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EL 1155 AND EL 1254

GIDDI GIDDINNA CREEK

PROGRESS AND TECHNICAL REPORTS TO LICENCE EXPIRY FOR THE PERIOD 16/6/1983 TO 23/9/1987

Submitted by
Evaporite Minerals (SA) Pty Ltd and CRA Exploration Pty Ltd
1987

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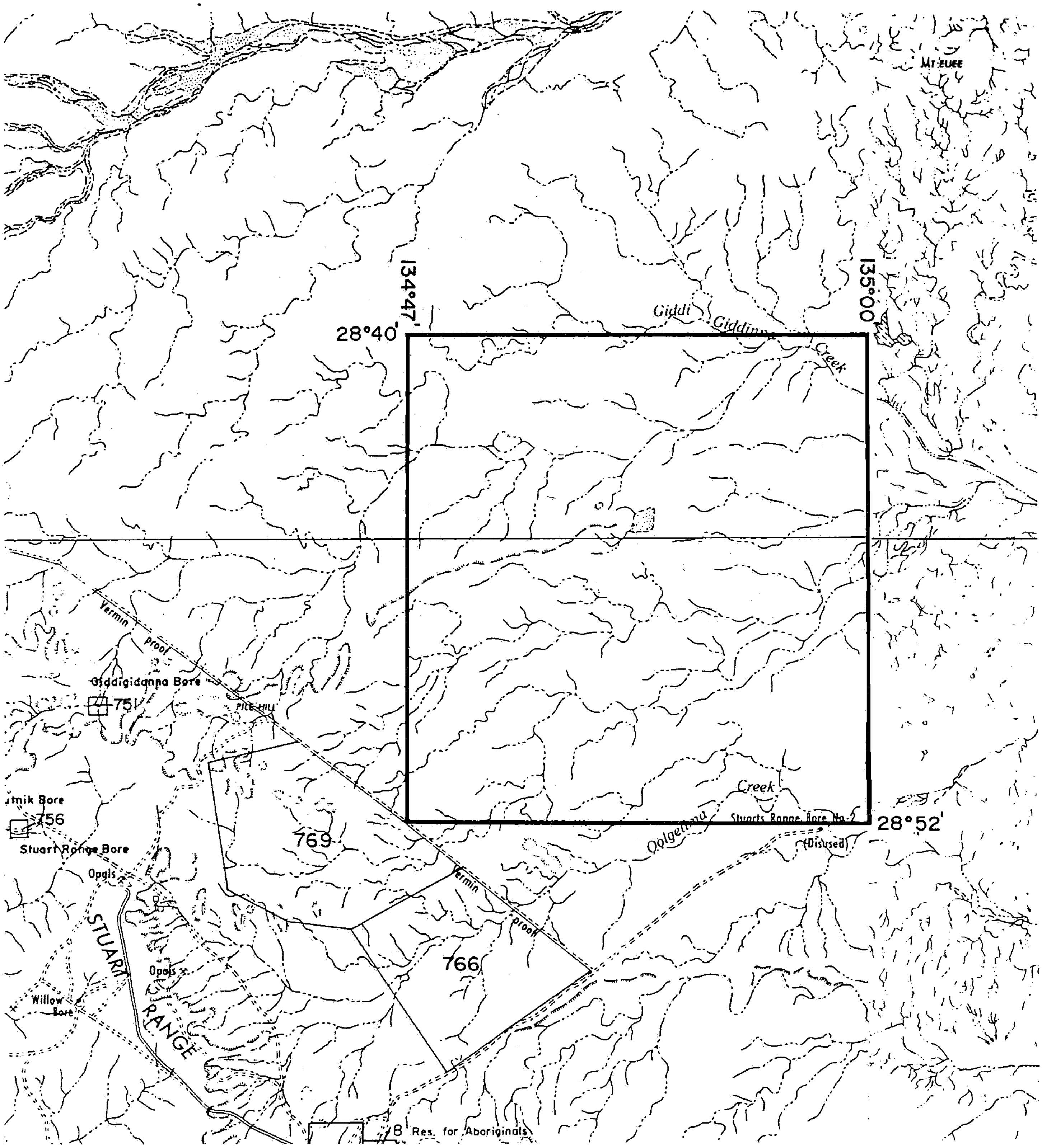
SCHEDULE A



EXPIRED

SCALE 1:250,000

KILOMETRES 5 0 5 10 15 20 25 KILOMETRES

APPLICANT: EVAPORITE MINERALS (S.A.) PTY. LTD.

DM: 452/82 AREA: 469 square kilometres (approx.)

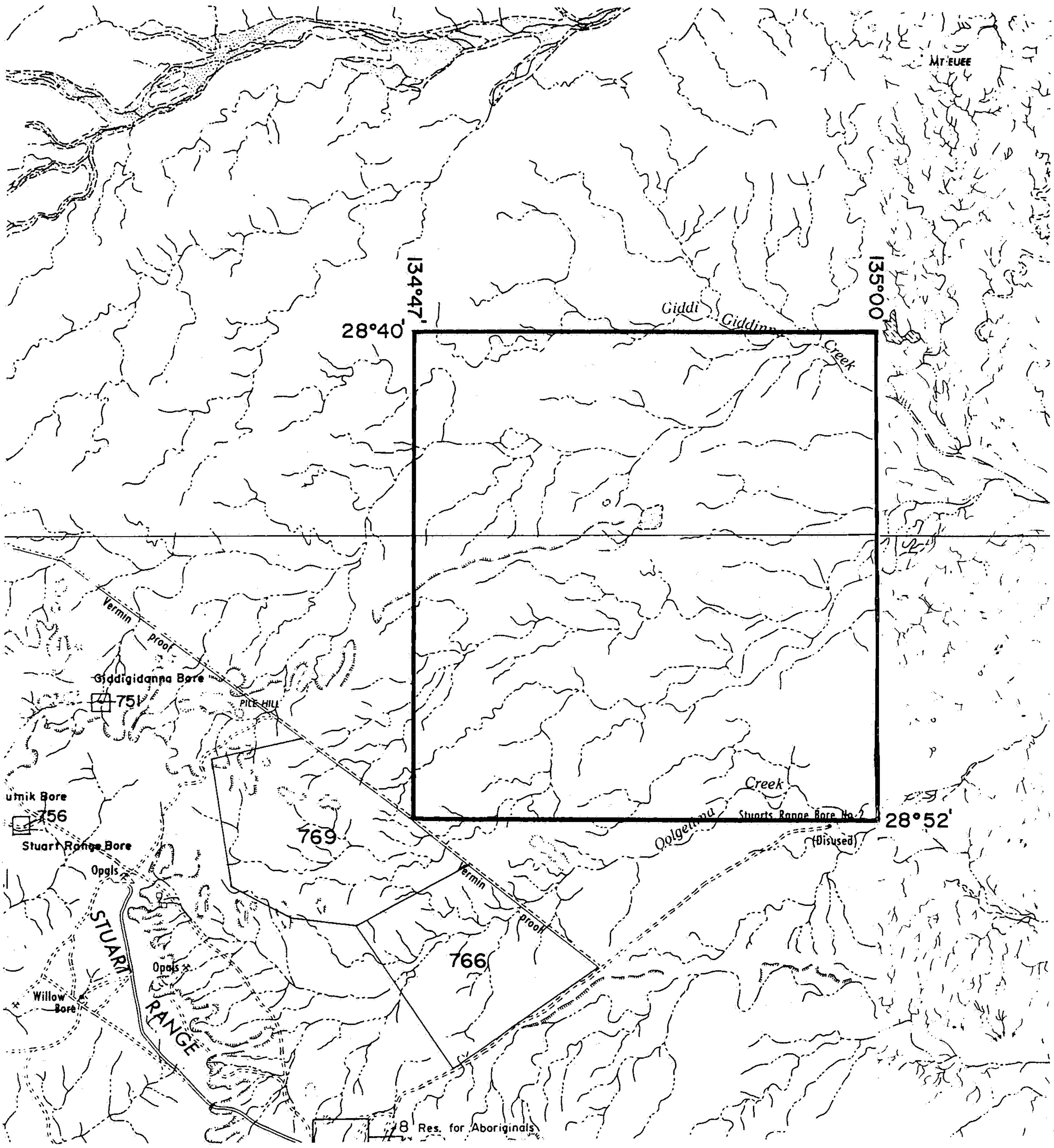
1:250000 PLANS: MURLOOCOPPIE

LOCALITY: GIDDINNA AREA – Approximately 30km northeast of Coober Pedy

DATE GRANTED: 17·6·83 DATE EXPIRED: ~~16·12·83~~ 16·6·84

EL No: 1155

SCHEDULE A



APP. 300/87

SCALE 1:250,000

KILOMETRES 5 0 5 10 15 20 25 KILOMETRES

EXPIRED

APPLICANT: ~~CRA EXPLORATION PTY. LIMITED~~ & EVAPORITE MINERALS (S.A.) PTY. LTD.
4.12.87

DM: 162/84 AREA: 469 square kilometres (approx.)

1:250 000 PLANS: MURLOOCOPPIE

LOCALITY: GIDDINNA AREA - Approx. 30km northeast of Coober Pedy

DATE GRANTED: 24-9-84 DATE EXPIRED: 23-9-~~85~~ 87 86

EL No: 1254

CONTENTS ENVELOPE 5258

TENEMENT: E.L. 1254 - Giddinna.

TENEMENT HOLDER: Evaporite Minerals (S.A.) Pty. Ltd.

AMINCO & ASSOCIATES PTY. LTD.
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EVAPORITE MINERALS (S.A.) PTY. LTD.

EXPLORATION LICENCE No. 1155

Quarterly Report for the Period ended 30th September 1983.

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Aminco and Associates

EVAPORITE MINERALS (S.A.) PTY. LTD.

EXPLORATION LICENCE No. 1155

Quarterly Report for the Period ended 30th September 1983

INTRODUCTION

Evaporite Minerals (S.A.) Pty. Ltd. was granted Exploration Licence No. 1155 for a period of six months, commencing 16th June, 1983. The southern boundary of the licence area is located approximately 18 km north-northeast of Coober Pedy via the Oodnadatta road. The same road continues diagonally across the licence to the northern boundary, a further distance of 25 km. Access to most parts of the licence area is reasonably good in a 4-wheel-drive vehicle in dry weather; wet weather would render much of the terrain treacherous to any type of vehicle.

FIELD TECHNIQUES EMPLOYED

The nature of the terrain within the licence area is such that the best geological exposures are found in incised river banks and, to a lesser degree, in patches of 'breakaway country' usually associated with the upper member of the Bulldog Shale and Quaternary gypsite. Geological traversing was, therefore, designed to concentrate on the major river systems where exposures frequently occur along the outer rim of meanders and on the breakaway areas in the southwestern and central-western portion of the E.L. To assist in establishing a ground control the Oodnadatta road (old alignment) was flagged at one kilometre intervals from the southern to northern E.L. boundaries.

The location and extent of Cretaceous bedrock exposures were recorded on plastic overlays on the 1:87,000 scale airphotos in the field, often with some assistance from the 1:10,000 scale enlargements. This geological data was later transferred to overlays prepared for the enlargements and formed the basis of the final geological plans (at 1:20,000 scale). Once a reasonable familiarity was established in the field with the photogeological characteristics of the various formations, it was possible to outline geological contacts reasonably reliably on airphoto evidence alone. It must be stressed, however, that most of the contacts, particularly those between the various Quaternary formations, are gradational and diffuse rather than abrupt and clear-cut.

The collection of rock chip samples was carried out with two main objectives in mind, namely, (1) to establish those areas where worthwhile near-surface concentration of water-soluble sulphate salts has taken place, and (2) to assess the geological, geochemical and geomorphological circumstances that give rise to the salt concentrations or the absence thereof. In many instances, the river bank exposures presented the best available sampling sites. Vertical cuts were made in the face of the bank (at or near the top), and the cuts were then chip-channel sampled over measured widths. In a number of localities holes were dug down into the land surface ten or more metres behind the river bank so that a comparison of values could be made. The samples were submitted to Amdel for analysis of water soluble Na, Mg, K, Ca and SO_4 (sulphate).

FIELD WORK COMPLETED

The writer, assisted by M. Burrell, Geologist, completed the programme of geological mapping of the entire E.L. during July. The geological reference selected for the mapping is as follows:

Age	Map Symbol	Lithology
Holocene	Qra (unnamed)	Fluviatile muds, sands and gravels occupying modern drainage channels, flood plains and minor claypans.
L. Pleistocene	Qp (Benitos Clay)	Red brown to brown clay to silty clay occurring over much of Stuart Range and Uplands. Very little vegetation.
"	Qpp (Oolgelima Gravel)	Gravels, sands and interbedded clays, weak to mod. consolidation, poor to mod. sorting, intertongues with Qp.
"	Qpr (unnamed)	Soft massive white gypsum powder, exposed on scarps parallel to creeks on the eastern side of the Stuart Range.
Cretaceous	Klb (Bulldog Shale)	Upper Member - dark grey silty shale, variably carbonaceous, pyritic or glauconitic, minor sandstone lenses, strongly bioturbated.

Cretaceous	Klt (Bulldog Shale)	Lower Member - dark grey organic-rich shale with partings of quartz sand, very fine-grained, pale grey, silty and micaceous, cone-in-cone limestones, characterised by remarkable 'boulder field' - a heavy boulder lag developed on soft gypseous soils.

Note: Q/Klt is a supplementary mapping unit representing the lower member of the Bulldog Shale where it is covered by a relatively thin dark brownish-grey clay of largely residual origin. It contrasts with the red-brown colour of the Benitos Clay. Much of this country is characterised by gilgai, often with large cracks in the surface.

The geological map has been constructed in three sheets, elongate in an east-west direction, at a scale of 1:20,000.

A total of 72 samples were collected and after pulverising were analysed by Amdel for % of water soluble Ca, Mg, Na, K and SO4. The analytical results show wide variations in the water soluble salt content of the material sampled. The sample locations were plotted on the geological map, with a colour code, based on the sum of % Mg plus % Na multiplied by the width (depth) of the sample is employed to illustrate the more prospective areas. The resultant product is more meaningful than the % Mg and % Na alone without taking into account the vertical extent over which these values are maintained. It is possible to see at a glance the areas from which the better values originate and they clearly tend to congregate in the southwestern corner of the licence area. It is in this locality that Tayler's original discovery was made some 12 months ago.

FUTURE PLANS

The programme of geological mapping and reconnaissance sampling has drawn attention to a number of areas within the E.L. where concentrations of water-soluble sulphate salts have developed. It would now be constructive to define these areas in more detail through a programme of back hoe pitting and sampling. This could then leave the way open for metallurgical testing to ascertain whether or not the complex sulphate "ore" can be economically separated into saleable mineral constituents. A comprehensive report on the first stage of geological work and on the analytical results has been prepared and will be made available to the Mines Department when the term of the E.L. is completed.

Adelaide S.A.
29 November 1983

D.L. Seymour
Consultant Geologist

PROGRESS REPORT

MAGNESIUM AND SODIUM SULPHATE PROJECT

COOBER PEDY DISTRICT

SOUTH AUSTRALIA

DECEMBER, 1983

Aminco
and
Associates

TABLE OF CONTENTS

PROGRESS REPORT - MAGNESIUM AND SODIUM SULPHATE PROJECT

INTRODUCTION

This report deals with the results of exploration carried out over the Exploration Licence area during the first six-month period of tenure.

A geological map of the E.L. area, as well as immediately adjacent country to the south of the southern boundary, has been prepared and accompanies this report. The map draws attention to those areas in which the Lower Member of the Bulldog Shale is either exposed or only thinly covered by largely residual clays, and from which encouraging magnesium and sodium sulphate values were recorded in the reconnaissance sampling programme.

A number of broad conclusions have been reached regarding the nature, extent and apparent controls of magnesium and sodium sulphate mineralisation. Recommendations for further, more detailed geological work are given at the end of the report.

TITLE

Evaporite Minerals (S.A.) Pty. Ltd. currently holds Exploration Licence No. 1155 comprising an area of some 469km^2. The Licence was granted for a period of six months, commencing 16th June, 1983.

LOCATION AND ACCESS

The southern boundary of the E.L. is located approximately 18km via the Oodnadatta road northeast of Coober Pedy. This same road continues in a north-northeast direction across the licence area to the northern boundary, a distance of some 25km. Access to most parts of the licence area is reasonably good in a 4-wheel-drive vehicle in dry weather. Wet weather would render much of the terrain treacherous to vehicular traffic. It should be noted that the Oodnadatta road has been recently realigned and surfaced with local gravels to produce, it is hoped, an all weather surface. The route of the road on the geological map is the old alignment as shown on the June 1981 aerial photography employed in the mapping activities.

The road along the dog fence northwest from the gate and a modern bulldozed track towards the north give access to the original discovery site on "Discovery Creek", a major tributary of Giddi Giddina Creek.

FIELD TECHNIQUES EMPLOYED

A review of the field techniques employed was incorporated in a Quarterly Report dated 29th Nov. 1983 and it is not proposed to repeat the review here.

GEOLOGY

The licence area lies near the southeast corner of the Murloocoppie 1:250,000 scale geological sheet which was mapped by G.M. Pitt and L.C. Barnes of the Geological Survey during the period 1972-74. Explanatory notes and the geological sheet were published in 1976 and form a standard reference for the geology of the licence area. The Coober Pedy 1:250,000 scale geological sheet, on the other hand, was mapped by V. Vitols and M.C. Benbow during the period 1973-75 with later colour aerial photographic and Landsat-1 imagery interpretation aiding the final presentation of Quaternary units. Several of Benbow's newly-named Quaternary units, e.g., Benitos Clay and Oolgelima Gravels, have been adopted in this report as these units do occur within the licence area. Pitt and Barnes made a clear distinction between the upper and lower members of the Bulldog Shale - they referred to the latter as an "unnamed transitional unit" - and mapped them as separate units. This practice has been adopted by the writer for it is to that "unnamed transitional unit" we can link the magnesium and sodium sulphate mineralisation.

The following is the geological reference adopted for the mapping of the licence area:

Age	Map Symbol	Lithology
Holocene	Qra (unnamed)	Fluviatile muds, sands and gravels occupying modern drainage channels, flood plains and minor claypans.
L. Pleistocene	Qp (Benitos Clay)	Red brown to brown clay to silty clay occurring over much of Stuart Range and Uplands. Very little vegetation.
"	Qpp (Oolgelima Gravel)	Gravels, sands and interbedded clays, weak to mod. consolidation, poor to mod. sorting, intertongues with Qp.
"	Qpr (unnamed)	Soft massive white gypsum powder, exposed on scarps parallel to creeks on the eastern side of the Stuart Range.
Cretaceous	Klb (Bulldog Shale)	Upper Member - dark grey silty shale, variably carbonaceous, pyritic or glauconitic, minor sandstone lenses, strongly bioturbated.

Cretaceous	Klt (Bulldog Shale)	Lower Member - dark grey organic-rich shale with partings of quartz sand, very fine-grained, pale grey, silty and micaceous, cone-in-cone limestones, characterised by remarkable 'boulder field' - a heavy boulder lag developed on soft gypseous soils.

Note: Q/Klt is a supplementary mapping unit representing the lower member of the Bulldog Shale where it is covered by a relatively thin dark brownish-grey clay of largely residual origin. It contrasts with the red-brown colour of the Benitos Clay. Much of this country is characterised by gilgai, often with large cracks in the surface.

The Benitos Clay is the most widespread Quaternary sedimentary unit within the licence area with its distinctive red-brown colour clearly visible on the recently procured colour air photography. It is well exposed in creek embankments either directly overlying the lower member shales or overlying an intermediate cover of Oolgelima Gravel (plate 1). Where the thickness of clay becomes thin, for example, less than 40cm, the surface becomes deeply cracked and hummocky, in contrast to a generally smooth boulder lag surface. The "working" of the surface is curiously reminiscent of permafrost areas in northern latitudes where freezing and thawing of the surface soils produces "frost boils" (hummocks) and deep cracks. In this instance, however, the "working" of the surface is likely to be the manifestation of the expansion and contraction of the suboutcropping shales, now known to have decidedly bentonitic characteristics. When the clay is either very thin or absent, the overburden becomes distinctly dark brown and dark greyish-brown, easily recognisable on the air photographs. The surface is then remarkably soft and spongey, making four-wheel-drive a mandatory facility.

The Oolgelima Gravel comprises weakly consolidated clayey gravels well exposed on the bank of Oolgelima Creek and in each of Highways Department road metal quarries along the Oodnadatta road (plate 2). The gravels are composed of 50% subangular to rounded pebbles of ferruginous chert (ferricrete), 35% subangular to well rounded creamy white pebbles of kaolinitic flint clay after alunite and 15% angular to subangular clasts of the lower member shales which are rapidly breaking down in place. The whole is loosely cemented by clay and fine silt, typical of ephemeral streams.

The soft white gypsum deposits which are found in several localities within the licence area, usually best exposed in the face of erosional escarpments, seem to represent the remnants of a much more widespread Quaternary unit. Only in a few places in the northern half of the licence area are examples of the original gypsite crust preserved.

The upper member of the Bulldog Shale is exposed only in the extreme western and northwestern portions of the licence area. Its presence is made immediately apparent by the peculiar weathering characteristics of the porcellanised silty shales; the shales tend to break up into a distinctive angular rubble with somewhat curved (almost conchoidal) fracture faces. The land surface developed upon these siliceous silty shales is lightly covered with ferricrete and silcrete gravel and supports some primitive grasses and other flora.

The base of the upper member is marked by an abrupt change to a soft, buff-brown argillaceous limestone with weathering characteristics quite unlike the porcellanised shales above (plate 3). The change to the mudstones of the lower member is indicated on the slope of the escarpment by the occurrence of thin plates of gypsum scattered over the surface. The gypsum plates do not extend up into the limestone bed; they are shed exclusively from the lower member mudstones/shales.

The uppermost few metres of the lower member of the Bulldog Shale in the northwest quarter comprise pale grey to brownish-grey siltstones with scattered small clasts of shale, virtually a conglomeratic siltstone. In fact, a perceptible trend towards more silty lithologies in the northwestern portion of the licence area does seem to exist. The literature repeatedly refers to this unit as having a "restricted marine" depositional environment. Lindsay (1975) noted '... the degree of diversity of the foraminiferal microfauna suggests at least a partially marine environment of deposition, but the lack of other fossils, the wholly agglutinated assemblage and the organic-rich lithology indicate restricted and/or marginal marine conditions.'.

Setting aside the reasons stated by Lindsay, the writer has observed a number of features which tend to give further support to the marginal marine theory.

(1) Cone-in-cone limestone. The distribution of hard, pale buff-coloured limestone, often showing distinct cone-in-cone textures, is widespread across the licence area. Yet it is by no means ubiquitous; for example, on the southeast side of Discovery Creek near Tayler's discovery site, limestone is common. On the opposite, or northwestern bank, limestone is absent. The 3^{o} southeasterly dip may account for its absence but, nevertheless, it does indicate that the limestone occupies a definite position in the stratigraphic column. In the east-central portions of the licence area limestone "rafts" literally dot the land surface producing a recognisable pattern on air photographs, giving the impression of an almost continuous layer of limestone. This impression is shown to be misguided by examples of adjacent river embankments totally devoid of limestone; what is in reality taking place is a surface concentration of the more competent limestone lenses on top of the softer incompetent shales.

While the origin of cone-in-cone textures remains the subject of some controversy (probably the result of differential vertical pressure due to the overlying sediments), the fact remains that the rather argillaceous limestone occurs as narrow lens-like layers or "rafts" of limited areal extent. Many are less than 10 metres square. The clear impression has been gained that the lenses were deposited in shallow water, perhaps lagoonal, conditions on a slightly undulating ocean floor. Another interesting feature is the capping of a few of the limestone lenses with up to 10-15cm of a hard, dark purplish-red ferruginous layer, known from previous experience some 40-50km to the east near Lake Cadibarrawirracanna to be rich in iron phosphate. This apparent phosphatisation of the uppermost layer of the limestone may be a recent supergene effect.

(2) Glauconite. The identification by Pontifex & Associates of glauconite as a 30% constituent of a sandy intercalation in dark grey shales at sample location 93/94 has interesting implications. Glauconite, a complex iron silicate with the variable composition expressed as (K Na Fe '' Mg). (Fe ''' Al). $Si_6 O_{18} .3H_2O$, apparently forms under conditions of slow sedimentation in partially restricted environments, but, once formed, it may be transported and sorted as detrital grains. The possible presence of jarosite, probably natro-jarosite in fact, may account for some of the sodium and sulphate content, as well as the yellow-brown iron-staining or banding frequently observed in partly weathered shales and mudstones. Both the quartz and feldspar grains are angular, while fine detrital muscovite tends to suggest sedimentation took place fairly close to the mouth of the river which carried the detrital particles to the inland Cretaceous sea.

(3) Gypsum. The gypsum content of the lower member mudstones and shales is also highly variable, although one can safely say that gypsum is always present. In certain areas, however, the gypsum content is appreciably higher than elsewhere and is evidenced at surface by abundant large shiny plates 1-2cm in thickness. This seems to indicate a variation in the chemical composition of the sediments themselves, as shown also by the analytical results discussed in a later section.

It seems fair to conclude that the sediments which comprise the lower member of the Bulldog Shale, reportedly only some 25m thick, show a considerable variation in lithology and, therefore, chemical composition in both the vertical and lateral sense. This is not unexpected in the restricted marine environment in which deposition took place. The sediments are generally flat-lying; maximum dips of $2\text{-}3^{o}$ have been recorded. A small number of stratigraphic drill holes through this unit into the underlying Cadna-owie Formation (quartz sandstone) would give some valuable insight into those portions of the lower member which have, for example, anomalous magnesium and/or sodium backgrounds.

A further characteristic of the sediments of the lower member is their bentonitic quality, i.e., their swelling tendencies with water. The soft surface above the dark grey mudstones is composed of very fine unconsolidated powdery "soil", which overlies the top of the higher grade epsomite mineralisation some 10-15cm below. The "soil" is clearly the product of decomposition of the underlying sediments which tend to swell up when wet. In a few localities, however, the "soil" consists of small shale/siltstone fragments which have not broken down, indicating a contrasting composition giving rise to a less reactive response to local weathering conditions. The very fine-grained, almost waxey, mudstones tend to hold their moisture to the extent that they are often quite moist as close to 30cm from the surface. When exposed to the surface they crack up as they dry out and, if rained upon, quickly break up losing all trace of their original angularity within a few months (as observed at the backhoe cut at the discovery site).

MINERALISATION

A variety of calcium, magnesium and sodium sulphate mineralisation has been observed within the licence area and it would be useful at this point to compile a check list of the various types, their diagnostic characteristics, mode of occurrence, and so on. It must be stressed, however, that in the absence of hard x-ray diffraction identification data, this summary must be left open for revision.

(1) Calcium - gypsum ($Ca SO_4 .2H_2O$) is widespread in its occurence within the licence area both as Quaternary gypsite crusts (Qpr mapping symbol) and as an obvious and common constituent of the lower member sediments. The most prevalent mode of occurrence is as medium to large plates of selenite rather than the fibrous satin spar variety so abundant in the upper member of the Bulldog Shale of the opalfields. The gypsum plates develop along bedding plane partings as well as in gently to moderately-dipping joint planes. Gypsum is seen to replace (and pseudomorph) fibrous epsomite in the upper more weathered mudstones, producing a white crumbly mineral which is somewhat reluctant to dissolve in water and to all intents and purposes tasteless. It is always possible that the mineral glauberite, $Na_2 Ca (SO_4)_2$, can account for the higher soluble calcium values recorded in some localities. A classic example of gypsum pseudomorphing after epsomite/bloedite was noted at sample 8333, which recorded a high calcium value. It is also notable that cracks which develop in limestone lenses tend to be filled with satin spar gypsum, while partial replacement of the limestone's upper and lower contacts by disseminated gypsum is also a common feature.

(2) Magnesium - epsomite ($MgSO_4 .7H_2O$) most commonly occurs as hair-like crusts composed of a myriad of tiny brittle spicular crystals which grow in fractures in the shales usually within one metre of the current surface. These crystals can and do grow at a very rapid rate; for example, a sample locality exposed to the air and showing negligible epsomite mineralisation in early July had grown a substantial deposit of spicular crystals one month later. The local sediments are quite moist and this moisture when attracted towards the exposed surface resulted in the growth of copious numbers of epsomite crystals just beneath the new surface.

Epsomite also occurs at depths below 0.5m as coarse-grained fibrous fracture fillings up to 5cm thick. Undisturbed, the epsomite fracture fillings are composed of colourless slender disphenoids, similar, at first glance, to satin spar gypsum, yet recognisable because they tend to grow out from both walls of the cavity like very sharp teeth. Within an hour of exposure the epsomite crystals start to lose some of their water of crystallisation leaving an opaque white coating on each crystal face. Within a matter of a day or so the whole of the crystal mass has turned white and opaque.

(3) Sodium - bloedite is the hydrated double sulphate of sodium and magnesium ($Na_2SO_4 .Mg SO_4 .4H_2O$) and consists of 42.5% Na_2SO_4, 36% $MgSO_4$ and 21.5% H_2O. Bloedite crystals tend to occur at least 0.6m below the surface and characteristically form squat but sharp prismatic crystals, usually growing on one surface of a bedding plane or fracture and often with a hook-shaped curved habit that is unmistakable. Digging away a sample channel by hand before sampling one can feel the sharp bloedite crystals rather like small rose thorns. Bloedite crystals are ice-like and remain colourless even on exposure to the air. They are harder than gypsum or epsomite. It is reasonably certain that in some instances epsomite pseudomorphs after bloedite, the result often showing up as bloedite crystals which will freely effloresce.

In addition to the four quite distinct types of sulphate mineralisation described above, the highest grade material, or salt cake, which occurs at the top of the mineralised zone immediately below the overburden is composed of an aggregate of granular crystals. The crystal aggregate is probably a composite of epsomite/keiserite and thenardite (?), the latter probably accounting for most of the sodium content. Thenardite is orthorhombic dipyramidal in its crystallography and can relate to the abundant granular crystals nearest the surface.

The licence area seems to be essentially free of other salts, especially chlorides. Only in the northwestern quarter in an area approximately 300m north of sample location 51/52, the silty shales have minor salt encrustations along joint planes which give the telltale sickly sweet taste of halite. It was notable also in this area that there is very little gypsum and only a trace of epsomite mineralisation. Something is clearly amiss with the local geological environment, and yet the sediments produce a thicker than usual soft dark greyish-brown overburden which almost defies low range four-wheel-drive. The presence of some chlorides can account for the apparent deficiency of sulphate in some samples, as discussed in the section which follows.

SAMPLING RESULTS

It was reported in the Quarterly Report of 29th Nov. that the sampling programme was carried out with two main objectives in mind, namely,

(1) to establish those areas where worthwhile near-surface concentration of water soluble sulphate salts has taken place, and

(2) to assess the geological, geochemical and geomorphological circumstances which give rise to the concentrations, or the absence thereof.

A total of 72 samples were collected and after pulverising were analysed by Amdel for % water soluble Ca, Mg, Na, K and SO_4. The analytical results show considerable variations in the water soluble salt content of the material sampled and a full discussion of the significance of the variations is given in the Discussion section. The sample locations are plotted on the geological map and a colour code, based on the total of % Mg plus % Na multiplied by the height (or depth) of the chip channel sample is used to illustrate the more prospective areas. The resultant product is more meaningful than the % Mg and % Na alone without taking into account the vertical extent over which these values are maintained.

In the sample-by-sample review which follows, the calcium, magnesium and sodium values are followed (in brackets) by the calculated % of anhydrous $CaSO_4$, $MgSO_4$ and Na_2SO_4 to give the reader some idea of the relative abundance of these theoretical mineral equivalents. In fact, if one were to calculate the relative abundance of gypsum $CaSO_4 .2H_2O$, epsomite $MgSO_4 .7H_2O$ and bloedite $MgSO_4 Na_2 SO_4 .4H_2O$ the values in brackets would increase even further. The anhydrous equivalents do give total values which in about 37.5% of the cases agree with the % SO_4, 50% give totals which exceed the % SO_4 while only 12.5% give totals less than the % SO_4. The samples in which the calculated % soluble salts exceeds the sulphate content strongly suggests the presence of soluble salts other than sulphate - probably chlorides or possibly carbonates or nitrates. Halite seems the most likely intruder, but the possibility of sodium carbonate, or trona, should not be overlooked. In those few cases where there is an excess of sulphate, and it is significant that these tend to be the higher grade samples, the excess may be brought about by the bentonitic, i.e. expansible clay, qualities of the shales/mudstones which when wetted while dissolving the water soluble salts tend to absorb some of the available Ca, Mg and Na cations leaving an apparent surplus of SO_4.

<u>Sample 8326</u> Ca 0.26 (0.62), Mg. 0.082 (0.33), Na 0.15 (0.32), SO_4 0.84%
Sample height 0.6m; % x ht = 0.14 Code blue.

This sample was taken from a Highways Dept. road metal quarry between the dog fence and the southern boundary of the licence area. It is composed of typical Oolgelima Gravel under 1 to 1.4m of red-brown sandy clay (Benitos Clay). There is virtually no trace of soluble salts and the very low potassium value (0.01%) confirms that the soluble potassium sulphate content of the originally alunitic clasts has been effectively removed by leaching.

<u>Sample 8327</u> Ca 1.16 (2.78), Mg 0.73 (2.92), Na 1.19 (2.50), SO_4 7.15%
Sample height 0.5m; % x ht = 0.96 Code blue.

This sample was cut from the top of a 2.4m high, south-facing river bank (tributary of Giddi Giddina Creek) of dark grey to black shales with a few thin sandy laminations. Negligible limestone. Epsomite as fine spicular crystals in fractured shale beneath 15cm overburden.

<u>Sample 8328</u> Ca 0.47 (1.13), Mg 0.83 (3.32), Na 0.99 (2.08), SO_4 5.91%
Sample height 0.6m; % x ht = 1.09 Code green.

Located on top of the north bank of Oolgelima Creek almost due north of the abandoned Stuarts Range Bore No. 2, the south-facing exposure shows only traces of spicular epsomite crystals in laminated dark grey shales with abundant limestone lenses. Minor gypsum.

<u>Sample 8329</u> Ca 1.09 (2.62), Mg 0.46 (1.84), Na 0.39 (0.82), SO_4 4.76%
Sample height 0.45m; % x ht = 0.38 Code blue.

Located on the south bank of Oolgelima Creek and from beneath 50cm of Benitos Clay this sample is another example of Oolgelima Gravel, this time crudely cemented by impure gypsum as confirmed by the Ca value.

<u>Sample 8330</u> Ca 0.95 (2.28), Mg 0.70 (2.80), Na 0.59 (1.24), SO_4 5.58%
Sample height 0.55m; % x ht = 0.71 Code blue.

Dark grey crumbly shales from beneath the previous sample. Only traces of epsomite crystals 20-30cm below base of gravel bed.

<u>Sample 8331</u> Ca 0.34 (0.82), Mg 6.23 (24.92), Na 4.85 (10.19), SO_4 41.2%
Sample height 0.1m; % x ht = 1.11 Code green (yellow + 8332)

This sample from the north bank of Oolgelima Creek was a selected sample of 10cm of high grade salt cake (granular aggregate) beneath 10-15cm of overburden. It recorded the highest individual Mg assay value and confirms that the maximum magnesium enrichment occurs nearest the surface - a reflection of capillary action.

Sample 8332 Ca 0.62 (1.49), Mg 2.08 (8.32), Na 1.92 (4.03), SO_4 10.6%
Sample height 0.25m; % x ht = 1.20 Code green.

This sample was collected from immediately below the previous sample with sparse epsomite needles in crumbly shale fragments. A composite of the two samples is code yellow (2.31).

Sample 8333 Ca 4.08 (9.79), Mg 0.50 (2.00), Na 0.43 (0.90), SO_4 12.8%
Sample height 0.25m; % x ht = 0.23 Code blue.

This sample located opposite the 'Atomic Bomb' exit recorded the highest calcium value from shales with glauberite (?) pseudomorphs after epsomite/ bloedite, reluctantly soluble and tasteless, and only traces of epsomite.

Sample 8334 Ca 1.52 (3.65), Mg 0.82 (3.28), Na 0.76 (1.60), SO_4 7.64%
Sample height 0.25m; % x ht = 0.40 Code blue.

This sample was collected from below the previous one with less visible glauberite (?) pseudomorphs and marginally more epsomite.

Sample 8335 Ca 0.18 (0.43), Mg 2.39 (9.56), Na 2.64 (5.54), SO_4 16.7%
Sample height 0.4m; % x ht = 2.01 Code yellow.

Sample collected just west of road in dark greyish-brown area littered with gypsum plates along minor creek, 10cm poor salt cake and 30cm lower grade salted crumbly shales, granular not spicular crystals. 5cm fluffy overburden.

Sample 8336 Ca 0.12 (0.29), Mg 1.55 (6.20), Na 1.52 (3.19), SO_4 8.34%
Sample height 0.3m; % x ht = 0.92 Code blue.

Sample collected from minor creek bank 1.4km north of 8335, similar setting but with mottled surface due to limestone rafts, 10cm overburden, 5cm of impure salt cake and 25cm of weakly salted shales.

Sample 8337 Ca 0.61 (1.46), Mg 1.13 (4.52), Na 0.87 (1.83), SO_4 7.17%
Sample height 0.25m; % x ht = 0.50 Code blue.

Sample taken at 4km peg in dark brownish-grey area to west of road under 15cm of fluffy overburden dotted with cobble lag. Mainly moderate spicular epsomite and some fibrous curved crystals (probably after bloedite).

Sample 8338 Ca 1.12 (2.69), Mg 0.74 (2.96), Na 0.77 (1.62), SO_4 6.18%
Sample height 0.4m; % x ht = 0.60 Code blue.

Sample taken on north bank of Discovery Creek east of road crossing, abundant limestone lenses and boulders, gypsum plates, 5cm overburden, 15cm brown clay over weakly mineralised laminated mudstones, mainly spicular crystals.

Sample 8339 Ca 0.12 (0.29), Mg 2.42 (9.68), Na 1.89 (3.97), SO_4 14.3%
Sample height 0.2m; % x ht = 0.86 Code blue.

Sample collected from bank of small creek system just south of 9km peg, surface dark brownish-grey and littered with gypsum fragments, 15cm of soft overburden over crumbly shales with only weak granular salts. The high Mg:Na ratio reflects the selective nature of the sample, i.e., topmost 20cm.

Sample 8340 Ca 0.96 (2.30), Mg 1.59 (6.36), Na 1.67 (3.51), SO4 9.24%
Sample height 0.2m; % x ht = 0.65 Code blue (green + 8341)

Sample collected from south bank of Halfway Creek east of road, black sooty or carbonaceous shales with soft white powdery salt accumulation for 20cm below 15cm of residual overburden. Some minor encrustations/aggregates. No limestone, no laminations, fossil wood occurrence.

Sample 8341 Ca 0.26 (0.62), Mg 1.05 (4.20), Na 1.24 (2.60), SO4 6.40%
Sample height 0.35m; % x ht = 0.80 Code blue (green + 8340)

Same location, sample from 35cm deeper, shales have spikey bloedite crystals growing on bedding plane partings. Marginally higher Na level seems to confirm.

Sample 8342 Ca 0.15 (0.36), Mg 1.91 (7.64), Na 2.31 (4.85), SO_4 11.7%
Sample height 0.3m; % x ht = 1.27 Code green

Sample collected just south of 14km peg in bank of minor creek, 30cm of overburden mainly dark grey clay, then sampled 30cm of granular salts in crumbly shales. High Na value is anomalous.

Sample 8343 Ca 1.05 (2.52), Mg 1.23 (4.92), Na 1.18 (2.48), SO_4 9.31%
Sample height 0.35m; % x ht = 0.84 Code blue.

Sample collected near main tributary junction on Giddi Giddina Creek east of road on north bank, beneath 10cm overburden, 10cm of crumbly clay, weak epsomite as spicular crystals, no salt cake, only minor limestone, abundant gypsum.

Sample 8344 Ca 0.32 (0.77), Mg 2.25 (9.00), Na 1.90 (3.99), SO_4 10.3%
Sample height 0.5m; % x ht = 2.08 Code yellow.

Best exposure to date, on south bank of G.G. Creek, 5cm overburden over very crumbly dark grey shale as fragments impregnated with granular salts, some aggregates. Thin buff laminae.

Sample 8345 Ca 0.62 (1.49), Mg 1.32 (5.28), Na 1.23 (2.58), SO_4 5.83%
Sample height 0.35m; % x ht = 0.89 Code blue (yellow + 8344)

Same location, deeper section, change to spicular epsomite crystals and minor bloedite spikes in laminated shale.

Sample 8346 Ca 0.11 (0.26), Mg 1.72 (6.88), Na 2.15 (4.52), SO_4 8.95%
Sample height 0.4m; % x ht = 1.55 Code green

On north bank of G.G. Creek just west of road, sloping bank exposure of very crumbly dark grey shales with grandular sulphate mineralisation and minor bloedite towards base. No limestone.

Sample 8347 Ca 0.68 (1.63), Mg 0.89 (3.56), Na 0.83 (1.74), SO_4 6.78%
Sample height 0.3m; % x ht = 0.52 Code blue

Sample collected on top of breakaway slope above 'the crater' area. Hard, gravelly brown clay with 10cm of greyish brown overburden. Amorphous white sulphate in top 10cm then weak spicular epsomite coatings to 40cm depth - still in clay at base.

Sample 8348 Ca 0.070 (0.17), Mg 2.77(11.08), Na 2.00 (4.20), SO_4 16.0%
Sample height 0.3m; % x ht = 1.55 Code green.

Located 30m downslope from 8347, 5cm overburden, 20cm dark brown-grey clay (residual) with no salts, then very crumbly dark grey shales with 15cm of moderate grade then 15cm much lower grade. No limestone.

Sample 8349 Ca 0.36 (0.86), Mg 0.41 (1.64), Na 2.55 (5.36), SO_4 12.2%
Sample height 0.45m; % x ht = 1.33 Code green.

Sample taken from G.G. Creek bank 150m east of abandoned bore, south-facing with sugary granular aggregates (almost salt cake) into crumbly shales with bloedite crystals. Minor limestone. Rosettes of salts as at discovery area. Anomalous Na is puzzling and worth checking.

Sample 8350 Ca 0.16 (0.38), Mg 0.92 (3.68), Na 1.82 (3.82), SO_4 6.37%
Sample height 0.4m; % x ht = 1.10 Code green.

Sample collected from soft flats below southeast limit of upper member siliceous shales north of G.G. Creek, 15cm of soft residual overburden and clay over decomposed shales with amorphous white sulphates (15cm), then crumbly shales with low grade granular salts. No limestone. Anomalous Na again - possibly halite?

Sample 8351 Ca 0.70 (1.68), Mg 1.18 (4.72), Na 1.23 (2.58), SO_4 7.70%
Sample height 0.6m; % x ht = 1.45 Code green.

South-facing, 5cm high bank on G.G. Creek, grey to dark chocolate brown mudstones with mustard yellow partings. Minor amorphous and spicular sulphates for 60cm. Minor limestone nearby. Mudstones are distinctly moist.

Sample 8352 Ca 0.20 (0.48), Mg 2.81 (11.24), Na 2.65 (5.57), SO_4 16.0%
Sample height 0.4m; % x ht = 2.18 Code yellow.

Six metres behind bank on near-level plateau, much better salt development than south face, some salt cake and scattered granular aggregates, minor fibrous epsomite and bloedite crystals common. Difference is in the position in relation to the sun.

Sample 8353 Ca 0.23 (0.55), Mg 1.81 (7.24), Na 2.51 (5.27), SO_4 11.8%
Sample height 0.35m; % x ht = 1.51 Code green.

Steep high bank with well exposed grey to greyish-brown laminated shale near western boundary. No limestone and minor gypsum. Narrow enriched layer 2-5cm, then weakly salted shales. High sodium content may be halite from sandy intercalations?

Sample 8354 Ca 0.26 (0.62), Mg 1.33 (5.32), Na 1.15 (2.42), SO_4 7.83%
Sample height 0.6m; % x ht = 1.49 Code green.

West-facing bank in tributary of G.G. Creek, 15cm reddish-brown powdery overburden, then crumbly laminated shales with both granular and spicular sulphates and below 55cm scattered large fibrous crystals of epsomite as at discovery site.

Sample 8355 Ca 0.23 (0.55), Mg 3.31 (13.24), Na 2.66 (5.59), SO_4 19.5%
Sample height 0.4m; % x ht = 2.39 Code yellow

South bank approx. 300m to west, similar sediments and 40cm of fair sulphate mineralisation where clay cover removed. Salt cake of 10cm followed by granular salts with some fibrous epsomite at depth. Dug out rounded cobble typical of gibber lag.

Sample 8356 Ca 2.03 (4.87), Mg 0.85 (3.40), Na 0.83 (1.74), SO_4 10.3%
Sample height 0.4m; % x ht = 0.67 Code blue.

On north bank further upstream in G.G. Creek. Spicular epsomite beneath 20cm of powdery overburden becoming unmineralised at 60cm. Sediments are greyish-brown shales with sandy to finely conglomeratic intercalations. No limestone, only minor gypsum, yet high calcium.

Sample 8357 Ca 0.17 (0.41), Mg 0.59 (2.36), Na 1.04 (2.18), SO_4 4.35%
Sample height 0.5m; % x ht = 0.82 Code blue.

Sample collected below gypsite outcrop area and near top of lower member. Sediments are siltstones to silty shales, pale grey to brownish-grey. Only very minor epsomite crystals. Higher Na could be halite?

Sample 8358 Ca 2.84 (6.82), Mg 0.40 (1.60), Na 0.50 (1.05), SO_4 9.32%
Sample height 0.4m; % x ht = 0.36 Code blue.

Sample collected from west side of wide amphitheatre below scarp. Again pale grey to buff siltstones and silty shales with only trace of sulphate minerals. High calcium from local gypsite?

Sample 8359 Ca 3.88 (9.31), Mg 0.44 (1.76), Na 0.43 (0.90), SO_4 11.9%
Grab sample only.

A grab sample of weakly mineralised material 'dozed up by Highways Department northeast of campsite. At least one metre of Benitos Clay overlies.

Sample 8360 — Ca 0.32 (0.77), Mg 1.12 (4.48), Na 0.62 (1.30), SO_4 6.15%
Sample height 0.2m; % x ht = 0.35 Code blue.

Located just west of the new road near the 8km peg, gilgai (hummocky) country and 'dozer has shown uneven nature of suboutcrop surface. Beneath 15cm of overburden, 20cm of hard dark greyish-brown clay impregnated with spicular epsomite crystals.

Sample 8361 — Ca 0.12 (0.29), Mg 1.65 (6.60), Na 0.79 (1.66), SO_4 8.05%
Sample height 0.35m; % x ht = 0.85 Code blue (green + 8360)

Same location, but sampled crumbly dark grey shales with low grade granular sulphate minerals. Area mottled with rafts of buff limestone.

Sample 8362 — Ca 0.13 (0.31), Mg 0.46), 1.84), Na 1.11 (2.33), SO_4 3.76%
Sample height 0.25m; % x ht = 0.39 Code blue.

Sample collected below northwest face of main gypsite plateau. Sediments are pale buff decomposed siltstones to very fine-grained santstones. Trace only of epsomite. Higher sodium levels may be due to halite.

Sample 8363 — Ca 1.15 (2,76), Mg 3.73 (14.92), Na 3.61 (7.58), SO_4 28.4%
Sample height 0.5m; % x ht = 3.67 Code orange.

Sample collected from gently-sloping bank of tributary north of Halfway Creek, 20cm soft overburden covering a thin limonitic (jarosite?) layer over 20cm of high grade salt cake, followed by lower grade granular sulphate minerals in crumbly shales with sandy laminae. Some spikey bloedite. Abundant gypsum float.

Sample 8364 — Ca 1.48 (3.55), Mg 0.54 (2.16), Na 0.46 (0.97), SO_4 6.30%
Sample height 0.12m; % x ht = 0.12 Code blue.

Located approx. 400m to the southeast, 1.5m thickness of Benitos Clay over laminated grey shales. 10-12cm of granular and spicular sulphate minerals. The higher calcium value is probably due to the effect of the clay cover. The inhibiting effect on sulphate accumulation is obvious.

Sample 8365 — Ca 0.40 (0.96), Mg 1.01 (4.04), Na 0.79 (1.66), SO_4 5.90%
Sample height 0.8m; % x ht = 1.44 Code green.

A southeast-facing river bank in Halfway Creek with 10cm overburden, moderate grade granular sulphate for 20-25cm changing to spicular epsomite in moist dark grey shales with irregular sandy laminae. Limestone fairly abundant.

Sample 8366 — Ca 0.30 (0.72), Mg 2.56 (10.24), Na 1.08 (2.27), SO_4 13.7%
Sample height 0.3m; % x ht = 1.09 Code green.

Collected approx. 6m behind bank, 10cm overburden, 30cm brown clay over crumbly shales with granular sulphate minerals. No salt cake. Salt accumulation is less than on the bank face.

Sample 8367 Ca 0.34 (0.82), Mg 2.10 (8.40), Na 1.62 (3.40), SO_4 11.5%
Sample height 0.5m; % x ht = 1.86 Code green.

North-facing bank in Halfway Creek, with moderate salt cake (25cm) beneath overburden made up of shale fragments (perhaps not so bentonitic?), then lower grade granular, spicular and occasional fibrous sulphate minerals. Minor bloedite, limestone lenses. Values less than expected.

Sample 8368 Ca 0.31 (0.74), Mg 0.93 (3.72), Na 0.99 (2.08), SO_4 4.83%
Sample height 0.4m; % x ht = 0.77 Code blue.

South-facing river bank capped by 60cm red-brown clay, 20cm at top barren, then 20cm of fair sulphate (amorphous and spicular), over 20cm of almost nil. Shales below have negligible sulphate. Inhibiting effect of transported clay is obvious.

Sample 8369 Ca 0.25 (0.60), Mg 1.71 (6.84), Na 1.69 (3.55), SO_4 8.16%
Sample height 0.6m; % x ht = 2.04 Code yellow.

Located only 10m to the west of 8368 on same river bank where no clay cover. Sulphate minerals to within 5cm of surface, crumbly shale from surface with granular, spicular and fibrous sulphate. Salt rosettes as at discovery area. Very minor limestone. Contrast with 8368.

Sample 8370 Ca 0.81 (1.94), Mg 1.77 (7.08), Na 1.55 (3.26), SO_4 7.03%
Sample height 0.55m; % x ht = 1.83 Code green.

Near western boundary on southeast-facing bank of Halfway Creek. Salted crumbly grey shales with limonitic (jarositic?) banding, crumbly granular grading down into lower grade spicular epsomite. Gypsum plates. Not far below base of Upper Member. Less silty than G.G. Creek.

Sample 8371 Ca 0.60 (1.44), Mg 0.71 (2.84), Na 0.73 (1.53), SO_4 5.02%
Sample height 0.45m; % x ht = 0.65 Code blue.

Collected on southwest-facing steep bank of Oolgelima Creek 6-7m high. Scattered clusters of spicular epsomite in dark grey shale partings beneath top 15cm which appears leached (no granular sulphate), then almost barren. Shales have sandy laminations. Clay cover to edge of bank.

Sample 8372 Ca 0.68 (1.63), Mg 0.73 (2.92), Na 0.47 (0.99), SO_4 5.36%
Sample height 0.3m; % x ht = 0.36 Code blue.

Gilgai country west of Atomic Bomb area (refer 60/61), dark surface littered with gypsum 10cm overburden and clay, then 30cm residual clay with spicular crystal growths in cavities, minor amorphous sulphate. Scattered rafts of limestone.

Sample 8373 Ca 2.27 (5.45), Mg 1.17 (4.68), Na 0.83 (1.73), SO_4 6.48%
Sample height 0.3m; % x ht = 0.56 Code blue.

Same location as 8372, sampled top 30cm of crumbly shales with weak granular and minor spicular sulphate. High calcium may just reflect abundant gypsum.

Sample 8374 Ca 0.036 (0.09), Mg 1.19 (4.76), Na 0.83 (1.73), SO_4 6.48%
Sample height 0.45m; % x ht = 0.91 Code blue.

Collected from low bank of tributary flowing into Atomic Bomb area, beneath 15cm soft residual overburden 20cm granular salts and decomposed shale transitional to less crumbly shale with low grade spicular epsomite. Abundant limestone, with some phosphatic ironstone caps.

Sample 8375 Ca 0.45 (1.08), Mg 0.88 (3.52), Na 0.71 (1.49), SO_4 5.60%
Sample height 0.45m; % x ht = 0.72 Code blue.

Located 10m north of 8374 in heaving dark brown residual clay with granular and amorphous salts below 10cm changing to spicular epsomite below. Shales not exposed. Some of the clay may not be residual. Impedes near surface salt enrichment.

Sample 8376 Ca 0.69 (1.67), Mg 0.77 (3.08), Na 0.73 (1.53), SO_4 6.01%
Sample height 0.3m; % x ht = 0.45 Code blue.

Located just north of Atom Bomb area in dark brown gilgai flats, beneath 10cm of overburden and clay, then 30cm of cracked, crumbly Benitos Clay with narrow line of white amorphous sulphate above weak spicular epsomite. Clay continues below 40cm and is damp.

Sample 8377 Ca 0.21 (0.50), Mg 2.51 (10.04), Na 2.18 (4.58), SO_4 14.9%
Sample height 0.55; % x ht = 2.58 Code yellow.

Small north-flowing tributary north of Atom Bomb area, low south-facing bank, 15cm overburden and blackish clay over dark grey crumbly shales, no sandy laminae, narrow 5cm salt cake, 30cm granular sulphates over spicular and some fibrous epsomite. Abundant limestone.

Sample 8378 Ca 0.22 (0.53), Mg 1.41 (5.64), Na 1.40 (2.94), SO_4 6.48%
Sample height 0.65m; % x ht = 1.83 Code green.

Sampled on south-facing bank of Discovery Creek, fair grade of sulphate mineralisation with 10cm of crumbly salt cake above crumbly laminated shales with iron banding with granular then spicular crystals below. Some bloedite. Abundant limestone. Clay layer to the north.

Sample 8379 Ca 0.38 (0.91), Mg 0.83 (3.32), Na 0.70 (1.47), SO_4 5.26%
Sample height 0.4m; % x ht = 0.61 Code blue.

Long exposure of shales on south-facing bank, numerous buff sandy intercalations and shales tend towards silty shales. Beneath 15cm of overburden and clay, weak granular and spicular sulphate, then spicular only. Abundant limestone, not much gypsum. Lithology not prospective?

Sample 8380 Ca 1.63 (3.91), Mg 1.96 (7.84), Na 1.10 (2.31), SO_4 13.6%
Sample height 0.6m; % x ht = 1.84 Code green.

Sample collected from flat country east of road, 2km northeast of Dog Fence outside E.L. Bulldozer cut showing 50cm red clay, 25cm residual black clay with sulphate impregnations, then limonitic band over crumbly shale with some granular aggregates dying out rapidly below 20cm. Total sulphate zone 40-45cm.

Sample 8381 Ca 1.74 (4.18), Mg 1.90 (7.60), Na 1.77 (3.72), SO_4 15.9%
Sample height 0.4m; % x ht = 1.47 Code green.

South-facing bank of Discovery Creek west of road, abundant limestone and gypsum plates, beneath 10cm overburden and 25cm residual clay over crumbly shales (top marked by limonitic band) with granular sulphates giving way to spicular epsomite. Minor bloedite at base of sample.

Sample 8382 Ca 0.32 (0.77), Mg 2.77 (11.08), Na 2.07 (4.35), SO_4 16.2%
Sample height 0.4m; % x ht = 1.94 Code green.

Southwest-facing bank with abundant limestone and gypsum, grey shales with sandier laminae showing mica, 10cm overburden, 10cm residual clay, then fair grade granular sulphates for 10cm followed by 30cm of very low grade.

Sample 8383 Ca 1.10 (2.64), Mg 1.72 (6.88), Na 1.74 (3.65), SO_4 11.2%
Sample height 0.6m; % x ht = 2.08 Code yellow.

North-facing bank of Discovery Creek 4-5m high with 10cm overburden, then crumbly finely-laminated shales with granular sulphate and gypsum pseudomorphing after epsomite. Abundant limestone. Possible glauberite present?

Sample 8384 Ca 0.38 (0.91), Mg 0.92 (3.68), Na 0.59 (1.24), SO_4 5.50%
Sample height 0.4m; % x ht = 0.60 Code blue (green + 8385)

Same location as 8385, very decomposed dark grey shales with limonitic (jarositic?) layers, mainly granular, some spicular sulphate, low grade continues further down.

Sample 8385 Ca 0.085 (0.20), Mg 1.62 (6.48), Na 0.81 (1.70), SO_4 8.27%
Sample height 0.3m; % x ht = 0.73 Code blue.

Gilgai country 10m behind river bank, 10cm loose overburden, 40cm salt impregnated dark greyish-brown clay with fine to coarse spicular epsomite. Below are shales.

Sample 8386 Ca 0.085 (0.20), Mg 0.03 (12.12), Na 2.05 (4.31), SO_4 15.7%
Sample height 0.7m; % x ht = 3.56 Code orange.

River bank near above 2 samples, southeast-facing, gradual slopes. Abundant limestone. High grade salt cake 15cm beneath usual 10cm overburden, then crumbly dark grey shales with granular sulphates plus coarse fibrous sulphate veinlets as 8383, but definitely epsomite.

Sample 8387 Ca 0.072 (0.17), Mg 0.78 (3.12), Na 0.92 (1.93), SO_4 4.91%
Sample height 0.5m; % x ht = 0.85 Code blue.

East-facing 1m high bank rimmed with red-brown clay, off main creek channel, 5cm overburden, 15cm clay, dark grey shales (no laminae) with mainly spicular epsomite (low grade), minor amorphous and granular. Minor limestone, abundant gypsum.

Sample 8388 Ca 0.36 (0.86), Mg 0.41 (1.64), Na 0.49 (1.03), SO_4 3.03%
Sample height 0.3m; % x ht = 0.27 Code blue.

Sample collected from steep southwest-facing bank capped with red-brown clay for 40cm then 20cm of transition through residual clay to hard grey shales or mudstones - a few fine laminations. Limestone in places. Only trace of sulphate in top 30cm of shales.

Sample 8389 Ca 0.16 (0.38), Mg 1.88 (7.52), Na 1.85 (3.89), SO_4 11.1%
Sample height 0.45m; % x ht = 1.68 Code green.

Long low outcrop area facing northwest, crumbly dark grey shales with 10cm of impure salt cake above 35cm of salted (granular) shales and spikey bloedite crystals at depth. Splashes of mustard yellow jarosite (?). Abundant limestone.

Sample 8390 Ca 0.17 (0.41), Mg 4.70 (18.80), Na 4.92 (10.33), SO_4 33.5%
Sample height 0.35m; % x ht = 3.37 Code orange (red + 8391)

Soft blackish soil area littered by gypsum, small limestone rafts, 5cm overburden, 15cm crumbly amorphous-granular material over 20cm high grade hard salt cake. Area west of gypsite hill near southern boundary.

Sample 8391 Ca 0.17 (0.41), Mg 3.47 (13.88), Na 2.77 (5.82), SO_4 19.7%
Sample height 0.25m; % x ht = 1.61 Code green (red + 8390)

Same location as 8390, decomposed to crumbly shales with granular sulphate minerals and small granular aggregates - continues deeper. Minor spikey bloedite.

Sample 8392 Ca 0.19 (0.46), Mg 2.02 (8.08), Na 1.94 (4.07), SO_4 10.3%
Sample height 0.55m; % x ht = 2.18 Code yellow.

Tributary bank southeast of Discovery Creek, black shales with occasional fine sandy laminae. 10cm overburden over 10cm of crumbly salt cake/ amorphous powdery sulphate over 45cm of crumbly shales with mainly granular sulphate and some spikey bloedite.

Sample 8393 Ca 0.11 (0.26), Mg 3.02 (12.08), Na 2.21 (4.64), SO_4 17.9%
Sample height 0.8m; % x ht = 4.18 Code red (lilac + 8394)

Gentle south-facing soft black slope, earlier pitted by Tayler (plate 4), chip channel sample of south face after new sulphate encrustation removed. Shales finely laminated. All except bloedite crystals have deliquesced to white powdery material. No limestone.

Sample 8394 Ca 0.37 (0.89), Mg 2.98 (11.92), Na 2.66 (5.59), SO_4 18.6%
Sample height 0.8m; % x ht = 4.51 Code red (lilac + 8393)

Lower half of above backhoe pit, notable that Na values increase with depth while Mg decreases marginally. Bloedite crystals at depth.

Sample 8395 Ca 0.066 (0.16), Mg 2.27 (9.08), Na 2.40 (5.04), SO_4 15.02%
Sample height 0.6m; % x ht = 2.80 Code yellow.

Large gypsum-littered, dark greyish-brown soft area similar to 93/94 yet not so black, 60cm of granular sulphate with 50cm white amorphous layer at top in grey (not dark grey) shales, scattered granular aggregates. Continues to greater depth. Abundant limestone.

Sample 8396 Ca 0.30 (0.72), Mg 1.42 (5.68), Na 1.43 (3.00), SO_4 6.97%
Sample height 0.75m; % x ht = 2.14 Code yellow.

Northwest-facing bank 400m north of discovery site, 4m high bank showing absence of limestone, clay almost to edge, dark grey shales with irregular buff laminae. Sulphate mainly spicular epsomite, some granular throughout. Disappointing sulphate values.

Sample 8397 Ca 0.029 (0.07), Mg 4.48 (17.92), Na 4.08 (8.59), SO_4 28.5%
Sample height 0.9m; % x ht = 7.70 Code lilac.

Discovery site, sampled approx. 5m northeast of backhoe cut. Dark grey waxy shales without laminae. High grade mixture of granular aggregates and minor spicular epsomite. A few salt rosettes and bloedite in basal section.

DISCUSSION

The recent programme of reconnaissance scale geological mapping and chip channel sampling has improved the writer's understanding of the various factors which have an effect on the localisation of water soluble magnesium and sodium sulphate salts. The three main factors which emerge as being of significant importance are:

1. Lithology,
2. Physiographic setting, and
3. Transported overburden.

Lithology is a term meaning the description of rocks, usually from observation of the hand specimen or outcrop - mainly for sedimentary clastic rocks. Lithologic variations refer to changes in composition and texture of the sediments. An earlier section of this report dealt with the depositional environment of the lower member of the Bulldog Shale; it has been described as restricted marginal marine. It is quite clear that both the composition and texture of the lower member sediments change perceptibly both laterally and vertically. Among the variations are lighter grey silty shales with fine-grained sandstone intercalations, dark grey carbonaceous shales, and laminated shales with or without cone-in-cone limestones, to name a few. The chemical composition of the sediments themselves would also vary widely depending upon the actual clastic constituents and the clays. Thus far, it seems that the concentration of water soluble magnesium and sodium sulphate salts at or near the surface tends to be maximised above and within dark grey to black waxy shales with or without fine laminations. The abundant presence of gypsum plates is another characteristic sign, while limestones are neither a positive nor a negative influence.

The fact that an excess of sulphate was reported from most of the anomalous samples could be an indication that the presence of shales with bentonitic characteristics, i.e. the retention and subsequent slow release of moisture caused by a predominance of montmorillonitic clays, is an important lithologic characteristic. The writer has doubts about the genetic importance of the scattered salt rosettes noted in the December report and observed again in a number of localities. It is now felt that these are secondary rather than primary sedimentary features, representing an early stage in the capillary transportation of water soluble salts towards the surface.

Considerable thought has been given to the idea of drilling two or three stratigraphic holes through the lower member of the Bulldog Shale into the Cadna-Owie Formation. The drilling would give interesting but, from an exploration point of view, largely academic information of the lithological variations, especially those sections which possess anomalous magnesium and sodium backgrounds, of the lower member sediments. The simple fact remains - unless a favourable lithology is exposed on the present land surface, one cannot expect a build-up of soluble sulphate salts to have occurred. The knowledge of the approximate depth to that favourable lithology at any point in the licence area (from the stratigraphic drilling) is really of no value in the exploration/economic sense. However, drilling would be most useful in a concerted search for bentonite layers.

The physiographic setting of the sample collection site has a lot to do with the values recorded from the chemical analyses. Incontrovertible evidence of higher grade soluble sulphate mineralisation on north-facing exposures contrasted against those facing south was gathered from a number of sample locations. In general, the richest concentrations of soluble sulphates occurred at or near the crest of creek embankments in which several metres' height of shales are exposed. This is the point at which one would expect the effects of capillary action to be maximised, not only because of the much larger surface expanse of shale "source rocks", but also because of the added influence of moisture left behind after the creek run-off. Salt values tend to decrease somewhat behind the embankments; the only exception was a location where a south-facing exposure (8351) produced lower values than a sample (8352) on the more level ground behind - where the effects of the sun were more keenly felt. Somewhat less important are cases in breakaway country where shales have recently been exposed; salts have apparently been leached away by surface waters in and immediately adjacent to incised gullies.

The inhibiting effect of a cover of transported overburden, commonly the red-brown Benitos Clay and less commonly Oolgelima Gravel, upon the ability of the underlying shales to produce concentrations of soluble sulphate salts is undeniable. Numerous examples of riverbank exposures of prospective shales covered with a half-metre or more of Benitos Clay were seen to have only traces of epsomite crystals. Contrast the values at 8396 some 300-400 metres north of the discovery site with those at 8397, immediately adjacent to the backhoe cut. The difference results from the fact that a cover of Benitos Clay comes to within a metre or two of the riverbank face at 8396; at 8397 the clay has been stripped off for some 150-200 metres to the east. The lower member sediments do themselves develop a dark greyish-brown residual clay some 10-40cm thick in places. In contrast to the transported overburden, the residual clay does not grealty impede the concentration of soluble salts. In fact, it is often impregnated with spicular epsomite overlying more granular salts within the crumbly shales beneath.

ECONOMIC GEOLOGY

The reconnaissance scale of the exploration work thus far completed precludes any definitive comment on the economic geological aspects of the project. However, a number of positive economic aspects have made themselves apparent, namely,

(1) The observed sulphate mineralisation is widespread in its occurrence and represents a potential resource of some magnitude.

(2) The mineralisation is soft, friable and occurs virtually at surface and could be mined by the most efficient and low cost methods, e.g. employing large earth-moving equipment (self-loading scrapers).

(3) Coober Pedy is an established community of some 3500 residents so that infrastructure costs will be absolutely minimal. Apart from senior technical staff, the township is capable of supplying all the necessary labour.

(4) The new Tarcoola-Alice Springs railway passes 38km to the west-north-west of Coober Pedy. The sealing of the Stuart Highway to Adelaide is expected to be completed during 1984.

(5) There is an ample supply of relatively low chloride groundwater at shallow depth beneath the Bulldog Shale (see section following). This supply is of great importance to the viability of the project.

Further, more detailed geological work, including test pitting, will be directed at the delineation of areas of consistently high grade mineralisation. This work will then permit the calculation of possible ore reserves. In this particular context the term "ore" is not at all easy to define. While the geologist will be able to calculate a potential resource of "x" tonnes at "y" grade, it will take the combined skills of a mining engineer and a chemist/metallurgist to define whether or not the potential resource is economically viable, i.e., is the mineralisation really "ore" in the established sense?

GROUNDWATER

The availability of substantial reserves of low-chloride groundwater will be of great importance to the viability of this project and some preliminary investigations into the local hydrogeology have been carried out with encouraging results.

Drilling undertaken during May, 1975 of Australian Selection (Pty.) Limited in exploration for coal resulted in the discovery of significant quantities of brackish groundwater in the Jurassic Algebuckina Sandstone and the Cretaceous Cadna-Owie Formation. The mesozoic units, which together comprise the acquifer and average 60m in thickness, are coarse to medium-grained relatively unconsolidated sands with minor fine sand, silts and silty shale layers. Five of the 14 holes drilled lie within the licence area. All the holes struck groundwater at depths from 14 to 37 metres. Two holes struck unconfined groundwater while the other three struck water under pressure which rose varying depths into the overlying and confining lower member of the Bulldog Shale. The salinity varied from 2880 to 4300 mg/litre (ppm) with groundwater flows from 23 to 91 m^3/hr or 5000 to 20000 gallons per hour. A full water analysis of a sample from 38m depth in hole MU-2 returned the following result: Ca 225 ppm, Mg 130 ppm, Na 835 ppm, K 47 ppm, HCO_3 (bicarbonate) 247 ppm, SO_4 754 ppm and Cl (chloride) 1398 ppm. The water table was at a depth of 8m, while the top of the Cadna-Owie Formation was at 14m. The total dissolved salts at 38m was 3516 ppm, while a sample higher up reported 3900 ppm.

A sample of bore water was collected from the Highways bore near the 5km peg. Cuttings around the collar of the hole consisted of iron-stained aeolian sand and fragments of medium-grained quartz sandstone. the water returned the following analysis: Ca 405 ppm, Mg 150 ppm, Na 970 ppm, K 45 ppm, HCO_3 157 ppm, SO_4 2330 ppm, and Cl 791 ppm. The total dissolved salts are 4854 ppm. The values are reasonably consistent with those from Selection's MU-2, with the exception of the higher SO_4 value.

The low potassium values remain something of an enigma considering the readily available potassium sulphate content of the extensive alunite deposits within the upper member of the Bulldog Shale. The question remains: where has the potassium gone? A sentence in the report by Mason of Australian Selection on the Giddi Gidina groundwater discovery caught the writer's eye: "Water at the top of the Cadna-Owie Formation, at its contact with the overlying gypsiferous Bulldog Shale, is generally about 40% more saline than the remainder of the aquifer." Mason also states that the intake along the courses of Giddi Giddina and Oolgelima Creeks has been facilitated through structural lineaments where the shale cover is thin. These two major creek systems would have carried significant quantities of dissolved potassium salts during the erosion of the laterised upper member. Evidence for the extensive nature of the alunite deposits lies in the Oolgelina Gravel, where up to 35% of the clasts were originally alunite. Does the top of the Cadna-Owie acquifer represent a potential source of potassium sulphate, as well as higher values in magnesium and sodium? The writer feels that the possibility of the existence of a brine pool from which salts can be produced direct from simple solar panning is worth some further investigation.

CONCLUSIONS

(1) Geological mapping and reconnaissance rock-chip sampling of Exploration Licence 1155 has confirmed the widespread occurrence of soluble sulphate salts in shales of the lower member of the Bulldog Shale beneath a thin veneer of residual overburden.

(2) The highest grade and greatest thickness of soluble sulphate mineralisation seems to develop under the following optimum conditions: dark grey waxy shales with bentonitic characteristics, a north-facing exposure in a river embankment and the absence of allochthonous (transported) overburden, e.g. Benitos Clay.

(3) There is little doubt the salts accumulate near the surface as a direct result of the capillary action of saline groundwater and that a cover of transported overburden tends to inhibit that action.

(4) Assay data shows that the grade of soluble sulphate mineralisation varies widely but, in general, the better grades are concentrated in the southwest corner of the licence area. The northern one-third is less prospective, apparently due to the presence of a somewhat more silty to sandy sedimentary facies in the lower member of the Bulldog Shale.

(5) Assay data also reveals that, in general, percentages of sodium and magnesium ore at similar levels, or in a ratio of 35:65 as anhydrous mineral equivalents.

(6) From the economic geological viewpoint it is not yet feasible to define possible ore reserves simply because of the reconnaissance scale nature of the work thus far completed. It is, nevertheless, clear that these early results point towards the presence of a resource of some magnitude.

RECOMMENDATIONS

(1) It is recommended that a programme of further exploration be carried out on the areas listed below in order to acquire much-needed semi-quantitative data to be used in grade and reserve estimations. The areas warranting follow-up work in the form of backhoe pitting and sampling to study the vertical extent and grade of the mineralisation are listed below:

(a) South of the discovery site.
(b) In the vicinity of samples 8393-94.
(c) East and west of the gypsite hill near samples 8390-91.
(d) East of sample 8356.
(e) Between Discovery and Halfway Creeks, just west of the road.
(f) Near the 14km peg on the Oodnadatta road.
(g) Between the 20 and 23km pegs.
(h) North of Giddina Creek near the western boundary.
and (i) Halfway Creek northwest of samples 8368-69.

(2) It is also recommended that as the logical conclusion of the purely geological aspects of the project is in sight the services of a competent Mining Engineer and a competent Metallurgist be sought out with the express objective of examining the economic viability of the soluble sulphate mineralisation delineated by the follow-up work. It seems certain that a detailed investigation of the metallurgy of the sulphate mineralisation by an organisation such as Amdel will be warranted.

Adelaide S.A.
12th December 1983

D.L. Seymour
Consultant Geologist

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APPENDIX

Plate 1 : Embankment of Oolgelima Creek at sample location 8329-30. Red brown Benitos Clay (50cm) overlying Oolgelima Gravel (45cm) unconformably overlying lower member of Bulldog Shale. Low grade mineralisation only.

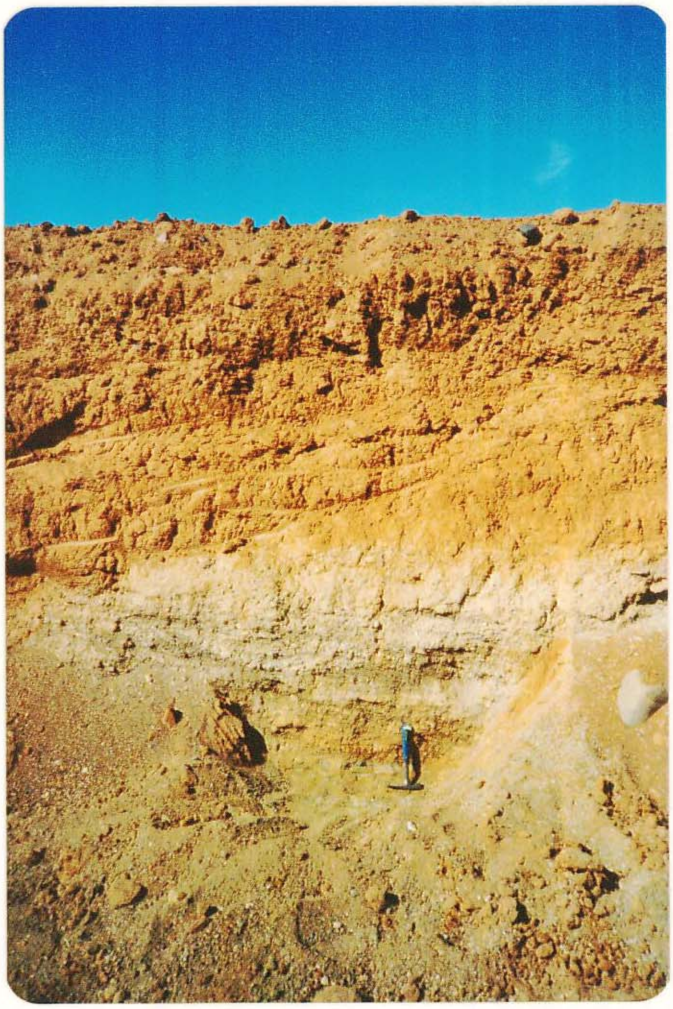

Plate 2 : Exposure of Benitos Clay (1.2m) overlying Oolgelima Gravel (90cm) over lower member shales in Highways Quarry. Sample location 8326 - very low grade.

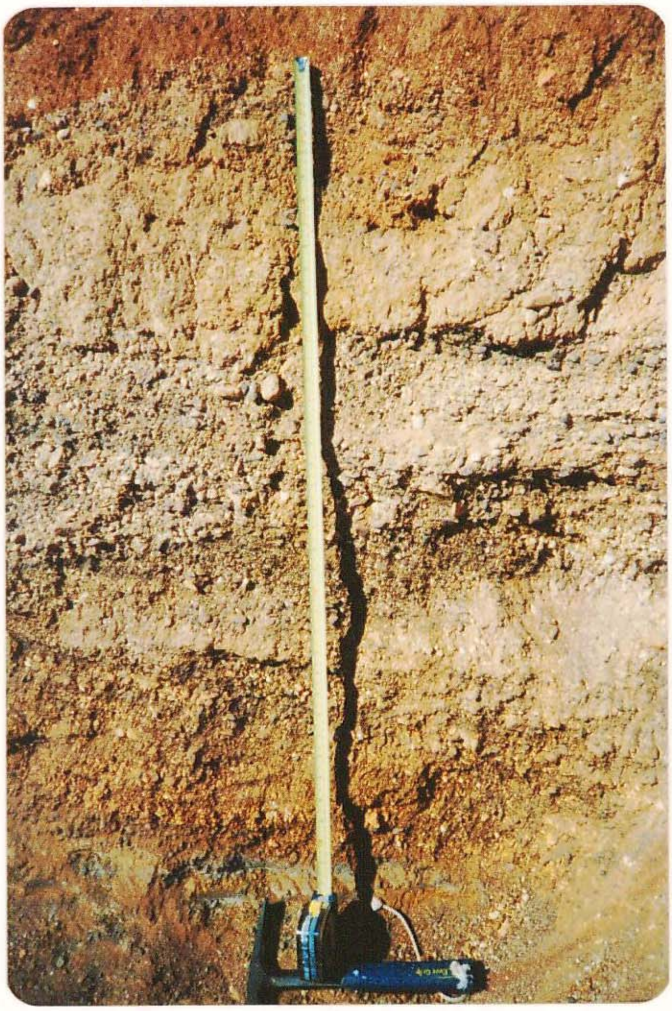

Plate 2a : Close-up of Oolgelima Gravel, poorly sorted with silt/clay layers and obvious white/cream clasts after alunite.

Gypsite crust

Upper member
siliceous shales

Limestone contact

Lower member
laminated shales

Plate 3 : Scarp near sample location 8357 showing limestone on contact between upper and lower members of Bulldog Shale. Note gypsum float in foreground ex lower member.

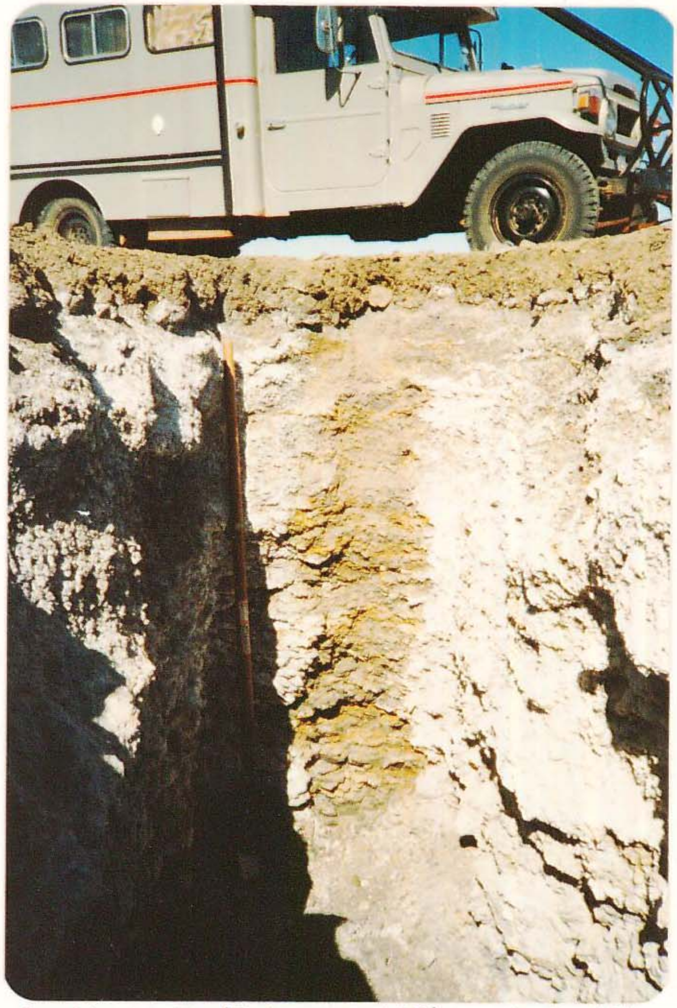

Plate 4 : Backhoe pit (February '83) coated with sulphate efflorescences, chip channel sampled in July '83 - Nos. 8343-94

Plate 5 : Looking southeast towards above sample pit from near edge of Benitos Clay cover; note change in colour of overburden.

Aminco and Associates

Plate 6 : Benitos Clay directly overlying lower member shales at sample location 8364. Halfway Creek area.

Plate 6a : Close-up of weak epsomite band (white) due to inhibiting effect of clay cover. Compare with high values at 8363 nearby where no clay cover.

Plate 7 : Abandoned bore near north bank of Giddi Giddina Creek (line of trees) and sample location 8349. Typical surface above thick Benitos Clay.

0045

Plate 8: Discovery area in August 1983 showing abundant sulphate mineralisation in creek embankment

Plate 9: Backhoe cut eight months after excavation, with cone-in-cone limestone layer

Plate 10: Backhoe cut showing heavy surface salt encrustations in upper section

Plate 11: Highways Dept. bore from which water sample was collected

(x)

The Australian
[M]ineral Development
Laboratories

[...]ington Street, Frewville,
South Australia 5063
[P]hone Adelaide 79 1662
Telex AA 82520

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SA 5063
In reply quote:

amdel

3/0/0 - AC 210/84

5 August 1983

NATA CERTIFICATE

0046

Mr. P. Taylor,
Managing Director,
Evaporite Minerals (S.A.) Pty. Ltd.,
Box 302, P.O.,
KINGSWOOD, S.A. 5062

REPORT AC 210/84

YOUR REFERENCE:	Application received 21.7.83
IDENTIFICATION:	As listed
DATE RECEIVED:	21 July 1983

D. Patterson
Chief Chemist

for B. Hickman
Managing Director

cc Mr. David L. Seymour,
Aminco & Associates Pty. Ltd.,
"Hawk Hill",
CRAFERS, S.A. 5152

cjw

CALCIUM % × 2.4 = ANHYDRITE × 1.26 = GYPSUM. $CaSO_4.2H_2O$.

MAGNESIUM % × 4.0 = ANHYDROUS $MgSO_4$ × 1.30 = BLOEDITE

SODIUM % × 2.1 = ANHYD Na_2SO_4 (THENARDITE) × 1.25 = BLOEDITE.

(Na_2SO_4. $MgSO_4$. $4H_2O$)

[...]t Plant: Osman Place
Thebarton S.A.,
Telephone 43 8053
Branch Laboratories:
Perth W.A.
Telephone 325 7311
Melbourne Vic.
Telephone 645 3093

NATA

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THE AUSTRALIAN MINERAL DEVELOPMENT LABORATORIES

0049

FORM 38

REPORT AC 210/84

ANALYSIS %

Sample Nº	Water soluble Ca	Mg	Na	K	SO_4			
8326	0.26	0.082	0.15	0.010	0.84			
27	1.16	0.73	1.19	0.075	7.15			
28	0.47	0.83	0.99	0.050	5.91			
29	1.09	0.46	0.39	0.035	4.76			
30	0.95	0.70	0.59	0.055	5.58			
31	0.34	6.23	4.85	0.060	41.2			
32	0.62	2.08	1.92	0.085	10.6			
33	4.08	0.50	0.43	0.080	12.8			
34	1.52	0.82	0.76	0.050	7.64			
35	0.18	2.39	2.64	0.12	16.7			
36	0.12	1.55	1.52	0.055	8.24			
37	0.61	1.13	0.87	0.060	7.17			
38	1.12	0.74	0.77	0.045	6.18			
39	0.12	2.42	1.89	0.065	14.3			
40	0.96	1.59	1.67	0.060	9.24			
41	0.26	1.05	1.24	0.060	6.40			
42	0.15	1.91	2.31	0.050	11.7			
43	1.05	1.23	1.18	0.055	9.31			
44	0.32	2.25	1.90	0.080	10.3			
45	0.62	1.32	1.23	0.070	5.83			
46	0.11	1.72	2.15	0.060	8.95			
47	0.68	0.89	0.83	0.055	6.78			
48	0.070	2.77	2.00	0.060	16.0			
49	0.36	0.41	2.55	0.060	12.2			
8350	0.16	0.92	1.82	0.030	6.37			

METHOD: I3.

THE AUSTRALIAN MINERAL DEVELOPMENT LABORATORIES

0050

FORM 38

REPORT AC 210/84

ANALYSIS %

Sample Nº	Ca (Water soluble)	Mg (Water soluble)	Na (Water soluble)	K (Water soluble)	SO4 (Water soluble)			
8351	0.70	1.18	1.23	0.040	7.70			
52	0.20	2.81	2.65	0.055	16.0			
53	0.23	1.81	2.51	0.050	11.8			
54	0.26	1.33	1.15	0.055	7.83			
55	0.23	3.31	2.66	0.075	19.5			
56	2.03	0.85	0.83	0.040	10.3			
57	0.17	0.59	1.04	0.035	4.35			
58	2.84	0.40	0.50	0.065	9.32			
59	3.88	0.44	0.43	0.055	11.9			
60	0.32	1.12	0.62	0.060	6.15			
61	0.12	1.65	0.79	0.060	8.05			
62	0.13	0.46	1.11	0.030	3.76			
63	1.15	3.73	3.61	0.055	28.4			
64	1.48	0.54	0.46	0.060	6.30			
65	0.40	1.01	0.79	0.055	5.90			
66	0.30	2.56	1.08	0.050	13.7			
67	0.34	2.10	1.62	0.080	11.5			
68	0.31	0.93	0.99	0.050	4.83			
69	0.25	1.71	1.69	0.060	8.16			
70	0.81	1.77	1.55	0.060	7.03			
71	0.60	0.71	0.73	0.055	5.02			
72	0.68	0.73	0.47	0.060	5.36			
73	2.27	1.17	0.68	0.050	11.9			
74	0.036	1.19	0.83	0.060	6.48			
8375	0.45	0.88	0.71	0.060	5.60			

METHOD:

THE AUSTRALIAN MINERAL DEVELOPMENT LABORATORIES

FORM 38

REPORT AC 210/84

ANALYSIS %

Sample Nº	Ca	Mg	Na	K	SO4			
	WATER SOLUBLE							
8376	0.69	0.77	0.73	0.070	6.01			
77	0.21	2.51	2.18	0.070	14.9			
78	0.22	1.41	1.40	0.060	6.48			
79	0.38	0.83	0.70	0.060	5.26			
80	1.63	1.96	1.10	0.050	13.6			
81	1.74	1.90	1.77	0.060	15.9			
82	0.32	2.77	2.07	0.070	16.2			
83	1.10	1.72	1.74	0.055	11.2			
84	0.085	1.62	0.81	0.055	8.27			
85	0.38	0.92	0.59	0.060	5.50			
86	0.085	3.03	2.05	0.095	15.7			
87	0.072	0.78	0.92	0.045	4.91			
88	0.36	0.41	0.49	0.050	3.03			
89	0.16	1.88	1.85	0.075	11.1			
90	0.17	4.70	4.92	0.060	33.5			
91	0.17	3.47	2.77	0.10	19.7			
92	0.19	2.02	1.94	0.065	10.3			
93	0.11	3.02	2.21	0.11	17.9			
94	0.37	2.98	2.66	0.075	18.6			
95	0.066	2.27	2.40	0.090	15.0			
96	0.30	1.42	1.43	0.065	6.97			
8397	0.029	4.48	4.08	0.11	28.5			

METHOD:

MINERAL RESEARCH & DEVELOPMENT PTY. LTD.

Hendon Industrial Park
113 Tapleys Hill Rd., Hendon 5014

Telephone:
(08) 268 8065

REPORT ON WATER SAMPLE.

SUBMITTED BY D.L. SEYMOUR - ACCOUNT EVAPORITE MINERALS PTY. LIMITED.

CALCIUM	(Ca)	406 parts per million.
MAGNESIUM	(Mg)	150 " " "
POTASSIUM	(K)	45 " " "
SODIUM	(Na)	970 " " "
BICARBONATE	(HCO_3)	157 " " "
PHOSPHATE	(PO_4)	3.5 " " "
CHLORIDE	(Cl)	790 " " "
SULPHATE	(SO_4)	2330 " " "
NITRATE	(NO_3)	3.5 " " "
TOTAL SALTS		4854 " " "
pH		7.2

For further information refer to Dr. P.A.L. Muthiah .

Pontifex & Associates Pty. Ltd. 0053

TEL. 332 6744
A.H. 31 3816

26 KENSINGTON ROAD, ROSE PARK
SOUTH AUSTRALIA

P.O. BOX 91, NORWOOD
SOUTH AUSTRALIA 5067

MINERALOGICAL REPORT NO. 4111

19th August, 1983

TO:	Mr. David Seymour, Aminco & Associates Pty. Ltd., P.O. Box 88, CRAFERS, S.A. 5152
YOUR REFERENCE:	Sample delivered 17/8/83
MATERIAL:	Rock sample
IDENTIFICATION:	93/94
WORK REQUESTED:	Thin section preparation, comment on possible volcanic content
SAMPLE & SECTION:	Retained, awaiting your collection

PONTIFEX & ASSOCIATES PTY. LTD.

93/94 : claystone (of ?montmorillonitic composition, in contact with bed and lens of clayey, silty, fine to medium sandy sediment, including gypsum, quartz grains, ?glauconitic to ?jarositic material, without any evidence of a volcanic contribution

Most of this sample consists of a fairly continuous to lenticular bed of "clays" about 12 mm thick. This clay could not be specifically identified optically, but it is extremely sensitive to water, and there is no positive evidence of a significant sericitic (illitic) component. They clay may thus be montmorillonitic.

This clay bed grades vertically in one direction (?down) into a silty to fine sandy layer. It forms a sharper contact with a thin lens of fine to medium sandy fabric in the other ?up) direction. These sandy layers have a clay-rich matrix similar in composition to the bed described above, but this matrix contains a loose-packed aggregate of grains of unsorted silt to coarse sand size of the following composition :-

fragments of clay	15 - 20%
fragments of "shredded" gypsum	15 - 20%
fragments of yellowish to weakly greenish, turbid, cryptocrystalline or amorphous, possible jarosite, but transitional in colour and optical characteristics to possible glauconitic material	25 - 30%
angular quartz grains (more in the sandy lens, than in the bed)	7 - 12%
angular felspar grains	1 - 2%
detrital micas (mainly fine muscovite)	5 - 7%

The quartz grains have an angular to splintery form, which of course may be found in fine tuff (ash) deposits, however, this is not specifically diagnostic of an exclusively volcanic source. Indeed, there are no corroded-looking quartz grains or shards which may have been considered more diagnostic of volcanic (tuffaceous) material.

Similarly some of the clays and micas may be altered fine glass fragments, but they are by no means positively or exclusively indicative of such a genesis.

RECEIVED
16 DEC 1983
DEPT. OF MINES AND ENERGY SECURITY
5258

5258-1


Halfway Creek
Halfway Creek
Qpp
Qp
Qra
Q/Klt
Klt
Klb
Qpr
N
SHEET 2
5253-2

Discovery Creek
DISCOVERY SITE
Oolgelima Creek
"Atomic Bomb Area"
Bore
N
LEGEND
QUATERNARY
Qra Fluviatile muds, sands and gravels of modern drainage channels, flood plains etc
Qp BENITOS CLAY : Red- Brown to brown clay to silty clay
Qpp OOLGELIMA GRAVEL : Weakly indurated gravels sands, silts and clays.
Qpr Soft massive white gypsum powder, exposed in scarps on elevated plateaus.
CRETACEOUS
Klb BULLDOG SHALE : Upper member, dark grey silty shale, variably carbonaceous, pyritic or glauconitic.
Q/Klt BULLDOG SHALE : Lower member, masked by thin cover of dark brown-grey residual clay.
Klt BULLDOG SHALE : Lower member, dark grey organic-rich shale with pale grey quartz sand partings cone-in-cone limestone.
SYMBOLS
Geological boundary (inferred)
Riverbank exposures
Drainage features
33/34 Sample location
Creek - Rivers
Road
Dog fence
E.L. Boundary
COLOUR CODE
LILAC 5.00 +
RED 4.00 – 4.99
ORANGE 3.00 – 3.99
YELLOW 2.00 – 2.99
GREEN 1.00 – 1.99
BLUE 0.00 – 0.99
(% Mg + % Na x Depth in m.)
Scale 1 : 20,000
0 500 1000 2000 Metres
RECEIVED 16 DEC 1983 DEPT. OF MINES AND ENERGY SECURITY 5258
Evaporite Minerals (S.A.) PTY. LTD.
Exploration Licence 1155
COOPER PEDY DISTRICT
Geological Map
Geology by : Aminco and Assoc.
Date : Nov. 1983
Drawn by : S. Messing
Scale : 1 : 20,000
SHEET 3
5258-3

CRA EXPLORATION PTY. LIMITED

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FIRST QUARTERLY REPORT ON GIDDI GIDDINNA CREEK E.L. 1254, SOUTH AUSTRALIA, FOR THE PERIOD ENDING 23RD DECEMBER, 1984.

AUTHOR: A.K. SCOTT

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EVAPORITE MINERALS (S.A.) PTY. LTD.
SADME

DATE: 19TH DECEMBER, 1984

SUBMITTED BY: J.P. Howard

ACCEPTED BY:

CONTENTS

0057

1. SUMMARY

E.L. 1254 covers an occurrence of magnesium and sodium sulphates in the Transition Unit at the base of the Lower Cretaceous Bulldog Shale near the western margin of the Eromanga Basin.

Epsomite and bloedite are found disseminated and in bunches in the top 1-2 m of a waxy lacustrine shale. Grades up to 20.5% $MgSO_4$ (by weight) were encountered.

Reconnaissance costeaning outlined three separate areas which contain a total of about 7 Mt of $MgSO_4$ (using a grade-thickness cutoff of 5 m.%) with a grade of about 7.4% $MgSO_4$. However, using a cutoff of 10 m.%, a resource of 3.4 Mt of $MgSO_4$ is indicated at an average grade of 9.6%, but contained in nine separate small areas.

Oil yields of <5 l/t were obtained from the shale.

A preliminary economic study of the viability of producing potassium sulphate from the magnesium sulphate was commenced.

2. RECOMMENDATIONS

The E.L. should be retained until a report on the preliminary economic study is received from TABS.

3. INTRODUCTION

E.L. 1254 of 469 km^2 was granted jointly to CRA Exploration Pty. Limited (CRAE) and Evaporite Minerals (S.A.) Pty. Ltd. (EMSA) on 24th September, 1984, for a period of one year.

The E.L. covers a near surface occurrence of magnesium and sodium sulphates in Mesozoic shales in an area centred approximately 25 km northeast of Coober Pedy (see plan no. SAa 2354).

This report describes exploration activities carried out and results obtained during the first quarter to 23rd December, 1984.

4. REGIONAL GEOLOGY

E.L. 1254 is located near the western margin of the Eromanga Basin. Although the magnesium and sodium salts occur in the Mesozoic Eromanga Basin succession, the E.L. also overlies the central Arckaringa Basin (plan no. SAa 3016 and SAa 3017). In this area the Arckaringa Basin is relatively shallow but it is surrounded by Palaeozoic fault-bounded troughs to the north (Wintinna Trough), east (Boorthanna Trough) and south (Tallaringa, Wallira and Phillipson Troughs). Proterozoic granites and metamorphics crop out east of the Boorthanna Trough in the Peake and Denison Block and north of the Phillipson Trough in the Mount Woods Inlier.

Most of the E.L. contains outcropping shales of the lower part of the Lower Cretaceous Bulldog Shale - a predominantly marine sequence with a basal unit of darker shales mapped as the Transition Unit on the Murloocoppie 1:250 000 sheet. This is underlain conformably by marginal marine sands, silts and minor coals of the Lower Cretaceous Cadna-owie Formation and a basal Mesozoic section of Jurassic fluviatile sands known as the Algebuckina Sandstone. These two sandy units together represent the main aquifer in the region.

Unconformably beneath the Mesozoic are Lower Permian sediments consisting of (in descending order) the Mount Toondina Beds (siltstone, sandstone, coal), the Stuart Range Formation (shales, siltstone, sandstone) and glacigene sediments of the Boorthanna Formation (shales, sandstones, diamictites). These are underlain by Lower Palaeozoic carbonates in the deeper troughs bounding the Arckaringa Basin.

The generalised stratigraphic column in the E.L. area is as shown in Table 1.

5. BULLDOG SHALE

The Bulldog Shale is predominantly a flat lying marine grey and grey-green laminated shale containing abundant very thin (up to 5 mm) partings of light coloured glauconitic siltstone and fine sandstone, and occasional thin beds (5-10 cm) of poorly sorted fine to coarse sands or grits.

However, at the base of this sequence is the Transition Unit which consists of 10-15 m of a dark grey to black, waxy, hydrocarbon-bearing shale containing siltstone partings as before, but also containing thin beds (10-15 cm) of hard dark brown to purple dolomitic siltstone associated with rafts of pale yellow cone-in-cone limestone varying in size from 1 m diameter to 10 m or so. Other thin intercalations are very

TABLE 1

STRATIGRAPHIC COLUMN, E.L. 1254

AGE	THICKNESS	FORMATION
Lower Cretaceous	50	Bulldog Shale
	10	Transition Unit
	40	Cadna-owie Formation
Jurassic	30	Algebuckina Sandstone
Lower Permian	90	Mt. Toondina Formation
	80	Stuart Range Formation
	70	Boorthanna Formation
Cambrian(?)	?	Carbonates, red-beds
Adelaidean	?	Sandstones
Proterozoic	?	Granite, metamorphics

fine, hard, grey dolomitic siltstone and carbonate- or gypsum-cemented unsorted grits. (For petrological descriptions of these rocks see Appendix I of CRAE Report 12398).

Where it is exposed, the Transition Unit contains many horizontal and dipping oxidised zones near the surface, characterised by yellow iron oxides and iron sulphates, and often containing veins of fibrous gypsum or clear selenite.

The ground surface is usually covered by Quaternary(?) brown clay 30-60 cm thick (but up to 2.5 m thick in places) and is generally littered with large sheets and cleavage blocks of selenite (most abundant where the brown clay is thinnest). Gibbers weathered out of the Transition Unit are common in all areas, although the size and number of boulders vary from place to place.

A striking feature of the surface of this unit is the complete absence of vegetation.

In the western part of the E.L., the Transition Unit is covered by the upper (main) section of the Bulldog Shale (plan no. SAa 3018). The contact is usually sharp and is defined by a scarp 5-10 m high. The scarp and surface of the upper unit are usually highly gypsiferous and the surface is characterised by gibbers and vegetation in the form of sparse grasses and small bushes.

Deep weathering of this unit forms the breakaways of the Stuart Range near Coober Pedy. The weathering is thought to have occurred in the Eocene and has resulted in development of a leached and mottled zone about 40 m thick containing iron oxides, silica, gypsum, alunite and opal, capped by a resistant layer of goethite and silica. Abundant pelecypods are found locally in this unit.

6. MINERALISATION

Fine white fibrous crystals of epsomite ($MgSO_4.7H_2O$) are commonly found in the surficial brown clay and are sometimes exposed along tracks by grading, however, the amount of epsomite in this material is low, probably less than 5%.

In the Transition Unit of the Bulldog Shale, the top 50 cm or so is usually composed of marble-sized fragments of weathered shale and soil. If epsomite is present it occurs as a mat of fine crystals throughout this material and grades may be up to 30% water soluble salts (mostly epsomite).

Beneath this layer the shale is more blocky and the yellow oxidised zones (referred to above) are conspicuous. Gypsum is common in vugs and veins, and where epsomite is present it occurs in sub-horizontal vugs averaging 20 cm in horizontal dimensions and 2-5 cm vertically. Crystal growth is vertical and the shale laminations are forced apart resulting in soft spongy ground at the surface over high grade epsomite. The mineral bloedite ($MgSO_4.Na_2SO_4.4H_2O$) may also occur in this zone.

The concentration of water soluble salts in this horizon is lower than in the upper layer, although grades up to 20% are believed to occur locally. The base of the epsomite-bearing zone is generally very sharp and is often marked by a fairly continuous layer of Mg sulphates. The oxidised zone and the gypsum occurrence extend below this level.

7. INVESTIGATIONS

Exploration activities for this quarter have consisted mainly of systematic backhoe costeaning and sampling over much of the E.L., and the instigation of a preliminary economic study of the viability of potassium sulphate production from magnesium sulphate. Additional field investigations included the logging of a continuous water pipeline trench across the southern part of the E.L. and the X-ray diffraction analysis of two samples.

Costeaning by backhoe has proved to be the best method of evaluation because it gives actual access to undisturbed material for both logging and sampling purposes. The backhoe is also a highly mobile machine even through the softest soils. A total of 183 costeans were excavated, 133 of which were situated on a reconnaissance grid to locate areas of $MgSO_4$, whilst the remaining 50 were dug on two traverses to assess the continuity of the $MgSO_4$ occurrence in an area that appeared to contain the best showing. No costeans were excavated in the western part of the E.L. because of the absence of the Transition Unit.

The location of all costeans is shown on plan no. SAa 3019, and logs of the first 133 are included in Appendix I. Cross sections showing the other 50 costeans are drawn on plan no. SAa 3020.

All costeans were logged and the vertical profile divided into three main units:- brown clay at the top, broken shale (with or without epsomite crystal mat) in the middle and blocky fresh shale (with or without vugs of $MgSO_4$) at the base. For the purposes of this report, the broken shale interval is called the upper unit and the blocky shale the lower unit. A visual estimate of $MgSO_4$ salts was made and any interval with more than about 5% was sampled over its full depth in several places. Sample weights varied but were usually about 10-15 kg which was riffle split down to 2-4 kg.

An attempt was made to obtain in situ specific gravities of the upper and lower units for resource estimation purposes, and for this the following procedure was adopted. The costean was dug and logged as normal. Then the surficial clay layer was stripped off the ground immediately adjacent to the costean and a steel box (about 30 cm square and 28 cm deep) with no top or bottom was pushed into the ground by the backhoe until its top was level with the cleared surface. The material inside the box was then scooped out by hand, weighed, and riffled down to 2-4 kg for analysis. In some costeans where the depth of the upper layer was not much greater than the depth of the box, this sample was accepted as representative of the whole layer and was the only sample taken.

After removing the box, the upper layer was stripped off by the backhoe until the lower blocky shale layer was exposed and the procedure repeated. This layer was usually thicker than the depth of the box so an additional more representative sample was also taken. The specific gravity calculations and sample numbers are set out in Appendix II.

A very useful, but unexpected, piece of information was able to be obtained from a continuous trench being dug for the laying of pipes to supply water to Coober Pedy from a bore in the southern part of the E.L. The trench varied in depth from about 1 m to 1.6 m and was logged rapidly over a distance of 9.9 km from the bore to the dog fence (for location, see plan no. SAa 3019). The content of $MgSO_4$ was visually assessed as high grade and continuous or as patchy or low grade. The result is shown graphically in plan no. SAa 3012.

Two samples of pure salts (nos. 1159351 and 1159352) were collected from the trench at the location shown on plan no. SAa 3019, and were investigated by X-ray diffractometry to determine their composition.

Ten samples of shale were submitted for oil yield analysis by Fischer distillation. They are described in the sample ledger sheets in Appendix VI.

A preliminary economic study is being carried out by personnel from the Technical and Business Studies section of CRA Limited on the feasibility of producing K_2SO_4 for use as a fertiliser from the $MgSO_4$ occurrence in E.L. 1254. No further information is available on the study at the present time.

8. RESULTS

The water soluble content of each sample was analysed for Ca, Mg, Na, K, Cl and SO_3 by the method described in Appendix III. Analytical results are set out in Appendix IV.

It was assumed that all Mg was present as $MgSO_4$ (in either epsomite or bloedite) and the $MgSO_4$ content of each sample was thus calculated from the Mg assay. A check was made to ensure that the SO_4 content thus calculated was equal to, or less than, the SO_4 content converted from the SO_3 analysis, thereby ensuring that adequate sulphate actually existed in the sample to make up the calculated amount of $MgSO_4$. This was in fact the case with all samples.

The calculated $MgSO_4$ contents were then transferred to the tables in Appendix V along with sample numbers, thicknesses, etc., in order to determine a total thickness and grade for each costean. A metre.% $MgSO_4$ figure was also calculated for all costeans and these were used to compile plan no. SAa 3019. The thickness and grades of samples from the costeans located on traverses A and B are shown on plan no. SAa 3020.

The analytical data show that $MgSO_4$ contents vary from zero to 20.5% (by weight) in the upper unit and from zero to 13.0% in the lower. The thickness of mineralisation varies from 0.2 to 1.1 m in the upper unit and 0.2 to 1.85 m in the lower.

Values for Na are variable up to 2.86% and probably indicate the presence of halite (Cl variable up to 2.88%), although bloedite is certainly present in some samples. Ca and K are both very low, being no greater than 0.17% and 0.04% respectively.

Specific gravity measurements were made on 16 samples from the upper unit and 13 from the lower (see Appendix II). Values for the former varied widely from 1.03 to 1.63 and had an arithmetic average of 1.31, whilst those for the lower unit were more consistent (range 1.29 to 1.75) with an average of 1.56.

As might be expected, there is a variation in specific gravity with grade. This is shown graphically in Appendix II where regression lines have been calculated separately for the upper and lower units. In both cases, bulk density decreases as salt content increases, due in part to the fact that epsomite is less dense than shale, and also to the fact that voids occur around the salt crystals.

The accuracy of the specific gravity determinations is not known but some errors could be expected due to deformation of the shale at the sides of the box and to incorrect depth placement. It is estimated that these errors would be equivalent to a maximum depth error of 1 cm, or 3.5%. The above average specific gravities could then be in error by up to +/- 0.05.

Logging of the water pipeline trench showed that good quality $MgSO_4$ salts occur fairly continuously over a distance of 2.2 km just inside the southern boundary of the E.L., and rather spasmodically northwards towards the bore. The most interesting result of this examination was that no correlation could be deduced between $MgSO_4$ occurrence and topography or other surface characteristics.

The XRD analysis of the two samples collected from the pipeline trench showed that the long, thin, brittle crystals are epsomite and the short, stubby, pyramid-shaped crystals which are much harder than epsomite are bloedite. These appear to be the only two $MgSO_4$-bearing minerals in the area. Bloedite was noted only in the southernmost part of the E.L.

The results of the oil yield analyses on ten samples of shale are given in Appendix V. All samples contained <5 litres/tonne and are thus of no interest.

9. RESOURCE

Plan no. SAa 3019 shows the distribution of $MgSO_4$ within E.L. 1254. The areas shown to contain the best $MgSO_4$ were determined mainly from costean sample results and partly from photo interpretation. Much of the southern area (Locality 1) in particular seems to coincide with a light greyish tone subtly different from the more brownish tones surrounding it.

Estimates of the $MgSO_4$ resource have been made using two different cutoffs. One involves all those costeans having a m.% product of 5.0 or more, whilst the other uses only those costeans with 10.0 m.% or more.

The resource estimates have been made by obtaining the arithmetic average for the thickness, and weighted average for the grade, of the upper and lower units from all costeans in each area. It is considered that the wide spacing of the costeans is insufficient to give validity or credence to a more sophisticated method of estimation. Furthermore, the shape of the high grade areas bears no relationship to the triangular grid of costeans, so that the polygonal (in this case, triangular) method of calculation is inappropriate.

The calculations are set out in Appendix VII where details of the individual thicknesses and grades of the upper and lower units are also given. The results are summarised below.

Cutoff 5 m.%

Location	Av. width (m)	Area (Mm^2)	S.G.	In situ (Mt)	Av. grade (wt %)	$MgSO_4$ (Mt)
1	1.49	24.33	1.61	58.2	6.22	3.62
2	1.14	6.80	1.44	11.2	7.95	0.89
3	1.21	15.55	1.33	25.8	9.80	2.45
Total	1.35	46.68	1.50	94.4	7.37	6.96

Resource statement:

94 Mt of in situ material with a grade of 7.4% $MgSO_4$ containing 7.0 Mt $MgSO_4$.

Cutoff 10 m.%

1a	1.48	0.24	1.41	0.5	8.00	0.04
1b	1.63	7.40	1.43	17.3	8.38	1.45
1c	1.43	1.75	1.44	3.6	8.61	0.31
1d	1.25	1.17	1.37	2.0	8.50	0.17
1e	1.05	0.55	1.39	0.8	10.00	0.08
2a	1.35	1.32	1.23	2.2	11.36	0.25
3a	1.40	4.37	1.18	7.2	12.50	0.90
4a	1.70	0.45	1.18	0.9	12.22	0.11
4b	1.35	0.55	1.35	1.0	8.00	0.08
Total	1.48	17.80	1.35	35.5	9.55	3.39

Resource statement:

36 Mt of in situ material with a grade of 9.6% $MgSO_4$ containing 3.4 Mt $MgSO_4$.

The above figures must be regarded with caution due to the non-rigorous nature of the calculations. This was brought about by the following factors:

* the wide spacing of the costeans,
* the patchy nature of the epsomite distribution,
* the uncertainty that photo-interpretation accurately reflects epsomite distribution,
* the unknown errors inherent in the sampling technique, specific gravity determinations and analyses.

For these reasons it is emphasised that the resource is a geological one. Factors that would need to be taken into account to produce an estimate of recoverable $MgSO_4$ in a production situation would include minimum mineable thickness, economic cutoff, location with respect to treatment plant and, very importantly, the extraction technique to be used.

It is considered that the resource estimates given above be classified somewhere between the "inferred" and "indicated" categories, as recommended by the A.I.M.M. and A.M.I.C. Joint Committee on Ore Reserves, 1981.

The amount of 3.4 Mt of $MgSO_4$ estimated to be available above a cutoff of 10 m.% would be sufficient to feed a 250,000 tpa K_2SO_4 plant for 20 years, whilst 7 Mt of $MgSO_4$ (cutoff 5 m.%) would feed a 500 000 tpa plant for the same period.

10. GENESIS

The origin of the $MgSO_4$ deposit is subject to considerable speculation.

It is believed that a major factor to be accounted for is that in the Coober Pedy district and elsewhere, epsomite appears to be most abundant in locations close to, and downslope from, the prominent erosion scarps of leached Bulldog Shale known locally as "breakaways".

It is suggested that deep weathering of the shale (during the Eocene?) caused widespread leaching which resulted in the downward mobilisation and redeposition of Fe, Si, Al, K, Na, Mg and Ca at different levels. The leached shale was thus transformed into a mottled, siliceous, ferruginous rock containing veins and stringers of alunite, gypsum and opaline silica. As erosion of the leached shale progressed, Ca and Mg were released and moved down the drainage (i.e.: to the northeast towards Lake Cadibarrawirracanna) perhaps as chlorides and combined with sulphur in the dark shales of the

Transition Unit to form sulphates. The impervious nature of the shale has permitted only a very slow lateral movement of these elements and compounds and thus they are found relatively close to the site of formation, i.e.: adjacent to the leached areas.

One drawback with this theory is that no pyrite has been noted in the shale. It is possible (but there is no evidence to support the idea) that the shale contains very finely divided pyrite or that sulphur is being (or was) liberated from hydrocarbons deposited with the shale.

An alternative suggestion is that Ca and Mg found their way from the leached areas into the very permeable Cadna-owie Formation which lies immediately beneath the Transition Unit and contains abundant framboidal pyrite. Waters of the Cadna-owie are high in Na, Mg, Cl and SO_4 and, because they are confined under pressure by the overlying Transition Unit, probably keep the shale in a permanent state of saturation. Capillary action in the shale produced by the region's arid climate could have caused the precipitation of Ca, Mg and Na sulphates at the surface.

11. OBSERVATIONS

During the course of field investigations a number of observations were made on the occurrence of the $MgSO_4$ salts which may be of interest in future work. They are listed below with little comment.

a) In vertical profiles, zones of gypsum and epsomite are often mutually exclusive.

b) Where a raft of limestone is encountered in the sub-surface, the overlying shale contains little or no epsomite. This appears to support an upward movement of epsomite-bearing solutions.

c) There is no apparent difference in the nature of shale between high grade $MgSO_4$ areas and adjacent areas containing no salts.

d) Bloedite seems to occur only in the southern part of the E.L., and in particular along the southeastern margin of the area designated Location 1 on plan no. SAa 3019.

e) $MgSO_4$ salts are often thickest in shale on high creek banks, the thickness decreasing sharply away from the creek.

f) There are generally little or no salts under thick layers of alluvium along the major creeks (light brown areas on colour air photos), although an exception to this occurred at costeans 159 and 160 on traverse A.

g) Salts are never found on low gypsiferous scarps such as those in the west of the E.L. This may be due to the fact that they are formed by the marine shale unit above the Transition Unit.

h) In the field, there appears to be no particular characteristics of the ground surface that distinguish $MgSO_4$-bearing from $MgSO_4$-barren shale beneath. However, the present field work has suggested that $MgSO_4$-bearing areas exhibit a slightly more greyish tone on colour air photos in contrast to the surrounding brown-toned areas which lack salts.

A.K. SCOTT per J.P. Howard.

AKS/pw

EXPENDITURE

Expenditure for the period ended 31st December, 1984, the nearest accounting period, was $26 410.00, as listed below.

		$
Drilling		2 587
Payroll		10 672
Supplies		2 641
Vehicle		903
Travel		1 287
Property		2 794
Tenement		104
Laboratory		1 120
Overheads		4 302
	Total	$ 26 410

KEYWORDS

Black shale, Evaporite, Facies lacustrine, Cretaceous, Reserve calculations, Weathering, Epsomite.

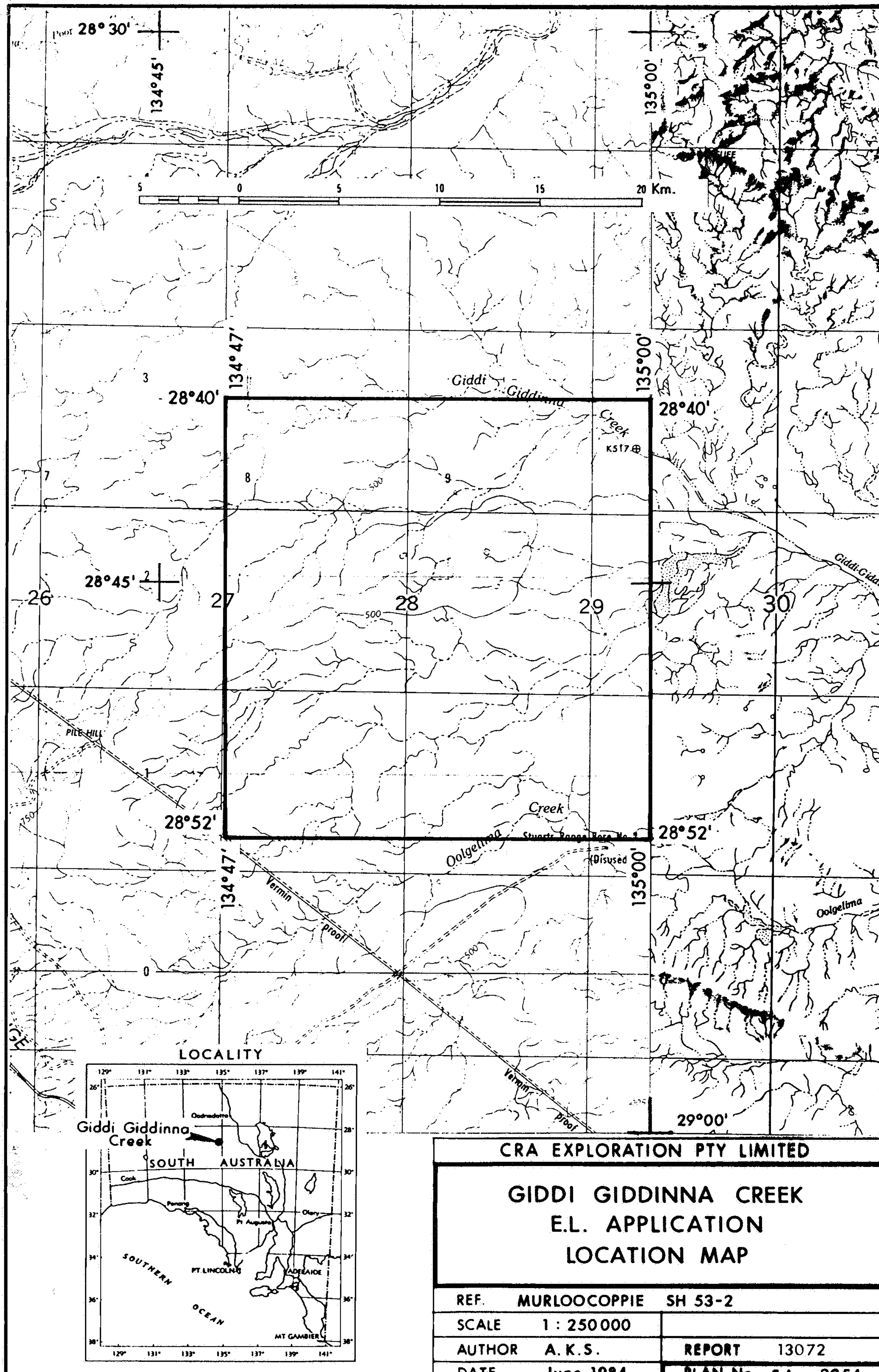
LOCATION

Murloocoppie SH 53-2 1:250 000

LIST OF PLANS

LIST OF TABLES

LIST OF APPENDICES



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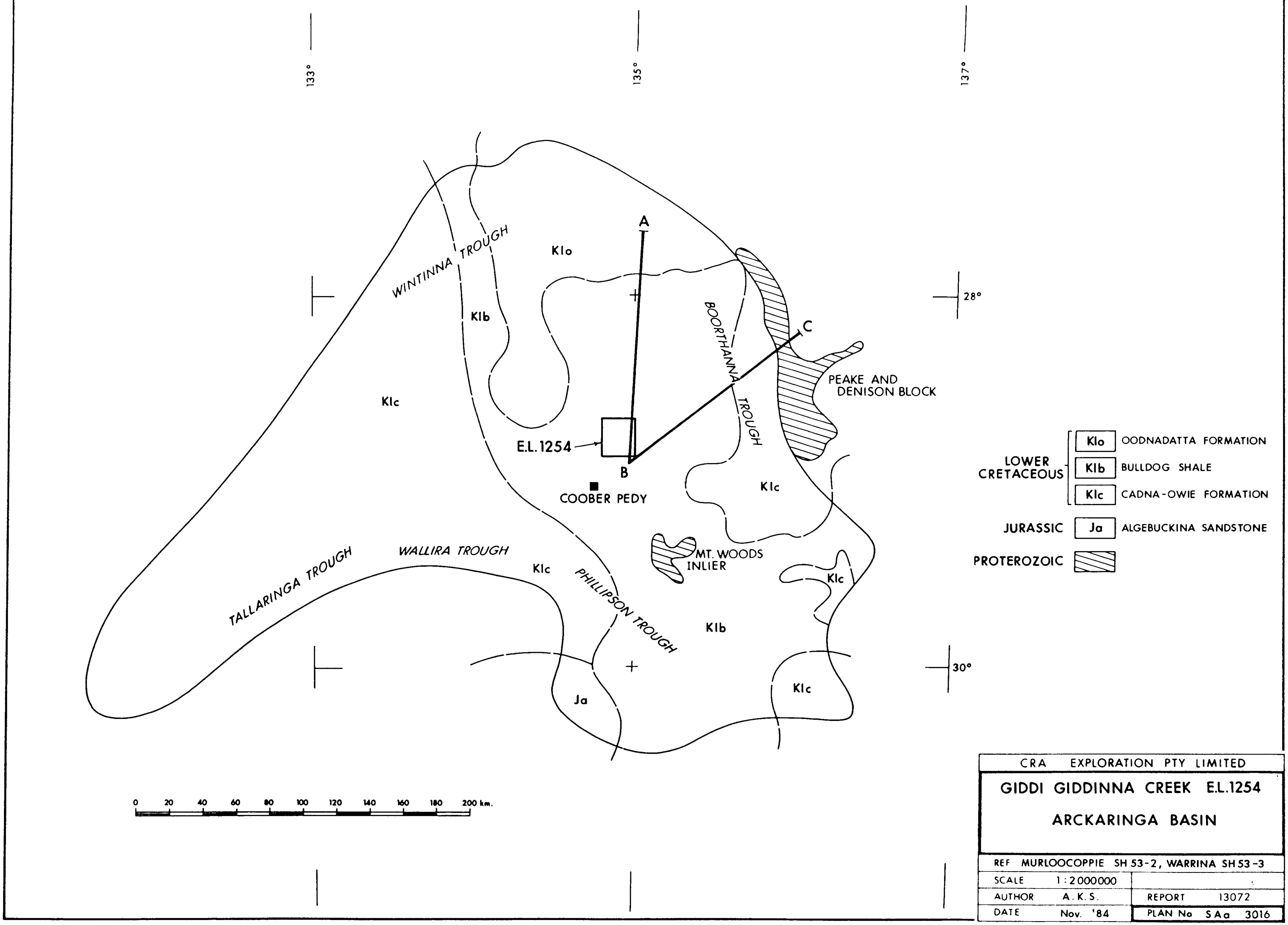
GIDDI GIDDINNA CREEK
E.L. APPLICATION
LOCATION MAP

REF.	MURLOOCOPPIE SH 53-2		
SCALE	1 : 250 000		
AUTHOR	A. K. S.	REPORT	13072
DATE	June 1984	PLAN No	SAa 2354



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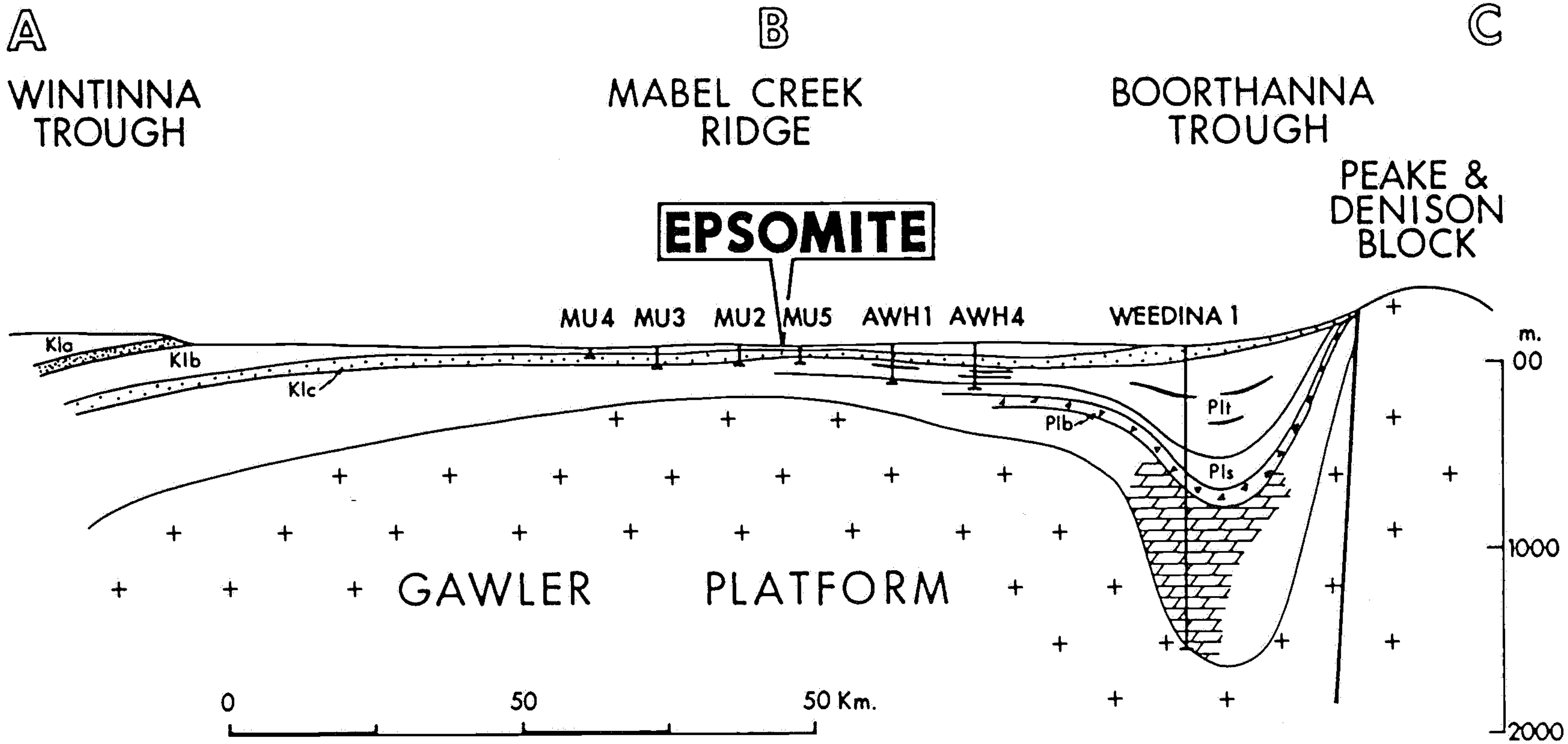
GIDDI GIDDINNA CREEK E.L.1254

ARCKARINGA BASIN

REF	MURLOOCOPPIE SH 53-2, WARRINA SH 53-3		
SCALE	1:2000000		
AUTHOR	A.K.S.	REPORT	13072
DATE	Nov. '84	PLAN No	SAa 3016



LOWER CRETACEOUS	Kla	OODNADATTA FORMATION
	Klb	BULLDOG SHALE
	Klc	CADNA-OWIE FORMATION
LOWER PERMIAN	Plt	MOUNT TOONDINA FORMATION
	Pls	STUART RANGE FORMATION
	Plb	BOORTHANNA FORMATION
EARLY PALAEOZOIC		COOTANOORINA FORMATION or OBSERVATORY HILL BEDS

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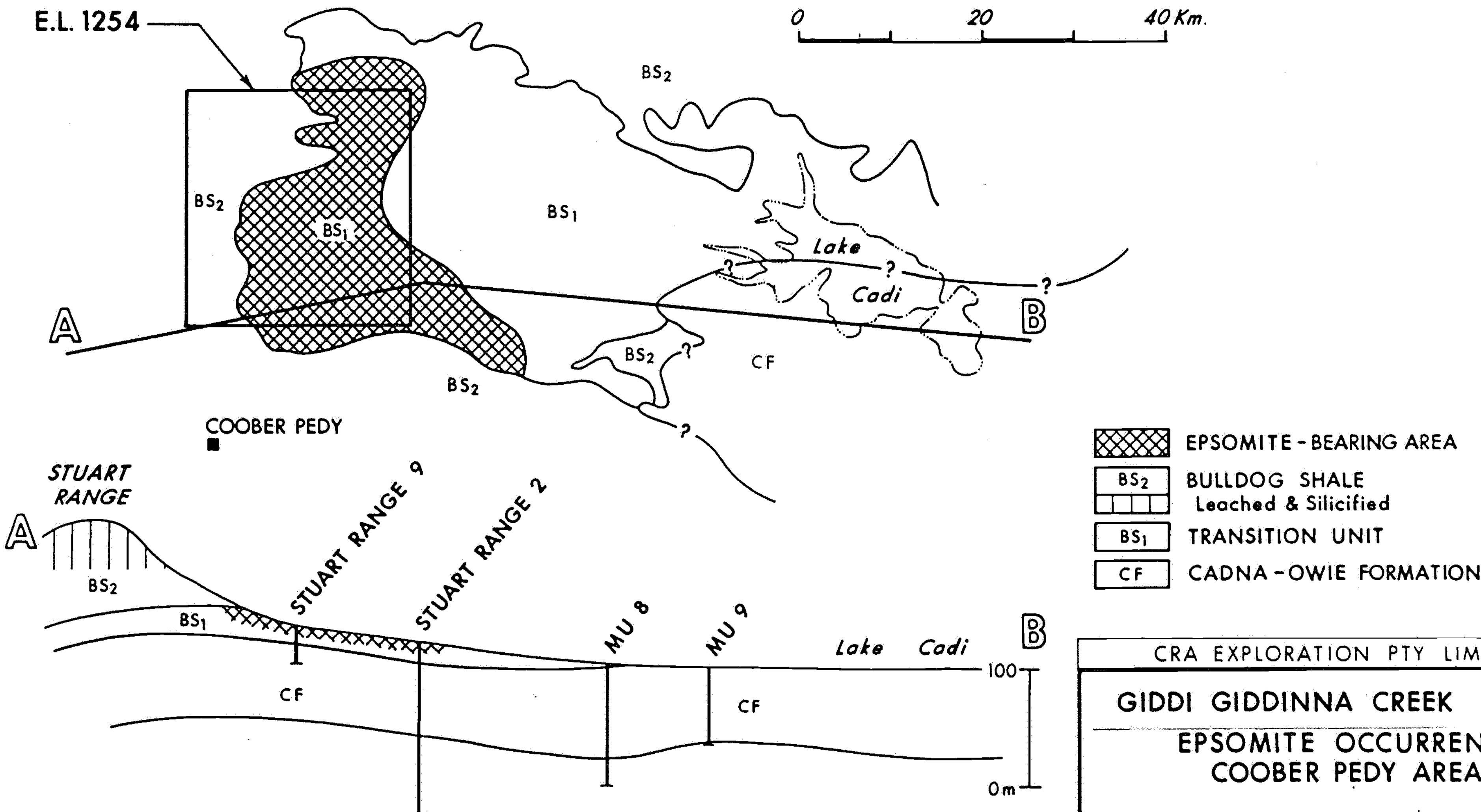
GIDDI GIDDINNA CREEK E.L.1254

ARCKARINGA BASIN
SECTION A - B - C

REFERENCE	Murloocoppie SH 53-2, Warrina SH 53-3		
SCALE	1 : 1 250 000		
AUTHOR	A.K.S.	REPORT	13072
DATE	Nov. '84	PLAN No	SAa 3017



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GIDDI GIDDINNA CREEK E.L.1254

EPSOMITE OCCURRENCE COOBER PEDY AREA

REFERENCE	Murloocoppie SH 53-2, Warrina SH 53-3
SCALE	1:700 000 (appx.)
AUTHOR	A.K.S.
REPORT	13072
DATE	Nov. '84
PLAN No	SAa 3018

LOCALITY 1 ... Resource area, cut off 5m.%
Boundaries based on :
Analyses only
Photo-interp. and analyses
1a 2a etc. .... Resource area, cut off 10m.%
Boundaries
49 .... Costean number
1·9, 3·80 .... Mineralised width (m), MgSO4 content (wt.%)
Costean with >10 m.% MgSO4
Costean with 5 - 10 m.% MgSO4
Costean with 2·5 - 5 m.% MgSO4
Costean with <2·5 m.% MgSO4
For values see Appendix V
Pipeline trench — high grade
Pipeline trench — patchy or low grade
LOCALITY 1
LOCALITY 2
LOCALITY 3
TRAVERSE 'A'
TRAVERSE 'B'
Giddi Giddinna Creek
Oolgelima Creek
Oodnadatta
old road
Dog Fence
Coober Pedy 14 Km.
Nilpinna
Bore
Location of samples 1159351, 352.
6830000 m N
6820000 m N
6810000 m N
480000 m E
490000 m E
500000 m E
510000 m E
134°47'
135°00'
28°40'
28°52'
0 1 2 3 4 5 6 7 8 9 10 Km.
COMPILED FROM UNCONTROLLED MOSAIC OF 1:87,000 AIR PHOTOS SVY 2726, nos. 82, 86, 89 & 93
CRA EXPLORATION PTY. LIMITED.
GIDDI GIDDINNA CK. E.L.1254 — S.A.
COSTEAN RESULTS
Ref.: MURLOOCOPPIE SH 53-2
Scale. 1 : 50000
Author. A.K.S.
Report No. 13072
Date. Dec. 1984
Plan No. SAa 3019

5258-5

CRA EXPLORATION PTY. LIMITED.

GIDDI GIDDINNA CK. E.L.1254 – S.A.

COSTEAN RESULTS
TRAVERSES 'A' AND 'B'

Ref. : MURLOOCOPPIE SH 53-2	
Scale : H - 1:2500, V - 1:50	
Author : A.K.S	Report No. 13072
Date : Dec. 1984	Plan No. SAa 3020

5258-6

CRA EXPLORATION PTY LIMITED

GIDDI GIDDINNA CREEK EL1254 - S.A.
SALT CONTENT OF PIPELINE TRENCH

Ref MURLOOCOPPIE SH53-2	
Scale 1:10,000	
Author AKS	Report 13072
Date NOV'84	Plan No. SAa 3012

APPENDIX I

COSTEAN LOGS

MAGNESIUM SULPHATE PROJECT

COSTEAN LOGS

Costean No.	AMG Co-ords		Depth (m)		Sample No.	Description
	E	N	From	To		
GC 1	486 300	6806700	0	0.15		Brown clay
			0.15	0.8	1159401	Broken shale. Est. 25 % salts.
			0.8	1.5	1159402	Blocky shale. Est. 15 % salts.
GC 2	485 000	6806700	0	0.3		Brown clay
			0.3	0.4		Broken shale. Est. < 5 % salts
			0.4	2.1	1159403	Blocky v. dark waxy shale, with some yellow bands. Minor siltstone. Nil salts.
GC 3	483 800	6806 700	0	0.45		Brown clay
			0.45	1.05	1159404	Broken shale with est. 20 % salts.
			1.05	1.9	1159405	Blocky shale, 10-15 % salts.
			1.9	2.6		Blocky shale. No salts.
GC 4	482 600	6806 700	0	0.55		Brown clay
			0.55	0.75	1159406	Broken very black waxy shale. 5% salts.
			0.75	2.1	1159407	Blocky shale. Some gypsum. No salts.

MAGNESIUM SULPHATE PROJECT

COSTEAN LOGS

Costean No.	AMG Co-ords		Depth (m)		Sample No.	Description
	E	N	From	To		
GC 5	481 400	6806 700	0	0.25		Brown clay.
			0.25	0.75	1159408	Broken shale – 20 % salts.
			0.75	1.3	1159409	Blocky shale – 15 % salts.
			1.3	2.1		Blocky shale with gypsum.
GC 6	480 200	6806 700	0	0.5		Brown clay.
			0.5	0.8	1159411	Broken grey shale with fine epsomite, est. 20 %.
			0.8	2.0	1159410	Blocky grey shale with much gypsum. Little or no salts.
GC 7	479 000	6806 700	0	0.3		Brown gypsiferous clay.
			0.3	1.6		Blocky grey shale, pale yellow shale, and gypsum. No salts.
			1.6	1.8		Yellow limestone. No salts.

MAGNESIUM SULPHATE PROJECT

COSTEAN LOGS

Costean No.	AMG Co-ords		Depth (m)		Sample No.	Description
	E	N	From	To		
GC 8	479 600	6807 750	0	1.2		Brown clay.
			1.2	1.6		Fossil surface. Lag gravel of hematite, rounded pebbles.
			1.6	2.0		Grey shale. No salts.
GC 9	480 800	6807 750	0	1.4		Brown clay.
			1.4	2.1		Fossil surface, as above.
			2.1	2.2		Grey shale. No salts.
GC 10	482 000	6807 750	0	1.5		Brown clay.
			1.5	2.2		Dark grey blocky shale, minor ~~salts~~ gypsum.
GC 11	483 200	6807 700	0	0.5		Brown clay, minor salts.
			0.5	1.0	1159412	Broken shale, 10 % salts.
			1.0	1.2	1159413	Blocky black waxy shale, with 10 % epsomite.
			1.2	2.2		Blocky black shale, no salts.

MAGNESIUM SULPHATE PROJECT

COSTEAN LOGS

Costean No.	AMG Co-ords		Depth (m)		Sample No.	Description
	E	N	From	To		
GC 12	484 400	6807750	0	0.65		Brown clay with minor salts.
			0.65	1.05	1159414	Broken shale 10% salts.
			1.05	2.05	1159415	Blocky black waxy shale, 20% salts. Band of yellow-brown waxy shale 1.35 – 1.50 with epsomite.
			2.05	2.75		Blocky shale – no epsomite.
GC 13	485 600	6807750	0	0.40		Brown clay.
			0.4	0.8	1159416	Broken shale with 8% salts.
			0.8	1.9	1159418	Blocky shale with salts in large vugs, mainly below 1.3. Sample No. 1159417 for s.g.
			1.9	2.2		Blocky shale. No salts.
GC 14	486 900	6807800	0	0.15		Brown clay.
			0.15	1.8		Broken shale. No salts.
			1.8	2.7		Blocky shale, some gypsum. No salts.

MAGNESIUM SULPHATE PROJECT

COSTEAN LOGS

Costean No.	AMG Co-ords		Depth (m)		Sample No.	Description
	E	N	From	To		
GC 15	488 600	6808 800	0	0.25		Brown clay with minor salts.
			0.25	1.05	1159419	Broken shale, 25 % epsomite.
			1.05	1.60	1159420	Blocky black shale with epsomite in 3 main layers, each immediately below a gypsum band. 10% salts.
			1.60	2.40		Blocky shale. No salts.
GC 16	487 500	6808 800	0	3.2		Brown clay. No salts.
			3.2	3.4		Grey shale with much gypsum. No salts.
GC 17	486 200	6808 800	0	0.4		Brown clay.
			0.4	2.4		Blocky black waxy shale with much gypsum. No salts. Sample for oil yield.
GC 18	485 000	6808 800	0	1.6		Brown clay.
			1.6	2.0		Broken black shale. No salts.
			2.0	2.3		Blocky black shale with gypsum No salts.

MAGNESIUM SULPHATE PROJECT

COSTEAN LOGS

Costean No.	AMG Co-ords		Depth (m)		Sample No.	Description
	E	N	From	To		
GC 19	483 900	6808 800	0	2.7		Brown clay. Fossil soil at base.
GC 20	481 400	6808 800	0	1.8		Brown clay.
			1.8	2.4		Broken grey shale. No salts.
GC 21	479 050	6808 800	0	1.05		Brown clay.
			1.05	2.1		Light grey shale with horizontal gypsum bands. No salts.
GC 22	479 550	6809 900	0	0.45		Brown clay.
			0.45	2.2		Blocky grey shale with gypsum. Thin fossil bands. No salts.
GC 23	482 000	6809 850	0	0.95		Brown clay.
			0.95	1.9		Broken grey shale with some gypsum.
			1.9	1.95		Gypsum.

MAGNESIUM SULPHATE PROJECT

COSTEAN LOGS

Costean No.	AMG Co-ords		Depth (m)		Sample No.	Description
	E	N	From	To		
GC 24	483 200	6809 800	0	1.25		Brown clay.
			1.25	1.6		Broken shale with gypsum
			1.6	2.1		Blocky shale with gypsum. No salts.
GC 25	484 400	6809 800	0	1.35		Brown clay.
			1.35	2.2		Blocky black waxy shale, gypsum common. Sample for oil yield.
GC 26	485 600	6809 800	0	2.8		Brown clay.
			2.8	3.0		Black shale, broken. No salts.
GC 27	486 800	6809 800	0	0.7		Brown clay.
			0.7	1.15		Broken dark grey shale with very minor epsomite at base.
			1.15	1.20		Blocky shale with gypsum.
			1.20	1.35		Cone-in-cone limestone.
			1.35	1.70	1159421	Blocky shale with epsomite in vugs.
			1.70	2.40		Blocky shale with gypsum

MAGNESIUM SULPHATE PROJECT

COSTEAN LOGS

Costean No.	AMG Co-ords		Depth (m)		Sample No.	Description
	E	N	From	To		
GC 38	497 600	6807 700	0	0.65		Brown clay
			0.65	1.0		Broken shale with some gypsum.
			1.0	2.1		Blocky shale with 3 cm thick sandstone band. Also gypsum. No salts.
GC 39	500 000	6807 750	0	0.25		Brown clay
			0.25	0.8		Broken dark grey shale with vugs of gypsum.
			0.8	0.85		Sub-horizontal vein of gypsum
			0.85	1.0		Cone-in-cone limestone.
			1.0	1.15		Hard brown ferruginous siltstone
			1.15	2.1		Blocky grey-green shale with gypsum.
GC 40	495 200	6807 750	0	0.4		Brown clay
			0.4	0.6		Broken shale.
			0.6	2.4		Dark grey to black waxy shale with several sub-horizontal gypsum veins. Sample for oil yield.

MAGNESIUM SULPHATE PROJECT

COSTEAN LOGS

Costean No.	AMG Co-ords		Depth (m)		Sample No.	Description
	E	N	From	To		
GC 31	488 600	6806 700	0	0.2		Brown clay
			0.2	0.8	1159427	Broken shale with 25 % epsomite
			0.8	1.6	1159429	Blocky shale with 25 % salts
						in vugs. Sample 1159428 for s.g.
			1.6	2.1		Blocky shale, no salts.
GC 32	489 800	6806 700	0	1.45		Brown clay
			1.45	1.8		Gritty conglomerate cemented with gypsum.
			1.8	2.4		Blocky black shale with some gypsum.
						No salts.
GC 33	491 000	6806 800	0	1.05		Brown clay, very gypsiferous in
						lower 0.4 m.
			1.05	1.15		Gritty conglomerate cemented with gypsum.
			1.15	2.3		Blocky black shale with some
						gypsum bands. No salts.

MAGNESIUM SULPHATE PROJECT

COSTEAN LOGS

Costean No.	AMG Co-ords		Depth (m)		Sample No.	Description
	E	N	From	To		
GC 34	492 200	6806 700	0	1.45		Brown clay.
			1.45	1.65		Gritty conglomerate, gypsum cement.
			1.65	2.3		Blocky shale with gypsum bands.
						No salts.
GC 35	493 400	6806 700	0	3.0		Brown clay.
GC 36	494 600	6806 700	0	0.5		Brown clay
			0.5	0.85		Shale and grit
			0.85	1.1		Broken shale
			1.1	2.2		Blocky shale with few gypsum veins.
						No salts.
GC 37	496 950	6807 900	0	0.25		Brown clay
			0.25	0.7	1159430	Broken shale with gypsum and
						5 % salts.
			0.7	1.4	1159431	Blocky shale with < 5 % salts
			1.4	2.2		Blocky shale.

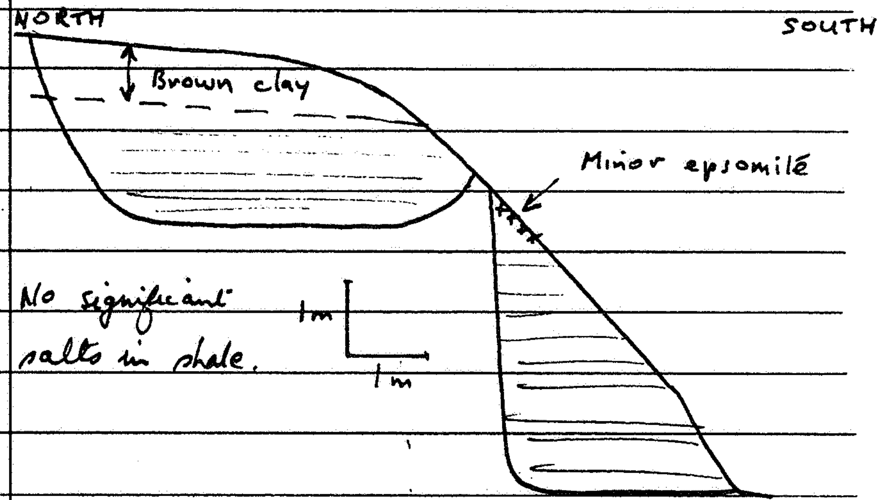
MAGNESIUM SULPHATE PROJECT

COSTEAN LOGS

Costean No.	AMG Co-ords E	AMG Co-ords N	Depth (m) From	Depth (m) To	Sample No.	Description
GC 38	497 600	6807 700	0	0.65		Brown clay
			0.65	1.0		Broken shale with some gypsum.
			1.0	2.1		Blocky shale with 3 cm thick sandstone band. Also gypsum. No salts.
GC 39	500 000	6807 750	0	0.25		Brown clay
			0.25	0.8		Broken dark grey shale with vugs of gypsum.
			0.8	0.85		Sub-horizontal vein of gypsum
			0.85	1.0		Cone-in-cone limestone.
			1.0	1.15		Hard brown ferruginous siltstone
			1.15	2.1		Blocky grey-green shale with gypsum.
GC 40	495 200	6807 750	0	0.4		Brown clay
			0.4	0.6		Broken shale.
			0.6	2.4		Dark grey to black waxy shale with several sub-horizontal gypsum veins. Sample for oil yield.

MAGNESIUM SULPHATE PROJECT

COSTEAN LOGS

Costean No.	AMG Co-ords E	AMG Co-ords N	Depth (m) From	Depth (m) To	Sample No.	Description
GC 41	494 000	6807 950	River bank 6 m high			 No significant salts in shale.
GC 42	492 800	6807 700	0	0.75		Brown clay
			0.75	2.9		Pebbly gypsiferous grit
			2.9	3.0		Dark grey green shale.
GC 43	491 550	6807 700	0	0.6		Brown clay
			0.6	1.4		Pebbly gypsiferous grit
			1.4	2.9		Brown clay.
GC 44	490 400	6807 750	0	0.3		Brown clay
			0.3	0.65	1159432	Broken shale with 20 % salts.

MAGNESIUM SULPHATE PROJECT

COSTEAN LOGS

Costean No.	AMG Co-ords		Depth (m)		Sample No.	Description
	E	N	From	To		
			0.65	2.5	1159433	Blocky black and dark grey-green shale with vugs of gypsum. No salts. Sample for oil yield.
GC 45	^{4}89 200	^{68}07 750	0	0.25		Brown clay
			0.25	0.6		Cone-in-cone limestone
			0.6	2.2		Blocky shale with much gypsum.
			Adjacent to this is:			
			0	0.25		Brown clay
			0.25	0.8	1159434	Broken shale with 20% salts
			0.8	2.2		Blocky black waxy shale. No salts.
GC 46	^{4}88 000	^{68}07 700	0	0.75		Brown clay
			0.75	1.0	1159435	Broken shale. No salts
			1.0	2.1	1159436	Blocky shale with 5% salts in few vugs.
			2.1	2.4		Blocky shale with no salts.

MAGNESIUM SULPHATE PROJECT

COSTEAN LOGS

Costean No.	AMG Co-ords		Depth (m)		Sample No.	Description
	E	N	From	To		
GC 47	489 800	6808 750	0	0.2		Brown clay.
			0.2	1.05	1159437	Broken shale with 25 % salts.
						Sample 1159439 for s.g.
			1.05	2.05	1159438	Blocky black shale with 20 % salts
						in vugs. Sample 1159440 for s.g.
			2.05	2.4		Blocky shale. No salts.
GC 48	490 950	6808 750	0	1.65		Brown clay.
			1.65	2.5		Black waxy shale with minor gypsum.
						Sample for oil yield.
GC 49	492 150	6808 750	0	0.3		Brown clay.
			0.3	0.65	1159441	Broken shale with 15 % salts.
			0.65	2.2	1159442	Blocky shale with much gypsum. No salts.
GC 50	493 350	6808 750	0	0.2		Brown clay.
			0.2	0.5	1159443	Broken shale with 5 % salts.
			0.5	2.3	1159444	Blocky shale with gypsum.

MAGNESIUM SULPHATE PROJECT

COSTEAN LOGS

Costean No.	AMG Co-ords		Depth (m)		Sample No.	Description
	E	N	From	To		
GC 51	494 600	6808 800	0	0.3		Brown clay.
			0.3	0.6	1159445	Broken shale with 5% salts
			0.6	1.95	1159446	Blocky shale (black) with gypsum veins
			1.95	2.1		Cone-in-cone limestone.
GC 52	495 800	6808 800	0	0.4		Brown clay.
			0.4	1.6	1159447	Blocky dark grey shale with abundant gypsum and possibly some salts.
			1.6	2.2		Blocky shale. No salts.
GC 53	497 000	6808 800	0	0.35		Brown clay.
			0.35	0.9	1159448	Broken shale with 15% salts.
			0.9	2.2	1159449	Blocky shale with much gypsum. No salts.
GC 54	498 200	6808 800	0	1.05		Brown clay.
			1.05	1.6		Broken shale with much gypsum. No salts.
			1.6	1.7		Hard brown siltstone and gypsum.
			1.7	1.95		Yellow cone-in-cone limestone
			1.95	2.2		Blocky grey shale.

MAGNESIUM SULPHATE PROJECT

COSTEAN LOGS

Costean No.	AMG Co-ords		Depth (m)		Sample No.	Description
	E	N	From	To		
GC 55	498 800	6809 850	0	0.65		Brown clay.
			0.65	0.7		Cone-in-cone limestone
			0.7	0.9		Brown siltstone
			0.9	1.0		Limestone
			1.0	2.2		Grey-green shale with minor gypsum.
GC 56	496 400	6809 850	0	2.5		Brown clay. No salts.
GC 57	495 200	6809 850	0	1.9		Brown clay. Very minor salts at top.
			1.9	2.5		Broken black shale. Minor gypsum.
GC 58	493 900	6810 000	0	0.4		Brown clay.
			0.4	1.4	1159450	Broken shale with 20% salts
			1.4	2.35	1159451	Blocky dark grey shale with 15% salts in vugs.
			2.35	2.55		Blocky shale, no salts.

MAGNESIUM SULPHATE PROJECT

COSTEAN LOGS

Costean No.	AMG Co-ords		Depth (m)		Sample No.	Description
	E	N	From	To		
GC 59	492 750	6809 850	0	0.55		Brown clay
			0.55	1.6	1159452	Blocky shale with several large vugs of salts
			1.6	2.3		Blocky shale.
GC 60	491 550	6809 800	0	0.3		Brown clay.
			0.3	1.25	1159453	Broken shale with 25% salts.
			1.25	2.4	1159454	Blocky black waxy shale with much gypsum. No salts.
GC 61	490 350	6809 800	0	0.2		Brown clay.
			0.2	0.85	1159455	Broken shale with 25% salts.
			0.85	1.5	1159457	Blocky black shale c̄ salts. (15%). Sample 1159456 for s.g.
GC 62	489 800	6810 850	0	1.1		Brown clay.
			1.1	1.5		Broken shale with much gypsum.
			1.5	1.65		Medium grained orange sandstone.
			1.65	2.4		Broken shale with much gypsum.

MAGNESIUM SULPHATE PROJECT

COSTEAN LOGS

Costean No.	AMG Co-ords		Depth (m)		Sample No.	Description
	E	N	From	To		
GC 63	488 600	6810 850	0	0.9		Brown clay
			0.9	1.15		Broken shale. No salts.
			1.15	1.55	1159458	Blocky black waxy shale with few vugs of salts.
			1.55	2.7		Blocky shale with much gypsum. Sample for oil yield.
GC 64	487 400	6810 850	0	0.6		Brown clay with minor salts.
			0.6	0.9		Broken shale, thin sandstone band at base. No salts.
			0.9	2.3		Blocky black waxy shale with few gypsum veins. No salts.
GC 65	486 200	6810 850	0	2.2		Brown clay
			2.2	2.6		Shale with gypsum
GC 66	486 150	6812 900	0	0.65		Brown clay.
			0.65	1.05	1159459	Broken shale with 5% salts
			1.05	2.05	1159460	Blocky black shale with 10% salts.

MAGNESIUM SULPHATE PROJECT

COSTEAN LOGS

Costean No.	AMG Co-ords		Depth (m)		Sample No.	Description
	E	N	From	To		
			2.05	2.6		Blocky shale. No salts.
GC 67	488 550	6812 850	0	0.35		Brown clay
			0.35	0.7	1159461	Broken shale with 10 % salts,
			0.7	2.0		Blocky shale. No salts.
GC 68	490 900	6812 850	0	0.55		Brown clay
			0.55	0.9		Broken shale with < 5 % salts.
			0.9	1.4		Blocky black shale with one band of salts at base (est.? 5%).
			1.4	2.2		Blocky shale with gypsum.
GC 69	490 950	6810 850	0	0.4		Brown clay
			0.4	0.9	1159462	Broken shale with 25 % salts
			0.9	2.1		Blocky dark grey shale with two thin sandy lenses and few gypsum veins. No salts.

MAGNESIUM SULPHATE PROJECT

COSTEAN LOGS

Costean No.	AMG Co-ords		Depth (m)		Sample No.	Description
	E	N	From	To		
GC 70	492 200	6810 850	0	0.15		Brown clay.
			0.15	0.7	1159463	Broken shale with 25% salts
			0.7	1.35	1159465	Blocky black - dark grey shale with 10% salts. Sample for s.g. 1159464.
			1.35	2.2		Blocky shale with several gypsum veins.
GC 71	493 250	6810 750	0	0.2		Brown clay.
			0.2	0.85	1159466	Broken shale with 25% salts.
			0.85	1.65	1159467	Blocky shale with 20% salts. Sample 1159468 for s.g.
			1.65	2.2		Blocky shale with no. salts.
GC 72	494 550	6810 850	0	0.65		Brown clay
			0.65	1.6	1159469	Broken shale with gypsum. Possibly very minor epsomite (< 5%).
			1.6	2.4		Blocky shale. Many gypsum veins.

MAGNESIUM SULPHATE PROJECT

COSTEAN LOGS

Costean No.	AMG Co-ords		Depth (m)		Sample No.	Description
	E	N	From	To		
GC 73	495 100	68 11 850	0	0.35		Brown clay.
			0.35	1.0	1159470	Broken shale with 20% salts
			1.0	1.6	1159471	Blocky black shale with 10% salts.
						Blocky black shale with some gypsum.
GC 74	493 950	68 11 900	0	1.85		Brown clay with fossil soil at base.
			1.85	2.6	1159472	Broken grey shale with few gypsum veins. No salts.
GC 75	492 700	68 11 850	0	0.55		Brown clay.
			0.55	1.2		Broken shale with 15% salts.
			1.2	2.3		Blocky black shale. No salts.
GC 76	491 500	68 12 000	0	1.8		Brown clay.
			1.8	2.6		Broken black shale with gypsum veins. No salts.
GC 77	493 350	68 12 900	0	1.2		Brown clay.
			1.2	2.2		Blocky shale with gypsum. No salts.

MAGNESIUM SULPHATE PROJECT

COSTEAN LOGS

Costean No.	AMG Co-ords		Depth (m)		Sample No.	Description
	E	N	From	To		
GC 78	495 750	6812 900	0	1.2		Brown clay.
			1.2	2.8	1159473	Blocky dark grey - black shale with large vugs of salts. Est.ᵈ 20%.
GC 79	498 200	6812 900	0	0.5		Brown clay.
			0.5	0.7		Chocolate brown hard siltstone with gypsum.
			0.7	0.95		Cone-in-cone limestone.
			0.95	2.3		Damp soft green shale. No salts. Sample for oil yield.
GC 80	499 450	6815 000	0	0.3		Brown clay
			0.3	0.85	1159474	Broken shale with 20% salts
			0.85	1.15	1159475	Blocky shale with one thick seam of salts. 30% overall.
			1.15	2.0		Blocky black waxy shale with veins of gypsum.

MAGNESIUM SULPHATE PROJECT

COSTEAN LOGS

Costean No.	AMG Co-ords		Depth (m)		Sample No.	Description
	E	N	From	To		
GC 81	498 150	6814 950	0	1.1		Brown clay.
			1.1	1.45		Broken black shale with gypsum.
			1.45	2.4		Blocky black waxy shale with thin orange sandstone. No salts.
GC 82	497 000	6815 000	0	2.6		Brown clay
			2.6	3.2		Blocky black shale with gypsum. No salts.
GC 83	495 750	6814 950	0	2.5		Brown clay.
			2.5	3.1		Blocky black shale. No salts.
GC 84	494 500	6814 950	0	0.8		Brown clay.
			0.8	2.2		Blocky dark grey shale with minor gypsum. No salts.
GC 85	492 150	6814 950	0	0.25		Brown clay.
			0.25	0.9	1159476	Broken shale with 10% salts.
			0.9	2.1		Blocky black shale with gypsum. No salts.

MAGNESIUM SULPHATE PROJECT

COSTEAN LOGS

Costean No.	AMG Co-ords		Depth (m)		Sample No.	Description
	E	N	From	To		
GC 86	489 800	6815 000	0	0.35		Brown clay
			0.35	0.95	1159477	Broken shale with 15% salts
			0.95	1.7	1159478	Blocky shale with 12% salts.
			1.7	2.2		Blocky black shale. No salts
GC 87	487 350	6814 950	0	1.95		Brown clay
			1.95	2.6		Blocky dark grey – black shale with gypsum. No salts.
GC 88	488 700	6817 050	0	0.2		Brown clay.
			0.2	1.15	1159479	Broken with 15% salts.
			1.15	1.9	1159480	Blocky black shale with 10% salts
			1.9	2.3		Blocky shale with gypsum.
GC 89	489 750	6817 050	0	0.35		Brown clay.
			0.35	0.6		Broken grey shale with < 5% salts.
			0.6	2.4		Blocky black shale with gypsum veins. No salts.

MAGNESIUM SULPHATE PROJECT

COSTEAN LOGS

Costean No.	AMG Co-ords		Depth (m)		Sample No.	Description
	E	N	From	To		
GC 90	490 900	68 17 050	0	1.3		Brown clay.
			1.3	2.2		Blocky dark grey shale. No salts.
GC 91	493 350	68 17 050	0	0.4		Brown clay.
			0.4	1.0	1159481	Broken shale with 8% salts.
			1.0	2.1		Blocky dark grey-green shale. No salts.
GC 92	495 750	68 17 050	0	0.2		Brown clay.
			0.2	0.95	1159482	Broken shale with 20% salts.
			0.95	2.1		Blocky black shale with gypsum. No salts.
GC 93	497650	68 16 950	0	1.05		Brown clay. Possibly 5% salts.
			1.05	1.5		Broken shale with gypsum.
			1.5	2.0		Blocky black shale with gypsum veins. No salts.
GC 94	496 500	68 19 100	0	1.35		Brown clay with < 5% salts.
			1.35	2.1		Blocky [illegible] shale with gypsum. No salts.

MAGNESIUM SULPHATE PROJECT

COSTEAN LOGS

Costean No.	AMG Co-ords		Depth (m)		Sample No.	Description
	E	N	From	To		
GC 95	494 500	6819 050	0	0.7		Brown clay
			0.7	1.1		Broken shale
			1.1	2.0		Blocky grey shale. Minor gypsum. No salts.
GC 96	492 100	6819 150	0	2.15		Brown clay
			2.15	2.6		Blocky grey shale with some gypsum. No salts.
GC 97	490 950	6821 200	0	0.7		Brown clay.
			0.7	1.1		Broken shale.
			1.1	2.3		Blocky grey shale, minor gypsum. No salts.
GC 98	493 450	6821 150	0	0.4		Brown clay.
			0.4	0.55		Broken shale.
			0.55	2.1		Blocky dark grey shale with gypsum. No salt
GC 99	495 850	6821 250	0	0.25		Brown clay.
			0.25	0.6		Broken shale with 5 % salts
			0.6	2.2		Blocky dark grey shale with gypsum No salts

MAGNESIUM SULPHATE PROJECT

COSTEAN LOGS

Costean No.	AMG Co-ords		Depth (m)		Sample No.	Description
	E	N	From	To		
GC 100	^{4}98 150	^{68}21 150	0	0.3		Brown clay
			0.3	0.9		Broken dark grey shale
			0.9	2.1		Blocky dark grey shale. No salts.
GC 101	^{4}99 400	^{68}23 300	0	0.4		Brown clay
			0.4	0.95		Broken shale.
			0.95	2.1		Blocky dark grey shale with gypsum. No salts.
GC 102	^{4}97 000	^{68}23 300	0	0.35		Brown clay.
			0.35	0.6		Broken shale with gypsum.
			0.6	2.1		Blocky dark grey shale with much gypsum. No salts.
GC 103	^{4}94 400	^{68}23 250	0	0.25		Brown clay.
			0.25	0.55		Broken shale with 10 % salts.
			0.55	2.1		Blocky dark grey-green shale with abundant gypsum. No salts.

MAGNESIUM SULPHATE PROJECT

COSTEAN LOGS

Costean No.	AMG Co-ords		Depth (m)		Sample No.	Description
	E	N	From	To		
GC 104	^{4}92 100	^{68}23 250	0	0.25		Brown clay.
			0.25	1.05	1159483	Broken shale with 22% salts.
			1.05	2.1		Blocky dark grey – black shale with much gypsum. No salts.
GC 105	^{4}89 850	^{68}23 300	0	1.5		Brown clay.
			1.5	1.85		Broken shale.
			1.85	2.5		Blocky grey shale. Minor gypsum. No salts.
GC 106	^{4}90 900	^{68}25 150	0	0.4		Brown clay
			0.4	1.0	1159484	Broken shale with 15% salts.
			1.0	1.9	1159485	Blocky black shale with 15% vugs of salts.
			1.9	2.3		Blocky shale. No salt.
GC 107	^{4}92 800	^{68}25 300	0	0.15		Brown clay.
			0.15	1.05	1159486	Broken shale with 18% salts.
			1.05	1.55	1159487	Blocky black waxy shale with 18% salts.
			1.55	2.4		Blocky shale. No salts. Sample for oil yield.

COSTEAN LOGS

Costean No.	AMG Co-ords		Depth (m)		Sample No.	Description
	E	N	From	To		
GC 108	495 800	6825 400	0	0.45		Brown clay.
			0.45	0.8	1159488	Broken shale, 10 % salts.
			0.8	1.3	1159489	Blocky black shale with 10% salts.
			1.3	2.1		Blocky shale. No salts.
GC 109	498 200	6825 400	0	0.3		Brown clay.
			0.3	0.85		Broken shale with < 5% salts.
			0.85	2.1		Blocky black waxy shale with gypsum. No salts.
GC 110	499 400	6827 500	0	1.9		Brown clay.
			1.9	2.5		Blocky dark grey shale. No salts.
GC 111	496 950	6827 450	0	1.0		Brown clay.
			1.0	1.4		Broken shale.
			1.4	2.3		Blocky shale, minor gypsum. No salt.
GC 112	493 750	6827 350	0	0.25		Brown clay.
			0.25	0.85	1159490	Broken shale with 10 % salts

MAGNESIUM SULPHATE PROJECT

COSTEAN LOGS

Costean No.	AMG Co-ords		Depth (m)		Sample No.	Description
	E	N	From	To		
			0.85	1.55	1159491	Black shale with 10 % salts
			1.55	2.0		Black shale, No salts.
GC 113	491 700	6827150	0	0.2		Brown clay.
			0.2	0.85	1159492	Broken shale with 15 % salts.
						Sample 1159494 for s.g.
			0.85	1.7	1159493	Blocky black shale with 15 % salts.
						Sample 1159495 for s.g.
			1.7	2.2		Blocky shale with no salts.
GC 114	489 600	6827150	0	0.6		Brown clay.
			0.6	0.85		Broken shale.
			0.85	2.2		Blocky black shale, no salts. Minor gypsum
GC 115	489 350	6825100	0	0.3		Brown clay.
			0.3	0.8	1159496	Broken shale with 10% salts.
			0.8	1.45	1159497	Blocky shale with 10% salts.
			1.45	1.9		Blocky shale, no salts.

MAGNESIUM SULPHATE PROJECT

COSTEAN LOGS

Costean No.	AMG Co-ords		Depth (m)		Sample No.	Description
	E	N	From	To		
GC 116	491 850	6825 150	0	0.5		Brown clay.
			0.5	1.45	1159498	Broken shale with sandstone band. 10 % salts.
			1.45	2.3		Blocky black shale. No salts.
GC 117	494 450	6825 300	0	0.3		Brown clay.
			0.3	1.35	1159499	Broken shale with 20 % salts.
			1.35	2.4		Blocky black shale with no salts.
GC 118	495 600	6827 250	0	1.3		Brown clay.
			1.3	1.6		Broken shale.
			1.6	2.3		Blocky black shale, no gypsum. No salts.
GC 119	492 700	6827 150	0	0.45		Brown clay.
			0.45	1.15	1159500	Broken shale with 10 % salts.
			1.15	2.2		Blocky dark grey-black shale with no salts.

MAGNESIUM SULPHATE PROJECT

COSTEAN LOGS

Costean No.	AMG Co-ords		Depth (m)		Sample No.	Description
	E	N	From	To		
GC 120	490 600	6827050	0	0.65		Brown clay.
			0.65	1.2		Broken shale.
			1.2	1.4		Blocky black shale with 20 % salts
			1.4	2.1		Blocky black shale with no salts.
GC 121	490 950	6823 250	0	0.2		Brown clay.
			0.2	0.8	1159501	Broken shale with 15 % salts.
			0.8	2.2		Blocky dark grey shale with no salts.
GC 122	493 300	6823 250	0	0.5		Brown clay.
			0.5	0.95		Broken shale with < 5% epsomite.
			0.95	2.1		Blocky black shale with nil salts. Sample for oil yield.
GC 123	487 650	6817050	0	0.6		Brown clay.
			0.6	1.1		Broken shale.
			1.1	2.4		Blocky black waxy shale. Several gypsum veins. No salts.

MAGNESIUM SULPHATE PROJECT

COSTEAN LOGS

Costean No.	AMG Co-ords		Depth (m)		Sample No.	Description
	E	N	From	To		
GC 124	494 100	6812 900	0	0.4		Brown clay.
			0.4	0.8		Broken shale with possibly 5% salts.
			0.8	2.0		Blocky black waxy shale with gypsum. No salts.
GC 125	496 950	6812 900	0	0.25		Brown clay.
			0.25	0.7	1159502	Broken shale with 15% salts.
			0.7	2.2		Blocky black waxy shale. No salts.
GC 126	499 400	6812 900	0	0.65		Brown clay.
			0.65	0.8		Chocolate brown siltstone with gypsum.
			0.8	1.6		Broken shale. No salts.
			1.6	2.1		Blocky soft grey-green waxy shale. No salts.
GC 127	500 000	6813 900	0	0.75		Brown clay.
			0.75	1.0		Broken shale.
			1.0	2.1		Blocky grey-green waxy shale with hard white siltstone near base. Minor [illegible] no salts

MAGNESIUM SULPHATE PROJECT

COSTEAN LOGS

Costean No.	AMG Co-ords		Depth (m)		Sample No.	Description
	E	N	From	To		
GC 128	498 800	6813 950	0	0.45		Brown clay.
			0.45	0.95		Broken shale with gypsum veins.
			0.95	2.1		Blocky black shale with gypsum veins. No salts.
GC 129	497 600	6813 900	0	0.35		Brown clay.
			0.35	1.1	1159503	Broken shale with 25% salts.
			1.1	2.1		Blocky dark grey - green shale with gypsum. No salts.
GC 130	496 300	6813 900	0	0.25		Brown clay.
			0.25	1.0	1159504	Broken shale with 25% salts.
			1.0	1.6	1159505	Blocky dark grey - green shale with 20% salts.
			1.6	2.1		Blocky shale, no salts.
GC 131	494 950	6813 950	0	1.35		Brown clay.
			1.35	2.35	1159506	Broken dark grey shale. 10% salts.
			2.35	2.5		Blocky dark grey shale. No salts.

MAGNESIUM SULPHATE PROJECT

COSTEAN LOGS

Costean No.	AMG Co-ords		Depth (m)		Sample No.	Description
	E	N	From	To		
GC 132	496 350	6811 900	0	1.05		Brown clay.
			1.05	1.25		Broken shale. No salts.
			1.25	2.2		Blocky dark grey-green shale with gypsum veins. No salts.
GC 133	495 800	6810 850	0	2.5		Brown clay.
			2.5	2.9		Broken black shale, minor gypsum. No salts.

APPENDIX II

SPECIFIC GRAVITY CALCULATIONS

MAGNESIUM SULPHATE PROJECT

SPECIFIC GRAVITY CALCULATIONS

Costean No.	Unit	Sample No.	Bucket Weights (kg)								Specific Gravity (Vol. = 0.02821 m^3)
			1	2	3	4	5	6	7	Total	
GC1	U	1159401	8.5	8.2	4.3	8.15				29.15	1.033
	L	1159402	8.8	8.6	9.35	8.85	7.3			42.90	1.521
GC 2	L	1159403	8.3	9.45	9.15	8.05	8.7	5.65		49.30	1.748
GC 3	U	1159404	8.9	9.55	9.85	10.05	3.85			42.20	1.496
	L	1159405	10.05	9.3	10.3	9.45	6.8			45.90	1.627
GC 4	U	1159406									
	L	1159407									
GC 5	U	1159408	8.75	10.0	9.75	6.9				35.40	1.255
	L	1159409	8.9	8.9	9.5	9.05				36.35	1.289
GC 6	U	1159411	9.0	8.75	7.85	8.55	5.0			39.15	1.388
	L	1159410									
GC 11	U	1159412	11.4	10.4	10.45	10.3				42.55	1.508
	L	1159413									
GC 12	U	1159414	9.7	9.3	9.95	10.9				39.85	1.413
	L	1159415									
GC 13	U	1159416	9.75	9.35	9.4	9.7				38.20	1.354
	L	1159417	8.2	8.8	8.55	8.8	9.5			43.85	1.554
	L	1159418									

MAGNESIUM SULPHATE PROJECT

SPECIFIC GRAVITY CALCULATIONS

Costean No.	Unit	Sample No.	Bucket Weights (kg) 1	2	3	4	5	6	7	Total	Specific Gravity (Vol. = 0.02821 m³)
GC 15	U	1159419	7.85	9.0	9.9	9.0				35.75	1.267
	L	1159420	8.55	9.7	10.0	9.5	8.8			46.55	1.650
GC 27	L	1159421									
GC 29	U	1159422									
GC 30	U	1159423									
	U	1159425	8.15	9.1	9.5	9.0				35.75	1.267
	L	1159424									
	L	1159426	9.9	10.5	10.9	9.6	4.1			45.00	1.595
GC 31	U	1159427	7.55	8.3	8.8	7.25				31.90	1.131
	L	1159428	9.4	8.95	9.15	9.1	8.5			45.10	1.599
	L	1159429									
GC 37	U	1159430									
	L	1159431									
GC 44	U	1159432	9.45	9.6	10.45	10.3	6.1			45.90	1.627
	L	1159433									
GC 45	U	1159434									
GC 46	U	1159435									
	L	1159436									

MAGNESIUM SULPHATE PROJECT

SPECIFIC GRAVITY CALCULATIONS

Costean No.	Unit	Sample No.	Bucket Weights (kg)								Specific Gravity (Vol. = 0.02821 m³)
			1	2	3	4	5	6	7	Total	
GC 47	U	1159437									
	U	1159439	8.1	8.8	8.75	5.9				31.55	1.118
	L	1159438									
	L	1159440	9.4	9.9	9.85	9.7	4.45			43.30	1.535
GC 49	U	1159441									
	L	1159442									
GC 50	U	1159443									
	L	1159444									
GC 51	U	1159445									
	L	1159446									
GC 52	U+L	1159447									
GC 53	U	1159448	9.8	10.0	9.65	9.9				39.35	1.395
	L	1159449									
GC 58	U	1159450									
	L	1159451									
GC 59	U+L	1159452									
GC 60	U	1159453									
	L	1159454									

MAGNESIUM SULPHATE PROJECT

SPECIFIC GRAVITY CALCULATIONS

Costean No.	Unit	Sample No.	Bucket Weights (kg)								Specific Gravity (Vol. = 0.02821 m³)
			1	2	3	4	5	6	7	Total	
GC 61	U	1159455	9.85	10.15	10.0	6.2				36.20	1.283
	L	1159456	9.2	7.9	9.3	9.6	8.1			44.10	1.563
	L	1159457									
GC 63	L	1159458									
GC 66	U	1159459									
	L	1159460									
GC 67	U	1159461									
GC 69	U	1159462									
GC 70	U	1159463	8.2	8.7	10.15	6.65				33.70	1.195
	L	1159464	12.0	11.1	10.85	10.9				44.85	1.590
	L	1159465									
GC 71	U	1159466									
	L	1159467									
	L	1159468	9.2	10.25	9.75	11.15				40.35	1.430
GC 72	U	1159469									
GC 73	U	1159470									
	L	1159471									
GC 74	U	1159472									

MAGNESIUM SULPHATE PROJECT

SPECIFIC GRAVITY CALCULATIONS

Costean No.	Unit	Sample No.	Bucket Weights (kg)								Specific Gravity (Vol. = m³)
			1	2	3	4	5	6	7	Total	
GC 78	L	1159473									
GC 80	U	1159474									
	L	1159475									
GC 85	U	1159476									
GC 86	U	1159477									
	L	1159478									
GC 88	U	1159479									
	L	1159480									
GC 91	U	1159481									
GC 92	U	1159482									
GC 104	U	1159483									
GC 106	U	1159484									
	L	1159485									
GC 107	U	1159486									
	L	1159487									
GC 108	U	1159488									
	L	1159489									

MAGNESIUM SULPHATE PROJECT

SPECIFIC GRAVITY CALCULATIONS

Costean No.	Unit	Sample No.	Bucket Weights (kg) 1	2	3	4	5	6	7	Total	Specific Gravity (Vol. = 0·02821 m³)
GC 112	U	1159490									
	L	1159491									
GC 113	U	1159492									
	U	1159494	9.3	9.3	9.55	5.9				34.05	1.207
	L	1159493									
	L	1159495	9.9	10.25	10.8	10.65	4.25			45.85	1.625
GC 115	U	1159496									
	L	1159497									
GC 116	U	1159498									
GC 117	U & L	1159499									
GC 119	U	1159500									
GC 121	U	1159501									
GC 125	U	1159502									
GC 129	U	1159503									
GC 130	U	1159504									
	L	1159505									
GC 131	U	1159506									

MAGNESIUM SULPHATE PROJECT

SPECIFIC GRAVITY CALCULATIONS

Costean No.	Unit	Sample No.	Bucket Weights (kg)								Specific Gravity (Vol. = m³)
			1	2	3	4	5	6	7	Total	
GC 134	U	1159507									
GC 138	Clay	1159508									
GC 140	U	1159509									
GC 141	U	1159510									
	L	1159511									
GC 142	U	1159512									
	L	1159513									
GC 143	U	1159514									
	L	1159515									
GC 144	U	1159516									
	L	1159517									
GC 145	U	1159518									
GC 146	U	1159519									
GC 147	U	1159520									
GC 148	U	1159521									
GC 149	U	1159522									
	L	1159523									
GC 150	U	1159524									
	L	1159525									
GC 151	U	1159526									
	L	1159527									
GC 152	U	1159528									
	L	1159529									
GC 153	U	1159530									
GC 154	U	1159531									
GC 155	U	1159532									
	L	1159533									

MAGNESIUM SULPHATE PROJECT

SPECIFIC GRAVITY CALCULATIONS

Costean No.	Unit	Sample No.	Bucket Weights (kg)								Specific Gravity (Vol. = m³)
			1	2	3	4	5	6	7	Total	
GC 156	U	1159534									
	L	1159535									
GC 157	U	1159536									
	L	1159537									
GC 158	U	1159538									
	L	1159539									
GC 159	U	1159540									
	L	1159541									
GC 160	U	1159542									
	L	1159543									
GC 161	U	1159544									
	L	1159545									
GC 168	U	1159546									
GC 167	U	1159547									
GC 173	U	1159548									
GC 174	U	1159549									
GC 175	U	1159550									
	L	1159551									
GC 176	U	1159552									
	L	1159553									
GC 177	U	1159554									
	L	1159555									
GC 178	U	1159556									
	L	1159557									
GC 179	U	1159558									
	L	1159559									
GC 180	U	1159560									
	L	1159561									

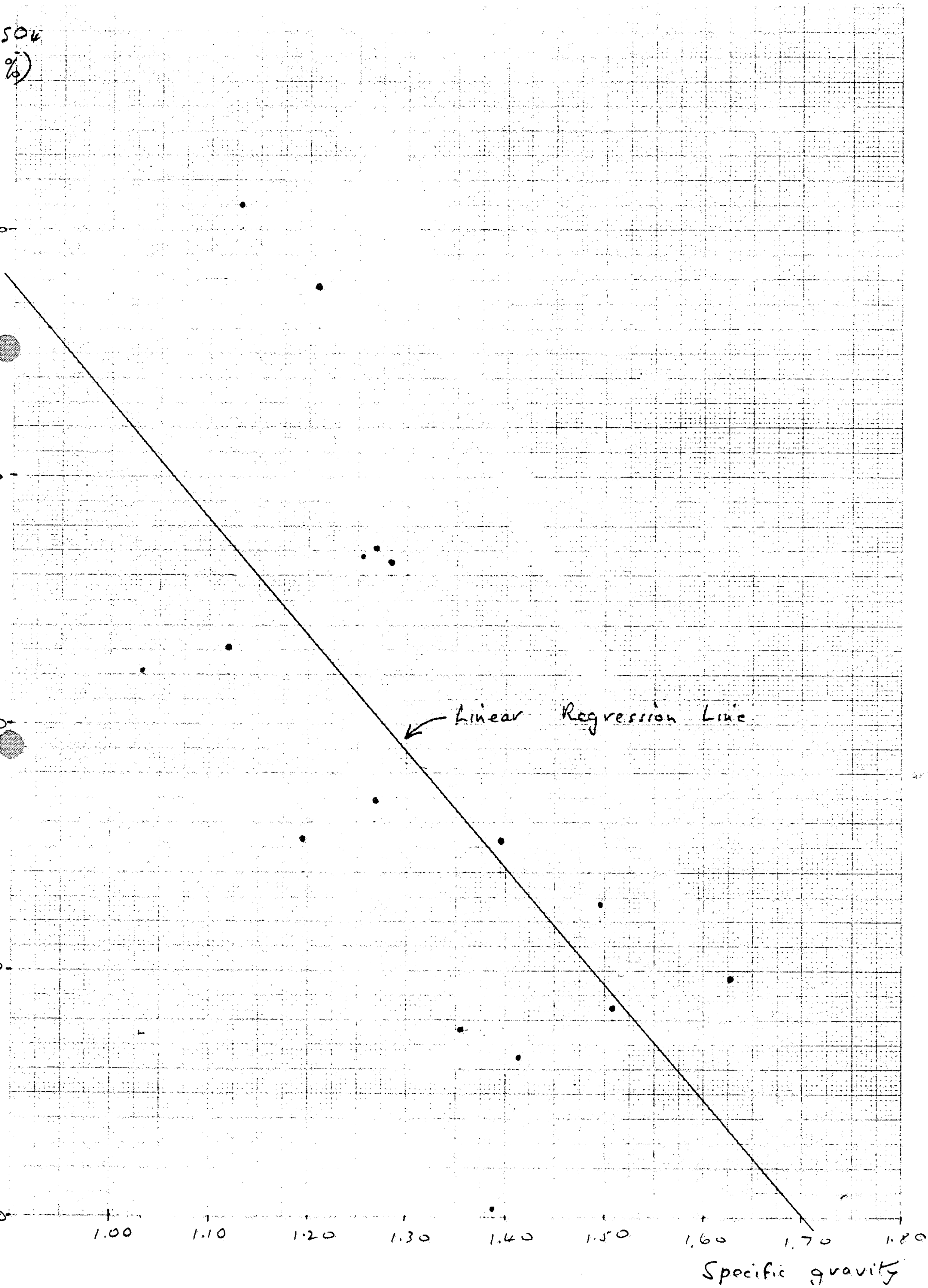
MAGNESIUM SULPHATE PROJECT

SPECIFIC GRAVITY CALCULATIONS

Costean No.	Unit	Sample No.	Bucket Weights (kg)								Specific Gravity (Vol. = m³)
			1	2	3	4	5	6	7	Total	
GC 181	U	1159562									
	L	1159563									
GC 182	L	1159564									
GC 183	U	1159565									
	L	1159566									

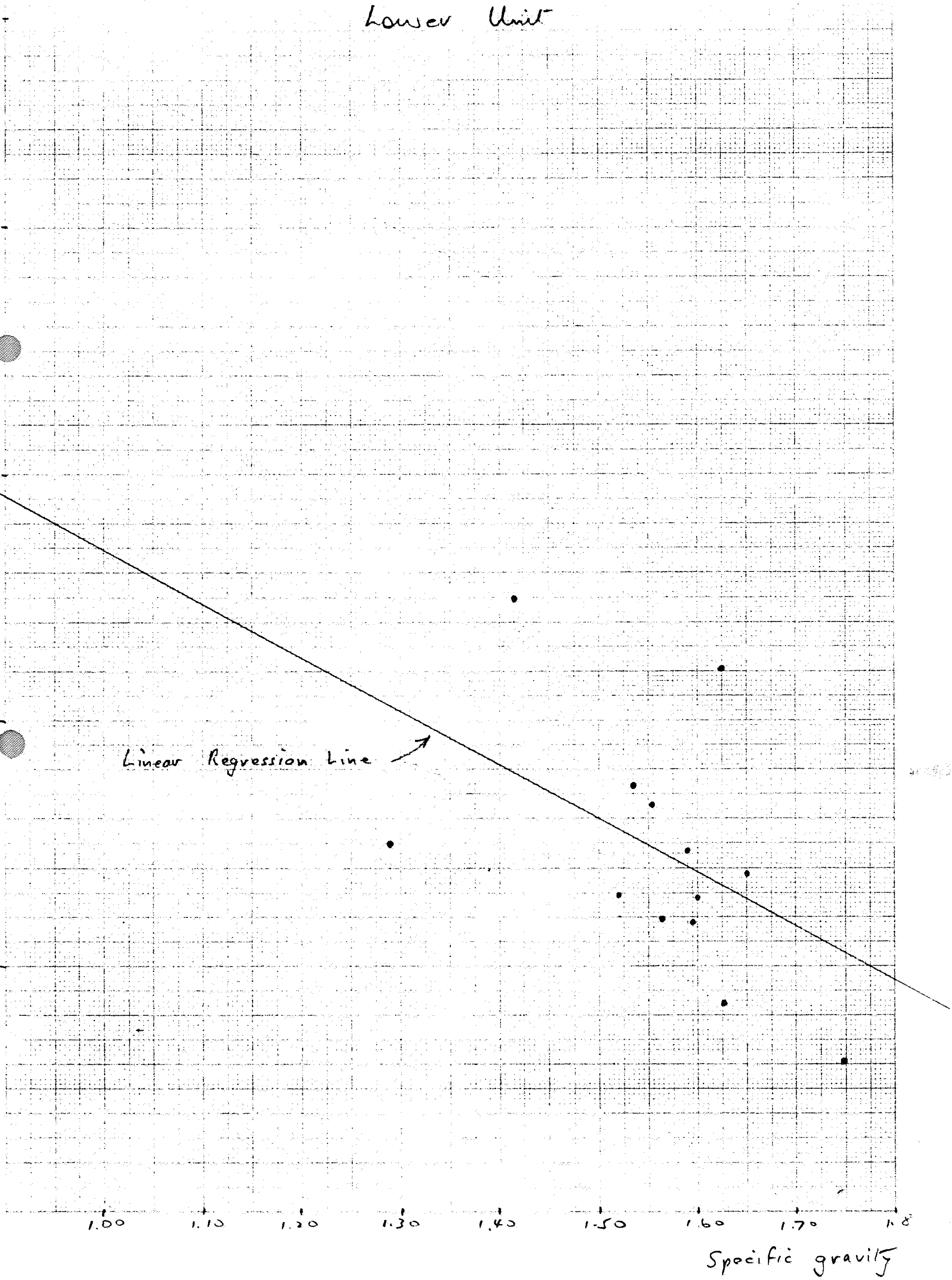
SPECIFIC GRAVITY

Upper Unit



SPECIFIC GRAVITY

Lower Unit



APPENDIX III

ANALYTICAL METHOD

The Australian
ineral Development
Laboratories

ngton Street, Frewville,
South Australia 5063
hone Adelaide 79 1662
Telex AA 82520

Please address all
correspondence to
.O. Box 114 Eastwood
SA 5063
In reply quote:

amdel

29 October 1984

RECEIVED
30 OCT 1984

AC 3/1/6/0

Mr. A.K. Scott,
Principal Geologist,
CRA Exploration Pty. Limited,
P.O. Box 254,
NORWOOD S.A. 5067

Dear Tony,

QUOTATION

Further to your letter of 17 October 1984 regarding your evaporite samples, we have the following to offer.

A. We can extract 100g samples using large plastic vials.

B. I agree that a simple extraction study should be made to check time required for maximum extraction.
This may well be around 60 minutes but should be checked.

200 Samples 2-4 Kg:

(1) Dry at 40^{o}C max. for at least 48 hours
Code P1/4

(2) Crushing Code P2/2

(3) Pulverising (Disc Mill) Code P4/3
(to ≅ 150#)

Check samples are dry before riffling. This should become obvious during disc pulverising.

(4) Further drying if required.
Code P1/1

(5) Split out 2 x 150g
(using fine-slot riffle).
1 sample for analysis
1 sample to be held pending possible
XRD analysis.

Head Office:
emington Street, Frewville
South Australia 5063,
Telephone (08) 79 1662
Telex: Amdel AA82520
Pilot Plant:
Osman Place
Thebarton, S.A.
Telephone (08) ~~48 8053~~ 43 5733
Branch Laboratories:
Melbourne, Vic.
Telephone (03) 645 3093
Perth, W.A.
Telephone (09) 325 7311
Townsville
Queensland 4814
Telephone (077) 75 1377

29 October 1984

(6) Analysis:

Extract water soluble salts and determine

(i) Cl Titration
Code W2/2/1

(ii) Ca Mg Na K SO_3 ICP
Code W2/2/6 Special

(7) Calculate water soluble salts as in AC 743/84
Decant, dry residue at $40^{\circ}C$ and weigh.
Express weight difference as % soluble salts.

Yours faithfully

D. Patterson

D. Patterson
Acting Manager
Analytical Chemistry Division

DP:ij

APPENDIX IV

ANALYSES

0127

3/1/6/0 - AC 2318/85

17 December 1984

The Australian Mineral Development Laboratories

Flemington Street, Frewville, South Australia 5063
Phone Adelaide 79 1662
Telex AA 82520

Please address all correspondence to
P.O. Box 114 Eastwood SA 5063
In reply quote:

amdel

NATA CERTIFICATE

Mr. A.K. Scott,
CRA Exploration Pty. Limited,
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REPORT AC 2318/85

YOUR REFERENCE: D.P.O. B 0635

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Pages 1 - 10

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ANALYSIS - ppm

SAMPLE MARK	CHLORIDE Cl⁻	SAMPLE MARK	CHLORIDE Cl⁻	SAMPLE MARK	CHLORIDE Cl⁻
1159401	640	1159426	6700	1159451	5800
402	28800	427	4900	452	4200
403	7200	428	8900	453	4600
404	6400	429	6500	454	6000
405	7400	430	5800	455	4600
406	5400	431	7300	456	7000
407	5000	432	10200	457	9400
408	10800	433	10100	458	4400
409	12200	434	3600	459	3600
410	6600	435	2900	460	3000
411	5400	436	3900	461	9000
412	5800	437	10600	462	7200
413	6800	438	12400	463	5000
414	2400	439	1440	464	6400
415	6600	440	13600	465	7400
416	4600	441	7200	466	8000
417	5400	442	6800	467	6800
418	5000	443	3800	468	8400
419	5200	444	4600	469	3200
420	6400	445	6000	470	7000
421	6800	446	6000	471	7800
422	5200	447	5800	472	3800
423	7800	448	4600	473	3600
424	6100	449	6400	474	4000
425	8400	450	4600	475	3000

Method: W2/2/1

ANALYSIS - ppm

SAMPLE MARK	CHLORIDE Cl^-	SAMPLE MARK	CHLORIDE Cl^-	SAMPLE MARK	CHLORIDE Cl^-
1159476	11000	1159507	1220	1159538	8000
477	7400	508	7600	539	4900
478	10000	509	5400	540	1720
479	14600	510	8400	541	3000
480	19800	511	6400	542	2400
481	6200	512	10600	543	2300
482	10200	513	7800	544	2800
483	12600	514	5600	545	1800
484	4600	515	5800	546	13800
485	5000	516	4800	547	8700
486	9400	517	6100	548	8600
487	21000	518	15300	549	9400
488	3600	519	3600	550	7900
489	4600	520	3100	551	10000
490	7400	521	6200	552	4500
491	7800	522	6000	553	4200
492	8600	523	5300	554	8000
493	11200	524	6500	555	5700
494	10000	525	5600	556	5300
495	11800	526	5100	557	6100
496	8400	527	4400	558	5500
497	9600	528	4600	559	6200
498	6800	529	7900	560	8400
499	5600	530	3700	561	6200
500	7600	531	9600	562	7600
501	9200	532	6800	563	6200
502	6800	533	3900	564	7000
503	5800	534	7200	565	8700
504	7800	535	5200	566	6400
505	7200	536	4100		
506	9200	537	2820		

Method: W2/2/1

ANALYSIS - %

SAMPLE MARK	MAGNESIUM Mg	CALCIUM Ca	SODIUM Na	POTASSIUM K	SULPHUR TRIOXIDE SO_3
1159401	2.24	0.10	2.30	0.03	16.16
402	1.30	0.13	0.98	0.02	2.91
403	0.62	0.10	0.64	0.02	2.68
404	1.28	0.10	0.80	0.03	5.83
405	0.85	0.10	0.72	0.02	3.76
406	0.46	0.10	0.83	0.01	2.22
407	0.61	0.09	0.62	0.02	2.91
408	2.70	0.10	1.97	0.02	15.2
409	1.51	0.10	0.98	0.02	6.24
410	0.06	0.17	0.40	0.01	0.49
411	0.03	0.16	0.37	<0.01	0.43
412	0.86	0.10	0.72	0.02	4.00
413	0.88	0.10	0.83	0.02	4.24
414	0.65	0.09	0.66	0.02	3.54
415	1.70	0.10	0.97	0.03	7.92
416	0.77	0.09	0.61	0.03	3.59
417	0.72	0.09	0.66	0.02	3.44
418	1.67	0.10	0.65	0.02	7.29
419	2.74	0.10	1.22	0.03	14.0
420	1.39	0.10	0.84	0.02	6.44
421	1.30	0.10	0.85	0.02	6.04
422	0.97	0.10	0.74	0.02	4.62
423	1.70	0.10	1.19	0.03	8.35
437	2.33	0.10	1.74	0.03	12.3
438	1.75	0.09	1.11	0.02	7.66

ANALYSIS - %

SAMPLE MARK	MAGNESIUM Mg	CALCIUM Ca	SODIUM Na	POTASSIUM K	SULPHUR TRIOXIDE SO_3
1159439	2.19	0.09	1.62	0.03	13.6
440	2.48	0.10	2.24	0.03	14.3
441	1.56	0.09	0.88	0.02	7.11
442	0.59	0.10	0.64	0.02	2.68
443	0.39	0.10	0.38	0.02	1.81
444	0.52	0.10	0.49	0.02	2.38
445	0.66	0.10	0.56	0.02	2.88
446	0.61	0.10	0.56	0.02	2.66
447	0.58	0.10	0.51	0.02	2.47
448	1.54	0.10	0.62	0.03	6.59
449	0.61	0.10	0.61	0.02	2.77
450	1.54	0.09	1.13	0.03	8.21
451	1.37	0.09	1.19	0.03	7.55
452	0.95	0.09	0.83	0.02	4.91
453	1.60	0.09	0.85	0.03	7.69
454	0.79	0.09	0.84	0.03	4.03
455	2.68	0.10	1.76	0.02	15.8
456	1.35	0.10	0.74	0.02	5.84
457	1.20	0.10	0.79	0.02	5.09
458	0.61	0.10	0.54	0.02	2.83
459	0.76	0.10	0.66	0.02	3.90
460	1.19	0.09	0.67	0.03	5.75
461	1.34	0.10	0.90	0.02	6.00
462	1.56	0.10	0.90	0.02	7.19
463	1.55	0.10	1.18	0.02	8.38

ANALYSIS - %

SAMPLE MARK	MAGNESIUM Mg	CALCIUM Ca	SODIUM Na	POTASSIUM K	SULPHUR TRIOXIDE SO_3
1159464	1.14	0.10	0.87	0.03	5.50
465	1.48	0.10	1.06	0.03	7.23
466	2.54	0.10	1.62	0.03	13.6
467	2.52	0.10	1.24	0.03	12.9
468	2.06	0.10	1.09	0.03	9.73
469	0.16	0.11	0.39	0.02	1.07
470	1.72	0.10	1.18	0.02	8.79
471	0.94	0.10	0.86	0.03	4.39
472	0.94	0.10	0.59	0.03	4.37
473	1.18	0.10	0.64	0.02	5.48
474	1.86	0.10	1.22	0.03	10.1
475	2.62	0.10	0.78	0.02	12.4
476	1.28	0.10	1.18	0.02	6.39
477	1.65	0.10	0.67	0.03	6.88
478	1.69	0.10	0.90	0.03	7.34
479	3.47	0.10	2.55	0.03	20.8
480	1.60	0.11	1.20	0.03	5.94
481	1.14	0.09	1.01	0.01	6.14
482	1.60	0.10	1.31	0.02	8.29
483	2.28	0.10	1.80	0.03	12.6
484	1.30	0.09	0.91	0.02	6.74
485	1.29	0.10	0.85	0.03	6.55
486	3.96	0.10	2.22	0.03	14.2
487	1.97	0.11	1.37	0.03	7.70
488	1.07	0.10	0.59	0.02	5.06

ANALYSIS - %

SAMPLE MARK	MAGNESIUM Mg	CALCIUM Ca	SODIUM Na	POTASSIUM K	SULPHUR TRIOXIDE SO_3
1159489	1.02	0.10	0.75	0.02	5.24
490	2.08	0.06	1.85	0.02	13.0
491	1.30	0.10	1.11	0.02	6.93
492	3.80	0.10	2.41	0.04	14.7
493	2.23	0.10	1.36	0.03	11.23
494	3.21	0.10	2.28	0.04	20.3
495	1.29	0.10	1.01	0.03	5.86
496	1.90	0.10	1.68	0.01	11.55
497	1.15	0.10	0.99	0.02	5.57
498	1.19	0.10	0.91	0.02	6.03
499	1.67	0.10	1.17	0.02	9.11
500	1.26	0.10	1.01	0.02	6.52
501	1.67	0.10	1.27	0.02	8.88
502	1.85	0.10	0.98	0.02	9.16
503	1.59	0.09	1.15	0.02	8.84
504	2.47	0.09	1.68	0.03	14.8
505	2.07	0.09	1.88	0.03	13.42
506	1.36	0.10	1.33	0.03	7.63
507	2.05	0.10	0.91	0.03	8.63
508	0.85	0.10	0.57	0.01	3.54
509	0.72	0.10	0.57	0.02	3.38
510	1.18	0.10	0.76	0.02	5.27
511	0.98	0.10	0.61	0.02	4.41
512	1.95	0.10	1.32	0.03	9.95
513	1.33	0.10	0.90	0.03	6.40
514	1.48	0.10	1.07	0.02	8.17
515	1.41	0.10	0.92	0.03	7.35
516	1.73	0.09	0.91	0.02	8.86

ANALYSIS - %

SAMPLE MARK	MAGNESIUM Mg	CALCIUM Ca	SODIUM Na	POTASSIUM K	SULPHUR TRIOXIDE SO_3
1159424	1.19	0.09	0.74	0.02	5.04
425	3.07	0.08	1.72	0.02	15.9
426	1.55	0.06	1.03	0.02	7.05
427	4.14	0.09	2.86	0.02	11.0
428	1.09	0.09	0.84	0.02	4.51
429	1.29	0.09	0.83	0.02	5.70
430	0.76	0.09	0.67	0.02	3.36
431	0.76	0.09	0.73	0.02	3.34
432	0.98	0.10	0.71	0.02	3.57
433	0.62	0.10	0.65	0.02	2.19
434	2.22	0.09	0.79	0.02	9.97
435	0.41	0.09	0.40	0.02	1.95
436	1.07	0.09	0.85	0.02	5.33
1159517	1.64	0.08	1.06	0.03	7.84
518	1.30	0.10	1.21	0.03	5.27
519	1.02	0.09	0.75	0.02	4.95
520	0.86	0.09	0.64	0.02	4.10
521	1.49	0.05	1.03	0.02	7.08
522	2.13	0.09	1.30	0.02	10.9
523	1.34	0.09	0.95	0.02	6.49
524	2.21	0.09	1.27	0.03	11.0
525	1.90	0.09	1.09	0.03	9.17
526	1.77	0.09	1.30	0.03	9.40
527	1.25	0.09	0.98	0.02	6.35
528	2.19	0.09	1.22	0.03	11.1
529	2.02	0.09	1.41	0.03	10.4
530	1.31	0.09	1.01	0.03	6.93
531	1.62	0.09	1.33	0.03	7.99
532	1.81	0.09	1.38	0.03	9.54
533	1.20	0.08	0.94	0.02	6.17
534	2.67	0.09	1.82	0.03	15.1
535	1.46	0.09	0.98	0.02	7.15
536	1.50	0.09	1.01	0.02	7.60

ANALYSIS - %

SAMPLE MARK	MAGNESIUM Mg	CALCIUM Ca	SODIUM Na	POTASSIUM K	SULPHUR TRIOXIDE SO_3
1159537	1.36	0.09	1.13	0.02	7.63
538	1.65	0.09	1.36	0.02	8.47
539	1.11	0.09	0.95	0.02	5.61
540	1.04	0.09	0.66	0.02	5.10
541	1.99	0.09	1.33	0.03	11.0
542	0.81	0.08	0.77	0.02	4.41
543	1.29	0.09	0.90	0.02	6.66
544	0.38	0.09	0.43	0.02	1.86
545	0.88	0.09	0.48	0.02	3.98
546	2.17	0.09	1.10	0.03	8.78
647	1.53	0.08	0.88	0.02	6.47
548	0.96	0.09	0.85	0.02	4.17
549	1.46	0.09	1.08	0.02	6.65
550	1.17	0.09	0.94	0.02	5.38
551	1.38	0.09	1.06	0.02	6.24
552	0.86	0.09	0.70	0.02	4.09
553	0.96	0.08	0.78	0.02	4.70
554	2.08	0.09	1.21	0.02	10.0
555	1.05	0.09	0.73	0.02	4.76
556	0.54	0.09	0.49	0.02	2.29
557	1.30	0.09	0.86	0.02	6.03
558	1.34	0.09	0.94	0.02	6.48
559	1.41	0.09	0.91	0.02	6.53
560	1.80	0.09	1.13	0.03	8.46
561	1.20	0.09	0.88	0.02	5.64
562	1.54	0.09	1.06	0.02	7.30
563	1.17	0.09	0.89	0.02	5.55
564	1.20	0.09	0.80	0.02	5.30
565	1.28	0.09	0.92	0.02	5.63
566	1.24	0.09	0.89	0.03	5.77

ANALYSIS - %

SAMPLE MARK	WATER SOLUBLE SALTS	SAMPLE MARK	WATER SOLUBLE SALTS	SAMPLE MARK	WATER SOLUBLE SALTS
1159401	14.4	1159429	8.21	1159457	8.30
402	10.8	430	6.15	458	5.13
403	5.68	431	6.50	459	5.98
404	8.38	532	7.14	460	7.39
405	6.84	433	5.90	461	8.89
406	4.91	434	10.6	462	9.40
407	5.64	435	3.93	463	9.74
408	15.2	435	7.35	464	7.95
409	9.91	437	13.7	465	9.57
410	1.96	438	11.3	466	13.7
411	1.54	439	12.6	467	12.6
412	6.58	440	16.0	468	11.1
413	7.26	441	9.62	469	2.82
414	5.64	442	5.38	470	10.5
415	10.1	443	3.93	471	7.35
416	6.24	444	4.74	472	6.32
417	6.28	445	5.47	473	7.35
418	8.89	446	5.30	474	11.1
419	13.0	447	5.04	475	11.6
420	8.55	448	8.46	476	9.91
421	8.21	449	5.56	477	9.06
422	7.00	450	9.74	478	3.08
423	10.3	451	10.0	479	22.4
424	7.61	452	7.14	480	11.5
425	14.7	453	9.40	481	8.63
426	9.23	454	7.00	482	11.1
427	24.6	455	14.0	483	14.0
428	7.69	456	8.36	484	8.72

ANALYSIS - %

SAMPLE MARK	WATER SOLUBLE SALTS	SAMPLE MARK	WATER SOLUBLE SALTS	SAMPLE MARK	WATER SOLUBLE SALTS
1159484	8.72	1159512	11.5	1159540	6.67
485	8.03	513	8.72	541	11.6
486	24.8	514	9.57	542	6.50
487	12.5	515	8.89	543	8.29
488	6.58	516	9.57	544	3.85
489	6.97	517	9.91	545	5.64
490	12.6	518	10.3	546	12.0
491	9.23	519	7.18	547	9.23
492	23.0	520	6.32	548	7.52
493	12.3	521	9.57	549	9.57
494	16.9	522	11.8	550	8.29
495	9.23	523	8.55	551	9.40
496	10.9	524	12.0	552	6.54
497	8.55	525	10.6	553	7.18
498	8.29	526	10.6	554	11.6
499	10.1	527	8.55	555	7.31
500	8.89	528	11.3	556	4.91
501	10.8	529	12.0	557	8.38
502	10.3	530	8.72	558	8.46
503	10.1	531	10.9	559	8.72
504	13.3	532	11.6	560	10.8
505	13.2	533	8.55	561	8.38
506	10.1	534	14.5	562	9.91
507	10.9	535	9.23	563	8.21
508	6.41	536	9.40	564	8.08
509	5.81	537	9.23	565	8.72
510	7.86	538	10.9	566	8.29
511	6.67	539	7.95		

APPENDIX V

GRADE-THICKNESS DATA

GRADE - THICKNESS DATA

Costean No.	Sample No.	Unit	Thickness (m)	$MgSO_4$ (wt %)	Total thickness (m)	Average $MgSO_4$	m.%
GC 1	1159401	U	0.65	11.09	1.35	8.68	11.72
	1159402	L	0.7	6.44			
GC 2					1.7	3.07	5.22
	1159403	L	1.7	3.07			
GC 3	1159404	U	0.6	6.34	1.45	5.09	7.38
	1159405	L	0.85	4.21			
GC 4	1159406	U	0.2	2.28	1.55	2.92	4.53
	1159407	L	1.35	3.02			
GC 5	1159408	U	0.5	13.37	1.05	10.28	10.80
	1159409	L	0.55	7.48			
GC 6	1159411	U	0.3	0.15	1.5	0.27	0.41
	1159410	L	1.2	0.30			
GC 11	1159412	U	0.5	4.26	0.7	4.29	3.00
	1159413	L	0.2	4.36			
GC 12	1159414	U	0.4	3.22	1.4	6.93	9.71
	1159415	L	1.0	8.42			
GC 13	1159416	U	0.4	3.81	1.5	7.08	10.62
	1159418	L	1.1	8.27			
GC 15	1159419	U	0.8	13.57	1.35	10.84	14.64
	1159420	L	0.55	6.88			
GC 27					0.35	6.44	2.25
	1159421	L	0.35	6.44			
GC 29	1159422	U	0.45	4.80	0.45	4.80	2.16
GC 30	1159423	U	0.6	8.42	1.5	6.90	10.35
	1159424	L	0.9	5.89			

GRADE - THICKNESS DATA

Costean No.	Sample No.	Unit	Thickness (m)	$MgSO_4$ (wt %)	Total thickness (m)	Average $MgSO_4$	m.%
GC 31	1159427	U	0.6	20.50	1.4	12.44	17.41
	1159429	L	0.8	6.39			
GC 37	1159430	U	0.45	3.76	1.15	3.76	4.32
	1159431	L	0.7	3.76			
GC 44	1159432	U	0.35	4.85	2.2	3.35	7.38
	1159433	L	1.85	3.07			
GC 45	1159434	U	0.55	10.99	0.55	10.99	6.04
GC 46	1159435	U	0.25	2.03	1.35	4.69	6.35
	1159436	L	1.1	5.30			
GC 47	1159437	U	0.85	11.54	1.85	9.99	18.48
	1159438	L	1.0	8.67			
GC 49	1159441	U	0.35	7.72	1.9	3.80	7.23
	1159442	L	1.55	2.92			
GC 50	1159443	U	0.3	1.93	2.1	2.48	5.21
	1159444	L	1.8	2.57			
GC 51	1159445	U	0.3	3.27	1.65	3.07	5.06
	1159446	L	1.35	3.02			
GC 52					1.2	2.87	3.44
	1159447	L	1.2	2.87			
GC 53	1159448	U	0.55	7.63	1.85	4.39	8.12
	1159449	L	1.3	3.02			
GC 58	1159450	U	1.0	7.63	1.95	7.22	14.07
	1159451	L	0.95	6.78			
GC 59					1.05	4.70	4.94
	1159452	L	1.05	4.70			

GRADE - THICKNESS DATA

Costean No.	Sample No.	Unit	Thickness (m)	$MgSO_4$ (wt %)	Total thickness (m)	Average $MgSO_4$	m.%
GC 60	1159453	U	0.95	7.92	2.1	5.72	12.02
	1159454	L	1.15	3.91			
GC 61	1159455	U	0.65	13.27	1.3	9.61	12.49
	1159457	L	0.65	5.94			
GC 63					0.4	3.02	1.21
	1159458	L	0.4	3.02			
GC 66	1159459	U	0.4	3.76	1.4	5.28	7.39
	1159460	L	1.0	5.89			
GC 67	1159461	U	0.35	6.64	0.35	6.64	2.32
GC 69	1159462	U	0.5	7.72	0.5	7.72	3.86
GC 70	1159463	U	0.55	7.67	1.2	7.49	8.98
	1159465	L	0.65	7.33			
GC 71	1159466	U	0.65	12.58	1.45	12.52	18.16
	1159467	L	0.8	12.48			
GC 72	1159469	U	0.95	0.79	0.95	0.79	0.75
GC 73	1159470	U	0.65	8.52	1.25	6.66	8.33
	1159471	L	0.6	4.65			
GC 74	1159472	U	0.75	4.65	0.75	4.65	3.49
GC 78					1.6	5.84	9.34
	1159473	L	1.6	5.84			
GC 80	1159474	U	0.55	9.21	0.85	10.54	8.96
	1159475	L	0.3	12.97			

GRADE - THICKNESS DATA

Costean No.	Sample No.	Unit	Thickness (m)	$MgSO_4$ (wt %)	Total thickness (m)	Average $MgSO_4$	m.%
GC 85	1159476	U	0.65	6.34	0.65	6.34	4.12
GC 86	1159477	U	0.6	8.17	1.35	8.28	11.18
	1159478	L	0.75	8.37			
GC 88	1159479	U	0.95	17.18	1.7	13.09	22.26
	1159480	L	0.75	7.92			
GC 91	1159481	U	0.6	5.64	0.6	5.64	3.38
GC 92	1159482	U	0.75	7.92	0.75	7.92	5.94
GC 104	1159483	U	0.8	11.29	0.8	11.29	9.03
GC 106	1159484	U	0.6	6.44	1.5	6.41	9.62
	1159485	L	0.9	6.39			
GC 107	1159486	U	0.9	19.61	1.4	16.09	22.52
	1159487	L	0.5	9.75			
GC 108	1159488	U	0.35	5.30	0.85	5.15	4.38
	1159489	L	0.5	5.05			
GC 112	1159490	U	0.6	10.30	1.3	8.22	10.69
	1159491	L	0.7	6.44			
GC 113	1159492	U	0.65	18.82	1.5	14.41	21.62
	1159493	L	0.85	11.04			
GC 115	1159496	U	0.5	9.41	1.15	7.31	8.40
	1159497	L	0.65	5.69			
GC 116	1159498	U	0.95	5.89	0.95	5.89	5.60

GRADE - THICKNESS DATA

Costean No.	Sample No.	Unit	Thickness (m)	$MgSO_4$ (wt %)	Total thickness (m)	Average $MgSO_4$	m.%
GC 117	1159499	U	1.05	8.27	1.05	8.27	8.68
GC 119	1159500	U	0.7	6.24	0.7	6.24	4.37
GC 121	1159501	U	0.6	8.27	0.6	8.27	4.96
GC 125	1159502	U	0.45	9.16	0.45	9.16	4.12
GC 129	1159503	U	0.75	7.87	0.75	7.87	5.90
GC 130	1159504 1159505	U L	0.75 0.6	12.23 10.25	1.35	11.35	15.32
GC 131	1159506	U	1.0	6.73	1.0	6.73	6.73
GC 134	1159507	U	0.6	10.15	0.6	10.15	6.09
GC 138	1159508	Brown clay	1.0	4.21	1.0	4.21	4.21
GC 140	1159509	U	0.6	3.57	0.6	3.57	2.14
GC 141	1159510 1159511	U L	0.45 0.8	5.84 4.85	1.25	5.21	6.51
GC 142	1159512 1159513	U L	0.8 0.65	9.66 6.59	1.45	8.28	12.01
GC 143	1159514 1159515	U L	0.7 1.0	7.33 6.98	1.7	7.12	12.11

GRADE - THICKNESS DATA

Costean No.	Sample No.	Unit	Thickness (m)	$MgSO_4$ (wt %)	Total thickness (m)	Average $MgSO_4$	m.%
GC 144	1159516	U	0.6	8.57	1.3	8.33	10.83
	1159517	L	0.7	8.12			
GC 145	1159518	U	0.4	6.44	0.4	6.44	2.58
GC 146	1159519	U	0.85	5.05	0.85	5.05	4.29
GC 147	1159520	U	0.7	4.26	0.7	4.26	2.98
GC 148	1159521	U	1.1	7.38	1.1	7.38	8.12
GC 149	1159522	U	1.05	10.55	1.8	8.92	16.06
	1159523	L	0.75	6.64			
GC 150	1159524	U	0.8	10.94	1.7	10.13	17.22
	1159525	L	0.9	9.41			
GC 151	1159526	U	0.65	8.76	1.5	7.30	10.96
	1159527	L	0.85	6.19			
GC 152	1159528	U	0.7	10.84	1.6	10.37	16.59
	1159529	L	0.9	10.00			
GC 153	1159530	U	0.9	6.49	0.9	6.49	5.84
GC 154	1159531	U	1.1	8.02	1.1	8.02	8.82
GC 155	1159532	U	0.85	8.96	1.25	7.99	9.99
	1159533	L	0.4	5.94			
GC 156	1159534	U	0.9	13.22	1.5	10.82	16.24
	1159535	L	0.6	7.23			

GRADE - THICKNESS DATA

Costean No.	Sample No.	Unit	Thickness (m)	$MgSO_4$ (wt %)	Total thickness (m)	Average $MgSO_4$	m.%
GC 157	1159536	U	1.0	7.43	1.7	7.14	12.14
	1159537	L	0.7	6.73			
GC 158	1159538	U	0.75	8.17	2.1	6.45	13.55
	1159539	L	1.35	5.50			
GC 159	1159540	U	0.9	5.15	2.0	7.74	15.47
	1159541	L	1.1	9.85			
GC 160	1159542	U	0.4	4.01	1.5	5.76	8.63
	1159543	L	1.1	6.39			
GC 161	1159544	U	0.45	1.88	1.5	3.62	5.42
	1159545	L	1.05	4.36			
GC 167	1159547	U	1.15	7.58	1.15	7.58	8.72
GC 168	1159546	U	1.0	10.74	1.0	10.74	10.74
GC 173	1159548	U	0.6	4.75	0.6	4.75	2.85
GC 174	1159549	U	1.0	7.23	1.0	7.23	7.23
GC 175	1159550	U	0.4	5.79	1.3	6.51	8.46
	1159551	L	0.9	6.83			
GC 176	1159552	U	0.45	4.26	1.45	4.60	6.67
	1159553	L	1.0	4.75			
GC 177	1159554	U	0.75	10.30	1.8	7.33	13.19
	1159555	L	1.05	5.20			
GC 178	1159556	U	0.35	2.67	1.75	5.69	9.95
	1159557	L	1.4	6.44			

GRADE - THICKNESS DATA

Costean No.	Sample No.	Unit	Thickness (m)	$MgSO_4$ (wt %)	Total thickness (m)	Average $MgSO_4$	m.%
GC 179	1159558	U	0.65	6.64	1.2	6.80	8.16
	1159559	L	0.55	6.98			
GC 180	1159560	U	0.75	8.91	1.9	7.11	13.51
	1159561	L	1.15	5.94			
GC 181	1159562	U	0.9	7.63	1.95	6.64	12.95
	1159563	L	1.05	5.79			
GC 182					0.65	5.94	3.86
	1159564	L	0.65	5.94			
GC 183	1159565	U	0.8	6.34	1.45	6.25	9.06
	1159566	L	0.65	6.14			

APPENDIX VI

OIL YIELD SAMPLE LEDGER SHEETS AND RESULTS

C.R.A. EXPLORATION PTY. LTD.- ROCK SAMPLE FIELD DATA SHEET.

PAGE N°

Area: Giddi Giddinna
Collected: AKS
Analysed by AMDEL
Map ref: EL 1254
Date collected
Date anal. rec.
Photo name
Date to lab:
Plan no:
Run No:
D.P.O. No: R 0636
Report no:

Less than detection limit [-]

Sample type: 1. Chip. 3. Channel. 2. Float 4. Panel.
Test: 1. Chemistry 2. Duplicate 3. Thin section 4. Polished section.

ANALYSIS METHOD: Fischer Distillation
DETECTION LIMIT (ppm):

Sample Number	COORDINATES AM.G/Long./Lat/Local EAST	NORTH	SAMPLE TYPE	WIDTH (m)	AREA (sq.m)	No. CHIPS	TEST		Oil Yield l/t	Water Yield l/t
1159567	Costeen	GC 4	1				1	Waxy soft black shale.	< 5	110
568	"	GC 17	1				1	Black waxy shale	< 5	112
569	"	GC 25	1				1	" " "	< 5	88
570	"	GC 40	1				1	Dark grey-green waxy shale.	< 5	106
571	"	GC 44	1				1	Dark black shale.	< 5	92
572	"	GC 48	1				1	Black waxy shale.	< 5	66
573	"	GC 63	1				1	" " "	< 5	99
574	"	GC 79	1				1	Soft green shale.	< 5	72
575	"	GC 107	1				1	Black waxy shale.	< 5	111
576	"	GC 122	1				1	" " "	< 5	104

APPENDIX VII

RESOURCE CALCULATIONS

RESOURCE CALCULATIONS (CUTOFF 5 m.%)

LOCALITY 1

1. Combining samples along traverses.

Because of denser sampling along traverses (i.e.: more costeans per unit area), analyses from several costeans should be combined so that sample density is approximately uniform throughout area. Samples were combined in pattern shown on accompanying sketch plan, which also shows the values obtained.

Method: Weight all grades in upper unit by sample width to obtain average grade. Average width is arithmetic average of all sample widths. Repeat for lower unit. This method is valid because costeans are spaced uniformly apart.

2. Calculation of average grade and width for whole area.

Method: As above.

Assumption: This method assumes that all costeans have an equal area of influence. Although this is not strictly true, their areas of influence are similar. For a preliminary estimate such as this, the error that might be introduced by making this assumption is of little significance.

The results are as follows:

	Av. width (m)	Av. grade (%)
Upper unit	0.54	9.02
Lower unit	0.95	5.03

3. Calculation of resource.

Area obtained by planimeter from accompanying sketch plan page (ii).

Specific gravity obtained from regression lines shown on graphs in Appendix II.

Results are shown on page (iii).

LOCALITIES 2 & 3

The calculations are made by the same method as above, except that step 1 is eliminated. Results are shown on page (iii).

CRA EXPLORATION PTY. LIMITED

SECOND QUARTERLY REPORT ON GIDDI GIDDINNA CREEK E.L. 1254, SOUTH AUSTRALIA, FOR THE PERIOD ENDING 23RD MARCH, 1985.

The contents of this report remain the property of C.R.A. Exploration Pty. Limited and may not be published in whole or in part nor used in a company prospectus without the written consent of the Company.

AUTHOR: J.P. HOWARD

COPIES TO: CIS CANBERRA
EVAPORITE MINERALS (S.A.) PTY. LTD.
SADME

DATE: 16TH APRIL, 1985

SUBMITTED BY: R.J.L. [signature]

ACCEPTED BY: [signature]

RECEIVED 3 MAY 1985 DEPT. OF MINES AND ENERGY SECURITY

13253

CONTENTS

1. INTRODUCTION

E.L. 1254 of 469 km^2 was granted jointly to CRA Exploration Pty. Limited (CRAE) and Evaporite Minerals (S.A.) Pty. Ltd. (EMSA) on 24th September, 1984, for a period of one year.

The E.L. covers a near surface occurrence of magnesium and sodium sulphates in Mesozoic shales in an area centred approximately 25 km northeast of Coober Pedy (see plan no. SAa 2354).

This report describes exploration activities carried out during the second quarter to 23rd March, 1985.

2. WORK CARRIED OUT

Economic assessment of this project by the Technological Assessment and Business Studies group (TABS) is continuing.

R.J.L.Lane
for

J.P HOWARD

JPH/dp

EXPENDITURE

Expenditure for the period ended 31st March, 1985, the nearest accounting period, was $10 329.00, as listed below.

		$
Payroll		2 854
Supplies		100
Vehicle		733
Property		753
Contractors		480
Laboratory		4 077
Overheads		1 332
	Total	$ 10 329

KEYWORDS

Epsomite.

LOCATION

Murloocoppie SH 53-2 1:250 000

LIST OF PLANS

Plan No.	Title	Scale
SAa 2354	Giddi Giddinna Creek E.L. 1254 Locality Plan	1: 250 000

CRA EXPLORATION PTY. LIMITED

THIRD QUARTERLY REPORT ON GIDDI GIDDINNA CREEK E.L. 1254, SOUTH AUSTRALIA, FOR THE PERIOD ENDING 23RD JUNE, 1985

The contents of this report remain the property of C.R.A. Exploration Pty. Limited and may not be published in whole or in part nor used in a company prospectus without the written consent of the Company.

AUTHOR: J.P. HOWARD

COPIES TO: CIS CANBERRA
EVAPORITE MINERALS (S.A.) PTY. LTD.
SADME

DATE: 8TH JULY, 1985

SUBMITTED BY: J.P. Howard

ACCEPTED BY:

RECEIVED 11 JUL 85
5258

CONTENTS

1. INTRODUCTION

E.L. 1254 of 469 km^2 was granted jointly to CRA Exploration Pty. Limited (CRAE) and Evaporite Minerals (S.A.) Pty. Ltd. (EMSA) on 24th September, 1984, for a period of one year.

The E.L. covers a near surface occurrence of magnesium and sodium sulphates in Mesozoic shales in an area centred approximately 25 km northeast of Coober Pedy (see plan no. SAa 2354).

This report described exploration activities carried out during the third quarter to 23rd June, 1985.

2. WORK CARRIED OUT

Economic assessment of this project by the Technological Assessment and Business Studies group (TABS) in continuing.

JP Howard.

J.P. HOWARD

JPH/dp

EXPENDITURE

Expenditure for the period ended 31st March, 1985 the nearest accounting period, was $11 919.00, as listed below.

	$
Salaries	10 350
Consultants	338
Patent Search	319
Drafting	414
Travel	498
Total	$11 919

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5 AUG 1985
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0165

KEYWORDS

Epsomite

LOCATION

Murloocoppie SH 53-2 1:250 000

LIST OF PLANS

Plan No.	Title	Scale
SAa 2354	Giddi Giddinna Creek E.L. 1254 Locality Plan	1:250 000

CRA EXPLORATION PTY. LIMITED

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FOURTH QUARTERLY REPORT ON

GIDDI GIDDINNA CREEK E.L. 1254, SOUTH AUSTRALIA,

FOR THE PERIOD ENDING 24TH SEPTEMBER, 1985.

AUTHOR: I.D. FINCH

COPIES TO: CIS CANBERRA
EVAPORITE MINERALS (S.A.) PTY. LTD.
SADME

DATE: 14TH NOVEMBER, 1985

SUBMITTED BY:

ACCEPTED BY:

RECEIVED
6 DEC 1985
DEPT. OF MINES AND ENERGY
SECURITY
5258

13642

CONTENTS

1. INTRODUCTION

E.L. 1254 of 469 square km was granted jointly to CRA Exploration Pty. Limited (CRAE) and Evaporite Minerals (S.A.) Pty. Ltd. (EMSA) on 24th September, 1984 for a period of one year.

The E.L. covers a near surface occurrence of magnesium and sodium sulphates in Mesozoic shales in an area centred approximately 25 km northeast of Coober Pedy (see plan SAa 2354).

A preliminary economic study on the viability of magnesium sulphate production commenced in October, 1984.

This report details the ongoing results of that study.

2. WORK CARRIED OUT

Bench scale testwork continued at CRA Research in Newcastle during the quarter. Leach tests indicated:

a) a good agreement with Amdel head assays;
b) very fine insoluble residues with 80% passing the 5 micron screen;
c) leaching was complete in two minutes on 3 mm topsize ore.

Calculations on a multi-stage countercurrent extraction process indicate maximum dewatering will be necessary at each stage.

Vendor trials for dewatering by vacuum filter and centrifuge will be initiated in the near future.

I.D. FINCH

IDF/pw

EXPENDITURE

Expenditure for the period ended 30th September, 1985 the nearest accounting period, was $7508.00, as listed below.

	$
Payroll	6200
Supplies	221
Office Expenses	13
Travel	1004
Overheads	70
Total	$7508

KEYWORDS

Epsomite

LOCATION

Murloocoppie SH 53-2   1:250 000

LIST OF PLANS

Plan No.	Title	Scale
SAa 2354	Giddi Giddinna Creek E.L. 1254 Locality Plan	1: 250 000

171

CRA EXPLORATION PTY. LIMITED

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FIFTH QUARTERLY REPORT ON GIDDI GIDDINNA CREEK E.L. 1254, SOUTH AUSTRALIA, FOR THE PERIOD ENDING 24TH DECEMBER, 1985.

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26 MAR 1986
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5258

AUTHOR: I.D. FINCH

COPIES TO: CIS CANBERRA
EVAPORITE MINERALS (S.A.) PTY. LTD.
SADME

DATE: 24TH FEBRUARY, 1986

SUBMITTED BY:

ACCEPTED BY:

13823

CONTENTS

1. INTRODUCTION

E.L. 1254 of 469 sq km was granted jointly to CRA Exploration Pty. Limited (CRAE) and Evaporite Minerals (S.A.) Pty. Ltd. (EMSA) on 24th September, 1984 for a period of one year.

The E.L. covers a near surface occurrence of magnesium and sodium sulphates in Mesozoic shales in an area centred approximately 25 km northeast of Coober Pedy (see plan SAa 2354).

A preliminary economic study on the viability of magnesium sulphate production commenced in October, 1984.

2. WORK CARRIED OUT

Bench scale testwork continued, at CRA Research in Newcastle, for part of the quarter. No further results are to hand.

I.D. FINCH

IDF/pw

EXPENDITURE

Expenditure for the period ended 31st December, 1985 the nearest accounting period, was $2098.00, as listed below.

		$
Payroll		536
Tenement		873
Consultants		394
Travel		122
Overheads		173
	Total	$2098

KEYWORDS

Epsomite

LOCATION

Murloocoppie SH 53-2 1:250 000

LIST OF PLANS

Plan No.	Title	Scale
SAa 2354	Giddi Giddinna Creek E.L. 1254, S.A. Locality Plan	1:250 000

CRA EXPLORATION PTY. LIMITED

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SIXTH QUARTERLY REPORT ON GIDDI GIDDINNA CREEK E.L. 1254, SOUTH AUSTRALIA, FOR THE PERIOD ENDING 24TH MARCH, 1986.

AUTHOR: I.D. FINCH

COPIES TO: CIS CANBERRA
EVAPORITE MINERALS (S.A.) PTY. LTD.
SADME

DATE: 9TH APRIL, 1986

SUBMITTED BY:

ACCEPTED BY:

RECEIVED 1986 DEPT. OF MINES AND ENERGY SECURITY 5258

13886

CONTENTS

LIST OF PLANS

Plan No.	Title	Scale
SAa 2354	Giddi Giddinna Creek E.L. 1254, S.A. Locality Plan	1:250 000

1. INTRODUCTION

E.L. 1254 of 469 sq km was granted jointly to CRA Exploration Pty. Limited (CRAE) and Evaporite Minerals (S.A.) Pty. Ltd. (EMSA) on 24th September, 1984 for a period of one year. An extension of one year to 23rd September 1986 was granted on 16th August 1985.

The E.L. covers a near surface occurrence of magnesium and sodium sulphates in Mesozoic shales in an area centred approximately 25 km northeast of Coober Pedy (see plan SAa 2354).

A preliminary economic study on the viability of magnesium sulphate production commenced in October, 1984.

2. WORK CARRIED OUT

Bench scale testwork at CRA Research in Newcastle has, to date, been unable to separate out the salts by leaching, due to the fine nature of the clays. Testwork on alternative separation techniques continues.

I.D. FINCH

IDF/dp

EXPENDITURE

Expenditure for the period ended 31st March, 1986 the nearest accounting period, was $5128.00, as listed below.

		$
Research Studies		5 128
	Total	$5 128

KEYWORDS

Epsomite

LOCATION

Murloocoppie SH 53-2 1:250 000

0182

CRA EXPLORATION PTY. LIMITED

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SEVENTH QUARTERLY REPORT ON

GIDDI GIDDINNA CREEK E.L. 1254, SOUTH AUSTRALIA,

FOR THE PERIOD ENDING 23RD JUNE, 1986.

AUTHOR: S.P. SUGDEN

COPIES TO: CIS CANBERRA
EVAPORITE MINERALS (S.A.) PTY. LTD.
SADME

DATE: 10TH JULY, 1986

SUBMITTED BY:

ACCEPTED BY:

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5258

14051

CONTENTS

LIST OF PLANS

Plan No.	Title	Scale
SAa 2354	Giddi Giddinna Creek E.L. 1254, S.A. Locality Plan	1:250 000

1. INTRODUCTION

E.L. 1254 of 469 sq km was granted jointly to CRA Exploration Pty. Limited (CRAE) and Evaporite Minerals (S.A.) Pty. Ltd. (EMSA) on 24th September, 1984 for a period of one year. An extension of one year to 23rd September, 1986 was granted on 16th August, 1985.

The E.L. covers a near surface occurrence of magnesium and sodium sulphates in Mesozoic shales in an area centred approximately 25 km north east of Coober Pedy (see plan SAa 2354).

A preliminary economic study on the viability of magnesium sulphate production commenced in October, 1984.

2. SUMMARY

Bench Scale testwork at CRA Research, in Newcastle, continued during the quarter.

S.P. SUGDEN

SPS/pq

0180

EXPENDITURE

Expenditure for the period ended 30th June, 1986 the nearest accounting period, was $16 489.00, as listed below.

		$
Research Studies & Administration of Tenement		16 489
	Total	$16 489

KEYWORDS

Epsomite

LOCATION

Murloocoppie SH 53-2 1:250 000

CRA

CRA EXPLORATION PTY. LIMITED
(INC. IN N.S.W.)
Adelaide Office: 31 OSMOND TERRACE, NORWOOD 5067
Head Office: 55 COLLINS STREET, MELBOURNE 3001

P.O. BOX 254 Norwood
TELEPHONE: 42 8871
TELEGRAMS: "EXPLORECO"
TELEX: AA 88605

30th October, 1986

0188

The Director-General,
Department of Mines & Energy, South Australia
P.O. Box 151,
EASTWOOD. S.A. 5063.

Dear Sir,

Re: Eighth Quarterly Report on Giddi Giddinna Creek E.L. 1254, South Australia, For the Period Ending 23rd September, 1986.

No further testwork was carried out during the quarter.

Insurmountable technical problems in separating the epsomite from its parent clays have been encountered. As a result, the agreement with Evaporite Minerals (S.A.) Pty. Ltd. was terminated and all interests in E.L. 1254 held by CRA Exploration Pty. Limited were transferred to E.M.S.A. Ongoing statutory reporting responsibilities will therefore revert to that company.

Yours faithfully,

I.D. FINCH
PRINCIPAL GEOLOGIST

IDF/pq

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31 OCT 1986
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5258

CRA SERVICES LIMITED
(INCORPORATED IN VICTORIA)
HAMERSLEY HOUSE
191 ST. GEORGE'S TERRACE, PERTH,
WESTERN AUSTRALIA, 6000.

TELEPHONE 327 2311
BOX A42, G.P.O.
PERTH,
WESTERN AUSTRALIA 6001
TELEX No. AA92315

0189

9 November 1986

Lee Kennedy,
Administration Officer,
CRA Exploration Pty. Ltd.,
31 Osmond Terrace,
NORWOOD S.A. 5067

Dear Lee,

EPSOMITE STUDY - EL 1254
GIDDI GIDDINNA CREEK, S.A.

Please find enclosed the preliminary economic assessment of the epsomite project and a copy of the report on bench scale testwork.

The economic assessment was undertaken as part of the Stage 1 study. The results were sufficiently encouraging to proceed to bench scale testwork. However, the bench testwork indicated low salt recovery, poor solid/liquid separation and high moisture content of the leach residue making the envisaged flowsheet unworkable. Therefore no further economic assessment of the process was undertaken and it was agreed the tenement should be released.

Kind regards,

KEVIN PARKES

ep116w/cmc

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2 DEC 1986

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EPSOMITE STUDY - PRELIMINARY ECONOMIC ASSESSMENT, FEBRUARY 1985

1. DEFINITION OF PROJECT

The project to be evaluated is to mine an epsomite deposit which lies to the north east of Coober Pedy and extract soluble sulphate salts from the ore. These sulphates are to be transported to a port on the South Australian coast where they will be reacted with imported potassium chloride in a process plant to produce 500,000 tonnes per annum potassium sulphate for export. 84,000 tonnes of co-product of Kieserite will also be produced.

2. BASIS FOR THE ENGINEERING STUDY

It was assumed :

i) An innovative mining procedure such as high pressure water sluicing would replace the conventional loader and trucking operation. This would eliminate stockpile and reclaim equipment.

ii) Company housing at Coober Pedy would be eliminated, and replaced by single person accommodation with air transport to and from Adelaide for all employees.

iii) Assume a suitable wharf with bulk loading and unloading facilities is available at Whyalla. The project would then not have to carry these as capital cost items.

iv) Harvest 20% of the sulphate as pure epsomite from the front end crystallisers and convert it to Kieserite for sale directly.

v) Feed the remaining mixed salt (epsomite and astracanite) harvest straight into the SOP plant.

vi) Recover Kainite from the process end liquor in a small subsidiary set of crystallisers. This would increase the recoveries of both potassium and sulphate.

The flowsheet developed and used as a basis for the engineering cost estimate is shown in Fig. 1.

3. TECHNICAL NOTES

i) Mining Technique

The proposed sluicing operation eliminates truck haulage of ore, stockpiling and reclaim but still requires ore transport via slurry pipeline and a tailings disposal facility. At the minesite after "hydraulicing" a mobile slurry collection and slurry pipeline charging facility would be required. This would include screening and crushing oversize material. Groundwater would have to be piped to the minesite and a slurry line would run from the mine to the processing plant.

The concept of mobile processing at the minesite can be carried a step further. The complete leaching plant can be located at the mine and made mobile by mounting it on tracks. This proposal is believed to be feasible when considering the number and types of equipment items in the process plant. A continuous dry surface miner would feed the mobile process plant via an interconnecting conveyor belt system and the soluble salts would be leached at the minesite. Dewatered tailings would be disposed of behind the mobile leach plant, thus eliminating the need for a tailings disposal facility. A water line would run to the leach plant and a brine product line would return to the pipeline head. The arrangement is shown in Fig. 2.

This is the concept used as a basis for the Coober Pedy cost estimates. The mining and tailings disposal capital and operating costs are possibly still on the high side. However, the costs of building and operating a mobile leach plant are difficult to estimate with the limited amount of data available at this time. The overall Coober Pedy costs are therefore, in total, thought to be realistic but conservative.

ii) Mobilisation and Accommodation of Staff

To reduce the capital and servicing costs of providing housing for company employees and their families at Coober Pedy it is proposed that only single-person accommodation will be provided and the work force mobilised to and from Adelaide. This would be a similar system to the one which will be operated for Argyle.

A contact in the VEL-Minenco, Perth Office advises that a capital cost of $60,000 per unit is required to establish the accommodation. A cost of $35/person/day is estimated to service the camp and provide meals.

It is worth speculating that Coober Pedy, being a town of approximately three thousand, could provide a workforce of 80 people and that personnel accommodation costs could be eliminated almost completely.

iii) Converting Astracanite directly to SOP

It has been demonstrated that it is possible to feed sodium ions into the process during the SOP pilot plant work at Cockle Creek. Calculations show that the quantity of sodium ions present in the harvested mixed salts for this project should not present any processing problem but ultimately this would have to be confirmed experimentally.

iv) Kainite Recovery

To increase potassium and sulphate recovery it is proposed to route the Process End Liquor through a subsidiary set of solar crystallisers and recover a harvest of Kainite and Halite. The Kainite is separated by screening, a procedure established in the SOP mixed salt beneficiation. Overall Potassium and Sulphate recoveries are both estimated to be increased to 92.5% by this additional step.

Costs

The capital and operating costs for each location are listed in the following set of tables. Table 6 shows the Cash Flow Schedule for the first five years of operation, after which it is constant.

4. ENGINEERING COSTS

The table below summarizes the capital and operating costs and estimates the annual revenue for Kieserite and Potassium Sulphate.

Capital Costs are:		$
Coober Pedy		30,210,000
Pipeline		79,409,000
Whyalla		97,066,000
	Total	206,685,000

Annual Operating costs are:		
Coober Pedy		12,410,000
Pipeline		1,280,000
Whyalla		58,110,000
	Total	71,800,000

Annual Revenues are:		
Kieserite ($100/tonne)		8,400,000
SOP ($230/tonne)		115,000,000
	Total	123,400,000

TABLE 1 : PRODUCTION DATA - EPSOMITE PROJECT

BASIS : 500,000 TONNES/YEAR POTASSIUM SULPHATE

Coober Pedy		
Epsomite ore	3,200,000	tonnes/year
Ground water	3.4	megalitres/day
Tailings disposal	2,200,000	tonnes/year
Pipeline		
Brine throughput	190	kilolitres/hour
Whyalla		
Primary crystallisers:		
Epsomite harvest	150,000	tonnes/year
Mixed salt harvest	640,000	"
Secondary crystallisers:		
Kainite/Halite harvest	193,000	"
Potassium chloride	462,000	"
Power Generation	6	megawatts
Process steam	300,000	tonnes/year
Coal burnt	30,000	"
Process water	2.8	megalitres/day
Kieserite production	84,000	tonnes/year

Table 2

Capital Costs

Coober Pedy

Process Plant		$'000
1.	Site Prep.	939
2.	Materials Handling (Ext.)	1141
3.	a) Process Plant	4443
	b) Piping, Valves & Fittings	725
	c) Mobile Platform	1195
	d) Building/Steel	899
	e) Electrics	564
	f) Instruments	309
4.	Services, Utilities	644
5.	Site Facilities	363
6.	Workshops	94
7.	Mobile equipment	188
8.	Engineering/Project Management	846
	Contingency (15%)	2040
	Sub Total	14390

External		
9.	Mining Equipment (includes brine to pond pipeline)	7500
10.	Tailing disposal	2700
11.	Brine storage pond	520
12.	85 person camp at $60,000/person	5100
	Sub Total	15820

TOTAL CAPITAL COST $ 30210

Pipeline

Capital Cost (Minenco estimate) $79,409,000

Table 3

OPERATING COSTS - COOBER PEDY

SUMMARY

Process/Mining :

Labour	7.27	
Power/Steam	3.20	
Distillate	2.35	
Water-Process	1.70	
Air fares & Accommodation	2.42	
Light Vehicles	.42	
Site Facilities	.33	
Services	.06	
Maintenance	.35	
Overheads	.50	
Insurance	.05	
Mining (Maintenance and mine planning)	6.17	
Total		24.82
Pipeline Operating Costs		
Labour		
Fuel		
Depreciation		
		2.56
TOTAL		27.38

Operating Costs $ per tonne SOP

Design based on 500,000 t.p.a. SOP

Table 4

Capital Costs

Whyalla

	Process Plant	$'000	
1.	Site Prep.	4778	
2.	Materials Handling (Ext.)	5802	
3.	a) Process Plant	22592	
	b) Piping, Valves & Fittings	3686	
	c) Concrete & Civil	6075	
	d) Building/Steel	4573	
	e) Electrics	2867	
	f) Instruments	1570	
4.	Services, Utilities	3276	
5.	Site Facilities	1843	
6.	Workshops	478	
7.	Mobile Equipment	956	
8.	Capital Spares	1297	
9.	Construction Facilities	1000	
10.	Engineering/Project Management	4300	
	Contingency (15%)	10238	
	Sub Total		75,331
	Externals		
11.	Bitterns (MgCl2) pond	5000	
12.	KCl stockpile	2000	
13.	Ship Unloader/loader/Jetty	2000	
14.	Crystalliser Ponds	8860	
15.	Harvesting Equipment	3875	
	Sub Total		21,735
	TOTAL		97,066

Table 5

OPERATING COST - WHYALLA

SUMMARY

Labour	10.40
Power/Steam	5.70
Distillate	.53
Water-process	1.10
Housing	.00
Light Vehicles	.45
Site Facilities	1.12
Services	.29
Maintenance-supplies	2.10
Overheads	1.94
Insurance	0.19
	23.82

TABLE 6 : CASH FLOW SCHEDULE

YEAR	0	1	2	3	4	5
			$\$ \times 10^6$			
CAPITAL COSTS						
Mining) Coober Pedy Process) Pipeline)	7.0 xxxxxxx	70 ———	32.6 ———			
Whyalla Crystlls.		xxxxxxxx 0.5	8.4 ———			
Whyalla Process		xxxxxxxx 4.3	62.8 ———	21.1 ———		
(206.7) Total	7.0	74.8	103.8	21.1		
OPERATIONS SCHEDULE						
Mining				———	———	———→
C.P. Process				———	———	———→
Pipeline				———	———	———→
Crystals. Fill				———	———	———→
Whyalla Process - Kieserite				———	———	———→
- SOP					———	———→
OPERATING COSTS						
				13.7	13.7	13.7
				6.0	9.0	12.0
				19.7	22.7	25.7
RAW MATERIALS KCl at $100/tonne					23.1	46.2
TOTAL				19.7	45.8	71.9
INCOME						
Kieserite at $100/tonne				4.2	8.4	8.4
SOP at $230/tonne					57.5	115.0
				4.2	65.9	123.4

OPERATING COSTS

COOBER PEDY

1. PERSONNEL

1.1 Shiftwork:

Process Plant:			
Operators	2		
Sub Total		2	
Laboratory:			
Shift Technician	1		
Sub Total		1	
Supervision:			
Shift Foreman	1		
Sub Total		1	
Maintenance:			
Mech. Fitter	1		
T/A	1		
Instrument Fitter	1		
Electrician	1		
Sub Total		4	
Security:			
Guard/Firstaid/Fire	1		
Sub Total		1	
Total shiftworkers/shift		9	
Total personnel for 4 shifts			36

1.2 Daywork:

Production:		
Dayforeman	1	
Crew	3	
Sub Total		4
Maintenance:		
Foreman	1	
Mechanical	3	
T/A	3	
Elect/Instr./	2	
T/A	1	
Civil	1	
Sub Total		11
Mining:		
Superintendent	1	
Operators	16	
Sub Total		17
Technical:		

Engineers/Process	1		
Technician	1		
Sub total		2	
Accounts/Admin:			
Clerks	1		
Storeman	2		
Typists	3		
Cleaners	2		
Canteen	2		
First Aid/Security	1		
Sub Total		11	
Total - Daywork			45

1.3 **Summary**

Shift 36 No.x $46,000 pa = $1,656,000
Day 45 No. x $44,000 pa = $1,198,000
81 — $3,636,000

$3,636,000 / 500,000t SOP pa = **$7.27/t. SOP**

2. **Power House**

2 Mw for 330 days/year
2000Kw x 24 x 330 x $0.10 = $1.580,000

$1,580,000 / 500,000t = $3.20/t. SOP

3. **Distillate**

(i) Capital cost of mobile plant (excl. mining) is $370,000. This is equivalent to 1.5 No. FEL's
1.5 No. x 80% x 330 x 24 x $10/hr.
= $95,000
$95,000 / 500,000 = (a)$0.19/t SOP

(ii) Mining:
2.55 x 10 litres
= 2300 tonnes/yr
Distillate = $470/t
= $1,081,000 pa.
1,081,000 / 500,000 = (b) $2.35/t SOP

Total Distillate = **$2.35/t SOP**

4. **Water-Process**

2.26 cu m/t SOP
2.26 @ $0.75 = $1.70/t SOP

5. **Accommodation & Air Transport**

Air fares 25 return trips/man/year at $250/return trip
= 25 x 81 x 250 = $506,250 = $1/tonne SOP

Service Camp for 81 at 250 days/man/year at $35/day
= 81 x 250 x 35 = $708,750 = 1.42/tonne

6. Light Vehicles

14 No. x 50 cents/Km at 30,000 km/yr.
= $210,000

$210,000 / 500,000 = $0.42/t. SOP

7. Site Facilities

(i) Area Maintenance = $50,000 p.a.
(ii) Purchased Services & Stores - use 30% of capital cost of $363,000 = $109,000
(iii) Water: 100 kl/person/yr
81 No. x 100kl x $0.75/kl= $6000
(iv) Power: included in process cost
Sub Total = $165,000

~~$266~~,000 / 500,000 = $0.33/t SOP

8. Services

(i) Power Supply & Reticulation:
5% of capital cost
= 5% of ($4,443,000 x 4.2 / 33.1
= $28,000

$28,000 / 500,000 t = $0.06/t SOP

(ii) Water - Elsewhere
(iii) Air - exclude
(iv) Steam - elsewhere

9. Maintenance

(i) Labour - elsewhere
(ii) Materials
- Pumps - capital cost is 5.2% of process equipment
= 5.2% of $4,443,000 = $231,000
Consumables = 30% of capital cost
= $69,000
- Feeders, conveyors - capital cost is 4.3% of process equipment
= 4.3% of $4,443,000 = $191,000
Consumables = 10% of capital cost
= $19,100
Electrical supply - see (13 (i)
Bins, tanks, structures -
Bins,/tanks : capital $490,000
Structure: 6.7 x $4,443,000
= $899,000
Total = $1,389,000
Consumables = 5% of $1,389,000
= $69,500
Process Equipment -
7 1/2% of $4,443,000 = $333,225

Consumables = 5% of $653,000
= $16,700

Total consumables = $174,300

$\frac{\$325,100}{500,000 \text{ t}}$ = $0.35/t SOP

10. Overheads

(i) Housing - covered in item 10

(ii) Labour

Total salary includes worker's compensation, superannuation and insurance. Other overheads, e.g. housing and admin. included elsewhere.

(iii) Marketing.

Allow 1% of total capital cost
= 1% of $25,110,000
= $251,000

Total Overheads = $251,000

$\frac{251,000}{500,000}$ = $0.50/t SOP

11. Insurance

0.1% of $25,110,000 = $25,110

$\frac{\$52,900}{500,00 \text{ t}}$ = $0.5/t SOP

12. Mining Expenses

(Excl. workforce, fuel and depreciation)
Incl. maintenance, mine planning and operation etc.

= $1.17/tonne ore

= $\frac{1.17 \times 2,637,398}{500,000}$ $6.17/t SOP

OPERATING COSTS

WHYALLA

1. PERSONNEL

1.1 Shiftwork

Process Plant :	Control Room	1	
	Area men	4	
	P'House (6 MW)	1	
	Subtotal		6
Laboratory :	Shift lab.	1	
	Subtotal		1
Supervision :	Shift F'man	1	
	Subtotal		1
Maintenance :	Mech. Fitter	1	
	T/A	1	
	Electrician	1	
	Instr.Fitter	1	
	Subtotal		4
Security :	Guard/1stAid/Fire	2	
	Subtotal		2
Total shiftworkers/shift			14
Total personnel for 4 shifts			56

1.2 Daywork

Crystalliser harvesting			
Dredge ops. & assnts.		4	
Field hand		1	
	Subtotal		5
Production/Process Suptd.		1	
Day foremen		2	
Day crew		8	
	Subtotal		11
Maintenance:			
Superintendent		1	
Foremen		2	
Mechanical		6	
T/A		6	
Elect/Instr.		4	
T/A		2	
Civil		2	
T/A		2	
	Subtotal		25
Technical:			
Superintendent		1	
Engineers/Process		2	
Technician		1	
Lab Assistants		4	
	Subtotal		8

Accounts/Admin.:

Personnel	1	
Accountant	1	
Clerks	3	
Purchasing	1	
Storemen	4	
Typists	6	
Cleaners	4	
Canteen	3	
First Aid/Security	1	
Public Relations	1	
Subtotal		25
Plant Manager	1	
Subtotal		1
Total Daywork		75

1.3 Summary

Shift 56 x $42,000	=	$2,353,000
Day 75 x $38,000	=	$2,850,000
131		$5,202,000

5,202,000 / 500,000 = **$10.40/t SOP**

2. Power House

Assume electricityis co-produced with steam
30,000 tonnes coal/yr. at $95/tonne
= $2,850,000
= **$5.70/t SOP**

3. Distillate

Capital cost of mobile plant
is $1,956,000 Equiv. to 4.0 FEL's
4.0 No. x 80% x 330 x 24 x $10/hr
= $265,000
= **$0.53/t.SOP**

4. Water Process

2.8 Ml/day = 1.85 Kl/t SOP x $0.6/Kl
= **$1.10/t SOP**

5. Housing

Assume nil

6. Light Vehicles

15 No. x 50 cents/km at 30,000 km/yr.
= $225,000
= **$0.45/t. SOP**

7. <u>Site Facilities</u>

(1) Area Maintenance $100,000

(2) Purchased services & stores
30% of capital cost of Site Facilities
= $553,000

(3) Water
100 kl/person/year
131 x 100 x 0.60 = $8000

(4) Power included in process cost = 0

Total 561,000 / 500,000 = <u>$1.12/t.SOP</u>

8. <u>Services</u>

(1) Power Supply & Reticulation
5% of capital cost = 5% of $2,867,000
= $143,000
= <u>$0.29/t.SOP</u>

(2) Water/Air/Steam elsewhere

9. <u>Maintenance</u>

(1) Labour - elsewhere

(2) Materials

<u>Pumps</u>
$22,592,000 x 5.2% = $1,174,784
Consumables = 30% of cap. cost
= <u>$352,000</u>

<u>Feeders & Conveyors</u>
$22,592,000 x 4.3% = $971,456
Consumables = 10% of cap. cost
= <u>$97,000</u>

<u>Bins, tanks & structures</u>
Bldg./steel 6.7 / 33.1 x C.P.P. = $4,573,000
Bins/tanks = <u>$7,415,000</u>
11,988,000

Consumables = 5% of cap. cost
= <u>$599,000</u>

Total consumables = $1,048,000
= <u>$2.10/t SOP</u>

7. <u>Site Facilities</u>

(1) Area Maintenance $100,000

(2) Purchased services & stores
30% of capital cost of Site Facilities
= $553,000

(3) Water
100 kl/person/year
131 x 100 x 0.60 = $8000

(4) Power included in process cost = 0

Total $\frac{561,000}{500,000}$ = **$1.12/t.SOP**

8. <u>Services</u>

(1) Power Supply & Reticulation
5% of capital cost = 5% of $2,867,000
= $143,000
= **$0.29/t.SOP**

(2) Water/Air/Steam elsewhere

9. <u>Maintenance</u>

(1) Labour - elsewhere

(2) Materials

<u>Pumps</u>
$22,592,000 x 5.2% = $1,174,784
Consumables = 30% of cap. cost
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<u>Bins, tanks & structures</u>
Bldg./steel $\frac{6.7}{33.1}$ x C.P.P. = $4,573,000
Bins/tanks = $7,415,000
11,988,000

Consumables = 5% of cap. cost
= $599,000

Total consumables = $1,048,000
= **$2.10/t SOP**

10. <u>Overheads</u>

(1) Housing - Nil
(2) Labour - elsewhere
(3) Marketing
Allow 1% of total cap. cost
1% of $97,000,000 = $970,000
= **$1.94/t. SOP**

11. <u>Insurance</u>

0.1% of $97,000,000 = $97,000
= **$0.19/t SOP**

cra research

CRA SERVICES LIMITED

RESEARCH - COCKLE CREEK

TECHNICAL REPORT NO. R86/008

BENCH SCALE EPSOMITE TESTWORK

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Date: 16th April 1986

File No.: 016512

MGT/DMB/AS.0016s

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OBJECTIVE

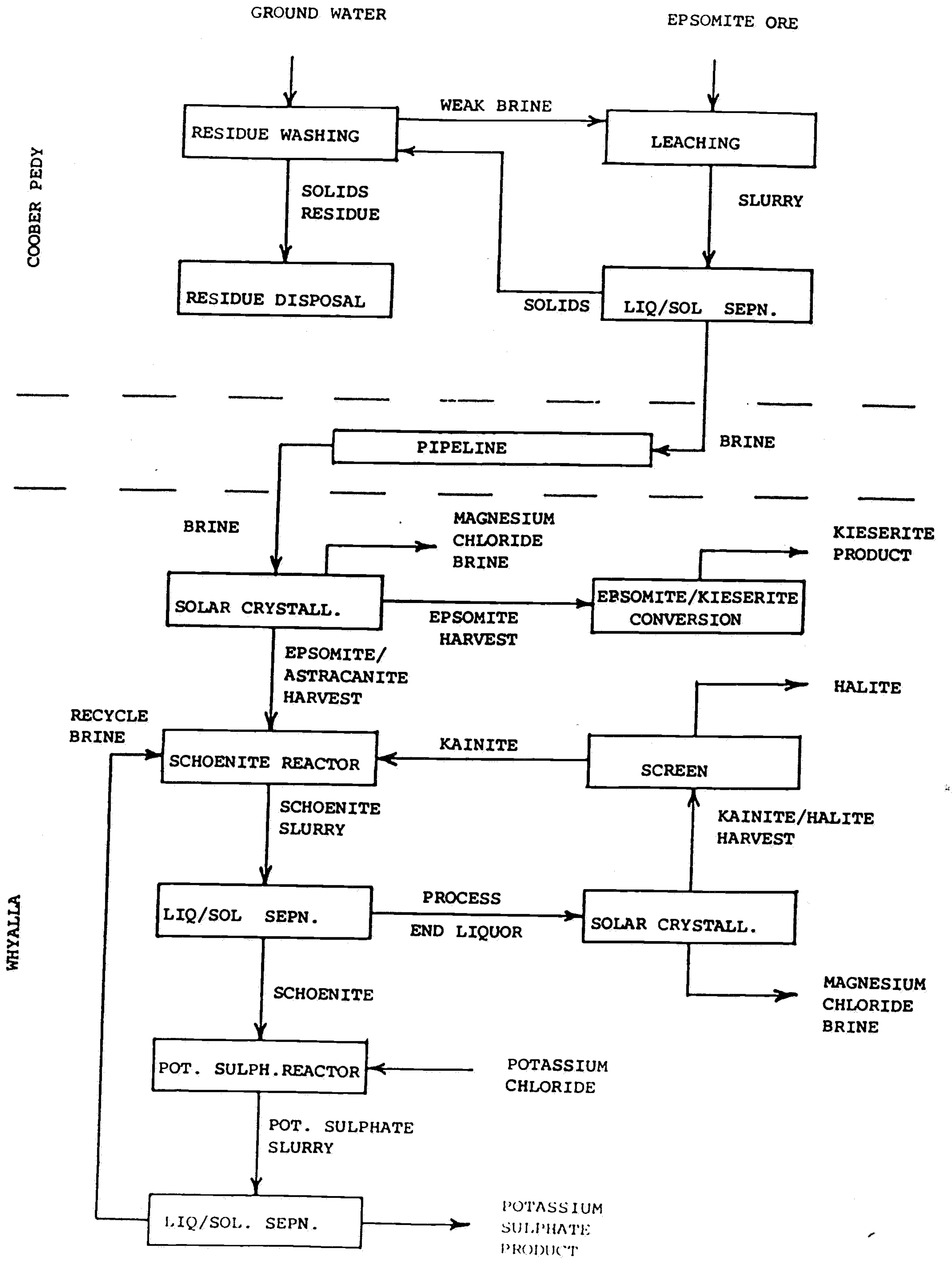
To evaluate extraction techniques for the recovery of epsomite (as brine) from epsomite ore.

CONTENTS

CONTENTS (cont.)

APPENDICES

FIG. 1 PROCESS FLOWSHEET - EPSOMITE PROJECT



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SUMMARY AND CONCLUSIONS

Results of a programme of laboratory scale testwork conducted with fresh water leaching of epsomite ore originating from Coober Pedy in South Australia are summarised below:

1. The ore leached readily producing brines of uniform composition with total salt extraction efficiencies of 56-67%.

2. Highest possible solids content practical for leaching was 33-1/3% (1 ore:2 water). Above this solids content the slurry was too thick to pour and solid/liquid separation almost impossible.

3. Solid/liquid separation problems were repeatedly encountered with leached slurries due to their high clay content and fine sizing analyses (≈80% -5 μ). Reasonable separation could only be achieved by centrifuge.

4. Because of the poor solid/liquid separation residual moisture content of the leached residue was high, usually above 40%, even after centrifuge separation.

5. Electrostatic beneficiation of dry 1 mm ore proved ineffective even though several electrode combinations were tried.

Although an economic assessment of the project has not yet been made it would seem for obvious reasons, viz. because of the low salt recovery, poor solid/liquid separation and high moisture content of the leach residue, that such a scheme would not prove viable unless the clays could be removed without significant salt loss prior to leaching.

1. INTRODUCTION

At the request of CRA Services Limited, Perth, CRA Research undertook a laboratory scale investigation into the leaching of epsomite brine from ore. The epsomite ore deposit is located approximately 50 km north east of Coober Pedy, South Australia covering an area of about 20 x 80 km.

It was proposed that the ore be leached using ground water in a mobile plant and the epsomite brine solution piped some 600 km to the South Australian coast. Here a second plant would treat the brine with imported KCl to produce an estimated 500,000 tonnes of K_2SO_4 and 84,000 tonnes of $MgSO_4.7H_2O$ per year.

2. EXPERIMENTAL WORK

2.1 Ore Samples

Five samples each of about 40 kg were received from the ore deposit. Three of the samples, Nos. 2, 47 and 71 were selected for the test programme because of differences in epsomite grade. Sighter and preliminary tests were carried out on sample No. 60 so that experimental procedures and parameters could be selected for the test programme. Head assays were also carried out and at this stage it was realised that solid/liquid separation would be a major problem. The leached residue contained 70-80% of the material at a sizing of less than 5 µm. Sample No. 179 was held in reserve.

2.2 Sample Preparation

On the "as received" samples, sizing analyses carried out prior to crushing or drying are reported and shown graphically in Appendix 1.

Samples 2, 47, 60 and 71 were reduced to -25 mm in a laboratory jaw crusher and subsamples were taken using a riffle. These four samples were then dried at 50°C in an air oven and reduced to -3 mm with a small rolls crusher. Each of the crushed samples was used as feed for all leach tests.

2.3 Ore Head Analysis

The three test samples were ground to a powder in a disc pulveriser and leached with boiling water. The analysis of the recovered brine, expressed as a percentage of the ore for each sample, is given in Appendix 2. The compared analyses reported by AMDEL are on different samples taken from the same trenches. Results reported by CRA Research are from duplicate ore samples.

2.4 Wet Sizing Analysis of Leached Residue

Sizing analyses were carried out on the three test samples following a 20 minute leach in an ultrasonic bath. The aim was to break down any agglomerated particles prior to passing through the microscreens. The sizing analyses are tabled and shown graphically in Appendix 3.

2.5 Crystallisation Tests on Leached Brine

Crystallisation tests were carried out to determine crystallisation order of the various salts contained in the ore.

A concentration test was carried out at 25°C to determine the number of leaches required for a brine to reach saturation point.

2.6 Settling Tests on Leached Slurry

The possibility of using thickeners for solid/liquid separation was considered and standard settling tests were carried out at various solid/liquid ratios with and without flocculent.

2.7 Filtration Tests

Several filtration tests were conducted at Cockle Creek on epsomite slurry by Delkor Pty. Limited to examine the possible use of horizontal bed filters for solid/liquid separation.

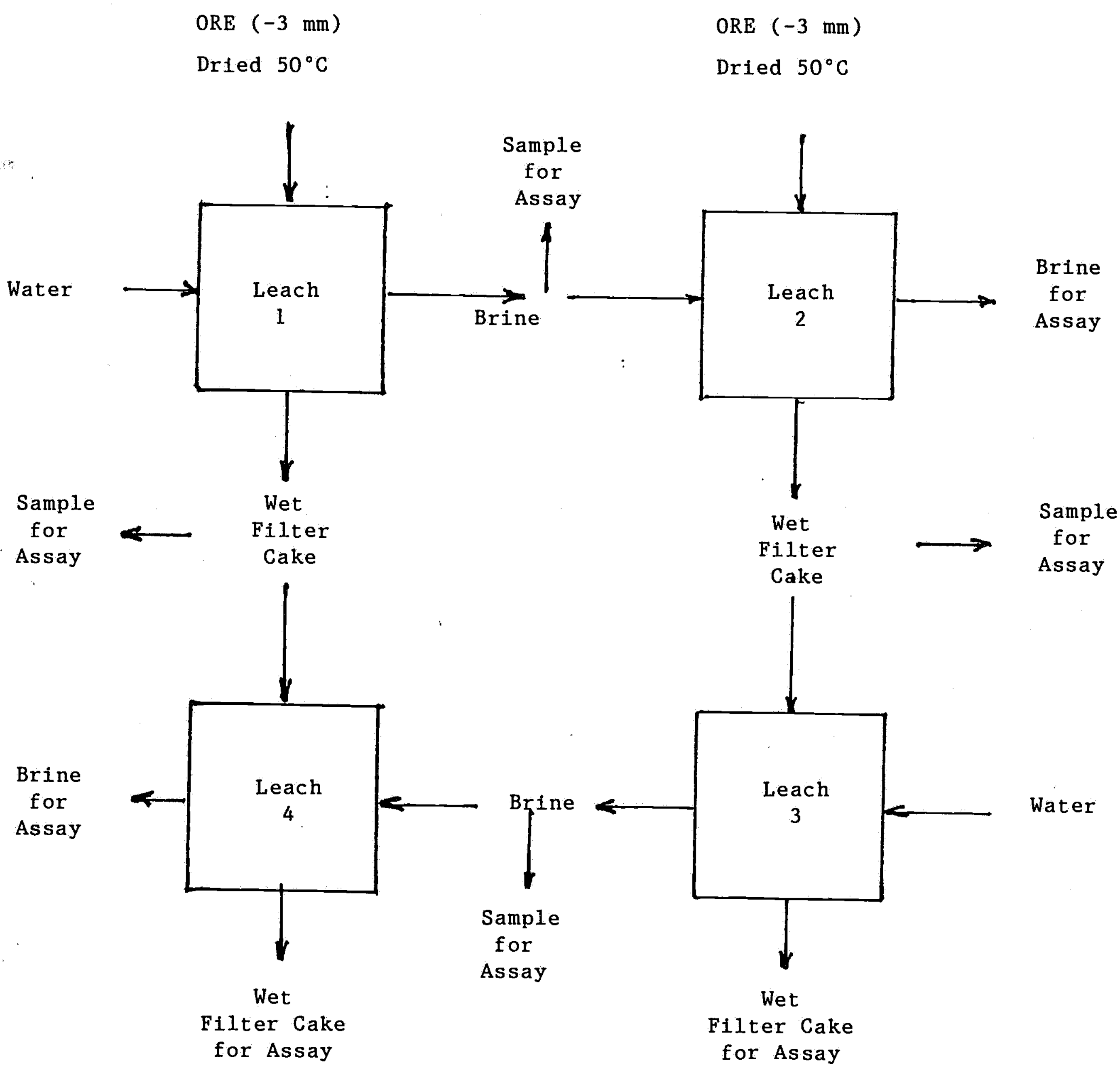
2.8 Electrostatic Separation Tests

Tests were conducted on dry sized epsomite ore at Vickers Australia Limited, Wyong, NSW using a Corpco Model HT (15, 25, 36) 111-15 laboratory electrostatic separator with the object of beneficiating the dry ore (clay separation) prior to leaching.

3. LEACH TEST PROGRAMME

3.1 Flowsheet of Testwork

A simplified version of the testwork flowsheet, originally proposed by K. Wellisch, was used in the leach test programme and is given below. The detailed original flowsheet appears in Appendix 4.



The recommended liquid to solid ratio of 1:1 was not adhered to as the resulting slurry was too thick to allow good blending and effective liquid solid separation. Consequently a liquid/solid ratio of 2:1 was used in the testwork (33-1/3% solids) which enabled a reasonable solid/liquid separation to be made.

Solid/liquid separation was achieved using a tube centrifuge with a portion of the recovered liquor analysed for concentration of elements. A representative portion of the solids was dried at 50°C and a moisture content determined. The portion was then leached in boiling water to determine the residual elements.

Brine analysis, moisture content and analysis of ore residues are tabled in Appendix 5.

Mass balances of the testwork flowsheet are shown in Appendix 6.

3.2 <u>Leaching of Sized Ore Fractions</u>

Crushed ore from sample 47 (-25 mm) was dried at 50°C and dry screened into nine fractions. Each fraction was leached at 33-1/3% solids and the recovered brines analysed. The analysis of each brine is shown in Appendix 7.

3.3 <u>Saturated Brine from Recycle Leaching of New Ore</u>

Ore from sample 47 was leached at 33-1/3% solids with water. The recovered brine was used to leach a fresh ore sample again at 33-1/3% solids. This procedure was repeated until salt recrystallisation was evident. Each brine was allowed to stand overnight at approximately 25°C to allow recrystallisation. Brine analysis for each of the seven leach tests and analysis of salt crystallised from the 7th leach are shown in Appendix 8.

3.4 Ore Slurry Settling Tests

As thickeners were considered to be a possible means of solid/liquid separation, settling tests were carried out on all three samples at solid/liquid ratios of 1:2, 1:5 and 1:10 (33.3, 16.6 and 9.1% solids).

Samples were tested with and without flocculent. Superfloc N2100 was used at a concentration of 0.1% in aqueous solution and added to the samples in various amounts.

The epsomite ore was found to break down to a very fine particle size slurry when agitated or wet. Each slurry was stirred for 30 minutes prior to adding flocculent and testing.

The settling curves for each slurry are shown in Appendix 9. The volume of flocculent was added to each test at a concentration ranging between the equivalent of 0-240 g flocculent/tonne ore.

3.5 Bed Filter Tests

Tests carried out by Delkor Pty. Ltd. found the epsomite ore slurry unsuited for use with horizontal bed filters due to the very fine particle size. Solid/liquid separation was not possible because of the blinding effect of the fine particles and the resulting high residual moistures.

3.6 Crystallisation Tests on Brine

Crystallisation tests were carried out to study the types of salts precipitated during crystallisation. The brines for each of the tests were prepared by using two leaching cycles, both with fresh ore at 33% solids.

Weights and assays are tabled in Appendix 10. The first salt to precipitate was gypsum ($CaSO_4.2H_2O$) followed by sodium and magnesium sulphates.

Crystallisation tests were carried out at 25°C with the salts being separated by filtration.

4. RESULTS OF TESTWORK

4.1 Efficiency of Salt Extraction from Epsomite Ore

All leach tests were carried out at 33-1/3% solids and involved four leach stages as shown schematically on page 4. The percentage of salt extracted from that contained in each of the three ore samples during each of the leach cycles and total percentage extraction from the treatment, is given in Table 1.

Table 1

Percentage Salt Extracted from Epsomite Ore

Ore Sample No.	2	47	71
Salt Content % by Wt.	5.05	15.28	14.23
Salt Extracted	% by Wt.	% by Wt.	% by Wt.
Leach Cycle No.			
1	48.9	63.1	56.6
2	27.7	40.4	16.7
3	49.6	57.4	45.7
4	4.5	-2.9	6.1
Total % Extraction	55.9	66.5	57.6

4.2 Residual Moisture Content of Centrifuged Leach Residue

Detailed residue analyses from each of the four leach stages are given in Appendix 5(ii). Each residue was separated from the brine by tube centrifuge and it is significant that residual moistures were unacceptably high on all samples as shown in Table 2.

Table 2

Moisture Content of Centrifuged Leach Residue

Ore Sample No.	2	47	71
Initial H_2O Content % by Wt.	66.7	66.7	66.7
Residual H_2O Content	% by Wt.	% by Wt.	% by Wt.
Leach Cycle No.			
1	42.5	42.6	46.1
2	42.4	39.1	44.0
3	44.9	43.4	47.3
4	43.7	45.1	46.0

Due to the nature of the finely sized clays contained in the ore a serious problem of a viable solid/liquid separation therefore exists in a potential commercial venture.

It was hoped that beneficiation of the ore by separation of clay fines on a dry basis prior to leaching could be effectively achieved.

4.3 Distribution of Salt from Leached Sized Ore

The distribution of elements from leaching nine sized fractions of crushed ore are detailed in Appendix 7. Largest amount of salt leached was from the -13.2 mm + 6.7 mm ore fraction as shown in Table 3 together with that leached from the other fractions.

Table 3

Salt Distribution in Sized Ore (No. 47)

Ore Size mm	Retained %	Total Salts Distribution Na, K, Mg, Ca, Cl, SO_4	K Dist. %	Mg Dist. %	SO_4 Dist. %
-25 + 13.2	21.9	9.5	21.9	11.2	6.0
-13.2 + 6.7	30.2	21.7	30.2	21.6	18.9
-6.7 + 3.35	14.5	12.9	14.5	12.7	12.4
-3.35 + 1.70	10.5	12.8	10.5	13.0	13.4
-1.70 + 0.85	8.2	13.0	8.2	12.7	14.5
-0.85 + 0.425	6.1	12.4	6.1	11.6	14.3
-0.425 + 0.212	3.8	8.5	3.8	8.0	9.8
-0.212 + 0.106	2.9	5.3	2.8	5.2	6.2
-0.106	1.9	3.9	2.0	4.0	4.5
	100.0	100.0	100.0	100.0	100.0

About 82% of the salt is shown to be distributed in the +0.5 mm fraction. It may be possible that the dry ore could be dry beneficiated by screening over 0.5 mm to remove the fine clays without excessive salt loss.

4.4 Salt Product from Recycle Leaching of Ore

It was necessary to carry out seven recycle leach tests with the one brine and new ore to achieve a crystallised salt product and a near equilibrium concentration brine at 25°C. Analyses of the brines and salt product are given in Appendix 8. The crystallised salt was comprised mainly of magnesium (10%) and sulphate (39.4%), a small amount of sodium chloride, but potassium or calcium ion was not detected.

4.5 Slurry Settling Tests

The results of the slurry settling testwork on each of the three ore samples at three slurry concentrations (ore:water, 1:2, 1:5 and 1:10) are shown graphically in Appendix 9. Poor settling rates were shown with all samples at 1:2 concentrations with or without flocculent additions.

The most effective settling rates were achieved with ore slurry at 1:10 concentrations using flocculent additions (superfloc N2100) equivalent to 44 g/tonne ore.

4.6 Brine Crystallisation Tests

The analyses of harvest salts and brines produced from each of the three ore samples are shown in Appendix 10. For sample 2 only three harvests were carried out because of the initially low salt content of the ore. In the case of samples 47 and 71 with significantly higher salt content five or six harvests were made. In all cases, however, final salt compositions were in many respects similar and are compared in Table 4.

Table 4

Crystallised Salt Composition

Sample No.	Salt Wt.(g)	Na %	K %	Mg %	Cu %	Cl %	SO_4 %	H_2O Crystallisation %	H_2O Free %
2	11.8	13.4	0.02	7.6	0.03	1.43	55.5	22.0	7.4
47	11.0	12.6	0.02	7.9	0.03	0.30	57.9	21.2	0.81
71	93.3	13.3	0.04	7.9	0.04	1.21	55.4	22.1	8.1

Likewise the final harvested brines showed some similarities with the obvious build-up of chloride and potassium, and a significant drop-off in sulphate concentration.

4.7 Electrostatic Separation Tests

Attempts to beneficiate the ore with a laboratory electrostatic separator did not prove very successful. The ore samples were passed through the separator using various combinations of electrodes, all of which tended to cause segregation with respect to particle size rather than improve ore quality. Careful microscopic examination of the ore revealed a fine matrix of soluble salts throughout each individual piece of ore, making total separation impossible.

Sample weights reporting in the various fractions and the respective salt analysis are tabled in Appendix 11.

4.8 Large Scale Solid/Liquid Separation

Discussions on solid/liquid separation of epsomite slurries were held with a representative of Tema (Aust.) Pty. Ltd. (agents for Siebtechnik Centrifuges) and a decanter type centrifuge was recommended as the most suitable unit for such an application.

For ore treatment rates of say only 400 kg/h, two or three TS 850E centrifuge units would be required for each leach cycle. Details of the centrifuge types are given in Appendix 12.

Appendix 1

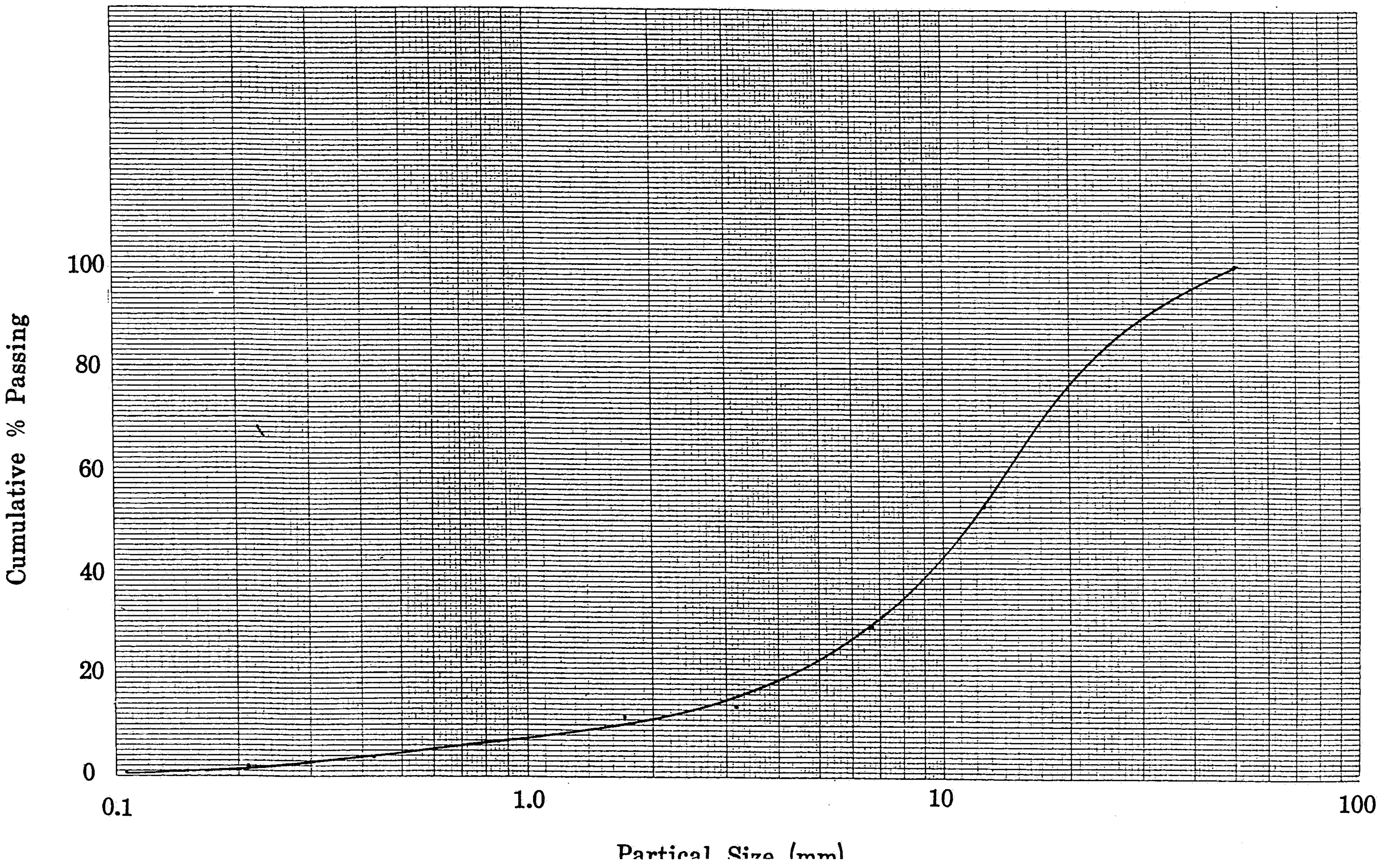
SIZING ANALYSES OF EPSOMITE ORE

Sizing mm	Trench/Sample No. 2 Retained %	2 Cumulative Passing %	47 Retained %	47 Cumulative Passing %	71 Retained %	71 Cumulative Passing %
+ 50	0	100.00	11.22	88.78	19.81	80.19
-50 + 25	14.83	85.17	19.85	68.93	23.22	56.97
-25 + 12.5	31.98	53.19	21.83	47.10	17.99	38.98
-12.5 + 6.7	23.68	29.51	13.68	33.42	10.54	28.44
- 6.7 + 3.15	15.73	13.78	11.52	21.90	10.67	17.77
- 3.15 + 1.7	2.40	11.38	3.54	18.36	3.85	13.92
- 1.7 + 0.85	4.61	6.77	6.57	11.79	5.19	8.73
- 0.85 + 0.425	2.98	3.78	4.59	7.20	3.75	4.98
- 0.425 + 0.212	1.81	1.98	3.05	4.15	2.08	2.90
- 0.212 + 0.106	1.18	0.80	2.72	1.43	1.61	1.29
- 0.106	0.80	0	1.43	0	1.29	0
	100.00		100.00		100.00	

EPSOMITE ORE

Sample No 2

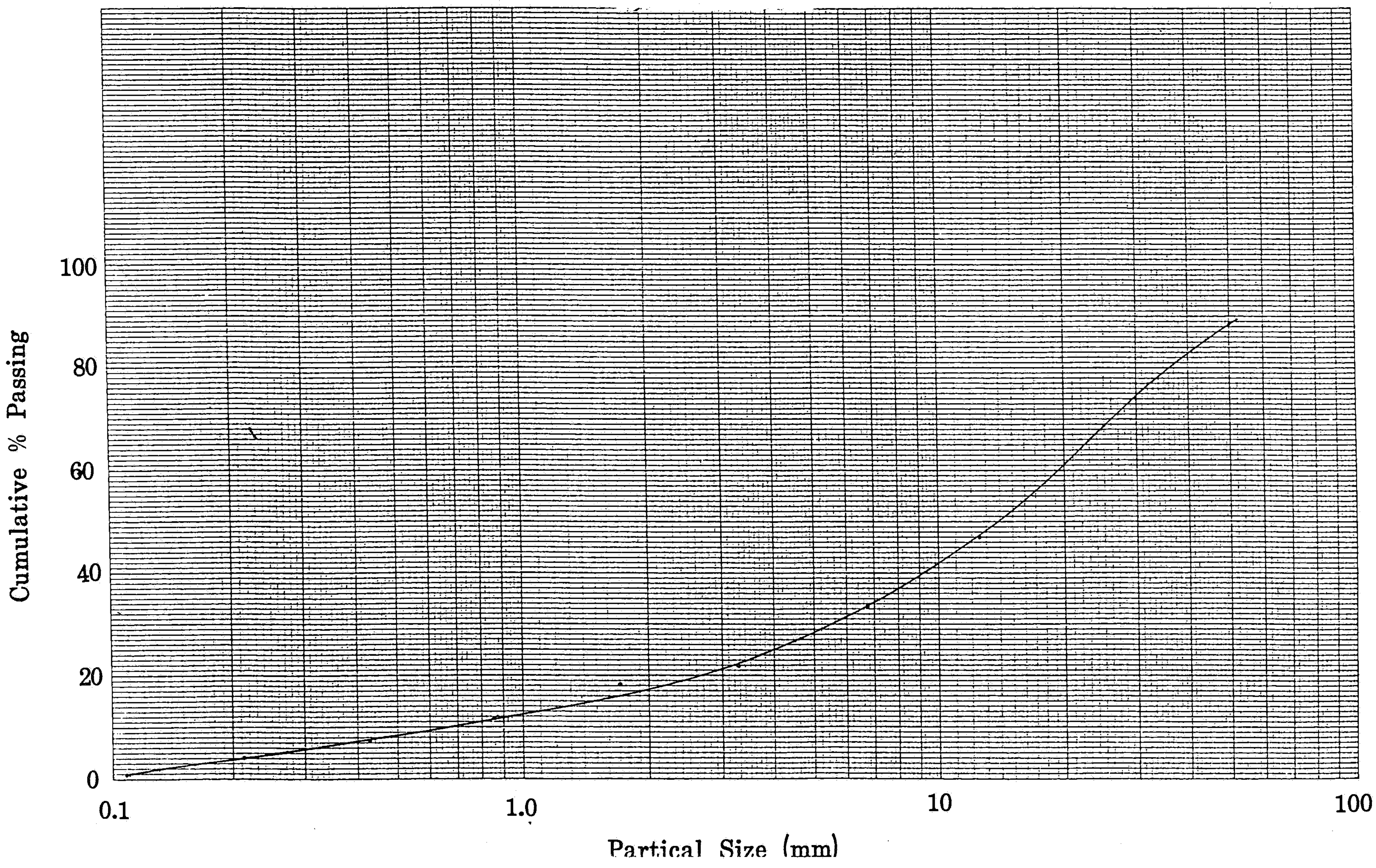
(dry screened)



EPSOMITE ORE

Sample No 47

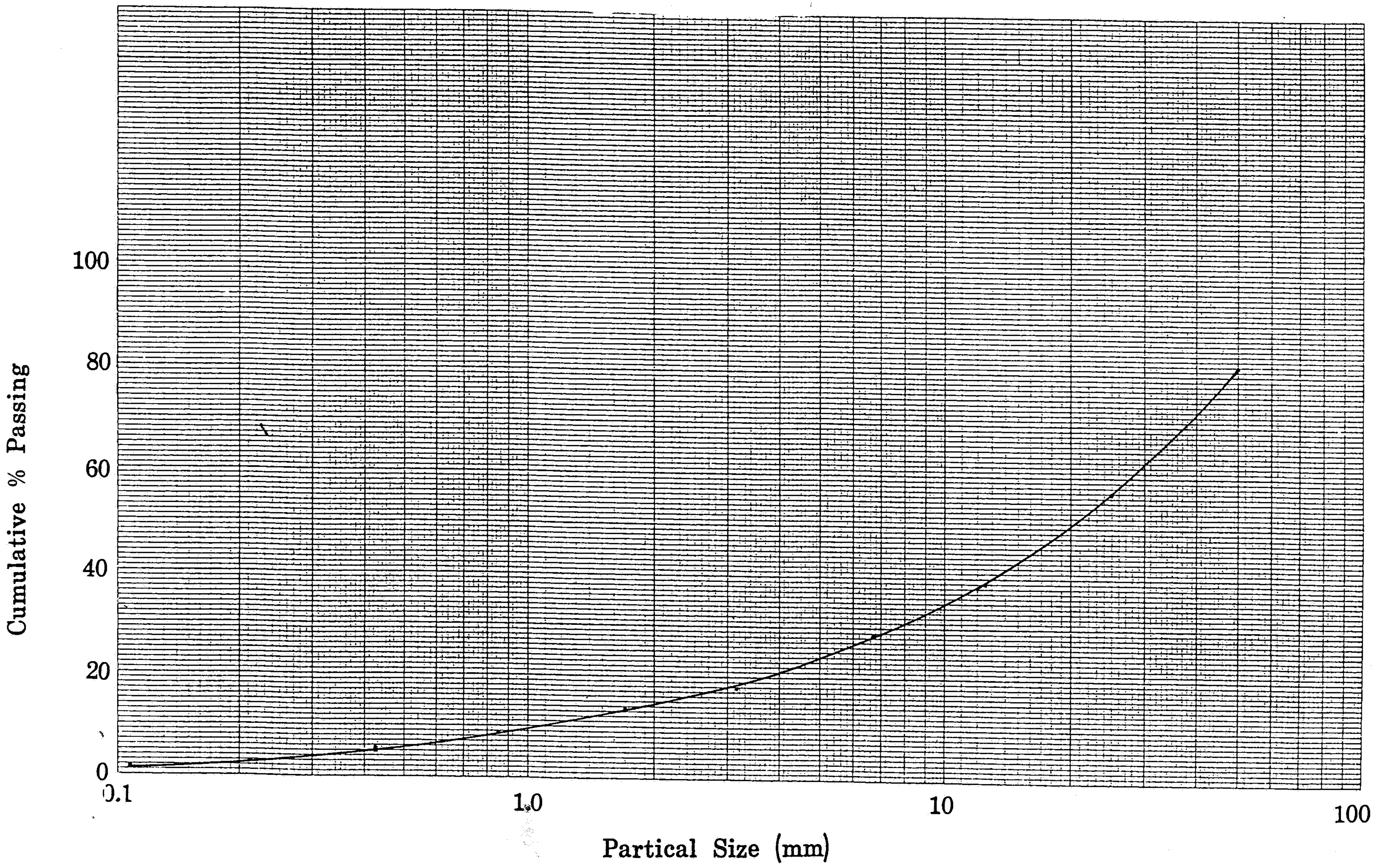
(dry screened)



EPSOMITE ORE

Sample No 71

(dry screened)



Appendix 2

Head Analyses of Epsomite Ore Samples

Sample/ Trench No.	ANALYSIS OF EPSOMITE ORE Wt. %			
	Element	AMDEL	CRA Research	
2	Na	0.64	0.55	0.60
	K	0.02	0.05	0.05
	Mg	0.62	0.50	0.55
	Ca	0.10	0.25	0.25
	Cl	0.72	0.65	0.70
	SO_4	3.22	2.75	3.20
47	Na	1.43	1.90	1.95
	K	0.03	0.05	0.05
	Mg	2.04	1.90	1.85
	Ca	0.10	0.25	0.25
	Cl	1.15	1.45	1.50
	SO_4	11.98	9.75	9.65
71	Na	1.12	1.50	1.55
	K	0.03	0.05	0.05
	Mg	1.52	1.90	1.95
	Ca	0.10	0.25	0.25
	Cl	0.57	0.65	0.70
	SO_4	9.36	9.80	9.80

Appendix 3

Wet Sizing Analyses of Leached Residue

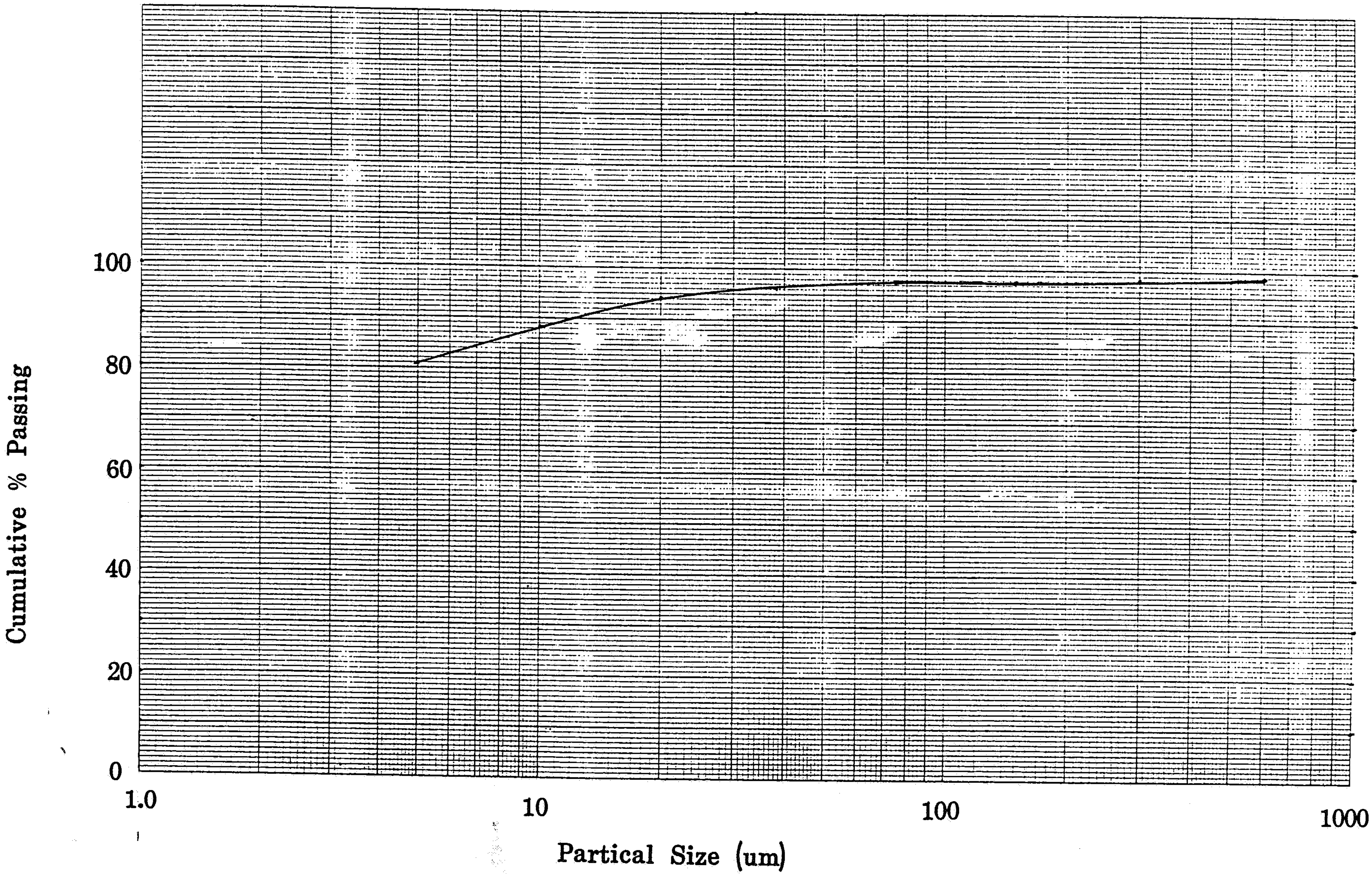
Sizing micron	Trench/Sample No.					
	2		47		71	
	Retained %	Cumulative %	Retained %	Cumulative %	Retained %	Cumulative %
+ 600	1.15	98.85	2.32	97.68	2.25	97.75
- 600 + 300	0.52	98.33	0.83	96.85	0.63	97.12
- 300 + 150	0.46	97.87	1.46	95.39	0.70	96.42
- 150 + 75	0.28	97.59	1.38	94.01	0.85	95.57
- 75 + 38	1.28	96.31	1.30	92.71	2.27	93.30
- 38 + 20	2.11	94.20	2.24	90.47	3.41	89.89
- 20 + 10	5.90	88.30	5.82	84.65	11.35	78.54
- 10 + 5	7.61	80.69	6.74	77.91	7.39	71.15
- 5	80.69	0	77.91	0	71.15	0
	100.00		100.00		100.00	

EPSOMITE ORE

Sample No 2

(screened leach residues)

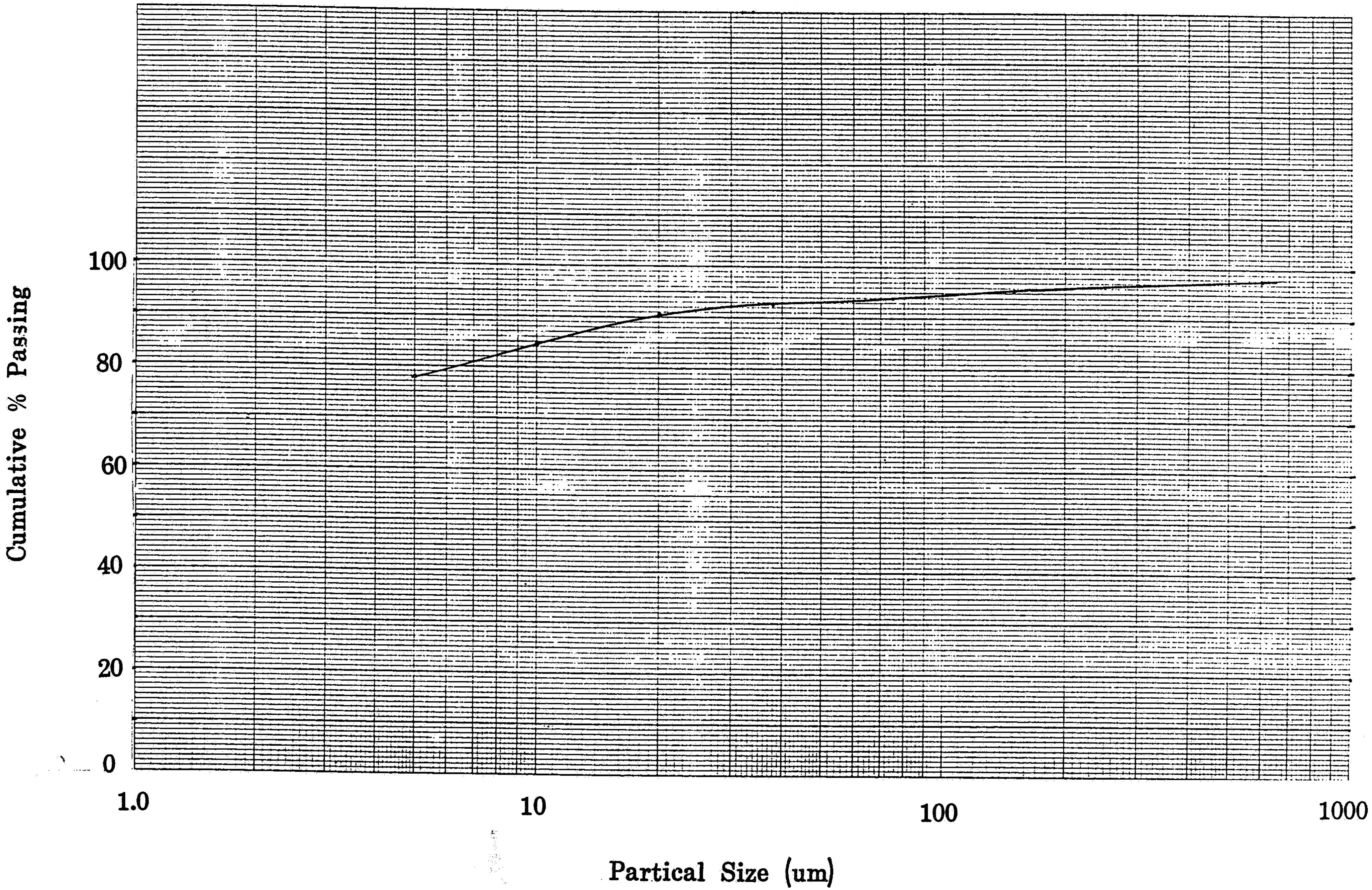
0232



EPSOMITE ORE

Sample No 47

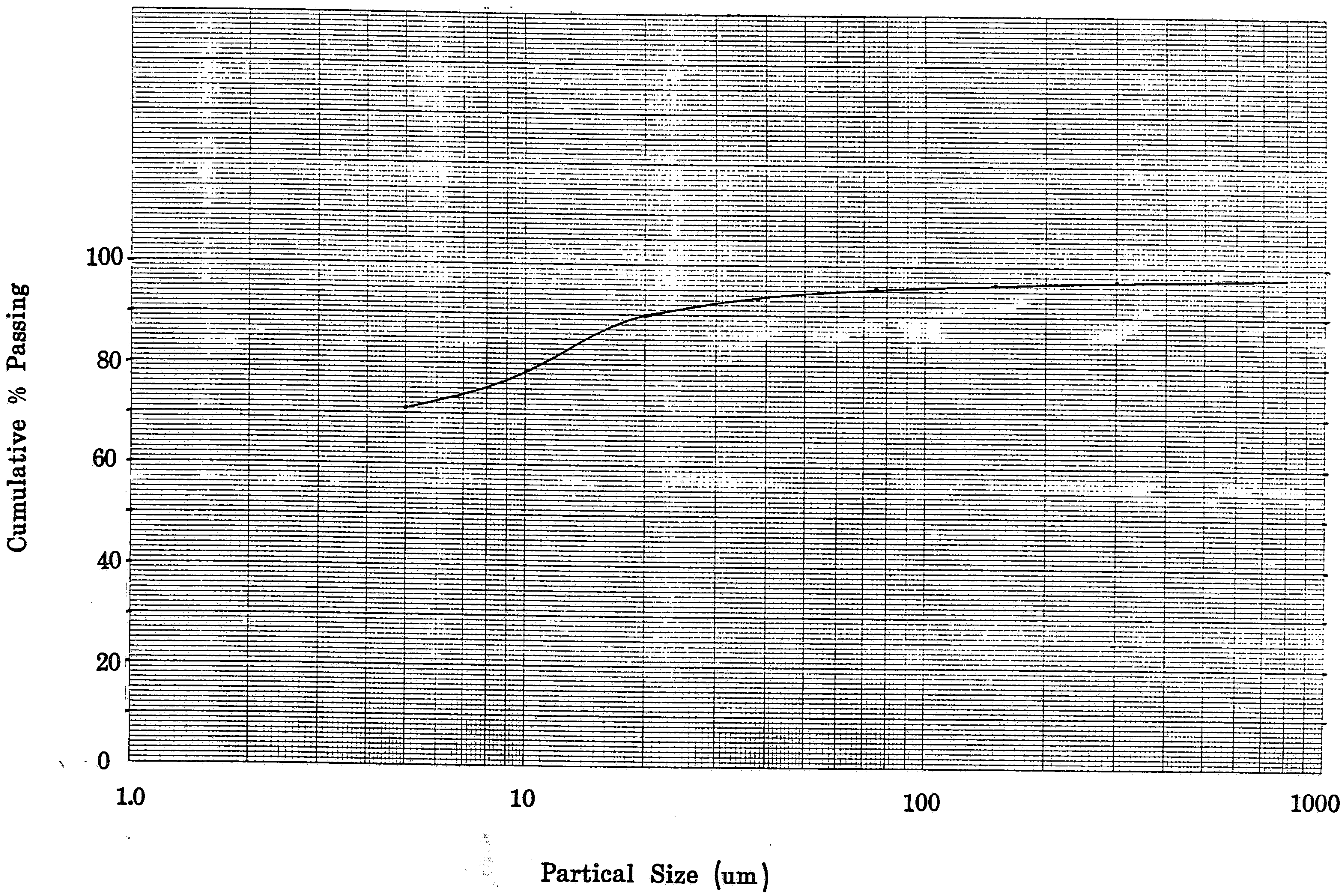
(screened leach residues)



EPSOMITE ORE

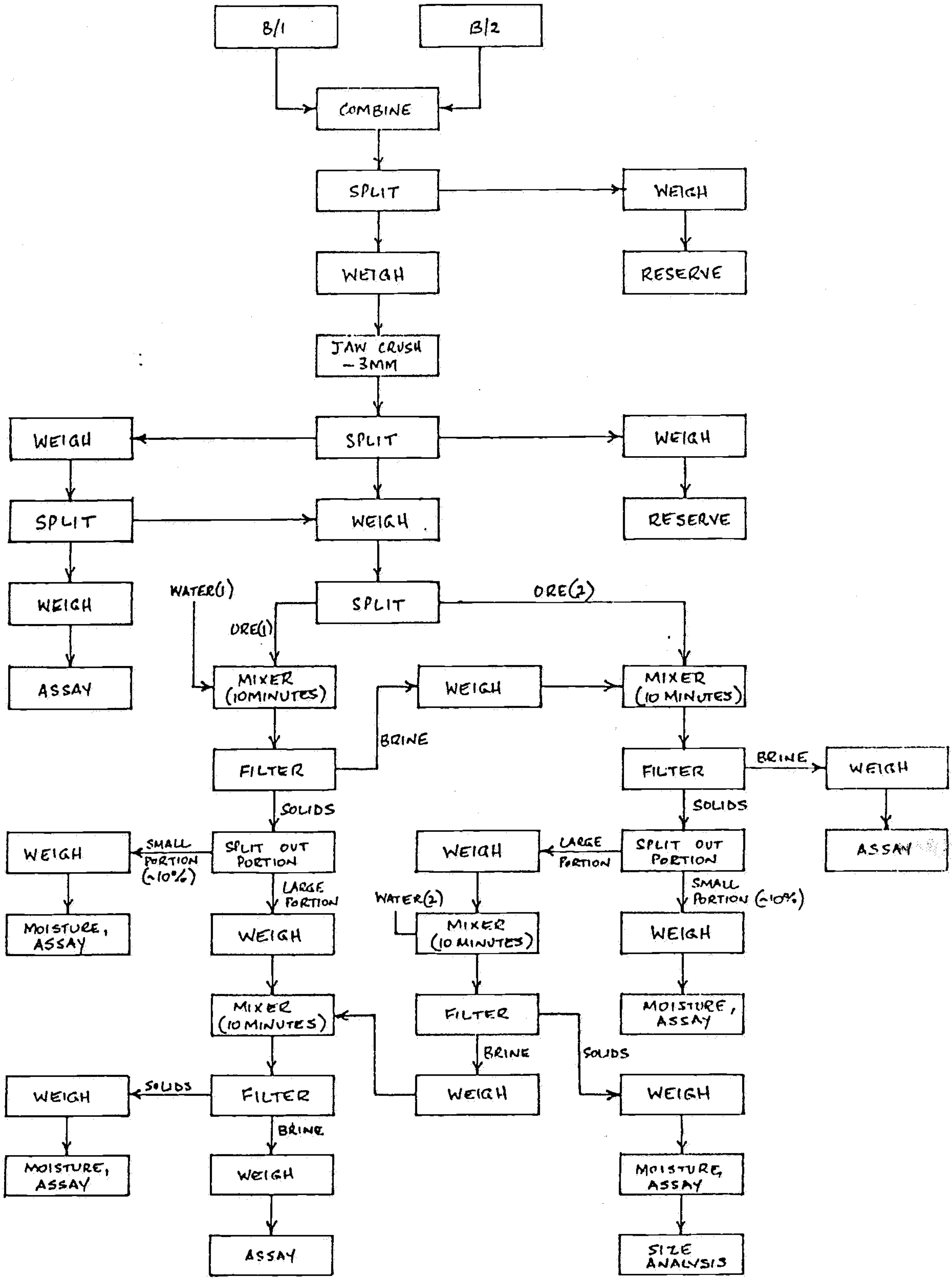
Sample No 71

(screened leach residues)



Appendix 4

EPSOMITE TESTWORK FLOWSHEET.



WEIGHT WATER(1) ADDITION = WEIGHT ORE(1)
WEIGHT WATER(2) ADDITION = WEIGHT ORE(2)

K. Wellisch
9.7.1985.

APPENDIX 5(i)

Brine Analysis of Flowsheet Testwork

Sample 2

Leach No.	Na	K	Mg	Ca	Cl	SO_4	H_2O
1	0.28	0.01	0.27	0.05	0.32	0.94	98.13
2	0.54	0.01	0.55	0.05	0.64	2.29	95.92
3	0.22	0.01	0.20	0.05	0.22	0.93	98.37
4	0.26	0.01	0.24	0.05	0.26	1.04	98.15

Sample 47

Leach No.	Na	K	Mg	Ca	Cl	SO_4	H_2O
1	0.85	0.01	0.82	0.05	0.62	4.10	93.55
2	1.66	0.03	1.68	0.05	1.23	8.57	86.78
3	0.67	0.02	0.59	0.05	0.47	3.25	94.97
4	0.74	0.01	0.69	0.05	0.54	3.77	94.19

Sample 71

Leach No.	Na	K	Mg	Ca	Cl	SO_4	H_2O
1	0.63	0.02	0.84	0.04	0.29	4.41	93.77
2	1.12	0.03	1.68	0.04	0.58	8.46	88.09
3	0.47	0.01	0.62	0.04	0.27	3.25	95.32
4	0.56	0.01	0.72	0.04	0.23	3.85	94.58

APPENDIX 5(ii)

Residue Analysis of Flowsheet Testwork

Sample 2

Concentration % dry wt. solids

Leach No.	Moisture %	Na	K	Mg	Ca	Cl	SO_4
1	42.5	0.12	0.02	0.10	0.06	0.10	0.44
2	42.4	0.20	0.02	0.14	0.08	0.18	0.70
3	44.9	0.14	0.02	0.10	0.08	0.12	0.62
4	43.7	0.12	0.02	0.10	0.08	0.08	0.58

Sample 47

Concentration % dry wt. solids

Leach No.	Moisture %	Na	K	Mg	Ca	Cl	SO_4
1	42.6	0.32	0.02	0.24	0.10	0.20	1.50
2	39.1	0.52	0.02	0.40	0.10	0.34	1.84
3	43.4	0.26	0.02	0.18	0.08	0.14	1.14
4	45.1	0.32	0.02	0.22	0.08	0.18	1.40

Sample 71

Concentration % dry wt. solids

Leach No.	Moisture %	Na	K	Mg	Ca	Cl	SO_4
1	46.1	0.24	0.02	0.28	0.08	0.12	1.66
2	44.0	0.40	0.02	0.48	0.08	0.20	2.72
3	47.3	0.22	0.02	0.20	0.06	0.10	1.14
4	46.0	0.24	0.02	0.22	0.06	0.08	1.54

APPENDIX 6(i)

Mass Balance of Flowsheet Testwork

Sample 2

Leach 1	Wt.	Na	K	Mg	Ca	Cl	SO_4	Salt Wt.
		Mass in grams						
IN								
Ore (dried 50°C)	252.29	1.45	0.13	1.32	0.63	1.70	7.51	12.74
Water	512.24							
TOTAL	764.53	1.45	0.13	1.32	0.63	1.70	7.51	12.74
OUT								
Brine	333.07	0.93	0.03	0.90	0.17	1.07	3.13	6.23
Wet solids at 42.5%	416.32							
Dry solids	239.38	0.51	0.10	0.41	0.45	0.61	4.26	6.33
Water in solids	176.94							
Lost solids	6.68	0.01	0.00	0.01	0.00	0.02	0.12	0.18
Lost water	8.46							
Recovered solids	245.61							
Recovered water	503.78							
Total lost	15.14							
Total recovered	749.39							
TOTAL	764.53	1.45	0.13	1.32	0.63	1.70	7.51	12.74
Salt recovered from ore (Leach 1)	48.9%							
Samples								
Brine before	333.07	0.93	0.03	0.90	0.17	1.07	3.13	6.23
Brine after	308.93	0.87	0.03	0.83	0.15	0.99	2.90	5.77
Salt in sample	24.14	0.06	0.00	0.07	0.02	0.08	0.23	0.46
Wet solids before	416.32	0.51	0.10	0.41	0.45	0.61	4.26	6.33
Wet solids after	146.65	0.18	0.04	0.14	0.16	0.21	1.50	2.23
Wt. in sample	269.67	0.33	0.06	0.27	0.29	0.40	2.76	4.10

Mass Balance of Flowsheet Testwork

Sample 2

Leach 2	Wt.	Na	K	Mg	Ca	Cl	SO_4	Salt Wt.
		Mass in grams						
IN								
Brine	308.93	0.87	0.03	0.83	0.15	0.99	2.90	5.77
Ore (dried 50°C)	155.50	0.89	0.08	0.82	0.39	1.05	4.63	7.86
Total wt. water	303.16							
Total wt. solids	161.27							
TOTAL	464.43	1.76	0.11	1.65	0.54	2.04	7.53	13.63
OUT								
Brine	194.73	1.05	0.02	1.07	0.10	1.25	4.46	7.95
Wet solids at 42.4% m	262.41							
Dry solids	151.15	0.70	0.09	0.57	0.43	0.78	3.03	5.60
Water in solids	111.26							
Dry wt. solids recov.	159.10							
Wt. water recovered	298.04							
Total recovered	457.14							
Lost water	5.12							
Lost solids	2.17	0.01	0.00	0.01	0.01	0.01	0.04	0.08
Total lost	7.29							
TOTAL	464.43	1.76	0.11	1.65	0.54	2.04	7.53	13.63
Salt recovered from ore (Leach 2)	27.7%							
Samples								
Wet solids before	262.41	0.70	0.09	0.57	0.43	0.78	3.03	5.60
Wet solids after	196.39	0.52	0.07	0.43	0.32	0.58	2.27	4.19
Wt. in sample	62.02	0.18	0.02	0.14	0.11	0.20	0.76	1.41

Mass Balance of Flowsheet Testwork

Sample 2

Leach 3	Wt.	Na	K	Mg	Ca	Cl	SO_4	Salt Wt.
				Mass in grams				
IN								
Water	143.65							
Wet solids at 42.4% m	196.39	0.52	0.07	0.43	0.32	0.58	2.27	4.19
Total wt. water	226.92							
Total wt. dry solids	113.12							
TOTAL	340.04	0.52	0.07	0.43	0.32	0.58	2.27	4.19
OUT								
Brine	128.44	0.28	0.01	0.26	0.06	0.28	1.19	2.08
Wet solids at 44.9% m	193.09							
Dry solids	106.39	0.23	0.06	0.16	0.25	0.29	1.03	2.02
Water in solids	86.70							
Dry wt. solids recov.	108.47							
Wt. water recovered	213.06							
Total recovered	321.53							
Lost solids	4.65	0.01	0.00	0.01	0.01	0.01	0.05	0.09
Lost water	13.86							
Total lost	18.51							
TOTAL	340.04	0.52	0.07	0.43	0.32	0.58	2.27	4.19
Salt recovered from ore (Leach 3)	49.6%							
Samples								
Brine before	128.44	0.28	0.01	0.26	0.06	0.28	1.19	2.08
Brine after	103.12	0.22	0.01	0.21	0.05	0.22	0.96	1.67
Salt in sample	25.32	0.06	0.00	0.05	0.01	0.06	0.23	0.41

Mass Balance of Flowsheet Testwork

Sample 2

Leach 4	Wt.	Na	K	Mg	Ca	Cl	SO_4	Salt Wt.
		Mass in grams						
IN								
Brine	103.12	0.22	0.01	0.21	0.05	0.22	0.96	1.67
Wet solids at 42.5% m	146.65	0.18	0.04	0.14	0.16	0.21	1.50	2.23
Water in solids	62.33							
Dry wt. solids	84.32							
Total wt. water	163.78							
Total wt. dry solids	85.99							
TOTAL	249.77	0.40	0.05	0.35	0.21	0.43	2.46	3.90
OUT								
Brine	94.25	0.25	0.01	0.23	0.05	0.25	0.98	1.77
Wet solids at 43.7% m	149.99							
Water in solids	65.55							
Dry solids	84.44	0.15	0.04	0.12	0.16	0.18	1.48	2.13
Wt. water recovered	158.03							
Dry solids recovered	86.21							
Total recovered	244.24							
Lost solids	-0.22							
Lost water	5.75							
Total lost	5.53							
TOTAL	249.77	0.40	0.05	0.35	0.21	0.43	2.46	3.90
Salt recovered from ore (Leach 4)	4.5%							
Overall salt recovery (Leaches 1-4)	55.9%							

Mass Balance of Flowsheet Testwork

Sample 47

Leach 1	Wt.	Na	K	Mg	Ca	Cl	SO_4	Salt Wt.
		Mass in grams						
IN								
Ore (dried 50°C)	250.21	4.82	0.13	4.69	0.63	3.69	24.27	38.23
Water	500.95							
	751.16	4.82	0.13	4.69	0.63	3.69	24.27	38.23
OUT								
Brine	374.07	3.18	0.04	3.07	0.19	2.32	15.34	24.14
Wet solids at 42.6% m	366.17							
Water in solids	134.94							
Dry solids	222.43	1.62	0.09	1.60	0.43	1.35	8.80	13.89
Wt. water recovered	493.67							
Dry solids recovered	246.57							
Total recovered	740.24							
Lost water	7.28							
Lost solids	3.64	0.02	0.00	0.02	0.01	0.02	0.13	0.20
Total lost	10.92							
TOTAL	751.16	4.82	0.13	4.69	0.63	3.69	24.27	38.23

Salt leached from solids (Leach 1) 63.1%

Samples	Wt.	Na	K	Mg	Ca	Cl	SO_4	Salt Wt.
Brine before	374.07	3.18	0.04	3.07	0.19	2.32	15.34	24.14
Brine after	346.35	2.94	0.04	2.84	0.18	2.15	14.20	22.35
Brine sample	27.72	0.24	0.00	0.23	0.01	0.17	1.14	1.79

Mass Balance of Flowsheet Testwork

Sample 47

Leach 2	Wt.	Na	K	Mg	Ca	Cl	SO_4	Salt Wt.
		Mass in grams						
IN								
Ore (dried 50°C)	175.50	3.38	0.09	3.29	0.44	2.59	17.02	26.81
Brine	346.35	2.94	0.04	2.84	0.18	2.15	14.20	22.35
Total wt. solids	197.85							
Total wt. water	324.00							
TOTAL	521.85	6.32	0.13	6.13	0.62	4.74	31.22	49.16
OUT								
Brine	250.82	4.16	0.08	4.21	0.13	3.09	21.50	33.17
Wet solids at 39.1% m	260.45							
Water in solids	99.30							
Dry solids	161.15	2.11	0.05	1.88	0.48	1.61	9.51	15.64
Wt. water recovered	316.95							
Dry solids recovered	194.32							
Total recovered	511.27							
Lost water	7.05							
Lost solids	3.53	0.05	0.00	0.04	0.01	0.04	0.21	0.35
Total lost	10.58							
TOTAL	521.85	6.32	0.13	6.13	0.62	4.74	31.22	49.16
Salt leached from solids (Leach 2)			40.4%					
Samples								
Wet solids before	260.45	2.11	0.05	1.88	0.48	1.61	9.51	15.64
Wet solids after	208.31	1.69	0.04	1.50	0.38	1.29	7.61	12.51
Sample wt.	52.14	0.42	0.01	0.38	0.10	0.32	1.90	3.13

Mass Balance of Flowsheet Testwork

Sample 47

Leach 3	Wt.	Na	K	Mg	Ca	Cl	SO_4	Salt Wt.
		Mass in grams						
IN								
Wet solids	208.31							
Water in solids	79.42							
Dry solids	128.89	1.69	0.04	1.5	0.38	1.29	7.61	12.51
Water	148.04							
Total solids wt.	128.89							
Total water wt.	227.46							
TOTAL	356.35	1.69	0.04	1.5	0.38	1.29	7.61	12.51
OUT								
Brine	142.24	0.95	0.03	0.84	0.07	0.67	4.62	7.18
Wet solids	200.78							
Water in solids	83.51							
Dry solids	117.27	0.72	0.01	0.64	0.30	0.60	2.88	5.14
Total water recov.	218.57							
Total solids recov.	124.45							
Total recovered	343.02							
Lost water	8.89							
Lost solids	4.44	0.03	0.00	0.02	0.01	0.02	0.11	0.19
Total lost	13.33							
TOTAL	356.35	1.69	0.04	1.50	0.38	1.29	7.61	12.51
Salt leached from solids (Leach 3)		57.4%						
Samples								
Brine before	142.24	0.95	0.03	0.84	0.07	0.67	4.62	7.18
Brine after	120.30	0.80	0.03	0.71	0.06	0.57	3.91	6.07
Brine sample	21.94	0.15	0.00	0.13	0.01	0.10	0.71	1.11

Mass Balance of Flowsheet Testwork

Sample 47

Leach 4	Wt.	Na	K	Mg	Ca	Cl	SO_4	Salt Wt.
		Mass in grams						
IN								
Wet solids	170.59	0.75	0.04	0.75	0.20	0.63	4.10	6.47
Water in solids	62.87							
Dry solids	107.72							
Brine	120.30	0.80	0.03	0.71	0.06	0.57	3.91	6.08
Total solids wt.	113.79							
Total water wt.	177.10							
TOTAL	290.89	1.55	0.07	1.46	0.26	1.20	8.01	12.55
OUT								
Brine	101.61	0.75	0.01	0.70	0.05	0.55	3.83	5.89
Wet solids	176.34							
Water in solids	72.75							
Dry solids	103.59	0.77	0.06	0.74	0.20	0.62	4.01	6.40
Total water recov.	168.47							
Total solids recov.	109.48							
Total recovered	277.95							
Lost water	8.63							
Lost solids	4.31	0.03	0.00	0.02	0.01	0.03	0.17	0.26
Total lost	12.94							
TOTAL	290.89	1.55	0.07	1.46	0.26	1.20	8.01	12.55
Salt leached from solids (Leach 4)	-2.9%							
Overall salt recovery (Leaches 1-4)	66.5%							

APPENDIX 6(iii)

Mass Balance of Flowsheet Testwork

Sample 71

Leach 1	Wt.	Na	K	Mg	Ca	Cl	SO_4	Salt Wt.
				Mass in grams				
IN								
Ore (dried at 50°C)	250.40	3.82	0.13	4.82	0.63	1.69	24.54	35.63
Water	500.62							
TOTAL :	751.02							
OUT								
Brine	323.41	2.04	0.06	2.72	0.13	0.94	14.26	20.15
Wet solids	406.95							
Water in solids	183.59							
Dry solids	223.36	1.73	0.07	2.04	0.49	0.73	9.97	15.03
Total water	486.85							
Total dry solids	243.51							
Total recovered	730.36							
Lost water	13.77							
Lost solids	6.89	0.05	0.00	0.06	0.01	0.02	0.31	0.45
Total lost	20.66							
TOTAL	751.02	3.82	0.13	4.82	0.63	1.69	24.54	35.63
Salt recovered from ore (Leach 1)		56.6%						
Samples								
Brine before	323.41	2.04	0.06	2.72	0.13	0.94	14.26	20.15
Brine after	294.86	1.86	0.06	2.48	0.12	0.86	13.00	18.38
Salt in sample	28.55	0.18	0.00	0.24	0.01	0.08	1.26	1.77

Mass Balance of Flowsheet Testwork

Sample 71

Leach 2	Wt.	Na	K	Mg	Ca	Cl	SO_4	Salt Wt.
		Mass in grams						
IN								
Ore	152.87	2.33	0.08	2.94	0.38	1.03	14.98	21.74
Brine	294.86	1.86	0.06	2.48	0.12	0.86	13.00	18.38
Water	276.48							
Dry solids	171.25							
TOTAL	447.73	4.19	0.14	5.42	0.50	1.89	27.98	40.12
OUT								
Brine	184.83	2.07	0.06	3.11	0.07	1.07	15.64	22.02
Wet solids	253.46							
Water in solids	107.84							
Dry solids	145.62	2.07	0.08	2.25	0.42	0.80	12.04	17.66
Total solids recov.	167.64							
Total water recov.	270.65							
Total recovered	438.29							
Lost solids	3.61	0.05	0.00	0.06	0.01	0.02	0.30	0.44
Lost water	5.83							
Total lost	9.44							
TOTAL	447.73	4.19	0.14	5.42	0.50	1.89	27.98	40.12
Salt recovered from ore (Leach 2)		16.7%						
Samples								
Wet solids before	253.46	2.07	0.08	2.25	0.42	0.80	12.04	17.66
Wet solids after	192.22	1.57	0.06	1.71	0.32	0.61	9.13	13.39
Wt. in sample	61.24	0.50	0.02	0.54	0.10	0.19	2.91	4.27

Mass Balance of Flowsheet Testwork

Sample 71

Leach 3 :	Wt.	Na	K	Mg	Ca	Cl	SO_4	Salt Wt.
IN								
Water	136.82							
Wet solids	192.22	1.57	0.06	1.71	0.32	0.61	9.13	13.39
Water in solids	81.78							
Dry solids	110.44							
Total water	218.60							
Total solids	110.44							
TOTAL	329.04	1.57	0.06	1.71	0.32	0.61	9.13	13.39
OUT								
Brine	131.13	0.64	0.01	0.81	0.05	0.35	4.26	6.12
Wet solids	186.47							
Water in solids	85.99							
Dry solids	100.48	0.90	0.05	0.87	0.26	0.25	4.69	7.02
Total water recov.	211.00							
Total solids recov.	106.60							
Total recovered	317.60							
Lost water	7.60							
Lost solids	3.84	0.03	0.00	0.03	0.01	0.01	0.18	0.26
Total lost	11.44							
TOTAL	329.04	1.57	0.06	1.71	0.32	0.61	9.13	13.39

Mass in grams

Salt recovered from ore (Leach 3) 45.7%

Samples	Wt.	Na	K	Mg	Ca	Cl	SO_4	Salt Wt.
Brine before	131.13	0.64	0.01	0.81	0.05	0.35	4.26	6.12
Brine after	101.90	0.50	0.01	0.63	0.04	0.28	3.31	4.77
Salt in sample	29.23	0.14	0.00	0.18	0.01	0.07	0.95	1.35

Mass Balance of Flowsheet Testwork

Sample 71

Leach 4	Wt.	Na	K	Mg	Ca	Cl	SO_4	Salt Wt.
				Mass in grams				
IN								
Brine	101.90	0.50	0.01	0.63	0.04	0.28	3.31	4.77
Wet solids	145.70							
Water in solids	65.73							
Dry solids	79.97	0.62	0.03	0.73	0.18	0.26	3.57	5.38
Total water	162.86							
Total solids	84.74							
TOTAL	247.60	1.12	0.04	1.33	0.22	0.54	6.88	10.15
OUT								
Brine	93.96	0.53	0.01	0.68	0.04	0.22	3.62	5.10
Wet solids	134.53							
Water in solids	61.43							
Dry solids	73.10	0.54	0.03	0.60	0.16	0.29	2.99	4.61
Total water recov.	150.29							
Total solids recov.	78.20							
Total recovered	228.49							
Lost water	12.57							
Lost solids	6.54	0.05	0.00	0.05	0.02	0.03	0.27	0.42
Total lost	19.11							
TOTAL	247.60	1.12	0.04	1.33	0.22	0.54	6.88	10.15

Salt recovered from ore (Leach 4) 6.1%

Total salt recovery (Leaches 1-4) 57.6%

APPENDIX 7

Distribution of Salt in Sized Epsomite Ore

Sample 47

Distribution of elements and salts (%)

Screen (mm)	% Retained	Na	K	Mg	Ca	Cl	SO_4	Total Salts
+13.2	21.9	9.4	21.9	11.2	13.9	26.1	6.0	9.5
+6.7	30.2	21.5	30.2	21.6	38.4	34.5	18.9	21.7
+3.35	14.5	13.5	14.5	12.7	9.3	15.3	12.4	12.9
+1.70	10.5	12.6	10.5	13.0	6.7	9.5	13.4	12.8
+0.85	8.2	12.8	8.2	12.7	5.2	6.2	14.5	13.0
+0.425	6.1	12.9	6.1	11.6	7.7	3.8	14.3	12.4
+0.212	3.8	9.0	3.8	8.0	7.2	2.1	9.8	8.5
+0.106	2.9	4.9	2.8	5.2	5.4	1.3	6.2	5.3
-0.106	1.9	3.4	2.0	4.0	6.2	1.2	4.5	3.9
	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

APPENDIX 8

Brine Saturation Test

Sample 47

Concentration % by wt.

Leach No.	Na	K	Mg	Ca	Cl	SO_4	H_2O
1	0.60	0.01	0.58	0.04	0.56	2.79	95.42
2	1.20	0.02	1.20	0.04	1.04	5.76	90.73
3	1.62	0.02	1.71	0.05	1.56	8.01	87.04
4	2.20	0.03	2.37	0.04	2.09	11.59	81.68
5	2.77	0.04	2.94	0.03	2.47	14.15	77.60
6	3.48	0.05	3.83	0.03	3.34	18.32	70.96
7	4.21	0.05	3.98	0.02	4.08	19.37	68.28

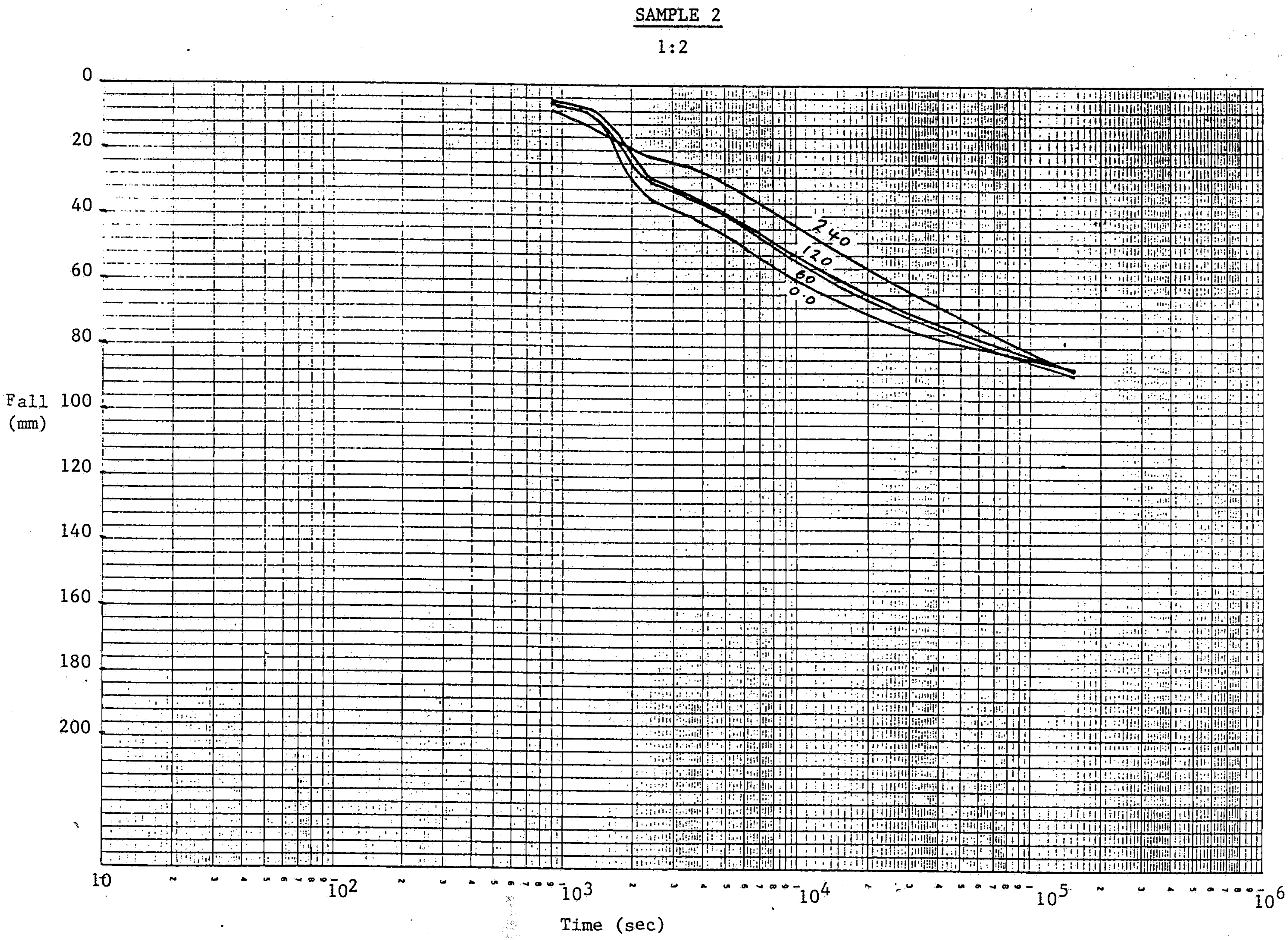
Salt Recrystallised from Leach No. 7 (% by wt.)

Na	K	Mg	Ca	Cl	SO_4	H_2O(wc)	H_2O Free
0.08	0.00	10.00	0.00	0.12	39.42	50.38	1.36

APPENDIX 9

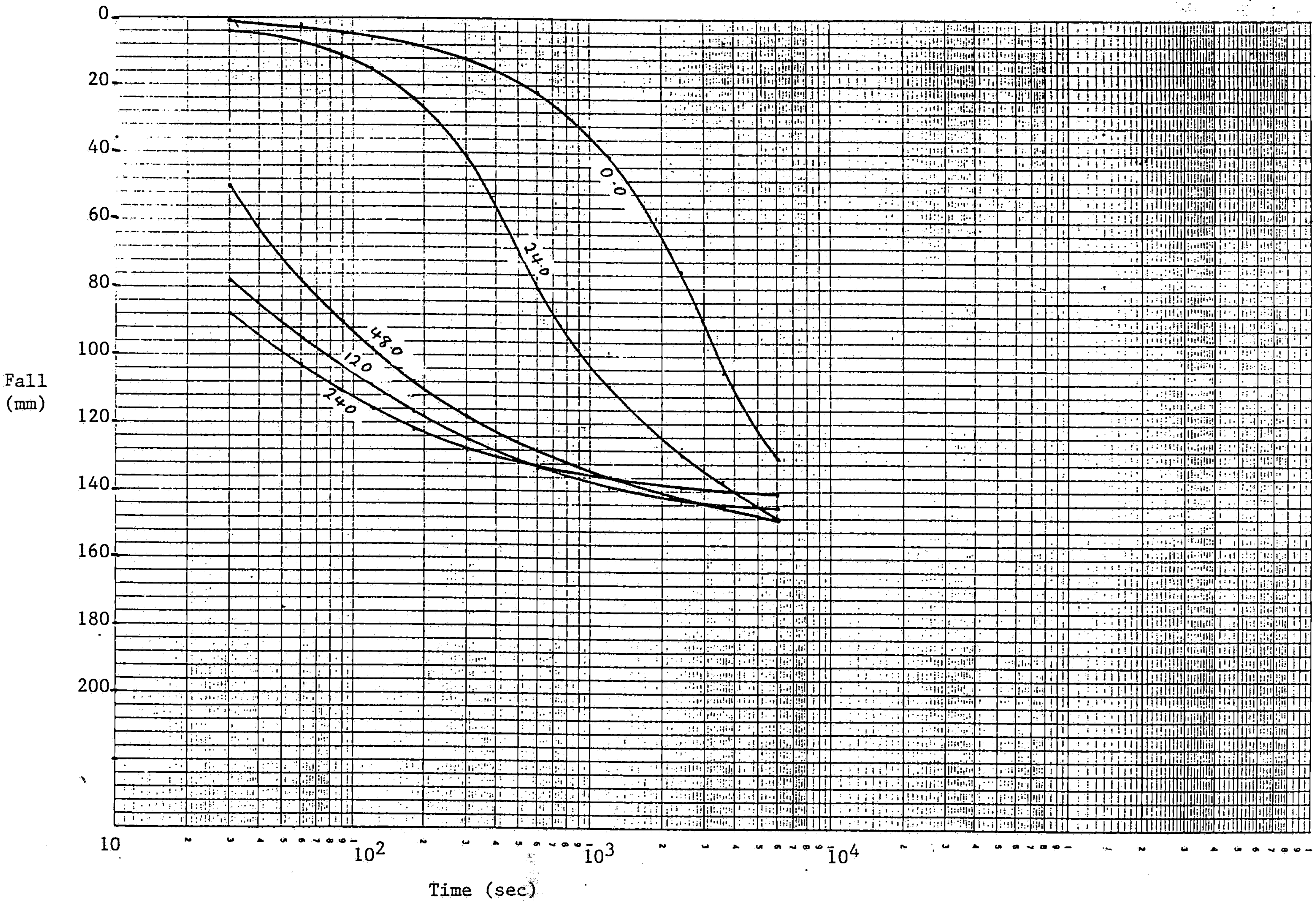
Settling Curves of Epsomite Ore Slurry

The amount of flocculent added in each test expressed as grams of flocculent per tonne of ore is shown against each curve.


SAMPLE 2
1:2
Fall (mm)
0
20
40
60
80
100
120
140
160
180
200
240
120
60
0.0
10
10^2
10^3
10^4
10^5
10^6
Time (sec)

SAMPLE 2

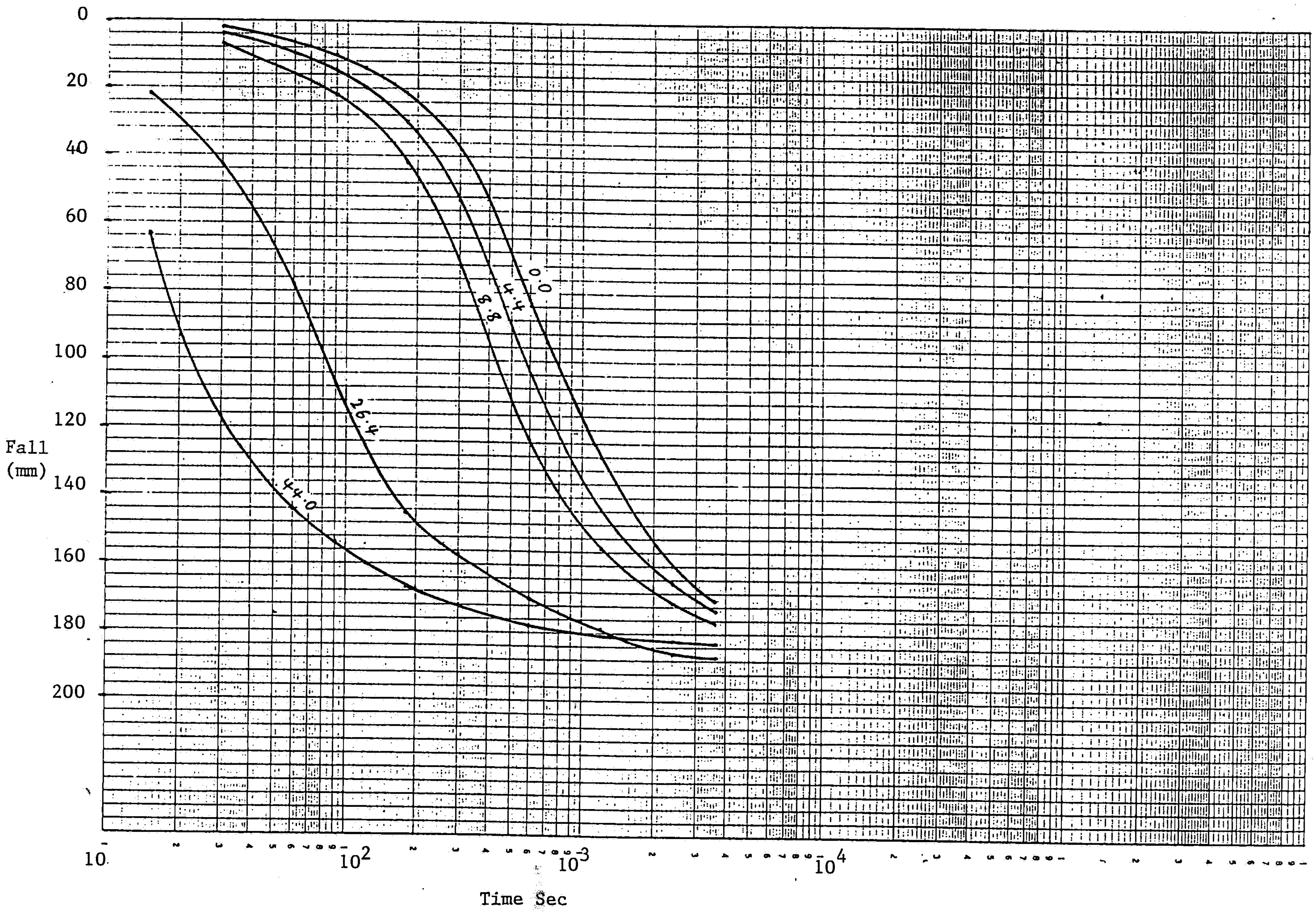
1:5



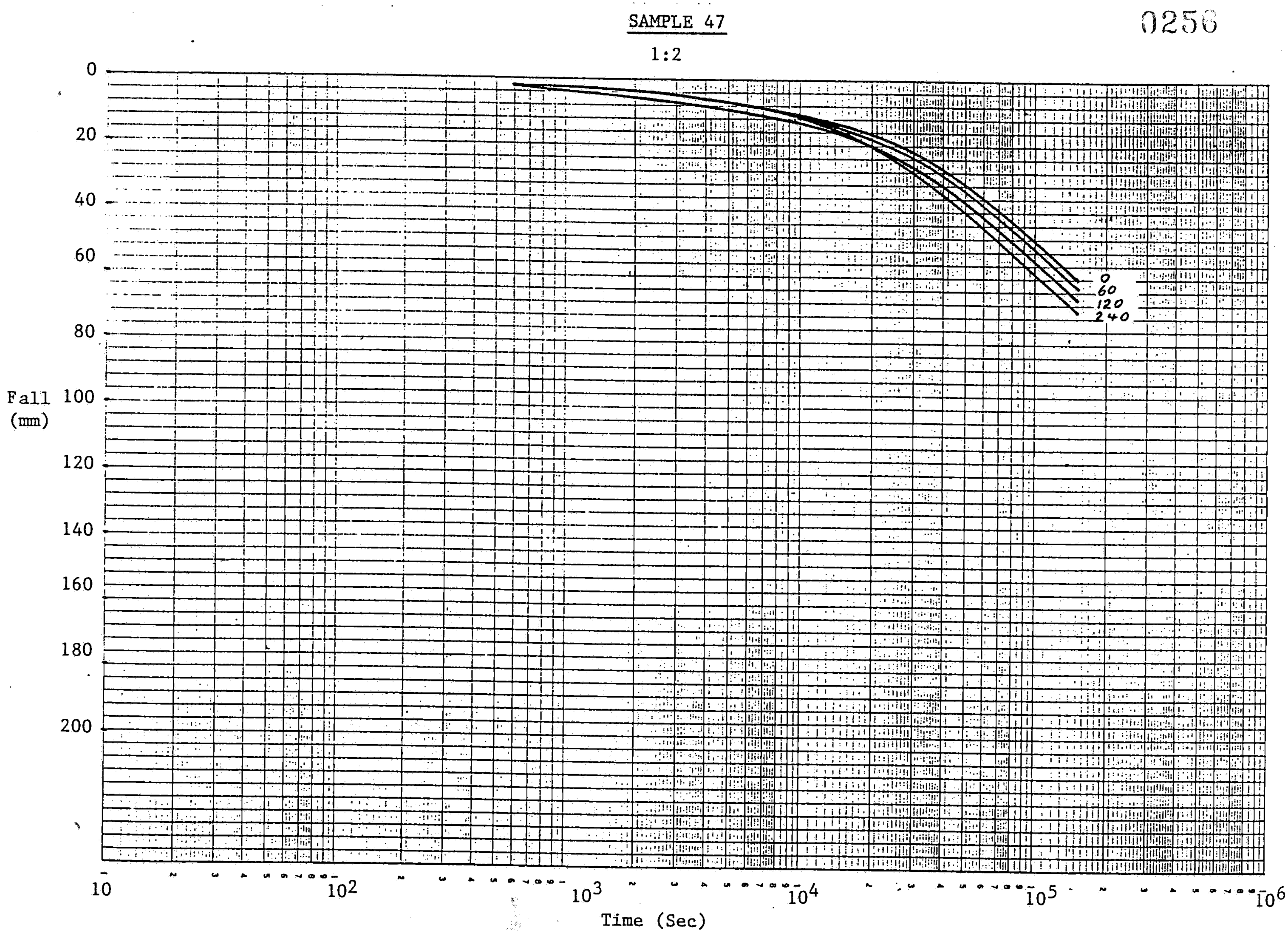
0
20
40
60
80
100
120
140
160
180
200
Fall (mm)
0.0
240
480
120
240
10
10^2
10^3
10^4
Time (sec)

SAMPLE 2

1:10


0
20
40
60
80
100
120
140
160
180
200
Fall (mm)
0.0
4.4
8.8
26.4
44.0
10
10^2
10^3
10^4
Time Sec

0256

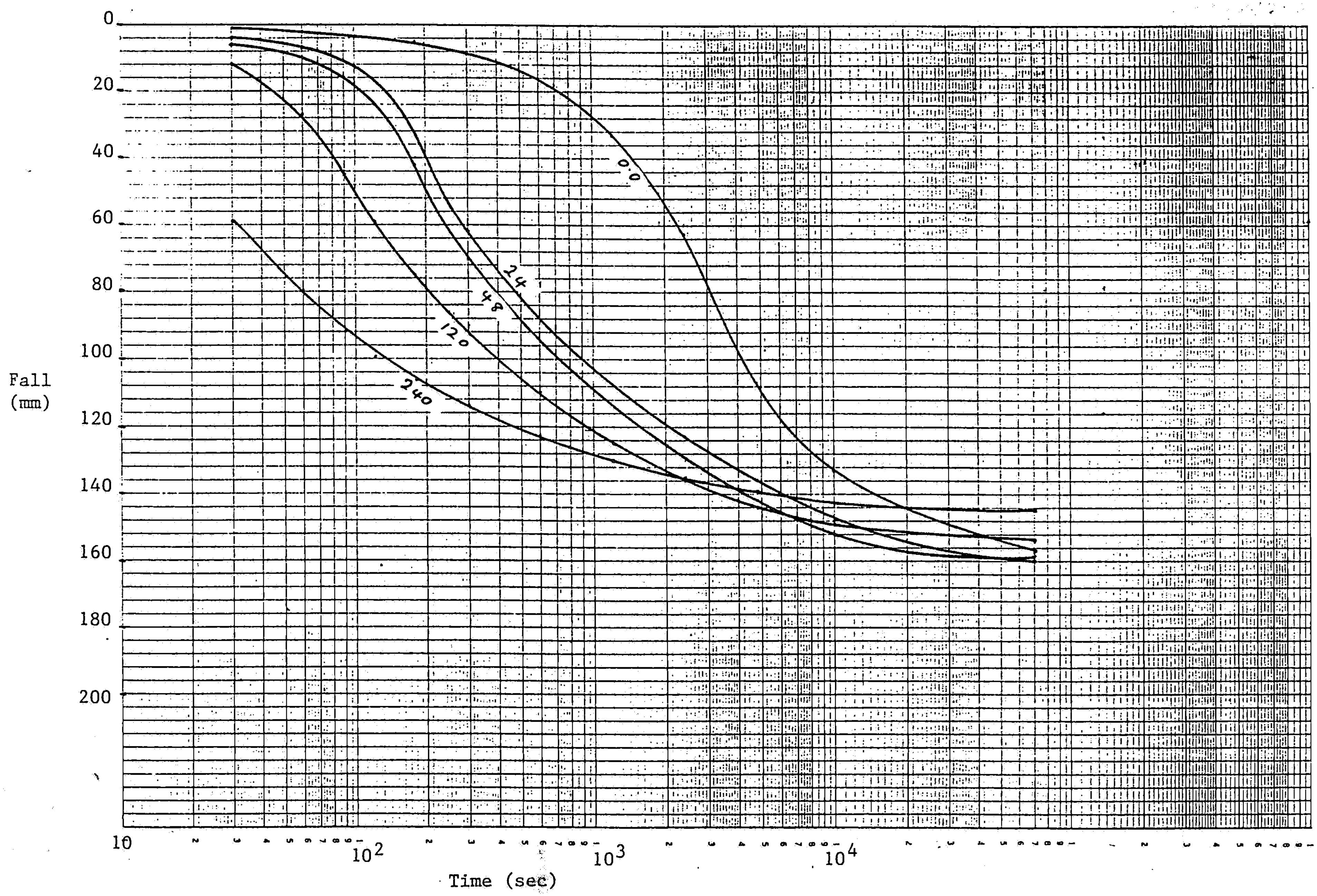


SAMPLE 47
1:2
Fall (mm)
0
20
40
60
80
100
120
140
160
180
200
0
60
120
240
10
10^2
10^3
10^4
10^5
10^6
Time (Sec)

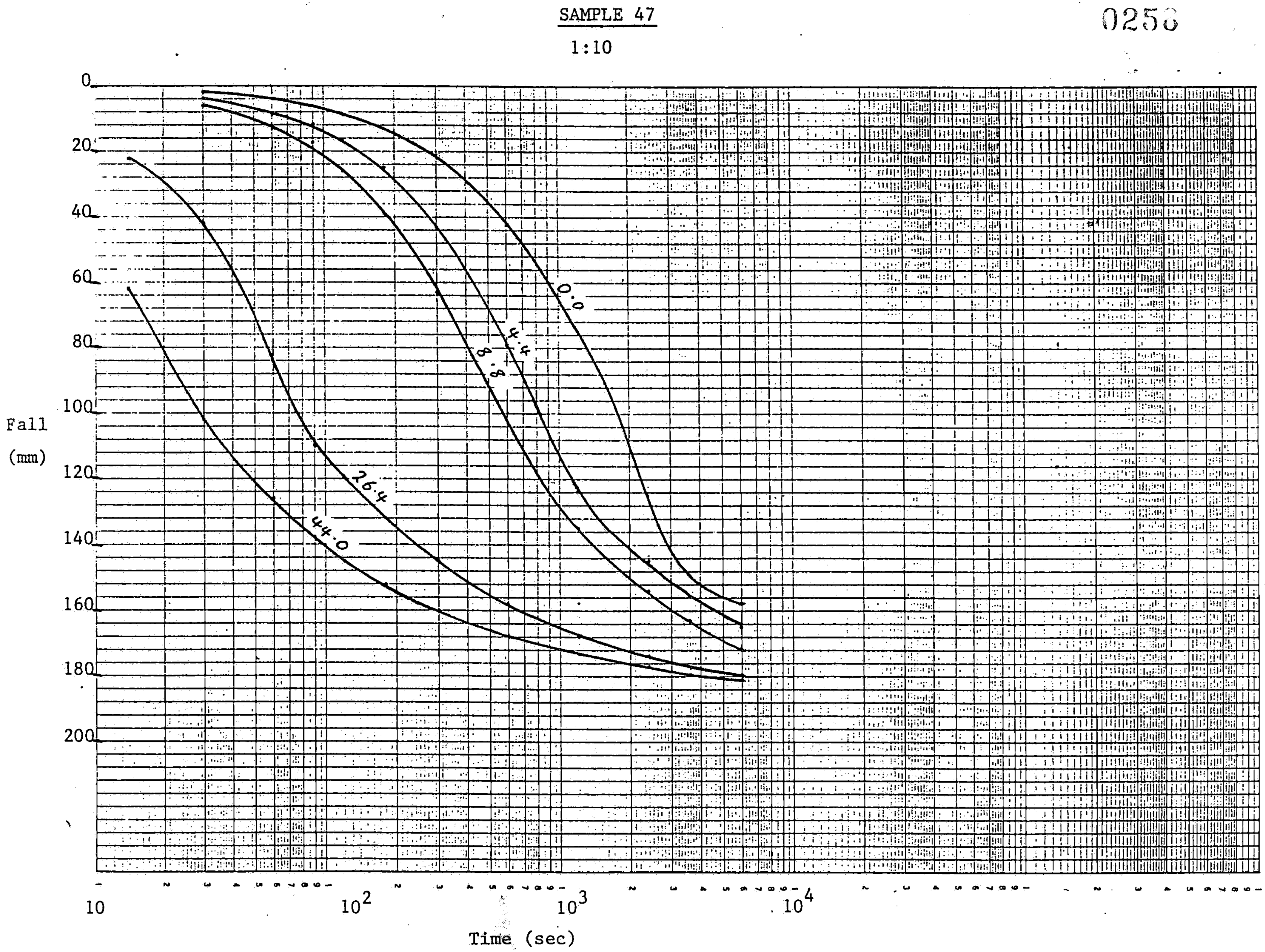
0257

SAMPLE 47

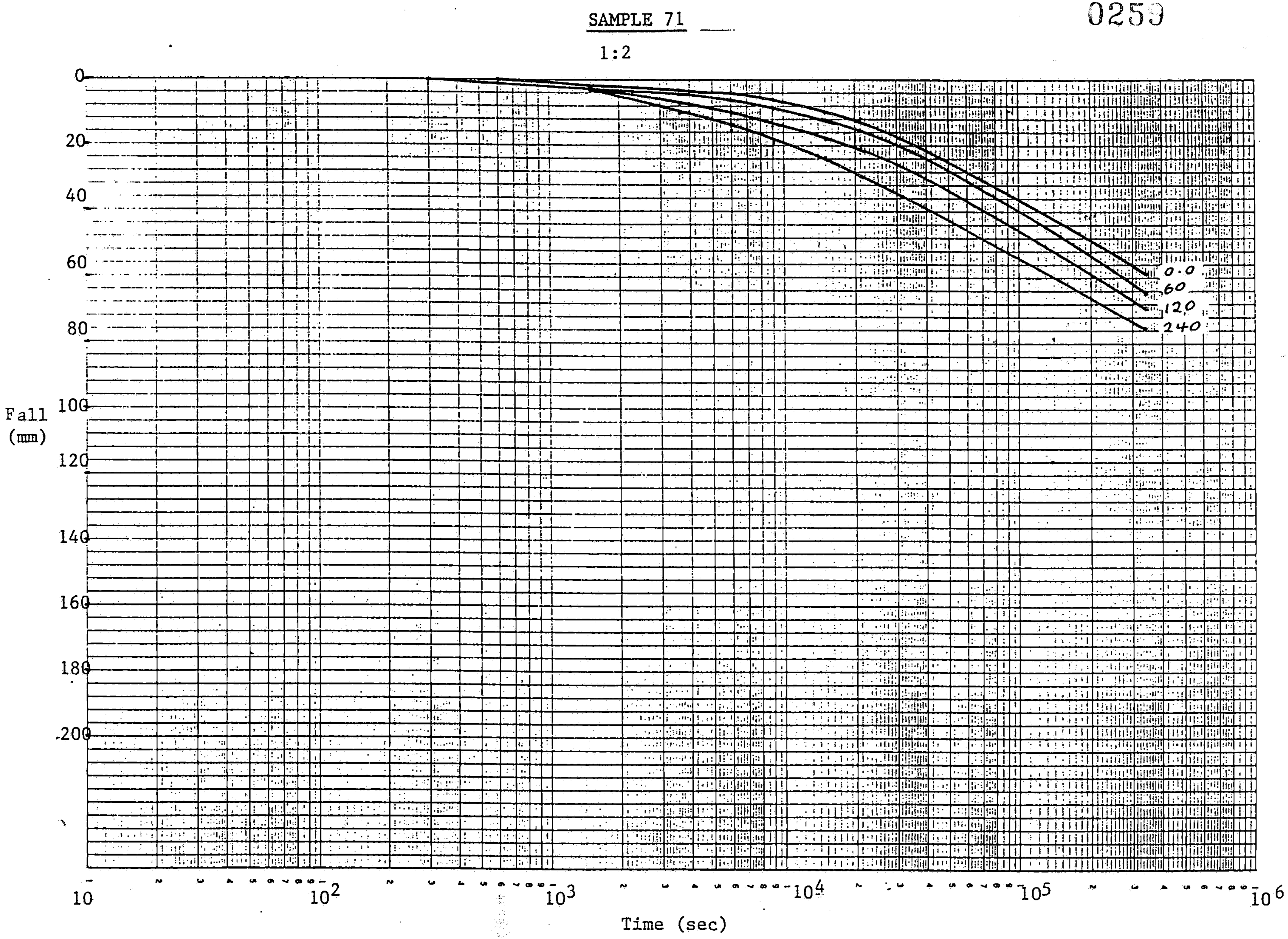
-1:5



0258


SAMPLE 47
1:10
Fall (mm)
0
20
40
60
80
100
120
140
160
180
200
0.0
4.4
8.8
26.4
44.0
10
10^2
10^3
10^4
Time (sec)

0259

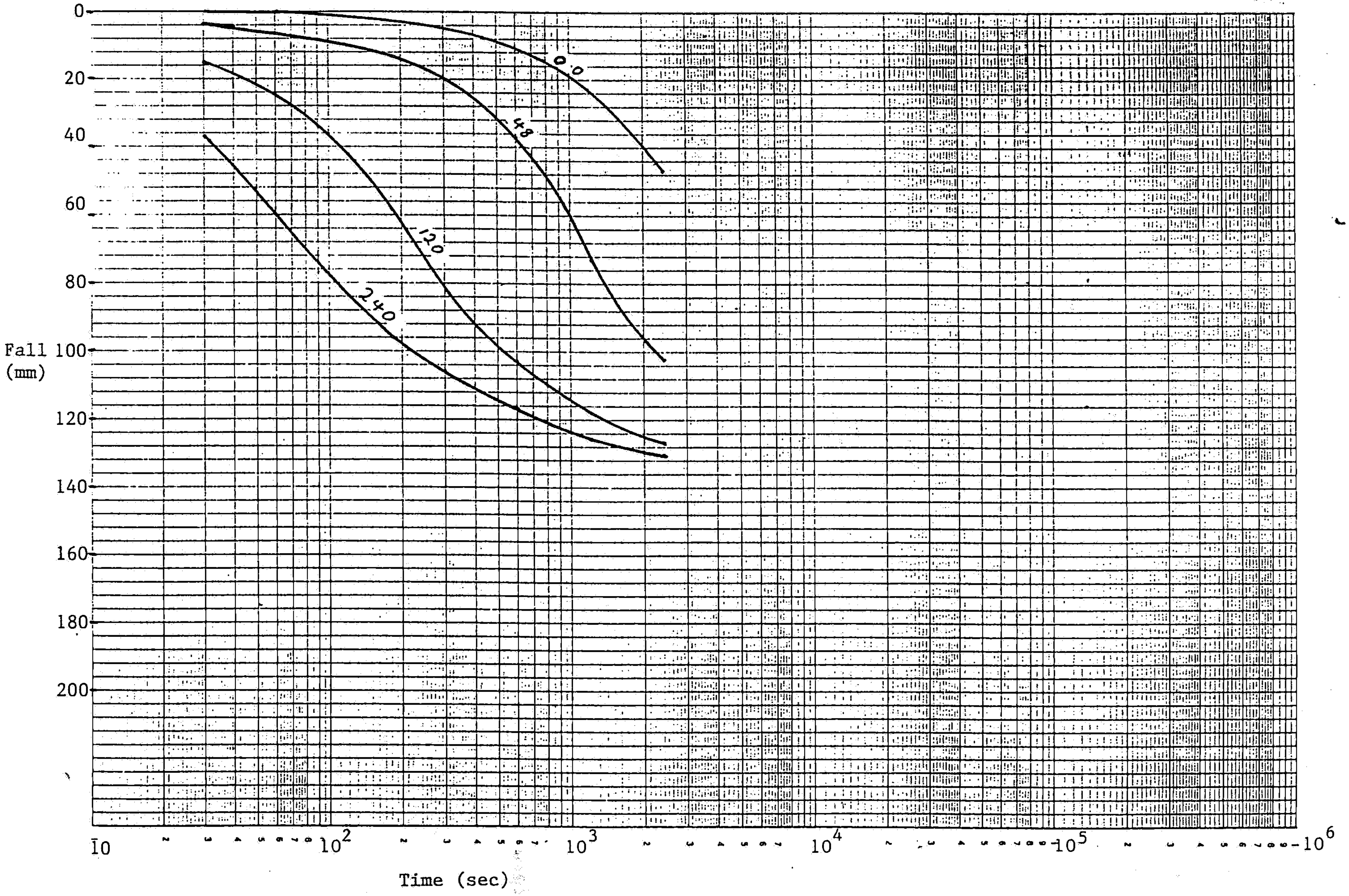


SAMPLE 71
1:2
Fall (mm)
0
20
40
60
80
100
120
140
160
180
200
10
10^2
10^3
10^4
10^5
10^6
Time (sec)
0.0
60
120
240

0260

SAMPLE 71

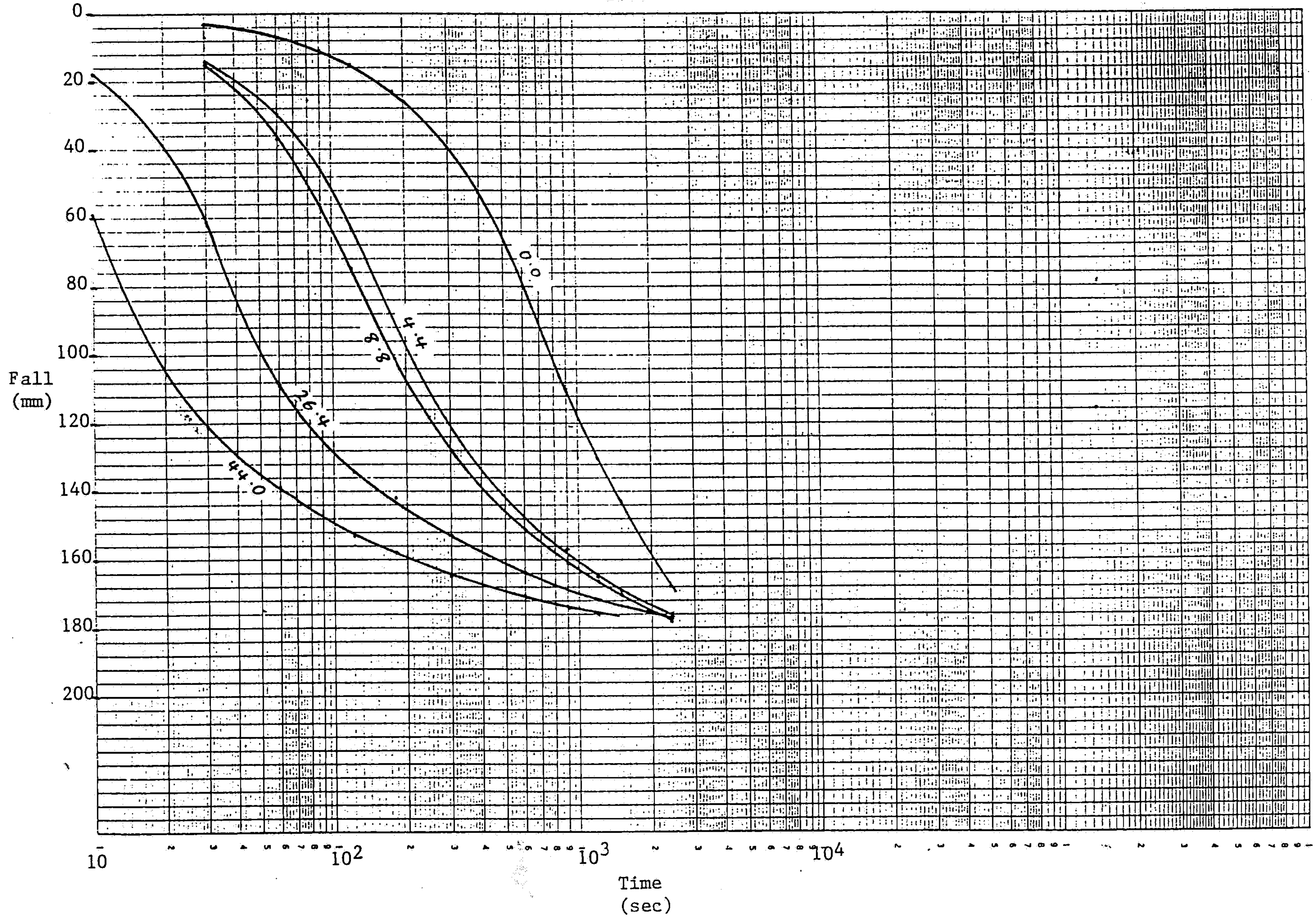
1:5



0261

SAMPLE 71

1:10



APPENDIX 10

Crystallisation Test Results

Sample 2

Brines

Harvest No.	Brine Wt. (g)	Concentration % Na	K	Mg	Ca	Cl	SO_4	H_2O
Start	2000.4	0.53	0.01	0.54	0.05	0.65	2.26	95.97
1	841.5	0.91	0.01	0.71	0.05	1.09	3.48	93.75
2	111.7	6.09	0.09	3.72	0.01	7.43	17.93	64.73
3	58.68	5.51	0.11	3.45	0.01	8.86	13.09	69.04

Salts

Harvest No.	Salt Wt. (g)	Concentration % Na	K	Mg	Ca	Cl	SO_4	H_2O (cryst.)	H_2O (free)
1	2.7	0.25	0.00	0.19	22.43	0.03	57.78	19.31	3.23
2	22.0	0.63	0.01	9.83	1.88	0.63	43.71	43.32	9.95
3	11.8	13.38	0.02	7.62	0.03	1.43	55.52	22.00	7.43

Crystallisation Test Results

Sample 47

Brines

Harvest No.	Brine Wt.(g)	Na	K	Mg	Ca	Cl	SO_4	H_2O
		Concentration %						
Start	2633.9	1.28	0.02	1.30	0.05	1.00	6.39	89.97
1	900.84	3.07	0.03	3.02	0.03	2.37	15.11	76.37
2	561.89	4.77	0.06	4.04	0.01	3.67	21.39	66.06
3	379.78	4.05	0.06	4.12	0.01	4.77	18.31	68.66
4	225.7	4.19	0.10	4.19	0.01	6.43	16.23	68.84
5	135.3	4.03	0.13	4.20	0.01	9.34	12.03	70.27
6	76.3	3.61	0.20	4.81	0.01	12.82	8.90	69.66

Salts

Harvest No.	Salt Wt.(g)	Na	K	Mg	Ca	Cl	SO_4	H_2O (Cryst.)	H_2O Free
		Concentration %							
1	3.86	0.98	0.01	0.92	22.65	0.04	56.51	18.88	15.13
2	17.67	0.39	0.00	9.88	0.65	0.21	40.59	48.38	3.06
3	77.39	12.92	0.03	7.75	0.01	1.51	54.53	23.24	12.37
4	50.16	8.23	0.02	8.84	0.04	1.55	49.54	31.78	10.72
5	36.94	8.47	0.02	8.89	0.04	1.48	49.99	31.11	8.34
6	11.03	12.63	0.02	7.89	0.03	0.30	57.92	21.22	0.81

Crystallisation Test Results

Sample 71

Brines

Harvest No.	Brine Wt.(g)	Concentration % Na	K	Mg	Ca	Cl	SO_4	H_2O
Start	2234.8	0.99	0.02	1.35	0.05	0.49	6.70	90.41
1	1230.87	1.77	0.02	2.54	0.05	0.87	12.89	81.87
2	710.33	2.98	0.05	4.06	0.02	1.47	20.65	70.78
3	353.20	5.32	0.10	3.79	0.01	2.87	22.85	65.06
4	101.18	3.75	0.24	4.57	0.01	6.68	15.41	69.33
5	11.59	2.19	0.91	5.72	0.01	14.53	5.24	71.39

Salts

Harvest No.	Salt Wt.(g)	Concentration % Na	K	Mg	Ca	Cl	SO_4	H_2O (Cryst.)	H_2O Free
1	2.1	0.13	0.01	0.16	22.89	0.00	58.65	18.16	0.14
2	1.9	0.59	0.05	0.78	3.09	0.40	11.23	83.86	8.75
3	150.0	1.11	0.01	9.95	0.05	0.70	40.78	47.41	1.99
4	93.3	13.31	0.04	7.89	0.04	1.21	55.44	22.08	8.06
5	33.8	8.61	0.22	8.97	0.03	11.09	36.42	34.67	11.14

APPENDIX 11

Electrostatic Separation Results

Run 1 - Sample 2 <1 mm

Fraction	Sample Wt.(g)	Leach Ratio Ore:water	Na	K	Mg	Ca	Cl	SO_4	H_2O
Non-conductors	12.6	1:2	0.24	0.01	0.22	0.06	0.28	0.89	98.31
Middlings	99.0	1:2	0.26	0.01	0.23	0.04	0.31	1.10	98.05
Conductors	931.4	1:2	0.27	0.01	0.23	0.04	0.31	1.13	98.01

Run 2 - Sample 2 <1 mm

Fraction	Sample Wt.(g)	Leach Ratio Ore:water	Na	K	Mg	Ca	Cl	SO_4	H_2O
Non-conductors	4.4	1:5	0.10	0.00	0.09	0.04	0.12	0.43	99.21
Middlings	9.8	1:5	0.11	0.00	0.10	0.05	0.12	0.56	99.06
Conductors	93.1	1:2	0.25	0.01	0.23	0.05	0.30	1.12	98.05

Run 3 - Sample 2 <1 mm

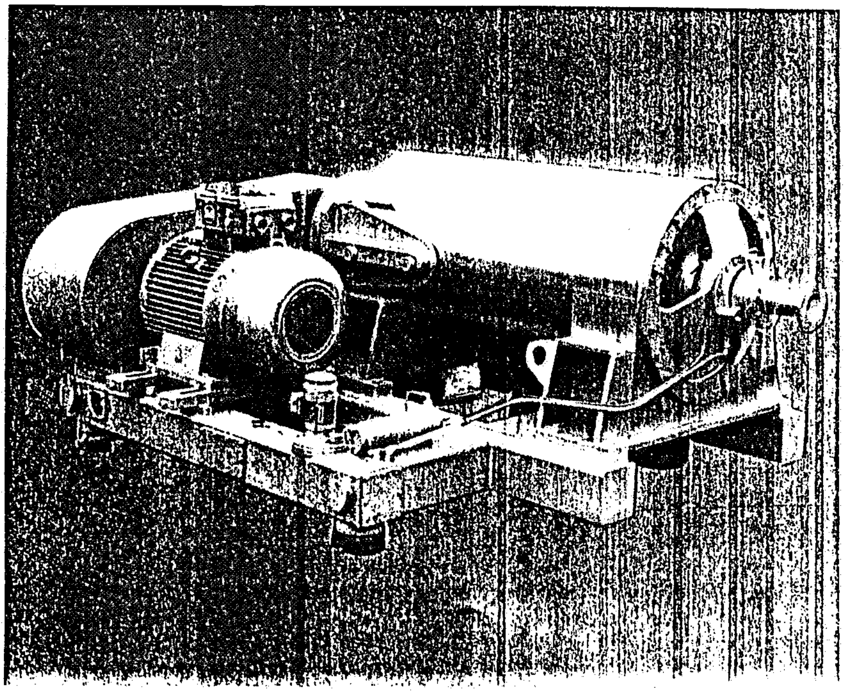
Fraction	Sample Wt.(g)	Leach Ratio Ore:water	Na	K	Mg	Ca	Cl	SO_4	H_2O
Non-conductors	7.8	1:5	0.11	0.00	0.09	0.04	0.12	0.32	99.48
Middlings	28.4	1:2	0.23	0.01	0.22	0.05	0.29	1.11	98.08
Conductors	174.7	1:2	0.25	0.01	0.23	0.05	0.30	1.16	98.01

Run 4 - Sample 71 <1 mm

Fraction	Sample Wt.(g)	Leach Ratio Ore:water	Na	K	Mg	Ca	Cl	SO_4	H_2O
Non-conductors	12.5	1:2	0.64	0.01	1.11	0.05	0.24	5.65	92.30
Middlings	15.3	1:2	0.53	0.01	0.86	0.05	0.26	4.30	94.00
Conductors	138.5	1:2	0.48	0.01	0.65	0.05	0.18	3.50	95.13

Decanter Centrifuges

● TS
● TSE
● TSS



Decanter Centrifuges TS 710

Description

Often the solids are too fine to be dewatered satisfactorily in the filtering screen/worm centrifuge. They can then be separated in solid bowl centrifuges provided their sedimentation speed in the mother liquid is sufficient, in other words when the settling time in the retort is less than 20 minutes under the influence of the force of gravity. The sinking speed which is determined by particle size, particle shape, difference in density between solids and liquids as well as their viscocity, can be decidedly improved by conditioning e. g. by heating or adding flocculation agents.

In decanter centrifuges the clearing of the liquid takes place in the cylindrical part whereas the dewatering of the solids by filtration or compression of the filter cake takes place in the conical part of the bowl. The geometry of the bowl, especially the relation between length and diameter, must be adapted to each different application. In most cases good results are obtained at a length relation of 2:1, as per our type TS. For difficult problems e. g. the clearing of waste water and dewatering very fine slurry a length relation of about 1:2.8 as per our type TSE, is required.

Apart from clearing liquids and dewatering solids, decanters can also be used for wet classification of small particles in the range of 1 – 10 microns. By controlling the flow speed of the liquids between the worm flights and the centrifugal force, the particle split is variable in a wide range.

When very low final moistures are required our Decanter Centrifuges can, in certain cases, be fitted with a screening area, as per our Type TSS. This execution is generally known as a Screen/Bowl Centrifuge. The screen portion can be fitted with segments that are interchangeable without dismantling the centrifuge.

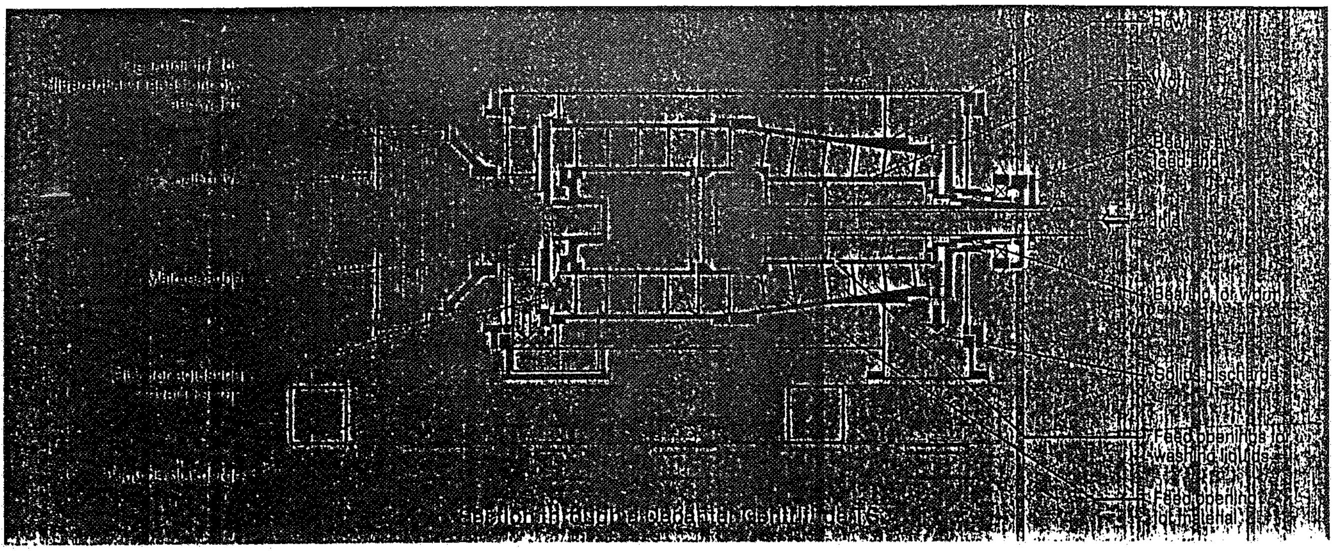
Special executions:

- Gastight
- Vapour tight
- Pressure tight
- Filtrate scoop discharge
- Filtrate cyclone
- Drive motor above centrifuge
- Solids mixer
- Flocculent facility

From a bowl diameter of 360 mm upwards Sk decanters are also available in TSS execution (as bowl/screen centrifuge). Special requirements can be included to suit individual applications.

Type Table

Typ TS	140 F	210 F	300 (300 E)	360 (360 E)	420 (420 E)	600 (600 E)	710 (710 E)	850 (850 E)	1000 (1000 E)
Feed capacity about t/h	1	2	10	20	25	45	65	95	140
Motor rating about kW	2.2	5.5	10 – 15	18.5 – 22	18.5 - 30	30 - 90	45 - 110	55 - 160	120 - 200
Length typ TS about mm	800	1000	1450	2000	1850	2800	3000	3500	4570
Length typ TSE, TSS about mm			1700	2350	2200	3300	3500	4000	5370
Width typ TS, TSE, TSS about mm	800	1000	1150	1500	1450	1800	2500	2700	3160
Height typ TS, TSE, TSS about mm	520	700	750	980	950	1150	1250	1600	1660
Weight typ TS about kg	200	500	1000	1500	1600	3000	5000	7500	10000
Weight typ TSE, TSS about kg			1200	2000	1900	3500	6000	9000	12000



Construction

Our decanters work according to the so-called counter-current principle. The suspension is fed in about the middle of the bowl where the separated solids are conveyed into the direction of the small diameter through the worm, which runs at a speed different from that of the bowl, whereas the cleared liquids flow over the opposite end. The level of the liquid in the bowl and thus the relation between wet and dry part is adjustable within wide limits. This enables an optimum adaption of the machine to the separation problem.

The speed differential between bowl and worm is produced via Cyclon-gears which have been designed for many years of trouble-free continuous operation. By selecting the right gear ratio and, where necessary, by changing the speed of the eccenter shaft which is driven by a separate vee-belt, the speed differential is adapted as required. The centrifuge is driven by a standard 3-phase squirrel-cage motor via vee-belts so that the speed of the basket can also be adapted easily to the conditions.

In order to restrict operational costs and wear, the speed of the bowl should be as low as possible i.e. must be only as high as absolutely necessary for the separation. In many cases e.g. when using flocculation agents, lower speeds also give better process-technical results.

Material of Construction

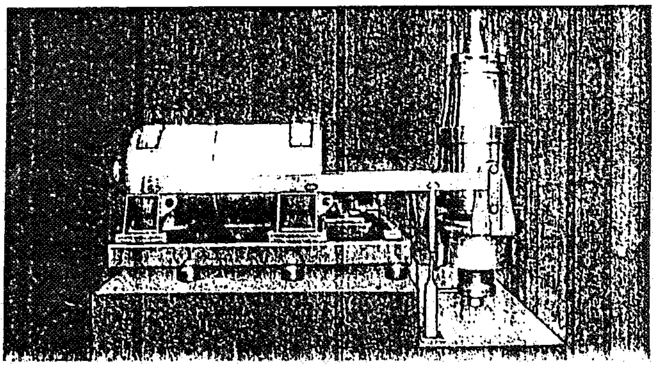
Depending on the conditions the contact parts are made of normal steel, chrome steel, chrome-nickel steel or special alloys e.g. Hastelloy. If necessary, the worm flights can be armoured or wholly made of wear-proof materials.

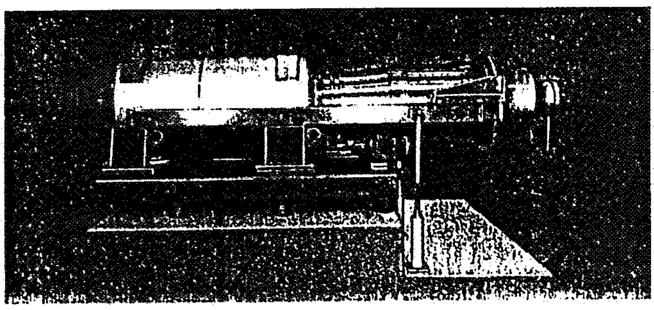
Used successfully for:

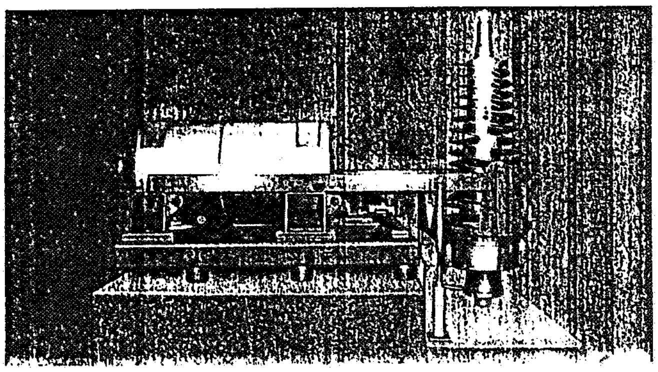
Aluminium-alkali
Barium carbonate
Bicarbonate
Biphenol
Calcium Carbonate (Powdered marble)
C.M.C.
Flotation concentrates
Flotation rocks
Graphite
Iron Hydroxide
Lead sulphate
Methylcellulose
Mica
Milk sugar
Nickel Formiate
Pearlpolymerisate
Polyethylene
Polyvinyacetyl
Polyvinylalcohol
P.V.C.
Silver nitrate
Sodium carbonate
Sodium Pyrosulphite
Vitriol of Copper
Waste water
Zinc chromate and many more

Accessibility of rotating assembly

The bowl in our decanters types TS and TSE rests via roller bearings in bearing shields which are attached to non-twisting product housings. After loosening some bolts the rotating parts can be slid horizontally out of the housing with the help of the supplied rails, and swivelled into a vertical position. Often the bowl remains in the housing and only the worm is taken out, as described above, for cleaning and/or inspection. Product housing, oil container for the lubrication of bearings and gear unit as well as the main motor are fixed to a common base-frame.







0268

AUSTRALIAN SOCIETY OF ACCOUNTANTS

C.T. LAMPARD & ASSOCIATES PTY.

CERTIFIED PRACTISING ACCOUNTANTS
REGISTERED TAXATION AGENTS

TELEPHONE: 2725600 2725167

"ANNESLEY"
67 KING WILLIAM ROAD
HYDE PARK 5061

Postal Address:
BOX 119, P.O.
UNLEY 5061

DIRECTORS
C.T. LAMPARD, FASA CPA
A.M. GIBBS, AASA CPA B.Ec

13th January 1987

The Director-General,
Department of Mines & Energy, South Australia,
P.O. Box 151,
EASTWOOD, S.A. 5063

Dear Sir,

RE: NINTH QUARTERLY REPORT ON GIDDI GIDDINNA CREEK E.L. 1254, SOUTH AUSTRALIA, FOR THE PERIOD ENDING 23RD DECEMBER 1986

We advise that no further test work was carried out during the quarter ending the period as above.

CRA Exploration Pty. Ltd. terminated their interest in the E.L. 1254 held by Evaporite Minerals (S.A.) Pty. Ltd. and themselves. The directors of Evaporite Minerals (S.A.) Pty. Ltd. have now instructed our office to advise you that they intend to continue test work under the terms of the E.L. 1254 and in that regard have further indicated that they are likely to expend an additional $40,000 over the next twelve (12) month period.

We would request that any further correspondence relating to E.L. 1254 is advised to our office which is the registered company office for Evaporite Minerals (S.A.) Pty. Ltd.

Yours faithfully,
C.T. LAMPARD & ASSOCIATES PTY.

C.T. LAMPARD

RECEIVED
16 JAN 1987
DEPT. OF MINES AND ENERGY SECURITY

File Env 5258

C.T. LAMPARD & ASSOCIATES PTY. LTD.
CERTIFIED PRACTISING ACCOUNTANTS
REGISTERED TAXATION AGENTS
TELEPHONE: 272 5600 272 5167

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67 KING WILLIAM ROAD
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Postal Address:
BOX 119, P.O.
UNLEY 5061

DIRECTORS
C.T. LAMPARD, FASA CPA
A.M. GIBBS, AASA CPA B.Ec

0269

18th June 1987

The Director General,
Department of Mines & Energy (South Australia),
P.O. Box 151,
EASTWOOD, S.A. 5063

Dear Sir,

RE: TENTH QUARTERLY REPORT ON GIDDI GIDDINNA CREEK E.L. 1254, SOUTH AUSTRALIA, FOR THE PERIOD ENDING 23RD MARCH 1987

The Directors of Evaporite Minerals (S.A.) Pty. Ltd. wish to advise that no further test work was effected during the quarter ending 23rd March 1987.

Discussions have taken place with various parties relating to the mining of the lease and it was decided that further testing at this stage was not viable.

Yours faithfully,
C.T. LAMPARD & ASSOCIATES PTY. LTD.

C.T. LAMPARD - Company Secretary
for Evaporite Minerals (S.A.) Pty. Ltd.

RECEIVED 22 JUN 1987 DEPT. OF MINES & ENERGY DIRECTOR GENERALS OFFICE

RECEIVED 29 JUN 1987 DEPT. OF MINES AND ENERGY SECURITY

File Env 5256

C.T. LAMPARD & ASSOCIATES PTY. LTD.
CERTIFIED PRACTISING ACCOUNTANTS
REGISTERED TAXATION AGENTS
TELEPHONE: 272 5600 272 5167

AUSTRALIAN SOCIETY OF ACCOUNTANTS

"ANNESLEY"
67 KING WILLIAM ROAD
HYDE PARK 5061
Postal Address:
BOX 119, P.O.
UNLEY 5061

DIRECTORS
C.T. LAMPARD, FASA CPA
A.M. GIBBS, AASA CPA B.Ec

0270

23rd June 1987

The Director General,
Department of Mines & Energy (South Australia),
P.O. Box 151,
EASTWOOD, S.A. 5063

Dear Sir,

RE: ELEVENTH QUARTERLY REPORT ON GIDDI GIDDINNA CREEK E.L. 1254, SOUTH AUSTRALIA, FOR THE PERIOD ENDING 23RD JUNE 1987

The Directors of Evaporite Minerals (S.A.) Pty. Ltd again advise that no further test work was effected during the quarter ending 23rd June 1987.

Discussions have continued as to the viability of extracting ore from the reserves and it is anticipated that further testing will be effected in the near future.

Yours faithfully,
C.T. LAMPARD & ASSOCIATES PTY. LTD.

C.T. Lampard

C.T. LAMPARD - Company Secretary
for Evaporite Minerals (S.A.) Pty. Ltd.

RECEIVED 22 JUN 1987 DEPT. OF MINES & ENERGY DIRECTOR GENERALS OFFICE

Env. 5258.

A STUDY OF POSSIBLE MARKETS FOR THE SODIUM AND MAGNESIUM SULPHATE DEPOSIT LOCATED 15 KMS NE OF COOBER PEDY, SOUTH AUSTRALIA.

BY: PETER TAYLER

000271

Based on a recently conducted literature survey at the libraries of (a) Flinders University, (b) Australian Mineral Foundation and (c) The South Australian Institute of Technology, the writer will attempt to rationalise possible and actual markets for sodium and magnesium sulphates.

Scientific comments were contributed by members of the faculties of Flinders and SAIT namely Prof. Chris Von der Borch and Prof. Ian Ketteridge. Their most welcome interest is supported by the intention of both institutions to use this new Australian discovery for education and subject matter for honours students.

Additional commercial information was gained by liaison with the staffs of the following;

I.C.I. Australia Ltd.
A.C.I. Australia
Adelaide and Wallaroo Fertilizers
A.C.S. Laboratories
Tennant Trading Aust. Ltd.
Comalco Australia
Aminco and Associates
Renison Gold Fields Ltd.
AMDEL
S.A. Department of Mines and Energy-Division of Economic Geology

Property Title

EVAPORITE MINERALS S.A. PTY. LTD. has applied for an Exploration Licence of some 610 square kilometers, (E.L. Application No. 452/82) which includes a small portion of the designated Coober Pedy Precious Stones Field. I have been informed by L. Oliver of the S.A. Department of Mineral and Energy that there would be no objection to the granting of leases in this area because it lies stratigraphically below and well to the northeast of the opal levels.

Location and Access

The discovery was made by the writer on the southeast bank of Giddi Giddina Creek, 17 kms N.E. of Coober Pedy Township. The area is easily accessible via the Coober Pedy-Oodnadatta Road which transects the EL in a northeasterly direction.

COOBER PEDY is a well established township of some 3,500 residents whose main occupation is the mining of opal. The township has all of the normal services including power, water, telephone, hospital, hotel-motels, etc. There is a daily scheduled airline (Opal Air) and Stateliner bus services to and from Adelaide. Sealing of the Stuart Highway to Adelaide will be completed in 1983. The newly completed standard guage railway from Tarcoola to Alice Springs lies 45 kms west of the 'discovery' area.

** Mr. Tayler is a Prospector and solely responsible for the discovery of this new deposit.

Estimated Reserves

Work on the property to date has indicated the existence of extremely large reserves of high grade, water soluble sodium and magnesium sulphates; some 30 centimeters to 2 meters from the surface, and over many square kilometers. The material has been confirmed by onsite examinations by D. Seymour, Consulting Geologist, Aminco and Associates; and by geologists and chemical engineers from two Australian mining companies who visited the site with the writer, and by laboratory determinations.

There are indications of the presence of potassium and sodium nitrate and a bentovitic material has been observed but not yet confirmed. Estimates of tonnages of product material by visiting professionals have ranged from 100 million tonnes to 400 million tonnes.

At this stage mining of the material appears to be quite straightforward and there appears to be abundant supplies of subsurface water in the area.

Markets - Australia

At the present time 100 percent of sodium and magnesium sulphates are imported. No tariffs apply because no deposits were known in Australia until the discovery of this deposit. The Commonwealth Department of Statistics supplied the following information:

Imported Material	Tonnes	Value
Sodium Sulphate	57000	A 14,000,000
Magnesium Sulphate	4700	A 3,500,000

In discussions with David Cameron, Sales Manager, Chemicals, ICI Australia Ltd., I was advised that ICI were the importers and that ICI would be only too happy to purchase their supplies from an Australian source subject to satisfactory grades, specifications, and prices.

NOTE: There are several small importers in Sydney and Melbourne.

New Zealand

I am informed that the New Zealand market is greater than ours because of the larger production of paper. About 60% of all sodium sulphate is used in the 'Kraft' process. Information on prices and grades are not available at the present time.

.../3

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000274

Markets - Overseas

As Canada, U.S.A., Mexico, U.S.S.R., Spain and Germany are net exporters of sodium sulphate it is unlikely that sales could be made to these countries. However it must be noted that their supplies are mostly produced by high energy consuming processes. Japan is a net exporter but is gradually cutting back domestic production in favour of imports.

Talks with Bill Murphy of Tennant Trading have revealed the following:

Magnesium sulphate is used at a rate of 100,000 tonnes per year in the palm oil industry as fertiliser. Most of this is supplied from Germany in the form of Kieserite Mg SO4Oh2, or 'Salt Cake' to Southeast Asia countries and the Philippines. Prices and composition of the salt cake have been requested from our contacts in that area.

Japanese production of magnesium metal is being cut back and imports are increasing proportionately.

Attached are data from a comprehensive market search carried out in 1981.

Discussion

The discovery of very large tonnages of sodium and magnesium sulphates by the writer has excited the interest of academics and industrialists alike. It is unique in its occurence, a first in Australian mining history and could herald the establishment of a new and viable industry in South Australia.

The techniques and chemistry required to make the minerals marketable are well known. They include mechanical beneficiation, leaching with water, and solar panning. Details of these procedures are better left to the engineers and chemists who will be responsible for their implementation and the notation of their existence is sufficient for this report.

Chemical analysis of material recovered from a number of back-hoe holes in the discovery area has shown that for every 100 tonnes of material mined, 25 tonnes of product material is recoverable with a ratio of 4 (magnesium sulphate) to 1 (sodium sulphate).

Assuming a sale of 60,000 tonnes of sodium sulphate to Australian markets; a market for 240,000 tonnes of magnesium sulphate would have to be found. As the SE Asia market for this product is 100,000 tonnes per year our initial market push should be limited to the following:

Mag. sulphate - SE Asia	100,000 tpy
Sod. sulphate - Australia	25,000 tpy

With obvious increases as more magesium sulphate sales are secured, I estimate the market value of these products to be:

Mag. sulphate - 100,000 @ 350 FOB Pt. Pirie	35,000,000
Sod. sulphate - 25,000 @ 200 FOB Pt. Pirie	5,000,000
	40,000,000

Prices are subject to confirmation and although these targets 000275 may take time, they are real and attainable.

Further Downstream

Professor Kitteridge of SAIT feels that a large tonnage of $MgSO_4$ could lead to the production of magnesium metal in South Australia. I have been quoted a current ingot price of 9000 dollars/ton versus a price of 1.34/lb in June '81. The establishment of a new Australian magnesium alloy industry using Australia produced magnesium metal would be a really significant achievement, closely linked with the aluminium industry.

Among the growth areas are iron desulphurisation where magnesium is rapidly taking over from calcium carbide and die casting and where the role of aluminium and magnesium is being reversed with magnesium castings having stiffness and resilience characteristics closer to those of steel. There is a continuing increase in the use of magnesium castings in the automotive industry.

Conclusions

A number of conclusions have been reached as a result of this study:

1. Large tonnages of magnesium and sodium sulphates have been discovered in the Coober Pedy area, South Australia.

2. Professional confirmation of the grades and probable size of the deposit has been obtained.

3. Favourable markets in Australia, New Zealand, SE Asia, and Asia exist.

4. The deposit is effectively protected by Exploration Licence 452/82.

5. The machinery to obtain production leases can be put into motion at short notice.

6. The project should attract financial support from the following government agencies.

   (a) The Industries Assistance Board
   (b) The Commonwealth Development Bank
   (c) The Australian Industrial Research and Development Incentive Board
   (d) The Productivity Promotion Council of Australia
   (e) The CSIRO ore dressing section

.../5

Recommendations

1. The company initiate contacts with acknowledged experts in the evaporites field.

2. Further exploration and/or development should be sustained until markets have been established.

3. A 'dry air float' beneficiation study be undertaken by CSIRO or AMDEL ore dressing section.

4. A wet- fractional crystallisation study be undertaken by Dr. Roy Beevers of ACS Laboratories of Marleston, S.A. Dr. Beevers has conducted similar studies for Dow Chemical Corp. in conjunction with the proposed Redcliff project.

Peter Tayler
Director
Evaporite Minerals S.A. P/L