Open File Envelope No. 1820

SML 633

MOUNT STURT CLAY DEPOSIT

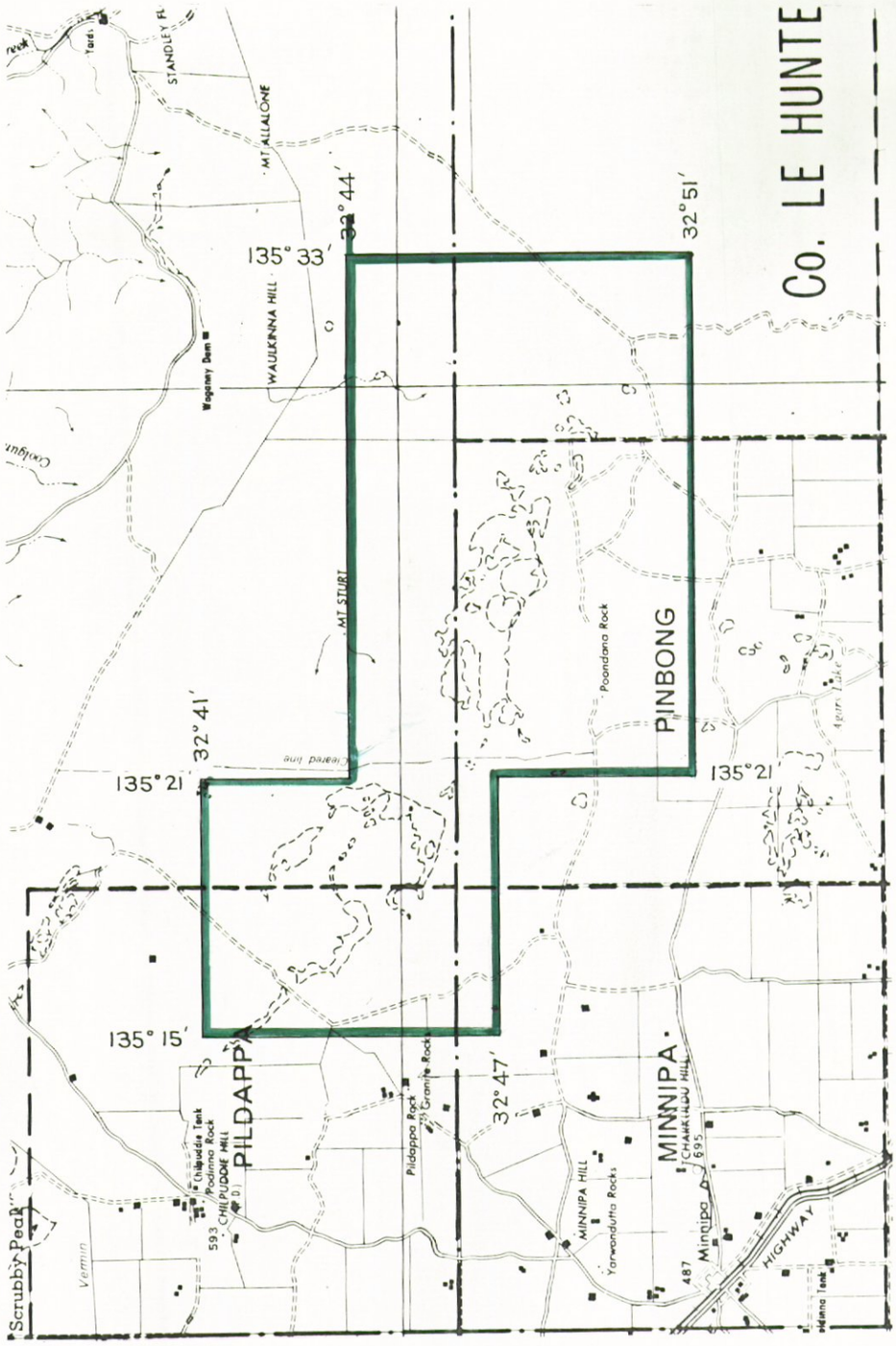
PROGRESS AND TECHNICAL REPORTS TO LICENCE EXPIRY / RENEWAL, FOR THE PERIOD 21/10/1971 TO 20/10/1972

Submitted by
Sadex Pty Ltd
1972

Enquiries: Customer Services Branch
Minerals and Energy Resources
7th Floor
101 Grenfell Street, Adelaide 5000

Telephone: (08) 8463 3000
Facsimile: (08) 8204 1880

Government of South Australia
Primary Industries and Resources SA



SCALE 1 : 250,000

721
F 23 EL APPLIED FOR
F 24

SADEX PTY. LTD.

DOCKET DM 995/71 AREA ~~94~~ 134 SQ MILES

1:250000 PLANS YARDEA

LOCALITY

S.M.L. No. 633 EXPIRY DATE 20.10.1972

1820

~~1802~~.

CONTENTS ENVELOPE [redacted] DM 995/71

TENEMENT: S.M.L. 633

TENEMENT HOLDER: SADEX PTY. LTD.

002

REPORTS:

BROWN, R.N. 1971

Clay and non- clay mineralogy (Scheme DG 1)
Recommendations on possible uses.
Dated 2nd July 1971 (pgs. 3-6)
(No Plans)

BROWN, R.N. 1971

Clay Mineralogy. (GD1) (pgs. 3-9)
Dated 4th August 1971
(No Plans)

ASHWORTH, D.R. and PLUCK, K.M. 1971

Preliminary assessment of clay for paper coating
and paper filler application. (pgs. 10-16)
REPORT MT 618/72

Dated 12th Ocotber 1971
(No Plans)

ASHWORTH, D.R. and PLUCK, K.M. 1971

Clay - Bulked samples A6, A7
and A8.
Further assessment of clay.
1. Brightness and mineralogy of minus 2 - micro fraction.
2. Current prices of refractory and paper clays. (pgs. 17-20)

Dated 5th November 1971

(No Plans)

BARNES, T.A. 1972

Mt. Sturt Clay Deposit.
Progress Report. Special Mineing Lease No. 633
(pgs. 21-22)

Plans: & Attached:

1/ Plan of S.M.L. 633 showing drill holes and geology.

1820-1)

CONTENTS ENVELOPE 1820 ~~1802~~

PLANS: ATTACHED:

2/ Logs of forty four bores. (pgs. 23-25)

REPORT:

SPENCER, W.G. 1978

REPORT MD 1326/79
Assessment of Data. Mt. Sturt Kaolin.

Dated 4th October 1978
(No Plans) (Pgs. 26-36)

004

amdel
The Australian Mineral Development Laboratories
Flemington Street, Frewville, South Australia 5063
Phone 79 1662, telex AA82520

Please address all correspondence to the Director
In reply quote: MP 5/0/0

2nd July, 1971.

Hines Metals Pty Ltd
GPO Box 1707N
ADELAIDE SA 5001

Attention: Mr. J. Hines

REPORT MP 5654/71

YOUR REFERENCE:	Order No. 2822, dated 24/6/71
MATERIAL:	Clay sample
IDENTIFICATION:	None given
DATE RECEIVED:	24/6/71
WORK REQUIRED:	Clay and non-clay mineralogy (Scheme GD1) Recommendations on possible uses

Investigation and Report by: R.N. Brown

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

K. J. Henley

for F.R. Hartley
Director

amw

EXAMINATION OF CLAY SAMPLE

1. SAMPLE

The sample consisted of soft creamy-white pieces of clay material with a noticeable sheen under the stereo microscope and a detectable grittiness between the fingers or teeth.

2. PROCEDURE

An X-ray powder diffraction photograph was taken of the bulk clay.

A weighed amount of the air-dry clay was dispersed in water, but since it flocculated it was washed by centrifuging and re-suspending. After sedimenting overnight a sample of the "clay" fraction (i.e. 0-2 microns settling diameter) was removed as a suspension. Measurements on this suspension, using a plummet balance, gave an estimate of the proportion of the bulk clay dispersing into the 0-2 micron fraction.

The suspension was used to prepare an oriented clay sample on a ceramic plate. This was saturated with magnesium ions, treated with glycerol, dried and examined on the X-ray diffractometer in a more sensitive check for clay minerals present in small quantities.

The quartz content of the bulk clay material was estimated by making quantitative diffraction measurements, using the X-ray diffractometer, on the quartz peaks from the sample and from a calibrated quartz standard.

3. RESULT

This is basically a kaolin-quartz clay, but it contains considerable quantities of sodium chloride (common salt) which is, of course, removable by washing. Also present are small amounts of mica and montmorillonite.

The proportion of the bulk clay dispersing into the 0-2 micron fraction is approximately 23%, and the ratio of mica to kaolin in this fraction is approximately 1:35. The montmorillonite content cannot readily be estimated, but it is present only in trace quantities, there being probably less montmorillonite than mica.

The quartz content of the bulk clay was estimated to be 10%.

4. REMARKS

Sodium chloride is deleterious in ceramic applications (acting as a flux) and would have to be removed by a washing process before these were considered. Apart from this consideration, this is a fairly promising clay, seen from the point of view of the mineralogy only.

Paper-coating applications require a kaolin with low montmorillonite (this mineral affects the viscosity of the coating slurry), low quartz and satisfactory whiteness. Fine screening and size separation is likely to remove most of the quartz. Whiteness should be checked, in the first instance on -300 mesh material, and later possibly on the finer fractions. The montmorillonite content may be low enough to be disregarded. A small proportion of mica, as found here, can probably also be disregarded.

Satisfactory ceramic applications might also be found for this clay, although naturally the higher-priced paper-coating and paper-filling used may tend to be considered first.

The suitability of clays for various applications can only be determined with certainty by practical testing programmes, and these are available at Åndel (Ceramic Section) if required.

amdel
The Australian Mineral Development Laboratories
Flemington Street, Frewville, South Australia 5063
Phone 79 1662, telex AA82520

007

Please address all correspondence to the Director
In reply quote MP 3/0/0

4 August 1971

Hines Metals Pty Ltd,
Box 1707N, GPO
ADELAIDE, SA 5001

Attention : Mr J. Hines

REPORT MP 305/72

YOUR REFERENCE:	Application dated 19/7/71. Order No. 2851.
MATERIAL:	Clay.
IDENTIFICATION:	B.
DATE RECEIVED:	19/7/71.
WORK REQUIRED:	Clay mineralogy (GD1).

Investigation and Report by : Dr R. N. Brown.

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

K. J. Henley
for F. R. Hartley
Director

MINERALOGY OF CLAY

1. SAMPLE

The sample was a composite one, being made up of clay from a large number of sampling paints. It consisted of damp off-white lumps of clay material.

2. PROCEDURE

The whole sample was dried, spread out on a sheet, crushed to break up the lumps, and reduced in size by a process of successive quarterings, followed by further crushing and riffling to give a small sample representative of the whole.

An X-ray powder diffraction photograph was taken of the bulk clay material.

Because the known high salt content prevented deflocculation and satisfaction dispersion of the sample in water, it was necessary to wash the salt from the clay. Two successive centrifugings in distilled water, followed by boiling and re-centrifuging, were necessary to deflocculate the clay, which was then dried. Ten grams of the salt-free clay were dispersed in water and allowed to sediment for separation of the -2 micron ("clay") fraction. The reminder of the procedure was identical with that given in the previous Report MP 5654/71.

3. RESULTS

The findings are very similar to those for the previous sample, reported under MP 5654/71. This is a kaolin-quartz clay, with quite large amounts of sodium chloride. Again, small amounts of mica and montmorillonite are present. The proportion of the dry (salt-free) sample dispersing into the -2 micron fraction is 20%, and the ratio of mica to kaolin in this fraction is about 1:50. The montmorillonite level is again low, and similar to that in the previous sample.

The quartz content of the bulk clay was estimated to be 12%. There was considerable difficulty in removing the sodium chloride from the clay in order to cause it to disperse in water (see "Procedure"). The reason for this is unknown.

4. REMARKS

This composite sample has been found to be very similar to the previous one, and the remarks given previously are equally applicable.

Further assessment of the economic possibilities of this deposit is unlikely to be forthcoming from studying the mineralogy alone, and practical testing is recommended, as discussed by telephone. A quantitative estimation of the salt content may also be of use.

dk:2.

amdel
The Australian Mineral Development Laboratories
Flemington Street, Frewville, South Australia 5063
Phone 79 1662, telex AA82520

010

Please address all correspondence to the Director
In reply quote: MT 3/0/0

12 October 1971

Mr J. Hines
Hines Metals Pty Ltd
Box 1707N GPO
ADELAIDE SA 5001

REPORT MT 618/72

YOUR REFERENCE:	Order No. 2867 dated 4/8/71
MATERIAL:	Two small samples of kaolin marked A6, A7, A8, A9
IDENTIFICATION:	CE 3967 - A6, A7, A8 CE 3968 - A9
WORK REQUIRED:	Preliminary assessment of clay for paper coating and paper filler application

Investigation and Report by: D.R. Ashworth and K.M. Pluck

Officer in Charge, Materials Technology Section: Dr G.L.F. Powell

for F.R. Hartley

scy

SUMMARY

A preliminary assessment of composite clay samples A6, A7, A8 and A9, shows that the minus 20-micron fraction has a reflectivity of 84-85% which improved to 86% after bleaching. This value is within specification for a paper filler (75-85%) or a paper coating (84-88%) clay.

Further investigations into its paper coating properties indicate that the viscosity of the clay slurry is less than that required by the specification (67% solids content at a viscosity of 500 cps). It is considered that the low value obtained (61% solids content) may be due to two factors:

a. traces of NaCl present in the original sample or
b. high mica content in the minus 20-micron fraction.

The valley abrasion test, carried out by the Institute of Paper Chemistry, Wisconsin, U.S.A., shows that the value of 54 mg obtained indicates that the clay (minus 20-micron fraction) is very abrasive. It had earlier been ascertained that the quartz content was very low (less than 0.1%), but the mica content was high at this stage of the investigation. It is considered that mica is the major cause of high abrasion.

It is recommended that methods of removing the mica should be investigated, principally by sedimentation or centrifugation, to obtain the minus 2-micron fraction and the viscosity and valley abrasion and reflectivity re-assessed. It should be noted that removal of the mica could also produce a clay with a higher reflectivity.

1. INTRODUCTION

Initially two clay samples (A8, A9) were submitted for evaluation. These were wet sieved, the amount of plus 300 mesh was determined and reflectivity measured on the minus 300-mesh material. As the two samples appeared identical, they were combined for further work. The minus 20-micron fraction was prepared by a sedimentation technique and this fraction was used to check reflectivity. Particle size distribution was measured and a mineralogical examination was carried out. Two further similar samples were supplied (A6, A7) and the minus 20-micron fraction obtained for valley abrasion and viscosity measurements.

2. EXPERIMENTAL PROCEDURE AND RESULTS

2.1 Preparation of Sample

Two samples were originally submitted for testing. These were crushed and then dispersed in water, forming a slurry. A small amount of deflocculent was added and the material was wet screened on 300 mesh BSS. The plus 300-mesh fraction was 38.3% for A8 and 39.1% for A9. Reflectivity was measured on the minus 300-mesh fractions using an EEL reflectometer which had been calibrated against a G.E. meter. A value of 84% on the G.E. scale was obtained for both samples. As the two samples submitted appeared identical, they were combined and the minus 300-mesh fraction was further processed. The fraction less than 20 micron, was then isolated by a sedimentation technique and the material filter washed to remove salt.

2.2 Properties of the Kaolin (Minus 20-Micron Fraction)

2.2.1 Brightness

A test sample of clay was prepared for reflectivity in accordance with TAPPI standard 646ts-54. The dry material was lightly pulverised, screened on 100 mesh and then compacted at 30 psi. Reflectivity was measured using a blue filter (457 nm). The value obtained, 84% on the G.E. scale, was only just below the brightness specified by the paper manufacturers for a paper coating clay (greater than 84-88%). In an attempt to upgrade the brightness, a bleaching technique was used in which HCl (5% by volume) was added to the slurry and gently heated just below boiling for three hours. After thorough washing and drying the reflectivity was re-checked and showed improvement (86% G.E. scale). This brings the brightness within specification for a paper coating clay and also would be suitable as a high grade filler clay (75%-85%).

The reflectivity of the minus 20-micron fraction as measured by the Institute of Paper Chemistry using the TAPPI recommended photometer, was determined as 84.8% and was in excellent agreement with Amdel's result.

2.2.2 Valley Abrasion

About 300 gms of the minus 20-micron portion was submitted to the Institute of Paper Chemistry, Wisconsin, U.S.A. and the valley abrasion value determined. An average of three measurements gave a value of 54 mg. This is an unexpectedly high value and would not be acceptable to the majority of paper coating users, a value of 20 mg or less being considered to be a low abrasive clay.

2.2.3 Viscosity

The sample was prepared for viscosity in accordance with TAPPI standard T648su-54. Viscosity was measured using a Brookfield viscometer (R.V.T.) fitted with a number 3 spindle. The specified requirements are that at a minimum solids content of 67%, the slip should have a viscosity of 500 cps. With the test sample at 67%, solids it was not possible to make a centrifugal slip. Only when the concentration was dropped to 53% solids, was viscous slip obtained and even at this low concentration the viscosity was extremely high (greater than 1500 cp).

As it was considered that any slight trace of salt remaining in the clay could contribute to the poor fluid properties of the clay, by acting as a flocculent, a sample was re-washed and the water decanted repeatedly. After drying, the fluid properties of the clay were again checked and some improvement was found. At 61.0% solids the slip had a viscosity of 500 cps.

2.2.4 Mineralogical Examination (Minus 20-Micron Fraction)

An examination of the clay by x-ray diffraction technique showed the material to be mainly kaolinite with a trace of mica and a trace only of quartz, (about 0.1%). These results are in agreement with a previous mineralogical assessment completed on this day (see report MP 5654/71). In the present examination however, no montmorillonite was detected and the ratio of mica to clay in the minus 2-micron fraction was estimated to be 1:15.

2.2.5 Particle Size Distribution

Particle size distribution, as shown in Table 1 and Figure 1, was measured using an EEL photosedimentometer. This showed that 21.2% of the minus 20-micron fraction was less than 2 micron. This would result in a good yield of usable material for paper coating.

2.2.6 Summary of Properties

Properties of the minus 20-micron fraction of the clay as detailed above are given collectively in Table 2.

3. DISCUSSION AND RECOMMENDATIONS

The reflectivity value of the minus 20-micron fraction (84-85%) was within the range for a paper coating clay (84-88% minimum) and for a paper filler (75-85%). The use of a bleaching technique improved the brightness to 86%.

Viscosity measurements carried out on washed kaolin to remove traces of NaCl indicated a solids content of 61% at 500 cps. The minimum acceptable specification is 67%, a value of 69% or greater being preferred. An

original mineralogical assessment on the bulk sample indicated a trace of montmorillonite which is known to be deleterious regarding the viscosity properties. However, no montmorillonite was detected in the minus 20-micron fraction, the limit of accuracy being less than 0.5%. It is unlikely that montmorillonite at such a low level would adversely affect the viscosity and this aspect of the assessment requires further investigation.

The valley abrasion value of 54 mg is too high to make the clay acceptable as a paper coating, the preferred value being less than 20 mg. The mineralogical examination shows that quartz, the normal cause of abrasion, is at an extremely low level (0.1%) and is most unlikely to be the source of high abrasion. Mica is also present at relatively high levels (Kaolin:mica = 1:15) and its removal is recommended to establish its effect on abrasion. Mica also has an effect on brightness and some improvement could be expected.

In conclusion, the sample of clay assessed shows that the minus 20-micron fraction would be suitable as a paper filler, but has certain basic deficiencies as a paper coating, in that the viscosity - solids content behaviour is not within specification and the valley abrasion value is too high. It is recommended that further work should be carried out on reducing its mica content and the brightness, valley abrasion and viscosity be re-investigated.

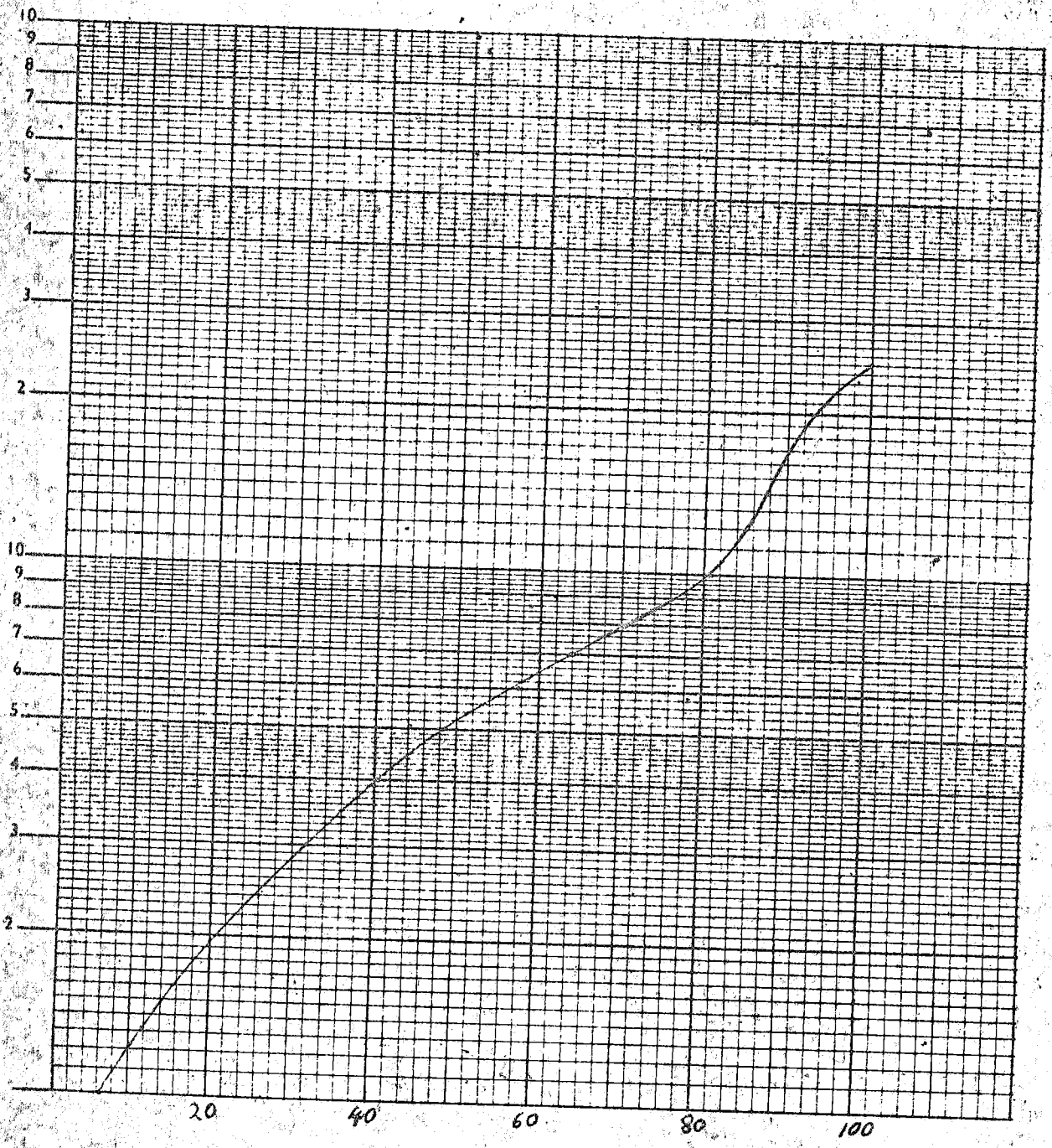
TABLE 1: PARTICLE SIZE DISTRIBUTION
(minus 20-micron fraction)

Stokes Diameter (micron)	Weight Percentage Less Than Stated Diameter (%)
25	100
20	92.8
15	87.7
10	81.1
8	71.6
7	63.9
6	57.5
5	48.7
4	40.4
3	31.8
2	21.2
1	6.3

TABLE 2: PROPERTIES OF THE MINUS 20-MICRON FRACTION

Property	Result	
Reflectivity: (blue filter G.E. scale)	Amdel	I.P.C.
reflectivity minus 20 micron	84%	84.8%
reflectivity minus 20 micron acid washed	86%	
Valley Abrasion:		
average of three tests	54 mg	
Viscosity on re-washed sample (10 rpm)	500 cps at 61% solids	
Particle Size Distribution		
minus 20-micron fraction	21.2 % less than 2 micron	

3/0/0 - 618/72 · CE 3967 · 16/9/71



0331 SEMI-LOG, 2 CYCLES x 10 IND.

FIG. 1 PARTICLE SIZE DISTRIBUTION

MINUS 20μ FRACTION.

017

amdel
The Australian Mineral Development Laboratories

Flemington Street, Frewville, South Australia 5063
Phone 79 1662, telex AA82520

Please address all correspondence to the Director
In reply quote: MT 3/0/0

5 November 1971

Mr D. Simmons
Sadex Pty Ltd
Box 1707N GPO
ADELAIDE 5001

REPORT MT 2152/72

YOUR REFERENCE: Letters dated 25 October and 26 October, 1971

MATERIAL: Clay - Bulked Samples A6, A7 and A8

IDENTIFICATION: CE 3967

WORK REQUIRED: Further assessment of Clay:

1. Brightness and mineralogy of minus 2-micron fraction.
2. Current prices of refractory and paper clays.

Investigation and Report by: K.M. Pluck and D.R. Ashworth

Officer in Charge, Materials Technology Section: Dr G.L.F. Powell

for F.R. Hartley
Director

scy

SUMMARY

A sample of minus 2-micron clay fraction, prepared by sedimentation, showed an increased brightness value of 89-90% compared with the minus 20-micron fraction (84-86%) and is well within the specification of a paper coating clay (84-88% or greater).

The mineralogy of the minus 2-micron fraction indicates the presence of a very low quantity of quartz (0.07%). The mica content was high, however, at approximately 5%.

This confirms the earlier work (MT 618/72) that mica could be the cause of the high abrasion value.

As conventional methods of removing very fine mica have not proved successful, it is recommended that the ultra flotation technique should be investigated as it has been applied to the removal of fine (minus 2-micron) anatase and quartz and could be applied to the removal of mica.

It has not been possible to obtain current prices of refractory and paper clays, but the following information is offered.

Refractory clays	$ 30-40 ton
Paper coating clays	$100-150 ton
Paper filler clays	$ 60-100 ton

amdel

1. INTRODUCTION

Previous work (MT 618/72) on clay sample CE 3967 showed that the minus 20-micron fraction had a brightness suitable as a paper filler clay, but the abrasive value was too high, being well above the acceptable value.

Further work was required to determine the cause and elimination of the high abrasive value and the effect of particle size on brightness.

2. PROCEDURE AND RESULTS

A representative portion of the minus 20-micron fraction used in the previous work, was processed by sedimentation to obtain the minus 2-micron fraction. After washing in distilled water and drying at a low temperature (105°C), a brightness measurement and mineralogical assessment was carried out.

2.1 Reflectivity

The reflectivity was measured on a samples prepared by the TAPPI specification 646ts-54 using an EEL reflectometer calibrated against a G.E. meter by the Institute of Paper Chemistry, USA. The G.E. value obtained (87-92%, average 89.5%) was significantly higher than the previous value on the minus 20-micron fraction (85%) and is well within the specification for a paper coating clay (84-88%)minimum).

2.2 Mineralogy

The minus 2-micron fraction consists of well crystalline kaolinite, only a trace of quartz being detected and estimated at 0.07%. The mica content was high, however, and was estimated to be 5% and agrees well with previous estimates (kaolin;mica is 1:15 i.e. 6.7%).

3. DISCUSSION

It is considered that although the brightness has increased significantly, the minus 2-micron fraction contains deleterious amounts of mica which is the only mineral present which could cause the high abrasive factor found for the minus 20-micron fraction.

It is recommended that furtherwork on means of removing the mica (partially or completely) by ultra flotation techniques, should be investigation. The presence of deleterious minerals in the fine fraction is quite common in paper coating or filler clays and ultra flotation techniques have been developed for removing fine quartz and anatase. Amdel is well versed in these techniques and laboratory cell experiments can be carried out to develop the necessary conditions for mica removal.

4. PRICES OF CLAYS

It has not been possible to obtain current prices of clays as requested, however, a range of values, depending on quality, is set out below:

Material	Price
Refractory clays	$ 20- 40 per ton
Paper filler clays	$ 60-100 per ton
Paper coating clays	$100-150 per ton

ENV 1820

T. A. BARNES PTY. LTD.
CONSULTING GEOLOGISTS

021

7 RALDON GROVE
MYRTLE BANK
ADELAIDE 5064
PHONE: 79 4756
OR 72 2826

MT. STURT CLAY DEPOSIT

Progress Report S.M.L. 633

Introduction

In early 1971 a Wudinna landholder Mr. L. Barns drew the attention of Sadex prospector G. Robertson to a substantial area of white clay on his property near Mt. Sturt, approx. 25 miles North of Wudinna.

After a preliminary examination a number of mineral claims were pegged covering the most promisin g looking area and some preliminary prospecting undertaken. Later examination including aerial reconnaissance suggested the areas of white clay might be more extensive than first thought, and the area was enlarged by taking a Special Mining Lease over 134 square miles and surrounding the original claims. Considerable work has been done on this S.M.L. No. 633 granted on 21st Oct. 1971, in both the field and laboratory, and this progress report sets out the present situation.

Location

S.M.L. 633 comprises an area of 134 square miles centred around a series of saline lakes just west of Mt. Sturt, approx. 25 miles North of Wudinna on Central Eyre Peninsula. Access is by a reasonable metal & dirt road for about 20 miles but the last 4-5 miles to the northern edge of the deposit traverses some ~~hay~~ heavy sand dunes requiring 4 wheel drive transport

General Geology

The white clay deposit outcrops around the margins of a fairly extensive system of small salt lakes - principally in three areas (1) Northern (2) Eastern and (3) South-Eastern as shown on the accompanying plan.
The material is highly weathered, comprising mainly white-buff kaolin and thin veinlets of grey quartz, and may have originally been a gneiss.
The clay areas have a siliceous and sometimes ferruginous capping and appear hard at surface. In the northern zone at least this hard crust becomes very soft within 2-4 ft. of surface.

The general impression is that the 'gneissosity' of the clay deposit is steeply dipping & trends N-S, but the true structural pattern is not clear in this very weathered material. Numerous dikes traverse the clay ranging in thickness from a few inches to several feet. These also are very heavily weathered & completely converted to cream-brown plastic clay. It is thought they may have been originally basic dikes.
Occasional barren grey quartz reefs from a few inches to a few feet thick also intersect the clay deposit. In a few places there are isolated outcrops of fresh gneiss, similar to the Pt. Lincoln gneisses in appearance-these are generally very small - only a few square yards in extent, with one exception in the South-East corner whish is exposed for 400-600 yds. Also appears steeply inclined and trending generally N-S.

Approx 2 miles W of the clay deposit a small knoll known as Poondana makes a fairly prominent local feature & consists of medium grained red-brown granite, covering several acres in area. Within 2 miles East of the clay deposit the twin peaks of Mt. Sturt make a prominent landmark rising sharply several hundred feet. They consist mainly of brownish porphyry similar in appearance to Gawler Range porphyry, and coarse reddish gneiss,

Access tracks were cut through thick mallee scrub & heavy sand dunes around the main lake area for drilling.

Drilling

Several holes were initially hand auger drilled in the northern area to a maximum depth of 30 feet, without bottoming the white clay. Samples from one of these drill holes were examined by Amdel.

Using a tractor mounted auger drill the northern area was drilled to depths of 4-6ft. at 200 ft. centres on E-W lines spaced 500 ft. apart, & indicated on area exceeding 300 acres of white clay reasonably encouraging. The drill was then modified to reach approx. 30 ft. depth and a total of 43 bores drilled mainly in the Eastern area. Depth of these bores ranged from a few inches where rock was too hard to satisfactorily drill, to 35 ft maximum and the total footage was 677 feet. Except for surface overburden the bores were carefully sampled at 3 foot intervals & stored in plastic bags. They were initially logged by the driller G. Robertson & finally logged by myself.

Positions of drill holes were spotted on air photos, and latitudes & longitudes established with assistance from S.A. Lands Dept. Due to the excessively wet spring it was not possible to drill a considerable portion of the area held, & this remains unknown & untested, although the impression has been gained that if the clay deposits do extend into the untested areas they may be under considerable sandy overburden. Water was cut in a number of holes drilled, but because of the large quantities of rain water on and near surface and the obvious resulting contamination, no water sampling was attempted at this stage. It is expected that the bulk of these waters would normally be very saline.

Laboratory

Samples were collected from a 30ft. hand drilled auger No. A hole as being reasonably representative of the better looking clay, & submitted to Amdel for examination. Mineralogical examination showed the clay to be dominantly kaolin, low in quartz, and the ceramics section of Amdel then carried out physical testing of the same samples. These results are contained in Amdel reports Nos. MP 5654/71 MP 305/72 MT 618/72 and MT 2152/72 and are very disappointing so far as the premium paper market is concerned. The possible usable fraction - 2 micron appears very low, perhaps 5% of the total, and viscosity and abrasiveness are far too high for paper coating, although brightness appears satisfactory. Discussions with Amdel staff have suggested the objectionable physical results are probably due to very fine mica, which could possibly be removed by special treatment - there are several patented processes which might be effective, but the cost of such treatment is not known, and samples should be sent to clay treatment specialists overseas to test.

Conclusion & Recommendations

Sadex has discovered a large easily mined deposit (S) of white kaolin near Mt. Sturt. A great deal more drilling would be required to reasonably determine probable reserves, but the possible tonnage available is undoubtedly large - perhaps in the range 10 - 50 million tons. While the work to date by Amdel makes the prospect of selling the material to the premium paper market very dubious, I feel its size merits additional effort to either solve the metallurgical problems, or test the possibility of alternative markets e.g. ceramics & refractories.

I therefore recommend that selected samples already supplied to Sadex be widely dispersed to try out all possible markets both overseas and local including limited additional work by Amdel and that further field testing of the Mt. Sturt clay deposit be suspended, pending results from these sample batches.

T. A. BARNES
Consultant Geologist

Attached 1 Plan of S.M.L. 633 showing drill holes & geology
2 Logs of forty four bores

ENV1820

Mt. Sturt Clay Deposits

023

Bore Logs

Hole No.	Depth (ft)	Log
A	0-6	0-2 surface sand 2-6 white kaolin-some quartz grit
	6-9	white kaolin some fine quartz grit traces v. fine white mica
	9-12	" " slightly more mica
	12-15	" "
	15-18	" "
	18-21	" "
	21-24	" "
	24-27	" "
	27-30	" "
		Bottom in Kaolin (Hand drilled)
1	(S_1-S_6) 0-2½	Brownish clay & brown sand
	5½	pale grey clay - some grit
	8½	" " & dark brown clay
	11½	grey & pinkish clay-some hard lumps
	12½	" " " "
		more hard lumps
	13½	pale grey clay - gritty -some hard lumps
	17½	light green & pale grey clay - traces fine mica
		Water cut approx. 12 ft.
2.	0-2	brown sand & gypsum
	2-5	brown sand
	5-8	" "
	8-11½	brown & grey sand - medium
		Water cut at approx. 2 ft.
3	0-2	grey sand & some clay
	2-5	dark brown sand & clay - lignitic (slightly oily odour)
	5-17	brown sandy slurry not sampled
	17-20	dark grey sand - medium grain
	20-26	" " " (not sampled)
	26-29	dark grey clay & sand fair amount fine mica
	29-32	green-grey sticky clay some sand
		Water approx. 4 ft.
4	0-2	quartz sand white & yellow
	2-5	dark brown fine sand (bituminous odour)
	5-8	grey sand
		Water at 4 ft.
5.	0-1	not sampled grey clay
	1-2	dark cream clay - hard-abandoned - hole ran off
6.	0-1	grey clay
	1-5	off-white clay & quartz with hard bars - abandoned
7.	0-2½	off-white clay - no grit traces fine mica
	2½-5	white clay " " "
	5-8	" " " " "
	8-11	" " " " "
	11-14	" " " " "
	14-17	" " " " "
	17-20	" " " " "
	20-23	" " " " "
	23-26	" " " " "
	26-32	" " " " "
		No water cut Still in clay at bottom
8	0-2	brown-grey clay
	2-4	light grey clays
	4-5	v. fine sand -pale yellow
	5-8	white clay -some fine mica
	8-11	" " " "
	11-14	white clay-considerable fine mica
	14-17	" " " "
	17-20	" " " "
		Strong flow water at bottom bottom still in clay
9	0-2	redbrown sand & clay
	2-5	white clay-some v. fine
	5-8	" " " " mica
	8-17	not sampled white clay & fine quartz
	17-20	v. pale brown clay-sandy - traces mica
	20-23	cream clay-fair amt fine quartz grit some fine mica
	23-26	not sampled -yellow clay
	26-29	cream clay -slightly gritty - some fine mica
	29-32	pale grey clay -some cligh tly greenish slightly gritty-traces mic
		Water at 18 ft. bottom still in clay
10	0-2	not sampled grey clay
	2-5	cream clay & chips soft rock - dry
	5-14	not sampled similar to abo ve
	14-17	cream clay-fair amt. mica some moderate flakes
	17-29	not sampled-similar above
	29-32	buff clay -some fine mica
		Water at 16 ft. bottom still in clay
11	0-1	not sampled grey clay
	1-3	" " yellow sand & gypsum
	3-5	off white clay -considerabl v. fine mica
	5-8	off white clay-some v. fine mica
	8-11	white clay-some pinkish grit & some v. fine mica
	11-14	off white clay -some v. fine mica
	14-17	white & pale yellow clay - some sm. quartz pebbles
	17-20	white clay-some fine quartz & mica
		bottom still in clay v. wet
12	0-1	red clay
	1-2	dirty white sandy clay
	2-5	mixture whiteish clay & fine brown sand
	5-8	varicolored clays -gritty- mainly brownish
	8-11	not sampled - as above
	11-14	mainly dark brown -some pale grey clay - gritty
	14-17	brown clay- some grit
	17-20	yellow clay
	20-29	not sampled - as above
	29-32	yellow & grey white clay
	32-35	yellow sticky clay - some grey white clay
		Water from surface bottom down

Hole no.	depth(ft)	Log
13	0-2	dark grey clay-little white clay
	2-17	not sampled - as above
	17-20	mainly dark grey clay-some white clay bottom
14	0-3	yellow-brown sand - traces clay
	3-6	whiteish clay - fair amt. v. fine mica
	6-9	mainly whiteish clay -little brown sand
	9-12	" " "- some brown clay some fine mica
	12-15	white clay some fine mica bottom still in clay
		no water cut
15	0-3	Not sampled grey clays
	3-6	grey brown clayey sand
	6-5	off white clay & quartz- some hard fragments abandoned-hole ran off
16	0-3	brownish sand
	3-6	buff dry clay
	6-9	" " " some hard fragments
	9-12	" " " softer
	12-15	grey-white clay fair amt. fine quartz some mica abandoned
17	0-3	brown sand & clay not sampled
	3-6	pale grey sand & clay
	6-10	not sampled as above
	10-12	whiteish clay -some grit- hard abandoned
		No water cut
18	0-5	not sampled grey compacted clays abandoned
19	0-2	not sampled " " " abandoned
20	0-3	dark brown sand - fine
	3-8	not sampled - as above
		hard layer at 8 ft. - abandoned
21	0-1	not sampled-drift sand
	2-3	" " sand clay & gypsum
	3-6	brown & grey sandy clay with gypsum crystals to $\frac{3}{8}$"
	6-7$\frac{1}{2}$	grey-brown sand some clay - wet hole abandoned
22	0-3	not sampled - yellow clayey sand
	3-6	varicolored clay & sand - gritty
	6-9	cream clay - some fine mica
	9-12	" " considerable " "
	12-15	" " " " "
	15-18	off white clay some fine mica
	18-21	" " " " " "
	21-24	grey brown clay - weathered schist?
	24- 27	grey clay
	27-30	mainly grey -some cream clay very micaceous -weathered schist?
		Water cut at 20 ft.
23	0-9	not sampled fine orange sand
	9-12	" " fine grey clay
	12-15	" " pale grey clay & sand fine
	15-18	" " grey mud
	18-21	" " slurry
	21-27	off white clay slurry
	27-30	" " " some grit & fine mica

Hole No.	Depth(ft)	Log
24	0-3	yellow sand v. fine
	3-12	not sampled yellow brown sand
	12-18	" " light grey clay & sand
	18-21	gritty clay-off white to pale brown
	21-24	off-white clay-some v. fine mica
	24-27	" " " " "
	27-30	mixture off white & brown clay - some fine sand
		No water cut
25	0-3	not sampled red brown sand & coarse grit
	3-9	" " grey sandy clay
	9-12	" " pale sandy clay
	12-15	" "
	15-18	pinkish gritty clay - v. micaceous
		Water cut 8 ft. - sampling difficult
26	0-3	not sampled redbrown sand
	3-6	" " pale orange "
	6-9	" " pale grey sand
	9-12	mainly red brown-some grey clay-hard seam red gravel at 10$\frac{1}{2}$ ft.
	12-13	mainly red brown clay too hard to drill - abandoned
		No water cut
27	0-1	inch pale grey kaolin rock outcropping too hard to drill - abandoned
28	0-1	not sampled pale brown sand
	1-3	fine yellow sand trace clay
	3-4	not sampled " " "
	4-6	grey&brown sand & clay
	6-9	dark grey gritty clay
	9-10	dark grey some yellow gritty clay considerable fine mica-hard drilling abandoned
		Water cut at 7 ft.
29	0-1	not sampled brown sand & clay
	1-3	yelllow silt - traces white clay
	3-6	white clay - little grit
		No water cut
30	0-2	red brown sand v. fine
	2-3	off white gritty clay some yellow sand
	3-6	off white gritty clay - considerable v. fine mica
	6-9	grey green gritty micaceous clay
		No water cut
31	0-3	red brown fine sand - traces clay
	3-6	off white gritty clay - very micaceous some coars mica abandoned
		No water cut

Hole no.	Depth(ft)	Log
32	0-1	chocolate clay-some mica
	1-2	mainly as above - traces whiteish clay
	2-3	pinker clay - some harder ironstone pebbles
	3-6	pale pink & off white gritty clay -some hard siliceous fragments
	6-9	mainly brown clay-traces white clay hole abandoned
33	0-1	Not sampled - brown clay
	1-3	off white clay - considerable fine mica
	3-6	" " " some hard fragments
	6-9	" " " softer
	9-12	" " " "
	12-15	white clay
		stopped in soft clay
		no water cut
34	0-1½	not sampled red-yellow clay & gravel
	1½-3	off white gritty kaolin-fairly hard
		abandoned
35	0-2	not sampled red clay
	2-3	off white clay- some fine mica
	3-6	" " " " " "
	6-8	cream clay " " "
	8-9	pinkish clay " " "
		hole abandoned - ran off
		No water cut
36*	0-2	fine pale brown sand
	2-3	white to buff clay - somewhat gritty
	3-6	off white clay - some fine mica
		some hard fragments
	6-9	off white clay -,some fine mica no grit
	9-12	" " " " " " "
	12-15	" " " " " " "
	15-18	" " " " " "
	18-21	" " " completed
		still in good clay
37	0-6ins	red clay
	½-3	off white clay - no grit
	3-6	" " " " "
	6-9	" " " " "
		completed in good clay
		No water struck
38	0-1½	white clay with red seams - not sampled
	1½-3	slightly pink clay-somewhat gritty
	3-6	" " " less grit
	6-9	" " " abandoned
		No water struck
39	0-3	not sampled - grey brown loam
	3-6	varicolored clay - some grit
	6-7½	yellow buff clay - gritty
	7½-9	off white clay - slightly gritty
		No water cut abandoned
40*	0-3	white clay - no grit - no mica?
	3-6	" " " "
	6-9	" " " " "
	9-12	" " " " "
	12-15	" " " " "
	18-21	white clay -not grit no mica?
	21-24	" " " "
	24-27	" " " "
	27-30	" " " "
		Water cut 29½ stopped in good clay
41*	0-8ins	clay & sand not sampled
	8ins-3ft.	white clay - grit free?no mica?
	3-6	" " " " "
	6-9	" " " " "
	9-12	" " " " "
	12-15	" " " " "
	15-18	" " "trace mica
	18-21	" " " " "
	21-24	" " " " "
	24-27	" " " " "
	27-30	" " " " "
		Water cut 28ft.
42	0-1	off white clay - little grit
	3-6	" " " " "
	6-9	" " " " "
	9-12	" " " some coarse gr grit
	12-15	" " " " "
	15-18	" " "more gritty
	18-21	buff clay " "
	21-24	" " v. gritty at bottom
43*	0-2	not sampled red soil
	2-3	buff colored clay-slightly gritty
	3-6	" " " " "
	6-9	" " " " "
	9-12	" " " " "
	12-15	" " " " "
	15-18	" " " " "
		completed in good clay
		abandoned due to plant breaking down

Bores drilled and sampled by G. Robertson
Oct - Nov. 1971

Logged by T.A. Barnes Jan. 1972.

T. A. Barnes

135° 15' 00" E
135° 20' 00" E
135° 21' 00" E
32° 41' 00" S
32° 45' 00" S
32° 47' 00" S

AREA PREVIOUSLY PEGGED (21 CLAIMS)
400 HOLES UP TO 6 FEET DEEP
SPACED 200 E to W by 500 ft N to S

tank

MT STURT

135° 25' 00" E
135° 30' 00" E
135° 33' 00" E
32° 44' 00" S
32° 50' 00" S
32° 51' 00" S

porphyry + gneiss

LEGEND
- DRILL HOLES
- DRILL HOLES IN KAOLIN
- KAOLIN OUTCROPS
- GNEISS, GRANITE ETC.
- TRACK EXISTING
- TRACK CONSTRUCTED
- ROAD

NORTHERN AREA

tank
43
sample D1
42
40
41
sample A
salt dam
granitic gneiss
County Peg
gneiss
dolerite?

siliceous capping
granitic gneiss
EASTERN AREA
SOUTH-EAST AREA
porphyry
gneiss

medium grained red granite
POONDANA ROCK

SML
Mt Sturt
salt lakes
Poondana
BLUE STURTS HOMESTEAD
Pinbong
Pygery
Wudinna
MILES
5 4 3 2 1 0 5
SCALE 1 = 250,000

CHAINS 80 60 40 20
MILES 0 1 2 3 4 6 7 8 9 10
1000 F

SADEX Pty. Ltd. SML No. 633
PLAN SHOWING DRILL HOLES & GEOLOGY

DRAWN: G.J. ROBERTSON, PROSPECTOR

CHECKED: CONSULTANT GEOLOGIST

DATE

DM 995/71

026

amdel
The Australian Mineral Development Laboratories
Flemington Street, Frewville, South Australia 5063
Phone Adelaide 79 1662, telex AA 82520

Winner of Award for Outstanding Export Achievement, 1975

Pilot Plant: Osman Place, Thebarton, Sth. Aust.
Phone Adelaide 43 8053
Branch Offices: Perth and Sydney
Associated with: Professional Consultants Australia Pty. Ltd.

Please address all correspondence to Frewville.
In reply quote: MD 1/16/0
1326/79

4 October 1978

(our ref.: 12.03.0217)

The Director-General
S.A. Department of Mines and Energy
P.O. Box 151
EASTWOOD SA 5063

REPORT MD 1326/79

YOUR REFERENCE:	Letter of 25 September Ref. 995/71 TC1.
SUBJECT:	Mt Sturt Kaolin.
DATE RECEIVED:	27 September 1978.
INFORMATION REQUIRED:	Assessment of Data.

Investigation and Report by: Dr William G. Spencer.

Manager, Materials Division: Dr Graham L.F. Powell.

for Norton Jackson
Managing Director

1. INTRODUCTION

It was requested that a review of data in files of the S.A. Department of Mines and Energy be carried out in order to determine the potential of the Mount Sturt deposit as a source of paper coating kaolin.

2. DATA EXAMINED

Four S.A.D.M.E. files containing data on the Mount Sturt deposit were examined by the writer. These are as follows :

Envelope 1820

Four Amdel Reports

MP 5654/71,	2/7/1971
MP 305/72,	4/8/1971
MT 618/72,	12/10/1971
MT 2152/72	5/11/1971

One Report by T.A. Barnes Pty Ltd undated, received by SADM on 10 February 1972, accompanied by map showing drill holes and geology and bore logs dated January 1972.

Envelope 2244

Sadex Report to 22 May 1973 with letter from Mr G. Parsons, Consultant Geologist for Englehard Minerals and Chemicals Corporation and a Report (TSR No. 188) unsigned but evidently from Englehard Laboratories.

Sadex Report to 22 August 1973 with final report from Mr G. Parsons dated 1 September 1973, with drill hole data.

Sadex Report to 22 November 1973 is not in the file, however a handwritten report bearing a date 2 November 1973 is present and such a report is referred to in the Sadex Report to 22 February 1974 as accompanying the Sadex Report to 22 November 1977.

Sadex Report to 22 February 1974 with a report from Englehard dated 6 November 1973.

Sadex Report to 22 May 1974 with drill logs.

Sadex Report to 22 August 1974.

Sadex Report to 22 November 1974.

Envelope 2152

Sadex Report to 12 March 1975 with drill logs in two reports received by SADM on 25/3/75 and 18/4/75.

Sadex Report to 11 June 1975.

Sadex letter dated 14 August 1975.

Englehard Report dated 29/9/75 received by SADM on 4/11/75.

Sadex letter dated 4/4/1976.

Envelope 2934

Two letters from Sadex each dated 10/5/77.

3. ASSESSMENT OF MATERIAL EXAMINED

The salient points in the various reports are presented and appraised as follows :

The early Amdel reports were for Hines Metals Pty Ltd. Amdel Report MP 5654/71 is a mineralogical investigation of a clay sample (origin unknown) which contains 23% by weight material finer than 2 micrometres which is mainly kaolinite with some mica (perhaps 3%) and a trace of montmorillonite for which testing on a paper-coating clay is recommended. A second mineralogical report on a sample labelled B (Amdel Report MP 305/72) is essentially similar. Amdel Report MT 618/72 is a preliminary assessment of four composite samples A6, A7, A8 and A9 for paper coating. It shows that the material (< 20 micrometre) has a moderate reflectivity, high abrasions and high viscosity in comparison with normal paper coating clays. The size distribution results show a low less than 2 micrometre content and the results suggest that an inappropriate sample was tested (less than 20 micrometres instead of less than 2 micrometres). The sample was responsive to bleaching and met paper-filler grade requirements. The second assessment is a coating kaolin (Amdel Report MT 2152/78) based on a composite of A6, A7 and A8. The less than 2 micrometre fraction gave a high G.E. reflectivity and contained well-crystallized kaolinite. However much of the kaolin is coarser than 2 micrometre.

The report by T.A. Barnes Pty Ltd concludes that the white clay deposit at Mount Sturt would be easy to mine and contains a large amount of material, possibly 10-50 million tons. It recommends further testing. The accompanying logs indicate kaolin-bearing material at depths of about 1 to 10 metres.

The report to 22 May 1973 with the technical data presented by Englehard includes comprehensive assessment of material for use as a paper coating clay. Three composites were examined.

Treatment by degritting, washing, filtering, high intensity magnetic separation, fractionation, bleaching and working by extrusion was applied to each.

Composite 1 (high brightness) gave a yield of 17.6%. This product met paper coating specifications in most respects and is reportedly competitive with coating clays of the residual type and of inferior viscosity to clays of the transported type.

Composite 2 (low brightness) was reported to give a yield of 19.3% with brightness and viscosity inferior to English coating grades. Note that this material meets the requirements for paper coating clay of some Australian buyers.

Composite 3 was similar to 2.

Composite 1 was prepared from six holes, using intersections of about five metres.

Composite 2 was prepared from three holes using intersections of about seven metres. Composite 3 was prepared from two holes, a 24 metre inclusion in CH14 and a 3.3 metre intersection is CH13.

Results given by Englehard indicated that the lack of brightness of Composites 2 and 3 were due to iron not titanium and that the sizing of the kaolinite was improved by extrusion.

The final report by G. Parsons, Consultant, dated 1 September 1973, distinguishes between the residual kaolin, low to high brightness, and the low brightness kaolin in the eastern area evidently transported. It expresses disappointment with the visual appearance of the residual material.

The handwritten report indicates that extensive processing is necessary to produce coating grade. High intensity magnetic separation and extrusion are necessary. These are expensive processes.

The Englehard report dated 6 November 1973 describes two Sadex samples as unacceptable. However, the comparison shows that the Sadex samples are satisfactory in respect of water viscosity and brightness but give slightly inferior properties to coated paper than English coating grades Dinkie A and SPS, both high quality paper coating grades.

The Englehard report by T.C. Shapiro dated 29 September 1973 relates to three samples A, B and C giving the following data (approximate):

	A	B	C
Yield of coating grade	25	21	30
Brightness	85	85	88
Brightness after processing	87	87	90
Viscosity	Fair	Poor	Good
Abrasion	Fair	Fair	Fair

These results suggest the materials do have potential for use as a paper-coating clay.

4. DISCUSSION

The reports do not include any economic evaluation of the deposit. Englehard Minerals and Chemicals Corporation have carried out extensive testing of composite samples which shows that the material, mostly a salty residual kaolin, requires extensive processing to meet paper coating specifications. This upgraded material is similar, but slightly inferior, to commercial paper coating clays such as English China Clays Dinkie A and SPS. Such processing is expensive in terms of capital and operating costs and could be justified only by a large production rate from a large deposit. The market would necessarily be mainly export and it is presumed that the lack of current interest by Englehard relates to the profitability of the operation and difficulty in competing on export markets.

The extent of interest shown by Englehard in previous years suggests that the deposit was regarded as having potential. No reserves figures are given and it is presumed that the reserves are less than 50 million tons. Minimum production rates likely to have been considered by Englehard are 5 million tons of crude per annum. It is possible that reserves of high brightness kaolin are insufficient. In comparison with other South Australian kaolins, the Mount Sturt material shares problems in respect of salt content, size distribution, iron/titanium oxide impurities and viscosity. Although yields are significantly better, Englehard have shown that each of these problems can be overcome to a large extent and a paper-coating grade kaolin can be produced. However such operations require much good water and energy and are expensive.

The development of the deposit for export markets would require the use of technical processes practised by major kaolin producers and it is unlikely that companies other than such producers could successfully produce and market the material. Development for local markets might be possible since the clay could be acceptable at lower specifications.

5. RECOMMENDATIONS

The lack of data on reserves is significant and it is recommended that if interest is to be stimulated, tonnages should be determined.

dk:4.

Appendix A

KAOLIN

Kaolin clays are a weathering product of feldspathic rocks. If found in situ they are termed primary or residual. In such deposits the kaolin is mixed with large quantities of rock material such as quartz, mica and feldspar. The proportion of kaolin in these deposits may be low, 10-20%. The U.K. Cornish deposits are examples. Some deposits are sedimentary and contain transported kaolin. Thus the highly productive Tuscaloosa formation in the United States contains kaolin washed down from the old Appalachian Mountain complexes. This formation runs through the centre of Georgia into South Carolina. Because of the separation of coarse and fine particles which takes place during transportation, sedimentary kaolin deposits contain more kaolin and less quartz, mica and feldspar. Kaolin contents are generally above 50% and may be close to 100%.

Kaolin clays of commerce are composed almost entirely of one mineral kaolinite. Any other minerals present constitute impurities.

Common impurities are quartz, illite, goethite, montmorillonite and anatase. Each of these reduces the value of the kaolin by alteration of the desired physical properties.

Many kaolin deposits produce only low-grade kaolin for local markets. Internationally-traded kaolins are very high grade and are produced from two main sources, the Cornish deposits in U.K. and the Georgia/S. Carolina deposits in U.S.A. English China Clays Ltd, of Cornwall, is the world's largest producer of kaolin (2½ m. t.p.a.) and supplies 80% of its production to the paper industry. Over 70% of its production is exported. The American clays are mined, processed and marketed by a number of companies; total production is about 5 m. t.p.a. of which half goes to the paper industry.

The essential characteristics of a commercial kaolin kaolin clay are :

1.	fineness	generally about 0.002 mm
2.	colour	white/whitish/cream
3.	chemistry	containing about 40-45% SiO_2, 35-40% Al_2O_3, 12-14% water. Other elements trace only
4.	inertness	

The main market for kaolin is the paper industry for use in paper-coating or paper-filling. Other important uses of kaolin are in ceramics, for china and refractories, and as a filler for rubbers. Among diverse other uses are as fillers for plastics, adhesives, paints and textiles, as carriers for insecticides, medicinal and cosmetic uses.

Appendix A (continued

The high-priced kaolins are the paper coating grades, currently over $A100 per ton in Australia, £50 per ton f.o.b. Cornwall. Paper-coating is the high-price, high volume market sector. Other sections are generally low volume or low price or both.

The uses of kaolin derive from the physical and chemical properties of kaolinite. Kaolinite ($Al_2O_3.2SiO_2.2H_2O$ or $Al_2Si_2O_5(OH)_4$) is a clay mineral with a perfect {001} cleavage. It occurs as small flakes generally about 2 μm in diameter with a range of about 0.1 to 20 μm. It is fairly inert chemically and melts at about 1750°C. Many kaolins are almost free of discoloring impurities and these kaolins are very white.

Appendix B

KAOLIN FOR THE PAPER INDUSTRY

There are two main uses for kaolin in the paper industry. One is as a filler, to occupy the interstices between the fibres of the paper. The other is to coat the paper to make it smooth, white and glossy. Filler-grade kaolin contains much material coarser than 2 μm. Generally about 40% < 2μm and brightness of over 80 are specified. Kaolin competes with other materials for this use. The market is not so large as for coating grades since less clay is required to fill a paper than to coat it. Prices are lower since the less stringent specification means that there are many clays unsuitable for coating which can be used as fillers. Potential supply exceeds demand.

Coating-grade kaolin has to meet certain requirements, set by the functions played by kaolin in the coated paper and by the machines used to coat the paper. Kaolin is the most widely-used material for paper-coating. It confers very high opacity, high gloss and whiteness to the paper. The high opacity results from the platy habit of kaolin and its small grain-size of chiefly 0.5 to 2 μm. This means that light scattering can occur at many places even in thin coatings, resulting in a high degree of scatter and high opacity. The high gloss results from the platy nature of the kaolin so that after calendering reflection on the surface is significant giving gloss. The whiteness results from the fact that a pure kaolin is generally free of ions such as Fe^{2+}, Fe^{3+} which absorb energy of a particular wavelength and hence impart colour.

Coating clay is applied by machine to paper. The coating clay is mixed with water, adhesive such as casein and dispersing agents. Machine application requires maximum fluidity and minimum water content. Good coating clays can be made up to a suspension of 70% solids or better (i.e. only 30% water) and show a fluidity similar to milk. Such materials enable coating machines to operate at very high speeds. Poorer materials would be either too viscous to spread or contain too much water and hence wet the paper. Clays should also be free of abrasive material which causes wear on the coating blades.

Many grades of coating clay are marketed. These cover a range of particle size, brightness, whiteness and viscosity. Higher grade materials such as those used for photographic paper command much higher prices. Typical properties of coating grade and filling grade clays are shown in Table 1. The first five are coating grade. Note that 'Supreme' contains 80% less than 1 μm and represents a very high grade coating material offering exceptional whiteness and fineness.

English paper clays are wet-processed. This is essential since the clays are won by monitoring. American clays are mined dry. Some of the lower grades are dry-processed to produce 'air-floated' grades. However, the superior grades are produced by wet-processing. Air-floated grades have higher abrasion values owing to quartz impurities and are generally coarser, being used as fillers. Wet-processed grades are beneficiated to a higher extent. Many are chemically bleached to remove iron and organic matter. Some are treated by high intensity magnetic separation to remove iron/titanium oxides, a common cause of low brightness.

Some are treated by ultraflotation to remove tourmaline, titania or other minerals not leached chemically. Some are centrifuged to remove montmorillonite, one cause of poor viscosities. Delamination is sometimes used to produce more flaky kaolin particles. Some coarse kaolins are treated by attrition-grinding to reduce the particle size. Few kaolins are not upgraded by physical or chemical beneficiation. Generally price increases resulting from significant improvements render some sort of beneficiation worthwhile.

Since even paper coating kaolin is a relatively low cost item ($A100+ per ton), transport costs are significant. Most kaolin is shipped dry but some is transported in slip form. Here the bulk of the kaolin slip is no greater than that of the equivalent amount of dry kaolin but it is heavier on account of the water.

As stated previously the market for coating clays is dominated by English and American companies. These companies maintain quality control and grading to ensure maximum exploitation of their resources. A wide variety of kaolin clays is produced to meet the needs of the paper industry. There is a clear trend to standardizing kaolin clays for other uses also. Whereas it was former practice to supply bulk or relatively unprocessed clay to the china clay user, it is now common for the china clays to be sold to a specification.

TABLE 1: DATA FOR VARIOUS PAPER CLAYS

	English													
	Coaters						Fillers							
	Supreme	Lee Moor SPS	SPS	Predis-persed SPS	Dinkie Special	Dinkie A	Grade A	Grade B	Lem-star	Grade C	Grade D	BN Filler	Grade E	Grade E Special
BRIGHTNESS														
Violet	91	89.5	89.5	89.5	90	89	85	86	86	84.5	83	83	80	80
Yellowness	3.0	3.0	3.5	3.5	3.5	3.5	3.5	4.0	3.5	4.5	4.5	4.5	7.5	4.0
VISCOSITY CONCENTRATION														
for 5 poise	68	69	69	69	73	72	-	-	-	-	-	-	-	-
PARTICLE SIZE DISTRIBUTION														
% BELOW 2 microns Stokes's Diameter	- 80% below 1 micron	80	80	80	85	75	50	45	55	45	45	45	20	33
% ABOVE 10 microns Stokes's Diameter(max.)	0.2	0.2	0.2	0.2	0.2	0.5	10	15	8	15	15	12	25	15
% residue on No.300B.S. sieve (max.)	0.01	0.01	0.01	0.01	0.01	0.01	0.02	0.02	0.02	0.02	0.02	0.01	0.03	0.03
pH	5.0	5.0	5.0	7.5	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0
CHEMICAL ANALYSIS														
SiO_2	46.6	47.5	46.2	46.2	46.5	46.72	47.8	46.8	48.2	46.7	46.88	46.73	47.3	49.49
Al_2O_3	38.3	37.5	38.7	38.7	38.5	38.21	37.3	38.0	36.8	38.0	37.65	37.84	37.2	35.53
Fe_2O_3	0.49	0.42	0.56	0.56	0.52	0.57	0.53	0.74	0.48	0.77	0.88	0.92	1.01	0.60
TiO_2	0.05	0.05	0.09	0.09	0.11	0.03	0.04	0.09	0.05	0.10	0.09	0.09	0.08	0.07
CaO	0.2	0.2	0.2	0.2	0.1	0.05	0.2	0.1	0.2	0.1	0.03	0.05	0.1	0.03
MgO	0.2	0.2	0.2	0.2	0.1	0.17	0.1	0.1	0.2	0.1	0.13	0.06	0.1	0.20
K_2O	0.68	1.30	1.01	1.01	0.75	1.03	1.72	1.53	2.05	1.68	1.60	1.70	2.43	2.15
Na_2O	0.07	0.06	0.07	0.07	0.06	0.06	0.05	0.05	0.03	0.07	0.21	0.07	0.07	0.08
Loss on Ignition	13.43	12.74	13.14	13.14	13.40	13.05	12.31	12.59	12.03	12.45	12.45	12.33	11.70	10.96

* Stokes's Diameter -
See British Standard 2955 : 1958

TABLE 1 (continued) DATA FOR VARIOUS PAPER CLAYS

	American				Australian		Mount Sturt	
	Huber Coaters		Huber Fillers		Kaolin Australia		Data is selective and not representative	
	Special Hydratex	X44	Air floated Paragon	Water washed SWW	Eckacote coating clay	Pittong Filler	Coater	Filler
							Englehard Data	
BRIGHTNESS								
R457	88 GE	86 GE	80 GE	82-84 GE	88	84	87-90	80-85
Yellowness	-	-	-	-	5	8.0	-	-
VISCOSITY CONCENTRATION for 5 poise	70	?70+	-	-	69	-	68-72	-
PARTICLE SIZE DISTRIBUTION % BELOW 2 microns	80	80	55	50	80	60	90	29
% ABOVE 10 microns Stoke's Diameter (max.)	-	-	-	-	0.7	11	-	-
% residue on No. 300B.S. sieve (max.)	0.01	0.01	0.05	0.03	0.05	0.05	-	-
pH	5	6	5	5	5	5	-	-
CHEMICAL ANALYSIS								
SiO_2	∿44	-	45	-	46	45	-	-
Al_2O_3	∿39	-	39	-	39	39	-	-
Fe_2O_3	∿1.3	-	0.7	-	0.49	0.57	0.4	0.8
TiO_2	∿0.7	-	0.9	-	0.63	0.91	0.8	0.8
CaO	-	-	0.49	-	0.04	0.06	-	-
MgO	-	-	0.14	-	0.06	0.20	-	-
K_2O	-	-	-	-	0.13	0.11	0.45	0.7
Na_2O	-	-	-	-	0.10	0.02	-	-
Loss on ignition	∿14.0	-	14.13	-	13.70	14.10	13.7	13.4