833	708	64	1090	1522	53	552	527	446	261
Ce	26	20	11	45	16	8	43	24	13	55	ND	10	51	67	14
Cu	ND	ND	144	33	64	4	9	ND	44	20	ND	ND	ND	17	75
Zn	ND	4	127	129	59	129	77	7	70	75	4	12	ND	128	126
Ni	ND	2	55	ND	74	287	106	2	58	36	4	2	ND	14	6
Cr	4	10	71	4	382	1260	532	ND	160	127	8	9	ND	144	85
V	3	5	345	3	75	156	92	3	160	92	2	7	5	230	56
Sn	2	2	ND	2	ND	ND	ND	ND	3	3	2	ND	ND	2	ND

APPENDIX 4

ROTARY-PERCUSSION DRILLING: TRACE-ELEMENT ANALYSES OF MESOZOIC AND CAINOZOIC ROCKS (p.p.m.)

(Analyst J. Pyke, BMR)

(Detection limits as for Appendix 3; ND=not detected)

	7312-1459	7412-7070	7071	7072	7073	7074	7075	7076	7077	7078	7079	7080	7081	7082	7083
U	ND	ND	ND	ND	ND	ND	3	ND	ND	ND	ND	ND	ND	ND	ND
Th	ND	12	13	12	11	13	13	11	13	11	7	12	6	10	12
Y	ND	13	19	10	4	4	5	5	3	5	ND	12	ND	5	26
Rb	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	9	4	10	20
Zr	16	417	307	265	207	213	331	205	155	149	79	146	54	128	126
Nb	ND	11	7	11	6	6	4	7	4	5	4	11	3	6	9
Sr	6	5	ND	ND	3	ND	2	ND	3	10	6	41	12	80	149
Pb	3	5	4	8	2	ND	2	3	8	14	11	21	9	26	30
As	8	4	ND	11	4	5	3	5	12	14	6	2	6	4	2
Cu	4	5	ND	ND	ND	ND	ND	ND	6	5	ND	ND	6	ND	24
Zn	14	3	2	ND	ND	ND	ND	ND	5	3	ND	ND	4	15	57
Ni	ND	11	4	6	6	ND	2	2	ND	ND	ND	3	2	19	45
Cr	31	105	281	153	111	165	153	135	342	233	141	74	181	182	190
V	53	139	660	329	109	185	13	18	410	354	158	34	76	126	133
Sn	ND	3	3	3	2	ND	ND	ND	ND	ND	ND	5	ND	ND	2
Ba	59														
Ce	14														

APPENDIX 4 (Contd.)

	7412–7084	7085	7086	7087	7106	7107	7108	7109	7110	7111	7112	7113	7114	7115	7116	7117
U	3	ND	ND	3	4	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Th	10	9	9	7	28	19	3	7	4	11	8	7	7	5	10	4
Y	26	16	12	8	12	11	ND	ND	ND	4	5	6	3	4	6	ND
Rb	40	75	177	101	4	13	ND	ND	ND	3	4	4	4	7	8	4
Zr	104	112	ND	5	323	156	69	96	91	144	127	180	105	124	261	121
Nb	5	5	9	6	13	12	4	5	4	5	4	5	7	6	7	4
Sr	84	130	131	107	3	23	4	5	4	9	7	11	8	5	11	8
Pb	22	18	36	25	24	17	2	4	3	10	11	6	5	4	13	4
As	ND	ND	ND	ND	21	7	22	2	ND	8	17	3	ND	2	9	3
Cu	38	30	31	26	8	ND	ND	ND	ND	ND	7	ND	ND	ND	4	ND
Zn	91	134	96	59	4	ND	ND	ND	ND	3	ND	2	2	2	3	ND
Ni	52	42	39	28	3	ND	ND	2	2	5	ND	2	5	5	3	ND
Cr	132	157	111	88	353	158	21	44	30	139	43	39	36	40	192	36
V	98	202	86	50	512	167	18	50	34	176	38	23	24	32	206	28
Sn	ND	2	3	4	2	3	ND	ND	ND	ND	3	2	ND	ND	2	ND

APPENDIX 4 (Contd.)

	7412-7118A	7118B	7119	7120	7121	7122	7123	7124	7125A	7125B	7126	7127	7128	7129	7130	7131	7132
U	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	3	3	4	5	4	5	6
Th	8	13	20	15	11	12	15	6	15	26	49	34	20	14	15	20	20
Y	7	12	16	14	9	11	11	9	5	3	9	ND	6	6	7	12	18
Rb	6	11	14	13	9	11	11	3	11	26	30	38	30	49	120	194	208
Zr	247	274	335	281	198	214	215	56	83	125	157	83	73	60	59	79	55
Nb	6	11	14	12	8	10	12	8	6	11	15	4	6	5	6	11	3
Sr	12	21	26	25	19	29	37	220	43	13	21	20	9	11	21	41	43
Pb	8	20	25	19	16	16	25	20	8	12	57	64	27	33	31	30	29
As	ND	6	3	2	5	8	4	2	ND	ND	ND	ND	ND	3	ND	ND	ND
Cu	ND	ND	13	ND	ND	ND	16	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Zn	ND	4	13	3	3	5	4	ND	4	7	9	11	14	20	9	6	15
Ni	ND	4	5	3	2	4	5	ND	ND	2	ND	2	3	3	3	2	4
Cr	31	85	85	84	85	120	140	49	38	21	18	20	23	15	7	9	10
V	17	73	49	47	56	66	77	23	24	9	3	5	4	3	5	3	3
Sn	2	ND	ND	2	ND	3	2	ND	ND	3	3	3	ND	2	ND	ND	ND

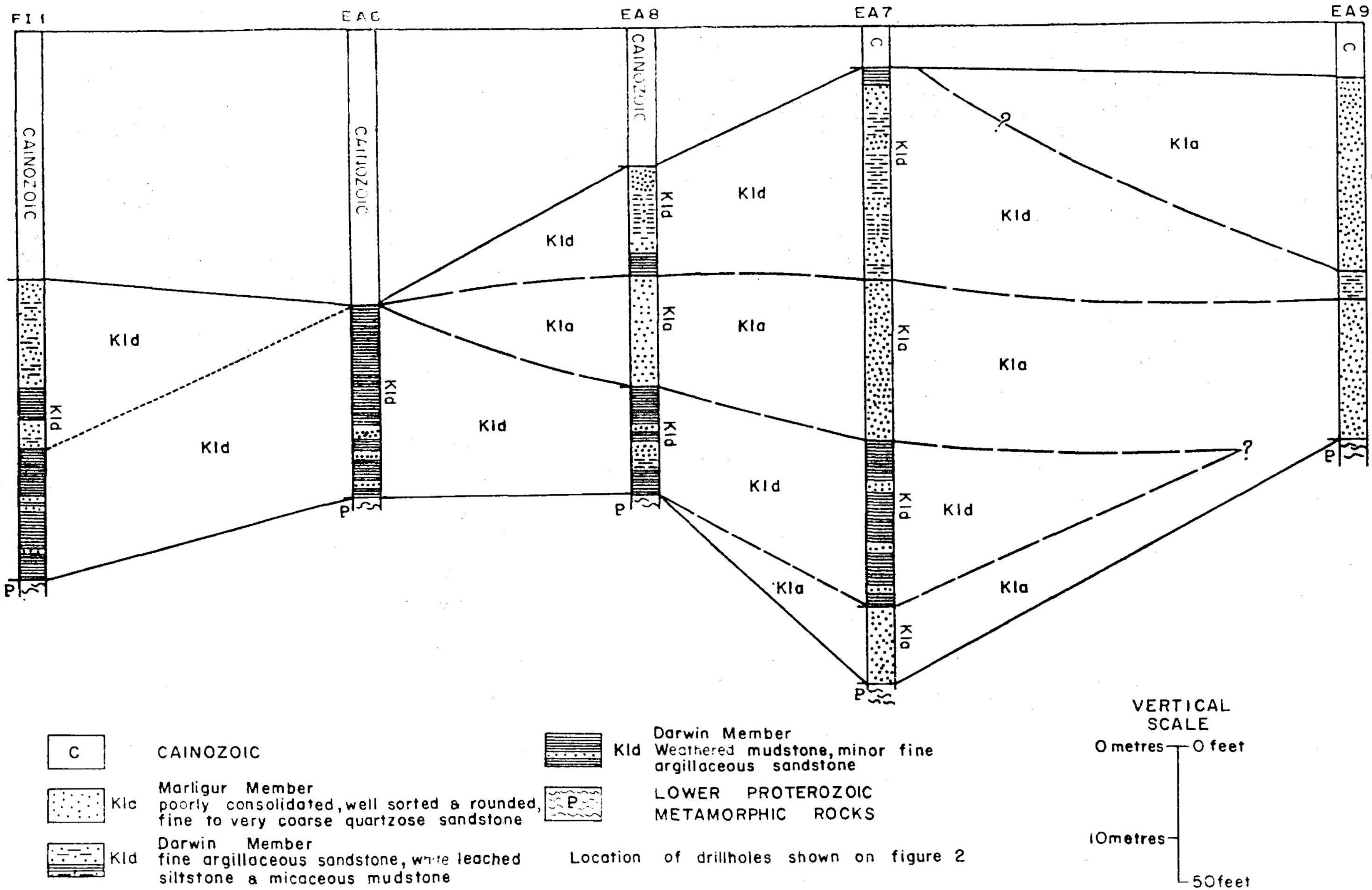

Fig. 26 Correlation from B.M.R. Field Island 1 to B.M.R. East Alligator 9 to demonstrate the interfingering relationship between the Marligur and Darwin Members of the Bathurst Island Formation in this area.

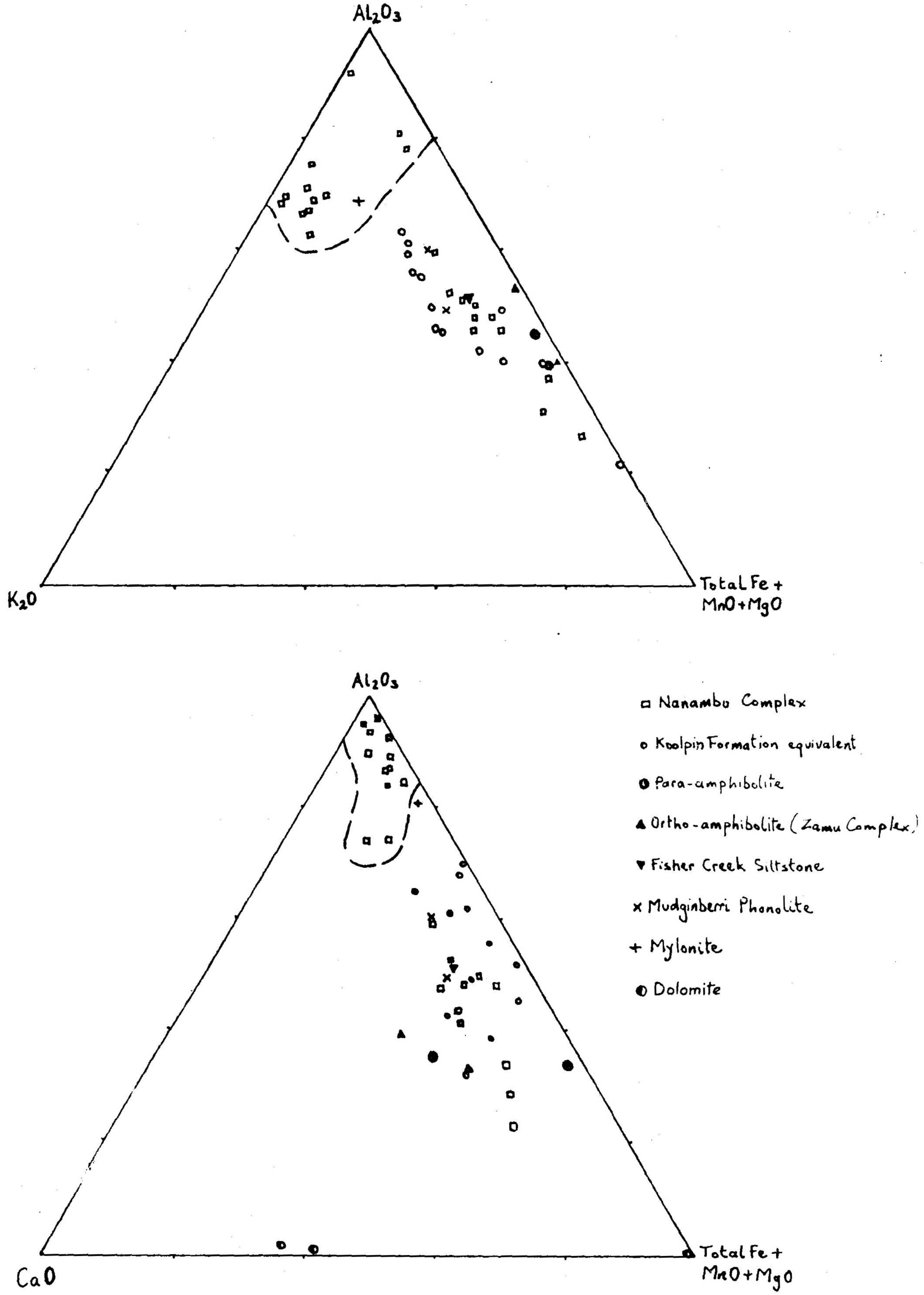

Figure 27

AKF and ACF Ternary Diagrams for Pre-Mesozoic Rock Types

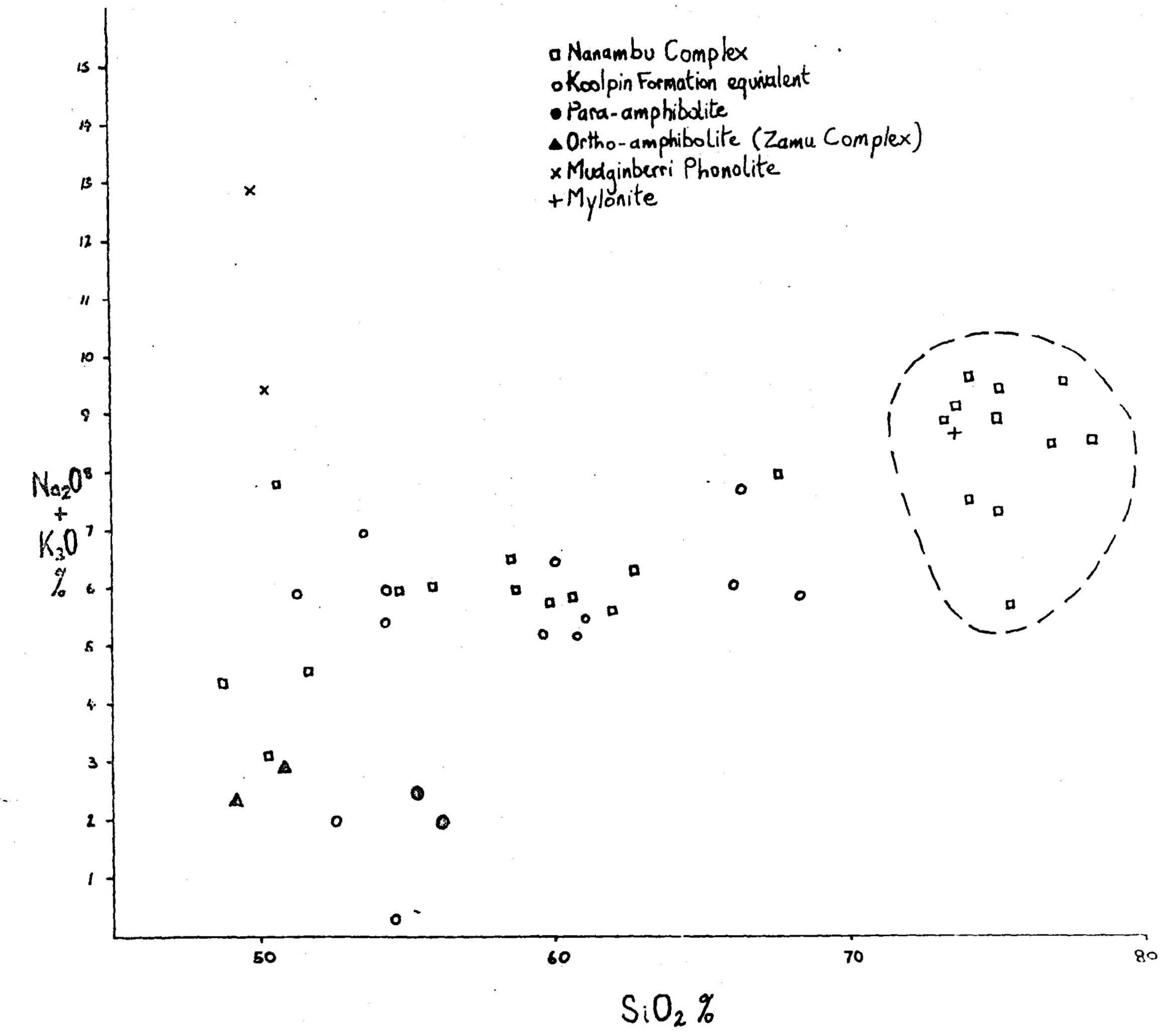

Figure 28 Plot of alkalis vs SiO_2 for Pre-Mesozoic rocks

APPENDIX 5. AUGER DRILLING RESULTS, TRAVERSE I EXTENDED

(radioactivity in counts/second; depths in feet)

Hole	Total depth	Lithology	Maximum radioactivity Value	Maximum radioactivity Depth	Remarks (T.P.D. = total probe depth)
1	30	Weathered feldspathic sandstone - clayey) 'Koolpin	16	14	
2	30	Ferruginous quartzite, vein quartz, sandstone) Formation	26	6	24 c/s at 26 ft (T.P.D.)
3	24	Ferruginous clayey sst)	12	14	
4	18	Ferrug. claystone, qtz sst, sand) Equivalent'	20	12	
5	30	Fine granular mica-quartz-feldspar gneiss	42	16	36 c/s at 26 ft (T.P.D.)
6	30	Weathered quartz-feldspar gneiss	38	2	26 c/s at 26 ft (T.P.D.)
7	30	Weathered claystone and feldspar	22	4	
8	30	Claystone, weathered gneiss	12	6	
9	22	Claystone with quartz fragments	10	12	
10	8	Quartz sand)	8	4	
11	12	Clayey sand) Nourlangie	4	10	
12	17	Clayey sand) Creek	9	8	
13	16	Clayey sand)	18	2	
14	8	Weathered gneiss	14	6	
15	15	Weathered gneiss	12	10	
16	30	Weathered gneiss	16	24	T.P.D.
17	23	Weathered biotite-feldspar schist and gneiss	8	16	
18	18	Quartz sand) Baroalba	6	12	
19	12	Quartz sand) Creek	5	6	
20	18	Coarse qtz sand)	12	6	
21	35	Weath. biotite schist; biotite-quartz-feldspar gneiss	48	18	28 c/s at 32 ft (T.P.D.)
22	30	Muscovite in clay; weathered gneiss	34	8	28 c/s at 26 ft (T.P.D.)

APPENDIX 5. (Contd.)

Hole	Total depth	Lithology	Maximum radioactivity		Remarks (T.P.D. = total probe depth)
			Value	Depth	
23	30	Fresh leucogneiss	18	12	
24	30	Weathered chloritic schist; granular leucogneiss	24	16	
25	17	Coarse quartz-feldspar leucogneiss, minor biotite	22	8	
26	26	Biotite-qtz-feldspar schist; quartz-feldspar gneiss	22	18	
27	27	Chloritic clay	18	16	
28	30	Weathered mica schist	12	24	

APPENDIX 6. RADIOACTIVITY ENCOUNTERED IN AUGER HOLES, TRAVERSE 6

(radioactivity in counts/second; depths in feet)

Hole	Total depth	Maximum radioactivity		Remarks (T.P.D. = total probe depth)
		Value	Depth	
1	30	35	18	30 c/s at 20 ft (T.P.D.)
2	18	18	4	
3	6	18	4	
4	30	20	0	
5	12	50	8	T.P.D.
6	24	40	2	30 c/s at 20 ft (T.P.D.)
7	30	65	16	T.P.D.
8	30	50	22	T.P.D.
9	30	70	8	30 c/s at 15 ft (T.P.D.)
10	30	26	12	
11	18	28	6	
12	18	28	10	T.P.D.
13	28	26	8	
14	30	72	2	50 c/s at 22 ft (T.P.D.)
15	30	64	6	38 c/s at 24 ft (T.P.D.)
16	30	40	30	31 c/s at 20 ft (T.P.D.)
17	30	35	10	25 c/s at 22 ft (T.P.D.)
18	30	30	6	
19	30	44	18	28 c/s at 29 ft (T.P.D.)
20	8	20	4	
21	30	28	6	
22	24	24	12	22 c/s at 22 ft (T.P.D.)
23	30	28	16	
24	7	20	2	
25	30	24	18	
26	24	26	18	T.P.D.

APPENDIX 7. AUGER DRILLING RESULTS TRAVERSE 7

(radioactivity in counts/second; depths in feet)

Hole	Total depth	Lithology	Maximum radioactivity	
			Value	Depth
1	30	red brown sand, clayey	20	20
2	35	brown sandy clay	15	4
3	17	brown sandy clay	12	8
4	34	brown sandy clay	12	24