

TABLE 1. DISTRIBUTION OF THE COPPER CONCENTRATIONS

ppm Range	Population	No. of samples	Percentage of samples
0-290	A	2,044	77.8
300-675	B	420	16.0
680-990	C	87	3.3
1,000-1,960	D	58	2.2
More than 1,980	E	18	0.7
Totals	2,627	100.0

RECOMMENDATIONS

The two high-order anomalies near the main shaft warrant testing since they indicate the possible existence of near parallel ore bodies 300 feet apart, each extending over some 800 feet in strike length.

A third high-order anomaly, localized near, and possibly representing the southwest extension of, the 'shaft' anomaly, could be a further target for prospecting.

Three diamond drill holes are therefore recommended. Two are designed to intersect the depth extensions of the sub-parallel anomalies below the zone of oxidation as well as testing the zone of lower order anomaly which separates them. The third hole is similarly sited to test the depth extension of the anomaly forming the southwest strike extension of the main shaft anomaly.

The three proposed diamond drill holes would involve a total footage of approximately 2,000 feet. These are located at the following sites :

Site 1 : At grid reference 8,320N, 7,910E ; hole to have azimuth 135 degrees, depression 45 degrees and length 700 to 800 feet.

Site 2 : At grid reference 8,250N, 7,510E ; hole to have azimuth 111 degrees, depression 45 degrees and length 700 to 800 feet.

Site 3 : At grid reference 8,320N, 7,030E ; hole to have azimuth 135 degrees, depression 45 degrees and length approximately 500 feet.

REFERENCES

- Johnson, W., 1950, A geological reconnaissance survey including parts of the Yalgoo, Murchison, Peak Hill and Gascoyne Goldfields : West. Australia Geol. Survey Bull. 106.
- Lewis, J. D., 1970, Petrological descriptions of 14 rocks and thin-sections from a cupriferous area at Twin Peaks, Yalgoo Goldfield, W.A. : West. Aust. Geol. Survey Petrological Report No. 195 (unpublished).
- Low, G. H., 1963, Copper deposits of Western Australia : West. Australia Geol. Survey Mineral Resources Bull. 8, p. 140.
- Maitland, A. G., 1919, The copper deposits of Western Australia. The Mining Handbook of Western Australia, Part 3, Section 2 : West. Australia Mines Dept. Perth.
- Sofoulis, J., and Williams, X. K., 1970, The geology and geochemistry of a cupriferous area at Twin Peaks, Yalgoo Goldfield : West. Aust. Geol. Survey Rec. 1970/2 (unpublished).
- Williams, X. K., 1967, Statistics in the interpretation of geochemical data : New Zealand Journ. of Geology and Geophysics, Vol. 10, No. 3.

PRELIMINARY REPORT ON TIN GRANITE IN THE PILBARA GOLDFIELD

by J. G. Blockley

ABSTRACT

In the Pilbara Goldfield, Western Australia, a distinct type of granite ('tin granite') has been recognized in eight intrusions. Pegmatite dykes associated with this granite have been the source of all the eluvial and alluvial tin produced in this area.

The tin granite is a late intrusive in the Pilbara granite complex and is seldom foliated. It is biotite adamellite in composition and forms tors and smooth exfoliation domes which rise above the flatter, mostly soil-covered areas of gneiss. In many outcrops the surface of the tin granite has a 'honey-comb' appearance.

There are three modes of occurrence of pegmatite : (a) intruding amphibolite and metasediments, (b) cutting granite gneiss and mignatite, and (c) within magmatic granite.

Tin mining in the Pilbara reached a peak of 1,238 tons in 1967 but has since declined ; recognition of the tin granite type should aid exploration for tin in this area particularly in the poorly drained parts.

INTRODUCTION

During an investigation of the tin deposits in the Pilbara Goldfield and the adjacent part of the West Pilbara Goldfield for a Mineral Resources Bulletin on Tin in Western Australia, an attempt was made to recognize and define the granite type responsible for the primary tin mineralization. Figure 8 shows the eight intrusions of 'tin granite' which have so far been identified. The information is published here to assist the prospectors and companies currently searching for new tin deposits in the region. Further work on the petrology and chemistry of the tin granites is to be carried out during 1970 in the hope that it will lead to the detection of similar granites in other parts of the State.

MINING

The first tin discovery in the Pilbara Goldfield was at Moolyella in 1898 ; later discoveries were at Eley's in 1899, Cooglegong in 1900, and Wodgina in 1902. Subsequent mining yielded 12,854 tons of tin concentrate, of which 6,100 tons came from Moolyella, 5,860 tons from the Eley's—Cooglegong field and 470 tons from Wodgina. The remainder was from small deposits at Abydos, Strelley, Tappa Tappa, Pilgangoora, Coodina and Bonnie Downs.

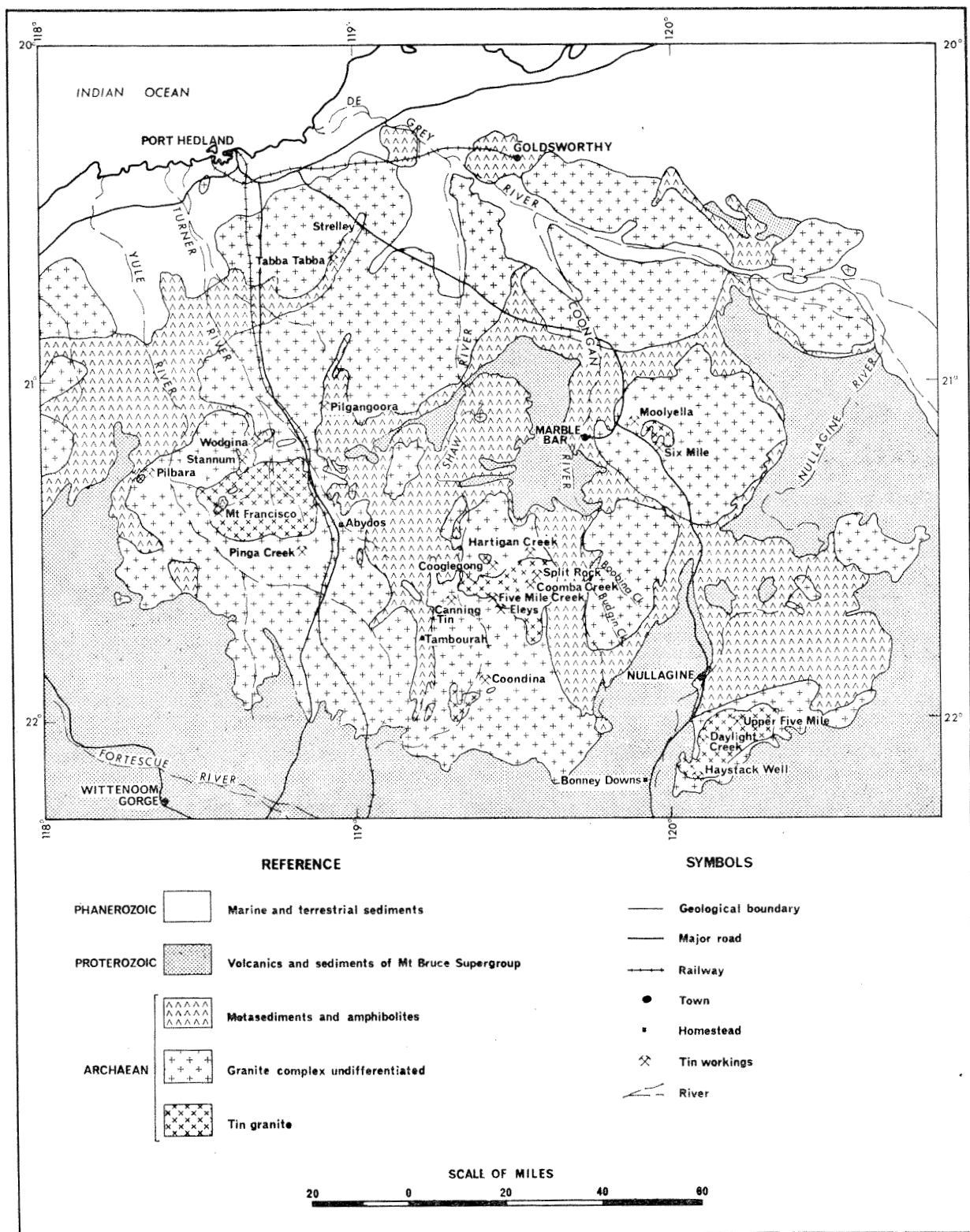


Fig. 8—Geological map of portion of the Pilbara Goldfield showing known tin granite occurrences.

After the initial period of tin mining, which lasted from about 1899 to 1914, and during which only the highest grade deposits were worked, interest in the Pilbara fields lapsed until rising tin prices brought about renewed activity in the area in 1955. Production reached a peak in 1967, when 1,238 tons of tin concentrate were mined, but has since fallen off appreciably, due to the exhaustion of payable ground.

TIN-BEARING PEGMATITES

Most of the tin mined in the Pilbara Goldfield was recovered from secondary alluvial and eluvial deposits formed close to the source areas of primary cassiterite.

Apart from 350 tons of tin concentrate produced from the Mount Cassiterite mine at Wodgina, the yield from primary deposits is small when compared to that from secondary accumulations. The source of all of the tin mined has been pegmatite dykes. Earlier reports of primary tin in granites or greisens could not be substantiated during the present investigation. Frequent references to tin 'lodes' in the literature all refer to pegmatites, or to a closely related tourmaline-mica rock; true tin lodes, of the type worked in Cornwall, New England and Tasmania, in which the tin is associated with sulphide minerals, have not been found in the Pilbara Goldfield.

There are three types of tin-bearing pegmatites in the region : (a) pegmatites intruding amphibolite and meta-sediments ; (b) pegmatites cutting granite gneiss and migmatite ; and (c) pegmatites within magmatic granite.

Type (a)

Pegmatites of type (a) are usually found at some distance from any possible source granite. Most are large, and some exceed a mile in length. Many are zoned, with a central core of blue-grey quartz surrounded by shells of pegmatitic material of varying composition. The outer shell is often found to be albite, and albite is also the most common feldspar throughout the pegmatite, although a small amount of microcline may also be present. In pegmatites of this type, tin, as cassiterite, is associated with other economic minerals such as beryl, lepidolite, zinnwaldite, spodumene, tantalite, and certain radioactive minerals. The tin production of Pilgangoora, Strelley, Tabba Tabba, and parts of the Wodgina field, has been from pegmatites of this type.

Type (b)

Pegmatites of type (b) occur in swarms close to their parent granite. They cut cleanly across the banding of their host gneiss or migmatite, and are appreciably younger. Typical pegmatites of this type range in length from a few tens to a few hundreds of feet, and in width from 2 feet to 12 feet. The thinner dykes comprise a central band of coarse grained quartz, microcline and biotite, surrounded by a marginal, fine grained aplitic rock made up of quartz, albite, green muscovite and spessartite garnet. In the thicker dykes, several alternating bands of these two rock types may be present. Most of the tin in the dykes is within the finer, albitic phase, which seems to have formed by soda metasomatism of the microcline.

Economic minerals associated with the cassiterite are tantalite, monazite (with a high content of rare earths) and gadolinite. Some fluorite is occasionally seen, but beryl and lithium minerals are absent. These pegmatites are richest in tin where they intrude the more mafic gneisses, or migmatites with an appreciable content of amphibolite and biotite rock. The placer deposits of Moolyella, Cooglegong, Eley's, Pinga Creek and Coondina were derived from pegmatites of type (b).

Type (c)

Pegmatites of type (c) resemble those of type (b), but are smaller, and contain relatively greater amounts of microcline and less albite. The cassiterite shed from these veins is finer than that from the other types of pegmatite. The tin mined at Coomba Creek, Split Rock and Gunpowder Creek, near Spear Hill, came from pegmatites of type (c).

TIN GRANITE

Previous work

The first recognition of a tin granite in the Pilbara Goldfield was made by Maitland (1919), who stated (p. 13) : ' Sections are to be seen near the tin mining centre of Wodgina, in the Pilbara Goldfield, showing an ancient intrusive granite which has been invaded by a newer (though still old) tin-bearing granite '.

Noldart and Wyatt (1962) made a study of the granite complexes in the Pilbara Goldfield during a geological survey of the Marble Bar and Nullagine 4-mile map areas. They recognized that the granitic

rocks could be divided into magmatic, gneissic, and granitised types, but mapped the first two of these as one unit. They regarded some of the granite complexes as having a magmatic origin (although with marginal granitization of the invaded rocks), and others as having been formed by widespread granitization, with partial paligenetic mobilization giving rise locally to magmas.

At the completion of their survey, Noldart and Wyatt (*ibid.*, appendices 1 and 2) submitted 44 samples of granite and granite gneiss to the Government Chemical Laboratories for mineral determinations. It was hoped that some correlation would be established that would assist in identifying the ' tin granite '. No field relationships of the specimens were given, and, as both the granites and gneisses of the region have similar mineral contents, no firm correlation was found. However it was recognized that some fluorite bearing granites may be associated with the tin deposits.

General features

The tin granites are relatively late intrusions within the granite complexes of the Pilbara Goldfield. They are seldom seen to be foliated, but in places have a flaty-flow structure and broad compositional banding due mainly to variations in the content of potash feldspar. In texture they range from even-grained to porphyritic. Mostly they are medium to coarse grained rocks although some fine grained varieties occur on the margins of the intrusions. Where examined in detail they are simple rather than multiple intrusions, and the different textural varieties grade into each other. The smaller intrusions have sharp, clean-cut contacts with the gneiss, but at the edges of the larger, and presumably more deeply eroded batholiths, the contacts are irregular, with much interfingering of gneiss and granite.

In composition the tin granites are biotite adamellite made up principally of microcline, oligoclase, and quartz with minor biotite and muscovite, and accessory hornblende, apatite, fluorite, garnet, ilmenite, sphene, rutile, zircon and clinzoisite. The microcline normally forms euhedral crystals and makes up the phenocrysts of the porphyritic varieties. It is perthitic in many specimens. Oligoclase is the most common plagioclase, but the plagioclase was albite or sodic andesine in a few specimens examined. The biotite is green in thin-section, and most grains are partly altered to chlorite. The fragments of pale green hornblende in the granite are always rimmed by biotite or chlorite. Of the silica analyses of granites published by Noldart and Wyatt (1962, p. 177) three (Nos. 758, 763, 773) are of known tin granites. They contain from 69.4 to 70.8 per cent silica.

The tin granites are more resistant to erosion than the gneiss and migmatite which they intrude. Consequently they form areas of rough hilly country, marked by tors and smooth exfoliation domes, which contrast well with the flatter, often soil-covered terrain underlain typically by the gneissic rocks. Topographic expression is not, however, an infallible guide to the tin granites as other types of intrusive granite also form tors and some more resistant varieties of gneiss form rounded hills. In many outcrops of the tin granites, silicification has taken place along fine polygonal joints. Subsequent weathering hollowed out the rock between the joints, leaving the exposed surface with a characteristic ' honeycomb ' appearance.

Relationship to mineralization

The relationship of these granites to the tin mineralization is indicated by the following field evidence :

1. The main tin producing centres are all close to, or within granites of this type.

2. Pegmatites within the tin granites are similar to the tin-bearing pegmatites of type (b) in having margins composed of fine grained quartz, albite, green muscovite and garnet.

3. At Moolyella, tin-bearing pegmatites can be traced into the tin granite, and at Split Rock, Coomba Creek, Spear Hill and Eley's, tin-bearing pegmatites are found within the granite.

4. At Moolyella and Eley's, fine grained, albite-rich marginal phases of the intrusive granite contain pink garnets, similar to those in most tin-bearing pegmatites.

It is believed that the tin granites are one of the more common types of magmatic granite within the Pilbara region, at least in the area east of the Yule River. It is likely that other stocks of similar granite are present in places not seen during the

present investigation, and therefore not shown on Figure 8. An examination of aerial photographs suggests that large areas of similar granite exist south of Tambourah, and in the country drained by the upper parts of Budjan and Boobina Creeks, south of Corunna Downs.

CONCLUSION

It is believed that the recognition of a tin granite type will aid exploration for tin in the Pilbara, particularly in the more poorly drained parts, where the traditional use of the prospectors panning dish is less effective in testing the potential of large areas.

REFERENCES

- Maitland, A. G., 1919, Mining handbook of Western Australia, Part 3, Section 3: West. Australia Geol. Survey Mem. 1.
Noldart, A. J., and Wyatt, J. D., 1961, The geology of portion of the Pilbara Goldfield, covering the Marble Bar and Nullagine 4-mile Map sheets: West. Australia Geol. Survey Bull. 115.

TIN-BEARING PEGMATITES IN THE NORSEMAN AREA

by J. Newton-Smith

ABSTRACT

Tin-bearing lithium pegmatites cut Archaean greenstones near Mount Deans and Mount Thirsty in the eastern part of the Yilgarn Block, Western Australia. The pegmatites are characterized by quartz, plagioclase, muscovite, biotite and lepidolite, with accessory tourmaline, garnet and cassiterite. The pegmatites were worked for tin between 1965 and 1967, during which time 15,013 lbs of tin concentrate were produced.

INTRODUCTION

Tin was produced from several lithium pegmatites in the Norseman area between 1965 and 1967, and during that period tin ore delivered to the Norseman State Battery yielded 15,013 lbs of tin concentrate. Four mineral claims cover the producing pegmatites: three in the vicinity of Mount Deans, about 8 miles south of Norseman, and one about 12 miles northwest of Norseman near Mount Thirsty (locality map Figure 9).

REGIONAL GEOLOGY

Norseman is situated close to the southern extremity of an Archaean greenstone belt which has been truncated by intrusive granites on the eastern and western margins. The tin-bearing lithium pegmatites at Mount Deans occur in basic lavas and associated intrusive rocks while at Mount Thirsty ultrabasic, basic, and acid volcanic rocks are host to the pegmatites. The granite on the western margin of the greenstone belt is considered as the source of the pneumatolitic solutions which formed the pegmatites. This granite comprises about 50 per cent quartz, 30 per cent potassium feldspar, and 15 per cent plagioclase. Accessory minerals consist mainly of muscovite with some biotite, chlorite, and epidote. Fluorite has been recorded from one specimen (Trendall, 1965). Simple quartz-feldspar pegmatites are common in the granite and greenstone, particularly where close to the intrusive contact between the granite and the

greenstone belt west of Norseman. Complex lithium pegmatites however, are confined to the greenstone belt. The occurrence of tin is closely related to the presence of lithium minerals in the pegmatite; no tin has been recorded from the granites of the simple quartz-feldspar pegmatites.

The tin-bearing pegmatite bodies occur in groups, and generally have an irregular outline and a dip of 45 to 60 degrees. They vary in width from a few inches to about 10 feet and may be traced along strike for over 500 feet. The pegmatites are complex and locally zoned. The principal minerals present are albite, commonly the platy variety called cleavelandite, quartz, locally forming graphic intergrowths with feldspar, muscovite, biotite, and lepidolite. Accessory minerals include tourmaline, garnet, and cassiterite. No potassium feldspar was noted in any of the tin-bearing pegmatites. Radiometric counts over the pegmatites are just above background. Isolated inclusions of a metamict mineral with attendant radiating cracks developed in the adjacent quartz were noted in some quartz grains from MC 95. Tantalite carrying about 70 per cent Ta_2O_5 has been recorded from the Mount Deans area (Simpson, 1952, p. 649) but no tantalite was reported by the purchasers of the tin concentrates.

MOUNT DEANS PEGMATITES

Tin-bearing pegmatites crop out within an area about two miles long (north-south) and one mile wide on the eastern flank of Mount Deans, eight miles south of Norseman. The pegmatites have invaded basic lavas and associated basic intrusive rocks. Alteration of the adjacent wall rocks is confined to a mild bleaching.

Mineral Claim 93

Mineral Claim 93 contained the most productive tin workings in the Norseman area, having yielded 14,065 lbs of concentrate from 915½ tons of ore. A field sketch of the workings is given in Figure 9. The