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Tanzania: Industrial and Mining Sector Survey

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Volume II: Annex II: Current Status and Development Prospects of the Mining Sector

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1 Tanzanian Shilling	=	US\$0.14
1 US\$	=	7.14 Tanzanian Shillings

This report is based on the findings of a mission to Tanzania in September 1974 consisting of P. Bottelier, A. Choksi, A. Drysdall (consultant), L. Graham (consultant), D. Papageorgiou and A. Sandig.

TANZANIA: INDUSTRIAL AND
MINING SECTOR SURVEY

Structure of Report

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CURRENT STATUS AND DEVELOPMENT PROSPECTS
OF THE MINING SECTOR IN TANZANIA

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SUMMARY AND CONCLUSIONS

1. Although the present level of mining and prospecting in Tanzania is at a low ebb, it would be wrong to assume that this situation is a fair reflection of either the history of the sector or its potential. A number of factors - including the recent establishment of the State Mining Corporation in 1973, the completion of the Tazara Railway giving access to important coal and iron reserves in the southwest and the discovery of natural gas off the coast near Kilwa - have contributed to the possibility of a major breakthrough in mineral development in the coming years. There are, however, serious manpower, technical and financial constraints to the realization of that potential. There are also a number of policy issues, particularly with regard to the role of private foreign capital in mineral development, that need to be resolved. Accelerated mineral development could contribute significantly to an improvement in Tanzania's balance of payments position.

2. The contribution of the mining sector to gross national product, exports and wage employment is at present small and measures approximately 2%, 8% and 1%, respectively. The only large-scale operating mine is the Mwadui diamond mine of Williamson Diamonds Limited. Diamonds are also by far the most important mineral export, followed by salt, colored gemstones, tin concentrates and minor quantities of other minerals. The Mwadui mine has been producing both gem and industrial quality diamonds since its discovery in 1940 and has been jointly owned (50/50) by the Government and a private foreign company since 1958. Until the recent adoption of a new mining plan Williamson Diamonds Ltd. was the most profitable company in Tanzania, and during the period 1967-72 accounted for nearly 40% of all income tax and 55% of all dividends paid by parastatal enterprises. The new mining plan aims at preventing the early closure of the mine and extends its probable life to 16 years at slowly falling production levels on a no profit/no loss basis.

3. Other mineral production in Tanzania has comprised mainly gold, salt, tin concentrates, gemstones, mica and minor quantities of magnetite, wolfram, lime, gypsum, glass sand, kaolin, coal and Meerschau. Gold production has fallen from nearly three tons in 1965 to an insignificant level, mainly because of rising costs and reserve depletion in a number of old mines. For various reasons the production of almost all other minerals, including diamonds, has declined in recent years. The overall situation was evidently a matter of concern and to stimulate mineral development the Government established in 1973 the State Mining Corporation which took over the National Development Corporation's mining and mineral based industries portfolio and was given the task of preparing new mining projects.

4. During the past decade new investment in mining has been negligible but this is rapidly changing. The State Mining Corporation has made good progress with the formulation of projects for the exploitation of beach

sands, phosphate, soda ash, gold, kaolin and some other minerals. Much preparatory work remains to be done, however. The manpower and financial resources of the Corporation are now spread so thinly that it is feared that further progress may be very slow unless there is a significant increase in the level of foreign technical and capital assistance. Alternatively the Corporation could concentrate its resources on, say two or three projects instead of working on at least ten projects simultaneously as is the case at present.

5. New mining projects which have reached or are approaching the implementation stage include two small gold mines and a major expansion of cement production. The technical and economic feasibility of extracting heavy minerals from beach sands is to be tested on a pilot scale. This could become a fairly substantial export project of considerable interest. Another interesting possibility is the mining and upgrading of low-grade phosphate occurring near Lake Manyara to supply the Tanga fertilizer factory. Much remains to be done, however, to determine the technical and economic feasibility of this project. The mission recommends that the Tanga factory should not be committed to the use of domestic phosphates until the various issues raised in this Annex have been resolved. One significant "external" benefit of the phosphate project would be the release of the Tanga deep water jetty for general cargo use.

6. The responsibility for the preparation of a natural gas-based project rests with the Tanzania Petroleum Development Corporation. No project has been formulated so far. The recent find near Kilwa, which is too small to be of interest to the present concession holders but big enough to be of interest to Tanzania for domestic use, opens up a number of new options for industrial and energy development some of which are mentioned in this Annex. These require careful study and comparison before a particular project is selected. In the light of the recent oil price "explosion", the gas strike near Kilwa and the improved access to coal reserves in the southwest, the mission suggests that there is an urgent need for a complete re-assessment of Tanzania's energy resources. The object of this should be the formulation of a long-term energy master plan for the use and development of hydroelectric potential, geothermal resources, coal, natural gas and fuel oil. Special technical assistance is likely to be required for a study of this nature, as the capacity within Tanzania to identify the various technical options particularly with regard to the use of natural gas, and compare their relative economic merits is very limited.

7. One important policy issue raised by the mission concerns the role of private enterprise in the development of Tanzania's mineral resources. With regard to prospecting there is, in a poor country like Tanzania, an obvious conflict between the need to promote this activity and to limit the risk to the Government. One solution would be to utilize the technical know-how and the financial resources of the private sector on condition that

the Government would have the option to acquire a controlling interest in any resulting mining venture. This approach does in fact appear to be the basis of the existing prospecting agreements with the Agip/Amoco Group (for oil and gas) and the Willcroft Corporation (a subsidiary of De Beers) for diamonds but the principles are not embodied in the legislation. Thus "the rules of the game" are not known. While the need for compromise arrangements with the private sector is recognized, the price which has to be paid in the form of guarantees to the partner has not been decided except in a few specific instances.

8. If this approach is adopted, the mining legislation needs to be changed. Clauses which empower the Minister or the President to refuse to issue or revoke a mining lease should be amended to ensure that the holder of a prospecting license has at least the first option to negotiate a mining right, and to allow appeal. Tanzania is not so rich in proven mineral resources, particularly base metals, that there is significant competition for prospecting rights, and under such circumstances the legislation should not deter whatever private interest there may be.

9. An alternative strategy would be to rely mostly on bilateral and multilateral aid and special contract arrangements for prospecting. A special United Nations revolving funds ^{1/} for the financing of prospecting in developing countries has recently been established and the possibility of obtaining assistance from the fund for Tanzania should be explored. A possible disadvantage of this approach is that it involves a distinct break in the chain between grass-roots prospecting and mining which may lead to long delays in the formulation and implementation of actual mining projects. On the other hand any company acquiring mining rights under such circumstances would not have borne the risks inherent in prospecting and the Government would therefore be in a stronger position in negotiating partnership terms.

10. The policy question with regard to the role of the private sector in mineral development is particularly relevant to very large, capital-intensive export-oriented operations such as the soda ash and large scale coal mining projects. Tanzania does not have the resources and technical know-how for the development of either, but the contribution of these projects to an improvement in Tanzania's balance of payments position could be significant. Unless a friendly bilateral donor can be found to assist, the choice for Tanzania is essentially between leaving these mineral deposits in the ground, or striking a deal with private foreign enterprises. Issues

^{1/} At the moment of writing the actual funding of this new U.N. facility is still uncertain.

like these have to be resolved on the political level but it is up to the State Mining Corporation to present the politicians with a clear choice setting out the costs and benefits associated with either approach.

11. In the years following the second World War the Mineral Resources Division (then the Geological Survey) was very active, and extensive prospecting programs were carried out by the Commonwealth Development Corporation, Consolidated Goldfields, Anglo American - the Western Rift exploration program - Union Corporation, Shell/B.P., and others. A great deal of useful geological data was recorded during this period, which is now held in Dodoma by the Mineral Resources Division, but although a number of mineral deposits were investigated in detail, for example the coal resources of the Lake Nyasa area, the Karagwe tinfield and the Mpanda mineralized area, no substantial finds which could be exploited immediately on a large-scale were made. As a result there was a marked fall-off in the level of activity which had already become apparent prior to independence.

12. For a country of Tanzania's size the level of prospecting is very low at present and essentially confined to the search for oil and gas by the Agip/Amoco combine in the coastal area, the search for diamonds by Williamson (on behalf and for the account of the Willcroft Corporation), the associated geochemical prospecting by Williamsons and prospecting by the Mineral Resources Division and the State Mining Corporation. The diamond prospecting program is scheduled to be completed by April 1975 (after decades of continuous prospecting which has covered almost the entire country) unless new mineral indications justify its continuation.

13. The facilities of the Mineral Resources Division in Dodoma are superior to those of many Geological Surveys in Africa, but its staffing position is so desperate that in certain important respects the Division is almost non-functional. The staffing position of the State Mining Corporation is somewhat better, but only because the staff has to a considerable extent been built up at the expense of the Mineral Resources Division which is perhaps a reflection of the Government's current concern to give priority to directly productive investment. Even in the Corporation, however, there is a lack of experienced personnel to plan and supervise, and as a result an obvious overextension of the few individuals available who can do so. The use of recent graduate geologists and engineers as managers of subsidiary companies, presumably because of a lack of experienced managerial staff, aggravates the situation and usually bars these graduates from acquiring more practical experience in their particular profession. A Geology Department has recently been added to the University of Dar es Salaam, but for the training of mining engineers and mineral dressing specialists dependence on foreign universities will continue for the time being. Manpower projections included in this Annex suggest that rapid development of the mining sector will require an increased inflow of expatriate personnel for years to come.

14. The 1974-75 budget of the State Mining Corporation for mining development totals about US\$10 million which is a more than tenfold increase over 1973-74. The Corporation is working on a large number of projects simultaneously and one of the main concerns of the mission is that financial resources - like high level manpower - are spread too thinly to achieve rapid progress. It would seem to be necessary to concentrate available resources over a limited number of priority projects. The selection of priority projects, however, is a difficult and time consuming process and the mission does not pretend to have all the data required or the knowledge to express definite opinions on project priorities. This Annex includes a survey of the many small and few large mining projects that are being prepared or considered and attempts to identify the various project issues so as to serve as a guide for the selection of priorities.

CHAPTER I - PROSPECTING AND EXPLORATION

A. Policy Issues

1. Apart from the general statement embodied in the Arusha Declaration relating to State control of and participation in the exploitation of Tanzania's mineral assets, the only published information relating to prospecting and mining policy is that contained in Volume 1, General Analysis, of the Second Five-Year Plan for Economic and Social Development, July 1, 1969 - June 30, 1974. Emphasis was placed on the development of known mineral deposits, the importance of an "aggressive policy of geological survey and mineral exploration", and import substitution. To promote development, the formation of a "special technical unit", which would have an advisory role, was proposed. By 1969 the State was already participating in mineral production on a substantial scale, and some emphasis was therefore placed on expanding small-scale mining activities by supporting mining cooperatives, ujamaa village groups and district authorities. The Mineral Resources Division would supply advice and services, and run courses in prospecting. Amendment of the legislation to bring the mining law into conformity with the concepts of the Arusha Declaration was proposed.

2. The proposal to form a special technical unit was in effect implemented by the establishment in 1973 of the State Mining Corporation. Emphasis has certainly been placed on assessing the possibilities of exploiting known deposits, particularly those which would lead to import substitution, but this has absorbed available resources to the extent that it has not been possible to pursue an aggressive prospecting policy simultaneously. None of the production targets set for 1973 in the Second Five-Year Plan was met except those for gemstones and diamonds. Another plan aim, namely to diversify mineral production was not achieved either.

3. As far as prospecting is concerned, the level of activity is low and a more positive approach is required if it is to be significantly increased. Large-scale grass-roots prospecting involves a very high level of risk expenditure and it can be reasonably argued that a developing country such as Tanzania with only limited capital resources available is not justified in accepting this risk, even though the potential return may appear to be attractive. Under such circumstances the best approach would appear to be a compromise whereby the private sector bears the risk, and Government retains the right to participate in any mining venture which might result.

4. Such an approach is in fact being followed in a number of cases, but if it is to be generalized and further developed it is essential that the rights and obligations of both parties, i.e., the licence holder and

Government, be clearly defined and spelled out in the relevant legislation. The conditions attached to prospecting rights which any government can lay down without inhibiting interest depend to a large extent on the already proven mineral resources. In the case of Tanzania these are limited, particularly as far as base metals are concerned. Therefore the conditions cannot be more restrictive than in the case of, for example, neighboring Zambia and Zaire if Tanzania wishes to compete for risk capital available to the international mining companies.

5. A second important consideration is that large-scale prospecting programs require not only capital resources but also "know-how" and trained manpower. In Tanzania the present shortage of trained manpower is certainly a major constraint, and it is for this reason that Tanzania could not in the short-term, and probably not for some years to come, adopt the approach used in most countries with centrally planned economies whereby the State assumes responsibility for all prospecting. The majority of such countries have systematically built up immense resources of skilled manpower and adopted a "saturation" rather than a "selected target" type of approach.

6. There is undoubtedly an awareness in Tanzania of the important contribution that mining can make to economic development, but there appears to be a reluctance to try and mobilize the financial and manpower resources of the private sector, particularly the major international mining groups, to accelerate development. To achieve greater private sector involvement, a price has to be paid in the form of guarantees to the partner. The absence of a clearly defined policy on this critical issue is probably the main bottleneck inhibiting a greater involvement of the private sector in the development of the mineral resources of Tanzania. This is understandable in light of the reputation for exploitation that some companies have acquired, but other developing countries have recognized that mutually acceptable partnership agreements can be negotiated and that the activities of the companies can be controlled.

7. Another possibility to accelerate prospecting could be to engage the resources of the recently established United Nations revolving fund for mineral exploration in developing countries, but the contribution that this fund could make to any one country will be limited and the problems of raising capital and "know-how" once the exploitation stage is reached will still exist. Moreover, the actual funding of this new UN facility is yet to be determined.

8. With regard to exploration, i.e., the proving of known mineralization as distinct from primary prospecting, the risk factor is reduced and it is possible to argue that the State should be extensively involved either on its own account or in partnership with the private sector. Much will depend on financial and manpower constraints, and it is in any case essential that individual cases be judged on their merits. This would seem to be a logical field in which the State Mining Corporation should develop its expertise, and this would in fact appear to be the present policy.

9. In theory the Mineral Resources Division is responsible for all primary prospecting on behalf of the State, and the State Mining Corporation takes over the obligation to prove and develop any mineralization discovered. In practice, mainly because of the shortage of geologists, the Division is able to do very little prospecting. If the policy outlined above is to be followed, the role of the Division should be that of a conventional Geological Survey providing the essential background information which gives a first indication of the mineral potential of individual areas and eventually the whole country. Without such information it is impossible to select areas for prospecting on a priority basis according to the geological environments represented and their mineral potential.

10. At present, emphasis in the government sector is on proving and developing known mineralization to accelerate the contribution that mining could make to easing the foreign exchange constraint and the development of the economy generally. It is thus logical that such skilled manpower as is available is largely concentrated in the State Mining Corporation.

11. In the recent past, extensive use has been made of multilateral and bilateral aid, and also contract agreements with such State enterprises as Technoexport of the USSR, to accelerate the mapping and reconnaissance prospecting being undertaken by the Mineral Resources Division in particular. One shortcoming of this approach appears to be the lack of continuity and follow through, i.e., neither funds nor manpower are necessarily available to develop and exploit any discovery which may result. On the other hand, once a discovery has been made and if the government is interested in a partnership arrangement for commercial exploitation of the deposit, the government should be able to negotiate such an arrangement from a position of greater strength than in the case where the partner had borne the original prospecting risk.

12. Contract arrangements such as the agreement with Technoexport, however, do involve government expenditure on primary prospecting which a country like Tanzania should in principle try to avoid because of the high risk factor. Organizations such as Technoexport offer the services of experienced well-qualified personnel at rates far lower than most alternative sources, but in taking advantage of this any contract should be framed to also allow for the utilization of alternative sources of supply of equipment, vehicles, supporting staff, etc., particularly local sources.

13. The basic mining legislation covering all minerals other than oil, dates from 1929 - Chapter 123 of the Laws (Revised) - though it has been amended on various occasions since. All mineral rights are vested in the President, and provision is made for the issue of simple Prospecting Rights and Mining Claims by The Commissioner of Geology and Mines, and Exclusive Prospecting Licenses and Mining Leases by the responsible Minister. This

legislation has many good features: mineral rights are separate from and in most cases take precedence over land rights; an applicant for an Exclusive Prospecting Licence or a Mining Lease must be able to prove that he has adequate capital resources and annual minimum work obligations to ensure that any area granted is prospected or mined. In practice an applicant for an Exclusive Exploration Licence or Mining Lease submits his application through the Controller of Mines of the Mineral Resources Division giving details of planned expenditure, etc. If the Minister approves in principle, a formal application is then submitted.

14. There are, however, other features which are likely to inhibit the interest of the private sector. For example, an Exclusive Prospecting Licence would normally only be granted for a maximum area of 8 square miles though provision is made for Special Licences covering larger areas. There is no indication in the Act that either license would in practice only be granted on condition that Government retained the right to participate in any mining venture which might result, and no indication as to whether or not in such an event the State would pay any part of the prospecting costs incurred. The holder of an Exclusive Prospecting Licence does not even have a guarantee of first option to negotiate exploitation rights, as the Minister may refuse to issue (or renew) a Mining Lease and the President may revoke a Lease without the holder being able to appeal in either event. 1/

15. It is evident that there is a need to revise the legislation, though this is probably only essential if Government does intend to try and increase the level of activity of the private sector. The "rules of the game" must be known and clearly spelled out in the Act. The need for revision is recognized but no specific action has been taken so far. In preparation for this exercise it might be useful for the Tanzanian authorities to consult the revised legislation of such countries as Botswana and Zambia.

16. The mining, and in particular the marketing of gemstones (other than diamonds) is controlled under separate legislation, the Gemstone Industry (Development and Protection) Act, 1967, which is administered by the Director of Gemstones. He monitors, and if necessary amends, all valuations of gemstones sold to local buyers and for export, and in effect controls prices as far as the market will permit. He is also responsible for the issue of export licences; dealers licences are issued by the Commissioner of Geology and Mines.

1/ In the relevant legislation of neighboring Zambia, the rights of both parties are assured as far as possible. The Minister may refuse to grant a Prospecting Licence without stating his grounds for doing so, but as no expenditure has been incurred at that point, this is not unreasonable. Once a Prospecting Licence has been granted, however, the holder, provided he discharges his obligations as laid down in the Act, must be granted subsequent exploration and mining rights if his proposed program is acceptable. In the event of any differences of opinion regarding the interpretation of the Act in this respect, or in the case of any mining right being withdrawn, the holder has the right of appeal to an independent tribunal.

17. Prospecting for and mining of diamonds are controlled under the Diamond Industry Protection Ordinance, Chapter 129 of the Laws. The legislation governing prospecting for and exploitation of petroleum and natural gas, Chapter 399 of the Laws, was not reviewed by the mission. The regulations made under this Act are currently being redrafted.

B. Current Activities

Government activities

18. Prospecting by the Mineral Resources Division is at a very low level mainly because of the small number of geologists available. Present activity is confined to some work on gold projects in association with the State Mining Corporation and the drilling of nickel mineralization at Kapalagulu in the west.

19. In the past extensive mapping and reconnaissance prospecting has been carried out under multilateral and bilateral aid programs, and also under contract. The largest contract was signed with Technoexport of the USSR in 1969 for the mapping of 16 quarter-degree sheets in the central and western parts of the country and prospecting for gold and base metals in the Mpanda area and gold in the Lupa area. Follow-up prospecting of the Lupa and Mpanda goldfields is continuing. Similar projects with the emphasis on mapping rather than prospecting have been undertaken by West Germany and the Netherlands, apparently under aid rather than contract arrangements. The Lake Victoria goldfields were prospected under a UNDP program between 1965 and 1968. The Kigugwe copper mineralization was prospected and drilled by the Rumanian State mining group, Geomin, under contract.

20. Under the Technoexport contract little use could be made of available local resources, particularly semi-skilled manpower while the training provided for counterpart staff was not fully effective because of the language problem. In contrast to a mapping agreement with West Germany, no provision was made for final drawing and printing of maps. As a result the drawing office at Dodoma is completely overwhelmed with manuscript maps, which although very well presented, have to be completely redrawn for publication. A further bottleneck will be the printing, which can only be done by the Survey Department.

21. A team of Chinese geologists has completed a prospecting program along the Tazara Railway line under a bilateral aid agreement with the Mineral Resources Division as the counterpart agency. No new mineral deposits were discovered, but the Government's plan to develop an iron and steel industry in the Chunya area presumably originated from this exercise.

22. The State Mining Corporation's exploration unit, based at the offices of the Mineral Resources Division at Dodoma, is small; current activity includes prospecting for gold, cement materials, building minerals, gemstones and abrasive raw materials. Extensive use is made of the Division's chemical and mineral dressing laboratory facilities.

Private sector activities

23. Prospecting by the private sector, apart from prospecting by individuals, is restricted to the activities of Williamson Diamonds Limited and the Agip/Amoco combination.

24. Diamond prospecting in Tanzania since 1960 has been entirely financed by interest-free loans - now totaling approximately Sh 49 million - from the Willcroft Corporation, a Bermuda registered company. The prospecting itself is undertaken by Williamson Diamonds Limited under the supervision of the Mine Geologist. The agreement provides for repayment as a first call on profits from any joint mining venture which may result. Thus only half the loan would actually be repaid, as the company making the repayment would itself be 50% owned by the Willcroft Corporation. The fact that this prospecting expenditure is apparently offset against the profits of Williamson Diamonds Limited for tax purposes further complicates the issue. The loan agreement is evidently flexible, as the small Kahama diamond mine, which had only a six year life and closed down in 1971, would not have been a viable project if it had been "loaded" with the repayment of all previous prospecting expenditure, as the average grade was only 4.3 c.p.h.t. (carats per hundred tons).

25. Almost all of Tanzania - excluding only obviously unfavorable areas - has now been prospected for diamonds though no formal licence exists. After reconnaissance sampling Williamsons have applied for Exclusive Prospecting Licences over areas considered to be of interest on the basis of their preliminary results, but they have no legal claim to title should an application be refused. In spite of this informal arrangement, comprehensive quarterly reports on all prospecting activity are submitted to the Mineral Resources Division.

26. Both drainage and loam sampling techniques are used depending mainly on the topography and drainage of an individual area. The average sample interval is 1 km. The heavy mineral fractions of all samples are forwarded to De Beers Prospecting (Zambia) Limited.

27. Of the 200 or so known kimberlites in Tanzania, 180 have been discovered by Williamsons, including Kahama. Approximately one kimberlite in 100 contains diamonds but not necessarily in economic quantities. Some years ago the prospecting program reached a peak of activity and 50 geologists together with 100 to 150 field officers were employed. The present number of employees is 100 samplers and laborers, using a fleet of 13 Landrovers, 5 Bedford trucks and 4 tractors. Total expenditure in 1974 is estimated at Sh 300,000/-. Williamson's diamond prospecting program for the whole of Tanzania is scheduled to be completed by April 1975.

28. In view of the extent and density of the sampling undertaken by Williamsons, it is doubtful whether further reconnaissance prospecting for

diamonds could be justified, except possibly in restricted areas selected on geological grounds after reviewing all results to date.

29. Williamson Diamonds Limited also prospect on their own behalf for minerals other than diamonds using geochemical techniques, and have spent some Sh 3 million on such projects in the last five years. The samples are analyzed in the laboratories of Zamanglo Exploration Limited, Lusaka, Zambia. An investigation of the large area underlain by volcanics centered on the southern end of the Gregory Rift in an attempt to locate fluorspar deposits of the Kenya type proved unsuccessful. (Drainage samples were analyzed for fluorine.) Geochemical prospecting in Masailand has located a copper anomaly which is currently being investigated.

30. Williamsons have also undertaken some prospecting and evaluation on behalf of the State Mining Corporation, e.g., the underground exploration of the Buck Reef gold deposit.

The search for oil and gas

31. Oil and gas exploration rights over a 5.7 million hectare onshore and offshore coastal area of Tanzania - including Zanzibar - have been held by Agip S.p.A., a wholly owned subsidiary of the Italian E.N.I. Group. This concession was held by Shell/B.P. between 1951 and 1964 and a summary of the geological results of their exploration, which included the drilling of 52 boreholes, is contained in Kent, Hunt and Johnstone (1971) and Aitken (1961). It is understood that the results of this prospecting program were reviewed by a team of geologists from the USSR in 1968. The cores and cuttings are held by the Mineral Resources Division in Dodoma. In 1974 Amoco negotiated a part share in the Agip concession. To date two wells of the minimum of four stipulated in the concession agreement have been drilled. The second well sited off Songo Songo Island northwest of Kilwa and completed in early 1974 struck natural gas in a Cretaceous horizon. The rig has since been moved by Agip to the company's Madagascar concession, and no drilling is currently being undertaken. (A contract for further drilling has recently been negotiated by Agip with Kenting's of Canada.)

32. The Agip/Amoco agreement is based on the "Indonesian model", i.e., the risk involved in exploration is borne by the concessionaire, but notional repayment may be recovered from production. Thus 35-40% of any production goes to the company as "equity" or "cost" oil, and the balance or "profit" oil is divided 60:40 between the Government and the company, respectively. Presumably any gas production would be divided in the same proportions.

33. Agip completed a seismic survey of the concession area in 1972, and are committed to drilling a minimum of two wells in 1974 and two in 1975. Although they had to relinquish a proportion of the area on September 1, 1974, this obviously comprised areas considered unfavorable from a

structural point of view, e.g., synclines. If the Agip/Amoco group fail to declare the gas strike a commercial find, the State owned Tanzanian Petroleum Development Corp., is likely to be interested in exploiting the deposit on behalf of the Government. In the event that Agip/Amoco relinquish exploitation rights over the gas find, all costs and expenses to date would become a first charge on profits after operating costs (including amortization) have been recovered.

34. The discovery of this gas deposit, whatever the reserves ultimately prove to be, must enhance the chances of further discoveries. T.P.D.C. is well aware of the advantages of encouraging drilling at an accelerated rate, and will presumably do so within the limitations imposed by the terms of the existing concession. The current Agip/Amoco drilling program was planned to obtain intersections in the Lower Tertiary, and in the Palaeocene in particular. The best oil show to date was found in the Shell/B.P. well on Mafia Island, and Songo Songo Island well was sited as a follow-up to this. Other structural features to be further explored are any other diapirs of the Mandawa-Mahokondo type, which was proved to be a piercement structure as a result of a Shell/B.P. well drilled in the core of the anticline, particularly any such structure affecting younger sediments. The most important structures may, however, well prove to be reef and fault traps of the types described in a recent paper presented by T.P.D.C. to the 1st African Petroleum Conference held in Tripoli, Libya, in February 1974.

35. It is understood that some interest has been expressed in deeper water offshore concessions, a zone which is to date unexplored but which advances in deep water drilling and recovery technology have now made of interest.^{1/}

36. Agip would appear to be unenthusiastic about the chances of finding oil, Amoco are undecided and T.P.D.C. - although for obvious reasons reluctant to say so - are optimistic. To the south, the new Government of Mozambique has very recently awarded new concessions to Hunt and Gulf Oil. The increasing level of activity along the East African coast from Ethiopia to the Republic of South Africa is an indication that the companies still regard this zone as having potential.

C. Information Flow and Review

37. It is stipulated in all prospecting licenses and agreements that activities and results must be reported at quarterly intervals and a final summary report submitted to the Mineral Resources Division or T.P.D.C. as

^{1/} A concession to explore five blocks of this zone has since been signed with Oceanic Exploration and a seismic survey is being undertaken.

appropriate. There is no provision for this in the Act, however. If the present legislation is to be amended with regard to reporting procedures, consideration should be given to including a provision that the Mineral Resources Division be offered all core and samples, particularly geochemical samples, before they are otherwise disposed of by a licence holder.

38. The present provisions may be adequate, but there seems no awareness that in this particular respect the State Mining Corporation is just another organization which should operate under the licensing system and be under an obligation to report on its activities. Unfortunately, because of serious staff constraints, it is doubtful whether the Mineral Resources Division is able to monitor and critically review the activities of license holders, few as they are.

39. All the relevant records are stored at Dodoma. In the case of licenses which have expired, the period for which the reports remain confidential is in some cases negotiable with the former licence holders. This seems unnecessary, and consideration should be given to amending the procedure so that reports, etc., can be made available for public inspection once a license expires or is abandoned.

CHAPTER II - MINING

40. This chapter provides a brief description and comments on ongoing mining operations in Tanzania. A survey of all producing companies, their location and the minerals they mine is provided below:

<u>MINERAL</u>	<u>LOCATION</u>	<u>PRODUCING COMPANY</u>
Cement raw materials	Wazo Hill, near Dar es Salaam	Tanzania Portland Cement Company
Coal	Ilima Colliery, SW of Mbeya	Ilima Colliery Production Co-op.
Diamonds	Mwadui, SE of Mwanza, New Alamasi	Williamson Diamonds Limited New Alamasi (1963) Ltd.
Colored gemstones	Various small mines mainly centered on Arusha	Tanzania Gemstones Industries Ltd, and various individuals and cooperatives.
Gold and silver	Mainly Lupa and Mpanda fields	Individual claim holders and co-ops.
Gypsum	Mainly from Mkomazi, W of Tanga	Individual claim holders and co-ops.
Kaolin and glass sand	Pugu Hills, near Dar es Salaam	Kioo Ltd.
Lime	Arusha, Tanga, Kigoma and Kasulu	Various small companies and individuals.
Magnesite	Chambogo	Tanganyika Magnesite Mines, Ltd.
Meerschaum	Singa	Tanganyika Meerschaum Corp., Ltd.
Mica	Morogoro	New Africa Mica Mining Co. and Uluguru Mica Mining Co-op.
Salt	Uvinza; various coastal salt works - Bagamoyo, Tanga, Dar es Salaam and Mtwara	Nyanza Salt Mines; various private companies.
Tin and wolfram	Karagwe	Claim holders and cooperatives.

41. A survey of mineral production and export (from 1970-73) in terms of both volume and value is presented in Table 1.

A. Diamonds

42. Williamson Diamonds Limited, who operate the Mwadui mine, has been jointly owned by the Government of Tanzania and the Willcroft Corporation of Bermuda - a wholly owned subsidiary of De Beers - since 1958, i.e., prior to independence. The company has been wholly self-managed since April 1973. Consulting services are undertaken by the Anglo American group on an as-and-when required basis. The adjacent New Alamasi mine is operated by a subsidiary company, New Alamasi (1973) Limited.

43. The near-circular Mwadui pipe which was discovered in 1940 and which has been worked continuously since (Table 2) is some 1,500 m in diameter and is the largest known diamondiferous kimberlite pipe. The mine lies on the Tabora-Mwanza Road, and a rail spur links the mine township, which has a total population of 10,000, with the Mwanza-Dar es Salaam Railway. The bulk of the diamonds, 45% of which are the gemstone quality, are contained within patchy superficial gravels which both rim and overlie the pipe. The pipe itself contains kimberlitic sediments - which on palynological evidence have been dated at 100 million years - but only the conglomeratic beds on the west side are of economic grade. The pipe has been explored with a shaft to 360 m and cross-cuts at 27, 60 and 90 m. Volcanic kimberlite was encountered at 360 m. The grade decreases markedly with depth both in terms of the number of carats per hundred tons (c.p.h.t.) and the value per carat. No mining is planned below 90 m. The reserve blocks measure 60 x 60 m and each has been valued by bulk sampling and assessment of the actual diamonds recovered.

44. New Alamasi comprises only scattered gravels adjacent to the east of the Mwadui pipe; the average mill-head grade is only 6 c.p.h.t. The production in 1973 was 37,643.15 carats compared with Mwadui's production of 463,864.30 carats, the value per carat being approximately the same.

45. Mining at Mwadui is undertaken with three small draglines, purchased in the early days of the mine when only the superficial gravels were being worked, from a large shallow (33 m) open pit. The ore is transported in 35-ton dump trucks. Ore production is 300,000 tons/month and the average yield 33,000 carats/month. Both the mine and the plant operate 24 hour days, six days a week. Serious operational problems are caused by the erratic supply of explosives and spares. All imported spares valued at more than 10,000/- have to be pre-inspected under the Exchange Control Regulations, but in an emergency permission can be obtained to air freight spares without pre-inspection.

46. The pit will have a maximum depth of 90 m. The present primary crusher in the pit will have to be moved and, if the proposed slope of 41° proves to be unstable, the other primary crusher on the edge of the pit will also have to be re-sited. In view of the very friable nature of the finer grained kimberlitic sediments which will form the wall of the pit at this point, this seems to be a likely possibility which will have a major effect on the mining program because crushing capacity is at present the main constraint on mill throughput.

47. The mill feed is the -150 cm (6 in.) output of the two primary crushers, which is scrubbed and screened at 38 mm (1-1/2 in.). The oversize is crushed and together with the undersize is then washed on 6 mm (1/4 in.) screens. The +6 mm fraction is fed to heavy media separating cones. The float is screened at 20 mm (3/4 in.) and the coarse fraction crushed and recycled; the undersize is tailings. The heavy fraction is treated in a ball mill and screened, the coarser fraction being fed to X-ray separators and the fine fraction to grease belts. The -6 mm fraction is passed through cyclones and the clay fraction discarded. The sand fraction is treated in heavy media separation cyclones, and the concentrates fed to the final ball mill, grease belts and X-ray separator circuit. The heavy media consumption is 35-40 tons/month of ferro-silicon and 35-40 tons/month of magnetite.

48. The mill currently processes some 12,000 tons/day of gravel and kimberlitic sediment which have to be blended in more or less constant proportions to avoid overloading the plant with fines. Recovery is very high; the tailings, which are constantly inspected, being virtually barren and containing only a small number of very small diamonds.

49. Also available is a pilot plant capable of treating 50 tons/hour which is used primarily for bulk samples for ore reserve evaluation. For the superficial gravels, 200 ton samples are used; for the less variable kimberlitic sediments 50 to 100 tons are adequate.

50. Power is provided by a 12 MW fuel oil station maintained by the mine. Power is also "exported" to the nearby town of Shinyanga.

51. The recently introduced 16 year mining plan, which was approved by the Board in April 1974 and is subject to annual review, involves mining and milling at a consistent rate of 3.6 m tons/year and monthly adjustment of the grade to ensure that the mine "breaks even" after royalty (15%) and levy (5%) have been paid. A similar plan is in operation at the adjacent New Alamasí mine. Previously, the mining plan allowed for a six or seven year remaining life. The new plan conceived after the steep diamond price increases of 1972 and 1973, is designed to maximize the life of the mine township of 10,000 which would otherwise rapidly become a ghost town. Thus the mine currently operates on a no profit/no loss basis using all 2,000 employees and existing techniques and equipment. Each month's production is valued by the Mine Geologist and the blocks for the following month selected to conform to milling constraints, i.e., the proportion of fines, and the limitations of tonnage and value inherent in this program.

Table 1

Survey of Mineral Production and Exports, 1970-73

Mineral	Unit	Volume								Value (Thousands of TShillings)							
		1970		1971		1972		1973		1970		1971		1972		1973	
		Production	Export	Production	Export	Production	Export	Production	Export	Local Sales	Export	Local Sales	Export	Local Sales	Export	Local Sales	Export
Calcite	mt.	-	-	1375.0	-	781.0	-	2425.0	-	-	-	13.5	-	7.8	-	6.1	-
Coal	mt.	2504.0	-	2797.5	1.0	3464.0	-	1994.2	-	134.4	-	139.5	-	172.5	-	100.3	-
Diamonds	gms.	141628.9	139741.3	167437.0	162981.6	148178.6	125828.8	100291.8	115003.0	-	161000.0	-	134452.2	-	123608.9	-	166826.1
Gemstone (colored)	kgs.	1071.7	568.8	1569.3	229.9	964.9	1647.8	4964.0	3879.0	86.6	2746.4	16.8	723.7	119.0	916.8	209.7	4567.3
Glass, sand	mt.	3937.8	-	52.7	-	11311.7	-	15233.3	-	36.1	-	79.1	-	50.3	-	63.5	-
Gold (refined)	gms.	244445.3	244445.3	5185.3	5185.3	6621.7	6621.7	1726.5	1144.0	-	2334.7	-	42.0	-	86.7	-	25.0
Gypsum	mt.	20716.3	2350.0	17690.9	5050.0	14006.3	2535.0	12871.5	4217.5	272.9	63.3	373.7	135.2	359.7	122.7	320.0	160.4
Kaolin	mt.	436.8	-	830.3	-	1460.1	-	870.0	-	86.6	-	147.6	-	130.9	-	150.3	-
Lime	mt.	546026.0	-	5202.5	-	1818.0	-	5987.6	-	1108.1	-	889.0	-	1139.9	-	1167.0	-
Magnesite	mt.	744.6	690.0	981.6	1000.6	541.6	811.0	108.7	410.0	-	349.8	-	209.9	-	420.4	-	76.0
Meersbaum	mt.	9.7	-	8.0	-	18.1	-	9.4	-	119.8	-	159.9	-	131.4	-	-	-
Mica Sheet	mt.	57.4	57.4	37.4	36.8	18.0	22.9	32.1	16.4	-	1220.3	-	613.0	-	473.0	-	433.3
Ornamental Stones	mt.	66.4	56.0	0.3	20.1	35.0	9.1	188.0	199.2	-	210.6	-	135.5	-	61.3	-	468.5
Salt	mt.	41944.4	5192.3	37278.2	15240.8	44247.2	18061.6	38392.3	9483.1	5987.0	2310.9	4210.3	4363.6	4443.9	3747.9	5164.8	2851.4
Silver (refined)	gms.	3427.7	3221.1	1125.6	1125.6	1602.4	1602.4	116.0	156.0	-	14.1	-	4.0	-	.6	-	-
Tin concentrates	mt.	162.1	319.9	194.7	163.0	27.1	73.5	33.5	16.0	-	594.1	-	3214.9	-	1133.1	-	328.0
Tungsten concentrates	mt.	13.4	4.9	10.7	7.1	6.6	16.8	2.1	-	-	69.4	-	151.6	-	195.9	-	-
Vermiculite	mt.	150.0	-	28.0	-	-	-	-	-	18.0	-	-	-	-	-	-	-
Total										7429.5	176264.7	6030.1	144037.8	6505.5	130107.3	7383.7	175736.0

Source: The Economic Survey, 1970-71, 1971-72, 1972-73

Table 2

MWADUI PRODUCTION SINCE DISCOVERY

<u>YEAR</u>	<u>TONNAGE "MINED"</u>	<u>METRIC CARATS</u>	<u>C.P.H.T.</u>	<u>GROSS REVENUE (T. SHILLINGS)</u>
1940	13,349	4,565.75	34.20	
1941	64,848	29,831.50	46.00	
1942	57,972	34,351.00	59.25	
1943	92,376	44,766.85	48.46	
1944	102,435	63,907.80	62.39	
1945	128,400	100,350.60	78.15	
1946	149,400	111,311.58	74.50	
1947	79,785	78,552.86	98.46	
1948	163,787	119,635.96	73.04	
1949	433,514	177,393.90	40.92	
1950	364,993	153,672.19	42.10	
1951	293,680	99,887.08	34.01	
1952	419,482	129,252.19	30.81	
1953	235,899	158,738.59	67.29	
1954	294,777	314,663.31	106.75	
1955	334,978	313,381.69	93.52	
1956	1,097,108	347,097.80	31.64	
1957	1,314,778	371,870.52	28.28	
1958	2,161,406	506,885.09	23.45	
1959	2,236,192	624,291.20	27.92	
1960	2,389,982	525,780.01	22.00	89,636,360/=
1961	2,788,496	667,619.03	24.38	105,186,240/=
1962	2,797,057	636,855.88	22.77	105,915,600/=
1963	2,781,947	571,632.01	20.55	95,596,180/=
1964	2,868,530	633,759.41	22.09	111,424,860/=
1965	2,919,255	742,042.91	25.42	132,461,620/=
1966	3,285,038	924,984.08	28.16	115,463,800/=
1967	3,298,384	883,896.96	26.80	272,212,560/=
1968	3,256,024	655,940.20	20.15	135,479,601/=
1969	3,397,518	732,187.43	21.55	141,099,632/=
1970	3,268,006	657,208.02	20.11	111,005,656/=
1971	3,511,164	791,410.24	22.45	125,257,362/=
1972	3,606,852	595,449.16	16.53	114,175,382/=
1973	3,600,061	463,864.30	12.88	154,271,739/=
accumulated totals	53,807,472	13,267,037.10*	24.65	1,839,186,592/=
	=====	=====	=====	=====

*Equivalent to 2.65 Metric Tons

Source: Williamson Diamonds Limited

52. This mining plan involves mining and milling of some 700,000 tons/year of very low-grade ground from outside the declared reserves which is "sweetened" with the high-grade gravels. The mill feed is not diluted with ore below cut-off grades, however, as this would inevitably involve a straight financial loss. Because the remaining tonnage of gravel is small and mining the kimberlitic sediments to 90 m will result in an overall lowering of the grade, the plan can only be maintained if the royalty and levy are reduced. The timing of this change will depend largely on future diamond prices. Present estimates are that it will be possible to maintain an output of some 400,000 carats/year for 12 years, and thereafter production will fall to 350,000 carats/year.

53. Finally, the plan provides for the retreatment of almost all the older dumps, most of which carry significant grades of recoverable diamonds, though the larger, better quality stones were of course recovered previously. These dumps are included in the ore reserves.

54. Security at the mine has always been a problem and reached an absolute nadir some 18 months ago when it was estimated that possibly as much as the equivalent of 40% of the value of production was being lost. Some improvement has taken place since, but the provisions are still not adequate.

55. It is evident that Tanzania could temporarily earn significant additional foreign exchange within a matter of months by amending the present mining plan and high-grading the remaining alluvial gravels. This would of course shorten the life of the mine, though the extent would depend on future diamond prices. Under the present circumstances, any profit generated as a result of a revised mining program would, if paid out as dividends, have to be divided between the State Mining Corporation and the Willcroft Corporation as joint owners. The State would, however, also receive additional return in the form of increased royalty and levy.

56. Under the current five year Diamond Sales Agreement with the Diamond Corporation of London, which expires in November 1975, the diamonds are sold through the Tanzania Government Diamond Sorting Organization, which was established in 1966 and is based in London. This Agreement was re-evaluated by the Government in 1973, and the decision made to continue. It is important to bear in mind that Tanzania now produces only some 0.2% of the world's diamonds, compared with 1.0% in 1950, and that the Diamond Corporation provides guaranteed sales. Any alternative would almost certainly mean a major fall-off in sales when market demand was low, as for example, at present when dealers are reducing stocks because of high interest rates.

57. Tanzania Diamond Cutting Co. of Iringa - Tancut - purchases its requirements from London, including gems from other producers. Payment for stones from Tanzania is made to Williamsons at market rates. (Tancut absorbs less than 10% of Mwadui's production.) Tancut is basically a partnership between the Tanzania Government and a foreign national, and is concerned only with faceting and polishing diamonds. The initial sawing is done in Antwerp, and the faceting in the company's workshops at Iringa. The operation has not

been particularly successful, but has shown improvement recently and made a Sh 3 million profit in 1973. No dividend could be paid, however, because of accumulated deficits.

B. Gemstones (other than diamonds)

58. Tanzania Gemstone Industries Ltd, based in Moshi and now a wholly owned subsidiary company of the State Mining Corporation and formerly of the National Development Corporation, was formed in 1971 to take over the privately owned Melelani, Umba and Longido mines. Melelani is the main producer of tanzanite, and comprises a group of small workings scattered over some 10 km² in the Arusha district. Umba, northwest of Tanga, produces ruby, sapphire and garnet. The Longido Mine, north of Arusha and formerly owned by a subsidiary company of the Continental Ore Corporation, is the main producer of ruby and is also the source of anyolite - "Tanzania artstone" - an unusual and attractive rock comprising well formed crystals of pink corundum, set in a bright green matrix of zoisite and amphibole. In addition, some tourmaline, ruby, emerald, grossularite and amethyst are produced by individual small workers who must sell their products to Tanzania Gemstone Industries, who cob and hammer the material if necessary, before reselling.

59. All these mining operations are on a very small scale and at the time of the takeover were left with very little, mainly old equipment. They have been plagued with all the difficulties inherent in attempting to manage small scattered operations by a conventional mining organization, which apart from any other consideration, has inevitably increased overhead costs. Further problems arise from the difficulties of maintaining security under such conditions, particularly as the strict foreign exchange regulations ensure the existence of a flourishing black market. As a result, official production has declined, particularly in 1974.

60. The reserves and grade of the deposits, which comprise only small pockets of mineralization, are difficult to determine and largely unknown. Detailed prospecting not only of the deposits being exploited but of the many other occurrences which are known, particularly in Masailand, is obviously necessary to determine the potential for increasing production, but it must be recognized that the evaluation of such mineralization is difficult and sometimes virtually impossible. The biggest demand is undoubtedly for tanzanite, of which Tanzania is the only producer. The constraints are not only lack of trained manpower, but also lack of financing to purchase even basic items of equipment such as tractors and pumps and to provide accommodation on site, as the company at best does no more than "break even".

61. Some polishing and faceting is done locally by privately owned companies based in Arusha and Dar es Salaam, but the bulk of the production is exported in rough form. Exports of tanzanite are sold exclusively to

Trans Africa Gemstones of the Federal Republic of Germany. The local manufacturers can only buy from Tanzania Gemstone Industries at prices controlled by the Director of Gemstones - which are usually set above export prices - and must submit returns to the Director regarding purchases, cutting losses and sales. Consideration is being given to provision which will enforce local retail outlets to sell only for foreign exchange.

C. Cement

62. Tanzania Portland Cement Co. (T.P.C.C.) is currently the sole producer of cement in Tanzania. The plant is located at Wazo Hill, 30 km by road north of Dar es Salaam. The present capacity is of the order of 350,000 tons/year. The cement is produced to British Standard Specification and the kilns - one Humboldt and one F.L. Smidth - are oil fired. A new kiln to expand the capacity of the Wazo Hill plant to 600,000 t.p.a. is on order. It is estimated that current demand exceeds local supply by perhaps as much as 250,000 t.p.a.

63. Tanzania Portland Cement Co. has been a wholly owned subsidiary of the State Mining Corporation since 1973. Previously it was a subsidiary of N.D.C. in which 25% of the shares were held by Associated Portland Cement Co. and 25% by Cementia A/S of Switzerland. First production was in 1966. Between 1969 and 1971 the plant produced at full capacity - 170,000 tons/year - supplying some 50% of the market. In 1971 the capacity was increased to 350,000 tons/year. 1972 production was 237,000 tons and the figure for 1973 was approximately 350,000 tons.

64. The basic raw materials are quarried approximately a kilometer north of the plant. The quarry comprises a single 10 m bench and produces some 2,000 tons/day, utilizing two tracked shovels, and four 15-ton and two 25-ton dump trucks feeding impact crushers. The shovels have been in use since quarrying began. Lack of spares is the main mining problem. Mining costs are very low. The royalty paid is Sh 1/25 per ton.

65. The limestone is a brecciated Pleistocene reef deposit, which has a very low magnesia content. The overburden, a red lateric soil with fine sand, kaolin and limonite as the main constituents, is quarried with the limestone in approximately the proportions required for cement making. The upper surface of the limestone is irregular, but the contact with the base of the soil profile is very sharp. The bed of limestone being quarried is horizontal and more than 6 m thick. This deposit was proved by the Mineral Resources Division, who outlined 20 m tons of suitable limestone. However, the company is now responsible for all its own prospecting, employing a geologist and operating its own drills. The prospecting now in hand is expected to prove additional reserves of more than 20 m tons.

66. Gypsum is purchased from small cooperatives and individual miners, mainly in the Mkomazi area, who are responsible for delivering their product to Wazo Hill. Transport problems - both road and rail - have affected the regularity of deliveries, but these now appear to have been largely overcome. The price paid is Sh 60/- per ton of gypsum containing 75% $\text{CaSO}_4 \cdot 2\text{H}_2\text{O}$, plus or minus Sh 1/- for every percent below or above. (The minimum acceptable is 65% $\text{CaSO}_4 \cdot 2\text{H}_2\text{O}$.) In addition, transport costs are paid, which in the case of gypsum delivered by road is Sh 80/- per ton. As the distance involved is some 400 km, it is hardly surprising that an increase in the transport rate has been requested.

67. The present cost of ex-factory bulk cement is Sh 140/- per ton, to which must be added 25/- sales tax and a bagging cost of Sh 45/- per ton, i.e., a total of Sh 210/- per ton. The controlled selling price - since the last increase in May 1974 - of ex-factory bagged cement is Sh 238/- per ton. The retailer's price in Dar es Salaam is Sh 14/- per 50 kg bag. Company tax (45%) is payable on profits, and given the small margin of selling price over total factory costs the opportunity to build up equity within the company for the financing of expansion is very limited.

68. Marketing is the responsibility of the company, who distribute through the Regional Trading Corporations. Transport costs are added and there is therefore no national uniformity of retail price as for certain other key construction inputs. The price of a bag of cement in Bukoba, for example is almost three times as high as in Dar es Salaam which appears to be contrary to the Government's policy of aiming at nation-wide price uniformity for essential goods. Bags have been in short supply and a shortage of railway wagons is currently resulting in delays in supplying up-country requirements. Shortages of cement are pervasive in many parts of the country and these shortages act as a cost raising factor in nearly all construction projects involving the use of cement.

69. It is estimated that in order to "equalize" the price of cement, it will be necessary to increase the ex-works' price by some 25% and to use the extra revenue to finance a transport cost-equalization fund.

70. Because of a significant shortfall in production compared with current demand, the distribution of cement is rationed on a regional basis by the Ministry of Commerce and Industry. Total consumption in 1972 was 459,000 tons, but this figure was distorted by the exceptional demands created by the Kidatu Hydroelectric Project and the Tazara Railway. "Normal" trend consumption is estimated to have been 267,000 tons in that year. Estimates of future demand growth vary within very wide margins. Such estimates are particularly difficult to make in view of the current shortages, the precise magnitude of which is not known because of restraints on imports and controls on ex-factory prices. Until recently cement used to be sold ex-factory on a first-come-first-served basis but the sale is now strictly rationed in accordance with Government building priorities.

71. The rate at which demand for cement will grow will be strongly influenced by the rate at which the Government is planning to build the proposed new capital in Dodoma. Cement expansion plans include the expansion of the Wazo Hill plant to 600,000 t.p.a. capacity and two new factories of 250,000 t.p.a. and 200,000 t.p.a. capacity to be sited in Tanga and Mbeya respectively. The Wazo Hill expansion project is bilaterally assisted by Denmark and the proposed Mbeya plant by the USSR. The financing of the proposed Tanga plant is still uncertain. After completion of the current expansion plans by 1979 or 1980, Tanzania will have an annual production capacity of 1,000,000 tons which in all probability will mean that the country will have a sizable exportable surplus. If the assumed "normal" trend consumption of 267,000 tons in 1972 grows at 8% annually (which seems to have been the historical growth pattern during the sixties), projected domestic consumption in 1980 would be only about 500,000 tons or half the projected production capacity. The mission has not been able to assess export possibilities in neighboring countries.

D. Salt

72. In the past the Uvinza salt works have accounted for almost two-thirds of Tanzania's production of coarse (unrefined) salt (40,000 t.p.a.), the balance being produced from solar pans at Tanga, Bagamoyo, Dar es Salaam, Lindi and Mtwara. The State Mining Corporation has a majority interest in Nyanza Salt Mines Ltd, who exploit from wells and boreholes the mineralized springs at Uvinza. All the coastal salt works are privately owned. Some 30% of the total production of coarse salt has been exported to neighboring countries, but there is a significant import of refined salt.

73. A project to increase production at Uvinza by 60,000 t.p.a. is under implementation. This involves supplementing the original wood-fired boilers by a solar system. The project is some two years behind schedule and salt production has fallen significantly in 1974.

E. Gold

74. The current production of gold is insignificant. Plans for expansion are described in Chapter V.

F. Coal

75. The present production of coal (around 2,000 t.p.a.) is from the Ilima Colliery in the Songwe-Kiwiri coalfield, south of Mbeya. The mine is operated by a cooperative, and the coal is used largely by the local tea estates.

G. Tin and Wolfram

76. Production of tin concentrates has been insignificant since the closure of the Kyerwa Mine in 1971. Present production of cassiterite and wolfram is by cooperatives and individuals in the Karagwe area. The volume of production is small but is not precisely known because of unofficial border trading in concentrates in the production area.

H. Mica

77. The production of mica by small workers and cooperatives in the Uluguru Mountains area has fluctuated widely, but also shows a marked overall downward trend. Pegmatites are notoriously difficult ore bodies to valuate, particularly for mica, and the potential is therefore largely unknown.

I. Kaolin and Glass Sand

78. Present production of kaolin and glass sand is from a friable kaolinitic sandstone outcropping in the Pugu Hills, 25 km southwest of Dar es Salaam. The company, Kioo Ltd., is privately owned and a member of the Madhvani group. Production has been erratic; in 1972 consumption of sand by the Kioo works for the manufacture of glass holloware was 7,236 tons, but the total tonnage of sand produced according to the mineral production statistics was some 50% more. Production of kaolin, mainly for use as a filler, was 87 tons in 1973. The reported capacity of the plant is 600 tons of sand and 200 tons of kaolin per month.

79. The present mine consists of two adits into the side of the hill measuring some 2 x 3 m and an apparently haphazard series of tunnels at right angles. There are also a number of similar abandoned adits in the area. There is no attempt at systematic room and pillar mining, which would considerably reduce the distance the ore has to be transported and improve the ventilation and mining recovery. Thus, in effect all the ore comes from development, and is mined by pick and shovel and transported in wheelbarrows. At the nearby plant the sandstone is passed through rolls, a coarse screen and a hydro-cyclone. The +200 mesh sand is finally cleaned on a shaking table and the coarsest fraction, together with the heavy minerals discarded. The water containing the -200 mesh fraction in suspension is led through settling tanks and the clay is finally separated in a filter press and dried. The kaolin produced is off-white in color and has a comparatively high plasticity, but this latter property depends at least in part on the grain size, which could be adjusted.

J. Gypsum

80. Gypsum is produced by small workers and cooperatives from the Mkomazi area near Tanga for use in the Wazo Hill cement plant. This lake bed deposit has been worked sporadically since 1952. In 1965 the total reserves were estimated as 829,000 tons, comprising 459,000 tons of the best grade of massive nodular gypsum (78-85% $\text{CaSO}_4 \cdot 2\text{H}_2\text{O}$), 195,000 tons of near-surface powdered gypsum, much of which had already been lost during exploitation, and 175,000 tons of low-grade flake gypsum. The small Itigi Lake bed deposit near Dodoma which has also been worked to supply Wazo Hill, comprises 15,000 tons of 70 to 75% $\text{CaSO}_4 \cdot 2\text{H}_2\text{O}$, including 2,000 tons of +80%.

K. Magnesite

81. All the magnesite produced is from the Chambogo mine in the Pangani Valley, 17 km from the Arusha-Tanga road and railway, which has been owned and operated by Tanganyika Magnesite Mines Ltd. since 1973. The magnesite is marketed in the calcined form. The magnesite occurs as stockworks of veinlets in an altered serpentine, capping and rimming a central zone of massive serpentine. The proved and probable reserves have been estimated as almost 2 m tons averaging some 20% magnesite, but the drilling results on which this estimate is partly based are suspect as the core recovery was low.

L. Operating Efficiency of Existing Mines

82. Present mining operations are scattered over the whole of Tanzania and the mission has not been able to gain more than a fairly general impression of the operating efficiency of some of them. The only large mine in the country is the Mwadui diamond mine. Given the mining plan as explained in paragraph 51, mining operations per se and recovery appear to be efficient. Security, however, which is the responsibility of the Tanzania police, is a major problem. The Wazo Hill limestone mining operation is efficient, but there are production and distribution problems. The Pugu Hill glass sand and kaolin mining operation near Dar es Salaam is very inefficient; there appears to be no mining plan at all.

83. The small-scale mining operations managed by the State Mining Corporation all have major problems. Production of gemstones has fallen significantly, partly because of a fall-off in the quality and quantity of reserves of gemstone ruby, and partly because of the technical and management

difficulties inherent in mining a number of small, scattered orebodies. Security is a particular problem. The expansion program of Nyanza Salt Mines has fallen behind schedule due to delays in commissioning the new plant and production has dropped significantly (20,000 tons in 1973 compared with a target of 60,000 tons). Tanzania Meerscham has cut production to virtually nil because of flooding of the workings.

84. Small-scale mines have been defined as operations on a scale which is inadequate to support a management as a distinct entity, or conversely, operations where the management is directly involved in production. Such operations are almost invariably marginal, and simply cannot survive with more than a minimum of overhead costs. The system, of which Tanzania Gemstone Industries provides the best example, whereby such operations are grouped under an operating company which is in turn a subsidiary of a parent holding company would seem to ensure that overheads are maximized rather than minimized. Moreover, both the operating company and the holding company will tend to use conventional methods of operation which are not necessarily relevant in the circumstances. Thus it would appear that for truly small-scale mining activities, the present parastatal institutional framework is top heavy and too rigid.

CHAPTER III - MINING TAXATION, ACCOUNTING METHODS AND CUT-OFF GRADES

85. A mining enterprise in Tanzania may be subject to four basic forms of taxation, a royalty calculated at a fixed rate per ton mined or a percentage of the net value (gross value less costs of transport to customer and insurance) in accordance with the table below, a sales tax or levy which varies according to the mineral mined (e.g., Mwadui diamonds: 15%, cement: Sh 25/- per ton: precious stones other than diamonds: 24%), company tax at a rate of 45% of profits and finally a withholding tax on expatriated dividends. The combination of these various taxes places a fairly heavy tax burden on the mining industry in Tanzania. Depending on the circumstances special concessions may have to be negotiated in the event that the Government should wish to attract private foreign capital to assist in the development of the country's mineral resources. The principle of negotiability does already appear to have been established with regard to the mineral royalty rate payable by different companies extracting the same mineral.

86. Although any royalty system not related to profits has the fundamental disadvantage of increasing the economic cut-off grade, thus resulting in the exclusion of some mineralization from minerable reserves, in Tanzania royalty rates are in general so low that this is probably not an important factor, except in the case of diamonds and some precious and semi-precious stones. Some mineralized ground is undoubtedly being left unmined at Mwadui, but the tonnages involved do not appear to be substantive, and in any event, because of the large shallow form of the pit, most of this is not irretrievably "lost". Moreover, blocks of low-grade ground away from the open pit can be - and have been - transferred to New Alamasi, which pays a lower royalty rate (7-1/2%) and no levy. The cut-off grade at Mwadui is probably 9 c.p.h.t., whereas the average mill head grade at New Alamasi is 6 c.p.h.t. which means that the cut-off grade in that mine is probably around 3 or 4 c.p.h.t.

87. Perhaps a more important factor raising the cut-off grade at Mwadui mine is the company's system of accounting. All capital expenditure, whether for additional equipment, replacement equipment, mine development or repairs, have traditionally been written off in the same year. By conventional business standards Williamson Diamonds Limited is heavily over-capitalized. The company has no long-term debts and most of its assets have been fully depreciated.

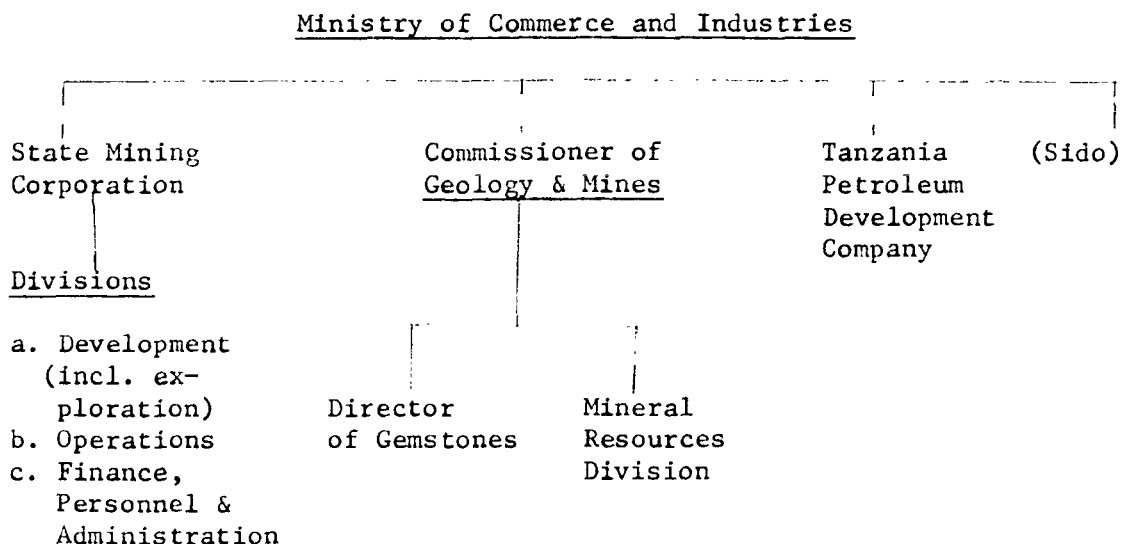
Table 3
Mineral Royalties
(in force October 1974)

<u>Metal or Mineral</u>	<u>Rate of Royalty</u>
(a) Diamonds	15% of net value*
(b) Precious stones other than diamonds	15% of net value
(c) (i) gold and silver	1-1/2% of net value
(ii) precious metals other than gold and silver	5% of net value
(d) Base metals	5% of net value
(e) Mica	5% of net value
(f) Coal	Sh 0/30 per ton raised
(g) Sand or clay (not including kaolin or china clay)	Sh 0/50 per 100 cubic feet
(h) Gravel or stone other than limestone used in the manufacture of lime	Sh 1/- per 100 cubic feet broken
(i) Lime	Sh 4/- per ton
(j) Salt	Sh 6/- per ton
(k) Non-precious minerals including guano, other than those in respect of which a specified royalty is or may be prescribed and those taken in accordance with the provisions of section 7 of the Ordinance	5% of net value
(l) Gypsum	Sh 2/- per ton
(m) Magnesite	Sh 3/- per ton
(n) Garnet, tourmaline, amethyst, gem corundum, chrysoprase, zircon, chalcedony, moonstone, peridot and gemstone normally used in the production of jewelry not elsewhere specified	15% of net value

* New Alamasi pays a lower royalty rate of 7-1/2%.

CHAPTER IV - INSTITUTIONS

88. All important institutions involved in mining and prospecting are under the control of the Ministry of Commerce and Industries.



89. The Board of Directors of the State Mining Corporation includes the Minister as Chairman, the Principal Secretary, the Commissioner of Mines, and a representative of the Bureau of Resources Assessment and Land Use Planning. The General Manager is normally in attendance at Board Meetings. The majority of the Directors of the subsidiary companies are State Mining Corporation nominees and include the General Manager. The subsidiary companies of the State Mining Corporation and the Corporation's share in their equity are:

- Tanzania Portland Cement Co. Ltd. (100%);
- Williamson Diamonds Limited (50%);
- Tanzania Diamond Cutting Co. (Tancut) (75%);
- Nyanza Salt Mines (83%);
- Tanzania Meerscham Corp. (58%);
- Tanzania Gemstone Industries Ltd. (100%);
- Beach Sands Mining Co. Ltd. (75% - the balance of the shares are held by Geomin, the State Mining Corporation of Romania) (not yet producing);
- Buck Reef Gold (100%)(not yet producing);
- Mbeya Cement Co. Ltd. (100%)(not yet producing);
- Lupa Goldmines Ltd. (100%)(not yet producing).

90. In the last financial year only three of the subsidiary companies declared a surplus: Williamson Diamonds, Tanzania Portland Cement Co., and Tancut. As mentioned, future operations at Mwadui will be on a no profit/no loss basis. T.P.D.C. has severe liquidity problems and Tancut accumulated losses; neither has so far been able to declare a dividend. The objective of the Government is that holding parastatals should be self-financing (except for major expansion projects) on the basis of dividend proceeds and/or commissions charged to subsidiary companies. The current annual operating costs of the holding parastatal, the State Mining Corporation, totalling some Sh 2 million, are met by levying a flat rate surcharge of Sh 20,000/- per annum on its subsidiaries plus a percentage on turnover. Because nearly all of its operating subsidiaries have been making losses recently (except Williamsons), the State Mining Corporation has not been able to build up any financial reserves and is almost entirely dependent on government budget allocations and foreign loans (which are also channeled through the budget) to finance feasibility studies and the development of new mines.

91. The role of the State Mining Corporation - established in January 1973 to take over control of the mineral-based industries within N.D.C. - is to promote mining development on all scales. It is not the policy of the Corporation to become involved in grass-roots prospecting, but it is involved in exploration, in theory taking over responsibility from the Mineral Resources Division once a target has been identified. However, the Corporation's ability to perform in accordance with these objectives is severely inhibited by shortages of qualified manpower, in spite of the fact that many of the staff have been transferred from the Mineral Resources Division and some of the work has been put out to contract.

92. The Mineral Resources Division was formed in 1965, by the amalgamation of the former Geological Survey and Mines Divisions, both of which were established over 40 years ago. The functions of the Mineral Resources Division are basically those of a Geological Survey, together with responsibility for issuing licences, implementing the mine safety and explosive regulations, compiling production statistics, etc. Prospecting for underground water resources and the investigation of problems in engineering geology are the responsibility of the Water Development and Irrigation Department of the Ministry of Water and Power. Thus the Division is responsible for the provision of background information relating to the geology of the country, undertakes prospecting on behalf of Government and should be a national depository of all information relating to the geology and mineral resources of Tanzania. It also provides technical advice and services to the public. The Division is, however, so hopelessly understaffed that it is doubtful if any of its functions are being discharged effectively. There are at present seven geologists in the Division, including the Acting Assistant Commissioner, compared with 30 in 1960 and 19 in 1971. Two of the six geologists are overseas attending post-graduate training courses, and two others are expatriates on short-term contracts. The only other expatriate earth scientist in the Division is a UNDP geophysicist.

93. The basic unit of mapping is a quarter degree sheet, an area of approximately 2,500 km² bounded by degree or 30 minute lines of latitude and longitude. The field mapping, which of necessity is of a reconnaissance nature and based on widely spaced traversing supplemented with photogeological interpretation, is undertaken on a scale of 1:50,000 for eventual publication on a scale of 1:125,000 with an accompanying brief explanation. More than 60% of Tanzania is now covered by such mapping and an additional 15 to 20% is covered by reconnaissance mapping on smaller scales (see map on next page). However, a substantial backlog in publishing has developed, and a significant number of recently completed maps are only available for inspection on "open file".

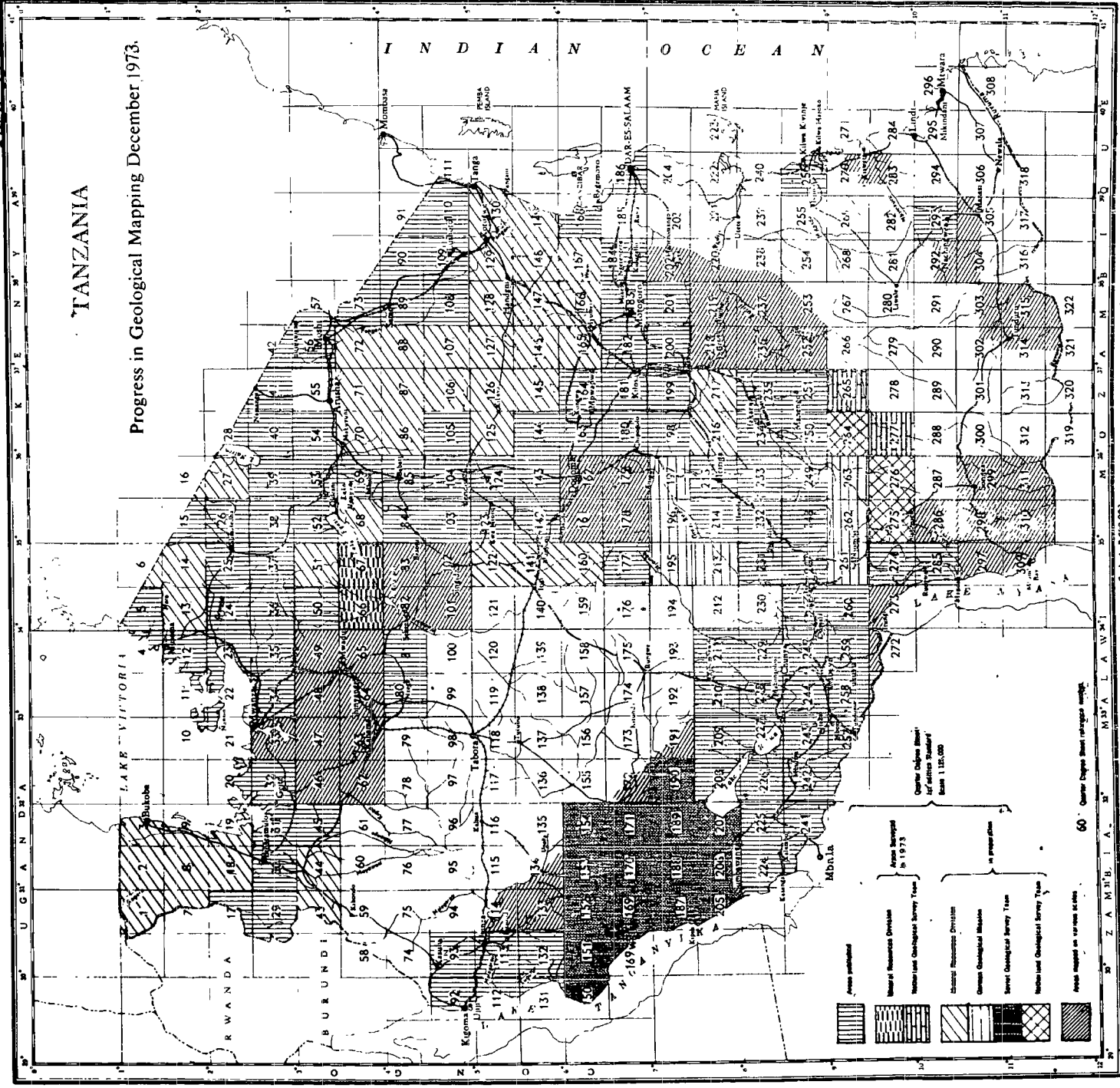
94. From 1961 until 1963 a number of Peace Corps geologists were attracted to the Division and contributed to the mapping program. Between 1962 and 1966 a total of 14 quarter degree sheets was mapped under an aid agreement with the Federal Republic of Germany. A team of staff and students from Dutch universities mapped a further eight sheets, and 16 sheets have been mapped under a contract with Technoexport of the USSR. No provision was made in this last contract for the fair drawing and printing of the maps, and as a result the Drawing Office at Dodoma is now virtually overwhelmed with the task of preparing the manuscript maps for publication.

95. The Division itself, because of staff shortages, has done very little mapping in recent years, and only a single mapping party was in the field in 1974. It has, however, provided counterpart staff for the Technoexport mapping teams.

96. Because of the length of time the Division, formerly the Geological Survey of Tanganyika, has been in existence and because so many different parties have been involved in recent years, the standard of mapping varies, but is generally high. Emphasis has been and to an extent still is placed on straightforward geological mapping, which is for the most part not supplemented with geochemical sampling or reconnaissance geophysical surveys. An attempt was apparently made by the Division to combine mapping and geochemical sampling - an approach used by many Surveys to reduce sampling costs and supplement basic geological data with information more directly related to potential mineralization - but this was abandoned. With regard to reconnaissance airborne geophysics, i.e., magnetometer and spectrometer surveys, there are a number of donors, notably Canada and Poland, who have specialized in this field and who might be willing to provide bilateral assistance to the Division. However, unless the Division is strengthened such surveys would be of limited value as the Division and the State Mining Corporation would only be able to follow up on a very limited scale under present circumstances. It would, however, be an additional stimulus to the private sector if such information was made available.

TANZANIA

Progress in Geological Mapping December, 1973.



Completed from printed and published by Mineral Resources Division, Dar-es-Salaam, 1973.
Ministry of Commerce and Industries

Scale 1:7,500,000
Miles 0 50 100 150 200 Miles

Quarter Degree Sheet (if section number) Scale 1:125,000
60 Quarter Degree Sheet (if range number)
Areas mapped in various scales

97. Much of the area that remains to be mapped is centered on Tabora in the western part of Tanzania; the remainder is a block south and southwest of Dar es Salaam. The western area lies largely within a large block which is being mapped topographically under a bilateral assistance agreement with Canada. This project will make available not only topographic map coverage on a scale of 1:50,000 but also up-to-date good quality air photographs, both of which will assist the Division in completing its mapping program.

98. There is an obvious need for the staff of the Mineral Resources Division to be sponsored to visit other surveys, not in Europe and North America where conditions are so different as to be almost irrelevant, but in Africa in particular. For example, the Division had no representation at a seminar on the role of Geological Surveys sponsored by the Commonwealth Scientific Committee held in Lusaka in July 1974, and could not have failed to benefit from participating in such a discussion.

99. In recent years the Division has concentrated on prospecting on behalf of Government in an attempt to complement what little was being done by the private sector. Many deposits have been investigated, but the reports indicate a very wide range of competence and in some cases a lack of experience is obvious. The Division's prospecting activities have been supplemented by a UNDP project carried out between 1965 and 1968 to re-evaluate the resources of the Sarama, Geita, Musoma and North Mara goldfields. It was this project which identified the previously worked Buck Reef gold deposit near Rwamagoza (Geita district) as the most promising gold deposit for follow-up study. A shaft for the mining of the deposit is currently being sunk by the State Mining Corporation. The contract with Technoexport referred to above includes provision for the re-evaluation of the gold and base metal mineralization of the Mpanda field and the remaining resources of the Lupa goldfield. This work is still in hand. A further contract, signed with Geomin, provided for the evaluation of the copper resources of Kigugwe, near Chimala, 60 km from Mbeya. A diamond drilling program proved this mineralization to be uneconomic.

100. The Division has two very old diamond drilling rigs and five others inherited from the Technoexport project, only three of which are in working condition. As in the case of the vehicle fleet, most of which is very old, lack of spares and poor servicing facilities, for which the Ministry of Works is responsible, result in extensive down-time and inefficiency.

101. The mines inspectorate is responsible for administering all aspects of the mining legislation, including the processing of applications for claims and mining leases by the Mining Wardens, and the compiling of statistics, as well as enforcing the mining and explosives safety regulations. Zonal offices are maintained at Morogoro, Mwanza, Moshi, Mbeya, Kayanga and Dar es Salaam. However, of the established posts of seven mining engineers, only two

are filled and one of these is occupied by an officer undertaking overseas post-graduate training. Thus, in its policing role the inspectorate is severely handicapped.

102. The inspectorate is also responsible for advising small workers and cooperatives in particular regarding mining techniques, and obviously little can be done in this respect. It is of interest to note that for a period Ilima Colliery (near Tukuya) was managed by an Inspector of Mines after it was taken over by a cooperative (following the departure of the previous owner) in 1973.

103. The Mineral Resources Division has ample accommodation at Dodoma, which would in fact be half empty if it did not also house the exploration unit of the State Mining Corporation, which currently comprises four geologists and supporting staff. The laboratories are not only spacious but well-equipped, and the analytical facilities include a Pye Unicam Sp 90B atomic absorption spectrophotometer, a recently installed Phillips XRF/diffraction unit and two optical spectrographs, one of which is of Russian origin. Servicing and spares are major problems and individual items of equipment have been unserviceable for long periods as a result. The mineral dressing laboratory is well-equipped with a wide range of equipment, much of it on a pilot scale. All these facilities are extensively utilized by the State Mining Corporation.

104. The drawing office is also spacious and well-equipped, but is again susceptible to the spares and servicing problem and the semi-automatic photographic pre-print unit has been out of use for a long time. Type has therefore to be set by hand, which is particularly time-consuming in the case of compiling the explanation which is printed to flank each map sheet.

105. All the ancillary services of the Division suffer from staff shortages which have reduced output to a very low level. The delay in publishing results stems not only from the backlog which has accumulated in the drawing office as a result of the Technoexport contract, but also from the lack of editorial staff. Delays at the Government Printers are of the order of years, and the Division recently set by hand, printed, bound and published its annual report for 1967. (The latest annual report available is a cyclostyled edition for 1971.)

106. There are comparable delays in printing maps, which is the responsibility of the Surveying and Mapping Division of the Ministry of Lands, Housing and of Urban Development. In an attempt to overcome this situation the Division has implemented an informal "open-file" system to permit inspection and copying of completed maps which are available only in "manuscript" form. (The Technoexport maps are well drawn and presented, and it would in fact have required very little additional work to have done the final fair drawing.) The drawing office is staffed with four Tanzanian cartographers who have been trained locally.

107. The laboratories have also been very understaffed, though the situation seems to have improved and there are now three expatriate Research Officers and six Tanzanians, including a mineralogist and a mineral dresser. Extensive use has had to be made in the past of personnel made available under contracts with such groups as Technoexport and Geomin, and even now a Russian chemist is working full time on samples for the Mbeya cement project.

108. No qualified librarian has been available to the Division for some years, though the library holdings are extensive and apparently reasonably organized, as is the records office, which holds the quarterly prospecting reports, etc.

109. The Tanzania Petroleum Development Company is involved in exploration only to the extent of closely monitoring the prospecting activities of the Agip/Amoco combination. In this function, the Company depends heavily on the expertise of an experienced expatriate exploration advisor who is being understudied by a Tanzanian geologist. This system enables the Company not only to monitor exploration activities, but to independently assess the results. In the event of a discovery, such as, for example, the recent gas strike, whether or not the exploration group concerned decides to exploit it, additional technical expertise will almost certainly be required to monitor the activities of the minority partner or to plan development by TPDC as the sole operator.

110. Other institutions involved in the identification and exploitation of mineral resources include the Ministry of Lands and Housing which is concerned with the development of the brick industry, though responsibility for prospecting for brick clays is to be taken over by the State Mining Corporation. The National Development Corporation is planning projects based on ceramic raw materials - particularly the Pugu kaolin - and glass manufacturing projects, including a possible plate glass plant based on the Pugu sand and a second bottle factory based on the beach sands of Lake Victoria near Bukoba. N.D.C. is also assessing the possibility of establishing a sandpaper manufacturing facility. The Small Industries Development Organization (SIDO) is planning development on a "village" scale of such mineral resources as clays, salt, gypsum, precious stones, limestone, coal, mica, ornamental stone and coal (see paragraph 120).

111. Very little attention is at present being paid to environmental and pollution problems which might arise in the event of a greatly expanded level of mining activity. It is understood that responsibility for this will be assumed by the National Council of Scientific Research. However, at present the Council does not have the capability in terms of staff and laboratory facilities, and it would seem that little relevant legislation exists which would enable the Council to enforce pollution control measures. Tanzania, like many other developing countries in their understandable haste to promote development, has made few provisions to set and enforce standards.

It is symptomatic of this attitude that responsibility for preserving the environment should be delegated to an institution such as the National Council for Scientific Research, which is responsible for the coordination and promotion of research, and which is not structured to act as a policing organization. Any possible environmental problems must be dealt with before final planning approval is given, and there is a need to develop an institutional framework within the Government to ensure that the conditions under which a project were approved are adhered to. In an environment where the Government itself, through one institution or another, is responsible for the planning and implementation of most projects, it should in principle be easier than in a private enterprise economy to ensure the best use of resources and protection of the environment.

CHAPTER V - EXPANSION PLANS

A. General Outline

112. One of the main concerns of the mission is that the State Mining Corporation appears to be attempting to promote too many projects at the same time. Because of serious manpower constraints within the Corporation, as well as overall financial constraints, it would seem to be necessary to concentrate available resources on a limited number of priority projects. The selection of priority projects, however, is a difficult and time consuming process and the mission does not pretend to have all the data required or the knowledge to express definite opinions about project priorities. This Chapter provides a general survey of the many small and few large projects that are being prepared or considered and attempts to identify the various project issues so as to serve as a guide for the selection of priorities. Some of the policy issues concerning the mobilization of additional resources for mineral development were discussed in Chapter I. The following table compiled from the 1974-75 budget estimates for the State Mining Corporation and the Mineral Resources Division is an illustration of the Government's plan to achieve an increase in the scale of mineral development:

Table 5

1974-75 Capital Budget Provisions for Mining Development
(In T. Shillings)

	1972-73 Provisional Actual expenditure	1973-74 Approved estimates	1974-75 Estimates
<u>State Mining Corporation</u>	<u>2,300,000</u>	<u>6,674,000</u>	<u>70,125,000</u>
Nyanza Salt Refinery		1,000,000	250,000
Tanzania Gemstone Industries	1,500,000		2,000,000
Chunya (Zira River) Gold			2,800,000
Mbeya Cement		400,000	9,000,000
Internal	2,000,000		
USSR (credit)	7,000,000		
Tanzania Portland Cement		19,000	45,000,000
Internal	5,000,000		
Denmark (credit)	40,000,000		
Tanga Cement			2,500,000
Liganga Iron Ore			500,000
Norway (grant)	500,000		
Beach Sands	800,000	1,575,000	975,000
Buck Reef Gold		3,000,000	2,500,000
Rwamagoza & Mawe Mweru (gold)		600,000	300,000
Exploration			4,300,000
External	4,300,000		
<u>Mineral Resources Division</u>	<u>7,500,000</u>	<u>4,359,000</u>	<u>5,703,000</u>
Mapping and reconnaissance prospecting	7,000,000	3,000,000	320,000
Prospecting - Karagwe (tin)		840,000	1,000,000
Internal	400,000		
Finland (grant)	600,000		
Prospecting - Tazara	500,000	519,000	1,000,000
China (grant)	1,000,000		
Prospecting - Panda Hill (niobium)			1,180,000
Canada (grant)	1,180,000		
Prospecting - Karagwe-Ankolean			2,203,000
Internal	600,000		
UNDP (grant)	1,603,000		

113. This is not, however, a complete list of mining projects. For example, the Minjingu phosphate project is not included, but is nevertheless being accorded a high priority because of import substitution possibilities. Also, the iron and steel project to be financed with Chinese bilateral assistance is not included in the budget. In some cases the budget allocations are to finance feasibility studies and pilot scale tests rather than to initiate an actual project.

114. A large part of the sharp increase in the State Mining Corporation's capital budget for 1974-75 is for the financing of additional cement manufacturing capacity. Another notable feature of the estimates is the reduction in funds for mapping and prospecting allocated to the Mineral Resources Division. This is to some extent complemented by the Sh 4.3 million allocated to the State Mining Corporation for exploration, but this presumably does not provide for any regional mapping. The reduction in expenditure on mapping probably reflects the completion of the Technoexport mapping program.

115. Other relevant allocations include Sh 0.2 million to N.D.C. for the Pugu kaolin project for which Geomin have been acting as consultants.

116. On the basis of this and other information the various projects may be grouped as follows:

- (a) Financed wholly from budget allocations
 - (i) Salt refining at Nyanza;
 - (ii) Gemstone production - this allocation is understood to provide for the re-equipping of the Longido ruby mine;
 - (iii) Establishment of the Sira River (Chunya) and Buck Reef gold mines, and prospecting at Rwamagoza and Mawe Mweru;
 - (iv) A feasibility study of coal mining possibilities;
 - (v) Expansion of the facilities of Tancut;
 - (vi) A feasibility study of the possibility of a ceramics industry based on the Pugu kaolin deposit; and
 - (vii) Exploration (general).
- (b) Jointly or wholly financed by external partners
 - (i) Expansion of cement production - Wazo Hill and Mbeya projects (the Tanga cement project is currently being financed by the State Mining Corporation);

- (ii) Iron and steel project - Chinese financing would appear to be available for the recently announced project; Norway has financed a feasibility study of a steel project based on the Liganga iron ore reserves and further investigations are ongoing (refer paragraphs 142 - 146 in this Annex and paragraph 106 of the Main Report in Volume I);
- (iii) Beach sands project - although it is not apparent from the estimates, the Romanian State Mining Corp., Geomin, holds 25% of the equity of the company;
- (iv) A re-evaluation of the Kyerwa tin mine in the Karagwe area;
- (v) Prospecting in the Karagwe-Ankolean for copper and nickel;
- (vi) A re-evaluation of the Panda Hill carbonatite as a source of pyrochlore (niobium); and
- (vii) Prospecting along the new Tazara Railway line.

117. The State Mining Corporation is also concerned in planning: (a) an expansion of gypsum production, which will be necessary for the expanded cement industry, (b) small-scale diamond mining, (c) the expansion of magnesite production, and (d) an expansion of the quarrying industry. A pre-feasibility study recently completed by two Japanese companies interested in large scale commercial exploitation of the Lake Natron soda ash deposit is currently under consideration. No provision for any of the projects mentioned in this paragraph has been made in the budget.

118. Possible joint projects with the National Development Corporation, apart from the development of the Pugu deposit as a source of kaolin as a base for white ware and ceramics industries and sand for an expansion of glass production, include a study of the possibility of establishing a sand-paper manufacturing plant.

119. A further joint project involves the State Mining Corporation and the Capital Development Authority, with a Kenyan company under contract to provide technical expertise, to establish a major brick-works in the vicinity of the new capital at Dodoma.

120. In addition, SIDO, the Small Industries Development Organization, has plans to promote the development of small-scale village industries to exploit such mineral resources as clay for bricks and ceramics, salt, gypsum, precious stones, lime, coal, mica, ornamental (carving) stone, etc. All these projects are very much in the preliminary planning stage, but SIDO does have an expatriate geologist to advise on the suitability of clays, etc. There is a degree of overlap with various projects listed above.

B. Gold

121. In recent years a number of prospects have been re-examined, particularly under the contract with Technoexport of the USSR, with a view to reviving the gold mining industry. A report on the Lupa goldfield submitted in May 1974 by Technoexport recorded various reef occurrences and highlighted the potential of an alluvial deposit along the Sira River, where the total reserves are estimated at 1.5 tons of metal.

122. The gold is reported to occur in free form with a maximum grain size of 0.3 mm in the gravel of the stream bed, which is overlain by alluvium. The average grade of the gravel is 1.86 g/m³. The gravel is very variable in thickness, but average 4 m; the average thickness of the overburden is 6 m. The overall average grade of the gravel and alluvium is stated to be 0.9 g/m³. The reserves, presumably of gravel and alluvium, are 2,000,000 m³. The proposed scale of operations is being discussed, but will probably be such as to give a guaranteed life of six years, and yield some 200 kg of gold per year which at current prices (\$150 per oz.) has a gross sales value of around Sh 7 million. Capital requirements are estimated by the consultants, Technoexport who are at the same time technical partners for project execution, at Sh 5.6 million. Operating costs are not known and an economic feasibility study has not been made. A wholly owned subsidiary of the State Mining Corporation to work the deposit has recently been registered as Lupa Goldmines Limited. Technoexport have apparently undertaken to start production before mid-1975.

123. Beneficiation will be based on screening, and subsequent sluicing of the fines. This is probably the cheapest and simplest method but, depending on a number of factors, recovery might be poor. Because the river flows strongly during the rainy season, working will probably have to be seasonal. The stability of the alluvial deposits is an unknown factor, and if it proves possible to maintain only shallow slopes, then the overburden ratio could be as high as 4:1. The material will be mined by bulldozer, after damming the river and pumping the water into a diversion trench. The gravel will be loaded into dump trucks by an "excavator", presumably a front-end loader. One bulldozer is already on site and some 22 people are currently employed on the project. This number will increase to 250 as full production is achieved. Some concern has been expressed about the wide spacing of the sampling lines and possible variations in grade. No pilot scale operations have been undertaken. The method for the final cleaning of the concentrates, i.e., panning, tabling or amalgaming has not been decided, though the facilities to do such tests exist at Dodoma and Mwadui. No consideration appears to have been given to the possibility of hydraulic mining.

124. Other specific gold prospects with which the State Mining Corporation is concerned include Buck Reef in Geita district. Following initial exploration of the deposit by a UNDP team, further drilling and some underground exploration was undertaken by the Mineral Resources Division and Williamson Diamonds Limited respectively on behalf of Government and a mining

plan proposed. The drilling results indicated reserves of 365,000 tons to a depth of 500 ft, grading 10 gms/ton; the underground exploration proved reserves within this block of 117,500 tons to a depth of 250 ft, grading 9.7 gms. UNDP estimated the reserves at 300,000 tons to a depth of 400 ft and the capital expenditure required to establish the mine at Sh 21 million, but a marked escalation in the price of mining equipment has occurred since. The State Mining Corporation is currently carrying out development, including shaft sinking to 21 m, but progress has been very slow because of delays in equipment deliveries.

125. Prospecting of the Mpanda goldfield by a Technoexport team is continuing. Reefs in the Rwamagoza and Mawe Mweru areas are being investigated by the State Mining Corporation. No details are available.

126. Illegal gold mining by groups of individuals sometimes numbering several hundred has been, and apparently still is a major problem, which became acute following the closure of the Mpanda and Chunya cooperatives. At present gold prices and because of strict exchange control provisions this activity is likely to increase. Effective enforcement of the law is expensive and in practice virtually impossible. Under such circumstances, it may be that the only pragmatic solution is to re-establish buying organizations under strict control. Such organizations have proved reasonably successful in the case of tin for example, but it is obvious that unless the miners are offered a reasonable cash price for their product, illegal mining and smuggling will inevitably continue.

C. Cement

127. There are no less than three expansion projects in hand involving a total investment of Sh 580 million. The aim is to increase production capacity to 1,000,000 tons/year by 1979. The three projects are: (a) an increase in capacity of the existing Wazo Hill plant, (b) the establishment of a new plant at Tanga, and (c) the establishment of another new plant at Mbeya.

128. The plant required to expand production at Wazo Hill by some 250,000 ton/year has already been ordered, and will be largely financed by a Danish Government loan. It is therefore presumably an additional F.L. Smidth kiln. The estimated cost of the expansion, scheduled to be completed by 1976, is Sh 130 million, including additional working capital.

129. The primary raw material for the 250,000 ton/year Tanga plant will be a limestone deposit occurring 5 km south of Tanga. The deposit is composed of pisolitic, semi-porcellanous and rubbly limestones of Jurassic age, overlain by red lateritic soils similar to those of Wazo Hill. Preliminary

tests showed that good quality cement could be made from these materials, and this has since been confirmed by further tests at Wazo Hill. The limestone is somewhat harder than that at Wazo Hill, and mining and milling costs are therefore likely to be higher. A feasibility study for the project has recently been completed by Energoprojekt of Yugoslavia working on contract for the State Mining Corporation.

130. The source of primary raw material for the Mbeya cement project is an extensive occurrence of travertine. The reserves were originally estimated to be of the order of 100 million tons, but detailed prospecting has shown that the travertine is not as homogeneous as it appears and contains horizons of soil. Further exploratory work, including diamond drilling, has had to be undertaken. To date it has not been possible to locate a suitable superficial clay in the vicinity of Mbeya which could be used as an additive - the known clays are high in alkalis and alumina and low in iron. The mission suggested to the State Mining Corporation that they should also prospect for a phyllite or schist which could be ground and used as an alternative as at the Chilanga works south of Lusaka, Zambia. (Analyses and samples of this material have been forwarded.) No gypsum occurs in the area and supplies will have to be "imported" from existing producers in the north-east or from Kilwa if these deposits are developed.

131. The planned capacity of the Mbeya plant is 200,000 ton/year and the kiln(s) will be coal-fired. This will necessitate an increase of some 40,000 t.p.a. in coal production from nearby coal deposits.

132. Technoexport as consultants have recently submitted a comprehensive feasibility study for the project, which is likely to be implemented on the basis of a turn-key contract partly financed by a bilateral loan from the USSR. The total capital cost is estimated at Sh 250 million, i.e., some 20% more than a new plant of similar capacity on the coast.

D. Phosphate

133. Phosphate occurs at Minjingu on the east shore of Lake Manyara in recent clayey lake sediments fringeing a large rock outcrop. This "soft ore" is capped, particularly to the south, by a bed of phosphatic conglomerate - the "hard ore" - which comprises coarse debris, evidently derived from the outcrop, impregnated with phosphate.

134. New Consolidated Gold Fields, who discovered the deposit, estimate the reserves to a depth of 60 meters as 5 million tons of hard ore averaging 21.4% P₂O₅ and 4.8 million tons of soft ore averaging 18.5% P₂O₅. These estimates are accepted in a report by Geomin and the preliminary report of a private consultant (J.L. Weaver, an ISEC volunteer executive). Klockner,

however, are more conservative and recalculate the reserves of the northern area as 1.3 million tons of hard ore and 3.0 million tons of soft ore to a depth of 18 meters. This depth appears to be related to the average depths of the pits originally sunk by New Consolidated Gold Fields (15 m). Since the mining rate to supply the fertilizer factory at Tanga would have to be of the order of 250,000 tons of soft ore a year to produce 120,000 tons of concentrate.

135. The soft ore has been subjected to various beneficiation tests all of which indicate that a concentrate assaying 28 to 30% P₂O₅ could probably be produced by dry screening. The mission recommends that no firm decision on the phosphate mining project is made until after the successful testing of a bulk sample of several hundred tons (of concentrate) in the Tanga fertilizer factory.

136. The present plant at Tanga produces triple superphosphate from imported Jordanian phosphate rock - 120,000 tons/year - assaying +32% P₂O₅. Production is extremely cost-sensitive to the grade of the feed, and costs rise particularly rapidly if the grade drops below 30% P₂O₅. However, the tests referred to above have shown that it is extremely difficult to concentrate the soft Minjingu ore to produce a concentrate assaying +32% P₂O₅ and that any such process is likely to be very difficult to control under production conditions and will result in substantial losses in the tailings. A possible compromise would appear to be to produce 60,000 tons of concentrate assaying +28% P₂O₅ to blend with an equal tonnage of imported phosphate rock assaying +32% P₂O₅ to produce a 30% P₂O₅ feed for the Tanga plant. If further dressing tests show that it is possible to produce a +30% P₂O₅ concentrate at Minjingu without unacceptable treatment losses and if the proposed bulk sample tests in the Tanga fertilizer factory show good results, the scale of the phosphate mining project could be increased to produce some 130,000 tons of concentrate per year.

137. Although the deposit lies alongside the Arusha-Dodoma Road and transport to Tanga should present no problems, it would be essential to ensure regular deliveries of concentrate. This might under the present circumstances involve considerable capital expenditure to improve the present Arusha-Tanga rail service and possibly even the operation of special trains. An alternative worth considering would be to truck the concentrate to Tanga.

138. Operations may have to be seasonal as the moisture content of the soft ore is critical in the beneficiation process and may have to be controlled by sun-drying. It may in any case be very difficult to work a pit in clay during the rainy season. No water was encountered in any of the prospecting pits, but these were only sunk to depths of the order of 15 meters.

139. The hard ore could probably be upgraded by screening to a 30% concentrate by a comparatively expensive grinding and flotation process. Moreover, the high pH of the water of neighboring Lake Manyara would result in a high consumption of reagents and make it necessary to wash the concentrates to remove the introduced salt. The preliminary ISEC report recommends simple grinding and screening of the hard ore and use of the product as a low-grade **fertilizer by direct application.**^{1/} Tests at various agricultural research centers are currently in hand to evaluate the feasibility of this approach. Similar tests were undertaken in the early sixties by the Ukiriguru agricultural research station near Mwanza and the results are reported to have been encouraging. The ground hard ore is estimated to cost Sh 105/- per ton ex-Minjingu.

140. No firm opinion can be expressed on the likely economic merits of a phosphate mining and concentrating project based on Minjingu ore. As mentioned, further investigations, including plant scale concentrate testing, are in the opinion of the mission essential before the technical feasibility and economic viability of the project can be established. Preliminary cost estimates suggest that total capital requirements for a project to produce 130,000 tons of +30% P₂O₅ concentrate per year would be around Sh 85 million, including infrastructure, and that the cost per ton delivered to Tanga would be Sh 280/- (or \$40). The current c.i.f. import price of Jordanian phosphate rock is \$86 per ton (including \$23 for sea transport), but world market prices are expected to fall.

141. One major side benefit of the phosphate mining project would be the freeing of the jetty at Tanga and its possible conversion for general cargo. This jetty is at present used exclusively for the unloading of imported supplies for the fertilizer factory. Given Tanzania's acute shortage of deep water berths, the conversion of the jetty, which could be accomplished at relatively minor cost, would be a major benefit to be taken into account in the appraisal of this project. Another benefit would be a greater security of supplies. In the recent past, the Tanga factory has suffered significant losses due to disruptions in the supply of phosphate rock.

E. Iron and Steel

142. Although the Liganga titaniferous iron ore deposit has for some time been considered as the most promising source of ore for a locally based iron and steel industry, an agreement has recently been concluded with the Chinese to investigate the feasibility of an alternative project based on the comparatively low-grade but less complex iron orebody in the Chunya district.

^{1/} Tests on the suitability of the soft ore for direct application are now also being planned.

143. The orebody is described (by Harris, 1961) as being similar to the banded manganiferous ironstones of the Mpanda area. These occur in a high-grade metamorphic environment, and are probably of sedimentary origin. The mineral composition is quartz and magnetite with manganiferous oxides and spessartine garnet, but there is local secondary enrichment in manganese and assays of up to 11% Mn have been reported. The reserves of these orebodies are of the order of tens of millions of tons; the grade averages some 30% Fe. Laboratory tests have indicated that beneficiation can be achieved by electro-methods (Harris, 1961), but if magnetite is the predominant iron oxide present, simple magnetic methods may prove the most efficient.

144. No details of the financial arrangements are available, but it is understood the investigation is to be wholly financed by China as part of a Sh 525 million loan agreement which was first announced by the Government in early 1974. No estimates of total capital or production costs are available.

145. It seems probable that blast furnace technology will be proposed, possibly a low shaft blast furnace. The fuel source being investigated is the coal of the Songwe Kiwira field, from which the Chinese are reported to have made a "weak coke", presumably a type of char or formed coke. It should be mentioned, however, that no final decision has been made to go ahead with a project based on Chunya ores. Further investigations of the Liganga deposit are continuing with Norwegian bilateral assistance and the choice of Liganga ore as a raw material would almost certainly involve a different reduction technology and the use of another coal deposit.

146. Although the rise of the project is as yet undetermined it is probable that the capacity of the proposed steel mill will be considerably in excess of local demand for primary steel products that could be made by a local mill. The target date for the commencement of steel production in Tanzania is understood to be 1980 or shortly thereafter.

F. Coal

147. There are several possibilities for the exploitation of Tanzania's very substantial coal reserves located in the southwestern corner of the country, south of Mbeya. The possibility of exploiting the 20 million ton reserves of the Songwe-Kiwira coalfield, which lies 30 km west of the northern extremity of Lake Nyasa - mainly in the valley of the Kiwira River - and 100 km from Mbeya, is currently being investigated by the Chinese. The coal is a possible source of fuel for the proposed iron and steel industry. A large

coal mine in this area could presumably also provide for the needs of the proposed Mbeya cement plant and possible other users in the southwest. (The producing Ilima colliery is sited in the Songwe-Kiwira coalfield, but production is only a few thousand tons a year.)

148. In addition, the Government is studying alternatives for the exploitation of the large Mchuchuma-Ketewaka coal field which lies in the Ruhuhu depression 25 km northeast of Manda and Lake Nyasa, and some 160 km from Makumbako on the Tazara Railway. Reserves are estimated at 200 million tons, the average caloric value at 12,000 B.T.U. and ash content at 12-20%. Possible uses include the manufacture of synthetic oil and a range of petrochemicals, the generation of electricity, the production of coal for domestic use and the export of coal.

149. The Government and the State Mining Corporation do not have the financial and manpower resources or the technical know-how required for a large-scale export and/or synthetic oil and petrochemical project based on Mchuchuma coal. If no suitable bilateral aid can be secured the quickest way to develop Mchuchuma would probably be to try and negotiate a concession agreement with a large international group with the requisite financial resources and technological know-how.

150. The State Mining Corporation has recently also considered the mining of Mchuchuma coal for domestic use, and the feasibility of a project for a 100,000 ton per year colliery has been studied by a group of Indian consultants. However, the market for coal as a fuel in Tanzania is at present very small (a few thousand tons per year) and is not likely to grow much beyond the requirements for the iron and steel project, the Mbeya cement project and some other industrial users. The cement project will require 40,000 t.p.a. (or 50,000 tons of mined coal if washing proves feasible). Thus even if all future cement production were based on coal, total coal consumption (for uses other than the iron and steel project) would still be only of the order of 200,000 t.p.a. (The existing East African railway locomotives are largely dieselized and the Tazara Railway will also use diesel locomotives.) The present and probable future market for coal as a fuel in Tanzania is too limited to justify the immediate development of two coal fields as sources of domestic fuel and a decision will have to be made to accord priority to one or the other.

151. The various alternative uses of Mchuchuma coal should ideally be considered in the framework of a national energy policy coordinating the optimum exploitation of Tanzania's hydroelectric, geothermal, and natural gas potential.

G. Beach Sands

152. The Beach Sands Mining Co. Ltd. was formed in November 1973, to investigate on a pilot scale the possibility of exploiting the coastal beach

sands of Tanzania. The shares in the Company are divided in the proportion, State Mining Corporation 75%: Geomin 25%. The Company holds a license for the entire coastal area and offshore islands. The coastal area has been extensively investigated by the Mineral Resources Division and at least four areas of sand with a heavy mineral content of the order of 10% were identified. Some follow-up work to prove the reserves is now being undertaken by the Company. The largest areas lie south of Bagamoyo, near the Mpiji River, in the vicinity of Kilwa and around Mtwara. A small area immediately north of Dar es Salaam, between the Silver Sands and Kunduchi Beach Hotels, has however been selected as the site for pilot scale operations as this area is rich in heavy minerals, and access, power and a supply of fresh water are all immediately available.

153. A pilot plant designed to process five tons of sand per hour was scheduled to be delivered in July 1974 but delivery has been delayed. The wet mill unit will comprise pumps, screens, cyclones, spirals and Lamflo sluices designed to produce a "common" concentrate of the heavy mineral fraction. After washing and drying this will be treated in a separate plant, comprising shaking tables, and high intensity magnetic and high tension separators. The results of the tests should be available approximately four months after the start-up of pilot scale operations, and a year will be required to finalize the feasibility study.

154. Full-scale mining will be by means of a dredge moving within a self-made artificial lake along the beach. Only the sands lying inland of the high tide mark will be exploited, and as only some 10% will be removed and the balance used as backfill, it should not be too difficult - or expensive - to ensure that the environment is not destroyed.

155. The ultimate production scale has not been decided, but will probably be of the order of 2 m tons of sand per year. The yield will be of the order of 125,000 tons of separate ilmenite, rutile and zircon concentrates, all of which should be readily marketable. In addition it will be possible to produce garnet and kyanite concentrates, though these will be more difficult to market. Clean sand suitable for building purposes, glass manufacture and silica refractories could be produced to order.

156. The State Mining Corporation estimates the capital expenditure required at Sh 30-50 million. Annual sales are tentatively projected at:

ilmenite	100,000 tons	Sh 70/ton	Sh 7.0 million
rutile	10,000 tons	Sh 1,260/ton	Sh 12.6 million
zircon	15,000 tons	Sh 910/ton	Sh <u>13.6 million</u>
			Sh 33.2 million (=\$4.7 million)

157. Current world market prices are two to three times higher than these figures but the tonnage estimates may be optimistic. The sands do not have a significant content of monazite and as sales of garnet, kyanite, etc., cannot be guaranteed, these are not taken into account. Operating costs at full production are expected to be approximately Sh 14 million per year. On the basis of these preliminary cost and sales estimates the project is expected to yield an excellent return.

158. The possibility of loading the concentrates from an offshore terminal using the recently developed Marconaflo system for handling and transporting fine solids is also to be investigated. If this proves to be feasible, the capital costs of the project infrastructure would be considerably reduced by comparison with the alternative of providing additional deep water berthing facilities.

H. Natural Gas

159. The site of the recent gas strike by the Agip/Amoco combine is on the west side of Songo Songo Island, 25 km northwest of Kilwa and approximately 20 km from the nearest point on the coast, i.e., approximately 220 km south of Dar es Salaam. The well is in 20 m of water, and the water between it and the coast is shallow.

160. Estimates of the reserves range between 16 and 42 billion m³. Assuming that reserves are 65% coverable and a price of US\$0.60 per million B.t.u. - the Mediterranean price - the total value of the deposit according to the state owned Tanzania Petroleum Development Corporation (TPDC), is \$756 million. TPDC consider that at least one more well is necessary to "prove" the deposit. Very preliminary estimates suggest that the daily sustainable production rate from the existing well could be 3 million m³.

161. TPDC's provisional plans include an assessment of the possibility of managing a group of five production wells from a single fixed platform. The gas, which is 99% methane, could provide the basis for an ammonia feedstock - 600 ton/day has been mentioned as a possible production level - for the ultimate production of such fertilizers as ammonium nitrate and urea. The cost of such an ammonia plant would be of the order of \$25 million. The possibility of producing plastics (VC and PVC) from acetylene as an intermediate feedstock and chlorine, possibly from salt from the nearby Mandawa-Mahokondo dome or from sea water, is being investigated. If there is surplus of gas available it would be used as fuel in the Dar es Salaam area (e.g. for the Wazo Hill cement plant or power generation), if a pipeline can be economically justified. However, in Dar es Salaam, the gas would probably displace fuel oil which is produced by the Tiper petroleum refinery as a residual and for which there is only a limited local demand. The bulk is at present exported from the refinery at unfavorable prices.

162. The possibility that the gas might be utilized to reduce iron ore pellets via the Hyl or Midrex processes to produce a metallized feed for an electric steel-making furnace had not been considered at the time of the mission. (This is the basis of very large-scale projects being implemented by Iran, Saudi Arabia and Venezuela to utilize their vast reserves of natural gas.) It is evident that apart from Kilwa itself, both Mtwara and Dar es Salaam must be considered as possible sites for any industrial complex based on the gas. The possibility of exporting the gas in liquified form cannot be seriously entertained.

163. Assuming the gas will be exploited, a complete reappraisal of the energy situation is necessary. In 1971 the total power generated was 124MW of which 49.2% was produced from hydroelectric schemes and the balance from thermal stations based on fuel oil or diesel generators. (The commissioning of the first stage of the Kidatu scheme in 1975 will add 100 MW.) A reappraisal of the relative merits of gas, coal and fuel oil as alternatives, i.e., a national energy policy, is urgently required as previously mentioned. It should also be borne in mind that Tanzania's geological environment is favorable for large-scale resources of geothermal energy, particularly along the rift valleys. It will in any event be necessary to reappraise the proposed Stieglers Gorge hydroelectric scheme, or rather the timing of it, if the proposal to mine large tonnages of coal is proceeded with, as it might be economically feasible to produce power on a significant scale from low-grade fuel which would otherwise be discarded as overburden. (Such material cannot be stockpiled for future use as it is subject to spontaneous combustion.)

164. It is clear that the completion of the Tazara Railway which gives access to Tanzania's important coal (and iron ore) reserves in the south-western part of the country, together with the recent natural gas strike near Kilwa, open up a whole new range of strategy options for industrial and energy policy. To illustrate the complexity of the issue, the mission has prepared a survey (see Appendix) of the various industrial uses that could be made of the natural gas. This survey is purely technical in nature, and no reference is made to the economic feasibility of the various alternative uses, nor is any comparison made with the possibility of using the gas as a fuel.

165. Tanzania's capacity to identify and compare the relative merits of alternative uses for the natural gas is very limited at present and the mission recommends that high level technical assistance is sought before any decision regarding exploitation is made. Ideally, such technical assistance should be provided within the context of an overall energy study which would lay the basis for an energy master plan.

I. Other Projects

166. Other projects in which the State Mining Corporation is involved include the following:

167. Tin. An agreement has been concluded with the Government of Finland under a bilateral aid agreement for a re-evaluation of the Kyerwa tin mine. The tin potential of the Karagwe area as a whole is being re-examined as part of the Kagera Basin Survey being undertaken by UNDP.

168. Gypsum. A major increase of production will be required to match the planned expansion of cement production. The State Mining Corporation is to investigate the possibilities of establishing its own mine in the Mkomazi area, northwest of Tanga, which is at present being worked by co-operatives and individuals to supply Wazo Hill, and will re-evaluate the extensive gypsum occurrences of the Mandawa-Mahokono dome, near Kilwa, which were prospected by the Mineral Resources Division some 10 years ago.

169. Gemstones. A feasibility study will be undertaken of the possibility of establishing a cutting and polishing facility at Moshi.

170. Diamonds. A small expansion of the Tancut factory and the transfer of the initial sawing from Antwerp to Iringa is planned. The estimated cost is Sh 1.5 million. The possibility of re-opening Mabuki, Dr. Williamson's original mine situated between Mwadui and Mwanza and worked between 1925 and 1929, is under consideration. Williamson Diamonds Limited have been requested to undertake the necessary prospecting. All indications are that conventional mining of the remnant gravels would be uneconomical, but one possibility to finally scavenge the deposit might be to fence off the area and lease plots to individual diggers or cooperatives who would have to sell to an authorized buyer. There would undoubtedly be security problems, but whether these would be any greater than if the State Mining Corporation were conducting an isolated small-scale operation is doubtful.

171. Salt. Longer term plans involve an evaluation of the potential of the Mandawa-Mahokondo dome where massive salt in a piercement structure was intersected at a depth of 100 meters in a Shell/B.P. borehole drilled to evaluate the hydrocarbon potential of the structure. The alternatives of underground and solution mining will be examined by Geomin. Consideration is also being given to the possibility of expanding production from coastal plants based on sea water.

172. Magnesite. The West German Government has been requested to finance a study of the mineral dressing processes used for the present small-scale production of calcined magnesite from the privately owned Chambogo mine.

173. Soda Ash. A detailed pre-feasibility study for a project to exploit the soda ash of Lake Natron has recently been completed by Japanese interest. A large-scale project (1,000,000 t.p.a. production and export has been proposed by these interests. Because of the scale of the investment required - over \$70 m capital expenditure and an equal expenditure on infrastructure - this project could only be undertaken with substantial aid or foreign investment. The project does not mesh with Tanzania's industrial development strategy, which gives priority to projects that process domestic resources for local use. Soda ash mining would be almost completely isolated from the present economic structure, with little potential for either forward or backward linkages. However, the project is potentially a major foreign exchange earner. At current world market prices, one million tons of Tanzanian soda ash would be worth between \$40 and \$70 million f.o.b. It is the type of project requiring a partnership arrangement, not only from the capital requirement point of view, but also because the relevant technical, management and marketing know-how are not at present available in Tanzania. If this approach would be acceptable it would as an initial step be worthwhile re-examining the following:

- (a) the assumption that the product must be of a high-grade and competitive in terms of quality with synthetic soda ash;
- (b) the possibility of a transport link to Magadi in Kenya;
- (c) the port facilities which would be required; and
- (d) the possibility of pipelining either the "ore" or a semi-processed product to reduce infrastructure requirements.

174. Nickel. A possible project to prospect for nickel in the northwest, particularly near the border with Burundi where an orebody was recently discovered, is under discussion with UNDP.

175. Sand and Kaolin. A pre-feasibility study for a project to produce high-grade kaolin from the Pugu deposit as a filler for export was completed by another Japanese group. This report indicates that a large-scale export-orientated project is economically not attractive. The possibility of expanding present production to produce kaolin suitable for the domestic production of tiles, sanitary ware and ceramics is being examined by N.D.C.

176. The feasibility of establishing a plate glass factory is also being investigated by N.D.C. A key consideration is that an economically feasible project would require the whole East African market. It is estimated that to produce 6,000 t.p.a. of plate glass would require a capital investment of the order of Sh 40 million. Production costs are tentatively estimated at Sh 2,000/- per ton or Sh 7/- per m² (well below c.i.f. import prices). The project would provide 300 jobs. The possibility of manufacturing sandpaper is also being examined and so is the possibility of establishing a bottle plant at Bukoba based on the very pure, nearby beach sands of Lake Victoria.

177. Niobium, etc. The Mineral Resources Division is planning with Canadian assistance to re-evaluate the Panda Hill carbonatite in the Mbeya area as a source of pyrochlore and apatite. No details of this project are available, but the geology of the carbonatite, which has been extensively investigated in the past by the Mineral Resources Division and the Mbeya Exploration Co. Ltd., is described in various publications, including Harris (1961). The pyrochlore is in a fine form and laboratory studies have indicated that recovery may be difficult on a commercial scale.

178. Finally, the State Mining Corporation's long-term plans include a proposal to re-examine the Wigu Hill carbonatite in the Morogoro district, but as a source of rare earth minerals rather than pyrochlore which is present in only very low concentrations.

CHAPTER VI - MANPOWER CONSTRAINTS

179. The shortage of graduate manpower - particularly, but not exclusively geologists, mining engineers and metallurgists (mineral dressers) - is evidently a major constraint affecting the expansion programs of the State Mining Corporation as well as current activities, and has reduced the Mineral Resources Division to a skeleton staff. Such Tanzanian geologists and engineers as are available have practically all been absorbed by the public sector. Because conditions of service in parastatal enterprises tend to be more favorable than in the civil service most public sector staff prefer to join these enterprises. The emphasis placed on production has resulted in large-scale transfers of staff to the State Mining Corporation, which has led for example to the reduction of the graduate staff of the Mines Inspectorate to two. Similarly the transfer of the most experienced mineral dresser from the Mineral Resources Division in Dodoma to the State Mining Corporation in Dar es Salaam is understandable in light of the emphasis on production and the acute shortage of experts in that field, but it has left the Division severely handicapped. A significant proportion of Tanzania's qualified geologists and mining engineers are now employed as managers or deputy managers of the State Mining Corporation or one of its 10 subsidiary companies. Because of their management functions, few are getting an opportunity to use and improve their technical knowledge.

180. As a short-term measure the State Mining Corporation is utilizing expatriates recruited under various aid agreements, and has recently requested UNDP to provide experts in such fields as coal, steel, salt, gold and cement production as well as a director of planning, an industrial accountant and other consultants on a shorter term basis. Technical assistance has also been requested from Canada. There are, however, very few expatriate personnel at grass-roots level, e.g., field geologists.

181. The largest operating company, Williamson Diamonds Limited, has sponsored the training of all its Tanzanian staff, and there are now only five expatriates left out of a total labor force of 2,000. Two are aircrew and a third is the Mine Geologist, who also supervises all diamond prospecting in Tanzania as the resident representative of the Willcroft Corporation. He is being understudied by a Tanzanian who will assume responsibility for the geological department of the mine. Most of Mwadui's graduates have had the opportunity to visit other diamond mines in Africa.

182. Other parastatal mining companies, in particular the State Mining Corporation, have drawn extensively on the pool of trained manpower at Mwadui, and the mine is now short of a number of graduates and technicians. Williamsons continue to sponsor training, but all overseas scholarships are now channeled through the State Mining Corporation and only a proportion are therefore available for Mwadui staff. Mwadui is currently placing emphasis on sending technical staff overseas to gain practical experience.

183. The Tanzania Portland Cement Company faces a more acute problem because of the proposed major expansion of the cement industry. The Company has trained most of its own staff, mainly to technical level, including a number who will be assigned to the new Mbeya and Tanga plants. The present total of expatriate employees is 11 - a shortfall of nine. It was planned to phase out all expatriates within two to three years, but this may be delayed by the expansion program which will stretch available management and technical expertise to the limit. The major constraint is the shortage of engineering graduates and technicians.

184. It is evident that the short-term solution to the manpower problem can only be to recruit more expatriates with qualifications and experience in the relevant fields. The only alternative is secondment of expatriate personnel to Tanzania by the minority partners in joint ventures. As far as the government institutions are concerned, it should be possible to obtain more expatriates on secondment from various geological and engineering institutions in donor countries.

185. The 11 Tanzanians employed by the State Mining Corporation and the Mineral Resources Division who hold degrees in geology all qualified in the first eight years after independence and all received their degree from a foreign university. The standard of training has been very mixed. Differences in the geology and environment, particularly the nature of the mineralization, in the country in which the geologist was trained compared with Tanzania are a major drawback particularly because field experience in Tanzania is usually short in duration or not provided for. It was partly for this reason and because of forecast requirements of geologists that the importance of establishing a training facility within the University of Dar es Salaam came to be recognized. The recently established Geology Department cannot, however, be expected to contribute significantly to an increase in the number of geologists for some years - the present total student population in all years is only 19 and the planned intake is 20 students per year. There is no plan at present for university level training in Tanzania of mining engineers, and mineral dressers. Reliance will have to continue to be placed on foreign universities, but the courses provided by the School of Mines of the University of Zambia in particular should prove to be relevant.

186. The State Mining Corporation's forecast of the requirement for graduates and technicians to 1984 is given in Tables 4 and 5. Actual requirements will, of course, depend on how many of the proposed projects currently under discussion are implemented. The differences between the first two columns in Tables 4 and 5 (present strength and estimated manpower requirements in 1974) bring out clearly the current shortfall of trained manpower.

187. Tables 4 and 5 do not include the requirements of the Mineral Resources Division or other users of geological and mining expertise. Considering the size of Tanzania, the reconnaissance nature of the existing mapping and the extent of the unmapped areas, the minimum current requirement

of the Mineral Resources Division is a total of the order of 30 geologists, 10 mining engineers as inspectors of mines and explosives, two mineral dressers and four chemists. If the Government is to eventually assume responsibility for all prospecting then an eventual requirement of the order of 60 geologists engaged in mapping and prospecting is probably not excessive. In such a situation far more use than at present could be made of technical staff, who would require a shorter period of training. This is in any case an approach worthwhile adopting, as many aspects of prospecting in particular can be delegated provided competent supervision is available.

188. One disturbing feature is that there appears to be very little opportunity for Tanzanian geologists, engineers, etc., to visit and meet their counterparts in neighboring countries. This growing isolation could develop into a serious situation and some effort should be made by the relevant international agencies and also by the governments concerned to organize sub-regional conferences. The geology and mineralization of, and prospecting and mining techniques used in neighboring countries are more relevant to Tanzania than those of other continents.

Projected Manpower Requirements of the
State Mining Corporation 1974-1984

Table 4

A. Professional Staff

Projected Requirements

Post	Present Strength (1974)		1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984
	<u>Expa- triates</u>	<u>Citizens</u>											
Mining Geologists	3	8	11	25	40	56	74	92	112	132	152	174	196
Mining Engineers	2	13	20	41	63	85	109	133	158	183	210	237	264
Miné Surveyers			2	5	9	13	21	29	37	47	57	67	79
Mechanical Engineers	4	7	21	44	68	93	122	128	134	140	146	152	158
Electrical Engineers		7	16	32	48	65	86	107	130	153	178	203	229
Mining Dressers			3	6	10	14	22	30	38	48	58	68	80
Civil Engineers	1	2	4	11	18	25	34	43	52	62	72	83	95
Geologists	1	1	2	5	8	11	15	19	23	27	31	35	39
TOTAL	10	38	79	168	263	361	482	605	733	867	1,005	1,146	1,294

Source: Projections by the State Mining Corporation.

Projected Manpower Requirements of the
State Mining Corporation 1974-1984

Table 5

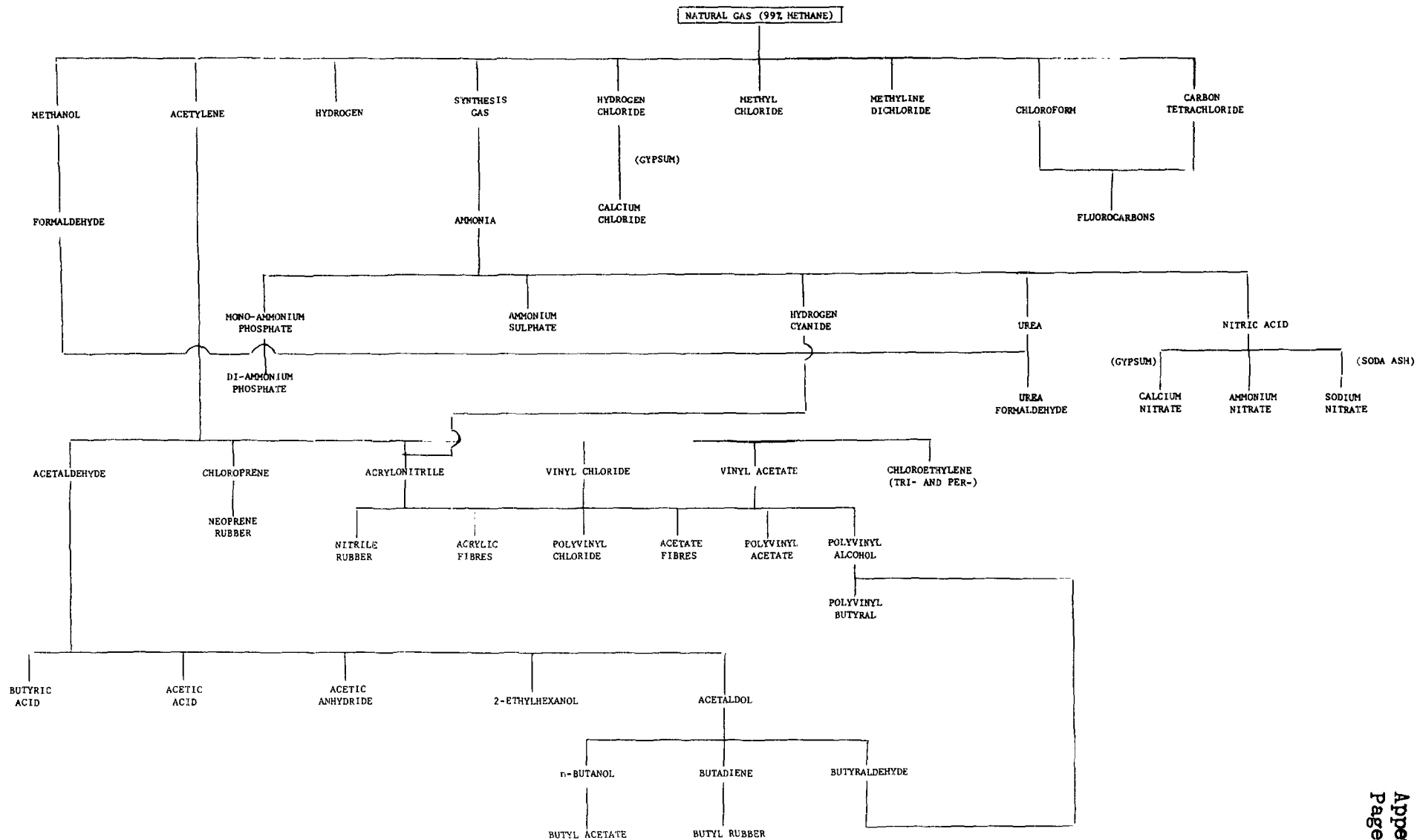
B. Technical Staff

Projected Requirements

Post	Present Strength (1974)		1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984
	Expatriates	Citizens											
Electrical Technicians	3	15	32	66	105	145	190	235	283	331	381	431	481
Salt Technologists			6	12	18	25	34	43	53	63	74	85	96
Cement Technologists			4	8	13	21	31	41	53	65	77	89	101
Mining Technicians	7	48	123	187	255	326	401	476	554	632	712	796	882
Mechanical Technicians	8	22	42	86	133	182	237	293	351	410	474	541	611
Civil Technicians	2	6	8	17	26	35	44	53	62	71	80	90	100
Drilling Technicians				4	10	18	26	35	44	53	62	72	82
TOTAL	20	91	215	380	460	752	963	1,176	1,400	1,625	1,860	2,104	2,353

Source: Projection by the State Mining Corporation

TECHNICALLY FEASIBLE PRODUCTS FROM NATURAL GAS



The Uses of the Products from Natural Gas

1. Methanol
 - (a) in the manufacture of formaldehyde
 - (b) as an anti-freeze
 - (c) as a methylating agent
 - (d) in solvents
2. Formaldehyde
 - (a) as "formalin" solution
 - (b) in the manufacture of phenolic, urea and melamine resins used in the plastic or surface coating industry
3. Synthesis Gas
 - (a) in the oxo process for the manufacture of alcohols for solvent, plasticizer and detergent use
 - (b) in the manufacture of synthetic ammonia
4. Methyl Chloride
 - (a) as a refrigerant
 - (b) as a methylating agent
 - (c) in the manufacture of silicones and butyl rubber
5. Methylene Dichloride
 - (a) as a solvent
 - (b) as a paint remover
 - (c) as a diluent for insecticides
 - (d) in the manufacture of plastics and plasticizers
6. Chloroform
 - (a) in pharmaceuticals
 - (b) in the manufacture of fluorocarbon refrigerants and resins

7. Carbon Tetrachloride

- (a) in the manufacture of fluorocarbons
- (b) as a grain fumigant
- (c) as a solvent
- (d) in fire extinguishers

8. Fluorocarbons

- (a) as an aerosol propellant
- (b) as a household and commercial refrigerent

9. Acetylene

- (a) in the manufacture of vinyl chloride, chloroprene, acrylonitrile, vinyl acetate and chloroethylene (tri- and per-)

10. Trichloroethylene

- (a) as a degreasing agent for metal, glass and some plastics

11. Perchloroethylene

- (a) as a drycleaning solvent
- (b) as a degreasing agent

12. Chloroprene

- (a) in the manufacture of neoprene rubber

13. Neoprene Rubber

- (a) in the manufacture of:
 - (i) wire coating
 - (ii) cable coating
 - (iii) gaskets
 - (iv) belts for power transmission
 - (v) industrial hoses

- (vi) solid tyres
- (vii) rubber gloves
- (viii) products where resistance to heat and solvents is required

13. Acrylonitrile

- (a) in the manufacture of:
 - (i) nitrile rubbers
 - (ii) vinyl copolymers

14. Nitrile Rubbers

- (a) in the manufacture of fuel tanks and gasoline hoses
- (b) in the food industry where strong resistance to oils, fats and solvents is required
- (c) in adhesives
- (d) for impregnating paper, leather and textiles

15. Vinyl Chloride

- (a) in the manufacture of:
 - (i) polyvinyl chloride (PVC)
 - (ii) vinyl copolymers

16. Polyvinyl chloride

- (a) in the manufacture of:
 - (i) raincoats
 - (ii) handbags
 - (iii) shower curtains
 - (iv) vinyl flooring
 - (v) garden hoses
 - (vi) plastic pipes

- (vii) coat fabrics
 - (b) as insulation for wire and cables
 - (c) to form film, sheet and floor covering
 - (d) in coating and adhesive resins
 - (e) in the molding of records, dolls and rainboots
17. Vinyl Acetate
- (a) in the manufacture of:
 - (i) polyvinyl acetate
 - (ii) polyvinyl alcohol
 - (iii) vinyl copolymers
18. Polyvinyl Acetate
- (a) in adhesives (of the hot-melt and emulsion type)
 - (b) in the production of water-based paints
 - (c) as a binder for textiles
 - (d) in the coating of paper
 - (e) in industrial finishes
 - (f) in chewing-gum
19. Polyvinyl Alcohol
- (a) as a thickening agent for emulsions
 - (b) as an adhesive
 - (c) in grease-proofing paper
 - (d) in polyvinyl alcohol fibres used as a replacement for cotton
 - (e) in the manufacture of polyvinyl acetals (e.g. polyvinyl butyral with butyraldehyde)

20. Polyvinyl Butyral

- (a) in the manufacture of safety glass

21. Vinyl Copolymers

- (a) in the manufacture of:

- (i) acetate fibres (90% vinyl chloride, 10% vinyl acetate)
(ii) acrylic fibres (60% vinyl chloride, 40% acrylonitrile)

22. Acetaldehyde

- (a) in the manufacture of:

- (i) acetic acid
(ii) acetic anhydride
(iii) acetaldol
(iv) 2-Ethylhexanol

23. Acetic Anhydride

- (a) in the manufacture of:

- (i) cellulose acetate resins
(ii) plastics

24. Acetaldol

- (a) in the manufacture of:

- (i) Butyraldehyde
(ii) Butadiene
(iii) n-Butanol

25. 2-Ethylhexanol

- (a) as a high-boiling solvent
(b) as a defoaming and wetting agent
(c) as an intermediate in the manufacture of plasticizers

26. n-Butanol

- (a) as a lacquer solvent in the surface coating industry
- (b) in the manufacture of butyl acetate

27. Butyl Acetate

- (a) in synthetic resins
- (b) in plasticizers

28. Butyraldehyde

- (a) in the manufacture of butyl rubber

29. Butyl Rubber

- (a) in the manufacture of:
 - (i) tyres
 - (ii) tyre inner tubes
- (b) as an inner liner and trim rubber in tubeless tyres
- (c) for wire and cable insulation

30. Ammonia

- (a) in the manufacture of:
 - (i) Nitric Acid
 - (ii) Urea
 - (iii) Hydrogen Cyanide
 - (iv) Ammonium Sulphate
 - (v) Mono- and Di-Ammonium Phosphate

31. Nitric Acid

- (a) in the manufacture of:
 - (i) Calcium Nitrate
 - (ii) Ammonium Nitrate
 - (iii) Sodium Nitrate

32. Calcium Nitrate and Ammonium Nitrate
 - (a) as fertilizers
33. Sodium Nitrate
 - (a) in the dye industry
34. Irea
 - (a) as a fertilizer
 - (b) in animal feed as a protein substitute
 - (c) as a softening agent for wood products
 - (d) in the manufacture of urea formaldehyde
35. Urea Formaldehyde
 - (a) as a fertilizer. It releases nitrogen slowly and is hence effective over the entire growing season.
36. Hydrogen Cyanide
 - (a) in the manufacture of acrylonitrile
37. Ammonium Sulphate, Mono- and Di-Ammonium Phosphate
 - (a) as fertilizers

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