

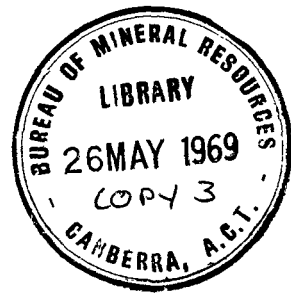
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REPORT ON A RECONNAISSANCE OF THE URANIUM PROSPECTS IN  
THE WYNDHAM-HALL'S CREEK REGION OF WESTERN AUSTRALIA

by

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## SUMMARY

Inspection of uranium leases in the Hall's Creek and Denham River Homestead areas of the East Kimberley district of Western Australia showed that, to date, no deposits of economic significance have been discovered. Of the radioactive occurrences which have been investigated by companies, discrete uranium minerals (all secondary) were observed by the authors at only two, and evidence of local hypogene mineralisation, in a quartz-hematite phase of hydrothermal activity, was confined to the deposit on the Denham Extended lease. The only other development of uranium secondary minerals was seen at Yorga's Find, where supergene deposition has occurred in fractured zones of radioactive acid volcanics.

On the Koongie Park prospect, where the principal anomaly is believed to be due to a similar supergene phenomenon, the radioactive element has been fixed in the weathered, ferruginous parts of a volcanic member of the generally arenaceous succession. All other radioactive anomalies could be referred to secondary enrichment by ground waters in the surface zones of basic dykes which occupy fractures within fault zones.

It is considered, however, that the area generally is worthy of further prospecting, and particular attention is drawn to the extensively faulted northern marginal zone of the Lamboo Granite belt.

Recommendations are made for the investigation by ground parties of two areas containing airborne anomalies which were located by the Bureau of Mineral Resources aerial scintillograph survey.

## INTRODUCTION

The first indication of the occurrence of radioactive anomalies in the East Kimberley district was given by the results of a high-level airborne scintillograph survey which was carried out by the Bureau of Mineral Resources in 1954. Although none of the anomalies recorded by that survey have as yet been related to uranium-bearing deposits of any significance, they stimulated aerial and ground prospecting by companies and the first deposit containing uranium minerals was discovered by ground parties of United Uranium N.L. in October, 1954. This and other prospects in the Denham River Area were investigated by company geologists during the 1955 field season, while to the south, in the Hall's Creek area, extensive prospecting was carried on, notably by the Rio Tinto Finance and Exploration Company. In this southern area numerous aerial anomalies were investigated by company geologists (both Bureau of Mineral Resources anomalies and those located by company low-level flying) but the only area which exhibited significant radioactivity on the ground, and which was considered to justify further investigation, was discovered by a syndicate of local prospectors south of the Koongie Park Homestead.

The region was examined in accordance with the requirements of the Atomic Energy Commission whereby reports of quarterly visits of inspection of working prospects and mines are desired, and by arrangement with the Under Secretary, Department of Mines of Western Australia. The authors' attention was therefore directed principally to those few prospects which the companies had considered to be worthy of geological and mining work. These included the following leases for which locality map references are given in the terminal paragraph of this report:-

### Denham River Area:

	<u>Mineral Claim No.</u>	<u>Area (Acres)</u>
Denham		
Denham Extended	41	288.8
Kimberley	38	288.8
Kimberley Extended	42	288.8
North Kimberley	44	288.8
North Kimberley Extended	43	288.8
Yorgas' Prospect		

Hall's Creek Area  
Koongie Park Prospect

No attempt was made to locate airborne radioactive anomalies shown on the Bureau of Mineral Resources map (G 187-1) since the nature of the terrain in which the anomalies occur will demand the employment of a well-equipped field party over a period of several weeks during the dry season. Recommendations for the investigation of a proportion of these anomalies, based on the authors' observations of local and regional geology, are submitted later in the report.

COMPANY ACTIVITIES IN THE AREA.

During the 1955 field season the following companies operated field parties in the Denham River-Hall's Creek Area:

Rio Tinto  
Northern Mines (Mineral Ventures)  
Broken Hill Pty.  
Esperance Oil Syndicate  
Kimberley Oil Syndicate  
Western Uranium N.L.

Rio Tinto carried out extensive aerial scintillograph traversing, mainly in the southern part of the region, as well as reconnaissance geological mapping and ground prospecting (on foot and with car-borne equipment) over selected areas, particular attention being given to an area in which the incidence of high-level airborne anomalies was highest. No uraniumiferous deposits were discovered.

United Uranium also employed low-level scintillograph aerial surveying and ground prospecting parties, mainly in the Denham River Area. Geological mapping was carried out on the Denham and Kimberley leases but no further radioactive deposits were located.

The Western Uranium prospector, J. Yorga, discovered a small deposit of secondary uranium minerals (described later) some six miles south of the Denham River prospects. It was inspected, and some radiometric gridding was carried out over it, by United Uranium geologists.

REGIONAL GEOLOGY

The geology of the Wyndham-Hall's Creek region is incorporated in the Bureau of Mineral Resources map of the Ord-Victoria Region (D.M. Traves, 1954). Known radioactive occurrences, and most of the aerial radioactive anomalies, are confined to an elongated belt of Pre-Cambrian rocks trending roughly south-south-west from the neighbourhood of the Denham River Homestead to south-west of Hall's Creek. The oldest rocks of this belt are termed Hall's Creek Metamorphics. They occur in the Hall's Creek area and extend to the north-east and south-west of the town as a tightly folded series of metamorphosed sediments of variable composition which is apparently extensively intruded by igneous rocks, frequently of doleritic nature. Quartzites, chloritic schists and slates appear to predominate but various workers in the field have recorded also tuffaceous sandstone, mica schists, sandy and silty limestones, marbles and calc-silicate rocks. The grade of regional metamorphism is rather low but many members of the series exhibit well-developed fracture cleavage. Quartz reefs and blows outcrop in the vicinity of Hall's Creek, and reputedly elsewhere in the group, and they probably represent infillings along lines of faulting parallel to the grain of the country. Some of the quartz reefs are sparsely mineralised and have provided a source for gold, the only economic mineral to have been produced from the area in the past.

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To the north-west the Hall's Creek Metamorphics are flanked by granitic rocks belonging to the Lamboo Complex, also of Lower Proterozoic age, which extends in a belt some 30 miles wide from south-west of Hall's Creek to within a mile or so of the Denham River Homestead. Isolated outcrops occur farther to the north-east and south-west. General observations made while travelling over this formation indicate considerable variations in composition and texture, from rather melanocratic medium-grained rocks of probable dioritic or granodioritic composition, to coarse-grained leucocratic granite. In the Denham River Homestead area the granitic rocks are very coarsely granular, weathering to a friable consistency and exhibiting a vague lineation which is suggestive of bedding in an original sediment which has been granitised near the margin of the main granite batholith.

Surrounding these Lower Proterozoic formations and unconformable on them are Upper Proterozoic sandstones, conglomerates, shales and calcareous rocks which are locally strongly folded but which are unmetamorphosed. On the eastern flank of the granite-Hall's Creek Metamorphic belt, the Upper Proterozoic unconformity is overlapped in places, and particularly to the north-east, by Lower Cambrian sequences, the basal member of which is the extensive Antrim Plateau Volcanics. Although the greatest development of these, and subsequent Cambrian rocks, is towards the east, small elongated outliers of basalt persist around the northern and north-western fringes of the Lamboo Granite Complex.

The regional geological map shows that the Pre-Cambrian rocks of the area are extensively faulted, the dominant fault trend being parallel or sub-parallel to the grain of the Proterozoic rocks i.e. east-north-east. The major faults are commonly infilled with quartz and/or amphibolite, the basic intrusive material (at least in those occurrences examined by the authors) being of later emplacement than the quartz. The basic infillings may, therefore, be related genetically to the Lower Cambrian basic igneous episode. Fault breccia shows repeated movement and infilling along the fault lines.

## THE URANIUM PROSPECTS

### Denham River Area

#### 1. Denham and Denham Extended

The most significant of the known radioactive occurrences in the East Kimberley District is that covered by the Denham Extended Lease. It is located about 6 miles south of the Denham River Homestead, on the shoulder of a steep-sided ridge and about five hundred feet north of the Northern Highway. Access to the occurrence is passable by Land Rover over a bulldozed track which leaves the main road 5.7 miles south of Denham River Homestead. Work which has been carried out by United Uranium N.L. includes geological mapping of a strip of country about 200 feet wide extending throughout the Denham Extended and the Denham leases, a distance of about 1200 feet. Radiometric gridding of areas of anomalous radioactivity was followed by costeaming across selected zones of greatest gamma-ray intensity. Four costeams were sunk on the main, or northern, anomaly (Denham Extended) with lengths of 15, 40, 40 and 14 feet, and three were opened on the extension of the structure south of the road (Denham Lease), their lengths being 13, 18 and 15 feet.

The principal structural feature of the geology of the locality is a zone of faulting which trends roughly north-south and which has facilitated emplacement of tabular bodies of quartz and of greenstone (altered dolerite). The faults are developed along, or close to, the western edge of a northerly extension of the Lamboo Granite Complex so that country rock to the east is granite while to the west the fault zone is flanked by folded members of the Upper Proterozoic succession and Antrim Plateau basalts of the

Lower Cambrian. Within the granite in the vicinity of the prospect there occurs a number of elongated lenses of quartzite rock which are apparently of sedimentary origin, having a saccharoidal texture imparted by rounded quartz grains cemented by a fine-grained siliceous matrix. From the attitude of these lenses, which appear to dip less steeply than the fault infillings and to trend with the regional strike, it seems probable that they represent bands of sedimentary rock which have largely resisted granitizing processes at the periphery of the granite complex. As already stated, the granite locally exhibits a form of lineation which cannot be definitely related to shearing or flowage and which must therefore be regarded as relic bedding in granitized sediments.

Uranium mineralisation at the Denham Extended prospect is in the form of metatorbernite, and yellow and green ochres, which occupy partings and small vughs in siliceous rock and which are locally disseminated in granite. The highest radiometric values are almost invariably associated with a quartz-hematite phase of mineralization which is developed locally both in granite and in the bars of "sedimentary" quartzite. Some concentration of uranium secondary mineralization is also apparent along the margins of some of the quartzite lenses. The latter have probably acted as structural traps to migrating uranium-bearing vadose waters, from which secondary minerals have been deposited in the more porous granite immediately adjacent to the quartzite. Further high-grade occurrences of uranium mineralization occupy strongly hematized shears in granite. The marked association of uranium minerals with small quartz-hematite veins and hematized shears therefore suggests that the uranium originated in this phase of mineralization, although the primary mineral could not be expected to persist at the surface. Smoky or grey vitreous quartz characterises this type of mineralization, as distinct from the milky granular quartz which constitutes the massive filling of the faults of the area. It occurs as small veins and aggregates grouting the granite and quartzite. Although the zones of highest radioactivity appear to have a rough north-north-easterly trend, this may be due to the control on secondary dispersion of uranium exercised by the quartzite lenses, rather than to lateral continuity of the quartz-hematite mineralization, which is sporadic in occurrence. It is doubtful, therefore, whether the loci of high-grade mineralization exposed in one costean can be definitely related to those in the next costean 20 feet away. A cause for the restriction of the uraniferous quartz-hematite mineralization to a small area within the major fault zone is not at present apparent.

The area of the Denham Extended anomaly is rather sharply delineated by the twice background isorad. This encloses a roughly rectangular area about 100 feet long by 50 feet wide, within which the four costeans are located. As already indicated, values within the costean are erratic. In the northermost costean (No. 4N), the highest ratemeter readings obtained on the 1292A ratemeter (25-B) suggest a grade of mineralization of between 0.05 and 0.1%  $\text{eU}_3\text{O}_8$ , over a width of 3 or 4 feet. The next costean to the south (No. 3N) contains a narrow zone of high-grade material associated with a hematized shear in granite. A ratemeter reading of 45A indicates a grade exceeding 1%  $\text{eU}_3\text{O}_8$  over 3 or 4 inches. This shear zone also contains numerous minute smoky quartz stringers. In this costean also, there is a zone about 10 feet wide, in which dispersed uranium secondary minerals produce ratemeter readings which indicate a grade of between 0.1 and 0.15%  $\text{eU}_3\text{O}_8$ . Costean No. 2N exposes high-grade mineralization in a narrow (1 foot wide) hematized shear zone along the margin of a quartzite bar; but elsewhere radiometric values indicate an equivalent uranium content generally less than 0.1 percent.

Specimen samples collected from sites of greatest activity gave the following results on radiometric assay:-

<u>Location</u>	<u>%eU<sub>308</sub></u>	<u>Remarks</u>
1. Hematised zone near east end of No. 3N Costean	1.03	Over a few inches (see text)
2. Small pit 20 feet N. of No.4 Costean	0.34	Pocket of quartz-hematite mineralisation in quartzite bar.

Disequilibrium tests show a slight enrichment in uranium.

In view of the sporadic disposition of high-grade uranium-bearing material at this prospect, and of the absence of any persistent structure with which the uranium is associated (since the major faults of the area do not appear to effect an appreciable control), it can be dismissed as a potential source of supply of uranium ore. If a treatment plant is ever available locally, then a few tons of ore-grade material may be recoverable by gouging. Uranium mineralization may persist in depth, but it is probable that, within the primary zone, its distribution would be even more restricted than that of the secondary phase now visible. In consequence no further exploratory work is warranted.

South of the Wyndham-Hall's Creek road, on the Denham lease, the major fault zone is well defined by the presence of infillings of white quartz and altered dolerite. The three costeans on this lease are located in the basic rocks on radioactive anomalies which seldom exceed twice background and nowhere exceed 4 times. Dolerite exposed in the costeans is fractured but there is little evidence of extensive shearing. Apart from slight movement resulting in fracturing and small-scale shearing and faulting, emplacement of the basic dykes was the last phase in the history of the fault zone, since the earlier quartz infilling is seen to have been brecciated prior to intrusion of the dolerite, which contains boulders of reef quartz. There is no evidence of a subsequent mineralization at this locality, which could have been responsible for the introduction of traces of radioactive element which give rise to the anomalies. It is suggested, therefore, that the minute amounts of radioactive element which occur sporadically in the basic rock are of secondary origin, the basic dykes forming a chemically suitable environment for the precipitation of uranium from waters draining granite or uraniferous deposits such as that on the Denham Extended.

The radioactive occurrences on the Denham Lease are therefore of no economic significance.

## 2. Kimberley and Kimberley Extended

About a mile east-north-east of the Denham prospects the Kimberley Leases were sited to cover a major north-south trending fault which belongs to the same system as that which occurs on the Denham Leases. Over a distance of 3,500 feet this fault is occupied by altered dolerite which is commonly flanked by reef quartz, the country rock being the coarse-textured friable granite already described. The geological environment is here very similar to that on the Denham Lease.

Radioactive anomalies of a low order occur over the basic dyke at irregular intervals along the length of the fault. They are generally small in area (between 100 and 600 square feet), the longest being exceptional, with an area of about 2,500 square feet, and they seldom produce ratemeter readings above 3 times background. Two costeans, 2000 feet apart, have been opened across the basic dyke and a shaft has been sunk to a depth of 21 feet on an anomaly near the northern end of the leases.

In the shaft the dolerite is cut by flat-dipping faults, containing clay gouge and dipping south at 40 degrees. A near-vertical shear zone also occurs in the lower half of the shaft,

trending parallel to the wall of the dyke. Radiometric readings are little above background level towards the bottom of the shaft, but they increase rapidly in the upper 10 feet within a near-surface zone of intense weathering and consequent development of abundant ferruginous material. Considering solid angle effect, the increase in gamma-ray intensity from the bottom of the shaft to the enriched zone near the surface is about four-fold. The average grade of material immediately below the shaft collar probably does not exceed 0.04%  $\text{eU}_{308}$ .

The radiometric profile in the shaft and the consistent association of traces of radioactivity with the basic dyke rock suggests a secondary origin for the radioactive element and its deposition in the weathered zone of fractured dolerite. In the shaft, enrichment occurs in a highly ferruginous zone and the iron minerals themselves would favour fixation of uranyl ion from migrating solutions. No uranium secondary minerals were observed.

The Kimberley Leases are therefore of no economic significance; radioactivity is probably restricted to a near-surface zone and further exploration in depth is not warranted.

### 3. North Kimberley and North Kimberley Extended

The North Kimberley Leases are located about a mile north of the Kimberley Lease. Only one small radioactive anomaly occurs on them and it seems likely that pegging of the leases was largely pre-emptive during the early period before geological investigations were started.

A 30-foot-long costean has been opened to investigate the anomaly, which occurs in basic dyke rock. The latter apparently forms a lense-shaped body infilling a fracture in a prominent fault zone trending north-south. The fault zone is characterised by white quartz which has been brecciated and recemented. Slickensiding is commonly evident within the basic dyke and the highest radioactivity is associated with a narrow zone of sheared, altered dolerite, about 1 foot wide. At one point in this shear a ratemeter reading of about 12 times background was obtained but elsewhere within the anomalous area the average reading is between 3 times and 5 times background. No uranium minerals were observed.

In view of the absence of a phase of metallic mineralization which could account for the concentration of uranium in the basic dyke, it is suggested that the radioactivity is due to supergene enrichment in the chemically favourable environment created by the weathered basic rock.

The deposit is of no commercial significance and further work on it would not be justified.

### 4. Yorga's Find

An occurrence of uranium mineralization which was discovered by J. Yorga (Western Uranium N.L.) is situated 6 miles south-south-west of the Denham Leases. It is approached by a graded track which leaves the Northern Highway at a point 12.8 miles south of Denham River Homestead and proceeds in a westerly direction for 1.8 miles.

The prospect is situated about 200 feet above the head of this track. It is located on the steep eastern slope of a ridge.

Yorga's prospect is located in acid volcanics, probably of Upper Proterozoic age. A major fault, marked by a prominent line of reef quartz, courses north-south some quarter of a mile east of the prospect, and granite of the Lamboo Complex occupies the country east of the fault.

The volcanic rocks exhibit a high background radiation and small areas of high intensity are disposed within them in a

restricted area about 40 feet square. They can be related to small local concentrations of uranium secondary minerals in strongly fractured zones of the volcanics. A specimen sample from a pocket of secondary mineralization assayed 0.12%  $\text{eU}_3\text{O}_8$ . There is no evidence of hypogene mineralisation in the vicinity of the uranium occurrences and the latter are regarded as being supergene enrichments from uranyl-charged ground waters. They are of no economic value and no target is apparent to which further exploration could be directed.

### Halls Creek Area

As stated already, extensive airborne and ground prospecting by companies in the Hall's Creek area have discovered a number of radioactive anomalies, all of which have hitherto been attributed to radioactive volcanics or granite rocks or, in one instance, to a slight supergene enrichment of radioactive element in a ferruginous capping. Only one prospect, at Koongie Park, discovered by local prospectors (E. Bridge, H. Caporn and B. Taylor), warranted inspection.

### Koongie Park Prospect

The two mineral claims held by the prospecting syndicate to cover the radioactive anomalies are located about 6 miles south of the Koongie Park Homestead. The anomalies occur over the crest of a ridge of steeply dipping Lower Proterozoic sandy and silty sediments (Hall's Creek Metamorphics) which rises sharply from the plain to a height of about 300 feet. Local strike is approximately north-south.

Two areas of anomalous activity occur along the ridge, about 500 feet apart, and a small costean and an 8 foot deep pit have been opened on the northern and southern anomalies respectively.

On the northern anomaly the twice background isorad encloses an area of about 1,300 square feet. Within it ratemeter readings are uniformly low (not exceeding  $2\frac{1}{2}$  times background) and beta-probe monitoring of the costean shows no concentration of radioactivity. The material underlying the anomaly is a fractured, weathered ferruginous sandstone containing abundant pyrite casts and it is gossanous in appearance. Small veins of barren white quartz occur in the sandstone nearby.

The southern anomaly as defined by the twice background contours is lenticular, persisting over a distance of 100 feet, in a north-south direction, and with a maximum width of about 25 feet. Gamma-ray intensity over this area is consistently low, although there are two smaller lenticular portions over which it reaches a maximum of 4 times background. The pit, which is sunk on one such "high", exposes a pale buff rock containing an anastomosing network of hard ferruginous veins which are a result of weathering. It is believed that the buff rock is a strongly leached volcanic. No increase in radioactivity is recorded downwards in the pit and no marked concentration of values occurs in slightly sheared zones of the altered volcanic. Discrete uranium minerals were not observed.

Since there is no evidence to indicate the presence of mineralised structures below the anomalies, it is suggested that the radioactivity is residual and that the occurrences are therefore of no value.

### FUTURE PROSPECTS OF THE AREA

The prospecting activities in the East Kimberley District have brought to light only two occurrences of uranium minerals, only one of which can be attributed to hypogene mineralization. Nevertheless, only a small proportion of the area has so far been covered, particularly by ground parties, and the Denham occurrence does show the presence of at least one phase of uranium minerali-

zation in the area, which, on general geological and geochemical grounds, appears to be favourable to the development of uranium deposits. The authors consider, therefore, that further prospecting in the district should be encouraged.

There remains the consideration of the most suitable areas on which to concentrate, and here a difficulty arises from the lack of direct evidence as to the age of the known mineralization. It is post-granite, and from its associations at the Denham lease it is probably post-faulting and therefore of late Upper Proterozoic or Lower Cambrian age. The whole of the Proterozoic succession must therefore be regarded as being favourable for uranium deposition, but extensive investigations and prospecting in the Hall's Creek Metamorphics, including areas of known gold mineralization, has failed to discover anomalies other than those due to volcanic rocks. It is tentatively suggested, therefore, that prospecting might prove more profitable around the northern and north-western periphery of the Lamboo Complex and across the Upper Proterozoic unconformity. If any of the numerous faults which transgress the granite-Upper Proterozoic contact have acted as channelways for uranium-bearing solutions, then the marked change in rock composition and lithology across the unconformity may have resulted in deposition near the contact. Also to be considered is the fact that the known uranium deposit on the Denham Lease is developed in this environment.

It is understood that uranium prospecting companies (notably United Uranium) are to continue operations in the East Kimberleys in the 1956 field season. During the visit under review advice was given to rather disillusioned prospectors in the Hall's Creek area to continue their spare-time search for radioactive deposits.

#### BUREAU OF MINERAL RESOURCES AIRBORNE SCINTILLOGRAPH ANOMALIES

Considering that part of the East Kimberley District which is incorporated in the geological map (Traves 1954), the distribution of airborne anomalies within the major geological formations is as follows:-

	<u>No. of anomalies</u>
Hall's Creek Metamorphics	9
Granitic rocks of Lamboo Complex (Main outcrop)	34
- ditto - (inlier, north-east of main outcrop)	4
Acid volcanics (marginal to Lamboo Complex)	8
Upper Proterozoic sediments and volcanics	10
Lower Cambrian Sandstone	1
Alluvium	1

Thus, more than half the total number of anomalies occurs in the granite rocks which generally exhibit a relatively higher background radiation than those about them. There is, however, a further marked grouping of anomalies within the granite belt. They are confined entirely to the south-eastern half of the Lamboo Granite Complex and there is a dense concentration in the region of the headwaters of the Ord River. This grouping is not apparently related to major structural features, and aerial photographs show that many of the anomalies lie within areas of

pronounced relief. This area of highest incidence of anomalies would therefore provide a favourable field of operations for a ground party to investigate the cause of the disposition of anomalies within the granite. The area which is recommended for such an investigation covers about 200 square miles between latitudes  $17^{\circ}20'S.$  and  $17^{\circ}30'S.$  and longitudes  $127^{\circ}42'E.$  and  $128^{\circ}00'E.$

The four anomalies which are associated with the inlier of granite rocks about 24 miles west-north-west of Denham River Homestead may be of greater significance in that they lie round the contact between granite and Upper Proterozoic sediments. Further, at least two of them occur close to faults which traverse the contact, the fault relationship of anomaly number 7(a) being particularly marked on the air photograph. These anomalies should therefore be investigated by a ground party.

In conjunction with the investigation of the central granite anomalies already suggested, it would be convenient to examine those which are apparently associated with a narrow belt of rhyolites and tuffs along the eastern margin of the Lamboo Granite Complex, and a distance of about 12 miles north-north-east of latitude  $17^{\circ}30'S.$

Of the anomalies in the Hall's Creek Metamorphics, reference may be made to extensive low-level airborne traversing which has been carried out by companies in the area. To date, all anomalies have been referred to high-background volcanic formations, or to ferruginous cappings, and further investigation of the Bureau of Mineral Resources anomalies, which occur generally in areas of high relief, is not warranted at this stage.

#### Locality Map Reference

This report should be read in conjunction with the Bureau's radioactive anomalies map of Wyndham-Hall's Creek Region, (No. G187-1) Sheets 1 and 2. The Denham and Denham Extended leases are situated at approximately lat.  $16^{\circ}24'S.$ , long.  $128^{\circ}14'E.$ , and the Koongie Park prospect at approximately lat.  $18^{\circ}25'S.$ , long.  $127^{\circ}35'E.$