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EXPLORATION LICENCE NO. 2368 - TANAMI DOWNS

THE GRANITES 1 : 250 000 SHEET : SF 52 - 3

NORTH FLINDERS MINES LIMITED

ANNUAL REPORT FOR THE PERIOD 23/11/83 TO 22/11/84

by T.J. Ireland
15/12/84
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"The Geology and Mineralisation of The Granites Gold Deposits, Northern Territory" by T.J. Ireland and T.E. Mayer

"Progress Report on Reconnaissance Investigation of Regional Geology" by Dr. C.W. Giles
SUMMARY

The licence was acquired to explore for gold and other commodities in the Tanami Complex and onlapping cover rocks.

Work during the first year included:

- appraisal of regional geophysical maps;
- assessment of existing exploration data from previous exploration and the results of work at The Granites; leading to
- program design;
- geological reconnaissance mapping, with associated rock chip sampling.

CONCEPT

Regional exploration for gold in the Tanami will be largely based on the results of continuing orientation studies of The Granites mineralisation.

Other commodities will be evaluated according to the geological environments revealed by our early generalised reconnaissance work.

As a small portion of a much larger reconnaissance area, exploration of this Licence is affected by two important considerations:

- while access to the remainder of the area is delayed by the negotiation process, full-scale regional and airborne surveys cannot be efficiently conducted;

- the results of this exploration, preceding the integrated regional effort which will follow granting of the other licences, provide a useful orientation to the logistics and effectiveness of various ground techniques in the region.
FIELD PROGRAM COMPLETED

The initial reconnaissance of the licence area was undertaken using 1:80000 RC 10 photography and existing regional mapping to produce a revised geological map; control the accompanying rock chip sampling program; and assess the potential of the area. Although sparse, outcrop was found to be adequate for this geological prospecting approach to reconnaissance, particularly in areas of greatest geophysical interest.

RESULTS

The attached report, sample data tabulation and map, record the results of initial reconnaissance of the Licence area.

CONCLUSIONS

1. Outcrop is adequate in parts of the Licence for ground reconnaissance to effectively delineate broad geological characteristics and geochemical signatures. Elsewhere, geophysics will be important in defining zones of interest; and in more advanced stages of exploration, sub-surface sampling by drilling and costeining is likely to be widely used.

2. Existing geological mapping effectively defines areas of major outcrop, and major rock unit associations, but is inadequate for detailed assessment or correlation purposes. Granite appears to be much more extensive in shallow subsurface than is apparent from regional maps.

3. Reconnaissance rock chip sampling shows significant base metal and arsenic anomalies, but no gold.

4. Reconnaissance geology indicates that the distinctive suite of metasediments containing The Granites deposits extends to portions of E.L. 2368.

5. It is highly desirable that reconnaissance effort be integrated across the whole region, so that exploration can be concentrated in those areas which correspond stratigraphically with The Granites.
REFERENCES


Davidson, A.A., 1905. Journal of Explorations in Central Australia by the Central Australian Exploration Syndicate Ltd. **South Australia Parliamentary Paper 27.**
PROGRESS REPORT ON RECONNAISSANCE

INVESTIGATION OF REGIONAL GEOLOGY

THE GRANITES REGION

by Chris Giles
December 1984
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INTRODUCTION

The present investigation continued that began earlier (Giles, November 1983) and mainly concentrated on these outcrops of Mt. Charles Beds that lay within E.L. 2368 on Tanami Downs pastoral lease. In general, the outcrop mapping by the B.M.R. is accurate and access to the various outcrops provided no problem apart from staked tyres.

Exposure in the area investigated is poor, with large areas being covered by sand plain. Those outcrops that do occur tend to be resistant rocks such as chert, silicified shale or banded-iron formation, which form narrow ridges with flanking scree-covered slopes.

All potentially prospective rocks encountered were sampled and locations are shown on accompanying plans. Field notes are recorded on the reverse sides of the 1:80,000 black and white photographs used for navigation.
DESCRIPTION OF AREAS

1. **North MacFarlane Peak Range** (Figure 1)

The rocks of interest crop out in a breakaway on the western side of a laterite-capped plateau. They consist of a well layered sequence of deeply weathered metamorphosed acid ash-flow tuffs and thin fine-grained sedimentary interbeds (greywacke and shale) that strike to towards 250°. Some of the acid volcanics contain quartz and feldspar phenocrysts and show possible compaction textures (flattened pumice fragments), although deformation could be responsible for the latter feature. Three thin ferruginous chert horizons occur in the sequence and these were sampled (samples 21922, 23 and 24).

A strong layer-parallel schistosity indicates that the sequence lies on the limb of a major fold structure. The only folding observed was minor crumpling of the thin ferruginous chert horizons.

These rocks are atypical of the dominantly sedimentary Mt. Charles Beds observed elsewhere. However, the comparable style of deformation suggests that they are of similar age.

Deeply weathered, coarse-grained granite occurs in breakaways to the east, beneath a cover of Paleozoic sandstone and basal conglomerate. This granite resembles The Granites granite and other granites of the district.
2. **Officer Hill Area** (Figure 1)

Scattered outcrops of Mt. Charles Beds (including Officer Hill) and granite were examined in the area southwest of Tanami Downs Homestead and north of the Muriel and Inningarra Ranges.

The Mt. Charles Beds outcropping along the disused track to Graveyard Bore comprise three separate strike ridges of massive recrystallised quartz (probably silicified shale), with intervening subdued exposures of amphibolite and minor ferruginous chert and andalusite-graphite schist.

Granite probably underlies much of the sandplain between these outcrops and the Muriel Range in the south. An outcrop of supposed Mt. Charles Beds just north of Muriel Range consists of steeply dipping, 070° striking white quartzite and conglomerate containing strongly flattened clasts. The obvious fluviatile facies of those rocks indicates that they are not Mt. Charles Beds, however the intensity of deformation distinguishes them from the gently dipping Adelaidean rocks of the Muriel Range. It is possible that they may be of Carpentarian age (e.g. Pargee Sandstone or Birrindudu Group) or alternatively they could be Adelaidean rocks caught up in a major fault-shear zone.

Officer Hill is composed of roughly east-west striking, resistant outcrops of chert, ferruginous chert and massive limonite, with intervening subcrop of graphitic schist and graphitic andalusite schist. The sequence is isoclinally folded and as a result many of the resistant units have an en echelon outcrop distribution produced by frequent repetition on the limbs of S or Z vergence parasitic folds. A major west-plunging fold closure is indicated by consistently shallow (10° - 30°) west and southwest dips and by abundant M vergence parasitic folds in silicified graphitic schist and ferruginous chert 2.5 km north of Officer Hill.

A monotonous sequence of fine-grained amphibolite, with a prominent east-west cleavage, crops out in the low ground immediately north of Officer Hill. These rocks strongly resemble the metamorphosed basalts of Archaean greenstone belts, although pillows and amygdales, frequently seen in the Archaean basalts, appear to be lacking in this case.
Granite probably underlies much of the country between Officer Hill and Inningarra Range, judging by odd scattered outcrops and contact effects observed in metasediments. Of particular note is a south-striking ridge of isoclinally folded banded-iron formation (BIF), located 3.5 km south of Officer Hill. The BIF consists of banded chert-magnetite/hematite and is strongly magnetic where not extensively oxidised to hematite. It is associated with silicified shale and other fine-grained metasediments, and abuts granite in the east. Minor occurrences of identical BIF were also observed at Officer Hill.
3. Madame Pele Hills Vicinity (Figure 1)

The Madame Pele Hills comprise two prominent outcrops of foliated microgranite (foliation strikes 060° - 080°) and associated pegmatite and porphyritic granite situated on the disused track linking Tanami Downs and Chilla Well.

A low, largely sand and quartz scree covered rise immediately north of Madame Pele Hills is underlain by Mt. Charles Beds. Outcrop is extremely limited, being mainly confined to a single 065° striking unit of silicified schist and banded ferruginous chert. Associated rocks, seen in the eroded bed of the old track, include chlorite schist, mica schist, amphibolite and metagreywacke. Much of the area to the north of the above outcrops is probably underlain by granite, judging from the odd quartz blows and abundant vein quartz scree.

Roughly 6 km northwest of the Madame Pele Hills, low laterite-covered hills, with protruding ridges of resistant lateritised metagreywacke and schist and massive quartz-limonite, rise above the surrounding sand plain. The northernmost and most prominent ridge is formed of 210° - 220° striking lateritised metagreywacke characterised by angular quartz and feldspar grains set in a fine-grained ferruginous matrix. Outcrops to the south tend to be fine grained isoclinally folded schists with lensoid pods of massive limonite and quartz-limonite. The latter rocks are probably a product of lateritisation of relatively iron-rich schists.
4. **Schist Hills** (Figure 1)

The Schist Hills were examined and reported on previously (Giles, November 1983) [The following two paragraphs are extracted from that report - TJI].

The main reason for visiting this area was to examine the minor quartz reef gold workings near Dead Bullock Soak, referred to by Hossfeld (1949) and Blake et al (1979). Unfortunately, the workings were not located inspite of careful search, nor were any lode or lode-associated rocks directly comparable with those at The Granites.

Most of the hills in the region are strike ridges, usually composed of complexly folded interbedded "chert" (probably silicified shale) and ferruginous schist (with abundant secondary limonite). The flanks of the hills and the lower rises are frequently underlain by schist (metamorphosed shale). Coarse gabbro and associated dolerite and metasomatised (amphibolitised) near-contact sediments were observed west of the broad magnetic anomaly in the region.

A broad two-fold subdivision of the sequence into metagreywacke and fine-grained schist (ex shale) is readily apparent. The former rocks are mostly found in the east and contain grains of quartz and feldspar up to grit size set in a fine-grained matrix.

They tend to be less structurally disturbed than the schists, but show a pronounced 090° schistosity. The latter rocks include silicified schist, ferruginous schist and ferruginous chert and frequently are caught up in tight parasitic folding. Massive and vughy ironstone of uncertain significance are common associates of these rocks. This sequence occurs in the western Schist Hills and is repeated across at least two major fold closures. One such closure occurs 3 km northeast of Dead Bullock Soak, where M vergence parasitic folds plunge consistently 30° - 35° towards the east, suggesting a similar plunge for the major structure.
DISCUSSION

Broad generalisations arising from the mapping are as follows:

1. The dominantly acid volcanic rock suite north of MacFarlanes Peak Range bears no obvious similarity to the Mt. Charles Beds observed elsewhere and is thus not considered to be directly correlatable with The Granites sequence. It is interesting to note, however, that these rocks and their correlatives could have provided the provenance for much of the detritus in the quartz-feldspar bearing metagreywacke of the region.

2. The interbedded silicified schists (or cherts) and amphibolites in the Officer Hill area may correlate with similar rocks at Grimwade Ridge. The stratigraphic position of the latter rocks with respect to The Granites sequence is uncertain. The occurrence of BIF at Officer Hill and to the south is significant as it provides clear evidence of chemical sedimentation in areas away from The Granites.

3. The rock sequence at Schist Hills and further south towards Madame Pele Hills has many similarities to The Granites sequence in a broad sense, although direct correlation is tenuous. By analogy with The Granites, the thick unit of finer grained rocks (silicified schists, ferruginous schists and ferruginous cherts) must be regarded as more prospective for The Granites style mineralisation. However, if the analogy is extended, it would be predicted that the most prospective host unit lithologies are unlikely to be exposed.

4. Granite and associated intrusive rocks are very common and probably underlie a much greater area than indicated by surface outcrops.

It is evident from the above that even the broadest correlations are uncertain owing to the general similarity of rock sequences, lack of obvious marker units, paucity of outcrop and the geographical isolation of outcrops. Certainly, areas such as Schist Hills could be mapped in detail and the complex structure resolved, however, it is unlikely that this work will greatly advance understanding of the regional geology.
Since the prime exploration target is stratiform mineralisation, high priority should be attached to developing a regional stratigraphy, so that the most prospective rock units are established on a regional scale. The serious limitations of surface geology necessitates use of techniques such as aeromagnetics, that can look beneath the surficial cover.

It is also apparent from the reconnaissance work that no one area stands out as being much more prospective than another. Rocks of certain host unit affinities were not found although fine-grained graphitic schists, which are potential associates, were located in several areas.

Moreover, other prospective lithologies such as mineralised, veined and altered basalt, dolerite and porphyry were not discovered. In such terrains, the most prudent exploration strategy is to work outwards from the known - in this case The Granites area.
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<td>13.11.84</td>
<td>23Km SW Tanami Downs H/S 500m Trig Hill</td>
<td>From massive chert unit (prob. silicified shale) Small, shallow man made depression on N side outcrop</td>
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<td>Ferruginous chert unit adj. to andalusite schist</td>
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<td>Ferruginous schist adj. to andalusite schist unit</td>
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<td>21904</td>
<td>13.11.84</td>
<td>23Km SW Tanami Downs H/S</td>
<td>From unit of andalusite-graphite schist adj. to massive silicified shale outcrop.</td>
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<td>21905</td>
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<td>2Km south of Officer Hill</td>
<td>Selection of hand specimen samples of B.I.F. and associated rocks.</td>
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<td>2 Km south of Officer Hill</td>
<td>Typical B.I.F.</td>
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<td>2Km south of Officer Hill</td>
<td>Typical B.I.F. (strongly magnetic)</td>
<td>N/L</td>
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<td>Quartz-lim. vein of margin microgranite, cutting B.I.F.</td>
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<td>B.I.F. adj. to quartz vein (sample 21908)</td>
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<td>21910</td>
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<td>1Km south of Officer Hill</td>
<td>Quartz-lim. vein material cutting metagreywacke adj. to microgranite contact</td>
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<td>21911</td>
<td>15.11.84</td>
<td>Officer Hill - east</td>
<td>Typical sample of banded ferruginous schist from ridge</td>
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<td>21912</td>
<td>15.11.84</td>
<td>Officer Hill - west</td>
<td>Typical sample ferruginous chert</td>
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<td>21913</td>
<td>15.11.84</td>
<td>Officer Hill - west</td>
<td>Typical sample ferruginous chert - from blasted outcrop at western end ridge</td>
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<td>195</td>
<td>780</td>
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<td>Officer Hill - west</td>
<td>Typical sample ferruginous chert</td>
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<td>Metabasalt (f.g. amphibolite)</td>
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<td>Banded ferruginous chert (upper unit)</td>
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<td>51</td>
<td>195</td>
<td>410</td>
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<td>Officer Hill</td>
<td>B.I.F. banded chert-magnetite (magnetic). C.F. sample 21905</td>
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<td>16.11.84</td>
<td>4 Km north McFarlanes Peak Bore</td>
<td>Selection representative samples across strike</td>
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<td>21922</td>
<td>16.11.84</td>
<td>4 Km north McFarlanes Peak Bore</td>
<td>? garnet shist (coarse gr. limonite pseudomorphs after ? garnet)</td>
<td>-</td>
<td>2</td>
<td>110</td>
<td>20</td>
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<td>Near Madame Pete Hills – 20 Km ESE Tanami Downs H/S</td>
<td>Banded silicified shale (B.I.F. affinities?)</td>
<td>16</td>
<td>45</td>
<td>10</td>
<td>125</td>
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<td>21954</td>
<td>18.11.84</td>
<td>Near Madame Pete Hills – 20 Km ESE Tanami Downs H/S</td>
<td>Banded silicified shale</td>
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<td>21955</td>
<td>18.11.84</td>
<td>17-18 Km E. of Tanami Downs H/S</td>
<td>Massive limonite/quartz association with f.g. lateritised schists</td>
<td>-</td>
<td>12</td>
<td>70</td>
<td>5</td>
<td>130</td>
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<td>21956</td>
<td>18.11.84</td>
<td>17-18 Km E. of Tanami Downs H/S</td>
<td>Massive limonite/quartz association with f.g. lateritised schists</td>
<td>0.50</td>
<td>900</td>
<td>570</td>
<td>56</td>
<td>1050</td>
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<td>21957</td>
<td>18.11.84</td>
<td>17-18 Km. E. of Tanami Downs H/S</td>
<td>Banded cherty rock (probably silicified shale)</td>
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<td>18.11.84</td>
<td>17-18 Km. E. of Tanami Downs H/S</td>
<td>Lateritised quartz graywacke with angular quartz-feldspar grains set in a f.g. ferrug. matrix</td>
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<td>21959</td>
<td>19.11.84</td>
<td>Schist Hills (south)</td>
<td>Massive quartz limonite in ferruginous schist-chert horizon</td>
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<td>21960</td>
<td>19.11.84</td>
<td>Schist Hills (south)</td>
<td>Various lithologies</td>
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<td>19.11.84</td>
<td>Schist Hills (south)</td>
<td>Massive quartz limonite in ferruginous schist-chert horizon</td>
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<td>21962</td>
<td>19.11.84</td>
<td>Schist Hills (south)</td>
<td>Vugggy gossanous ironstone and chert within metagreywacke</td>
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<td>Schist Hills (north)</td>
<td>Banded ferruginous chert within sequence f.g. schists</td>
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<td>21964</td>
<td>19.11.84</td>
<td>Schist Hills (north)</td>
<td>Thin, folded, ferruginous chert band within silicified shale/chert sequence</td>
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<td>21965</td>
<td>19.11.84</td>
<td>Schist Hills - far north</td>
<td>Vugggy quartz-limonite rock within chert-silic. shale sequence</td>
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THE GEOLOGY AND MINERALISATION OF THE GRANITES GOLD DEPOSITS, NORTHERN TERRITORY

By

TREVOR J. IRELAND AND THOMAS E. MAYER

ABSTRACT

The Granites Goldfield is located 550 km northwest of Alice Springs. Mineralisation was discovered in 1900 and intermittently worked along nine km of strike until the early 1950's, yielding a recorded production of 470 kg of gold. The geological environment, pre-existing exploration drilling results, and an optimistic view on gold, prompted acquisition of the property by North Flinders Mines Limited in 1975. An agreement was signed with the Central Land Council in August 1983 and drilling commenced in the same month.

In the past, gold was won from alluvial deposits, rich quartz veins and lower grade, disseminated stratabound mineralisation. The last is contained within a distinctive unit in the Mt. Charles Beds, of the Early Proterozoic Tanami Complex. This informally named "Host Unit" is a metamorphosed, chemical-pelitic sediment. The schist contains variable proportions of amphibole, quartz, garnet, clinopyroxene, carbonate and sulphide, intercalated with recrystallised chert beds. Free gold occurs in several mineralised horizons within the Host Unit, generally conformably distributed within lithologic bands or at lithologic contacts. The Host Unit occurs within a sequence of metamorphosed pelitic sediments and intermediate volcanics. Although mostly confined to the Host Unit, stratabound gold mineralisation also exists in both Footwall and Hanging Wall Schists, usually within zones displaying certain Host Unit characteristics.

The deposits may be loosely categorised as being of banded iron formation (bif) type, although some important differences are noted between them and classical bif type orebodies.

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INTRODUCTION

The Granites gold deposits are located 550 km northwest of Alice Springs, centred on longitude 130° 19' E, latitude 20° 33' S (Fig. 1) and adjacent to the Alice Springs/Halls Creek road. The surrounding Tanami Desert lacks permanent surface water and is characterised by undulating, spinifex-covered red sandplain with patches of scrubby vegetation, and interrupted by occasional sand dunes and low rises of basement rocks or their lateritised remnants.

In this paper we review the history of The Granites Goldfield, summarise relevant regional geology and geophysics and present some recent observations on the detailed geology of the deposits.

The data are inevitably somewhat generalised and of a preliminary nature, reflecting the present early stage of evaluation.

FIG. 1 - Location

EXPLORATION AND MINING HISTORY

A.A. Davidson, leading the first expedition into the region in 1900, discovered both The Granites and Tanami Goldfields (Fig. 1) (Davidson, 1905). Prospecting parties intermittently worked vein and alluvial gold deposits at The Granites between 1910 and 1932 but were seriously hampered by lack of water and logistic difficulties.

In 1932, the discovery of richer and more extensive alluvial gold mineralisation on the slopes of Chapmans Hill (Fig. 2) sparked a short-lived rush to the area, and an associated stock market flurry (Baume, 1933). Chapmans Gold Mines N.L., established by C.H. Chapman, was the only survivor, and continued for 20 years to mine small tonnages of ore from alluvial, vein and stratabound deposits.

Early production came from transgressive quartz veins with gold grades of a few ounces per ton over widths of several centimetres. However, these did not persist at depth and in later years, lower grade stratabound mineralisation was mined over widths of several metres, and to depths of about 25 m. The best deposits of this type were at Bullakitchie and Shoe, in the centre of the Field (Fig. 2), although stratabound mineralisation is known from almost the entire nine km of strike length at The Granites. The total recorded production from all sources is about 470 kg.

During 1939 the Aerial, Geological and Geophysical Survey of Northern Australia completed a magnetic survey of the Goldfields, and surveyed selected traverses, in the Bullakitchie/Shoe area (Fig. 2), using potential ratio, self-potential and electromagnetic techniques (Daly, 1962). An elongate ridge of positive magnetic response, parallel to the strike of mineralisation, was inferred to be due to a 'magnetic bed' forming part of the host sequence. Potential ratio anomalies were interpreted as repeated narrow conductors, also parallel to the lithological layering, within and adjacent to the mineralised sequence (Daly, 1962). Although interpreted as possible mineralised horizons, the conductors have been shown by subsequent drilling to be graphitic and pyrrhotitic horizons not directly related to gold mineralisation.

During the same period, Anglo-Queensland Mines Limited (a subsidiary of Mt. Isa Mines Ltd.) undertook a program of costeaming, and drilled 15 core holes to test depth and lateral extensions of the Bullakitchie and Shoe workings. This drilling, plus a further five holes in 1947-48 (total 2300m) outlined a probable geological resource in the two deposits of 250,000 tonnes averaging 11.5 grammes/tonne (g/t). This gold above 120 m depth, and open at depth, was apparently insufficient to justify further evaluation. A subsequent six hole drilling program in 1953-54 by Melbourne-based Northern Mines Develop-
ment N.L. confirmed, but failed to upgrade, the previous result.

The region has been covered by airborne magnetics surveys (1962) and gravity surveys (1967) of the Bureau of Mineral Resources (BMR).

Records of the N.T. Department of Mines and Energy show that modern mineral exploration of the region has been extremely limited, comprising mostly reconnaissance surveys for uranium, base metals and gold, supported by the drilling of a very few base metal targets, with discouraging results. Weak uranium mineralisation has been identified in scattered locations around the unconformity between the Tanami Complex and onlapping sediments. The only gold-orientated program of note is that conducted by Geopeko around 1970. Relevant excerpts of internal company reports have been generously provided to N.F.M. by Geopeko management. Prominent magnetic anomalies appearing on 1:250 000 scale magnetic contour maps were diamond drilled. Two anomalies were tested in The Granites Goldfield, at Twin Hills and at Ivy (fig. 2), and both revealed significant gold mineralisation. However, no follow up work was attempted. Results from elsewhere in the region are currently unavailable.

Political and legal constraints rendered the area inaccessible to general exploration between 1976 and the present.

North Flinders Mines Limited was introduced to The Granites property in 1975 by prospectors S. Griffiths and F. Glastonbury. Federal Government enquiries into matters relating to Aboriginal Land Rights forced the indefinite postponement of the grant of the mineral tenement applications. Eventually after the enactment of the Aboriginal Land Rights (N.T.) Act, 1976, and the formation of the Central Land Council, the Walpiri people successfully claimed an area of 90,000 km² which included The Granites Goldfield. This action was followed after 1980 by negotiations leading to the establishment in August 1983, of the present operating agreement, covering both evaluation activities and arrangements for any subsequent mining of the deposits.

Fieldwork commenced immediately after the signing of the agreement and by December 1983, 20 diamond drillholes totalling 4000 metres were completed at Bullakitchie and Shoe (Fig. 7), in conjunction with programs of percussion drilling, costeaming, mapping, petrography and ground magnetics over the deposits and strike extensions.

REGIONAL GEOLOGY

The Granites Goldfield occurs within the Early to Middle Proterozoic Granites-Tanami Block which covers at least 20,000 sq. km overlapping the N.T.-W.A. border (Fig. 3).

The regional geology is comprehensively described by Blake, Hodgson and Muhling (1979). This work has provided the basis of regional geological investigations by N.F.M.

The Granites-Tanami Block comprises the Early Proterozoic Tanami Complex metamorphic basement, relatively unstressed granitoid intrusions and associated comagmatic acid volcanics, plus slightly deformed sedimentary cover sequences.

The Tanami Complex is very poorly exposed, and rocks which do outcrop are usually pervasively weathered, lateritised or silicified. Combined with the absence of marker horizons, these features make effective geological mapping difficult. Consequently many aspects of the geology of the Complex remain unresolved. The Complex is subdivided into five units, based on palaeoenvironmental criteria and geographic separation. These units may be time-equivalents. The Mt. Charles Bed is host to all known gold mineralisation. This unit consists predominantly of thinly bedded chert which may be limonite-banded or gossanous, silicified siltstone, phyllitic sandstone and greywacke, with minor shale, acid volcanics and metabasalt.

The metasedimentary-metavolcanic sequences in the Tanami Complex are thought to be a few thousand metres thick. Folding in the eastern
half is tight to isoclinal with widespread disruption by faulting, so that regional structural patterns are largely indeterminate, given the sparse exposure available. The attitude of layering is mainly sub-vertical and the tectonism has imparted a strong schistosity which is usually parallel to bedding. The grade of regional metamorphism is lower greenschist, but this is locally elevated in the thermal aureoles of some post-tectonic acid intrusions.

These acid intrusions are scattered through the Complex but appear to be concentrated close to the rim of overlapping sediments. On a regional scale, they are not geophysically distinguishable and they may be more extensive under surficial cover than is implied by their localised bold outcrop (as for example, at The Granites). The suite is lithologically consistent, and most examples consist of biotite adamellite, with ages ranging from around 1700 to 1800 my (page et al., 1978).

The major tectonism is dated at about 1960 my corresponding in time and style to that which affected the Halls Creek Province (Dow & Gemutz, 1969, Blake 1979). The depositional, igneous and tectonic history is also closely comparable with that of the Pine Creek Geosyncline. It is with these two provinces that correlations with the Tanami Complex have been most frequently made.

GENERAL GEOLOGY
OF THE GRANITES GOLDFIELD

The Granites derives its name from an impressive cluster of tors that rise abruptly to heights of 20m above the otherwise subdued landscape. Westwards from The Granites, an arcuate strike ridge of Mt. Charles Beds is defined by a line of low hills extending westnorthwesterly for six km, then west-southwesterly for three km before disappearing under desert sandplain (Fig. 2). This belt of rocks, approximately 200m wide, contains all the excavations and mineralisation collectively known as The Granites Goldfield.

STRATIGRAPHY

From the weak outcrop on the crests of the hills and exposures in workings and costeans, the units of the sequence from south to north are informally named the Footwall Schist, Host Unit and Hanging Wall Schist. The Footwall Schist is >20m thick, and is a massive, deeply weathered, fine grained, micaceous to earthy schist which is distinguished from overlying units by the absence of chert layers.

The Footwall Schist is up to 35m thick, and is a pervasively oxidised, thinly bedded to laminated, chert banded garnet-amphibole schist, limonite rich due to oxidation of ferromagnesian silicates, and sulphides.

The Host Unit is up to 100m thick and contains a variety of schists including graphite schist and andalusite (sometimes chiastolite) schist, which are interlayered with chert, sericite schist and occasional layers similar to Host Unit. Lenticular outcrops of a distinctive massive, blue-grey 'quartzite' typically about a metre thick, probably formed by silicification of fine-grained graphitic schist. This member has previously been described as the Blue Quartz Marker horizon (Anglo Queensland Mines records).

The character of lithological layering and the consistency of this sequence in several exposures along the nine km line of strike, indicate that the metamorphic layering generally preserves bedding. The outcropping hills occur intermittently along the strike, where silicification of Hanging Wall Schist is most intense and where cherts of the Hanging Wall Schists are thickened by intraformational folding. The rocks are variably lateritised. The sequence is subvertical, and in the absence of firm evidence of facing, is assumed to young to the north, that is, away from the granite. A major fold is inferred from the curved trace of outcrop, but there appears to be little disruption of unit boundaries by parasitic folding or faulting. However, intraformational meso-scale isoclinal folding is locally conspicuous within the Hanging Wall Schist. Isolated exposures hundreds of metres into the hanging wall consist of rocks more typical of the Mt. Charles Beds, including siliceous siltstone and schistose greywacke.

THE GRANITES GRANITE

The Granites is the type locality for the suite of post tectonic granitoids intruding the metasediments. The principal granitoid is biotite adamellite which is locally porphyritic with feldspar megacrysts up to 50mm in length.

Its contact with metasediments at the southern end of Chapmans Hill is sharp and transgressive. The schists and cherts are not sheared nor unduly disrupted close to the contact, but metre-wide granite dykes and thinner veins of quartz, and muscovite-rich pegmatite are scattered in the contact zone. A higher metamorphic grade is observed than in adjacent regionally metamorphosed sediments and may be due to contact effects.
MINERALISATION

As described in historic records and literature, and as is apparent from the old workings, alluvial gold occurs in short gullies draining the mineralised hills, and associated outwash fans. Eluvial soil on adjacent slopes is also auriferous. Workings appear to be limited to areas of up to 200m x 150m, located mostly around Chapmans Hill (Fig. 2). Hard rock gold occurs in transgressive quartz veins, characterised by grades of the order of ounces per tonne and of limited lateral and depth persistence. The veins are localised within the Host Unit and in the more brittle rocks of the Hanging Wall Schist. Examples are identified by gougings on most of the hills. Also, stratabound, disseminated gold mineralisation occurs in layers within the Host Unit. This mineralisation is laterally and vertically more continuous than the vein-type and is more conspicuous at Bullakitchie and Shoe, but is also identified at Chapmans, Bunkers and Twin Hills, Quorn and Ivy (Fig. 2).

The concentrating mechanism and structural controls of both the vein and stratabound mineralisation are as yet unclear.

GEOPHYSICS

Magnetics confirms the continuity of the sequence along the line of outcrop. The contours (Fig. 4) reveal a series of bullseye anomalies which are linked by a weak ridge truncated by the granite at the eastern end, and at the disappearance of outcrop under soil in the west. The major magnetic response is attributed to layers of graphite-pyrrhotite schist and magnetite bearing schist observed in core within the Hanging Wall Schist.

DEPOSIT GEOLOGY

BULLAKITCHIE AND SHOE

STRATIGRAPHY

The metasedimentary and metavolcanic sequence intersected by diamond drilling at Bullakitchie and Shoe can be divided into three stratigraphic units which correspond with those mapped on surface.

Footwall Schist

The Footwall Schist exceeds 50m in thickness and is a variable sequence consisting principally of hornblende-albite ± quartz schist interbedded with andalusite-biotite schist. The unit is interpreted as a metamorphosed sequence of fine-grained volcanioclastic sediments of intermediate to basic composition, with pelitic interbeds.

Generally conformable calcite veins (1 to 50mm thick) occur intermittently. They have altered margins of similar width of clino- pyroxene-grossular garnet schist. These veins may have formed by infilling of dilatatory structures during folding, and can carry gold mineralisation.

Small porphyroblasts of almandine occur locally in both hornblende-albite-quartz and andalusite-biotite layers. Additionally, interbeds of hornblende-almandine schist are increasingly abundant towards the base of the...

FIG. 4 - Total magnetic intensity contours of The Granites Goldfield

Host Unit, forming a gradational contact. Thin, recrystallised chert beds form a very minor constituent of the Footwall Schist.

The sulphide content is low and rarely exceeds 0.3% with chalcopyrite > pyrite > pyrrhotite.

**Host Unit**

The Host Unit is 5 to 35m thick and consists of a variably silicified sequence of cherty metasediments with probable volcanic exhalative affinities. It is characterised by well defined banding and frequent lithological changes and repetitions on micro and meso scales. The scale of the finest laminations can be gauged from the description in one case of nine lithological layers in a single thin section. The principal lithologies include:

1. hornblende ± cummingtonite ± almandine ± quartz schist,
2. clinopyroxene ± grossular schist,
3. calcite-rich marble with minor ferroan calcite and ferroan dolomite, and
4. recrystallised chert.

Minor minerals include albite, actinolite, tremolite, graphite, epidote, biotite, chlorite, cordierite and clays with rare sphene and tourmaline.

The relative abundance of lithological types varies both laterally and vertically throughout the Host Unit. For example, calcite is very abundant at East Bullakitchie, particularly in the upper half, and near the base of the Host Unit, but is far less abundant elsewhere.

Sulphide occurs mostly as disseminations and less commonly as small aggregates, laminae and remobilised veinlets in hornblende rich layers. Sulphide content is variable, averaging approximately three percent and rarely exceeding eight percent. The principal sulphides are pyrrhotite and pyrite > arsenopyrite, with trace amounts of chalcopyrite and sphalerite. Arsenopyrite occurs as concentrations of coarse grained subhedral aggregates, which are relatively abundant at Shoe (approximately two percent with half-metre intervals up to five percent). However at East Bullakitchie, arsenopyrite is only a minor constituent, confined to the uppermost five metres of the Host Unit.

The shape of the Host Unit tends to be consistent and tabular (Fig. 5) but occasional rapid variations in thickness are observed over short distances. Internally, evidence of deformation includes disruption and remobilisation of calcite layers, streaking of disseminated sulphides, and rare micro-fold closures.

**Hanging Wall Schist**

The Hanging Wall Schist is more than 100m thick and consists of a metamorphosed sequence of fine grained aluminous and ferromagnesian sediments and volcanics. The sequence is generally less silicified than the Host Unit. Laterally, lithological variation is abrupt, as a result either of rapid facies change or complex internal structure. Correlation over intervals of as little as 25m may be very difficult.

The contact between the Host Unit and the Hanging Wall Schist is usually sharp. The base of the Hanging Wall Schist generally consists of graphite ± cordierite ± andalusite ± hornblende schist. At East Bullakitchie, it is very graphitic and strongly brecciated. The brecciation is weaker to the west and absent at Shoe.

Lithologies within the Hanging Wall Schist include:

1. andalusite-biotite ± graphite ± cordierite schist,
2. cordierite-graphite ± biotite schist,
3. chert,
4. hornblende-graphite schist,
5. hornblende-aldite-biotite schist,
6. hornblende-biotite schist, and
7. hornblende-almandine schist.

Certain intervals of hornblende-almandine schist display Host Unit characteristics including chert interbeds, arsenopyrite aggregates, and sometimes gold mineralisation.

Sulphide content of the Hanging Wall Schist is variable with pyrrhotite > pyrite > marcasite, arsenopyrite and rare chalcopyrite. Pyrrhotite and pyrite are often abundant within graphitic zones (up to 15 percent) but elsewhere are minor constituents occurring as thin stringers in schistosity planes, disseminations and veneers on joints. At Shoe, arsenopyrite is much more abundant in the Hanging Wall Schist, with hornblende-cordierite -graphite schist layers locally containing concentrations similar to the Host Unit.

As well as the contact brecciation noted above, the Hanging Wall Schist reveals a possible complex deformation history in a variety of features including shearing and
streaking of graphitic-sulphidic schists, zones of intense jointing and brecciation in more massive schists, rare fold closures, plus occasional low-angle discordance between lithological layering and schistosity.

Mineralisation at East Bullakitchie

Although the following comments are based on observations at East Bullakitchie, the style of mineralisation is similar in the remainder of Bullakitchie and at Shoe.

There are several lodes (comprising closely grouped mineralised layers) within the Host Unit (Figs. 5 and 6). The mineralisation is usually visible, although gold particles vary in size from about 1.2mm to submicron. Usually the gold occurs as clusters of coarse and fine particles. However, single particle gold occurrences are sometimes observed.

Gold mineralisation is stratabound. Within the Host Unit, gold generally occurs within thin lithological bands or at lithological contacts. The clustering of gold particles along primary layers is maintained, both in zones of small scale folding, and where the schistosity (which is usually parallel to bedding) crosses bedding at a low angle. In one case within a transgressive quartz vein, the gold particles lie in a plane parallel to bedding.

Some remobilisation of gold is believed to have occurred, forming narrow-high grade veins such as those previously worked at New Find adjacent to Bullakitchie, where 600 tonnes of ore yielded 1800 ounces of bullion and other localised enrichments within the Host Unit. However, the disposition of gold within lithological layers indicates that in general, remobilisation has been quite localised with gold tending to move along strike rather than across strike.

Gold occurs in various rock types within the Host Unit. These are listed in Table 1. Gold particles may be interstitial to porphyroblasts or incorporated within them, either on fractures or as solid inclusions (for example, within garnet and hornblende).

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**FIG. 5** - Geological cross section 50775E (looking west)

**FIG. 6** - Histograms of distribution of gold grades. Cross section 50775E (part of)
Gold is occasionally present adjacent to sulphides and very rarely within sulphides. Neither the occurrence nor the intensity of gold mineralisation appears to correlate with either the presence or the abundance of any commonly associated mineral or lithological type. All gold appears (on the basis of colour) to be of high purity, and measurements indicate fineness values in excess of 950.

**Table 1: Frequency of Occurrence of Visible Gold in Various Host Unit Lithologies**

<table>
<thead>
<tr>
<th>Lithology</th>
<th>Frequency</th>
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<tr>
<td>1. Chert</td>
<td>Frequent</td>
</tr>
<tr>
<td>2. Hornblende-cummingtonite schist</td>
<td>Frequent</td>
</tr>
<tr>
<td>3. Hornblende-almandine schist</td>
<td>Frequent</td>
</tr>
<tr>
<td>4. Clinopyroxene-grossular schist</td>
<td>Moderate</td>
</tr>
<tr>
<td>5. Calcite</td>
<td>Rare</td>
</tr>
<tr>
<td>6. Quartz vein margins</td>
<td>Rare</td>
</tr>
<tr>
<td>7. Clay</td>
<td>Rare</td>
</tr>
<tr>
<td>8. Transgressive quartz veins</td>
<td>Very rare</td>
</tr>
</tbody>
</table>

Individual lodes show variable lateral continuity and depth persistence. The cross section (Fig. 5) shows examples of good continuity. The longitudinal projection of the Upper Lode of Bullakitchie (Fig. 7) illustrates the lateral continuity of mineralisation. Continuity and grade distribution within individual lodes however is less predictable, as illustrated by the grade histograms (Fig. 6).

**CONCLUSIONS**

There is little doubt that the mineralised Host Unit is a metamorphosed, partly tuffaceous, pelitic sediment with a high chemical component. The gold was probably introduced by hot spring activity on the sea floor. In this sense the stratabound gold mineralisation at The Granites appears comparable with other Precambrian biff-hosted gold deposits (for example Homestake, Cullaton Lake, Lupin and Pickle Crow in North America, Vubachikwe in Zimbabwe, Mt. Magnet, Lancefield, Bullfinch and many others in Western Australia and Enterprise in the Pine Creek area of Northern Territory). However, there are important differences between The Granites deposits and the examples cited above, notably

1. absence of obvious structural controls,
2. relatively low total iron content (rarely > 20 percent),
3. paucity of iron oxide and carbonate minerals, and
4. general low content of iron sulphides (Giles, 1983).

![Bullakitchie Main Lode Diagram](image)

**FIG. 7 - Longitudinal projection of upper lode, Bullakitchie, looking north, showing down-hole width and grade of intersection**

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It is anticipated that the full significance of some of these features will emerge as knowledge of the deposits and their host rocks evolves.

ACKNOWLEDGEMENTS

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