FINAL REPORT
ON THE
JABILUKA TWO DEPOSIT
EXPLORATION LICENCE 12,
NORTHERN TERRITORY,
AUSTRALIA

FOR THE

PANCONTINENTAL MINING LIMITED
GETTY OIL DEVELOPMENT COMPANY LIMITED
JOINT VENTURE

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FEBRUARY 28, 1974

SYDNEY, N.S.W.
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1.0 SUMMARY

This report covers the drilling programme carried out on the Jabiluka Two deposit on Exploration Licence 12 during the period June 1st to December 3rd, 1973. The work was carried out by Pancontinental Mining Limited as operator of the Pancontinental Mining Limited/Getty Oil Development Company Limited Joint Venture.

The Jabiluka Two deposit occurs in the same westerly striking asymmetrically folded succession of Lower Proterozoic metasedimentary rocks as the Jabiluka One deposit. The fold axis dips about $70^\circ$ north and has an irregular plunge that appears to flatten from the average $7^\circ$ east plunge at Jabiluka One. The north limb of the syncline dips about $35^\circ$ to the south and the south limb is essentially flat. The deposit so far delineated is located in a sandstone valley which extends east of the Jabiluka One deposit.

The drilling at Jabiluka Two proved a uranium deposit with indicated in situ ore reserves of 4.5 million metric tons of ore at an average grade of 0.41% $U_3O_8$. A total of 16 holes intersected ore grade mineralisation.

The Mine Sequence rocks contain approximately 90% of the uranium ore reserve at Jabiluka Two. About 9% is contained in the Hanging Wall and Footwall Schist Series and the remaining 1% occurs in two separate horizons, one above the Hanging Wall Schist Series and one below the Footwall Schist Series.
The Mine Sequence is composed of four stratigraphic members. The top of the Mine Sequence is a graphitic schist which varies in thickness from 1 - 3 metres.

A second member consists of a chlorite graphite complex which is developed only in the eastern part of the Jabiluka Two deposit. This member reaches a maximum thickness of 60 metres in the north limb of the fold and pinches out completely down dip in the axial plane area.

A light coloured series of quartz chlorite muscovite and quartz muscovite chlorite schists occurs below the graphite schist member in the western part of Jabiluka Two and has a variable thickness from 0 - 7 metres. This member pinches out completely to the east.

The lowest member of the Mine Sequence consists of two separate submembers which occur along the same stratigraphic horizon within the deposit. One is a chlorite breccia with associated dark coloured chlorite and chlorite graphite schists. This submember reaches a maximum thickness of 42 metres. The breccia shows a maximum thickness of 17 metres but pinches up dip where it disappears in the axial plane area. A series of dolomite magnesite bodies and associated dark coloured chlorite and chlorite graphite schists occurs as a submember to the extreme west of Jabiluka Two.

The Hanging Wall and the Footwall Schist Series contain approximately 9% of the uranium mineralisation in the Jabiluka Two deposit and consist of quartz chlorite muscovite and quartz muscovite chlorite schists.

Two additional uranium horizons are developed at Jabiluka Two and together account for 1% of the present ore reserve. One is developed in
the graphite and associated chlorite graphite breccia that occur above
the Hanging Wall Schist Series. The other horizon is developed in the
Dolomite Magnesite Complex that occurs below the Footwall Schist Series.

A series of pegmatite dykes and, to a much lesser extent, basic
dykes cut the metasedimentary succession. The pegmatite dykes are
probably premineralisation and appear to have been poor hosts for uranium
deposition except where the dykes are chloritized. Where intersected,
the basic dykes are not anomalous and their relationship with the
uranium mineralisation is unknown.

Uranium minerals that occur at Jabiluka Two include pitchblende
and uraninite. Minor secondary uranium minerals occur but have not
been identified. Accessory minerals include pyrite, galena, chalcopyrite,
marcasite, hematite and minor native gold.
1.1 INTRODUCTION

This report covers results of the drilling programme carried out between June 1st, 1973 and December 3rd, 1973 on the Jabiluka Two deposit on Exploration Licence 12, Northern Territory, Australia. This work was carried out by Pancontinental Mining Limited/Getty Oil Development Company Limited Joint Venture.

An adequate description of property, location and access, topography, climate and vegetation, facilities, history, regional geology and rock types is included in report No. 3, The Jabiluka One Deposit dated April 27th, 1973. To avoid repetition these sections have been omitted from this report.
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2.0 JABILUKA TWO DEPOSIT

2.1 SURFICIAL GEOLOGY

The Jabiluka Two deposit occurs in Lower Proterozoic metasedimentary rocks which subcrop at the unconformity with the Kombolgie Sandstone.

The deposit so far delineated is located in a sandstone valley which extends east of the Jabiluka One deposit. In the valley a thin cover of unconsolidated sand overlies the weathered surface of the Kombolgie Sandstone. To the north, south and east of the valley the Kombolgie Sandstone rises abruptly to form rugged hills which reach elevations as high as 100 metres above the lowland plains.

West of Jabiluka Two the valley widens to become part of a gently dipping plain covered by recent alluvial deposits.

2.2 MINE GEOLOGY

The Jabiluka Two deposit occurs in the same westerly striking asymmetrically folded succession of Lower Proterozoic metasedimentary rocks as the Jabiluka One deposit.

This metasedimentary succession is essentially the same as at Jabiluka One with a few exceptions (see Table 2). A stylised cross-section through the Jabiluka Two deposit shows the following stratigraphic succession.

At surface a thin cover of sand, 0.5 to 12 metres thick, lies on the weathered surface of the Kombolgie Sandstone.
The Kombolgie Sandstone overlies the Lower Proterozoic meta-
sedimentary succession at Jabiluka Two. It forms an unconformity at
the north of the deposit and is in faulted contact at the south of the
deposit. The thickness of sandstone above the deposit varies from 20
to 70 metres.

The Upper Schist Series forms the highest stratigraphic sequence
of metasedimentary rocks intersected thus far at Jabiluka Two and consists
primarily of light coloured quartz chlorite muscovite and quartz muscovite
chlorite schists. The maximum thickness intersected to date is 13.0 metres.

A Graphite Schist underlies this unit. At Jabiluka Two a
chlorite graphite breccia is developed at the base of the unit. Maximum
thickness intersected for the graphite schist to date is 12 metres; for
the breccia 4 metres.

The Hanging Wall Schist Series underlies the Graphite Schist and
breccia and shows a maximum thickness of 60 metres in drilling to date.
The Series consists predominantly of light coloured quartz chlorite
muscovite and quartz muscovite chlorite schists.

The Mine Sequence underlies the Hanging Wall Schists and is
composed of four different members. These members are similar to those in
the Mine Sequence at Jabiluka One. However, there are notable changes
in thickness, composition, degree of brecciation and location.

A graphite schist is present at the top of the Mine Sequence.
From west to east this graphite member becomes more chloritic and less distinct.
In the western part of Jabiluka Two the graphite schist occurs as a well defined member underlain by a series of light coloured quartz muscovite chlorite and quartz chlorite muscovite schists. In the eastern part of Jabiluka Two this member interfingers with a series of dark coloured chlorite and graphite schists (chlorite graphite complex) in the north limb of the fold and to the south appears to thin against the underlying chlorite breccia and associated dark coloured chlorite schists.

The chlorite graphite complex is developed in the eastern part of Jabiluka Two and underlies the light coloured Hanging Wall Schist Series in the north limb of the fold. This member reaches a maximum thickness of 50 metres near its subcrop with the unconformity. To the south the complex pinches out completely down dip in the axial plane area. This member occurs at approximately the same stratigraphic level as the graphite schist member.

A third member consisting of a series of light coloured quartz muscovite chlorite and quartz chlorite muscovite schists underlies the graphitic member and has a thickness ranging from 0 - 7 metres. The schist series is thinner and less regular at Jabiluka Two than at Jabiluka One where it forms a waste block between two generalised ore horizons; one subparallel to the graphite member and one subparallel to the chlorite breccia member below. At Jabiluka Two this light coloured series of schists pinches out completely to the east.

The lowest member of the Mine Sequence consists of two separate submembers that occur along the same stratigraphic horizon within the deposit. One is a chlorite breccia with associated dark coloured chlorite and chlorite graphite schists. The chlorite breccia subparallels the other
members in the Mine Sequence, and is continuous over most of the known extent of the deposit. The breccia fragments are varied but the dominant rock type is a medium grained chlorite metaquartzite, often crenulated, and composed of mosaic quartz with thin streaks of chlorite and some hydromuscovite flakes. There are also graphite quartz chlorite schists and a few chert fragments. The matrix, to these variably sized and shaped fragments, consists of granular quartz and relatively coarse flakes of colourless magnesian chlorite. This member reaches a maximum thickness of 42 metres. The breccia within the member shows a maximum thickness of 17 metres but pinches up dip where it disappears in the axial plane area.

A series of dolomite magnesite bodies and associated dark coloured chlorite and chlorite graphite schists, which is present as a submember south and east of Jabiluka One, also occurs to the extreme west of Jabiluka Two. Limited drill data indicates the continuity of this submember between the two deposits.

The Footwall Schist Series consists of light coloured quartz muscovite chlorite and quartz chlorite muscovite schists. The maximum thickness of this series at Jabiluka Two is 65 metres. This Series rarely contains any mineralisation of economic significance except in the north limb of the fold adjacent to the Mine Sequence. Most often sporadic small pitchblende veinlets cross cut the Footwall Schists immediately below the Mine Sequence rocks.

A Dolomite Magnesite Complex underlies the Footwall Series at Jabiluka One and contains several thin dolomite magnesite bodies with associated chlorite and graphite schists.
A series of chlorite and chlorite graphite schists correlates with this complex along strike at Jabiluka Two and from limited drill data shows a maximum thickness of about 30 metres. At Jabiluka Two there is evidence of minor brecciation and fracturing within the complex and the occurrence of uranium mineralisation. The dolomite magnesite bodies are not present in the complex at Jabiluka Two in the area drilled to date.

Underlying the Dolomite Magnesite Complex is a Lower Schist Series of light coloured quartz muscovite chlorite and quartz chlorite muscovite schists. The deepest hole at Jabiluka Two bottomed in this series and therefore the total thickness is not yet known. Maximum thickness from drilling to date is 15 metres.

Pegmatite dykes intrude the metasedimentary succession in the Jabiluka area and occur as cross-cutting features. One very large dyke occurs in the western section of the Jabiluka Two orebody. The dyke is irregular but has an apparent maximum thickness of 60 metres and an apparent strike and dip of 340° and 78° east respectively.

No basic dykes (phonolites) were intersected in the core drilling. However, cuttings containing basic dyke chips were noted in the percussion drilling. The infrequency of these chips indicates the dykes intersected are very thin (＜1 metre).

These dykes may have originated as differentiates of the Nanambu granite of Lower Proterozoic age.
2.3 STRUCTURAL GEOLOGY

The Jabiluka deposits are contained within an east-west striking, open, asymmetrical syncline in a succession of Lower Proterozoic metasedimentary rocks. The Jabiluka Two deposit lies approximately 500 metres east of Jabiluka One. The fold axis dips about 70° north and has an irregular plunge that appears to flatten from the average 7° east plunge at Jabiluka One. The north limb of the syncline dips about 35° to the south and the south limb is essentially flat.

The metasedimentary succession at Jabiluka Two is overlain by Kombolgie Sandstone. The north limb of the fold subcrops at the unconformity with the sandstone. The south limb is overlain by a downfaulted block of Kombolgie Sandstone and metasedimentary rocks, the result of a north-south striking normal fault. The plane of the fault trace dips approximately 13° south.

The folding of the metasedimentary succession apparently caused the development of breccias within the Mine Sequence and to a lesser extent at the base of the Graphite Schist above the Hanging Wall Schist Series and in the Dolomite Magnesite Complex below the Footwall Schist Series. The breccias occur as zones subparallel to the schistosity trend and are best developed in the axis of the syncline and in the flat south limb.

Strike extent of the Mine Sequence breccia east is unknown and to the west the breccia probably terminates at a dolomite magnesite-chlorite breccia interface. Up dip the breccia pinches out in the axial plane area. The breccia is well developed in the most southern drill holes and additional drilling will be necessary to determine the limits of the breccia
in the south limb. Numerous randomly-orientated fractures are present in the north limb of the fold within the Mine Sequence and to a lesser extent in the Hanging Wall and Footwall Schists.

A breccia similar in appearance to the Mine Sequence breccia is developed at the base of the Graphite Schist above the Hanging Wall Schist Series. This breccia is not present at Jabiluka One and at Jabiluka Two appears to be best developed in the eastern part of the known deposit. Limited drilling indicates that a third breccia zone may be developed in the Dolomite Magnesite Complex below the Footwall Schist Series. Additional drilling east and south will be necessary to determine the limits and economic significance of these breccias.

Current drill spacing (60 metre centres) does not permit accurate correlation of small displacement faults, and the current correlation of cross sections is therefore biased to folding and pinch and swell.
2.4 **MODE OF OCCURRENCE**

The Mine Sequence contains approximately 90% of the uranium ore reserve at Jabiluka Two as calculated in December, 1973. Refer to Report 5 - "Indicated In Situ Ore Reserves Jabiluka Two Deposit". About 9% is contained in the Hanging Wall and Footwall Schist Series and the remaining 1% occurs in two separate uranium horizons, one above the Hanging Wall Schist Series and one below the Footwall Schist Series.

Uranium anomalism occurs in the Kombolgie Sandstone above the ore deposit but is not of economic significance.

The metasedimentary succession at the Jabiluka Two deposit is covered by 20 - 70 metres of Sandstone. Jabiluka Two occurs along strike within the same asymmetric fold structure as Jabiluka One. The Mine Sequence is conformable to the rest of the Lower Proterozoic succession and subcrops at the unconformity with the sandstone in the north limb of the fold. To the south of the deposit the Kombolgie Sandstone is in faulted contact with the metasedimentary succession. The folded succession dips at approximately 35° to the south and then flattens out at depth.

The Mine Sequence is composed of four stratigraphic members:

The top of the Mine Sequence is a graphitic schist (graphite to chlorite graphite schist) which varies in thickness from 1 - 3 metres. Uranium mineralisation occurs within the graphitic schist and in some cases immediately above and below it. This member contains a much smaller percentage of the total ore reserve at Jabiluka Two than at Jabiluka One.
A second member of the Mine Sequence consists of a chlorite graphite complex which reaches a maximum thickness of 60 metres near its subcrop with the unconformity in the north limb of the fold. The complex is developed only in the eastern part of the Jabiluka Two deposit and pinches out completely down dip in the axial plane area. The schist units consist of dark coloured chlorite graphite schists separated in some cases by light coloured quartz muscovite chlorite and quartz chlorite muscovite schists. The dark coloured schists contain the most uranium and appear to have been more favourable hosts. The light coloured schists are mineralised where they are fractured. The complex appears to have provided a favourable environment for deposition and as a result caused a wider dispersion of uranium mineralisation in the north limb of the fold.

Below the graphitic schist, a light coloured series of quartz chlorite muscovite and quartz muscovite chlorite schists occur as the third stratigraphic member of the Mine Sequence. This series of schists has a variable thickness from 0 - 7 metres. The member is less continuous at Jabiluka Two than at Jabiluka One and eventually pinches out completely to the east. As a result these unfavourable host rocks form a less defined break between the more uraniferous horizons above and below.

The fourth member of the Mine Sequence consists of two separate submembers.

One submember consists of a chlorite breccia and associated chlorite and graphite schists. The breccia is conformable with the other members of the Mine Sequence and is almost always uraniferous. The lithic fragments in the breccia are irregular in shape and size, and are set in a matrix of fine
quartz and almost colourless magnesian chlorite. The matrix appears to be partly introduced and perhaps partly remobilised rock components. The matrix contains finely disseminated pitchblende/uraninite as well as galena and pyrite traces. Microfractures in fragments of chloritic metaquartzites are sometimes filled with hairline pitchblende veinlets.

The second submember consists of a series of dolomite magnesite bodies with associated chlorite and graphite schists. At Jabiluka Two this submember occurs only at the extreme west of the known deposit. The dolomite magnesite bodies contain no economic uranium although the associated chlorite and graphite schists are sometimes anomalous.

The Footwall and Hanging Wall Schists Series consist predominantly of uniform, light coloured quartz muscovite chlorite and quartz chlorite muscovite schists. They are generally unfavourable hosts but contain uranium mineralisation where fractures developed and/or chlorite was introduced. These light coloured schists are best mineralised in the north limb of the fold where the most extensive fracture systems are developed.

There are two uranium horizons in the Jabiluka Two deposit which are not present at Jabiluka One. This uranium mineralisation comprises 1% of the present ore reserve at Jabiluka Two.

One uranium horizon subparallels the Graphite Schist and associated chlorite graphite breccia that occur above the Hanging Wall Schist Series. The uranium mineralisation occurs in the Graphite Schist where fractures are developed locally and in the breccia immediately below the Graphite Schist unit.
The second uranium horizon appears from limited drilling information to subparallel the Dolomite Magnesite Complex that occurs below the Footwall Schist Series. At Jabiluka Two no dolomite magnesite bodies are present and the complex is composed of chlorite and chlorite graphite schists. The uranium mineralisation appears to occur in these favourable schist units where they are either fractured or brecciated.

The basal unit of the Kombolgie Sandstone is uraniferous adjacent to the subcrop of Mine Sequence rocks at the unconformity. Uranium also occurs in the sandstone adjacent to the fault contact at the south of the deposit.

Uranium anomalism extends up to 14 metres above the unconformity and was noted 30 metres above the fault contact. The uranium mineralisation appears to be associated with chlorite which has filled most of the sandstone interstices with aggregates of very fine, pale green, semi-amorphous chlorite. In places the chloritised sandstone is moderately brecciated and shows sections from 0.1 - 4.0 metres thick of massive chlorite occasionally with associated dolomite veins and patches. Closely associated with the emplacement of chlorite are several sulphides. The main one is galena which forms conspicuous crystals in cavities. Others are pyrite, marcasite, and chalcopryrite which are present as minute crystals.

The uranium mineralisation at Jabiluka Two consists of pitchblende and uraninite which occur in both disseminated and massive forms. Colloform textures are generally evident in both forms. Veins of uraninite often show relict colloform textures and no doubt were derived from
colloform banded pitchblende. The uranium mineralisation is often associated with fine galena. Galena patches are up to 0.1 mm in size, but commonly the inclusions of galena in pitchblende are 10 - 30 microns in size with many minute but perfect cubes developed.

Secondary uranium minerals occur infrequently along the sandstone metamorphic unconformity at Jabiluka Two.

Accessory minerals include pyrite, galena, chalcopyrite, marcasite, hematite and minor native gold. Small grains of chalcopyrite, galena and pyrite are found as disseminations in the Mine Sequence rocks but are more common in the "intrusive" chlorite and in the vicinity of the uranium mineralisation.

Hematite is a relatively common accessory within the metasedimentary succession and often occurs as a weathering profile at the unconformity. Hematite sometimes occurs in the Mine Sequence but there does not appear to be any direct association with uranium mineralisation.

A selected number of samples from the Jabiluka Two deposit have been assayed for gold. The highest value recorded to date is 4.3 grams/tonne. Further petrographic work and assaying will be necessary to determine the economic significance of the gold mineralisation.
2.5 CONTROLS OF ORE DEPOSITION

The Jabiluka deposits are contained within an east-west striking, open, asymmetrical syncline in a succession of Lower Proterozoic metasedimentary rocks.

The folding appears to have caused the development of breccias and fracture systems within the metasedimentary succession. The best developed and most continuous breccia occurs within the Mine Sequence rocks at both deposits. Two additional breccia zones have been developed at Jabiluka Two: one at the base of the graphite unit above the Hanging Wall Schists and one in the Dolomite Magnesite complex below the Footwall Schist Series.

The breccias subparallel the schistosity and appear to have acted as channelways for the uranium bearing fluids. The uranium mineralisation occurs as generalised horizons subparallel to the zones of disruption occurring either in or adjacent to them.

The Mine Sequence rocks have been the most susceptible to mechanical disruption and contain \( > 90\% \) of the economic uranium mineralisation. Although essentially the same metasedimentary succession (i.e. chemical environment) is present at both Jabiluka One and Two, the development of two new breccia zones at Jabiluka Two show coincident uraniferous horizons. This supports a strong structural control to the uranium mineralisation.

The dark coloured chlorite and graphite schists appear to have been the most favourable hosts for uranium mineralisation. Graphite occurs
in the Mine Sequence rocks and in the two newly discovered uranium
horizons at Jabiluka Two. Graphite may have played a chemical role in
lowering the oxidation potential of the solutions to a degree where
reduction occurred and led to the precipitation of the uranium.

Semi-amorphous magnesian chlorite occurs within the metasedimentary
succession and is associated with disseminated uranium mineralisation
in the matrix of breccias, as fillings in voids and as haloes around
pitchblende veinlets. In the Kombolgie Sandstone uranium anomalisism is
associated with magnesian chlorite where it occurs as masses in zones
of mechanical disruption and as interstitial fillings between quartz
grains. The close association between uranium mineralisation and "intrusive"
chlorite suggests the uranium and chlorite may have been emplaced
contemporaneously by the same migrating fluid.

A series of pegmatite dykes (0.1 - 60.0 m) and to a minor extent
basic dykes (≤ 1.0 m) cut the metasedimentary succession apparently
in random directions.

The pegmatite dykes are generally well mineralised where they have
been chloritised and deformed within the Mine Sequence. The large dykes
were more resistant to mechanical deformation and appear to have been poor
hosts for uranium deposition. The dykes are probably premineralisation
and the larger ones may have impeded the flow of uraniferous solutions
during the period of deposition.

Small basic dykes have been intersected at both Jabiluka deposits.
The dykes are not anomalous and their relationship with the mineralisation is not clear.

Uranium mineralisation transgresses the sandstone metamorphic unconformity at Jabiluka Two. Primary uranium mineralisation occurs in the sandstone where it has been moderately brecciated and chloritised. However, without such local controls the sandstone does not appear to have been a favourable host. The uranium in the sandstone is not of economic significance.
2.6 ORE RESERVES

In December of 1973 the present ore reserve for Jabiluka Two was calculated by J.C. Rowntree of Pancontinental Mining Limited. Refer Report 5 titled "Indicated In Situ Ore Reserves Jabiluka Two Deposit". The ore reserves are based on 18 drill holes, 16 of which intersected ore grade mineralisation. The holes were drilled on a 60 metre grid and the resulting reserves are classified as drill indicated in situ ore reserves.

Jabiluka Two contains 4.5 million metric tons of ore at an average grade of 0.41% $\text{U}_3\text{O}_8$. This is equivalent to 18,600 metric tons of contained $\text{U}_3\text{O}_8$. Jabiluka Two has only been partially delineated to date and it is possible that further reserves exist to the south-east.

Respectfully submitted,

Pancontinental Mining Limited,

D. V. Mosher