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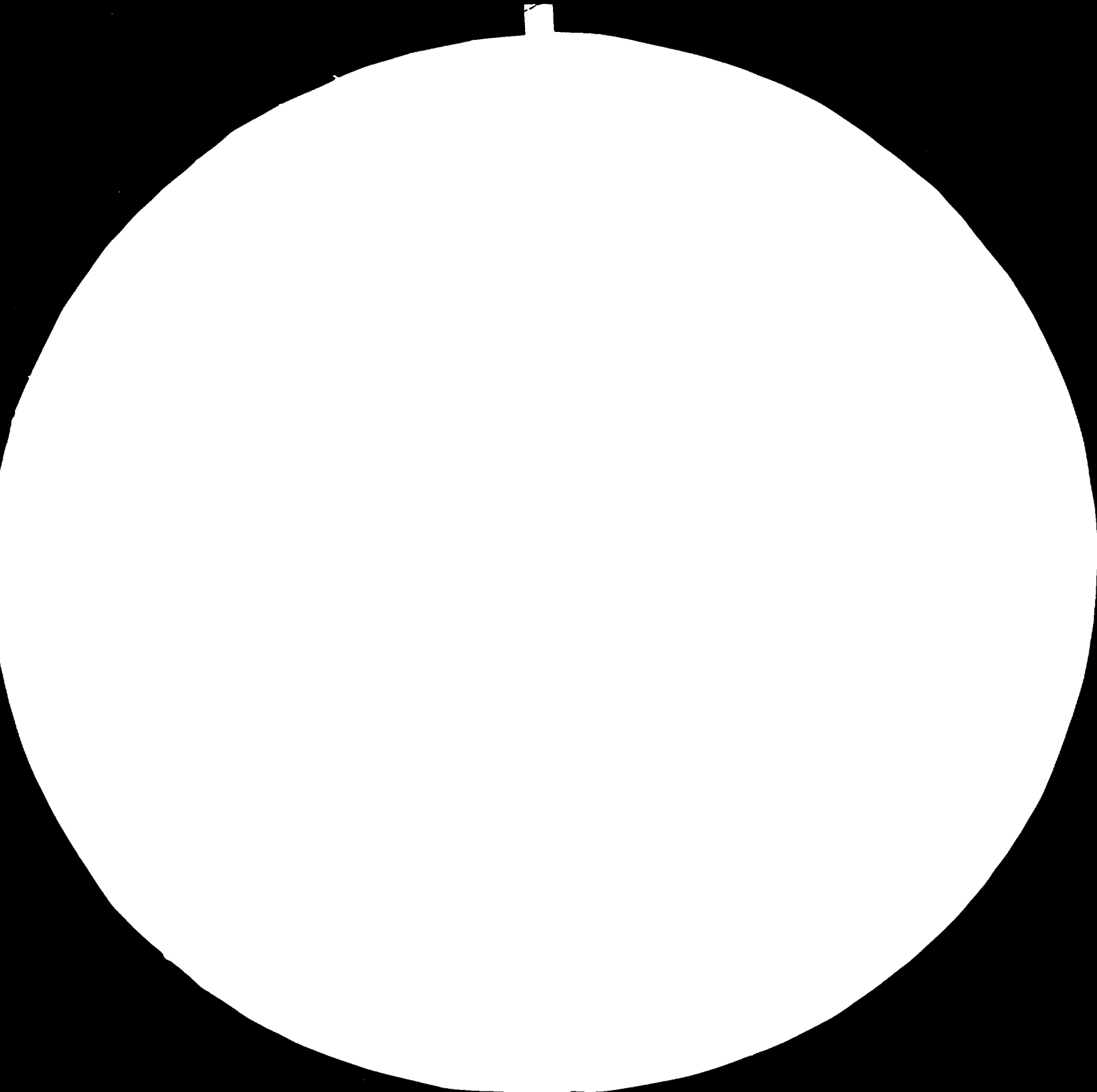

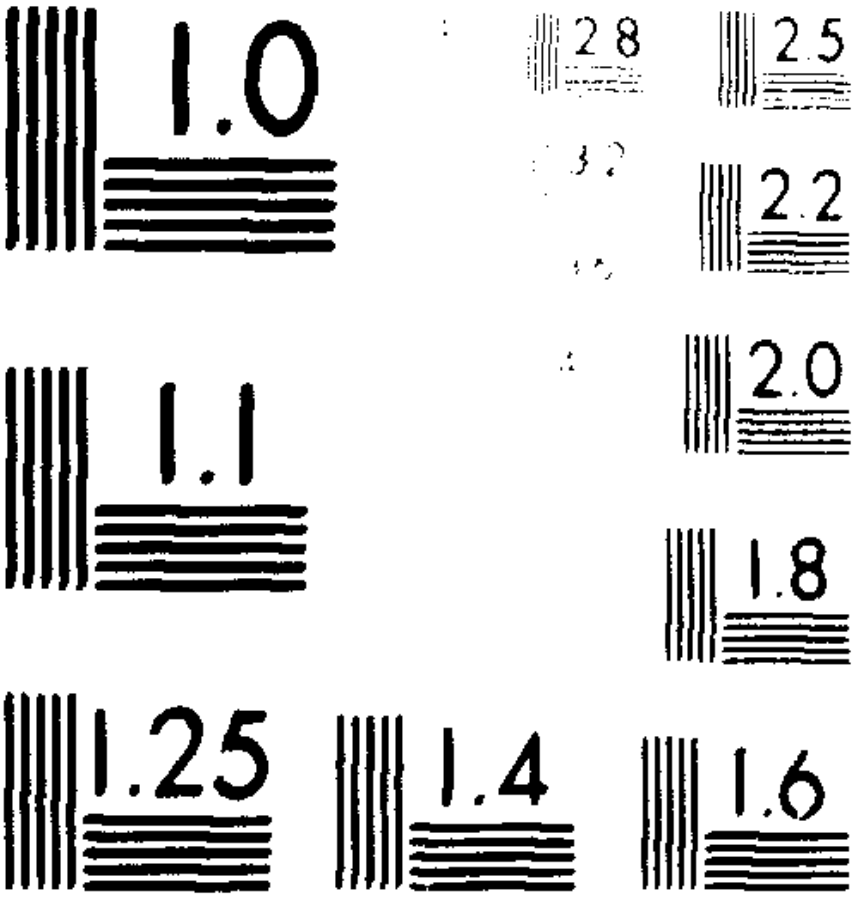
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DP/ID/SER.B/427
2 November 1983
English

Seychelles.

THE POTENTIAL FOR DEVELOPMENT OF A GRANITE QUARRYING AND PROCESSING OPERATION

SI/SEY/82/802

SEYCHELLES

Terminal Report*

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

Based on the work of William Cotter,
expert in granite quarrying and processing

United Nations Industrial Development Organization
Vienna

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English

THE POTENTIAL FOR DEVELOPMENT OF A GRANITE QUARRYING AND PROCESSING OPERATION

SI/SEY/82/802

SEYCHELLES

Terminal Report

Corrigendum

Cover

The project number should read as above.

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REPORT TO THE GOVERNMENT OF SEYCHELLES

ON

THE POTENTIAL FOR DEVELOPMENT OF A GRANITE QUARRYING AND PROCESSING OPERATION

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SEPTEMBER 3 1983

1 PURPOSE AND SCOPE OF MISSION

The purpose of the mission and the specific requirements to be developed in the report are set out on Job Description Sheet SI/SEY/82/802/11 - 01/32.1.B. of the United Nations Industrial Development Organisation a copy of which is attached. The report will address these questions and any related topics arising.

The Seychelles Ministry of Planning and Development at the commencement of the mission had already evolved into two separate ministries - The Ministry of National Planning and the Ministry of Economic Development. On the instructions of Mr Nourrice, Principal Assistant Secretary, Ministry of National Development the programme for the mission was developed in conjunction with the Ministry of National Development.

Liaison was maintained with Mr Gendron of the Ministry of Planning and External Relations and valuable assistance was received from officers of both Ministries.

In particular the kind assistance rendered by Dr Khana, Geologist, Mr Faure, Chief Economist, Dr Selwyn Gendron. Research and Development, Mr Lindsay Chong Seng, Conservation Officer is gratefully acknowledged.

Mr Edouard Gendron's initiative and assistance in arranging introductions to these officers and in assisting in many other ways with the mission is deeply appreciated. Finally, Mr Nourrice's continuous attention and unfailing courtesy in arranging the minutiae of Inter Island transport and accommodation, daily transportation on field work and at duty station, was generously provided, often when coping with other pressures, and without his efforts the field work could not have been concluded expeditiously.

The following papers were made available by Dr Selwyn Gendron and these together with geological maps provided the guide lines for on site investigation:-

(a) Geology and Mineral Resources of the Seychelles Archipelago - By B H Baker B.Sc. F.G.S. 1963

(b) A report on some observations made on the geology of the Main Granite Islands, Seychelles. By W E Stephens B.Sc.

Five islands were visited and samples of granite were catalogued and displayed at the Conference Room, Independence House, indicating sources. The islands were Mahe, Praslin, La Digue, Curieuse and Silhouette.

2 COMMERCIAL ASSESSMENT OF GRANITE QUALITY

The principal commercial characteristics of these granites may be described as follows:

The colour varies from grey to "red". The pinks and reds would tend to be more valuable than greys on the international market.

All are chemically stable i.e. do not contain elements likely to cause surface erosion or disintegration due to chemical alteration.

All are "hard" granites i.e. do not contain "soft spots" which can be a defect when these occur in a polished face. Generally they would be considered as difficult to split which is not desirable from the point of view of the extraction process.

All of these granites can therefore be regarded as good building stones and would certainly have been exploited in locations closer to larger domestic or international markets, for buildings or monumental grave stones.

Baker Page 128 (i) says:-

"Trimmed granite blocks are used as construction material and are normally variable in sizes, walls being built with a high proportion of lime mortar. The granite of Mahe and Praslin is excellent for the production of building-stone, having a good resistance to weathering and ample strength. The general absence of close jointing and the lack of any directional fabric in the rock makes it difficult to reduce to workable size, and the proportion of waste rock is high. There are no facilities for cutting or polishing granite in the islands.

In the circumstances granite blocks are rather expensive because of quarrying and trimming problems. Some of these could no doubt be overcome by more efficient use of explosives, and by the use of plugs and feathers for splitting the larger blocks.

Granite will undoubtedly continue to be used as a building material especially for larger structures of value. There are no quarries devoted specifically to the production of granite blocks. It is customary for stone to be obtained either on or near the construction site, this being facilitated by the abundance of large blocks of granite nearly everywhere on the granite islands.

The writer attempted to find suitable sites for large-scale quarrying of granite where the joint system would favour easy extraction, but no accessible sites were found. It would undoubtedly be beneficial if a sizeable quarry near Port Victoria could be established as a source of building-stone and aggregate. Quarrying efficiency would improve with experience, and a regular cadre of stone cutters and masons could be kept employed on a permanent rather than a shifting temporary basis as at present."

3 EXTENT AND DEVELOPMENT POTENTIAL

No attempt was made during the mission to select quarrying sites but three sites on Mahe have been worked recently. Subject to ecological considerations the selection of a suitable site or sites for quarrying using modern tools and equipment would not present any difficulty in any of the islands visited.

The quantity of stone used in what may be called "dimension" stone work is small relative to its value when worked to a finished condition. For example granite tomb stones are sold in Europe at a value of approximately £1 Stg. per Kilo. Compared with granite aggregates whose value may be £1 Stg. per 100 Kilo, it will be appreciated that the extent of granite deposits required for a dimension stone work industry need not be very large.

Carrara Marble Quarries in Italy have been worked since Roman times more extensively than any other marble source without supply problems arising. In Seychelles on the granite islands the extent of the granite reserves can be regarded as satisfactory.

In considering the development potential of any of the Seychelles granites, three main factors emerge:-

(a) Small size of domestic market

(b) Remoteness of nearest foreign market.

(c) All granite must pass through port of Victoria for Foreign Market.

The consequences arising may be stated thus:-

(a) Inhibits scale of development

(b) Makes marketing and shipping costs expensive

(c) Involves trans-shipping if granite originates in islands other than Mahe.

It should also be understood that the granite deposits in themselves do not possess an intrinsic value which could offset or compensate for these costs.

The red granites tend to have a higher value than grey but traditionally the red granites have proved more costly to extract and to work, thus producers were not willing to sell the reds for prices comparable to the common greys. Similarly harder granites sell for more than "softer" varieties reflecting again the relative working costs.

Demand for granite is very cost sensitive and specifiers tend to substitute other less costly forms of cladding when price increases.

Scarcity factors in the short run can create conditions for the successful development of a particular type of granite, but in the long run, producers find other supply sources competing and price dropping to the pre-scarcity level.

In the case of "Black" granite, a period of relative scarcity extending over about five years to date has been experienced by European buyers. This granite is mainly used in Europe and elsewhere for gravestones.

New suppliers from India and Africa are at present developing as a result of the scarcity and attendant higher prices. However no significant deposits of Black Granites were located in Seychelles during the mission.

The development policy of a National Granite Industry should therefore include the following considerations:-

(a) It must be export oriented bearing in mind the small domestic market but not exclusively so.

(b) It should seek to market the Mahe Granite for the Architectural granite industry as a first step.

(c) It should seek to specialise in primary sawing and polishing in the long run.

(d) The industry should be cost competitive with foreign producers.

(e) It should later introduce the Praslin red granites for the paving set market and develop into architectural granite later.

(f) The processing operations should be located as close as possible to the Port of Victoria.

A comparison of estimated Cost of Production for partly processed granite as between European and Seychelles producers would appear as follows:-

PROCESS - QUARRYING	Costs per unit of Production (tonne)	
Cost heading	Seychelles	Europe
Depreciation	16	16
Finance	8	8
Consumables	2	2
Energy	5	4
Repairs	5	4
Labour	6	22
Supervision	8	6
Total unit cost of output	50	62

PROCESS - PRIMARY SAWING AND POLISHING

One tonne of quarried block will produce approximately .8 tonnes of slabs.

MATERIAL COST	Seychelles	Europe
Cost of input to processing operation per tonne of finished output = ÷ .8	62	77
PROCESSING COSTS		
Depreciation	50	50
Finance	25	25
Consumables	105	80
Energy	50	25
Repairs	25	20
Labour	20	60
Supervision	3	4
Total Unit Cost of Output	340	341

It can be concluded that the higher costs of energy and consumables in Seychelles will be offset by lower labour costs resulting in total costs being competitive with European producers when shipping costs are excluded.

It is necessary to understand the complexities of the market for granite so as to make a correct appraisal of the additional costs of freight and transportation and its effects on competitiveness. Appendix (1) "structure and Organisation of the Architectural Building Stone market" may be referred to in this context. In addition, some attempts to standardise Building Components have led to the development of a small market for standard floor paviors in polished granite. This type of market although nor "Architectural" may be considered for present purposes as forming part of the Architectural Stonework Market.

Freight from Mahe to European Countries at the present time although containerised, is charged at general cargo rates, reflecting the lack of volumn and scarcity of outward cargo. The rate indicated by Hunt Deltel the local Shipping Agent is US$2 000 per Container from F.O.Q Victoria to German Port. Containers to off route ports incur transhipment costs and were not considered. The rates paid on containers of marble to United Kingdom Ports from Leghorn Italy are approximately US$1 000 per container.

Assuming that comparable rates apply from Leghorn to Germany Port, the Seychelles material would suffer a 10% cost disadvantage on the total value of the goods. On the other hand Italian producers have already paid freight on granite in Block from producing countries - Portugal, USSR, South America etc. which represent a cost disadvantage to the Italian Producer.

Reference has already been made to the recently Completed Building Contract in New York. In that case the granite was quarried and sawn in Brazil, shipped in containers to Ireland and after processing and fabricating was containerised and despatched to New York. The special circumstances in which this procedure took place involved:-

(a) inability of American producers to compete in cost and delivery terms

(b) Simplification of site fixing procedures.

(c) Standardisation of finishing processes.

Brazilian producers were able to quarry and primary saw to meet contractural requirements but could not provide the finishing processes. The capacity and expertise were available in Ireland at the time.

It can be said in general that very large Building Contracts overseas demand processed stone in such large volumns within narrow time constraints that a specialised producer able to handle such a market has a substantial prior advantage owing to the reduction in performance time which can be offered over the average producer.

Bearing in mind the variety and extent of the Seychelles Granite resources the thrust of the marketting effort should be in the direction of high volumn partly processed output. This market however is the most difficult to access. One cannot market in advance of production. Samples output, quality, must all be tested before engagement. Production involves commitment to a very heavy capital expenditure which in turn cannot commence producing revenue until the marketting effort produces results, and then only if quality and output prove to be on target. The risk of the enterprise failing because of these initial problems is so serious that alternative approaches must be considered.

It may be possible to attract a foreign producer to the Seychelles. Such a producer will seek to offer primarily employment possibilities for direct and indirect workers. He will offer only the minimum royalties on the volumn of granite taken and will seek exclusivity in the form of contractual guarantees from the Government inhibiting any parallel arrangements by the Government with competing producers.

He will also require Governmental participation in some form either by equity, loan or grant.

He will provide expatriate specialists to train local workers and will expect Government assistance towards worker training costs.

The benefit created may be worthwhile in the short run but it may be difficult ultimately for the Government to realise its objectives of developing a National Granite Industry.

An alternative approach would involve the creation of a pilot plant designed to carry out primary and secondary processing so as to have the capacity and cost structure capable of competing for medium sized overseas building contracts. This plant would also have spin-off advantages for the development of a domestic market.

> Appendix (2) "Pilot Plant for Granite" provides proposed investment costs, output volumn, and revenue returns expected from the investment.

Inherent in this proposal is the assumption that a sustained marketting effort be generated to attract Architectural interest at the pre-contract stage or later if possible, with a view to obtaining Bills of Quantities for pricing.

The obvious market place for the pilot plants output is the South African Building Market.
The high quality granites available in South Africa are mainly exported and do not appear to be widely used in construction. These are the blacks and dark greys. There is a rather unattractive grey and red veined granite which appears to be the local Building Granite. It has been used in Johannesburg Air Terminal and elsewhere. There is no nearer granite producing source than the Seychelles and shipping to Durban is not a significant cost factor in the exercise.

The enterprise should not rely on Agents to make contact with clients but should ensure that regular visits are made to architectural prospective clients, quantity surveyors, public authorities and others who influence design by a senior representative in the enterprise such as the Marketting Director. Samples and brochures should be quickly available and personal acquaintance built up with the various professional offices. Enquiries should be undertaken to ensure against the possibility of "Tariff walls" and to develop methods of easy access to the market. The use of Seychelles Granite in one Building will lead to much easier promotion of the granite. Clients can be taken on inspection tours, and photographs used in Brochures and advertising propaganda etc.

The alternative of seeking markets elsewhere e.g. Sauci Arabia Libya or in European countries pose language problems which can be difficult to overcome. In addition building contract law and usage will demand careful study. The United Kingdom, is however a reasonable market target and a Seychelles producer may have cost advantage over a local producer relying on foreign granite sources.

The enterprise must be composed of disciplined and dedicated participants who must be prepared to study the technology of the modern granite industry, its usages and peculiarities, its language and its image in the architectural profession. The production supervisor must himself be intimately familar with every detail of his plant and equipment. He must be prepared to invest all of his time as the enterprise may demand to avoid and minimise downtime of machines. The example he sets himself will be followed by his subordinates and this is most important in a capital intensive industry, where much realiance must be placed on the integrity and dedication of the machine operators if stoppages are to be avoided.

These conditions could most probably be realised by a combination of private and state investment. The private investor being selected by invitation and negotiation from Seychelles Nationals of proven business ability.

Expatriate technical assistance would be essential initially. The role of the expatriate would be primarily to set up the standards of output and quality for every process. To arrange for the training of supervisors and machine operators. He would assist in the extraction of production control and costing data for estimating purposes. Initially he would be expected to price up Bills of Quantities in conjunction with the permanent estimator.

A small drawing office with architectural draughtsman would be found to be essential and the expatriate would determine the format and content of working drawings in conjunction with the permanent draughtsman. Registers of overseas suppliers would be built up with his assistance and the organisation of the sales and purchasing functions would also involve his attention. The expatriate's function would also include advice and assistance to the Marketting Director , including the resolution of questions involving unit size of granite elements, finish details, and very often advice on the methods of fixing for various locations.

Fixing should not be included in the services offered by the enterprise. In this regard, the main contractor must engage the local fixing firm but rapport should be quickly built up between enterprise personnel and fixing firms so as to minimise friction and argument which often arises when stones arive late, or damaged or worked incorrectly. The production supervisor and the drawing office personnel should have a "Building" background. The Marketting Director would find much advantage if he had a Civil Engineering degree or diploma. It would be essential for him to talk to architects on a technical as well as a commercial level.

He should have made a study of Commercial Law and in particular Building Contracts.

It will have been noted from the details given in Appendix (II) that primary sawing, secondary sawing and finishing plant is necessarily involved in the pilot project. The type of primary sawing facilities referred to is recommended for its relative simplicity and trouble free operation. It can also be regarded as a cost efficient tool but for high performance high quality output the most modern system must be installed. The most recent innovation in primary sawing plant was displayed in Nuremburg Exhibition this year. It uses a diamond tipped continuously rotating steel strip similar to a timber "bandsaw" and is claimed to

provide an efficient method of using diamonds in primary sawing granite. To date only circular discs have this ability and they are limited to a depth of cut of one metre. The advantage of diamond cutting over traditional abrasives lies in the smoothness of the resulting cut surface which allows substantial economies in subsequent polishing costs.

With regard to the possible development of a domestic market, the traditional use of stone for grave memorials should be considered. A visit to Mont Fleuri Cemetery revealed that in this very large cemetery near Victoria almost every grave had a memorial constructed in concrete. Sometimes precast concrete crosses or other emblems were also used. There appeared to be about half a dozen imported granite or marble headstones and a number of war graves with stone markers also imported. A careful check revealed that not one memorial was the work of a local stonecutter. However enquiries at the Polytechnic indicated that in the past some stonecutters were remembered to have worked granite units such as door thresholds. The stone steps to St Michaels Church at Anse Aux Pins suggest the existence at one time of a stonecutter and limestone handworked cutstone features can be seen at the Catholic Cathedral which were locally worked.

Excellent facilities exist at the Polytechnic which can be extended, to include the training of young men in the technique of tool tempering, punching, chiselling, pitching and letter cutting. The pilot plant could supply polished only or polished and lettered grave markers, kerbs or other furniture from the local granites giving impetus to the development of one or more monumental craft type of industries. In addition any facing steps, floor paviors, or other granite requirements of the local Building Industry could without any difficulty be supplied.

It may be concluded that the development potential of the granite deposits lies in the extent and variability of colour and texture available in the islands, a major resource constantly in demand by architects and specifiers which should be exploited for the benefit of the people of Seychelles. No cost advantage exists and no intrinsic value attaches to the granite by reason of the richness of colour. On the other hand no disadvantage exists and great care must be taken that a disadvantage is not created by reluctance or lack of commitment in the minds of future participants by reason of difficulties technical or

commercial arising. Other producers have these difficulties and only the successful ones produced solutions as they arose.

4. EXTRACTION AND PROCESSING TECHNIQUES

(a) QUARRYING

Extraction can take place more readily from boulders than massive deposits or bedrock. The object of extraction will be to split the rock vertically and horizontally so that blocks of square or rectangular sections and within the size and weight limitations required will be produced with a minimum of labour and minimum of rock. Ideally the quarry orders will allow some flexibility in dimensions and weights thus:

Length	3	metres	max	2,0 metres	min
Height	1.1	"	"	,3 . "	"
Weight	12	tonnes	"	6 tonnes	min
Width	2	metres	max	-	

Inspection will be made after carefully washing the surface of the rock to determine the presence of natural joints. These will be used to induce opening of the rock along the plane of the joint thus creating the initial "split". Horizontal cracks are of great importance particularly if they occur so as to allow uniform division of the block into suitably sized horizontal slices. Vertical partings will terminate on these horizontal cracks and the parts of the boulder will be wedged or levered to slide along the horizontal partings. The boulder may be very large, let us say 300 tonnes, and it is hoped to extract about thirty blocks. Machinery or other means must be used to clear away all restraining debris from the perimeter. Explosives must be used to reduce restraining rock, so as to free the boulder to allow movement during the splitting process. The most difficult part of the operation will be to introduce a straight vertical crack dividing the boulder into two parts so that each part can successively be toppled and further splitting take place. Explosives are used in this operation.

Drilling "rigs" are used to ensure that pneumatic drills produce a series of drill holes in line with each other so that each hole is drilled on the same drilling plane as the adjoining one. Holes will be positioned about 150mm apart and will be about 30mm in diameter. Expanders are introduced into the holes on completion of drilling and applied until the rock ultimately splits in two.

The operation is repeated on each part of the boulder until the reduction process results in the desired size of block emerging. Blocks and debris must continuously be cleared away from the working area to prevent congestion and taken to a loading area in the case of blocks and a tiphead in the case of debris.

Channelling operations may be necessary where quarrying cannot be undertaken from boulders. This technique involves opening a "channel" usually about 75 mm wide for a vertical depth of up to 6 metres and for as long as may be required. The tool used is a blow torch fed by a mixture of compressed air and diesel oil. This emits a piercing scream or whistle during operations with an effective audio range of up to three miles in suitable conditions. Its noisy operation can give rise to complaints from residents and care must be taken to protect workers from damage to their hearing capability. It is also a costly process but occassionally an esential method of "opening" a rock for quarrying. Workers engaged in rock drilling or who are exposed to the inhalation of dust from the drilling or other process must be protected. Suitable silica trapping masks are available rom the trade suppliers. Only "anti silica" types are effective. The consequences of exposure are usually not felt for up to twenty years, but workers who have suffered this degree of exposure can contract irreversible silicosis and be unable to continue a useful working

Already dimension stone quarrying has taken place on the island of Mahe. A stock exists of about four hundred tons of granite blocks well trimmed and suitable in terms of quality dimensions and weights for use in the type of pilot plant envisaged in this report. The blocks appear to be the property of Societe D'Exploitation De Granite (Seychelles) Limited. In addition an essential range of quarrying tools and equipment, which appear to be in excellent condition is also stored in that company's quarry near Grand Anse. It includes the following:-

One Caterpillar front loader ontracks 955L

Two Holman compressors thought to have a capacity of 350 CFM

Two drilling rigs

Eight drilling machines together with a range of tungsten tipped drill rods.

In addition a large quantity of spare parts and accessories including a large coil of steel rope are also stored. These items are intended for re-export to Italy when Government permission becomes available. Subject to good mechanical condition being demonstrated, the equipment could not be replaced at the present time for less than US$300 000. A letter from the company is attached offering the equipment at 165 000 United States Dollars or reasonable offer. If it is decided to proceed with granite extraction , equipment similar to this must be purchased, and it would seem worthwhile to keep this equipment available.
The Caterpillar and drilling equipment can be used of course for public works and the only specialised items are the drilling rigs which have an application only for quarrying.

A major difficulty arises in connection with transporting large blocks to a processing plant. The maximum weight allowed on public roads on Mahe appears to be seven tonnes. This restriction however does not appear to be strictly enforced in view of the presence of heavy plant seen in various parts of the island. No suitable vehicle is readily available for block transportation. A low loading trailer was previously used because of the absence of cranage facilities at quarry.
It is essential for the success of any granite enterprise that loads compatible with the processing plant's requirements be moved without restraint or difficulty from quarry to Plant. Such movements can take place at night but should be under control of the enterprise and not involve police escorts, police permits etc. Suitable traffic safeguards should be provided by the enterprise during these operations such as a front and rear warning vehicle etc. Initially one or two loads per week would constitute the total traffic but in the long run traffic could build up to 30 ton-loads at a frequency of two to three per day for four or five days per week.

A special transporter would be necessary for block movements and a 20 tonne derrick or mobile crane for loading would be required at quarries.

(b) PROCESSING

The pilot plant proposed should be a permanent feature of the National Granite Industry. It will be a revenue producing enterprise and not merely a training facility for workers. It will catalyse downstream activities, and be the vehicle by which the Seychelles granites enter the international granite market on the scale appropriate to its availability.

consequently the location, layout and servicing of this plant deserves very careful consideration.

The location of the plant in the vicinity ofthe Port has a number of advantages:-

(i) Direct and easy access for containerised output

(ii) Availability to domestic market

(iii) Convenient to service suppliers electrical, plumbing and engineering workshops

(iv) Waste run-off can be economically disposed in reclaiming land.

(v) Minimise transport on imported consumables

(vi) Workers' movement to and from plant can utilise public transport system.

The layout should incorporate the following features:-

(i) Block storage area serviced by forklift truck capacity maximum 12 tonne lifts.

(ii) Circular disc type sawing machine 3,00m diameter fully automatic for continuous sawing. This machine to be serviced by the 12 ton forklift referred to for loading and 1 ton pillar crane for offloading.

(iii) Automatic polishing machine capable of producing minimum 3 square metres per hour of polished face, serviced by conveyor and pillar crane.

(iv) Automatic secondary sawing machine 600mm disc with step-cutting facility for granite with digital measuring facility, automatic programming of work sequences. With tilting head and facility for square and splay cutting with gravity conveyor and pillar crane servicing.

(v) Edge polishing machine with gravity conveyor servicing.

(vi) Flame texturing bay with conveyor servicing

(vii) Checking loading and despatch area.

(viii) Stores for consumables and spare parts, carperters stores oil and greases, filters stores, electrical stores etc.

(ix) Water supply at 150 gallons/minute at 60lbs involving booster or supply pump.

(x) Sludge disposal area

(xi) Stonecutters bay

(xii) Production supervision office

(xiii) Drawing office

(xiv) Estimates, sales and cost control offices

The arrangement of these facilities is shown on attached suggested

layout sketch - Appendix 3

5. FUTURE DEVELOPMENT AND RECOMMENDATIONS

Equilibrium must be achieved as quickly as possible between quarrying output and processing demand. This can be achieved either by selling surplus rough blocks overseas and realising the net value after freight cost or by developing the large scale sawing and polishing operation for which the pilot plant was set up.

The scale of the eventual operation can be increased over time by the addition of more machines according as the marketting effort progresses. Essentially the enterprise must achieve a leading place in the market by careful investment in modern fully automatic equipment, attention to cost and quality factors, and by maintaining a constant and effective presence in the minds of specifiers and buyers. The high cost of shipping overseas which adversely affects marketting at the present time will reduce as volumn increases and a constant effort to speed up this process should be maintained.

The Marketting Director should keep constantly in mind his long term objective - to utilise the pilot plant capability as a means of demonstrating in the most effective way the quality and range of the Seychelles granite. He will be aware that the Praslin granites will be more difficult to present than the accessible Mahe varieties. Pressure must be maintained to bring this granite to the workplace at an early date. The red granite at Baie St Anne is accessible to landing craft for most of the year. Utilising derrick crane loading, rapid turn round could be achieved and loads of 300 tons transported to Victoria for a unit cost of about SR50/- per ton. A landing stage to allow forklift unloading would be necessary at Victoria.

The set paving market can be considered for utilisation of waste granite. The granite is split into slices or slabs roughly 200 mm thick, using expanders, it is then further broken to allow it to pass through a guillotine especially made for sett production. Outputs of 10 tons per hour are achievable per guillotine. The stone is split several times until a standard cube size 100mm x 100mm x 100mm is achieved. Current selling prices for grey sets delivered at £60 Stg ton. Red setts are scarce and selling price is not known.

The possible uses of granite in forms other than already described does not give scope for large developments. Granite chips are used

as exposed aggregates in pavings and cladding panels. Already there appears to be a ready supply available from a local producer for the home market. Overseas markets exist for quartz chip and marbles of various colours. Quartz is used for grave covering and also for cladding panels. Marbles are used for dry-dashing (a form of decorative plaster) to the outsides of buildings. It is unlikely that coloured granites which have relatively high crushing and granulating cost could successfully compete with the softer and easily accessed coloured marbles.

The solutions proposed in this report for the development of a national granite industry rely on the range and attractiveness of the indigenous granites to the market and also on its physical properties. Some grey granites are sold on the market which contain unstable elements in their composition, traces of iron pyrites and biotite which on exposure to atmosphere tend to leach out yellow rust stains which appear as patchy discolouration on the fresh granite.

It was not possible to have polished samples prepared for reasons already stated. However small hand samples should be prepared as soon as possible. Facilities can be made available in Zimbabwe involving only the expense of air freight and transportation to and from Harare. Assistance can be given in the recruitment of an experienced expatriate assistant capable of performing all of the duties outlined in this report.

As a first step towards implimentation, a market survey should be attempted. The international exhibition at Saint Ambrogio N. Italy (Near Verona) is held each year during September. Granites as well as marbles are displayed together with stone-working machinery. Current selling prices can be obtained for granites and five days minimum would be required to obtain maximum information from the exhibitors.

The dates for this year's exhibition will be made available courtesy of Mr Gendron of the Ministry of External Relations and Planning.

Advantage can be taken of the visit to obtain current quotations for the pilot plant machinery together with delivery dates, payment terms etc. No engagement should be contemplated without expert assistance in the selection of the most cost efficient types of machines and without the results of the market survey.

In contemplating a survey of the South Africa Market, an experienced technical assistant would be necessary. Introductions to architectural clients may be difficult in the absence of a National Trade mission in that country. Application to the Institute of

Architects or other professional body would produce a list of names and addresses Each should be circularised and later telephoned before visiting. The object would be to establish the volumn of projects involving granite currently "on the drawing board". Prices may be more difficult to establish as suppliers will be reluctant to divulge confidential data. Building Contractors and Estimating firms should however prove a fruitful source of information.

Recruitment of an expatriate on a six months contract basis for this purpose would also provide an opportunity to assess his character, attitudes, experience and ability and provide the basis for a longer term engagement.

A suitable candidate would ideally be a recently retired technician who had managerial and administrative experience as well as having developed technical expertise in the quarrying production and marketting of architectural cut stone.

A study should be made of site conditions for the proposed factory and future sawing/polishing plant adjoining. Adequate space should be allowed and access to the container port should be as direct as possible. A future requirement of say 20 000 square metres should be kept in mind for the future sawing/polishing plant.

Delivery of machines for the pilot plant could be expected to require seven to eight months from date of engagement, bearing in mind shipping variables. During this time, machine foundations could be installed, electrical plumbing drainage and sludge disposal works completed as well as the factory and approach roadways and working areas.

Allowing for training and commissioning of plant, production should commence not more than four months after arrival of machines.

The management structure involving recruitment of the production supervisor marketting director and expatriate assistant should be decided and implemented as soon as possible if a decision is reached in favour of proceeding. The standing costs must be considered when delays are encountered involving planning and other considerations, and these should be minimized by careful attention to environmental and other planning requirements.

Finally the existence of a trained nucleus of six quarry workmen on Mahe can be seen as a bonus. These men produced the block from Grand Anse and Takamaka quarries and can be contacted courtesy of Mr Bill Jackson of Air Seychelles. They are familiar with the existing quarrying equipment and have nearly two years

experience in the extraction and trimming of blocks.

The layout and plant requirement for the sawing/polishing plant has not been covered in this report but is seen as a development requiring approximately five years to mature. In that time technological changes could make current methods of production obsolete and for that reason it is not considered prudent or advisable to make specific recommendations at this time.

WILLIAM COTTER B.Comm. (Dublin)
EXPERT ON MISSION UNIDO

APPENDIX (1)

Structure and Organisation of the Architectural Stone Market

The use of the word "stone" in this description includes all types of granites, limestones, marbles, used as exterior or interior wall claddings, window sills, copings, floor pavings, steps, landscapings etc.

Granite used in Buildings is likely to have been selected by the Architect in the pre-contract stage of planning. The selection will have been made on the basis of quality, finish, colour, grain, availability and cost within the constraints of the Building Programme and Building Budget.

Main Contractors tendering for such projects will seek to obtain advantageous prices from firms offering the specified type of granite. Some main contractors finding that the supply of the granite has been wholly or partly monopolised will seek to offer alternative materials to the one specified. Very often the conditions of tendering will allow such a procedure to be followed.

Main contractors will usually obtain prices from specialised sub-contracting firms who undertake to obtain the granite from quarries or stockists in partly processed or block form. The sub-contractors accept responsibility for cutting the granite unit to final size, carrying out any additional processes required by the contract such as edge polishing, splay cutting, fabricating. Subcontractors will also undertake the work of fixing the granite to the building. More frequently this difficult and responsible work is undertaken by specialised "Fixing" firms employed by the main contractor.

The subcontracting firm will have access either to quarries where he will produce the required quantity of Block or to Stockists for Block or Slab purchases. He may therefore have primary sawing facilities or use those of the quarry owner or stockist.

Upon the selection of the successful tender, negotiations are entered into between main contractor and the subcontracting firm selected for the execution of the granite work, with the object of defining contractually start and finish dates, for the production and fixing of the granite work, programmes for the progressing of various sections of the work and definitions and penalties applicable to delays or breaches of contract.

In addition, the granite supplier may be obliged to obtain appropriate guarantee bonds for . . due execution of the contract. Delay and non-performance penalties can be very heavy and would constitute unacceptable losses to the parties if invoked.

In order to ensure successful performance all parties to the building contract will seek to anticipate as far as possible all delay hazards likely to arise.

The architect will try to influence the choice of granite supplier away from firms with whom he previously had unsatisfactory experience. The building contractor will tend to rely on the subcontractors guarantee bond provided the profit margin on the granite subcontract is adequate. The granite supplier will in his own interest immediately secure the supply of all the requisite "raw" material. These may be in the form of rough blocks which he intends to process or in the form of sawn labs, (Sawn by another company from Blocks) which he intends to polish or finish in some other way. When his supply is secured he can predict his output rate with confidence and usually satisfy all parties in the performance of the contract.

In order to cope adequately with the demands pressures and strictures of the architectural granite market, the industry has developed, particularly in the post war years, into elements which often tend to be linked together commercially by partnerships or shareholdings or price agreements. Thus quarry owners may sell blocks to firms who saw only and stock sawn only slabs. The latter firm often is a shareholder with other competing companies in the quarry enterprise, sometimes seeking a competitive advantage against other competitors.

The demand for a variety of granite originates with the architects who are exposed to the various types and finishes at industrial or trade exhibitions such as the Annual International events at Carrara and Verona N. Italy, Nuremburg, Birmingham (United Kingdom) and other centres. They are also introduced by trade magazine advertisments and by constant direct contact with local suppliers and subcontractors. Furthermore, architects tend to travel very much and to repeat specifications for granite and to reproduce finishes, the work of other architects.

In this way demand patterns are set up for the popular building granites. Other architects looking constantly for new materials will increase the variation of colour and texture demanded.

The block stockist/primary sawyer will feel this demand from the large buyers of slab. These are the sub-contracting firms who will polish and cut to finished size, work the edges, fabricate and very often undertake the difficult and responsible task of fixing the granite to the building.

Sub-contracting firms prefer to buy block from quarries and carry out all the down stream processing from primary sawing to fixing. Primary sawing is a highly specialised twenty four hour day, seven day/week process and is more economically carried out by the firm specializing in block sawing.

All architectural granite must be cut to precise tolerences and fit exactly dimension-wise in its building location. Each slab therefore is numbered for its final location and its size, shape and other characteristics determined from working details or full size set outs prepared from architects drawings by technicians employed by the subcontracting firm.

Slabs which are deficient in dimensions or finish or have been damaged in handling are rejected and must be replaced quickly to avoid a hold up on the building programme.

Contemporary specifiers tend to adopt modular construction methods and this imposes further discipline in the industry as the demand pattern for unit size now becomes a critical consideration. For example, a recent New York contract called for slabs 1½metre x 1½ metre x 40 mm, exclusively. This size was a building module and was based on the concept of using composite cladding units, 6 metres by 1½ metres consisting of steel support frames on each of which were mounted four granite slabs. The size of the composite unit was suitable for containerisation. The granite was quarried and sawn in South America, polished and worked in Ireland and fixed in New York.

Standardisation of size is difficult for the quarry as very often unsalable waste arises in the effort to obtain large quantities of the demanded size. This increases quarry cost, but the down stream economic effects are such as to make the increased quarrying cost acceptable.

In ordinary circumstances the limitations on Block size are:-

(a) Capacity of Customers Cranes;

(b) Lifting facilities at port terminals;

(c) Maximisation of saw load.

(a) and (b) are weight factors (c) is a dimensional requirement.

Primary Sawing Cost decreases with size of Block Sawn, and the incentive for the sawyer is therefore to try to get the biggest possible blocks. Usually frame saws are used for sawing large blocks. These machines can accept blocks up to 3 metres by 2 metres x 2 metres. Such a block would weigh 40 to 45 tons and is not usually handled. Weight of 30 tons are more common but the most frequently used size is in the range 10-20 tonnes.

Sometimes however the capacity of the quarry to deliver very large blocks in quantity gives it an advantage over price and other considerations and secures the order price not withstanding. In such cases the architect makes the decision to accept the quarry offer and instructs the subcontractor to buy from the quarry.

It will be seen therefore that to obtain entry into this market, Architectural specifiers must first be exposed to the granite in its various finishes. This may be done by relying on stockists to introduce the granite by buying and sawing blocks or buying sawn slabs. The price obtained in this way is not good as the stockists will tend to favour the older more realiable range of stock.

Alternatively, the quarry can consider setting up a sawing plant and offer slab to the subcontractor firms. This is a high risk investment with slow returns and should not be considered without financial participation of a subcontracting firm to guarantee energetic marketting. Usually subcontracting firms have their own traditional supplier or suppliers but will venture to buy occassionally from newcomers if there is a reasonable price advantage or if the newcomer has succeeded in marketting his granite to an architect specifier.

Some subcontracting firms are also main contractors or are owned by main contractors. These are often disadvantaged by suppliers, on the basis that competing subcontractors pressurise suppliers to supply the main contractor at a premium cost, since he already has a cost competitive advantage, to the detriment of the trade generally.

Such main contractors tend very often to set up their own supply lines and to do so they are prepared to take financial risks of entering the quarrying industry.

APPENDIX (2)

PILOT PLANT FOR GRANITE

	Investment Cost Stg
Primary saw D/D Seychelles	60 000
2 Diamond Discs	20 000
Bogeys and rails	20 000
Auto polisher and spares	45 000
Secondary saw	35 000
2 Diamond Discs	4 000
Edge polisher	10 000
Conveyor	6 000
3 Pillar cranes	12 000
Factory building (incl machine beds)	100 000
Electrical services	30 000
Plumbing services	5 000
Drainage	5 000
	352 000
12 Ton Forklift	30 000
	£382 000

FIXED COSTS

	Per Annum	Per Week
Depreciation at 20%	76 400	1 523
Finance over 5 years at 12% reducing	24 000	480
Repairs provision	10 000	200
Marketting Dept.	50 000	1 000
Production wages and salaries		
	per week	
7 Workmen	50	
1 Supervisor	150	
1 Clerk	60	
1 Draughtsman	100	
	34 320	660
Total Weekly Fixed Costs		£3 868

Fixed Costs = £3 868 / week

VARIABLE COSTS PER M^2

Freight and transport	6,00
Granite quarrying	8,50
Bladewear	11,00
Electricity	10,00
Abrasives	5,00
Sundry	2,00
Total V C per M^2	42,50

:: Est. value $1m^2$ of 40mm thick polished and cut to size granite slab d/d Durban = 100

Deduct variable costs = 42,50

$57,50

Break even volume = 3868 ÷ 57.5

= $67M^2$/ week Approx.

Representing approx. 50% of capacity

:: Note (1) Market Survey should verify these estimates for various market locations.

(2) Expatriate labour costs absorbed in Quarry Cost

QUARRYING

	Investment STG	Per annum	Per week
Assume purchase of quarry equipment at	100 000		
Add: 20 ton loading derrick and freight and erection	40 000		
	140 000		
Add: Block transporter costs	20 000		
	£160 000		
Depreciation at 20%		32 000	640
Finance at 12% over 5 years reducing		9 600	192
Labour		17 500	350
Supervision		25 000	500
TOTAL FIXED COSTS		£84 100	£1 682

		Stg	
Value of granite D/D Victoria to processing plant	=	£50	ton
Deduct: variable costs/ton		16	
Fixed cost value per ton	=	£34	

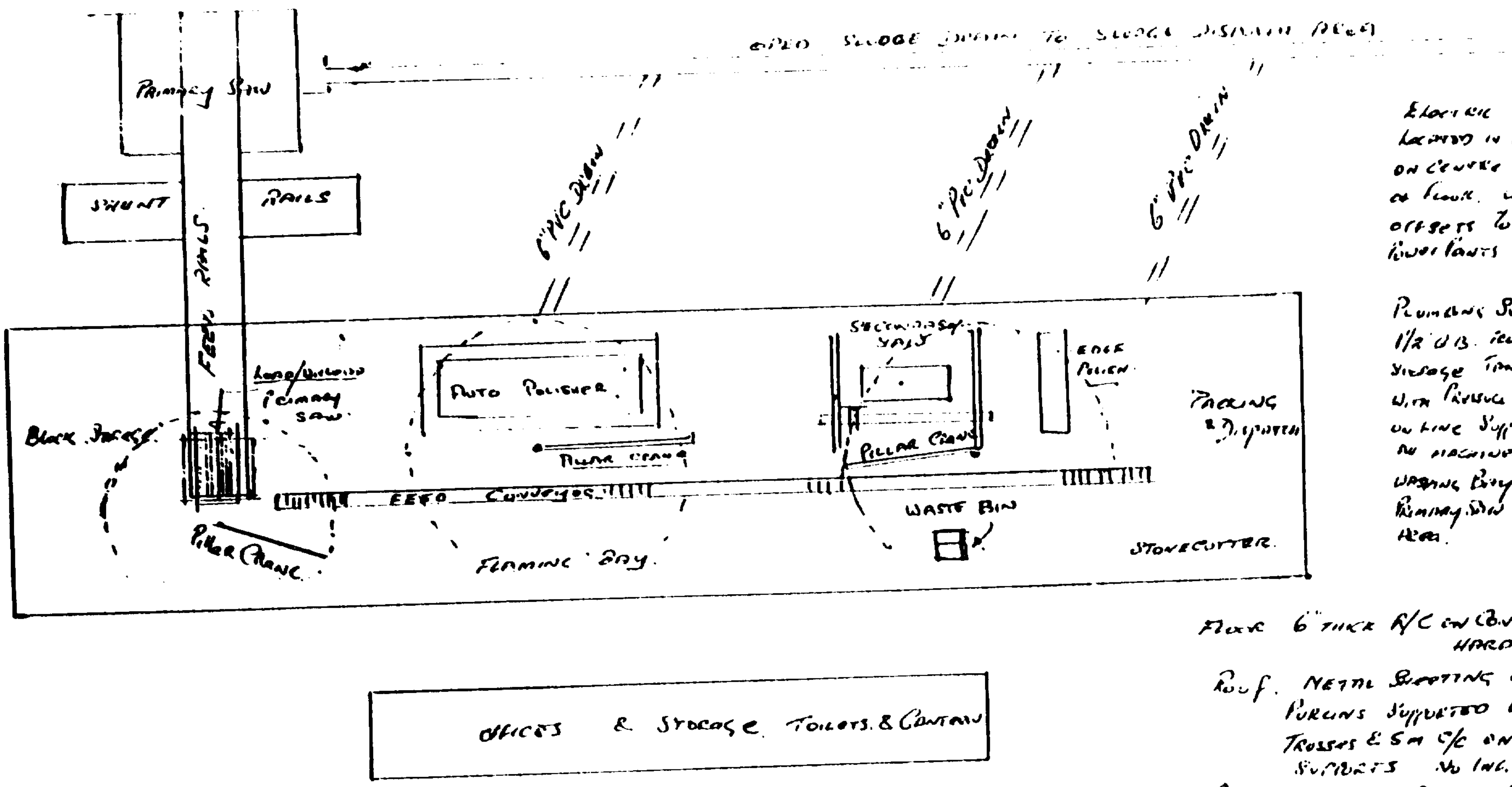
Breakeven = 1682 ÷ 34 tons/week
= 50 tons

(i) NOTE Pilot Plant has a maximum requirement of 20 tons/ week when producing on shift work. Therefore excess quarry production will create inventory investment and require extra working capital varying between 35 000 Stg per annum to 75 000 Stg per annum. Pending full utilization of quarry output.

(ii) NOTE Utilizing existing stocks of about 400 tons would add to inventory investment by the amount of the purchase cost.

(iii) NOTE If it is possible to utilize the plant available for public works, hire to Building Contractors etc. The non-productive costs can be recovered rendering the quarry operation self financing.

APPENDIX 5



Electric mains located in duct on centre line of floor, with offsets to machine power points & lights

Plumbing supply 1/2" U.G. iron storage tank with pressure pump on line supplying to machines and washing bay at primary saw loading area.

Floor 6" thick R/C on consolidated hardfill.

Roof. Metal sheeting on purlins supported by trusses & 5m c/c on column supports. No infill walls.

Pillar cranes 360°. 1 ton electric lift on rolling carriage.

Open area surfaced with decomposed granite sand.

Sketch of Proposed Layout for Pilot Plant Seychelles 3.9.83

0 10 20 30 40 50 60 70 80'

Scale in feet

1 September 1983

Ministry of National Development
Independence House
Victoria

(for attention of Mr Cotter Room 214)

I have now received a reply from the owners of the equipment which is located at Grand Anse.

The asking price for the lot including spares etc is US$165,000. They are however open to counter offers should these be reasonable in nature.

Please indicate to my secretary if you have any interest. I am sorry that lack of time has precluded me from compiling a list of this equipment but please feel free to visit the quarry again and compile your own list.

Kind regards

Yours sincerely

W Jackson
Director

UNITED NATIONS

UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANIZATION

UNIDO 1 November 1982

Request from the Government of the Republic of Seychelles

for Special Industrial Services

JOB DESCRIPTION

SI/SEY/82/802/11-01/31.1.B

Post title	Expert in Granite Quarrying and Processing
Duration	1 month
Date required	As soon as possible
Duty station	Praslin, with travel within the country
Purpose of project	To identify the potential for the development of a granite quarrying and processing operation
Duties	The expert will be attached to the Ministry of Planning and Development and will specifically be expected to:

1. Assess the quality, extent and development potential of granite deposits on the islands of inter alia Mahe and Praslin.
2. Advise on all aspects related to the exploitation of these deposits such as extraction and processing technologies, marketing and possible end uses and ecological as well as legislative considerations.
3. Elaborate a plan for the future development of the granite quarrying and processing industry.

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

..../..

Qualifications	Expert in stone technology with experience in granite quarrying and processing, as well as in stone development
Language	English
Background information	The islands of Mahe and Praslin are both rich in deposits of good quality granite in colours ranging from black over different shades of yellow and pink to red. Of particular interest is the red granite deposit of Praslin which appears to be very large and produces a very attractive polished surface. Conscious of the economic potential of these natural stone reserves the Government has already for some years given attention to their possible economic exploitation. So far, however, only quarrying and export of unprocessed blocks has been considered. The possibility of using part of the material locally in the form of building blocks or terrazzo (made from granite chips) seen in conjunction with a fairly promising export market for high quality polished slabs has now led the Government to request an exploratory mission which would define the potential for developing a national industry based on the country's stone resources.