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DEPARTMENT OF NATIONAL DEVELOPMENT.

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BIOGEOCHEMICAL PROSPECTING INVESTIGATIONS IN THE NORTHERN TERRITORY, 1954

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CONTENTS

ILLUSTRATIONS

ABSTRACT

The vegetation of the Northern Territory was examined for the presence of any uranium indicator or accumulator plants. No indicator plants were discovered, but a uranium accumulator tree was shown to grow in certain areas. Most plants were found to accumulate uranium when growing over high-grade uranium mineralization.

Testing procedures are tedious when dealing with botanical samples. Comparative soil tests indicated that soil sampling was more direct, and gave more precise results than those obtained from vegetation.

INTRODUCTION

Biogeochemical prospecting methods have been used in the United States with some success during recent years. (Cannon, 1953). If a suitable uranium indicator or accumulator plant occurs in the Northern Territory it may assist considerably in the search for uranium.

The present investigation aimed at testing as many botanical species as possible over known uranium deposits, to discover which plants grew specifically on the deposits or which plants accumulated uranium to a sufficient degree to allow anomalous amounts to be indicated by a simple testing procedure. To obtain complete results it was necessary to sample all parts of the trees and plants: leaves, twigs, wood (heart and sap), bark, roots, fruit, and seeds (if available.)

When a suitable uranium accumulator was discovered it was used at new uranium prospects to obtain additional information on the possible existence of commercial grade ore.

The established uranium deposits sampled were at Rum Jungle, Adelaide River, Brocks Creek and the ABC Area. The new areas investigated were at the Sleisbeck and Arnhem Land Prospects, and the ABC Prospects.

BACKGROUND OF THE INVESTIGATION

Sampling Procedures

In the preliminary investigations at known uranium deposits all available parts of the trees and plants were sampled - leaves, twigs, heartwood, sapwood, bark, roots, fruits, and seeds. In surveys over new prospects the majority of samples were the leaves of the species Xanthostemon paradoxus.

Samples were placed in cloth bags and labelled for identification. In the laboratory they were removed from the bags and allowed to dry in the air for 2 or 3 days. They were then ready for testing.

Wherever possible samples were collected within 8 feet of the ground (easily reached by hand). If required, a rope weighted at one end was used to break branches from high tree limbs.

Soils were sampled with a post-hole digger or pick and shovel, usually from a depth of 12 to 15 inches below the surface.

Water samples were collected in 600 ml. bottles and analysed as soon as possible after collection.

Testing Procedures.

For botanical samples, testing procedures were as follows:

(i) Weigh 1 gm. of air-dried sample, and reduce to small pieces suitable for ignition.

(ii) Ignite slowly to ash in a silica crucible.

(iii) Weigh the ash on an accurate balance and transfer to a small sample tube.

(iv) 5 mgm. of ash is weighed and added to 2 gm. of flux (45.5% Na_2CO_3, 45.5% K_2CO_3, 9% NaF) in a special platinum dish.

(v) Fuse the ash in the flux at the lowest possible temperature (below 700°C) for 2 minutes.

(vi) When cool the discs are tested visually for fluorescence by comparing them with a series of standard discs of known uranium content.

For soil samples steps (i), (ii), and (iii) are omitted, the only preliminary operation is to crush a small amount of sample to approximately 100 mesh.

An ion-exchange resin was used to extract the uranium from 100 ml. of a water sample. The resin was then ignited and fused with flux as described.

The phosphors (discs) were prepared in batches of 100-120 (6 hours work) and tested together in a dark room. The results gave direct measurements in gammas of uranium (1 gamma = 10^{-6} gm.) in the phosphors. These figures were then converted to p.p.m. uranium in the original leaf or soil sample.

Sensitivity of the fluorescent method was in the order of 0.02 gamma of uranium in the phosphor, corresponding to 4 p.p.m. in the ash, and 0.2 p.p.m. in the original botanical sample (5% ash content), or 4 p.p.m. in a soil sample.

The fluorescent methods for uranium determinations have been fully investigated and reported by Jacobs (1950), and Fletcher (1950).

DESCRIPTION OF THE INVESTIGATION

The following deposits and prospects were investigated: White's Deposit, White's Extended Prospect, Timber Yard Prospect, Dyson's Deposit, Brown's Deposit, Rum Jungle Creek Prospect, at Rum Jungle; Adelaide River Deposit; Brocks Creek Deposit; Sleisbeck Deposit and Prospects; Arnhem Land Swamps; ABC Deposit, ABC Extended, ABC Reconnaissance area, Alluvial Prospect, Valley Prospect, and Miscellaneous samples in the ABC area; and Howard Springs.

The total number of samples tested was 383. They were distributed as shown in Table 1.

TABLE 1

DISTRIBUTION OF SAMPLES

Area	Botanical Samples	Soil Samples	Water Samples	Humus and Vegetable matter
Rum Jungle				
White's Deposit	6	-	4	-
White's Extended	1	1	-	-
Timber Yard	20	2	-	-
Dyson's Deposit	11	-	-	-
Brown's Deposit	1	-	-	-
Rum Jungle Creek	17	3	-	-
Adelaide River	29	1	-	-
Brock's Creek.	-	2	-	-
Sleisbeck				
Sleisbeck Deposit and Prospects	69	14	-	-
Arnhem Land Swamps	13	1	1	4
Miscellaneous samples	11	-	-	-
ABC Area				
ABC Deposit	38	3	-	-
ABC Extended	15	-	-	-
ABC Reconnaissance	69	-	-	-
Alluvial Prospect	22	3	-	-
Valley Prospect	13	-	-	-
Miscellaneous samples	7	-	-	-
Howard Springs	-	-	2	-
TOTALS	342	30	7	4

In the preliminary investigations all plant species occurring on the selected area were sampled and tested. The list below includes all the species sampled. The common ones are marked ✡.

Acacia spp. (Wattles)

Brachychiton paradoxum (Kurrajong)

✡ Calathryx microphylla (Heath)

Cochlospermum fraseri

Cycas media (Cycad palm)

✡ Erythrophleum chlorostrachys (Ironwood)

☆ Eucalyptus alba (White gum)

☆ E. clavigera (Moreton Bay ash)

E. confertiflora (Cabbage gum)

☆ E. dichromophloia (Bloodwood)

E. foelscheana (Fan-leaved bloodwood)

E. miniata (Woollybutt)

E. setosa

☆ E. tectifica (MacArthur River box)

E. tetrodonta (Stringy bark)

Eugenia bleeseri

Evodia elleryana

Ficus spp. (Figs)

☆ Gardenia spp.

Gmelina dalrympleana (Beech)

☆ Grevillia heliosperma

Grewia retusifolia

☆ Livistona spp. (Fan palms)

Lucuma sericea?

Melaleuca spp.

Melastona malabaricum

Owenia vernicosa (Hickory)

☆ Petalostigma quadriloculare (Quinine bush)

Phyllanthus simplex

Planchonia australis

☆ Sorgum intrans (Sorgum grass)

Tephrosia astragaloides

☆ Terminalia spp. (Nutwoods)

☆ Xanthostemon paradoxus

Xanthostemon paradoxus was the only species which gave consistent high uranium results when growing over uranium-bearing rocks. It was considered to be a reliable uranium accumulator tree, and was used almost exclusively in the surveys at Sleisbeck and the ABC Prospects.

In the following discussion only the results obtained from leaf samples are considered, except for special cases. In the preliminary work all parts of a botanical specimen were sampled and tested. This required up to six separate tests on some specimens. Bark samples were the first to be discarded, owing to consistant negative results which were apparently due to the high ash percentage causing low sensitivity. Root samples were seldom collected. When they were tested the results were negative or considerably lower than those for the corresponding leaves. Thus uranium is not fixed in the roots, but is able to proceed to other parts of the plants. Twigs gave inconsistent results, always much less than the corresponding leaf results. Wood samples invariably gave lower results than leaf samples from the same specimen. The low ash content of many wood samples (as low as 0.1%) offered possibilities of greatly increased sensitivity, but owing to low results this property could not be used to advantage.

Twig and root samples were difficult to prepare as they required scraping or peeling to remove contamination on the outside layers.

Contamination was the main source of error when testing leaf samples. It occurred particularly in areas where active mining operations were in progress. When the possibility of contamination was present several leaf samples were scrubbed in water to remove dust particles before the tests were carried out.

The results obtained were compared with those for unwashed samples. Relatively high results for unwashed samples indicated contamination.

Each area investigated is considered in detail.

Rum Jungle

Samples were collected from 6 areas in the Rum Jungle district. The surface at all deposits and prospects had been considerably disturbed by open-cutting or costeaning. At White's Deposit all samples were collected from trees growing on dumps. Contamination could be a major factor causing high results.

White's Deposit and White's Extended.

All components of the trees were tested. The results are given in Table 2.

TABLE 2

URANIUM CONTENT OF TREE COMPONENTS, WHITE'S DEPOSIT AND WHITE'S EXTENDED

Sample No.	Species	leaf unwashed	Leaf washed	twigs	bark	sap-wood	heart-wood	roots	soil
W1.1	Xanthostemon paradoxus	1.9	2.0	1.0	0.18	0.18	0.18	-	-
W1.2	Eucalyptus tectifica	1.0	0.5	0	0	0.05	0.05	-	-
W1.4	Ironwood	0.34	0.33	0.34	0	0.04	0.01	-	-
W1.5	Eucalyptus tectifica	1.9	1.1	0.06	0	0.03	0.04	-	-
W1.6	Acacia sp.	1.4	1.5	0.15	0.1	0.04	-	-	-
WE1.1	Eucalyptus tectifica	0.56	-	0	-	0.02	-	0	15

The table indicates the lack of uranium in the bark samples, the low results for wood and root samples, and the inconsistent results for twig samples. Even at such an early stage the high and consistent results for <u>Xanthostemon paradoxus</u> were apparent. A soil sample taken from amongst the roots of the <u>Eucalyptus tectifica</u> at White's Extended gave 15 ppm. uranium in the field, and 16 ppm when retested in Canberra.

Timber Yard

This prospect lies between White's Deposit and White's Extended. Low-grade uranium mineralization had been disclosed below soil cover by costeaning with a bulldozer.

<u>Xanthostemon paradoxus</u> did not occur at this prospect. Twenty botanical specimens were sampled. Ten gave positive uranium tests but all were less than 0.3 ppm. in the leaf

sample.

Two soil samples were collected at the Timber Yard prospect. They gave 9.5 ppm. and 8.5 ppm. uranium respectively. Repeat tests in Canberra gave 13 ppm. and 12.5 ppm., the increase being due to an improvement in testing techniques. This was the first example of the superiority of soil samples over leaf samples.

Dyson's Deposit

The samples from this deposit were collected above an extension of the footwall of the orebody which was estimated to be 40 feet below the surface. It is probable that the leaf samples were extensively contaminated with dust containing uranium minerals. The results are given in Table 3.

TABLE 3

RESULTS FOR DYSON'S DEPOSIT SAMPLES

Sample No.	Species	p.p.m. uranium in leaf.
D2.1	Cochlospermum	1.06
D2.2	Eugenia bleeseri	0.45
D2.3	Livistona	0.44
D2.4	Terminalia	0.56
D2.5	Xanthostemon paradoxus	0.43
D2.6	Ironwood	0.32
D2.7	Fig	0.98
D2.8	Eucalyptus foelscheana	0.09
D2.9	Grevillia	0.13

Brown's Deposit

One sample only, a Xanthostemon paradoxus, was tested from this deposit. A negative result was obtained. The mineralization in this area consists mainly of copper and lead carbonates.

Rum Jungle Creek

At this prospect, where costeaning had previously been carried out, a sampling area, 30 feet square, was chosen at the centre of a 45 times background radiometric anomaly.

Sixteen botanical specimens were sampled. Most samples gave negative uranium tests. Two Xanthostemon paradoxus samples gave the only appreciable positive results, 2.2 p.p.m. and 0.9 p.p.m. uranium.

The results for 3 soil samples, also collected within the sampling area, are shown in Table 4.

TABLE 4

RESULTS FOR SOIL SAMPLES, RUM JUNGLE CREEK

Sample No.	Depth inches	p.p.m. uranium (in field)	p.p.m. uranium (in Canberra)
RJC1.11	8	12	13
RJC1.15a	6	10	12
RJC1.15b	36	14.5	23

The results indicate that for a given area soil samples gave more reproducible results than botanical samples.

Adelaide River

The radioactive beds at the Adelaide River deposit dip very steeply and are only 2 to 3 feet thick at the surface. Botanical samples were collected along the strike of these narrow beds for a distance of 250 feet.

The results obtained from leaf samples of the tree specimens are given in Table 5.

TABLE 5

ADELAIDE RIVER DEPOSIT, URANIUM RESULTS

Sample No.	Species	p.p.m. Uranium
AR1.1	Eucalyptus dichromophloia	0.3
AR1.2	E. alba	0
AR1.3	Ironwood	0
AR1.4	Terminalia	0.17
AR1.5	Livistona	0
AR1.6	Quinine bush	0
AR1.7	Gardenia	0.41
AR1.8	Xanthostemon paradoxus	3.1
AR1.9	Calathryx microphylla	0.14
AR1.10	Brachychiton	0
AR1.11	Grevillia	0
AR1.12	Owenia vernicosa	0
AR1.13	Eucalyptus dichromophloia	0
AR1.14	Livistona	0
AR1.15	Quinine bush	0
AR1.16	Xanthostemon paradoxus	0.55
AR1.17	Ironwood	0.14
AR1.18	Grevillia	0.24
AR1.19	Xanthostemon paradoxus	4.2
AR1.20	Eucalyptus dichromophloia	0.16
AR1.21	Xanthostemon paradoxus	6.1
AR1.23	Terminalia	0.35
AR1.24	Grevillia	0.5
AR1.25	Gardenia	0.35
AR1.26	Acacia sp.	0
AR1.27	Calathryx microphylla	0.37
AR1.28	Eucalyptus dichromophloia	0.47
AR1.29	E. dichromophloia	0.1
AR1.30	E. alba	0.47

The results for Xanthostemon paradoxus are outstanding. They demonstrate conclusively that this species is a uranium accumulator.

Specimen AR1.19, a Xanthostemon paradoxus, was the most interesting tree tested at this deposit. An adit passed directly beneath this tree and one of its roots was discovered 30 feet below the surface, in uranium mineralization. Results for the root gave similar indications to those obtained on sample WE1.1 - that the roots do not immobilize the uranium and prevent it from passing to the other components of the tree. The complete results for AR1.19, together with those for AR1.21, are given in Table 6.

TABLE 6.

XANTHOSTEMON PARADOXUS RESULTS, p.p.m. URANIUM

Sample No.	leaf	twig	bark	sap-wood	heart-wood	root
AR1.19	4.2	0.34	0.10	0.16	0.25	0.20
AR1.21	6.1	0.65	0.07	0.33	0.14	-

These results also substantiate the remarks made previously about amounts of uranium in other parts of the trees compared with the amount found in the leaves.

A soil sample, AR1.22, collected at a depth of 18 inches from the wall of a new ventilation shaft, gave a result of 20 p.p.m. uranium.

Brocks Creek

Two soil samples, taken from soils above the line of lode, were the only samples tested from the Brocks Creek deposit. The results, given in Table 7, indicate the possibility of using soil as a sampling medium.

TABLE 7

SOIL RESULTS, BROCKS CREEK

Sample No.	p.p.m. Uranium (in field)	p.p.m. Uranium (in Canberra)
1	44	60
2	38	50

Sleisbeck

The majority of samples collected at Sleisbeck were leaves of the species Xanthostemon paradoxus which was prolific in some parts of the district. Other trees were sampled if the Xanthostemon was not present.

Humus samples from the swamps were useful, and many soil samples were collected.

Sleisbeck Deposit and Prospects

The Sleisbeck deposit and prospects occur on the flanks of three ridges, originally thought to consist of a quartz-hematite breccia but more recently recognised as a silica replacement of a biohermal limestone breccia (Condon and Walpole, 1955).

In this report the eastern ridge is called the No.1 Ridge, the centre ridge No.2, and the western ridge No.3; they all lie along the same east-west line. Their heights above the general level range from 50 feet to 200 feet. The areas between the ridges are covered with residual soil.

The Sleisbeck deposit is at No.4 Exposure, approximately half-way along, and on the southern flank, of No.2 Ridge. Open-cut mining operations had been started when the sampling programme was carried out.

The uranium accumulator tree Xanthostemon paradoxus did not occur on No.1 Ridge, nor east of No.4 Exposure on No.2 Ridge. However west of No.4 Exposure the species grew prolifically, and this was the section of greatest interest for biogeochemical investigations. Only one tree of this type was found on No.3 Ridge.

The results of the uranium tests on samples from the section of No.2 Ridge west of No.4 Exposure are presented in Table 8 and on Plate 1, where the anomalies are delineated.

The strong anomaly is at least 450 feet in length (omitting the negative result for sample Sl.11) and the weak anomaly extends another 200 feet to the west. Uranium mineralization may be discovered beneath the area covered by the strong anomaly. Positive results shown on the northern side of the ridge, opposite the strong anomaly, should be further investigated.

Another weak anomaly extends over a large area at the western end of the ridge. This anomaly is 1200 feet in length.

TABLE 8

URANIUM RESULTS FOR SAMPLES FROM NO. 2 RIDGE, SLEISBECK

Sample No.	Species	p.p.m. Uranium in leaf sample		
		Unwashed	Water Washed	Acid Washed
Sl.1	Xanthostemon paradoxus	4.2; 4.1	2.9	3.0
Sl.2	- do -	5.0	3.1	4.2
Sl.3	- do -	-	1.6	-
Sl.4	Eucalyptus dichromophloia	-	0.6	-
Sl.5	- do -	4.3	4.2	5.3
Sl.6	Xanthostemon paradoxus	-	-	-
Sl.7	- do -	-	0.3	-
Sl.8	- do -	-	0.7	-
Sl.9	- do -	-	0.2	-
Sl.10	- do -	-	0.9	-
Sl.11	- do -	7.9	0	-
Sl.12	- do -	5.1	3.5	-
Sl.13	- do -	-	0.3	-
Sl.14	- do -	0.8	0.2	-
Sl.15	Eucalyptus dichromophloia	-	0.7	-
Sl.16	Xanthostemon paradoxus	1.9	1.2	-
Sl.17	- do -	5.9	2.7	-
Sl.18	- do -	0.9	0.3	-
Sl.19	- do -	-	0	-
Sl.20	- do -	1.3	0.8	-
Sl.21	- do -	0.8	0	-
Sl.22-Sl.26	- do -	-	0	-
Sl.27-Sl.30	- do -	0	0	-
Sl.31	- do -	0.7	-	-
Sl.32	- do -	0.3	-	-
Sl.33,Sl.34	- do -	0	-	-
Sl.35	Brachychiton (seeds)	0	-	-
Sl.36	Xanthostemon paradoxus	0.2	-	-
Sl.37	- do -	0	-	-
Sl.38	- do -	0.03?	-	-
Sl.39	- do -	0.15?	-	-
Sl.40,Sl.41	- do -	0	-	-
Sl.42	- do -	0.5	-	-
Sl.43	Lucuma sericea?	0	-	-
Sl.44	Xanthostemon paradoxus	1.0	-	-
Sl.45	- do -	0.3	-	-
Sl.46	- do -	0	-	-
Sl.47	- do -	0.1?	-	-
Sl.48	- do -	0.04?	-	-
Sl.49	- do -	0.2	-	-
Sl.50	- do -	0.06?	-	-
Sl.51	Lucuma sericea?	0	-	-
Sl.52	Xanthostemon paradoxus	0	-	-
Sl.53	Lucuma sericea?	0	-	-
Sl.54	Xanthostemon paradoxus	0.05?	-	-
Sl.55	- do -	0.05?	-	-
Sl.56	- do -	0	-	-
Sl.57	Lucuma sericea?	0	-	-

Without further investigations, involving closer sampling points, this anomaly can only be mentioned as interesting, with perhaps the one small area around S1.44 being worthy of prior investigation.

The one sample collected from No.3 Ridge gave a negative result.

Three soil samples from the vicinity of No.4 Exposure gave very interesting results. A strong uranium anomaly was revealed; it extends at least 300 feet downslope from the mineralization and is possibly greater than 100 times background at its strongest point. Table 9 gives the results obtained, and the positions of the sampling points are shown on Plate 1.

TABLE 9

URANIUM RESULTS FOR SOIL SAMPLES AT NO.4 EXPOSURE, SLEISBECK.

Sample No.	Position of Sampling Point	Depth of Sample (inches)	p.p.m. Uranium
OC1	Above open cut. Topographically above uranium mineralization. Black surface humic soil.	3	0
OC2	From costean used by truck for loading under chinaman. 150 feet from open cut.	18	65
OC3	On south side of soil dump at end of costean. 300 feet from open cut.	12	22

Xanthostemon paradoxus did not occur on No.1 Ridge, so a new species *Lucuma sericea*? was sampled. All results on 9 samples were negative. This species was later proved not to be a uranium accumulator, so the negative results do not eliminate the possibility of uranium mineralization occurring at No.1 Ridge.

Attention was paid to the outcrops at the western end of No.1 Ridge where uranium minerals were visible. Three types of trees were sampled - Terminalia, Gardenia, and Eucalyptus tectifica - but only one positive result, 0.3 p.p.m. uranium, was obtained from the leaves of the Terminalia.

Three soil samples were collected in the vicinity of these outcrops, but negative results were obtained. It is unlikely that substantial uranium mineralization occurs at this exposure.

The sampling points and results for No.1 Ridge are presented on Plate 2.

Eight soil samples were collected from a traverse along a costean which had been opened up between Nos. 1 and 2 Ridges to locate a possible extension of the No.4 Exposure mineralization. The radiometric results were negative. Geochemical tests on the soil samples revealed a weak but significant uranium anomaly (6 p.p.m. uranium, probably 10 times background). Results are shown on Plate 2.

Arnhem Land Swamps

The air-borne scintillometer indicated that several swamps along the Katherine Valley in Arnhem Land were radioactive. The two swamps of particular interest occurred 6½ miles east of the western border of Arnhem Land, close to the southern escarpment of the Katherine River Valley, (Lat. 13°46'43"S; Long 133°05'E and 133°06'E). Their positions are shown on Plate 4.

The biogeochemical investigations were carried out to establish the presence or absence of uranium in the swamps.

Two swamps were investigated. No.1 consisted of black soils and black humus material, and No.2 of red soils and red humus material. They are formed by water passing over, or emerging from, the sandstone escarpment south of the Katherine River. The radioactive substances have probably been carried by the water from a source above or behind the escarpment. Carbon in the humus materials may remove the soluble uranium compounds from the water. During radioactive disintegration the insoluble daughter products may also be retained by the humus and soil.

The results for the swamp samples are presented in Table 10, and sample locations are shown on Plate 3.

TABLE 10

ARNHEM LAND SWAMP SAMPLES, URANIUM RESULTS

Sample No.	Type of Sample		p.p.m. Uranium
ALS1.1	Soil		0
ALS1.2 to ALS1.6	Leaves of trees (various species)		0
ALS1.7a	Vegetable matter + solids	(ignited 29%)	0.6
ALS1.7b	Humic matter	(ignited 74%)	1.3
ALS1.8a	Vegetable matter + solids	(ignited 7.4%)	1.0
ALS1.8b	Humic matter	(ignited 67%)	1.5
ALS2.1a	Vegetable matter + solids	(ignited 5.7%)	0.4
ALS2.1b	Humic matter	(ignited 70%)	8.2
ALS2.2 to ALS2.8	Leaves of trees (various species)		0
ALS2.9a	Vegetable matter + solids	(ignited 37%)	3.7
ALS2.9b	Humic matter	(ignited 70%)	8.2
ALS2.10	Water (100 mls. tested)		0

The presence of uranium, indicated by the positive results, could be due to the passage of the groundwaters through either an extensive zone of low-grade uranium mineralization or a relatively small zone of high-grade mineralization. The second possibility is the most likely, as only a small number of the many similar swamps are radioactive.

Miscellaneous Samples

Xanthostemon paradoxus leaves were collected from four trees growing on the conglomerate ridge situated approximately 500 yards south of No.2 Ridge, and from seven trees growing on sandstone in the vicinity of the aboriginal cave paintings, 4 miles south-west of Sleisbeck.

The samples were tested to establish the negative background for the biogeochemical prospecting. All results were negative.

The ABC Area

A total of 164 trees, of 19 different species, were sampled. Five soil and one termite hill samples were also collected.

The 53 specimens from the ABC Deposit and ABC Extended were exhaustively tested - leaves, twigs, and wood were all sampled - but only leaves were collected from the other 111 trees.

ABC Deposit

Results obtained on samples from the ABC Deposit have no direct prospecting significance owing to extensive contamination resulting from surface mining operations.

Much of the vegetation had been removed from above the main orebody, but most of the trees which were still growing were sampled. The results are given in Table 11, where only those for the leaf samples are reported. Plate 4 shows the sampling positions of the ABC Deposit samples, and those collected at Area 3 to establish a negative background.

Although the trees tested were not considered as likely uranium accumulators, some gave strong positive uranium tests. In all cases the leaves contained the highest amount of uranium, twigs and wood giving low or negative results.

Owing to possible contamination, positive results must be treated with caution. In particular, samples collected close to ground level were probably subject to extensive contamination. Several leaf samples were retested after washing in water to eliminate surface dust. For trees rooted in ore the result was little affected by washing, whereas for trees growing in barren ground washing eliminated the positive result.

Three soil samples were collected. The results, shown in Table 12, were more consistant than those of leaf samples.

TABLE 11

URANIUM RESULTS FOR ABC DEPOSIT

Sample No.	Species	Height feet	p.p.m. uranium unwashed leaf	p.p.m. uranium washed leaf
ABC1.1	Ironwood	18	0.11	-
ABC1.2	Eucalyptus tectifica	30	0.47	-
ABC1.3	Ironwood	20	0.26	-
ABC1.4	Terminalia	3	2.04	1.87
ABC1.5	Ironwood	20	0.17	-
ABC1.6	Ironwood	0	1.07	0.84
ABC1.9	Eucalyptus tectifica	30	0.65	-
ABC1.10	Gardenia	1	0.49	-
ABC1.11	Eucalyptus clarigera	20	2.47	-
ABC1.12	Quinine bush	½	2.66	-
ABC1.13	Quinine bush	1	1.49	-
ABC1.14	Terminalia	10	1.62	0.33
ABC1.15	Gardenia	15	0.35	-
ABC1.16	Eucalyptus clavigera	35	0.21	-
ABC1.17	Quinine bush	1	0.29	-
ABC1.18	Tephrosia astragaloides	3	1.24	-
ABC1.19	Eucalyptus tectifica	35	0.36	-
ABC1.20	Ironwood	25	0.15	0
ABC1.21	Gardenia	18	0.63	0
ABC1.22	Gardenia	½	0.40	-
ABC1.23	Phyllanthus simplex (twigs)	¾	0.14	-
ABC1.24	Eucalyptus foelscheana	35	0.35	0.31
ABC1.25	Ironwood	15	0.21	-
ABC1.26	Eucalyptus tectifica	22	0.08	-
ABC1.27	Grewia retusifolia	1	0	-
ABC1.28	Quinine bush	1	0.11	-
ABC1.29	Gardenia	¾	0.07	-
ABC1.30	Grevillia	2	0	-
ABC1.31	Acacia	2	0.24	-
ABC1.32	Eucalyptus clavigera	½	5.68 (heavily contaminated)	
ABC1.33	Quinine bush	1/6	27.2 (- do -)	
ABC1.34	Gardenia (root)	0	8.88 (- do -)	

TABLE 12

ABC SOIL SAMPLES, URANIUM RESULTS

Sample No.	Depth, inches	p.p.m. Uranium (in field)	p.p.m. Uranium (in Canberra)
ABC1.7	9	800	1125
ABC1.8	9	565	667
ABC1.35	3	187	210

These high results indicate that soil testing is more reliable for uranium prospecting than botanical testing under the same conditions.

The six samples from 6 different tree species collected from Area 3 gave negative results. They established the negative background for the ABC Deposit.

ABC Extended

The area investigated was on gently sloping ground approximately 1 mile north-west of the ABC Deposit (see Plate 6). Geophysicists had discovered a large but weak (2 times background) radiometric anomaly in the area.

Fifteen trees, of 7 species, were sampled along a traverse running S.W.-N.E. across the anomaly. All results were negative. Even though the trees were not uranium accumulators it can be concluded that no high-grade uranium mineralization occurs in the area.

Several trenches were later dug at a point close to the traverse, but no uranium minerals were revealed.

ABC Reconnaissance

The uranium accumulator tree, <u>Xanthostemon paradoxus</u>, was found growing in large numbers on the sandstone ridge bordering the valley of McAdden Creek in a north-westerly direction from the ABC Deposit.

Sampling was carried out in a reconnaissance traverse along the top of the ridge, as shown on Plate 6. The gullies which dissect the ridge were given particular attention, as they indicate cross faults which, by analogy with the ABC Deposit, could be a control for mineralization.

The 69 samples collected, all <u>Xanthostemon</u> leaves, gave negative uranium tests. Unfortunately this species did not extend out onto the flat soil-covered valley where uranium mineralization was most likely to occur.

It is now considered that soil sampling along traverses parallel to the sandstone ridge would be a more reliable method of uranium prospecting in this area.

Alluvial Prospect

This prospect (see Plate 6) was investigated after readings of 6 times background were recorded by a Geiger ratemeter, over recent alluvial soils (or muds). Soil samples from the area of highest readings, and leaves from Xanthostemon trees, growing in the deep gorge in which the prospect was located, were collected. All uranium tests were negative.

Valley Prospect

Several Xanthostemon paradoxus trees, growing in a single line in the valley near the Alluvial Prospect, were noticed whilst travelling to this prospect (Plate 6).

It is unusual for this species to thrive on thick alluvial soil in this area, and it was thought that they may have been selectively rooted in an acid dyke. In this district uranium mineralization appeared to be associated with acid dykes. However all tests on leaf samples were negative.

Miscellaneous Samples

Seven leaf samples were collected at random wherever Xanthostemon paradoxus trees were found near the road from the ABC Deposit to the Alluvial Prospect. Approximate locations are shown in Plate 6. No positive uranium results were obtained.

Howard Springs

Two water samples were collected at the point where the springs issue from below the surface. Both gave negative uranium tests. Control water samples from the East Finnis River, which flows through Rum Jungle, gave definite positive results.

CONCLUSIONS

The main achievement of the investigations was the discovery of the uranium accumulator, Xanthostemon paradoxus.

This discovery may present an opening for the introduction of biogeochemical prospecting methods for uranium. Unfortunately a simple uranium indicator plant was not found. Such a plant would simplify botanical prospecting to a degree where the ordinary prospector could make use of it.

It is apparent that most plants will accumulate uranium if growing over high-grade uranium mineralization. Deep-rooted trees give more reliable results than those plants which are only shallow-rooted e.g. quinine bush and grasses.

Leaves were found to accumulate more uranium than the remainder of the plants. The uranium is not fixed in the roots, but is able to proceed to other plant components. If contamination is absent, or is removed before testing, leaves give higher and more consistent results than twigs or wood.

Surface soils in the area being investigated should be relatively undisturbed to minimise the risk of contamination of leaf samples.

Soils were found to give stronger and more easily distinguished anomalies than those given by botanical samples. Anomalies in the order of 100-1000 times background were obtained with soils in areas where trees gave anomalies of only 30 times background. Soils offer infinite scope as a sampling medium whereas vegetation is seldom consistent from one area to another.

In general, the biogeochemical methods were found to compare unfavourably with geochemical methods on three main points which are important for the success of this type of prospecting. They are:

(a) Leaves are easily contaminated by uranium-rich dust, causing erroneous results. Washing the leaves is a laborious process and should be avoided if possible.

(b) The uranium accumulator Xanthostemon paradoxus does not always grow in areas where testing is required. Its distribution is often limited to ridges. At Sleisbeck, owing to the absence of the species in Nos. 1 and 3 Ridges and part of No.2 Ridge, most of the prospect was not sampled, even though uranium mineralization may be present.

(c) The preparation of leaf samples for testing is a time-consuming process. Many operations, e.g. drying, weighing and ashing, are necessary before beginning the actual testing procedure.

Soil sampling overcomes these difficulties. There is no risk of contamination when dealing with fresh soil samples collected below the surface. Soils are available on the sides of ridges and on flat ground where testing may supply valuable information. Crushing is the only operation required to prepare a soil sample for analysis.

Geochemical prospecting techniques may supply a solution to problems which are presented by the use of counters and ratemeters for locating uranium. The geochemical method tests specifically for uranium, whereas field ratemeters detect only the gamma particles emitted by the daughter products of the uranium disintegration i.e. UX_1, UX_2, Ra, RaC, and RaD (Wright, 1953). RaC is the strongest emitter and is the source of most of the radioactivity detected by counters.

During leaching of a uranium deposit the uranium is removed, leaving the insoluble compounds of the daughter products. When completely leached the rock will still exhibit strong radioactivity due to the disintegration products. Material of this nature has little or no uranium and is not worth mining. An occurrence of this type was encountered at Lake Dundas, Western Australia.

The uranium removed by leaching may be precipitated at another locality as a secondary deposit. It does not achieve radioactive equilibrium for one million years. Thus a recent secondary uranium deposit, although it may be rich in uranium, may not be detectable by counters owing to a deficiency of the daughter products which emit gamma particles. Many secondary uranium deposits in the Northern Territory may fall into this category.

During leaching some uranium will be precipitated in the soil near the deposits. The radon, a gas with half-life of 3.8 days, which is formed during the radioactive disintegration, may diffuse through the soil and be lost to the atmosphere. Radon is formed before RaC in the disintegration series. The net result would be a diminished amount of RaC in the soil to emit gamma particles. Radiometric surveys may thus fail to detect significant uranium anomalies in soils.

The advantages of the geochemical techniques are obvious. They do not indicate uranium in completely leached deposits which are poor in uranium but which exhibit strong radioactivity, and they detect uranium in rocks and soils which are deficient in uranium daughter products.

Some of the daughter elements of the thorium disintegration series are strong gamma particle emitters, and they can cause confusion in radiometric prospecting. Thorium does not interfer with uranium determination in geochemical prospecting.

RECOMMENDATIONS

Biogeochemical prospecting should only be used in special cases where the accumulator tree Xanthostemon paradoxus is present in large numbers, and where soil sampling may not give definitive results. The sampling procedures are too tedious, and the results too variable, to permit general application of the method.

Geochemical prospecting, using soils as the sampling medium, appears to offer the most suitable uranium prospecting method. Soil testing in detail at newly discovered radiometric anomalies should be carried out. Reconnaissance soil sampling, collecting samples at 100 foot intervals along both sides of suitable ridges, and about 100 feet downslope from the rock outcrops, should be undertaken. Promising areas of flat soil-covered country could be sampled in traverses or on a grid system. Areas exhibiting uranium in quantities higher than normal background would be readily discovered.

The radioactive swamps in Arnhem Land should be further investigated. It may be possible to work back along the creeks above the escarpments and to localise the uranium, with the use of biogeochemical or geochemical prospecting methods. Other swamps which have exhibited radioactivity are worthy of investigation.

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PLATE I

SLEISBECK No.2 RIDGE
GEOBOTANICAL PROSPECTING
SURVEY
Western end of ridge
Ridge
Saddle
Ridge
Saddle
Ridge
Ridge
Ridge continues to the east
OPEN CUT
No. 4 EXPOSURE
SCALE
0 50' 100' 200' 300'
(APPROXIMATE)
N
(approx.)
W
E
LEGEND
more than 4 ppm. U in leaf
1 – 4 ppm. U in leaf
·2 – 1 ppm. U in leaf
less than ·2 ppm. U in leaf
X32 sampling point (tree)
soil sampling point with ppm. U in the soil.
Sampling points without U values to be disregarded
·2–1 ppm.
1–4 ppm.
A.H.D.
17-12-54

PLATE 2

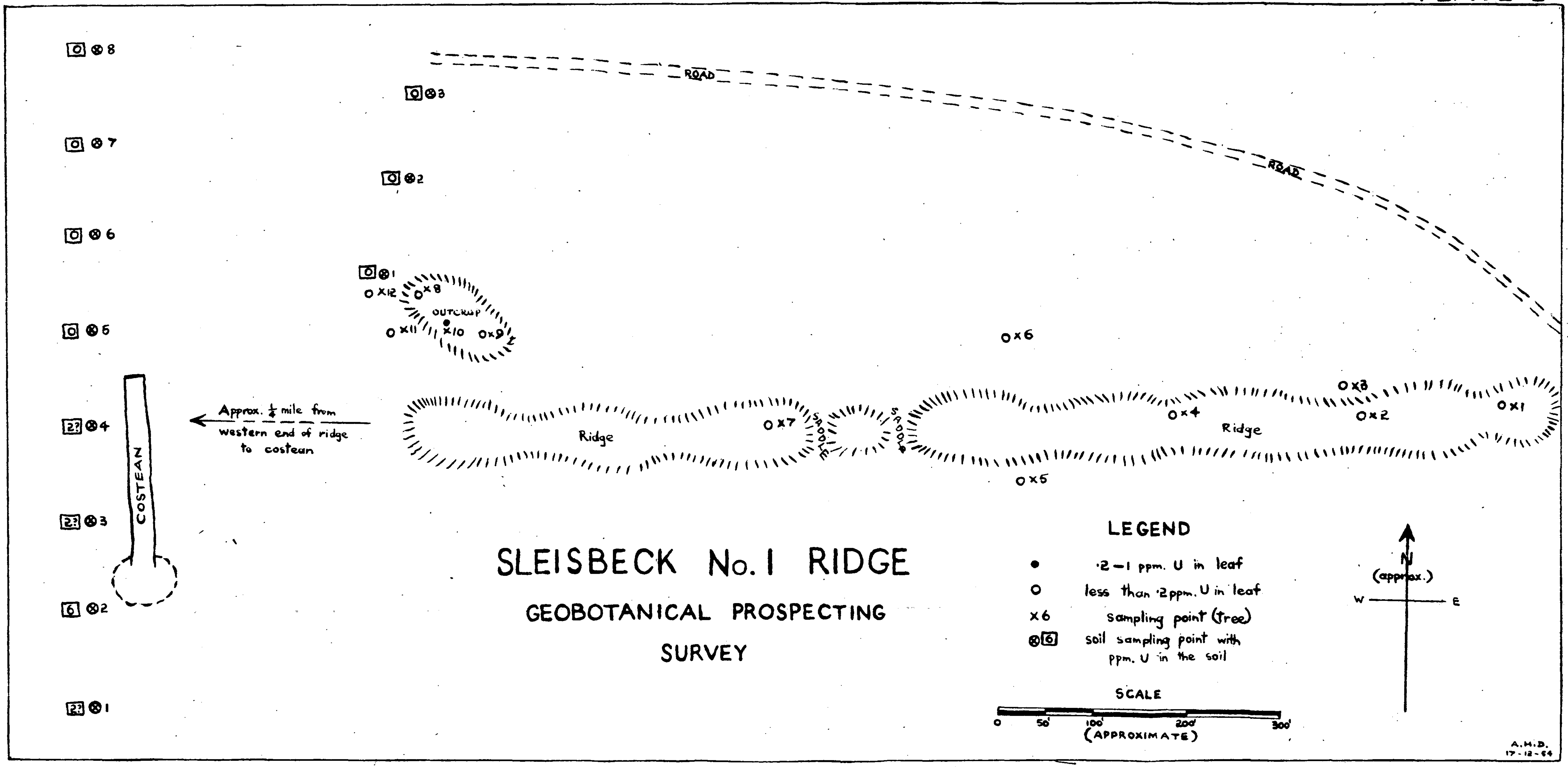
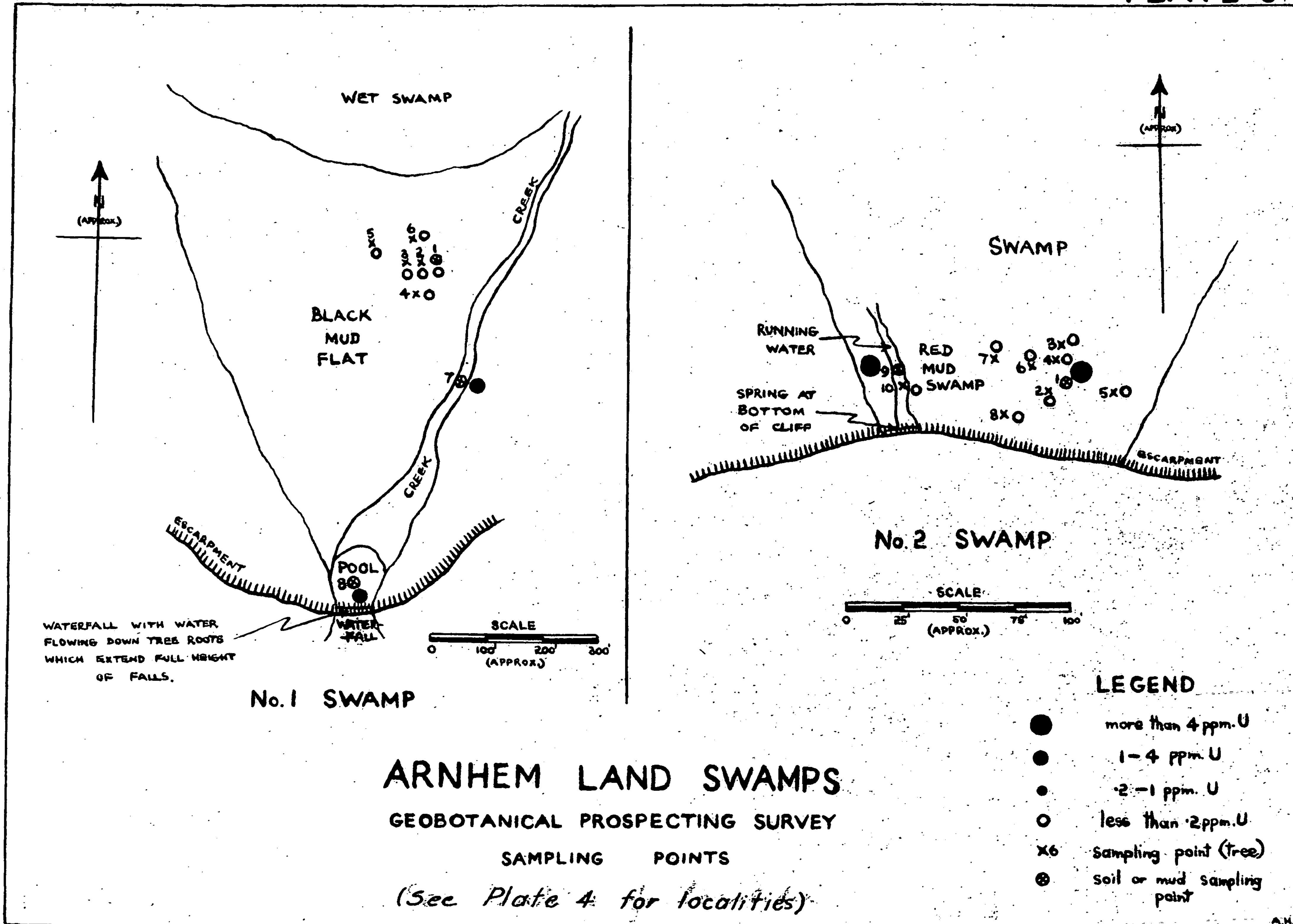

SLEISBECK No. I RIDGE
GEOBOTANICAL PROSPECTING
SURVEY
ROAD
ROAD
OUTCROP
Ridge
Ridge
SADDLE
SADDLE
COSTEAN
Approx. ¼ mile from western end of ridge to costean
LEGEND
·2 – 1 ppm. U in leaf
less than ·2 ppm. U in leaf
x6 sampling point (tree)
soil sampling point with ppm. U in the soil
SCALE
0 50' 100' 200' 300'
(APPROXIMATE)
N (approx.)
W
E
A.H.D.
17-12-64

PLATE 3



ARNHEM LAND SWAMPS

GEOBOTANICAL PROSPECTING SURVEY

SAMPLING POINTS

(See Plate 4 for localities)

PLATE 4

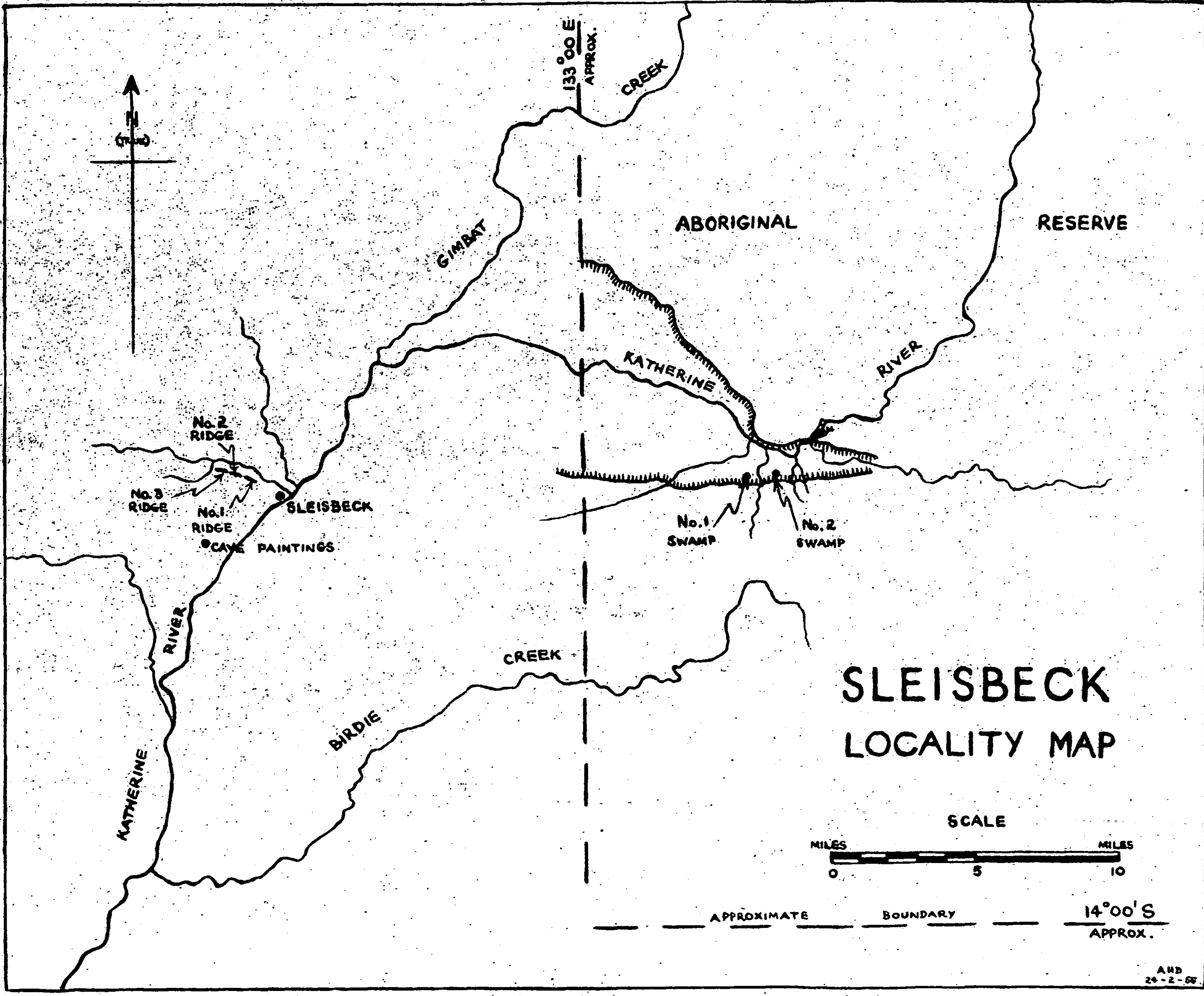

N
(TRUE)
133°00'E
APPROX.
CREEK
GIMBAT
ABORIGINAL
RESERVE
KATHERINE
RIVER
No. 2
RIDGE
No. 3
RIDGE
No. 1
RIDGE
SLEISBECK
CAVE PAINTINGS
No. 1
SWAMP
No. 2
SWAMP
RIVER
KATHERINE
CREEK
BIRDIE
SLEISBECK
LOCALITY MAP
SCALE
MILES
MILES
0
5
10
APPROXIMATE BOUNDARY
14°00'S
APPROX.
AHD
24-2-58

PLATE 5

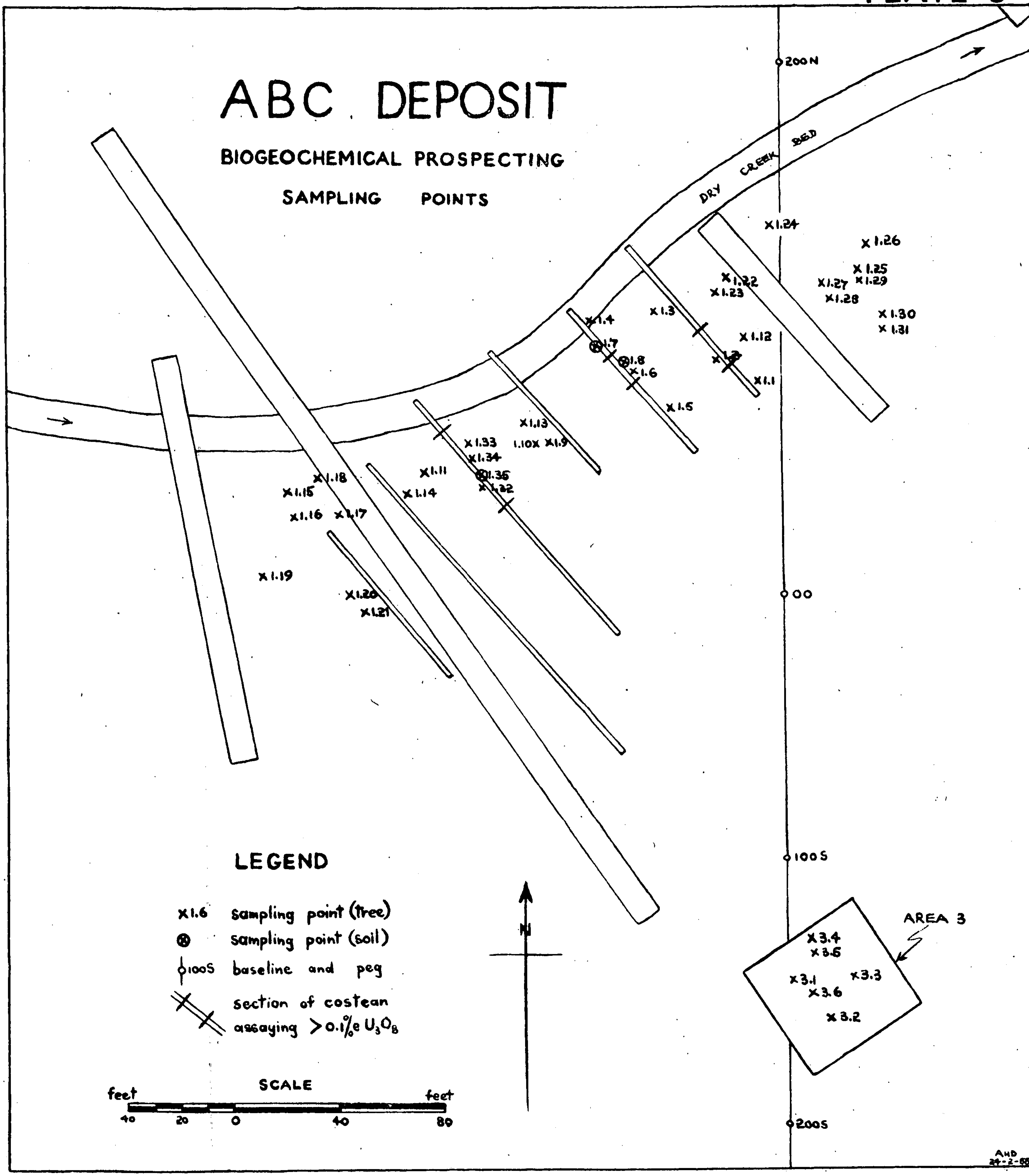
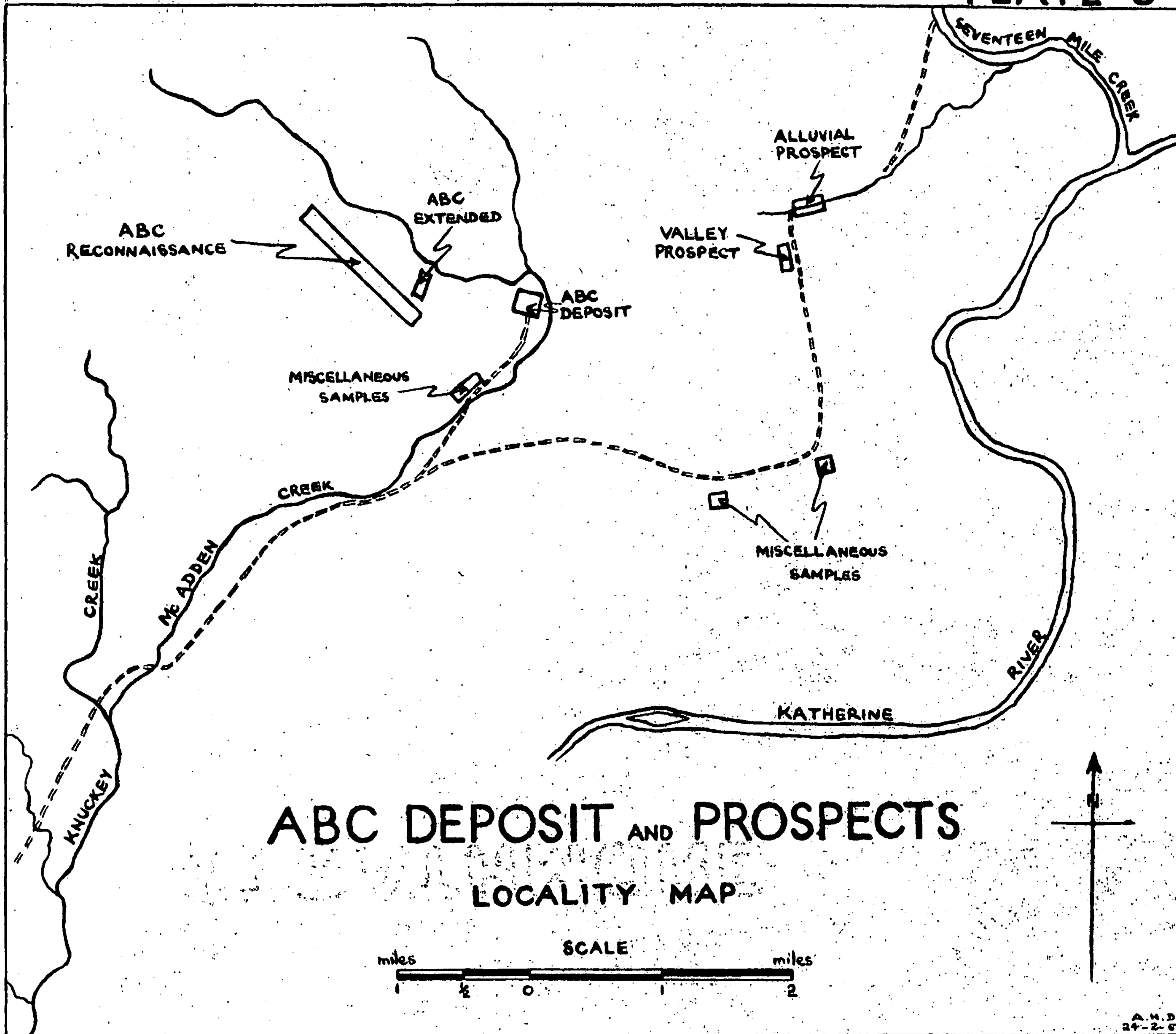

ABC DEPOSIT
BIOGEOCHEMICAL PROSPECTING
SAMPLING POINTS
DRY CREEK BED
200N
00
100S
200S
x1.1
x1.2
x1.3
x1.4
x1.5
x1.6
1.7
1.8
x1.9
1.10x
x1.11
x1.12
x1.13
x1.14
x1.15
x1.16
x1.17
x1.18
x1.19
x1.20
x1.21
x1.22
x1.23
x1.24
x1.25
x1.26
x1.27
x1.28
x1.29
x1.30
x1.31
x1.32
x1.33
x1.34
1.36
AREA 3
x3.1
x3.2
x3.3
x3.4
x3.5
x3.6
N
LEGEND
x1.6 sampling point (tree)
sampling point (soil)
100S baseline and peg
section of costean assaying >0.1%e U_3O_8
SCALE
feet
feet
40
20
0
40
80
AHD
24-2-65

PLATE 6



ABC DEPOSIT AND PROSPECTS

LOCALITY MAP