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MICROFILMED

EL 23/79, WYNYARD

and

EL 33/79, WARATAH

TASMANIA

WATER SAMPLING PROGRAMME

HYDROGEOCHEMISTRY

WARATAH AND WYNYARD EL'S

NORTH WEST TASMANIA.

WATER SAMPLING PROGRAMME AT WARATAH AND WYNYARD, TASMANIA.1. INTRODUCTION.

Much of Watatah and Wynyard Exploration Licences in Tasmania are covered by a relatively thin veneer of Tertiary basalt anywhere from 0 to 100 + m thick. The underlying topography appears gently undulating and covered by patches of clean Tertiary quartz gravel locally containing carbonized wood fragments. This appears no more than a few meters thick in the Waratah area, but may be several tens of meters thick locally in the Wynyard EL south of Table Cape. Windows of older Cambrian and Pre cambrian rocks appear through the basalt forming low silicified hills in the Waratah area, rising above the basalt plain.

The target, tin mineralization of the Mt. Bischoff or Cleveland or Renison type, is sought in the Cambrian and Pre cambrian rocks below the gravel/basalt cover. Present geophysical techniques are severely hampered in their effectiveness to detect mineralization under these conditions. Magnetic bodies will be masked by the strongly magnetic basalt. Aeromagnetic data may best serve to indicate the thin areas of basalt which possibly overlie topographic highs. These may represent more resistant silicified and ? mineralized rocks. Electrical methods may be effected by ground water which is encountered at or within a few meters of the surface the year round.

It was considered therefore that ground water sampling may be a useful approach to get information about the rocks below the basalt. A proposal was put to sample spring water around the scarp of the basalt plateau below the basalt/Cambrian-Pre cambrian sediments contact.

2. METHODS.

2.1 Time of sampling.

Sampling was carried out in March and April of 1982 at the end of the dry season (monthly rainfall distribution for three NW region centres is given in figure 1). This time was chosen because :

- 1) dilution of spring water from rainfall run-off was likely to be at a minimum,
- 2) the recharge rate is at its lowest thereby producing the highest salt content for the spring water and,
- 3) The springs still running at the end of the dry period are more likely to represent longer and therefore more significant groundwater flow paths than those springs that might run for a couple of days after a rain period.

2.2 Sampling Methods.

The samples were collected in one litre low density polyethylene bottles with plastic screw caps. Three samples were taken at each site, one only being acidified. The acidified and one non acidified samples were despatched to Allison Laboratories Ltd in Hobart and the other non acidified sample was retained for analysis at field base.

The bottles were rinsed with the sample twice in most cases before filling and where possible the bottles were completely filled. When filling, the mouth of the bottle was pointed in the direction from which the water flowed and filled slowly to avoid backwash contamination from the sampler's hand (a source of Na, Cl, Zn and possibly As). Where depth and rate of flow was very low a hole was dug by hand deep enough to immerse the bottle for filling. When the water had completely cleared of visible clay suspension the pool was deemed flushed and the sample carefully taken using a plastic glove to cover the sampler's hand.

2.3 Bottle Preparation.

The bottles for sample collection were prepared by East Melbourne Laboratories Pty Ltd in Melbourne and transported by sea and road to field base camp. The acidified sample bottles were acid washed (method 3.2 E.P.A. (1979)) and a glass vial (also acid washed) containing 10ml of double distilled concentrated HNO_3 was placed in each bottle. The non-acidified sample bottles were given a normal wash (method 3.1 EPA (1979)).

The use of a glass vial of pure HNO_3 placed in the bottle prior to going into the field has been shown to reduce the risk of contamination considerably. (Guest and Blutstein (1981)). It is obviously more convenient (and much less dangerous!) than carrying a separate dispenser of concentrated HNO_3 on a difficult bush traverse. The glass vials are simply broken inside the bottles immediately after they have been filled with the sample and sealed by giving the portion of the bottle in contact with the vial a sharp tap from the outside. The bottle is then shaken to disperse the acid.

2.4 Site Analyses.

Four parameters were determined on site : water temperature, conductivity, pH and dissolved oxygen. Conductivity was determined using a TPS LC 81 conductivity meter and K = 1 electrode. pH and dissolved oxygen were determined with an Orion 407 A specific ion meter using an Orion model 91 - 62 glass electrode (pH) and an Orion model 97 - 08 oxygen electrode. The electrodes were calibrated on site before each measurement.

The oxygen electrode is temperature compensating giving corrected dissolved oxygen values even though the temperature of the standardizing medium (water saturated air) is different from the sample temperature. The pH electrode is not temperature compensating but the difference between

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standards and unknowns did not exceed 10°C and was usually about 5°C. This will produce an error of no more than about 0.05 pH units in the temperature range encountered.

The conductivity electrode was calibrated on 25.4 ppm and 254 ppm NaCl solutions (reading 53.8 and 520 μS at 25°C respectively) before going into the field. Only the 25.4 ppm NaCl calibration was used as most waters were found to have conductivities between 30 and 170 μS. All conductivity values are temperature corrected to 25°C. Other notes made at each site included an estimation of the average width and depth of the water flow, vegetation, types of rock fragments in the stream bed and any visible outcrop.

2.5 Field Base Analyses.

Five parameters were determined at base camp - pH, HCO_3^- , Ca^{2+} , Na^+ and Cl^- . In addition the temperature for the HCO_3^- determination was noted. The pH was too low (< 8.3) in all cases for any significant CO_3^{2-} species to be present.

Bicarbonate was determined by plotting potentiometric titration curves for each sample. The Orion 407 A specific ion meter and model 91 - 62 glass pH electrode was used and the titration was carried out on 100ml of unknown solution using a 10ml microburette delivering 0.0207 N H_2SO_4 . In each case the titration was carried to below pH 4.5. The inflection point usually occurring at about pH 5.0 was noted and the amount of acid consumed used to calculate the HCO_3^- content.

Calcium, sodium and chloride were all determined using appropriate specific ion electrodes. Complexing was considered likely in the case of Ca^{2+} and therefore the standard addition method was used. Calcium

will form complexes with HCO_3^- and SO_4^{2-} which cannot be detected with the Ca electrode using the direct reading method. Only free Ca^{2+} ions are detected. It was found in the two cases checked that the standard addition method gave values about 10% higher than the direct method. This proportion of complexing is typical for solutions of this concentration.

Sodium and chloride do not form significant complexes under normal solution conditions. Potentiometric titration for dissolved CO_2 using 0.0454 N Na_2CO_3 was carried out on a few samples and as expected yielded levels closely approximating those of water in equilibrium with the atmosphere. None of the samples could be collected close enough to the point of groundwater emergence to give values of the true ground water levels.

3.0 RESULTS.

3.1 Site and Field Base Analyses.

Site and field base analyses are summarized on the analysis sheets (Appendix 1). Locations are shown on figures 2, 3 and 4.

3.1.1 Water Temperature.

Field water temperatures are significantly below maximum daily air temperature by between 5 and 10°C and most commonly in the range of 10 to 12°C.

3.1.2 pH.

Field pH is mostly in the range 6.3 to 7.6. Four samples occurred in the range 4.7 to 6.0, but each had oxygen levels below those for water in atmospheric equilibrium and flow cross-sections less than

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5cm² (figure 5). It is likely that this water is in various degrees of stagnation and has significant humic acid content. Even within the common range of pH the deviation from saturation with atmospheric oxygen is broadly related to pH. The median pH for water at atmospheric equilibrium is about 7.2. Water containing 0.75 ppm oxygen less than saturation has a median pH of 6.6 (figure 6).

The difference between base camp determined pH and field site determined pH is 0.05 ± 0.19 (1 σ) pH units, the field site determinations being the lower on average.

3.1.3 Conductivity.

Conductivities ranged between 30 and 170 uS with the exception of 007W, mine adit water from Mt. Bischoff. Here the conductivity was extremely variable, depending where the electrode was placed in the pool of water.

3.1.4 Free CO₂.

Free CO₂ was determined on 8 samples and these generally agreed with the nomographically determined values at base camp temperature, pH and HCO₃⁻. The determinations were carried out potentiometrically using 0.0454 M Na₂CO₃. The determinations were discontinued as it was considered that the CO₂ content of the water would be at equilibrium with the atmosphere and any deviation was likely to be biological rather than a reflection of original groundwater levels.

3.1.5 Calcium, Sodium, Chloride.

Calcium ranged from 1ppm to 7.2ppm and there is no detectable difference between the Waratah and Wynyard samples. In contrast Na is higher in the Wynyard streams (11.5 to 23 ppm) compared to Waratah (4.5 to 9.9 ppm)

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possibly reflecting the influence of sea spray.

Although chloride determinations were not completed for the Wynyard samples a similar area bias is suggested by the available chloride and conductivity data.

There is no apparent correlation between rock type and Na/Ca or Ca/Conductivity ratios or absolute Ca or Na values in either exploration licence. Hence it is difficult to relate the water back to rock type.

3.2 Laboratory Analyses.

The samples were all submitted to Allison Laboratories Pty Ltd in Hobart for analysis. The non acidified samples were analysed for Na, K, Cl⁻, SO₄²⁻, HCO₃⁻, F⁻, pH, conductivity and in most cases Ca and Mg. The acidified samples were analysed for Cu, Pb, Zn, Fe, Ca, Mg, F, As and in some cases Na. The analyses were carried out generally in accord with APHA "Standard Methods for the Examination of Water and Waste Water" 14th Edition (1975).

Corresponding laboratory and field analyses are shown on the sample analysis sheets (Appendix 1).

3.2.1 pH

The pH values show no more than 0.5 pH units difference between field and laboratory determinations and are mostly within 0.1 or 0.2 pH units of each other.

3.2.2 Conductivity.

The field conductivity measurements are about 10% higher than the

laboratory conductivity measurements over the entire range (30 to 170 microsiemens (uS) @ 25°C) (fig.7). This suggests a calibration difference. The field instrument was calibrated at 53.8 uS for a 25.4 ppm NaCl solution and an automatic temperature compensation coefficient of $-2.2\%/^{\circ}\text{C}$.

3.2.3 Sodium.

Sodium shows an absolute error of 1.6 ppm over the range 3 to 21 ppm (fig.4). This may be explained by the presence of 1.6 ppm Na in the distilled water used to prepare the standard solutions for the field determinations.

3.2.4 Calcium.

Agreement for calcium is poor (fig7) variation being anywhere between a factor of 1 and 2. Agreement between Ca determined on acidified and non-acidified sample pairs determined by the laboratory is much better, but leaves a little to be desired - of the 14 determinations, 11 non acidified samples returned higher values than their respective acidified samples and 2 were lower. This problem needs further investigation.

3.2.5 Chloride.

Field chloride determinations are higher than the laboratory by between 10 and 30% in most cases (fig7). This is somewhat puzzling as the chloride electrode showed good response time and little tendency to drift. Chloride does not have complexing tendencies and is not significantly affected by even several months of storage so the variation is not readily explicable.

3.2.6 Bicarbonate.

The bicarbonate values show fairly good agreement. A laboratory vs field plot (fig.7) shows a linear array of points which is slightly deviant from

the 1:1 line. This line and the linear array intersect at about 21 ppm HCO_3^- and the linear array intersects the Y axis (field HCO_3^-) at -1.4 ppm.

3.2.7 Potassium and Magnesium.

Potassium and magnesium range from 0.3 to 1.3 ppm and 0.9 to 5.7 ppm respectively. No correlation is apparent between rock type and K or Mg content. Values for both species are clearly higher in the Wynyard EL than Waratah EL.

3.2.7 Base Metals : Copper, Lead, Zinc.

Values are generally below detection for Cu (1 ppb) and Pb (10 ppb). Zinc gave a background range of 2-7 ppb. The acid blank contained below-detection Cu and Pb and 2 ppb Zn.

Apart from the mine adit sample (007W) from Mt. Bischoff, the only sample anomalous in any of the base metals was 029W from the Wynyard EL, with 84 ppb Zn. This value is an order of magnitude higher than the upper limit of the background range and should be followed up with more detailed sampling.

Lead is below saturation with respect to PbCO_3 and PbSO_4 in all samples and similarly Cu and Zn are below saturation with respect to their sulphates, simple carbonates and malachite.

3.2.8 Iron.

Values range from 0.08 to 1.3 ppm with the exception of the mine adit sample at 14 ppm. The iron is in excess of that expected if it was in equilibrium with ferric hydroxide. It therefore appears that most of the iron detected is in the ferrous state and would be well below saturation with respect to ferrous hydroxide.

There is no relationship between stream flow section or pH and iron content, nor is there any relationship between rock type and Fe/conductivity ratio.

3.2.9 Fluoride.

Levels ranged from 0.05 ppm to 0.25 ppm in the natural stream water. A value of 1.2 ppm was obtained for the Mt. Bischoff mine adit sample. All values were below CaF_2 saturation by one to three orders of magnitude. No significant difference was noted between the values from the two EL's and no relationship between rock type and F' level was observed.

3.2.10 Arsenic.

Arsenic has been determined on six samples and because the mine adit sample (0.14 ppm) was in excess of the detection limit (0.02 ppm), no further analyses have been carried out until a more sensitive method is devised.

3.2.11 Sulphate.

All values are below detection (0.2 ppm).

Apparently genuine analytical difficulties exist for lowering the detection limits of the latter two species. Normally As can be determined down to 1-2 ppb but for some reason poisoning of an analytical reagent (Zn) seems to be occurring. Barium chloranilate is used to provide a very sensitive technique for SO_4^{2-} determination, however this chemical has not been obtainable in Australia and shipment from overseas is awaited. The classic turbidometric method is limited to about 100-200 ppb SO_4^{2-} detection.

3.3 Water Characterization.

The waters could not be characterized in relation to rock type. Plots of K, Na-Fe-Mg, Ca; Na-K-Ca; Fe-K-Ca and Ca-Fe-Mg (figs 8,9,10) revealed no meaningful separation of waters sampled from streams containing dominantly sediment and dominantly basalt fragments.

3.4 Contamination.

A contamination study was made for the trace components. An acid blank was analysed and returned $<0.001 \text{ } \mu\text{Cu}$, $<0.01 \text{ } \mu\text{Pb}$, $0.002 \text{ } \mu\text{Zn}$, $0.004 \text{ } \mu\text{Fe}$.

Ca, Mg and Na were not detected. Another acidified sample was sent which had been deliberately contaminated by pouring distilled water over human hands and allowing the water to run directly into the sample bottle.

This sample returned $0.001 \text{ } \mu\text{Cu}$, $<0.01 \text{ } \mu\text{Pb}$, $0.005 \text{ } \mu\text{Zn}$ and $0.008 \text{ } \mu\text{Fe}$.

Mg and Ca were less than 0.1 ppm (detection).

3.5 Charge Balance.

A complete charge balance for all major species is given in Table 1.

The figures are calculated from the values obtained by Allison Laboratories.

No significant SO_4^{2-} species have been detected by the turbidimetric method, however the high net positive charge balance suggests the presence of some negative species. An improved analytical technique may show this indeed to be sulphate although the presence of nitrate cannot be ruled out.

4.0 Conclusions.

A real Zn anomaly of 84 ppb exists at sample site 029W in the Wynyard EL and should be followed up. No other anomalous results were obtained and all species with the exception of Fe appear to be at sub saturation levels.

REFERENCES.

1. Environmental Protection Authority (E.P.A.) of Victoria.
1979 : A Guide to the Sampling and Analysis of Water and Wastewater.
Publication 95/79. 42p.

2. Guest, R.L. and Blutstein, H.
1981 : Delivery of Acid Preservative for Trace Metal Determinations
in Waters. Analytical Chemistry 53, 727 - 731.

APPENDIX 1

SAMPLE DESCRIPTIONS.

CODE... T.65.0...

Sample No	Site	Temp.	pH	Cond.	O ₂	Free CO ₂	Ca	Cl	Na	Alk	HCO ₃ ⁻	CO ₃ ²⁻	CO ₂ tot	Comments
001W	Field	9	6.5	41.5	10.7	3.2	1.48	9.1	4.8	5.8	7.1	0		Small Creek. 30x2.5m flow 19-3-82 Myrtle forest. Basalt & sediment fragments
	Lab.		6.2 ₁	36			0.6	7	4.1		7.0			
002W	Field	9	6.8	60.0	10.65	2.5	2.70	11.6	6.05	10.9	13.3	0		Small Creek. 45x2.5m flow 19-3-82 Myrtle forest. Basalt & sediment fragments.
	Lab.		6.5 ₃	53			1.7	9	5.6		12.5			
003W	Field	9.5	6.75	41.0	10.4	3.8	1.64	11.4	5.15	2.4	2.9	0		Very small flow about 6m downstream ¹⁹⁻³⁻⁸² from highest active seeps. Sediment out crops upstream. Myrtle forest.
	Lab.		6.2 ₀	43			0.6	10	4.4		3.5			
004W	Field	10	5.95	33	8.1	9.1	1.00	6.8	4.5	5.0	6.4	0		Seep. No surface flow 20/3/82 Dig hole and left to accumulate water for 24 hrs. Button grass plain.
	Lab.		6.0 ₅	32			0.5	5	3.4		5.7			
005W	Field	9.5	5.75	33	7.4	10.6	1.14	6.9	4.85	4.9	6.0	0		" 20/3/82
	Lab.		5.9 ₃	32			0.5	5	3.2		5.3			
006W	Field	10.5	7.00	59.5	10.45		2.76	9.6	7.3	12.6	15.4	0		Small Creek. 30x1.5m flow. 20/3/82 Myrtle forest. Tree ferns. Sediment & basalt fragments.
	Lab.		6.7 ₅	54			2.1	8	5.6		12.9			
007W	Field	8	3.1	500-600	6.75		4.4	7.5	6.4	0	0	0		Still water in mine adit. Mt Bischoff 20/3/82
	Lab.		3.0 ₇	445			2.5	9	5.4	Acidity 960	0	0		
008W	Field	12	7.4	87	10.15	1.7	5.8	7.25	7.6	26.8	32.7	0		Very small creek. 20x2cm flow 22/3/82 Myrtle forest. Sediment & basalt fragments.
	Lab.		6.9 ₂	80			3.3	9	6.1		27.0			
009W	Field	13	6.7	58	9.75	1.8	2.64	11.1	7.4	10.8	13.2	0		Seepage flow 20x1cm. 22/3/82 Basalt & very minor sediment fragments Myrtle forest, tree ferns.
	Lab.		6.8 ₂	56			1.4	10	5.8		12.6			
010W	Field	13.5	6.85	70	9.2	4.0	2.20	13.0	9.9	16.4	20.0	0		Seepage flow 10x1cm. 22/3/82 Basalt & very minor sediment fragments Myrtle forest, tree ferns Pug small hole.
	Lab.		6.8 ₈	70			1.1	11	8.1		16.3			
		°C		micro-siemens	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	
										CaCO				

Sample No	Site	Temp.	pH	Cond.	O ₂	Free CO ₂	Ca	Cl	Na	Alk	HCO ₃ ⁻	CO ₃ ²⁻	CO ₂ tot	Comments
011W	Field	13	7.6	101	9.9	2.0	6.6	12.2	9.1	33.9	41.4	0		Moderate stream 100x2cm flow. 22-3-82 Basalt & sediment fragments. Myrtle forest, Horizontal sands.
	Lab.		7.1	97			3.0	10	7.1		33.1			
012W	Field	10.5	6.35	68	9.4		1.90	15.1	9.0	6.4	7.8	0		Very small seep/stream 24-3-82 1x10cm flow. Myrtle forest, tree ferns Basalt & sediment fragments. Sediment outcrop.
	Lab.		6.55	60			1.3	12	6.9		7.8			
013W	Field	10	6.7	60	10.2		1.90	12.5	7.6	8.7	10.6	0		Small creek. 20x1.5cm flow 24-3-82 Basalt fragments Myrtle forest, tree ferns, Horizontal sands
	Lab.		6.8	54			1.3	9	5.8		9.5			
014W	Field	11.5	7.0	50	10.45		2.04	10.1	6.9	9.9	12.1	0		Stream 100x2cm flow 24-3-82 Basalt boulders Tree ferns, Myrtle
	Lab.		6.95	49			1.2	5	5.0		10.7			
015W	Field	11.5	7.1	79	10.1		4.3	14.0	8.8	16.6	20.3	0		Small spring 3x0.5cm flow 24-3-82 Basalt boulders Tree ferns, myrtle Dug small pit.
	Lab.		7.18	74			2.7	11	7.1		16.7			
016W	Field	9.5	7.05	68.5	10.1		4.6	10.0	7.1	18.5	22.6	0		Small spring 5x1cm flow 24-3-82 Basalt fragments Tree ferns, myrtle.
	Lab.		7.23	64			3.0	8	5.7		18.2			
017W	Field	11	7.25	90	10.25		7.2	12.0	8.4	20.2	24.6	0		Very steep. Small seep 31-3-82 3x1cm flow. 40m above Coldstream R. Tree ferns, Callery top Sediment outcrop.
	Lab.		7.24	85			5.4	10	6.7		20.2			
018W	Field	12	6.5	62	9.75		2.02	14.2	8.3	6.2	7.6	0		Very steep (35°) small seep 31-3-82 2x1cm flow. Tree ferns, myrtle. Sediment fragments.
	Lab.		6.7	60			1.6	12	6.6		6.9			
019W	Field	11.5	6.7	62	10.2		2.32	13.0	8.0	8.0	9.8	0		Stream. 100x5cm flow 31/3/82 Tree ferns, myrtle Sediment outcrop.
	Lab.		6.85	59			1.6	10	6.1		8.4			
020W	Field	12	6.8	65	10.0		3.20	12.2	7.9	10.6	12.9	0		Smaller stream than for W019 31/3/82
	Lab.		6.78	58			1.9	10	6.3		10.8			Sediment fragments.

°C micro-siemens ppm ppm ppm ppm ppm ppm ppm ppm ppm ppm

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Sample No	Site	Temp.	pH	Cond.	O ₂	Free CO ₂	Ca	Cl	Na	Alk	HCO ₃ ⁻	CO ₃ ²⁻	CO ₂ tot	Comments
021W	Field	11	6.6	59	10.35		1.88	12.1	7.5	7.1	8.7	0		Small stream 20x1cm flow 1/4/82 Myrtle, sassafras, tree ferns
	Lab.		6.70	55			1.7	10	6.0	.	8.7			Chocolate shales, basalt fragments
022W	Field	10.5	6.6	56	10.1		1.64	13.4	7.5	4.2	5.1	0		Stream 100x1cm flow 1/4/82 Myrtle, sassafras, tree ferns
	Lab.		6.60	51			1.3	11	5.9		5.0			Sediment, basalt fragments
023W	Field	11	6.8	61	10		2.22	13.3	7.9	7.2	8.8	0		5x1cm flow 1/4/82 Myrtle, sassafras, tree ferns
	Lab.		6.74	57			1.1	10	6.0		8.6			Sediment, basalt fragments Sediment outcrops.
024W	Field	10	6.95	55	10.2		3.58	10.2	6.4	9.7	11.8	0		Hay Creek. 100x1cm flow. 1/4/82 Horizontal scrub, tree ferns.
	Lab.		6.90	51			1.9	9	4.9		10.0			Basalt, sediment fragments.
025W	Field	10.5	6.5	53	10.03		1.64	11.0	7.1	3.7	4.5	0		100x2cm flow. 1/4/82 Horizontal scrub, tree ferns.
	Lab.		6.40	47			1.3	10	5.6		5.7			Sediment, basalt fragments.
	Field													
	Lab.													
	Field													
	Lab.													
	Field													
	Lab.													
	Field													
	Lab.													
	Field													
	Lab.													
		°C		micro-siemens	ppm		ppm	ppm	ppm	ppm	ppm	ppm	ppm	
										ppm CaCO				

CODE... 7.6.4.0...

Sample No	Site	Temp.	pH	Cond.	O ₂	Free CO ₂	Ca	Cl	Na	Alk	HCO ₃ [']	CO ₃ ["]	CO ₂ tot	Comments
		°C		micro-siemens	ppm		ppm	ppm	ppm	ppm	ppm	ppm	ppm	
026W	Field	10	6.5	122	10.15		2.02	27.9	17.0	5.6	10.5	0		20x2cm flow 6/4/82 Tree ferns, mosses Sediment + some basalt fragments Trace vein Qtz.
	Lab.		6.5	114			1.4	22	15.6		7.6			
027W	Field	11	5.4	130	9.5		1.04		18.5	1.1	1.3	0		2x1cm flow 6/4/82 Tree ferns, mosses Sediment fragments & outcrop
	Lab.		5.8 _g	116			0.6	21	16.4		2.7			
028W	Field	12	7.4	119	10.5		2.48	17.3	15.5	24.4	29.8	0		20x3cm flow. Sample taken 6/4/82 just below water fall Sediment outcrop Tree ferns, mosses, eucalypts
	Lab.		7.1 _o	107			1.4	13	14.6		24.3			
029W	Field	12	6.5	156	9.75		2.56		20.1	17.1	20.9	0		30x1cm flow 6/4/82 Sediment, quartz fragments Tree ferns, eucalypts
	Lab.		6.5 _g	140			1.9	21	18.9		16.4			
030W	Field	12	7.05	158	9.95		2.32		23.0	20.6	25.1	0		20x2cm flow (approx) 6/4/82 Sediment fragments Tree ferns, mosses
	Lab.		7.0 _g	140			1.8	22	20.8		20.0			
031W	Field	11	7.2	123	10.55		4.85		13.0	23.7	28.9	0		100x1.5cm flow 7/4/82 Basalt, sediment fragments Sediment outcrop Tree ferns
	Lab.		7.2 _o	110			3.9	13	12.0		22.4			
032W	Field	11	6.6	170	7.35		6.53		18.1	19.7	24.0	0		3x1cm flow 7/4/82 Sediment outcrop Tree ferns
	Lab.		7.0 _o	154			5.3	23	16.7		19.5			
033W	Field	11	4.7	136	8.3		1.74	32.2	15.8	0	0	0		3x1cm flow 7/4/82 Quartz, sediment (e quartz) fragments Tree ferns, eucalypts, mosses
	Lab.		4.2 _g	120			1.2	23	14.6	Acidity 10.8				
034W	Field	11	6.8	117.5	10.15		3.16		14.0	12.7	15.5	0		5x2cm flow 7/4/82 Sediment & quartz fragments Phyllitic outcrop
	Lab.		6.6 _g	104			2.3	16	12.7		13.8			
035W	Field	12.3	7.5	114	10.7		4.47		11.5	31.1	37.9	0		50x2cm flow 7/4/82 Sediment, basalt, vein of quartz fragments. Black bearing, tree ferns, eucalypts, bracken fern
	Lab.		7.2 _g	104			4.0	12	10.5		28.5			

APPENDIX 2.

LABORATORY ANALYSIS SHEETS.

CODE... J. 640.....

Sample No	Site	Temp.	pH	Cond.	O ₂	Free CO ₂	Ca	Cl	Na	Alk	HCO ₃ [']	CO ₃ ["]	CO ₂ tot	Comments
036W	Field	13	7.25	152	9.83		4.76		18.5	27.5	33.6	0		100 x 2 cm flow 7/4/82 Quartz, ? sediment fragments (?Tertiary gravel source only). Sassafras, blackwood tree ferns, eucalypts .
	Lab.		7.2	137			3.5	19	17.0		25.5			
	Field													
	Lab.													
	Field													
	Lab.													
	Field													
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	Field													
	Lab.													

119021

°C micro-ppm ppm ppm ppm ppm ppm ppm ppm

TABLE 1 : CHARGE BALANCE. Values in epm (ppm/atomic wt X charge).

Sample No.	Fe ²⁺	Cu ²⁺	Mg ²⁺	K ⁺	Na ⁺	Cl ⁻	HCO ₃ ⁻	F ⁻	Total
1	.01	.03	.11	.01	.18	-.2	-.11	-.01	.01
2	.01	.08	.18	.02	.24	-.25	-.2	-.01	.06
3	0	.03	.08	.01	.19	-.28	-.06	-.01	-.03
4	.01	.02	.08	.01	.15	-.14	-.09	0	.03
5	.01	.02	.07	.01	.14	-.14	-.09	0	.02
6	.01	.1	.16	.01	.24	-.23	-.21	-.01	.09
7	.5	.12	.15	.02	.23	-.25	0.85*	-.06	1.41†
8	.02	.16	.3	.02	.27	-.25	-.44	-.01	.07
9	.01	.07	.16	.02	.25	-.28	-.21	-.01	.01
10	.03	.05	.21	.02	.35	-.31	-.27	-.01	.08
11	0	.15	.35	.02	.31	-.28	-.54	-.01	0
12	.04	.06	.15	.02	.3	-.34	-.13	-.01	.1
13	0	.06	.18	.01	.25	-.25	-.16	-.01	.09
14	.01	.06	.15	.01	.22	-.14	-.18	-.01	.12
15	.02	.13	.23	.02	.31	-.31	-.27	-.01	.12
16	0	.15	.19	.01	.25	-.23	-.3	-.01	.07
17	0	.27	.22	.02	.29	-.28	-.33	-.01	.18
18	.02	.08	.15	.02	.29	-.34	-.11	-.01	.09
19	0	.08	.15	.02	.27	-.28	-.14	-.01	.08
20	0	.09	.16	.02	.27	-.28	-.18	-.01	.09
21	0	.07	.15	.02	.26	-.28	-.14	0	.07
22	.01	.05	.12	.01	.26	-.31	-.08	-.01	.05
23	.01	.07	.15	.02	.26	-.28	-.14	-.01	.07
24	.01	.12	.12	.01	.21	-.25	-.16	0	.05
25	.02	.05	.12	.02	.24	-.28	-.09	-.01	.06
26	.01	.07	.3	.02	.68	-.62	-.12	-.01	.33
27	.02	.03	.28	.02	.71	-.59	-.04	-.01	.42
28	.05	.07	.35	.03	.64	-.37	-.4	-.01	.36
29	.01	.09	.42	.03	.82	-.59	-.27	-.01	.5
30	.02	.09	.35	.03	.9	-.62	-.33	-.01	.42
31	.01	.19	.37	.03	.52	-.37	-.37	-.01	.38
32	.02	.26	.47	.02	.73	-.65	-.32	-.01	.53
33	.02	.06	.26	.01	.64	-.65	0.05*	-.01	0.38
34	.02	.11	.31	.02	.55	-.45	-.23	-.01	.33
35	.01	.2	.4	.03	.46	-.34	-.47	-.01	.28
36	.01	.17	.4	.03	.74	-.54	-.42	-.01	.4

NB. No significant SO₄²⁻ detected.

* H⁺ † : Zn²⁺ + Cu²⁺ included.

021

119022

022

119023

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Our ref 28174/84

Dr G Watmuff
BHP Minerals Ltd
20 O'Connell Street
SYDNEY .. NSW ... 2000

ANALYSIS OF WATER SAMPLES

11 water samples contained in 1L (nominal) poly bottles and labelled as shown hereunder were received on 24/3/82. The contents were analysed by methods generally in accord with the APHA "Standard Methods for the Examination of Water and Wastewater" 14th Ed. (1975), details of which are available on request. The results of these analyses were as follows: (except for pH and conductivity, all figures are mgm/L)

	<u>Cu</u>	<u>Pb</u>	<u>Zn</u>	<u>Fe</u>	<u>Ca</u>	<u>Mg</u>
T650-001 WA	∠0.001	∠0.01	0.003	0.25	0.6	1.3
002 WA	∠0.001	∠0.01	0.004	0.23	1.7	2.2
003 WA	∠0.001	∠0.01	0.006	0.079	0.6	1.0
004 WA	∠0.001	∠0.01	0.006	0.29	0.5	1.0
005 WA	∠0.001	∠0.01	0.004	0.14	0.5	0.9
006 WA	∠0.001	∠0.01	0.005	0.18	2.1	2.0
007 WA	0.72	0.019	4.1	14	2.5	1.8
008 WA	0.001	∠0.01	0.006	0.58	3.3	3.7
009 WA	∠0.001	∠0.01	0.004	0.23	1.4	2.0
010 WA	0.001	∠0.01	0.007	0.80	1.1	2.6
011 WA	0.001	∠0.01	0.005	0.12	3.0	4.3



G. ALLISON
CHARTERED CHEMIST (AUSTRALIA)

REPORT NO 8872

ISSUED 20 May 1982



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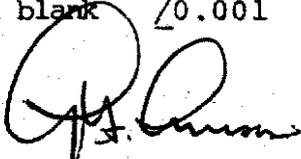
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Dr G Watmuff
BHP Minerals Ltd
20 O'Connell Street
SYDNEY .. NSW .. 2000

ANALYSIS OF WATER SAMPLES

14 water samples contained in 1L (nominal) poly bottles and labelled as shown hereunder were received on 2/4/82. The contents were analysed by methods generally in accord with the APHA "Standard Methods for the Examination of Water and Wastewater" 14th Ed. (1975), details of which are available on request. The results of these analyses were as follows: (except for pH and conductivity, all figures are mgm/L)

	<u>Cu</u>	<u>Pb</u>	<u>Zn</u>	<u>Fe</u>	<u>Ca</u>	<u>Mg</u>	<u>Na</u>
T650-012 WA	0.002	<0.01	0.005	1.2	1.3	1.8	7.0
013 WA	0.001	<0.01	0.004	0.10	1.3	2.2	5.8
014 WA	<0.001	<0.01	0.004	0.17	1.2	1.8	5.2
015 WA	0.001	ca 0.01	0.006	0.62	2.7	2.8	7.2
016 WA	<0.001	<0.01	0.006	0.12	3.0	2.3	5.6
017 WA	<0.001	<0.01	0.003	0.10	5.4	2.7	6.8
018 WA	0.001	<0.01	0.004	0.61	1.6	1.8	6.8
019 WA	<0.001	<0.01	0.004	0.08	1.6	1.8	6.3
020 WA	<0.001	<0.01	0.005	0.08	1.9	2.0	6.4
021 WA	<0.001	<0.01	0.003	0.10	1.4	1.8	5.9
022 WA	<0.001	<0.01	0.002	0.15	1.1	1.5	5.8
023 WA	<0.001	<0.01	0.006	0.24	1.4	1.8	6.0
024 WA	<0.001	<0.01	0.002	0.20	2.5	1.4	4.9
025 WA	<0.001	ca 0.01	0.004	0.53	1.0	1.5	5.5
Acid blank	<0.001	<0.01	0.002	0.004	N.D.	N.D.	N.D.


G F ALLISON
CHARTERED CHEMIST (AUSTRALIA)

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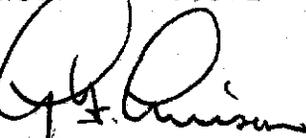
Our ref 29008/19

Dr G Watmuff
BHP Minerals Ltd
20 O'Connell Street
SYDNEY .. NSW .. 2000

ANALYSIS OF WATER SAMPLES

12 water samples contained in 1L (nominal) poly bottles and labelled as shown hereunder were received on 8/4/82. The contents were analysed by methods generally in accord with the APHA "Standard Methods for the Examination of Water and Wastewater" 14th Ed. (1975), details of which are available on request. The results of these analyses were as follows: (except for pH and conductivity, all figures are mgm/L)

	<u>Cu</u>	<u>Pb</u>	<u>Zn</u>	<u>Fe</u>	<u>Ca</u>	<u>Mg</u>
WO26A	0.001	∠0.01	0.005	0.39	1.4	3.7
WO27A	∠0.001	∠0.01	0.006	0.56	0.6	3.4
WO28A	0.001	∠0.01	0.004	1.3	1.4	4.3
WO29A	∠0.001	∠0.01	0.084	0.32	1.9	5.1
WO30A	∠0.001	∠0.01	0.004	0.50	1.8	4.2
WO31A	0.001	∠0.01	0.003	0.25	3.9	4.5
WO32A	0.001	∠0.01	0.004	0.59	5.3	5.7
WO33A	0.001	∠0.01	0.005	0.58	1.2	3.1
WO34A	0.001	∠0.01	0.002	0.55	2.3	3.8
WO35A	∠0.001	∠0.01	0.003	0.33	4.0	4.9
WO36A	0.001	∠0.01	0.006	0.32	3.5	4.9
WO37A	0.001	∠0.01	0.005	0.008	∠0.1	∠0.1



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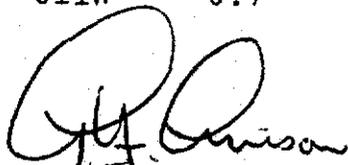
Our ref 28174/84

Dr G Watmuff
BHP Minerals Ltd
20 O'Connell Street
SYDNEY .. NSW .. 2000

ANALYSIS OF WATER SAMPLES

11 water samples contained in 1L (nominal) poly bottles and labelled as shown hereunder were received on 24/3/82. The contents were analysed by methods generally in accord with the APHA "Standard Methods for the Examination of Water and Wastewater" 14th Ed. (1975), details of which are available on request. The results of these analyses were as follows: (except for pH and conductivity, all figures are mgm/L)

	<u>K</u>	<u>Na</u>	<u>Cl⁻</u>	<u>pH</u>	<u>Cond</u> μ S	<u>HCO₃⁻</u>
T650-001W	0.4	4.1	7	6.2 ₁	36	7.0
002W	0.6	5.6	9	6.5 ₃	53	12.5
003W	0.4	4.4	10	6.2 ₀	43	3.5
004W	0.3	3.4	5	6.0 ₅	32	5.7
005W	0.3	3.2	5	5.9 ₃	32	5.3
006W	0.5	5.6	8	6.7 ₅	54	12.9
007W	0.8	5.4	9	3.0 ₇	445	NIL ACIDITY 96.0
008W	0.8	6.1	9	6.9 ₂	80	27.0
009W	0.6	5.8	10	6.8 ₂	56	12.6
010W	0.8	8.1	11	6.8 ₈	70	16.3
011W	0.7	7.1	10	7.1 ₁	97	33.1



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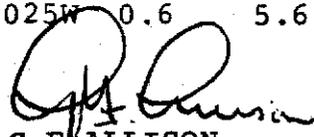
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Dr G Watmuff
BHP Minerals Ltd
20 O'Connell Street
SYDNEY .. NSW .. 2000

ANALYSIS OF WATER SAMPLES

14 water samples contained in 1L (nominal) poly bottles and labelled as shown hereunder were received on
The contents were analysed by methods generally in accord with the APHA "Standard Methods for the Examination of Water and Wastewater" 14th Ed. (1975), details of which are available on request. The results of these analyses were as follows: (except for pH and conductivity, all figures are mgm/L)

	<u>K</u>	<u>Na</u>	<u>Cl⁻</u>	<u>pH</u>	<u>Cond</u> <u>µS</u>	<u>HCO₃⁻</u>	<u>Ca</u>	<u>Mg</u>
T650-012W	0.9	6.9	12	6.5 ₅	60	7.8	1.5	1.7
013W	0.5	5.8	9	6.8 ₂	54	9.5	1.5	2.1
014W	0.5	5.0	5	6.9 ₅	49	10.7	1.4	1.8
015W	0.7	7.1	11	7.1 ₈	74	16.7	2.7	2.6
016W	0.5	5.7	8	7.2 ₃	64	18.2	3.4	2.4
017W	0.6	6.7	10	7.2 ₄	85	20.2	5.8	2.7
018W	0.9	6.6	12	6.7 ₇	60	6.9	1.7	1.8
019W	0.6	6.1	10	6.8 ₅	59	8.4	1.7	1.8
020W	0.9	6.3	10	6.7 ₈	58	10.8	1.9	2.1
021W	0.7	6.0	10	6.7 ₀	55	8.7	1.7	1.8
022W	0.5	5.9	11	6.6 ₀	51	5.0	1.3	1.4
023W	0.7	6.0	10	6.7 ₄	57	8.6	1.1	1.8
024W	0.4	4.9	9	6.9 ₀	51	10.0	1.9	1.3
025W	0.6	5.6	10	6.4 ₀	47	5.7	1.3	1.5


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CHARTERED CHEMIST (AUSTRALIA)



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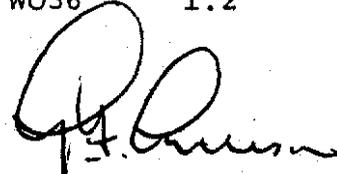
Our ref 29008/19

Dr G Watmuff
BHP Minerals Ltd
20 O'Connell Street
SYDNEY .. NSW .. 2000

ANALYSIS OF WATER SAMPLES

12 water samples contained in 1L (nominal) poly bottles and labelled as shown hereunder were received on 8/4/82. The contents were analysed by methods generally in accord with the APHA "Standard Methods for the Examination of Water and Wastewater" 14th Ed. (1975), details of which are available on request. The results of these analyses were as follows: (except for pH and conductivity, all figures are mgm/L)

	<u>K</u>	<u>Na</u>	<u>Cl⁻</u>	<u>pH</u>	<u>Cond</u> μ S	<u>HCO₃⁻</u>
WO26	0.7	15.6	22	6.5 ₂	114	7.6
WO27	0.7	16.4	21	5.8 ₈	116	2.7
WO28	1.3	14.6	13	7.1 ₀	107	24.3
WO29	1.1	18.9	21	6.5 ₈	140	16.4
WO30	1.0	20.8	22	7.0 ₃	140	20.0
WO31	1.1	12.0	13	7.2 ₀	110	22.4
WO32	0.8	16.7	23	7.0 ₀	154	19.5
WO33	0.5	14.6	23	4.2 ₅	120	NIL ACIDITY 10.8
WO34	0.9	12.7	16	6.6 ₉	104	13.8
WO35	1.1	10.5	12	7.2 ₆	104	28.5
WO36	1.2	17.0	19	7.2 ₁	137	25.5



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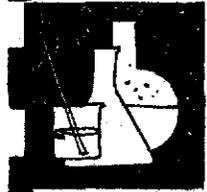
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119029

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Our refs: 28174/84
28809/22
29008/19

Dr G Watmuff
Senior Geochemist
BHP Minerals Ltd
20 O'Connell Street
SYDNEY

ANALYSIS OF WATER SAMPLES - ARSENIC

From the thirtysix water samples labelled 001W to 036W received 24 March, 2 April and 8 April 1982, six were selected which were thought might have detectable arsenic levels. They were analysed in accord with APHA "Standard Methods for the Examination of Water & Wastewater" 14th Ed. (1975), Method 404A with the following results:

Results are expressed in mgm/L

<u>LABEL</u>	<u>ARSENIC</u>
T650-007W	0.14
012W	less than 0.02
018W	less than 0.02
025W	less than 0.02
W028	less than 0.02
W032	less than 0.02

G F ALLISON
CHARTERED CHEMIST (AUSTRALIA)

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TELEPHONE: (002) 34 7681

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- TANK AND CARGO SURVEYS
- EFFLUENT ANALYSIS

Dr G Watmuff
Senior Geochemist
BHP Minerals Ltd
20 O'Connell Street
SYDNEY

Our refs: 28174/84
28809/22
29008/19

ANALYSIS OF WATER SAMPLES - FLUORIDE

36 water samples contained in 1L poly bottles and labelled as shown hereunder were received 24 March, 2 April and 8 April 1982. The samples were analysed for fluoride by APHA "Standard Methods for the Examination of Water & Wastewater" 14th Ed. (1975), Method 414 C modified in this laboratory.

Results are expressed in mgm/L:

<u>LABEL</u>	<u>F⁻</u>	<u>LABEL</u>	<u>F⁻</u>	<u>LABEL</u>	<u>F⁻</u>
T650-001W	0.12	T650-012W	0.16	WO26	0.14
002	0.18	013	0.18	027	0.12
003	0.10	014	0.13	028	0.25
004	0.08	015	0.23	029	0.20
005	0.05	016	0.15	030	0.20
006	0.15	017	0.11	031	0.12
007	1.2	018	0.24	032	0.11
008	0.14	019	0.12	033	0.11
009	0.18	020	0.12	034	0.17
010	0.20	021	0.09	035	0.13
011	0.15	022	0.10	036	0.14
		023	0.13		
		024	0.07		
		025	0.20		



G F ALLISON

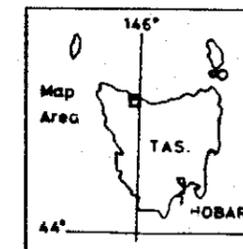
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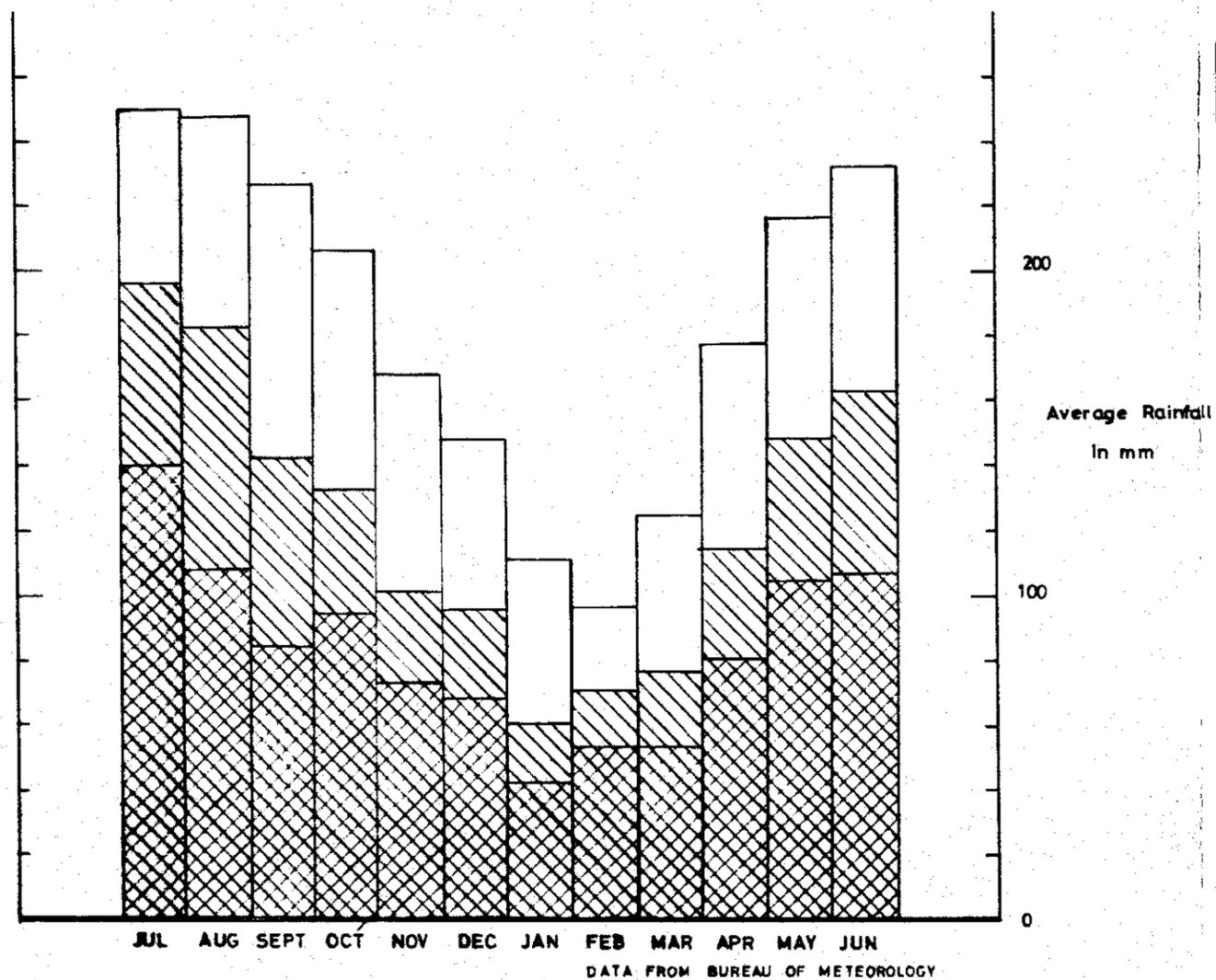
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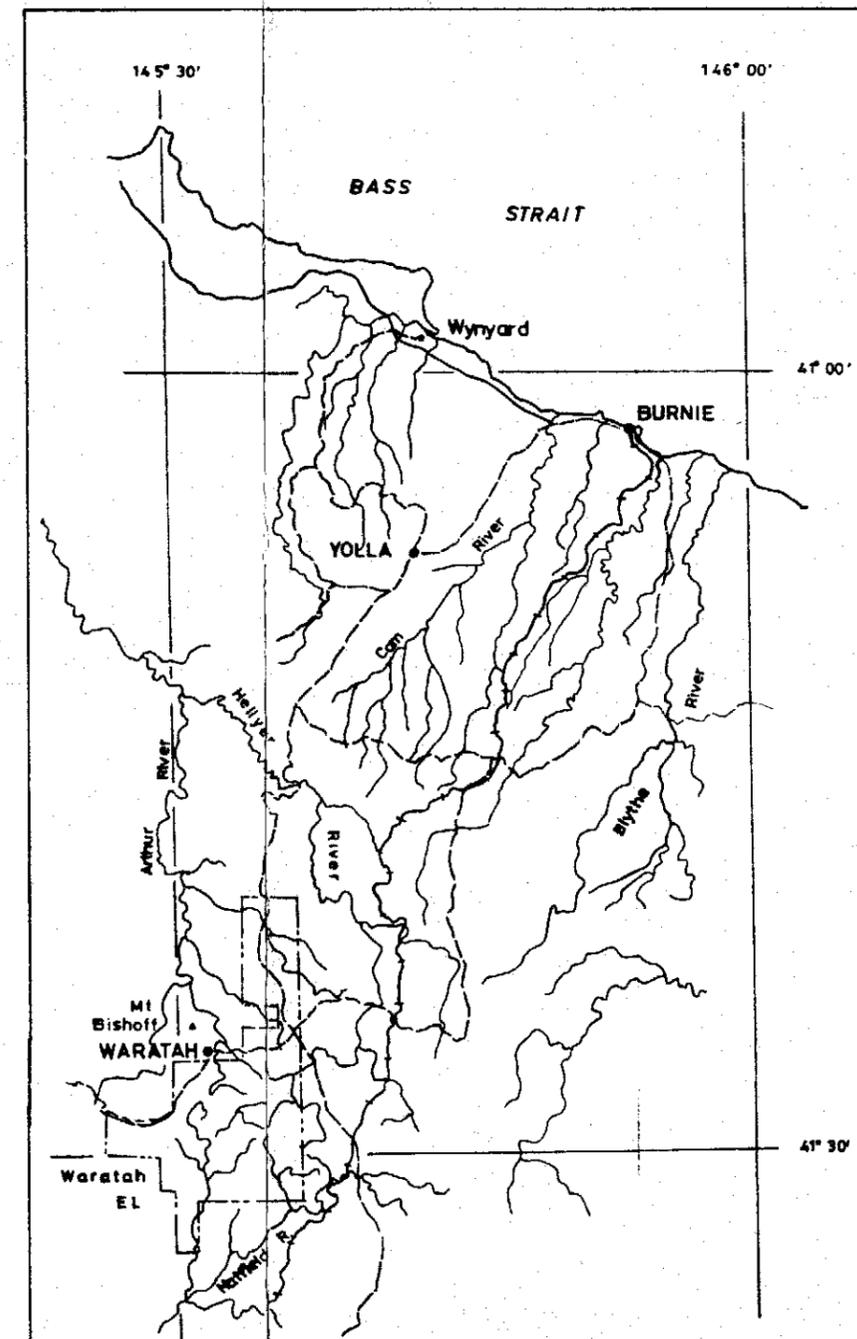
LOCATION MAP

-  WARATAH 1862 - 1973
-  YOLLA 1905 - 1979
-  BURNIE 1944 - 1980

Graph of Average Monthly Rainfall
WARATAH - YOLLA - BURNIE DISTRICT



5 cm



- ROAD 
- RAILWAY 
- RIVER 

Map copied from TASMANIA 1:500 000

0 10 20 30 Km

THE BROKEN HILL PROPRIETARY CO. LTD.
EXPLORATION DEPARTMENT

MONTHLY AVERAGE RAINFALL 359

NW. TASMANIA 85-2453

Prepared by: G. WATMUFF

Centre: SYDNEY

Date: 25.11.8

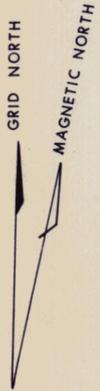
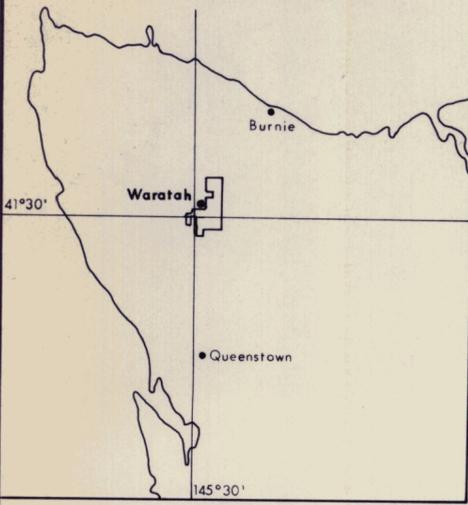
Project No.

Drawing No.

LOCALITY MAP

EL 33/79

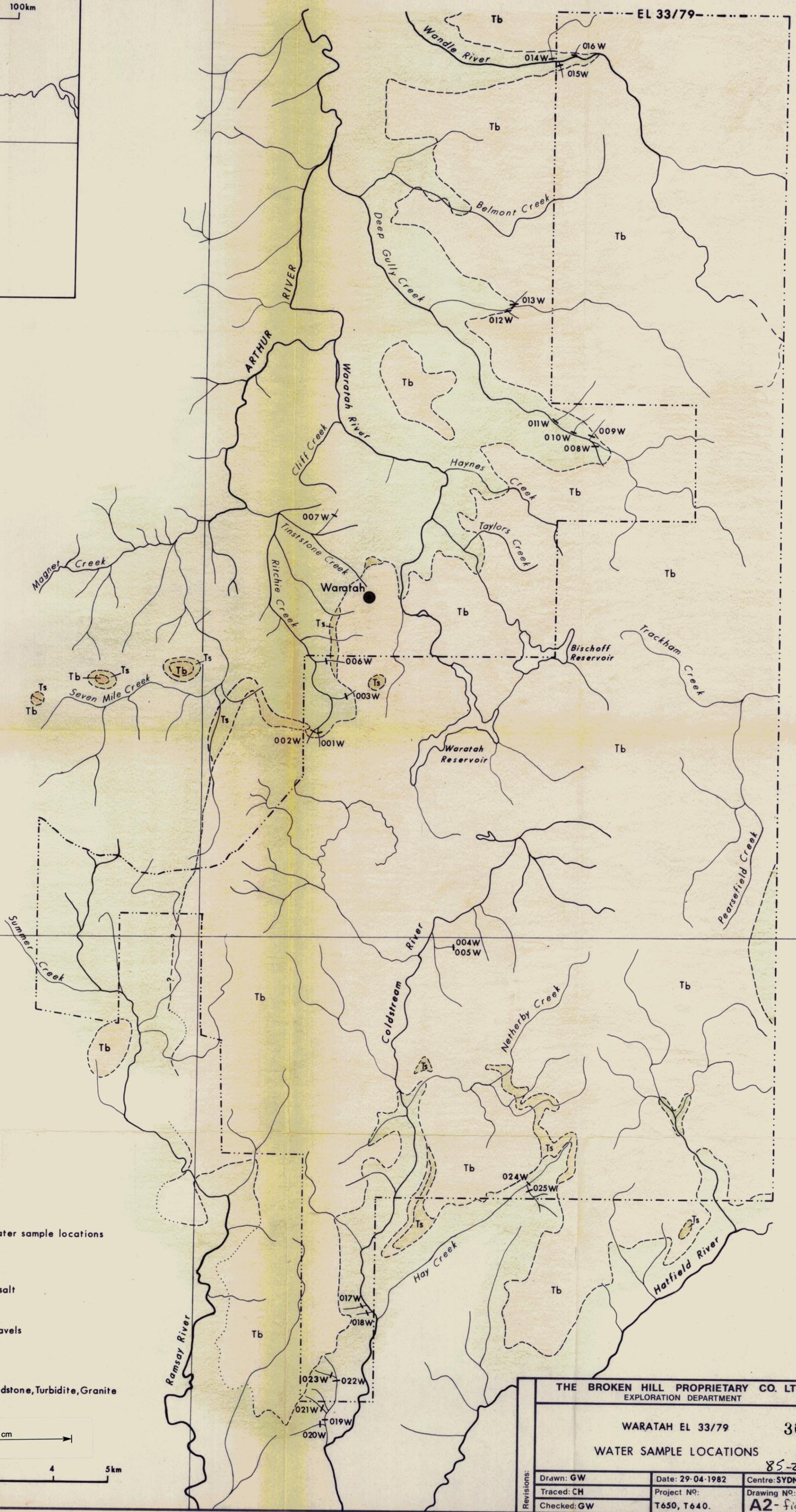
0 20 40 60 80 100km



41°30'S

145°30' E

EL 33/79



LEGEND

025W Water sample locations

TERTIARY

- Tb Basalt
- Ts Gravels

PALAEOZOIC & PRECAMBRIAN

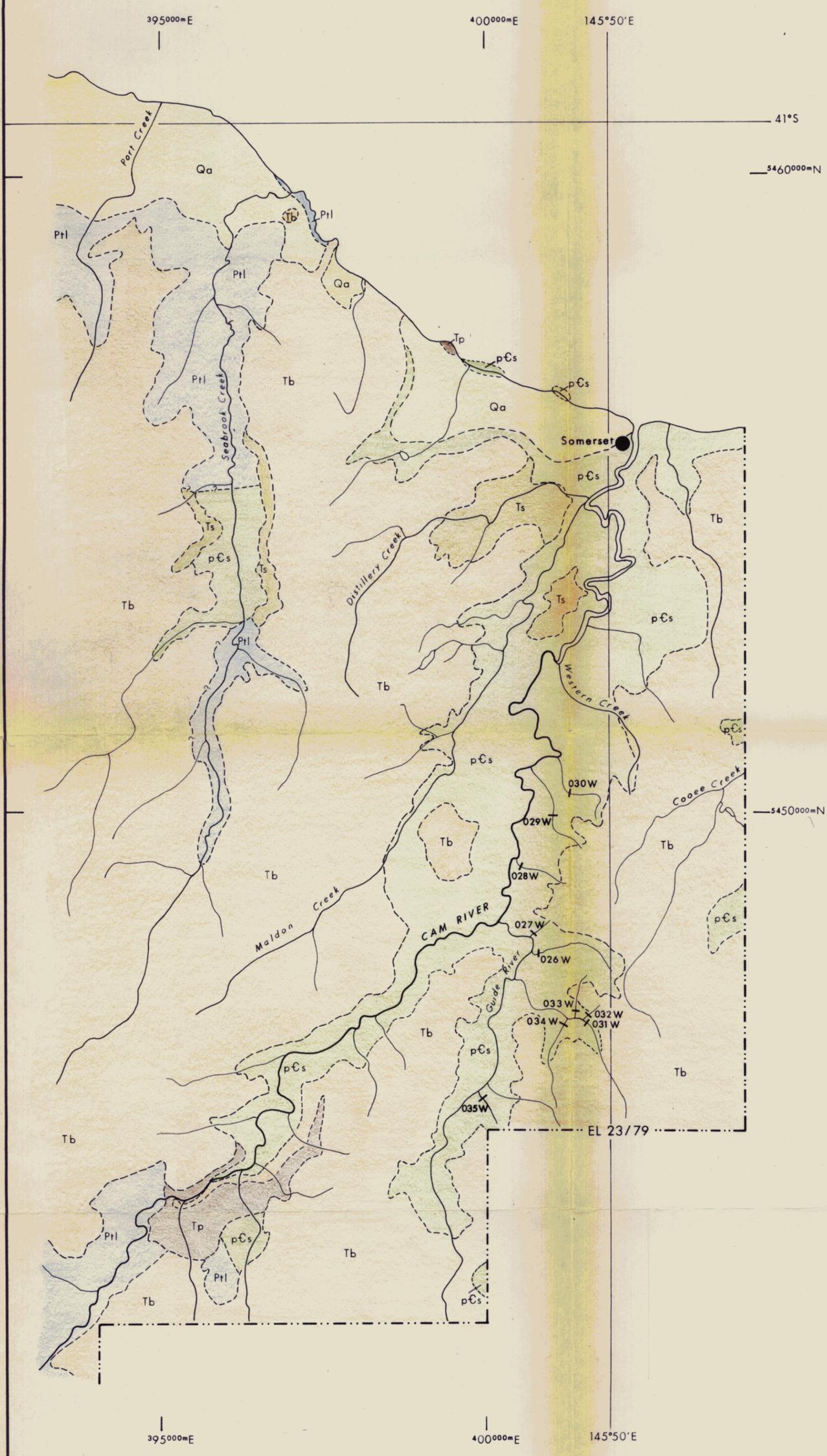
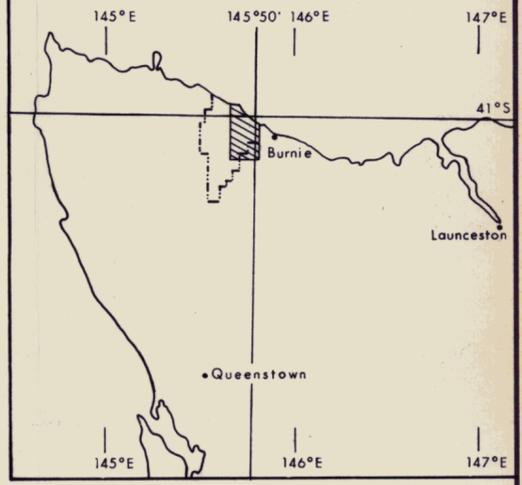
- Mudstone, Turbidite, Granite

5 cm

0 1 2 3 4 5km
SCALE 1:50,000

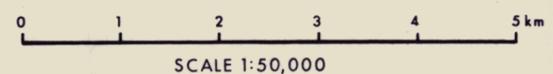
THE BROKEN HILL PROPRIETARY CO. LTD. EXPLORATION DEPARTMENT		
WARATAH EL 33/79		360
WATER SAMPLE LOCATIONS		
85-2453		
Drawn: GW	Date: 29-04-1982	Centre: SYDNEY
Traced: CH	Project NO:	Drawing NO:
Checked: GW	T650, T640.	A2-fig 2

LOCALITY MAP
EL 23/79, N.W. TASMANIA



LEGEND

- 031W Water sample locations
- Qa Alluvium } QUATERNARY
- Ts Sediments, silt, sand, conglomerate } TERTIARY
- Tp Pyroclastics }
- Tb Basalt }
- Ptl Tillite } PERMIAN
- pCs Quartzite, shale } PRECAMBRIAN



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EXPLORATION DEPARTMENT

EL 23/79 WYNYARD, N.W. TASMANIA

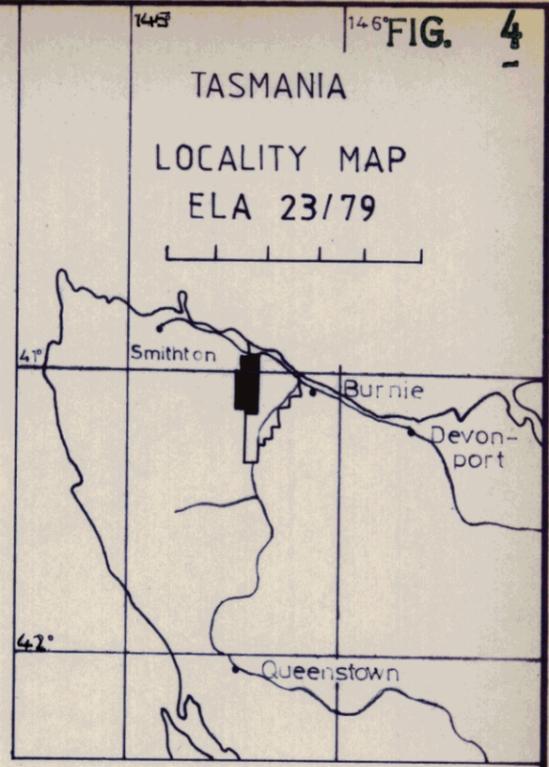
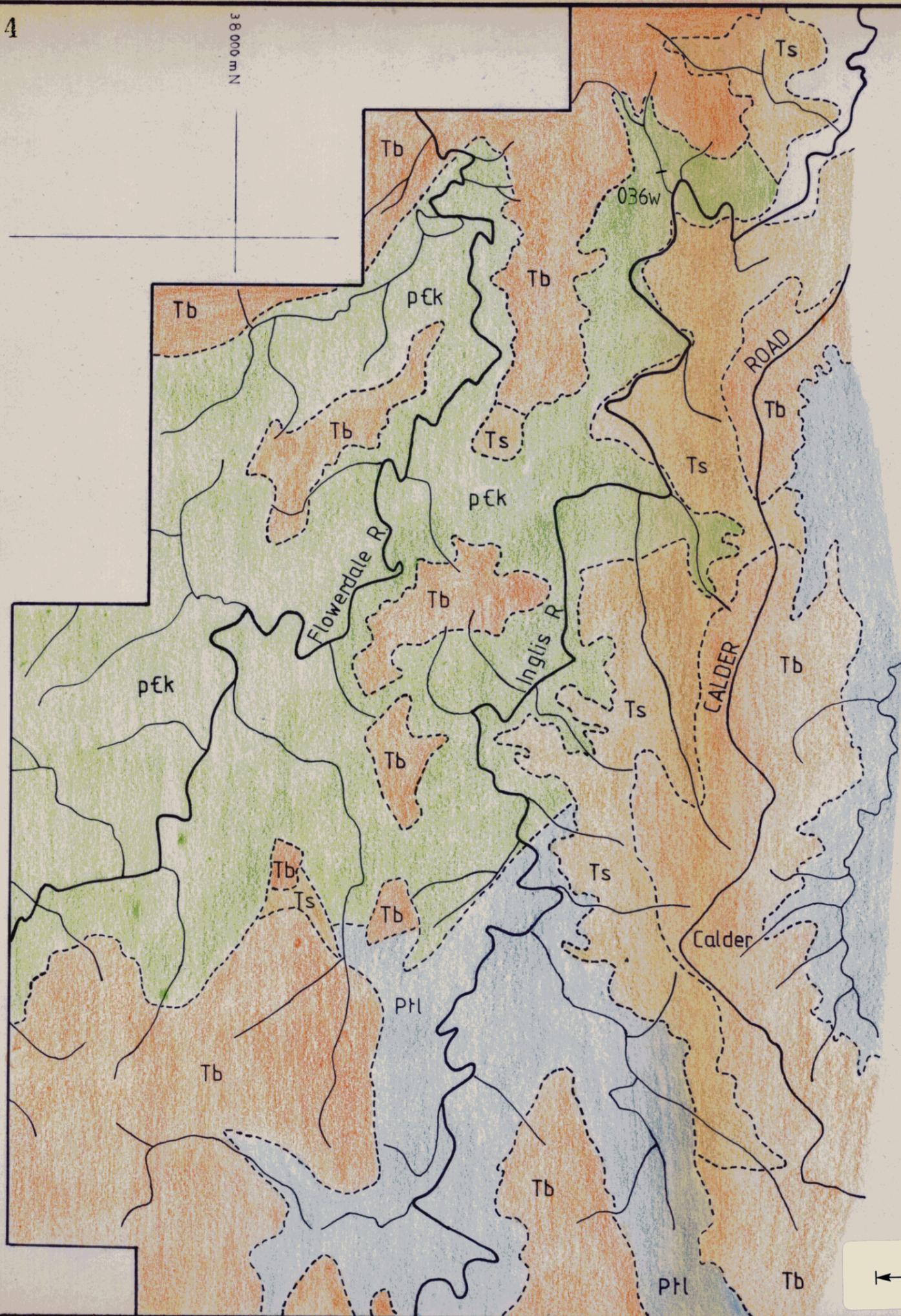
WATER SAMPLE LOCATIONS **361**
85-2453

Revisions:	Drawn: GW	Date: 13-05-1982	Centre: SYDNEY
	Traced: CH	Project No:	Drawing No:
	Checked: GW	T640, T650	A2- fig 3

119034

380008

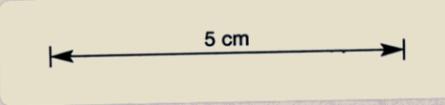
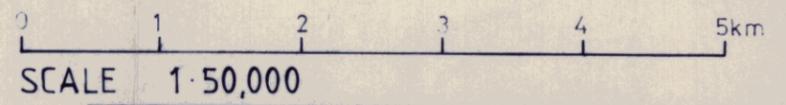
54 60 000 mN



LEDEND

x water sample locations

- TERTIARY
 - Tb Basalt
 - Ts Gravel
- PERMIAN
 - PH Glacial
- PRECAMBRIAN
 - pck Metasediment

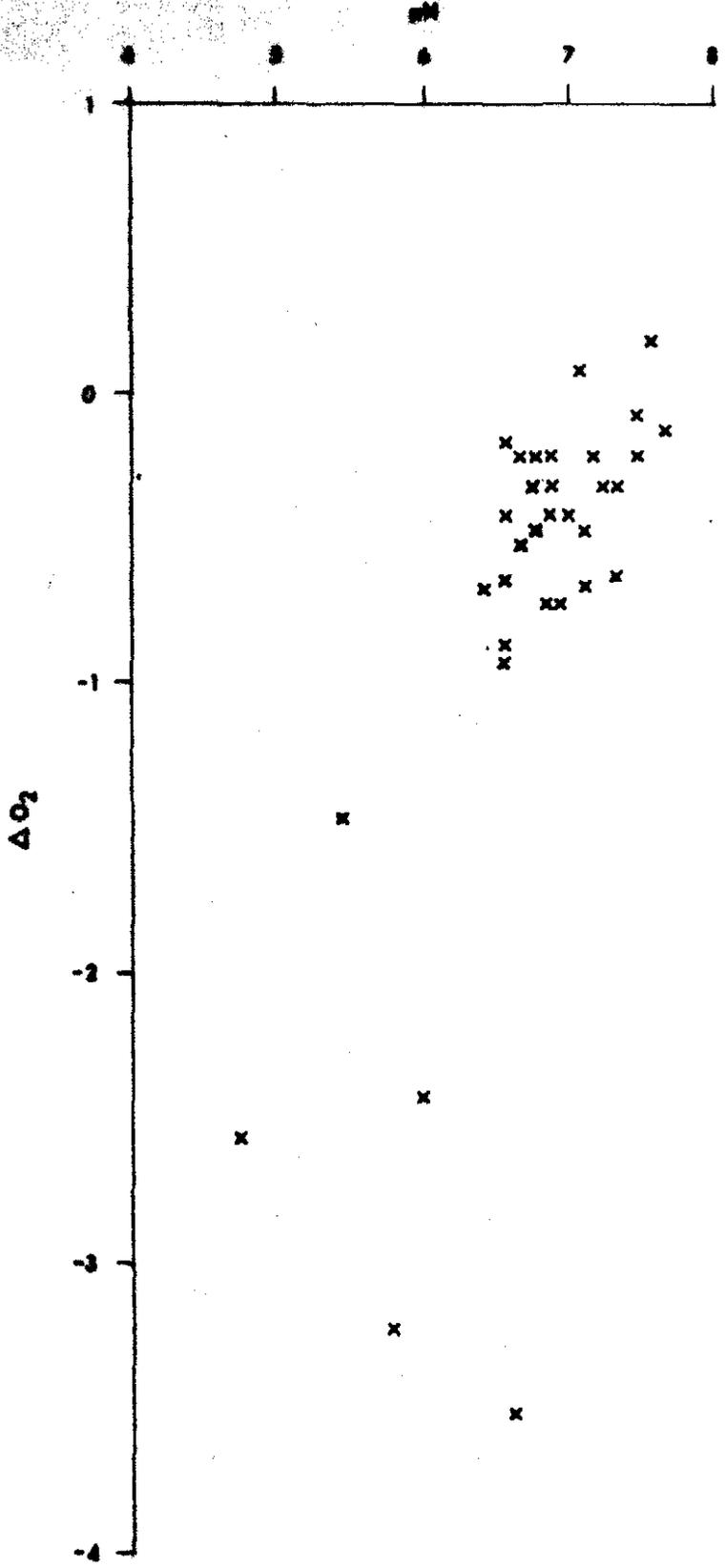


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WYNYARD EL 23/79		362	
WATER SAMPLE LOCATIONS 85-2453			
Revisions:	Prepared by:	Centre:	
	Date:	Project No.	Drawing No.
	Drawn:	A3-fig 4	

031

119036

FIG. 6



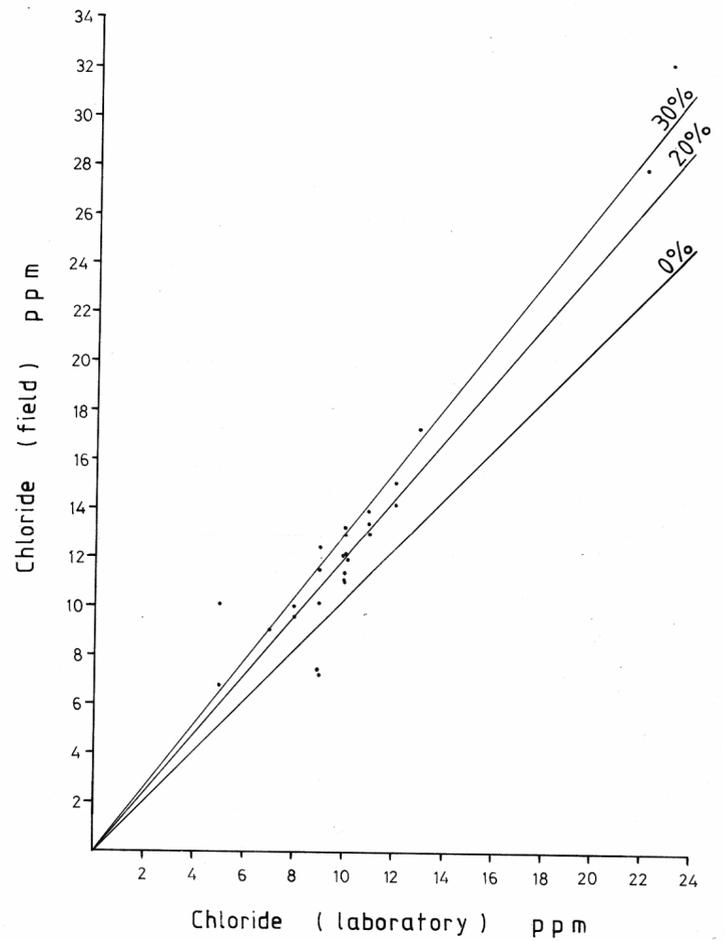
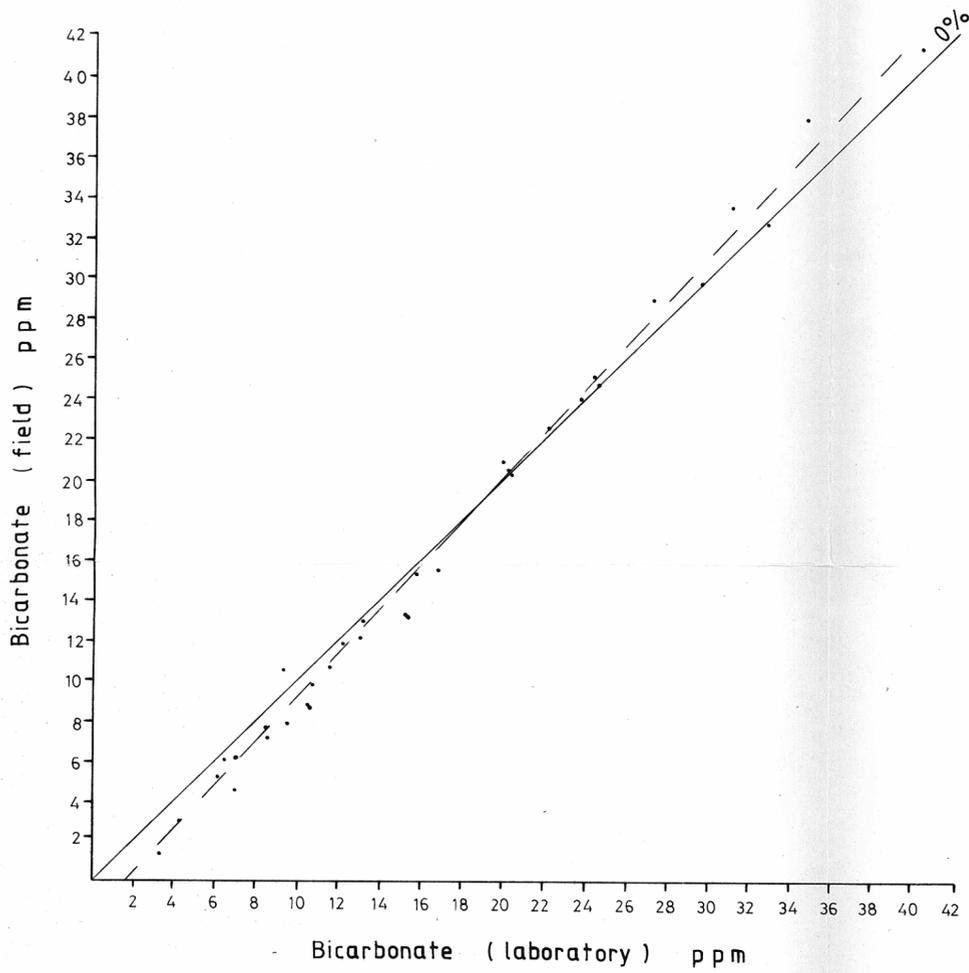
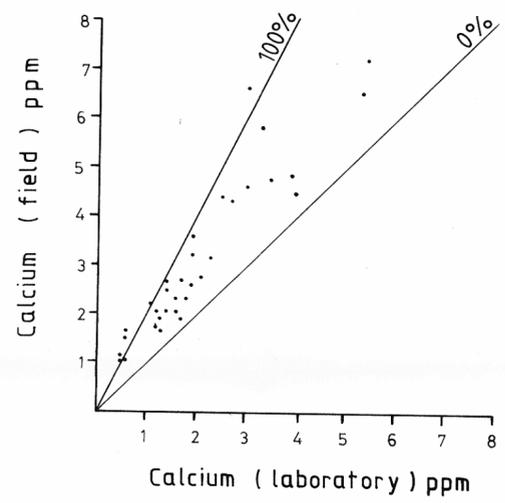
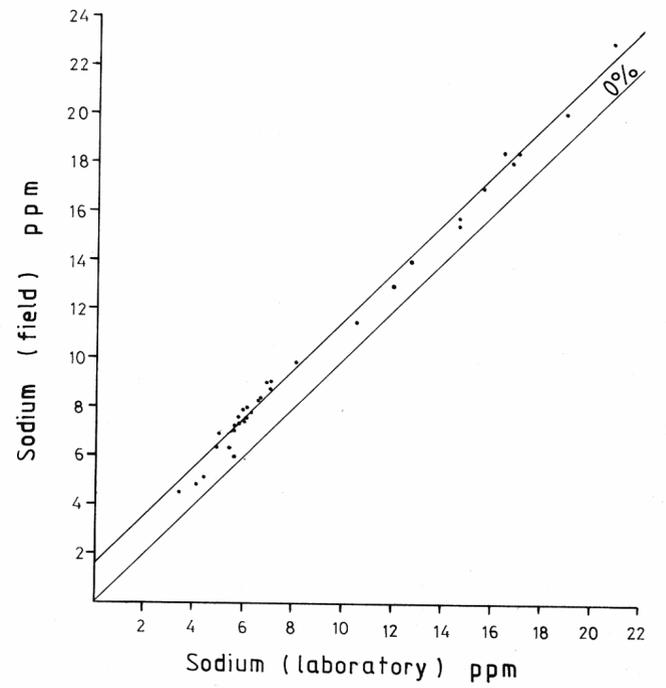
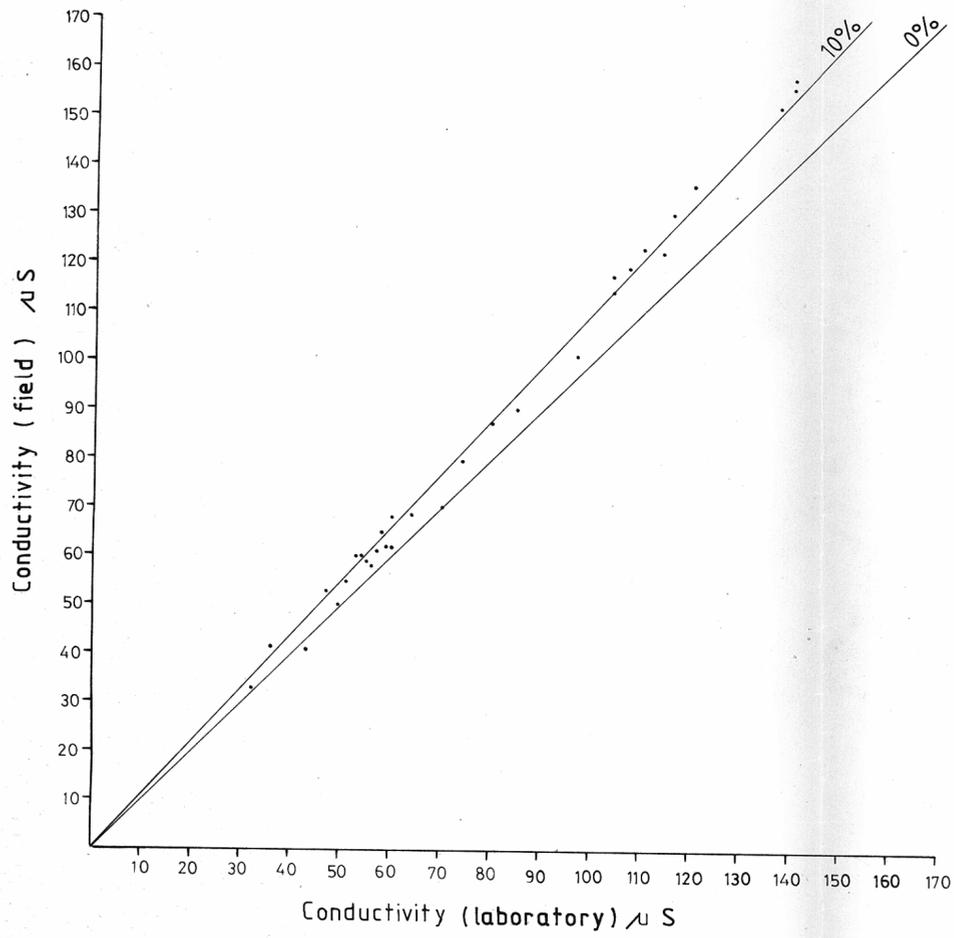
ΔO₂ vs pH
 (ΔO₂ = O₂ measured (ppm) — O₂ at saturation (ppm))

Centre:
 SYDNEY.
 Date:
 19-04-1962.

THE BROKEN HILL PROPRIETARY CO. LTD.

WARATAH-WYNYARD SPRING WATER

Project No:
 T450, T640.
 Drawing No:
 A4-



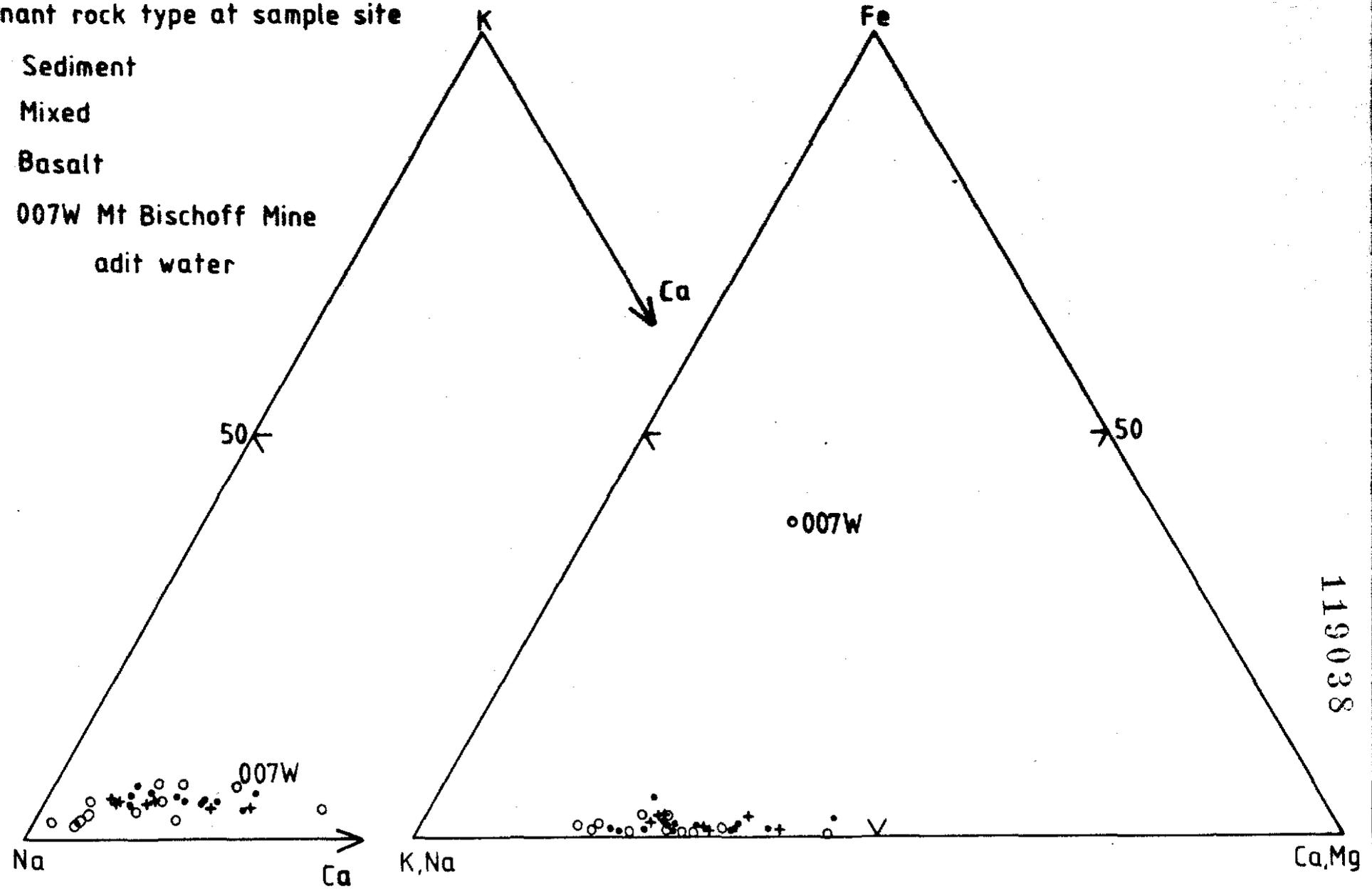
THE BROKEN HILL PROPRIETARY CO. LTD. EXPLORATION DEPARTMENT			
85-2453			
Field vs Laboratory Determinations			
Conductivity Ca Na Hco ₃ Cl			
Drawn:	G W	Date:	10 June 82 Centre: SYDNEY
Traced:	D S	Project No:	Drawing No:
Checked:			A2-

FIG. 8

LEGEND

Dominant rock type at sample site

- Sediment
- Mixed
- + Basalt
- 007W Mt Bischoff Mine adit water



Date 12/6/82
Course SYD

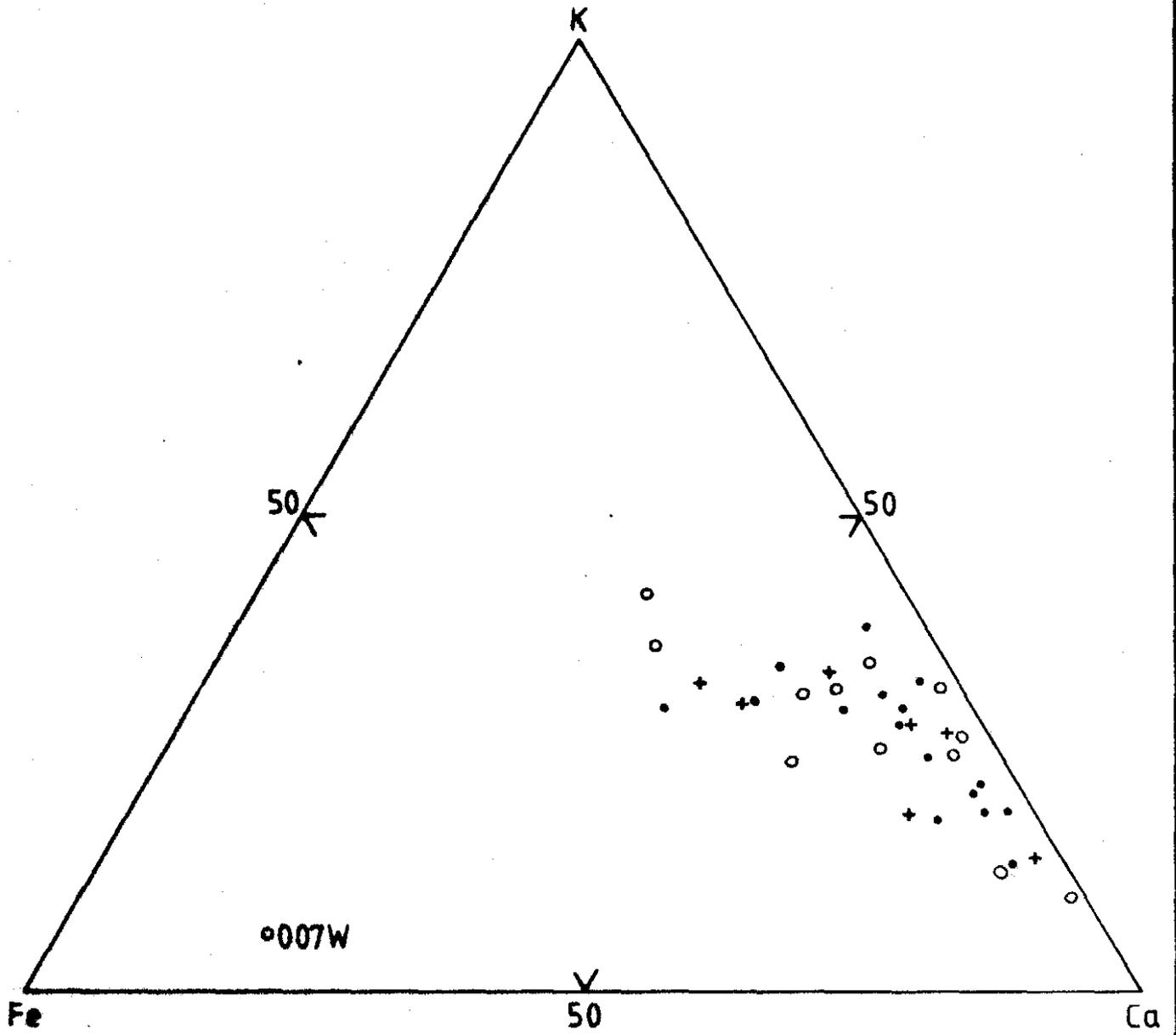
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EL 23 and 33/79 WYNYARD AND WARATAH
ATOMIC Na-K-Ca and AFM PLOTS FOR WATERS

Project No.
Drawing No.

033

119039

FIG. 9



LEGEND

Dominant rock type at sample site

- o Sediment
- Mixed
- + Basalt
- o 007W Mt Bischoff Mine adit water

Centre
SYD.....
 Date
 12/6/82

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 EL 23/79 and 33/79 WYNYARD and WARATAH
 ATOMIC Fe-K-Ca PLOT FOR WATER SAMPLES

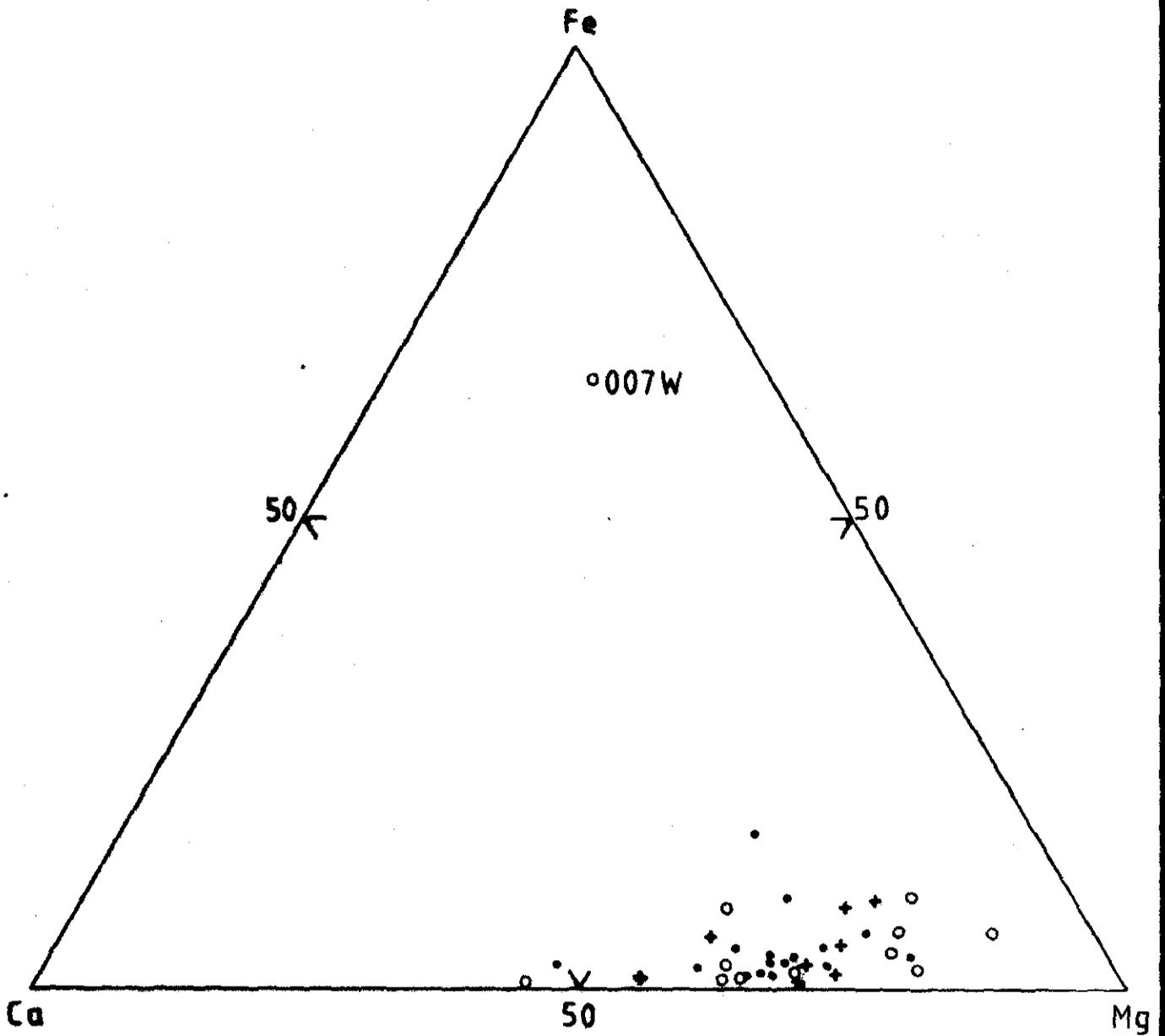
Project No.

 Drawing No.

034

119040

FIG. 10



LEGEND

Dominant rock type at sample site

- Sediment
- Mixed
- + Basalt
- 007W Mt Bischoff Mine adit water

Conty
SYD
Date
12/16/82

THE BROKEN HILL PROPRIETARY CO. LTD.

EL 23/79 and 33/79 WYNYARD and WARATAH
ATOMIC Ca-Fe-Mn PLOT FOR WATER SAMPLES

Project No.
.....
Drawing No.