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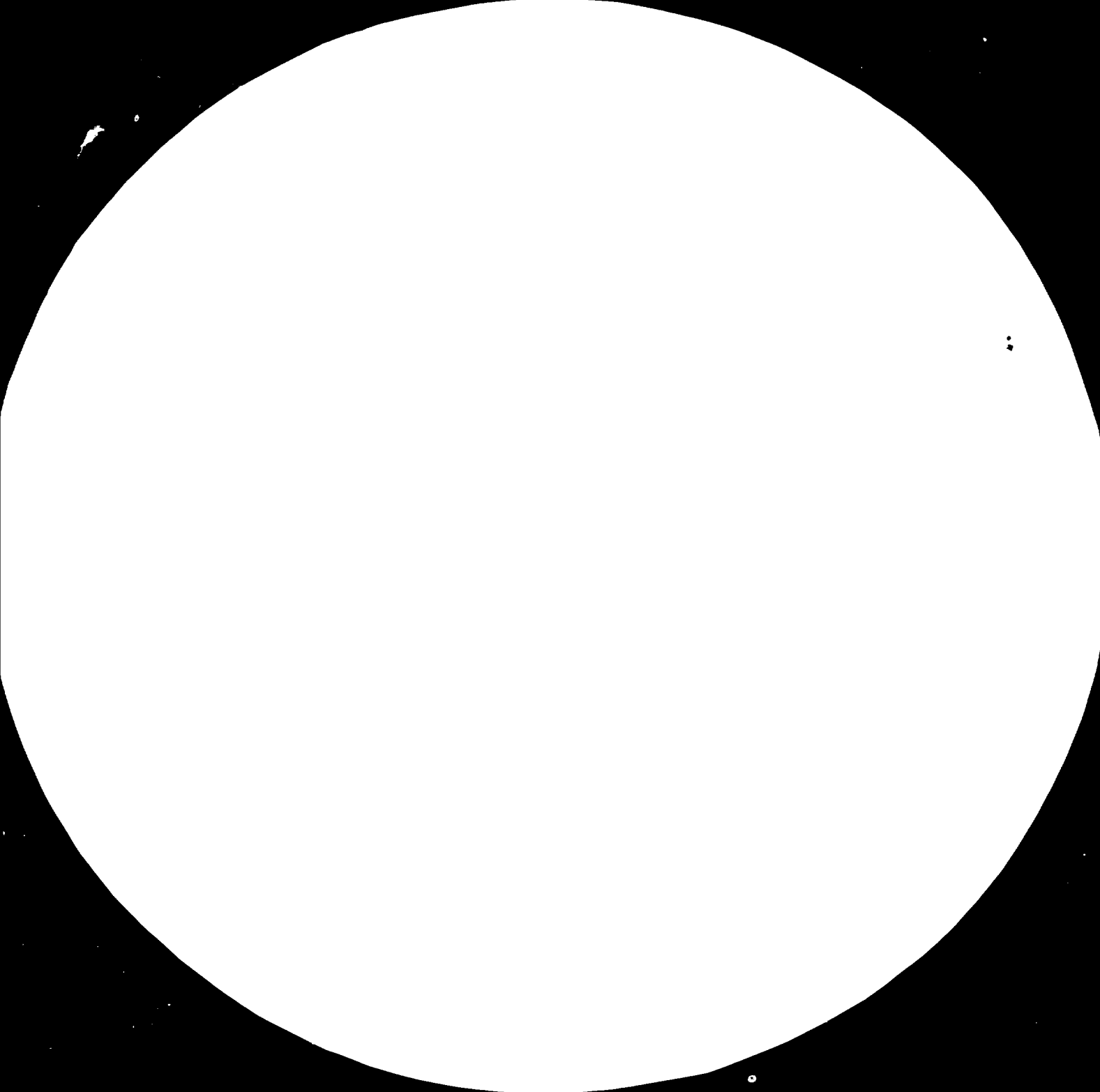

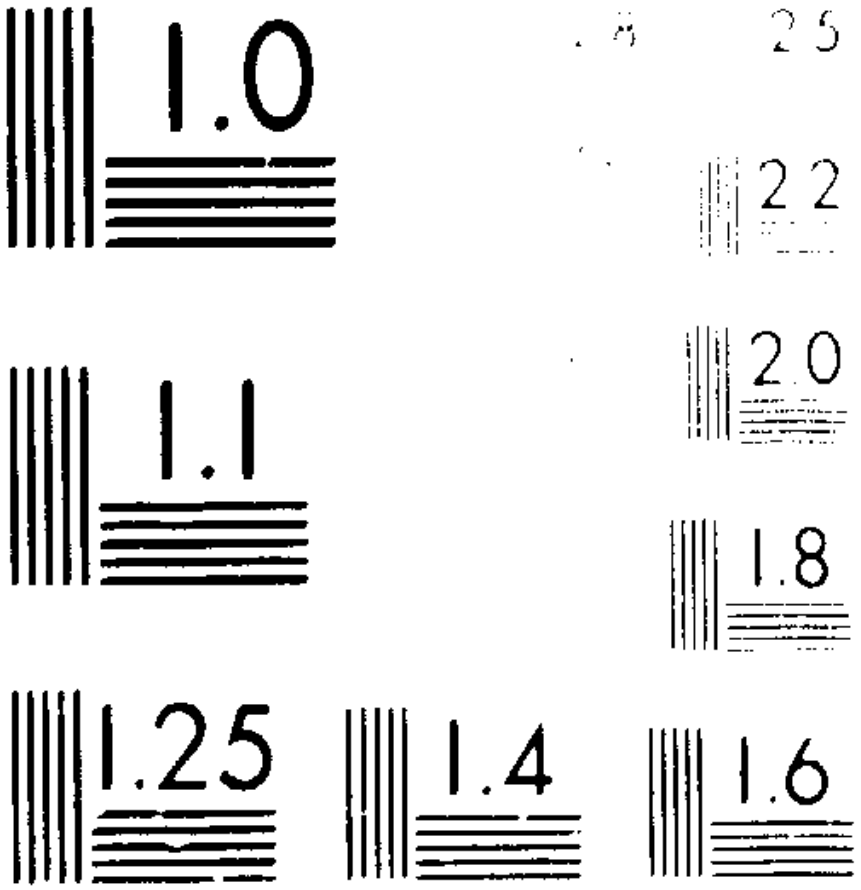
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15 November 1982
English

Botswana.

TECHNICAL ASSISTANCE TO THE DEVELOPMENT OF BUILDING MATERIAL PRODUCTION IN THE SOUTHERN DISTRICT.

RP/BOT/82/002

BOTSWANA

Technical Report*

Prepared for the Government of Botswana
by the United Nations Industrial Development Organization,
acting as executing agency for the United Nations Development Programme

Based on the work of Neville R. Hill
Non-metallic Minerals Geologist

United Nations Industrial Development Organization
Vienna

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Abstract

During October 1982, a UNIDO Non-metallic Minerals Geologist provided technical co-operation to the Mineral Holding Trust (MHT) of the Southern Rural Development Association in Kanye, Botswana. MHT has been implementing projects for the local production of lime, bricks, slate, terrazzo stone, road and concreting aggregate, mineral iron oxide pigment and talc.

The assignment was aimed mainly to assist SRDA to assess local resources of limestone, mainly dolomite and calcrete, for lime making. This was done by field survey and batch firings of the raw materials in a small purpose built test kiln fired with coal. A set of eight quality control tests for lime, using relatively simple apparatus, has been drawn up. These will be used to monitor the performance of SRDAs 3 t/d production kiln nearing completion and to check the quality of the products. The assistance of the Research Officer, a chemist, in the Rural Industries Innovation Centre in Kanye will be of much help in the establishment of these testing facilities.

Technical advice was also provided on the hydration of lime, quarrying and processing of slate and aspects of the operation of the brickworks.

UNIDO support is being sought for the recruitment of the Industrial Minerals Mining Engineer who is to be attached to the Botswana Technology Centre in Gaborone and who should work closely with SRDA/MHT.

Finally, it is suggested that the work of SRDA/MHT in this field should receive wider recognition as being an effective way of initiating the exploitation of industrial rock and mineral resources, especially for supplying the local demand for building materials.

Explanatory Notes

Exchange Rate	:	US$ = Pula 1.08 approx.
		Pl = US$0.95 approx.
SRDA	:	Southern Rural Development Association.
UNDP	:	United Nations Development Programme.
BTC	:	Botswana Technology Centre.
GSD	:	Geological Survey Department, in Lobatse.
MHT	:	Mineral Holding Trust, of SRDA.
HCl	:	Hydrochloric acid.
RIIC	:	Rural Industries Innovation Centre.
MgO	:	Magnesium oxide.
BMC	:	Botswana Meat Commission.
UNIDO	:	United Nations Industrial Development Organization.
CV	:	Calorific Value
B.Th.U.	:	British Thermal Unit.
SiO_2	:	Silica.
District	:	refers to the Southern District of Botswana.
FEF	:	Friedrich Ebert Foundation.
BDC	:	Botswana Development Corporation.
RIP	:	Rural Industries Promotions.
IT-IS	:	Intermediate Technology Industrial Services division of Intermediate Technology Development Group Ltd., of the U.K.
IGS	:	Institute of Geological Sciences, of the U.K.
t	:	metric tonne
y	:	year
mm	:	millimetre
m	:	metre
lb	:	pound
kcal/kg	:	kilocalories per kilogram
km	:	kilometre

INTRODUCTION

In September 1981, the Southern Rural Development Association (SRDA), based in Kanye, Botswana, was seeking technical assistance for a proposed project for the small scale production of lime, using limestone occurring in the form of calcrete. At that time, and until September 1982, the present expert was in Malawi in UNIDO project MLW/78/003 and was able to provide various technical advice by correspondence. Through the Ministry of Commerce and Industry, SRDA made a request to UNDP in Gaborone for the expert to carry out a one month mission in Botswana.

It was hoped that the expert would be recruited in time to assist with the assessment of geological raw material surveys and proposed processing operations for a set of six feasibility studies being made by SRDA. In the event, the expert began the present one month assignment to Botswana on 29th September 1982 with briefing in Gaborone at UNDP, Ministry of Commerce and Industry, Ministry of Finance and the Botswana Technology Centre (BTC). (The assignment ended with de-briefing at UNDP on 23th October.)

Following the national Independence Holiday, the assignment continued with briefing at the Geological Survey Department in Lobatse on 4th October, followed by kiln trials on limestones in the test kiln at Moshaneng, inspection of the slate quarries at Dipotswana, sand moulding of bricks at Moshaneng and assimilation of Geological Survey Department (GSD) reports on raw materials relating to the six projects being developed by the Mineral Holdings Trust division (MHT) of SRDA. The Job Description, showing the original duties of the mission , is included in Appendix I. The experts own summaries of the MHT projects are given in Appendix II, based on the data given in SRDA Viability Studies of January 1982 by Mr. John Spiropoulos.

After the initial week in Kanye, it was agreed with SRDA that the remaining 2½ weeks in Kanye should be concentrated on the follow-activities:

1. Testing of the Moshaneng dolomite as raw material for lime making.
2. Identifying the most suitable limestone (calcrete) deposits in the Barolong Farms area, for establishment of lime making

there, and carry out test firings to assess quality.

3. Develop a quality monitoring procedure for use when the the SRDA/MHT 3 t/d lime kiln goes into production at Moshaneng.

This was carried out though certain tests, such as those for reactivity and available lime, will only be possible when suitable weighing facilities, standard HCl solution, etc have been made available at the Rural Industries Innovation Centre (RIIC) in Kanye. There was a visit to the large tannery in Lobatse which could be a main customer for SRDA/MHT lime, and it was also scheduled to visit, before departure from Kanye, the deposits of red slate at Moshupe and Mogobane*. These and all other locations investigated were within the area covered by the SRDA.

I.CONCLUSIONS AND RECOMMENDATIONS

1. Small scale batch firing trials, in the SRDA replica of the expert's 'Zomba' kiln, have shown that calcrete from Metlojane can be used to make lump quicklime which slakes quickly to a white hydrated lime. The deposit at Metlojane is sufficient for a small kiln, of the type nearing completion at Moshaneng, and is readily accessible on non-cultivated land. The location is suitable for a lime kiln which could supply lime by road to much of the Southern District. The cost of Morupule (Botswana) coal to Metlojane should be somewhat less than that for the coal presently supplied to the brick and lime kilns at Moshaneng.

2. The test firings of limestone (dolomite) from Moshaneng and Diphawana, on the other hand, produced hydrated limes of pale purple (lilac) and greyish-purple colour respectively. The colour need not prejudice its use as building lime for mortars. The fact that these rocks are of dolomite and the quicklime from them has been reported by GSD to contain as much as 35% MgO, will mean that either the slaking must be to lime putty, in deep slaking pits for possibly several days, or else by means of pressure hydration if the risk of unsoundness in the lime-based mortar is to be removed.

3. The Botswana Meat Commission (BMC) tannery in Lobatse has a demand for 180 t/y of hydrated lime of the type supplied for building use. The company is willing to carry out small scale trials to test the

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* the visit was not possible

suitability of any SRDA lime for use in the de-hairing part of the the tanning of cattle hides.

4. The set of eight Lime Quality Control Tests, drawn up by the expert and included in Appendix III, should be very useful, as well as fairly easy to apply, for comparing the quality of SRDA limes with those that are commercially available already. The eight tests will enable 1) the comparison of different limestone deposits as possible sources of raw material and 2) the monitoring of the performance of the SRDA production lime kilns.

5. The value of the small batch kiln as a tool for testing limestones as possible raw materials for feeding vertical shaft kilns, has been well demonstrated by the use made of it both before and during the expert's mission, as it also was when used in the previous mission in Malawi. It enables practical results to be obtained quickly and relatively cheaply. It showed that none of the Botswana raw materials decrepitate in the kiln during calcination and all should be satisfactory for feeding the continuous kilns that are to be built.

6. The deposit of grey 'slate', or hard, fissile shale, at Dipotswana has geological features which make it easy to work, at low cost, provided that surface water does not accumulate in the quarry floor. The present system of working the stone produces an even higher proportion of 'offcuts' than is usual with the slate industry. It is recommended that trials be made to extract the rock as regular blocks, in sizes that will provide, after allowing for cutting, a multiple number, say 6, 8 or 12, of the desired size of tile from each splitting. Either the blocks can be split at the quarry or taken to Kanye and split and cut at MHT. In either case, the transport will be used more economically, carrying a higher value product, from which there will be less offcuts.

7. The present system of slop moulding in the SRDA brickworks at Moshaneng results in a proportion of the bricks, possibly 20%, developing a large shrinkage crack across the middle. If slop moulding is to be continued much longer, then simple flaps should be made so that the draught across the drying shed floor is reduced in windy conditions. Alternatively, and preferably, sand moulding should be introduced as soon as possible. This will result in less breakages as the drying shrinkage will be less, reduce distortion of the brick

and make sharper arrisses, make drying quicker and consume less water. The floor of the drying shed should be made smooth and clean, say by laying a lime-powdered brick topping, so that the bricks become less cluttered with stones and other adhering dirt. Bricks should be sold direct from the clamp to avoid unnecessary double handling.

8. The work of the SRDA/MHT is one way of creating small scale industries in rural areas based on locally occurring raw materials. Similar enterprises may be possible in other Districts of Botswana and certainly, in the expert's experience, in other countries, where the findings of geological survey work are not being applied to exploit the industrial rock and mineral - building material potential that exists. It is recommended that UNDP/UNIDO and other funding organizations consider how the SRDA/MHT achievements, with materials such as bricks, lime, slate, mineral oxide pigments, terrazzo and other building stone and talc, can be applied elsewhere.

9. It is recommended that UNIDO consider if it can assist the Botswana Technology Centre (BTC) in the recruitment of the Industrial Minerals Mining Engineer for which a Job Description is given in Appendix IV.

II. ACTIVITIES

A. Limestone Firing Trials

As a result of information, including photographs and drawings, sent earlier from the expert's previous duty station, Zomba in Malawi, the SRDA/MHT counterpart (Mr. John Spiropoulos) had built a replica of the expert's Mk.I Zomba test kiln for trial firings of limestone. Prior to the mission, the kiln had already been fired eight times, using Morupule (Botswana) coal, of CV 9,900 B.Th.U./lb (5,500kcal/kg). During the mission, the expert fired this kiln a further six times, with raw materials from three locations. The reactivity of the quicklime and whether it retained a lump nature were noted, and also the colour of the hydrated lime. The degree of calcination achieved was checked by weighing the quicklime and comparing it with the same volume of original limestone (see procedure of Lime Control Test No.1 in Appendix III). The results are shown in Table 1 and

Table 1: KILN TRIALS OF RAW MATERIALS FOR LIME MAKING

Deposit	Rock	Analysis			Wt. loss on firing (%)		Quicklime		Slaked Lime
		Cao	Mgo	Sio_2	Actual	theor. max. *	Lump	Reactivity +	Colour
Moshaneng	Yellow/white dolomite marble	28	19	7	30.3 27.7 23.0	44.2	yes	Quick	pale purple or lilac
Diphawana	Dark grey dolomite marble	-	-	-	37.6	-	yes	Quick	purple-grey
Metlojane A	White.grey hardpan calcrete	46	2.3	11	33.7	39.0	yes	Quick	white
Metlojane B	" "	40	3.8	20	16.0	35.1	yes	Quick	white

* based on calculated CO_2 content.

\+ ASTM C5-59. Appendix A1. classification of Limes:-

Slaking begins in less than 5 min : "Quick slaking"
" " " 5 to 30 min: "Medium slaking"
" " " over 30 min : "Slow slaking".

and are summarized below.

Moshaneng Dolomite. The first of SRDA/MMTs production shaft kilns, to a modified Khadi and Village Industry Commission (KVIC) design for 3 t/d, is being built at Moshaneng, 10 km north-west of Kanye, and adjacent to the very large dump of broken dolomite waste from the old asbestos mine. The principal reason for SRDA to select this location was the availability of pre-crushed material that requires only hand selection of the chosen size e.g. 75 - 100 mm. However, the firing and slaking trials showed that although the colour of the raw material is mainly yellow, white, etc., that of the slaked lime is pale purple or lilac. Only test marketing will indicate whether this lime will find acceptance for decorative purposes. Though the colour should be of no disadvantage for mortars for masonry and renderings, the fact that the raw material consists of 93% dolomite, $CaCO_3.MgCO_3$, is very likely to mean that slaking will have to be to lime putty in deep slaking pits, unless pressure hydration, at 4 to 7 kg/cm^2 (say 60 to 100 lb/in^2), can be arranged. Marketing of lime as lime putty may prove to be more difficult than for a dry lime hydrate. It is recommended that a trial slaking be done as a putty under water and samples checked daily for soundness by means of Lime Quality Control Test No.6 (Appendix III) to determine how long it takes for the lime to become sound.

Moshaneng dolomite, which is a fine grained, hard marble, does not decrepitate when being fired but is fairly susceptible to air slaking, more so than is Diphawana dolomite lime. Thus, it should be discharged promptly from the production kiln and slaked fairly soon after to avoid deterioration due to atmospheric CO_2.

Diphawana Dolomite. This is a dark grey, fine grained, hard, compact dolomite marble from a location about 11 km south of Kanye. When calcined this produces a good lump quicklime. This is less susceptible to air slaking than is Moshaneng dolomite but it is still a 'quick slaking' lime, i.e. starts within 5 min. This raw material also has the above mentioned disadvantage that it will probably require slaking to lime putty to remove unsoundness. Also, the colour of the slaked lime, greyish-purple, is even darker than the Moshaneng lime.

Metlojane Calcrete. Two samples were fired from the locations, described under B. Geological Field Work, both within 2 km of Metlojane, which is 70 km south of Kanye. These are localities 4 and 5 described by Gwosdz in his Geological Survey Department, Lobatse, (GSD), report no. WG/26/81. They are both described as hardpan calcrete, the purer of which, locality no.4, is greyish-white and occurring 1 km north-east of Ramah's store and only 150 m north of the road to Pitsane Siding. The average analyses of Gwosdz's eleven samples from locality no.4 gave 46.5% CaO, 2.35% MgO and 10.97% SiO_2. The silica is mainly as sand grains or small pebbles.

These calcretes produced white and yellowish lump quicklime, i.e. no decrepitation, and it was quick slaking to a bright white lime wash. The presence of the finer sand grains will be no disadvantage in building mortars and straining the lime wash through a fine cloth or fly mesh will make it acceptable for decoration purposes. The easy accessibility of the location, the reserves of at least 20,000 m^3, with more in the area, as well as its performance, strongly recommend the material at 'locality no.4' Metlojane as being the best known for locating the next SRDA 3 t/d production lime kiln.

B. Geological Field Work

Calcrete. Following examination of GSD report WG/26/81, describing calcrete occurrences in the Barolong Farms area, it was decided to visit localities 1, 2, 4, 5, 9 and 10 described by Gwosdz as being close to the road linking Metlojane, Ramatlabama and Pitsane Siding. Other localities, 7 and 8 near Pitsane Molopo, seemed not so attractive nor so well located as, say, those at Metlojane, 4 and 5, or west of Pitsane Siding, 1 and 2.

Localities 9 and 10 to the north and west respectively of Ramatlabama were ruled out on visual inspection and similarly 1 and 2 to the west of Pitsane Siding which are badly exposed. In Metlojane, locality 5 is being exploited by the Roads Department. A sample was taken from slightly further to the north-west and was fired in the test kiln at Moshaneng. However, by far the better deposit is locality 4, approximately 1 km north-east of Ramah's store and lying only 150 m on the north side of the road

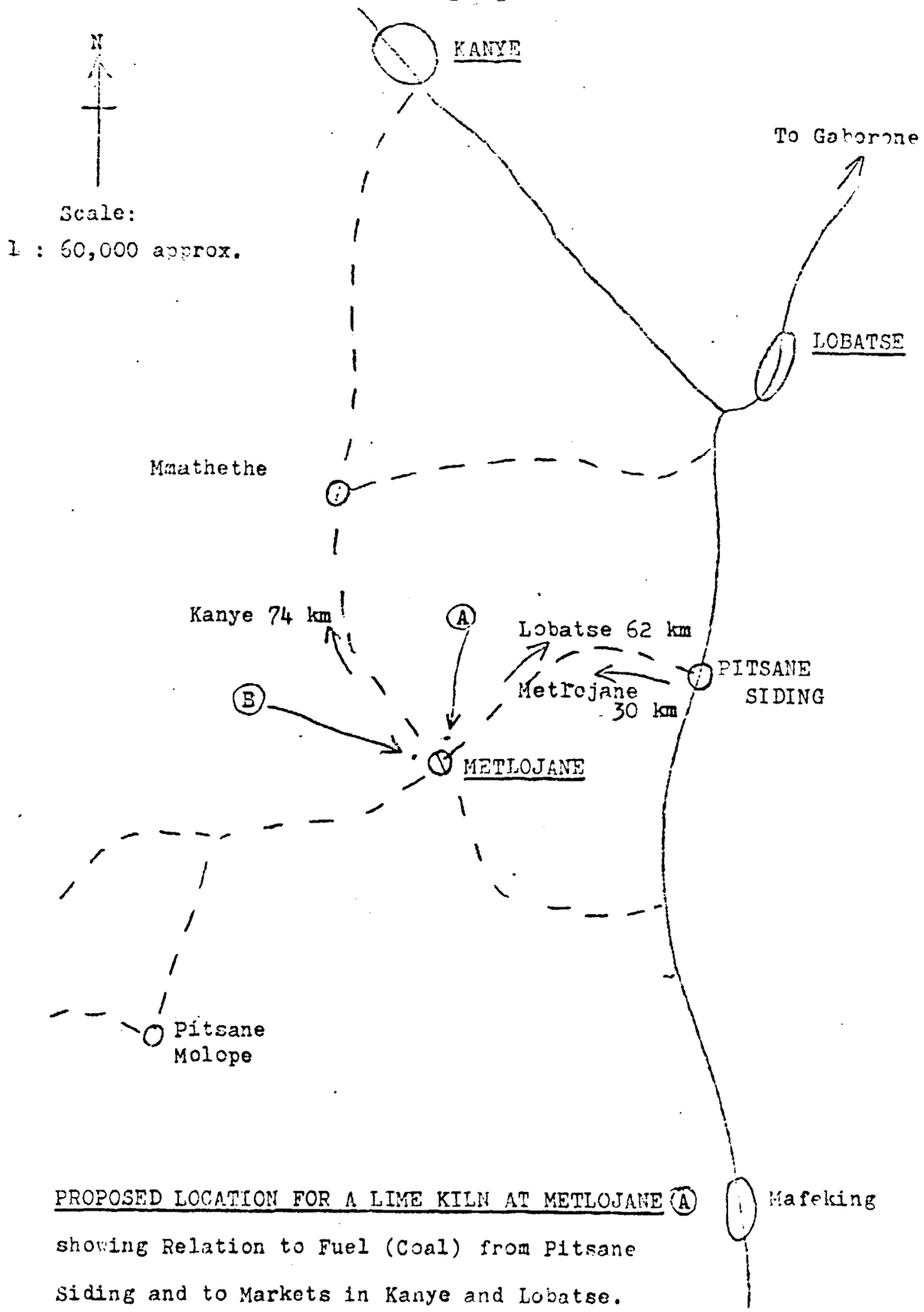
to Pitsane Siding. This is non-cultivated land with white or pale grey hardpan calcrete exposed at the surface over an area of at least 1 hectare. There are 2.5 m exposed in the top of an old well. About ten houses lie a short distance to the north of the location. Access is excellent and the ground is fairly flat. A kiln built there would have to be loaded by means of a gantry there being no place where the slope of the ground is adequate for building a ramp. The distance north to Kanye is 63 km via Mmathethe, which itself is 41 km. The main road and railway at Pitsane Siding are 30 km to the east with Lobatse a further 31 km to the north of that. Reserves are probably in excess of 20,000 m^3, sufficient for establishing a 3 t/d kiln of the Moshaneng type, and more calcrete exists in the general area.

The price of coal fuel delivered to Metlojane should be no more than the P36.00 that it now costs delivered to the SRDA brickworks,and lime kiln, at Moshaneng. In January 1982 the costs were as follows:

	Moshaneng Jan.'82	Metlojane estimate(now)
ex-Morupule coal mine	P11.22	P12.50
rail to Lobatse	P9.15	
rail to Pitsane Siding,30 km extra.		P12.00
road to Moshaneng.	P14.37	
road to Metlojane 33km less.		P9.00
TOTAL:	P34.74 (now P36)	P33.50

The location of Metlojane in relation to markets and the delivery of coal is shown on the sketch map.

Grey Slate . 'Slate' which the GSD suggests is a hard shale rather than a metamorphic rock, is being quarried at Dipotswana, 40 km by road to the south-east of Kanye. The slate is being extracted as irregular 'planks' and then taken by truck to MHT in Kanye. There it is split by hammer and cold chisel into approximately 10 mm sheets. These are either sold as such or else cut by circular saw into tiles 150 X 150 mm, 220 X 220 mm or 300 X 300 mm.



PROPOSED LOCATION FOR A LIME KILN AT METLOJANE (A)

showing Relation to Fuel (Coal) from Pitsane Siding and to Markets in Kanye and Lobatse.

(A) Calcrete deposit 1 km NE of Ramah's Store.

(B) Additional calcrete resource 2 km NW of crossroads.

Neville R. Hill

Kanye, 15th October 1982

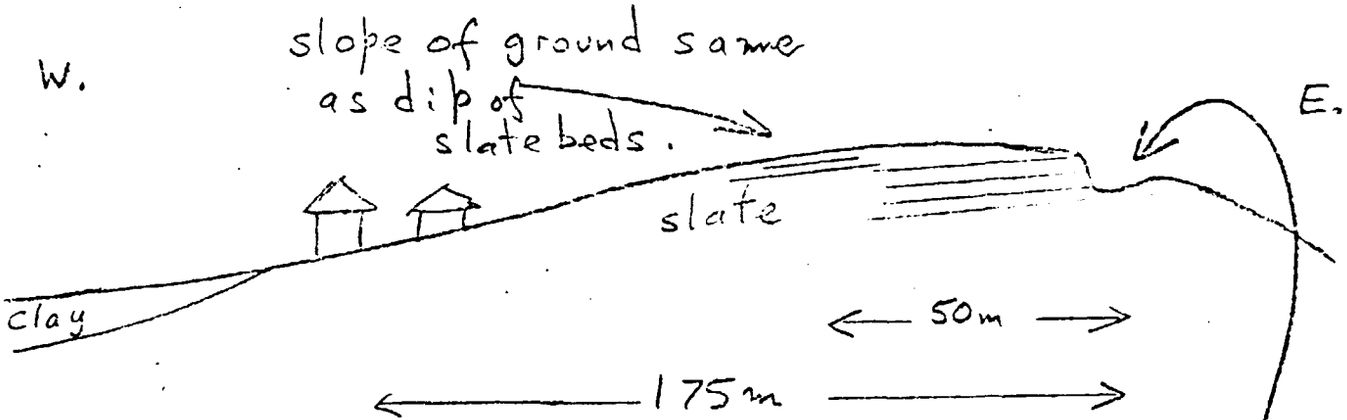
At Dipotsvana there are at least two active quarry exposures where six men work in pairs. The cross sectional drawing shows that the present extraction points are a few metres to the east of the crest of the low hill, which has a scarp face to the east and a long, shallow dip slope, at about 10°, to the west. Only about 50 m west of the quarries the dip of the beds is very nearly parallel to the ground surface. Generally, the location is a good one for the removal of stone, provided water is able to drain from the workings through joints and bedding planes.

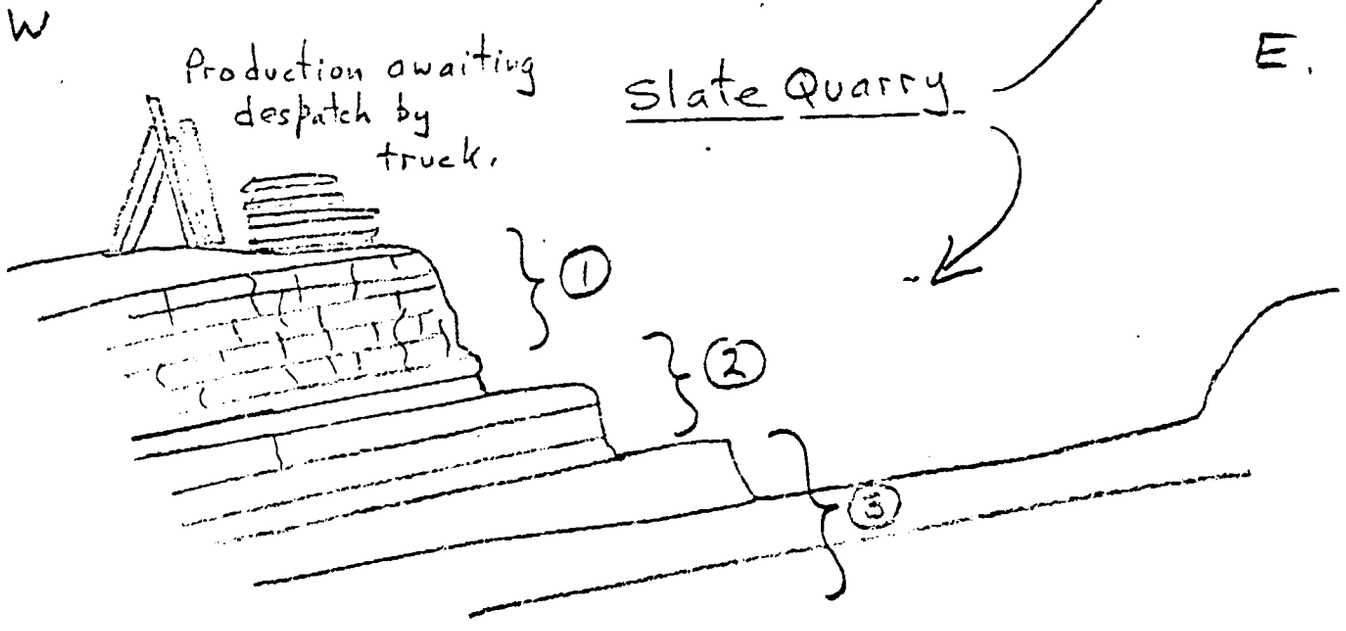
The quality of 'slate' stone being produced under the present system is limited by the lifting capacity of each pair of men. After removing the approx. 1 m of fragmented shale overburden and little or no soil cover, only the underlying 1 to 2 m of rock is quarried, as 'planks' up to a maximum of about 100 mm thickness. These are lifted out by hand and stacked on the down dip, i.e. west, side to await collection by the truck. In the next 0.5 m and floor of the quarry the rock is less fractured and it is suggested that it is this more uniform, better quality stone that should be quarried.

In addition to the well developed bedding planes, which, of course, facilitate the splitting by hand, there are also some near vertical (plunging 75° to the south) joints running approximately east-west. Though they are spaced more than a metre apart, these joints will greatly assist in the removal of the stone as blocks, which is the procedure that is recommended should be tried. The size of the blocks should be selected so that the dimensions are a multiple of 150 or 220 mm, or slightly more to allow for cutting. Some of the east-west 'cuts' can be along joints. The others and the north-south cuts will be by a line of chisels or by holes plugged with dry wood plugs which expand when moistened and crack the rock. The depth of the block will depend on where the next bedding plane split has occurred or else on the maximum safe working load of the tripod or derrick crane fitted with pulley and tackle. Probably blocks of 1 m X 1 m X 0.7 m, and weighing around 800 kg, are what should be tried initially.

These blocks would then either be split at the quarry or else be transported to Kanye for splitting and cutting. The main

LOCATION OF SLATE QUARRIES, DIPOTSWANA
with detail of present quarry operation.





① fragmented slate and soil overburden.

② present production horizon.

③ unexploited better quality slate that should be extracted as blocks.

Neville R. Hill
UNIDO Industrial Minerals Geologist.

October 1992

advantage to quarrying these regular shaped blocks is that there will be much less 'wastage' or production of 'offcuts' and other irregular pieces for which there is less sales value. The slate industry is usually well known for the quantity of waste rock produced in relation to the shaped pieces. Where possible these 'offcuts' should be left at the quarry and the relatively expensive transport element of cost should be aimed at moving the higher value prepared material.

Red Slate. This is said to occur in at least two locations in the Southern District. These are Moshupa, north of Kanye, and Mogobane, to the east of Moshupa and near to the Lobatse-Gaborone road. As an intended visit there was to take place the day prior to departure from Kanye, the findings, if any, from that visit will be found as an appendix to this report.(In fact the visit was not possible).

C. Development of Lime Quality Control Tests

The 3 t/d lime kiln nearing completion at Moshaneng, is the first to be set up by SRDA/MHT, apart from the small 'Zomba' kiln for testing raw material. At the request of SRDA/MHT, a set of tests has been compiled for monitoring the quality of lime made with these kilns. The tests can be used for checking the suitability of a possible new raw material as well as for monitoring the performance of the kiln in operation. The tests are devised and chosen so as to be those that can be performed with the facilities that can be made available as well as being appropriate for the grade of product and type of market. Apart from the GSD laboratory in Lobatse, over 60 km away, no laboratory exists in Kanye. The Rural Industries Innovation Centre (RIIC) in Kanye has a qualified chemist as well as some analytical equipment such as a burette, conical flasks, oven, thermometers, etc. Arrangements are being made for establishment of a small laboratory at RIIC which then would be able to do the available lime determination (Test No.5) and any others that could not be performed at the kiln site.

The simple equipment and reagents required are listed in each test and the eight tests, listed below, are described in detail in Appendix III.

1. Degree of calcination by weight loss.
2. Reactivity by hydration temperature-time curve.

3. Content of coarse particles by sieving.
4. Overall fineness comparison by bulk density.
5. Available lime by rapid sugar test.
6. Soundness by the pat test.
7. Degree of hydraulicity.
8. Colour of the lime wash.

Tests 1 and 2 are used to check the firing efficiency of the kiln and the quality of the quicklime being produced and can be performed at the kiln every 4 to 6 hours that quicklime is being drawn. The remaining six tests check the quality of the hydrated lime and are suitable for assessing the product of each kiln trial or production run.

D. Lime Hydration

The original SRDA/MHT proposal has been to hydrate the lime in slaking pits and then grind it. Unless some means of pressure hydration, at 4 to 7 kg/cm^2 or say 60 to 100 lb/in^2, can be devised and made by the SRDA or RIIC workshops, the dolomites will have to be slaked under water in deep slaking pits for possibly as long as 14 days to lower the risk of unsoundness. Then the lime would have to be sold and used as lime putty.

In this author's opinion, the more suitable raw material is the calcrete, e.g. at Met[illegible]; and although this could be slaked by traditional flo[illegible]atform slaking, it would be preferable to use a small mechanical hydrator. This could be say either a batch pan mixer or a continuous horizontal cylinder hydrator. Rough sketches have been drawn for SRDA/MHT to see whether it could be built in Kanye. Alternatively, slaking trials could be conducted using a building contractor's mortar mixer, i.e. of the rotating and tilting 'coffee-pot' type.

In SRDAs Building Materials Production Viability Study of January 1982 it was envisaged that the lime would be sold in 50 kg bags, at a price of P2.40 each. It is recommended that 25 kg bags be used as for lime 50 kg bags will be too bulky to handle. (The proposed selling price of P2.40 for 50 kg is very

low compared with prices elsewhere).

In the calculation of yield of hydrate upon hydration of of the quicklime, the SRDA Viability Study uses a factor of 1.333. This assumes that the quicklime is 100% CaO, though, and a more realistic yield of marketed hydrated lime would be 1.0 t per tonne of quicklime.

Finally, it was learned that the Botswana Meat Commission (BMC) tannery is importing lime. During a visit to the tannery the company said it consumes 180 t/y of white building lime imported from South Africa. Though the presence of magnesium hydroxide and grains of silica in SRDA lime might not be objectionable, there was strong preference for white lime, as otherwise it was considered that the hides would become stained. BMC has a small pilot vat available in which it is willing to carry out trials to check the de-hairing performance of any lime samples that SRDA would like to submit.(See Appendix V)

E. Brickworks

During visits to Moshaneng to conduct lime firing trials, visits were also made, with the counterpart, to the newly established fired clay brickworks in the village. The present system of slop moulding produces a very wet, soft brick which has many disadvantages. It tends to distort on demoulding, sticks to stones and other dirt on the drying shed floor, takes longer to dry and and is very susceptible to drying shrinkage cracking in windy conditions. Fortunately, the Moshaneng clays have a relatively moderate drying shrinkage, about 5% as measured on dried bricks being placed in the clamp and the firing shrinkage is only a further 1% approx. Otherwise, with no means at present of preventing strong wind blowing through the drying shed, one would expect much more of a cracking problem with wet slop moulding.

Attempts were made at sand moulding but the clay was too wet and when sand was added to make it drier, it became too weak and unable to maintain its shape when being released from a steel mould. Photographs of successful sand moulding by hand being practiced in southern England and elsewhere have been shown to the counterpart. It has been agreed that sand moulding will be adopted when the present production system has settled down. In the meantime, it is recommended that simple baffles be

erected around the drying floor on windy days.

The drying shed floor could be made smoother by applying and rolling a 1:3 mixture of hydrated lime and powdered underfired brick.

III. SRDA/MHT

The Southern Rural Development Association was established in 1979 and has its base in Kanye. There it operates a wholesale outlet, sales van, hardware, sorghum mill and extension services for collecting and marketing pottery, baskets, etc., shoe production and, in 1983, forestry. So far six trusts have been or are in the process of being set up as legal entities. Five of these are established in villages in the District and run grain mills, concrete block production and so on. The sixth trust, Mineral Holding Trust, started operating its projects in February 1982 and is to become legally established in November 1982.

MHT has acquired the mining rights to deposits of slate, dumps of waste dolomite and dolerite for the supply of stone for terrazzo, road and other building work, talc which also occurs in mine dumps, clays for brickmaking, limestone for lime manufacture and mineral iron oxide for red and yellow pigment.

Funding for SRDA has been by the Friedrich Ebert Foundation (FEF) of the Federal Republic of Germany which also recruits a team of advisers. MHT has been established with capital of around P200,000 supplied by USAID, FEF, the Dutch Government and SRDA itself, the latter having a 51% controlling interest.

Under a Board of Trustees, MHT has an Executive Committee which includes the Chairman of the Board of Trustees, the FEF representative, the MHT technical manager, the Secretary of the Board and representatives of Botswana Development Corporation (BDC) and Rural Industries Promotions (RIP). In Appendix II are short summaries of the present MHT projects. These range in capital investment from P6,700 for the slate to P39,000 for the lime and P57,000 for the terrazzo and road and building stone.

Although too soon yet to assess the economic success of all these activities by MHT, it is evident that they are being vigorously pursued. Many creative jobs have been established and

locally produced materials are becoming available, sometimes displacing items that would otherwise have to be imported and even obtaining export orders, to South Africa, as well.

As soon as an activity has become properly established and able to demonstrate that it can continue without further financial and technical support from SRDA, FEF, etc., then there will be the possibility of selling the operation as a going concern to an entrepreneur or lease it to a co-operative or some other arrangement.

These brief details are given here as it is considered that the work of SRDA/MHT in the industrial rock and mineral and building material field should receive wider recognition. It may act as a model for such development in other Districts of Botswana as well as outside the country. From this UNIDO adviser's experience of assignments in ten previous countries, very often the field and laboratory work, maps and reports and other good work of geological survey departments is not being used in the best interests of local people. This is because those wishing to work in mining of the non-metallic rocks and minerals and local production of building materials, etc., kaolin, graphite, talc, and so on which tend to be very much smaller operations than is the case with metalliferous mining, do not have the technical and entrepreneurial/managerial ability to get started and make the venture a success. There is the need in the non-metallic sector for bodies such as SRDA/MHT to be the catalyst and fill the gap existing between geological findings and self-sufficiency in building materials and other non-metallic mineral products which are basic to domestic living requirements.

The bulky nature and relatively low cost of these materials means that they cannot withstand more than fairly short haulage distance, either for the raw material or the products. As the element of transport cost rises with higher fuel prices, so there will be more local production, that is more small scale mining and mineral processing which can be based on quite small deposits. In turn this provides more business and employment opportunities in rural areas, which makes it more attractive for people to live and work there rather than migrate to the cities.

Accordingly, it is recommended that UNDP/UNIDO and other

funding organizations should take note of the work of SRDA/MHT in developing these activities in the industrial rock and mineral field and consider to what extent they may be applicable in similar situations elsewhere.

IV. FUTURE WORK PROGRAMME

The further technical assistance to SRDA/MHT, and elsewhere in Botswana, in small scale mining and mineral processing will be provided by an industrial minerals mining engineer who will be working with the Botswana Technology Centre (BTC). The expert fully supports this proposal and does not consider that it will duplicate the work done by the Geological Survey or Mines Departments, though close liaison with them will be beneficial to all departments working in this field. The person recruited will be able to take advantage of the information and other services of the newly formed African Regional Network for Small Scale Mining, based in Lusaka.*

It is recommended that UNIDO should consider whether a UNIDO expert or associate expert can be recruited to fill the above post of Industrial Minerals Mining Engineer at BTC. In Appendix IV there is a draft UNIDO Job Description for this post compiled from the data supplied by BTC. It is presumed that initially, at least, the BTC appointment will spend some time based in Kanye to further develop the SRDA/MHT mineral based projects. Improvement of the system of slate quarrying is one job and another will be implementing the IT-IS/IGS proposals for processing the talc.

Apart from the foregoing, it is not considered that any further follow-up work, by UNIDO, to the present mission is necessary. The chemist at RIIC is fully competent, when her laboratory is set up, to carry forward and implement the proposals made in this report (Appendix III) for the Quality Control Tests for Lime.

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* the contact is: W.B.Sikombe, Mindeco Small Mines Ltd., P.O.Box 32441, Lusaka, Zambia.

Acknowledgements

Various people and organizations have provided assistance with this assignment. The facilities provided by the Southern Rural Development Organization in Kanye are are gratefully acknowledged as also those of the Resident Representative, Mr. Manzur Zaidi, and his staff in the UNDP office in Gaborone.

Much relevant and useful geological data, particularly on the deposits of calcrete, was willingly provided, in the form of numerous reports, by Dr. Werner Grosdz, industrial minerals specialist in the Geological Survey Department in Lobatse.

The ready co-operation of Mrs.Sonja Barrett, research officer at Rural Industries Innovation Centre in Kanye, in agreeing to collaborate by establishing lime testing facilities is much appreciated. As a chemist she will be able to adapt the proposed Lime Quality Control Tests to the equipment and reagents that she is able to acquire for her laboratory at RIIC.

Finally, much benefit and enjoyment was obtained by being able to work with an active and interested counterpart, Mr. John Spiropoulos, Technical Manager of SRDAs Mineral Holdings Trust. Without doubt, much of the rapid progress made by SRDA/MHT in developing local industrial rock and mineral resources has been due to his energetic dedication to the implementation of MHTs various projects.

UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANIZATION

UNIDO 23 April 1982

Request from the Government of

BOTSWANA

JOB DESCRIPTION

RP/BOT/82/002/11-01/32.1.B

Post title Non-metallic Mineral Geologist

Duration 1 month

Date required As soon as possible

Duty station Gaborone, with travel within the country.

Purpose of project To facilitate the assessment of the relative merits of projects for the manufacture of mineral pigments, slate, quicklime, clay bricks, building stone and syenite.

Duties The expert will be attached to the Southern Rural Development Association (SRDA) under the Ministry of Commerce and Industry and will, specifically, be expected to:

1. Assist the SRDA in an assessment of the results obtained by geological raw material surveys and related laboratory investigations and their interpretation as a basis for a set of feasibility studies for the manufactures in question.

2. Advise on general aspects of the mineral processing operations under consideration and particularly on questions related to raw material quality and co-operate in the finalization of the feasibility studies to the extent the time permits.

3. The expert will also be expected to prepare a final report, setting out the findings of the mission and his recommendations to the Government on future action which might be taken.

..../..

Applications and communications regarding this Job Description should be sent to:

Project Personnel Recruitment Section, Industrial Operations Division
UNIDO, VIENNA INTERNATIONAL CENTRE, P.O. Box 300, Vienna, Austria

V.81-33106

Qualifications	Geologist with specific practical experience in evaluating non-metallic minerals in respect of their suitability for industrial processing.
Language	English
Background information	There is a promising potential in the Southern District for the production of building materials from minerals found in the region. The Production Development Committee (PDC) is very interested in promoting small-scale labour-intensive mining, especially since there seems to be a potential in its communal First Development Area. The SRDA has been identified by the PDC as being the most appropriate body in the district to implement the project. It is in line with the SRDA's objectives of rural employment creation and using local raw materials and they hold the rights from the Land Board for a variety of extraction sites in the district. The SRDA currently has two small projects in this field; slate stone at Dibajakwena and mineral pigments at Selokolela. There is much scope for improvement on these two projects and given this financial support to do through investigations these would be consolidated before doing any further exploitation. In addition, there are other mineral deposits which have been located, with the help of the Geological Survey, in or near the following villages, which could be exploited for the production of building materials, on a small scale. (a) Phitshane Molopo and Metlojane - calcrete for quicklime production (and possibly for the manufacture of low-grade cement). (b) Diabo and Digawana - brick clay (c) Moshana - building stone and dolomite and dolorite for producing terrazzo tiles (d) Letlapana - syenite for the production of wall tiles and building facades. Should the production of the above-mentioned building materials prove to be feasible, the various projects then established would provide employment in rural areas where there are few alternative sources of employment. After successfully establishing viable projects, the SRDA would seek to divest them to local entrepreneurs. of organizations while still providing marketing and technical assistance when necessary.

APPENDIX II (i)

MHT PROJECT SUMMARY

TITLE LIME MANUFACTURE

PRODUCTS Hydrated lime 1188 t/y

MARKET Local builders in Southern District. Also as far as Gaborone. Tannery in Lobatse imports 180 t/y. Total 1980 imports said to be 5,649 t. Possible applications for acid soils and in road stabilization.

FINANCE Total capital projected Jan.1982: P39,031.

PERSONNEL 11 to 13 full time.

RAW MATERIALS Dolomite in mine waste at Moshaneng from asbestos mining. Is hard,compact dolomite marble,many thousands of tonnes of rock already mostly to appropriate size for feeding lime kiln. Other dolomite deposit at Diphawana,11 km S. of Kanye. Also calcrete at Metlojane, etc.

PROCESS The waste dolomite is selected according to the size to be burned. Then fed-alternately with Morupule coal as fuel, in approx. proportion 1 of coal to 3 of limestone by weight, into top of a continuously operated vertical shaft kiln, capacity 3 t/d. The quicklime is then hydrated with water, preferably to a dry hydrate by mechanical hydrator, or else by pressure hydrator or deep slaking pit if magnesia is causing unsoundness.

QUALITY CONTROL A set of 8 Lime Quality Control tests: On the quicklime:1)degree of calcination by weight loss.2)reactivity by temp/time curve of hydration.On the hydrate: 3)coarse particle content by sieving. 4)Overall finess by bulk volume. 5)Available lime content by RST. 6)soundness by pat test.7)Hydraulicity 8) Colour..

ASSESSMENT Moshaneng dolomite,raw material selected for first SRDA kiln, makes pale purple or lilac hydrated lime. May have to be marketed as lime putty after several days slaking.Ready crushed rock at Moshaneng is a big advantage if lime can be marketed. The better prospect for lime making is using calcrete at Metlojane.

PRESENT STATUS Moshaneng kiln awaits arrival of imported refractory bricks for kiln lining. Also development of hydrating method not settled.

Date: October 1982.

APPENDIX II (ii)

MHT PROJECT SUMMARY

TITLE	BRICK MAKING.
PRODUCTS	Fired clay bricks, hand made 220X110X65 mm. 1500 to 2000 a day planned for first two years. 2500 to 3500 by the end of the second year.
MARKET	Southern District, radius of 50 km, could include Lobatse. No other local clay brick production. To compete with cement based blocks and 'bricks'. Sale price of Moshaneng bricks to be P60 per 1000 for harder blue bricks. P54 (now P60?) for the red fired bricks, less hard.
FINANCE	Capital cost of plant, equipment, buildings and contingency was forecast in Jan.'82 to be P18,215.
PERSONNEL	Usually 14 at present, full time, at P3.20 per day.
RAW MATERIALS	Three clays from the Moshaneng area, including two on site. Low drying shrinkage - about 5 to 6%, low FS - about 1%. Probably adequate resources for small scale production. Coal fuel from Morupule at approx. P36 /t, to Moshaneng.
PROCESS	The clays are blended and soaked overnight in a pit. Then being pugged by a manually operated vertical pug mill and slop moulded in a 4-gang wooden brick mould. Dried for two days in a drying shed on the floor then stacked in hacks. Fired by coal in a clamp. 100 kg of coal per thousand bricks. Then restacked and some taken to MHT Kanye for sale there.
QUALITY CONTROL	none at present . Bricks graded according to colour/hardness.
ASSESSMENT	Production process has not yet settled down to present system. Wet slop moulding and lack of wind breaks is causing 20%? breakage due to shrinkage cracking. A switch to sand moulding would improve product quality and reduce breakages. Unnecessary handling of bricks from the clamp before sale can be eliminated by selling direct from the clamp.
PRESENT STATUS	Production and sale of slop moulded stock bricks has been established. Prospects are good for production of better quality bricks with the good clays available. Present production rate is 1500 to 1600 a day. Clamp holds 15,000 to 20,000 bricks.
Date:	October 1982.

MHT PROJECT SUMMARY

TITLE — TERRAZZO CHIPS BUILDING AND ROAD STONE

PRODUCTS — Terrazzo chips, various colours, 3 - 7mm and 7 - 12 mm. Crushed dolerite for road abd building stone.

MARKET — In Botswana and also S.A. for terrazzo chips. P45.00. Used for terrazzo tiles, exposed paving and concrete facades. Building and road stone in Kanye area. There is a crushed stone plant in Lobatse. P12.00/m^3.

FINANCE — Capital cost estimates in Jan.'82:
Terrazzo: P24,000. Building stone: P72,800.

PERSONNEL — Terrazzo 8 and road/building stone 12. Of those 20, 8 would be on the crushing plant.

RAW MATERIALS — Hard, fine grained dolomite, in various colours, yellow, white, etc., exists in large quantity as ready crushed mine waste at Moshaneng. Resources adequate for many years.

PROCESS — The stone is to be washed and sorted by hand at Moshaneng. Then to be passed through a jaw crusher and a Kennedy Gyratory Crusher to produce equidimensional chips for terrazzo work. Blocks of dolerite from near the old asbestos mine dumps will be blasted and crushed for use as road and concreting material in selected size grades.

QUALITY CONTROL — By visual inspection of the terrazzo.

ASSESSMENT — Apperas to be a good market for building stone as already local contractors are paying P15 to load the mine waste onto their own trucks.

PRESENT STATUS — Jaw crusher and gyratory crusher, purchased second hand from S.A., now being installed at Moshaneng.

Date: October 1982.

APPENDIX II (iv)

MHT PROJECT SUMMARY

TITLE SLATE

PRODUCTS 10 mm thick cut tiles:150, 220 and 300 mm square. Irregular stones. Offcuts. Grey 'slate'.

MARKET Slate from S.A. is sold at P16 to P25 / t. Francistown slate is P14 /t. SRDA sells irregular slate at P8 /t. Floor tiles, cut to size, sell for P7 /m^3 in Gaborone. In 1981 SRDA sold 310 t.

FINANCE Capital and contingency cost forecast in Jan.'82 to be P6,723.

PERSONNEL 6 part time in 3 teams of 2 in the quarry at Dipotswana. 3 full time, at MHT Kanye, etc.

RAW MATERIALS A hard, fissile shale, dark grey, occurs at the surface at Dipotswana 42.5 km south of Kanye. A minimum of 50,000 m^3 exists there and probably very much more.

PROCESS The 'slate' is extracted by means of crowbars, chisels and hammers as irregularly shaped 'planks' up to a maximum of approx 100 mm thickness. The size (thickness) is limited by the strength of each pair of men. Then by truck to Kanye where it is split by hammer and cold chisel into thinner irregular slabs. Some is sold in that form, other is sawn by circular saw into tiles.

QUALITY CONTROL None seen. The wastage of raw material, after transport to Kanye appears to be high.

ASSESSMENT The quarrying and processing procedure need to be changed so that wastage (amount of offcut material) is reduced at Kanye. With the help of simple tripod or derrick cranes the men should cut and lift out regular shaped, thick blocks. These would be easier to split without breakage occurring.

PRESENT STATUS Quarrying proceeding on an irregular basis. Regular hand splitting but no regular production of sawn tiles.

Date: October 1982.

APPENDIX II (v)

MHT PROJECT SUMMARY

TITLE	RED AND YELLOW MINERAL PIGMENT
PRODUCTS	Red and yellow mineral iron oxide pigment in 500 g and 1 kg bags.
MARKET	In floor screeds, etc. In Botswana and possibly also in Mafeking and elsewhere in S.A. The Botswana market estimated to be 1500 kg a month, and 2000 kg a month to sell in S.A. In Botswana: red 0.44 Pula /kg, yellow 0.40 Pula /kg.
PERSONNEL	50 part-time digging the deposit and pounding the pigment. 2 full time.
RAW MATERIALS	Red and yellow iron oxide mudstone at Selokolela, 22 km west of Kanye. The red contains 55 % Fe_2O_3 and the yellow 35 % . At around 2.5 t a month there would be a few years supply, according to the GSD.
PROCESS	Mudstone is dug from pits. Screened, selected and pounded by hand at Selokolela. Bought by the basket by SRDA(MHT) and packed into 500 g and 1 kg bags.
QUALITY CONTROL	Coarse particle determination. i.e. % retained on 0.063 mm.
ASSESSMENT	Life uncertain. Provides part time employment for many villagers. Some wastage by broken plastic bags which have to be re-filled.
PRESENT STATUS	Trommel screen being set up to improve fineness of pigment.
Date:	October 1982.

APPENDIX II (vi)

NHT PROJECT SUMMARY

TITLE	TALC
PRODUCTS	To be milled, refined talc for ceramic and possible other applications.
MARKET	Ceramic industries in S.A.
FINANCE	
PERSONNEL	12.
RAW MATERIALS	Dumps of two grades of talc at the old Mabelane talc mine of Ceramic Industry (PTY) Ltd.
PROCESS	The lumps of talc are removed by picks and shovels and then trimmed by small axes to clean off dirt.
QUALITY CONTROL	
ASSESSMENT	Market already exists in S.A. for raw talc. Upgrading by milling and beneficiating is logical means of getting added value. Reserves not seen.
PRESENT STATUS	Samples collected by T. Wels of IT-IS are to be assessed by IGS to determine appropriate method for processing. Sales of raw talc rock to S.A. have been suspended.
Date:	October 1982.

LIME CONTROL TESTS FOR MONITORING THE OPERATION OF SMALL LIME KILNS AND FOR CHECKING THE QUALITY OF THE HYDRATED LIME

A. TESTS ON THE QUICKLIME DURING KILN OPERATION

Test 1. To determine the degree of calcination of the limestone, by determining percentage weight loss.

Test 2. To assess the reactivity of the quicklime, by determining the temperature v.time hydration curve.

B. TESTS TO COMPARE THE QUALITY OF THE HYDRATED LIME

Test 3. To check the fineness by determining the proportion of coarse particles by sieving.

Test 4. To compare the overall fineness by determining the bulk density.

Test 5. To determine the content of available lime, by the Rapid Sugar Test.

Test 6. To check the soundness of the lime, by the pat test.

Test 7. To test the degree of hydraulicity of the lime.

Test 8. To compare the colour of limewash made using different limestones as raw material.

Note: Tests 1 and 2 can be performed on the batches of quicklime drawn every 4 to 6 hours so as to monitor the performance of the kiln during firing trials, as well as for periodic checks during production runs.

Tests 3 to 8, inclusive, as well as Tests 1 and 2, can be used for comparing the quality of the lime made, either when carrying out kiln trials or when testing different sources of raw material.

TEST FOR THE DEGREE OF CALCINATION OF A LIMESTONE

(and proportion of unburnt material)

This test is used as a means of monitoring the performance of a lime kiln. The quicklime that is discharged every 4 to 6 h is weighed and compared with the original weight of the limestone. If the carbonate content of the limestone is known then the actual weight loss obtained can be compared with that maximum which is theoretically possible for that limestone.

APPARATUS

Steel bucket, capacity 10 to 20 litres or 2 to 4 gallons, having a straight, level top.

Scale, weighing to at least 25 kg or say 50 lb.

METHOD

Weigh the bucket empty (W_b).

Weigh the bucket filled to the top with pieces of limestone of the size that are to be burned. (W_1).

Weigh the bucket filled to the top with lumps of the quicklime.(W_2)

Obtain two more values for W_2, and take the average.

The the percentage weight loss of the limestone is given by:-

$$\frac{W_1 - W_2}{W_1 - W_b} \times 100 = WL\% = \underline{\%\ \text{weight loss.}}$$

This figure can be used for comparing the effect of changing parameters, such as fuel : limestone ratio, size of limestone feed, etc.

Suppose the content of CO_2 in the limestone, in the calcium and magnesium carbonates present, is CC% .

Then the degree of calcination can be expressed as the proportion:

$$\frac{WL\ \%}{CC\ \%} = \underline{\text{degree of calcination}}.$$

When $\frac{WL}{CC} = 1$, then the limestone has been fully calcined.

The proportion of unburnt material, as carbonate still in the product, is given by:-

$$CC\ \% - WL\ \% = \underline{\%\ \text{unburnt carbonate}}.$$

Caution. This method will give satisfactory results provided that the quicklime has remained as lumps, of approximately the same size and form as the original limestone feed.

METHOD FOR ASSESSING THE REACTIVITY OF A QUICKLIME

(temperature v. time curve)

The procedure makes use of the fact that the slaking of quicklime, with water, to produce hydrated lime is an exothermic reaction. Lime that has been softly burned, i.e. at a temperature maintained just long enough to calcine the limestone i.e. to remove the CO_2 from the $CaCO_3$ and leave quicklime, CaO, will react rapidly with water and produce calcium hydroxide: $CaO + H_2O = Ca(OH)_2$ plus heat. Lime made by burning at a too high temperature will be hard burned or overburned and be either slow in hydrating or even non-reactive.

By comparing the rate of evolution of the heat of hydration, the reactivity of samples of quicklime may be compared.

APPARATUS

No.7 mesh sieve (2.83 mm).
Thermos flask.
Thermometer reading to at least 100°C.
Clock or watch with seconds hand.
Scale to weigh 50 g to ± 0.5 g.

Also a pestle and mortar or other means of crushing the quicklime to pass the No.7 mesh.

METHOD

Take several lumps of fresh quicklime and break them in a pestle and mortar, or by hammer on a clean surface, into small fragments. Take a representative sample, by cone and quartering or use of a riffle, until 100 to 200 g remains. Pass the whole of this sample through a No. 7 mesh sieve (2.83 mm), grinding up the oversize , re-sieving and repeating. (It is important that not just the outside, calcined portion of the quicklime lumps passes the sieve but also any underburned core as well as other, harder material such as any siliceous rock fragments).

Carefully weigh out 50 g of the passing 7 mesh quicklime and put it into a thermos flask in which there is 170 ml of water at the normal prevailing water temperature. If it is, say, 23°C, then the water temperature should be brought to that temperature, if necessary, before adding the lime. At one minute intervals note the temperature of the water, keeping the lime-water mixture gently stirred with the thermometer.

Record the maximum temperature observed and the time that it was reached. Continue taking readings for 24 minutes. To compare rectivities graphically, plot the temperature readings on a graph to obtain temperature v. time curves.

SIEVE METHOD FOR CHECKING THE FINENESS OF HYDRATED LIMES

(sieve method)

When quicklime is hydrated, the product i.e. slaked or hydrated lime, is normally a very fine, voluminous, soft powder which is quite fine enough for its many uses. This is providing that the material is actual lime hydrate, $Ca(OH)_2$. Because the original limestone is seldom pure, and part of the limestone may have been underburned so leaving some limestone 'core' when hydrated, these coarser particles can be deleterious and should be removed. To check on the proportion of coarse material still remaining in the hydrated lime, after screening, milling, cycloning, etc., and before despatch of the product to the customer, a simple quality control check is to determine the amount of material that is retained on two selected wire mesh sieves.

APPARATUS

No. 30 mesh sieve (600 microns).

No. 200 mesh sieve (76 microns).

Scale reading up to say 500 g with an accuracy of 0.5 g. *

* or coarse laboratory balance.

METHOD

Take a representative sample of the hydrated lime.

Reduce it in size by riffling or cone-and-quartering to between 100 and 200 g. Weigh this lime. (W_1).

Sieve the whole of the sample through the No.30 and No.200 mesh sieves and weigh the amounts retained on the two sieves, W_{30} and W_{200}, respectively.(As a check, weigh also the remainder that passes the No.200 mesh.).

Calculate the percentages retained thus:

$$\% \text{ retained on No.30 mesh} = \frac{W_{30}}{W_1} \times 100$$

$$\% \text{ retained on No.200 mesh} = \frac{W_{200}}{W_1} \times 100$$

Check that $W_{30} + W_{200}$ plus the weight of the material passing the No.200 mesh agrees with the original weight, W_1.

Some Specifications:	No.30	No.200
Hydrated hydraulic lime, ASTM C141.	Not more than 0.5% retained.	Not more than 10% retained.
Hydrated lime for Sugar Manufacture. (Bureau of Standards, USA)	-	98% will pass the mesh

A METHOD FOR COMPARING THE OVERALL FINENESS OF HYDRATED LIMES

(by bulk density)

One of the properties of hydrated lime that makes it a valuable component of building mortars is its plasticity. Lime not only improves the plasticity, or workability, of a mortar but it also increases the water retentivity of the mix. This is because the specific surface area of lime, around 13,000 cm^2/g, is much greater than that of Portland cement which can be only 3,200 cm^2/g. The specific surface area of the other mix component, sand, is much lower still, of course. There are various methods for determining the plasticity properties of fine powders such as hydrated lime and mortar mixes, including the use of a flow table, etc.

When one wishes to compare the specific surface area, or overall fineness, of powders made of the same mineral substance, or having closely similar specific gravities, the bulk volume of the uncompacted powder can be used. The method has been applied by Robertson to diatomaceous earths.

APPARATUS

Bucket or other plain, flat top receptacle, 10 to 20 litres capacity, or say 2 to 4 gallons.

Scale weighing up to 25 kg, or say to 50 lb.

METHOD

Weigh the bucket empty. (W_b).

Weigh the bucket filled to the brim with water. (W_{b+w})

Hence determine the weight of water: $W_{b+w} - W_b = W_w$.

Dry the bucket and fill it to the brim with the hydrated lime. For each determination, use a uniform procedure for filling the bucket, eliminating any possible large air voids by tapping the top of the bucket a set number of times with a piece of wood.

Weigh the bucket full of lime. (W_{b+l}) . The weight of lime is then: $W_{b+l} - W_b = W_l$.

As the density of water can be taken as being 1 g/ml, then the volume of the bucket, V_b, in ml, is the same as the weight of water in the bucket, W_w, in g, i.e. $V_b = W_w$.

Then the bulk density of the lime is given by: $\frac{W_l, \text{ in g}}{V_b, \text{ in ml}}$.

For commercial hydrated lime this will be around 0.575 g/ml, or 575 kg/m^3.

Values obtained by this procedure for other mortar materials are likely to be: Ordinary Portland cement, approx. 1400 - 1450 kg/m^3.
Silica sand, for building use, approx. 1675 kg/m^3.

LIME CONTROL TEST No. 5.

DETERMINATION OF AVAILABLE LIME BY THE RAPID SUGAR TEST

The following is the procedure specified by the ASTM. Boynton (p.492, The Technology of Limestone and Lime, Wiley, New York, 1966) considered it to be the simplest, most expeditious method and equal or superiour in accuracy to other methods.

APPARATUS

300 ml Erlenmeyer flask i.e. a conical flask, having approx. volumes marked at certain intervals .

100 ml burette, with stand. (A wooden stand can be made locally).

Balance, capable of weighing 0.85 and 0.5 g to an accuracy of 2%, i.e. to 0.01 g. Also a No.100 mesh sieve.

MATERIALS

CO_2 free distilled water, if available.

Hydrochloric acid (sp.gr. 1.18). 15.7 ml per litre of dist.water.

Anhydrous sodium carbonate, Na_2CO_3. 0.85 g.

Methyl orange indicator.

Phenolphthalein indicator. 2 drops.

Sucrose, granulated sugar is satisfactory. 15 g.

METHOD

Take 0.5 g of -100 mesh lime and brush it into a 300 ml Erlenmeyer flask containing 20 ml of CO_2 free dist. water and stopper the flask. Swirl and heat to boiling for 2 min. Add 150 ml water and at least 15 g of sucrose. Stopper flask, shake at intervals for 5 min. and allow to stand for 30 min. to 1 h. Add 2 drops phenolphthalein, wash down stopper and sides of flask with more pure water, then titrate in the original flask with the standard HCl soln.* Add about 90% of the estimated amount of acid before shaking the flask and then complete titration, with the final acid being fed slowly until the pink colour disappears. Note the reading: 1 ml of the acid soln. is equivalent to 1% available lime expressed as CaO.

* Standard HCl solution: 15.7 ml of HCl (sp.gr. 1.18) per litre of CO_2 free distilled water. The solution is standardized against 0.85 g of anhydrous Na_2CO_3 with methyl orange as indicator, so that this amount will neutralize exactly 90 ml of standard HCl soln. In adjusting for this, add more water if it is too strong or more acid if too weak.

LIME CONTROL TEST No. 6.

A SIMPLE TEST FOR CHECKING THE SOUNDNESS OF HYDRATED LIME

(pat test)

When a calcitic limestone, i.e. consisting of calcium carbonate, $CaCO_3$, is calcined to CaO, quicklime, and then hydrated with water, the conversion of calcium oxide to calcium hydroxide, $Ca(OH)_2$, proceeds without much delay providing the lime has not been over burned. Overburning causes the calcium oxide to develop larger crystals which are slow to hydrate. If this hydration takes place in the mortar, then the brickwork or rendering may suffer damage due to the volume increase that takes place as the hydrate is formed. There is greater risk of the lime being unsound if it has been made from a dolomitic limestone, i.e. containing crystals of dolomite, $CaCO_3.MgCO_3$, in addition to calcite, $CaCO_3$. The quicklime then contains not only calcium oxide but also magnesium oxide or periclase, MgO. The hydration of this to magnesium hydroxide, or brucite, $Mg(OH)_2$, is much slower than the hydration, or slaking, of calcium oxide. In the United States, lime made from dolomitic limestones is now the preferred lime for building purposes, but this has become possible because of the installation of autoclave or pressure hydrators that force the reaction to completion. For the typical smaller scale lime making industries in developing countries, in many cases it is still necessary to slake dolomitic lime as a lime putty, keeping the saturated lime covered with water in a deep slaking pit, for as long as 14 days, or until all the magnesia has hydrated. (Such slaking also improves the plasticity of the lime. In A.D.79 Pliny the Elder advocated that no lime should be used until it had been slaked for three years).

The following very simple test can be used to check whether any unsoundness remains in the lime.

APPARATUS

Some watch glasses or discarded saucers.

A palette knife or other broad-bladed, round-ended knife.

An impervious smooth surface such as a sheet of plate glass or slate.

METHOD

Mix the hydrated lime with some water into a stiff paste on the slate surface, using the palette knife. Fill the saucer with the paste and draw the knife across the surface to leave a smooth, flat surface. Leave to stand on the workbench, i.e. indoors, and observe the condition of the surface. If the surface develops 'pitting and popping' then the lime is adjudged to be unsound. The lime should be examined daily for up to four weeks.

TEST FOR HYDRAULICITY OF LIME

This test determines whether the lime is able to harden under water and thus have applications as a binding material for use in aqueous environments, such as the linings of irrigation ditches, as well as for the usual uses of lime in building.

Equipment.

Curing tank with water at known, constant, ambient temperature.
Plain brick moulds, e.g. 225 X 110 X 65 mm approx.
Simple 3-point load device for comparing bending strength of brick sized prisms.
Grocer's scale for weighing up to 10 kg of sand, also lime.

Method.

Hydrate the quicklime to a dry powder. Remove underburnt core and other lumps by sieving through a coarse mesh e.g. 3/8th inch (9.51 mm) and then through a No.30 (0.6mm) or No.35 (0.5mm) mesh sieve.

Weigh out one part of the lime and three parts of dry, standard, building sand (100% passing 3/16th inch sieve, 4.76 mm, and mostly between No.7, 2.40mm and No.100, 150 micron, sieves). Mix together and add only enough water to make a stiff paste. (Preferably note the volume (ml) of water required, for comparison with other limes).

Cast the mix into three or more brick moulds. Allow to harden sufficiently to be de-moulded, say two days (48 hr from moulding) in the test laborarory. Then carefully place the bricks under water in a curing tank, maintained indoors at the prevailing 'ambient' temperature (probably about 23°C).

After a further 12 days, i.e. 14 days from casting, remove the bricks, dry the surface water with a towel, weigh the bricks for comparison with other tests as a check on degree of compaction, and test in a three-point load flexural strength test frame. Record the total load applied on the brick when failure was reached and average the results.

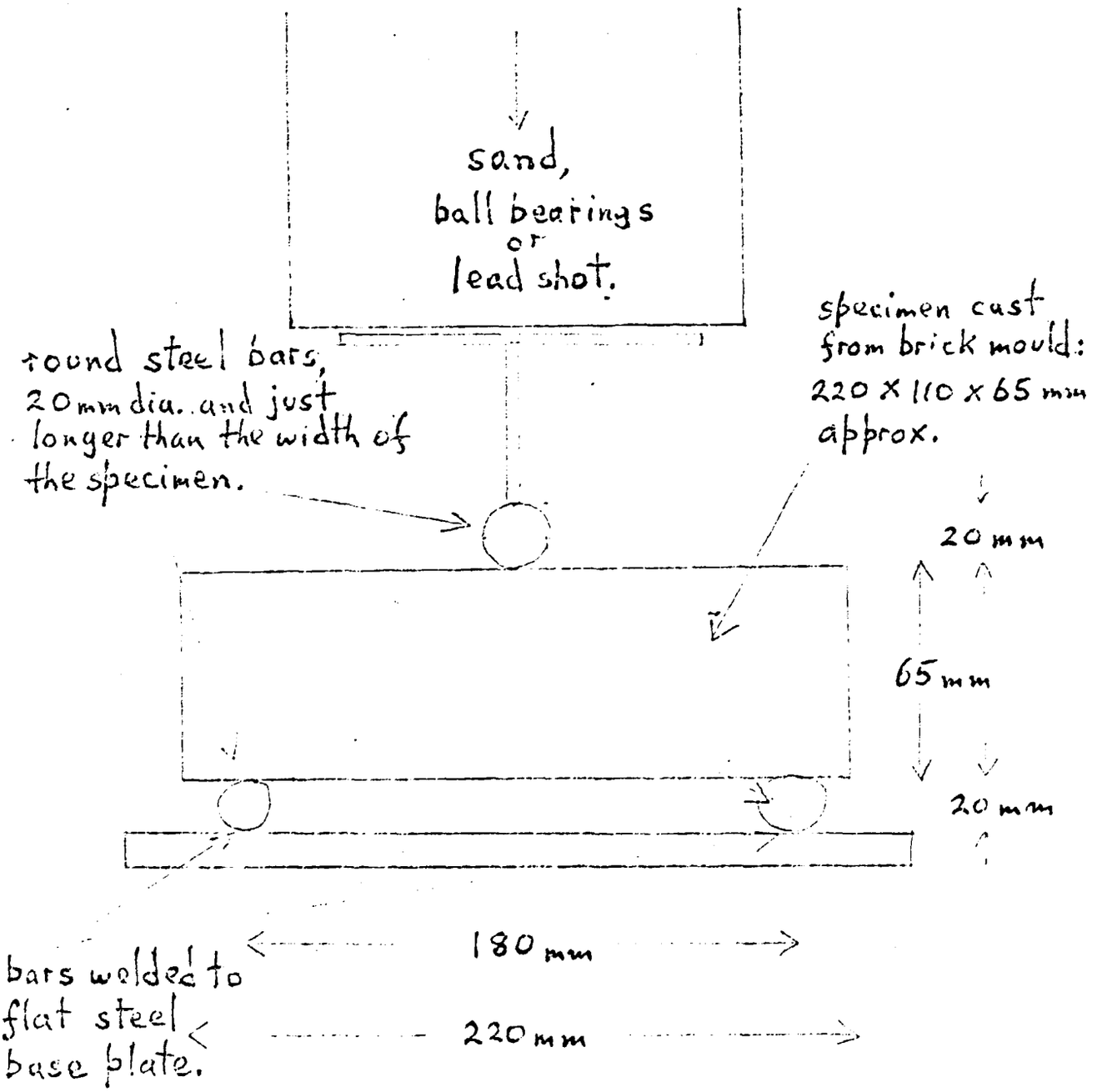
Notes.

An indication of degree of hydraulicity of the lime from particular limestones can be gained from the content of clay-grade material:-

Active Clay Content (%)	Designation (after Spence)
less than 12	feebly hydraulic
12 - 18	moderately hydraulic
18 - 25	eminently hydraulic

If, because of the thickness of the bricks or the load possible with the testing device, the bricks do not break, the mix proportions can be weakened to, say, 1 : 6.

SCHEMATIC DIAGRAM TO SHOW PRINCIPLE OF 3-POINT LOAD TEST FOR MEASURING FLEXURAL STRENGTH



A METHOD FOR COMPARING LIMESTONES AS RAW MATERIALS FOR MAKING LIMEWASH

One of the important uses for lime, especially in rural areas, is as a whitewash for the decoration of the walls of houses. Using lime in this way also helps to reduce germs in buildings, as the alkaline nature of the lime makes it a mildly antiseptic surface and so this is particularly useful for dispensaries, dairies and kitchens, etc. Limewash has been shown to be the most cost effective means of preserving bamboo matting, used in south-east Asia, for instance, as wall panels. Finally, a bright, white surface on an exterior wall reflects much of the Sun's heat and so helps to keep the interior cool during the day.

Limestone that is light in colour will often produce a white lime when it has been calcined and then slaked. This is not always the case and the final colour of the dried limewash cannot be predicted. Some quite dark grey limestones, such as parts of the Carboniferous Limestone of Derbyshire, in England, are the raw material for the principal U.K. lime manufacturer, whose white lime is exported to many countries.

The preference for a white lime for decorative limewash should not mean that all lime for building purposes has to be white. Unfortunately, for this or some other reason, there has developed in many countries a kind of anti-grey lime propaganda. As a result, the useful properties of hydraulic and semi-hydraulic limes, that can be made by using argillaceous, clayey (alumino-siliceous), limestones, not only for irrigation ditches, but also in ordinary building mortars for brickwork and renderings, are not being realised).

For much decoration work, especially internally, in bedrooms and elsewhere, a coloured limewash may find a ready market. The Moshaneng dolomite of the Southern District of Botswana produces an attractive, lilac coloured limewash, and yet the raw material finds application as terrazzo because of its bright white and yellow colours.

METHOD

Fire the limestone in a small batch test kiln and slake the lime to a thick creamy consistency. Drain through a fly mesh (approx 1 mm) and brush the limewash onto a flat surface, such as a slab of slate, a bare wall of rammed earth, etc. Allow to dry. Compare the dry colour with that of limewashes made using other sources of limestone. Use such an exposure site for testing the durability of waterproof lime washes, made by incorporating tallow during the slaking, etc.

U N I T E D N A T I O N S

UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANIZATION

U N I D O

Request from the Government of

BOTSWANA

J O B D E S C R I P T I O N

/BOT/ / / /

Post title :Industrial Minerals Mining Engineer

Duration :12 months with the possibility of extension

Date required :As soon as possible.

Duty station :Gaborone, with periods spent in Kanye and elsewhere within the country.

Purpose of project :To assist miners and others in the promotion of village based mining and processing operations. The expert will work as a staff member of the Botswana Technology Centre, reporting to the Chief Engineer, and specifically will be expected to carry out the following duties.

Duties

1.:Provide technical advice to Government authorities, development associations, etc., on the exploitation of deposits and the treatment of minerals, including: sources of finance, equipment, safety and health, marketing and uses as well as the requirements of small scale miners and mineral processors.

2.:Liaise with the Department of Mines and Geological Survey Department, particularly in the compilation of an inventory of deposits likely to be suitable for small scale exploitation.

3.:Provide direct technical assistance to small scale mining and processing activities, including assistance

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with applications for prospecting licences, registration of claims and other formalities.

4.: Dissemination of ideas and information on small scale mining, by written articles, assist maintaining the BTC library on the subject, organise local courses for operators and arrange for attendance at other courses as appropriate.

Language :English

Qualifications :A degree or other qualification in mining engineering and experience in small scale mining and mineral processing operations, especially surface exploitation of non-metallic rocks and minerals. Must be a practical, resourceful person with initiative and the ability to improvise when necessary.

Background :Traditionally agriculture, particularly the raising of cattle, has been the mainstay of the Botswana national economy. In recent years the contribution of the mining sector to the GNP has become increasingly important with the development of major industries for the recovery of diamonds and copper and nickel. These have reduced, to some extent, the migration of people to the towns as well as to South Africa.

The Botswana Technology Centre (BTC), founded in 1979 to serve and co-ordinate all appropriate technology endeavours, has an annual budget from the Government equivalent to approx. US$220,000 and a core staff of eight. Its major objectives are:

:to evaluate the possibility of new technologies adapted to local conditions, especially in rural areas.

:to assist in the application of suitable technologies on the creation of new industries.

:to found a National Technology Library and Information Retrieval Centre.

The Southern Rural Development Association (SRDA) in Kanye has brought into operation through its Minerals Holding Trust projects for exploiting limestone for lime making, clays for brick production, dolomite

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for terrazzo, dolerite for concreting and road stone, iron oxide mineral for pigments and talc as a ceramic raw material. SRDA works in close technical collaboration with the Rural Industries Innovation Centre, also located in Kanye.

The Ministry of Commerce and Industry is to commission a country wide survey by consultants on raw materials for building material manufacture. The findings are likely to reveal many further opportunities for small scale quarrying and processing of industrial rocks and minerals.

THE USE OF LIME IN THE TANNERY OF THE BOTSWANA MEAT COMMISSION, LOBATSE.

Date: :22nd October 1982

Personnel: Mr. Sven Jönsson, Tannery Manager.
Mr. Andy Esplin, Tannery Technician.
Mr. Neville R. Hill, UNIDO Non-metallic Minerals Geologist.

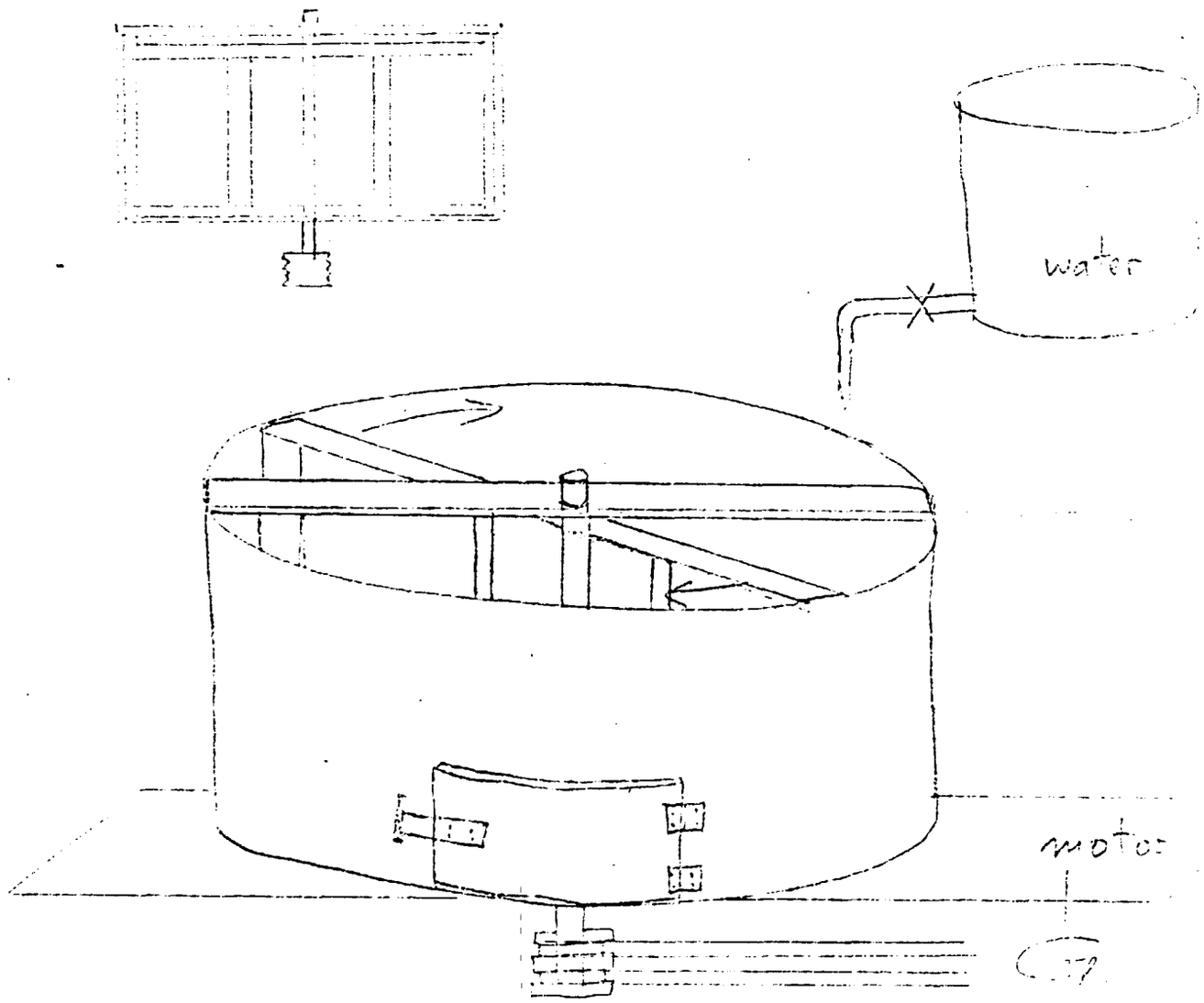
At the time of the visit the tannery was shut down for the annual one month maintenance.

Lime Usage. From January to June, inclusive, 21 t a month of hydrated lime is used. For the remainder of the year the rate is 40% of that. Hence the annual consumption is 180 t/y.

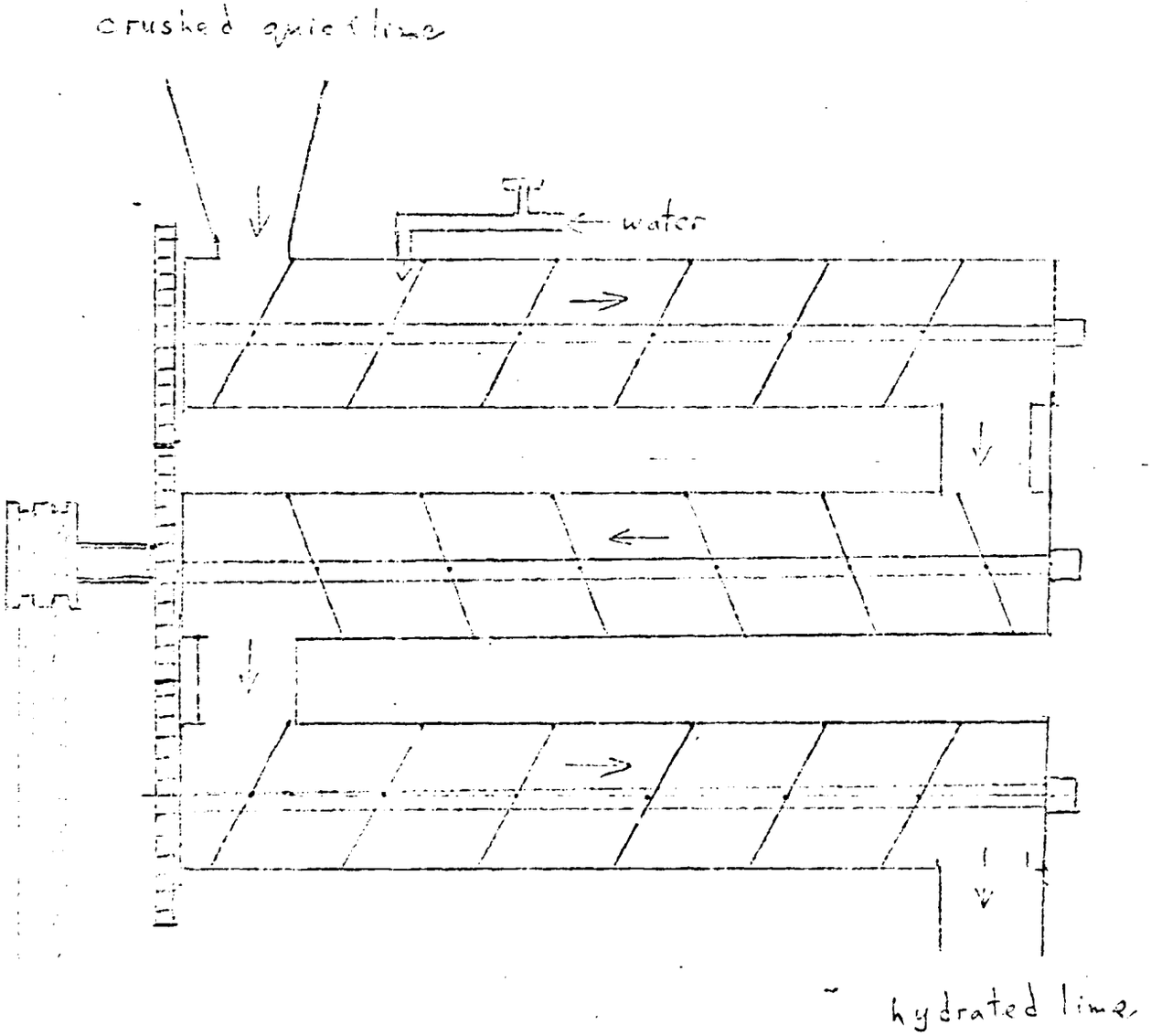
The lime is imported from S.A. The price inc. transport was said to be 9 thebe/kg, i.e. Pula2.25 /25 kg bag or Pula 90 per metric tonne. (approx 1.08 Pula to 1 US Dollar). There are at least two S.A. suppliers: Premier Lime and Daghalim. The latter is designated as being Type A2 Hydrated Building Lime for plaster and bedding mortar. For an average size cow skin, approximately 0.75 kg of lime is consumed.

Process. The lime is used to de-hair the skins, and this is the first stage of the tanning process and starts usually only a day after the animal has been killed. If lime is used on its own, as was done traditionally, dehairing can take 10-12 days for a cattle skin. BMC uses some sodium sulphide, Na_2S, to accelerate the process to around one day. The solubility of lime in water is from 1.2 to 1.7 g/litre, according to temperature, or say 1.5g/l in the process. The rotating, wooden vats have a capacity of 5000 litres, so 7.5 kg can be dissolved. To ensure there is always enough, as the lime gets absorbed into the skin, BMC uses 3%, i.e. 150 kg. The pH is kept to 13.5 and on discharge from de-hairing the pH is 13. Thereafter, the skins are de-limed with ammonium sulphide and the rest of the tanning process, with chrome, etc proceeds in a second lot of vats.

Possibility of using SRDA lime. There is a small vat available in which the company would be able, and willing, to try out SRDA lime. There would have to be no colour staining of the skin and so Mr. Jonsson believes the lime should be white. The effect of magnesia in the lime, from dolomite, is not certain.(1500 kg of magnesium oxide, from Germany, is consumed a month for precipitating the chrome at the effluent plant.) Any switch to SRDA lime would be judged on cost,(price v.quantity needed) and performance.



TYPE OF PAN MIXER FOR BATCH HYDRATION OF LIME.



TYPE OF HYDRATOR FOR CONTINUOUS HYDRATION OF LIME