Title: ANNUAL REPORT FOR YEAR THREE
EXPLORATION LICENCE 7684
MARY RIVER AREA, NORTHERN TERRITORY
13.04.94 TO 12.04.95

Project Name: ALLAMBER SPRINGS

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Report No. 19450
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Report Number: 19450

Title: ANNUAL REPORT FOR YEAR THREE
EXPLORATION LICENCE 7684
MARY RIVER AREA, NORTHERN TERRITORY
13.04.94 to 12.04.95

Author: I K Butler

Date: 18 May, 1995

SUMMARY

EL 7648 is part of a contiguous block of tenure (EL's 7138 and 7935) referred to as the Allamber Project. It is located in the Pine Creek Inlier and the geology of the area comprises Early Proterozoic metasediments that have been intruded by Carpentarian granite. TOTAL Mining postulated the area to be geologically and structurally similar to Rum Jungle Mineral Field and subsequent work by Aztec Mining supports this interpretation.

The metasediments are concordant with the granite contact and in ascending order are interpreted by Aztec Mining to be equivalents of Crater Formation, Coomalie Dolomite, Whites Formation and Acacia Gap Quartzite of the Namoona and Mt Partridge Groups. The Cullen Granite is interpreted to be recrystallised basement.

Intense exploration by TOTAL Mining located pods of East Alligator/Rum Jungle type uranium mineralisation at the Twin, Dam and Cleos prospects. They also located a previously unrecorded secondary copper occurrence with a shaft at a similar interval in the stratigraphy as the uranium.

Work conducted by Aztec Mining within EL 7684 during Years One and Two included:-

- Literature research
- Detailed stream sediment sampling
- Soil sampling
- Geological mapping
- Purchase of airborne magnetic/radiometric data
- Diamond and RC drilling

The results of this work were disappointing. Work conducted during Year Three of tenure included a review of exploration data, petrological examination of selected core samples and rehabilitation of drill sites. Aztec Mining has subsequently withdrawn from the Joint Venture.

Annual Report Exploration Licence 7684
1. **INTRODUCTION**

Exploration Licences 7138, 7684 and 7935 form a contiguous tenure block and are located 40kms north east of Pine Creek (see Figure 1). They are situated on the Mary River Pastoral Lease and encircle the Mary River Homestead. Access is gained via the Kakadu Highway, the Mary River Homestead formed road and station tracks.

The area covered by the licences is considered to be prospective for differing styles of base metal and gold mineralisation.

The purpose of this report is to outline the work conducted during the third year of tenure for EL 7684.

2. **TENURE**

Exploration Licence 7684 comprised eight graticular blocks and was granted on 13 April, 1992, for a period of four years. Three graticular blocks were relinquished at the end of Year Two of tenure. The current ownership is Earthowl 50%, Day 45% and Teelow 5%.

On 4th December 1992, Aztec Mining Company Ltd entered into a joint venture agreement on all three EL’s with the licence holders whereby Aztec may earn a 90% interest by contributing to all expenditure until Aztec has completed a feasibility study.

Aztec withdrew from the Joint Venture on 3 March, 1995.

3. **CONCLUSIONS**

1. Exploration conducted by Aztec Mining supports TOTAL Mining’s interpretation that the geology and structural setting of the Allamber project area is similar to the Rum Jungle Mineral Field.

2. Exploration within EL 7684 located a strike extensive stratabound cupriferous horizon, however, no areas of higher grade Cu mineralisation have been located to date.

3. Aztec Mining Limited withdrew from the Joint Venture after being taken over by Poseidon Gold, and rationalisation of tenements back to the Woodcutters Operation.
Aztec Mining Company Ltd.

Scale: 1:100 000
Compiled: LKBlair
Date: DEC 1992
Drawn: M.C.B.

LOCATION MAP
EL 7684, 7935 AND 7138

Figure 1
4. **PREVIOUS EXPLORATION**

The first systematic exploration was not conducted until the late 60's early 70's. During that period, Australian Geophysical Pty Ltd conducted airborne radiometric surveys covering part of EL 7138 (Australian Geophysical Company Reports). No anomalies or ground follow up was reported for the area presently covered by EL 7138.

Ferruginous units overlying the Masson Formation found in the south-west corner of EL 7138 have been investigated by Wandooroo Mining (Company Report) and CRA for their iron ore potential. Tonnages and grade were found to be insufficient for mining.

CRA Exploration Pty Ltd (Ikvstrums and Swensson, 1979) conducted regional soil traverses covering a majority of EL 7138. This sampling identified 19 anomalies, five of which were followed up with detailed soil sampling, mapping and gossan sampling. Anomaly 1.5, approximately 12 km west of EL 7138 was considered to have the most potential. A diamond drill hole targeted at the best geochemistry within anomaly 1.5 yielded disappointing results (max 2m @ 0.16% Pb and 0.19% Zn) and the ground was relinquished.

Uranium, tin, tungsten, molybdenum and base metal exploration conducted by Australian and New Zealand Exploration Company (Davies, 1981) consisted of ~80# stream sediment sampling at 1km intervals, heavy mineral concentrate sampling, radiometric surveys and soil sampling. Elevated base metal values were found in a number of localities along the granite contact (max 140ppm Cu, 200ppm Pb and 460ppm Zn). Follow up rock chipping located anomalous strata-bound ironstone outcrops (max 130ppm Cu, 600ppm Pb and 1800ppm Zn). The base metal potential was interpreted to be limited and little evidence of uranium, tin, tungsten or molybdenum mineralisation existed.

Greenex (Company Report, 1983) conducted a photo interpretation and an ironstone sampling programme to test the gold, tin and tungsten potential of the area. Only low level results were recorded.

TOTAL Mining Australia Pty Ltd held two EL's (4414 and 4460) which corresponded roughly to the original EL 7138 boundary.

TOTAL Mining’s primary target was hydrothermal uranium mineralisation. Their initial exploration identified anomalous scintillometer (SRAT SSPP2 x 15,000cps) readings in silicified dolomite within the BMR mapped Mundogie Sandstone, 8km south of the Mary River Station.
Detailed follow up work identified an interbedded sequence of carbonaceous shales and dolomites following more or less concordantly the Cullen Granite contact. The dolomites on surface invariably manifest themselves as intermittent siliceous bodies, easily mistaken for quartz veins. TOTAL reported two locations containing stromatolitic structures and mapped a small area containing gneisses, migmatites and other metamorphic igneous rocks suggested to be possible Archaean remnants. TOTAL recognised a resemblance to the stratigraphy of the Rum Jungle Mineral Field, where uranium and base metals are associated with near shore biothermal sedimentation.

TOTAL postulated that the Carpentarian Cullen Granite Batholith intrusive history was similar to that of the Rum Jungle and Waterhouse Archaean granite domes.

TOTAL’s uranium search culminated in the discovery of many small radiometric anomalies over a 20km strike length and pods of U mineralisation at Dam, Twin and Cleos prospects.

TOTAL’s exploration activity within both EL’s are reported as follows:-

- EL 4414 CR85/072, 86/144, 87/67, 88/209, 89/151
- EL 4460 CR85/200, 86/204, 87/047, 89/909.

5. GEOLOGY AND MINERALISATION

The Allamber Springs Project area lies within the Pine Creek Inlier adjacent to a north eastern lobe of the Cullen Granite Batholith. The granite intruded sediments of the Early Proterozoic Mundogie Sandstone and Masson Formations (Figure 2) and it is largely concordant with those sediments.

Mundogie Sandstone (Ppm) as described by the BMR (1985) consists of coarse pebbly felspathic quartzite arkose and mica quartzite, minor chert and quartz pebble conglomerate, red and white banded phyllite, carbonaceous phyllite, sandy siltstone, mica-hornfels, and chiastolite carbonaceous hornfels. The BMR (1984) correlated this unit with the Crater Formation in the Rum Jungle Mineral Field.

Masson Formation (Pnm) as described by the BMR (1985) consists of carbonaceous phyllite, slate, silty phyllite, siltstone, minor quartzite, rare marble, tremolite, silicified dolomite and rare dolomitite. The BMR (1984) correlated this formation with the Beestons Formation at Rum Jungle.

Along much of the granite contact zone, thermal metamorphism is evident in the sediments. Locally, chiastolite and andalusite crystals are abundant in carbonaceous shales, which also show signs of hornfelsing and sericitization.
A combination of field observations and data collected from previous explorers has highlighted discrepancies with the BMR mapping and its correlations with units of the Namoona and Mt Partridge Groups.

Work conducted by TOTAL Mining and Aztec indicates that an alternative interpretation is that the Masson Formation is an equivalent of Whites Formation/Coomalie Dolomite and the Mundogie Sandstone can be correlated with the Acacia Gap Quartzite. Wildman Siltstone has been excluded from the stratigraphy in this interpretation and sediments stratigraphically immediately above Mundogie Sandstone are assigned to the Koolpin Formation. The Whites Formation has been extensively intruded by Zamu Dolerite sills.

The metasediments mapped within the survey area are moderately to gently folded. The folding intensity increases away from the granite. Large regional concordant fault structures have been mapped.

A small shaft sunk on secondary copper mineralisation developed within hornfelsed pyrrhotitic carbonaceous mudstone is located within EL 7684. No mining history has been recorded on this prospect. Mineralisation is predominantly malachite with minor azurite.

Intense exploration by TOTAL Mining located uranium mineralisation in a strongly folded syncline (embayment) of Early Proterozoic metasediments enclosed by Carpentarian granite at the Cleos, Twin and Dam prospects 10km south of Mary River Homestead. The mineralisation occurs as pods of unconformity vein type uranium concentrated in axial plane faults similar to the East Alligator/Rum Jungle type.

6. WORK CARRIED OUT AND RESULTS

A total of 10 samples were submitted for thin sectioning and petrological examination by RN England of Townsville. The descriptions are in Appendix I and locations of drill holes and surface samples plotted on Enclosure 1.

A review of the results of exploration to date was conducted after Aztec Mining was taken over by Poseidon Gold. Aztec withdrew from the Joint Venture with the tenement holders on 3 March, 1995, because of the disappointing results to date and a rationalisation of tenure.

The drill sites were visited at the end of the 1994 field season, hole collars capped below the surface and plastic sample bags removed from site. Some rehabilitation was carried out where necessary.
7. **EXPENDITURE**

Salaries/Labour ............................................................... $3,420
Consultants ................................................................. 1,250
Stores ........................................................................ 55
Fuel/Tyres .................................................................. 120
Administration (15%) ..................................................... 718

Total ............................................................................... $5,508
8. REFERENCES

Australian Geophysical Pty Ltd Company Reports, 1968 and 1969, Reports on exploration activity on Authority to Prospect 1727 and 2226. *Department of Mines and Energy Library, Open File Records CR 68/007 and CR 69/003 A-B*


APPENDIX I

PETROLOGICAL DESCRIPTIONS
ALLAMBER SPRINGS

Samples from White's Formation equivalent.

ASDDH 1, 72.0 m. Biotised fine-grained quartz monzodiorite.

Roughly tabular, lightly sericitised plagioclase (35%) has weak normal zoning in the range An<sub>50-40</sub>. <0.2-mm quartz (30%) and <0.3-mm microcline (20%) are anhedral. Randomly oriented, roughly tabular 50-600 μm biotite forms about 15% of the rock. Tabular <0.1-mm muscovite is very rare. Other rare phases are <50-μm pyrite in <0.5-mm clusters, <30-μm columnar and granular apatite, and <50-μm tabular ilmenite.

This is a more mafic, more rapidly chilled body than the local Cullen Granite. The field relations given in the notes accompanying the samples indicate that it is a sill. The texture suggests metamorphic partial recrystallisation at high T in the aureole of the main granite. The slightly peraluminous composition would be unusual for a rock so low in silica, and probably reflects loss of Ca and enrichment of K during alteration which may have preceded metamorphism.

ASDDH 1, 75.8 m. Graphitic pelitic hornfels with coarse chalcopyrite.

Abundant muscovite forms 0.2-3 mm anhedral. 30-μm to 1 mm quartz (25%) is granoblastic except if it is contiguous with 0.2-3 mm masses of chalcopyrite (3%) and rare siderite, where it forms terminated prisms. Tabular to anhedral 10-μm to 1 mm chlorite occurs in small clumps and whispy lenses a few m long. 1-400 μm flakes of graphite (10%) form abundant inclusions in muscovite and chlorite, aggregates with fine-grained quartz, and whispy anastomosing trains defining a foliation. There is only a weak preferred orientation of sheet silicate basal planes parallel to the foliation.

Chalcopyrite and quartz are concentrated together in streaky disseminations parallel to the foliation.

Weakly formed 1-2 mm augen consisting of coarse muscovite depleted in graphite inclusions may be retrograde pseudomorphs after andalusite or cordierite (though nothing fresh is preserved). Minor leucoxene inclusions in chlorite suggest that it is a retrograde alteration product of biotite.

Graphite is especially coarse (suggesting higher T than elsewhere) and abundant. The retrograde chlorite probably formed below 400°. The chalcopyrite texture is compatible with a pre-metamorphic origin. Siderite could have been stable to 500°, but only in a very CO₂-rich fluid, which is unlikely. Thus it may also be retrograde.
ASDDH 1, 98.8 m. Retrogressed nodular and bedded coarse-grained, formerly dolomitic metapelite.

Two major rock types form beds on a cm scale. Most of the section is a formerly dolomitic bed of matted 0.2-2 mm randomly oriented, roughly prismatic altered amphibole (probably actinolite), with interstitial <0.2-mm anhedral quartz and minor chloritised biotite. The amphibole is altered to 10-100 µm calcite, chlorite, and minor albite. Extremely rare tiny colourless relics remain as inclusions in quartz. <0.1-mm graphite flakes (2%) are disseminated through the whole rock, though rare in the nodules (q.v.).

Centimetre-scale siliceous nodules in this formerly dolomitic bed are dominated by 0.1-5 mm anhedral quartz, with minor <0.5-mm subhedral pyrite and clumps of <0.2-mm graphite flakes. Minor <5-mm bodies of spongy and massive pyrite occur in pressure shadows between the nodules and also in the (formerly) amphibole-rich layers. The hand specimen has a bedding-parallel 2 mm-thick lens of coarse massive pyrite.

Minor separate layers consist mostly of 20-500 µm lighty chloritised red-brown biotite, and 50-400 µm granoblastic and interstitial quartz. A fine-grained biotite-rich bed contains 5-10% graphite, and has a strong layer-parallel foliation. Minor <2-mm clusters of subhedral pyrite in all rock types are probably relics of pyrrhotite, rare small relics of which are preserved in quartz.

Rocks like this can be transitional to Fe formation, but the biotite is not dark brown enough to be very Fe rich.

ASDDH 1, 117 m. Laminated, clinopyroxene-graphite rich calc-silicate rock (skarn?).

Prominent bedding laminations range from 0.1 to 10 mm thick. The thickest beds are mainly <0.2-mm granular and stubby prismatic clinopyroxene and subordinate <1-mm interstitial anhedral quartz and clinozoisite. Much of the compositional variation from bed to bed reflects changes in proportion of these minerals. Quartz is never a major phase.

Minor <5mm-thick beds contain abundant anhedral and rarely subhedral grossular-rich garnet. Garnet in one almost continuous layer replaces an unknown coarse bladed or prismatic mineral.

Thin beds at one end of the sample contain prominent <0.2-mm granoblastic microcline, with fine-grained clinopyroxene and biotite. Right at the end of the core is a bed of 50-µm to 1-mm subhedral garnets and an interstitial <1-mm green mica-like phase. The small garnets suggest that this might be a Mn-rich layer, once containing manganosiderite. Nearby clinopyroxene is carbonated by retrograde fluid.

Diopside-rich beds contain about 15% graphite, which is present in lesser amounts throughout. Garnets tend to push graphite aside rather than include it: the coarsest grossular is partly rimmed with 5-mm graphite tablets.

The diopside-clinozoisite-grossular assemblage limits $X_{CO2}$ in the fluid phase to <0.02 (Labotka, 1991), but T is poorly
constrained at this low \( X_{CO_2} \). My calculations suggest that the fluid phase would probably have to be about half methane at 500° to support graphite with so little \( CO_2 \).

This graphitic, i.e. reduced calc-silicate assemblage is related to more oxidised skarns by the following:

<table>
<thead>
<tr>
<th>Reduced Assemblage</th>
<th>Oxidised assemblage</th>
</tr>
</thead>
<tbody>
<tr>
<td>( Ca_3Al_2Si_3O_12 + 5CaFeSi_2O_6 + 5/4O_2 + 0.5H_2O = 2Ca_3Fe^{3+}_2Si_3O_12 + Ca_2Al_2Fe^{3+}_3Si_3O_12(CH) + 4SiO_2 )</td>
<td>Grossular</td>
</tr>
<tr>
<td></td>
<td>hedenbergite</td>
</tr>
<tr>
<td></td>
<td>andradite</td>
</tr>
<tr>
<td></td>
<td>epidote</td>
</tr>
<tr>
<td></td>
<td>quartz</td>
</tr>
</tbody>
</table>

Just how skarn-like this rock might be would depend on the molar ratio of \( Fe/(Fe+Mg) \): a high value could be due to reaction with Fe-rich magmatic fluid. On the other hand it might have a sedimentary origin, like the BIF layers in formerly dolomitic metapelites in the Tanami area. The layers with fine ?manganiferous garnets suggest an affinity with banded Fe-Mn formations, and the "garnet sandstone" units at Broken Hill. The ore at Pegmont can contain graphite + magnetite + garnet, though the graphite there commonly reacts with magnetite, quartz and aqueous fluid to form fayalite.

ASDDH 3, 123.5 m. Biotite-rich metasediment with quartz-tourmaline-plagioclase vein.

The metasediment contains about 50% of 0.1-1 mm interlocking anhedral quartz, with abundant 0.1-1 mm anhedral biotite: biotite was originally pale brown (i.e. not Fe rich), but retrograde alteration has given it a green colour. Weakly prismatic to anhedral 5-\( \mu \)m to 1-mm tremolite-actinolite is common in a 5 mm-thick lens: all but \(<50-\mu \)m grains protected by inclusion in quartz are altered to siderite, giving the lens a buff colour in hand specimen. The host rock is dusted with a little 50-\( \mu \)m graphite.

A coarse vein about 50 mm thick is dominated by \(<10-\mu \)m terminated prismatic quartz and interstitial 15-mm blue tourmaline (schorl). Parts of the vein contain \(<5-\mu \)m tabular plagioclase (An\(_{38}\)) and minor clumps of \(<0.5-\mu \)m anhedral biotite; they have the texture and mineralogy of coarse pegmatitic granodiorite. A little partly sericitised \(<2-\mu \)m subhedral plagioclase is included in tourmaline. Minor 1-4 mm anhedral garnets (red in hand specimen, suggesting Fe-Mn-Ca?) occur along the vein wall.

Minor \(<10-\mu \)m clusters of \(<0.2-\mu \)m subhedral pyrite, and minor chlorite and marcasite occur in both vein and host rock. Some pyrite aggregates interstitial to plagioclase tablets may be relics of sulphide that crystallised from a silicate melt. All pyrite would have replaced pyrrhotite, tiny relics of which are still preserved in quartz. Rare stringers of \(<0.1-\mu \)m galena occur with green altered biotite in the host rock. Rare \(<50-\mu \)m pale brown sphalerite and chalcopyrite accompany some galena. More chalcopyrite forms \(<300-\mu \)m patches and veinlets in garnet.

This rock is practically migmatite. Perhaps a high boron content has depressed the solidus of the assemblage (lithium borate is used as a flux for dissolving silicates for XRF: tourmaline can contain bi). I am not sure whether the metals are
early, or late (coeval with sideritic alteration of tremolite-actinolite).

ASDDH 3, 139 m. Muscovite-chlorite-quartz-graphite coarse-grained, bedded pelitic hornfels with Cu mineralisation. Shear zone.

This rock is mostly 0.1-1 mm strained anhedral quartz and 0.1-3 mm strained tabular to poikiloblastic anhedral muscovite, with minor <1-mm tabular and anhedral chlorite. 1-500 μm graphite flakes (3%) form 0.2-5 mm-thick concentrations, probably bedding. They are quite lustrous and may have been mistaken in the log for chalcopyrite. A sparse dusting of fine leucoxene in chlorite suggests that it is derived by retrograde alteration of biotite.

Prominent <5-mm clusters of <0.5-mm anhedral pyrite are disseminated through the rock. Chalcopyrite (2%) occurs as disseminated <2-mm masses and <10x1 mm stringers of coarse anhedral roughly parallel to bedding. Quartz forms terminated prisms along contacts with chalcopyrite.

It is not clear whether the Cu mineralisation is associated with the chloritisation of biotite or earlier. The unusual amount of strain is clearly due to the shear zone.

ASDDH 3, 142.5 m. Muscovite-biotite-quartz-graphite coarse-grained bedded pelitic hornfels.

This rock consists mainly of 0.1-2 mm anhedral quartz (40%), and randomly oriented muscovite (40%) and biotite (15%). Minor <1-mm anhedral plagioclase or cordierite, completely altered to <10-μm sericite and chlorite, occurs in beds at least 25 mm thick. <0.1-mm graphite flakes form up to 5% of some beds, and about 1% elsewhere. Bedding on a scale of 0.5 mm upwards is defined by variation in the proportions of these phases.

Anhedral <1-mm chalcopyrite accounting for c. 1% Cu occurs in disseminations and narrow stringers parallel to the bedding. Some is slightly supergene-altered to digenite. Biotite seems quite happy in contact with chalcopyrite, suggesting that the mineralisation occurred or was already present during the high-grade metamorphism.

Digenite has a similar composition and appearance to chalco-
cite. The only stable Cu phase in a metamorphic rock containing some Fe, and with the assemblage biotite-muscovite-graphite would be chalcopyrite (or cubanite which almost always reacts to chal-
copyrite + pyrrhotite and/or pyrite on cooling). Chalcopyrite and digenite are confined to very oxidised, low-T (or extremely high-
ph) conditions. They are commonest in supergene environments or red beds at low T.

ASDDH 4, 142 m. Muscovite-quartz-graphite-biotite-microcline schist.

This rock consists mostly of 0.1-1 mm anhedral quartz (30%)
and microcline (10%), anhedral to roughly tabular 0.1-5 mm muscovite (40%) and chloritised <1-mm biotite (10%), and 10-μm to 1-mm flaky graphite (10%). 2-mm roughly prismatic tourmaline is very minor.

Minor disseminated <0.5-mm cubes and anhedral of pyrite are probably after pyrrhotite.

A foliation defined by preferred orientation of chlorite and graphite anastomoses around 0.5-2 mm subround masses of muscovite which may be retrograde pseudomorphs after cordierite or andalusite. Muscovite seems to be randomly oriented.

It is possible that the rock once contained the assemblage cordierite-Kfeldspar. This may have formed on the influx of CO₂-rich fluid from local calc-silicate beds, and then been converted back to the more hydrous muscovite-biotite-quartz assemblage by a more H₂O-rich fluid.

Allamber 01. Felsic granofels: tuff marker?

Most of the rock is 30-500 μm anhedral quartz and microcline. Anhedral 0.2-2 mm oligoclase (5%) is concentrated in a 5 mm-thick layer. Variations in the abundance of randomly oriented <0.1-mm flaky biotite (2%) and clustered 10-200 μm granular Mn-Fe-Ca garnet (0.5%) define a weak 0.2-10 mm layering. Rare 0.2-mm beds enriched in <30-μm ilmenite and zircon are clearly placers (implying sorting). <50-μm graphite flakes are widespread but rare.

The composition is rhyolitic, consistent with an arkose precursor. Some beds could have been a tuff markers, like those at Woodcutters (Taube, 1991).

Allamber 02. Sandstone.

Rounded 0.1-1 mm lightly strained quartz grains are cemented by 10-100 μm anhedral quartz dusted with a couple of percent of 5-μm to 1-mm leached and goethised subhedral pyrite, and with very minor <30-μm graphite flakes. <50-μm whitemica flakes are very rare.

This is another unit which may once have been an oil reservoir. The degree of recrystallisation suggests that it predates the granite.

ALLAMBER SPRINGS: GENERAL COMMENTS

The pelitic rocks here are very coarse grained, but with weak fabrics typical of granite aureoles. The coarse grain size suggests that the aureole is a deep one. At about 3.5 kb (c. 10 km) without externally derived CO₂, the assemblage muscovite-biotite-quartz-graphite would be stable to at least 600° (where it breaks down to cordierite+Kfeldspar+melt).

An early, shale-hosted model for the Cu mineralisation would fit well if Cu/Au ratios were high, and especially if there were red beds and oxidised Cu source rocks in the underlying Crater
Formation. In a uniformly reduced régime (e.g. with ubiquitous graphite), Cu is mobile in low-pH, chloride-rich brines, and precipitated where the brines encounter high-pH buffers such as rocks with magnetite or calc-silicate assemblages. The pelites here would buffer any brine at fairly low pH, and it is hard to see how they would act as a trap unless the original Cu fluids had a red-bed source (Cu is much more soluble under oxidised conditions). Sverjensky (1987) shows how oil-field brines which migrate through red beds can produce Cu deposits when they pass back into reduced rocks.

The Cu/Au ratio distinguishes deposits formed from low-T, moderately oxidised fluids (where Au is virtually insoluble) from those formed at higher T, say, during metamorphism (McGoldrick & Keays, 1990). Values around $10^5$-6 are consistent with low-T deposits, whereas $10^4$-5 is the norm for high-T mineralisation. Note that in their Fig. 6, the Cu/Au isopleths are understated by a factor of 10.

Potential for gold skarns in reduced calc-silicates

Relatively mafic intrusions like that at ASDDH1, 72 m have the potential for producing gold skarns (with associated As and Bi) in graphitic calc-silicates (Meinert, 1989). Even the Cullen Granite, which is responsible for Au deposits with As and Bi could produce Au skarns in these hosts.