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# EVALUATION OF THE AMMAROO TURQUOIS DEPOSIT


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1. OBJECT.

1.1 To determine the Proterozoic basement of the turquois bearing Middle Cambrian Sandover beds, at the Ammaroo Deposit.

1.2 To determine the chemistry of the Sandover claystone beds and estimate the environments potential for quality turquois formation.

1.3 To locate by drilling other potential deposits of turquois within the local area.

2. INTRODUCTION.

Turquois production has commenced from the Ammaroo deposit. Stone of good second and third quality has been won in some abundance; but top quality material is only found in trace amounts.

The turquois layers occur within claystones that overlie a conglomerate bed that was thought to be a false basement. The occurrence of first quality stone below the conglomerate was therefore thought a possibility.

A study was made of the previous drilling programme ( Morrison 1968), recently exposed cuts and pits were mapped and sampled. Five percussion holes were drilled into the basement, one directly; samples at two foot intervals were logged and some selected for copper and phosphorous assay.

3. SUMMARY.

3.1. Within the main pit area a conglomerate forms the basement to any turquois bearing claystones.

3.2. Immediately underlying the conglomerate and in places the claystone occurs a quartzitic sandstone that forms part of the Proterozoic metamorphic basement.

3.3. The quartzitic - sandstone in places grades into, or is interbedded with, a purplish phyllite that is a metamorphosed sandy shale to siltstone.

3.4. The Proterozoic ? has been intruded by granite and granite porphyry that were intersected in the previous drilling programme.

3.5. The main turquois horizon is close to the base of the claystones particularly where ferroan and phosphatic beds are abundant.

3.7 The basal four feet of claystone contain abundant beds of kaolinite and khaki - rusty brown - tobacco coloured clay rich rocks thought to be tuffs. The coloured beds contain up to 4000 ppm copper, while all are alumina rich.

3.8 Phosphate beds and lenses are commonly interbedded with 3.7 rocks. The phosphate occurs as an aluminium variety, a mineral that can convert to turquois by the addition of copper.

3.9 Light coloured claystones and solid basement rocks contain from 35 - 250 ppm copper. Values to 740 ppm occur in weathered basement rocks where leached copper from the basal claystone beds is thought contaminatory.

3.10 Little first quality turquois has been won during the current mining operation; though carving grade is more plentiful and hobby type material is in greater supply.

3.11 Overburden can generally be dumped as shown in Morrison's report, without covering any grade turquois. The material from Area D, however should be dumped away from the NW corner of the area indicated. No area should be opened unless the turquois can be removed quickly.

3.12 An exploration programme for turquois in the mine area can be done using a percussion drill on 50 foot spacings; utilising copper and phosphate assays of the lower 4' of claystone and top 2' of siltstone.

3.13 With regard to local exploration the two main areas of interest are Area D and the east of Area A where the turquois beds are under at least 40 feet of cover.

3.14 Areas of interest from 3.12 programme can be discerned from turquois chips together with high copper and phosphate assays (over 1000 ppm Cu and 5% $PO_4$).

3.15 An exploration programme for turquois in other areas can be done by scout percussion drilling and geochemistry as given above. Areas containing interbedded claystones and limestone may be of high interest.

3.16 The main problem probably effecting the grade of polished turquois is the expansion of montmorillonite clay, initiated by the treatment water.

## 4. RECOMMENDATIONS.

4.1 Extract and 'wax' all accessible turquois exposed by the mining operation to date.

4.2 Investigate methods of cutting and polishing the turquois without using water, thus containing the expansion of montmorillonite.

4.3 With future mining, only expose enough of the turquois beds that can be quickly mined. Maximum overburden should be retained over future mine areas.

4.4 Continue market studies, particularly for sizable specimens of carving and specimen quality turquois.

4.5 If 4.4 is encouraging, open limited zones of Area D to ascertain turquois quality. Continue similarly in Area A.

4.6 Scout drill other local areas utilising the geochemical methods as outlined herein. Interbedded areas of claystone and limestone are probably of high interest.

## 5. DISCUSSION

### 5.1 Production to date.

The Ammaroo Turquois deposit is located approximately 250 miles.NE of Alice Springs.

Production to date has been mostly of good carving and specimen quality stone with minor first quality. The preponderance of low quality material is though due principally to the relatively shallow level reached by the present mining operation. Higher quality stone should occur at a greater depth towards the bottom of each individual sedimentary basin.

### 5.2 Previous Investigations

Previous geological work was carried out by Morrison in 1968. A summary of Morrisons paper is given in Appendix 1, together with pertinent comments on several conclusions reached. Appendix 1 gives an outline of the mining and drilling operations carried out to 1968. Relevant points are as follows.

(a) Overburden ranges from 12 -44'.

(b) Close spaced drilling (20') is required to delineate the turquois potential of all areas. A percussion rig should be adequate. Only traces of turquois are required for evaluation.

(c) Ore sorting must be done manually, with +½" material loaded into 44 gallon drums; the minus ½" retained for heavy media separation.

(d) The host rock is a Mid Cambrian siltstone to mudstone of the Hatches Creek Formation. They are fossiliferous, only gently folded and faulted,and variously coloured.

(e) The basement quartzite is not interdigitated with the turquois bearing mudstones and possesses a marked outcrop.

(f) The basement quartzite has been intruded by a medium grained granite, that is strongly weathered in outcrop and appears to have no relationship to copper mineralisation.

(g) Wavellite occurs as radio active phosphatic layers within the mudstone. A scintillometer picked up fair indications to the west of Map 2; but only shallow poor quality turquois will be dected by this method.

(h) Limonite stains and bands are common; they are possibly due to sulphides that may carry the copper required for turquois formation.

(i) The environment contains all the compounds necessary for turquois formation.

(j) Turquois outcrops at shallow depth are always of poor quality.

(k) Geochemistry of above basement samples may prove usefull.

Drill programme: 30 feet spacing to east and north east of Area A, then to south and west of pit.

### 5.3 Problems requiring solution

1. Is the conglomerate a true basal unit. What are the basal units.
2. Is the conglomerate of flood plain origin or an ancient streambed.
3. At what particular horizon within the claystones is turquois formed; is its presense governed by the original occurrence and distribution of wavellite horizons.

4. What is the source of the copper; the brown claystones; volcanic tuffs and/or an outside source.

5. What is the relationship between weathered claystone colour and the quality of the turquois. Do the iron oxide bands play some part here.

## 5.4 Programme October 1973.

### 5.4.1 Percussion Drilling.

The main object of the present programme was to determine the true basement underlying the turquois bearing claystones. A percussion rig was abailable and five holes were drilled at the localities indicated on Fig 1. The localities are as follows.

RH 1. Area A. Collared at the edge of a shaft about 100 feet west of T 5.

RH 2. Area A. Collared a few feet from T 5, approximately 18 feet below the cut top.

RH 3. Area B. Collared about 20 feet SSE of T 16, close to blast pit A.

RH 4. Area D. Collared about 156 feet WNW of T 60 on bearing of 109°.

RH 5. Area A. Collard about 100 feet cast of the Zero Station.

Samples were taken from the percussion holes on two foot increments. Drill hole logs and sample descriptions are given in Appendix II B. Selected samples were assayed for copper and/or phosphate. The results are given in Table 1.

Samples from the percussion holes were collected at two foot intervals Drill hole logs and sample descriptions are given in Appendix II B.

### 5.4.2 Field Mapping and Sampling.

All major exposures in the mine area were sketch mapped and sampled. Mining operations and exploration costeans have exposed strata from cap-rock to basement. Appendix II A lists and describes all the samples collected. Appendix III gives the stratigraphy. Figs 2 - 10 are sketch maps of the following areas.

Fig 2. Cross Section. Area A. North East Face.
3. Basal Section. Area A. Traverse 1.
4. Basal Section. Area B. Blast Pit B.
5. Cross Section. Area B. Blast Pit A.
6. Cross Section. Area B. Blast Pit B.
7. Cross Section. Area D. South Face.
8. Cross Section. Area D. South West Face.
9. Stratigraphic Relationships: Georgina Basin.
10. Phosphate Deposits of the Georgina Basin.

Figs 9 & 10 have been taken from Economic Geology Vol 67. No 8. PP 1180-1192. (P. Howard).

5.4.3 Petrology of Host Rocks.

The principal rock type encountered that forms a host to turquois is claystone (or mudstone). At the surface the claystone is partly silicified and possesses the appearance of siltstone. Basal sections tend to be silty. Claystone colour ranges from off white to dark brown to deep red brown, with the darker colours dominant in the base and middle of the sequence.

Interbedded with the claystones are clay rich to mono mineralic clay beds that are thought to be volcanic ash beds. The clay is dominatly kaolin, particularly in the white beds, with montmorillonite (± iron oxide) probable important constituents of the khaki coloured beds. The claystones are also thought to contain a proportion of volcanic tuff.

Other important rocks in the claystone sequence are chert nodules and bands, semi continuous goethite rich beds, phosphatic and calcareous nodules and bands. The above tend to occur in basal units with the chert and goethite also thought to be of volcanic origin, particularly as ash beds are often interbedded.

5.4.4 Petrology of the Basement.

The basement underlying the turquois bearing claystones can be one of the following rock types: quartzitic sandstone, phyllite, granite or conglomerate. The latter rock may occur above the first three rocks, representing a 'low zone' at the time of Cambrian sea denundation.

Quartzitic Sandstone: A coarse grained rock (1-2 mm) composed of angular grains of quartz, kaolinised feldspar and minor mica. The source of the sandstone is probably granite that formed part of the old crystalline basement and outcrops locally.

Phyllite A silty clay rock with 20 - 40% sand and grit sized grains sized to 3mm. The quartz grains are both angular and rounded with the colours varied: white, pink, smoky, milky, vitreous and non vitreous. Also present are fragments of mica, phyllite and 1 - 2% heavy mineral.

The phyllite is interbedded with the sandstone and therefore in part derived from granite. The different varieties of quartz high clay content etc; however, suggest that much of the phillite has been derived from a more remote source and includes rocks other than granite.

Granite A coarse grained varity of typical mineralogy; quartz, orthoclase and muscovite. Apparently this granite is not part of the Archean crystalline basement; but is younger than the quartzite, having intruded this unit.

Conglomerate. The claystone is seen to grade at the base into siltstone, sandstone and then conglomerate. The silt and sand each average about 6" in thickness with the top 1-2' of conglomerate, containing - 3" pebbles, with 6" + pebbles, below this. The conglomerate may be underlain or replaced in the sequence by basic lava flows.

5.4.5 Petrology - Mineralogy of Turquois.

TS. No. 11146. (No description but called mottled green by C.M.S.)

Nodules sized from 0.3 - 3mm, average 0.5mm, are bound by jezekite (identified by C.M.S. using X.R.D.) and possibly chalcedony. The jezekite grains are arrow head shaped and sized to 0.5mm masses of 0.1mm grains.

The internal texture of the turquois is fine herringbone with a low bi-refrigence. The matrix also contains occasional grains of quartz and feldspar sized to 0.2mm. The rock should polish reasonably.

TS. No 11147. (Siliceous type blue).

Fine grained turquois, average 0.2mm range to 0.8mm, tightly bound; but with a few relatively coarse chalcedony zones and quartz grains to 0.6mm.

C.M.S. identified a montmorillonite type clay as part of the nodule core.

The matrix is composed of fine jezekite which appears in part to be derived from apatite, residuals of which occur sporadically.

TS. No 11148. ('S' matrix type blue.)

Very finely crystalline turquois as 0.2±mm nodules set in a goethite matrix with grains of quartz, chalcedony and jezekite. C.M.S. detected montmorillonite by X.R.D. The turquois is almost cryptocrystalline and should therefore polish well.

TS. No. 11149. (Coarse grain green.)

Coarse grained stringy turquois, grains are over 5mm, strings over 2mm. The matrix is composed of goethite and a clay mineral. C.M.S. detected abundant montmorillonite by X.R.D. and kaolinite in crusts.

TS. No 11150. (Nodule bun nut green.)

Fine grained but distinctly stringy turquois, though the grains are up to 10% cryptocrystalline. C.M.S. identified the stringers as a mineral probably related to morinite - jezekite; also they again detected montmorillonite by X.R.D.

TS. No 11151. (Nodule bun nut blue.)

Very coarse stringy turquois with veins of other phosphates.C.M.S. identified the veins as collophane, jezekite with fine kaolin and detected montmorillonite by X.R.D.

The thin section does not match the turquois description. Nodule bun nut blue should be fine grained nodules composed of cryptocrystalline turquois, a variety that can give a good polish.

The mineralogy of Ammaroo turquois is:

| | | (Chemistry) |
|---|---|---|
| Major component: | Turquois | (Cu, Al, OH, $PO_4$) |
| Minor components: | Jezekite | (Ca, Na, Al, $PO_4$) |
| | Goethite | ($Fe_2 O_3$ ) |
| | Montmorillonite | (Mg, Fe, Si, Al) |
| | Chalcedony | ($Si O_2$) |
| Trace components: | Apatite | (Ca, F, OH, $PO_4$) |
| | Quartz | ($SiO_2$) |
| | Kaolinite | ( Al, Si ) |

collophane

The Ammaroo turquois possess the following physical properties.

| | | | |
|---|---|---|---|
| Hardness: | 4 | Overseas | 5 - 6 |
| Specific Gravity: | 2.55 - 2.69 | " | 2.81 Average. |
| | | " | 2.65 - 2.75 American. |

1. The hardness and specific gravity are less than Overseas Material, but colour is equivalent.

An aluminium phosphate (form B) has been identified by X.R.D. in a phosphate rich sample (I 2607). This mineral is apparently formed by the de-hydration of Variscite: (Al, Fe) $PO_4$ - $2H_2O$ with possibly also a little Mg and Ca and occasionally manganese. Colour is green, blue, yellow, or white, with pink tints indicating high manganese. Crystals pyramidal or prismatic to fibrous with one perfect clevage.

2. The presense of montmorillonite in all the turquois samples studied by C.M.S. is significant with regard to weathering and quality control. Montmorillonite is a bentonitic clay that will expand markedly when mixed with water (particularly if the sodium variety). All Ammaroo turquois samples must therefore be kept away from all moisture as much as possible.

This would mean that all turquois should be removed from the working pit immediately it is exposed and placed in wax as suggested by Mr. J. Cummings. In fact no area should be opened up to the turquois horizon and let stand. Small scale complete mining removal operations would appear to be the key.

5.4.6 Stratigraphy and Phosphogenesis.

The summary of P. Howards paper "Exploration for Phosphorite in Australia" 1. states the following:

Phosphogenesis has occurred in shallow water and near shore conditions. All the water in the sea was thought to be phosphogenic, possibly fed by upwelling of sea water. Within confined basins the water was buffeted and precipitated phosphate.

The figures reproduced from Howard's paper (Figs 9&10) show that the most favourable environment contains considerable thicknesses of dolomite or limestone, either interbedded or along strike. These factors suggest that a greater thickness of phosphatic sediment, and possibly turquois, may occurr more into the limestone county about Limestone Bore.

Figs 9 and 10 also show that basic volcanics can form an immediate cap to the Proterozoic metamorphic basement, that are in turn overlain by conglomerate or phosphatic siltstones (includes silty clayshales in the Ammaroo area). As basic lavas can flow for great distances, they do not indicate the proximity of volcanic centres that may have added pyroclastic debris to the siltstones. However this evidence of volcanic activity preceeding or possibly semi contemporaneous to the phosphatic siltstone (mudstone) deposition strengthens the idea that the copper is of volcanic - sedimentary origin.

1. Economic Geology: Vol 67. No 8. pp 1180 - 1192.

The Stratigraphy of the Ammaroo area is as follows:

Mid Cambrian: A claystone series that may be up to 100 ft thick in the subject area.

| | ZONE | DESCRIPTION |
|---|---|---|
| (a) | Top | Silicified claystone - light coloured, ± a cap of weathered rock. |
| (b) | Upper Middle. | Varicoloured pink to brown claystone, in part bleached, ± goethite, khaki tuffs. |
| (c) | Lower Middle. | Dark coloured claystones; mauve, red brown, rusty brown ± clay (khaki) tuff beds, chert nodules; sometines within goethite bands . May possess an outer bleached zone or be completely bleached but higher silt content. |
| (d) | Lower | As for (c) khaki, tobacco and other'greenish' coloured tuff beds are abundant. Productive turquois horizon; with most occurring at or near the base. (Copper and phosphate assays high). |
| (e) | Basal. | Conglomerate with sandstone and silt top. The siltstone top may be highly phosphatic and a possible turquois horizon. In other areas, basic lava flows may underlie or replace this conglomerate in the sequence. This bed may be Lower Cambrian in age. No turquois will be found below the siltstone top, unless high angle reverse faulting has transposed the conglomerate over the claystones. |

Lower Proterozoic: One of the following rock types may be the metamorphic basement on which lie the Cambrian beds.

(a) Silicified quartz sandstone.

(b) Phyllite.

(c) Muscovite granite.

(d) Quartz feldspar porphyry.

(e) Greywacke.

(f) Dolerite.

In the subject area (a) is commonly found, with (b) and (c) encountered less frequently.

5.4.7 Geochemistry and Turquoise Formation.

Samples were selected from the drilling and field mapping programmes and assayed for copper and/or phosphate. Assays on percussion drill samples are given in Table 1, with field sample assay given in Table 2. The main object of this study was to determine the source of two turquois components not readily discernible. Kaolin as an alumina source was abundant, forming a major part of the claystones and also occurring in almost monomineralie beds.

With reference to Tables 1&2, and Appendices 11 A & B, the following data is pertinent for copper geochemistry.

| Rock type | | | Cu (ppm) |
|---|---|---|---|
| Claystone | - | pale coloured | 170 |
| | - | bleached | 110 - 250 |
| | - | light brown | 100 - 130 |
| | - | amber to brown | 310 |
| | - | amber to dark brown | 35 - 150 |
| | - | dark amber | 90 - 220 |
| | - | rusty brown | 210 |
| | - | rusty brown | 780 - 1500 |
| | - | red brown | 210 |
| | - | red brown | 170 |
| | - | mauve | 400 - 600 |
| | - | rusty brown & khaki | 350 - 1100 |
| | - | rusty brown & tobacco | 500 - 2200 |
| | - | khaki | 4000 |
| | - | Kaolin | 20 - 50 |
| | - | Turquois horizon | 7000 |
| | | Goethite bands | |
| | - | 2nd goethite horizon | 365 - 850 |
| | - | Ferroan tuff | 1600 |
| | - | Rusty to dark goethite | 2300 |
| | - | Hematite bands | 220 - 1100 |
| Basement | - | Silt - sandstone top | 350 |
| | - | Sandstone + pebbles | 190 |
| | - | Conglomerate | 110 - 130 |
| | - | Quartzite top + clay | 420 |
| | - | Quartzite, coarse | 210 |
| | - | Quartzite, flinty and massive | 110 - 190 |
| | - | Quartzite, phosphatic | 20 |
| | - | Quartzite, massive rock | 20 |
| | - | Conglomerate + phyllite | 540 - 740 |

The above data shows that the background copper of both basement and host rocks is between 20 - 210 ppm. Basal units of the claystone and medium coloured beds range between 170 - 310 ppm Cu, the dark coloured beds to 600 ppm Cu. A sharp rise in the copper values is seen in rusty brown and khaki coloured

beds where the range in values is 350 - 4000 ppm Cu. These latter beds are thought to be tuffs or tuffaceous and the copper therefore of volcanic sedimentary syngenetic origin. A rock in the turquois horizon assayes 7000 ppm copper.

Goethite bands may be iron rich tuff bands after pyrite or possibly a weathered residual of iron rich beds. The former origin is favoured. Copper values range from 365 - 2300 ppm.

At contacts between claystone and basement copper values of 350 - 420 ppm are recorded in the basement rocks. These relatively high values are probably due to leaching from the basal claystones with their high copper content. The phyllites also appear to be copper rich as a conglometate - phyllite sample assayed 540 ppm Cu.

Most of the high phosphate analyses were obtained from the base of the claystones, particularly where interbedded with khaki tuff beds. Range in values to 6.5% $PO_4$. The highest phosphate values (up to 39%) were obtained from the siltstone contact between claystones and conglomerate. This phosphatic siltstone is probably the base of the claystone beds; but shows it greatest development above the conglomerate, indicating a high turquois potential for this stratigraphic sequence.

The data in § 4.6 & above show that basal beds of claystone contain in abundance the elements required for turquois formation. The environment is apparently favourable for phosphate deposition, while volcanic activity has supplied the clay (kaolin) and copper in tuff and tuffaceous claystones. The percolation of rain water down through the beds has removed copper from the richer tuff beds and fixed it in the phosphatic clay zones. The arid climate in the area is apparently conducive for the formation of turquois from the copper impregnated phosphatic clay.

The quality of the turquois improves with depth as shallow material apparently suffers from weathering effects (montmorillonite problem). Higher quality turquois can therefore be expected in the deeper eastern part of Area A and in Area D where the cover exceeds fourty feet.

TABLE 1.

ASSAY RESULTS - PERCUSSION DRILL SAMPLES

| Sample I | No (LT) | Cu (ppm) | Sample I | No (LT) | Cu (ppm) |
|---|---|---|---|---|---|
| 2517 | (2) | 420 | 2563 | (38) | 130 RH2 |
| 2518 | (3) | 350 | 2574 | (49) | 130 |
| 2525 | (10) | 190 | 2575 | (50) | 600 |
| 2526 | (11) | 740 | 2576 | (51) | 400 |
| 2530 | (15) | 210 | 2577 | (52) | 170 |
| 2531 | (16) | 110 RH1 | 2585 | (60) | 170 |
| 2538 | (23) | 110 | 2587 | (62) | 250 |
| 2539 | (24) | 540 | 2588 | (63) | 1100 |
| 2542 | (27) | 130 | 2589 | (64) | 350 RH4 |
| 2561 | (36) | 130 | 2601 | (76) | 170 |
| 2562 | (37) | 110 | 2603 | (78) | 150 RH5 |
| | | $PO_4$% | | | $PO_4$% |
| 2517 | (2) | 5.0 RH1 | 2587 | (62) | 2.0 |
| 2538 | (23) | 0.3 | 2588 | (63) | 6.5 |
| 2561 | (36) | 0.1 | 2589 | (64) | 1.5 RH4 |
| 2562 | (37) | 0.1 | 2601 | (76) | 1.0 |
| 2563 | (38) | 0.1 RH3 | 2603 | (78) | 0.6 RH5 |

TABLE 2.

ASSAY RESULTS - FIELD SAMPLES

| Sample I | No (TqD) | Cu (ppm) | Sample I | No (TqD) | Cu (ppm) |
|---|---|---|---|---|---|
| 2456 | (5) | 850 | 2480 | (29B) | 25 |
| 2459 | (8) | 90 | 2480 | (29C) | 10 |
| 2460 | (9) | 365 | 2481 | (30) | 2200 |
| 2461 | (10) | 20 | 2482 | (31) | 210 |
| 2463 | (12) | 150 | 2484 | (33) | 90 |
| 2465 | (14) | 220 | 2485 | (34A) | 2300 |
| 2466 | (15) | 170 | 2485 | (34B) | 350 |
| 2467 | (16) | 110 | 2485 | (34C) | 1200 |
| 2472 | (21) | 35 | 2487 | (36) | 4000 |
| 2473 | (22) | 7000 | 2489 | (38) | 50 |
| 2474 | (23) | 335 | 2491 | (40) | 1200 |
| 2475 | (24) | 1600 | 2492 | (41) | 1500 |
| 2476 | (25) | 750 | 2496 | (45) | 20 |
| 2477 | (26) | 500 | 2497 | (46) | 250 |
| 2478 | (27) | 1100 | 2498 | (47) | 780 |
| 2479 | (28) | 310 | 2605 | (55) | 20 |
| 2480 | (29A) | 20 | 2607 | (57) | 20 |
| | | $PO_4$% | | | $PO_4$% |
| 2464 | (13) | 0.5 | 2488 | (37) | 26.0 |
| 2470 | (19) | 1.0 | 2605 | (55) | 0.08 |
| 2474 | (23) | 7.0 | 2606 | (56) | 4.5 |
| 2476 | (25) | 0.2 | 2607 | (57) | 39.0+ |

APPENDIX 1

## 1. THE AMMAROO TURQUOIS DEPOSIT - SUMMARY OF WORK TO DATE.

### 1.1 Mining Sequence. (Morrisons Report 1968).

Area A — All contain turquois
Area B — of good carving quality
Area C

And if drilling is successful then evaluate.

Area D — and subsequent areas proven by costeaning and drilling.

### 1.2 Exploration Sequence.

Overburden Ranges from 12' - 14'

Exploration limited to wagon type drill; but an air track drill will do the job.

Test overburden and drill to the quartzite basin in

Areas A. B. and C (possibly also costeaned using the D6 where the turquois is shallower).

and if the area is to be mined then remove the overburden from

Area D.

### 1.3 Ore Sorting.

Overburden removal until approx 6" above the turquois lenses can be done by ripping and pushing with a D6 dozer. When the ore is exposed and broken to just enough to facilitate handling, the ore should be placed into the end loader bucket by a combination of manual handling, shovelling and bucket crowding. Some gemstone quality ore can be won at this stage.

The end loader can then dump the material on to a prefrabricated table as shown in diagram 1 where the ore can be convienently sorted and chipped and loaded into 44 gal drums.

Manual batch sorting and chipping will be necessary, simple mechanicial methods will not work. The ore is screened at ½", minus to waste or a heavy media separator. The coarse is hand sorted to drums.

### 1.4 Drilling.

Halco track drill.
3½" holes
Suction cyclone
$3/foot cost. ($10.meter)
Sample interval 2' (0.6m)

Turquois occurs mainly in thin layers and only tracrs were required for evaluation. The sample was split and washed for examination and a Bulk sample retained.

Drill Programme one 60' spacing N & E.
40' spacing W & S.

The trend of mineralisation was established.

Total footage 1967 feet - 60 holes depth from 6 - 100 feet once basement control was established. Common depth was 14 - 28 feet.

Accurate thickness was difficult; but colour and hardness of ore could be determined. 3 Men were required to handle splitting washing, logging, marking and storing of samples.

1.5 Complete Evaluation.

Drilling appears to be the only method, and 20 foot centres were recommended.

2. GEOLOGY.

2.1 General

The area was mapped at 1" / ft, contours at 2' interval.

The main problem was the relationship between turquois and folding, basement quartzite, granite.

2.2 Basement

Proterozoic quartzite of the Hatches Creek Formation immediately underlies the turquois bearing Mid Cambrian siltstones. Hole T1 was drilled to 100' to show that the Mid Cambrian siltstone was not interdigitated with the basement quartzite and so yield turquois at greater depths.

2.3 Quartzite

A medium grained, porous, hard rock, that at depth grades in someplaces through finer phases and locally into a somewhat schistose sandstone that can be purplish. At surface it is usually brownish to whitish, in drill holes it is grey-white. The turquois is usually found overlying it, to as much as 30 & 40 feet above it.

The quartzite has been intruded by a medium grained rock of approx a granodiorite composition. The Proterozoic is strongly weathered in outcrop, kaolin and chlorite outcrops 30' NW of the open cut and extensively to the North. There is little metamorphism at the quartzite contact with the relationship roughly horizontal to slightly rolling and showing little relationship to any copper mineralisation.

2.4 Mid Cambrian mudstone.

The mudstone occurs extensively south of its contact with the Hatches Creek Formation, and contains brachiopoda and trilobite fossils. Thickness 3 - 16 ft.

The beds are gently folded, occasionally faulted, predominantly horizontal to slightly inclined;the dips seldom exceed $10^{o}$ except for rare loca fold limbs with dips up to $30^{o}$.

The mudstone colour is usually white to brownish white, with ± redbeds of dark reddish to purple of similar composition to the mudstone, which may occur a few feet above the turquois.

2.5 Wavellite.

Occurs in layers within the mudstone as radio active phosphate and can be detected by a scintillometer.

On map 2 to the west there are fair indications of turquois and more drilling remains to be done.

2.6 Limonite.

Stains and bands, possibly due to sulphides (± Cu). A marked band of limonite occurs with the turquois horizon.
Mudstones range from non phosphatic to weakly phosphatic. Wavellite bands are the richest phosphate horizons (Turquois is 38% $P_2O_5$).

2.7 Turquois

The various chemical units are thought derived as follows.

Alumina - mudstones, claystones.

Copper - syngenitic limonite.

Phosphates - sediments.

Outcrop, in creek at present pit.

(a) 100 - 160' N in loop of road.

(b) 360' N of pit at the foot of quartzite hill.

(c) Near a shaft 500' north east of the open cut.

(d) NW of O/C near the granite of the bulldozer trench and continuing toward the camp at the point of the hill etc. Most are poor and at surface lie on quartzites. None was found at depth.

2.8 Basement Quartzite:

Drill cutting's. Angular to blocky grains, brittle, definite grain structure in most, though glassy grains do occur. 2 - 3% clay, probably derived from weathered orthoclase (granite origin). Field outcrops strongly to the west of the area as rounded hills.
At shaft strike approx 320°. Dip 42 - 47° @ 250°.

| | | | |
|---|---|---|---|
| Well jointed: | S. 295° D. 80° to 20° | | (Sample TqD 3). |
| Interbedded: | 255 | Vert | Crosscutting Kaolinite. |
| Clay horizon (TqD 2) | 50° - 40° to 150° | | felsic dyke. |
| | 55° | Vert | S. 160° D. 75 - 80° to 80°. |

2.9 Conglomerate

Boulders in the conglomerate are constituted mostly of tight grained quartzite, flinty quartz and jasper, in addition to coarse grained quartzitic sandstone. However there is less than 10% of this latter material. A few conglomerate boulders are composed of suggary quartz.

2.10 General

If turquois outcrops, it must dip away reasonably sharply to provide a sizable deposit of acceptable quality. With the generally flat host rock, deposits can only be located by drilling or other than surface methods alone. The turquois is lensy, trends NNE. At 40' - 60' drill spacing, lenses may have been missed. Trends difficult to explain, not basins or channels or depressions in the basement quartzite. Turquois location may be related solely to minor original concentrations of copper syngenetically laid down in the sediments close to phosphate concentrations (wavellite).
Close spaced drilling is the only method that can be used to locate deep high quality material. Geochemistry and scintillometer surveys will only locate shallow, leached poor quality turquois.

APPENDIX 11

SAMPLE INDEX PROGRAMME OCTOBER, 1973.

11 A Field samples.

| Sample No I | Field No TqD | Description |
|---|---|---|
| 2452 | 1 | Massive quartzite. |
| 2453 | 2 | 'Interbedded' clay horizon. |
| 2454 | 3 | Sand grit-bands. |
| 2455 | 4 | Underlay to lower goethite band. |
| 2456 | 5 | Massive goethite horizon. |
| 2457 | 6 | White bleached mudstone. |
| 2458 | 7 | Light mauve mudstone. |
| 2459 | 8 | Amber band below 2nd goethite horizon. |
| 2460 | 9 | 2nd Goethite horizon. |
| 2461 | 10 | Green chloritic ash bed + khaki goethite bands. |
| 2462 | 11 | Kaolin pods. |
| 2463 | 12 | Var amber-dark brown claystone. |
| 2464 | 13 | White mudstone. |
| 2465 | 14 | Amber bands. |
| 2466 | 15 | Hematite bands. |
| 2467 | 16 | Basal mauve ms - sts West of T1. |
| 2468 | 17 | Kaolin. |
| 2469 | 18 | Typical breccia embaying Turquois. |
| 2470 | 19 | Top iron horizon on claystones. |
| 2471 | 20 | Chert - claystone breccia. |
| 2472 | 21 | Dark brown, purple tint, mudstone. |
| 2473 | 22 | Turquois horizon. |
| 2474 | 23 | Fine clay bound siltstones at top of sequence. |
| 2475 | 24 | Ferroan band almost immed above semi brecciated. |
| 2476 | 25 | Var silty claystones + nodules of phosphate. |
| 2477 | 26 | Tobacco and rusty brown cs + high clay and crusts. |
| 2478 | 27 | Hematite and goehtite. |
| 2479 | 28 | Var. amber-brown silty claystone - |
| 2480 | 29 | Massive mauve - purple red brown claystone. |
| 2481 | 30 | Tobacco and rusty brown claystone. |
| 2482 | 31 | Top weath. 3" of 29, red-brown clay. |
| 2483 | 32 | Bleached dark brown cs + pink bands. |
| 2484 | 33 | Claystone + silts + green turquois. |
| 2485 | 34 | Yellow brown + dark goethite + chert. |
| 2486 | 35 | Top khaki brown clay. |
| 2487 | 36 | Lower khaki brown clay. |
| 2488 | 37 | Pods of possible phosphate. |
| 2489 | 38 | Mauve claystone as matrix to conglomerate. |
| 2490 | 39 | White silty claystone. |
| 2491 | 40 | Ferroan rusty brown tuff + kaolinite. |
| 2492 | 41 | Ferroan tuff. |

| No I | TqD | Description. |
|---|---|---|
| 2493 | 42 | Turquois horizon. |
| 2494 | 43 | Chert nodules - semi banded. |
| 2495 | 44 | Kaolinite. |
| 2496 | 45 | Purple ferroan band, 1% above floor. |
| 2497 | 46 | Rusty brown 2-4" layer, 4' above floor. |
| 2498 | 47 | Rust coloured silty claystone. |
| 2499 | 48 | Volcanic rock - cellular. |
| 2500 | 49 | As above, base of pod. |
| 2501 | 50 | Flint sample. |
| 2502 | 51 | Chloritic chert. |
| 2503 | 52 | Phosphate nodule. |
| 2504 | 53 | Chocolate mudstones. |
| 2505 | 54 | Chert fragment. |

11 B Drill Samples.

| S. No.I | S. No. L.T. | Depth (ft) | Description |
|---|---|---|---|
| RH I. | | | |
| 2517 | 2 | 0 - 2 | CS + Siltstone + nodules of possible phosphate. |
| 2518 | 3 | 2 - 4 | Q. High silt bands in gritty sandstone. (Q. quartzite). |
| 2519 | 4 | 4 - 6 | " |
| 2520 | 5 | 6 - 8 | " |
| 2521 | 6 | 8 - 10 | " |
| 2522 | 7 | 10 - 12 | " |
| 2523 | 8 | 12 - 14 | " |
| 2524 | 9 | 14 - 16 | Q. + pebbles - low silt and sand. |
| 2525 | 10 | 16 - 18 | Q. + high sand pebbles of def ss |
| 2526 | 11 | 18 - 20 | Q. + high sand + noticable kao. feldspar. |
| 2527 | 12 | 20 - 22 | Q. + high feldspar. |
| 2528 | 13 | 22 - 24 | " |
| 2529 | 14 | 24 - 26 | " |
| 2530 | 15 | 26 - 28 | Coarse grained. |
| 2531 | 16 | 28 - 30 | Definite solid base, gritty clay nodules. |
| RH 2. | | | |
| 2532 | 17 | 0 - 2 | Weathered quartzite |
| 2533 | 18 | 2 - 4 | Slightly weathered quartzite |
| RH 3. | | | |
| 2534 | 19 | 0 - 2 | Mixed population of flinty and quartzite. |
| 2535 | 20 | 2 - 4 | Very fine grained quartzite jasper and flint type. |
| 2536 | 21 | 4 - 6 | Jasperdom, lower fines, 2-3% clay material. |
| 2537 | 22 | 6 - 8 | Jasperdom, high silt. |
| 2538 | 23 | 8 - 10 | Flinty quartzite, very coarse grained. |
| 2539 | 24 | 10 - 12 | ½ Conglomerate. ½ Red - Bn Se Phyllites. |
| 2540 | 25 | 12 - 14 | High silt and grit. |
| 2541 | 26 | 14 - 16 | silt and grit. |

RH 3

| | | | |
|---|---|---|---|
| 2542 | 27 | 16 - 18 - 130 | 50% clay, to 40% silt sand, 10% grit |
| 2543 | 28 | 18 - 20 | As above. |
| 2544 | 29 | 20 - 22 | As above. |
| 2555 | 30 | 22 - 24 | As above. |
| 2556 | 31 | 24 - 26 | 50% Clay 30% silt 10% sand 10% grit (Qite) |
| 2557 | 32 | 26 - 28 | High silts to fine ss. |
| 2558 | 33 | 28 - 30 | As above, high clay content. |
| 2559 | 34 | 30 - 32 | As above, high clay content. |
| 2560 | 35 | 32 - 34 | As for 31. |
| 2561 - 0.1 | 36 | 34 - 36 - 130 | Coarser grained, mod clay, sts - ss. |
| 2562 - 0.1 | 37 | 36 - 38 - 100 | High grit at 30%. |
| 2563 - 0.1 | 38 | 38 - 40 - 130 | 50% grit, white quartz. 30 sand, silt, 20 clay High HM. |
| 2564 | 39 | 40 - 42 | Basement phyllite. |
| 2565 | 40 | 42 - 44 | Basement phyllite. |
| 2566 | 41 | 44 - 46 | Basement. (Top zones possibly highly weathered). |

RH 4.

| | | | |
|---|---|---|---|
| 2567 | 42 | 0 - 2 | Commenced on chert horizon. Light brown etc claystone |
| 2568 | 43 | 2 - 4 | Light brown etc claystone. |
| 2569 | 44 | 4 - 6 | Light brown etc claystone. |
| 2570 | 45 | 6 - 8 | Light brown etc claystone. |
| 2571 | 46 | 8 - 10 | Light brown etc claystone. |
| 2572 | 47 | 10 - 12 | Light brown etc claystone. |
| 2573 | 48 | 12 - 14 | Ligth brown etc claystone. |
| 2574 | 49 | 14 - 16 - 130 | Light brown etc claystone. |
| 2575 | 50 | 16 - 18 - 200 | Mauve silty clayshale. |
| 2576 | 51 | 18 - 20 - 400 | Mauve silty clayshale. |
| 2577 | 52 | 20 - 22 - 170 | Red brown CS - silty + occ indurated band. |
| 2578 | 53 | 22 - 24 | Red brown CS - silty + occ indurated band. |
| 2579 | 54 | 24 - 26 | Red brown CS - silty + occ indurated band. |
| 2580 | 55 | 26 - 28 | Red brown CS - silty + occ indurated band. |
| 2581 | 56 | 28 - 30 | Red brown CS - silty + occ indurated band. |
| 2582 | 57 | 30 - 32 | Red brown CS - silty + occ indurated band. |
| 2583 | 58 | 32 - 34 | Red brown CS - silty + occ indurated band. |
| 2584 | 59 | 34 - 36 | Red brown CS - silty + occ indurated band. |
| 2585 | 60 @½ | 36 - 38 - 170 | Bleached CS. |
| 2586 | 61 | 38 - 40 | Bleached CS. |
| 2587 - 2.0 | 62 | 40 - 42 - 250 | Bleached CS. |
| 2588 - 6.5 | 63 @½ | 42 - 44 - 1100 | Rusty brown + band of khaki. |
| 2589 - 1.5 | 64 | 44 - 46 - 350 | " |

RH 5.

| | | | |
|---|---|---|---|
| 2590 | 65 | 0 - 2 | Silicified, dark red + chock bn silty CS. |
| 2591 | 66 | 2 - 4 | As above all are very silty. |
| 2592 | 67 | 4 - 6 | As above all are very silty. |
| 2593 | 68 | 6 - 8 | As above all are very silty. |
| 2594 | 69 | 8 - 10 | As above - not silicified. |

RH 5. 104%

| | | | |
|---|---|---|---|
| 2595 | 70 | 10 - 12 | Silty, chock. to red brown CS. |
| 2596 | 71 | 12 - 14 | Sand, & silicified bands. |
| 2597 | 72 | 14 - 16 | As above, lower silt & lighter brown. |
| 2598 | 73 | 16 - 18 | As above, lower silt & lighter brown. |
| 2599 | 74 | 18 - 20 | As above, lower silt & lighter brown. |
| 2600 | 75 | 20 - 22 | Type claystone. |
| 2601 - 1.0 | 76 | 22 - 24 - 1.5 | Type + high ind.* fgs (slightly ind. silty CS). |
| 2602 | 77 | 24 - 26 | Type no flinty bds, in part slightly ind. |
| 2603 - 0.6 | 78 | 26 - 28 - 1.5 | Bleached CS (silty) beige + pk-bn tint. |

(* ind indurated).

# APPENDIX III

## STRATIGRAPHY OF OPEN CUT EXPOSURES

### 1. STRATIGRAPHY CUT A. TRAVERSE I

| Interval | Description. |
|---|---|
| 0 - 1.0' | Weathered, slightly silicified claystone, pinkish. |
| 1.0' - 4.0' | Well bedded, off white claystone with goethite bands. |
| 4.0' - 6.0' | As above with many goethite bands, particularly at the contact with the lower khaki ash bed. |
| 6.0' - 9.0' | Khaki ash bed with 1-2" basal massive goethite. |
| 9.0' - 9.75' | Amber to light brown claystone. |
| 9.75'- 12.75' | Light amber brown claystone with off white pods up to 5.0 x 2.0 ft, angular fragments and bands of purple claystone with medium silt. |
| 12.75'- 13.0' | Massive goethite. (TqD 5) up to 6". |
| 13.0' - 14.0' | Beige claystone. (TqD 4). |
| .14.0' | Various amber - dark brown horizon (TqD 12). |
| 14.0' - 17.5' | Khaki Tuffs (TqD 10) + bands and pods of Kaolin (TqD 11). |
| 17.5' | 2nd goethite horizon. (TqD 9). |
| 17.5' - 18.5' | Dark amber claystone, (TqD 8) with light amber base |
| 18.5' - 21.0' | Off white to purple claystone, mauve mottled, with 1.0'x 0.3' white pod. (TqD 13). |
| 21.0' | Lower goethite horizon with light amber top.(T14&15) |
| 21.0' - 22.5' | Khaki tuff with pods of phosphatic siltstone (TqD 37), wavellite and minor turquois. |
| 22.5' | Basal sandstone. |

### 2. STRATIGRAPHY MAIN S.W. FACE.

| Interval | Description. |
|---|---|
| 0.0' - 1.5' | Red brown coated, slightly siliceous silty claystone. |
| 1.5' - 3.0' | Well bedded, faint pink to off white silty claystone. |
| 3.0' - 4.5' | Rusty to mauve coated and banded claystone. |
| 4.5' - 7.0' | Very light mauve, claystone with rusty bands 3x1' kaolin pockets. |
| 7.0' - 11.0' | Light grey green claystone with high rust bands coatings and zones with numerous kaolinite lenses. |
| | The lower 3-4' is more grey and less stained than the above, to a light grey green with kaolinite pockets, many at 2 x 1', some to 7' x 8". Also interbedded are chert lenses, usually sized from 2' x 4" and broken. A few are sized to 8". The lower structure is difficult to discern, probably high in volcanics and slumped. The lower zones are definitely volcanic. |

3. STRATIGRAPHY - Blast Pit A - Area B.

| Interval | Description. |
|---|---|
| 0.0' - 3.0' | Silty claystone: Massive mauve, purple browns etc (TqD 29). |
| 3.0' - 5.0' | Silty claystone: amber - brown series: (TqD 28, 1' - 3') light brown, light amber etc - considerably thicker to the West. |
| 5.0' | Hematite and goethite (TqD 27, 2"). |
| 5.0' - 5.5' | Tobacco and rusty brown rock, crustiform 6" with many clay nodules. (TqD 26, 6"). |
| 5.5' - 8.5' | Var silty claystones + nodules of phosphate,semi brecciated (TqD 25). |
| 8.5' - 10.0' | Ferroan bed (TqD 24, 1'-2'). |
| 10.0' - 11.5' | Sand to silt. (TqD 23, 1'-2'). |
| 11.5' - 12.0' | Sand, medium grained. (6"). |
| 12.0' - 13.0' | Sand, medium to coarse + occasional pebbles of 1"-6' |
| 13.0' - 16.0+ | Conglomerate: Boulders over 6" set in a coarse sand and clay matrix. |

4. STRATIGRAPHY - Blast Pit B. Area B.

In Mudstone Canyon (Area 2-3, down face).

| Interval | Description. |
|---|---|
| 0 - 9.0' | Redbrown etc claystones. (Sampled in back cut). |
| 9.0' - 11.5' | Bleached, redbrown claystones to siltstones (TqD 35) with pink bands (TqD 32). |
| 11.5' - 15.0' | Claystone + siltstone bands with green to dark green turquois bands up to 0.5". Irregularly banded, and also occurs massive at the base of the horizon. (Sample TqD 33.)The claystone is in part pinkish. |
| 15.0' - 16.0' | Yellow brown claystone with dark goethite ± cherty quartz up to 1.5" and nodular chert. (Sample TqD 34a) Chert + possible phosphorite. (Sample TqD 34b.) |
| 16.0' - 16.5' | Wavellite. |
| 16.5' - 17.5' | Turquois overlies the sand basement ± ferroan bands at the contact. The turquios also biufraucates abou a khaki brown ashbed, possibly equivalant to opposite wall occurrence. |

STRATIGRAPHY OF BASEMENT (at TqD 37)

| | |
|---|---|
| 0.0' - 1.5' | Medium to coarse sand + occasional small pebble to 2". |
| 1.5' - 5.0' | 1 - 3" pebbles in a clay bound coarse to fine grained sand. |
| 5.0' | Basement Conglomerate (50% pebbles) with red - brou clay matrix. (Sample TqD 38) Assay test for relationship to either claystones or weathered granite. The redbrown claystone beds are found approximately 7" above the sand bed. |

# FIG 1 PERCUSSION DRILL HOLE LOCATIONS.

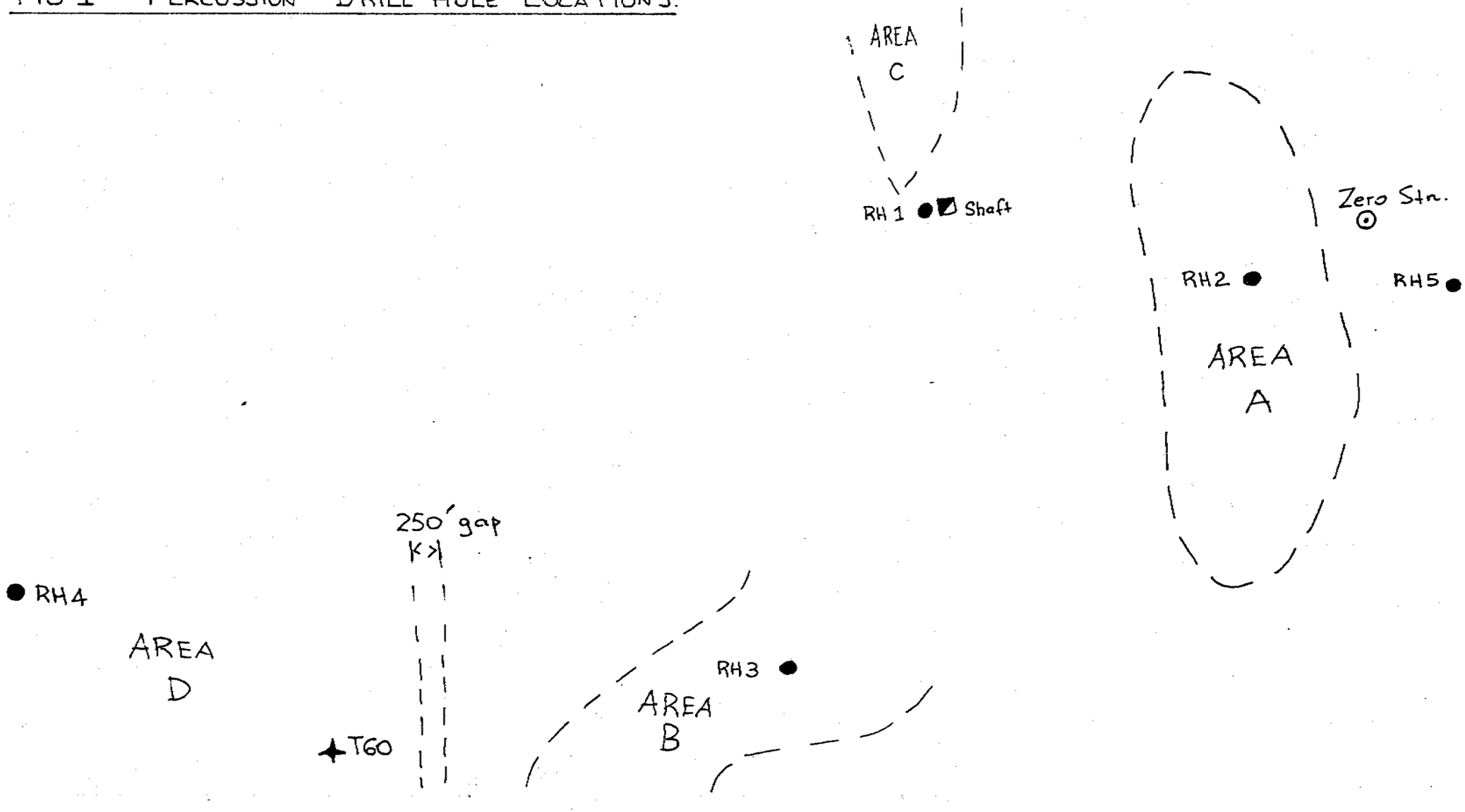


FIG 2 CROSS SECTION. AREA A : NORTH EAST FACE.

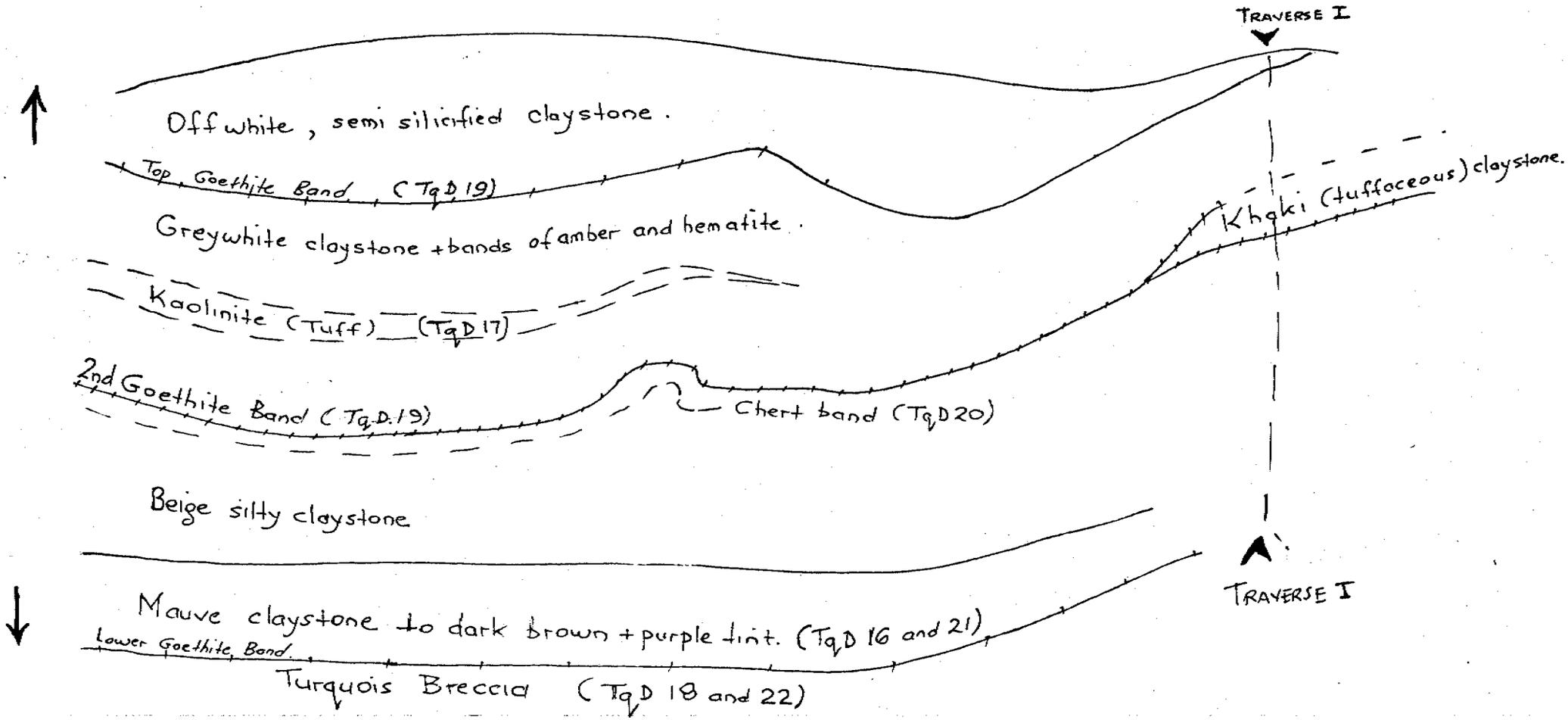


FIG. 3 BASAL SECTION . AREA A . TRAVERSE I

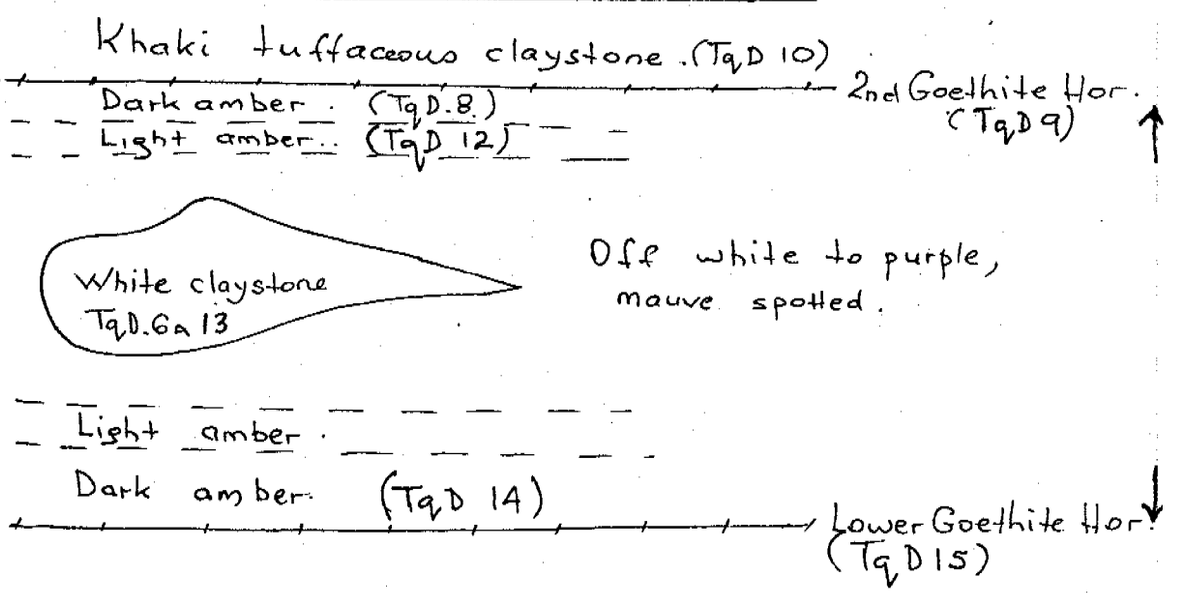
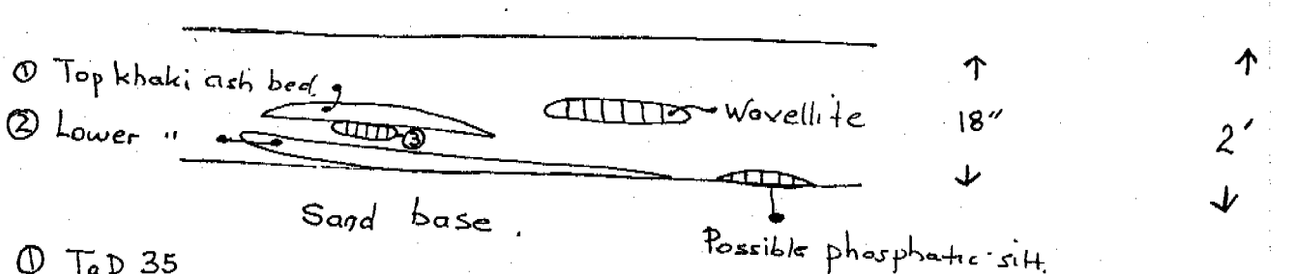
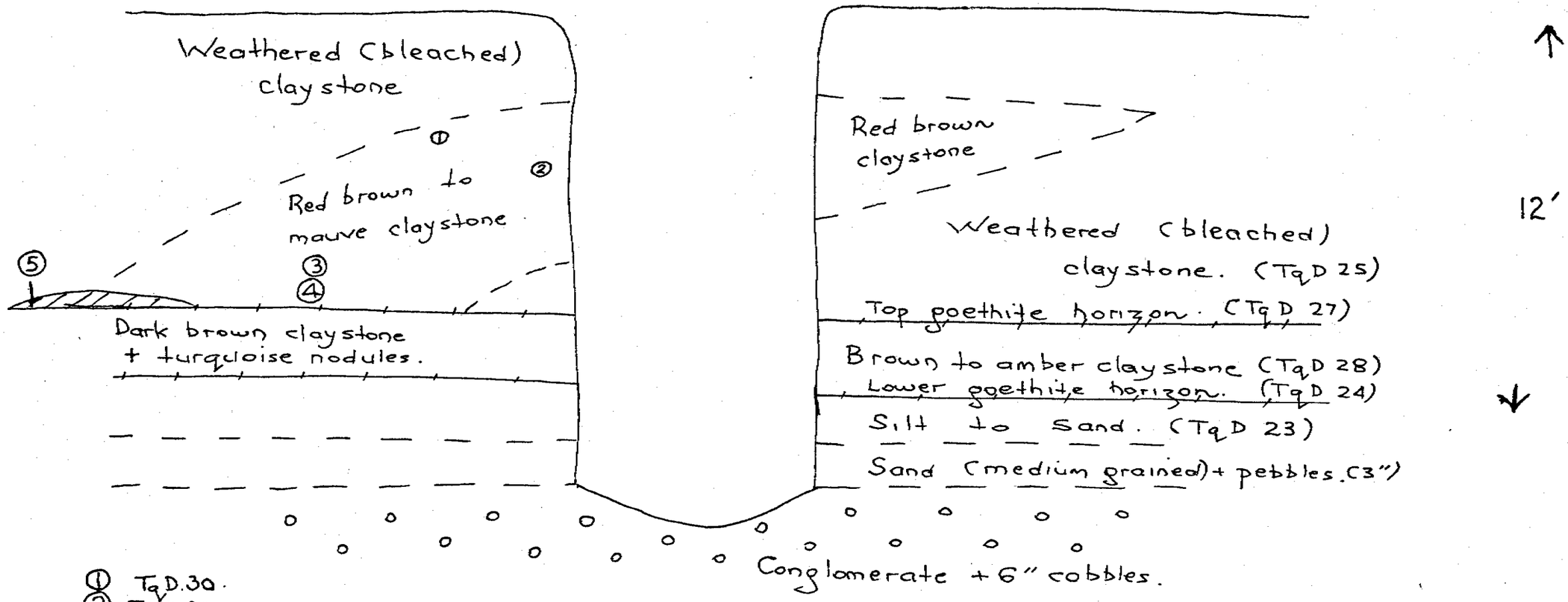



FIG 4 BASAL SECTION BLAST PIT B . AREA B .




① TqD 35
② TqD 36
③ TqD 37

# FIG 5 CROSS SECTION. AREA B. BLAST PIT A.




① TqD.30.
② TqD.29C.
③ TqD.29B.
④ TqD.29A.
⑤ TqD.26+30. Khaki to rust brown 'tuff'

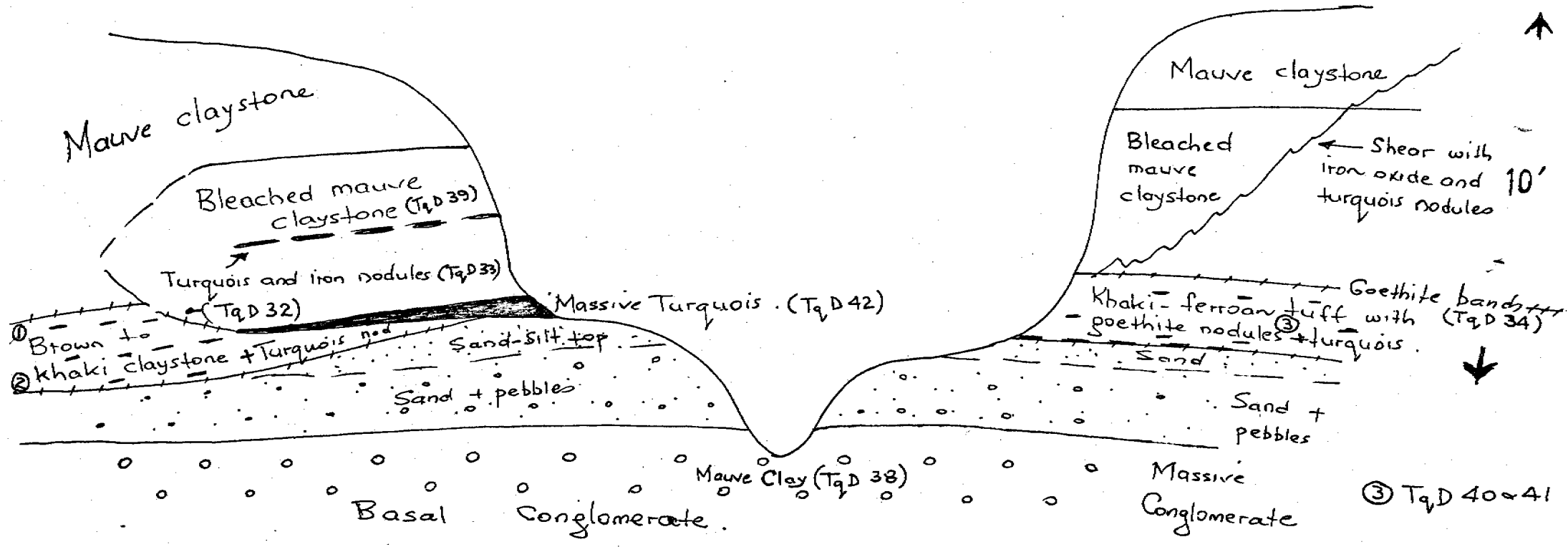
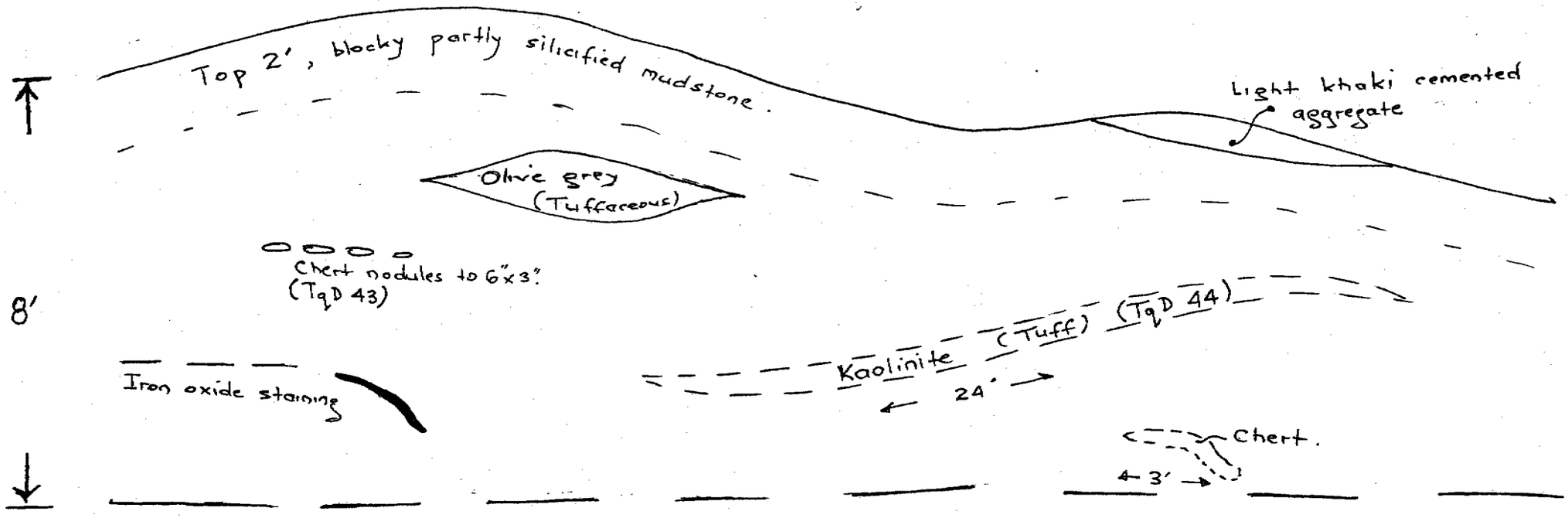

Mauve claystone
Bleached mauve claystone (TqD 39)
Turquois and iron nodules (TqD 33)
(TqD 32)
Massive Turquois . (TqD 42)
① Brown to
② khaki claystone + Turquois nod
Sand-silt top
Sand + pebbles
Mauve Clay (TqD 38)
Basal Conglomerate .
Mauve claystone
Bleached mauve claystone
Shear with iron oxide and turquois nodules
10'
Goethite band (TqD 34)
Khaki - ferroan tuff with ③ goethite nodules + turquois .
Sand
Sand + pebbles
Massive Conglomerate
③ TqD 40 ~ 41

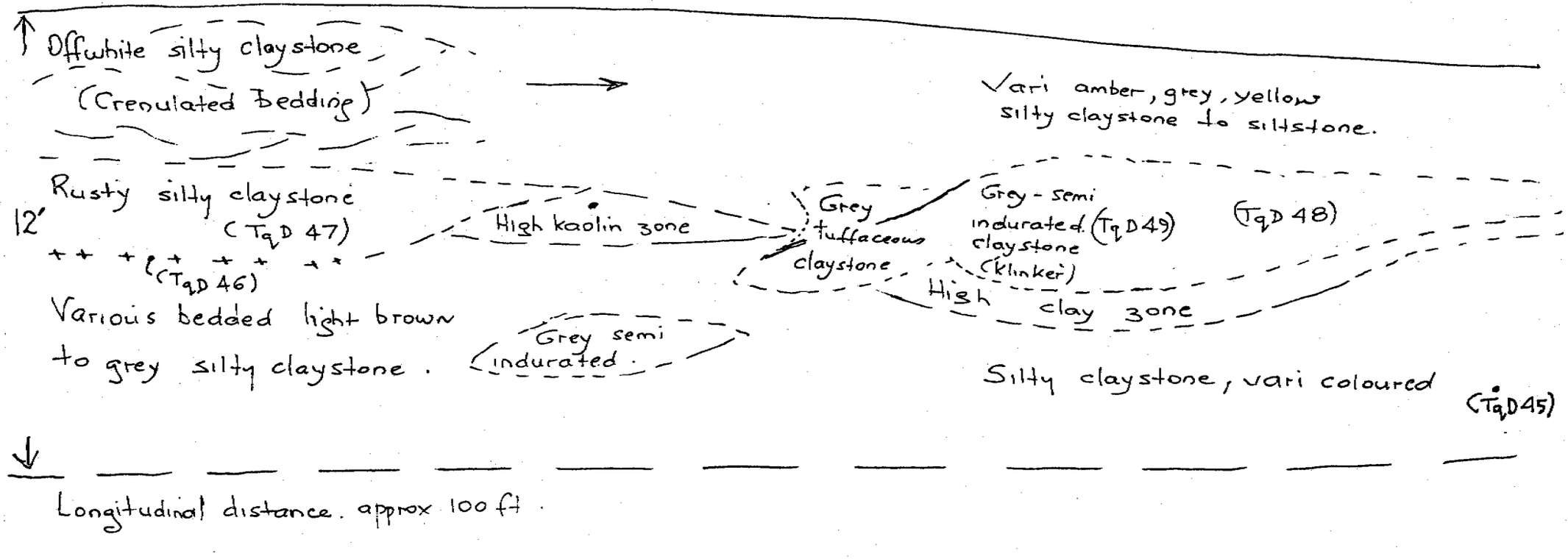
FIG 7 CROSS SECTION. AREA D. SOUTH FACE.



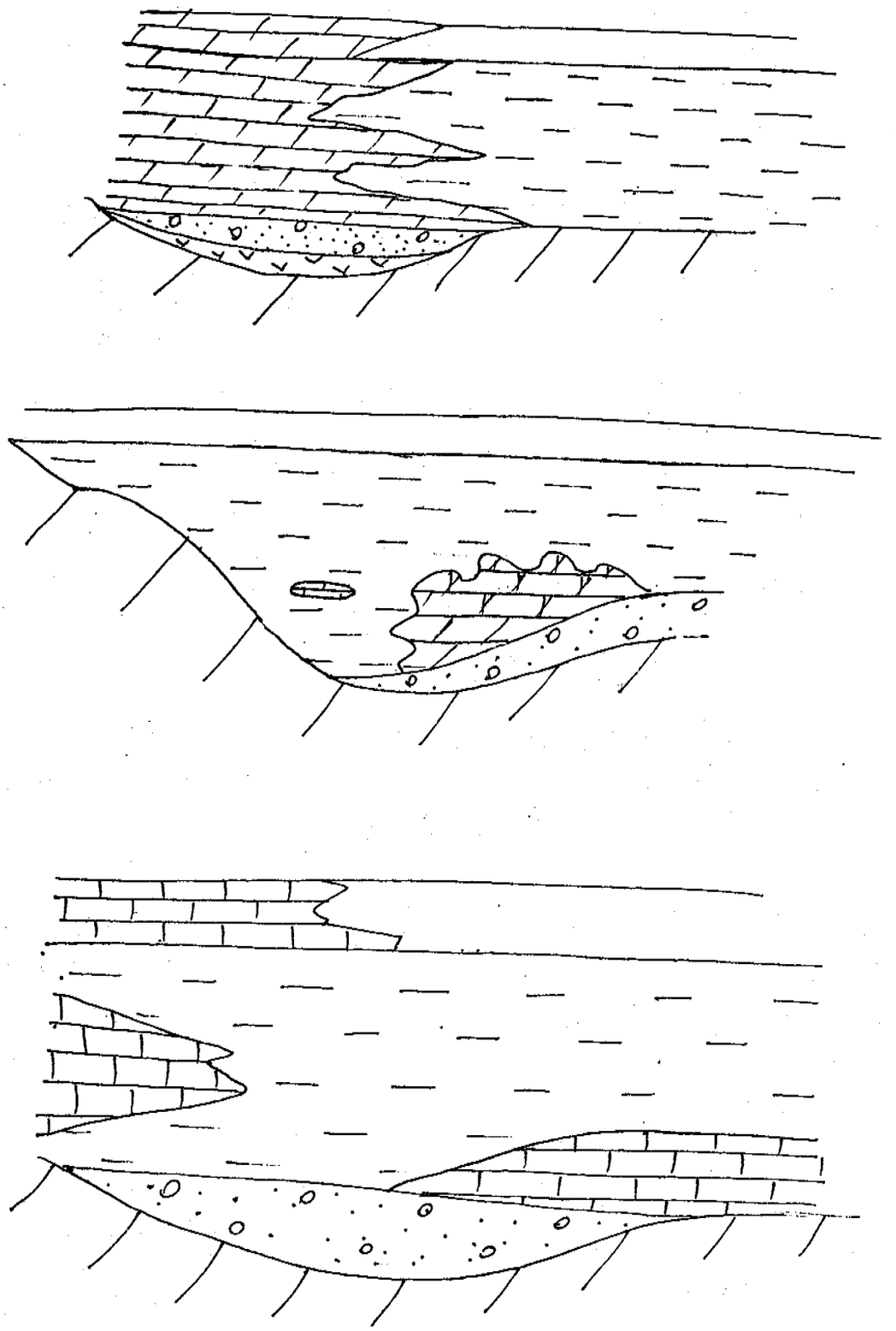

Major rock type is a silty claystone coloured, off white, grey, light brown with a moderate rust staining

Location. Approximately 200m on bearing of 223° from the Zero Station
Cut direction 130°, length 100m.

# FIG 8 CROSS SECTION. AREA D. SOUTH WEST FACE.



# FIG 9 STRATIGRAPHIC RELATIONSHIPS GEORGINA BASIN



CAMBRIAN

Dolomite, dolomitic limestone

Micritic limestone, marlete.

Siltstone, fine sandstone.

Silt-shale, siliceous shale, chert, chert breccia

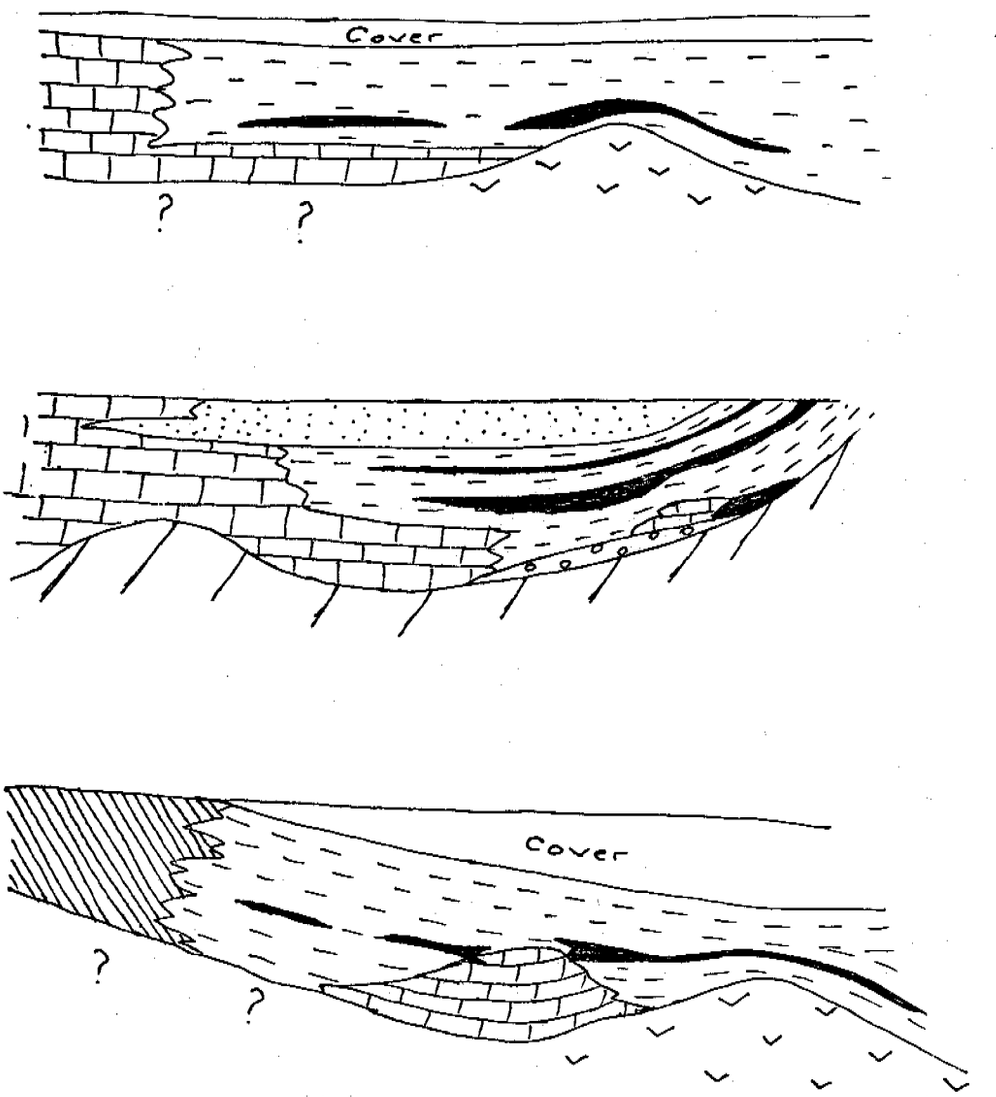
Coarse basal Conglomerate and sandstone.

Basic volcanics

PRECAMBRIAN

Basement.

Fig 10. PHOSPHATE DEPOSITS OF THE GEORGINA BASIN.




CAMBRIAN

- Non phosphatic, siltstone, sandstone.
- Phosphatic siltstone
- Phosphorite
- Conglomerate, sandstone.
- Limestone and chert, some siltstone.
- Red beds, siltstone, sandstone & interbeds of limestone & anhydrite.
- Undifferentiated volcanics.

PRECAMBRIAN.

1. OBJECT.

1.1 To determine the base metal potential of areas to the west and south of Limestone Bore. Ammaroo Area Northern Territory.

1.2 To comment on the turquois potential of the Limestone Bore area.

2. SUMMARY.

2.1 The Limestone Bore West area is marginally anomalous in zinc (280 ppm).

2.2. The area 2.25 miles south east of Limestone Bore (Orange Tree Hill) is probably anomalous in zinc (610 ppm).

2.3 The area 2 miles south of Limestone Bore is marginally anomalous in both zinc (370 ppm) and copper (370 ppm).

2.4 The steep dip of limestone in the Limestone Bore area may indicate a Pre - Cambrian age and thus limit the area's potential for Turquois deposition. However detailed stratigraphy and geochemistry are required.

3. RECOMMENDATIONS.

3.1 Carry out a two day field mapping and geochemistry programme each of the areas examined in 2.1 to 2.3 above.

3.2 Determine the stratigraphy of the Limestone Bore area. Sample all iron rich rocks and basal sections of silt and mudstones; assay for copper and phosphorus.

4. DISCUSSION.

The area from Limestone Bore to Orange Tree Hill is flanked by massive quartzite outcrops that generally strike 110 - 125$^{o}$ and dip from 60$^{o}$N to near vertical. The major unit is a quartzitic sandstone; but feldspathic units can dominate while siltstones occur sporadically.

The Proterozoic Basement outcrops within the quartzite ridges. The principal rock units found were;
Hematite quartz siltstones
Ferroan quartzites (sandstone)
Actinolite amphibolites (± epidote)
Hornblende schists (basalts)
Gabbro
Granodiorite.

The general strike of these basement rocks is 60 - 90$^{o}$ with dips from 70$^{o}$ N to vertical.

Iron rich gossanous like rocks were found capping 1 - 2 metre bands of fine grained sand to silt sized sediments at

(a) West of Limestone Bore.
(b) 2.25 miles south east of Limestone Bore (Orange Tree Hill).
(c) 2 miles south of Limestone Bore.

The samples assayed as follows.

| Sample | Cu | Pb | Zn | (ppm) |
|---|---|---|---|---|
| (a) | 80 | 40 | 280 | |
| (b) | 70 | 40 | 610 | |
| (c) | 370 | 20 | 370 | |

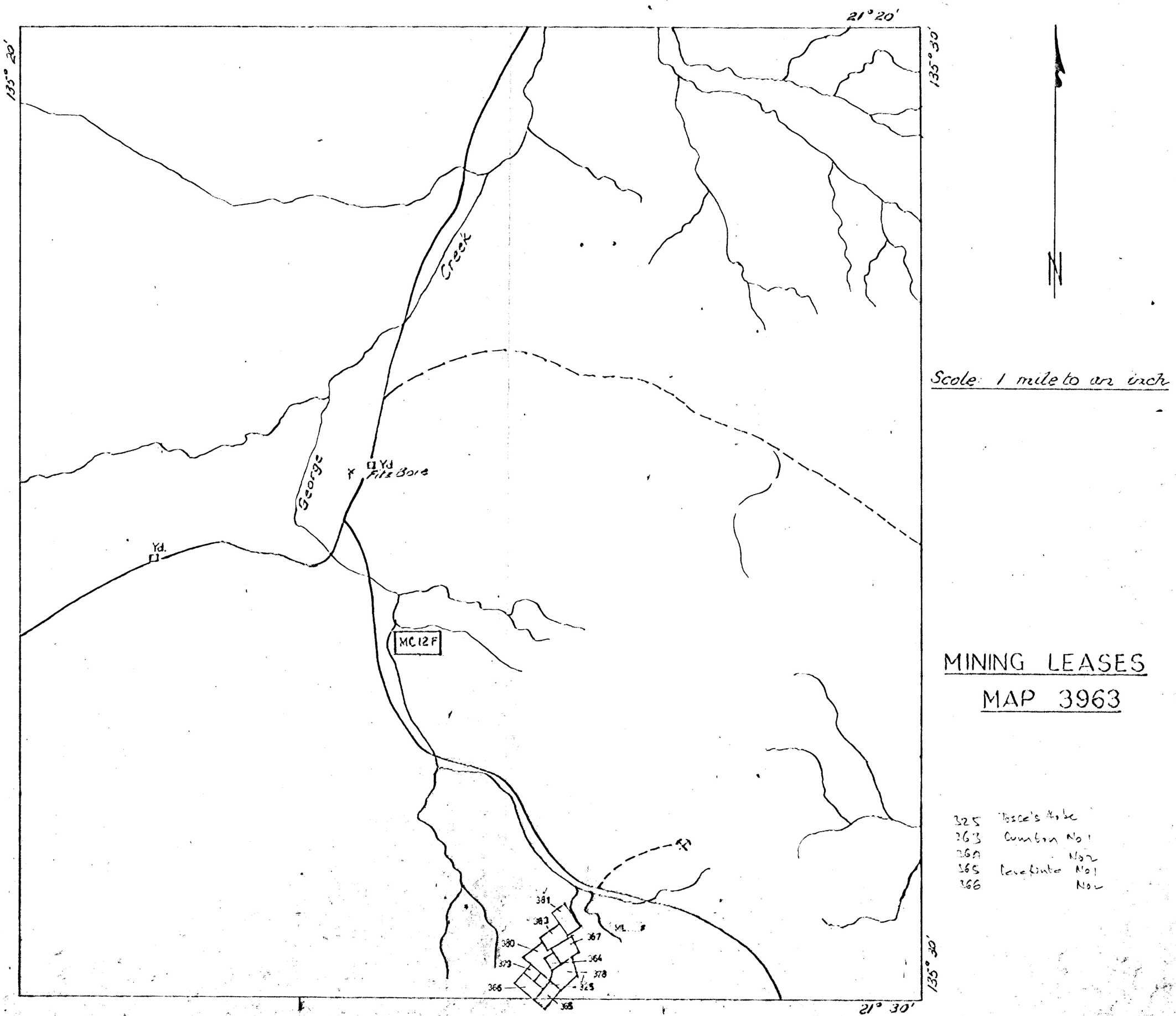
Sample (a) is marginally anomalous in zinc.

Sample (b) is probably anomalous in zinc.

Sample (c) is marginally anomous in bath zinc and copper.

Limestone Bore Area:

Limestones are interbedded with siltstones which strike about 120° and dip from 300 to steep north. Detailed work was not done; but the steep dip indicates that the area may be of Pre-Cambrian age and therefore not prospective for turquois. However a detailed examination is required where the stratigraphy will be mapped in some detail. All iron rich rocks and the basal sections of silt and mudstones will require assaying for copper and phosphorus. The areas potential for turquois formation will then be determined.




MINING LEASES
MAP 3963

325 Tosca's Hole
363 Cumbon No 1
364 No 2
365 Carafinta No 1
366 No 2

MINES BRANCH M.T.A. DARWIN

Submitted as annual report EL 555 for 97C

amdel
The Australian Mineral Development Laboratories
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Please address all correspondence to the Director
In reply quote: MP 3/513/0

26 March, 1971

James Cumming & Son Pty Ltd,
319 Parramatta Road,
AUBURN, NSW 2144

Attention : Mr John Cumming

REPORT MP 3667/71

| | |
|---|---|
| YOUR REFERENCE: | Telegrams dated 22/2/71 and 11/3/71. |
| LOCALITY: | Elkedra 1:250,000 sheet NT. |
| WORK REQUIRED: | Field Report with recommendations. |

Investigation and Report by : Dr R. Davy.

Officer in Charge, Mineralogy and Petrology Section : Dr K. J. Henley.

R. Davy

for F. R. Hartley,
Director

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# ELKEDRA AUTHORITY TO PROSPECT 2000 AND TOSCA'S HOPE

## 1. INTRODUCTION

Authority to prospect 2000 and the mineral claims at/near the Tosca Mine were visited by R. Davy in company with L. Gallagher and J. Weir (whole period) and J. Cumming (24/2/71 - 26/2/71) of J. Cumming and Sons Pty Ltd, from February 24 to March 4, 1971.

The environments of the Tosca Mine area were examined to make some assessment of

a) the potential of the area as a turquoise prospect
b) the origins of the turquoise

An assessment was made of the likely mineral potential of A. to P. 2000 and exploration programmes are here suggested. All major tracks through the A. to P. were traversed with frequent inspection of outcropping rocks. Mr L. Gallagher's previous work was examined and a further programme of work for him was suggested to him in the field. A copy of this suggested work programme has been forwarded to Mr J. Cumming independently. The A. to P. was examined for its suitability for geochemical prospecting.

An attempt was made to find the Juggler Tungsten prospect but this was not successful.

The Mines Department in Alice Springs was visited on two occasions to read published reports on the Elkedra 1:250,000 sheet and to discuss what stratiform mineralization was known in the Alice Springs area.

## 2. THE TURQUOISE PROSPECT AREAS

There are two prospects visible, Tosca's Hope and Cumton No. 1, and these are described in the following sections:-

### 2. 1 Tosca's Hope

At the main prospect (Tosca's Hope) there has been a certain amount of bulldozing and a section showing turquoise has been revealed. Two 20' trial shafts about 100' apart have been sunk through the turquoise layer. A series of holes have been drilled adjacent to the main area. Three of these holes appear, from the cuttings, to have intersected turquoise.

The turquoise appears to occur in two different layers. The sequence revealed in section and by drill cuttings appears to consist of

white siltstones
yellow limey siltstones
buff ?phosphatic siltstones
purple red ) siltstones
buff pink )
(turquoise)
cream siltstone, parts of which are phosphatic
(turquoise)
grey quartzite
conglomerate

The thickness of the layers is quite variable with the upper white-cream-buff rocks 10-50' thick, the purple-pink-red siltstones probably 4-10' thick. The quartzite below has a very variable thickness and away from the claim is over 100' thick. At Tosca's Hope it appears to be 10-15' thick. The conglomerate is equally variable. The turquoise is variable in thickness but is most commonly 1/2" to 6" thick.

Analyses have been made of 9 selected samples of cuttings from each of two drill holes on claim Larapinta 1. These assays are presented in Appendix 1. Thin sections have been made of the turquoise and the purple-red siltstones to consider their origins. (TS 26400, 26401 respectively).

The turquoise is always below the purple-pink siltstones but turquoise may be found either above or below the cream siltstone. It appears likely that phosphate originally partly replaced a limey siltstone and that the purple-pink beds possibly originally contained a fairly high concentration of copper which has since been leached. The copper bearing solutions would have travelled downwards until they met phosphatic rocks where the copper has reacted with the phosphate to give turquoise. Where the cream layer is phosphatic near its surface the turquoise is found at the top of this layer. When there is phosphate near/at the bottom of this layer but not at the top, the turquoise is found at/near the bottom. Where this layer is not phosphatic no turquoise is found at all.

Traces of malachite and chrysocolla are present in association with the turquoise.

The results of the assays show the general low levels of copper, lead and zinc. The samples marked TH are from one of the upper line of holes on claim Larapinta 1; the samples marked BH are from one of the middle line of holes on the claim Larapinta 1. They were 100-150' apart. The presence of turquoise is shown by enhanced copper (and zinc) values in BH7 and 8 (equivalent to bags 17 and 18 from the supposed top). A moderately high value of lead in TH 3 (seventh bag from the top) while not of economic interest, is of interest as it indicates some possibility of finding lead concentrations elsewhere in rocks of this age and type.

The slide of purple siltstone (TS 26401) shows framework grains of quartz and feldspar in a fine-grained matrix containing phyllosilicates (such as white mica and chlorite) and silica. No direct evidence of any volcanic origin was found but as feldspar is not a normal constituent of silty rocks it is felt that this rock has been derived from an igneous source. There are small, ovoid pebbles of claystone and chert in the rock. The rock is therefore believed to be sedimentary with an igneous component, but it is not clear whether any material such as volcanic ash (tuff) has been a primary component of the rock or whether the siltstone has been formed partly by the reworking of an acid (siliceous) igneous rock. No source - either vent, lava or intrusion is known in area.

Copper in the purple red beds of TH6 and 7 shows slightly higher values than those normal for siltstones (commonly 20-50 ppm) though TH3 and 4 (yellow siltstones with carbonate) also show higher values than normal (20-30 ppm). The corresponding values for rocks of the same type are lower in BH5 and 6 and the present indications are that copper and zinc in the upper zones have been leached by percolating ground water and reprecipitated a few feet below in the phosphate bearing rocks.

It is noted that the copper concentration in the turquoise bearing fragments are relatively low indicating either that the turquoise layer is not thick (in proportion to the contents of each bag sampled) or that the turquoise is not very rich in copper. Examination of the thin section (TS 26400) shows that the "turquoise" is composed of a mixture of three minerals; turquoise, chalcedony and quartz.

## 2.2 Cumton No. 1'

Turquoise is present on this mineral claim where it occurs in company with malachite. Limited bulldozing of this prospect has been carried out.

In this area the turquoise lies under a ferruginised cap and immediately on top of a quartzitic conglomerate. The caprock has the appearance of a gossan and probably represents a Cu-leached, iron enriched layer of sulphide bearing sediment. The copper bearing minerals lie in a thin (2-3") layer which gave positive tests for both phosphate and carbonate.

A zone N-NW of this area and W of this area (and W of S of the known gnamma hole) has a ferruginised caprock and appears to be similar in character and to be gossanous.

## 2.3 Discussions and Recommendations

(a) The chief defect of the exposed turquoise is its weathered and partly leached nature. The chippings from the drill holes contain turquoise which is deeper coloured and rather harder.

(b) Though the observed turquoise is low-grade and probably weathered it is considered that this is an area of promise and should be prospected further in the hope of finding fresh unweathered turquoise.

(c) The Sandover beds in which the turquoise is found die out north and west of Cumton No. 1 claim and it is felt that there is little point in prospecting in this area except for the area described below in point (d).

(d) There is a ferruginous outcrop which appears to be possibly gossanous on or just outside the northwest border of Cumton No. 1. This area is west of south of the bluff with the water hole. This area should be investigated by ripping when a bulldozer is brought to the area. Ripping or dozing should penetrate through the ferruginised caprock so that less altered material below may be exposed. Fresh samples of the iron enriched caprock and the underlying rock should be analysed for copper, lead, zinc and manganese.

(e) The apparent controls of turquoise formation are the purple-red siltstones with their igneous component, and the presence of phosphatic rocks below. It appears that as the known turquoise occurs in close proximity to the

purple-red beds the probable limits of turquoise are defined by the limits of leaching of the purple pink beds. If the copper is leached from these beds there must be either carbonate or phosphatic layers to trap the descending copper.

The two shafts showed a silty sandstone bed (as seen in the dumps) below the quartzite, but no turquoise (or malachite) was detected in the dumps. Elsewhere in the area the quartzite rests directly on conglomerate or is absent.

It appears likely, therefore, that the turquoise is patchily deposited. This is confirmed by the apparent absence of turquoise from several of the drill holes SE of the Tosca's Hope prospect. It is considered unlikely that phosphate will be found with the main quartzite or the conglomerate. These beds are of near shore origin and the conditions for their deposition are inappropriate for phosphate. It is noted that some of the turquoise has been deposited from solution on the surface of joints in quartz rich (?silicified) rock where it now forms a thin layer with botryoidal texture.

The recommended pattern of further prospecting for the turquoise is as follows:-

The area should be mapped on a 1" equals 200' basis and the areas showing basement (Hatches Creek beds), basal conglomerate and quartzite disregarded.

The remaining area should be drilled on a 400' square basis, using, preferably, a diamond drill. The anticipated maximum depth of drilling is of the order of 75'; many holes will be shorter. Drilling should be terminated when the quartzite is reached. If a diamond drill is not available a rotary drill could be used but would be less satisfactory.

It turquoise is present in any hole, further holes at 100' intervals should be drilled on a square pattern round the occurrence to determine the extent and direction of the turquoise.

The turquoise may be mined by bulldozer where the overburden is thin. The turquoise will be less spoilt if a ripper is used than it would be if it were bulldozed clear. Where the overburden is deeper the occurrence should be tested by the sinking of a trial shaft.

N.B. A note on a small, hand held diamond drill is included as Appendix 2.

## 3. A. TO P. 2000

A summary of the geology of this A. to P. has been given in Amdel report MP 3/513/0 3290/71.

There are three broad divisions to the geology. An older, Proterozoic, land mass lies to the NW of the Elkedra sheet and is represented by the Hatches Creek beds and associated igneous rocks in the North West and along the northern boundary of the A. to P. Isolated outcrops of even older beds, those of the Arunta complex, occur in the north east of the A. to P. Beach and shallow water fossiliferous sediments, the Sandover Beds, were laid down over the Proterozoic rocks in Middle Cambrian times. These crop out mainly in the south and east of the A. to P. Overlying these to the west and abutting directly on to Proterozoic rocks in the north west are the Upper Cambrian-Lower Ordovician rocks of the Tomahawk Beds.

### 3.1 Topography

The topography of the area is generally one of low relief. Wide plains and river valleys show little outcrop though there are rare patches of river gravel in the valleys.

The lower portions of the Davenport ranges appear as upstanding ridges 300-400' above the general topographic level. Outcrops of Tomahawk Beds in this region have similar lithology to the Hatches Creek Beds in the Davenport Ranges, and also form prominent ridges.

The south western portions of the A. to P. are flat to gently undulating. There are rare outcrops of Tomahawk Beds which, however, rarely rise more than 3" above the ground.

The eastern parts of the A. to P. have undulating relief with ridges 200-300' high capped with chert, and rolling hills capped with ironstone.

### 3.2 Current Exploration

Exploration to date has been confined to the gridding and geochemical sampling of an area known as Elkedra 4, over which an Induced Polarization (I.P.) survey has been carried out, and the gridding and sampling of an adjacent area; the gridding and geochemical sampling of an area known as Elkedra 3 (also the site of I.P. studies); and the beginning of regional sampling along reconnaissance traverses in the Andagera Creek, Arganara Creek area. Regional sampling to date has involved the collection of samples at 1/4 mile intervals on traverses 1 mile apart. The sampling programme has been modified (4-3-71) and now consists of the collection of soil samples in outcrop areas at 1000' intervals along traverses 1 mile apart, together with one sample taken from the alluvial inter-outcrop areas.

A further programme for Mr Gallagher has been laid out as directed by Mr Cumming. A copy of this programme, as given to Mr Gallagher, is attached at the end of this report as Appendix 3.

## 3.3 Discussion

### 3.3.1 The Davenport Ranges

This area covers the NW portion of the A. to P. Rocks present are those of the Hatches Creek series, overlain by the Tomahawk Beds.

Rocks examined in both groups were conglomerates and quartz-rich rocks - siltstones, quartz sandstones and quartzites.

The map indicates the presence of basic rocks in the Hatches Creed Beds. These rocks were not inspected but very small patches of basic rock were seen in the Hatches Creek beds further east, SE of Fitz Bore. A film of malachite seen on a joint face indicated that these rocks have some possibilities as hosts of ?minor copper mineralisation.

It is recommended that the basic rocks be located and examined for signs of copper mineralisation.

The area is more suitable than other sections of the A. to P. for stream sediment geochemical investigation; however, no indication of worthwhile mineralisation was seen.

### 3.3.2 The Eastern Portions of the A. to P.

The northeastern boundary of the A. to P. is a fossil shore-line and the sediments called the Sandover Beds were deposited near shore against the old land mass.

Near the northern boundary of the claims the Sandover Beds consist of conglomerates, quartzites and quartz sandstones, some of which show ripple marking. With increasing distance from the shore (or with effective sinking of the land) the sediments become finer and the lithology changes to siltstones, shaley marls, phosphatic shales and carbonate rocks. The coarser siliceous rocks are very prominent for up to 5 miles from the northern limits of the Sandover Beds indicated on the 1:250,000 map. Localised fine-grained beds either succeed or interdigitate with the coarse siliceous beds in many places (e.g. at Tosca's Hope) possibly reflecting a local deepening of the sea.

The remainder of the Sandover Beds are of appropriate lithology for containing stratiform ore bodies except that no igneous rocks or ash (tuff) bands were detected.

The picture is confused by the extensive surface/superficial modifications to the rocks. The outcrop areas of the northern part of the Sandover Beds are commonly capped with chert or a siliceous conglomerate or breccia. This appears to be 10-15" thick and is creamy to bluish in colour. Further south there

is less chert, though it is still present and there is some development of ferruginised caprocks. The latter may be composed of either hematite or goethite with chert or quartz. The cream or blue chert apparently overlies the more siliceous rocks whereas the ferruginous caprock is more common over the lime, phosphate or shale beds.

The extensive development of the ferruginised caprocks precludes easy visual recognition of gossans and it is essential that all ironstones be sampled for analysis, particularly if no geologist is present. (See ironstone analyses I 1-4 in Appendix 1)

Below the silicified or ferruginised surface rocks there is a zone of partial silicification caused mainly by the addition of silica to the intergranular spaces of sandstones or siltstones, or by the partial replacement of either phosphate or carbonate by silica.

It is likely that, in these surface layers, there has been quite extensive leaching and that the elements of interest (copper, lead, zinc)have been carried down away from the surface by descending water. The current geochemical sampling programmes in the Limestone Bore (Elkedra 4, run 2) and Andagara Creek area is of considerable interest. The values reported for the Elkedra 4 area, run 1 (Amdel Report AN 3/513/0 3655/71) are low indicating that in all probability leaching has taken place. If further values are low it will indicate that soil geochemistry is not a very useful prospecting tool in this area.

Thin sections have been made of purple-pink siltstones from drill hole L4 (TS 26399) and of a banded chert from the Andagera Creek area (TS 26402). Both appeared to be wholly sedimentary, with secondary silicification and no sign of any igneous component.

The lines of the faults shown on the 1:250,000 map in the Andagera Creek area were discovered. Additional geochemical sampling should be undertaken along the lines of these faults.

A manganese bearing ironstone found on the Elkedra 4 I.P. area (run 2) will be discussed later.

3.3.3 <u>The South Western Portion of the Area - The Tomahawk Beds</u>

Relief in this area is very slight with the bulk of the area being flat with minor low undulations. Outcrop is commonly 3-6" high above the ground only.

The Tomahawk Beds are later in time than the Sandover Beds. They occur west of the Sandover Beds, and extend north on to the Proterozoic rocks of the Davenport Ranges. They are contemporaneous in time with the copper bearing rocks of the Waterhouse Range.

It appears that at the close of deposition of the Sandover Beds there were earth movements with some tilting. Direct deposition on to the Sandover Beds appears absent and this area may have been effectively dormant for either sedimentation or erosion. A new 'basin' opened further west and the 'Davenport Range' area effectively sank a little.

The Tomahawk Beds, as seen, have a rather similar lithology to the Sandover Beds. In the Davenport Range area they are highly siliceous quartzites, conglomerates and sandstones deposited under beach and near shore conditions. These appear to pass south (under cover) into yellow-cream sandy limestone beds. Traces of phosphate were detected in the sandy limestone beds. Little outcrop was examined, but again in the rocks seen there was evidence of some surface silicification. However karst like cracks in the limestones had developed and had later been filled with surficial sand and mud.

The area is sufficiently like the eastern part of the A. to P. for further exploration of this area to be warranted.

Geochemical testing of outcrop areas should be carried out but no extensive programme arranged until the geochemistry is proved worthwhile.

3.3.4 Elkedra 4 I. P. Survey Zone

This area was located on the ground. There is little outcrop and the surface is covered with red alluvium with patches of sand and dust.

A black-brown outcrop was discovered by Mr Gallagher during systematic gridding in the anomaly area. A sample sent to Amdel has been thin sectioned and assayed. The assay figures are given in Appendix 1. (Mn rock). The sample assayed contains 14.5% manganese metal. Further samples are currently being assayed, but it should be noted that manganese is not economic at concentration of less than 30-35%.

The thin section (TS 26406) showed the rock to be largely composed of goethite (hydrated iron oxide) -50-70%, quartz 15-20% manganese dioxide (15-20%)

The thin section showed that the rock is secondary with most of the manganese being emplaced after the iron oxides and the silica. No signs of former sulphide minerals were detected.

This rock is the probably cause of the I.P. anomaly. Origins of the manganese remain obscure. It is our experience that it is more likely to be related to ground water movement than to be related to sulphide mineralisation

It is recommended that if any drilling be carried out in the A. to P. or at Tosca's Hope, one or two holes be drilled into this outcrop and the core or cuttings sampled, examined and assayed every 5 feet. The small drill suggested in Appendix 2 would be very suitable for this purpose.

3.3.5 Mines Department, Alice Springs

A visit was made to the Alice Springs Mines Department on 3 March, 1971. In conversation with Dr Fruzzetti and Mr Morlock of the Mines Department it was learned that four stratiform copper ore bodies were known in the Alice Springs area. Two of these are in Proterozoic rocks (and included Mt Skinner); the other two are in Cambrian rocks. Dr Fruzzetti would not say where these deposits are located though one is believed to be in the Waterhouse Ranges,west of Alice Springs, but samples of ore were inspected. Mineralisation in one instance, is green malachite in a fine-grained sandstone, and in the other case is malachite with rare chalcopyrite grains in dolomitic shale. A rock of similar aspect to the dolomitic shale was examined at Elkedra in the Sandover Beds.

## 3.4 Summary

The lithologies of rocks of the A. to P., south of a line running approximately NW through McRobs and Limestone Bores and possibly swinging north along Andagera Creek towards Andagera Bore are suitable for the rocks to act as hosts to base metal mineralisation. However no gossans, and no signs of igneous acticity have been detected. A manganiferous ironstone has been discovered at Elkedra 4 I.P. site.

The current programme will show whether soil geochemistry is viable in this area. If not a different programme of exploration will be needed.

## 3.5 Recommendations

The present system of geologists and field staff working from 1:250,000 maps is totally inadequate. Before any constructive mapping and/or interpretation can be done a full set of aerial photographs with mosaics must be provided. It is advisable that two sets of such photographs be obtained to allow the geologists and the field operators to work independently. Key sheets which indicate the total number and code-numbers of such photographs and mosaics have been ordered from the Department of National Mapping but have not yet arrived.

3.5.1 Exploration for Ore Bodies at the Surface

Under the present conditions of exploration only surface outcropping ore bodies can be expected to be found. Reconnaissance exploration may be simply achieved by walking the whole area in a systematic manner e.g. at 1 mile intervals by collecting all samples from all outcropping ironstones and by collecting soils from outcrop areas on a regular basis. Unusual rocks should be sent to Amdel for laboratory investigation.

When the area has been walked and samples have been analysed it will be necessary to carry out a field inspection of any interesting sites. A map should be made showing sample sites and outcrop areas, and locating all ironstones and unusual rocks. This cannot be done adequately without aerial photographs.

The current programme of geochemical sampling in the Arganera Andagera Creeks area (soil samples collected at 1000' intervals in outcrop areas on EW traverses 1 mile apart) should be continued but no goechemical work in other areas should be started until

(a) photographs are available
(b) the worth of general soil geochemistry has been evaluated.

In addition to the regular traversing of this area, the lines of the faults indicated on the 1:250,000 map,(and located from the track to Andagera Bore,) should be walked. All outcrops on and near the fault zones should be examined for

(a) ironstones
(b) unusual white heavy minerals (these may be stained red or brown by iron)

Soil samples should be taken at 1000' intervals along the length of the fault lines. If the valleys are wide three roughly equal sized samples should be collected across the valley floor and bulked and a composite sample sent in for analyses.

Plans of outcrop areas and of all sample sites should be made.

For this study in the Andegera-Arganara area Mr Gallagher has been asked to collect for comparison purposes one sample for each alluvial area traversed.

The manganese rich outcrop should be drilled (one or two holes) and samples taken at 5' intervals submitted for petrographic and chemical analysis.

Costs involved in this programme will be directly proportional to the work done. Amdel involvement will be the carrying out of chemical analyses (at cost according to the price list), petrographic analyses, interpretation of geochemistry and such field follow-up work as is needed. Recommendations about the suitability of geochemical sampling and the manner of sampling will be made following interpretation of each batch of analyses.

The costs of this work would be charged on a daily basis and would vary with the amount of work actually carried out. However, it is estimated that the geological services of Amdel would cost up to $6,000 with analytical services extra at cost.

3.5.2 Exploration for Concealed Ore Bodies

The cost of exploring for such ore bodies is very much higher than the cost of exploring for exposed ore bodies but the search is likely to be more rewarding.

A recommended programme, supplementary to that desribed in section 3.5.1 is as follows :-

1. Photo interpretation of the geology of the area.
2. The carrying out of an aerial geophysical survey as indicated in our report MP 3290/71. This would involve flying the southern half of the A. to P. at 1/5 mile line spacing and 150' and carrying out magnetometer, scintillometer and E.M. surveys.
3. A field visit to examine key lithologies and examination of selected anomalous areas on the ground.
4. Following interpretation of the geophysics the drilling of at least 3 diamond drill holes to basement followed by reinterpretation of the aerial geophysics.
5. The location of either (a) areas to carry out ground geophysical surveys or (b) further drilling sites. In the event of unpromising data the exploration programme would be stopped at this stage.

   Costs of an additional programme such as this would be not less than $50,000 and would be open ended depending on the work carried out.

# APPENDIX 1

## Table of Chemical Analyses

(Values in ppm unless stated)

### 1.A Cuttings from Drill Holes, Larapinta 1

| Sample No. | | Bag No. | Colour | Cu | Pb | Zn | $P_2O_5$* |
|---|---|---|---|---|---|---|---|
| TH | 1 | 1 | White | 65 | 35 | <5 | - |
| | 2 | 4 | White | 20 | 85 | 5 | - |
| | 3 | 7 | Yellow | 120 | 3600 | 45 | - |
| | 4 | 11 | Deep yellow | 95 | 150 | 55 | - |
| | 5 | 14 | Buff | 65 | 30 | 90 | + |
| | 6 | 17 | Purple red | 75 | 30 | 35 | - |
| | 7 | 19 | Pink red | 120 | 20 | 35 | - |
| | 8 | 21 | Cream | 35 | 20 | 20 | - |
| | 9 | 24 | Gray(quartzite) | 70 | 25 | 75 | - |
| BH | 1 | 2 | Cream | 65 | 75 | 35 | - |
| | 2 | 7 | Cream | 40 | 25 | 130 | - |
| | 3 | 10 | Cream | 45 | 10 | 70 | - |
| | 4 | 13 | Pink purple | 35 | 10 | 20 | - |
| | 5 | 15 | Pink purple | 45 | 10 | 15 | - |
| | 6 | 16 | Purple | 40 | 10 | 15 | + ? |
| | 7 | 17 | Cream+turquoise | 1500 | 15 | 250 | + |
| | 8 | 18 | Brown+turquoise | 750 | 15 | 450 | + |
| | 9 | 20 | Quartzite | 70 | <5 | 55 | - |

*Qualitative test to determine whether any phosphatic material is present.

### 1.B Various Ironstones

| Sample No. | | Locality | Cu | Pb | Zn | Mn |
|---|---|---|---|---|---|---|
| I | 1 | Andagera Creek ) Samples N | 250 | 50 | 75 | 90 |
| | 2 | Andagera Creek ) to S at ca. | 35 | 15 | 65 | 45 |
| | 3 | Andagera Creek ) 4 mile | 45 | 15 | 210 | 410 |
| | 4 | McRob's Bore intervals | 65 | 110 | 190 | 400 |

### 1.C Elkedra 4, I.P. Survey

| | | Cu | Pb | Zn | Ni | Mn |
|---|---|---|---|---|---|---|
| Mn rock | Elkedra 4 | <5 | 5-25 | 300-450 | 200-210 | 14.5% |

## APPENDIX 2

### Portable Diamond Drilling Equipment

by Dr J. Gordon-Smith

The Mindrill "Minor" Mk II is a light portable and inexpensive machine, alleged to be obtainable ex-stock. In the hands of an experienced driller it will core 30 feet Ex (approx 1" external diameter) per shift in hard basalt. Its potential performance in the shales, siltstones etc of the Elkedra area would be better than this, but actual progress would,of course,depend upon the skill of the operator. The machine is self-contained and driven by a two-stroke petrol unit, normally marketed to drive a chain saw. There is also a petrol driven water circulating pump. Fuel consumption for the two engines is of the order of three gallons per shift. Since both are light and fast running they require careful handling and appropriate maintenance. Suitably looked after, both are reliable and adequate for their duties.

The drill weighs about 50 lbs and the pump rather more. Steel or light-weight-alloy drill rods can be used, the former are probably the more satisfactory. The maximum depth obtainable depends upon conditions and available skill. Using "E" rods, and an AWL (1" core in 1 3/8" hole) swivel tube core barrel, between 75 and 100 feet should be possible in the Elkedra rocks. With an E barrel this might be increased by another 50 feet.

In addition to fuel, it will be necessary to provide water at the rate of 5-10 gallons per minute of drilling time. They may present some difficulties, particularly since no "return" and re-use of the drilling water can be expected. The quality of this drilling water is not important, possibly it could be pumped from some nearby water hole and if this is less than a mile away 7/8 or 1 inch polythene hose will be found adequate.

Two Small Portable Diamond Drills (suggested units with costs)

| Mindrill HMB | | Mindrill Minor Mk III | |
|---|---|---|---|
| Drill head<br>Power unit including water pump | $1226 | Drill<br>Pump | $819 |
| Weight - about 100 lbs?<br>(More elegant, possibly easier on the operator) | | Weight - | drill - about 30 lbs<br>pump - about 60 lbs?<br>(More portable and cheaper) |

Equipment (common to either drill)

| | | | |
|---|---|---|---|
| 1 | E Rod Jack | $106 | |
| 1 | Lever Pulldown | 117 | |
| 80 ' | of E rods, in 2 ' lengths or part in say 5 ' lengths (according to drillers preference) | 282 | (or thereabouts) |
| 1 | E-A. Sub | 4 | approx. |
| 1 | AXT Starter barrel | 30 | " |
| 1 | AXT Double Tube S.I.T. Core Barrel | 100 | " |
| 1 | Set water hoses | 40 | " |
| 1 pr. | 18" Stilson Wrenches | 10 | " |
| | Total | $689 | " |

Consumable Stores (common to either drill)

| | | | | |
|---|---|---|---|---|
| Diamond-set | AXT BW Core bits each | 80 | approx. | ) |
| | AXT Reaming Shells each | 120 | " | ) $372 per 1000' or thereabouts. |
| Core Lifters | each | 3 | " | ) |

The consumption of bibs, shells and corelifters will depend on drilling conditions - 3 bits, 1 shell and 4 core lifters per 1000 feet of hole may be reasonable.

In the above, no provision has been made for fishing equipment, spares for contingencies etc. If the work is to be carried out in remote places, it would be prudent to include a set of spares for the engine(s), a core-picker, bell-tap,spare core barrel and possibly spare rods also.

## APPENDIX 3

### Work Programme for Mr L. Gallagher, Elkedra Area
### Suggested by R. Davy 3.3.71

N.B. 1. This programme is to be regarded as provisional and will probably, at least in its later stages be modified following discussions between R. Davy and J. Cumming.

2. Mineralisation on the area is likely to be reflected by

   a. the presence of green or blue copper staining; basic (or acid) rocks most likely hosts with turquoise in the sediments.

   b. iron-gossan outcrops, ± boxwork. This represents iron enriched oxides cap rock over a sulphide ore body.

   c. Heavy white minerals, ironstained at the surface, (?possibly also inside). These will be size for size heavier than quartz, and they will be softer than quartz.

#### Suggested Programme

1. Re-sample Elkedra 4 area, same basis as before, new site. 2½ days

2. Continue line traverse in Andagera and Arganara areas sampling soil in outcrop areas at 1000' and also collecting one sample only from each river flat traversed. Soil should be sieved to -80 mesh.

   Rocks which cannot be identified should be sent to Amdel for examination (packed separately from samples despatched for analysis).

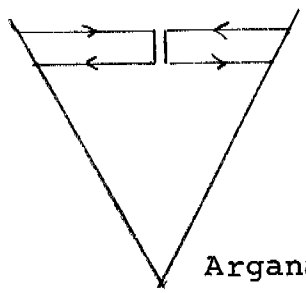
   All ironstone outcrops seen, whether on or off the traverse lines, should be sampled for analysis. To do this 5 pieces taken from the whole outcrop, about 1" cubes, with fresh faces, should be collected.

   A rough map should be made on graph paper showing sample sites, and the position of changes from outcrop areas to river flats or other covered areas. Some attempt should be made to identify rocks.

   To facilitate orientation it is suggested that Mr Callagher drive up the tracks from Arganara bore to the N boundary of the A. to P. at (a) Andagera bore (b) on the road to Fitz bore, and leave tagged fence droppers every mile.

Estimated working time 3 weeks

Traverses may be split thus to facilitate collection and to restrict walking to a normal days capacity. If a landrover is provided which can accompany Mr Callagher on the traverses when necessary this traversing can be rationalized and probably carried out more rapidly.




3. Some attempt should be made to explore the area W of McRob's bore. Soils from each outcrop zone should be collected on a 1000' square basis. Representative rocks should be collected for lab identification and analysis.

Estimated working time 2 weeks

4. Limestone Bore area (N to turquoise mine (A. to P. limit)
(S to Ammaroo No. 2 (A. to P. limit)
(E to grid line 340000E
(W to grid line 320000E

Phosphate rock is known at the surface.

All ironstones in this area should be sampled as before.

Main areas of outcrop should be located and a sketch plan made. (Geological map will be of use as basis). Area should be "walked" at 1 mile intervals and soil samples collected at 1000' intervals from outcrop areas.

Representative samples or rocks should be collected and forwarded for identification and, if necessary, analysis.

Estimated work time uncertain ?3-4 weeks

5. Davenport Range area.

a. Identify basic lavas (green on map), examine for copper signs. Sample rocks.

b. Examine rock types away from track. Identify but ignore areas with conglomerates and quartzites.

Soil sample over all remaining outcrop areas. If aerial photographs are available convert soil sampling to stream sediment survey, Amdel will lay out guide lines.

Estimated working time 3-4 weeks

This programme was given in the field to Mr Gallagher at Mr Cumming's request.

N.B. The main body of the report adds additional traversing along the fault lines in the eastern part of the A. to P.

It is recommended that an assessment of the worth of soil geochemistry be made at the close of the present programme of sampling in the Andagara Creek-Argarara Creek areas.

It is likely to be necessary, however, even if soil geochemistry is less useful than hoped, for the area to be walked, all rockstypes identified and samples of all ironstones collected.

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