THE GEOLOGY OF THE RUM JUNGLE URANIUM DEPOSITS

By

D.A. Berkman*

ABSTRACT

Three major and two minor uranium deposits have been worked by open cut mining since the discovery of the Rum Jungle field in 1949. Total production has been about 967,000 tons of uranium ore at 7.39 lb U_3O_8/ton and 402,000 tons of copper-uranium ore at 6.27 lb U_3O_8/ton and 2.7% Cu, with significant tonnages of base metal ores.

The deposits occur in or near black pyritic slates of the Lower Proterozoic Golden Dyke Formation, near the contact with the underlying Coomalie Dolomite. The mineralization is probably younger than the granite complexes in the area, and a structural-stratigraphic control of ore deposition is used as a basis for uranium exploration.

INTRODUCTION

The discovery of uranium minerals in the Rum Jungle area probably dates from 1869, when a surveyor noted a green platy mineral associated with copper carbonates near the East Finniss River. This site was apparently rediscovered by Mr. J.M. White in 1949, and a comparison of the platy material with illustrations in a Bureau of Mineral Resources (B.M.R.) booklet suggested that this was a uranium mineral. A geological investigation by the B.M.R. between 1949 and 1952 established the presence of an ore deposit at White's find. Uranium prospects were identified at Dyson's and Mt. Fitch during this period, and over 200 radiometric anomalies were found by airborne surveys.

Discussions between the Commonwealth, United Kingdom and United States governments in 1952 resulted in the provision of funds by the U.K. - U.S.A. Combined Development Agency for rapid development of the Rum Jungle deposits, and a contract was negotiated with this agency for the purchase of uranium oxide.

In 1953 the Hundred of Goyder, a land subdivision of about 168 square miles with Rum Jungle in the approximate centre, was declared a restricted area, and Territory Enterprises Pty. Limited (T.E.P.) a subsidiary of the ten Consolidated Zinc Group (now Conzinc Riotinto of Australia Group) was formed to operate the Rum Jungle project on behalf of the Commonwealth Government.

* Supervising Geologist, Territory Enterprises Pty. Limited.

Since this time the White's, Dyson's and Mt. Burton deposits have been mined and treated under the C.D.A. contract. The Rum Jungle Creek South deposit was evaluated, and following the expiry of the C.D.A. contract in January, 1963, the Commonwealth Government decided to mine and stockpile the ore at Rum Jungle. Treatment of this ore, financed by the Commonwealth Government has continued to the present time.

A joint B.M.R.-T.E.P. exploration programme financed by the Australian Atomic Energy Commission (A.A.E.C.) since 1953 has identified further uranium prospects and prospecting these is currently in progress.

REGIONAL GEOLOGY

The Rum Jungle area contains sediments of the Agicondian System which were deposited around the Rum Jungle and Waterhouse granite complexes in the Lower Proterozoic Pine Creek geosyncline (Fig. 1). The sediments were folded at the close of sedimentation in the geosyncline, with accompanying regional metamorphism reaching the green schist facies (Walpole and Crohn, 1965).

The sediments have been divided into a basal Batchelor Group of orthoquartzite facies (mainly dolomites and littoral clastics), and the overlying Goodparla Group of black shale facies(Golden Dyke Formation and Acacia Gap Tongue) and greywacke facies (Burrell Creek Formation).

A major structural feature is the Upper Proterozoic - early Cambrian Giant's Reef Fault, which strikes northeast across the centre of the Rum Jungle area with horizontal displacement three miles in the sense west side north. This fault has displaced a wedge shaped mass of sediments which now embays the western margin of the Rum Jungle granite (the Embayment), and this mass contains White's and Dyson's uranium ore deposits and some base metal mineralisation. By returning the rock units to their pre-faulting position, White's, Dyson's and the Rum Jungle Creek South deposit fall along an arcuate line paralleling the rim of the Waterhouse granite. This line is believed to be the axial plane of a major syncline.

MAJOR ORE DEPOSITS

WHITE'S MINE

Location

White's Mine is at Longitude 131° 00' 24" E Latitude 12° 59' 21" S, beside the East Finniss river, about 38 air miles south of Darwin. The mine and adjacent buildings have been called Rum Jungle since 1949, although this name was originally applied to a small railway settlement (now practically abandoned) about three miles south of the mine.

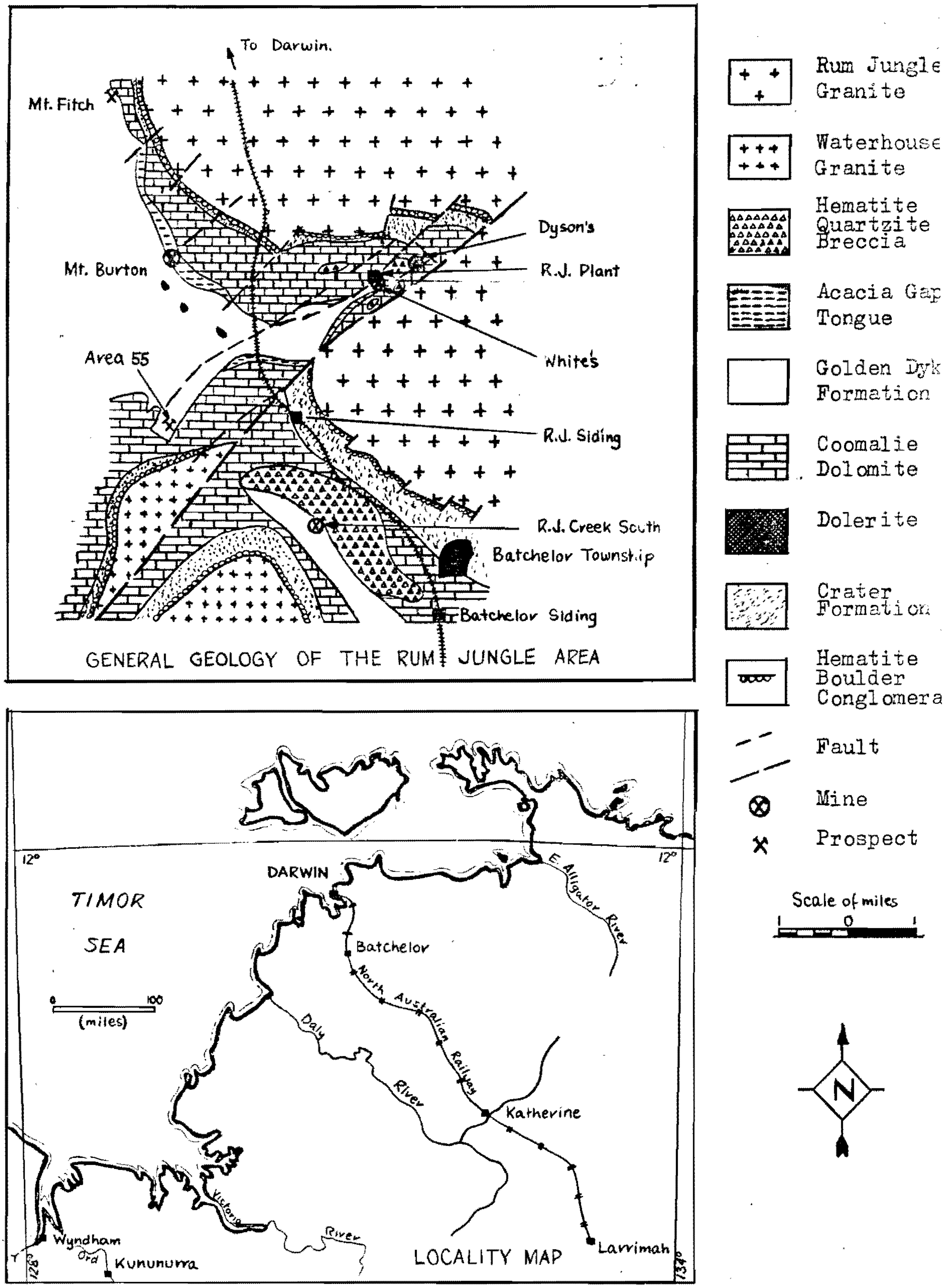

Fig. 1 - General location and geology of Rum Jungle area.

Evaluation and Mining

The B.M.R. examination required about 2000 feet of trenching, and 43 diamond drillholes of total length 8233 ft, including 16 holes for 2964 ft drilled from underground openings. Core recovery throughout averaged less than 30 per cent. Two small shafts were sunk to the 100 foot (No. 1) level, and 1545 ft of crosscutting and driving were mined on the 50 and 100 feet levels. A small winze was sunk 40 ft below the 100 foot level, and two other small shafts were commenced and abandoned, so that the total length of sinking was 276 ft. This programme established ore outlines on the 50 and 100 foot levels, and the persistence of the mineralisation to about 350 ft depth. (Matheson, 1953).

T.E.P. decided initially to extract White's ore by cut and fill square set stoping, and a programme of mine evaluation and development was begun in early 1953 and completed in February 1955. The shape of the orebody was established with about 10,000 ft of trenching, about 20,000 ft of shallow non core drilling, and 28,570 ft of diamond drilling. A major production shaft (No. 5) was sunk to 501 ft depth, plats were cut on four levels 100 ft apart, and a further prospecting shaft (No. 6) was sunk to 323 ft depth about 750 ft SE of No. 5. Development and exploration headings from these two shafts entailed 343 ft of raising and winzing and 4803 ft of driving and crosscutting. (Thomas, 1956). All underground development was in soft slates or intensely fractured chloritic rocks, requiring close timbering and occasionally fore poling, and the chronic shortage of experienced miners was a serious difficulty.

Hence it was decided in November of 1953 that the ore could be more efficiently and completely extracted by open cut mining. This work was let to George Wimpey Ltd. under contract, and was carried out between November 1954 and November 1958. Total excavation, to a pit floor 365 ft deep, was about 4.6 million cu. yd., with an average overall wall slope of about 40°. The overburden : ore ratio was 28:1 considering uranium ore only, or 8.4:1 for all the ores extracted. Some 750 million gallons of water were pumped from the open cut during mining. (Fitzgerald and Hartley, 1965).

Production was:

Uranium ore	270,000 tons at 7.39 lb U_3O_8/ton, 3.4% Cu
Main Shear Zone ore	40,000 tons at 6.27 lb U_3O_8/ton,
Below ore grade uranium material	86,000 tons at 1.34 lb U_3O_8/ton, 2.0% Cu
Total uranium ore treated	396,000 tons at 6.05 lb U_3O_8/ton, 2.7% Cu
Copper ore treated	290,000 tons at 2.8% Cu 0.3% Co
Lead ore stockpiled	85,000 tons at 5.1% Pb, 0.8% Cu, 0.3% Co

Stratigraphic Succession

The lithological units in White's Mine area in order from north to south (which places the beds in order of diminishing age in the Lower Proterozoic) is:

The Coomalie Dolomite, which is exposed in the open cut north wall, overlain by hematitic quartzite breccia (Fig. 2). The breccia has a very irregular contact, (possibly an erosion surface) with the dolomite, and is transitional from siliceous breccia at the surface to dolomitic-breccia immediately overlying the dolomite. The dolomite is usually fine gained, white, pink or grey in colour, and contains occasional lenses of grey slate. The dolomite continues from the north wall underneath the open cut into the south wall.

The dolomite is overlain by the basal mudstone sequence of the Golden Dyke Formation in the northern part of the open cut, and by the black slate sequence in the central and southern parts.

The mudstone sequence contains green, pink and purple mudstones, talcose and chloritic schists, "augen" slates and minor blocky black shales. The beds are often lenticular and transitional, and in several areas continue into the hematite quartzite breccia.

The black slate sequence comprises dark grey to black carbonaceous quartz sericite rocks, which, depending on the degree of tectonic distortion have been called "black graphitic schist", "grey sericitic slate", "grey hematitic slate", or "knotted slate". This sequence also contains chloritic schists and blocky chloritic slates. The orebody is a conformable layer in the black slate sequence, with grey sericitic slate the most common host.

Structure

The gross structure at White's is the Embayment syncline, a part of the inter-granite syncline which has been displaced by Giant's Reef faulting so that a triangular mass of sediments embays the granite margin. The closure of the Embayment syncline, as depicted by the Golden Dyke-Coomalie contact, is about 2000 ft NE of White's deposit.

The major fold is a complex of a northern and southern syncline, separated by a central anticline, in which the axial planes are near vertical and strike around 250°. The northern syncline contains mainly mudstone sequence rocks, and the southern syncline predominantly black slate sequence, with the orebody in the north limb of the southern syncline.

The mudstone-black slate contact has a general southeasterly strike, except for a major northerly flexure at the orebody. This flexure

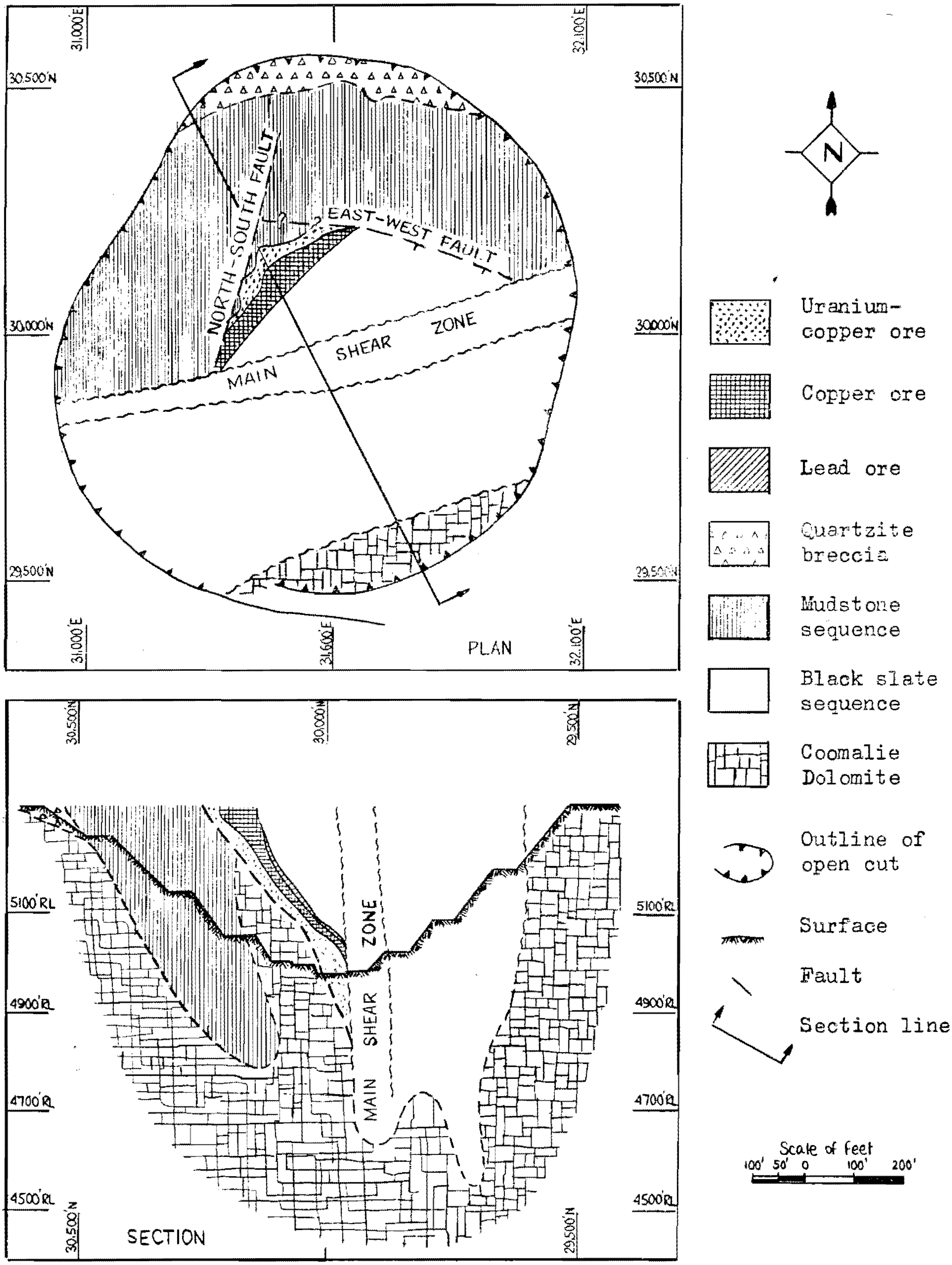

Fig. 2 - Geological plan and cross section of White's Mine.

is bounded by the "North-South fault" and the "East-West fault" which were previously interpreted as broad fault zones, but are now considered to be due to tectonic shattering at formation boundaries, without significant displacement. These "faults" are terminated to the south by the Main Shear Zone, a band of intensely sheared rock about 50 to 80 ft wide, which strikes parallel to the axial planes of the major folds, and probably represents axial plane shearing in the southern syncline or the Embayment syncline. Both vertical and horizontal movement have occurred in the zone, with displacement in the sense south block down and westerly.

The orebody is truncated at depth where the North-South and East-West shatter zones meet the Main Shear Zone, but the Zone contains pods of uranium and base metal mineralisation quite separate from the main orebody. The Main Shear Zone movement is apparently the last major structural event, and is probably of late Giant's Reef age.

Mineralisation

White's orebody is a steeply dipping layered deposit, with the layers conformable with the black slate-mudstone contact in the north limb of the southern syncline. The various layers are, in order from north to south: the uranium-copper zone, the copper-cobalt zone, the cobalt-nickel zone and the lead-cobalt zone. The layers occasionally overlap, and are sometimes separated by a band of barren material. The cobalt-nickel zone and the lead-cobalt zone are lenticular and did not outcrop.

The uranium-copper zone has a narrow oxidised capping containing various yellow and green uranium ochres and secondary copper minerals. Torbernite $Cu(UO_2)_2(PO_4)_2\ 8\text{–}12\ H_2O$, autunite $Ca(UO_2)_2(PO_4)_2\ 10\text{–}13\ H_2O$, phosphuranylite $Ca_3(UO_2)_5(PO_4)_4(OH)_4\ 1\ H_2O$, gummite $UO_3\ n\ H_2O$, saleeite $Mg(UO_2)_2(PO_4)_2\ 10\ H_2O$, and johannite $Cu(UO_2)_2(SO_4)_2(OH)_2\ 6\ H_2O$ have been reported, and some authorities include zippeite $(UO_2)_2(SO_4)\ O\ n\ H_2O$ and schoepite $UO_3\ 2\ H_2O$. These minerals are usually powdery and fine grained, but coarse flakes of torbernite and autunite are not uncommon.

Pitchblende was first noted at 28 ft depth, and is predominantly fine sooty spherules to 0.01 in. across and as veinlets in bedding, cleavage and joint planes. There is often a bleached halo, apparently a radioactive alteration effect, around the uranium mineral. Under high magnification the pitchblende veinlets show a colloform texture, and the crystalline form is quite rare.

The common sulphide ore minerals are:

in the copper-cobalt zone	- chalcopyrite, chalcocite, digenite, bornite and covellite
in the cobalt-nickel zone	- linnaeite, carrollite and gersdorffite
in the lead-cobalt zone	- galena and linnaeite.

Pyrite is common in all the ore zones, and in the barren slates. (Roberts, 1960).

DYSON'S MINE

Location

The mine is about 3000 ft E of White's open cut, on the western flank of a low ridge.

Evaluation and Mining

Uranium mineralisation was indicated by a strong radiometric anomaly during a B.M.R. ground survey in 1950, and the prospect was named after the geophysicist in charge. Trenching across the anomaly exposed high grade secondary uranium mineralisation. Two shafts were sunk: No. 1 about 30 ft E of the trenches (to 45 ft), and No. 2 about 120 ft further east (to 84 ft). The shaft exposures, and five diamond drill-holes for a total of 735 ft, indicated uranium ore in black slates and quartzite over a length of 120 ft and dipping about 30 to 40° E to around 160 ft vertical depth.

T.E.P. initially deepened No. 2 shaft to 110 ft, and a small crosscut was advanced 19 ft from the shaft on the 100 foot level. This opening was abandoned in April 1953 when caving of the back became dangerous. The overburden was then cleared from the trench exposures, first by hand then later by bulldozing. This examination developed into a quarrying operation, from which 61,000 tons of ore were won by April 1954. About 2000 ft of shallow non core drilling, and 9617 ft of diamond drilling were used to evaluate the ore deposit during and after the quarrying period.

Open cut mining began in November 1957 and was completed in November 1958. The total excavated volume was 1.2 million cu. yd., in a pit 150 ft deep with overall wall slope from 40 to 45°. The overburden: ore ratio was about 15:1, and around 10 million gallons of water were pumped from the mine.

Production was:

Uranium ore treated	- 154,000 tons at 7.66 lb U_3O_8/ton
Below ore grade uranium material stockpiled	- 44,000 tons at 1.79 lb U_3O_8/ton

Stratigraphic Succession

The lithological units in Dyson's area, from west to east (i.e. from the base of the sequence up), are

The Coomalie Dolomite, irregularly overlain by purple mudstones and hematite-quartzite breccia;

The Golden Dyke Formation, with blocky black pyritic slates along the contact with the dolomite, and grey sericitic slates, often veined and coated with red hematite, further east. The two slate types are separated by a major fault (Fig. 3), and both contain bands and irregular masses of grey pyritic quartzite. The quartzite probably represents the southeastern limit of the Acacia Gap Tongue.

Structure

The major structure at Dyson's is probably a steep isoclinal syncline, but this fold has been so disrupted by faulting that the symmetry can no longer be clearly established. There are four major faults, all striking northeasterly, which are (in order from west to east):

The Thrust Fault, an irregular crush zone averaging 40 ft wide along the contact between the hematite quartzite breccia - mudstone - dolomite mass and the blocky black slates to the east. The displacement along this contact is unknown, but is probably slight, and the crush zone is now considered to be due to interformational shearing during folding, rather than faulting sensu stricto. The Thrust Fault dips steeply at the surface, flattening to nearly horizontal at depth, the position of this flattening deepening from north to south. The Thrust Fault is terminated at depth, and truncated to the south, by:

The West Fault, a near vertical plane, which has produced mainly 300 ft of horizontal displacement of the dolomite-slate contact in the sense east block north. The dolomite-slate contact west of this fault (i.e. the displaced portion of the Thrust Fault) is known as the Centre Fault.

The West Fault continues in depth, after the intersection with the Thrust Fault, as a steep easterly dipping shatter zone along the dolomite-slate contact. This contact (i.e. the Thrust and Centre Faults, and the West Fault at depth) are truncated by:

The Main Fault, a plane seperating the blocky black slates from the grey sericitic slates to the west, which is vertical throughout the section known from open cut exposures and diamond drilling. Movement along this plane has been mainly several hundred feet of vertical displacement in the sense east block up.

The ore is confined to the block between the Thrust Fault and the Main Fault with the highest grades in the Thrust Fault Zone, with the exception of some secondary uranium ore found near the surface in hematite quartzite breccia and mudstone west of the Thrust Fault.

Mineralisation

The oxidised uranium mineralisation is almost entirely saleeite $Mg(UO_2)_2(PO_4)_2.10H_2O$. This occurs as pale green micaceous plates or "books" on cleavage and fracture planes in the slates, and on fracture planes in the quartzites and hematitic quartzite breccia.

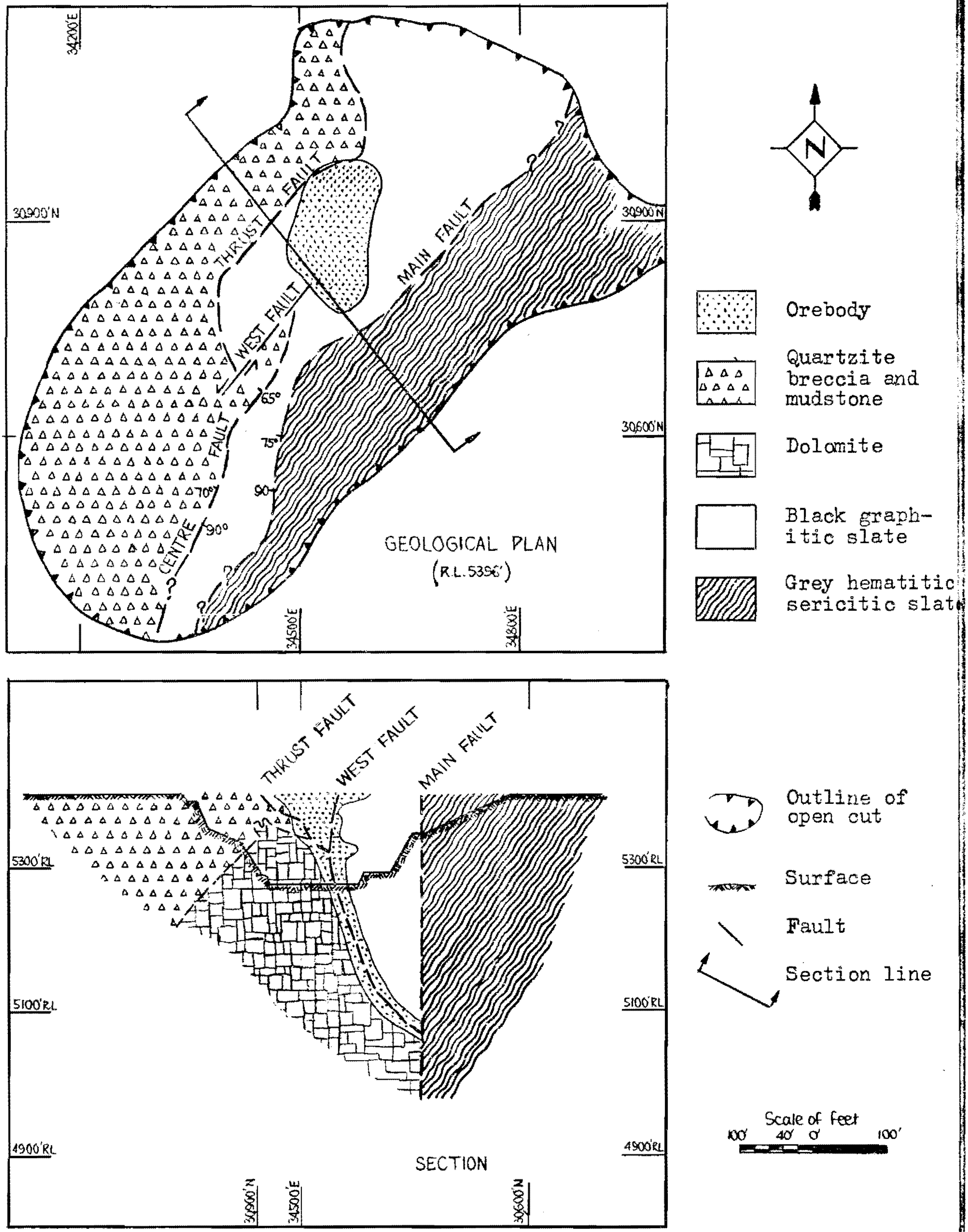

Fig. 3- Geological plan and cross section of Dyson's Mine.

The mineral is a yellowish powdery crust where it has been exposed to recent weathering. Saleeite is occasionally accompanied by a pale green platy mineral with a strong greenish yellow fluorescence, possibly autunite $Ca(UO_2)_2(PO_4)_2 \cdot 10\text{-}12\, H_2O$. The near surface zone contained brilliant yellow nodules of sklodowskite $Mg(UO_2)_2(SiO_3)_2(OH)_2\, 6H_2O$ with traces of an orange uranium mineral, possibly uranosphaerite $Bi_2O_3 \cdot 2UO_3 \cdot 3H_2O$.

Saleeite continues as the predominant mineral to at least 140 ft depth in the Thrust Fault Zone, but pitchblende is known from about 80 ft depth in fresh black pyritic slates. No copper, lead, zinc, cobalt or nickel minerals were seen in diamond drill core or in open cut exposures.

RUM JUNGLE CREEK SOUTH MINE

Location

The Rum Jungle Creek South (R.J.C.S.) mine is about four miles south of White's, and one mile south of the headwaters of Rum Jungle Creek, immediately west of the base of the Castlemaine Hill hematite quartzite breccia ridge.

Evaluation and Mining

Several radiometric anomalies were found west of Castlemaine Hill during airborne surveys in 1952, 1956 and 1957. Ground radiometric surveys to check these anomalies identified two small areas of weakly anomalous radioactivity, generally less than three times background. Pattern churn and diamond around the anomalous area, generally on 400 or 200 ft centres, had indicated a broad zone of apparently random uranium mineralisation by December 1959.

The mineralised zone was about 4000 ft long northerly, by about 350 ft wide, and contained a zone of higher grade mineralisation in the south-east, about 1000 ft by 300 ft. The detailed evaluation of the high grade zone, which was completed by March, 1964, required 150 diamond drillholes for a total of about 34,000 ft and 45 churn drillholes for about 12,000 ft. In addition a prospecting shaft 237 ft deep was sunk in the approximate centre of the orebody, and 105 ft of driving and 89 ft of crosscutting was carried out from the 220 ft level. This programme indicated an orebody of 600,000 tons of grade 6.5 lb U_3O_8/ton.

Open cut mining began in April 1961, and was completed by August 1963. Total excavation was 2.9 million cu. yd., in a pit 225 ft deep, with an overburden:ore ratio of 7:1. The pit was designed with an overall wall slope (including a 30 ft road) of 33° for the first 50 ft from the surface and 45° below that depth. While this design proved sstisfactory for half of the perimeter, deep weathering in the upper 100 ft of the east and south walls required relief excavation to a final 16° batter. About 208 million gallons of water were pumped from the mine.

Production was:

Uranium ore stockpiled	-	653,000 tons at 9.67 lb U_3O_8/ton
Below ore grade uranium material stockpiled	-	114,000 tons at 1.47 lb U_3O_8/ton

Stratigraphic Succession

The rock types at R.J.C.S., in order from east to west, are:

The Castlemaine Hill hematite quartzite breccia mass, which has siliceous breccia and minor quartz sandstone at the surface grading into dolomitic breccia at depth. This unit contains minor lenses of black and chloritic slates, and has a very irregular contact with the underlying Coomalie Dolomite;

The eastern chloritic slate, which forms most of the east wall of the open cut, and is apparently the basal member of the Golden Dyke Formation at R.J.C.S. This is a coarse grained quartz-muscovite-chlorite rock with abundant thin white or red carbonate veins, and usually with a felted mylonitic texture. The chloritic slate is considered to be equivalent to the mudstone sequence at White's;

A band of blocky black pyritic slate in the east wall, averaging about 50 ft thick. This is a fine grained carbonaceous quartz sericite schist, in which both bedding and a schistosity plane are evident. This rock only contains uranium mineralisation for a five to ten foot width along its western rim, associated with white clay in fractures. Total rock analyses (Table 1) show that this bed is reasonably comparable with the uranium-copper ore host in White's Mine:

A greyish green pyritic chlorite schist, which contains nearly all of the uranium ore. This rock is highly sheared along the contact with the black slate, this shearing diminishing westerly so that the open cut west wall is a massive blocky chloritic slate. Total rock analyses (Table 1) prove that these two rocks differ in the

TABLE 1 - TOTAL ROCK ANALYSES

Component	R.J.C.S. E wall black slate	R.J.C.S. Orebody chlorite schist	R.J.C.S. W wall chloritic slate	White's - Uranium-Copper Zone	White's - Copper Zone	White's - Lead Zone
SiO_2	59.3	48.2	47.3	49.3	50.2	55.7
Al_2O_3	10.2	14.9	15.8	13.24	8.89	6.24
Fe_2O_3	3.05	4.00	3.70			
FeO	1.19	6.45	6.30			
Total Fe				5.5	4.7	3.2
MgO	7.35	11.4	11.7	2.72	2.47	1.04
CaO	2.70	0.69	0.76	0.02	0.02	TR
Na_2O	0.03	0.04	0.07	0.03	0.02	0.02
K_2O	2.20	2.25	2.50	1.89	1.12	1.16
H_2O-	3.85	7.05	7.25	1.80	0.86	0.50
H_2O	0.66	0.95	0.87	1.83	1.00	0.58
CO_2	3.65	0.12	0.08	8.5	9.9	9.3
P_2O_5	0.13	0.32	0.24	0.26	0.27	0.06
S	0.71	1.19	1.15	2.45	1.84	1.61
MnO	0.01	0.03	0.03	0.02	0.02	0.01
C	4.45	0.39	0.35	3.98	4.84	4.90
TiO_2	0.49	1.89	1.92			
ThO_2	TR	0.03	TR			
U_3O_8	TR	0.14	0.04	0.32	0.01	TR
Cu				3.32	2.11	0.33
Co				0.04	0.04	0.16
Ni				0.13	0.40	0.15
Pb				0.04	0.20	5.90
As				0.01	N.F.	TR
Sb				0.01	0.01	TR
Bi				0.07	TR	TR
Ag				TR	TR	TR
Zn				TR	0.02	0.41
N.D.				4.9	11.6	8.9
	100.0	99.9	100.0	100.0	100.0	100.0

degree of tectonic distortion only, and not in chemical composition. These chloritic schists and slates are pyritic quartz biotite chlorite schists, containing black slate lenses in the open cut west wall. A bedding and schistosity surface are visible, and occasionally a second schistosity plane. (Berkman, 1964).

Amphibolite and dolomite, which are found in diamond drillholes west of the open cut. The two rock types are transitional, the amphibolite probably representing a metamorphosed impure dolomite. Diamond drilling has shown that dolomite is continuous from the base of the hematite quartzite breccia in the east, underneath the Golden Dyke rocks, to the dolomite-amphibolite mass west of the ore deposit.

Structure

The R.J.C.S. area is part of the inter-granite syncline, which strikes about northwest (F. 1). This is a complex isoclinal fold, with the chloritic schist containing the ore as the central number, defined to the east and at depth by the shape of the black slate bed. (Fig.4). This band is apparently attenuated west of the axial plane, and appears as lenses of black slate in the open cut west wall. The axial plane of the syncline is vertical to 200 ft depth, then dips steeply to the east. This fold plunges from the southeast and the northwest so that the orebody is in the deepest part of the structure.

Parasitic folds with the same general symmetry as the major syncline have been identified in the black slate-chloritic schist contact.

Williams (1963) has identified two later periods of folding which distort the F. 1 schistosity: F.2, rare monoclinal folds with axial planes horizontal and striking northwest, and F.3, major steeply plunging monoclines with axes striking northeasterly.

The F.1 folding is by far the most important, with the schistosity and the long dimension of the orebody conforming to this direction. The major joint pattern, with a set striking northwest and a cross joint set about southwest, are apparently related to this structure.

Mineralisation

Uranium mineralisation was found in all the Golden Dyke rocks at R.J.C.S., but ore grade mineralisation was confined to the chloritic schist and adjacent black slate. The orebody was an elongate tabular mass, of maximum dimensions 800 ft long northwesterly and 200 ft wide, and was mined for about 150 ft vertically. The weathered rock from 75 to 100 ft thick which overlies the orebody was barren of uranium mineralisation except for three small near surface pods of saleeite.

The ore thins to the north into a series of lenses, and is abruptly terminated to the south by deep weathering along cross joints. The

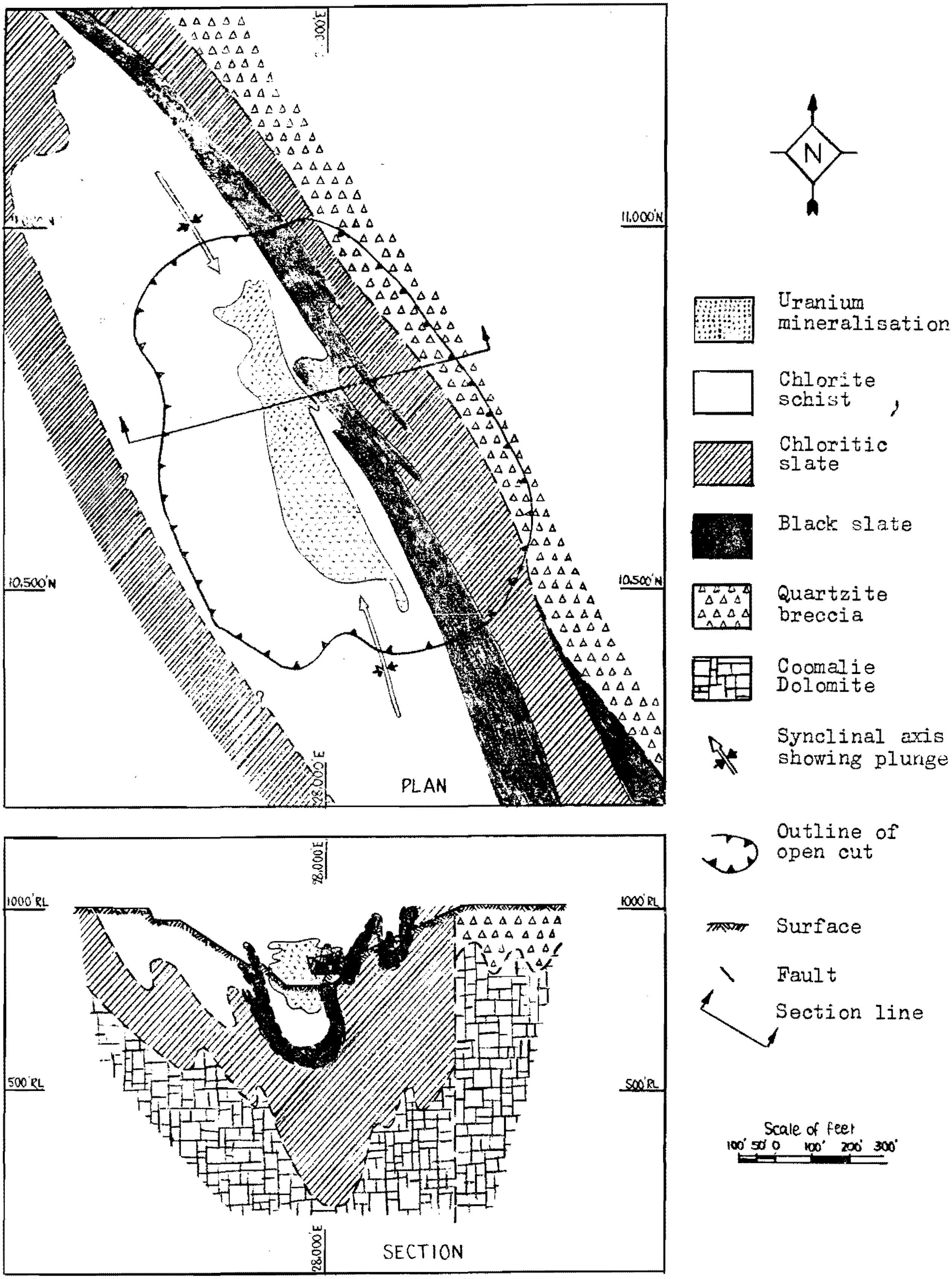

Fig. 4 - Geological plan and cross section of R.J.C.S. mine.

ore grade decreases rapidly to the east of the black slate-chloritic schist contact, and decreases gradually to the west as the amount of shattering in the chloritic schist diminishes.

Within the ore zone pitchblende is the only uranium mineral, and sulphides (other than pyrite) are virtually absent. Assays of 47 drill core samples (Daly, 1963) do not show any relationship between carbon, pyrite and pitchblende. Pitchblende most commonly occurs as a fine sooty coating on schistosity planes and joints, with some thicker veins near the black slate-chloritic schist contact. Mineragraphic examination shows a first generation of subhedral pyrite, with the bulk of the pitchblende syngenetic with this pyrite, and a second generation of spherical aggregates of pyrite apparently in later pitchblende. Minute blebs of sphalerite were noted in pyrite in one specimen.

MINOR ORE DEPOSITS

MT. BURTON MINE

Location

The mine is three miles west of Rum Jungle, on the north flank of a low ridge of Acacia Gap quartzites, and about 2000 ft SE of Mt. Burton survey station.

Evaluation and Mining

The deposit was discovered in 1954 as near surface secondary uranium mineralisation during a programme of trenching across the dolomite-slate contact westerly from White's mine. A detailed evaluation of this prospect by churn and diamond drilling was completed in 1957.

Open cut mining began on 2nd October 1958, and was completed on 19th November, to a floor 100 ft below the highest point on the pit perimeter. Total excavation was 132,000 cu. yd. at an overburden: ore ratio of about 43:1 and an overall wall slope about 45°. About two million gallons of water were pumped from the mine.

Production was:

Uranium-copper ore treated	- 6,000 tons at 4.70 lb U_3O_8/ton 1.04% Cu
Below ore grade uranium material stockpiled	- 2,400 tons at 1.57 lb U_3O_8/ton
Copper ore stockpiled	- 1,400 tons at 2.66% Cu

Mine Geology

The uranium-copper mineralisation occurs in black slates and quartzites of the Acacia Gap Tongue, near their contact with the underlying Coomalie Dolomite. The orebody is a saddle reef, restricted to the crest of an anticlinal fold (as depicted by the dolomite-slate contact) which plunges about 45°W. Williams (1963) has described two other periods of folding, each earlier than the ore structure, of which a series of narrow isoclinal folds with axial planes striking northerly, and dipping steeply to the west, is the most important.

The dimensions of the ore zone, and the ore grade, diminish rapidly below 100 ft depth. The oxidised zone contained mainly torbernite and malachite, with minor chalcocite and native copper, with pitchblende, pyrite and chalcopyrite below the zone of weathering. All of the copper ore won was obtained from the oxidised zone.

WHITE'S EXTENDED

The White's Extended uranium mineralisation occurs near the nose of the Embayment syncline, about 1000 to 1800 ft E of White's orebody. The ore host is green chloritic slate or talcose "augen" slate of the mudstone sequence, with minor mineralisation in the black slates above and the hematite quartzite breccia below this unit.

Diamond drilling has shown a number of narrow (averaging 40 ins horizontal width) intersections of quite high grade uranium mineralisation in the mudstone sequence. The mineralisation is entirely uranium ochres, and is probably due to supergene processes.

About 100 tons of near surface material of average grade 4.0 lb U_3O_8/ton were mined from a small open cut here in 1958.

URANIUM PROSPECTS

MT. FITCH

The Mt. Fitch prospect is about five miles northwest of Rum Jungle, on a low rise east of the Finniss River. The prospect was indicated as an airborne and ground radiometric anomaly, and shallow trenching exposed sporadic secondary uranium and copper mineralisation.

A programme of shallow non core drilling between 1952 and 1961 established the stratigraphic succession and the major structures, but did not find continuous uranium or copper mineralisation. The Golden Dyke slates at Mt. Fitch are present in a shallow syncline overlying the Coomalie Dolomite, then dipping steeply west. The geology west of the shallow syncline is practically unknown.

A detailed diamond drilling programme, to investigate the shallow syncline with holes to 400 ft depth on 100 ft centres was begun in 1966. A body of uranium mineralisation of about 800,000 tons of grade 1.5 lb U_3O_8/ton has been identified in the dolomite on the eastern limb of the syncline, with minor higher grade lenses in the overlying slates. The examination of the mineralisation in the slates is in progress.

AREA 55

Airborne scintillometer anomaly No.55 is about seven miles southwest of Rum Jungle, near the western closure of the inter-granite syncline.

Sporandic uranium mineralisation has been identified in the basal green talcose schist of the Golden Dyke Formation near the synclinal nose. Oxidised lead and copper mineralisation has also been found in this bed, but neither the uranium nor base metal mineralisation is presently of ore grade.

CRATER FORMATION

The Crater Formation, which rims the Rum Jungle and Waterhouse granite complexes, contains a number of lenticular conglomerate beds. These beds are highly radioactive in outcrop, with the surface radioactivity apparently entirely due to thorium minerals.

Limited diamond drilling has shown that the radioactive beds are weathered to at least 500 ft vertical depth, with abundant limonite after pyrite. The possibility of a thorium-uranium association of the Blind River type will be tested by deep diamond drilling to unweathered rock in the near future.

ORIGIN OF THE URANIUM ORES

Although three major uranium deposits have been exposed in detail by open cut mining, the origin of the mineralisation remains obscure. Previous opinions on the genesis of the uranium ore were:

a. For White's and Dyson's deposits - "by selective replacement of carbonaceous slate beds adjacent to their intersection with the axial plane shear" (Sullivan and Matheson, 1952).
b. "Within the Embayment at least, uranium mineralisation and (base metal) sulphide mineralisation are related to two distinct sets of faults ... the uranium mineralisation was deposited before the sulphide mineralisation". (Thomas, 1956).
c. For White's deposit - "the uranium-copper mineralisation ... is related to hydrothermal process". (Robers, 1960).
d. "Two possible sources of the uranium have been suggested, the granite, and the black slates of the Golden Dyke Formation". (Spratt, 1965).

The uranium deposits have a number of common features, suggesting the same origin for all. Each of the orebodies occurs in, or near, the carbonaceous pyritic slate member of the Golden Dyke Formation, but there is no quantitative relationship between pitchblende, carbon and pyrite. The primary uranium mineral is almost exclusively pitchblende, of the same fine grain size as the silicate minerals of the host rock. There are no gangue minerals other than pyrite (which is ubiquitous in the Golden Dyke Formation), and no high temperature alteration effects.

Field mapping and total rock Rb-Sr age determinations (Richards, 1967) show that most of the Rum Jungle granite complex is older than the sediments, but the possibility of a period of remobilisation and low temperature hydrothermal mineralisation during the Pine Creek orogenesis can not be excluded.

It seems most likely that the first generation of pyrite and pitchblende at R.J.C.S. were deposited as sedimentary constituents near the black slate-chloritic schist contact, in either or both rock types, and that this mineralisation has been dispersed through the chloritic schist as a second generation of pyrite and pitchblende by supergene processes.

A structural-stratigraphic control of uranium emplacement is used as a basis for ore search, with the most detailed investigation along the dolomite-slate contact and in synclines in the slates near this contact.

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