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REPORT ON RECONNAISSANCE SURVEY IN THE SEARCH FOR RADIO-ACTIVE MINERALS, MARBLE BAR DISTRICT, PILBARA GOLDFIELD.

by

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REPORT ON RECONNAISSANCE SURVEY IN THE SEARCH FOR RADIO-ACTIVE MINERALS, MARBLE BAR DISTRICT, PILBARA GOLDFIELD.

(Report No. 1947/78 Plan Nos. WA.12A/1-7 and WA.12B/1-2).

I. SUMMARY AND CONCLUSIONS.

The report is the result of five weeks survey of radio-active occurrences in the Marble Bar District. The principal deposits of alluvial monazite have been checked and two new radio-active occurrences in granitic rocks are reported.

The richest alluvial monazite deposits were found in the Cooglegong Area, but even there, the deposits are shallow and patchy. Furthermore, they are confined to the headwaters of very small streams draining the granitic rocks and pegmatites. Thus it is unlikely that any great quantity of alluvial monazite will be won from this locality.

Since black tin is generally associated with the monazite small quantities of mixed concentrates could be obtained by small "fossicking" parties. In view of the patchy nature of the monazite concentrates no estimate of yardage has been attempted.

Radio-active Occurrences Nos. 1 and 2 have been described in detail as they are new finds. Notwithstanding the fact that they gave high Geiger-Muller counts in the field, preliminary petrographic study indicates that they do not constitute marketable ore. Their radio-activity is due to myriads of microcrystalline inclusions in the dark mica and mill concentration would appear to be impracticable.

Minor occurrences of monazite were examined in the Moolyella Tin-field and at Old Shaw, but these areas are regarded as unimportant. Pegmatites at Stutz tin mine, Cooglegong Area were slightly radio-active, but no more so than many other pegmatites in the Cooglegong Area.

Several pegmatites at Wodgina have been tested with the Geiger-Muller counter. They are described in the text because the paragenesis of the radio-active minerals and their mode of occurrence may have a bearing on future prospecting.

It is considered that further regional prospecting for radio-active ores is warranted in the Marble Bar District. The tri-angular area between Cooglegong Creek and the main Pilga-Hillside road and bounded on the south by a line running east-west through the old wells on Boonana Creek, (see Plate WA.12A/2), should be thoroughly tested.

Further work in the Wodgina area is justified, and geological traverses could be made from Wodgina and Abydos west to the Yule River. Occurrences reported from Eley's, Trig Hill and Mount Francisco should also be investigated in the field.

II. INTRODUCTION.

A reconnaissance survey of the Marble Bar district was commenced on 10th September, 1947, and carried on until 20th October. The party consisted of two geophysicists, Messrs. J. Daly and W.B. Clarke and two geologists, Mr. W.C. Smith and myself. An experienced alluvial prospector, Mr. A. Jones of Marble Bar, was attached to the party.

Mr. C.J. Sullivan, Superintending Geologist, and Mr. R. Thyer, Geophysicist, assisted the party in an advisory capacity in the early stages.

Throughout the survey we were greatly assisted by the use of two portable Canadian Geiger-Muller counters made by the Electronic Associates, Toronto. These instruments rendered valiant service and their extreme portability and ruggedness are worthy of special mention.

Primarily, we were to attempt to prove the extent of the alluvial monazite deposits, but when these proved to be limited in distribution we concentrated on testing the radio-activity of the granitic rocks and associated pegmatites. This led to the discovery of radio-active lenses and bodies associated with the pegmatites in Radio- Active Occurrences Nos. 1 and 2 in the Cooglegong Creek area.

The following method was adopted in making field observations with the portable Canadian Geiger-Muller counter. The instrument of "Geiger", as it is referred to in the text, was set as closely as possible to a background count of 40 clicks per minute as registered in the head-set. This background count was taken in air (instrument slung over shoulder) or on non-radio-active rock outcrops such as the white quartz blows in Radio-Active Occurrences Nos. 1 and 2, the observer standing at least 10 feet away from the rock or concentrate suspected as being radio-active.

Numerous samples and specimens were collected in the field and 28 samples were submitted to Mr. H.P. Rowledge, Director, Government Chemical Laboratories, Perth. Analysis for ThO_2 content was requested for monazite concentrates, and radio-active rocks were to be assayed for U and Th. A request was also made for microscopic determination of minerals, paragenesis and structure particularly relating to any extremely fine inclusions or accessory minerals which could be of the radio-active variety. Mr. Rowledge was asked to reserve portion of each rock sample for despatch to the Chief Geologist, Canberra. In the meantime nine representative thin-sections have been prepared and described by myself.

Petrography.

The petrographic descriptions of nine thin-sections of radio-active granitic rocks from Radio-Active Occurrences Nos. 1 and 2, Cooglegong District, are given in Appendix I. The numbers alloted to the thin-sections correspond to field-sample numbers. The radio-active rocks at Radio-Active Occurrences Nos. 1 and 2 are composed of quartz, oligoclase and biotite. Pleochroic haloes are present in the mica of all of the rocks sectioned. The average grain-size of the radio-active inclusions in the mica is of the order of 0.02 m.m. and, on account of finely crystalline nature, positive determination could not be made with the available microscope. The radio-active inclusions are tentatively determined as monazite in thin-sections 28, 39, 40 and 42 which represent the respective rock types in Nos. 1, 2 and 4 lenses at Radio-Active occurrence No. 1 and outcrop D at Radio-Active Occurrence No. 2; Zircon or monazite is present in thin-sections 26 and 35 which represent outcrop B, Radio-Active Occurrence No. 2 and Nos. 3 lens, Radio-Active Occurrence No. 1 Zircon or Xenotime is present in thin-section 36, which represents a silicified granitic rock at Radio-Active Occurrence No. 1.

It is considered that the high radio-activity at Radio-Active Occurrences Nos. 1 and 2, can be accounted for by the numerous inclusions in the biotite and dark mica. Several of the rocks sectioned have been affected by mineralisers, as evidence

the small amount of fluorspar, but the mineralisers were for the most part fairly deficient in water in the Cooglegong District. This is inferred from the almost complete absence of greisenisation.

In four of the rocks sectioned the quartz is optically continuous over a considerable portion of the area of the slide, and in section 39 eutectic intergrowth of quartz and biotite, and plagioclase and biotite have been detected. These unusual phenomena would appear to indicate either that the biotite is late-magmatic or that the rock has suffered mild metasomatism. The latter alternative is considered to be the more likely of the two. The mild sericitisation of the plagioclase and bleaching of the biotite would be a normal result of metasomatic action.

The granité from Radio-Active Occurrence No. 1 contains 35 per cent quartz, 30 per cent microcline, 20 per cent plagioclase, 15 per cent biotite (altering to chlorite). The mica contains considerably fewer radio-active inclusions and pleochroic haloes than that in the rocks constituting the adjacent radio-active lenses; this will explain why the granite is less radio-active than the lenses.

III. GENERAL GEOLOGY.

The general geology of the region is shown on Plan No. WA.12A/1. The geological boundaries have been adopted from Gibb Maitland's frontispiece map (Maitland, 1908), and superimposed on the latest military map.

The terrain which carries the alluvial monazite and radio-active rocks is made up principally of biotite granite. It is often gneissic with hornblende developed at the expense of the biotite, and sometimes possesses a banded structure which is distinctly resemblant of original bedding. The strike of the foliation planes in the gneiss almost invariably approximates to north-south. Vertical quartz veins have been intruded along the north-south tensional joints in the granite. Ores of tin, tungsten, tantalum and columbium and rare earch minerals are associated with pegmatite dykes, which are rather flatly disposed. Radio-active lenses were discovered by our field party in association with pegmatite in the Cooglegong District.

In contrast to the mature topography of the granite country there stand out rugged ranges of the Warrawoona Series composed of altered sedimentary rocks (quartzites, conglomerates, schists) and metamorphic rocks (mostly greenstone schist). They trend generally north-west and south-east, Unconformably overlying the granite and the Warrawoona Series is the Nullagine Series composed of sandstones, grits, conglomerates, thin limestones and volcanic rocks. The Series commences with a very coarse conglomerate.

A number of folerite and basic dykes in the granite, form a series of sub-parallel ridges which extend for several miles in a general north-east to south-west direction. They follow a structural line of weakness in the Pre-Cambrian granites and are the most striking topographical features of the landscape in the Cooglegong District.

IV. STRUCTURAL GEOLOGY.

In view of the fact that field reconnaissance was confined almost exclusively to the granitic rocks, the structure of the metamorphic rocks has not been fully investigated. Nevertheless, an attempt has been made to determine the main structural features of the area. This is based on the interpretation of folding and faulting in the banded jasper and lavas at Marble Bar pool on the Coongan River, approximately 3 miles west of Marble Bar.

The jasper bar is 80 feet wide; the strike is 307 degrees* and the dip is 55 degrees easterly. On the right bank of the Coongan River a strong fault zone 27 feet wide was observed in the jasper. This fault zone strikes 163 degrees. The dip of the fault plane could not be observed. Within the fault zone the jasper was crushed and intensely brecciated. It will be noted in the text that at Radio-Active Occurrence No. 1, three radio-active lenses, No. 1, 2, and 3, have a general strike parallel to a strong jointing system in the granite, 152 degrees. The similarity between this strike and the strike of the strong fault zone at the Marble Bar pool suggests a structural relationship.

A second fault at Marble Bar pool strikes 217 degrees. It is a vertical fault and the horizontal displacement is 3 feet. This fault appears to be of the normal type. The Black Range and similar prominent dolerite dyke ridges are elongated in a direction which is parallel to this fault.

Pillow lavas 200 feet thick outcrop 200 feet east of the jasper bar. The beds dip 70 degrees east but the disposition of the pillow indicates that the beds have been overfolded to the west.

V. COOGLEGONG CREEK AREA.

(i) Radio-Active Occurrence No. 1.

At a locality south of Cooglegong Creek and approximately 9 miles south of the old Pilga Head Station, five lenticular bodies of granitic rock show pronounced radio-activity. These were mapped by plane table on 20th October, and Plan No. WA.12A/3 has been prepared to indicate the relationship of the bodies or lenses to the associated pegmatite and granite.

No. 1 and 2 lenses gave Geiger readings over 100 per minute against a background count of 35 per minute, No. 3 lenses gave Geiger readings which were too high to count against a background count of 35 per minute, No. 4 lens gave Geiger readings which were too high to count against a background count of 32 per minute, and No. 5 lens gave Geiger readings over 120 per minute against a background count of 32 per minute.

The granite possesses a higher radio-activity than any other tested in the Cooglegong District. The highest Geiger reading on the granite was 105 per minute against a background count of 32 per minute, but other Geiger readings for the granite are indicated on Plan No. WA.12A/3. The granite is porphyritic and contains 35 per cent quartz, 30 per cent microcline, 20 per cent plagioclase and 15 per cent biotite (altering to chlorite). The granite is foliated in places and it is strongly jointed.

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* All directions of strike and dip in this report are referred to magnetic north.

Two sets of master joints strike 10 degrees and 106 degrees. A cross-jointing striking 152 degrees is followed by quartz-felspar pegmatite veins. Radio-active lenses No. 1 and 2 are associated with a pegmatite which has followed this latter jointing system; No. 3 lens is also parallel to the 152 degrees joint-system and the orientation of No. 4 and 5 lenses suggests that they are parallel to the master joints.

No. 1 lens is composed of an even textured coarse-grained rock, made up of fresh white subhedral plagioclase, colourless quartz and black biotite. Microscopic examination indicates that the plagioclase is oligoclase. The biotite tends to occur in clusters and it is crowded with numerous microcrystalline inclusions with pleochroic haloes. The inclusions which measure from 0.02 m.m. to 0.2 m.m. in diameter are tentatively determined as monazite and they are sufficiently numerous to be responsible for the high radio-activity of the rock. Rarely fluorspar is associated with the biotite. This rock is most unusual in that eutectic intergrowths occur between quartz and biotite and felspar and biotite. This would seem to indicate that the biotite is late-magmatic. The percentages of the essential minerals in the rock are as follows :- oligoclase 55 per cent, quartz 30 per cent and biotite 15 per cent.

The true thickness of No. 1 lens ranges from 2'6" to 3'6" over a length of 10 feet. It is enclosed by quartz felspar pegmatite which contains large crystals of biotite mostly at right angles to the strike of the lens. The pegmatite has a dip of 40 degrees east with which No. 1 lens is conformable. No. 1 lens is terminated at its southern end by a strong joint which strikes 064 degrees. Geiger readings on No. 1 lens were over 100 per minute against a background count of 35 per minute.

Sample No. 39 was taken over a width of 2 ft. 5 inches. This sample was collected for analysis of radio-active content (U and Th.)

No. 2 lens is composed of a granitic rock which is very similar in macroscopic features to the rock in No. 1 lens. The rock is porphyritic with phenocrysts of oligoclase. The percentages of essential minerals present are practically identical with those in No. 1 lens also. The biotite is studded with numerous inclusions which measure from 0.02 m.m. to 0.2 m.m. in diameter. Pleochroic haloes are associated with the inclusions which are tentatively determined as monazite. Geiger readings of over 100 per minute were obtained against a background count of 35 per minute.

Sample No. 40 was taken over a width of 1 ft. 6 inches accoss the lens. The sample was collected for determination of radio-active content (U and Th).

No. 3 lens is composed of a black biotite-rich pegmatitic granite and is traversed by veins of white felspar and clear colourless quartz. It is 16 feet long and has a maximum width of 2 feet. The lens has a dip of 35 degrees east. Geiger readings on No. 3 lens were too high to count when the instrument was adjusted to a background count of 35 per minute. Porphyritic granite lies on the footwall side and it appears to be leached of biotite. This granite gave a Geiger reading of 76 per minute against a background count of 35 perminute.

Sample 41 is representative of the rock in No. 3 lens and was taken over a length of 4 feet. It was collected for determinations of radio-active content (U and Th).

No. 4 lens. Several large boulders are distributed over a length

of 12 feet and width of 4 feet. These appear to be "in situ". The rock is comparable in macroscopic features with that constituting No. 1 lens. Under the microscope the similarity in rock type between No. 1 and No. 4 lenses is confirmed and the percentages of the essential minerals in the rocks are almost identical. The biotite in No. 4 lens also contains abundant inclusions with pleochroic haloes. The inclusion range from 0.02m.m. to 0.1 m.m. in diameter, and they are tentatively determined as monazite. Geiger readings were too high to count when the instrument was adjusted to a background count of 32 per minute.

Sample 42 is a grab sample taken over 4 feet width of outcrops. It was collected for determination of radio-active content (U and Th).

No. 5 lens is composed of a porphyritic biotite granite with colourless quartz and white felspar. The felspar phenocrysts are partly ovoidal and the rock has a rude foliation. The lens has a length of 13 feet and width of 5 feet. Geiger reading was over 120 per minute against a background count of 32 per minute.

Sample 43 was taken across 5 feet width of outcrop. It was collected for determination of radio-active content (U and Th).

Additional Samples:

Sample 36 was taken from a highly radio-active silicified biotite granite. It is composed of quartz, colourless and white felspar and abundant black mica. Magnetite occurs as an accessory. The rock contains clusters or "black balls" of biotite 1-inch across. The rock is also traversed by quartz veins with pyramidally terminated prisms of quartz. On the inner surface of vugs is a black deposit. The quartz veins are one quarter of an inch thick down to thin strigers parallel to one another. One vug contains yellow crystals. Geiger readings were too high to count when the instrument was set to a background count of 32 per minute.

Sample 17 was taken over 6 feet on an outcrop of sandy semi-weathered porphyritic granite (see south-east corner of mapped area on Plan No. WA.12A/3. The rock is composed of quartz, felspar and altered biotite and carries a few veins of pegmatite up to 1-inch thick. The Geiger count on this rock was 100 per minute against a background count of 45 per minute.

(ii) Radio-Active Occurrence No. 2.

This is south of Cooglegong Creek and distant 1,500 feet approximately from Radio-Active Occurrence No. 1 on a bearing of 115 degrees.

Elevated quartz blows intrude the granite and outcrop prominently at intervals in a south-easterly direction towards the Black Range.

At Radio-Active Occurrence No. 2, beryl has been worked on a small scale - about 2 tons having been extracted by A. Jones of Marble Bar. This section was examined in detail and several large blocks of beryl were observed in talus. Tests with the portable Geiger-Muller counter indicated high counts for seams of biotite granite in the vicinity of the beryl occurrences.

A plane-table survey was made on 12th October and a large number of Geiger readings was taken. The highest readings were obtained near the south-weat margin of a large blow of white quartz. The geological features and Geiger readsings are shown

on Plan No. WA.12A/4. For comparison purposes blank Geiger readings were taken on the white quartz blow. These readings are the "background" readings referred to below.

The radio-active rock in outcrops, A, B, C, D, is a medium grained biotite granite composed of colourless quartz, white felspar, and abundant black biotite. In the hand specimen there is a similarity between this rock and that present in the lenses at Radio-active Occurrence No. 1.

Outcrop A is approximately 17 feet long by 1 ft. 6 inches wide. The rock is a medium grained biotite granite. Geiger reading on the rock was 88 per minute against a background count of 35 per minute. Sample 25 was collected over a width of 1 ft. 6 inches. It is to be analysed for radio-active content (U and Th)

Outcrop B is composed of biotite granite lying on a joint-plane in pegmatitic granite which dips easterly at 36 degrees. Outcrop B is regarded as a seam in the granite and it is 12 feet long by 1 ft. 6 inches wide. Geiger readings were too high to count when the instrument was set to a background count of 35 per minute. The biotite contains pleochroic haloes around microcrystalline inclusions, zircon or monazite, which range in size from 0.02 m.m. to 0.2 m.m. One large inclusion in biotite measures 1.4 m.m. by 0.9 m.m. It has not been specifically determined. Sample 26 was collected from outcrop B, and is to be analysed for radio-active content (U and Th).

Outcrop C is composed of porphyritic biotite granite and contains 60 per cent plagioclase, 25 per cent quartz and 15 per cent biotite. Under the microscope the type of plagioclase has been determined as Oligoclase. The biotite contains a few rounded inclusions which have pleochroic haloes but they are indeterminate on account of their extreme fineness.

A Geiger reading of more than 200 per minute was obtained against a background count of 35 per minute.

Sample 27 was taken over a thickness of 1 foot. It is to be analysed for radio-active content (U and Th).

Outcrop D A seam of biotite rich granite 5 feet long and 1 foot thick lies on flat-jointing in normal biotite granite which contains veins of pegmatite. The radio-active seam is composed of black biotite, slightly yellow quartz and pink felspar. Psiloclane forms a deposit on the weathered surface of the seam. Sample 28 is a large block of the radio-active seam (16" x 10" x 4"), which was collected for testing.

Alluvial.

While crossing a small creek about 250 feet north of outcropnA, a high Geiger reading (100 per minute) was observed, against a background count of 36 per minute. The high reading was obtained over sand and gravel. As the granite in the vicinity of the creek was not highly radio-active, samples of the sand in the creek were collected.

Sample 33 represents the dish concentrate from the bottom 5 inches of sand and gravel. The magnetite removed by a bar magnet weighed 1¼ oz. and the radio-active fraction 2¾ oz. The latter concentrate contains very coarse monazite crystals up to 1-inch across and a steel grey mineral in large fragments (undetermined).

The amount of monazite present in the 5 inches of sand and gravel is estimated at 170 lb. per cubic yard.

Sample 34 represents the dish concentrate from rhe top 1-inch of sand. It consisted mainly of magnetite, but the non-magnetic fraction was very highly radio-active.

Only a trace of monazite was detected and a little red garnet, quartz and felspar. It is suspected that fine yttrotantalite or some radio-active mineral other than monazite is present. The concentrate gave Geiger counts greater than 150 per minute, against a background count of 40 per minute. One small dish of the sand (4 lb.) gave a radio-active concentrate weighing 5½ oz., after the magnetite was removed.

(iii) Alluvial Occurrences of Monazite.

Cooglegong Creek Area.

The locations of alluvial occurrences in the Cooglegong District are shown on the Cooglegong District location map (Plan No. WA.12A/2).

The alluvial monazite at Cooglegong has been described (Simpson, 1912), as cinnamon-brown in colour. Closer inspection according to Simpson reveals a mottled colouring, the base being of an oyster colour, tinged with various shades of brown in streaks and cloudy masses. The mineral is opaque and free from visible inclusions (analysis indicates the presence of microscopic intergrowths of albite and in a thin-section of some of our alluvial monazite from Cooglegong included quartz has been detected).

(a) Alluvial Occurrence A.

Small concentrations were found to occur about 3 miles south of Pilga in a small sandy creek which flows into Cooglegong Creek. Pegmatites on the banks of the Creek were found to be slightly radio-active, (e.g. Geiger reading on pegmatite 70 per minute, against a background count of 46 per minute).

(b) Alluvial Occurrence B.

This occurrence is adjacent to the main road between Pilga and Hillside and distant 4.7 miles from Pilga by road. Three samples, Nos. 8, 9, and 10, were taken of the alluvial material and one, No. 11, of a pegmatite.

As monazite was detected in the small creek bed it was considered that it may have been shed from the pegmatite or the granite. A series of Geiger readings was taken by Messrs. Daly and Clarke with a portable Rate-meter set and the pegmatite was sampled at the point where the highest reading was obtained (see Plan No. WA.12A/5).

The Creek shown in Plan No. WA.12A/5 is small and shallow, about 4 feet wide and has an average thickness of 3 inches of sand and gravel.

Sample No. 8. represents the Yandie[1] concentrate obtained from the wash. The sample consisted principally of magnetite. The amount.

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[1] The Yandie is a small open "U"-shaped tray which when properly manipulated in the fashion of a jig can be used for effective dry concentration of alluvial samples. The natives are experts in the use of the Yandie and our prospector, Mr. A. Jones is one of the few white men who can handle it.

of pure monazite present in the wash is estimated at 14 lb. per cubic yard and it is estimated that the wash contains 28 lb. black tin per cubic yard.

Visually it is estimated that, after separation of the magnetite with a bar magnet, the monazite-rich concentrate contained 10 per cent monazite, 20 per cent black tin, 70 per cent red garnet, quartz and felspar. A little ruby tin is also present. The monazite is partly euhedral and obviously has not travelled far from its source.

Sample No. 9. represents the Yandie concentrate obtained from about 20 lb. of wash. The sample consists mostly of magnetite. Black tin and a little quartz, felspar and red garnet are also present, No monazite could be detected. Geiger count on the sample was over 120 per minute against a background count of 40 per minute. It is likely that Yttrotantalite or some other radio-active mineral is present.

Sample No. 10 is a Yandie concentrate obtained from the wash, and consists of quartz, felspar, magnetite, black tin, and a few rounded crystals of monazite and a little red garnet.

Sample No. 11 was collected from a pegmatite outcrop over a width of 4 feet. The location of the sample is shown on Plan No. MA.12A/5. Portion of the sample was dollied and panned off. A little black tin and red garnet were detected in the dish. The pegmatite from which this sample was taken showed moderately high radio-activity.

(c) Cooglegong Creek.

Four holes were sunk in the bed of Cooglegong Creek to ascertain if the wash carried monazite. The following results indicate that no workable concentrations of monazite could be found at shallow depths in Cooglegong Creek.

Hole No. 1. Depth 3 feet 6 inches.

Six inches of wash at 2 feet 0 inches to 2 feet 6 inches. Bottom in greenish decomposed clayey granite. A dish concentrate of the 6 inches of wash 2 feet 0 inches to 2 feet 6 inches gave a small amount of black tin(estimated at 1 lb. per cubic yard), and traces of garnet, magnetite and monazite.

A sample of the decomposed granite bed-rock was panned off, but no concentrate was obtained.

Hole No. 2. Depth 5 feet.

This hole was sunk 57 feet east of No. 1 in sand and gravel. The hole bottomed on decomposed granite. No black tin or monazite could be detected in panning off a sample from the bottom section of this hole.

Hole No. 3.

This pot-hole was sunk half a mile downstream from Hole No. 1.

Hole No. 3 revealed 2 inches of coarse wash on a bottom of decomposed granite. Sample 16 represents the Yandie concentrate obtained from the wash. The concentrate contained 75 per cent black tin, 3 per cent monazite, 3 per cent magnetite and 19 per cent red garnet, quartz and felspar. It is estimated that the wash contains 1 lb. monazite per cubic yard, and 12 lb. black tin per dubic yard.

Hole No. 4.

HoleNo. 4 was a pot-hole about 150 yards upstream from Hole No. 3. It was approximately 1 foot deep. No monazite could be detected in the wash.

Sketch of Portion of
Cooglegong Creek.

Geophysical Testing.

A large bar of granite outcrops in the bed of Cooglegong Creek near the main Pilga-Hillside road and about 150 feet from the right bank. The results of a magnetmometer traverse across the stream bed carried out by Messrs. Daley and Clarke indicate a channel 100 feet west of the granite bar. The depth to the wash could not be determined, but it may be as great as 20 to 30 feet.

(d) Alluvial Occurrence C.

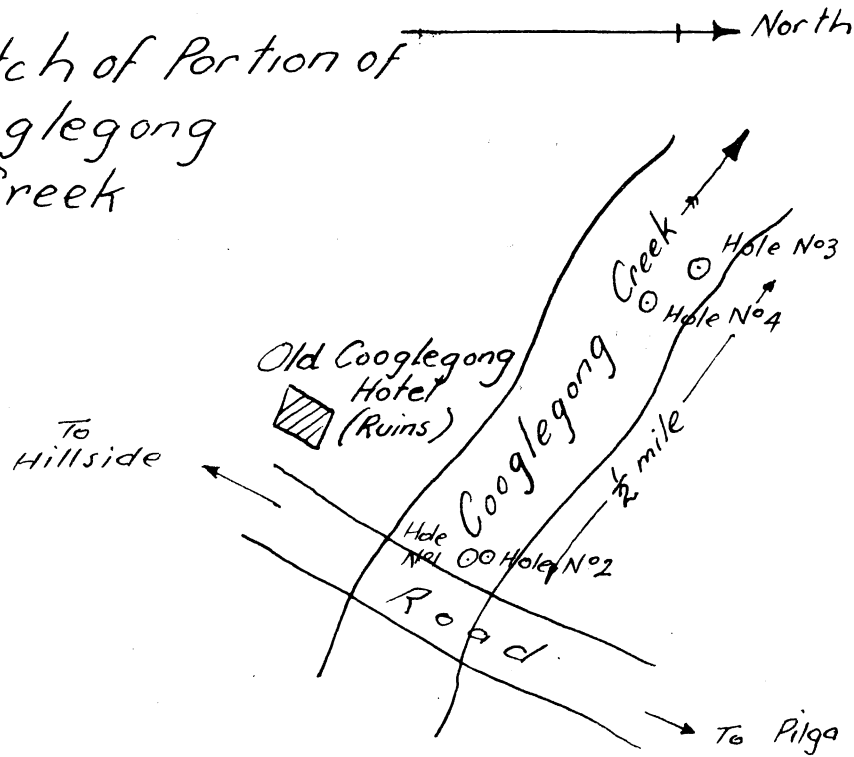
This includes several small shallow alluvial deposits at the headwaters of small creeks draining south from Radio-Active Occurrence No. 1 into Boonana Creek and distant approximately 9 miles south of Pilga. Samples No. 13, 14 and 15 were collected from a creek ¾ mile from Radio-Active Occurrence No. 2 on a bearing of 220 degrees. The Creek in which the samples were collected is about 10 feet wide, and the thickness of the wash 3 inches. The wash rests on a bottom of decomposed granite.

Sample 13. A sample of the wash was yandied and the concentrate was treated with a bar magnet for removal of magnetite. The amount of pure monazite present in the wash is estimated at 120 lb. per cubic yard and the black tin at 24 lb. per cubic yard.

The monazite-rich concentrate contained 75 per cent monazite, 15 per cent black tin and 10 per cent quartz, felspar and red garnet. The monazite was quite coarse and often indiomorphic and, therefore, has not travelled far from its source.

Sample 14. was collected from a pot-hole 1 foot 3 inches deep in the Creek. A trace only of magnetite was present. The wash is estimated to contain 14 lb. monazite per cubic yard and 7 lb. black monazite, 10 per cent black tin, 70 per cent quartz and felspar.

Sketch of Portion of Cooglegong Creek



A trace of red garnet is present as well-formed crystals and as in Sample 13 some monazite is idiomorphic.

Sample 15 was collected from a hole 9 inches deep. The amount of monazite present in the wash is estimated at 56 lb. per cubic yard and the black tin at 28 lb. per cubic yard. The concentrate contains 60 per cent monazite, 30 per cent black tin and 10 per cent quartz, felspar and magnetite.

(e) Boonana Creek.

At approximately 10½ miles south of Pilga, preliminary testing indicated monazite to be present near two old wells on Boonana Creek.

In order to test the creek bed thoroughly seven holes were sunk at intervals of about 200 feet. The position of the holes was surveyed by plane table. The granite bordering the creek was found to be non-radio-active for the most part, but in one case, a pegmatite showed slight radio-activity (see Plan No. WA/12A/6), and in two places indicated on the plan the granite was lsightly radio-active with Geiger counts of 70 and 100 per minute against a back-ground count of 56 per minute.

The amount of monazite present in the seven holes is far too small (the amount of concentrate obtained from large dishes was less than 2 drams) to allow working even on a small scale. In each case the seven holes bottomed on hard rock - decomposed granite.

Hole No. 1. Depth 3 feet 2 inches.

0 - 1ft. 10 inches. Light sand and gravel.
1 ft. 10 inches - 2 ft. 8 inches. Coarse brown grit.
2 ft. 8 inches - 3 ft. 2 inches. Fine greay sand, firmly packed.
Decomposed granite bottom.

A sample (34 lb.) of the sand from 2 ft. 8 inches to 3 ft. 2 inches was yandied. The concentrate contained about 3 per cent fine black tin and a trace of fine monazite (less than 1 per cent). The concentrate consisted mostly of colourless quartz and creamy felspar.

Hole No. 2. Depth 3 feet 6 inches.

0 - 2' 0" Light sand and gravel.
2'0"- 2' 6" Coarse brown grit.
2'6"- 3' 6" Light coloured firmly packed grit.

Decomposed granite bottom.

A sample (34 lb.) of the sand from 2 ft. 0 inches to 3 ft. 6 inches when panned off gave only a trace of fine black tin and garnet. No monazite was present.

Hole No. 3. Depth 3 feet 3 inches.

0 - 2'0" Light aand and gravel.
2'0" - 3"3" Greyish firmly packed gravel.

Decomposed granite bottom.

A sample (24 lb.) from 2 ft. 0 inches to 3 ft. 3 inches after dish concentration gave only a trace of fine black tin and garnet.

Hole No. 4. Depth 1 foot 3 inches.

0	-	3"	Light gravel.
3"	-	1'3"	Greyish compact gravel.

Decomposed granite bottom.

A sample (24 lb.) from 3 inches to 1 ft. 3 inches was yandied. The concentrate contained about 3 per cent monazite and 1 per cent black tin. The bulk of the sample consisted of colourless quartz and creamy felspar.

Hole No. 5. Depth 11 inches.

0	-	3"	Light gravel.
3"	-	11"	Greyish compact gravel.

Decomposed granite bottom.

Sample from 3 inches to 11 inches was yandied, but no concentrate was obtained.

Hole No. 6. Depth 2 feet 6 inches.

0	-	2'0"	Loose gravel.
2'0"	-	2'3"	Coarse gravel.

Decomposed granite bottom.

Sample (12 lb.) from 2 ft. 0 inches to 2 ft. 3 inches was yandied, but gave no concentrate.

Hole No. 7. Depth 2 feet 6 inches.

In this hole about 6 inches of gravel rested on the bottom of decomposed granite. A concentrate obtained by panning consisted of monazite and black tin and red garnet. The amount of monazite present in the wash would be about 4 lb. per cubic yard.

A concentrate of the surface sand at one point approximately 150 feet downstream from the junction of the two creeks (shown on Plan No. WA.12A/6) carried a large proportion of monazite as well as garnet, magnetite and a trace of tin. This is only a local surface concentration, trapped by a rocky outcrop.

VI. OLD SHAW, ALLUVIAL MONAZITE.

The gullies in the vicinity of the new windmill have been worked for tin, but only very small traces could be detected in the old dumps of rejected fines. Sample 18 contains a little black tin, and monazite. This sample was obtained as a Yandie concentrate from 20 lb. of the gravel and coarse granitic sand on the bank of a small creek which has been worked in the past.

Two hundred yards north of the new windmill an old well was examined. The material on the well dump is pegmatitic granite (non-radio-active). Nearby a dump of material has been previously treated. Sample 19 represents the yandie concentrate from 25 lb. of this latter material. It consisted of a few ounces of monazite and black tin.

A pegmatite dyke 300 yards west of the new mill was tested with the Geiger, but it was not radio-active.

VII. TURNER RIVER.

While testing some pegmatite dykes alongside the Abydos-Fort Hedland Road and about 10 miles by road north-east of Abydos, it was noted that the granite appeared to be slightly radio-active. A Geiger reading of 73 per minute was obtained against a background count of 56 per minute. In order to determine whether or not the effect was local we ran south towards Abydos for ½ mile by road, A reading on the reddish sandy soil was obtained viz. 73 per minute against a normal background count of 56 per minute. Overlying the granite at this point by the roadside there is 13 inches of sand cover.

The top 1-inch of sand is represented by sample 22. The sand is composed principally of quartz with some felspar and a little brown limonite and fine black mineral (non-magnetic when tested with a bar magnet). Sample No. 23 represents the next 3 inches of chocolate loam with grains of quartz and felspar and a little zircon (perfect bipyramids) and black grains of magnetite (?) and clayey material. Sample 23 when tested at Marble Bar gave a Geiger count of 45 per minute against a background count of 34 per minute.

Sample 24 was taken over the bottom 9 inches of chocolate sand which is composed of coarse angular quartz and felspar, rounded grains of limonite, a little psilomelane, a trace of magnetite, fine black grains (non-magnetic) and reddish grains (?) garnet. Under-lying this sand there is decomposed granite which is not highly radio-active.

VIII. WODGINA.

Although the occurrences of radio-active ores at Wodgina are not considered to be sufficiently widespread to be of commercial value, they have been closely studied because their paragenesis and mode of occurrence may have a bearing on other deposits in the district.

The researches of Simpson (1928) have established four distinct radio-active mineral species at Wodgina namely mackintoshite, thorogummite, pilbarite and hydrothorite.

The pilbarite appears to be the most plentiful of the four but hydrothorite is also readily recognisable.

The pilbarite occurs at the south-west corner of a quarry at the north-end of the tantalite lode (see Plan No. WA.12B/1) . It is immediately north of a strong vertical fault which cuts obliquely across the greenstone-schist hanging-wall and the pegmatite.

The pilbarite and hydrothorite appear tofill small pockets and cavities, in a small biotite-rich zone measuring 2 feet 6 inches by 1 foot within a mass of albite-felspar which contains ovoids of bluish quartz up to 9 inches by 4 inches. The small biotite-rich zone studded with pilbarite and hydrothorite lies within a larger biotite-rich zone, 8 feet long by 1 foot thick, which follows the jointing of the albite host-rock, dipping at 40 degrees west. Pink garnet (Spessartite) occurs within the 8 foot by 1 foot biotite-rich zone. The albite occurs partly in radiating acircular crystals and the biotite in radiating clusters from which in one case at least the albite crystals radiate out. The pilbarite is cream coloured and the hydrothorite is pink and cream, the average size of the particles being about one quarter of an inche across.

Pilbarite was also observed in association with lithiophilite ($LiMnPO_4$), the latter altering to purpurite ($H_2O.(MnFe)_2O_3$.

P_2O_5) and psilomelane. No lithiophilite was observed "in situ", but the reported location near the strong fault is shown in Plan No. WA.12B/1. Several large fallen blocks of lithiophilite were examined in the open cut and occasional small inclusions of pilbarite were observed. Beryl (rosterite) has been mined extensively close to the radio-active occurrences (see Plan No. WA.12B/1).

It was reported by Mr. Kennedy, Manager of Tantalite Ltd., that several hundredweights of stone containing pilbarite have probably been derived from the north-end of the tantalite lode as specimens, as wastage in quarry blasting and as run-off into the tailings.

Several sections along the tantalite-bearing pegmatites were tested at Wodgina, but no outstanding indications were detected with the portable Canadian Geiger-Muller counter. It is interesting to note, however, that in the felspar footwall lode in the Houston shaft small brown zones surround crystals of tantalite. Some of these zones or "eyes" are slightly radio-active and give counts up to 60 per minute against a background count of 30 per minute.

At the southern end of the tantalite lode according to Rowledge (1943) "an unknown radio-active mineral was associated with tantalite and albite - the radio-active mineral being in pockets the size of a pea and in veinlets, and sometimes coating the tantalite".

Tailings.

(i) The tailings paddock at the new mill was tested by a surface traverse with the portable Geiger. The highest count obtained was 52 per minute on the western edge of the tailings paddock against a back-ground count of 44 per minute. This slight increase in the count rate would appear to indicate only a trace of radio-active material.

(ii) The surface of the tailings paddock at Cassiterite Hill was traversed with a Geiger-Müller counter. The highest reading obtained was 45 per minute, against a background count of 30 per minute. Two holes were bored in the tailings each approximately 18 inches deep. The Geiger readings obtained from the borings was only of the order of 45 per minute against a background count of 30 per minute.

Erosion has exposed a channel 5 feet deep in the tailings. The section exposed was tested, but no high Geiger readings could be obtained. On the western side of the tailings paddock there is exposed an average thickness of 6 feet of sands. The Geiger-Muller readings obtained in a vertical section were all less than 50 per minute against a background count of 30 per minute.

The Rock-hole Pegmatite.

This is a large pegmatite dyke which is approximately 1,800 feet west of the mill at the north-end of Tantalite Limited workings. The pegmatite dyke is shown on Plan No. WA.12B/2. It has a maximum width of 85 feet and length of approximately 600 feet. The pegmatite is composed of albite, quartz and white mica.

Two small masses of lithiophilite occur within the pegmatite (see Plan No. WA.12B/2). These occurrences of lithiophilite appear to be "in situ", each block being about 3 feet across. Geiger counts of 100 per minute and 130 per minute were obtained on the lithiophilite masses against a background count of 30 per minute. Sample 38 was obtained from one of the masses of lithiophilite.

IX. STUTZ TIN MINE.

This occurrence is approximately 3 miles south-south-east of Pilga. The total production is reported to be only 11 bags of tin and the mine is relatively unimportant. However, it was decided to take a series of Geiger-Muller readings in the area adjacent to the small adit. The area was mapped by plane table on 23rd September, 1947 (see Plan No. WA.12A/7).

The main ore dump contains approximately 2 tons of low grade ore which would average about 1 per cent black tin. A Geiger reading of 56 per minute was observed on the dump against a background count of 43 per minute. In the adit the Geiger reading was 55 per minute against the same background count. Admittedly these are only slight increases in the count-rate. Some of the pegmatites are slightly radio-active and the Rate-meter readings were recorded by Mr. J. Daly.

The principal rock type is a hornblende gneiss composed of quartz, felspar and hornbelnde, but large outcrops of hornblende granite and hornblende schist were mapped.

Several large pegmatite dykes are shown in Plan No. WA.12A/7, and with but one exception these show a tendency to be elongated parallel to the foliation of the gneiss.

Four samples of the low-grade tin ore were taken in the adit which has been sunk 30 feet on a slight grade.

There are two pegmatite dykes on the south wall averaging 12 inches and 15 inches in thickness respectively. These dykes cut across the foliation lines of the hornblende schist country at acute angles. On the north wall there is only one vein of pegmatite which has a dip of 20 degrees east. The material on the main dump consists of pegmatite bearing black tin and garnet; brecciated pegmatite carrying epidot and hornblende schist.

In samples Nos. 29, 30 and 31, the rock sampled consists of a pegmatite composed of quartz and albite with a little pink garnet and cassiterite. The cassiterite content in each of these samples is estimated at 1 per cent.

Sample No. 29 was taken from a flat lenticular pegmatite with an average thickness of 12 inches over a length of 12 feet on the south wall. The sample contains a little chlorite.

Sample 30 was collected from a flat vein on the north wall over a length of 10 feet.

Sample 31 represents a pegmatite dyke which has a dip of 23 degrees east, and is well exposed on the south wall of the underlie for a length of 10 feet with an average thickness of 12 inches.

Sample 32 was collected over a width of 2 feet 6 inches in a pegmatitic granite composed of colourless quartz, white felspar and a little pink garnet and black tin. Estimated ore content is less than 1 per cent black tin. A large pot-hole 4 feet deep lies 50 feet east of the adit. It exposed a flat pegmatite veins 12 inches thick carrying a small amount of black tin.

Alluvial.

A run of alluvial and eluvial ground over 500 feet long and 60 feet wide is exposed in a small depression immediately

to the west of Stutz Tin Mine. This ground has been well worked, but no monazite was observed. Monazite has been recorded to the no north-west of Stutz Tin Mine (Simpson, 1927). It was stated that there was a fair percentage of gravelly monazite associated with black tin in 6 inches of payable gravel exposed in pot-holes, 8 to 15 feet deep. According to Simpson the ThO_2 content of the monazite was 4.5 per cent.

X. MOOLYELLA TIN-FIELD.

The Moolyella tin-field has been a good producer of high-grade tin ore from shallow alluvial workings. At present about 180 natives are working on the field producing Yandie concentrates. Last year they produced 15 tons of tinstone concentrates estimated to contain 66 per cent tin.

No commercial output of monazite can be expected from this field. The tin concentrates are sold to Mr. D. Thompson at Moolyella. Mr. Thompson is of the opinion that monazite is not present to any extent in the alluvial and eluvial tin concentrates in the Moolyella tinfield. Our own field-work confirms this opinion.

The alluvial monazite from Moolyella is very similar in appearance and composition to that at Cooglegong. The mineral is opaque and of a somewhat darker and more greyish-brown colour than the Cooglegong mineral. It is richer in thorium than the latter. The amount of monazite present is at the most a trace even after yandie concentration and there are few locations where even a trace can be found. In fact, monazite to the extent of a trace was found at only 2 locations - 4 miles south-south-east of Thompson's store, and in Johansson's jig concentrates. The four feet thickness of eluvial material exposed in Johansson's workings on Huntsman Lead was tested with the Geiger-Muller counter, but no radio-activity could be detected and the amount of monazite present must be very small indeed. The amount present in the jig concentrate is still only a trace.

The Moolyella granite is traversed by veins of pegmatite, and quartz which rather elongated and strike roughly north-south. The quartz veins tend to be steeply dipping, but the pegmatites generally have a low dip, 30 degrees or less. The largest pegmatite dyke observed was that in which a tin deposit known as Aitkin's lode (Montgomery, 1908) has been worked. It has a maximum length of 300 feet and maximum width of 52 feet and intrudes porphyritic biotite granite which is gneissic in places. The pegmatite dyke is only slightly radio-active (highest Geiger reading 60 per minute against a background count of 40 per minute).

The granite is a biotite granite which is commonly pegmatitic and in some places is foliated and gneissic. The pegmatites have generally followed one system of joint planes which strike from 350° to 020° magnetic and have a dip of about 30° to the east, though in one case a dip of 10° was observed. The near-vertical joints observed had strikes of 042°, 060°, 085°, 137°, and 160° magnetic.

Analyses.

Previous analyses (Simpson, 1912) quoted for monazite from Moolyella are as follows ThO_2 percentage = 5.03, 5.17, 5.24.

XI. ADDITIONAL LOCALITIES.

Three localities Eley's, Trig Hill and Mount Francisco

were considered worthy of investigation. However, acting largely on the advice of our prospector and guide it was not considered expedient to visit each of these. An attempt was made to find Trig Hill, but after traversing some extremely rough country the search had to be abandoned. The following information regarding occurrences at the three localities has been supplied by Mr. H.P. Rowledge, Director, Government Chemical Laboratories, Perth.

Eley's.

At Eley's tanteuxenite has been recorded (Simpson, 1927), as plentiful in alluvial tin rejects from M.C. 15, forming 27 per cent of a parcel of rejects collected by Simpson in 1927. Monazite made up 69 per cent of the sample, and occurred in fragments from ⅛ inch to 1 inch in diameter. Dr. Simpson stated that although there was very little evidence as to the extent and value of the alluvial deposits, there was an area of about 3 square miles of made ground, which might pay to work on a large scale.

Trig Hill.

Yttrotantalite has been recorded from alluvial material said to be from a gully on the side of "Trig Hill". Later it was found "in situ" in a pegmatite. An attempt was made to find the occurrence, but after traversing some extremely rough country in a jeep the search had to be abandoned.

Yttrotantalite has also been recorded by E.S. Simpson from two localities in the Cooglegong District. A small parcel concentrated by Simpson in 1927 in a creek bed alongside Angelo's gadolinite vein, half a mile west of the Black Range, contained 10 per cent yttrotantalite and a small percentage of monazite.

Another parcel obtained in 1937 from a place four miles east of Cooglegong Creek tin workings contained some yttrotantalite intimately intergrown with monazite in angular pebbles up to 10 grams in weight.

Mount Francisco.

Alluvial monazite associated with detrital tin ore has been recorded 5 to 6 miles south-east of Francisco Well and tanteuxenite occurs in alluvial tin-ore from P.A. 630, 6 miles south-west of the Government Well.

List of References.

Maitland, A. Gibb, 1908 : The Geological Features and Mineral Resources of the Pilbara Goldfield. Reprint of Bulls. No. 15, 20 and 23.

Montgomery, A., 1908 : Appendix III to above report by A. Gibb Maitland. pp.79-80.

Rowledge, H.P., 1943 : Preliminary Report on a Mineralogical Examination of Portions of the Pilbara Goldfield. Ann. Rep. Dept. Mines W.A. for 1943, pp. 109-110.

Simpson, E.S., 1912 : The Occurrence of Monazite at Cooglegong and Moolyella. Geol. Surv. W. Aust. Bull. No. 48. p.44.

_____ 1919 : Rare Metals of Western Australia. The Min. Hd.Bk. Geol. Surv. Mem. No. 1. Ch. 2, pt. III. Sectn. 18, Rare Metals, pp. 7 and 17.

_____ 1928 : Report on the Pilbara Tin and Tantalum Deposits. Appendix to Ann. Rep. Chem. Branch Mines Dept. W. Aust. for 1927 p. 19.

_____ 1928A : Contributions to the Mineralogy of Western Australia. Journ. Roy. Soc. W. Aust. Vol. XIII. pp.37-41.

_____ 1928B : Contributions to the Mineralogy of Western Australia. Journ. Roy. Soc. W. Aust. Vol. XIV. p.45-48.

_____ and Gibson, C.G., 1907 : Distribution and Occurrence of the Base Metals in Western Australia. Geol. Surv. W. Aust. Bull. No. 30, pp. 50-55.

Sullivan, C.J., 1939 : The Moolyella and Cooglegong Tin Fields, Pilbara Goldfield. Aer. Geol. Geophys. Surv. Nth. Aust. Rept. No Aust. No. 57. pp. 1-7.

APPENDIX I.

DESCRIPTION OF THIN SECTIONS.

THIN-SECTION 39.

From Sample 39, No. 1 lens, Radio-Active Occurrence No. 1.

Plagioclase as colourless crystals, slightly sericitised. Lamellar twinning (albite law) general with probable Carlsbad twins. Composition determined from combined Carlsbad and albit twinning is andesine containing 32½% anorthite.

Quartz clear, colourless, interstitial.

Biotite as ragged plates, pleochroic straw to dark brown. The biotite contains numerous neutral coloured inclusions, both rounded and lozenge shaped (suggesting strong development of 110 face). The inclusions are somewhat turbid and have high order interference colours and pleochroic haloes. Tentative determination : monazite, fluorite occurs along cracks in the biotite. Biotite and quartz occur in eutectic intergrowth (graphic). Biotite and plagioclase occur in eutectic intergrowth (graphic). Size of inclusions 0.02 m.m. to 0.2 m.m.

Essential Mineral Percentages.

It is estimated that the average composition of the rock is as follows :-

Plagioclase	=	55 per cent.
Quartz	=	30 " "
Biotite	=	15 " "
Total		100

THIN-SECTION 40.

From Sample 40, No. 2 lens, Radio-Active Occurrence No. 1.

Plagioclase as large tabular crystals and phenocrysts. Partly sericitised and cloudy due to advanced kaolinisation. Lamellar twinning on albite law general with one probable carlsbad twin. The composition determined from combined Carlsbad and albite twinning is oligoclase containing 26% anorthite. Purple fluorspar is associated with the sericite.

Biotite as ragged plates, pleochroic straw to dark brown. Inclusions, numerous neutral to grey grains, high order interference colours, rounded with pleochroic haloes. Similar grains, but larger occur at the margins of the biotite. These also have pleochroic haloes and high order interference colours, rounded with pleochroic haloes. Similar grains, but larger occur at the margins of the biotite. These also have pleochroic haloes and high order interference colours. Size ranges from 0.02 m.m. to 0.2 m.m. Tentative determination : monazite.

Violet fluorspar is associated with the biotite and the crystals are parallel to the cleavage plans of the biotite.

Quartz clear, colourless with numerous fine dusty inclusions arranged in parallel lines (the grains are indeterminate). The quartz is interstital and optically continuous over large areas. Traversed by broad cracks. Shadlow extinction. In one case micrographic intergrowth of quartz and felspar was observed.

Essential Mineral Percentages.

It is estimated that the average composition of the rock is as follows :-

Plagioclase	55 per cent
Quartz	28 " "
Biotite	17 " "
Total	100

THIN-SECTION 35.

From Sample No. 35, No. 3 lens, Radio-Active Occurrence No. 1.

Quartz clear, colourless interstitial. Rare inclusions of zircon and very fine indeterminate inclusions arranged in parallel lines.

Biotite as ragged plates, pleochroic straw coloured to dark brown. The biotite contains a great number of clear colourless inclusions with strong pleochroic haloes. The inclusions range from 0.02 m.m. to 0.2 m.m. across. They could be either zircon or monazite.

Microcline, rare tabular crystals with typical cross-hatching under crossed-nicols. Slightly sericitised and kaolinised.

Essential Mineral Percentages.

It is estimated that the average composition of the rock is as follows :-

Quartz	=	50 per cent.
Microcline	=	30 " "
Biotite	=	20 " "
Total :		100

THIN-SECTION 42.

From Sample 42, No. 4 lens, Radio-Active Occurrence No. 1.

Quartz, clear, colourless but contains great number of clear colourless inclusions, order high-interference colours, probably zircon. The quartz is interstitial and optically continuous over large areas.

Plagioclase, tabular aspect, moderately sericitised. Multiple twinning on albite law is general, but there are no Carlsbad twins in the section. Composition determined from maximum extinction angle in symmetrical zone is basic oligoclase containing 29% anorthite.

Biotite as ragged plates. Pleochroic straw to dark brown. Abundant inclusions clear, colourless and greyish with pleochroic haloes and high order interference colours. The inclusions possess one parting and range in size from 0.02 m.m. to 0.1 m.m. Tentative determination : monazite.

Essential Mineral Percentages.

It is estimated that the average composition of the rock is as follows :-

Quartz	=	50 per cent.
Plagioclase	=	40 " "
Biotite	=	10 " "
Total :		100

THIN-SECTION No. 36.

From Sample No. 36. Radio-Active Occurrence No. 1.

Quartz, clear, colourless interstitial with a myriad of clear colourless inclusions (indeterminate). The quartz is optically continuous over the whole area observed in the thin section. Shadow extinction.

Plagioclase, crystals with lamellar twinning on Ab law. No Carlsbad twinning is present in the slide and there are insufficient crystals to allow a determination of composition by maximum extinction in symmetrical zone. The refractive index lies between those of quartz and basam so the felspar is probably oligoclase.

Mica as ragged plates, light coloured. Pleochroic, colourless to light straw. This may be zinnwaldite. Pleochroic haloes sometimes even without any visible core, but where core is visible it occurs as rounded grains and 0.02 m.m. across and clear, colourless, with high order interference colours. In one case, an idio morphic bipyramidal prism may be zircon or xenotime.

Essential Mineral Percentages.

It is estimated that the average composition of the rock is as follows ;-

Quartz	=	80 per cent
Plagioclase	=	15 " "
Mica	=	5 " "
Total -		100

THIN-SECTION 29.A.

From Sample No. 29A, near No.2 lens, Radio-Active Occurrence No. 1.

Quartz clear, colourless, interstitial, Shadow extinction. Fine microcrystalline inclusions, arranged in parallel lines (indeterminate).

Microcline as large tabular crystals studded with quartz blebs in one case. Characteristic cross-hatching under crossed-nicols. Slightly kaolinised.

Plagioclase as phenocrysts of tabular aspect. Sericitised more extensively than the microcline. The plagioclase is also kaolinised. Lamellar twinning on albite law general with one probable Carlsbad twin. The composition determined from combined Carlsbad and albite twinning is oligoclase containing 25½% anorthite.

Biotite as ragged plates pleochroic straw to dark brown, but mostly altering into chlorite with some secondary magnetite appearing. Inclusions and pleochroic haloes very rare. The inclusions are indeterminate.

Essential Mineral Percentages.

Microcline	=	30 per cent.
Plagioclase	=	20 " "
Quartz	=	35 " "
Biotite (altering to chlorite)	=	15 " "
Total -		100

THIN-SECTION 26.

From Sample No. 26, Outcrop B, Radio-Active Occurrence No. 2.

Quartz, fairly clear colourless, optically continuous over large areas. Very fine lines of colourless inclusions (?) zircon, (high order interference,colours). The quartz shows shadow-extinction and patch-work effects.

Biotite as ragged plates, blotchy in appearance. Pleochroic colourless to dark brown. Microcrystalline inclusions : zircon or monazite with pleochroic haloes. The inclusions range in size from 0.02 m.m. to 0.2 m.m. with one exceptionally large crystal measuring 1.4 m.m. by 0.9 m.m.

Plagioclase, rare with lamellar twinning(albite law). The plagioclase is moderately sericitised. The twin lamellae were not sufficiently clear to allow of statistical determination of the type of plagioclase, but, as the .RI. lies between those of quartz and balsam it is probably oligoclase.

Essential Mineral Percentages.

It is estimated that the average composition of the rock is as follows :-

Quartz	=	92 per cent.
Biotite	=	7 " "
Plagioclase	=	1 " "
Total		100

THIN-SECTION No. 27.

From Sample No. 27, Outcrop C, Radio-Active Occurrence No. 2.

Quartz, interstitial, clear, colourless with myriads of inclusions arranged in parallel lines (indeterminate). The inclusions are clear colourless and are possibly zircon. The quartz is optically continuous over large areas and shows shadow-extinction and patch-work effects.

Plagioclase: Large phenocrysts, broad tabular, lamellar twinning on albite law general. Partially sericitised with secondary magnetite along broad cracks and cleavage planes. No Carlsbad twinning is present in the slide and there are insufficient crystals to allow an accurate determination of composition by maximum extinction in symmetrical zone. Its refractive index lies between those of quartz and balsam and this, together with the extinction angles obtained, indicates its composition to be oligoclase containing at least 23% anorthite.

Biotite as ragged plates, pleochroic straw to dark brown. Contains only a few inclusions (indeterminate on account of their extreme fineness) with pleochroic haloes. The cinlusions are rounded and have high order interference colours. The largest grains was 0.04 m.m. across.

Essential Mineral Percentages.

It is estimated that the average composition of the rock is as follows :-

Plagioclase	= 60	per cent.
Quartz	= 25	" "
Biotite	= 15	" "
Total	100	

THIN-SECTION 28.

From Sample 28, Outcrop D, Radio-Active Occurrence No. 2.

Biotite, pleochroic straw to dark brown. Ragged plates occurring in clusters. The biotite contains numerous neutral coloured inclusions (high order interference colours) which are surrounded by pleochroic haloes. These inclusions possess a basal parting and range in size from 0.02 m.m. to 1.16 m.m. across. Tentative determination : monazite.

Associated with the biotite, but no within the biotite is sericite, and a little felspar and quartz.

Quartz, clear colourless, interstitial, but optically continuous over a large area. The thin-section contains 75 per cent biotite and 15 per cent quartz. The hand-specimen contains 70 per cent biotite, 20 per cent quartz and 10 per cent kaolinised felspar.

APPENDIX II

ANALYSES.

Mineral	LOCALITY	Occurrence	ThO_2 %	UO_3 %	UO_2 %	Reference.
Yttrotantalite	Cooglegong	Alluvial	1.02	1.18		W.Aust.Geol. Surv.Bull.35
"	"	In pegmatite	0.53	2.38		p.44.
Monazite	Cooglegong	Single x'tal	3.80	strong		Geol.Surv.W.
"		Large bulk sample	4.38			Aust.Bull
"		Small " "	3.46			No.35, p.44.
Monazite	Moolyella		5.03			
"	"		5.17			Geol.Surv.W
			5.24			Aust.Bull.No.
			5.02			35. pp.43,44.
	Near StutzP.A.		4.50			
Euxenite	Cooglegong			6.69		N.S.Geol.Surv. Bull.35. p.53.
Mackintoshite	Wodgina	In pegmatite			35.60	W.A.Geol.Surv.
Thorogummite	"	"		37.33		Bull.59, p.54.
Pilbarite	"	"		27.09		
Hydrothorite	Wodgina	In pegmatite	57.79	2.98		Jour.Roy.Soc. W.Aust.Vol. 13, p.38.

APPENDIX III.

FIELD MEMORANDUM.

Name of officer : C.W. Ball. Date : November, 6th, 1947.

PILBARA GOLDFIELD.

Field No.	Locality	Circumstance of Occurrence Field Determination	If for Section Determination	If for Analysis or Assay	Remarks	Reg.No.	Geiger Reading	Back Ground Count.
BMR/AM 1/C.W.B. = Sample 8	Cooglegong Ck.	Concentrate Yandied from alluvial material near main road 5 miles from Pilba H.S. (Abandoned).	Concentrate contains Monazite, limonite, hematite, magnetite & cassiterite and brownish red garnet-Magnetic iron oxide removed with magnet. Visual estimate of percentages:- Monazite 10% Black tin 20% Garnet, quartz felspar and limonite 70% Total : 100%	ThO_2	Iron oxide removed by bar magnet = 12 oz. 7 drams. Monazite rich conc = 7 oz. 11 drams. Estimated content of wash 14 lb. pure Monazite per cubic yard. 28lb black tin per cubic yard.		>150 for concentrate	40
BMR/AM 2/C.W.B. = Sample 9	Cooglegong	Ditto	Mostly magnetite and black tin with red garnet and a little quartz. No monazite detected. Sample is radio-active.	Is there any Yttrotantalite present? Or other radio-active substance.	20 lb. of wash yandied.		> 120	40
BMR/AM 3/C.W.B. = Sample 11	Cooglegong Ck.	From pegmatite 15ft wide. Near Main Road 5 miles from Pilga H.S. (Abandoned) Sample taken over width of 4 feet.	Sample taken over width of 4 ft. Dish prospect:- concentrate of black tin and red garnet.	Radio-active content.				Radio-active.
BMR/AM 4/C.W.B. = Sample 12	Cooglegong	Alluvial concentrate. Approx. 8 miles south of Pilga H.S. (Abandoned). (Yandied).	Estimated contents: Monazite 20% Black tin 30% Quartz and Felspar 50% Total : 100% The magnetite was removed. The monazite is coarse.	ThO_2	Monazite conc = 2oz. 15 drams Magnetite = 1 oz 15 drams			(When radio-active content do test for U and Th. Min. Determination.)
BMR/AM 5/C.W.B. = Sample 13	Cooglegong Ck. Approx. 8 miles south of Pilga H.S. (Abandoned).	Alluvial Creek concentrated (Yandied).	Magnetite removed with bar magnet. Balance of concentrate contains:- Monazite 75% Black tin 15% Quartz & Felspar) and trace of red) garnet) 10% Total : 100% The monazite is quite coarse.	ThO_2	Monazite conc= 3 oz. 15 drams Magnetite = 15 drams 5 lb. Yandied. Estimated content of wash: 120lb monazite per cubic yard. 24lb black tin per cubic yard.			

Field No.	Locality	Circumstance of Occurrence	Field Determination	If for Section	If for Determination	If for Analysis or Assay	Determination	Reg. No.	Geiger Reading	Back ground count
BMR/AM 6/C.W.B. = Sample 14	Cooglegong Ck. Approx. 8 miles south of Pilga H.S. (Abandoned).	Alluvial Creek concentrated (Yandied.)	Magnetite removed with magnet. Balance of concentrate contains:- Monazite 20% Black tin 10% Quartz and felspar 70% Total : 100% Trace of reddish garnet. As in previous sample some monazite is euhedral and therefore has not travelled far from source.			ThO_2	Monazite-rich conc = 1½ oz. Magnetite = 3 drams. 10 lb. yandied. Estimated content of wash 14 lb monazite per cubic yard. 71b black tin per cubic yard.			
BMR/AM 7/C.W.B. = Sample 15	Ditto	Ditto Represents about 3" wash.	Estimated content:- Monazite 60% Black tin 30% Quartz & felspar) and Magnetite) 10% Total : 100%			ThO_2	10 lb of wash yandied. Estimated content of wash 56 lb monazite per cubic yard. 28 lb Black tin per cubic yard.			
BMR/AM 8/C.W.B. = Sample 17	Cooglegong Ck. Approx. 8 miles south of Pilga H.S.(Abandoned).	Porphyritic granite sandy, semi-weathered. Sample taken over a width of 6 feet.	Composed of quartz felspar and altered biotite with a few veins of pegmatite up to 1-inch thick. Rock is radio-active, Sample taken over width of 6 feet.		Radio-active content.				100	45
BMR/AM 9/C.W.B. = Sample 25	B. Beryl lode approx. 8 miles south of Pilga H.S. (Abandoned) Outcrop A.	Outcrop 18" wide.	Medium grained biotite granite composed of colourless quartz, white felspar and abundant black biotite. The quartz grains have a very rounded aspect.		Radio-active content.				88	35
BMR/AM 10/C.W.B. = Sample 26	B. Beryl lode. Approx. 8 miles south of Pilga H.S. (Abandoned). Outcrop B.	Outcrop 1'6" wide appears to occupy a joint-plane in pegmatitic granite. Length of biotite rich seam = 12ft.	Medium grained biotite granite composed of colourless quartz lesser cloudy felspar and abundant black biotite.		Radio-active content.				Too fast to count	35
BMR/AM 11/C.W.B. = Sample 27	B. Beryl lode. Approx. 8 miles south of Pilga H.S. (Abandoned). Outcrop C.	Outcrop 5 ft. long by 1 ft. wide. Sample taken over width of 1 foot.	Medium grained biotite granite composed of colourless quartz and white felspar and abundant black biotite.	Yes	Radio-active content.				Too fast to count	35
BMR/AM 12/C.W.B. = Sample 28	Beryl lode. Approx. 8 miles south of Pilga H.S. (Abandoned). Outcrop D.	Large block 16" x 10" resting on granite outcrop. Manganese dioxide forms a deposition on the weathered surface of the rock.	Biotite granite composed of black biotite slightly yellow quartz and pink felspar.	Yes	Radio-active content.				Not determined.	

Field No.	Locality	Circumstance of Occurrence	Field Determination	If for Section	If for Determination	If for Analysis or Assay	Determination	Reg. No.	Geiger Reading	Back ground count
BMR/AM 13/C.W.B. = Sample 29	Stutz tin lode approx. 5 miles south of Pilga H.S. (Abandoned).	Flat lenticular pegmatite average thickness 15".	Pegmatite, fine grained composed of quartz and felspar, black tin and chlorite. Contains approx. 2% black tin.	Yes	Radio-active content					
BMR/AM 14/C.W.B. = Sample 30	Ditto	Flat veins on north wall, average thickness 12" over length of 10 ft., in flat underlie shaft.	Pegmatite composed of white felspar and colourless quartz, black tin and rare pink and amber garnets. Estimated content of Black tin = 1%.		Radio-active content					
BMR/AM 15/C.W.B. = Sample 31	Ditto	Average thickness 12" on south wall over length of 10ft. in flat underlie shaft.	Pegmatite composed of white felspar (albite) and quartz and a little black tin and pink garnet. Rarely canary yellow stains with waxy appearance. Tin content estimated at 1%.		Radio-active content					
BMR/AM 16/C.W.B. = Sample 32	Ditto	Pegmatitic granite sample taken over thickness of 27" and length of 5 ft. lying between vertical joint-planes in flat underlie shaft.	Coarse pegmatitic granite composed of colourless quartz white felspar and a little pink garnet and black tin. Estimated content < 1% black tin.		Radio-active content					
BMR/AM 17/C.W.B. = Sample 33	In creek near Beryl lode. Approx. 8 miles south of Pilga H.S. (Abandoned).	Alluvial concentrate Yandied sample taken over 5 inches depth.	Magnetite removed with magnet. Very coarse monazite up to 1 inch across and a steel grey mineral in large fragment.		Th and Ur. and nature of steel grey mineral.		Yield of clean monazite = 2¾ oz Magnetite = 1¼ oz. Amount of wash yandied = 2 lb. Estimated content of wash = 170 lb monazite per cubic yard.		Very high	36
BMR/AM 18/C.W.B. = Sample 34	Beryl lode approx. 8 miles south of Pilga H.S. (Abandoned).	Alluvial concentrate top 1 inch of sand, 1 small dish panned and yandied.	Very much magnetite but non-magnetic fraction very highly radio-active. Trace of monazite and a little red garnet and quartz and felspar.		Nature of radio-active minerals Th and Ur.		Yield of radio-active concentrate = 5½ oz.		>130	41
BMR/AM 19/C.W.B. = Sample 36	Near Beryl lode Approx. 8 miles south of Pilga H.S.	Not "in situ". Near large pegmatite outcrop.	Biotite granite composed of quartz (Colourless), white felspar and abundant black biotite. Magnetite as an accessory. The rock contains clusters or "black balls" of biotite 1 inch across. The rock is also traversed by quartz veins with pyramidal terminated quartz crystals. On inner surface of Vugs there is a black deposit. One vug contains yellow crystals.		Radio-active content Th & Ur.				Too fast to count	32

Field No.	Locality	Circumstance of Occurrence	Field Determination	If for Section	If for Determination	If for Analysis or Assay	Determination	Reg. No.	Geiger Reading	Back ground count
BMR/AM 20/C.W.B. = Sample 38	Rock hole pegmatite Wodgina.	Small outcrop in central portion of pegmatite.	Lithiophyllite.	Radio-active content Ur.					150	30
BMR/AM 21/C.W.B. = Sample 39	Near Beryl lode approx. 8 miles south of Pilga H.S. (Abandoned). No. 1 Lens.	Biotite rich pegmatitic granite as a lens in pegmatite dyke intruding biotite granite. Sample taken over width of 2 ft. 5 ins.	Coarse grained even textured biotite granite composed of fresh white euhedral, felspar, colourless euhedral quartz, and black biotite. The biotite tends to occur in clusters.	Radio-active content Ur. & Th.					Very high > 100	35
BMR/AM 22/C.W.B. = Sample 40	Ditto No. 2 Lens.	Biotite rich phase of granite underlying a pegmatite dyke. Sample taken over thickness of 18 inches.	Biotite granite compare previous sample in macro-features. One phenocryst of felspar 1 in. across.	Radio-active content Ur. and Th.					Very high > 100	35
BMR/AM 23/C.W.B. = Sample 41	Near Beryl lode approx. 8 miles south of Pilga H.S. (Abandoned). No. 3 Lens.	Black biotite rich pegmatitic granite. Enclosed within porphyritic granite which appears to be leached of biotite. Sample taken on face of outcrop over 4 feet.	Biotite granite traversed by veins of felspar and quartz. Throughout the rock euhedral quartz crystals observed. The quartz is clear colourless. The felspar is white and the biotite black.	Radio-active content Ur. and Th.					Too fast to count	45
BMR/AM 24/C.W.B. = Sample 42	Near Beryl lode. No. 4 Lens.	Large boulders of biotite with granite - probably in place. Grab sample over 4 feet width of outcrop.	Biotite granite compare sample BMR/AM 21/C.W.B. in macro-features Idiomorphic quartz (hexagonal prisons) suggest quartz secondary. Rock is very highly radio-active.	Radio-active content Ur. and Th.					Too fast to count.	32
BMR/AM 25/C.W.B. = Sample 43	Near Beryl lode. No. 5 Lens.	Sample taken across 5 feet width of outcrop of biotite rich granite.	Porphyritic biotite granite with colourless quartz, white felspar & phenocryst of felspar which are partly ovoidal. The rock has a rude foliation.	Radio-active content Ur. and Th.					> 120	32

Field No.	Locality.	Circumstance of Occurrence	Field Determination	If for Section	If for Determination	If for Analysis or Assay	Determination	Reg. No.	Geiger Reading	Back ground count
BMR/AM 26/C.W.B. = Sample 22	9 miles north of Abydos alongside main road Abydos Port Hedland.	Sand; top 1" of sand	Brown sand composed mostly of quartz with brown limonite and fine black grains.			Ur and Th.				
BMR/AM 27/C.W.B. = Sample 23	Ditto	Chocolate loam. 3" in thickness underlying the top sand cover.	Chocolate loam with grains of quartz and felspar and a little zircon. (Perfect bypyramids), black grains (query magnetite) and clayey material.			Test for heavy minerals Ur. and Th.			Reading on surface of ground = 73.	56
BMR/AM 28/C.W.B. = Sample 24	Ditto	Ferruginous sand over 9" underlying the chocolate loam.	Ferruginous sand.			Test for heavy minerals and Ur. and Th.				

C.W. Ball.
19.12.47.

LOCATION MAP OF
MARBLE BAR AREA

Geology after Gibb Maitland 1906
Topography from Army 4 mile series 1944

Scale 1 in. = 10 miles

miles 10 0 10 20 miles

LEGEND

- Nullagine series (sandstones, grits, conglomerates and volcanic rocks)
- Mosquito Crk series (shales and fine conglomerates)
- Warrawoona series (metamorphic sedimentary rocks and greenstone schists)
- Granite and gneiss
- D — Dolerite, diabase and gabbro dykes
- where doubtful — Geological boundaries
- Watercourses
- Roads
- Railway

119° 120° 21° 22°

To Port Hedland

Great Northern Highway

Turner River

East Strelley River

Talga

Coongan River

Shaw River

Laminated cherts

Wodgina

Abydos

Woodstock

Yule River

Tambourah

Pilga

Cooglegong

Old Shaw

Hillside

Split Rock

MARBLE BAR

Moolyella

Mt Edgar

Corunna Downs

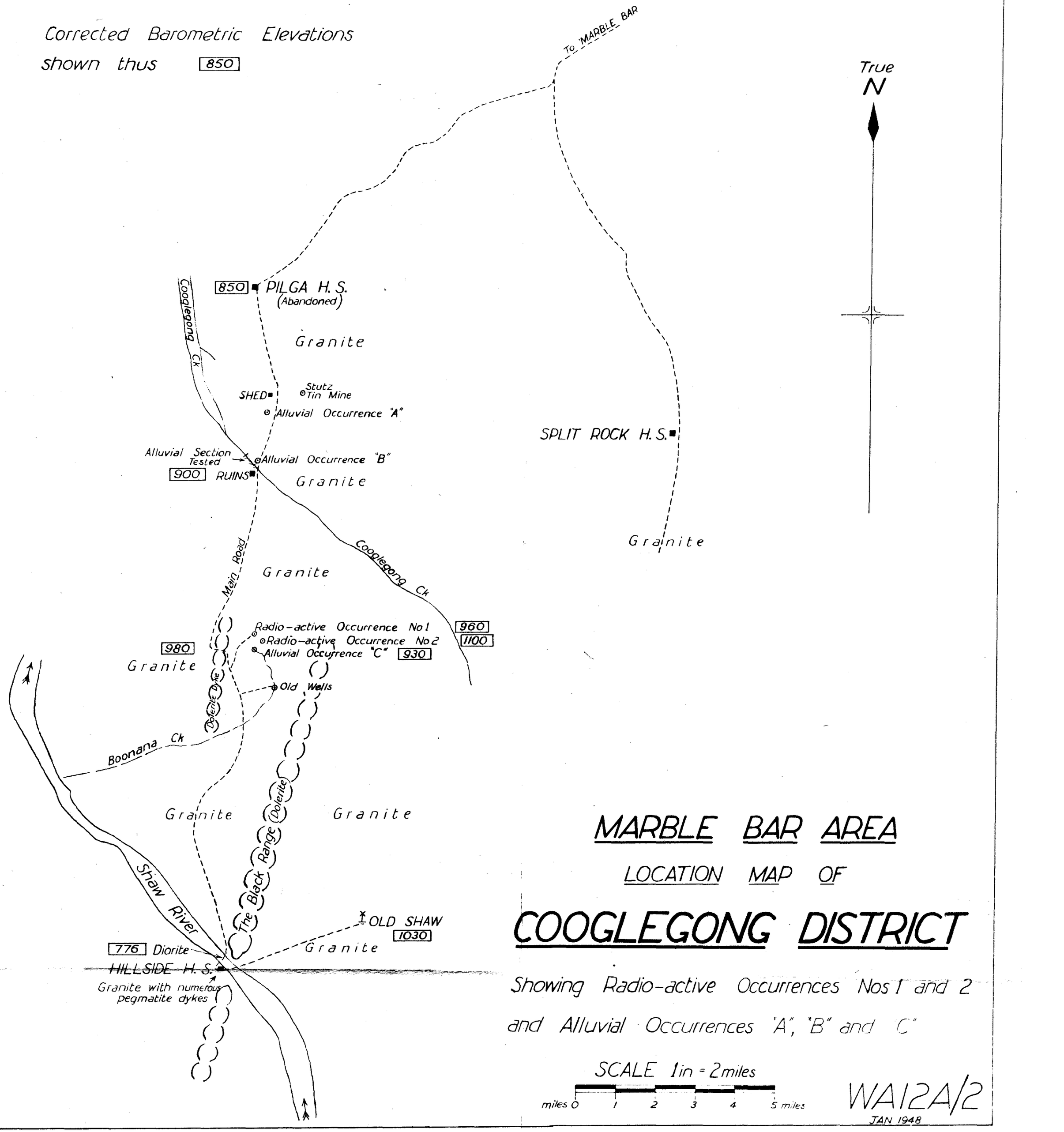
Nullagine River

NULLAGINE

To Roy Hill

WA12A/1

Corrected Barometric Elevations
shown thus 850



MARBLE BAR AREA

LOCATION MAP OF

COOGLEGONG DISTRICT

Showing Radio-active Occurrences Nos 1 and 2
and Alluvial Occurrences "A", "B" and "C"

SCALE 1in = 2miles

miles 0 1 2 3 4 5 miles

WA12A/2

JAN 1948

MARBLE BAR AREA

RADIO-ACTIVE OCCURRENCE No.1

(Approx. 4 miles South of Cooglegong Ck Crossing)

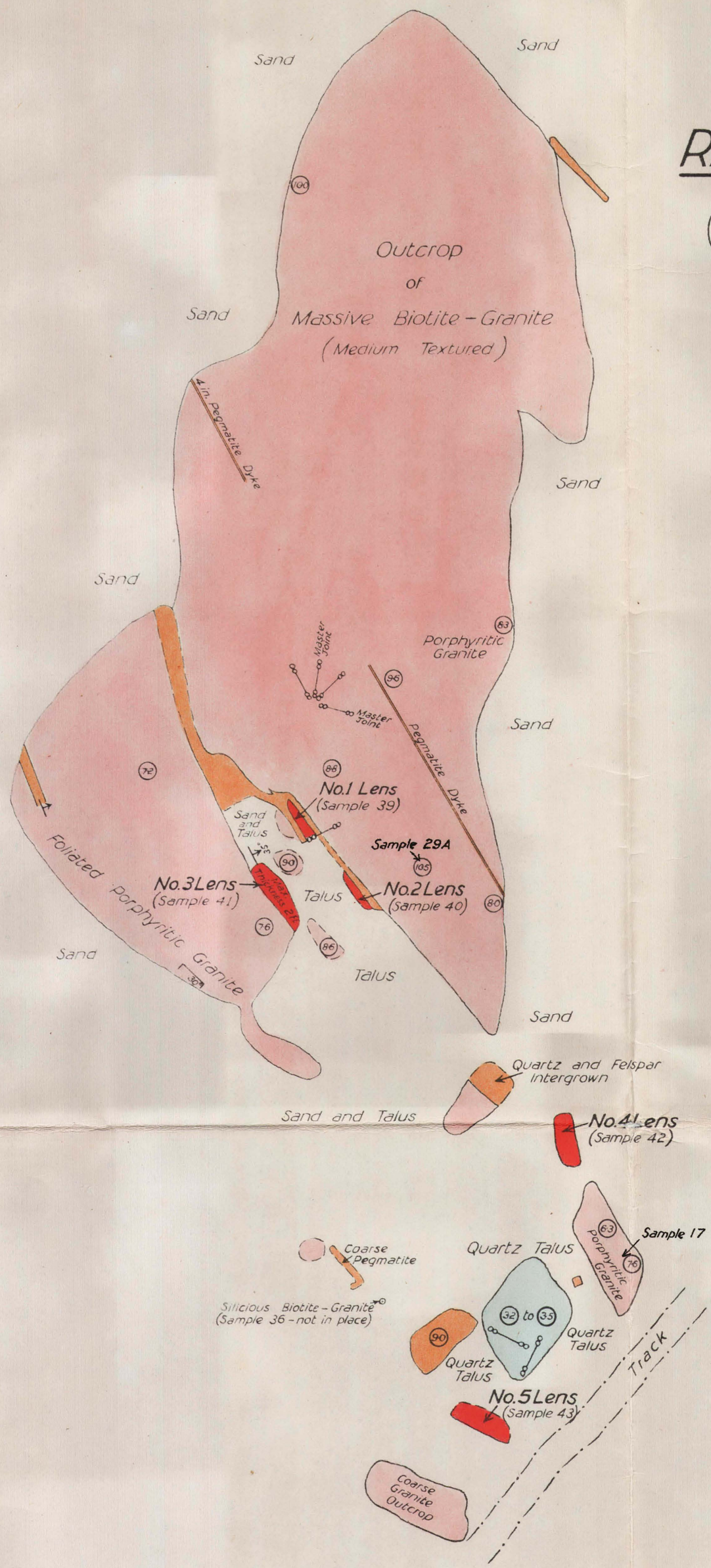
SCALE 1in. = 20ft

Ft 10 0 10 20 30 40 50 ft

Geology by C. W. Ball 20 Oct 1947

LEGEND

- Radio-active granitic rock
- Granite
- Pegmatite
- Quartz
- Dip of dyke or lens (35°)
- Strike of vertical joints
- Strike and dip of foliation (30)
- (86) Geiger-Muller count (expressed as clicks per minute)



Mag. N

WA12A/3

JAN 1948

MARBLE BAR AREA

RADIO-ACTIVE OCCURRENCE No.2

(Approx. 4 miles South of Cooglegong Ck Crossing)

SCALE 1 in = 50 Ft

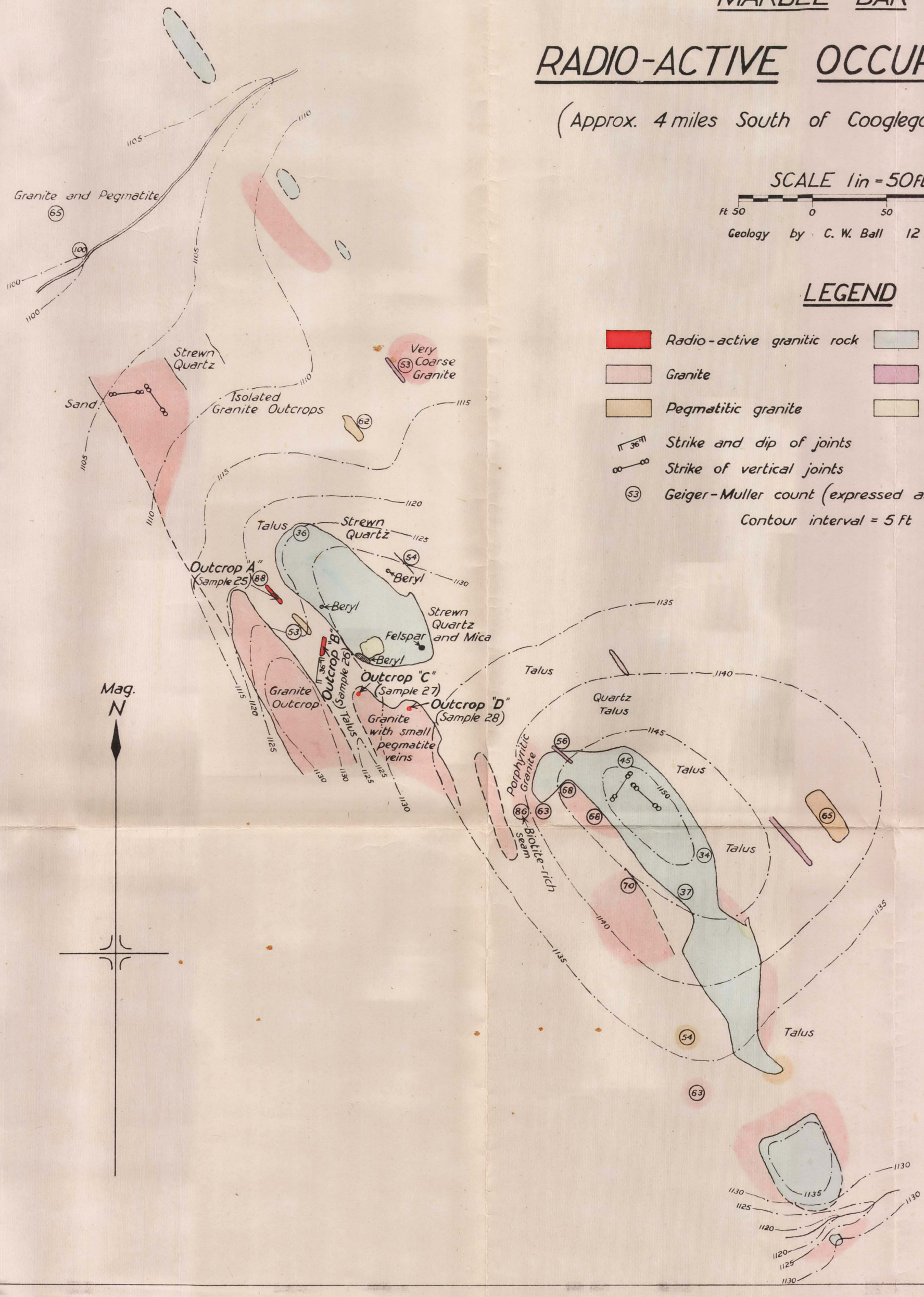
Ft 50 0 50 100 Ft

Geology by C. W. Ball 12 Oct 1947

LEGEND

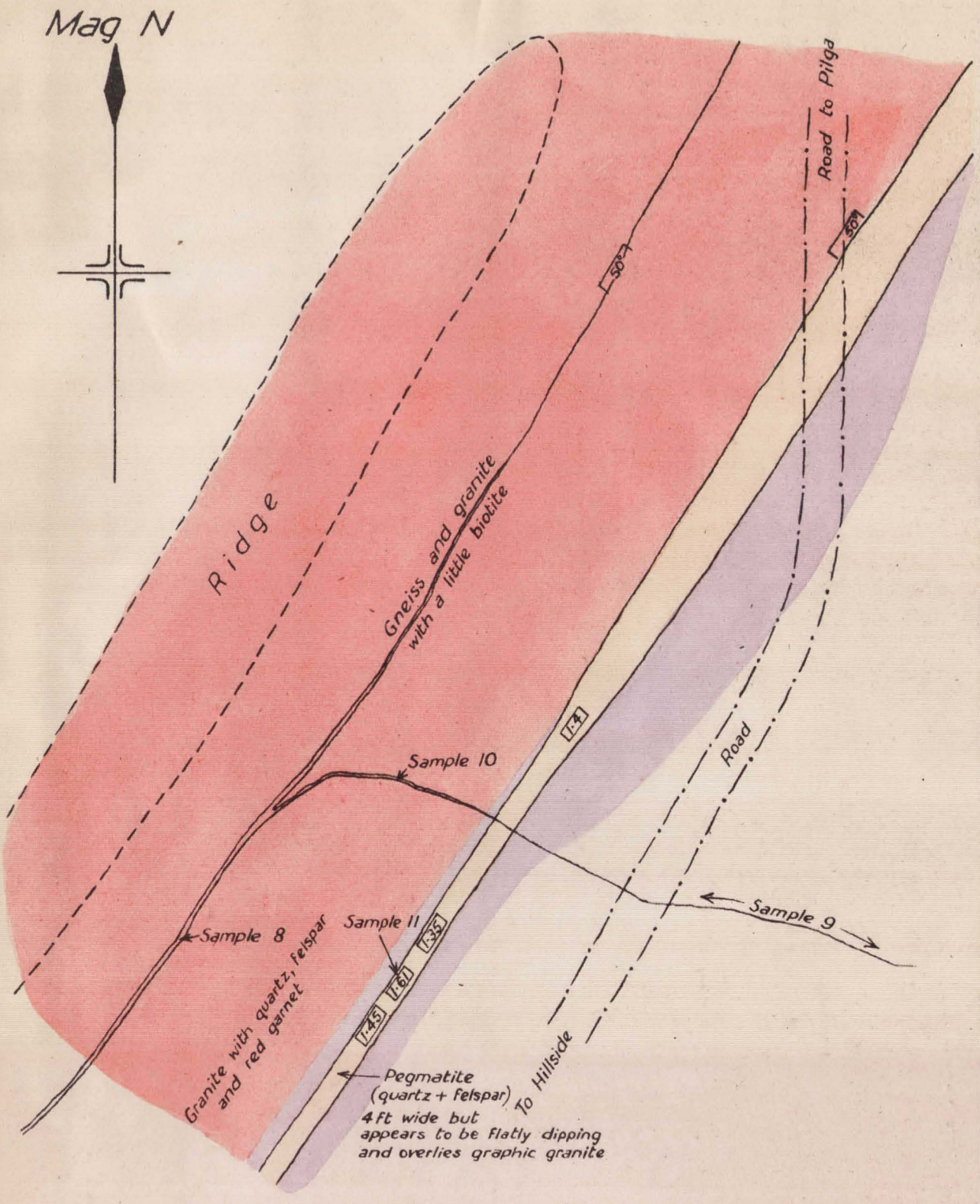
- Radio-active granitic rock
- Granite
- Pegmatitic granite
- Quartz
- Quartzite and silicified granite
- Imperfect white mica
- 36° — Strike and dip of joints
- Strike of vertical joints
- (53) Geiger-Muller count (expressed as clicks per minute)

Contour interval = 5 ft



WA12A/4

JAN 1948



MARBLE BAR AREA

SKETCH MAP OF

ALLUVIAL OCCURRENCE "B"

LEGEND

- Granite and gneiss
- Pegmatite
- Graphic granite
- 50° Strike and dip of foliation
- 1·45 Portable ratemeter reading

SCALE 1in = 40ft

Ft 40 0 40 80 Ft

Geology by C.W. Ball 29 Sep 1947

WA12A/5

JAN 1948

MARBLE BAR AREA

PLAN SHOWING POSITION OF

TEST HOLES ON BOONANA CREEK

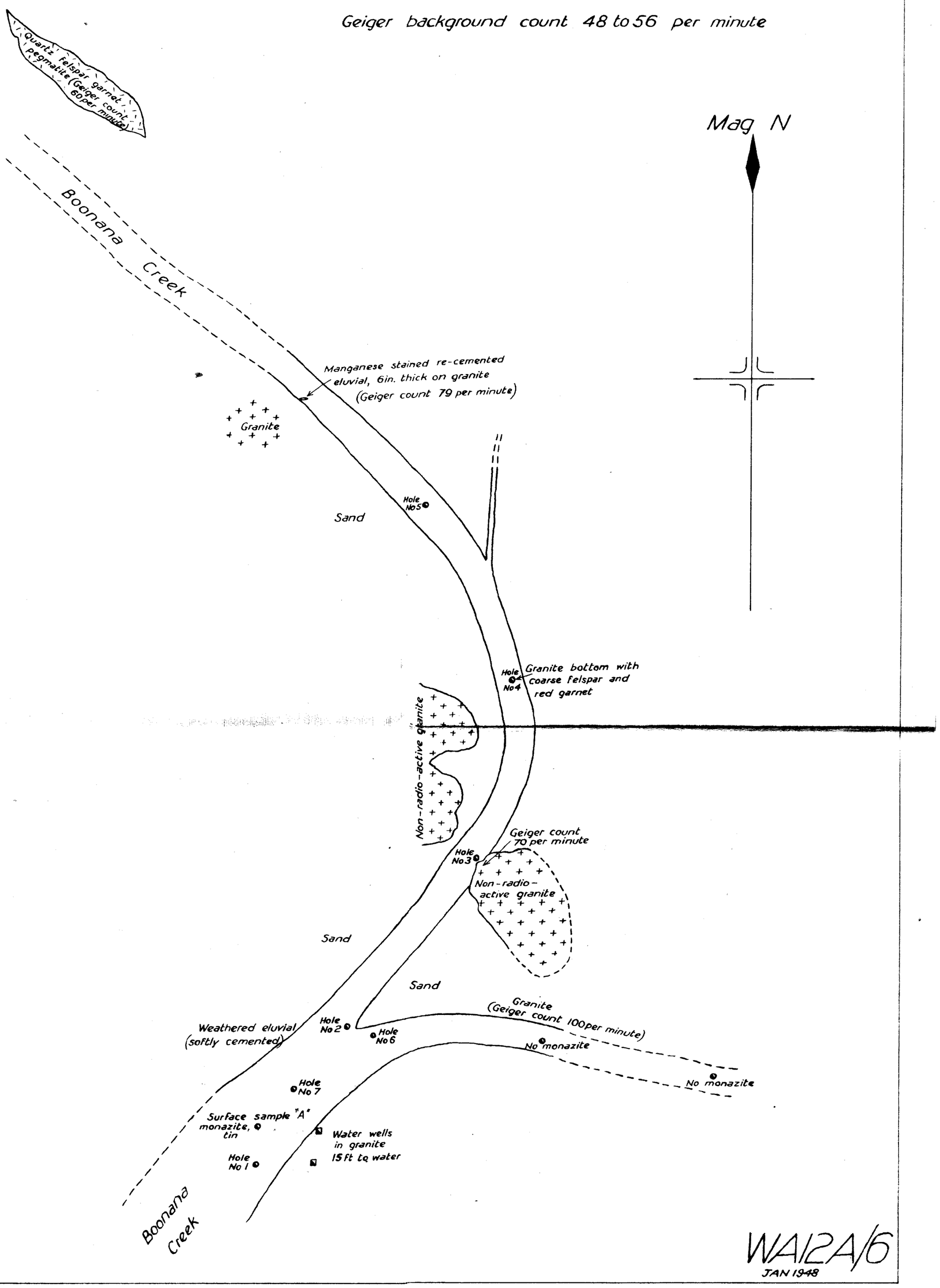
SCALE 1 in = 100 ft

ft 100 50 0 100 200 ft

Geology by C. W. Ball 28 Sep 1947

Elevation 1300 ft (uncorrected barometer reading)

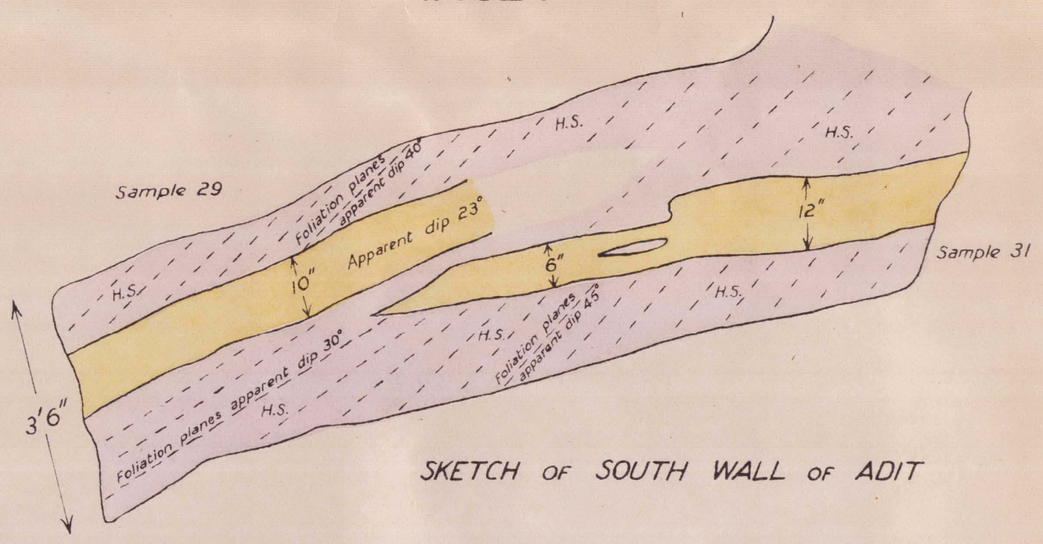
Geiger background count 48 to 56 per minute



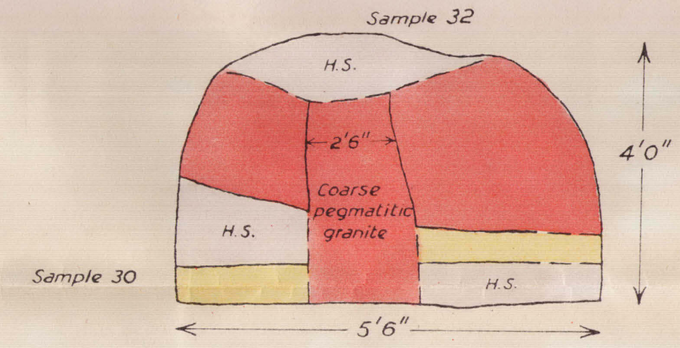
WA12A/6

JAN 1948

INSET



SKETCH OF SOUTH WALL OF ADIT



SKETCH OF VERTICAL CROSS-SECTION NEAR TOP OF ADIT

MARBLE BAR AREA

STUTZ TIN MINE

(Approx. 2½ miles N.N.E. of Cooglegong crossing)

SCALE 1in = 20ft

Ft 10 0 10 20 30 40 50 Ft

Geology by C. W. Ball 23Sep1947

LEGEND

- Granite
- Pegmatite
- Gneissic hornblende granite with thin pegmatite veins
- 40° Strike and dip of foliation
- 36° Strike and dip of jointing
- Strike of vertical joint
- Open cut
- Dump
- 950 Contours based on an uncorrected barometer reading
  Contour interval 5ft
- H.Gn. Hornblende gneiss
- H.S. Hornblende schist

WA12A/7

JAN 1948

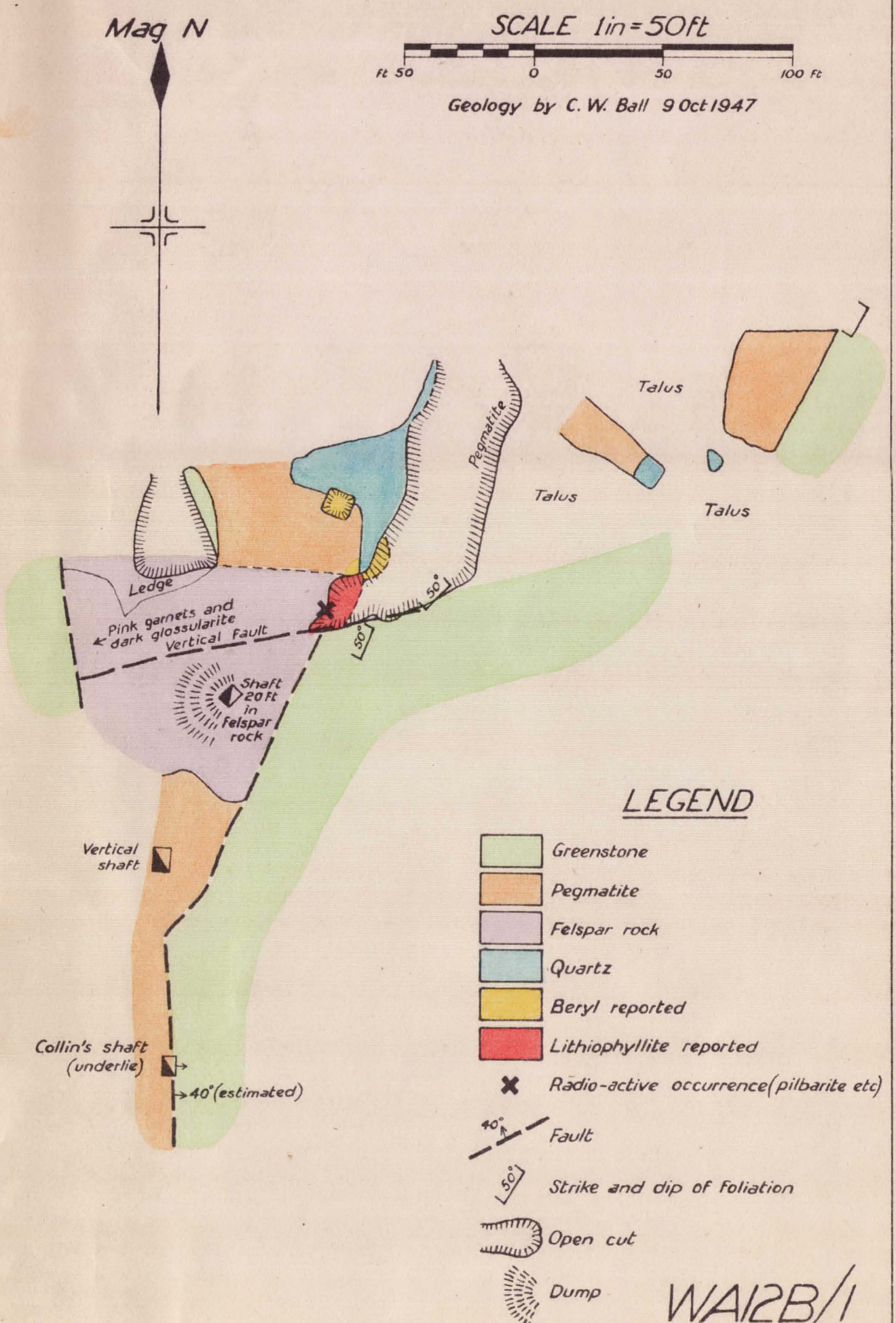
WODGINA AREA

PLAN OF NORTH END OF

TANTALITE LTD WORKINGS

SHOWING

RADIO-ACTIVE OCCURRENCE



WA12B/1

JAN 1948

WODGINA AREA

SKETCH PLAN OF THE

ROCK-HOLE PEGMATITE (M.L. 333)

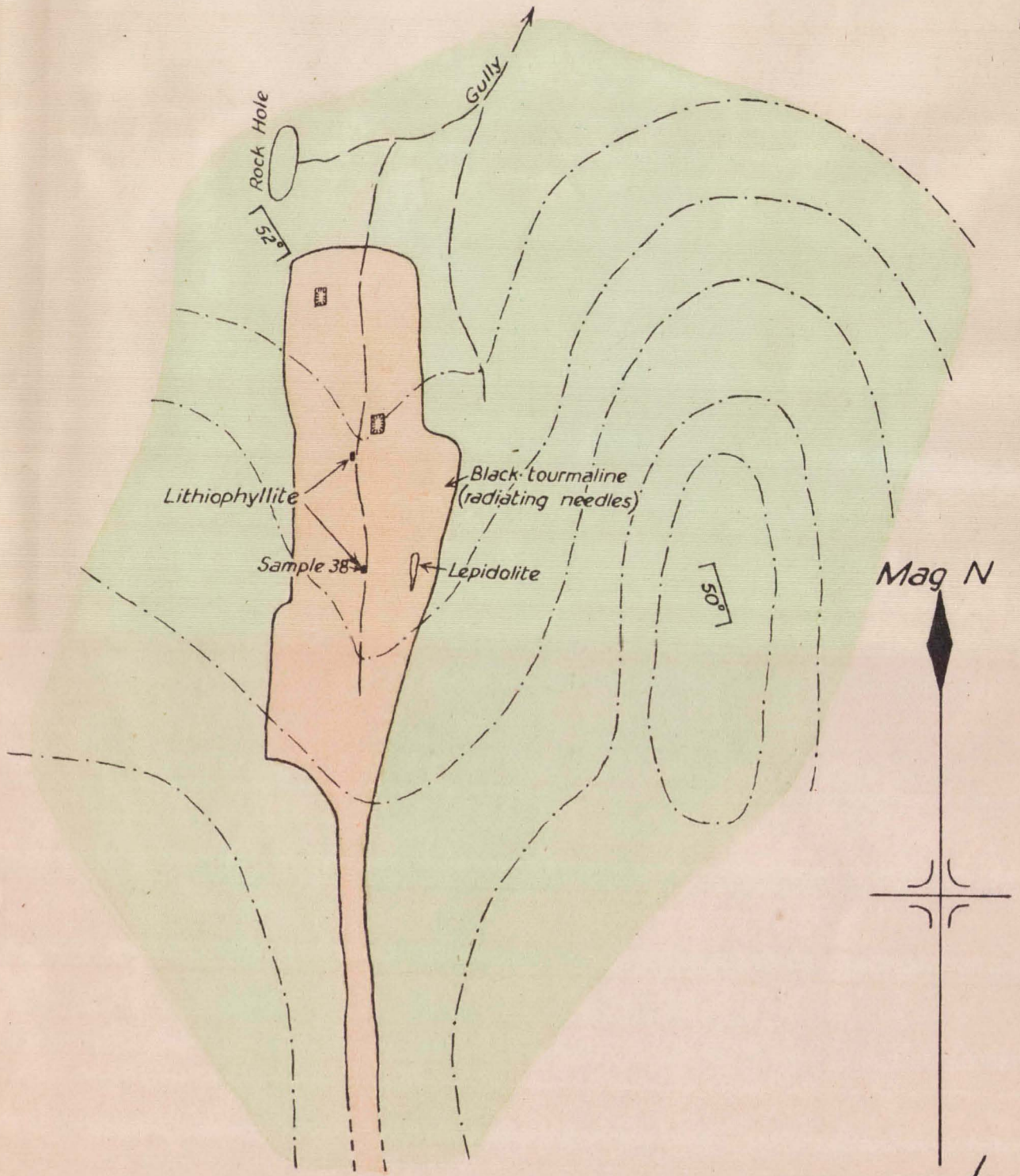
LEGEND

- Greenstone
- Pegmatite
- 52° Strike and dip of Foliation
- Test pit approx. 6 ft deep
- Form line
- Watercourse

SCALE 1in = 80ft

Ft 40 0 80 160 Ft

Geology by C. W. Ball 9 Oct 1947



WA12B/2

JAN 1948