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MINISTRY OF ENERGY AND MINERALS

*Mineral Sector Development Project*

*P. O. Box 2000, Dar es Salaam*

FINAL REPORT

ON

BASELINE SURVEY AND  
PREPARATION OF  
DEVELOPMENT STRATEGY FOR  
SMALL SCALE AND ARTISANAL  
MINING PROGRAM

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## EXECUTIVE SUMMARY

### INTRODUCTION

Tanzania is blessed with a variety of minerals, including gold, gemstones, base metals and industrial minerals. The country is characterized by diverse geological environments favourable for the mineralization of wide varieties of minerals. Its high mineral potentials have attracted various exploration companies over the years but the overall contribution of the sector to the national economy has never been significant.

Prior to independence in 1961, mining activities contributed about 10% of the GDP, and indigenous Tanzanians were already participating in this activity. The socialist policies of 1967 emphasized state ownership, therefore retarding private investments. The state enterprises entrusted to develop the sector could not achieve their objectives, for reasons including inadequate technologies, manpower and capital resources. Meanwhile, many individuals resorted to informal artisanal mining, winning easily saleable minerals such as gold and gemstones. Since the government did not recognize these operators, their mineral marketing channels were underground, encouraging smuggling.

The economic reforms introduced in late 1980s and early 1990s were aimed at increasing the private sector participation in production. Parallel to this, the government recognized the importance of artisanal and small scale mining activities, and liberalized marketing arrangements by allowing free auctions of gemstones, and instructed the Central Bank to purchase gold. The policy change impact was reflected in the national economy when the sector registered an economic growth rate of 24% in 1992 and mineral exports rose from USD 15.8 million in 1989 to USD 53.2 million in 1992. Almost all of this growth is attributed to artisanal mining as foreign mining companies are still in the exploration stages. Apart from economic contributions, artisanal mining provides employment to many people in the rural community. For instance the labour involved in artisanal mining rose from 100,000 in 1989 to 300,000 in 1992, up to 550,000 in 1995. Artisanal mining is usually carried out by people with only an informal operational organisation, crude mining and mineral processing technique and marketing knowledge with poor technology, using cheap crude tools. These uncontrolled activities resulted into environmental degradation; another likelihood of epidemics as well as the smuggling of precious minerals, thereby denying the government revenue.

The Mineral Resource Department (MRD) of the Ministry of Energy and Minerals established an artisanal and small - scale mining development office (SSMO) for implementation of artisanal and small scale mining development on a sustainable basis. To achieve this SSMO examined ways of transforming artisanal miners into formal organized miners by engaging a consultant to undertake a baseline survey study and development strategy as a first step.

The objective of the baseline survey is to provide reliable quantitative information on the current position and performance of the artisanal and small scale mining activities. The survey encompassed the relevant economic, social, organisational, technical, marketing, environmental and health and safety factors as well as institutional aspects. The consultant started the assignment in October 1995 and it took five months to complete the field surveys. The survey covered 17 administrative regions in eight mine zones in which there are 37 administrative districts. A total of 108 mine site localities were visited out of which 39 localities were for gold mining and 33 localities for gemstones. Other minerals covered include gypsum, building minerals, salts and coal.

This report is in two parts with Part 1 covering the baseline survey findings and Part 2 recommending the development strategies. The data and information on the baseline survey were organized and processed to cover the tasks given in the Terms of Reference on organisation; mining and processing; commercial aspects, socio-economic, environmental and health and safety factors.

## ORGANIZATION ASPECT

Government institutions, namely the Ministry of Energy and Minerals (MEM), the Planning Commission, the Ministry of Finance and the Regional and District administration have roles in implementing the laws, regulations and fiscal regime of the sector.

The Mineral Resources Department (MRD) under the MEM is responsible for the development of the sector. The duties of its Mines Division affect artisanal and small scale miners. Its activities have increased in the recent years as registered mineral claims increased from 425 in 1991 to 4123 in 1995. The mines' offices are faced by inadequate staff and insufficient facilities and budget to undertake their duties smoothly. For instance in Songea, the mine's office has staff without a vehicle yet has to oversee mining activities in other areas such as Tunduru which is about 300 km and away has 200,000 artisanal miners.

These constraints cause mineral registration backlogs. For instance the average period to complete claim registration formalities is between 2 - 12 months. A major cause of low Mines Offices' activity is insufficient funds to undertake fieldwork.

The Regional and District administrations are not directly involved in mining activities but are responsible for maintenance of law and order, provision of health services and oversee environmental control measures. These institutions however receive a meagre budget for the services.

As the role of government changed from that of an implementing agent to a promoter and facilitator, mining associations have arisen to take the responsibilities. Regional Miners Associations among them are (REMA) which stand at 17, the Tanzania Mineral Dealers Association (TAMIDA), the Federation of Miners Association of Tanzania (FEMATA) and the Chamber of Mines. However, such associations are characterized by lack of funds, uncommitted leaders, poor development plans, lack of offices and poor facilities.

Some specialist micro-finance institutions have shown interest in fulfilling certain of the needs of artisanal miners. The Business Center which is funded by the United States Agency for International Development (USAID) has taken a keen interest in the capacity building of FEMATA, and also in addressing marketing development of FEMATA products like gold and gemstones. Poverty Africa, which relies on donor support, is interested in informal artisanal miners. Pride Tanzania, which offers credit services and training in financial matters to the informal sector, is willing to work with artisanal miners in the area through donor support.

## MINING AND PROCESSING

In mining and processing, the study team examined the methods used for prospecting, mining and processing together with the technologies employed by artisanal and small scale miners. The survey revealed that mining and processing methods practised were determined by the geology of the deposit and the nature of the ore. Further, it was shown that much gold occurred in thin quartz reef structures with localized secondary enrichment zones, which are difficult to mine. There are also eluvial and alluvial deposits of limited size which are easier to mine. Gemstones occurred in pegmatites, localized fissures and eluvial and alluvial deposits underlined by granulitic bedrock. Due to the small size of mineralization and their frequently highly irregular form most of the deposits are not amenable to open-pit mining on a medium or large scale.

The prospecting methods thus employ traditional and conventional techniques. Traditional discoveries include tracing indicators such as vegetation, while hunting or grazing livestock. Conventional methods identified include tracing floats, panning, pitting, trenching and tracing indicator minerals. Due to poor technologies and unplanned activities mineral discovery is usually by "luck" or "accident". Upon discovery mining commences without the delineation of deposits or the blocking out of ore reserves. Design and development planning is largely arrent typical mining method for gold is by pitting and trenching. The pits are sunk in mineralized zones typical 100m - 15m deep although some over as deep as 100m. Typical tools used, are moil points, picks and shovel which account for 65% of extraction methods.

In hard rock hammers and chisels are used for drilling followed by blasting using explosives. This technique covered 12% of extraction methods. Other techniques of gold extraction include hoes and crow bars assisted by hammers which constitute 22% of extraction techniques. Pits are haphazardly spaced with a distance park of between 3 m. and 4 m. A few pits an interconnected by small drifts and cross cuts driven in the ore, spaced at vertical distances of about 20 m to improve ventilation. However the absence of ventilation doors impairs their effectiveness.

Poor ventilation and lighting lead to poor working conditions. About 47% of mines visited used natural ventilation; 28% had no air circulation; the balance were accounted for by hand operated fans converted from blowers (13%), and compressors with hose pipes (12%). In underground mining, torches account for 45% of the light source and open flame lanterns ("Vibatari") contributed to 45% Natural light covers 4%, while candles, electricity, and hurricane lanterns account for 2% each.

Vertical transport in underground mining is accomplished by ropes or notches cut on opposite sides of the pit walls. In the mine, bad practices such as robbing pillars were noted, which could lead to walls collapsing. One of the major constraints faced by artisanal miners is water. Only 4% of mines used pumps for dewatering, otherwise traditional methods using buckets, or drums were employed. These problems, combined with ventilation and lighting constraints eventually force most operators to abandon the mines.

During mining, artisanal miners observe visual indicators such as visible gold, and reef colomition. Samples collected had gold values of 58.8 gm per tonne of ore, while the marginal ore which normally is thrown away showed values of up to 38gm of gold per tonne of ore.

Gold processing consists basically of manually crushing the ore with sledge hammers, followed by grinding in traditional with mortar vehicle axles used as pestles. Fine grinding is carried out with grinding stones, commonly undertaken by women. These practices present 64% of the gold miners visited. Mechanical grinding contributed to 18% of grinding, whereas hammers on stones accounted for the balance. Very few miners, (about 3%), used jaw crushers, the majority employed sledge hammers.

The ore is concentrated by sluicing and panning and the concentrate is finally amalgamated with mercury. The amalgam is heated in a pan or on a shovel over an open fire. The survey revealed that mercury retorts were hardly being used. Gold concentration techniques identified in the survey were amalgamation 45%, panning and sluicing 23%, sluice boxes 26%, washing and sieving 5% and cyanidation 1%. Gold refining included open heating of amalgam 79%, panning 5%, hand sorting 5%, zinc shavings and furnace 8% and mercury retorts 3%. Trials on cyanidation have been carried out at Matinje in Nzega with some success. Due to rudimentary techniques, much of the gold in the fine fraction is lost to the tailings. Laboratory results showed gold recovery in many artisanal operations ranging between 50% and 53% of the mineable gold.

Gemstone mining used mechanical equipment for rock extraction and pumps for water circulation. The gemstone bearing rock sometimes extracted by drilling and blasting using low velocity explosives. These techniques accounted for 13% of extraction methods. The majority of gemstone miners use simple manual tools such as moil points, picks, shovels, hammer and chisels for ore extraction, which covered 65% of extraction methods. Eluvial and alluvial gemstone miners employ shovels, sieves and crow bars. Processing of the gemstone is by hand screening, washing and hand sorting on pans and screens.

Due to the rudimentary techniques used, productivity is very low. For instance average productivity in gold ore is 90 kg/day/person, while that of the gemstone ore is 27 kg/day/person.

Industrial minerals such as gypsum, salt, limestone and coal were also mined using the same techniques, but due to limited markets the production is small. Similar constraints face the building minerals, resulting in cost reduction by their being sited in convenient areas, no matter what other ills (such as environment damages), may be.

## COMMERCIAL ASPECT

Mineral marketing, especially of valuable minerals such as coloured stones and gold, are normally carried out in privacy, and it is difficult for an outsider to monitor market trends. The study identified types of traders, marketing channels and examined causes of smuggling.

Local mineral trading is usually in the hands of small mineral brokers who consist of traders and miners and mineral dealers. The mineral brokers are in large numbers in mine rush areas, but much lower in stable mining village. Mineral brokers determine the nature of mineral trading as a black market or on at official basis. The survey estimated that they were 710 mineral brokers practising in the country. It was further found that mineral dealers conclude their deals in urban centres and do not carry out business in mine sites.

From the survey it is estimated that 60% of the recovered gemstones and 70 - 85% of gold recovery is being smuggled. The study revealed that the number of participants at various stages of the marketing channels is changing due to the following factors: (i) type of mineral commodity in demand. (ii) trading location (iii) credit arrangements between dealer smugglers and brokers (iv) price. (v) foreign order of legal dealer and importation requirements. The activity of trading routes changes with the above factors.

The survey identified that the price fluctuation in local markets of the gemstone is caused by (i) number of middlemen (ii) market knowledge of the producer, and (iii) type of coloured gemstone. Another factor is the remoteness of a trading place which has direct effect on the risk involved. Unlike gemstones, gold trading involves few middlemen and the collection networks are more established. Gold brokers normally provide essential items such as mercury so as to make a bond on production sales. These brokers are usually in urban centres and assign an agent to oversee production activities.

Other products such as salt, industrial and building minerals and coal had a common problem of high transportation cost to reach market centres. In addition to this snag, markets are not readily available.

Gold exports through formal channels had a sharp increase from USD 1.1 million in 1989 to a peak value of USD 31.4 million in 1993. This is a reflection of changing from unofficial to official channels. However the smugglers improved incentives and again more export was through unofficial channels. The number of private gold dealers dropped from 14 in 1989 to 6 in 1992. On the other hand gemstone dealers could not rapidly increase their export due to factors like: (i) stiff competition with smugglers (ii) lack of export credit facilities (iii) disadvantages of utilizing forex cheques with loss in exchange rates and (iv) inability to set strategies to penetrate value added markets. Other products namely lime, gypsum, magnesite and salt do not meet international standards and therefore are not exported.

Smuggling exists mainly due to excessive taxation and as a consequence of informal credit arrangements with the smugglers. Costs incurred while smuggling are much lower compared to official dealers expenses, (mainly from taxation) and therefore the latter cannot compete with smugglers.

Lack of formal credit facilities for the small scale mining sub sector has caused a lot of hindrance in the development of orderly mining and mineral trading activities. To overcome the problem, artisanal miners have resulted to:-

- the formation of informal tributing systems in production structures.
- obtaining credit from informal sources, mainly from mineral smugglers.

Most artisanal and small scale miners do not qualify to borrow from financial institutions because they lack a formal legal structure such as a registered company. Further artisanal miners cannot qualify for loans from cooperation lenders because they lack quantified ore reserves.

## SOCIO - ECONOMIC ASPECTS

The impact of mineral trade liberalization policy introduced in 1987 was reflected in the emergence of a mining contribution to GDP from 0.4% in 1988 to 1.5% in 1994. This is a steady growth of 24% per annum. The official earnings

from sales of gold and gemstones stood at USD 32,144,247 in 1994 which is about one third of the actual exported minerals. Non-recognition of artisanal mining activities by the government is contributing to smuggling.

The income of mine operators depends on type of commodity, occupation, title and richness of the mine but generally a gold miner earns between USD 200 - 1,000 per month whereas a gemstone claim holder exports less than USD 400 per month. There are rare cases where a gemstone gang of 5 - 10 earn USD 50,000 per week. The survey further revealed that mine workers give first priority to the basic needs of their family and that the surplus is spent on non-productive items. Successful claim holders invest very little in mining activities probably due to the risks involved. They instead invest in other businesses such as transportation, guest houses etc.

Artisanal miners are transient workers who tend to concentrate in rich mineral locations such as Tunduru. The rapid increase of miners population in mine rush areas creates new hygienic and health problems and the community lives in a disorganised, lawless environment. However in traditional mining villages the health conditions are far better than other surrounding villages. Social amenities and shelters are normally available, although the quality of the infrastructure depends on the age of the mining village and richness of the deposits.

The participation of miners in community development activities depends on stability of mineral production, existing authority structure and past experiences with the results of their contributions. Normally, mining settlements and nearby villages depend on each other resources various for such as labour forces, market places for essential goods etc. As miners generally have a higher income than villagers such a trend results in localised inflation as was observed in Ngapa - Tunduru in 1995. Maintenance of law and order depends on authority structures, the closeness of the police force and the available communication systems.

Women are directly involved in the mining, processing and trading of minerals and indirectly involved in the provision of socio - economic services such as vending food. The Mining Regulations barred women from underground activities and the survey showed that they were active in surface activities such as grinding ore, washing and panning or washing and sieving. Their income is USD 20 - 400 per month in gold mining and USD 5 - 140 in gemstone mines. Some women owned claims and pits although this group is less than 5% of total number of claim holders interviewed. However the survey further revealed some women made fortunes out of

mining business. Cultural and social barriers have in some cases discriminated against women. Traditional are often of the opinion that women bring misfortune if they visit active mines and frequently women's discrimination is influenced by tribal composition of a particular mine area. The survey revealed that 143,153 women were directly involved in mining, which represents 24% of the artisanal and small scale mining population.

The survey identified the cause of child labour in mining to be principally worsening economic hardships whereby poor families are forced to send their children to income generating activities. Other causes include increased costs in education and the poor future of unsuccessful school - children. Some of the children had been street boys in urban areas before resorting to mining activity for a better future. Children are given light duties such as processing ore, assisting in mercury amalgamation and, in some cases, working in the woman's groups. Other activities carried out by children included sales boys/girls in food stalls and kiosks. There are both negative and positive factors for children joining mining activities and it is therefore suggested that a detailed study should be carried out to come to a realistic conclusion.

#### ENVIRONMENTAL IMPACT, HEALTH AND SAFETY

The environmental impact assessment examined land degradation and the contamination of water and air through mining activities. The analyses were carried out at site and in laboratories using standard methods.

The survey estimated that 10,000 ha were destroyed by formal artisanal miners while informal miners accounted for 6,000 ha. The degraded land was characterized by devegetation, abandoned pits and intrusive unsightlines. The mine rush areas such as Tunduru damaged the scenes through disorganized mining and individual ambition to become rich. Heavy metal analyses of soils revealed high concentrations of arsenic in scattered regions such as Lusu in Nzega - 990 ppm; Mawemeru in Geita - 1274 ppm. This probably is due to the use of agricultural chemicals. Lead contamination was high in Mpanda 7110 ppm, and Tarime 184 ppm as a result of mineralization.

Acid mine drainage was observed in areas where sulphides are present such as Geita and Rwamagaza, which showed mine water with pH values of between two and four respectively. Water contamination through sedimentation was found in locations which process minerals directly in water or mined on river banks. Such locations include Tunduru (Ruvuma); Mwalazi and Lukande in Morogoro Region;

and Ikungu (Musoma rural) district. In extreme cases such as at Sirori Simba and Maji Moto, streams were blocked by sediments. That Water contamination analyses showed only mercury posed a threat. Its concentration was as high as 2.306 ppm at Mugusu river. The maximum permissible level that WHO of the standards is 0.002 ppm.

Air monitoring revealed that underground mining resulted in poor air quality. Generally air particulate matter was at unacceptable levels, for instance in Merelani - Arusha, where the measured airborne concentrations showed values of 6,830 mg/m<sup>3</sup>. The recommended maximum permissible level by WHO is 320 mg/m<sup>3</sup> for less than 8 hours of exposure. Carbon monoxide was also often high, with concentrations of between 9 and 14 ppm. The maximum permissible level recommended by WHO is 9 ppm. Apart from pump engine exhausts, other contributors were smoking, open lanterns and poor ventilation.

Surface process plant test showed that airborne particulates were about 510 mg/m<sup>3</sup> in open spaces. The noise from engines was monitored to be between 90 and 115 dB(A). This affected operators and residents living near the sites. The engines were operating about 15 hours/day during the mining season, thereby exposing operators to a high risk. The maximum tolerable noise level recommended by USEPA is 80 dB (A) for under eight hours of exposure per day.

Living conditions in mining communities are characterized by diseases, unsafe water supply and over crowding in poorly ventilated shelters. The survey showed that frequently occurring diseases included diarrhoea, malaria, schistosomiasis, eye diseases and upper respiratory infections. Medical officers could not establish the contribution of dust effects to respiratory infections but cautioned that high dust concentrations could easily lead to fibrosis. The effects of mercury on operators' health were not covered in the study but preliminary investigations were done on hair samples of gold mine operators. Laboratory analysis showed 33% of the sampled population exceeded the WHO recommended level of 6.4 mg of mercury per kg of hair, with contamination of up to 43.5 mg/kg. The concentration levels arise from a combination of individual habits and contamination of the surroundings.

Laboratory investigations on drinking water showed the presence of coliform bacteria, parasites and other pathogens. The locations with these harmful micro-organisms included Tunduru, Muhuwesi, Morogoro, Mara river and Lake Victoria. The major reason for poor quality of drinking water was inadequate sanitation in the working sites and dwellings causing run off containing human and animal waste, thereby contaminating water.

Sexually transmitted diseases (STD), including AIDS, affected miners like other communities in rural areas. There were hardly any women in mining camps or sites, and social interactions between the two sexes were predominantly in nearby villages. Therefore, the percentage of miners affected by STD reflects the ratio infected in nearby villages. Due to their high incomes, miners are inclined to promiscuity. Extension services by medical officers promoting safe sex were reported to have decreased the STD cases. Health care in mining settlements was in a very bad condition as Government could not match its control efforts with the migrating behaviour of miners. It was observed in some locations such as Amani - Ludewa, that a miner has to travel 50 km to reach the nearest health centre, resulting in the predominance of unauthorized practitioners or traditional healers.

Unsafe practices have resulted in many accidents in mining areas. Most small scale and artisanal miners conduct mining operations without observing the requirements of the safe working regulations under the 1979 Mining Act.

Underground mines and works have claimed the biggest number of victims. Not all mine accidents are reported and some are never noticed, especially in illegal mining activities. In 1994 about 42 accidents happened but only 24 were reported.

Among the reasons for mine accidents include: - Suffocation due to poor ventilation and the use of open flame lanterns underground; roof collapse; slabs falling from hanging wall and roof; rock slides in open pits and trenches; people falling into hardly located pits; poor hoisting mechanisms, shaft collapse; storage of explosives in places other than approved ones such as magazines, storage boxes etc.

## DEVELOPMENT STRATEGY

The baseline survey revealed that the operations of government institutions like the Ministry of Finance; the Bank of Tanzania and Regional/District administrations are poorly coordinated towards the development of artisanal and small scale mining. This has resulted in uncontrolled artisanal mining, leading to unacceptable environmental degradation, poor social, health and safety conditions and the unlawful mining and selling of valuable minerals.

The proposed development strategy therefore aims at transforming artisanal miners so that they conduct mining activities properly. The elements of this development strategy have been identified as: - (i) reviewing of legal issues and strengthening of institutional frameworks; (ii) improving the use of modern technologies and introducing acceptable marketing systems; (iii) improving social, environmental, health and safety conditions. Each option gave clearly defined objective(s) for the proposed measures, which vary in improving performance. Though the options are given at different hierarchy levels and subjects, it is recommended that an intergrated approach with strategic alliances be adopted. The proposed development options are in two scenarios; the least cost and the most productive.

Under the legal, regulatory and institutional framework, it was found that existing laws and regulations are not enforced and that there was a need to amend the Mining Act. Further, there is a need to transform and legalize artisanal mining, the security of mineral property, the creation of competitive market and the creation of mining advisory boards at different levels, the setting up of standards for environmental health and safety matters and a fiscal regime that addresses issues on revenue and investments. The Institutional framework focuses on improving, monitoring and boosting administrative support to the sub-sector.

In technological and market issues, it is imperative that the government sets up incentives and regulations which encourage miners to use formal financial systems such as credit facilities and to advise on suitable technologies. Social, environmental and health factors demand monitoring programs and the enforcement of laws and regulations. However these programs would only work effectively in an organized mining environment.

At production unit level, it is recommended that the operators be classified according to their operational levels. An initial stage is transforming informal to formal artisanal miners. The next step is to create enabling conditions for introduction of technologies and the adherence to laid down procedures. The last step focuses on transforming artisanal miners into small scale miners.

The development strategy also deals with specific commodity options for gemstones, gold, salt and building materials.

An action plan which shows areas of concentration in the implementation and the duration of item implementation is given in the development strategy. It is anticipated that a detailed work plan will be drawn up when implementing the programme. The action plan has a preparation stage which covers a period of establishing enabling conditions, the formulation of strategic alliances and conducting pilot projects in selected areas. The implementation phase covers project coordination and field activities. An evaluation of the project program will be carried out at the end.

During implementation, the government is responsible for coordination and establishing enabling conditions. Mining associations have roles to assist their members by soliciting technical and financial assistance and by requiring adherence to procedures. NGO's have roles in assisting mine operators in different fields such as health and credit systems. Donor agencies are expected to offer technical and financial assistance. Targeted action will focus on technology transfer and strengthening the ability of micro-finance institution, local NGO's and miners associations.

## A. INTRODUCTION

### I BACKGROUND

1. Tanzania is endowed with a variety of minerals, including gold, varieties of gemstones, base metals, industrial minerals etc. The presence of these reserves of various types of minerals in many parts of the country is attributed to the nature of the geology of Tanzania which includes diverse geological environments favourable for wide varieties of minerals. This high potential justifies the efforts by the government to promote the mineral sector.

2. Prior to independence in 1961 mining activities contributed about 10% of the country's gross domestic product (GDP). The new policies which were introduced in the country after independence, particularly after the Arusha Declaration of 1967, emphasized state-directed development strategies in all major sectors of the economy, including the mineral sector. This situation impeded the inflow of private investment, both local and foreign. Consequently, the mineral sector became predominantly state-owned until the late 1980's. However the state enterprises which were entrusted to develop the mineral sector had inadequate technological, human and capital resources. Meanwhile, individuals resorted to informal artisanal mining activities of easily marketable items such as gold and gemstones. These informal mining activities were not officially recognized and hence their marketing by black markets and by smugglers of gold and precious stones.

3. In the late 1980's and early 1990's the government of Tanzania introduced economic policy reforms which were aimed at disengaging the government from direct involvement in the productive sectors and transforming its role to that of administrator and facilitator. The Investment Promotion Centre (IPC) Act of 1989 was aimed at creating further incentives for private investment especially to big companies. These policy changes created an "enabling environment" that is expected to attract foreign and local big private mining companies which have the capital and expertise to carry out mechanized and large scale mining operations.

4. Furthermore, from the late 1980's to early 1990's the government recognized the need to control the activities of artisanal miners and smuggling of precious minerals and hence it introduced an economic reform programme pertaining to procurement and sales of minerals; "the gold and gemstone trade rationalization strategy of 1987". This allowed the licensing of private gold and gemstone dealers in order to provide a wider market for private small scale and artisanal miners. The government also directed the Central Bank to buy gold from the miners and gold dealers.

5. These recently introduced macro - economic changes and mineral trade liberalization have attracted several large scale private mining investors into the country and have positively impacted the growth of the mineral sector and hence its contribution to the national economy. Shown below are some examples -

- (i) The sector recorded the highest growth rate of 24% in 1992 and mineral exports rose from USD 15.8 million in 1989 to USD 53.2 million in 1992. Simultaneously, government fiscal revenue collection rose from Tshs. 76.9 million in 1990/91 to Tshs. 121.2 million in 1992/93 fiscal year.
- (ii) The number of mineral dealers' licences has increased from 17 in 1989 to 180 in 1995. To-date the government has issued about 200 mineral dealers licences.
- (iii) The number of registered claims has increased from 1998 (in 1990) to 2782 ( in 1993) to 4123 (in 1995).
- (iv) From January 1992 to date, the government has granted more than 312 reconnaissance and prospecting licences to public and private companies of both local and foreign nationals. The number of investors applying for these types of mineral rights is increasing, such that by the end of 1996/97 financial year, the number of licenses is forecasted to rise by more than 30%.

6. Although the mining sector has shown a positive growth in the near past, much of this growth is attributed to the development of small scale and artisanal mining operations, because most of the big mining companies which have decided to invest in Tanzania are still in the exploration phase of their operations. Therefore, small scale and artisanal mining is so far the most productive sub-sector of the mining industry in Tanzania.

7. The importance of small scale and artisanal mining in Tanzania is also reflected by the fact that: -

- (i) It offers attractive employment to many people, particularly from the rural community.
- (ii) It resettles those who have lost their jobs in the cities due to the newly adopted structural adjustment programmes. For example, the number of people involved in artisanal mining increased from an estimated number of 100,000 in 1989 to 300,000 in 1992.

8. Although small scale and artisanal mining is such an important sub-sector in Tanzania, artisanal mining is usually carried out by people with only informal operational organization, with poor technology, using cheap crude tools and limited marketing knowledge. Concurrently the government has not yet given it proper attention in its Mining Act in terms of the governing rules and regulations, their access to credit facilities and extension services. All these factors are to the disadvantage of the sub-sector in its productivity and sustainability, and on its health, safety and environmental aspects.

9. Because of the afore-stated importance of the small scale and artisanal mining sub-sector in Tanzania and its constraints, the Mineral Resources Department (MRD) of the Ministry of Energy and Minerals (MEM) has established an artisanal and small - scale mining development office (SSMO) for the implementation of the artisanal and small scale mining development of the sub-sector on a sustainable basis.

**The objectives of the program are to: -**

- (i) Further legalize the informal segment of the sub-sector and to progressively transform artisanal operations, health and safety standards and to eliminate undesirable environmental practices in all high-density artisanal and small scale mining districts.
- (ii) Establish a reliable and competitive channel of supply of appropriate mining and processing equipment in the country.
- (iii) Enhance productivity and mineral recovery through the introduction of appropriate mining and processing equipment, combined with basic technical and business training and

- (iv) Transform regional miners' associations into efficient and sustainable self-help organizations and training centers.

## 2. FACTORS CONTRIBUTING TO THE EXISTENCE OF SMALL SCALE AND ARTISANAL MINING.

10. Past economic policies and geological environment are the influencing factors for the existence of the sub-sector in the country. Much of the sub-sector existence and growth in Tanzania is attributed to: -

- The favourable geological environment in the country with numerous sites of high grade mineralization easily workable by the sub - sector operators.
- The everlasting hunger of mankind to search for wealth even when they have no adequate technology and financial resources. This factor is applicable to other productive sectors also like agriculture and industry where we have peasants and SIDO - industries respectively. It is not restricted to Tanzania alone, but is a world wide phenomenon.
- The closure of the privately owned mines in Tanzania in the early seventies forcing lots of semi-skilled people to resort to small scale and artisanal mining.
- The government in the mid seventies and early eighties required sophisticated technical and financial submission before granting mineral rights to applicants. This increased the informal operations.
- The discovery of new gold deposits in Lake Victoria areas in the mid seventies attracted more indigenous people into mining, while the government lacked resources to cope with this sudden increase of mining sites.
- The economic policy reforms of 1980's and early 1990's particularly those of mineral trade liberalization.

### Characteristics of Small Scale and Artisanal Mining in Tanzania.

11. Several attempts have been made to define and characterize artisanal and small scale mining but until now there have been no universally accepted definitions. In his earlier report Mr. Frank Skelding, (United Nations, 1972. p.25) who compiled and analysed as much information on technology, distribution, sales and institutional factors, defined a small mine as any single mining operation having an annual production of 50,000 metric tonnes of ore or less, as measured at the entrance of the mine.

12. In Mexico a small mine is defined in terms of gross income, whereas in Peru a small mining company is defined in terms of area and production based on reserves. In India small scale mining is distinguished from large scale by the absence of deep blasting and heavy earth - moving equipment and limitation of employment in opencast workings and underground operations.

13. Small Scale mines may also be defined on the basis of the individual commodity. This approach is used for coal, alluvial diamonds and uranium. In Tanzania, part IV of the 1979 Mining Act describes small scale mining as mining and prospecting operations that do not involve substantial expenditure or the use of specialist technology.

14. Artisanal and small scale mining in Tanzania can be characterized as those mining operations which are labour intensive where operators with informal technical knowledge of mining and mineral processing and little capital, embark into mining with simple tools like picks, shovels and pans. Consequent to this, their operations are coupled with:

- (i) a lot of wastage of minerals due to poor ore and mineral recovery during mining and mineral processing, respectively.
- (ii) the wide scattering of mine waste products.
- (iii) the poor handling of mineral processing chemicals, e.g. mercury.

15. However, organized small scale mining is carried out on: -

- A formal basis where operators abide to the laid - down mining and mineral marketing procedures.

- They keep mining records which they furnish to the relevant authorities.
- In their operations there is limited use of appropriate technology approved by the mine inspectors.

Contrary to that the artisanal miners basically operate: -

- On an informal basis without adhering to the laid-down laws, regulations and technology.
- They shift from one site to another, working in both registered and unregistered lands.
- There is no work preparation and organization before production in artisanal mining, and hence the prospecting stage is totally omitted and there is no reserve estimation.
- All mining is undertaken as a mine development operation. (i.e. no stoping).
- Mainly in gold and gemstone, particularly in areas with high grade reserves, shallow levels ( near surfaces ) vein - type of alluvial mineralization, i.e. in easily extracted richer parts of the mineral reserves.

16. Small scale mining operators in Tanzania are mainly engaged in mining gold, gemstones, of them also work on salts, industrial minerals and building but numbers materials, e.g. sand, aggregates, dimension stones etc.

### 3. JUSTIFICATION: (RATIONALE)

17. The government effort from the mid 1980's to restructure its mineral policy has not been very successful because it was addressed in a piecemeal manner. Efforts to solve one problem have always ended up creating other problems which hinder the development of the sub-sector. A good example is the implementation of the government efforts in 1990 to create a reliable gold market for small scale miners by instructing the Bank of Tanzania (BoT) to buy gold the from general public. The move produced short lived economic benefits when gold exports increased rapidly between 1990 and 1992, but on the other hand it created an administration

problem for the Mineral Resources Department Department number of illegal miners increased, forcing the BoT to almost suspend its buying operations. As a result gold smuggling is on the increase more than before.

18. The SSMO of the MRD has realized a need to conduct a baseline survey and to outline development strategies for small scale and artisanal mining, as the principle initial step for the successful implementation of a development programme for the sub-sector.

19. It is due to this realization that the SSMO of the MRD, through the World Bank project on "Mineral Sector Development", has commissioned this consultancy work on "baseline survey and development strategy" from the Tan Discovery Mineral Consultancy Co. Ltd.

#### 4. SCOPE OF THE STUDY

20. The purpose of this baseline survey is to provide reliable quantitative information on the current position and performance of the artisanal and small scale mining activities in Tanzania. The survey therefore encompasses the relevant economic, social, organizational, technical, marketing, environmental, health and safety issues, as well as the institutional aspects, as outlined in the summary of the Terms of Reference (paragraph 22 below). The baseline survey will be followed by the detailed design of promotional initiatives and support programs in the form of a sub-sector development plan, based on the results of the survey.

21. The specific aspects covered by the study are:

- (i) **Census:** The task involved estimation of the number of people involved in the informal, formal artisanal and small scale mining by location/district/zones and mineral commodity groups. The information gathered included the number of men and women involved in the sub-sector. The activity did not include jewellers in urban areas and the counting did not commence on a single day for all locations.

- (ii) **Organisational structure:** This part of the study aimed at estimating types of existing operational organisations and also collected information on members/ workers. Information on functions and activeness of regional and national associations was also gathered.
- (iii) **Mining and Processing:** Tasks involved included determination of labour productivity, establishing grades of ore processed, and examined the mineral recovery and quantified waste materials per unit of production. Information on the education background of workers was collected. (Identification of appropriate technologies and technical data for machinery specifications were out of the scope).
- (iv) **Product Marketing:** The marketing section established five years time series of sales of gold, diamonds and coloured gemstones and related them to the world market gold price to test price elasticity. It further estimated current shares and participants in parallel markets.
- (v) **Environmental Impact:** This section assessed environmental impacts caused by mining activities, including affected area, pollution levels in waters, air and land. Furthermore preliminary quantification of costs associated with damage repair and land rehabilitation was carried out. The study was limited to mining areas.
- (vi) **Health and Safety:** Time series of the past three years accidents were reviewed for reported and unreported cases. Initial investigation on mercury levels of operators was conducted. Drinking water supply, sanitation facilities and the numbers of AIDS cases were also assessed. Effects in non-mining areas were not covered.
- (vii) **Institutional Aspects:** A five-year time series of mining claims was assessed and the estimated time required for claim registration derived. This section determined pending mining title applications, number and validity of mining title, inspection frequency and estimated formal and informal mine production.
- (viii) **Development Strategy:** Based on analyses of data and information gathered in the survey, options to improve social, technical, economic and environmental performance were formulated. Further specific options for each commodity group and action plan were prepared.

## 5. STUDY AND INVESTIGATION APPROACH

22. The baseline survey took 5 months and covered almost all sites within the country where there are artisanal and small scale mining activities (Appendix 7). The survey was conducted in 17 regions in 8 mine zones covering 37 administrative districts. A total of 108 mine site localities were visited out of which 39 localities were for gold mining and 33 localities for gemstone mining. The rest of the localities can be sub divided into 1 gypsum mining site, 2 dimension stone quarries, 1 coal mine, 4 limeworks, 2 diamond mining sites, 17 saltworks, 6 sand mining sites and 3 aggregate stone quarries. These numbers exclude several other stop-overs along the road and towns to study informal sand and aggregate mining works. The mining operators in these sites encompassed people of diverse cultural and educational backgrounds.

23. The following methodology was adopted to achieve the objectives to the study and the specific tasks of the consultancy team. Preparations were made by designing and producing questionnaires and census sheets; the subject was introduced to zonal mines' officers, regional and national miners association leaders, and the identification of groups/persons to be interviewed and the selection of sites was made with their assistance.

24. Information and data were gathered through literature reviews, interviews with policy makers, implementing agencies and individual miners and traders, by on the spot field determinations, laboratory investigations and opinion gathering meetings. In an effort to improve the reliability of information gathered questions were repeated in a different manner to check the reliability of the replies.

25. Appendix 7 shows the mine sites visited and samples collected, including water, tailings, soil, rocks and air. The laboratory analyses looked for bacteria, and parasitic organisms in drinking water supplies and water pollutants such as sediment level, heavy metals (using atomic absorption spectrophotometer techniques) and nutrients. Soils were examined for fertility to assess the effect of mining activity. Rocks were crushed and pulverized to analyse for gold using fire assay and atomic absorption spectrophotometers. Air samples were collected in field and analysed for carbon monoxide, sulphur oxide and nitrogen oxides. The results were organised and analysed using a computer, to assess environmental impacts caused by artisanal and small scale miners.

## 6. PRESENTATION OF THE RESULTS:

26. The results of this Baseline Survey are presented in accordance to the Terms of References (TOR) stipulated in Appendix 6. The Sub-Sector Census given in Appendix IA

27. The Consultancy team found it better to present matters on institutional aspects together with those on organizational structures {components (g) and (b) of TOR} in one chapter of institutional and organizational aspects (Chapter B). This is because the survey results show that it is the government institutions (particularly the MRD) which play the major role in planning, organizing and administering most of the aspects of the sub-sector.

28. During the survey, it was realized that the financial aspects of the sub-sector (through were not asked for in the TOR) have great influence on the sub-sector operations. The financial aspects of the sub-sector are therefore also dealt with in this report and they are presented together with the mineral marketing aspects {Component (d) of TOR} in chapter D on commercial aspects.

29. A strong interrelationship between Environmental, Health and Safety Aspects {Components (e) and (f) of TOR} was realized during the survey, hence all these aspects are presented together in chapter F on Environmental Health and Safety Aspects. Much of the information requested for in component (A) - Sub - Sector Census of TOR are better presented in table form. Therefore much of these information is presented here as Appendices in Table - form. This tables also contain additional specific comments and information on the sub-sector census.

30. However, inclusion of a chapter E on socio - economic aspects in this report (though not requested for in theTOR) was made to provide a complementary description of the sub-sector census data in the appendices and also to provide vital descriptive information on the importance of the sub-sector to the society and the role of women and children in the sub-sector.

31. Some information on the sub-sector at locality level which was asked for in the TOR is are not presented here because there are no proper and reliable records on them in the MRD zonal offices, REMA offices and other institutions which are linked with the sub-sector operations.

32. For example there are no proper and reliable records on the number of claim holders and their categories (i.e. those owned by individuals, partnerships, co-operations et.c.) at locality levels. Records on production quantities and values by commodity groups at location levels are also not available. It was also not easy to estimate the ratio of mineral sales through formal procedures and those through parallel market because it is not possible to access information of the latter. It was also not possible to obtain reliable figures for numbers of formal and informal mineral operators because most of the registered claim holders do their operations informally. Questionnaires seeking such information were distributed by the consultant to the zonal mine's offices and REMA officials but this information was not delivered even after persistent enquiries and reminders. A detailed study is required if this information is to be obtained..

- Mining and Processing component in the TOR is presented in Chapter C: whereas component H in the TOR is presented in Part II of this report as Development Strategies which aim at transform Artisanal Mining into sustainable Small Scale Mining.

33. The development of the development strategy was achieved after a thorough analysis of the baseline survey results and after incorporating various recommendations and suggestions put forward by government officials and key players in several mining related NGO's, during workshops, consultations and interviews. Details of the strategies to be used to mobilize and sensitize artisanal and small scale miners, the type of technological requirements and implementation programs for improving artisanal and small scale mining are given in part II of this report.

## **B. INSTITUTIONAL AND ORGANIZATIONAL ASPECTS.**

34. The life and activities of artisanal miners are strongly influenced by the kind of services rendered by the existing organization entities. Organization services are offered by government institutions, mining associations and various production units in the mining area.

### **I. INSTITUTIONAL ASPECTS**

35. The government institutions have the duty to create the legal, regulatory, fiscal and institutional conditions for the orderly conduct of artisanal and small scale mining activities in the country. The government institutions involved with the sub-sector are: -

- MEM - Ministry of Energy and Minerals
- Planning Commission, under the President's Office<sup>5</sup>-Ministry of Finance.
- Regional and District Administration
- BoT - Bank of Tanzania.

#### **1.1. The Ministry of Energy and Minerals (MEM)**

36. The Mineral Resources Department (MRD) administers the mineral sector on behalf of the MEM. The Commissioner for Mineral Resources administers and monitors the activities of the department and he is the government chief advisor on all mineral matters.

(a) The MRD has four divisions:

- Geology
- Mines
- Research and laboratory services
- Mineral trading

37. The mines division has the closest responsibility to the development of small scale mining. The main responsibilities of the mines division are:

- Granting of prospecting rights and mining claims.
- Administering mining laws and regulations.
- Offering technical assistance in geology, mining and processing.
- Monitoring mining production and keeping mining statistics.
- Overseeing mine safety issues and punishing defaulters where necessary.

38. The division relies on zonal and district offices to implement its responsibilities. Coordinating sections at the Divisions headquarters in Dodoma "Madini" include:

- Mines registrar - Registers claim titles and transfers and reports all disputes on claim titles to the Commissioner;
- Mines Record office - Maintains statistics of mining activities;
- Inspector of mines - Inspects mine operations, mine accidents, explosives magazines, administers mining laws and regulations and conducts prosecutions when necessary.
- Zonal mines controller - Coordinates zonal mines administrative office activities with the division's head office.

(b) **Activities of Mines Division:** As mentioned earlier, the mining activities have increased considerably in the past seven years. The number of artisanal miners has increased from 150,000 in 1987 to 550,000 in 1996. Registered Mineral claims have increased from 425 in 1991 to 4123 in 1995 and the number of mineral prospecting licences is now above 330. Operations in these mineral properties are monitored and administered by MRD and the field inspections are done mainly by Zonal/District mines offices.

39. Mining areas and locations are scattered in 19 regions of the country and new major mine rush areas, which involve rapid population changes in remote regions, occur almost every two years. The distances covered by Zonal mines officers to reach mining areas vary. For example, active mining areas at Mpanda are within

a radius of less than 40km from the mines office which has 6 technical staff, while the Songea mines office services are too far from the mine rush areas of Dar - Lunyere in Mbinga district which is located 140 km south of Songea and Ngapa in Tunduru district which is 330 km north - east of Songea. These two areas have more than 200,000 artisanal miners, but the Songea mines office has no vehicle and is staffed by only 3 people. This shows that there is need to open more mines offices closer to active mining areas.

40. Claim registration formalities can take 2 to 18 months depending on a number of factors, but important ones are the applicant's ability to finance costs for field inspection work and constant follow-ups on the application.

41. The process of registration of claims passes through three stages. First there is the submission of a claim registration application to the mines office after endorsement by the authorizing officer of the district where the claim is pegged. There are unnecessary delays caused by some District Commissioners which are not part of claim registration procedures and mining regulations. The second stage involves the District/Zonal mines office upon receiving the application, setting a date and conducting claim registration inspection, writing the inspection report and sending the report to the Dodoma Madini office. Applicants in active mining areas have the chance to have their claims inspected faster than those working in isolated areas where, in most cases, it is the duty of the applicants to provide transport to mine inspectors. The disadvantaged applicants may have to wait for months until the mine office receives funds to enable its staff to inspect the claims. The last stage involves the period taken from the time the inspection report is sent to Dodoma to the time when approval is given by the Assistant Commissioner for Mines, who is the only authorized person to sign claim titles on behalf of the Commissioner for Mineral Resources. The mines registrar's office has cited poor communication with Zonal offices in clearing discrepancies in some claim inspection reports, and the frequent absence of the Assistant Commissioner from Dodoma as major factors causing delays in approving new claim applications. It was also noted that during the year 1994 the registration office conducted a special operation to clear all backlogs of pending mining title applications.

42. It was observed that claim registration applicants are not normally in a position to know whether or not the applied area is free or is already licensed out to an exploration company. Most Zonal Offices visited do not have up to date records on new Prospecting Licences granted within their Zone areas. This has led to complaints from applicants who continue to spend money and time developing their claims and are later told that their applications were rejected because the land

is within an existing Licence Area of a prospecting company. The Chunya District Mines Office had 12 claim registration applications rejected in this way with some applicants operating their claims for more than nine months after submitting claim registration forms.

43. The records kept by the Zonal/ District mine offices in most cases differ from those of the mine registrars' Office in Dodoma ( Appendix 2 B) illustrates some of these differences. The responsible staff blame poor communication and the use of old recording systems as major causes of these differences.

44. Extension services mainly on prospecting and mining techniques are not carried out due to the shortage of funds, lack of proper programmes to conduct the services and a shortage of qualified staff. Prospector courses were stopped more than ten years ago, and experienced miners deprecate the present procedure of issuing prospecting rights without requiring attendance at prospectors courses, which in the past instructed prospectors not only in basic mining techniques but also in the mining regulations.

45. The problem of a professional imbalance was noted in the Zonal/District mines offices. Only some mines offices have geologists and/or mining engineers; others have none at all. (See Appendix 2 E). It was also noted that most of the mining engineers attain their positions as inspectors of mines straight from college, without working under experienced engineers on any working mine. Mining technicians who visit mining areas on claim inspection do not have sufficient knowledge and skill to advise miners on proper prospecting and mine safety issues. Most technicians have never had the opportunity to attend courses or seminars on mining related issues.

46. Common problems identified in most Zonal and district mine offices visited which are linked with the present performance of the mines division are:

- Insufficient budgets to run the offices, maintain vehicles and cover travelling expenses. For example, in 1995 Shinyanga and Mwanza zonal mine offices received only TShs 50,000 for a period of four months. Despite the increase of work to inspect a greatly increased number of claims between 1990 and 1995, the budget remained almost the same.
- Most offices do not have vehicles and those few available are beyond economical usage.

- Most of the zonal offices are accommodated in the backyards of other government departments. The office space in most cases is not adequate and there is a shortage of office equipment and materials.
- There are communication problems between zonal offices and "Madini" Dodoma. The telephone links sometime do not exist and other have been disconnected due to non-payment of outstanding bills.

### 1.2. The Planning Commission - President's Office .

47. The Commission is responsible for national economic planning and management. Among its main activities is the preparation of planning guidelines for the national budget after consultation with respective government departments and institutions. Also the commission has a duty to administer the economy, which involves monitoring the utilization of the government's development budget.

4.8. The Commission through its Industry and Minerals Directorate support programmes to strengthen the Mineral Resource Department in the provision of transport facilities. However to most observers there is a general feeling that the Commission is not doing enough to support the development of the mineral sector, especially in realising and utilizing effectively the rich mineral resource base of the country. The Mineral Resource Department requires adequate facilities such as transport and equipment to enable it to administer properly mining activities. Facilities are also needed to improve the extension services to small scale miners.

### 1.3. The Ministry of Finance.

49. The Ministry of Finance, amongst other things is responsible for revenue collection and overseeing the budget allocations of the government departments. The Income Tax, Revenue and Customs Departments are responsible for collecting various taxes on behalf of the Ministry of Finance.

50. Revenues are also collected by other Ministries for the services rendered by institutions and departments to the public. The Ministry of Energy and Minerals collects royalties, fees and various annual rents levied to mineral property operators and traders. Such fiscal rates and procedures commonly influence mineral

production and export trends. Lack of coordination between government departments in collecting revenue from mineral operators has sometimes brought negative impacts in mineral production and an increase in informal practices both in the mining and smuggling of minerals. Efforts to transform the informal mining depends also on having simple tax clearance formalities, single point collection of government revenue and close co-operation between the Income Tax, Internal Revenue, Customs and Mineral Resources Departments.

#### **1.4. Bank of Tanzania - BoT**

51. The Bank of Tanzania started buying gold directly from miners and dealers in 1990 by establishing gold buying centres in Dar es Salaam, Mwanza, Arusha, Mbeya, and also established buying agents at various National Bank of Commerce (NBC) throughout the whole country. Later on, the Co-operative and Rural Development Bank (CRDB) joined the buying agencies.

52. In order to compete with the parallel market, the bank offered competitive prices and on the spot payments which caused many miners and brokers to sell their gold through the bank. The legal gold dealers, who were not interested in forex earnings, decreased from 14 in 1989 to only 6 in 1992. Due to inadequate preparation and lack of economic appraisal, the banks incurred heavy losses, which lead to the closure of some of the buying centres. There is a need to liberalize the gold trade, especially in export procedures, in order to allow the present foreign buyers of raw gold, for jewellery purposes to utilize formal market channels. The BoT should review export earnings remittance procedures to prevent under-invoicing and to enable exporters to utilize their forex earnings at the most convenient exchange rates.

#### **1.5. Regional and District Administrations: -**

53. The regional and district administrators traditionally are not directly involved in the day to day supervision of mining activities but they have responsibilities for certain issues: the maintenance of law and order in mining camps; the provision of essential social services especially during epidemic outbreaks, and to settle land disputes between local communities and mining groups/companies or individual claim holders.

54. Recent developments show that Regional and District authorities are also involved in allocating mining claims/blocks especially where there is a conflict of land between mining companies and artisanal miners. The cases of Block, B at Merelani tanzanite mines and the reallocation of mining claims in Mtwara, Lindi and Ruvuma regions are typical examples. The Regional authorities also screen and recommend applicants for mineral dealers licences.

55. District authorities, especially council members, have an additional burden to shoulder by providing essential services to the mine rush communities, but they do not get sufficient returns in the form of revenue collections from mining operations. The Ministry of Energy and Minerals is now proposing an allocation of 20% of the mine revenues to go back to the mining districts. Representation of the mining communities in the decision-making organs of the districts is indirect in most cases. Only at Mpanda it was observed that the miners have their own councilor in the district council.

56. There is lack of coordination between government departments when attending issues related with the mining sector. On several occasions police, immigration, natural resources, health and mines department officials have visited mining areas and given instructions which conflict with the standing regulations of other government departments. Some senior mine association leaders are requesting the government to reinstate the old mine boards at district, regional and national levels. The boards could help not only to improve coordination of the government departments, but also dialogue with representatives of the mining communities.

## **2. ORGANIZATIONAL ASPECTS**

### **2.1 Mining Associations**

57. The development of mining activities in the past ten years and the change in government policy from implementor to that of promoter and facilitator, has resulted in the formation of mining industry related associations like Regional Miners Associations (REMA's), Tanzania Mineral Dealers Association (TAMIDA), and the Tanzania Chamber of Mines.

58. In 1983 the government issued the first mineral policy draft which among other things encouraged participation of Tanzanians in mining activities. In 1984 the then Ministry of Water, Energy and Minerals spearheaded the formation of Regional Miners Associations in a number of regions.

59. The increase in artisanal mining activities and the introduction of a trade liberalisation policy in 1987 resulted in the participation of private mineral dealers who later in 1989 formed the Tanzania Mineral Dealers Association (TAMIDA). The number of mineral exploration licences issued to private operators rose steadily from 10 licences in 1990 to 366 active prospecting licences in 1995. The Chamber of Mines was formed in 1994 to meet the needs of the growing mining industry of Tanzania.

**(a) Regional Miners Associations (REMA's)**

60. There are 17 registered REMAs operating in the following regions; Mwanza, Shinyanga, Tabora, Musoma, Arusha, Tanga, Coast, Singida, Dar es Salaam, Morogoro, Mbeya, Rukwa, Mtwara, Lindi, Ruvuma, Dodoma and Kilimanjaro. REMA membership is limited to miners only, and at the moment there are 20,345 members nation wide.

61. At national level the interests of REMAs are represented by the Federation of Miners Associations of Tanzania (FEMATA). Leaders of this body are drawn from representatives of REMAs. There is new leadership which was elected in November, 1995 and there are fresh initiatives to activate the functions of REMAs. So far no concrete program of action has been taken, except consultations with the Ministry of Energy and Minerals, while consultations with donor organizations are also underway.

**Main Objectives.**

62. All REMAs have had similar constitutions with very few amendments in the past ten years. Likewise the organization structures are similar, with the main objectives being summarized as follows:

- (a) To unite all miners within a region.
- (b) To act as a foremost advisor on mining and mineral matters within the region.
- (c) To serve as a platform through which miners can air their opinions and discuss matters of common interest.
- (d) To look for steady mineral markets for their members.
- (e) To safeguard miners' interests through dialogue with the government.
- (f) To improve the skills and working conditions of miners through education.

63. The performance of REMAs varies considerably from one region to another. Few REMAs have opened branches in selected mining areas, but most of them have centralized their operations in regional centres, or only in very active mining areas such as Nyarugusu in Geita district, Mpanda district and Makongolosi in Chunya district. A better organization setup was observed in Tanga, where the Regional Miners Association - TAREMA-has active branches at Kalalani, Uмба, Kiomoni and Handeni town. In addition every major mineral commodity group such as salt or building mineral has its own standing committee. It was also observed that the mines office in Tanga enjoys good working co-operation with TAREMA. The Rukwa Regional Miners Association (RUREMA) in Mpanda, has a permanent office, and its leaders have good contacts with district authorities. The association has managed to organize, in collaboration with the mines office in Mpanda, several extension services to its members. The association has contacted several foreign missions in Dar es Salaam with the aim of requesting for technical assistance.

64. MOREMA, MWAREMA, and AREMA have worked hard to secure reserved lands for artisanal miners, and they even formed business companies which for some resources were not very successful. Other REMAs have worked with the District authorities to motivate miners to participate in rural development activities, mainly through financial contributions.

65. In spite of these few short-lived achievements, most of the REMAs have failed to fulfill their objectives due to a number of problems such as: -

- (a) Lack of committed leaders to serve the associations.
- (b) Weakness in leadership and organisation skills due to the poor education of most leaders.
- (c) Lack of development plans and specific aims in areas of concern.
- (d) Lack of alternative sources of funds to finance association activities.
- (e) Lack of transport and communication facilities to reach members.
- (f) A lack of established offices has forced most of them to rely on individual member premises.

Subscription and annual fees from members form the sole base of most of the REMAs financial resources. (See Appendix 1 E).

66. Despite these problems, the Regional Miners Associations are the only organs directly representing the interests of artisanal and small scale miners. Regional mine leaders thus have high hopes in the new leadership of FEMATA, which has the task of representing the issues of small scale miners at national level.

**(b) TAMIDA.**

67. The Tanzania Mineral Dealers Association (TAMIDA) has the role of bringing together all those involved in mineral trade activities. This also involves miners who export their mineral products themselves. At the moment TAMIDA has 64 members, mainly gemstone dealers, most of who operate from Dar es Salaam and Arusha.

**Specific objectives of TAMIDA include:**

- (a) To protect the interests of legal mineral dealers.
- (b) To advise the government on issues related to the mineral trade.
- (c) To form a platform for mineral dealers, both local and foreign, for smooth transactions.
- (d) In collaboration with the Ministry of Energy and Minerals, to organise frequent mineral auctions and fairs.
- (e) To cooperate with FEMATA and REMA's in developing the sector and to create a conducive business atmosphere between local miners and foreign dealers.
- (f) To render advice and other technical services to individual dealers according to existing laws and regulations.

68. Despite its poor technical and financial base, TAMIDA has scored a number of positive achievements in the past few years, including the organisation of six International Gem Auction/Shows in Arusha. The Gem shows help to create business confidence between TAMIDA members and foreign gem dealers. This relation has reduced the tendency for Tanzanian minerals to be exported through neighbouring countries. Through the shows most local dealers have been motivated to start cutting gemstones to maximize earnings.

67. TAMIDA has been offering sponsorship to government officials and to its members to attend various international gem shows and gatherings as a way of gaining experience from others. Every year TAMIDA issues a gem traders' directory which assists business contacts between members and foreign buyers.

#### **TAMIDA's Shortfalls and Constraints:**

- (1) Some mineral dealers are accused of being involved in mineral smuggling activities.
- (2) Lack of gemological, valuation and gem identification services to miners and dealers.
- (3) Failure to secure information and guidance on equipment and essential skill requirements for members venturing into value-added activities.
- (4) Failure to monitor international market trends closely.
- (5) Failure to attend and boost local mineral markets. Miners frequently complain that dealers do not purchase low-grade material.
- (6) Failure to diversify its activities beyond the gold and gemstone trade.
- (7) Lack of sources of financing and credit facilities as TAMIDA operates from members contributions only, hence major development projects cannot be implemented.

70. Despite these short comings, TAMIDA might be one of the few NGOs in Tanzania that has fully supported itself in its operations without any donor assistance since it was formed.

#### **(c) Chamber of Mines**

71. The mining investment promotion efforts have resulted in an increase in the number of companies and individuals investing in the mineral sector in Tanzania. This development has led to calls for a sectorial umbrella to protect the interests of investors. The Chamber of Mines was thus formed in 1994 in response to the above needs, and now has 48 members. Membership is open to individuals and entities involved in formal mining, mineral trade and those giving essential services to the sector.

72. The main objectives of the Chamber are: -

- Liaising with Government on matters of interest for the development of the mining industry in the country, for example mining legislation, taxation, labour and wage matters.
- Encouraging the settling of disputes in the mining industry through reconciliation.
- Promoting safety and environmental protection practices in the mining industry.
- Presenting a vehicle through which assistance to the mining industry from donors or government could be channelled.

73. The Chamber has started functioning by appointing an experienced executive secretary and other supporting staff. Contacts with other Chambers of Mines are maintained and there have been several consultations with senior government officials on matters of interest to the Chamber. The Chamber was consulted and sometimes participated in formulating development programmes such as the Export Development Strategy and Action Plan, the formation of the Tanzania Business Council etc. The Chamber has started to issue a newsletter which carries articles of interest to the members.

74. The Chamber is seeking financial and technical assistance to establish itself and improve its services which are becoming vital for the fast growing mining industry, and also to portray a good image of the industry in order to attract serious local and foreign mining investors.

#### **(d) The Business Centre**

75. The Tanzania Business Centre (TBC) is a development project financed by the United States Agency for International Development (USAID) to facilitate the emergence, growth and sustainability of responsible, well managed, private businesses in Tanzania. The project started operations in July, 1994 and is currently planned to be supported by USAID until December, 1998. The project has its main office in Dar es Salaam and a branch in Mwanza to serve the Lake Victoria zone. The host ministry for the project is the Ministry of Finance.

76. The services of TBC are provided to the private sector business community and are targeted at both individual businesses and at business service providers (especially business consultants and business associations). The type of services offered are: basic business services, business development planning, business policy and service environment. The services are provided at a fee to individual businesses and at cost sharing to organizations.

77. TBC has shown interest in assisting with institutional capacity building for FEMATA and with marketing development for FEMATA member products, e.g. gold and gemstones. TBC has no in-house staff with experience in the mineral industry but is willing to cover the cost of engaging experts, especially in organizing gem auctions. TBC needs to work closely with the Ministry of Energy and Minerals and other mining associations in order to achieve its aims and avoid duplication of effort. Records show that all successful gem shows/auctions around the world are organized by mineral traders in collaboration with flexible governments and not by gem - experts from gemological associations or institutes.

#### (e) Poverty Africa

78. Poverty Africa (Tanzania Branch) was established in April 1992 as a non-governmental and no-profit making organisation. Its head office is in Dar es Salaam. The organisation has a patron, a National Assembly, a National Executive Committee, a National Committee, a National Programmes Coordination Committee, Advisory Meetings and a Secretariat.

79. Poverty Africa operates in national, regional, at district centres and at other local levels depending on identified programmes. Programmes are initiated, launched and monitored by the National Programmes Coordination Committee, which is made up of National Directors, Regional Executive Secretaries and the Secretariat.

80. The primary objective of Poverty Africa is to help alleviate, on a sustainable basis, poverty in Tanzania by promoting a global partnership for the implementation of local community - based programmes and projects capable of improving the living conditions of the poor in Tanzania.

81. The priority activities of the organisation are in the following areas; food, water, shelter, sanitation, energy, primary health care, child care, literacy, village community services, youth and women income generating activities, environment and other poverty alleviating activities.

82. Recently Poverty Africa initiated two programmes aimed at improving operations and management of the gemstone small scale mining in Ruvuma, Mtwara, Lindi and Tanga regions. The programmes general objective is promoting employment and income generation in the sector. The programmes are expected to be implemented in co-operation with the respective District Councils in the mining areas, by offering technical and managerial training. Poverty Africa is now seeking donors and District Council contributions in order to implement the project. Human resource assessment has revealed that Poverty Africa will have to rely on external technical mining experts to implement the project but it has invaluable experience in organizing grass roots' informal groups especially in the urban areas.

**(f) Pride - Tanzania**

83. Promotion of Rural Initiative and Development Enterprises (Pride - Tanzania) was established in September, 1993 in collaboration with Pride - Africa with the objective of promoting small - scale business in the informal sector. The project is funded by the Norwegian Development Agency - NORAD. Pride - Tanzania is an NGO which operates as a business entity and it offers soft loans to the informal sector under the principles of Grameen Bank of Bangladesh.

84. Pride - Tanzania has its base in Arusha where in 1994 it started with initial 450 members who inspired the NGO to open more branches in Tanga, Dar es Salaam and Moshi. To date, all branches have a total of 4,700 clients, 65 percent being women. The client total savings have reached TShs. 133.3 million, against 6,633 loans offered by the NGO, all worth TShs. 516.7 million. Present records show the loan repayment is more than 98%.

85. Pride - Africa is working out localities of setting up a bank for Pride clients, that will assist in promoting small - scale enterprises through provision of non - collateral credit facilities to individual entrepreneurs in East Africa. Pride - Tanzania has shown interest in small scale mining by starting to offer credit to Merelani Tanzanite mineral brokers.

## 2.2 Production Organization Structures.

86. There exist various forms of production organization structures in the artisanal and small scale mining operations. The type adopted depends on: legality of the mining operations of the area; existing credit mechanisms and the quality of applied technologies; the presence of mine rush areas; and the ability and efficiency of government institutions to service the sub-sector.

87. Prospecting rights (PR) are issued under the following categories: individual; partnership; co-operative or company. Claim titles are also registered on the basis of the above category, but the monthly claim return forms are designed with the assumption that artisanal mining operations are conducted under a formal enterprise system. The present study shows a very contradictory picture in that less than 1% of the mining groups visited operate under a formal enterprise system and only about 2% practice a loose form of co-operative. Co-operative activities occur mainly in low value minerals. The informal tributing system or production sharing system is the valve nmost widely used system, both in mine rush areas and in most registered claims in Tanzania.

88. The study shows that the present mining groups can also be classified on the basis of skills and legality of mine operation as: mine rush gangs; special service gangs/operators; formal/informal mine claim organizations and village/association organizational structures. It must also be noted that these types of operational organizations usually depend on each other, so that it is common to see specialized gangs and mine gangs operating in informal mine claim organizations.

Any effort to transform the artisanal miners must take into account the existence of these organization structures.

### (a) Mine Rush Gang:

89. This type of working group is very common in all mine rush areas both in gold, gemstone, and also in alluvial mining works. In recent years, similar groups have sprung up in sands, limestone, and land mining in the Kilimanjaro, Tanga and Dar es Salaam regions.

90. A mine group is usually formed by members who simply recognize the need to team up together in order to perform better the different basic mining operations such as digging, haulage and ore processing. In remote mining areas the group members normally work, eat and sleep in the same or close-by huts. The size of the group depends on the type of mining work and the distance to transport the ore for processing. The present survey shows that most groups are formed by 2 to 8 members. In a very few alluvial mines such as Tundururu, groups can have 4 to 20 members to help dewatering river channels especially when water pumps are not available.

91. The mine rush gang operates independently under a group leader, chosen for his mining skills and wisdom to settle the disputes of gang members or amongst nearby gangs. The working capital of the group comes from individual members' contributions of basic working tools like sieves, picks, shovels and also food. Mineral buyers also offer financial support to mine rush gangs working on grounds with known mineral potential.

92. The gang changes working places and migrates from one location to another depending on the quality of recovered minerals and size of the deposit. The present study shows that mining methods of the mine rush gangs are most destructive to the environment. On invading a potential mining area these groups will start opening up pits on any available space, and the activities in most cases do not observe any mine safety and other regulations. Observations indicate that it is the type of the organization structure rather than knowledge of the operators which contributes to the above destruction. During the survey it was observed that experienced miners (claim holders) who have shifted in mine rush areas were forced to operate in chaotic manners simply because the most favoured production organization structure of the area did not allow proper mining practices.

**(b) Specialized Service Gangs/Operators:**

93. Some miners preferred to specialize in specific mining and processing operations and offer their services on commercial terms. These types of work organization exist in all types of artisanal and small scale mining activities. They operate both on an informal tributing system for non-mechanized operations and on formal enterprise systems with mechanized activities e.g., custom mills. Specialized services are available to operations like: de-watering of mine pits; drilling and blasting; timbering; shaft sinking; ore crushing and grinding; panning; amalgamation and fire assay works.

94. It was observed that the efficiency of these services varies from one group/area to another depending on the skills, experiences and type of technology employed.

95. The service gangs can be seen in non-mechanized works requiring skills e.g. shaft sinking, grinding etc. The group can be of 2 to 10 members, and share income and work strictly on contract basis. The contract terms of this group are flexible and in some areas this advantage is used to compete with mechanized service operators. A mechanized batch mill operator at Ibindi, Mpanda was forced to leave to another area after he increased mill charges to Tsh. 1,100.00 per pan (Karai of 20kg) and his competitors, service gangs, using wooden mortars and steel pestles decided to lower their charges from Tshs 1,000.00 to Tshs 700.00 per pan (Karai) (20 kg) of ore aggregates. It was also noted that service gangs which use poor technology normally work in prolonged exposure to harmful dust and toxic fumes. This can be observed in ore/tailing grinding huts in the Chunya, Mpanda, and Dodoma mining areas, where women and children are also involved.

96. When work is scarce, mine rush gangs send some of their members to offer temporary hired services such as ore haulage operations. The practice enables mine gangs to survive while working in low grade mine pits. It was also noted in various mining locations that committed specialized service gangs, some members prefer to get small but reliable fees fixed for their services, rather than working on their own. Most of these miners are those who have lost hope of becoming rich out of mining activities.

97. As stated above, most mechanized and specialized services are operated under a formal enterprise organization system. The machine owners hire skilled workers to run and maintain the equipment and most of the workers also get performance allowances, free food and medical expenses. In high rewarding mining operations machine owners will prefer to get shares of the production rather than receive service fees. This is the case in the Tunduru and Liwale gemstone mining areas where water pump owners work with artisanal miners within the river valleys. If a gold ore is very rich, the plant owners will support ore extraction and transport operations in order to get a sizeable production share. The stamp mill owners at Safari Mine - Chunya pay for dumper truck hire and extend credit to miners preparing their ore for milling. These offers are important to miners as they cannot access short term credit from financial institutions.

98. It was generally noted that activities of specialized service gangs/operators improve the efficiency of artisanal/small scale mining, e.g. the use of equipment increases the value and minimizes the ore waste and time. The equipment in use is better cared for and, with regular maintenance services, are better utilized, as many mining groups can use the same specialized service, e.g. mobile batch mills in Mpanda, Geita, Nzege and Singida mine districts.

99. Although there are several examples of individual initiatives by operators to improve their present technologies, the general observation is that technologies were adapted without consideration for their suitability and hence are often not economically viable. In many cases miners are purchasing water pumps which are either of very low capacity and or of types which are not meant for such duties.

100. It was observed that despite the improved output efficiency of the specialized services, there was a common short - coming of observing safety measures when these gangs accomplish contract assignments. Special gangs/operators performance and technologies can be improved, and later be models influencing artisanal miners to adapt new working habits. Most of these operators have skills to use and maintain machines, they can continue to operate custom mills as private operators, co-operation with claim holders or be employed by mining investors.

**(c) Mining Claim Organization Structure:**

101. Production organization structures in areas with registered claims can be formal or informal. The formal organization structure is one which abides to the regulations of Part IV of the Mining Act of 1979. Existing mine claim organization structures and the system to monitor mining activities usually do not fully reflect the type of entity holding/operating the claim. One would expect the claims owned by individuals to be operated differently from those owned by co-operative groups, but this is not the case. As stated above the monthly return form is designed to assist only formal enterprise operators to submit reports and is not suitable for co-operative or informal tributing operators. There is a need to consider the best way to record and monitor existing mining operations to make the official mineral statistics reflect a true picture of the industry.

102. A formal claim operator has the responsibility to make sure that all mining and processing activities are conducted in accordance proper practices which take into account care of the environment, safety and health issues. He is also supposed to build a camp, and provide other social amenities for his workers. It is his responsibility to supply all mining camp requirements. He keeps custody of the recovered minerals, markets them and pays a salary to his workers. The successes and risks of mining operations belong to him. However, adoption of this type of organization structure is limited in many areas by the presence of informal systems (e.g. the presence of mine rush areas).

103. The informal organization structure is adopted when the claim holder can no longer supervise or finance, due to lack of funds for mining operations and instead delegates the running and supervision of the mining activities to the pit financiers, also known as pit owners, for a fixed duration of time. The claim holder therefore becomes a landlord and the pit owner finance and supervises the mine operations, and they share the products with the claim holder on agreed terms. The pit owner and his mine workers, usually a group of 5 to 12 people, normally operate on short ( single cycle operation ) contracts, and they split their products using agreed ratios. The ratios range from 20% to 50% retained by the pit owner and 70% to 50% remain with the miners. The retention figures depend on factors such as the rate and quantity of recovered minerals, the number of mine workers, the nature of the mining operation, and the incentives given by the pit/claim owner. The claim owner retains a commission of US\$ 1.00 to 2.00 less the prevailing market price of gold. The claim holder can also adopt an informal production organization by negotiating a production sharing agreement with the mine workers without involving the pit owner/financier.

104. Mining activities under the village/association usually fall on registered claim areas but the production organization structure involves the village authority and the mining association leaders. Normally, the registered areas are divided into small plots and are given to individual operators who will mine and pay 10% to 20% of their recovery to the village/association. The village authority/association often lobbies to acquire rich concessions on behalf of the miners.

105. The mining associations are now less involved in organizing mining production as this, in the past, resulted into conflict of interest with its members. Examples of these are AREMA and MWAREMA operations in Merelani and Nyarugusu respectively AREMA was allocated block D at the Merelani tanzanite mines and was collecting 10% of minerals produced but it failed to submit the accounts to its members for a period of two and half years. Village governments on the other hand have often sublet the supervision of mining operations to special committees which operate on commercial basis. Uchira village in Kilimanjaro and Seza Kofi village in Tanga are good examples of this, type of organization.

## C. MINING AND PROCESSING

The main purpose of this section is to give a general description of mining and processing methods applied by artisanal and small scale miners in Tanzania, in order to evaluate the labour productivity, recovery and loss of valuable components during ore beneficiation, grades of concentrates and tailings as well as to establish mining education levels of the miners. The subject covers the geology of Tanzania and the related mineralization, exploration, mining, mine operation and ore beneficiation.

### GEOLOGY OF TANZANIA AND RELATED MINERALIZATION

106. Tanzania has been the subject of formal geologic mapping and exploration activities for almost a century now. Several major geologic environments have been identified. They include: an archean craton, orogenic mobile belts, platform sediments, coastal marine sedimentary deposits and various types of superficial accumulations. Several of these geologic environments contain diverse types of minerals like gold, base metals, salts, diamonds, gemstones and various industrial minerals. Alluvial deposits in Tanzania are formed by natural processes of weathering, transportation and deposition, with water as the main transportation medium. While the three processes take place, the minerals are sorted and concentrated into workable deposits either due to resistance to weathering, difference in specific gravity or both reasons. Such workable deposits include sand and gravels within sedimentary basins along the coastal plain of Tanzania, alluvial gold deposits in greenstone belts, and industrial minerals such as Pugu Kaolin deposits in Kisarawe district. Most of the alluvial deposits are located in recent or ancient river and lake beds, beaches and offshore zones.

A brief regional geology and description of the structural controls on mineralization are given in Appendix 3I.

### PROSPECTING OPERATIONS

107. Prospecting covers a mineral potential area that has been previously selected using geological considerations. The results from prospecting give an indication as to whether it is profitable to engage in the development of a discovery. At the present time, most of Tanzania's mineral output is from small scale mines, yet the activities of these small scale miners are self-limiting because most of the mining activities start without proper prospecting, and in many cases, such as gemstones operations, prospecting is non-existent. However, there are some miners who carry

out limited prospecting prior to discovery of workable mineral deposits. Two systems of mineral prospecting are practised in Tanzania. The first system is traditional mineral identification using either:-

- **Vegetation indicators**

This phenomenon, sometimes known as "botanic signals" has been used in Geita District, where certain tree species grow in soils or rocks with gold mineralization. Gold mining areas at Buziba and Nyakagwe in Geita District were discovered this way. Such geobotanical methods are very scientific, and have been used to locate the biggest copper deposits in Zambia and Zaire.

- **Herdsman, hunters and farmers**

Herdsman in major pasturage areas have played some role in the discovery of minerals especially in alluvial and gem oriented stones. Nyabigena gold mines Tarime District, Keki Pit at Uмба in Korogwe District, gemstone mines at Lukande, Mahenge in Ulanga District, Pit F at Uмба, Korogwe District, gold at Buckreef Gold Mine, in Geita District and Longido Ruby Mines in Monduli District are some examples of such findings. Gold has been found by farmers encountering small nuggets of what is probably reprecipitated gold in laterite, for example at Bulyankulu in Kahama District, and Serengeti. At Mwamanga village in Kwimba district diamonds were discovered while digging a pit latrine. Farmers at Kibangile (Matombo) in Morogoro Rural District discovered rubies in their rice fields.

108. The second system is the conventional prospecting method which includes:-

- **tracing float minerals, outcrops and pebbles**

In rough terrains, float gold or gemstones may be found a long distance from their source point. The gold reef discovery at Iluma in Manyoni district was by tracing a float that was observed at the river bank. In a few cases, minerals may outcrop and pebbles resulting from weathering may be found on the surface. For example, gemstones in many localities in Tanzania have been discovered this way by examining outcrops and breaking up pebbles to see if they contain any valuable ore or minerals. Such mines are found at Kigwasi in Korogwe district.

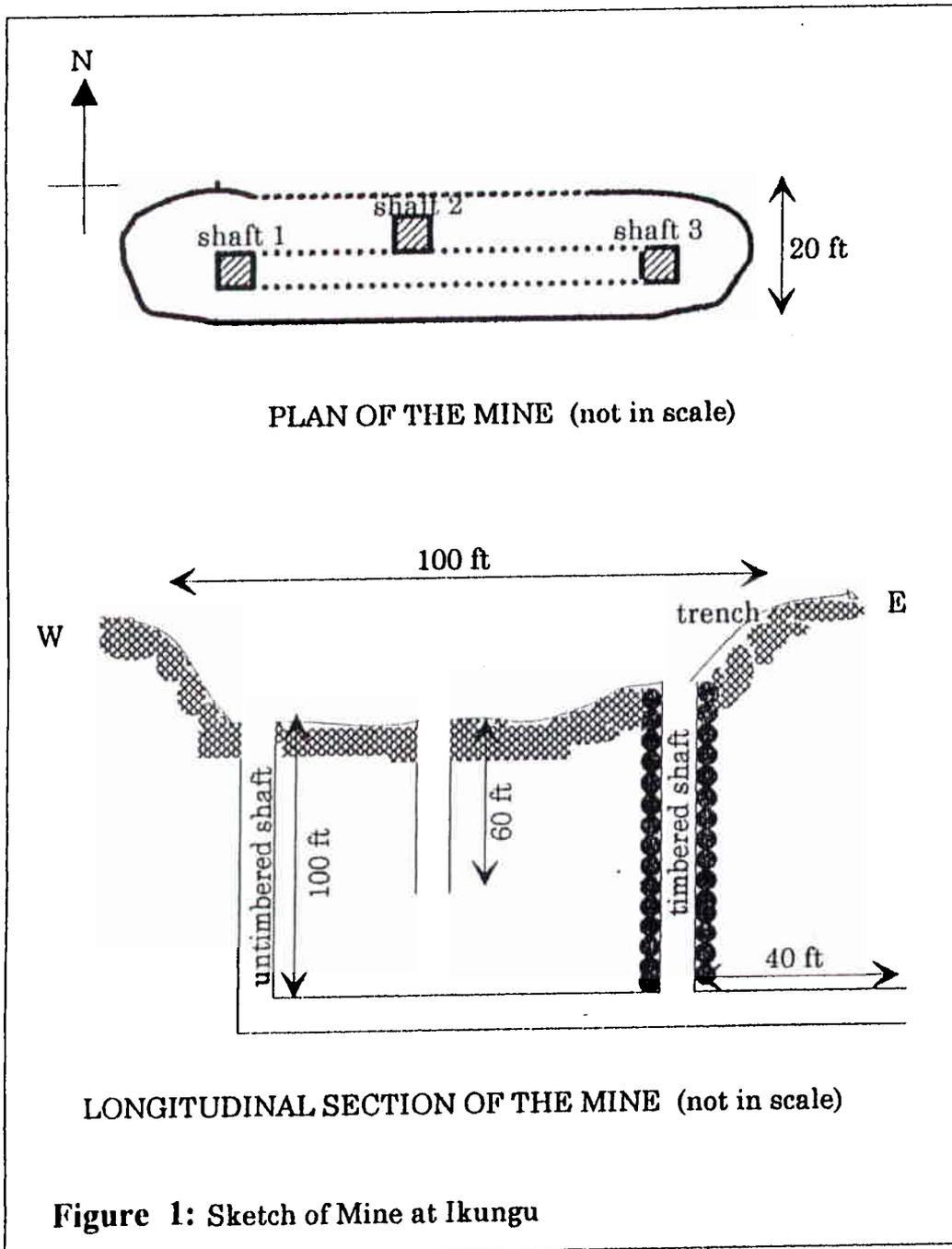
- **panning**. This method is used for prospecting for gold in Mbinga, Chunya and Mpanda districts as well as for prospecting for gemstones in Korogwe and Muheza districts.
- **pitting and trenching**. Digging shallow pits and trenches are the most popular methods for prospecting for minerals in various parts of the country. Samples are collected from pits and trenches, panned and sorted for the presence of minerals.
- **indicator minerals or trace elements**. Some minerals, such as diamonds, cannot be visually spotted on the ground, hence, prospectors looking for diamonds or other heavy minerals look for indicator minerals or trace elements which are associated with such precious stones. Samples are collected, sieved, and analysed for the presence of such associations. Such prospecting methods are used to prospect for diamonds at Nyangh'wale in Kahama district, Mwamanga and, Mabuki in Kwimba District.

109. The above mentioned prospecting methods used by artisanal and small scale miners are simple, cheap and employ traditional tools such as picks, shovels, moil points, pans and sieves. During the baseline survey, no properly planned prospecting methods were observed. Due to a lack of technical know-how, most miners spend a long time and a lot of capital, prospecting in the wrong places.

## MINING OPERATIONS

110. Artisanal mining activities in Tanzania are either conducted underground or on the surface, depending on location and shape of the ore body. Open cast operations consist of excavating an open pit.

111. With an exception of dimension stones, the most common method of opencast operations practised by artisanal miners uses a single-bench. Open pit mines in the districts visited, formed a single level of operation where ore and waste materials are excavated from the bench face. If there is indication of mineralization in the pits, these are widened into trenches. Such an example was seen at Ikungu gold mines, Musoma District. Three shafts were sunk with their collars starting from the bottom of a trench whose depth has reached 3 metres from the original surface. These shafts were sunk to intersect the secondary enrichment of the ore. (See Fig. 1). The depths of underground mine operations vary from a few meters to 100 m.



112. Underground gold mining methods are carried out in 35 locations, out of 39 gold mining locations visited. The miners, under contract with the pit-owners start gold prospecting by trial and error, without proper technology, digging pits and trenches straight down the mineralized zones until they hit vein type deposits. This uncontrolled mining creates tens to hundreds of pits very close to each other.

113. Field observation indicates that underground mining contributes to 90% of gold mining operations (while the rest 10 %) is associated with open cast working. Rukwa and Mbeya regions account for more than half of the open cast gold mining and one third of the underground gold mining operations .

114. Underground gemstone mining activities in Tanzania contribute 22%, while the rest 68 % is associated with open cast mining activities. Again Appendix 3E highlight Arusha and Tanga regions as the main areas where underground gemstones mining while Ruvuma and Morogoro regions are the main open cast - alluvial - gemstone mining.

115. General observations in most of the mining sites visited show that there was often no proper work organisation coupled with a lack of planning, and technical know-how. According to the baseline survey, only 16% of the miners have basic technical know how in gold mining and 19% in gemstone mining. The knowledge of most miners is gained by practical learning from other unskilled but experienced miners. Appendix 1G and Appendices 1C - 1D show the level of education of mine workers and claim holders. They do not understand proper mine development methods that will enable them delineate ore reserves and do not understand the nature of the mineral deposits to mine, nor do they know any conventional mining methods such as benching in opencast mining or stoping in underground mining. Table 1 depicts the most commonly used ore extration and hoisting methods.

Table 1 : Gold and gemstone mining methods in Tanzania

<b>METHODS</b>	<b>GOLD MINING</b>	<b>GEMSTONE MINING</b>
	<b>(%)</b>	<b>(%)</b>
<b>ORE EXTRACTION.</b>		
Manual-moil point, hammer, chisel	65	83
Mechanical - Axels, blasting,	35	17
<b>Total</b>	<b>100</b>	<b>100</b>
<b>HOISTING METHODS</b>		
Buckets	27	26
Bags	16	2
Shovels	3	50
Rope	30	20
Windlass	11	
Pans	13	
Winch		2
<b>Total</b>	<b>100</b>	<b>100</b>

116. Due to uncontrolled mining practices, underground workings head in all directions and in all planes. There is no method of relating one level to another due to a lack of maps as the mines are not surveyed. There is no clear knowledge of location, altitude and composition of the ore zone. Instead the norm applied is discovery of a rich vein or lens, always at the surface or near the surface because small scale miners do not have the technical and/or financial resources to delineate buried deposits. These small scale miners are restricted to only one mining method that is pitting or shaft sinking. Some of these shafts, such as at Matinje and Mgusu have gone down to levels more than 100 m below the surface. At Matinje (Fig. 4) adjacent shafts/pits have been connected with drifts at 50 feet intervals all the way down to the 320 ft level, the first drift being 100 ft from the surface. These drifts have been opened to improve ventilation down the shafts and mine workings and are not meant for blocking out the reserves for mining. After opening up a mine, ore is removed in many mines removed by using moil points, picks and shovels. Only in a few cases is ore blasted and reclaimed by mechanical equipments.

In general, the mining procedures practised by artisanal miners can be summarised as follows:

### 117. Excavation

Excavation of country rock and ore is done mostly by using moil points, a single-sided pick locally known as a "sokomoko", a double sided pick axe, sharpened vehicle leaf springs, shovels or any other tools that the small scale miner finds useful to excavate the rock mass. According to the baseline study carried out, 65% of the artisanal miners visited extracted gold ore and waste using moil points, picks and shovels and 20% of the miners used vehicle leaf springs, chisels and hammers. Those using jackhammers prior to blasting by gelignite are 12% of the total. The rest use chisels, hammers and sharpened drill steels to drill blast holes .

118. Ore extraction is achieved by chipping the rock using sharp ends of the chisel or drill steel and a hammer. The chisel or drill steel is twisted 90° after each hammer blow to extract the ore.

During blasting, the same procedure is used to produce a hole. When the depth of the hole is sufficient to receive an explosive charge, detonators and explosives are charged and blasted by connecting the two terminals of a vehicle battery to an electric wire coming from the detonator. Drilling by using a jackhammer and compressor is conducted at Mgusu in Geita district, Kerende in Tarime district, Ushrombo in Kahama district and Matinje in Igunga district. At Nzuguni, artisanal miners heat the rock mass followed by rapid cooling in order to crumble them as an alternative to blasting. Due to fear of possible theft of ore, it was noted at Simba Sirori that immediately after blasting, artisans rush to the mines to muck out ore while toxic fumes and dust particles are still present in the shafts and drifts.

### 119. Shafts and Hoists

Most of the shafts in use today started as prospecting pits or trenches which measure approximately 1m x 2m or less. These pits were later on developed into shafts which serve as manways and for hoisting ore, waste and ventilation purposes. Typical examples of shafts which started as trenches can be found at Ikungu, Simba Sirori and Maji Moto in Musoma district. On the other hand, at Nyabirama in Tarime district the shafts started wide, measuring 1.5m x 6m. As the mineralized zone was delineated, the size was reduced to 1.5m x 2.5m. The shaft is inclined at 75° following the dip of the orebody.

120. As stated earlier, all pits, trenches and (later on) shafts are sunk in the mineralized zones. Therefore, the nature of the shaft depends on the slope of mineralized zone. If the mineralized zone is vertical, the pit or shaft will also be vertical, and likewise if the mineralized zone is inclined, or changing direction, the

shaft will also follow the same trends. Eventually the shaft often appears to be a series of benches as shown in Fig 2 and 4. These types of shafts are typical for Sekenke, Nyakagwe and Mgusu mines. With this method of shaft sinking it is not possible to install a hoist without modifying the shafts.

121. The depths of these shafts depend on a number of factors. At Matinje where the mineralized zone is near vertical, some shafts reached more than 100m from the surface. At Ushirombo, shafts are shallow, at depths of 15 to 30 m, due to a high water table which cannot be efficiently drained. Mgusu mine had a shaft which has reached a depth of 100m without encountering ground water. Due to the lack of pumps and the absence of gold mineralisation, the shaft had to be abandoned. Another reason that contributed to the closure of some deep pits at Mgusu mine was high production costs (eg. batteries for torches, increase in the number of underground workers, high costs of bags (sacks) for hoisting ore and waste and rising costs of hoist ropes). Most of the pits in the country are equipped with locally made wooden windlasses for raising ore and waste to the surface. A windlass is a round timber log of about 6 in diameter cut into a size slightly more than the width of the shaft, to which a 3 cm sisal rope is tied and wound around. The timber log is placed on two vertically forked timber posts of the same size as the log, which are erected on both sides of the shaft. The log is then turned manually to raise or lower the rope, which is attached either to a bag for hoisting ore and waste, or to a 20 lts bucket for mine drainage. This arrangement has gained popularity amongst the miners. At the time of the study, it was found that 43% of the mines visited had installed windlasses.

122. At Matinje an improved leverage system has been introduced to ease hoisting by windlass whereby the V-like posts have been sighted away from the pit and the rope runs over a wooden pulley erected at the centre of the pit mouth. These pulleys are greased using special watery plant leaves from time to time. A windlass has limitation with respect to depth. That is why they are normally used in prospecting and small mine development. Therefore, if mining is to continue at deeper levels another system of hoisting ore and waste must be devised. Of the total of 39 gold mines surveyed, 23% were found with shafts or pits without ropes. Miners enter the mine workings by stepping on notches cut on the sides of the shaft walls. A few mines have shafts with benches cut on one side to enable miners go down the mine workings. The same benches are used by miners carrying ore and waste. Timber support is applied in highly weathered weak rocks, while natural support accounts for 31% of the mines visited.

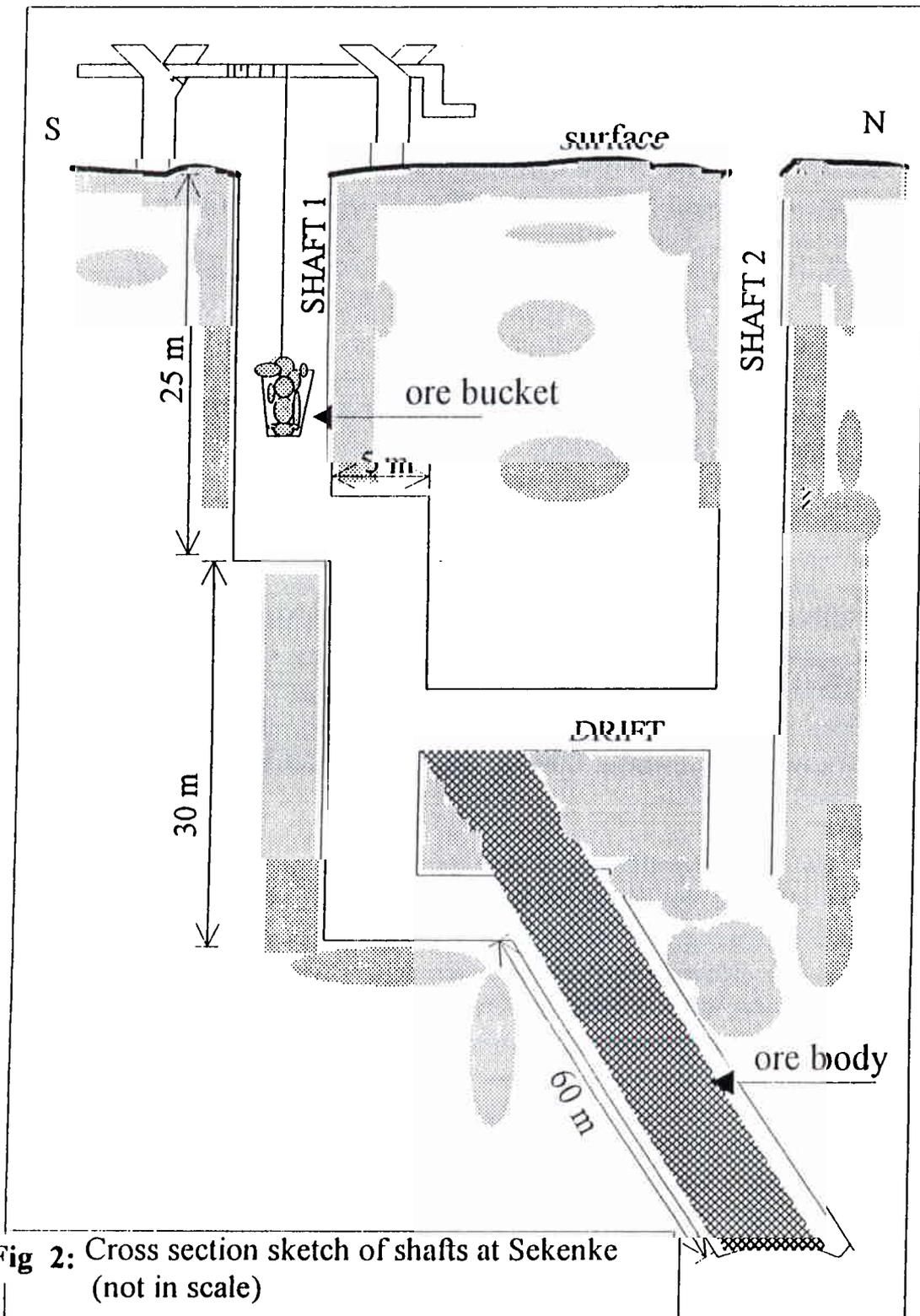


Fig 2: Cross section sketch of shafts at Sekenke (not in scale)

### 123. Tramming and Hoisting Methods

Ore and waste are trammed from the drift or working face to the shaft bottom by either of two methods. One method is by loading ore or waste into a 25kg or 50 kg canvas bag or sack. The bag is tied to a strong sisal rope and dragged along the floor of the drift by miners until it reaches the "shaft station". The bag is then hoisted to the surface by a windlass, or by a rope pulled upwards by a team of miners standing at the top of the pit. The second method is by shovelling in stages. Miners with spades are lined up at intervals of 4 m from the shaft bottom to the working face. Ore or waste is then shovelled from the working face in stages by these miners until it reaches the pit bottom. Thereafter the material may be raised to the surface by rope or may be shovelled up the shaft benches to the surface. In a few cases miners climb up ladders carrying loaded bags on their shoulders. The study showed that 50% of the mines used rope and bags to hoist ore and waste.

124. In the Mara Region, it is common practice to transport ore or waste from the working face to shaft bottom and then hoist it to the surface by using pans. Miners with bare hands line up from the working face to the pit bottom at intervals of 2 m. Other miners stand on ladders from the pit bottom to the surface. The pans loaded with 10-15 kg of ore or waste are tossed from one miner to another from the working face to the surface. Women also take part in this dangerous task. 60% of the mines in the Mara region use this method of hoisting and tramming. Only 11% of the mines visited there use windlasses for hoisting ore and waste.

125. Although ventilation is necessary for the provision of fresh air in the working areas, most of the underground work are poorly ventilated. Only about 16% of undergrounds working gold mines visited showed adequate ventilation system (see Appendix 3E - B ). Most of the mine workers depend on natural ventilation or they have to climb to the surface from time to time in order to breathe fresh air. Poor ventilation and lighting sources considerably impair the working efficiency in underground mining. Natural ventilation is used in some mines such as at Matinje and Sekenke by joining adjacent shafts with drifts or crosscuts. Hand operated blowers used in forges have been turned into ventilation fans at Busolwa (Geita) and Isungangwanda (Nzega district). Out of 39 gold mines surveyed, 45% used torches and 45% used locally made open paraffin flame lanterns called "Vibatari".

In a few cases hurricane lamps and candles were also used.

126. Many underground mines have been abandoned due to excessive water flows. This has been a major production bottleneck which most miners have failed to solve. According to the baseline survey, 40% of the mines visited used pumps. These pumps are all hired from individuals or companies who, miners consider, charge exorbitant fees for such services. Often in those mines using hired pumps, lack of maintenance for the equipment has brought their operations to a stand still. Hence they use buckets, half - cut drums and plastic containers to dewater their mines using such hoisting systems as are available at their mines. This is possible for mines with pits less than about 15m deep. Some mines in Mpanda and Nyarugusu in Geita district have installed engine - driven water pumps underground. Both gold and gemstone mines face severe rainfall or natural ground water seepage to pit bottoms. Ways of removing water include the use of fuel driven pumps (40 %) and buckets (60 %) in gold producing areas. Only few miners use fuel driven pumps in gemstone mining areas. The majority of them (> 75 %) depend on hand buckets to drive water from working stopes.

#### 127. Productivity

Mineral discoveries are struck by "luck" or "accident" after many trial and error prospecting methods, mostly done by pitting and trenching. After discovery, there is only one mining method, and that is pitting or trenching. In practice ore reserves are not proven, for the miners exploit the mineral as soon as they discover it. In the case of gold they dig straight down the reefs until the secondary enrichment is encountered, typically about 10 to 15 m. At this point they cast about on the reef laterally along drifts, or crosscut up to the limits of their section, seeking for visible minerals in it. There is no provision for water drainage from the drift faces. Fig. 1 "Vietnam" Mine, Merelani, is a good example of unplanned development heading.

128. The low technology base, together with lack of machinery and equipment, result into poor mining practices and low productivity. Average labour productivity is very low (Table 2 below) All the ore produced comes from development ends, i.e. pit (shafts) and drifts or crosscuts. Mining activities are conducted in many locations, including old gold formal mines which were closed during the 1960s and 1970s due to low mineral prices and political uncertainty. In these old mines, small scale miners are scavenging what was left. The old gold mines being reworked include Sirori Simba, Mobrama, Maji Moto, El dorado (Ilika), Mara Mine (Kerende) old Geita mine, Saza etc. The average labour productivity for gold and gemstone is given in Table 2.

Table 2: Average gold and gemstone labour productivity

<b>Mineral Mined</b>	<b>Ore mined (kg/day/person)</b>	<b>Ore processed (kg/day/Person)</b>
Gold (All sites)	90.4	87.8
Coloured gemstones (All)	27.2	23.4
Diamond (Nyanghwale)	16.7-167	16.7 - 167
Diamond	0.65m3	0.65m3

Appendices 3A to 3C show labour productivity per district and region.

### 3.1 Gold Mining

129. Gold mining activities are concentrated in the following areas: -

- The Geita - Buckreef greenstone belt
- The Kahama - Mabale greenstone belt
- The Nzega - Igunga greenstone belt
- The Mara greenstone belt
- The Musoma greenstone belt
- The Iramba - Sekenke greenstone belt
- Mpanda Mineral field
- Lupa Goldfield
- Mbinga goldfield
- Nzuguni gold prospect

### 130. Processing of gold

Panning and sluicing accounts for more than 69 % of the total gold unit processing. Districts which have the highest concentration of panners and installed sluice boxes include Mbinga, Mpanda, Geita, Musoma, Kahama and Chunya. At all these sites such activities are carried out throughout the year. However, in Biharamulo, Shinyanga, Igunga, Nzega and some parts of Chunya district, panning and sluicing is restricted to the wet season, being limited during the dry season due to shortage of water.

## 131. Evaluation of the grades of ore

During prospecting and mining there is frequently no clear cut off in value between veins with low grade dissemination (Figure 3). However the whole gold mineralization may have significant grades with dimensions which could support long term small scale mining or medium to large scale mining. Spot sampling in different regions has shown average gold contents in gm/t as given in Table 3

**Table 3: Average gold Contents**

Region	Country Rock gm/t	Ore gm/t	Tailings gm/t
Mwanza	0.8	24.5	47.4
Mara	16.7	10.6	16.9
Shinyanga	5.3	5.4	12.14
Mbeya	8.8	19.9	-
Mpanda(Rukwa)	5.5	27.3	9.5

The high gold value in the tailings is due to processing of gold ores in closed ponds where spillage may cause concentration of gold.

More fire assay results are shown in Appendices 3F and 3G

132. Due to a Lack of knowledge of the characteristics of the orebody, a paucity of technical talent and desire to get rich quickly with minimum inputs, mining occurs only on the rich part of the vein which in most cases is less than 30 cm. The marginal ore, which is normally wider, and can be up to 5 m wide, is left unmined. Future extraction of the marginal ore will require special technical attention. Sometimes this marginal ore gold is extracted but all is not processed due to low grades and poor technology of recovering the gold content. Such ore was found by the study team at Matenje in Igunga district where the grade of marginal ore varied from 15 to 60 gm/t.

133. The grades of samples taken at Matinje, Mgusu and other localities confirm that the ore processed is often of high grade 58.8gm/t (See Appendix 3D). Marginal ore could still be processed to recover gold if blended with high grade ore before it is crushed and ground. By using this method the life of the mine will be lengthened without incurring any losses.

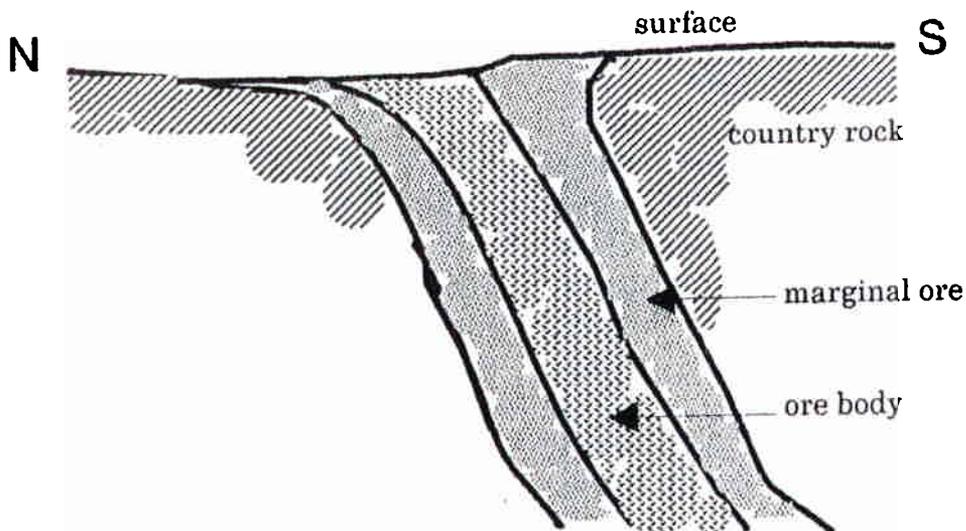


Figure 3: Gold vein at Matinje

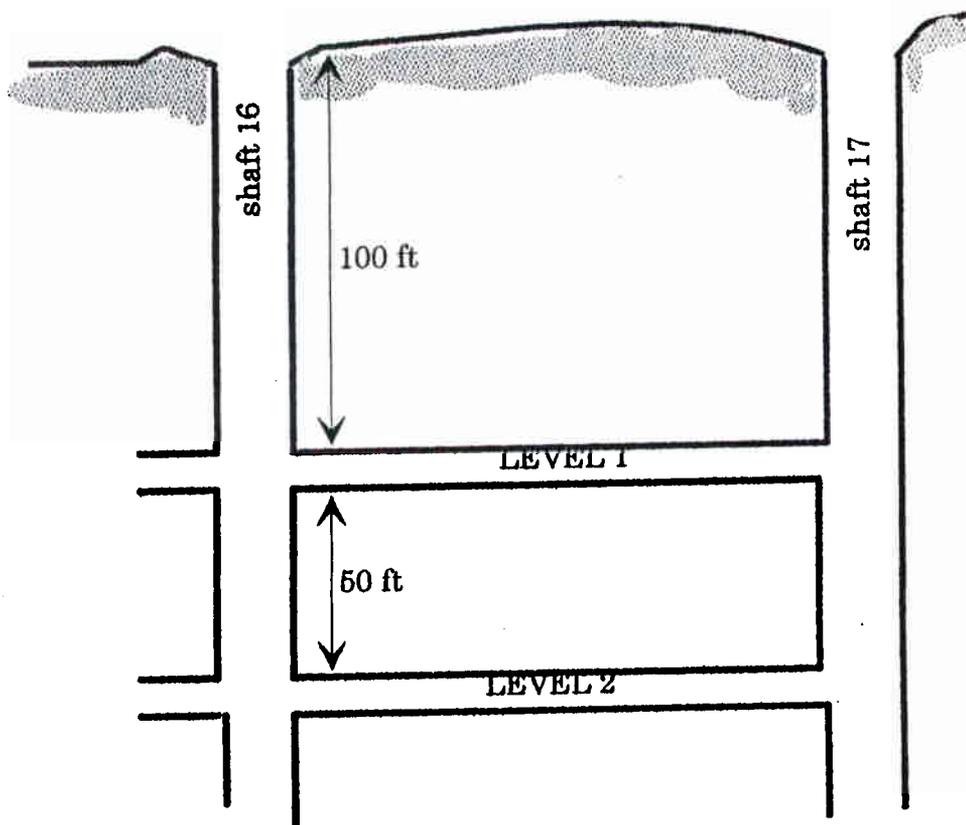


Figure 4: Shafts and drifts at Matinje

### 134. Processing Methods

After mining, gold ores and gem bearing stones are usually processed on the mine sites. At first, physical separation which requires size reduction of the material has to take place prior to actual ore separation. General recovery is low due to the simple technology employed, especially during size reduction of the ore. Three major concentration stages of gold recovery operations commonly used by miners are :- panning, sluicing and amalgamation. However, these methods are not efficient to extract gold from low grade ores or refractory gold which is locked up in sulphides because sulphides do not react with mercury. Therefore a fourth stage, known as cyanidation is used by a few mines on an experimental basis. Gold recovery can be achieved by a combination of these methods as follows: -

### 135. Panning

In situ or primary lode, mineral bearing rocks have to be mined, milled and concentrated in order to extract the valuable component. Alluvial mining is simpler than primary lode mining because nature has done much of the work of ore extraction. The host rocks are already broken down by weathering and erosion processes. Minerals are usually sorted, and concentrated by water flow. Artisanal miners apply simple tools such as hand shovels, pans etc. Gold or gemstone placer mining is done on small scale with a number of individuals ranging from one to ten. The simplest and common method applied is panning. This method is quite efficient for washing gold bearing stones from gravels in a pan. It is widely used at Geita district for recovery of alluvial gold as well as gemstone mining in Morogoro and Songea regions. Currently at Mpepo in Mbinga district, panning accounts for about 12.5% of mines visited. Alluvial/eluvial gravel is excavated from the river beds or river benches, and panned directly to recover the gold without passing through other stages.

### 136. Panning and Sluicing

A two-way approach, which is a combination of panning and sluicing, is used to recover coarse and fine gold from alluvial or eluvial deposits. Mined ore is passed through an inclined sluice box whose bottom is lined with a sisal mat and fitted with riffles to trap the gold for several cycles. Coarse gold is trapped by the riffles and on the sisal mat placed in the sluice box. The sluice box is emptied by removing the sisal mat and washing it thoroughly in a bucket of water to remove all the entrapped gold. The pulp obtained is then panned to remove all light materials until the heavy gold bearing fraction is left behind.

137. Most small scale miners in Tanzania have not yet acquired the technology for designing and setting up a sluice box for maximum gold recovery. For example, the use of unriffled sluice boxes in Musoma and Tarime districts causes significant losses of gold to the tailings, particularly for fine gold of below 50 microns. In such cases tailings have to be reprocessed through sluice boxes several times to recover the remaining gold.

### 138. Panning, Sluicing and Amalgamation:

This three-stage approach is used in the recovery of gold from primary ore where both coarse and fine gold may be present. The process of recovery by this method is as follows: -

- (i) The Primary reef ore mined is broken by hand with a hammer to sizes less than 19 mm (about 3/4 inch.).
- (ii) The Secondary stage of grinding is by either one of the two methods. In the first method, the ore is crushed manually down to 100 mesh size ore in a hardwood mortar using a vehicle half-shaft axle as a pestle. The crushed ore is sieved from time to time by using rectangular locally made metal sheets perforated by nails as screens. Some miners use mosquito wire gauze as screens. Only a few miners use the official 100 and 200 mesh screens. In the second method, the primary crushed ore is charged into a locally made unlined batch mill of about 60kg capacity, which is powered by a tractor engine through a transmission shaft. Most of the miners in the Mara Region grind (pound) ore by hammers on stones only until it is fine.
- (iii) The finely ground ore from either of the two methods is then processed as follows: -
  - If the ore is very rich, it is panned directly to recover gold.
  - If it is not rich it is preconcentrated over sluice boxes, the concentrate is then amalgamated. The amalgam bullion is recovered by heating it in the open on a soft drink crown cap in silver paper or on a shovel over a charcoal fire. Amalgamation is applicable where gold - occurs as fine particles. The concentrate from the sluice box is washed in a gold pan to reduce the amount of lighter material, leaving behind the fine black concentrate. Mercury is added in the form of a small bead, commonly the amount that can be contained in a soft drink crown

cap, and is allowed to circulate in the pan during the final stages of washing. The excess mercury is removed from the amalgam by squeezing it through a fine cloth. A typical flow chart showing this method of gold recovery is shown in Figure 5.

139. From the survey, 97% of the mines crush the ore by hand using hammers and stones, and 3% use mechanical jaw crushers, 64% grind ore by using wooden mortars and vehicle half-shaft axles as pestles, 18% use batch mills driven by tractor engines. The remaining 18% grind manually using hammers and stones. Regarding refining, 79% heat the amalgam bullion in the open air, 3% use mercury retorts, 5% use furnace and crucible and the remaining 13% pan and hand sort. Some operators showed a reluctance to use mercury retorts which recover the mercury due to cultural barriers; many operators heated the amalgam inside their rooms.

#### 140. Cyanidation

Fine gold, most of which is below 50 microns, cannot be easily recovered by panning and amalgamation process, but it can successfully be recovered by cyanidation, as practised in Matinje, Igunga district.

The cyanidation process at Matinje is as follows: -

- (i) Ground ore is concentrated in sluice boxes where gold is trapped in the sisal mats lined in the sluice boxes.
- (ii) The gold concentrate is amalgamated, while the sluice box tailings are loaded in six cyanide leaching tanks constructed on the ground. These six cyanide leaching tanks have a total capacity of 210 tonnes. Out of these, three tanks can be used at a time.
- (iii) A total of 140 kg of sodium cyanide solution is sprayed on the three tanks and allowed to percolate through down to the bottom of the tanks. The bottoms are set up so that the solution drains through sacking set above loose bricks or coarse pebbles. The Pregnant solution, which contains gold cyanide in solution form, is discharged from the bottom of the leaching tanks through pipes which lead it to two clarification tanks. These clarification tanks are loaded with fine sand which filters the pregnant solution to remove any impurities that may interfere with the chemical reactions on zinc shavings, like suspended clay.

- (iv) Clean pregnant solution is then led into four 'zinc boxes' which are charged with zinc shavings. As the pregnant solution passes through the zinc boxes, the gold in solution reacts with the zinc shavings and is precipitated on them. Barren solution is discharged from the last zinc box and pumped back to the cyanide leach tanks.
- (v) After a period of one week from the time the pregnant solution was allowed to pass through the zinc boxes, the gold concentrate is emptied from them, and cleaned with water. Any zinc shavings that might not have reacted with the pregnant solution are returned to the zinc boxes for the next feed. Fresh zinc shavings are added in the boxes, to restore them to their original level.
- (vi) The gold loaded zinc shaving is then roasted in a large tray before it is leached with dilute sulphuric acid.
- (vii) The remaining black slime is dried and put in a crucible. Borax, soda ash and silica are further added to the crucible and the mixture is heated at a temperature of around 1200°C until the mixture melts.
- (viii) The molten mixture is then poured into a mould and gold separates from slag and settles at the bottom.
- (ix) The leached tailings from the cyanide leaching tanks are removed and spread thinly on the ground to allow quick oxidation. Ferrous sulphate solution is sprayed on the tailings to neutralize the toxic cyanide ions.

A flow chart for cyanide leaching plant is shown in Fig. 6

141. Gold recovery is still low due principally to inadequate comminution. The ore is usually not milled fine enough to liberate the gold.

Sizing assay tests carried out on some tailings samples collected from Nzuguni, Dodoma showed that small size tailings in sieve size range of - 63 microns and 63 microns have high values of gold due to past amalgamation activities in closed ponds. These grain sizes are result from dust emission during processing. The - 63 microns grain sizes are less than 8% of the weight retained.

# SIMPLIFIED FLOWSHEET OF GOLD RECOVERY AT IMWERU BIHARAMULO DISTRICT

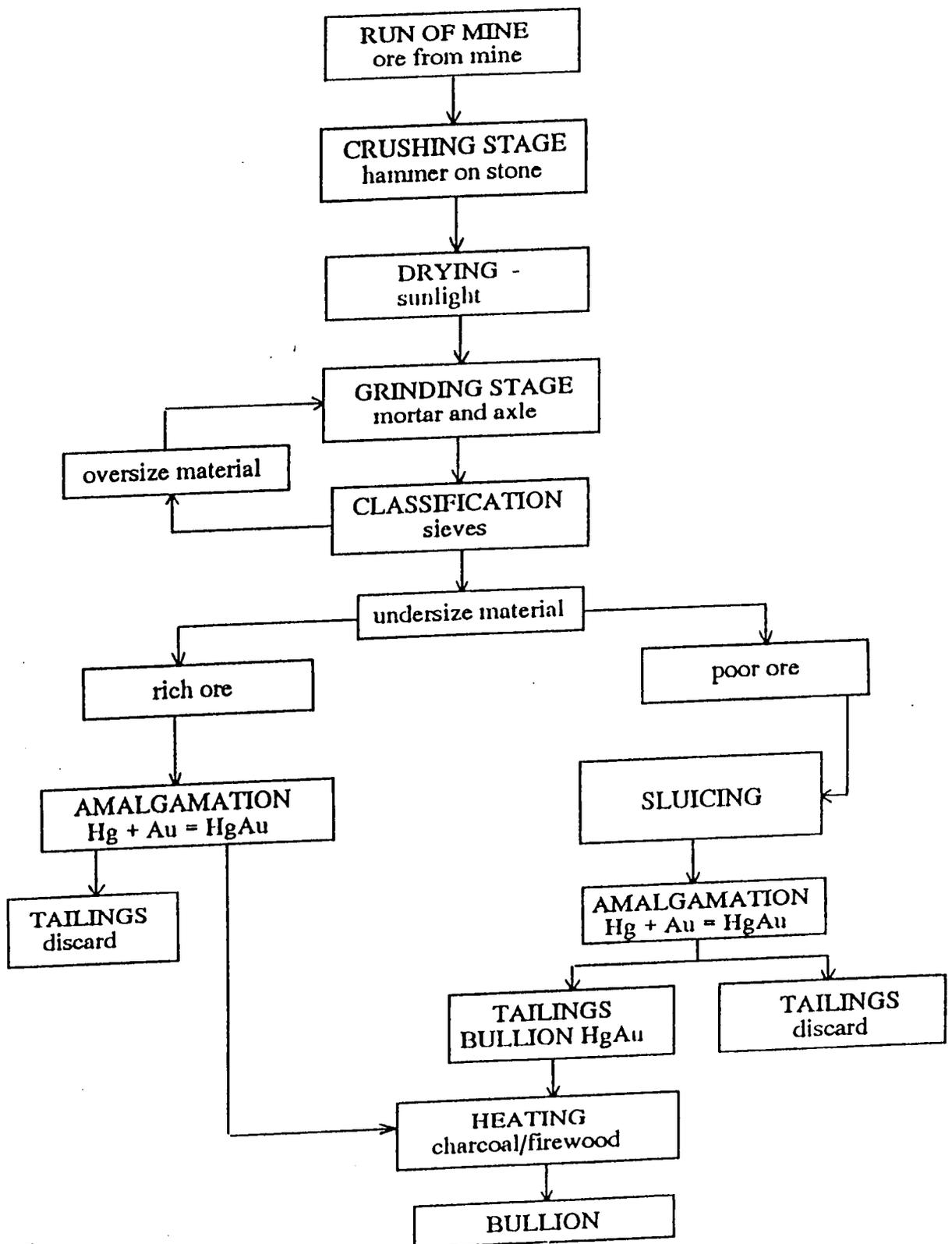
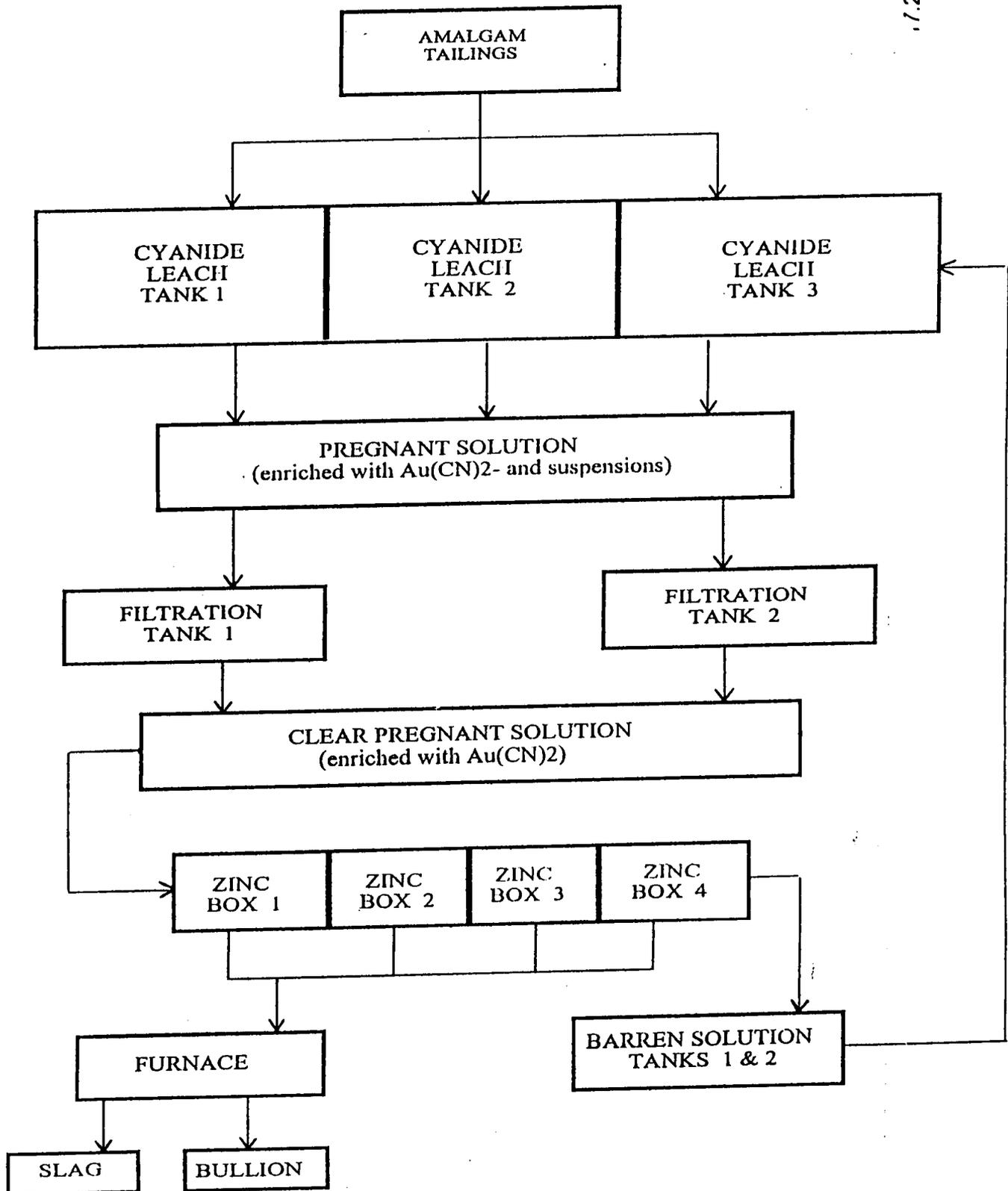


Fig: 5

**Fig: 6 SIMPLIFIED FLOWSHEET OF CYANIDE LEACHING PLANT AT MATINJE**



17.25/1

During sieving the highest percentage of weight retained is in the 150 microns, which goes up to 45% of sieves weight retained.

Further tests are needed to determine recovery trends based on present technology of artisanal miners

Appendices 3D and 3F shows the gold recovery rates for samples collected from some of the mines.

### 3.2 Gemstone Mining and Processing

142. There is a large variety of gemstones that are mined in Tanzania. These include ruby, sapphire, tanzanite, green grossular garnet (tsavorite), tourmaline, emerald, aquamarine, alexandrite, amethyst, scapolite, iolite, spinel, apatite, chrysoprase, garnets (rose, rhodolite, almandite), zircon and malaya garnet (spessartine). Small scale gemstone mining is carried out in several areas in Tanzania with gemstones being found in the proterozoic (Usagaran and Ubendian) granulite system.

143. Due to the unique geological nature of gemstone deposits, whereby mineralization is localized in small pockets, both prospecting and mining are carried out concurrently Appendix 3H show gemstone mining methods. It is also common to find different types of gemstones in one locality. For example, at Muhuwesi river valley in Tunduru District and tributary of Mbwemkuru river at Kitowero (Liwale), sapphires and alexandrites are found in the same area. Likewise along the Uмба river valley rose garnet, blue sapphire, red garnet, malaya garnet and rhodolite garnets are all found in areas close to each other.

144. Areas visited by the study team included Tunduru (9 localities,) Mbinga (2 localities,) Mahenge (2 localities), Matombo (2 localities), Sumbawanga (one locality), Simanjiro District (4 localities), Longido (one locality), Muheza District (3 localities), Korogwe District (2 localities), Handeni District (2 localities) and Liwale District (one locality). Both open cast and underground mining methods are used. The deposits mined may either be primary in the host rocks or secondary (which include both alluvial along rivers, and eluvial in the weathered zones above/or adjacent to the primary deposits).

145. Small scale gemstone mining in Tanzania is in most cases a labour intensive activity. For example, in alluvial deposits along rivers such as the Uмба, Muhuwesi, Lukande, Ruvu etc., large numbers of miners shovel gem-bearing gravels on to screens and wash them in nearby stream waters. In primary deposits like the emerald occurrence at Mponda in Sumbawanga, rhodolite deposits at Kalalani (Korogwe), Kangala, Landaban and Tiriri (Simanjiro) and tanzanite deposits at Merelani (Simanjiro), low-energy explosives are used to break up the gem bearing rock and then the material is sorted by hand after cobbing. Details relating to the type of mining associated with a particular deposit are provided below in the discussion of specific gem minerals.

146. The following are the mining and processing methods used by some of the gemstone mines visited. As stated earlier the mining method adopted depends on the nature of the deposit.

**Table 4: Classification of Gemstone Deposits.**

<b>Mine</b>	<b>Mineral</b>	<b>Classification of deposit</b>	<b>Mining Method</b>
Lesmundarara (Longido)	Ruby	Primary deposit	Open pit/trech
Landaban (Simanjiro)	Rhodolites	Eluvial Deposit	Opencast and Underground
Tiriri (Simanjiro)	Rhodolites	Eluvial Deposit	Opencast and Underground
Kaangala (Simanjiro)	Rhodolites	Primary Deposit	Opencast and underground
Merelani (Simanjiro)	Tanzanites	Primary Deposit	underground
Tundururu	Sapphires alexandrites Chrysoberyl	Alluvial and Eluvial	Opencast
Kigwasi (Umba)	Garnets, Sapphires	Alluvial	Opencast
Mwakijembe (Muheza)	Garnets, Sapphires	Alluvial	Opencast

147. Results from the baseline survey show that the majority of gemstone mines are operated by opencast methods. Mining is by pitting and trenching. Benches or steps are cut on one side of the pits and trenches for use by miners to enter the mines. The same benches are used to raise ore and waste to surface using shovels. The mined materials are sieved using locally made screens with openings that allow 0.5gm stones to pass through. These are considered uneconomic to mine because of the low prices in the international market.

#### **(b) Tanzanite Mining**

148. Miners at Merelani dig through country rock down to 20 - 40m until they reach the graphitic schist which is the tanzanite host rock. The rocks are hand broken and sorted underground for the tanzanite stones. The main underground mining method used is room and pillar. Pits measure 1.5m x 2m across with depths of up to 100m. The drifts may be much narrower and undulating as shown in the sketch (Fig. 7) but some of the drifts are more than 200 m. from the shaft bottom. It is common for different underground drift workings operated by different miners to cross each other, as shown in the sketch.

149. Traditional mining tools such as picks, shovels and moil points are used to extract rock and ore. Most of the individual mines are equipped with compressors, jackhammers, explosives and accessories and tractors for hoisting ore and wastes. The problems of underground mining were also reflected at Merelani. Hoisting is carried out manually through pulleys mounted on wood using drum hoists, or by using tractors for pulling several 12 kg bags tied to a hoisting rope through pulleys. The sketch in (Fig. 7) shows a tractor hoisting waste.

#### **(b) Sapphire Mining**

150. Opencast sapphire and alexandrite mining is conducted at Muhuwesi, Maji Maji, Ngapa and Msinji in Tunduru District and Kitowero in Liwale District. These areas are new gemstone rush areas which have been invaded by local and foreign gemstone miners. In these areas, gemstones are deposited in alluvial sediments overlying granite, granitic gneisses and some pegmatites, which are drained by perennial rivers and streams.

151. Mining activities start by deviating the river flow using sand bags. The remaining water is removed by buckets, pans or sometimes hired water pumps. Pits of sizes 1m to 5m diameter and 2m to 6m deep are then dug in the river bed or on the flanks to exploit the deposit. Mining of the gemstone bearing gravels is conducted by using picks and shovels. Buckets are used for hoisting the ore, and crowbars are used to remove large boulders.

152. After mining, the following treatment process is carried out: -

- The gravels are wetted to loosen individual grains from rock matrices.
- This is followed by shaking and washing to break the surface tension, rejecting large boulders after sorting.
- Washing and sieving; and then,
- Hand sorting the gemstones.

153. Sapphire is also mined at Kalalani (Kipingoni) in Korogwe district. The mine visited was a narrow open trench approximately 50m long, 3.5m wide and 17m deep. Sapphire is found both at the contact between micaceous pegmatite as well as serpentinite and in pegmatites. Shallow pits and trenches of average size 2m x 2m and deep ranging from 1 to 2m are sunk in surrounding areas at Kalalani to mine alluvial sapphires. Materials from alluvial works are sieved in dry or wet conditions depending on the distance from the water source and the soil texture. Tools used to extract gemstones are picks, shovels, hoes and moil points. Blasting is sometimes used in hard overburden, which is mainly magnesite.

### (c) Ruby Mining

154. Ruby is mined by opencast methods at Lesmundarara, in Longido district; Lukande and Kitonka in Mahenge district, and Mwalazi and Ng'ongolo in Matombo district. Alluvial gravels are excavated washed in pans and sieved before hand sorting. Rubies at Lesmundarara (Longido) and some areas at Lukande and Kitonka are found in primary rocks. At Lesmundarara, the host rock is green zoisite, locally known as anyolite and at Lukande, Matombo and Kitonga the rubies are found imbedded in marble. The rubies are cobbled out of the host rocks using pliers,

chisels and small hammers. Hand sorting of rubies is done by observing colour, clarity and cleavage. The final stage is sizing the recovered gemstones, which is done by grouping them according to size of each individual stone. Where the host rocks are very hard, blasting is carried out to reduce the sizes to a manageable level for cobbing.

A general flow chart for processing gemstones is therefore: -

COBBING

GRADING

SIZING

#### (e) Rhodolite Mining

155. Rhodolites are mined by both opencast and underground methods at Sezakofi in Handeni district and Kangala in Simanjiro district. At Tiriri in Simanjiro district, they only practise open cast methods in which pits and trenches with depths ranging from 1 to 2m are sunk in the mineralized zones and gravels. The alluvials and eluvials mined are then sieved and sorted by hand.

156. Underground mining, starts with prospecting trenches to a length of about 10m. If the excavated trenches hit mineralized zones, the next task is to locate rhodolite bearing veins. Thereafter vertical or inclined shafts are sunk in the veins along the dip. Access into the workings is by means of benches or steps cut on the footwall of the shafts as shown in (Fig. 8). The same benches are used for raising waste to surface by shovelling upwards on the benches. Rhodolite ore is processed and sorted at the working faces (working area) underground.

157. At Kangala, there are several inclined shafts sunk in the orebody. For example, in one of the mine claims visited, there were a total of 15 inclined shafts. Pillars of 1.5 metres widths are left between shafts. This type of mining, known as room and pillar, leaves a lot of ore underground. Ventilation, lighting, tramming and excavation methods are similar to other underground gemstone mines. Dewatering is not done due to a lack of pumps, and hence shafts are abandoned soon after they intersect underground water. Rhodolite was being mined at Kalalani in a narrow open pit, but due to the high walls the mine caved in.

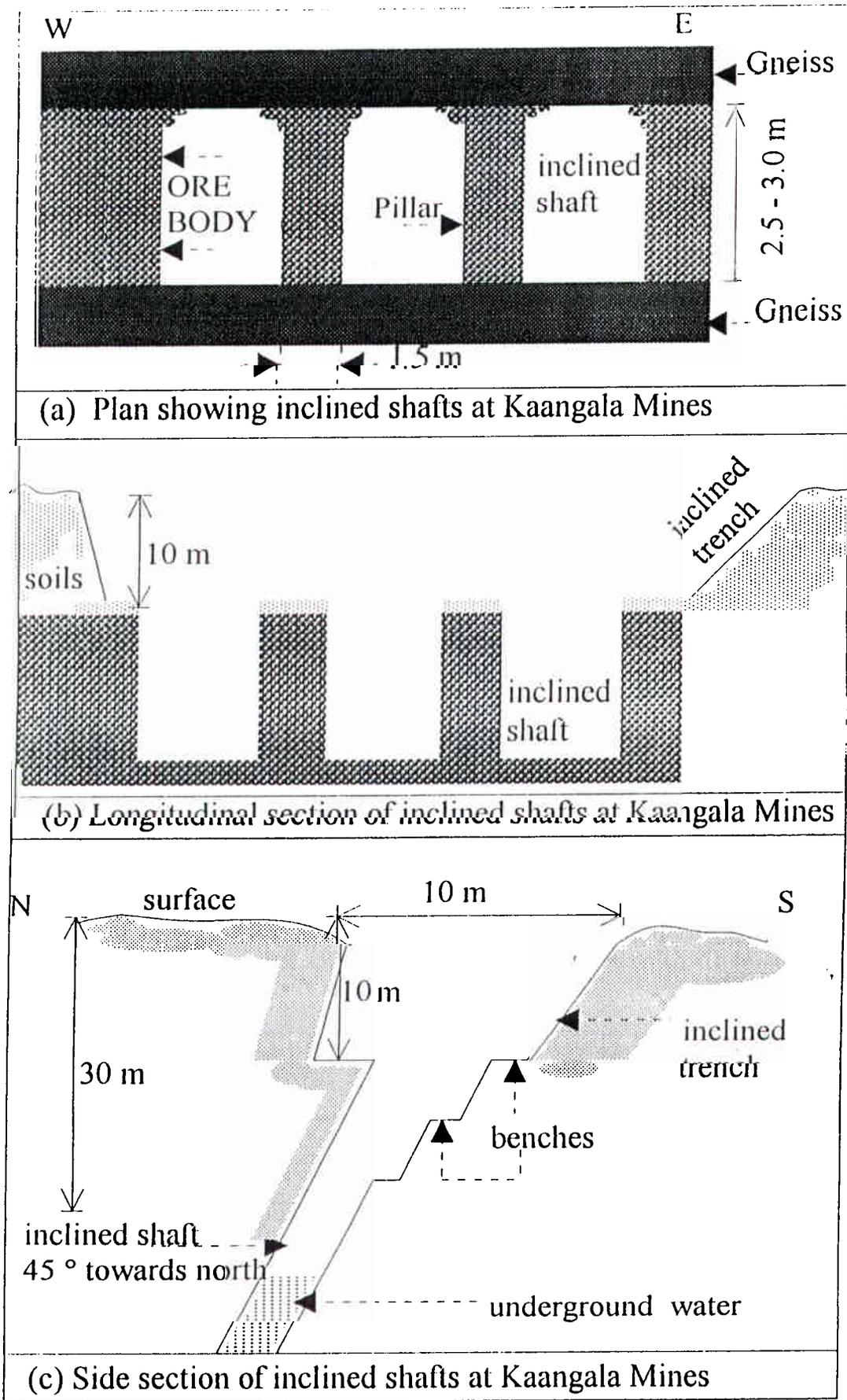
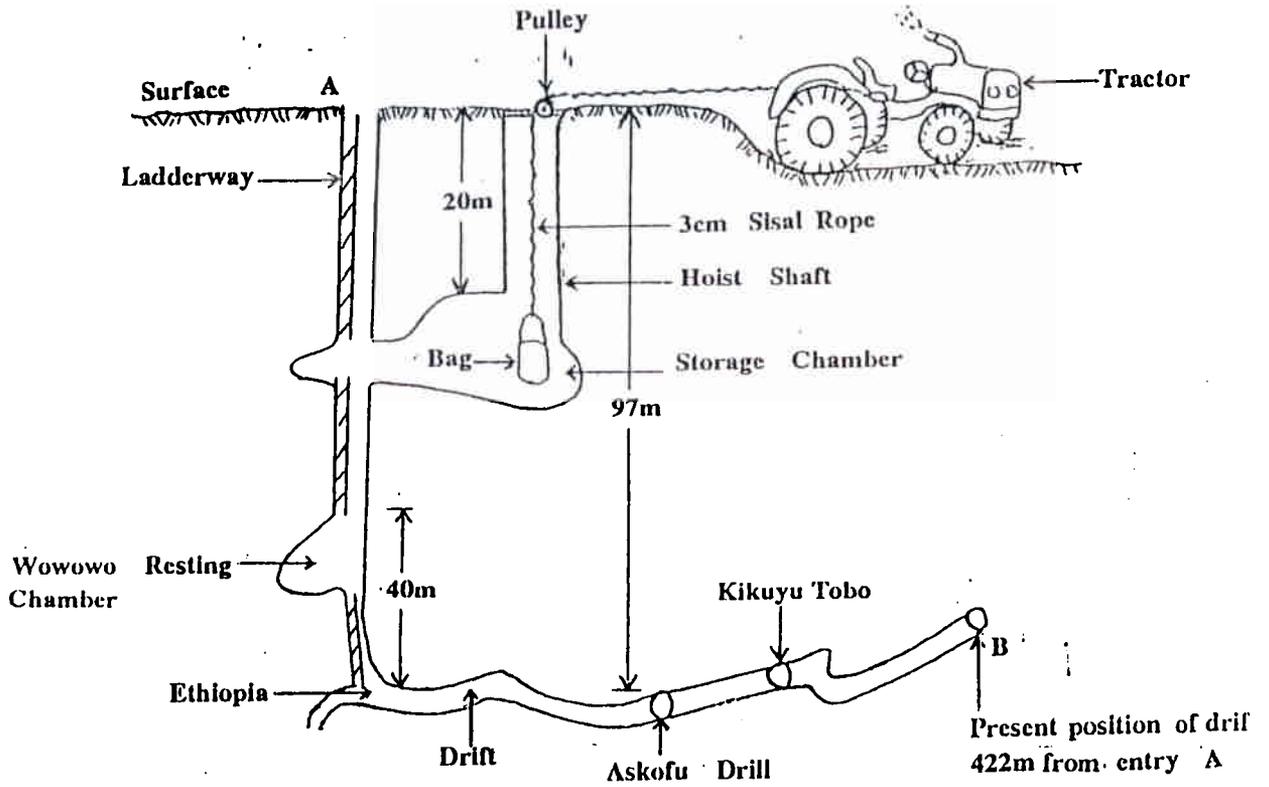


Fig 8:

### SKETCH OF HOISTING AT VIETNAM MINE, MERELANI



**NOT TO SCALE**

**Fig. 7**

**Note:** At Askofu drill and Kikuyu tobo, Vietnam Mines' drift holed other mines' underground workings

### (e) Diamond Mining Methods

158. Gravels containing diamonds at Nyangh'wale in Kahama district and Mabuki in Kwimba district are overlain by black clay (locally known as black cotton soil) with a thickness ranging from 30 to 40 cm. At Mabuki, diamondiferous gravels are 1.5 m to 2m thick while at Nyangh'wale the gravels (conglomerates) are up from 15m to 30m thick. The high grade diamond bearing gravels are at the bottom, in contact with the bedrock.

159. Opencast miners start by stripping the black cotton soil until a greyish colour soil with some gravels is exposed. The gravels containing diamonds are then excavated by picks and shovels and stockpiled near the pits, until an amount required to be processed for a day has been won. Gravel is then put in a 60 cm diameter round sieve which has a sieve sizing of 5 to 6mm fine mesh. The sieve containing the gravel is held in a tub of water or a pool constructed to hold water, where it is sharply twisted one way then the other repeatedly and then moved more gently up and down in a jiggling motion. The actions are repeated until the lighter gravels are graded towards the top of the sieve and the heavier ones are concentrated in the middle to the bottom of the sieve. The sieve is lifted out of the water and taken to a flat ground or a picking table where it is deftly turned over and the contents dumped on the flat ground or table like a child making a mud-pie. When the sieve is lifted off, the gravel is left, shining wet, in the shape of a large flat cake. The picker examines the stones on the top in the middle of the pile, and picks out any diamond crystals. Then, to make sure that no diamonds have remained in the rest of the gravel, he goes through the "Cake" gravel, one slice at a time.

160. Due to the nature of the occurrence of alluvial diamonds and the mining methods applied diamond production is limited to an average of 1 - 10 carats a day. For example at Nyangh'wale ore extraction varies from 5 buckets (of 20kg each) to one tonne. This can give a production of up to 5 carats of diamonds.

161. Shaft spacing at Nyangh'wale is 10m, each shaft having a size of 0.75 - 1.5m. Ore is found at levels 15-30m in loose sediments. Shaft sinking to reach the ore may take two weeks (working day and night) using 6 persons. Ladders and ropes are used for access into the mines. The hoisting of ore is by using buckets tied to a rope and wooden windlasses. Although the shafts are properly timbered, the ventilation system is poor. In addition, the lighting system of open flame paraffin lanterns tends to consume the oxygen necessary for miners, sometimes making conditions unbearable. Dewatering is done by buckets or hired pumps.

Support of weak ground is by using timber, although if mining activities cease, the timber is hoisted to the surface for further use in the next shaft.

### 4.3 Mining and Processing other Minerals

162. The baseline survey team visited 33 localities where other minerals, other than gold and gemstones, are mined. These minerals include, salt, aggregates, sand, dimension stones, coal and limestone. The intention was to study the various methods used in extraction of these minerals and methods of marketing them.

#### (a) Salt Production

163. Small scale salt production in Tanzania comes from two main sources. The first source is from the Rift Valley lakes of central Tanzania while the second source is through the evaporation of sea water along the Indian Ocean.

164. The baseline survey team visited seventeen saltworks at Kibululu Village (Sekenke in Singida Region), Mnyanjani in Tanga, Mtongani and Ras Kilomoni in Dar es Salaam Region; Sange in Pangani District, Mpara, Mandawa and Kilwa Masoko in Kilwa District, and Mikindani, Kirumbi, and Mtwara Urban, in Mtwara Region. Salt is produced through the evaporation of brine water using either solar or thermal energy. Thermal salt production is where brine is heated in open pans by firewood until salt crystallizes and solar salt production is where sea water is evaporated in reservoirs using solar energy. A brief description of these methods follows:

#### Thermal Salt Production

165. This salt is produced from two sources:

- (i) Salt pans in the Rift Valley at Kibululu Village, Sekenke. At Kibululu Village women collect salty soil from different localities in the dry Rift Valley swamps during the dry season. This soil is stockpiled on the ground in three layers

ranging from what is called " Mbuga " soil to salt crusts. This soil is then put in a bottom perforated filtering pot in a ratio of 1:1:1 of each soil type. At the bottom of the filtering pot there is a layer of grass, above which a layer of filtering sand is placed before the mixture of soil is put into the pot.

Water is added to the salty soil mixture, and as it soaks through it dissolves the salty soil. Clean brine comes out at the bottom of the filtering pot and is collected in a container. The brine is then put in salt pans of 10 litres capacity and boiled over firewood until the salt crystallizes.

166. This salt production involves about 40 to 50 women mainly, during the dry season, when the swamp is also dry. Each woman is capable of producing 2 to 2.5 tins 20kg of salt each per day during wet season and 3 tins per day during a dry season.

#### **(ii) Brine boiling at Mnyanjani, Tanga**

167. Sea brine is collected from pits about 2-3m deep, dug along the Mnyanjani beach during low tides. During high tides, sea water percolates through the sediments around the pits, bringing sea water and sand into the pits. During low tides, the sea water evaporates to leave brine, locally called "nyongo" meaning "bile". The brine is collected and further concentrated by evaporating it through evaporation pans using fire. The process starts by putting in 240 litres of brine in 10 pans and boiling it for a while to see if the brine is sufficient to produce a thin layer of salt crust. If the results are positive, more firewood is added and boiling continues for 6 hours before another 240 litres of brine is added into the pan. Salt is harvested after 12 hours. On average, the process requires 480 litres of sea brine for 10 salt pans, and about 112 kg of firewood to boil and crystallize one batch of salt. One salt pan produces between 60 and 80kg of salt, per batch.

#### **Solar Salt Production**

168. This salt is produced from sea water by the evaporation of sea water in the sun in specially constructed reservoirs or solar pans. A fairly gently sloping area with clay soil and located very close to the high tide mark is selected as a suitable site for construction of the salt pans. These pans are reservoirs constructed with clay soil dykes to retain sea brine over a certain period and to allow evaporation and crystallization of salt. The dykes have a minimum width of 2 m. and are not more than one metre high.

169. The process of producing salt is in two stages. The first stage is to pump sea brine from the reservoirs to the condenser pans where primary evaporation takes place. The second stage is to allow the sea brine to flow freely by gravity from the condensers to the crystallizer pans and to settle until salt crystallizes.

Salt production methods at Mpara, Kilwa Masoko, Mandawa, Mikindani, Kirumbi, Mtwara Urban are the same as those practiced at Ras Kilomoni, Mtongani and Sange as described below.

**(i) Salt Production at Ras Kilomoni**

170. These saltworks were constructed in 1987. There are 5 condensers of size 150m by 50m and 7 crystallizers of size 200m by 100m. Once a month brine from the sea enters the channel leading to the reservoir constructed at one end of the saltworks. For 3 days during high tide, brine, which has a density of 3° Bromine is pumped from the reservoirs and circulated through the 5 condensers for one week. When density reaches 18° Bromine, brine is pumped into crystallizers where salt starts crystallizing at 24° Bromine. When salt concentration reaches 30° - 32° Bromine, harvesting starts. Each crystallizer has 9 salt harvesters, each capable of harvesting 40 bags (of 50kg each) of salt per day. Average production is 400 -500 bags (of 50 kg) per week. This may rise to 10,000 bags per month if the climate is dry.

**(ii) Salt Production at Mtongani:**

171. Mtongani saltworks were constructed in 1988. At present, the salt works consist of 32 condensers and 15 crystallizers. Sea water at a density of 2° Bromine is allowed to enter the reservoir once a month during high tides. The water is pumped into the 32 condensers where it is solar evaporated and circulated for one month until density rises to 10° Bromine. Concentrated brine is then allowed to flow into the 15 crystallizers in stages, leaving behind the crystallized carbonates and bicarbonates in the condensers. Salt concentration in the crystallizers rises to 15° - 20° Bromine within a period of 21 days, and salt crystallization starts at 25° Bromine. Salt harvesting starts when the concentration reaches 28° Bromine or more.

172. Harvesting is done twice a week if the weather is sunny and dry. Weekly production is 800 bags, each of 50kg an equivalent of 160 tons/month. The workforce consists of 40 to 50 workers, out of which 30 to 40 are women.

**(iii) Salt Production at Sange and Mwakaja**

173. Construction of the Sange saltworks was completed in 1990 and of the Mwakaja saltworks in 1989. The Sange salt works consist of 2 condensers of size 80 - 90m by 80 - 90m and 25 crystallizers of size 10m by 10m. It employs a workforce of 6 harvesters. During high tide brine, at a density of 3° to 3.5° Bromine, is pumped by one pump from condensers to crystallizers and allowed to settle and evaporate until the density rises to 22° - 24° Bromine, when the salt is ready for harvesting. At Mwakaja south of Sange the harvesting of salt is done when the density reaches 25° - 27° Bromine. The production of salt at Sange is 400 bags (of 50kg), or about 20 tons per year; whereas production at Mwakaja is 120 bags (of 50 kg), i.e 6,000 kg/year.

174. The baseline survey team observed that the salt pans at Sange were badly sited. Instead of locating the condensers on high ground to allow the free flow of brine from the condensers to crystallizers, the condensers are constructed on lower ground. Hence brine has to be pumped to the crystallizers. With this set-up the salt produced will always be contaminated with carbonates and bicarbonates. There is a need to reconstruct saltworks with similar problems to Sange's. Appendix 3I shows a sketch plan of a typical solar saltworks.

**(b) Limestone for Lime Production**

175. Limestone is mined by opencast methods at Kiomoni, Tanga using picks, shovels, axes, hammers, sieves, buckets and pans. The limestone is then transported by trucks from the quarry to a processing site, about 2 km away where it is sorted by hand to remove silica-rich limestone, leaving soft white limestone. The latter is then crushed manually by hammer to about 10 cm diameter, which is the maximum size required for lime production. Fire wood is stacked on the ground until the heap is 2m high after which the sorted limestone is packed on top of the firewood and the firewood ignited to burn for one day. The unburnt limestone left at the top during the heating process is sorted out. The burnt limestone is transferred to a concrete floor and water is poured on top of it, breaking it into slaked lime. The general reactions which take place can be summarized as follows:



176. The slaked lime is sieved to remove coarser material, crushed manually into small size and ground into powder in a hammer mill before it is sieved again to separate into two sizes; namely fine lime and slightly coarse lime. Testing as to whether it is fine or coarse is done by the feel of fingers. One truck load of firewood is enough to produce 100 bags of lime (of 18 kg weight each). The present production uses old technology, but a new plant comprising of a furnace, 5 motors, 3 blowers, a tank for furnace fuel oil and 6 burners is under construction. This plant will use industrial oil as fuel. The present production capacity of lime is 700 bags (of 18 kg each) per month.

### ( c ) Gypsum

177. Gypsum is mined by opencast methods at Chankonko, Makanya and Bendera at Mkomazi. There are a number of gypsum claims at Chankonko, Makanya and Bendera belonging to the following groups: -

- Claims owned by Makanya village
- Claims owned by Saruji Corporation, Dar es Salaam.
- Claims owned by private individuals

The study team interviewed personnel involved in village claims and the Saruji Corporation claims.

178. Geologically, the gypsum deposit is an evaporite (calcium sulphate) which is mixed with limestone (Calcium carbonate) and clay. It is used in the cement industry as a retarder to prevent solidification of cement. When calcined, gypsum becomes plaster of Paris, which in turn is made into various kinds of prepared plaster, and other products.

179. Due to its heterogenous composition, gypsum is sorted manually to separate waste clay and limestone from the gypsum. Mining is done by excavating pits of typical depth of between 1 and 2 m. with pit openings of 2m by 2m. Tools used for extraction include "rato" (or fork hoes), ordinary hoes, picks, shovels and drill steels, as it is often consolidated. After mining, and sorting, gypsum is loaded on to lorries or wagons and transported to the markets, which are cement factories in Tanga, Dar es Salaam and Mbeya. Production depends on the market demand, but one miner can produce 7 tonnes of gypsum per week.

**(d) Coal**

180. Coal is mined on small scale at Namwele, which is about 30 km to the northwest of Sumbawanga. Namwele coalfield is one of the 9 main coalfields of Tanzania, all of which are located in the south of the country. The coal reserves at Namwele are estimated to be between 18 and 20 million tonnes, of the following characteristics: -

**Table: 5 Namwele Coal Characteristics.**

Parameters	Values (Percentages)
Moisture	5%
Ash	26%
Volatile matter	34%
Fixed carbon	37%
Sulphur	7%
Heating value MJ/kg	92%

181. The deposit outcrops, striking N-S, dipping 24° - 30° towards the west, and is overlaid by limestone and clay. Currently it is being mined by one private small scale miner who has acquired mineral rights over the area. Mining is by strip mining, extracting the coal with picks and shovels. A strip of overburden is removed and then the limestone is mined and stockpiled. This is followed by mining of the coal seam, which is then stockpiled for various uses. The mined coal is hand sorted to remove upper sandstones, calcareous limestone and basal sandstones. The top coal seam being worked now is about 2 m thick.

182. The sorted coal is packed in bags of 50 to 80 kg each and sold. Coal for brick making is packed and used directly by the mine owner, whereas coal for domestic use is made into briquettes by mixing lime and coal at a ratio of 3:7 in order to reduce the effect of sulphur. (This locks up the sulphur to CaSO<sub>4</sub>). Run-of-mine coal production is more than 10 tons per day, and may be as high as 130 tonnes per day, using a labour force of 10 to 15 people.

**(e) Dimension Stones**

183. The survey team visited two quarries for dimension stones at Uchira, in Moshi rural district and Boko Magereza in Kinondoni district (Dar es Salaam). The mining activities of these dimension stones can be summarized as follows: -

### Volcanic Rock Dimension Stones

184. In 1984, Mabungo and Uchira villagers living on the slopes of mount Kilimanjaro, Moshi opened a quarry along a hill side for the purpose of mining volcanic rock, which is cut into the shape of bricks for the construction of houses. The quarry, with a bench measuring one metre high, 3 m. long and 2 m. wide, was opened by removing the overburden to expose the volcanic rock. This quarry has been expanded to its present size of 100m long, 20m wide and 40m high bench.

185. Mining is done by cutting with axes, large slabs of volcanic rock measuring approximately 75cm long, 60cm wide and 60cm thick. One slab, which takes 6 hours to cut, can produce 20 bricks of standard dimensions. Processing the dimension stones into bricks is done by using three axes of different sizes. The axes are locally made from vehicle leaf springs. The long axes with narrow blades measuring 25 inches in length are used for cutting large slabs at the pit faces. The large slabs are then cut into various small slabs using middle size axes with blades measuring 11 in. Bricks are carved out of the small slabs by using small sized axes with blades measuring 9 in, thus ensuring that the width and thickness of the bricks measure 9 in by 6 inches respectively. The lengths of the bricks vary slightly in length from normal concrete blocks, which are 18 in. Apart from axes and picks, spades are also used to muck murram, which is used for road construction. The quarry offers employment to women and children as well, who carry the bricks from the quarry bottom to the surface for stockpiling and marketing.

### Limestone Dimension Stones

186. Limestone dimension stones are mined at Boko Magereza Quarries located 40km north of Dar es Salaam. This is a banded limestone with a thickness varying from one metre to 2 m. The colour ranges from white to brown or brown spotted. Due to its attractive colours it is used to decorate the outside walls of houses. The formation of this limestone deposit, which is in layers extended over several periods, during which time a layer was deposited each a different season. There is also a hard calcium carbonate which was deposited later. The limestone which precipitated slowly resulted in large crystals of calcite. Fossils of small animals and insects can be seen.

187. This limestone dimension stone is mined by crow bars and vehicle leaf springs and hammers. Blasting is avoided because it would shatter the rock. The top red soil is removed by pick and shovels to expose the banded limestone. The mined porous banded limestone is sold after being slated and massive limestone is used as aggregate. This quarry offers employment to 29 people who have formed a co-operative society.

#### (f) Limestone Aggregates

188. Three limestone quarries were visited at Bunju A, and Kunduchi in Kinondoni district (Dar es Salaam) and C.I.C. at Kiomoni in Tanga Urban district. The mining methods of the quarries at Bunju A, and Kunduchi are the same, using only picks and shovels to extract the limestone. The Bunju quarry is operated by one miner who has employed 12 workers, including 6 women, while the quarry at Kunduchi has several miners working as individuals, women included. The mine at Kiomoni with 13 employees is being operated by C.I.C. a subsidiary of the Somaia Group of companies. The quarries have benches with average heights of 2.5m.

189. Processing at the Bunju A and C.I.C quarries are mechanised. At Bunju A the mined limestone is carried on the heads of women from the quarry to a crushing plant erected at the edge of one of the quarry benches. The stones are fed manually into a jaw crusher whose capacity ranges between 5 and 7 tonnes per day. The aggregate is discharged by gravity into two trommels mounted in series and separated into two sizes of 3/8 in and 1/2 in respectively.

190. At the C.I.C quarries, limestone is blasted after drilling using jackhammers and compressors. The blasted limestone is crushed manually to 10 inches size by hammers before it is transported to the crushing plant by trucks. At the crushing plant, which has a capacity of 30 tonnes per day, the stones are fed manually into the crusher. The crushed aggregates are transported by conveyor belt into a trommel with four different openings of sizes 3/8 in, 3/4 in, 3/4 in and 1 in the. The aggregates are stock piled, ready for marketing.

#### (g) Sand

191. The survey team visited six sand mining sites out of which three are river valley deposits and three are raised beach deposits. The river valley deposits are located at Mirongorinne in Aru Meru district (Arusha), Msitu wa Tembo in Simanjiro district and Kisangiro in Mwanga district, while the raised beach deposits

are located at Mwakanga and Kitunda in Ilala district and Dovya (Chamazi) in the Temeke district of Dar es Salaam Region. Sand is mined manually along river beds and quarries using shovels. Due to its readily available market, the sand is loaded into trucks using shovels, ready for disposal.

### General Observations

192. Apart from the above specific observations for each mineral commodity, the field survey team have generally observed that:

- The mining methods applied are not appropriate. Artisanal miners do not take into account the stability of hanging wall and footwall when choosing the best method of ore extraction.
- The blasting methods applied focus on rock rupture without considering the amount of explosives charged. In most cases, excessive explosives over break the ore or crack pieces of gemstones.
- Underground timbering is badly practised; typical structures are weak yet use excessive materials.
- Ores that contain metallic sulphides require complex processing procedures in order to recover the refractory gold locked in it. A comparison of the ideal and actual processing methods as applied to different gold bearing ores is given in Table 6.

Table 6:

## PROCESSING METHODS APPLIED FOR GOLD ORES

GOLD OCCURRENCE	TREATMENT METHODS	
	ARTISANAL MINERS	STANDARD METHOD
Alluvial gold	gravity concentration (i) Hand pans (ii) Blanket tables (sluices) Amalgamation	Gravity concentration (i) Hand pans (ii) Spirals (iii) Jig (iv) Shaking tables Amalgamation retorting.
Free milling lode gold	Gravity separation (i) Blanket tables Amalgamation	Gravity concentration (i) - (iv) above methods Amalgamation - retorting Cyanidation.
Gold in sulphidic ores	Gravity concentration (i) Blancet tables Amalgamation Cyanidation	Floatation Roasting Cyanidation Biohydrometallurgy

## General recommendations

193. From the field observations, the following recommendations are made in order to improve both mining and processing methods as well as for less toxic waste production. Prior to mining, artisanal miners should seek assistance from the nearest mines office on:

- uses of the available geological data for the area
- how to improve their prospecting methods.
- the choice of mining method and how to access professional advice before dealing with complex operations such as timbering, ore extraction and processing.
- how to handle toxic chemicals and waste with regard to mine closure. environmental regulations should be enforced.

194. Specific recommendations are given in the various development options in Part II of this report. Table 4 shows recommendations for some underground mining methods that can be used.

**Table 7:**

**RECOMMENDATION FOR UNDERGROUND MINING METHODS**

<b>SELF SUPPORTING OPENING</b>	<b>ARTIFICIAL SUPPORT OPENING</b>
Open stope mining	Cut + Fill stope
Room + Pillar Mining	Long or Short wall mining
Sublevel stoping	

## D. COMMERCIAL ASPECTS

### 1. MINERAL MARKETS:

195. Mineral dealing, especially of precious minerals, coloured stones and gold are normally conducted in privacy and it is very difficult for outsiders to follow market trends. In order to understand the currently prevailing mineral markets in Tanzania, a study was carried out to identify types of traders, marketing channels and to examine the causes behind mineral smuggling.

#### 1.1. Influence of Mineral Markets

196. Mineral markets influence the behaviour and activities of artisanal miners in a number of ways:

- (i) The intensity of artisanal mining activities is directly related to the existence of good markets for the mineral sought.
  - If the market disappears the miners also stop working, and shift to other areas, e.g. active ruby mining in Morogoro ended in 1994 with the discovery of better quality gemstones in the southern regions.
- (ii) Where there is stable production of minerals, the miners or the producer tends to get fair price for his or her products, the number of middle men also decreases. A well known garnet miner at Kalalani, Tanga didn't know where to sell his products previously but now he can sell his output directly to gem-exporters at favourable prices.
  - In another example Merelani tanzanite miners are sometimes more knowledgeable on the quality and prices of their products than are their buyers. Some miners now sell faceted stones instead of rough material.
- (iii) Active local mineral markets do not automatically reflect the contribution of the mineral sector to the local community and to the nation as a whole.

- Not all the purchased minerals are exported through official channels.
  - The present market system does not allow local leaders to know what has been produced in the district/region.
- (iv) The presence of a good market is understood differently by various stake holders in the industry. To the government, the creation of mineral markets is mainly a matter of issuing dealers' licences and regulating export procedures. To mineral dealers, it is a constant supply of minerals either through brokers or direct from miners, and having a reliable foreign buyer to purchase the collected minerals. To the artisanal miner the market is good when he can easily sell most of his minerals at a price higher than the previous offers he has had before. It is not of concern to miners if the buyer is a licenced dealer or a smuggler, provided the price offered is good. During February and March, 1996, miners and mineral brokers complained bitterly about the absence of mineral markets when the government intervened to remove illegal foreign buyers in the Tunduru mining areas. The price offers were good, but very little of the purchased gemstones were exported through the official channel. The basic interests of the miners, the mineral traders and the government must be considered in reviewing the trade regulations.

## 1.2. Mineral traders and areas of operations

197. Local mineral trading is usually in the hands of: small brokers, mineral brokers (traders and miners) and mineral dealers who can either be licenced or smugglers.

### (i) Small broker:

Operates within the mining area and some of them live on commissions for linking services. Sometimes they are hired by mineral brokers as informers or body guards. In mining rush areas their number is sometimes three times that of mineral brokers. The Tunduru area alone has 1500 to 2000 such small brokers. Among the small brokers there are fulltime operators and part time ones who are also engaged in mining or small trading activities. Because of this, it is not possible to get the exact number of small brokers for a particular mining area.

(ii) Mineral brokers:

The number of mineral brokers is great in mine rush areas and decreases considerably in stable mining villages. It is estimated that there are 710 brokers nation wide, with as many as 400 people involved in some districts.

Mineral brokers provide a reliable major market for materials produced by artisanal miners. Brokers can strongly influence export channels of the purchased minerals as they can sell their products either to official dealers or to smugglers. They operate in mining areas and then travel to the cities to sell their mineral collections. Normally, the broker's market selection is influenced by the price offered and the credit facilities available. Mineral brokers can be full time or part time traders and this is the case with most claim holders.

From March, 1996 the Government of Tanzania issued the new gemstone marketing procedures which, for the first time, legalized the activities of mineral brokers upon securing a broker's license. The license, which is renewed every six months, enables the operator to buy and sell minerals to registered mineral dealers. Already 86 licenses had been issued by April, 1996. (See Table 8). There have been some complaints from brokers who fail to secure business trading licenses before getting brokers license. This situation suggests a need for the government to simplify procedures and conditions during the transition periods of informal to formal business operations of the sub sector.

Claim holders are actively involved in mineral trading for a number of reasons:

- To minimise mining operational costs
- The buying and selling of minerals is an extra income generating activity and has a high profit margin.
- It offers security and confidence to his or her mine workers.
- It is a way of recovering minerals which have been stolen by mine workers.

- A claim holder is also the first buyer of products from miners working under a production sharing system. This practice also reduces the number of outside mineral brokers. For example in Chunya and Mpanda gold mining areas there very few gold brokers, as claim holders are active in buying produced gold in their areas.

### (iii) Mineral dealers

There are licensed and unlicensed mineral dealers both in gold and gemstones. The number of licensed mineral dealers is changing from year to year see Table 8 below:

**Table 8: Licensed mineral dealers**

YEAR	1989	1990	1991	1992	1993	1994	1995	1996
<b>DEALERS</b>								<b>April</b>
Gemstone	-	-	56	105	128	127	145	63
Gold	14	13	7	6	9	23	23	12
Lapidary	3	3	4	7	10	11	12	20
Brokers	-	-	-	-	-	-	-	86

**Source: The Ministry of Energy and Minerals**

Mineral dealers have varying financial capacities and mineral trading knowledge depending on their trading preparations and degree of cooperation with foreign partners/buyers. There are both locally owned companies and joint ventures. Local companies have been complaining of unfair business practices conducted by foreign owned companies, especially the tendency to invite foreign buyers to utilize their dealers licences. For that, the volume of gem purchases is not reflected in the gem export figures. This has led the government to install new procedures limiting foreign gemstone dealers to regional centers only.

198. The present study shows that most dealers don't visit the mining areas but operate from small towns and regional centers close to mining areas. Most dealers interviewed say this is a way to reduce security risks, transport and marketing costs. Mineral brokers usually use public transport and those with private cars in most cases undertake a parallel business of carrying goods and passengers. Many mineral dealers don't trust strangers in their cars and some are not used to a rural existence and hence feel uncomfortable and at risk when staying in mining areas. It will cost a mineral dealer between TShs. 250,000/= to TShs. 350,000/= for a round trip from Dar es Salaam to Tunduru, using a four - wheel drive, whereas a mineral broker will need TShs. 25,000/= to TShs. 30,000 only to reach the same area by public transport. A dealer will stay at a TShs. 8,000/= per night lodge but a broker will pay Tsh. 1,000/= in a normal guest - house. It has been difficult to assess the number of unofficial mineral dealers, as most of them operate other businesses to cover up their dealings in mineral trade. Interviews with miners and brokers show that there are between 80 and 220 unofficial gold and gemstone dealers respectively, operating mainly in district centres and major towns. At present licensed dealers are the major revenue contributors.

### 1.3. Marketing channels

199. As noted, mineral trading exists in both formal and informal marketing channels and is normally performed in two phases:

1. Buying - Collecting minerals from miners
2. Selling - Selling of minerals to foreign buyers either by exporting or smuggling

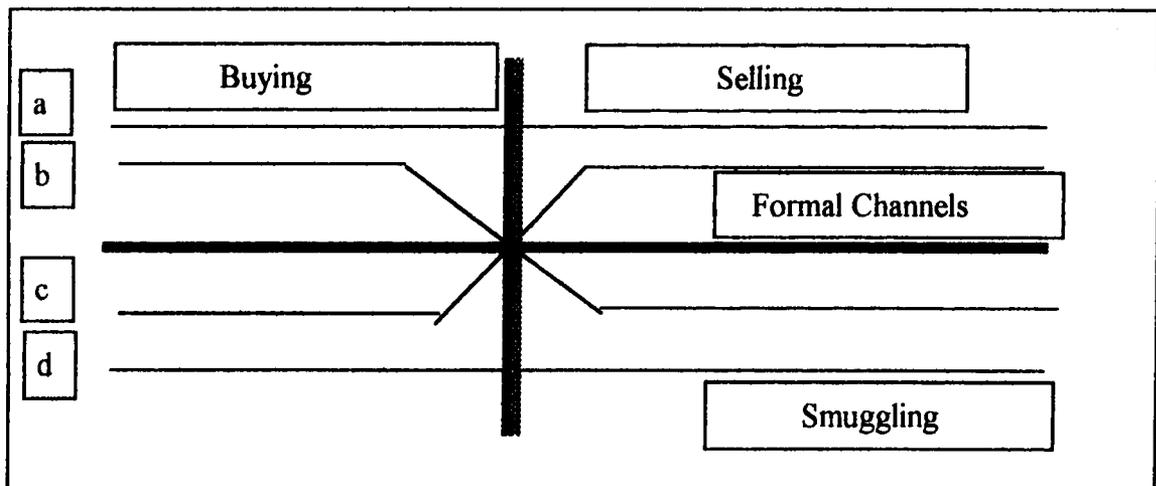


Figure 9: Mineral Marketing Channels.

200. As fig: 9 shows, minerals can be purchased from miners using formal channels and later exported through informal channels and vice versa.

A comprehensive market chain for gemstone, gold and diamond is given in the chart of Appendix 5 E. During the survey it was estimated that 60% of the recovered gemstones and 70 - 85% of the gold produced is currently being smuggled outside the country. These estimates were given by several active mineral dealers, brokers and gold smiths, in various parts of the country. The consultants also observed the nature of the mineral trade in certain areas like Tunduru, Merelani, Arusha, Geita and Mwanza and the backgrounds of the buyers in order to determine the exit routes of the purchased minerals. The estimated percentage volumes of trade suggest that the number of participants at various stages of marketing channels is variable. Factors behind these variations are related to the type of mineral commodity in demand, trading locations, credit arrangements between brokers and dealers/smugglers, prices, foreign order to legal dealers and the demand for imported consumer goods. **It was also noted that it is not possible to determine share of parallel market at the district level because of secrecy nature of the trade and some of the mineral commodities are traded far away from the mine locations**

201. The intensity of activity in the various trading routes and networks keeps changing, and this is also influenced by the above factors. It was observed that brokers usually specialize in a particular type of mineral commodity, although occasionally they deal with more than one type, especially when there is a new mine rush area. Also it was noted that brokers frequently move from one area to another, looking for materials for which they can find an easy market. In Tunduru, Tarime

Geita and Mahenge, etc. a broker with a motor vehicle can visit more than 3 or 4 areas in a single day. After selling his minerals, in town, where he meets other brokers, he may, change his buying area to another part of the country. This leads to similarities in the trading networks of a particular mineral commodity.

202. It was also observed that although there is limited financial co-operation between dealers/brokers and brokers/miners, most deals are concluded separately, and each individual is at liberty to choose his buyer and supplier of minerals. Limited syndicates are reported to exist in the gold trading networks of Chunya - Dar, Mpanda - Dar, Geita - Mwanza, and Tarime - Kisumu. The Merelani Tanzanite networks start with the provision of technical assistance in mining by tanzanite exporters. The main gemstone networks are Merelani - Arusha - Foreign markets, and Merelani - Nairobi/Mombasa - foreign markets. Other routes are Tanga - Dar, Songea, Mtwara - Dar, Morogoro -Dar and Sumbawanga - Dar and Tunduma.

#### **1.4 Local Mineral Markets:**

##### **( a) Gemstone Markets:**

203. Buyers normally visit the mining areas and even attempt to book production. Sometimes they offer a little assistance and incentives to miners in order to improve business relationships. The trading of gemstones is conducted in the form of parcels, without grading or weighing the minerals. Some buyers prefer to select only minerals of preference, but others purchase the whole parcel and later grade it according to export market needs. Bargaining skill rather than gemological techniques determine the price of the commodity. Various ruses are also involved between buyers and miners, e.g. adding ingredients by the miners to improve the appearance of the mineral commodity while the buyer tries to discredit the quality of the gem parcel. Neither the buyers nor the sellers keep true records.

204. The Ministry in collaboration with TAMIDA and Regional Miners Associations, initiated weekend gemstone local markets in 1993. The aim was to bring a reliable gemstone market close to miners. The exercise didn't last long due to opposition from mineral brokers, who managed to collect good stones from miners before the official market days, and who preferred to sell them straight to dealers offices in major towns. Failure to have an alternative market near mining areas has left the small producers dependent sheck on the offers of brokers, as it is expensive to travel to major towns to sell to mineral dealers. Occasionally brokers are obliged to escort miners with big gem parcels to go and sell direct to dealers, and they receive a commission for this.

205. Detailed studies in various trading centers have revealed that the prices changes in the above market chain vary depending on the number of middlemen, the market knowledge of the miner and the type of coloured stone. Other factors influencing price changes are the distance apart from one stage of the claim to another and the season of the year. As prices fluctuate from time to time, the price ratio changes give the retention shares of various parties. Examples of price changes in a trading network show that a 2.00 - 3.50gm cats eye round-shaped rough chrysoberyl stone bought at Ngapa in Tunduru and sold to a foreign buyer in Dar es Salaam during January 1996 will change price as follows:-

**Table 9: Price changes in different levels of trading - Chrysoberly**

From	Trading location	Price Offer (Tsh. Million)	% Change
Miner	At Ngapa	0.5 - 0.8	-
1st broker	" Tunduru	0.5 - 0.5	200 - 220
2nd broker or dealer	" Dar es Salaam	3.0 - 3.5	100 - 40
Export/Fereign Buyer	" Dar es Salaam	04/04/06	33 - 128

By May, 1996 the price offers were one third of the January prices.

206. The above quotations are similar to price offers for a 0.75 - 1.0 gm alexandrite of clean colour A material. The price for blue sapphires changed drastically more than that of any other precious gemstone between November, 1995 and May, 1996. A top colour 1.0gm inclusion-free blue sapphire had the following price offer:

**Table 10 : Price changes - Blue Sapphire**

Trading Location	Price Offers (In Tsh. Millions)	
	2 Nov 1995	May 1996
Tunduru	0.2 - 1.1	0.05 - 0.08
Dar es Salaam	0.5 - 4.0	0.1 - 0.15

207. A gram of tanzanite, colour A, round-shape, without any inclusion, bought at Merelani and sold to a foreign buyer in Arusha during the month of April - May, 1996 changed price as:-

**Table 11 : Price Changes - Tanzanite**

From	Trading location	Price Offer (Tsh. Million)	% Change
Miner	At Ngapa	0.5 - 0.8	-
1st broker	" Tunduru	0.5 - 0.5	200 - 220
2nd broker or dealer	" Dar es Salaam	3.0 - 3.5	100 - 40
Export/Foreign Buyer	" Dar es Salaam	04/04/06	33 - 128

208. The above changes in prices along the market chain explain why mineral dealers prefer to operate close to mining areas in the southern regions but don't have offices at Merelani tanzanite mines. As noted above, gemstone market networks are delicate, with prices fluctuating frequently, depending on demand and visits by foreign buyers. This tendency affects mineral brokers, as their working capital is sunk in their stock of minerals. Sometimes they loose money due to a fall in prices, or even the disappearance of the markets for a certain mineral.

**(b) Gold Markets:**

209. There are a few middlemen in gold trading, and the collection networks are more established than those of gemstones. Gold brokers (diggers) usually provide mercury to miners on specific agreements as a way of booking production. Small brokers purchase gold by experience without any technical test. The gold bullion is normally wet and they weigh by using hand scale - balance with razor blades as units of measure (1 chapa = 1 cent = 2 gms). There are many ruses used when weighing the gold. This is usually done to compensate the high price which the gold broker offers compared to the official rate. It was noted that gold dealers don't have regular visits to mining areas, as do their gemstone counterparts. The usual practice is to assign agents or brokers because quality control is less complex and purchase prices are stable for considerable periods of time.

210. In the past few years, some gold brokers conspired with a few bank officials to mix bullion gold with silver alloys and other heavy minerals before selling it to the Bank of Tanzania. This contributed to the losses incurred by the Bank. Goldsmiths are traditionally by illegal gold buyers, and they provide credit to gold brokers and agents. This arrangement has enabled the parallel market to compete well with the Bank of Tanzania's gold buying activities and the few official private dealers. Gold buying centers are in Songea, Mbeya, Mwanza, Arusha, and Dar es Salaam.

#### **(c) Marketing of other minerals:**

211. Salt, industrial building material and coal producers have a common problem of high transportation costs to reach their markets and clients. Discussion with miners of these mineral commodities showed that they have never tried to establish proper market outlets for the minerals. Most of them sit and wait for customers to visit them rather than the opposite. In one godown in Lindi there were more than 500 metric tones of salt which could not be shipped to Dar es Salaam because the production and transport cost would be Tshs 93,000 per ton, which is well above the Dar es Salaam market price of Tshs 54,000.00 per ton. At the same time it was noted that Tanzania is currently importing salt from Kenya and other countries due to low delivery rates compared to the local ones.

212. Co-operative group activities are common in most non-precious mineral works, but other areas of joint effort were identified to be the protection of mineral rights and lobbying for better social services. None of the groups visited have worked seriously on product marketing issues. Even at Kunduchi, Dar es Salaam quarry area, miners still sell a 7 ton full truck of aggregates for Tsh. 10,000/= only while the truck driver will resell the trip 20km away at Tsh. 40,000/= to 45,000/=. Other mineral products like coal bricks and volcanic building blocks require special market promotional efforts, as their utilization will help to reduce demand on scarce alternative materials, e.g. sand at Moshi town or firewood in Rukwa region.

#### **1.5. Mineral Exports:**

213. The export figures for various mineral commodities are given in Appendix 5C. Mineral exports have increased since the introduction of the mineral trade liberalization policy in 1987. Mineral dealers' licenses were issued to private operators and the Bank of Tanzania started to buy gold produced by artisanal miners from April, 1990.

214. The sharp increase in gold exports from US \$ 1.1 million in 1989 to the peak level of US\$ 31.4 million in 1993 reflected how much of the gold produced by artisanal miners was smuggled through parallel markets. However this achievement was short lived, as the Bank's efforts to increase purchase prices did not match the incentives offered to gold brokers by smugglers - Appendix 5D shows gold purchases were directly influenced by price increases, although exchange rate changes didn't have an immediate or significant impact on gold purchases from artisanal miners. It was also observed that the number of private gold dealers dropped from 14 in 1989 to 6 in 1992 which were the years when the Bank of Tanzania was buying gold directly from artisanal miners. The number of gold dealers started to increase again to 23 in 1994 and to in 1995. However it has to be noted that the ratio of volume of gold exported by the number of license dealers in 1995 does not match that of 1990. Gold dealers complain about the present gold export procedures as not favouring growth of official exports. The present condition to send gold for assaying before selling, and this, coupled with delays in remitting export proceeds have been cited as weakening dealer's competition against gold smugglers. Most smuggled gold is used to finance importation of goods, while the gold itself feeds jewellery industries in the Middle - East and Asia.

215. The increase of gemstone exports from year 1990 is directly associated with the number of gemstone dealers and incentives to retain foreign currency earnings. Gemstone dealers cannot rapidly increase their exports due to factors like the existence of smuggling which is discussed below, lack of export credit facilities, disadvantages in utilizing forex cheques with loss in exchange rates, poor mineral collection networks, little knowledge of export market trends and an inability to set strategies to penetrate value added markets. Market information and value added activities are essential to enable most industrial minerals that are produced to be exported. Miners of lime, gypsum and magnesite are currently unable to prepare their products to meet international market quality requirements.

#### 216. Gemstone Shows/Auctions

TAMIDA and the Mineral Marketing Division of MRD have been organizing international gemstone shows since 1992. They are normally held in Arusha in May every year. The aim of organizing such gemshows was to promote the gemstone business and the image of local dealers in the eyes of international gem buyers. TAMIDA show organizers made several trips to attend and learn from major gemshows in Europe, America and the Far East. Some of the developments associated with staging gemshows in the country are: -

- An improvement of business relationships between local dealers and foreign gem buyers.
- Mineral dealers normally secure reliable purchase orders at the show.
- A rare opportunity to exchange information about supply and demand of various types of coloured stones.
- A major one-stop collection of mineral royalty. In 1992 the government collected revenue from show sales of Tsh. 2,8 million, which had increased to Tsh. 200 million in May, 1996 during the 6th International Gemshow. (See Appendix 5F)
- The quality of the merchandise on offer has improved, with more dealers selling polished stones while the display facilities are now of international standard.
- The gemshows give an opportunity to various government departments to understand the nature and problems of the gemstone trade.

217. Despite these developments, the Arusha Gemshow is still very young in comparison with other international gemshows in Europe, Asia and America. There is a need to organize a variety of gemshow gatherings at intervals convenient to the participants, especially the international traders, who normally plan their foreign trips to be able to attend several gem centres and shows. It is important to further the idea of having regional gemshows, to pull in sufficient merchandise and numbers of buyers, as well as having frequent smaller gem exchanges to allow small foreign gemtraders and miners to participate in an open trading floor. This also helps to reduce smuggling practices. The frequency of gem exchanges should take into account the peaks of gemstone production in the year and the ability of gemstone brokers and dealers to purchase goods from miners. It was also observed that the successful gemshows are those which traders were involved in organizing, and where government institutions were present to provide essential services such as, security, sealing, banking, custom clearance and immigration services. All the major gemshows in USA, Germany, Israel and Thailand are organized by gemstone traders associations. The importance of gemshows cannot be over emphasised, for here dealers can secure orders from foreign buyers, in turn creating stable markets for the minerals produced by small scale miners. It may be noted that past efforts by the Board of External Trade (BET) to organise gemshows didn't attract any serious gem buyers.

### 1.6. Mineral Smuggling:

218. Motives for smuggling are of an economic nature and hence are subject to change from time to time. The major factors behind mineral smuggling in Tanzania are:-

- Search for better markets and prices
- To avoid official bureaucracy
- To avoid excessive taxation
- To finance barter trade
- Existence of informal foreign credit given to mineral operators.

219. A licensed mineral dealer has to pay several taxes which put him in unfair competition with mineral smugglers. Among the taxes facing the dealers are: -

- Royalty - 5% of export quotation
- Withholding Tax - 2.0% of export quotation
- Stamp duty - 1% of the gross purchase figure

Other annual tax commitments are: -

- Corporate - 35% of profit in a year
- Dealers licence .
- Business trading license

220. A separate mineral dealers and trading licenses are required when the dealer operates an additional branch office. By comparison the costs of smuggling are very low. It costs US\$ 200 to US\$ 400 to have a gemstone parcel of any value smuggled into a neighbouring country from Arusha or Tanga town. Smugglers are mostly foreign brokers operating in mining areas, and registered and unregistered mineral dealers. Gold smiths are used to purify raw gold before marketing. Smuggling outlets involve the usual limits of formal mineral trading routes or border towns. The major outlets are therefore Dar es Salaam, Tanga, Moshi, Arusha and Tunduru for coloured stones, and Dar es Salaam, Zanzibar, Mwanza, Tunduma, Tarime, and Arusha for gold.

### 1.7. Market service needs.

221. Despite the fact that Tanzania is one of the few countries in the world with a large variety of coloured stones, there are no established institutions to offer essential services like basic gemological studies, training in value added and enhancement activities like gemstone cutting, polishing and modern jewellery works. Ignorant miners are exploited by brokers and dealers, and mineral exporters cannot penetrate into the world gem markets. Efforts by the Mineral Trade Division of MRD and TAMIDA to educate mineral dealers are not sufficient and do not meet the needs of the producers and those who wish to invest in added value activities.

222. The Ministry of Energy and Minerals should supervise the marketing of both mineral and mineral products. At present several government institutions are involved in approving and controlling mineral exports. The Bank of Tanzania is involved in gold export, but gold smiths get their licenses from the Ministry of Industry and Trade. This also includes industrial minerals like gypsum. The Ministry of Health is involved in salt marketing. This makes it very difficult to assess common problems facing mineral producers and traders. The system also creates unfair competition among operators, as licences are issued under different conditions, giving an opportunity to tax evaders to choose the weaker system. An example of this is that the gold smith licence, obtained from the Ministry of Industry is simple to acquire, whereas obtaining a gold dealing licence from the Ministry of Energy and Minerals, has several conditions and decision procedures. Yet both allow the licence holder to deal in gold.

## 2. FINANCIAL ASPECTS

223. Lack of formal credit facilities for the small scale mining sub-sector has greatly hindered the development of orderly mining and mineral trading activities. Most of the claim holders interviewed didn't even think of seeking loans because they know they would not qualify. (See Appendix 5G and Appendix 5G).

## 2.1. Problems of Insufficient Operational Funds

224. Efforts of small scale miners to overcome the problem of insufficient operational funds have resulted in: -

- The existence of an informal tributing system in production organization structures. Here the claim holder sublets mining operations to pit financiers. Incentives are used to retain mine workers (See Appendix 5I)

In alluvial workings, the production sharing systems are used instead of paying salaries to mine workers.

- The existence of hazardous mining practices and insufficient safety measures, especially in underground mining.
- Miners obtain credit from informal sources, mainly mineral smugglers and this denies the country forex earnings. About 15% of mine operators interviewed in the Mbeya and Morogoro zones and 21% in the Arusha mine zone admitted, taking loans on terms of personal guarantees. Lenders do not accept claim titles as collateral as they have no legal mandate to own the claims.

225. Most artisanal and small scale miners do not qualify for lending from financial institutions because: -

- they lack a formal legal structure, such as registered company or a co-operative.
- they have no tradition of using banks in their dealings. Most mine workers save their earnings through mineral brokers - 'diggers'.
- they are not in a position to provide security for the loans desired, or to raise the capital contribution requirements (of 15 - 35% of capital), hence do not qualify for loans by formal financial institutions.

## 2.2 Position of Local Lending Institutions

226. Local lending institutions have negative attitudes towards the small scale mining sub sector because:

- they do not have skilled personnel who can assess the potential of miners and their resources.
- they do not have specialized funds which can be lent at favourable lending terms.
- most institutions do not have any experience in financing an informal sector like artisanal mining.
- they do not distinguish between the risk categories of small scale mining. Mineral dealers are routinely denied overdrafts even if they have collateral.
- some banks might give loans for mining development, but do not cover the cost of feasibility studies. On the other hand very few small scale miners have the ability to prepare or commission professional feasibility studies.

### 2.3 Other potential sources of funds and technical requirements

227. Due to the factors listed above it can be seen that very few organized mines can qualify for credit from financial institutions. Nonetheless the study shows that miners' incomes, although small, are relatively higher than many other rural economic activities. So, the first alternative for fund sources should be the reinvestment of mineral revenue to fund mining development activities. Income saving has enabled successful miners to purchase essential equipment and mining supplies. 45-65% of the operators depend directly on mineral sales to finance mining operations and less than 20% seek direct loans from private dealers. Better mineral markets and a knowledge of mineral reserves could reduce the present resistance of miners to reinvesting in mining development activities.

228. The sharing of facilities by joint ownership or hiring has helped to improve efficiency and production in some areas. Where forming a partnership was not possible, individuals maintained equipment and offered it for hire. Examples of this were noted in compressor and water pump hire in the gold producing areas of Lake Victoria and alluvial gemstone mining in the southern regions of Ruvuma, Mtwara and Lindi. A partnership arrangement is the most favoured system of co-operation preferred by the artisanal miners. (Appendix 5 J). Any efforts to offer technical assistance to artisanal miners should take this fact into consideration .

229. Informal sector credit schemes along the lines of the Grameen Bank of Bangladesh can help not only to provide the much needed credit but also to transform the savings and spending culture of artisanal miners. Pride Africa, an NGO operating on Grameen Bank principles, has recently started providing funds on a credit basis to mineral brokers of Merelani, Arusha. It is too soon to assess the performance but indications are that the groups are repaying their loans in time.

230. Donors and other interested parties should be encouraged to donate funds which can be administered by competent institutions to provide soft loans to serious miners.

## **E. SOCIO - ECONOMIC ASPECT**

### **1. ECONOMIC SIGNIFICANCE OF ARTISANAL MINING:**

231. The economic significance of artisanal mining in Tanzania is important from the increase of the forex exchange earnings, mainly from sales of gold, gemstones and diamonds and the government revenue as explained in the summary notes. Job creation by the sub sector has increased considerably. The present study shows that more than 555,000 people are directly involved in mining activities around the country. Some of them are full time miners and others alternate mining with other economic activities, principally farming. It has to be noted that most artisanal miners originate from rural areas with minimum skills and education levels. The number of artisanal miners is also not fixed, as they are self employed, and the intensity of mining operations changes from one season of the year to another.

232. Some of the negative economic aspects of artisanal mining are poor organization, low overall due recoveries to poor mining and processing technologies and loose control of the mineral produced, which ends up being smuggled. It was observed that government revenue would have increased in line with expanding mining activities if only the tax base had been broadened. This broadening can be achieved by establishing a modest fiscal and legal framework to enable the government to collect revenue from artisanal miners and mineral brokers. Fiscal reform must balance how best to increase local revenue without affecting forex exchange earnings.

#### **Contribution of artisanal miners to house -hold income:**

233. The income of an individual miner depends very much on his position and type of production organization structure in which he is involved. In alluvial gemstone mining the claim holder gets 50% of the material produced, while in gold mining the claim holder gets 10% - 40%, the pit owner gets 20% - 40% and the rest goes to the mine workers. The claim owner collects the above percentages from each producing pit in his claim. The income of an individual mine worker, in reef gold mining is only 2 - 8% of that of a claim owner. An average gold claim holder expects to earn between USD 200 - USD 1,000 per month, while gemstone claim holders expect less than USD 400 per month. However a gemstone mine worker can earn more than USD 800 in good alluvial grounds. There have been several cases where a gemstone mining gang has collected USD 50,000.00 from a single day's production.

The incomes of mining groups varies considerably from one pit to another and from one mining location to another (See Appendix 1F) depending on the type of mineral commodity, nature of occurrence and the mining and the mining and processing technology in use.

234. It has been noted that miners give first priority to their families in the allocation of their expenditures. Most mine workers save their earnings through claim holders or mineral brokers and usually spend the surpluses by investing in non-productive assets. Successful claim holders invest very little in mining businesses activities but opt for new businesses perceived as of lower risk, like transport and guest houses. It was also observed that miners spend most of their savings during low seasons when production is poor.

## **2. OTHER SOCIO-ECONOMIC ASPECTS:**

### **2.1 Population changes:**

235. Tanzania, being a cosmopolitan state, with political stability and peace, has enabled miners to migrate freely from one part of the country to another without any constraint. Mining groups are formed not on tribal or religious bases but on mutually acceptable agreements in work conditions and objectives.

235. There is a rapid increase of the miners population in mine rush areas and this creates unexpected hygienic and health problems. There is also a poor maintenance of law and order. On the other hand, it was observed in well established traditional mining villages that the sanitation conditions and observation of law and order were better than in most farming villages. The rapid population changes associated with mine rushes drain locally available resources such as water, food and medicine. In most cases the local authorities cannot cope adequately with these sudden demands.

### **2.2 Social amenities and shelters:**

236. The level of development of social amenities, the quality of shelters and of infrastructure depend very much on the presence of large workable reserves of minerals and the development of mine activities. Shelters for miners in mine rush areas are very poor. Modern houses are seen in established mining towns such as Merelani and Makongolosi - Mbeya. Most mining villages have basic social amenities. However it was observed that there is poor drug

handling and poor medical services in areas without government dispensaries. Operators are usually not licenced and conduct their business illicitly, with drugs and equipment stored in unhygienic environments. Camp leaders have requested authorities to allow private mobile dispensaries, but they have been told that no such permits do not exist.

### **2.3. Participation of artisanal miners in community development activities.**

238. The participation of miners in community development activities depends on the stability of mineral production, the existing authority structure and the previous experience of how past contributions were utilized.

- Most districts rely on contributions from the mining community for development projects.

e.g. A district secondary school in Chunya town was built with major contributions from miners.

- Health centres, primary schools and village offices in most mining villages were built by miners through self-help schemes.
- Miners under strong leadership in Mbinga District contributed in constructing a 15 km gravel road from Mpepo to the Mozambique border at Dar Lunyere.
- Miners in mine rush areas do not actively contribute towards development projects of surrounding areas. Nonetheless, they participate closely in all traditional and social functions.

### **2.4. Linkage with the rural economy:**

239. Interlinkages of artisanal mining activities with the rural economy exist because miners get their basic needs from the nearby villages, and the self-same villages supply labour to the mines. The extent to which a village can benefit from mining activities depends on its level of economic development and the extent of the participation of its people in mining.

240. Villages with little to offer due to the poor development of its people tend to be negatively affected by the presence of mining activities in the area. Life at Ngapa village in Tunduru district became unbearable when a gemstone rush started in mid 1995. Families were forced to send children to work in the mines in order to cope with the price increases of basic commodities. The costs of living can also change once a mining activity stops. For example the prices of food stuff dropped in Ruaha - Mahenge when ruby mining declined there.

241. Villages near mining areas benefit from selling food stuffs which were originally not common cash crops. It was not possible to get any statistics for this economic linkage, as there are no records kept of the transactions. Material accumulation and created services were the only indicators to reflect the benefits the villages had gained from the presence of mining activities. At Muhesi village in Tunduru, the village chairman cited the achievements of some villagers, including the purchase of 8 vehicles, the building of more than 10 modern houses, while the roofs of 26 houses were changed into corrugated iron sheets and half of all petty trading activities are owned by local people. This is also true of Arumeru village near Merelani tanzanite mines.

## 2.5. Maintenance of Law and order.

242. Drug abuse, the excessive consumption of alcohol and other social ills are very common in mining areas, especially in mine rush areas and small mining towns. The frequency of drinking and the type of alcohol used depend on the type of activity:

- Mineral brokers and alluvial mine workers are more likely to be heavy drinkers than reef mine workers.
- The use of marijuana is very common, but for most users it was a habit acquired before they joined mining activities.

243. The incidence of crime is reported to be low in mining villages, and normally involves petty theft and fighting.

- There was no evidence of organized crime. Security officers cited very few incidences of armed robbery and explained that these were directed from towns rather than being planned from within mining areas.

- Police in various districts stated that the incidence of crime was the same as in other rural communities.

244. The maintenance of law and order is in the hands of various authority structures, depending on the level of mining development in the area. The basic authority structures are, those in mining camps, mine rush/mining settlements and mining villages/towns. Mine rush areas and mining towns offer a good environment for sexual promiscuity and prostitution freely. This has increased the spread of sexually transmitted diseases, including AIDS.

The present survey shows that awareness campaigns on the dangers of AIDS have not reached the mining communities effectively. There are very few visits by health officials in mining areas. However World Vision International, an NGO, is operating awareness campaigns on dangers of AIDS in Dodoma, Singida and parts of Shinyanga regions. Camp leaders confirm the campaigns have helped to change the sex behaviour of the majority of miners in their camps.

### 3. WOMEN AND CHILDREN PARTICIPATION

#### 3.1 Women

245. The study has established that women are directly and indirectly engaged in mining development activities. Direct involvement is in mining, processing and mineral business activities while their indirect involvement is in the provision of other social and economic services in mining communities.

246. Parallel to their male counterparts, women have been found to take part in mining and processing. In the Lake Victoria gold fields especially the Mwanza, Shinyanga, Mara and Tabora regions, women were noted to be active participants in the grinding of ore on a contractual basis. Women were also seen to take part in gold recovery processes, such as the reworking of tailings, the washing and panning of gold concentrates and sometimes digging for ore in shallow sandy trenches. It must be noted here, however, that in all the locations visited women have been found to engage themselves only on surface works, and do not enter shafts for underground work. A case was reported in Merelani when a woman attempted to enter a deep shaft only to collapse and die. The requirements of the Mining Act 1979 prohibit women from underground mining activities. Women's activities have been noted to be more intensive in gold and gemstone alluvial deposits, where they

work near rivers and streams in washing and sieving for minerals. This practice is common in Tunduru, Tanga and parts of Morogoro region. Women prefer working either individually or in groups and earn about USD 20 to 400 a month, while those working on gemstone deposits earn between USD 5 - 140 per month.

247. Another group of women involved in mining activities comprises those owning claims and pits. In general terms, this group forms a very small percentage of the total number of claim holders; in most visited areas it is below 5%. This group normally employs other people (mainly men) to work under various agreements in their claims and pits. The income of this group of women is directly comparable to that of male counterparts. Judging from their material assets, a number of women have been very successful and possess luxurious houses and motor vehicles. The survey has also established that a number of women are mineral traders, particularly at Merelani, Longido and Tunduru. Some women shTheir income could be compared to the claim owners group, judging from their life style and visible wealth.

#### **The indirect involvement of women in mining communities**

248. Many women in mining areas and mining communities are engaged in providing social services or supporting businesses. These include food vending, the selling of alcohol and soft drinks, water supplying, the selling of second hand clothes, and the operation of general goods kiosks. The level of women's participation is directly influenced by the distance of a particular mine location from nearby villages. Cases of sexual harassment are reported to have taken place, but the frequency of occurrence to an individual depends on her marital status and the kind of economic activity she is involved in.

249. Traditional and social barriers have sometimes brought about discrimination against women. At Makongolosi in Chunya it is believed that women might bring misfortune if they visit active mining sites or cross active pits. The same beliefs are also shared by other people in parts of the Morogoro, Mpanda, Singida, Tabora and Shinyanga mining areas. Women's discrimination is also influenced by the tribal composition of a particular mine area. Survey results have established that 143153 women are directly involved in mining activities, which is 24 percent of the population of artisanal/small scale miners in the country.

### 3.2 Children Participation

250. The present survey has identified that the principle cause of child labour in mining is growing economic hardship, causing poor families to involve their youngsters in economic activities. Other reasons include, the increase in education costs and the decline in education quality and opportunities, especially in rural areas. This situation has forced children as young as 10 years old to become involved in economic activities including mining..

251. Most of the children interviewed came from poor or troubled families. Those from towns had experienced street life before retreating into mining where, according to them, there is hope and their security is greater than when sleeping in the streets. This is the case for most Merelani "Nyoka" boys. Children from the villages join the mining community in a number of ways. Some accompany family members who are active miners or traders, and they offer assistance in domestic work or work in alluvial mining or processing; this is the case with most children in Mahenge, Ruvuma and Nzuguni mining areas. Groups of ex-standard seven leavers join mining activities as there are no work opportunities in their home villages; this is the case with most children in Amani - Ludewa, Kalalani - Umba, Chunya, and Tunduru mining areas. In some areas like Chunya and Mpanda, children are involved in mining as a traditional practice; as they were born in mining villages and even their grand parents were miners.

252. Children engaged in alluvial mining are mainly self employed operators. In processing activities they are mainly on piece work contracts. They also get part time employment in supporting services.

253. In mining, children work alone or with women's groups in alluvial gold and gemstones. Small scale aggregate and chip making in towns and cities also attract children as young as 4 - 5 years. In underground works children are used to bring in supplies such as food, drinking water, etc. They are also used to extract minerals from narrow workings and for security surveillance. The "Nyoka" boys of Merelani are involved in underground mining mainly in the areas listed above, and are not assigned heavy duties such as drilling and ore haulage. These boys don't seem to care about the dangers of underground mining and they interpret accidents as bad luck incidents which can happen anywhere..

254. Children are involved in processing ore tailings and helping in the mercury amalgamation of gold in most gold mining areas. Most of them are not aware of the health hazards associated with their work. At Uchira village, children

are hired to carry volcanic blocks from the mine to the sizing site and loading them into transport trucks. In some gemstone mining areas, like Kalalani, Lukande and Merelani, children are engaged in gem sorting and grading.

255. In most mining areas visited, children were actively engaged in manning the kiosks of their relatives and employed on a part time basis in food stalls and restaurants. The employment terms in restaurants are exploitive but most of them prefer to work for a while in these as they are assured of food and shelter. They are free to leave the job at any time, which normally happens when a new rich mineral location is discovered in the area. Some children are involved in selling tobacco and alcohol, mainly in mine rush areas.

256. There is a need for a detailed study to assess the effects of child participation in mining, in order to provide guidelines and conditions for their involvement, especially in established mining villages where mining is already a tradition. Life in mining areas with weak authority structures can cause delinquent behaviour among young children. This was observed in several of the mineral rush areas of Tunduru and Nachingwea, where children were openly selling marijuana and some helped to carry illicit alcohol.

## **F. ENVIRONMENTAL, HEALTH AND SAFETY ASPECTS**

257. A baseline assessment of environmental, health and safety factors was carried out according to the terms of reference given in Appendix 6. The baseline findings are the result of information gathered through questionnaires, interviews, discussions, field surveys, aerial photo interpretations and sample collection for chemical and biological analyses. The parties involved included relevant Government officials such as the Departments of mines, Forestry, Health, Local Government, and Natural Resources as well as the local mining community.

258. This chapter presents the assessment by first describing the existing physical and biological environment relevant to the study under the Natural Environment Section, and then points out major environmental issues associated with artisanal mining activities and proposes mitigation measures. A summary is then provided of pertinent environmental problems and possible solutions in a matrix. Health issues and safety factors are also covered under separate sections.

### **1. ENVIRONMENTAL MATTERS**

259. In assessing the environmental impact caused by mining activities, it is worth giving information on the physical and biological environments in which artisanal and small scale miners operate.

#### **1.1 Natural Environment**

260. Tanzania is a land of plateaus at different levels. The low plateau of less than 200m is found to the east and is at its broadest in the region of Rufiji basin. The mining activities carried out in the coast belt covers the following minerals: salt, gemstone, lime, sand and aggregates. The commonest altitude is between 1,000 and 1,500m and most of the mining activities are carried out at this level. Higher plateaus of over 2,000m are also found but have little significance in the context of mining activity.

261. The major lakes in Tanzania include Lake Victoria which is surrounded by the mining of gold and fed by the rivers Kagera, Isaga, Mbalageti and Mara. Lake Rukwa in the west rift valley is near locations which process gold using mercury and cyanide. Several rivers flow through mine locations such as the Mara, Mbalageti, Lukande, Ruaha, Ruhuhu, Ruvuma, Pangani and Uмба. Lake Nyasa faces a threat of contamination by effluents from mining activity in southern highlands.

262. Most parts of Tanzania, including mining sites, show loamy sand and sandy loam soil texture. These textures indicate that the soil is in good physical condition and thus of high potential for agricultural use. Vast areas of Tanzania receive less than 1,000mm of rainfall per annum. In the central and northern part which cover Dodoma, Singida, Handeni and Simanjoro normally less than 750mm is received. The temperature in mine locations varied considerably from 22°C to 34°C. Near the east coast and around Lakes Victoria, Tanganyika and Malawi the humidity is high, because of evaporation from the sea and lakes. The windy season varies between April to September (South east monsoon) and November to March (North east monsoon) and is very apparent on the coast. The effect becomes less noticeable further inland.

263. Mining activity is largely carried out in *brachystegia - isoberlinia* woodland covering the Lake Victoria zone and the Southern highlands and also in other types of vegetation such as forest, bush and thicket as at Sekenke and Singida, the grassland surrounding Sumbawanga, and semi - desert areas as at Nzuguni - Dodoma. In some cases the mine sites were in proximity to wild animals, as at Tunduru and Lukande, which are close to the Selous game reserve; Kalalani, Uмба, Kigwasi Mkomazi are on the periphery of the the Mkomazi game reserve; and the mining villages of Simba Sirori and Lingwani, Kimalambo are on boundaries the of the Serengeti national park. Other national parks close to mining activities are Tarangire in South Arusha and the extension of Ngorongoro in Longido. The common game species are buffalo, ostrich, wildebeaste, elephant, giraffe, zebra, impala, bushbuck, reedbuck, dik - dik and guinea - fowl.

264. Marine life is characterized by estuaries in rivers like Pangani, Rufiji and Wami; mangroves associated with italic trees and shrubs along the coast, coral reef and sea fish. Coastal fisheries are limited to inshore operations. A great diversity of different species of fish both pelagic and demersal bony fishes are exploited. The typical species landed are *Scomberomorus* (king fish), sharks and rays (*Chondrichty*) and *Cephalopods* (Octopus and squids). Other species are sharks, mullet, mackerel, parrot fish, barefaces and breams. Lobsters (various *Palinurus*

*gilchristi*; *P. ornatus*; *P. longipa*; and *P. versicolor*) are also taken by artisanal fishermen as well as are shrimps and crabs. There is a small but useful export trade in such specialized marine products such as dried shark fins, *beche - de - mer* (holothurians), seashells, tortoise shells and red sea weed.

265. The mass of freshwater fish harvested is ten times that from the sea. This is because it is easier to fish in shallow water than in deep water, but the coastal shelf is only about 5 - 6.5km wide or probably only a sixth of the area of Lake Victoria. Lake Victoria is the major producer of fish and mining activity can affect its fauna. Typical fishes from L. Victoria include *Tilapia*; *Cichlid fishes*, *Haplochromis*, catfish namely *Bagrus* and *Clarias*; and lung fish - *Protopterus* and *Synodontis*.

## 1.2 Environmental Impact Assessment

266. The environmental impacts emanating from the activities of small scale mining are increasingly arousing the concern of environmental specialists, decision makers and the public. At the same time the growing population of practising artisanal/small scale miners increases the pollution levels.

267. The survey assessed the different types of pollutants which are the result of mining activities and evaluated their effects on the environment. The assessment was carried out in the field by physical inspection of land, water and air quality respectively. The survey also examined equipment and vegetation deterioration and human health. The survey team studied some parameters in the field such as electrical conductivity, dissolved oxygen, and acidity as well as alkalinity in water and dust levels. It was found imperative to collect samples of air, water and soil for further investigations in the laboratory using qualitative and Atomic Absorption spectrophotometer techniques respectively.

The results, by environmental media, are given below: -

### (a) Air Pollution

268. Pollutants which impair air quality examined during the baseline survey include: -

- Dust, whose nature is similar to the elements composing suspended solids in liquid effluents. Such particulate includes coal, free crystalline silica, gypsum, graphitic dust and volcanic ash.

- Toxic gases produced during combustion processes such as underground paraffin candles, blasting and internal combustion engines. Such gases include CO, CO<sub>2</sub>, NO<sub>x</sub> and SO<sub>2</sub>.
- Noise and vibration produced by blasting, mining and processing plant equipment.

269. Suspended particles caused by artisanal mining activities are of concern to human health. Fall-outs may cause contamination to soils and vegetation as well as to water bodies. The study team collected air samples in mining/processing areas in dwellings and also the nearby surroundings from about 50 - 100 m from the mining sites. Total suspended particulate was determined by using high volume air samplers, thereafter filters were packed in plastic bags before being weighed, using a laboratory balance. Some 500 ml gas sampling bags were used to store field air samples for the analysis of sulphur oxides, nitrogen oxides and carbon monoxide. It should be noted that these pollutants were expected in sites which burnt petroleum products for various reasons, such as the provision of motive power or lighting.

270. The impact of pollutants is assessed below: -

(i) Total Suspended Particulate

Artisanal mining in all the sites surveyed, except in salt mines and wet alluvial sites, was causing dust emissions from at least one stage of their mining process. The operators were inadequately protected against dust and the techniques employed were too inferior to control the particle matters.

The dust levels in underground mining were at a high level. For instance in Merelani graphitic dust showed values of 6,830mg/m<sup>3</sup> and 252mg/m<sup>3</sup> on the surface.

The results further suggest that many tanzanite locations were affected by silicate emission and graphitic dust, as well as by carbonaceous materials. Dust emission was a result of inadequate technologies to suppress dust in mining and processing including an absence of water during drilling. Poor ventilation in underground mines caused severe consequences to the operators, and a lack of trees as windbreaks caused unpleasant effects to inhabitants living there.

Tiny particles of hydrocarbon material are caused by burning petroleum products such as diesel, petrol or kerosine. In the provision of mechanical or electrical energy, diesel/petrol is burnt and one of the by-products is soot, which was, however, found to be at a low level. In some sites such as Seza Kofi, Chunya, and Mpanda, kerosine was used to produce light in the underground mines. The soot coming up as a by-product was at unacceptably high level.

Graphite - rich dust is the main source of air pollution in Merelani. The measured level was at  $6,830 \text{ gm/m}^3$  in underground pits and  $0.252 \text{ gm/m}^3$  for the surface. The former is much higher than recommended values by WHO which is  $0.32 \text{ gm/m}^3$ . Other dust sources included overgrazing, farming and driving on poor roads. A high level of dust underground from drilling is exacerbated by blasting and poor ventilation. This dust consists of volcanic ash and graphitic materials.

The lead compound, which is one of the most toxic metals, enters the air when gasoline which contains the antiknock additive tetraethyl lead is burnt in engines, but their presence was not monitored. The potential areas with high levels of TSP (Total Suspended Particulates) included ore grinding sheds, underground pits, in the packing of powdery minerals and in extracting minerals. The effects of such suspended particles are : - *Impair Vision*: Sites which are prone to high TSP levels such as Merelani (Arusha); Nzuguni (Dodoma); Ikingu (Musoma) and Kiomoni (Tanga), had poor visibility problems in some working places. Reduced visibility is caused by absorption and scattering of light by suspended particles.

271. ***Equipment and Vegetation deterioration:*** The dust emitted may settle on buildings, machines, clothes, the human body, vegetation or water. Therefore most surfaces in mining sites looked dirty and there were organized cleaning schedules. For instance, operators had no working clothes to protect them against dusts, and the stoppages of machines were increased due to dust. On the other hand, dust settles on vegetation or pollutes water bodies such as rivers/streams in the surroundings of mining sites. Cases were reported in Lusu in Nzega district and the Lupa - Saza area in Chunya. Soiling the leaves of vegetation impairs the photosynthesis of a plant, resulting in poor growth and production. There were no visible symptoms such as mottling to justify this effect.

272. **Health:** The types of suspended particles described earlier namely silica, carbonaceous material, calcium carbonate and lead which were encountered in the survey are harmful to health.

273. The fraction of suspended particles inhaled by miners depends on the properties of the particles, speed and direction of the wind, breathing rate and whether breathing is through the nose or mouth. Inhaled particles can either be deposited in the respiratory tract or exhaled. In principle, particles must be deposited into the body to have a biological effect. The recommended limits for airborne particles for good health set by the WHO are levels of less than 260 mg/m<sup>3</sup> in 24 hours, or an annual mean of 75 mg/m<sup>3</sup>. The results show that the majority of monitored locations were exposing operators (and sometimes the inhabitants of surrounding sites) to levels above this.

274. Fibrosis is a disease caused by particles deposited in the lungs, resulting in an accumulation of scar tissues. The diseases silicosis and black lung are given individual names from the source of disease (silica or carbonaceous material) but they really are very similar in development and effects. Cells respond to irritants and foreign material in the lungs by sealing off damaged areas with scar tissue. As the lungs fill up with fibrotic tissue, respiration is blocked and the affected person slowly suffocates. In some cases, cell growth stimulated by the presence of foreign material in the lung results in tumour formation or cancer. Medical officers near mining sites indicated that upper respiratory infections were common to mine operators. It should be noted that "chest infections" are universally reported to be among the top 5 killer diseases.

## (ii) Mercury Vapour

In the recovery of gold by the amalgamation process, significant quantities of mercury are vapourized, condense in the atmosphere and fall to the ground. The survey team collected air samples in some gold-mercury processing locations. The collected air samples refrigerated prior to cold vapour analysis in an Atomic Absorption Spectrophotometer.

The permissible level of mercury in air by WHO standards is 0.02 mg/m<sup>3</sup>. The results showed low concentration and a major reason for low contamination is the mercury vapour condenses quickly in the atmosphere and falls to the ground, thereby reducing the chances of collecting air samples with high contamination. The survey showed that operators in several locations, for instance the regions of Mara, Shinyanga and Mwanza fired their amalgam in dwellings and only in a few cases in open spaces. The effect of this is to confine the contaminated air in an enclosed room and thereby increase its concentration level considerably. It is therefore envisaged that contamination levels while in firing amalgam are higher than WHO guidelines. To assess the situation, the team studied the mercury consumption by two different approaches.

Through a questionnaire, it was revealed that on average 68.8 gm of gold was produced using 5cc of mercury, yielding a gold - mercury ratio of 1 to 1. Further it was shown that 1/4 kg bottle of mercury was consumed in 4 to 6 weeks by a working team. The estimated working teams totalled 930, giving an annual consumption of mercury of 2.3 tonnes. From other studies it is estimated that 60% of it is evaporated in the air. The second approach was based on the estimated total gold production by artisanal miners, which stood at 6 tonnes/annum. The processes involved in production included cyanidation 1%, amalgamation 45%, alluvial 23%, sluice boxes 26%, and washing, sieving 5%.

The gold produced by amalgamation is therefore about 2.7 tonnes/annum. By using the ratio of gold to mercury as 1:1; the mercury consumption is estimated to be 2.7 tonnes/annum. The quantity of mercury evaporated in air is therefore between 1.4 and 1.6 tonnes/annum.

Metallic mercury is poorly absorbed by the body if it is ingested, but approximately 80% of inhaled mercury vapour (a mono-atomic gas) crosses the alveolar membranes rapidly. A certain amount stays unchanged long enough in the blood to cross the blood - brain barrier where serious brain damage can occur. Its effect is failure of the central nervous system, resulting in loss of appetite and weight, tremors and insomnia. During the survey, practising gold mining operators and

medical officers in nearby sites were asked about occupational health cases resulting from mercury vapour. The response showed no such cases had been experienced, either by operators or medical officers. However it should be noted that mercury poisoning or intoxication has a long time effect on the human body.

### (iii) Hydrocarbon Emission

Hydrocarbon emissions in underground mines, result from exhaust gases released by diesel/petrol engines and blasting fumes. Diesel and petrol are used to provide the motive power to run pumps etc. and sometimes to provide electrical power. The locations which had mechanised some of their activities were around 30%. The rest run their operations manually. The survey revealed that some locations such as in Chunya district, used significant quantities of kerosene in underground mining for lighting. Isolated cases like Nzuguni (Dodoma) were observed applying biomass heat energy for fire - setting rocks to break them.

Although methane is uncommon, carbon dioxide emissions resulting from the decay of organic materials, such as wood, in some abandoned shafts was noticed. This process of decay can lead to the production of hydrogen sulphide which is very poisonous and is associated with a bacterially-induced oxygen deficiency. This gas was detected in the Geita mines. During the survey air samples were collected in engine rooms, underground pits, in camps and 50 - 100 m into the vegetation. The samples were tested for carbon monoxide, sulphur dioxide or trioxide and nitrogen oxides using the Draeger gas analyser.

It was observed that the values of pollutant gases such as NO<sub>x</sub> were in low levels in open spaces. The probable explanation is that most mining sites were in remote areas where human activity was of low level and the consumption of hydrocarbons by artisanal mining operators was rather low. The results further suggested that toxic gases in underground mining were at high level due to poor ventilation and continuous emission of hydrocarbon gases.

The recommended levels by WHO in ppm for nitrogen oxides, sulphur oxides and carbon monoxides are 100, 80 and 9 respectively.

The survey has shown that operators in underground mines are affected by these toxic gases. The effects of carbon monoxide is to tie up the haemoglobin in the blood. The normal function of haemoglobin of transporting oxygen is prevented. Therefore, the symptoms of carbon monoxide poisoning are those of oxygen deprivation. These symptoms show up when 10% of the haemoglobin is tied up by the carbon monoxide, and when this fraction rises to 20%, death can result unless the victim is removed from the area. However all except the most severe cases of carbon monoxide poisoning are reversible.

Carbon monoxide poisoning impairs the ability of the blood to transport oxygen, and the heart has to work harder to supply oxygen to the tissues. Chronic exposure to even low levels of carbon monoxide may put an added strain on the heart and lead to an increased chance of a heart attack. During the survey it was found that there were deaths due to carbon monoxide poisoning at Nzuguni in Dodoma, where operators used charcoal to fire - set rocks underground. Another incident occurred in Tarime district where engine - driven water pumps in pits emitted carbon monoxide in concentrations that caused death to miners. A similar incident was observed in Chunya district, which was also caused by carbon monoxide emitted from water diesel pumps.

Sulphur dioxide irritates the upper respiratory tract. When sulphur oxide comes into contact with alveoli of the lungs, the cells are broken down. The alveoli lose their resilience, making it difficult to exhale carbon dioxide. Such lung damages lead to, or at least

contribute to, pulmonary emphysema, a condition characterized by an increasing shortness of breath. However while there were cases of upper respiratory infection reported by medical officers, this study could not confirm the contribution of sulphur oxides.

The oxides of sulphur and the aerosol mists of sulphuric acid are toxic to vegetation. Depending on toxicity, within certain periods mottling (bleaching of chlorophyll) and then necrotic (dead) spots develop. These observations, though seen in some sites, are difficult to attribute to mining activities. The study team could not distinguish whether affected leaves were the result of sulphur dioxide or not.

In low concentration  $\text{NO}_x$  are not particularly dangerous. However nitric oxide at high concentration reacts with haemoglobin in the human body and its effects are the same as those of CO poisoning. Nitrogen dioxide is an irritant to the eyes and the respiratory system. Nitrogen oxides also contribute to acid rain, which damages vegetation. Their specific effects cannot be separated from other pollutants, such as sulphur dioxide and the survey could not identify either inhabitants or vegetation affected by nitrogen oxides.

#### (iv) Noise Level

Artisanal miners in underground operations are often exposed to high noise levels emitted during drilling, blasting, the supply of compressed air and (on surface) due to working close to machines such as generators, mills and pumps as shown on Table ..... Continuous exposure to such intense noise can interfere with communication, diminish hearing, and affect health and behaviour. Major sources of sound identified in the survey include milling machines, pumps, generators, tractors, vehicles, drilling, blasting and compressors. The baseline survey revealed that semi-mechanised sites such as Merelani (Arusha), Safari mine (Chunya) and Matinje (Nzega) were producing high sound levels.

The results of the survey are given below:

**Table 12: Sound Levels**

LOCATION	SOURCE	SOUND LEVEL (dB)		
		Operating Time	Machine Operator Working area	Maximum noise level in Dwelling
Matinje	Compressor	10 to 12	88	63
	Tractor	10 to 18	98 to 105	78
	Mills	10 to 18	98 to 108	85
Ikungu	generator	10 to 12	100 to 102	68
Sekenke	tractor	10 to 18	98 to 102	85
Lusu	tractor I	10 to 18	100 to 115	87
	tractor II	10 to 18	106 to 116	87
Kimarambo	Traditional			
	Mortar/			

The sound levels measured were higher than the recommended standards. For instance, USEPA has established maximum acceptable noise exposures as follows: -

**Table 13: Maximum Acceptable Noise Exposures**

<b>Duration (per day)</b>	<b>Limit (dB)</b>
Less than 1.5 Minutes	120
3 Minutes	110
7 Minutes	103
15 Minutes	97
30 Minutes	93
1 Hour	90
2 Hours	87
4 Hours	85
8 Hours	87

As noted, high noise level has the following effects.

#### **Communication Interference:**

In places where sound levels were above 80 dB communication was rather difficult. Background noise from machines, vehicles, tractors prevented operators from hearing what they wanted, and the places were characterized by background noise interference. The operators and sometimes inhabitants had to speak louder to superimpose over a noisy background, suggesting a loss of hearing to individual miners.

#### **Loss of hearing**

In general, noise levels of about 80 dB or higher can produce permanent hearing loss although, of course, the effect is faster for louder noises, and it is somewhat dependent on the frequency. At 2,000 Hz for example, it is estimated that the exposure to a lawn mower will depress one's hearing ability by about 15 dB in 10 years. Occupational noise such as that produced by jackhammers, heavy trucks, or grinding mills can cause hearing loss to operators and inhabitants.

During the survey it was observed that operators were working in such noisy environment for periods of up to 15 hours/day. Although medical officers could not distinguish between deafness caused by environmental noise and other causes, it is evident that underground workers speak very loudly; a sign of loss of hearing.

### Effects on health and behaviour

Loss of hearing is not the most serious consequence of lengthy exposure to excess noise. The first effects are anxiety and stress reactions or, in extreme cases, fright. These reactions produce body changes, such as increased rates of heart beat, constriction of blood vessels, digestive spasms and dilation of the pupils of the eyes. The long term effects of such overstimulation are difficult to assess but in games and sports it damages the heart, brain, liver and results in emotional disturbances.

### (b) Water contaminants

275. In addition to the natural contaminants in water, some pollutants resulting from mining activities can enter water bodies. The pollutants are unrecognized by the mining community, and their magnitude is not understood by them. Water pollutants are therefore causing serious concern and hence this study has identified the following areas of attention. (See Appendices 4F, 4G, 4H)

#### (i) Acid Mine Drainage: (AMD)

Physical data parameters on water tested in mines, rivers, streams, wells and lakes are given in Appendix 4I. The results suggest that drainage water in some mines such as Rwamagaza, (Geita) were acidic, with pH values of between 2 and 5. The acidity is caused by oxidising metal sulphides in a water-logged mine, thereby producing an excess of hydrogen ions. The ions then react with mineral water in the mine, releasing a soluble product at a rate ten to fifteen times greater than the non mined areas. As a consequence, mine drainage water has low pH values.

Acid mine drainage has high sulphate and iron concentrations and in most cases contain heavy metals, such as in gold mines at Chunya, Tarime and Geita.

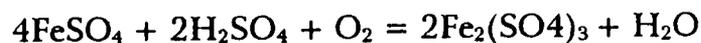
Following reactions with sediments, or mixing with surface or ground water, chemical or bacterial oxidation of ferrous compounds may occur, and iron may precipitate as ferric hydroxide. This usually colours the water, a situation which was not observed in the field, suggesting that its impact on water resources was low.

AMD is formed through complex stages that involve both chemical and biological reactions. In simplified form, three major stages have been proposed for the generation of AMD.

Stage I involves slow chemical and biological oxidation of metal sulphide, eg. pyrite ( $\text{FeS}_2$ ), at near natural pH, in a wet environment, producing ferrous iron and acidity.

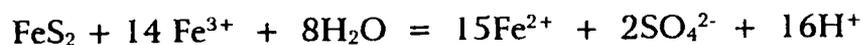


In the second stage, in the presence of oxygen, ferrous iron is oxidized to ferric iron, which precipitates as ferric hydroxide and releases more acidity. As the pH falls below 3.5, ferric iron remains in solution and oxidizes the pyrites directly.



During the last stage, the presence of the bacterium thiobacillus ferro-oxidans catalyzes the oxidation of ferrous iron into ferric iron, which rapidly increases the rate of acid production.

At this stage, large quantities of acid are produced, associated with release of toxic heavy metals.



**(ii) Sedimentation:**

The survey showed that some mining activities were carried out in rivers or streams. For instance the Chunya area Mwalazi and Lukande in Morogoro, Sirori Simba in Mara and several sites along the Ruvuma river. This results in raising the bed level, burying aquatic life in the bed. The consequences of this include a low flow rate in sediment accumulation zones which are predominant in streams with low volume flows such as the Lupa. This encourages a variety of aquatic flora and

fauna, which cannot be supported due to insufficient nutrients and high biological oxygen dissolved demand.

In the rainy seasons, these zones can cause floods or change the channel configuration as observed in Sirori Simba, Maji Moto and Lukande. Of great importance is the fact that the rivers can transport large quantities of debris into the estuarine bays and cause shoaling, which in turn diminish the tidal prism of the bay, denying nurseries for estuarine organisms.

The scope of work of the baseline survey did not include the assessment of magnitude of the effect of sediment on the environment, but such an investigation is worth undertaking in some of the Morogoro, Tunduru, Musoma, Tarime, Sekenke, Kigwasi, Mwakijembe and Mwangi mining sites. The survey revealed that sediments caused an increase in suspended particles in streams, rivers and lakes. The turbidity levels of zones where sediments were dumped into water resources reached up to 200 JTU. This high level of pollution affects spawning areas of fish and impairs photosynthesis of aquatic plants due to decrease of light intensity. The above-mentioned locations prove these effects.

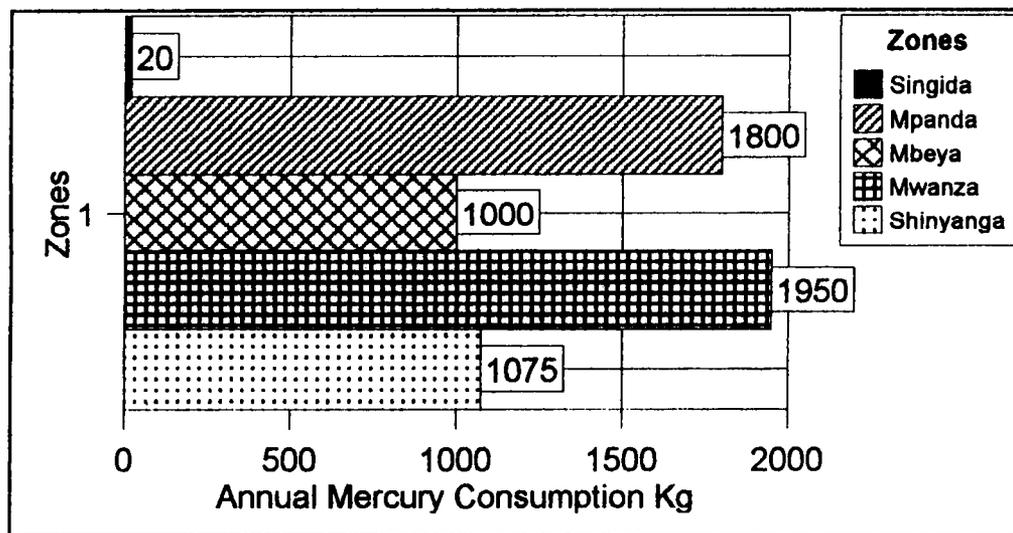
During the dry season, most of the surface water dries up and causes a dust problem to the mining community. Mud cracks is another result of siltation caused by intensive artisanal mining activities. The mud cover blocks the surface humus layer of soils and prevents air exchange so causing an anaerobic, acidic reducing environment. Mud cover and cracks are common features in Lupa in Chunya, the Lake Victoria gold fields and the Mpanda mineral fields.

### **(iii) Toxic Pollutants**

The toxic elements dealt with in the study are mercury and cyanides used directly in gold recovery process and heavy metals namely lead, arsenic and cadmium which depend on mineralization and anthropological activities in the area concerned. There were only three sites with facilities for the cyanidation processing but they had not been operational during the visits. Sodium cyanide consumption was only estimated at Matinje (Nzega) where, during the study period, it was learnt that the site had produced substantial gold in the past ten months using the technique. The annual sodium cyanide consumption

was under one tonne per annum. The sites at Nzega and Saza in Chunya stopped production long ago.

Mercury was directly used in recovering gold but its handling was below acceptable norms resulting into environmental pollution. The total estimated mercury consumption is 2.7 tonnes/annum. The consumption data per zone is given in Fig: 10



**Fig: 10 Mercury Consumption Estimates**

The Mwanza zone shows that 1800 kg/annum of mercury are used by artisanal and small scale miners. The methods employed in recovering the gold were crude and significant quantities of mercury ended up in water sources. In Ikungu (Musoma), amalgamation was carried out directly in Lake Victoria thereby polluting it with poisonous metal; water samples showed a concentration of 0.574 ppm of mercury. The areas which showed high consumption of mercury in Mwanza zone are Mgsusu, Nyangoto, Imweru, Busolwa and Mwalolela. Several rivers and streams flow through the mining locations and discharge into Lake Victoria which is the source of River Nile.

The Mpanda zone equally consumes a significant quantity of mercury in gold processing. Major consumers were found to be Ibindi, D - reef, Chemchem and Katisunga. Rivers and streams which are polluted by the metallic poison discharge into Lake Rukwa which has no outlet river, hence concentrating the pollutants as more wastes flow into the lake.

The water analysis results are given in Appendix 4. The permissible contamination levels are categorized according to the applications of water. As the samples were collected from rivers, streams, lakes and wells which are also sources of domestic water supply, it is logical to employ the standard of domestic water quality.

The results suggest that arsenic and mercury contaminations were at unacceptable levels in most gold mining sites. The arsenic level of up to 6.43 ppm observed at Kimalambo was on the high side as compared to WHO acceptable level of 0.05 ppm. Mercury contamination showed equally high values of up to 0.574 ppm. at Mgusu. The maximum recommended contamination level of mercury by WHO is 0.002ppm. Mercury contamination is a result of uncontrolled amalgamation processes carried out by small scale and artisanal miners.

### (c) Land degradation

276. In general artisanal mining activities deal with land degradation, i.e. breaking of rocks and sediments, recovering small portions of it followed by discarding large quantities of materials as waste. Rock wastes, tailing ponds, pits, quarries as well as barren landscape were common features in many sites.

277. In determining the environmental impacts of land caused by artisanal and small scale miners, the survey team assessed vegetation destruction, land degradation through settlement, ground subsidence, pits, chemical contamination and aesthetics.

#### (i) Forests

Forests protect the underlying soil from the direct effect of rainfall, generating an environment in which soil erosion rates tend to be low. The canopy plays an important role by decreasing the velocity of raindrops and thus reducing kinetic energy. Possibly, more important than the canopy in reducing erosion rates in the forest, is the presence of humus in forest soils, for this both absorbs the impact of rain drops and has an extremely high permeability. The forest soils analysed show high infiltration capacities. Another feature of forest soils is their ability to transmit large quantities of water through their fabric, which is a result of many micro pores produced by roots and the rich soil

fauna. Forest soils are also well aggregated, making them resistant to both wetting and water drop impact. This superior degree of aggregation is a result of the presence of considerable organic material, observed to be between 0.5 and 1.5%, which is an important cementing agent in the formation of large water table aggregates. Furthermore, earthworms also help to produce large aggregates. Deep-rooted trees help to stabilize steep slopes by increasing the total shear strength of the soils.

From all this, it is therefore expected that with the removal of forests by mining activities, settlement, fuel wood collection, etc. the rates of soil loss will rise and mass movement will increase in magnitude and frequency. The rates of erosion that will result are particularly high if the ground is left bare as was observed in Maji Moto in Musoma and Landabani and Tiriri in Arusha. Furthermore, the topography of site precipitation and the size of the deforested area have an influence on the severity of erosion.

The survey revealed that mining activities cover an area of about 16,000 ha km<sup>2</sup> and that, due to the secondary growth of vegetation, the area remains almost constant. But in some locations, such as Mgusu, pits were becoming deeper and deeper with less clearing of sites. The mining locations in forests occupied less than 3 percent of the natural resources.

In geographical areas with adequate precipitation, secondary growth thrives in a very short period. For instance Iluma - Singida in 1991 was the scene of intense artisanal mining activity, but by 1995 it was observed that abandoned pits were filled by silt washed from dumps. Hence the vegetation recovered and this further discouraged rapid run off. Generally the influence of mining activity on erosion is low.

It was also noted that if wild animals (in nationally protected game reserves) are within the proximity of mining activity, they tend to migrate. In some cases, mining is close to game reserves and thereby encourages poaching. It was revealed that miners themselves seldom poach game but are a market for game meat.

Mining locations featuring this include Longido, Serengeti, Minjingu and Kigwasi.

**(ii) Ground Subsidence**

The subsidence caused by mining perhaps is the most noteworthy feature, though its importance varies according to factors such as the thickness of the seam removed, its depth, the width of working, the degree of filling after extraction and the mining method adopted.

The survey showed that the vertical displacement by subsidence can be more than the thickness of the seam being worked. Meanwhile, miners in certain locations such as Merelani (Arusha), Chunya (Mbeya) and Geita (Mwanza) excavated deep pits. Such an activity might interfere/disrupt groundwater aquifers and hence pollute water. Another environmental factor concerning underground mining is the case of unstable ground limiting the uses of land. However, in many cases there was no immediate pressure for occupation of the land.

The pits and tailings were almost invariably abandoned without remediation, causing visual intrusions and obstruction of the land for other economic activities. The unattended tailings in some cases contained toxic substances such as heavy metals and cyanide. The analysis of heavy metals in these locations showed values of lead of up to 7,110 ppm at Chemchem in Mpanda, as a result of mineralization. Arsenic measurements showed high values of 990 ppm in Lusu (Nzega) which may be due to arsenopyrite most probably resulting from agricultural chemicals used.

The wind encourages dispersal of the contaminated tailing into distant water sources or on to agricultural land. Cyanide, for instance, can easily be absorbed in food chains by plant root which have a strong tendency to concentrate cyanide. A good example was at Nzega cyanidation plant, whereby the community cultivated cassava, yams and potatoes close to site.

**(iii) Abandoned Pits**

Pits were abandoned by miners for a variety of reasons, including financial constraints, the use of abandoned pits as vent, uncertainty of value the ore in the pit and bad land-keeping practices. The abandoned pits can be classified as shallow and deep ones. Shallow pits fill up quickly and secondary vegetation thrives, discouraging run off and therefore soil erosion.

However about 50 locations were mining in deep pits. The activeness of pits at a location was taken as a ratio of the working pits to the total pits available there. The results showed that activeness varied considerably from 0.7 to 100%. Further investigations revealed that 40% of surveyed locations utilized less than 10% of available pits in the area. Locations which used more than 50% of available pits were only 8%. This suggests that the majority of pits in the mining locations are inactive.

The abandoned pits can act as traps to animals and people. There were cases in Simba Sirori where wild animals fell into abandoned pits, and it was at this village that the village authority established by - laws to penalise any claim holder who failed to refill abandoned pits. The success of this measure is largely due to the village leaders and miners all being permanent residents of the area.

### 1.3 Legislation:

278. The government policy on mining activities was prepared by the Ministry of Energy and Minerals, governed by the Mining Act, of 1979. Regulations which contain relevant information on environmental issues include:

- Mining licences under mineral rights part III
- Surface Rights part V
- Miscellaneous part VIII
- Mining claims (Regulations) 1980

279. The sections which dwell on environmental issues underscore matters of prevention or treatment of pollution to safeguard fishing and navigation; other coverages include the monitoring of environmental and safety factors, disposing

debris in acceptable manner, the restriction on the exercise of mining rights in sensitive areas such as river banks, and near developed infrastructures like bridges, highways, bore holes and agricultural land. The claim regulations stipulate the obligations of a claim holder when abandoning the site and the conditions and preconditions for the deposit of tailings, particularly those which are near water sources.

280. Secondary regulations are implemented by other government departments such as the Ministry of Natural Resources who protect areas through the National Park Ordinance, the Ngorongoro Conservation Area Ordinance and the Game Controlled Areas and Forest Ordinance. There are also restrictions on mining in water catchment areas, and on polluting water under the water policy. It was observed that there was no primary regulation on environmental issues and standards of toxic substances. Since the government is reviewing the Mining Act, it is believed that such amendments will be included.

#### 1.4. Mitigation Measures:

The problems identified during environmental impact assessment can be classified as follows: -

##### (a) Good conservation measures:

281. Polluting factors such as high total suspended particles could be minimised by adopting alternative measures, such as excavating or wet processing. However such techniques might not be valid for some of the minerals like sand or gypsum, which need specialist advice.

Other sources of airborne particulate result from blasting, wind erosion from bare land and tailings. The operators need to store tailings in a proper manner such as planting vegetation. If it has no economic value then they could be used to refill abandoned pits. In addition, operators should be encouraged to clear only a minimum of vegetation where necessary and to restore vegetation immediately after stopping operations. Apart from minimising airborne particulates, it will also reduce erosion due to runoff, thereby conserving the land and minimising contamination in water bodies. Further, the contaminated tailings will be safe from children in areas processing ore in villages.

282. Hydrocarbon emissions in air although was found to be at a low level, concentrations from exhaust fumes were high due in part to poor maintenance of machines. If more artisanal miners change to mechanised systems, the pollution level will be of concern if proper measures are not taken. It is therefore recommended that operators should regularly tune the engines to minimise emissions.

283. It was noticed that noise pollution was high partly due to machinery conditions and the installation of milling machines close to camps. It is therefore recommended that a fair distance should be maintained between work places and residences and ear plugs should be used by machine operators. Rubber lined ball mills could considerably reduce noise levels at the source.

284. Land management showed that there were strategies which could minimise pollution through good conservation measures, namely preventing vegetation destruction, avoiding impairing land by toxic chemicals and making use of topographic features. The majority of mining inhabitants were aware of the importance of vegetation but they did not give it due priority. The reasons included unplanned activities, no one being held responsible for the destruction of vegetation unnecessarily and sometimes, other economic activity took precedence, as with making charcoal from trees in Mabadaga (Mbeya) or the construction of temporary shelters and fuelwood supply. It is suggested that claim holders, through the camp leaders, should be held responsible for the destruction of vegetation, and given the task of replanting mining sites. Individuals cutting trees for other purposes such as making charcoal should pay a levy to discourage unnecessary destruction of trees and the collected revenue can be used for revegetation.

285. The problem of toxic substance contamination and the alteration of topographic features is a result of disorganised activities and a lack of monitoring programmes. It is therefore recommended that monitoring programmes be initiated, not only to cover land but to include air and water as well.

286. Poor sanitation contributed significantly to polluting water bodies through run off. The major reason for this includes individual habits, a lack of facilities and weak regulations on health matters. It is therefore suggested that health regulations should be amended and enforced.

**(b) Technology advancement:**

287. It was observed that technologies which were being used by artisanal miners encourage environmental destruction. The heating of amalgam in a crude manner resulted in high level of air contamination by mercury vapour. It is therefore recommended that mercury retorts be used, which, apart from reducing contamination level in air, conserve the metal thereby saving the operating costs.

288. The hazard of mercury poisoning is further enhanced by the significant vapour pressure of the metal at ambient temperature. The relationship between the temperature, partial pressure and the concentration in air is given below: -

Table 14 : Variation of mercury concentration on vapour pressure

Temp (oC)	Vapour Pressure (Pa)	Concentration of Mercury (ppm)
10	0.0653	0.9
20	0.16	2.2

289. USEPA specifies a maximum value of  $0.05\text{mg/m}^3$  of mercury vapour which can be tolerated in a working environment for 8 hours of continuous exposure. Such levels are easily achieved by using mercury retorts. It should be noted that other institutions, such as the Institute of Production Innovation, designed and fabricated air cooled mercury retorts, but that this equipment has not penetrated the market, partly due to cultural barriers and also the low volumes of amalgam heated by operators. It is therefore imperative to focus on demonstrations and awareness campaigns as generally the buying cost is affordable to a typical artisanal miner. The problem of heating small quantities will be overcome through increased production. It was also observed that mechanisation would considerably reduce the suspended particles in air, especially in ore processing and excavation.

290. The direct processing of minerals in water bodies has a tremendous negative effect on the environment. The key factor in polluting water bodies is the large quantity of water required for processing and the limited alternative for recycling the water. It is therefore suggested that alternative methods should be looked into, such as constructing ponds say, over 100m from rivers or lakes for such purposes. These ponds can be filled using water pumps, or where the water table is high water will naturally seep up. It should be noted that sediments will accumulate in these ponds and their regular cleaning is important. The sediments should be used to fill abandoned pits. If water pumps are to be used, rural technologies such as solar and wind systems should be encouraged. Ponds will also minimise the mud crack problems cited earlier under the section on impact assessment.

291. It was noticed that some of the reasons for leaving abandoned pits were the uncertainty of ore reserves left. It is therefore suggested that prior to closing a pit expert knowledge should be employed to assess the ore reserve. Also proper mining methods, which include ventilation systems, should be imparted to mine operators, well ahead of their excavation.

**( c ) Monitoring Programme:**

292. A critical component of the Environmental Management Programme is the monitoring activity. It is recommended that the monitoring programme be closely tied to the environmental conditions placed on the claim title, as one of the functions of the monitoring programme is to ensure and demonstrate compliance with the regulatory requirements. Environmental standards for emission and discharge from a site should be established.

293. The monitored results and details of any actions triggered by the results should be included in an annual environmental report to the relevant government authorities. This report will show the state of the environment on the mine site and give details of environmental parameters monitored. Where monitoring indicates that environmental parameters are exceeding statutory levels, for example mercury pollution or high sedimentation levels in rivers and streams, a planned response should be set in place to effectively control any adverse effects. Each monitored parameter will require an individual contingency plan to be approved by the relevant authority.

294. Mine site environmental monitoring programmes initially appear as an expensive item for artisanal mining operators to implement. However, in reality they are a sound financial investment, particularly when critical environmental constraints are identified. If detected at an early stage, they enable mine operators to obtain the necessary information concerning the natural environment as part of the planning process, thereby enabling necessary environmental protection measures to be integrated into the design of the operation (or ongoing extensions or upgrading of the operation). Planning can then ensure that cost-effective mitigating measures are adopted, a clean hazard-free operating environment is maintained and mine site rehabilitation and afforestation are undertaken in a continuous, cost effective and satisfactory manner.

**(d) Training:**

295. It has emerged that the training of small scale and artisanal miners particularly on environmental issues is lacking. This fact has manifested itself in the continued environment pollution resulting from mining activities. One of the reasons for this is that those required to impart knowledge to miners are themselves not trained in environmental management.

It is therefore recommended that:

- There is a need for zonal offices to conduct awareness campaigns, demonstrations, and seminars to miners with particular emphasis on environmental education. This could be done by first giving proper education to trainers and later, arranging training programmes. NGOs, government departments and institutions and private firms should be involved where necessary.
- Deliberate efforts must be made to introduce awareness through video cassettes, radio, and posters dwelling on environmental issues. This task should be given to a competent consultant working closely with zonal offices.

**(e) Legislation:**

296. The present Mining Act (1979) is inadequate to deal with the environmental problems created by the artisanal miners. No efforts whatsoever from the government or relevant agencies such as the National Environment Management Council are being made to monitor and assess the current trends in order to avert more serious environmental problems. It is therefore recommended that the government and relevant agencies should establish standards for pollutants and review the present regulations on mining and the environment with the objective of coming up with practical and enforceable environmental regulations.

**(f) Cost of Rehabilitation**

297. In artisanal gold mines, there were about 3,000 pits of between 50 and 100m deep, of which only 500 pits were active. 170 pits out of 1770 pits of gemstones were active and the depth varied from 50 to 100m. Diamond mines showed shallow pits of about 5m deep, and in 2000 pits observed only 120 were productive. The small scale mining of aggregates showed only 3 mines and all were active. Artisanal mining of building mineral did not create deep pits. Sand is won in deep valleys along the seasonal streams, and in some cases the activity was carried out in areas close to developed structures such as bridges and, houses, which result in soil erosion and in extreme cases damaging the structures.

298. In estimating the cost of a rehabilitation programme, attention is given to refilling abandoned pits, reclaiming land and revegetation. The earth material around the site was about 40% of the refilling material needed. Rough cost estimates based on a forest officer's data and construction companies are presented below:-

**Table. 15: Estimates of Land Rehabilitation Program**

<b>Treatment</b>	<b>Estimated Cost (TShs.)</b>	<b>Quantity involved</b>	<b>Cost Tshs. (,000)</b>
Filling Material	3,000/cu.m	500,000cu.m	1500000
Labour	-	-	600000
Temporary roads	2,000,000/km	700km	1400000
Top soil spreading	100,000/ha	10,000ha	1000000
Revegetation	250,000ha	10,000ha	2500000
	<b>Total</b>		<b>7000000</b>

## 2. HEALTH MATTERS

299. Health matters deal with the sicknesses of miners and dependants by identifying frequently occurring diseases; examining their causes which have led to the persistent infections to mining communities and outlining corrective measures.

### 2.1 Problems and Constraints

The main factors which have led to diseases in mining settlements may be categorized as follows: -

#### (a) Safe and Clean Water

300. The team collected water samples from drinking water sources such as wells, rivers, streams and lakes and these were analysed for *coliform* bacteria, ova, parasites and other pathogens. The results showed that in areas with adequate water resources such as rivers/streams or lakes, a high number of mining operators were prone to diseases from biologically contaminated water. Specifically samples from

Tunduru (Songea), Muhesi (Morogoro) and along the Mara river were observed to contain bacteria and parasites. These areas are mainly characterized by the mine rush type of camp.

The lake zone miners engage in livestock keeping, which increases further the risk of infections. The major reason for the poor quality of drinking water was inadequate sanitation at the working site and in the settlements of mining operators, causing runoffs containing human and animal waste, so contaminating the water.

301. Constraints encountered in the provision of a safe and adequate water supply to mining operators are widely varied but the most significant ones are: -

- Poor hygienic practices, including drinking water which may be unfit for domestic use.
- Inadequate funding to adopt suitable techniques for supplying and treating water for domestic use.
- Inadequate skilled manpower to maintain a mechanized water system.
- Temporary settlements that discourage heavy investments in infrastructure such as water supply.

#### **(b) Debris**

302. It is undisputable that both liquid and solid wastes were common litter in mining settlements. Debris identified included food wastes; organic materials, discarded cans, bottles, and human waste products, especially in Tunduru and Mtwara. The garbage in most cases was scattered in the living and working areas, resulting into problems of vermin and rodent attraction, and polluting the environment.

303. The constraints encountered in handling debris were contributed by: -

- Poor housekeeping measures practised in the settlements associated with ignorance and personal habits.
- A lack of funds to undertake proper measures such as spraying pesticides in dumping and breeding sites.

- The legislation in force is not explicit on the roles of the communities and local governments in terms of community health
- Communities have not been motivated to seriously participate in waste management, the majority of miners were of the opinion that the levies they pay to such leadership were sufficient to cater for all kinds of services.

### (c) Food Hygiene

304. The hygienic status of foodstuff depends very much on the surroundings in which the foods were grown, stored, prepared, cooked and served. The investigation of food quality was not part of the study but it is worthwhile mentioning areas of interest for the future. These include the investigation of heavy metals, especially mercury and arsenic, in fish, livestock, poultry and agricultural products. Given the prevailing situation of inadequate and unsafe water supplies together with poor sanitation, it is believed that most foods were unfit for human consumption because of their bacterial loads. In villages which are more developed, fewer problems of food hygiene are observed due to business competition.

305. Food contamination sources included unsafe water, flies, rats, unclean working surfaces especially in foodstalls, and dirty. This problem was more dangerous to those living single than couples as the latter adopted more elements of good health practices. The stalls for food and local beverages are believed to be a major contributor to the problem yet majority of mining operators depend on them.

### (d) Health Care

306. Health services were provided by traditional healers, unauthorized medical practitioners and authorized health centres/dispensaries in nearby mining sites. The factors influencing a mining operator to choose a medical service depends on availability of service, treatment costs and individual beliefs. The survey results showed Government efforts to establish dispensaries/health centres were not in pace with the artisanal mining activities consequently most visited sites had no dispensary or health centre. There were cases whereby a dispensary is 30 - 50 km from a mining settlement such as Amani in Ludewa district.

307. The results further revealed about 55% of the operators were treated by unauthorized medical practitioners; 27% by the traditional healers and the balance is accounted for by established dispensaries and health centres. It should be noted that there are cases when operators use more than one service. The government

medical officials expressed fear that such practices might cause serious effects to patients as the majority do not attend health centres, moreover unauthorised practitioners and traditional healers do not carry out laboratory investigations and might well dispense medicines which have expired.

#### (e) Occupational Health

308. The working environment of most operators is unhealthy as it is characterized by airborne particulate, mercury vapour, insufficient light especially for underground mining and high noise level. These problems were dealt with under environmental impact assessment. Also under occupational health are injuries due to poor safety practices and individual bad habits which include excessive drinking of alcohol, smoking, and drug abuse.

#### (f) Under Nutrition

309. Good health is not only a matter of eating nutritious foods. Heavy worm infections, and frequent illnesses as those due to diarrhoea or malaria are contributors to malnutrition. While worms feed on the already digested foods, diarrhoea has a tendency of purging out food from the intestines before it has had time to be assimilated and absorbed in the body cells. Infections have characteristics of reducing the appetite of the sick person thereby leading to inadequate food and nourishments intake. Other factors include non availability of nutritious food in a family for lack of money, poor feeding habits, inability to balance diet due to ignorance, and availability at food or high prices.

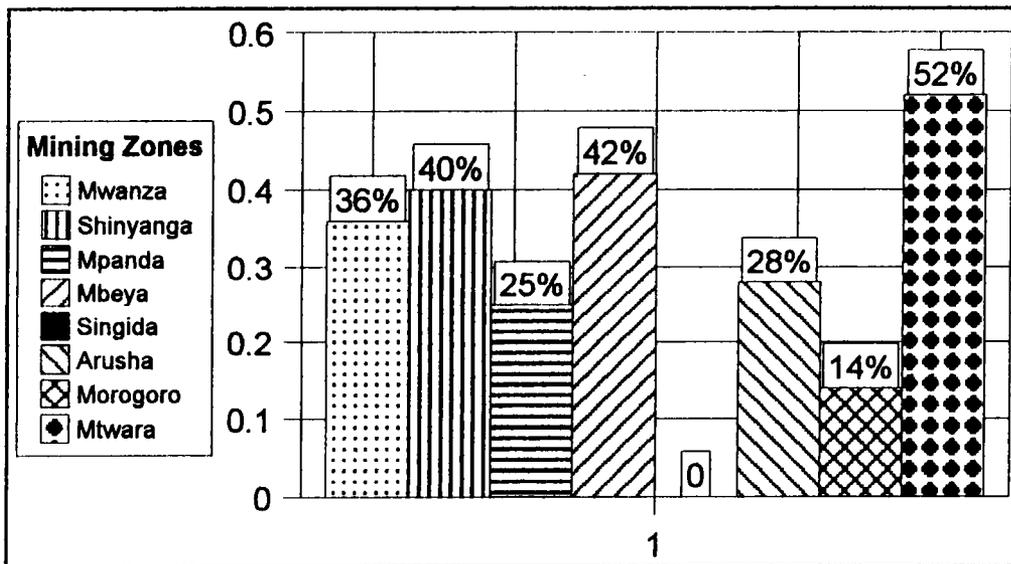
## 2.2 Diseases

310. The disease patterns are a reflection of poor sanitation, inadequate safe water supply and unhygienic personal habits. The living standards and nutritional status were poor. This encouraged persistence of various types of diseases, like droplet-based infections and faecal oral diseases. After discussion with regional/district medical officers efforts were directed to common diseases affecting artisanal miners such as malaria, schistosomiasis, scabies, tuberculosis, respiratory infection, chronic bronchitis, typhoid, bacillary dysentery, enteropathic diarrhoea, sexually transmitted diseases and epidemics covering cholera and meningitis. The baseline survey covered over 100 locations in five months, it was not possible therefore to give details of the disease per age, sex, occupation, frequency of

occurrence and, typical diet used. However, results show that the top five diseases affecting most mine locations are faecal oral, water washed, excreta - borne, water-based and STD diseases.

**(a) Faecal Oral Diseases**

311. Faecal oral diseases were leading in causing morbidity and mortality in these communities to children less than five years who were in settlements due to their parents involvement in mining activities and were particularly victims to diarrhoea. The frequently occurring diseases were enteropathic diarrhoea and in some cases cholera as well. The number of locations which rank this diseases in the top five were compared to the total locations visited in a zone. The relative severity is shown below: -



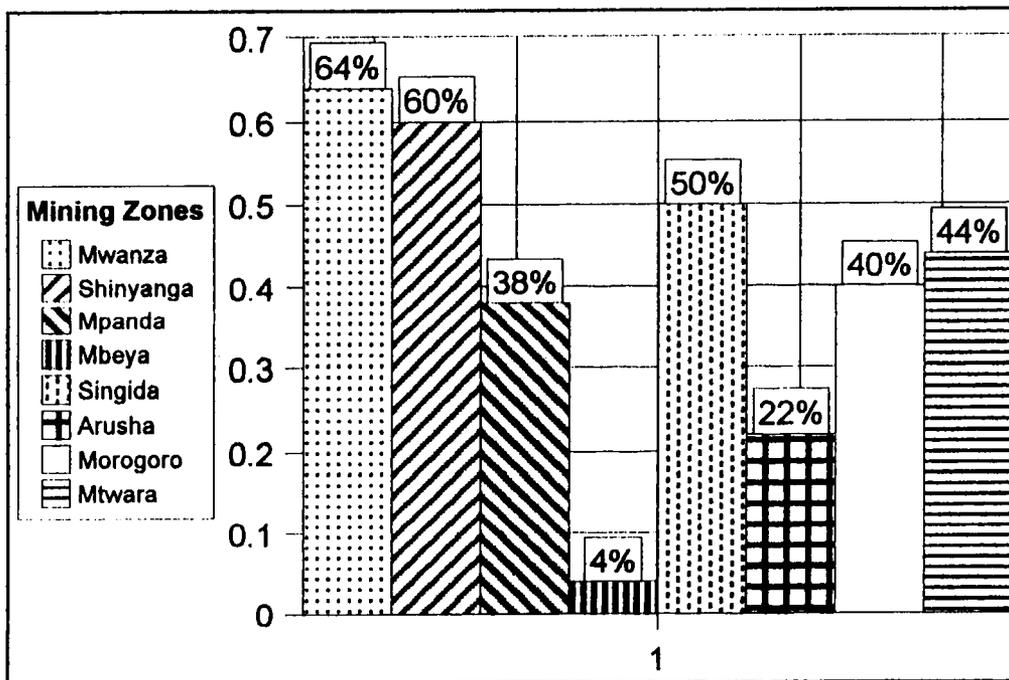
**Fig : 11 Severity of Faecal Oral Disease**

312. Mtwara zone shows a high rate of faecal oral diseases principally due to mining rush areas of Tunduru along the Ruvuma river and has poor sanitation which will definitely result in high level results. Singida zone showed the lowest level of such diseases due to the fact that mining activities in the zone are at low level; only four locations were covered. It was also found that the zone was dry, discouraging breeding sites. In general, the problem was a result of poor sanitation, unsafe eating practices and unsafe drinking water.

**(b) Water Washed Diseases**

313. These diseases arise from inadequate water supply in a community. Skin and eye diseases were reported to be predominant in Mwanza, Shinyanga, Singida and Morogoro zones. Inadequate water not only prevents people from keeping their bodies and clothes clean but also does not permit houses to be well plastered and to be kept in hygienic conditions. Unplastered houses tend to be full of cracks and crevices which harbour vermin like ticks, body lice, mites and jigger fleas. These arthropods (insects) are notorious for transmission of such diseases as relapsing fever, scabies and jiggers. The mining camps that were visited were found to be in poor hygienic condition which encouraged persistence of such diseases. In addition, the shelters were poorly ventilated with high levels of congestion.

The ratios of locations affected by eye disease are given below:



**Fig : 12 Spread of Eye Diseases**

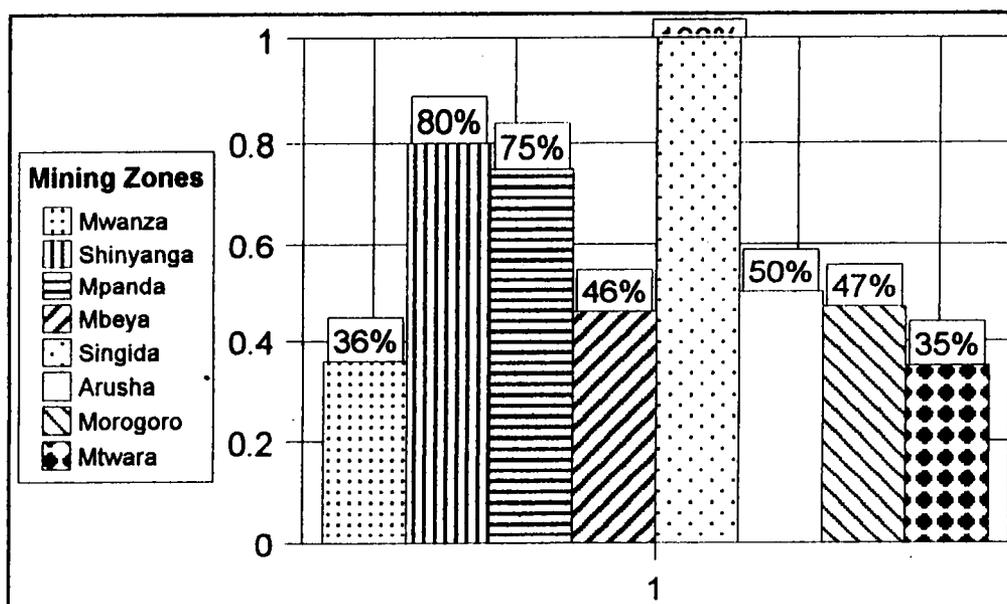
It should be noted that eye diseases were a result of bacterial infection and injuries from foreign bodies.

**(c) Excreta-Borne Diseases**

314. Worm infection and schistosomiasis were identified in mining settlements. Basically, these diseases are result of not using toilets or digging and use of shallow latrines. Intestinal worms and schistosomiasis principally result from indiscriminate defaecation in the bush which allows faeces to be washed into water sources by rain. On the other hand, careless urination into water bodies is the major cause of urinary schistosomiasis (Bilharzia) which is a special hazard in school-age children. Although the fatality rate of these diseases is considered insignificant, they are nonetheless responsible for considerable ill health including general body debility, anaemia and poor nutritional status which consequently lowers the body defence mechanisms to diseases and renders the victims economically weak. Mining communities in Mwanza, Mpanda and Singida zones were highly affected by the diseases. On the contrary, Arusha zone showed low levels of these infections.

**(d) Water Based Diseases**

315. Malaria, one of the water based diseases is normally common where pools of fairly clean water are found such as water collected in pit holes, stagnant water in seasonal streams, ponds, discarded cans and shells. The high incidence of Malaria is the result of many breeding sites for mosquitoes and no protection against the mosquito bites.



**Fig : 13 Spread of Malaria**

Generally, poor environment management has led to conducive mosquito breeding sites.

#### **(e) Sexually Transmitted Diseases (STD)**

316. Sexually transmitted diseases including Acquired Immuno Deficiency Syndrome (AIDS) were reported in mining settlements. Several locations in Mbeya, Singida and Arusha brought up these diseases as a major concern. As was observed, in most camps there were no women as operators did not stay with their wives. As a result, promiscuity was not uncommon. Thus the STD cases were closely linked with individuals' sexual behaviours in Village Social Centres. The infected operators' population reflected the ratio of victims of the sexually transmitted diseases in the area.

#### **(f) Occupational Diseases**

317. The diseases which are the result of working in mining sites include fibrosis, consisting mainly of silicosis and black lungs, and injuries, while toxication due to mercury, arsenic and cyanide is possible but was not evidently shown in the field. Report by medical officers at Singida revealed that inhabitants using jointly with miners a pond which was highly contaminated by mercury through processing of gold, had severe skin conditions.

318. Random sampling of amalgamating gold miners covered about 30 operators in the locations of Lusu and Isunga in Nzega district and Simba Sirori in Musoma rural. In other locations, operators were reluctant to give their hair due to taboos. The laboratory results revealed that about two thirds of operators had below the maximum tolerable limit of mercury established by WHO which is 6.4mg/Kg. Operators with high concentration of mercury were from Simba Sirori between 35.6 and 43.6mg/Kg in Lusu varied from 10.3 to 37.1 mg/Kg. Isungangwanda and Sekenke showed acceptable concentrations of between 1.9 and 3.8mg/Kg.

319. The level of mercury contamination is related to individual habits such as diet, specialization, e.g. in mercuric processing activity and the time one is exposed to risky environment. The study indicates that severe health hazard in the near future can be anticipated but additional research is urgently needed to justify this point. Mercury pollution has a strong time component; thus, intergenerational considerations play an important role in its solution. Future generations are more likely to suffer considerably from this pollution than current ones.

320. There were no data to distinguish between victims of occupational health and other diseases. It is however believed that most upper respiratory infections were a result of suspended particles and the graph below shows the ratios of affected locations by zones.

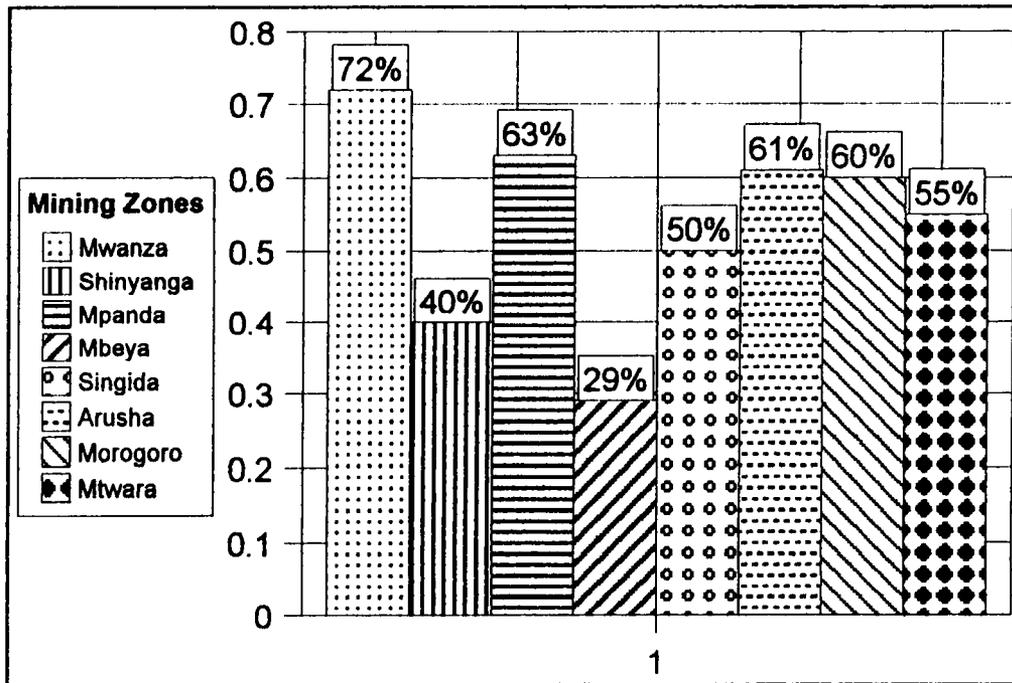


Fig : 14 Severity of Upper Respiratory Infection

It should be noted that the effect is not instantaneous, it develops after quite some time, therefore operators who are exposed to such risks for a long period are the more prone to these effects.

23. Corrective Measures

321. As it was shown in section F. 2 (a) the major problems facing mining operators were unavailability of safe and clean water, filthy surroundings in settlements, unhygienic food, health care services, occupational health and unbalanced diets.

Remedial measures are grouped as follows:

**(a) Awareness Campaigns**

322. The effect and magnitude of unhealthy conditions are greatly underestimated by mining operators. Just a handful of operators recognize the importance of clean and safe water, balanced diet, living in clean surroundings and protection against occupational diseases. It should be noted that community health will yield maximum positive results, if all individuals participate in eradicating the disease through adoption of health procedures. As it was revealed, the majority of operators were unknowingly encouraging the spread of diseases. It is of paramount importance that awareness campaigns be launched. These should focus on basic health issues like boiling of drinking water, use of toilets, washing bodies and clothes, and living in plastered shelters to eliminate vermin, and to live in well ventilated rooms and keeping the surroundings clean. In many instances, operators have heard the appeal to upgrade their standard of living but are not conversant with negative effects. It is therefore suggested that the campaigns should be through video shows, posters, leaflets radio programmes, demonstrations, and meetings.

323. Another area of concern is occupational health which results in health problems to operators and even children accompanying their mothers. Of notable consequences were airborne particulate, toxic substances such as arsenic, mercury and cyanide. It is therefore imperative to launch awareness campaigns on the effects of poor working conditions and to encourage the measures which reduce the risks.

**( b) Health Care**

324. The mining population faces acute shortage of appropriate medical services. Consequently, majority are treated by traditional healers or unauthorized practitioners. This study cannot quantify the magnitude of its effect but it is believed to be unacceptable. It is therefore suggested to introduce the services at all levels. Claim holders should keep First Aid kits containing appropriate medicines according to nature of diseases expected. Mandatory keeping of some medicines in kits such as sodium thiosulphate for cyanidation process or dimercaprol for amalgamation should be enforced. During inspection of rural communities, health doctors should inspect the First Aid kits and give appropriate recommendation such as replacing expired drugs etc. Doctors are expected to sign a monitoring card which will be used as a yard stick for monitoring health care at mine site level.

325. At camp level, local authority is expected to give licences to practitioners who will render medical services. The practitioner might use mobile services in a van or tents. As the mining camp settles, permanent infrastructures are expected to be built. The local government is equally expected to initiate safe and clean water supply programmes. Such programmes may not be operated by the government but servicing agencies should adhere to regulations stipulated by local government and sell water to miners. This will involve digging of modern wells, pumping water and treating before supplying. District medical officers are expected to monitor and advise the services accordingly.

326. Additionally, health officers are expected to inspect camps regularly to monitor various health aspects such as cleanliness of surroundings, sanitation, adequacy of living shelters etc. Mining camps that threaten health should be reported to the District Commissioner and punitive action taken.

### **( c ) Monitoring Programmes**

327. The survey team observed that there were no planned inspections of mining communities. It is therefore recommended that inspections be carried out by health officers from regional or district levels depending on the circumstances. The inspections should focus on primary health matters. Drinking water supply is of major concern in mining communities with dense populations. Positive measures such as boiling of water before use or treating drinking water before distribution are not observed. Some of the reasons for this include insufficient funds to embark on such programs and mining operators are very nomadic.

328. In most cases, miners live single in camps and devote most of their time in searching for minerals as a result they have no time to boil water. There were cases where miners used untreated water from pits for drinking purposes. These problems are caused by inadequate supply of clean and safe water and if available it is bottled water which is three folds the price in nearby towns. Efforts to supply clean and safe water either through Local Government, private companies or NGO's should be sought and operators be discouraged from using untreated water. The monitoring of such activities will definitely minimise the effects of contaminated water.

329. The living conditions were pathetic. Miners were very congested in small unventilated rooms. Inspection shelters will reveal shortfalls and suggest ways of improving. It is envisaged that traditional barriers will be encountered and in such situations health regulations should be employed to prosecute defaulters. The success of monitoring programs requires good co-operation of community leaders, local governmental authority and implementing agencies.

### 3. SAFETY MATTERS

330. The Mining Act of 1979 has stipulated regulations regarding safety mining. Operators adhere to these regulations only cursorily, the reasons including the desire to extract ore at the earliest possible time, insufficient funds to adopt correct measures and ignorance of better alternatives.

#### 3.1 Mine Accidents

331. Unsafe mining has resulted in accidents in many artisanal mines. Most small scale and artisanal miners conduct their operations without observing the requirements of the safe working regulations under the 1979 Mining Act. Underground mines and works have claimed the largest number of victims (about 70%). The reasons for accidents in mines and their surroundings include: -

- The poor handling of explosives and their storage at unsafe places instead of approved magazines, explosive stores or storage boxes.
- Roof collapse (caving)
- Slabs falling from the hanging wall and roof
- Rock slide in open pit trenches
- People falling into hazardly located pits
- Poor hoisting mechanisms (windlass, ropes)
- Shaft collapse.

332. Appendix 4B through Appendix 4 D shows the survey results of mines accidents from 1993 to 1995. In 1993 a total of 61 accidents occurred of which 50 were reported and 11 were unofficial. During 1994, 42 accidents occurred in the whole country of which 24 were reported and 18 unreported. Of the three years analysed, 1995 shows the smallest number of accidents with 25 events, 15 of which were fatal cases reported, and 6 unreported cases.

333. Poor knowledge of safe mining contributed significantly to the accidents. Poor practices observed include use of the same shaft for people to access underground/surface and also to haul ore or wastes as noted at Merelani (Arusha), Shinyanga and Sekenke (Singida). Most of these underground mines did not have proper ladderways but instead ropes and notches on the sides walls were used for descending and ascending. Some unproductive pits were interconnected at the bottom with active pits to function as duct for natural air circulation. However as some pits were as deep as 150 m such technique could not provide sufficient air. Underground operators had no safety equipment such as helmets, and were prone to falling slabs from mine roofs. The general feeling is that the number of victims established in the survey is only about 75% of actual number of accidents. Due to the considerable involvement of informal miners, many accidents occur but are not reported to the mines offices. Inspectors of mines and explosives are responsible for routine inspections, and the extension of technical services on safety issues to formal miners. The survey revealed that such duties were impaired by insufficient resources, such as transport, a lack of communicating facilities and limited operating funds.

### 3.2 Human Safety

334. Small scale artisanal miners are strenuously involved in searching for and winning minerals, and thereby run the risk of impairing their health. Artisanal miners in underground operations were also exposed to high noise levels in some locations such as Merelani (Arusha); Matinje (Nzega), Musoma, (Tarime) due to the use of drilling machines, explosives and compressed air. While there is a risk of hearing loss at 75dB, many locations monitored showed high values of over 100dB and the operators were not protected. Other risks exposed to operators include vibration due to jack hammers resulting into: -

- neurovascular alterations in the hands

- bone alteration and muscle atrophy.
- degenerative alterations, primarily in the ulnar and medium nerves.
- tenosynovitis

### **Thermal atmosphere**

335. In many deep underground mines such as the gold mines at Mugusu, tanzanite mines at Merelani (Arusha), and the Mundarara mines at Longido, the workers suffer problems caused by heat stress. The main sources of heat include rock walls (rock temperature increases with depth), adiabatic auto - compression of the air inhaled, and the presence of machines as well as underground workers.

### **Light**

336. Poor illumination presents safety problems in most underground mines visited. Miners face problems as they depend only on poor illumination with poor visibility and so dangerous obstacles are rarely seen and harm their eyes in the long run. The major causes of these unsafe practices include:

- a poor technology base
- inadequate funds to procure appropriate items.
- a lack of knowledge by mine operators on negative effects.
- regulations were inadequate and not enforced.

## **OBSERVATIONS AND RECOMMENDATIONS**

337. Observations and recommendations have been given at each section in the report. They are also highlighted in the Executive Summary and in sections of the Development Strategy in the Part II of the report.

UNITED REPUBLIC OF TANZANIA  
MINISTRY OF ENERGY AND MINERALS

*Mineral Sector Development Project*

PART II

DEVELOPMENT STRATEGY FOR  
SMALL SCALE AND ARTISANAL  
MINING PROGRAM

*Credit Support from:*  
THE WORLD BANK

*Prepared by:*  
**TAN DISCOVERY**

November, 1996

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## A - PROPOSED DEVELOPMENT STRATEGY

### BACKGROUND

A baseline survey which provided quantitative information on the current position and performance of the artisanal and small scale mining activities in Tanzania was carried out during the month of October, 1995 to April, 1996. The key aspects covered by the survey included organizational structures; institutional capacity; technical; socio-economic; marketing and finance; environmental, health and safety. The issues identified in the survey were related to shortcomings in the existing legal and regulatory system, poor technical base and constraints to access reliable market and finance, environmental degradation and law-less living coupled by unreliable social services. Target areas which will require assistance to alleviate the identified constraints are; sectorial level (to cover mainly legal, regulatory, and institutional aspects) community level (health, environmental, maintenance of law and order issues, special programs issues); mining production units (transformation process of informal/formal artisanal miners, small scale miners, and potential mining investors).

The proposed development strategy aims to improve social, technical, economic and environmental performance of small scale mining and to encourage the process of transformation of informal artisanal mining into formal mining operations. The components of the strategy are; review of legal, fiscal and institutional frameworks; technological advancement; improve marketing and credit facility sources; and improvement of community living and services. An integral approach and strategic alliance between interested parties is essential to achieve the above mentioned objectives. In order to assist the decision makers and implementors, the proposed development options target specific areas of assistance and in two extreme scenarios of least cost proposed ahead of most productive ones. Some of the development options will aim at improving performance and others will have impact on the transformation process.

## I. SECTORIAL LEVEL

Legal, regulatory and institutional set up issues are expected to be attended at ministerial level. Development options are proposed with the aim of establishing enabling conditions for development of artisanal and small scale mining in Tanzania.

### I.1 Legal Aspects.

The Mining Act (1979) could not cover some essential parts of laws and regulations which could lead to a conducive working atmosphere for mineral practitioners. Of relevant to the study the survey pointed out short falls as the existing laws and penalties are out of date and hardly being practised; the role of artisanal miner is not covered; generally laws and regulations were inadequate to explicitly address issues on market, institutional frame work, mineral properties, authority in government and associations and their linkage. Matters on environmental pollution, safety and health were secondary in the Act and in most cases should be supplemented by laws and regulations from other government departments such as local authority, forest, water which were observed with unsatisfactory cooperation concerning artisanal miners issues.

In an effort to correct the shortfalls the study team suggest measures for a short term with low costs and long term but of significant impact in the mining activity.

#### *To attend immediate needs.*

- Amendment of the current Mining Act to enable smooth implementation of the artisanal mining transformation process.
- Artisanal miners should adhere to the basic requirements of Mining Act. Powers of inspecting mining activities and prosecuting defaulters should be used.

***On legality of artisanal mining***

- The Act should recognize artisanal mining activities and show their roles.
- Simplify registration and licencing procedures by suggesting conditions which can easily be met by a common mineral practitioner.
- Provide discretion and incentives during the transition period from informal to formal operations.

***On security of mineral property***

- Acknowledge the right to transfer mineral property and simplify procedures for it.
- Right to use of mineral property as collateral.
- Improve security of tenure by increasing claim title life to three years instead of the present one year term.

***Creation of competitive markets***

- Review mineral trade regulations
- Simplify registration procedures to mineral dealer
- Review procedures to monitor mineral sales from producers to exporters.
- Legislate creation of open markets, gem exchanges and gemshows.

***Formal consultations with stakeholders***

- Creation of mining advisory boards from District, Regional and National level
- Legal recognition of roles of key mining associations.

*Power to delegate*

- Strengthen the, Zonal Offices to register and transfer mining claims and submit reports to the registers office at Madini Dodoma.
- Enforce powers of mining inspectors and frequency of regular inspections.
- The Commissioner for Mineral Resources should be given discretionary powers to facilitate transformation of miners in mine rush areas into organized and legalized mining operations.
- Re- establish mine wardens who should be trained to deal with illegal mineral activities.
- Stipulate qualifications of mine inspectors, mine wardens, etc. and specify duties and limitations.

*To ensure environmental, safety and health matters.*

- Enforcement of existing mining safety and environmental regulations.
- Review mining safety regulations to incorporate environmental aspects.
- Cities and municipal authorities should demarcate suitable areas for mining and mineral processing. Present concerns involve building, industrial minerals and salt works.
- Set minimum work standards for small scale mining.

*Training aspects.*

- Publication of information and guidelines on how to acquire mineral title and obligations of title holders.
- Publish information on basic mining procedures, such as claim pegging, basic prospecting, timbering etc.

- Review record keeping formats and issues to appear in the monthly activities report.
- Conduct awareness campaigns on mining laws and regulations and other aspects through posters, radio , TV, seminars, workshop etc.

## **1.2 Fiscal Regime**

Most artisanal and small scale miners are carrying out various informal practices such as mining, trading of minerals, and supporting services without paying any taxes. The existence of informal activities have severe consequences to the government revenue collection and in general it retards the development of the mining sector.

It is imperative to put efforts on formal activities, so as in return the Government can increase revenue collection. It is therefore suggested to look into ways of formalizing the economic activities in the sector with the view of, attracting more investment and to increase the government revenue. The Ministry of Energy and Minerals should make consultations with the Ministry of Finance and Tanzania Revenue Authority on modalities to implement the proposed development strategy.

*To encourage formal operations and to increase government revenue.*

- Simplify revenue collection procedures
- Use a single revenue collection point where mineral operators performance records are kept and can be verified: *Operators are assessed by many organs e.g. mines, sells and income tax dept. Time and sometimes harassment's are associated with these exercises.*
- Revise fees, annual rent, royalty and other tax rates to be modest: *to enable tax payers to declare true values and discourage use of informal networks or bribery.*
- Use modern technology to analyse and revising the returns and performances in order to determine fair tax rates and to know the tax payers.
- Expand the tax collection base by legalizing operation of informal operators (miners, brokers, pet traders etc.) in mining areas.

- Use transparency and standard system in grading, valuation and sealing of mineral parcels, especially precious minerals.
- Provide incentives and other benefits to revenue collectors.
- Make the fiscal regime competitive especially with neighbouring countries: *this will reduce the present under invoicing of export parcels and discourage mineral smuggling. Experiences and tax regimes of Kenya, Mozambique, Thailand and Sri Lanka should be utilized.*
- Strengthen administrative capacity to enforce tax regulations.
- Give stiff penalties such as confiscation of properties, to mineral smugglers and award those who disclose illegal dealings.

***To attract investment and reinvestment***

- Stimulate productive operation and increase exports.
- Provision of tax incentives to mining development operators.
- Extend capital allowances to all documented exploration/prospecting costs including capital expenditure: *this will enable small scale mining investors to enjoy existing investment promotion incentives given to mining companies.*

### **1.3 Institutional Setup**

Mineral Resources Department has been unable to support the rapid increase needs of artisanal and small scale mining operations due factors like: inadequate operation budge; poor working facilities; and unskilled and understaffed manpower. There is no specialized unit within the MRD to deal with issues of small scale miners hence the extension services are not carried out properly and in some mining zones have ceased to exist all together.

The review and strengthening of the institutional setup are aimed at improving performance in monitoring and boosting administrative support to the sub-sector.

***Strengthen MRD to improve its routine performance and monitoring activities***

- Lay down standards and procedures of the sub-sector in exploration, mining and processing activities.
- Assist in identifying mining and processing technologies which are safe, efficient and economically viable to safeguard long-term benefits to operators and the nation.
- Establish and approve environmental, health and safety standards
- Regularly carry out needful actions on safety, health and environmental regulations.
- Enforce the law to defaulters and impose penalties such as written warnings, shut - down of operations, non - renewal, revocation of mining rights and prosecution in civil courts.
- Establish Small - Scale Mining Unit within the Mine Division to accomplish the aforementioned options. The unit will work under the Director of Artisanal and Small - Scale mining Development Program.
- Appoint competent Mines Officers.
- Ensure adequate operational budget for the program to be successful.
- Enforce powers to arrest, and prosecute those who will continue in illegal mining and mineral trading/smuggling.
- Motivate good operators through annual performance awards to miners and MRD staff to inspire others to improve performances.

***To improve support to the sub - sector.***

- *reduce, Increase*  
Reduce the ratio of mine officers to operators and increase frequency of site visits per professional needed.
- Provide adequate, and efficient working facilities such as computers, GPS, radio transmitters/receivers, field gears etc.

- Improve quality of extension services on prospecting, mining and processing techniques, management of small miners activities, finances; mineral market needs and report preparations.
- Prepare national training guidelines at different skill levels to be used by instructors, NGO's and others.
- Identify training needs of MRD staff serving the sub - sector, and encourage induction courses.
- Establish courses of mining inspectors at Madini Institute.
- Provide mineralogical, geological and analytical services.
- Assist in property evaluation.
- Identify and recommend areas demanding special attention or research programmes.

#### **1.4 Technological Advancement**

Use of inferior working tools has resulted into low productivity in mining and processing operations of artisanal and small scale miners. These activities are associated with a lot of waste, lack of safety and destruction to the environment.

Poor mining technology also hinders economic exploitation of the mineral reserves where mines are abandoned at shallow depths. Past efforts to introduce semi-mechanized Small Scale Mining in Tanzania was not very successful mainly due to poor choice of the adapted technology.

The aim of this component of development strategy is to alleviate technological constraints of artisanal and small scale mining and provide proper means to access, adopt and maintain the appropriate technology.

Implementation of these development options is costly and time involving both to the government and miners. It is proposed the technological advancement be attained in two steps, first to assist claim holders and operators to access the technology and second, to assist those who have acquired it to properly use, adopt and maintain it.

***To access appropriate technology***

- Identify appropriate technology for different mineral commodities to suit geological set ups and ore characteristics.
- Encourage potential technological partners to work with artisanal miners.
- Organize mining equipment fairs and demonstrations.
- Provide inventory of manufacturers and suppliers of mining equipment
- Set up demonstration plants at mining center/areas in areas without modal mines. *model ?*
- Establish modal mines for demonstration purposes and to act as service centers to surrounding areas such as provision of customer's mill services and equipment hire.
- UNIDO Initiative Programme to provide improved gold processing technology and control of mercury pollution, should be coordinated in the implementation of the Mineral Sector Development Project. 
- Encourage and support equipment hire cum purchase arrangements through agents, branches etc.
- Establish advisory services to investors on mining equipment to avoid failure repetitions.

***Proper adaptation and maintenance of technology.***

- Organize demonstrations and assistance on proper installation, use and care of machines and equipments.
- Establish and conduct technical training programmes.

- Encourage creation of mining supporting services such as:-
  - Surveying
  - drilling
  - assaying
  - testing and supply of equipment and chemicals
  - shaft sinking and mine development
  - feasibility studies and mine evaluation
  - gem and jewellery appraisal services.
- Encourage local manufacturing of mining equipment
- Conduct research studies on specific technological needs of the subsector.

### **1.5 Financial**

Lack of formal financial sources to finance small scale mining operations has influenced existence of present wide practice of production- sharing arrangements and increase in mineral smuggling. Informal financial sources normal finance mineral trading and stimulation of mineral production in rich claims only (like purchase of explosives, compressors or water pumps and labour costs), in very rare cases these funds are used to finance mining development activities. e.g. geophysical or drilling works. Most small scale miners are not in a position to meet loan conditions of financial institutions. On the other side local financial institutions don't fully realize the economic potential of the subsector hence reluctant to formulate appropriate financial schemes to support development of small scale mining.

The improvement of financial services to the sub sector should aim to create incentives and regulations which will encourage easy transfer of mineral properties and provide security to creditors. Efforts should first be directed to maximize utilization of resources within the sector it self before opting to approach financial institutions.

*Before seeking funds from financial institutions.*

- Support efforts to increase incomes of miners through added value activities, minimizing waste and securing better mineral markets even for lower value mineral product.
- Promotion of income saving culture to artisanal and small scale miner.
- Support formation of formal enterprise groups.
- Formalization of traditional funding systems mainly:
  - hire cum purchase
  - Grabs - staking
  - third-party collateral arrangements.
  - forward sales
  - mutual group saving schemes.
- Establishment of close business cooperation between small scale miners and mining companies.

*Access financial markets*

- Use of mineral rights as collateral and facilitating easy transfer of it: *to reduce the present security risk felt by many potential creditors.*
- Creation of mineral property markets: *to enable discoverers to secure better offers from property developers.*
- Categorizing risk factors of various mining sector activities: e.g. *prospecting, mining, processing and marketing. This will help investors with collateral to acquire credit for their project proposals.*

- Creation of mining credit schemes: *which is appropriate to the sector requirements and accessible to artisanal and small scale miners.*
- Support formation of miners' cooperative banks: *in a form of saving and credit schemes with support from donors, NGO's Government and Private Sector.*
- Revising government mining trust funds: *to operated as revolving fund and can be supported by diverting some of the mineral revenue collection, grant from BoT, Treasury or donor contributions.*
- Encourage financial institutions to support the sub sector: *by allocating funds and formulating affordable credit schemes for the sub - sector.*
- The Bank of Tanzania should lower the start up capital: *to encourage establishment resource banks to finance mining and mineral trading operations.*
- Support informal sector credit facilities: *by giving financial and technical assistance to organization like PRIDE AFRICA which uses Grameen Bank principles.*

### ***Training requirements***

Mineral property developers will have to undergo short courses on:

- Project management and monitoring.
- Promoting mineral property and investment skills
- Assistance in preparation of feasibility studies

The financial institution personnel will need to be familiar with:

- Economic opportunities of the mining sector in Tanzania
- Mining project appraisal methods
- Mining project monitoring and supervision.

## 1.6 Mineral Markets.

Present mineral trading practices are very secretive and this sometimes leads ignorant miners to be exploited by those who know the market and make it difficult to establish the actual mineral export volume or revenue losses.

Effort of the government 1990 to allow artisanal miners to sell raw gold to the Bank of Tanzania helped only to improve the local market but the existence of export conditions to sell gold to foreign buyers after assaying has helped the growth of illegal gold mining and smuggling to jewellery markets of Asia. Most of the exported minerals are unprocessed (raw or rough) because very little effort is taken on value added activities.

To achieve better market arrangements efforts must be taken to ensure growth of both local and export market. Improved market arrangements should aim to establish formal competitive mineral markets and to improve market knowledge of miners. Marketing arrangements should support longterm growth of the sector, improve revenue collections and exports of minerals through official channels. It is essential also to assist mineral exporters with foreign markets information and establishment of favourable export credit schemes from financial institutions.

### *Local mineral markets*

- Establish competitive mineral markets close and within the mining areas, to be operated by mining associations, licenced individuals, companies and financial institutions.
- Encourage more mineral brokers to acquire brokers licences by further simplifying application procedures.
- Simplify mineral sales records and improve monitoring of the same.
- Support mineral grading and valuation services, to miners and dealers.
- Formalize dealers credit schemes to mineral brokers.

- Support efforts of mineral producers to access better markets.

*Export markets*

- Facilitate market loans and export credit guarantees.
- Improve of gem exchange and gemshows in volume and quality of displayed merchandise and number of foreign buyers.
- Promote value - added activities through incentives and training.
- Frequently monitor formal and informal marketing channels and formulate incentives and regulations which will improve competitiveness of the legal exporter over the smuggler.
- Provide competent staff, sufficient budget and better working facility to Mineral Marketing Division.
- Allow mineral exporters to utilize at convenience forex earnings.
- Consider possibilities of establishing a permanent Gem Exchange center in collaboration with other sub-regional neighbours.
- Mining and marketing regulations of unique and precious minerals such as tanzanite and alexandrite, should be reviewed in order to protect prices and maximize benefits against the dangers of over flooding the market.
- The government should improve investment climate in order to attract private funds and participation in controlling the prices and minimize public resources in mitigating smuggling activities of minerals.
- Further liberalize gold trade and export by eliminating gold export control to enable foreign buyers of raw gold to utilize formal market channels without assayers conditions.
- Assist in collection and dissemination of market information.

### **1.7 Essential Training institutions for sustainable development of the mining sector.**

It was observed in many parts of the country that mining investors and miners are taking risk in investing in mining operations without any professional advice or project planning. This problem becomes crucial for lack of specialized or commercial institutions to meet mining investment needs such as appraising mineral property, skilled labour work force, modern prospecting techniques, etc.

It was observed in many parts of the country that mining investors ( small operators and mining companies ) will soon require qualified work force to met the technical challenges in mining development activities. There is a need to plan and establish various institutes which will upgrade industry professionals and offer skill development programs to both miners and technical staffs.

- Madini Institute should be upgraded and allocated sufficient funds so as to offer formal training to the small scale mining sub-sector. The long term strategy should be to allow the institute to commercializes its services with the view to sustaining itself.
- Some Vocational Centers Should incorporate mining sectors skills development programs, such as technical management, environmental monitoring and mineral marketing skills.

## 2. COMMUNITY LEVEL

Aim is to improve environmental, living and working conditions, of the mining communities.

### 2.1 Strengthening of environmental, health and safety Management programmes.

The management programmes on environmental pollution, health and safety were characterized by uncoordinated efforts, lack of operating funds, inadequate experts and lack of support of the inhabitants. The uncontrolled mineral extraction and mineral processing has resulted into adverse effects upon the environment. The living conditions of the community are characterized by poor sanitation, unsafe and unclean drinking water, high congestion in shelters which were poorly ventilated. The mining safety regulations were not enforced, thereby encouraging high rates of accidents and pollution of living areas and water bodies.

The proposed development options will enable the small scale miners to conduct mining, mineral beneficiation and other supporting service activities in an environmentally sound manner. Also regulations on safety and sanitation should be put in place to reduce the rate of accidents and epidemic outbreaks hence improving living standards in mining community.

To achieve this monitoring and training programmes are proposed.

#### ***Monitoring Programmes***

The monitoring programme is designed so that it identifies and regularly measures certain parameters such as physical data on water, air and soil characteristics as well as features identified from regular aerial photography (such as vegetation disturbance). In health matters similarly planned regularly visits on mining Community to assess health practices such as boiling drinking water, improve sanitation living shelters is important.

***Safety practices should be monitored.***

- Coordinate issues of environmental, health and safety at district level.
- Carry out regular and random inspections on environmental pollution, community/occupational health and safety at working place.
- Ministry of Health and Community development should be involved to set health/sanitation standards and conducting training programs.

***Establishing and strengthening authority structures***

- Improve coordination and involvement of the local government in the affairs of mining communities.
- Institute guidelines for mining camp regulations.
- Ensure every mining community has elected leaders and empower them.
- Improve mining community direct and indirect communication with the local government, donors and concerned NGO's.

***Improvement of social services***

- Establish miners security units in mining camps.
- Encourage and offer incentives to private operators of essential services, health, water supply, etc.
- Incorporate the provision of social services to mining communities in district development plans

### **2.3 Community Development Programs**

Special programs should be initiated to improve the performance of specific groups for the benefit of the mining community or national interests.

**Among the groups in need of assistance are:**

- Mining Associations such as Chamber of Mines, FEMATA, REMAS and TAMIDA

**Provision of Capacity building assistance is of importance to the associations.** Each of these associations will require assistance to establish office premises which will have to be equipped with necessary communication and storage equipments. The Chamber of Mines and TAMIDA will need few offices but REMA's will require more.

Leadership and other organization courses will have to be provided as part of project preparation program in order to improve the efficiency of these associations prior to project implementation stage.

- Active women groups

**Assistance should be made to enable women to participate at equal level in mining activities as their male counterparts.** Community development experts should work with women groups to eliminate cultural barriers and improve economic performances of women. In the supporting services in the mining areas.

Research activities could also be initiated on areas such as child labour in mining and the effects of mining pollution.

### 3. PRODUCTION UNIT LEVEL

Efforts to transform informal artisanal mining into organized small scale mining operations cannot be achieved without proper planning and rational use of scarce resources to undertake the program. It is expected that the various promotional programmes, e.g. appropriate technology and training, should address specific mining groups on the basis of the level of mining operations and needs.

The baseline survey show the sub-sector operators can be assisted well by taking into account the three levels of mining development; informal artisanal miner, organized artisanal/small scale miners, and advanced small scale miners. It is expected that each mine zone will make effort during the initial awareness campaigns, to get details of the individual operators and classify them into above groups in order to implement properly the promotional programmes.

Three phases of transformation are proposed based on development of mining activities of the claim and operators performance. The first phase will involve transforming informal miners both in traditional lands and mine rush areas to formalize/legalize their operations and abide to camps regulations. The second phase will aim to upgrade the formal claim holder into organized small scale miners utilizing appropriate environmental sound technology and improved market knowledge.

In the third phase, organized small scale mining will be upgraded into advanced small scale mining operations. At this phase mining development activities will be conducted and a feasibility report will determine the economic viability of the mineral project. The report is essential to justify commitment for further investment to increase mineral production.

Each transformation phase has few progress steps which are attained after specific programme inputs and assessment. In the course of this transformation process it is expected that some operators will leave the mining activities and other investors/operators will be attracted with the mineral opportunities and join in. As stated above the quality of mining operation and facility in place will be the basic criteria on to determine the level of transformation process from informal artisanal mining into advanced small scale mining operations.

## *Phase I - Legalizing*

### *Artisanal Mining Operations*

At this phase efforts will be made to transform informal artisanal miners into formal artisanal miners. This transformation will cover two steps, See diagram No. 1. First, miners in uncontrolled areas will be required to establish basic authority structures and meet fundamental requirements to remain working in mining areas. Among the conditions to be met, include obeying camp rules, forming working groups and use formal mineral market channels.

The second steps will be to legalize mining operations by registering claims or discs. Law enforcement will act upon those ignoring campaigns for change and failures in observing basic mining regulations and proper record keeping.

The programme set up and input at this phase is aimed to achieve the following objectives:

- To legalize artisanal mining operations and honour mineral discoverers with claim titles.
- To discourage disorganized mining and minimize itinerancy.
- To create and empower authority structures to maintain law and order and attend community needs.
- To expand government tax base by collecting revenue from present informal artisanal mining operations.
- To increase the volume of minerals exported through official channels.

Main activities at this phase will be to conduct awareness campaigns, extension services and frequent field inspections. The awareness campaigns will elaborate both the objective of the project and the need to establish law and order, improve living conditions and state the responsibilities of each individual group in achieving project goals. The extension services will give the basics of proper mining practices including observing mining laws and regulations; ways of forming effective working groups; procedures of pegging and maintaining a claim and the importance of record keeping and selling through official channels etc.

Field inspections will cover monitoring changes in the performance of the artisanal miners; enforcing law to defaulters; claim inspection, registration etc.

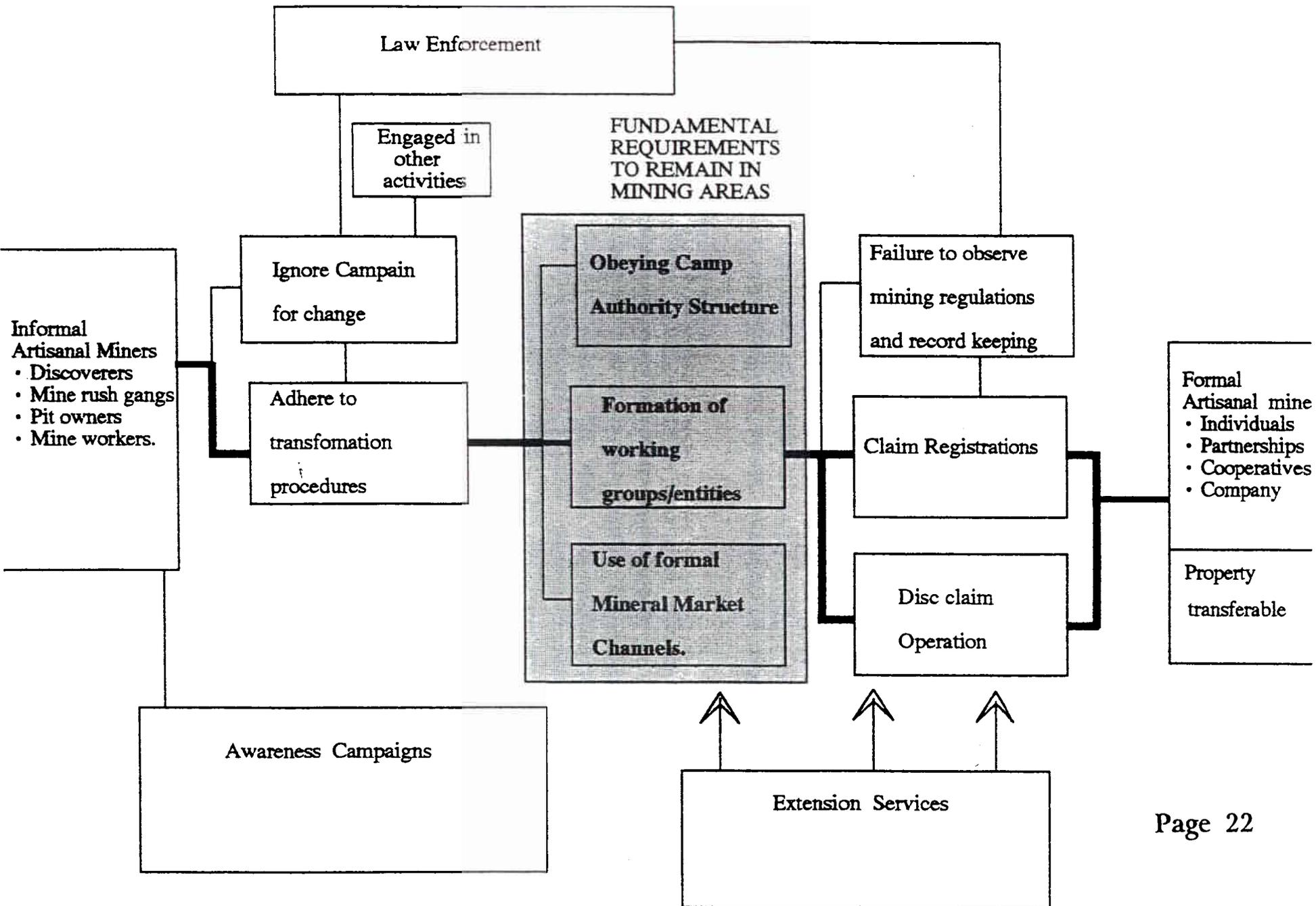
Informal artisanal miners, both discoverers and mine rush gangs, pit owners and mine workers, are expected to attend the awareness campaigns and start forming effective authority structures in their camps where register will be maintained and project staff could arrange various activities in consultation with elected camp leaders. The formed working groups will enable miners to acquire prospecting rights and later register mining claims as individuals, partnerships, cooperatives or company entity.

Camp authority leaders will also keep registers of mineral brokers and dealers operating in their areas. This duty will shift to claim holders once the mining areas have been registered into mining claims. Field inspections will also monitor mineral recovery and sales in order to encourage use of formal market channels. Camp leaders will also maintain records of contributions/fees levied to business operators in the camp which will contribute to the costs of improving basic services to the community.

With the assistance of the local government and the project staff, the claim holders and camp leaders will identify the defaulters of reform and, advice them to leave the mining activities or face the law. At this stage the mining activities will be carried only in registered land and this will give opportunity for claim holders to start activities of Phase II of the transformation program. Few claim holders who wish to transfer their claims should be allowed to do so without delaying to enable new owners to benefit from the next program activities.

Diagram No. 1

# Phase I - Efforts to legalize artisanal mining operations



### *Phase II - Skill and Production Improvement*

This transformation phase is aimed to enable registered formal/informal artisanal miners to adapt proper mining skills and use of appropriate technologies in mining and processing activities; attain basic business knowledge to improve resource management skills, and maximize mineral incomes through provision of better mineral markets. For artisanal mining to be transformed into organized small scale mining, two progress steps will have to be attained, see Diagram No. 2. First, training programs will be conducted to achieve orderly mining practices which abide to existing mining regulations.

At this progress stage, mining operations are expected to show: existence of orderly mining practice; observance of mining safety and environmental standards; proper maintenance of records and submission of true monthly returns; etc. Inspection activities will be carried to ascertain the above and successful operators will be encouraged and given preference to attend technology improvement programs. Law will be enforced to defaulters and if reminders and warnings are not attended, then claim reallocation measures should be taken as a final solution to enable capable operators to develop the property.

The second program of this phase will be the provision of technical assistance in adapting appropriate technology and access to credit facilities in order to improve productivity. This program is costly hence care must be taken in the preparation stage and in the choice of trainees in order to maximize benefits and avoid past mistakes in similar operations, e.g. gold plants - at Kasanga Chunya and Buziba, Geita.

The first part will involve technological introduction and demonstration and will involve various development options as explained above. The aim is to introduce the new mining culture by demonstrating its efficiency benefits, and how to access it. Movements of equipments and facilities as well as participants from one place to another will be inevitable, hence it is advised that miners should pay part of their attendance costs.

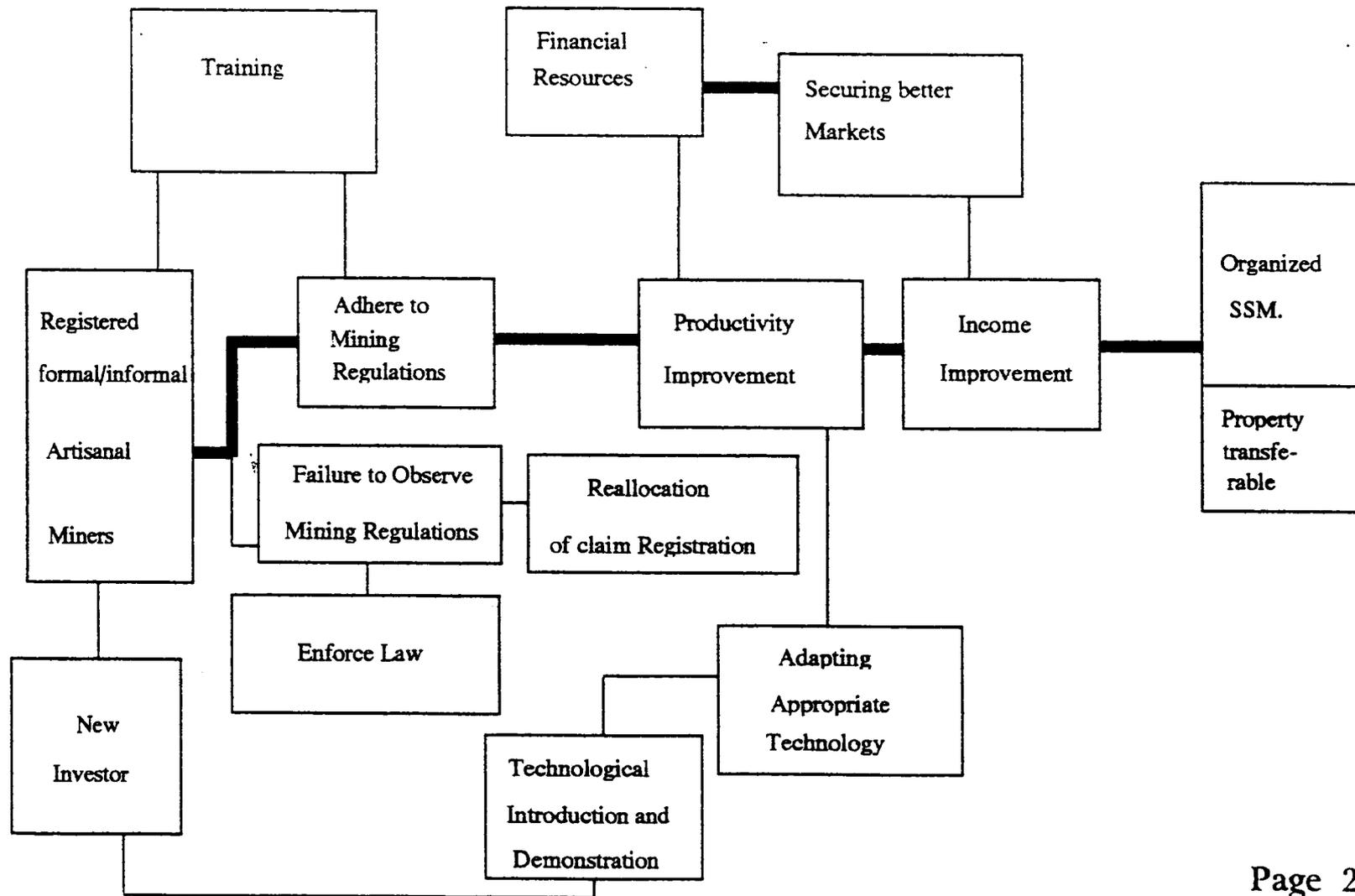
The second part will cover efforts to adapt and maintain the appropriate technology. This will involve not only proper installation, use and care of machines but also extension services on modern prospecting and mining techniques. Special skill training should be considered if it is essential to maintain the new technology.

Assistance in credit schemes should be made to enable miners to acquire the new technology on the basis of individual savings or ability to source collateral.

Like any other products essential mineral market knowledge will vary from one mineral commodity to another, so specific training programs should be prepared to improve miners knowledge on how to prepare the products before marketing. There is a need to assist miners to know the prevailing marketing prices and how to reach the best markets. Successful implementation of the above programs will transform artisanal mining into organized small scale mining operations. These achievements might attract new investors into the sub-sector who might joint at the beginning of the programs or simply purchase business from operators who want to leave the mining sector.

Diagram No. 2

Phase II - Skill and Production Improvement



### ***Phase III - Mining Development Activities***

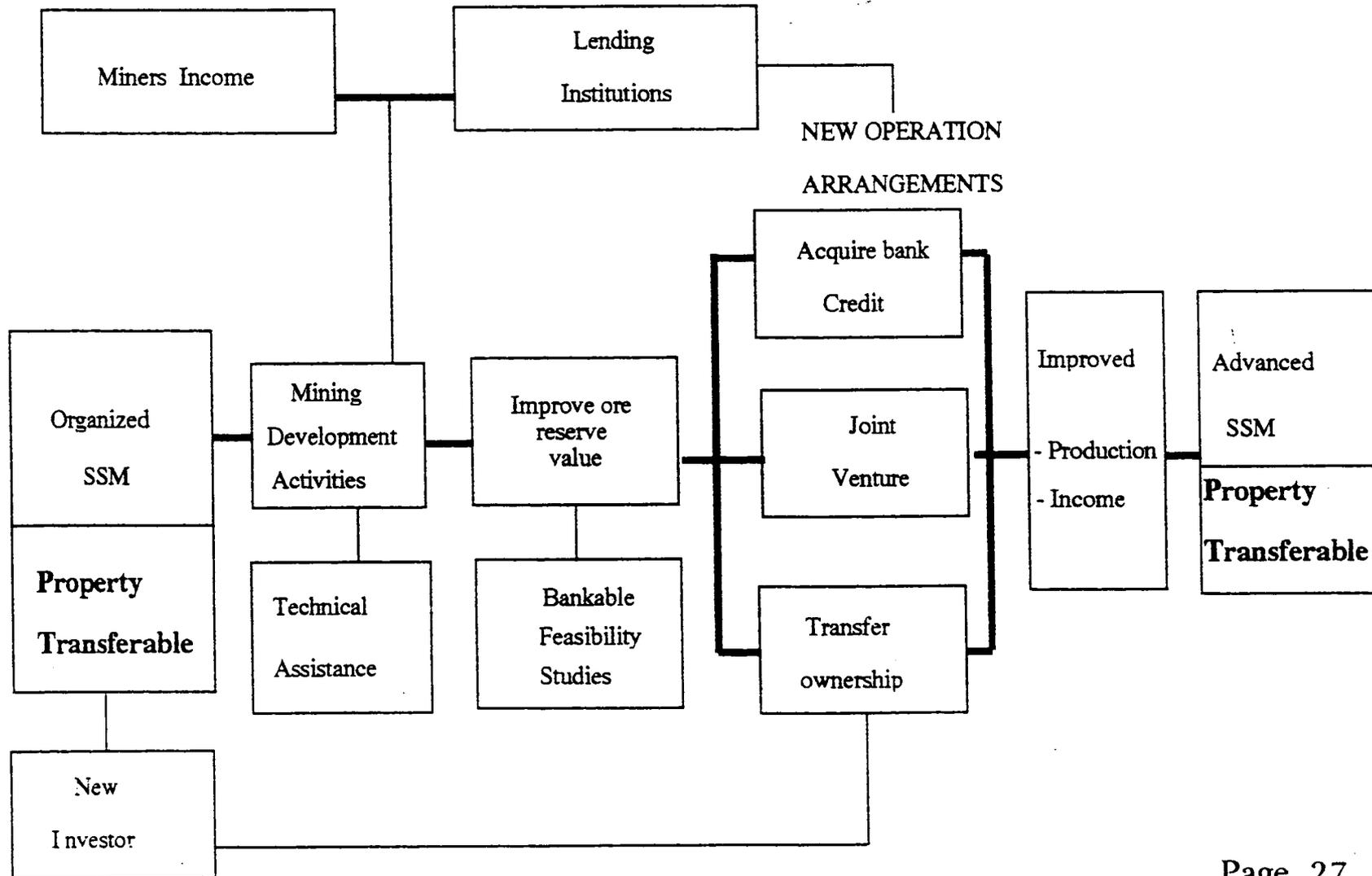
Organized small scale mining can turn into advanced small scale mining if there are proven ore reserve and sufficient mining funds for economic exploitation. Success of this transformation depends on: presence of rich ore; use of modern ore evaluation techniques; and presence of market for mineral properties.

The transformation will pass through two progress stages; please see Diagram No. 3 . First, is the conducting of mineral development activities followed by preparation of a feasibility report. The improved property value will attract and assist miners to acquire mining development funds. The second progress stage will focus on accessing available mineral property markets and this will require new operation arrangements before further investments are committed.

Technical assistance will be given in the mining development activities and in preparation of bankable feasibility studies and miners will be expected to cover most of the costs of these operations. Advice will also be given on how to market mineral properties and easy formulation of new operation arrangements. The availability of mining development fund and presence of a rich mineral property will enable advanced small scale mining to increase operations and production and turn into medium scale mining. At the beginning of the project, it is expected that very few mining operations will qualify for Phase III of the transformation process. This gives opportunity for efforts to be concentrated on a few successful mining operations which could later be used as models to inspire those in Phase II to progress further.

Diagram No. 3

Phase III - Mining Development Activities



#### 4. SPECIFIC COMMODITY SUBGROUPS

The following development options are proposed to address problems which were more specific to a particular mineral commodity. The options are related with various stages of mining operation, processing and marketing.

##### 4.1 Gemstones

- Avail prospecting techniques on a fee basis. Geologists should specialize in specific types of coloured stones and learn the art of experienced field prospectors.
- Disseminate information on pocket formation and mode of occurrence of economic recovery gems for each type of coloured stones. The information should be available in mines offices near the mining area, and it should be in a form to be understood by the miners.
- Impart blasting techniques which have minimum effect on quality of gems such as cracks and breaking into small pieces. Give demonstrations on these techniques and show the advantages on bases of good mineral recovery and economic use of blasting material.
- Introduce tools/equipment which minimizes stealing /misplacement of gemstones in pits and working grounds. Loose of recovered gemstone is a serious problem faced by claim holders and most of the stolen goods is marketed through unofficial channels.
- Undertake basic gemological training on precious gemstones covering sorting, grading and valuation.
- Promote and allow commercial lapidary activities such as cutting, heat treatment near mining centres for increasing value added. Seek technical assistance from friendly countries with social economic background and mining history similar to Tanzania. Experiences of India, Sri Lanka and Thailand should be sorted.

- Provide independent appraisal services in gem markets/show for fair deals to both sellers and buyers. Institutions and competent individuals should be licenced to provide the services which are becoming vital with the present developments to manufacture synthetic materials.
- Educate financial institutions to accept gemstones parcel with "an appraisal certificate" of qualified registered gemologist for collateral purposes. Proper information and expertise should be sorted form major gem centres New York, Los Angelos etc. on how investors use special stones for collateral purposes

## **4.2 Gold Mining**

- Employ exploration techniques to identify rich gold reefs.
- Disseminate information on model and formations characteristics of known gold reefs so that miners can apply the most suitable mining techniques.
- Impart tunnelling techniques in secondary enriched zones to avoid wide tunnelling which lead to wall collapsing. Audio visual aids should be used to demonstrate bad and good practices.
- Render mineralogical/geological/analytical services to miners wishing to examine gold levels of different sources, e.g. primary ore, tailings, marginal ore, etc.
- Adopt processing techniques suitable for particular type of ore to maximize recovery.
- Approve and monitor techniques which employ toxic substances such as cyanide, mercury by renown experts.

## **4.3 Salt**

- Provide incentives such as soft loans to thermal salt operators to change into solar operations.

- Adhere to food industry standards including use of special boots and gloves for hygienic conditions.
- Examine a cost-effective manner of producing and supplying salt ex - southern coasts of Tanzania. Study on ways to lower production cost to equal those of imported salt will help the marketing problems faced by salt producers in the southern regions

#### **4.4 Building Material**

- Formalize market system of minerals. The market of most building minerals is very close to the mining site. The mining groups should make direct supply contracts and hence increase their incomes.
- Demarcate and improve the access roads to sites so as to encourage operators to practice on reserved sites for building minerals such as sand, aggregates, etc.
- Impose heavy penalties to defaulters extracting coral for lime making.
- Adopt efficient kilns to calcine limestones for both enhanced quality and increased productivity.

## **B - IMPLEMENTATION PROGRAM**

### **5. IMPLEMENTATION APPROACH**

Good preparation is necessary for a successful implementation of proposed development options to transform the sub-sector. It is important for the government to source funds, and adapt the program of intergrated activities which can best be implemented in cooperation with donors, interested NGO's and mining associations.

The improvement of enabling conditions for the growth of artisanal and small scale mining is very crucial for other programs of the project to be achieved. It is proposed that the government should take immediate steps towards achieving enabling conditions before the actual field activities to transform artisanal mining commences. Implementation approach to improve social, technical, economic and environmental performance of Small - Scale Mining is given below:

#### **5.1 Establishing Enabling Conditions for Small Scale Mining**

The orderly development of artisanal and small scale mining can be achieved first by amending, and later by reviewing the Mining Act of 1979. This should be accompanied by initiating macro-economics and sectorial reforms. It is understood that the government through the Mineral Sector Development Project has already appointed consultants to undertake studies on legal, regulatory, fiscal framework as well as institutional strengthening aspects. The findings of the baseline survey and proposed development options will be utilized in those consultancies.

Smooth implementation of the artisanal mining program activities will require the establishment of a small scale mining unit at MRD HQ's and it will also be necessary to set up an **interdepartmental mineral committee**. The committee will have the duty to oversee the implementation of all government commitments to the project. The committee members are expected to be representatives of MRD divisions, Planning Commission - Presidents Office, Tanzania Revenue Authority, Ministry of Finance, Ministry of Home Affairs, Ministry of Industries Bank of Tanzania and Investment Promotion Centres.

It will be the duty of the government to promote the selected project activities in order to win the support of donors, NGO's and other interested parties. The role of each major project participant and areas of operation will be coordinated to improve productivity and to avoid duplication of efforts. Expected roles of some of the key participants are given below (see section 7). A **Project Advisory Committee** consisting of experts and project contributors will be formed with the task of implementing the Action Plan.

## **5.2 Essential regular services**

Essential regular services will have to be provided to the mining community in order to improve individual performances and living conditions in the mining settlements. Organizational and extension services will have to be provided as planned by advisory committee and it will be the duty of MRD staff to administer the mining law to ensure compliance.

### **(a) Organization Aspects**

There is a need to review and in certain areas strengthen the existing organization structures both in production units and the authority structures in mining communities. The production unit should be organised to allow the following operation: mineral production improvement and development of mineral properties where claim holders will be able to reinvest back into the sector. The production sharing system widely practised at present hinders proper development of the mineral properties. The production organization structures should also allow simple ways to administer the sub sector. The claim holders should be fully accountable for all mining activities carried out in ones property, this should included formal marketing of minerals produced.

All mining communities should have strong authority structures to support proper implementation of the project activities. Good leaders in these communities will maintain law and order; organize miners to attend the various development programmes of the project; together with mining association leaders; assist the government in the administration of the mining law in these communities; and also plan and execute various social service programs essential to the mining community.

**(b) Extension Services**

Regular extension services will have to be carried out during and after the end of the project, in order to introduce, train and monitor performances of the mining communities to adapt new ideas and techniques in production, commercial and community based services. Project advisory committee in collaboration with small scale mining unit will prepare and coordinate the necessary extension services to various groups and activities. Rational use of resources should be emphasised and the government should allocate sufficient funds to carry out the services and seek donor assistance if necessary.

The extension services will have to be conducted in the mining areas to enable more miners/in habitants to attend. The services will be carried out in a form of field demonstrations, site visits and meetings. Some of the special programmes, like trainers courses will have to be attended by representatives of the mining communities and will be conducted as seminars and in short courses.

Mineral production services will cover training techniques and use of appropriate technologies in prospecting, mining and mineral processing. The courses will also deal with mining safety and environmental pollution. Proper procedures and understanding of mining regulations in claim registration and monthly returns will be emphasised to reduce claim disputes and improve mineral statistics. Miners will also receive training on entrepreneurship, options to raise working capital and mineral market aspects. Health officers and community development officers will be involved in conducting training on health, sanitation and miners participation in community development projects. Special training programs will also be arranged to selected groups like women and children participating in mining activities.

**(c) Administration of the law and regulations**

Smooth operations of the Mines Division especially the Zonal Officers are essential to ensure operators comply with the mining regulations and immediate steps are taken to prosecute defaulters. It is necessary for the government to allocate funds and provide the Zonal Offices with proper working facilities and incentives to its staff in order to improve their performance in conducting regular mining inspections and claim registrations.

The mineral data recording system and communication facilities will have to be modernized to allow easy retrieval and manipulation of various mining statistics. The training requirement and essential working facilities to MRD are presently being assessed under the project sub - component of Institutional Strengthening.

### **5.3 transforming Mining Production Units**

Direct assistance to the mining production units will require rational use of scarce resources and an implementation plan which can easily be assessed regularly.

The proposed transformation process emphasises the importance of giving assistance to groups of miners depending on their levels in mining developments. The problems of illegal mining activities should be addressed first before embarking on skill and production improvement programmes which are directed to registered claim holders. A few capable miners operating in good claims will have to be assisted in conducting mineral development activities.

**Project Working Committees** will be formed in the mining locations with members from village leaders, association representatives, selected miners and registered brokers. The committee will be the grass root coordinating organ on issues related with development of mining activities of the area. Among the activities of this committee will be to mobilize miners to attend various project programmes and to give feedback on performance of miners in adapting new ideas. The committee members will work on voluntary basis, and for this reason, it is important to make sure its members are people who are active in mining activities and do care for the development of the community they represent.

**(a) Formalizing Activities of Artisanal Mining Operators**

Efforts to transform artisanal and small scale mining cannot be achieved if illegal mining is allowed to continue in many parts of the country. There is a need to start registering mining claims in all areas where there is a mine rush or mining operations in unregistered land.

Awareness campaigns should be conducted and timeframe given to illegal operators to enable them form working groups and identify land to peg claims. It is expected that organization effort will be made to ensure every mining location possesses recognized authority structures with leaders who will participate in the registration process in order to minimize complaints and claim border disputes. The claim registration process should be done on the site under supervision of a committee consisting of district leaders, mining association representatives and the zonal mines officers. All regular formalities will be made on site where applicants will submit their forms and claim beacons inspected before issuing of temporary claim registration numbers. The experience gathered in Tunduru operation in March, 1996 should be used with the above proposal, to tackle other problematic mine rush areas in the country.

After the initial exercise is completed it will be the duty of the registered miners and the settlement leaders to work with the government officials at district level to fight those opting to continue with illegal mining operations, by disclosing them for prosecution. In areas where duration of mining operation is too short and it is not logical to register normal claims, eg shallow alluvial gemstone, gold works, it is proposed to introduce disc claims. mine wardens should be allowed to issue the disc claims and collect the revenue on site. Disk claim holders will be required to deposit cash for land reclamation or be guaranteed by the local project working committee that the disc holder will refill the pit after mining and processing the alluvial productive layer.

The project working committee will also assess the volume of mineral produced in the areas and the presence of mineral traders. In collaboration with zonal mines office, Regional Mining Association and TAMIDA arrangements should be made to arrange for competitive markets for the minerals produced in the area.

**(b) Skill and Production Improvement**

- Technical Assistance to improve skill should be given to those abiding by proper mining practices as demonstrated in the extension service programs. Mine inspectors should work with experience prospectors and demonstrate to miners the various applicable methods of prospecting and mining. Miners should learn the importance of proper prospecting in saving resources and environmental damages. Model miners can be established in selected areas to assist the training programs and donors assistance should be sought to enable more miners to attend the courses.

The governments should seek the services of experienced consultants to formulate appropriate mining and processing technologies for different types of mineral commodities and geological set ups. This can be achieved by investigating the current mining methods and efficiency in performing basic activities eg. ore extraction, transportation, hoisting, dewatering, ventilation etc. The experts will also have the task of proposing the best ways of mechanizing most of the above mining activities by giving options of machine types, capacities and performance in various combinations. The choice of appropriate processing technology will depend on laboratory and field tests to determine the best methods to recover specific type of minerals depending on the nature of occurrence. This approach will improve mineral recovery by designing tailor made technologies and reduce the present universal processing technologies which are characterized with high mineral wastage especially in gold processing.

Equipment fairs and demonstrations should be organized in collaboration with mining associations to ensure claim holders and financiers attend with their technical representatives. The small scale mining unit in the MRD should make regular exercises to evaluate miners acceptance of new technology and pass the information to equipment suppliers and operators of credit schemes. Suppliers, donors and MRD should work closely to ensure miners install and maintain the mining equipments properly. Care of machines should take into account regular maintenance and economic usage to avoid regular breakdowns before repayment of capital investment. To achieve this the MRD should work with the machine suppliers to ensure proper training programs are carried out to users of new technology.

Capable Miners wishing to get quick results in their mineral projects should be advised to employ competent technical staff who will be responsible with all technical matters related to prospecting, mining, processing and maintenance of equipments.

Together with programmes to improve productivity, miners will be assisted in ways to access credit and improve market knowledge as explained separately below. Efforts of individual miners to learn on market requirements and trading will reduce the number of middle man and hence increase their incomes.

**(c) Support to Mining Development Activities**

Organized small scale miners might wish to expand their operations by investing in better machines and employing professional staff. This can only be done if there is a proven ore reserve and sufficient mining funds for economic exploitation. The project programme can support these property developers with technical and promotional activities.

Miners should be advised whether it is of economical benefit to conduct development activity or not. The project technical staff should study the mineral property, past mineral sales records as well as conduct preliminary geological survey to determine the nature of mineral occurrence and if it is worthwhile to undertake, the expensive, ore evaluation work. It will also be necessary to educate the claim holders on the activities which will be carried out, duration and various costs related to the exercise and the obligations of claim holders.

Provision of various professional services related with mining development activities eg. geological, and geophysical survey, lab tests, mapping, preparation of feasibility study ect. will be carried out by the project through MRD staff or NGO's and donor support to pay private companies/individuals. the technical support will involve provision of working facilities, consumables and personnel to conduct the surveys. Promotional support will be the preparation of feasibility studies and organization of investment opportunity gatherings to market the mining projects to potential investors or financial institutions. It is expected that commitment and contribution of individual claim holder will be vital for the successful implementation of mining development activities.

## 5.4 Financial Aspects

The seed and operational capital requirements of mining operators vary considerably from one mineral commodity to another and it also depends on the level of mining development in the area. It is proposed that the projects, role on financial requirements of small scale miners should be that of promoter rather than of implementor. The major assistance which needs to be given to mining operators is to improve their commitments to invest in mining, better financial discipline and desire to cooperate in raising credit funds and collaterals. Two approaches are proposed for among other reasons they are in themselves least cost options and most effective ones.

### *The Least Cost Approach*

Campaigns should be made through the media and seminars to attract the interest of the local business community to invest in small scale mining. Claim regulations and tenure should be revised to enable claim titles to be accepted as collateral by creditors. Deliberate efforts should be made to formalize traditional funding systems in order to protect the interests of both creditors and miners/mineral traders. Donors, legal institutions, mining and dealers associations should work together on this issue as it will assist most operators who don't qualify to the credit requirements of financial institutions. In the past studies it was observed that mineral smuggling was closely related to informal sources of funds, so successful formalization of traditional lending practices will increase official export of minerals.

Mining claims with big reserves, especially those of gold and diamond, can easily be developed by establishing partnership with nearby mining companies. This will reduce the uncalled for socio tension and improve technical cooperation between small scale miners and mining companies. The experience of Kalalani garnet mine in Tanga should be a reference point, where garnet production increased tremendously creating a sustainable employment to local mine workers, because the claim holders went in to technical co-operation with nearby mining companies.

### ***The Most Effective Approach***

The government should support the activities of NGO's and donors with experience in informal sector credit schemes. These institutions will provide entrepreneurship training to miners, especially on financial managements in mining projects and introducing a saving culture which will help miners to utilize their earning to acquire production assets. This training will also assist the miners to form formal enterprise groups, transform their organization skills and thereby improve their credibility to access credit form financial institutions.

Creation of mining credit schemes which are appropriate to the sector requirements is possible if the financial institutions could be attracted to fiance the sector. A separate study needs to be carried out to reveal the economic potentials and various risk factors of the sector. The study could also highlight different ways of establishing the various credit schemes for the sub sector.

The funding needs of various operators in the sub sector should be considered to enable them improve their performance. Mineral dealers require short term loans or overdrafts while miners will need medium to long term loans for mining development.

## **5.5 Mineral Markets**

The best assistance to mineral producers should be to educate miners as regards the quality of their mineral products and market information. The presence of reliable markets in the mining areas depend very much on the existing production organization structures and stability of the mineral production. It is expected that as the claim holders improve their control of the minerals produced and as they acquire better market knowledge, the number of middlemen in the mining areas will decrease as more miners will prefer to sell direct to mineral dealers. The need to have special market in the mining areas will then be reduced to save the very few small producers and to help collection of stolen minerals from the registered claims.

Mineral market issues usually touch the interests of every group (miners, brokers and mineral dealers) in the mineral sector. Because of this, it is common time to time to find the groups accusing one another in their effort to protect group members income margins from the mineral trade arrangements. It is thus suggested that a progressive mineral market arrangement should support the long term growth of the sector, where producers should get a fair income to enable them to finance mining development activities. The arrangements should also improve revenue collections and increase exports of minerals through the official channels.

*The least cost approach.*

The government should consider to further simplify application procedures to enable more mineral brokers to acquire dealers' licences. The licences should also be issued to different categories of brokers depending on their working areas and the scale of trading operations. There should be different licences to small brokers operating only in mining areas and those travelling from one region to another.

Establishment of free market days in mining areas and major mineral trading centres can be achieved in close cooperation with FEMATA, TAMIDA and representatives of registered mineral brokers. Mineral market standing committees should be formed in every area. The committees will have the task to ensure smooth operations and growth of these markets and among other duties will be to monitor mineral production and collection from the area, fix market days and make public advertisements to attract more participants.

The Mineral Market Division should prepare short training programmes to educate miners and dealers on issues related to mineral marketing. The project implementation committee should disseminate market information to mining operators through radio and other mass communication media. The Bank of Tanzania and other financial institutions should be educated on the importance of offering market base exchange rates to mineral exporters and deliberate efforts should be made to formulate export credit schemes to assist mineral exporters.

Miners of building minerals should be assisted to market most of their products directly to builders in the nearby towns and cities. Market promotion groups should be formed and be supported with the necessary inputs from the Cooperative College, donors and informal sector supporting NGO's like Poverty Africa. Salt producers in the southern-eastern coast ( Mtwara and Lindi regions ) should also be assisted through transport costs to enable the salt produced to reach the market at a competitive price. Cooperation of the Ministry of Finance, TRA and the relevant shipping lines will be necessary and the achievements of this move will reduce the present dependence on imported salts.

*The most effective approach.*

The government should seek donors assistance to send more MRD staff to attend courses dealing with mineral marketing and value added activities. Specialized short courses on mineral marketing issues can be organized and participants should pay attendance fees. The small scale mining unit at MRD HQ's should work with competent representatives from mining and dealers' associations to set quality standards of various mineral commodities, both for primary/rough and value - added products.

The government should work with donors and NGO's to establish a centre, in the existing mining institutes, to promote transfer of technology on value - added activities. Salt producers can learn how to iodize salt and best ways of packing and labelling. Producers of industrials minerals such as gypsum, magnesite and coal could access information or technologies to process the minerals as well as ways to access technical and financial assistance for their projects.

Gemstone dealers and gold smiths can acquire information on lapidary and morden jewellery technologies. The investment requirements and market promotion of the finished products should be provided by the centre in collaboration with the lapidary and gemstone associations in the country and abroad.

The government, through its research institutions and in collaboration with interested private investors should approach countries possessing heat treatment technology of gemstone and start to experiment with locally mined materials especially rubies and sapphires. Successful implementation of this project will open up new market to these gemstone which are abundant but at present with very narrow market outlet.

Market research activities should constantly be carried out by government or as private consultancies to monitor formal and informal market channels. These regular studies should also estimate revenue collections, potentials and leakage and formulate measures and incentives to correct these shortcomings. This exercise will enable the government to asses implementation of policy directives and benefits of the sector to the national economy.

Formal trading contacts between local mineral operators and foreign mineral buyers encouraged but adequate arrangements should be made to ensure most of the purchased minerals are exported through the official channel. The Arusha International Gemshow should be expanded and new gem exchange centre should be established in Dar es Salaam, Arusha and later on, Mtwara. The gem exchanges should be organized by TAMIDA and FEMATA, and conditions of participation should allow registered miners and small foreign buyers to attend.

## 6 ACTION PLAN

An integrated action plan is presented which will later be formulated into a program of activities when choice of the options is adapted and budget set. The action plan will consist of preparation and implementation of activities. Program evaluation will be carried at different levels and time frame.

PROGRAM ACTIVITIES	PROPOSED PERIOD (MONTHS)
<b>6.1 Preparation Stage</b>	
<p>The preparation stage is essential in order to establish enabling conditions for artisanal mining and project implementation. It is necessary to formulate a strategic alliance with concerned parties in order to share responsibilities and establish coordination networks. A pilot project will be initiated at allocation convenient for demonstration and training of trainer/ implementing agencies.</p>	3 to 12
<b>(a) Establishing enabling conditions for artisanal mining</b>	
- Amend the existing Mining Act	Less 6
- Review the mining laws	12 to 18
- Establish a small scale mining unit	Less 6
- Conduct training of the trainers	3 to 6
- Strengthen Zonal/District mines offices	12 to 18
<b>(b) Formulating strategic alliances</b>	
- Establish government interdepartmental mineral committee	< Less 3
- Seek donors support and assistance	9 to 12
- Identify NGO's and other interested parties with potential to participate in the program implementation	6 to 9
- Form Project advisory committee consisting of experts and other contributors.	Less 3
<b>(c) Conducting pilot projects in selected areas.</b>	
- Select pilot area and facilities	1 to 3
- Conduct pilot demonstration and mobilize training	1 to 3
- Review implementation procedures	1 to 3

PROGRAM ACTIVITIES	PROPOSED PERIOD (MONTHS)
<p><b>6.2 Implementation stage</b></p>	
<p>Implementation stages will involve project activities at zonal, regional, district and mining area.</p>	2 to 3
<p><b>(a) Project support and coordination work.</b></p>	
<p>- To appoint Zonal/District project supervisors and conduct seminars on project objectives and supervision.</p>	2
<p>- To conduct awareness and project implementation meetings /seminars to Regional, District, REMA's and other interested parties.</p>	3 to 4
<p>- To appoint a consultant and other specialized service companies or institutions to assist in the implementation of the program</p>	3
<p>- Government to appoint and hand over demonstration equipments to contractors</p>	2 to 4
<p><b>(b) Field Activities</b></p>	
<p><b>(I) Ground work activities</b></p>	3 to 9
<p>- To conduct awareness campaigns</p>	3 to 6
<p>- Zonal mines offices to register and categorize mining development levels of artisanal miners.</p>	3 to 6
<p><b>(ii) Execute Transformation Programme.</b></p> <p>In order to concentrate efforts and to minimize implementation errors the transformation programme is proposed to start in the following areas:</p>	12 to 36

PROGRAM ACTIVITIES	PROPOSED PERIOD (MONTHS)
(1) To attend active mine rush areas.	3 to 6
(2) First four mining Zones based on productivity and type of mineral commodity' and	12 to 24
(3) The remaining mining zones.	12 to 23
Main activities in the three phases of transformation are:-	
<i>Phase I - Legalizing artisanal mining operations</i>	
- Conduct awareness campaigns	3 to 6
- Camp registration and formation of working groups to apply for prospecting rights.	
- Conduct claim/disc registration and monitor mineral production and sale records.	
- Conduct inspections and prosecute defaulters	
<i>Phase II - Skill and Production Improvement</i>	
- Conduct training programmes	12 to 36
- Carry out claim inspections to recommend eligible operators to access technological and financial assistance.	12 to 36
- Technological introduction and demonstrations to be attended by claim holders.	12 to 24
- Adaptation of appropriate technology	12 to 24
- Offer assistance to access credit facilities and improve marketing skills	12 to 36

<p><b>Phase III - Mining Development Activities</b></p> <ul style="list-style-type: none"> <li>- provide technical assistance to mining development activities</li> <li>- Provide professional support in preparation of feasibility reports acceptable by financial institutions and potential mining investors.</li> <li>- Smoothen and ease procedures to acquire technical and financial support/backing.</li> </ul>	<p>12 to 36</p>
<p><b>(iii) Executing Community Development Programs.</b></p> <ul style="list-style-type: none"> <li>- Initiate monitoring programs on health, environmental, social welfare and law and order aspects.</li> <li>- Conduct training programs for specific groups, e.g. FEMATA, REMA's active women groups etc.</li> <li>- Conduct research in specific areas of concern such as, child labour in mining, effects of mining pollution, etc.</li> </ul>	<p>12 to 36</p>
<p><b>6.3 Program Evaluation</b></p> <ul style="list-style-type: none"> <li>- Use records and reports to show different trends and their causes</li> <li>- Conduct monthly / quarterly review exercises at Zonal and Project levels</li> <li>- Conduct mid year project evaluation and take remedial measures.</li> <li>- Appoint a consultant to conduct the project mid term</li> </ul>	<p>12 to 36</p>

## **7. KEY PLAYERS IN IMPLEMENTATION OF DEVELOPMENT STRATEGIES.**

Success of the transformation process requires good cooperation between the government and parties such as donors agencies, mining associations, NGO's and financial institutions.

### **7.1 Government**

The government is primarily responsible in coordinating efforts of the key players and to:

- Improve the enabling conditions through donor agencies support.
- Initiate macroeconomics and sectorial reforms which aim at orderly development of artisanal mining.
- Establish ways of extending technical services such as testing of equipment, carrying out laboratory and assay services etc.
- Encourage formalization by introducing incentives such as training, technical assistance, soft loans directed to formal operators.
- Set clear environmental objectives, regulations on community/ occupational health and safety requirements, parallel to this, monitor the compliance and take necessary remedial steps.

### **7.2 Mining Associations**

Duties of mining associations are to fulfill objectives of their respective association which reflect interests of members who are the main recipients of project programs. It is expected that technical assistance will be provided to the associations at the preparation stage, to give opportunities for active grass-root participation during implementation stages of the project.

**(a) Small Scale Miners Association - FEMATA and REMA's**

These are official representatives of artisanal and small scale miners, also they have contacts with remote mining areas and in some areas they maintain office branches. Mining associations are expected to show a leading role in project implementation by engaging in:

- Mobilizing mining community during awareness campaigns
- Organizing miners to attend training programmes.
- Assisting formation and maintenance of basic authority structures in mineral rush areas .
- Preparing works to identify priority areas, local logistic problems and prominent miners to be included in the project activities.
- Motivating, guiding and organizing miners to form working groups and to secure mining rights and credit.
- Helping to sensitize mining communities about the potential health and environmental hazards of present artisanal mining operations.
- Helping to identify illegal miners and point out smuggling of minerals.
- Representing general views of the miners on program implementation activities.

**(b) Tanzania Mineral Dealers Association -TAMIDA.**

The association deals with mineral market issues and protects interest of mineral exporters, these are traders And miners preferring to export their minerals themselves. Mineral dealers provide the local market for minerals produced by artisanal miners and major contributors of mineral royalty to the government. TAMIDA is a potential association to participate in the programme through:

- Improving its cooperation with FEMATA and REMA to make local mineral markets near and within mining areas grow up through active participation of dealers and mines.
- Encouraging its member to offer technical and financial support to specific mining groups where there is mutual interest as well as direct investment in mining by financing mining development activities.
- Formalizing credit schemes of its members to mineral brokers and keeping proper records of mineral purchase and sales.
- Encouraging its members to invest in added value activities and to provide commercial gem cutting services to miners.
- Promoting exports of minerals hence creating a steady demand and reliable market to minerals produced by artisanal miners.

**(c) Tanzania Chamber of Mines - TCM**

The Chamber of Mines is the mineral sector umbrella body and its involvement is expected in the following areas:

- Offer advice on policy matters and on mineral sector development issues.
- Establish a mutually beneficial relationship between small scale miners and mining companies to reduce socio-economic differences.
- Seek assistance from other established chamber of mines, donors and International Mining Companies to help in program activities.
- Create good working conditions to enable small scale miners to acquire assistance from nearby mining companies showing interest in supporting the operators.
- Organize training activities to selected small scale mining groups in the form of seminars, study tours etc.

### **7.3 Micro Finance institutions and NGO's**

Recent developments of mining activities have started to draw concern of various institutions and NGO's who are working independently on the needs of the sub-sector. Some of the areas which these groups can be asked to participate in the program are:-

- Grassroots organization of the artisanal miners to form working groups to access technical assistance. POVERTY Africa has already initiated similar pilot projects to miners in Mtwara/Ruvuma and Tanga region.
- Offer business training and assistance in marketing. The Business Centre, a USAID project is working with FEMATA to identify areas requiring assistance within their project mandate.
- Set up informal credit schemes. Some mineral brokers at Merelani tanzanite mines have benefited from PRIDE AFRICA lending schemes.
- Contribute to the needs of mining communities by setting up and supporting charitable foundations which provide social services and improve environmental and health standards. Some mining villages in Dodoma, Singida and Shinyanga region are under AIDS campaign programs of WORLD Vision International.
- Formulate assistance programmes aimed at transfer of appropriate technology to small scale miners.
- Build a constructive relationship between the local community and the small scale miners in their areas of operation.

### **7.4 Donor Organizations**

The donor community should be approached and requested to offer vital technical assistance, and financial support to ensure programme objectives are achieved.

**Technical assistance is needed in areas such as:-**

- Support conferences, seminars and workshops to promote sub - sector activities.
- Provide experts to participate in the programme implementation activities.
- Offer training and logistic support to MRD.
- Improve efficiency of mining associations and NGO's serving the sub - sector.

**Financial support is essential in:**

- Conducting policy reforms
- Enabling MRD to execute the program smoothly.
- Funding of technology transfer.
- Strengthening the ability of micro - finance institutions such as PRIDE AFRICA.
- Contributing to a government trust fund to support small scale mining.

## **APPENDICES**

**Appendices 1: Sub-Sector Sencus/Socio - Economic Aspects**

**Appendices 2: Institutional Aspects**

**Appendices 3: Mining and Processing**

**Appendices 4: Environmental; Health and Safety Aspects**

**Appendices 5: Commercial Aspects**

**Appendix 6: Terms of Reference**

**Appendix 7: Mining Areas visited during the Baseline Survey**

## **Appendices I: SUB-SECTOR CENSUS/SOCIO-ECONOMIC ASPECT**

A - Sub - Sector Census

B - Woman Participation in Mining

C - Education Level - Mine Workers/Claim Holders

D - Work Organization and Monthly Production

E - Activities of REMA's

F - Mining Participants Monthly Incomes

G - Professional backgrounds of some Artisanal/ Small Scale Miners.

**ARTISANAL/SMALL SCALE MINERS  
POPULATION CENSUS**

**Appendix 1A**

COMMODITY	ZONE	DISTRICT	MINE LOCATION	PUPULATION		
				MEN	WOMEN	TOTAL
GEMSTONE	ARUSHA	SIMANJIRO	MSITU WA TEMBO	2500	30	2530
			MERELANI	10000	6000	16000
			LESMNDARARA	200	100	300
			LANDABAN	198	44	242
			TIRIRI	90	50	140
			KANGARA	36	205	241
			SUB TOTAL	13024	6429	19453
			OTHER LOCATION	24620	5380	30000
			TOTAL	37644	11809	49453
GEMSTONE	ARUSHA	HANDENI	SEZAKOFI	416	239	655
			KWEDIRIMA	790	398	1188
			SUB TOTAL	1206	637	1843
			OTHER LOCATION	1480	520	2000
			TOTAL	2686	1157	3843
GEMSTONE	ARUSHA	KOROGWE	KALALANI	1200	1104	2304
			KIGWASI	400	50	450
			SUB TOTAL	1600	1154	2754
			OTHER LOCATION	2820	1180	4000
			TOTAL	4420	2334	6754
GEMSTONE	ARUSHA	MUHEZA	NGOMBENI	2000	60	2060
			MWAKIEMBE	200	-	200
			SUB TOTAL	2200	60	2260
			OTHER LOCATION	3790	210	4000
			TOTAL	5990	270	6260
SALT	ARUSHA	PANGANI	SANGE	400	-	400
			TOTAL	400	-	400
SALT, LIME & AGGREGATES	ARUSHA	TANGA	MNYANJANI	30	16	46
			KIOMONI	20	-	20
			KIMONI	73	3	76
			SUB TOTAL	123	19	142
			OTHER LOCATION	160	90	250
			TOTAL	283	109	392
GYPSUM	ARUSHA	SAME	MAKANYA	90	-	90
			SUB TOTAL	90	-	90
			OTHER LOCATION	500	-	500
			TOTAL	590	-	590
TOTAL - I				52013	15679	67692

**ARTISANAL/SMALL SCALE MINERS  
POPULATION CENSUS**

**Appendix 1A**

COMMODITY	ZONE	DISTRICT	MINE LOCATION	POPULATION		
				MEN	WOMEN	TOTAL
DIMENSION- STONES	ARUSHA	MOSHI (R)	USHIRA MABUNGO	75	15	90
			SUB TOTAL	75		90
			OTHER LOCATIONS	150	30	180
			TOTAL	225	45	270
SALT & AGGREGATES	MOROGORO	KINONDONI	MTONGANI	40	30	70
			KUNDUCHI A.	7	NIL	7
			KUNDUCHI B.	60	37	97
			KUNDUCHI C.	18	1	19
			BOKO	10	4	14
			BUNJU	9	6	15
			RAS KILOMONI	16	2	18
			SUB TOTAL	160	80	240
			OTHER LOCATIONS	16	8	24
TOTAL	176	88	264			
SAND	MOROGORO	ILALA	KITUNDA	80	10	90
			PUGU MWAKANGA	30	13	43
			SUB TOTAL	110	23	133
			OTHER LOCATIONS	300		300
TOTAL	410	23	433			
SAND	MOROGORO	TEMEKE	CHAMANZI-DOVYA	12	3	15
			SUB TOTAL	12	3	15
			OTHER LOCATIONS	450	110	560
			TOTAL	462	113	575
GEMSTONE	MOROGORO	ULANGA	LUKANDE	240	NIL	240
			KITONGA ESAKA	12	NIL	12
			KITONGA ONE	108	26	134
			SUB TOTAL	360	26	386
			OTHER LOCATIONS	660	40	700
TOTAL	1020	66	1086			
DIAMOND	SHINYANGA	KAHAMA	NYANGWALE	80	8	88
GOLD	SHINYANGA	KAHAMA	KATENTE	416	70	486
			SUB TOTAL	496	78	574
			OTHER LOCATIONS	2200	800	3000
			TOTAL	2696	878	3574
TOTAL - 2				4989	1213	6202

**ARTISANAL/SMALL SCALE MINERS  
POPULATION CENSUS**

Appendix 1A

COMMODITY	ZONE	DISTRICT	MINE LOCATION	POPULATION		
				MEN	WOMEN	TOTAL
GOLD	SHINYANGA	SHINYANGA	ITIRIMA	190	160	350
			MUNHUNZE	70	-	70
			OLD SHINYANGA	68	-	68
			SUB TOTAL	328	160	488
			OTHER LOCATIONS	9000	3000	12000
			TOTAL	9328	3160	12488
GOLD	SHINYANGA	IGUNGA	MATINJE NO. 6	2690	810	3500
			MATINJE NO. 2	870	630	1500
			SUB TOTAL	356	1440	5000
			OTHER LOCATIONS	1200	900	2100
			TOTAL	4760	2340	7100
GOLD	SHINYANGA	NZEKA	LUSU	1060	340	1400
			ISUNGANGWANDA	2620	280	2900
			SUB TOTAL	3680	620	4300
			OTHER LOCATIONS	1140	60	1200
			TOTAL	4820	680	5500
GOLD	SINGIDA	IRAMBA	SEKENKE	1030	770	1800
			SUB TOTAL	1030	770	1800
			OTHER LOCATIONS	600	300	900
			TOTAL	1630	1070	2700
GOLD	MWANZA	GEITA	ILILIKA	120	-	120
			MAWEMERU	900	-	900
			BUSOLOWA	760	40	800
			BUZIBA	810	200	1010
			MGUSU	10380	1620	12000
			NYARUGUSU	8990	5510	14500
			MWALOLELA	870	330	1200
			NYAKAGWE	20	NIL	20
			SUB TOTAL	22850	7700	30550
			OTHER LOCATIONS	5100	7900	59000
			TOTAL	73950	15600	89550
GOLD	MWANZA	BIHARAMULO	IMWELU	880	620	1500
			OTHER LOCATIONS	3000	200	3200
			TOTAL	3880	820	4700
GOLD	MWANZA	SERENGETI	KIMARAMBO	540	60	600
			TOTAL	540	60	600
TOTAL - 3				98908	23730	122638

**ARTISANAL/SMALL SCALE MINERS  
POPULATION CENSUS**

Appendix 1A

COMMODITY	ZONE	DISTRICT	MINE LOCATION	POPULATION		
				MEN	WOMEN	TOTAL
GOLD	MUSOMA	TARIME	NYANGOTO	4080	800	4880
			OTHER LOCATIONS			
			TOTAL	4080	800	4880
DIAMONDS	MWANZA	MISUNGWI	MABUKI	1400	1020	2420
			OTHER LOCATIONS			
			TOTAL	1400	1020	2420
GOLD	MWANZA	MUSOMA(R)	MAJIMOTO	614	206	820
			SIRORI SIMBA	180	56	236
			IKUNGU	36	6	42
			SUB TOTAL	830	268	1098
			OTHER LOCATIONS	100	50	150
			TOTAL	930	318	1248
GEMSTONE	MBEYA	TUNDURU	MUHUESI	7110	1390	8500
			DAR MAKARATASI	180	NIL	180
			MAJIMAJI AREA	17290	910	18200
			NAMANGO	1090	110	1200
			NGAPA - DAR	8760	440	9200
			NGAPA-MSUMBILI	2130	770	2900
			NGAPA-LUKANDE	3500	1000	4500
			NGAPA-ZANZIBAR	12800	3200	16000
			MSINJI NO. 8	11520	480	12,000
			MSINJI NO. 6	24900	7100	32000
			SUB TOTAL	89280	15400	104680
			OTHER LOCATIONS	60000	38000	98000
			TOTAL	149280	53400	202680
			GEMSTONES	MBEYA	MBINGA	MKAKO
DARNGEMBAMBILI	4010	190				4200
TANZ ROAD	390	260				650
LINDI MASUGURU	300	60				360
TEMEKE	1740	526				2266
SUB TOTAL	8050	1226				9276
OTHER LOCATIONS	2770	1730				4500
TOTAL	10820	2956				13776
<b>TOTAL - 4</b>			<b>166510</b>	<b>58494</b>	<b>225004</b>	

**ARTISANAL/SMALL SCALE MINERS  
POPULATION CENSUS**

Appendix 1A

COMMODITY	ZONE	DISTRICT	MINE LOCATION	POPULATION		
				MEN	WOMEN	TOTAL
GOLD	MBEYA	MBINGA	LUNYERE	2340	1060	3400
			SONGEA PORI	2250	850	3100
			NJALAMBE	510	290	800
			TANZONE	1330	1170	2500
			MPEPO	2870	1730	4600
			SUB TOTAL	9300	5100	14400
			OTHER LOCATIONS	2250	1350	3600
			TOTAL	11550	6450	18000
GOLD	MBEYA	CHUNYA	SANGAMBI	2100	2000	4100
			IHAMA	200	3	203
			LUPA MANYANGA	63		63
			SAFARI MINES	36	6	42
			MATUNDAS CENTER	3000	2100	5100
			ITUMBI	1600	200	1800
			ITUMBI JESHINI	24	-	24
			MAKONGOLOSI	8004	8000	16004
			MLIMANJIWA	10000	-	10000
			SAZA MKWAJUNI	400	-	4000
			RIFT VALLEY	24	-	24
			MWEMBE	218	-	218
			MBANGALA	125	-	125
			SUB TOTAL	29394	12309	41703
			OTHER LOCATIONS	3000	1100	4100
TOTAL	32394	13409	45803			
GOLD	MBEYA	MBEYA (R)	MADABAGA	450	200	650
			SUB TOTAL	450	200	650
			OTHER LOCATIONS	-	-	-
			TOTAL	450	200	650
GOLD	MPANDA	MPANDA	IBINDI SOUTH	3000	1000	4000
			MDAKUNI MATONGO	40	30	70
			JAPHET MWAKALA	60	-	60
			MAGULLA CAMP	1400	100	1500
			CHEMCHAM	930	270	1200
			KATISUNGA A.	2000	1000	3000
			KATISUNGA B.	1360	640	2000
			D REEF MAWENI	1310	1190	2500
			NTUMBA	29	14	43
			KASAKALawe	1200	300	1500
			SUB TOTAL	10105	4544	1469
			OTHER LOCATIONS	10000	1224	11224
TOTAL	20105	5768	25873			
<b>TOTAL - 5</b>				<b>64499</b>	<b>25827</b>	<b>90326</b>

**ARTISANAL/SMALL SCALE MINERS  
POPULATION CENSUS**

**Appendix 1A**

COMMODITY	ZONE	DISTRICT	MINE LOCATION	POPULATION		
				MEN	WOMEN	TOTAL
GEMSTONE	MPANDA	SUMBAWANGA	HUSSEIN KABOYOCA	20	-	20
			SUB TOTAL	20	-	20
			OTHER LOCATIONS			
			TOTAL	20	-	20
GEMSTONE	MTWARA	LIWALE	KITOWERO	14150	850	15000
SALT	MTWARA	MTWARA	MTWARA	7640	17360	25000
			TOTAL	21790	18210	40000
			<b>TOTAL - 6</b>	<b>21810</b>	<b>18210</b>	<b>4002</b>
			<b>GRAND TOTAL</b>	<b>408729</b>	<b>143153</b>	<b>551882</b>

## Appendix 1B

## WOMEN PARTICIPATION IN MINING

COMMODITY	GOLD						
	ZONE	DISTRICT	DIRECT	INDIRECT	TOTAL	INDIRECT %	
MBEYA	CHUNYA		1100	12309	8	92	
	MBINGA		1350	5100	6450	79	
	MBEYA (R)		20	5180	200	10	
	TOTAL		2470	17589	20059		
	MPANDA		380	3188	3768	10	
SINGIDA	IBAMBA		190	880	1070	18	
MWANZA	BHAKAMULO		200	620	820	24	
	GETA		4350	11250	15600	28	
	MUSOMA		120	198	318	38	
	TARIME		200	600	800	25	
	SERENGETI		10	50	60	17	
TOTAL		4880	12718	17598			
SHINYANGA	KAHAMA		60	2565	2625	2	
	SHINYANGA		20	50	70	29	
	KGURGA		140	2200	2340	6	
	NZEKA		60	620	680	9	
	TOTAL		280	3435	3715		
TOTAL 1		1400	41810	50216	1717	8385	
<b>DIAMOND</b>							
MWANZA	MISUNGWI		520	500	1020	51	
SHINYANGA	KAHAMA		3	5	8	38	
TOTAL 2			523	505	1028	5191	494
<b>GEMSTONE</b>							
ARUSHA	SIMANIRO		380	11429	11809	3	
	BANDINI		57	1100	1157	5	
	KOROGWE		134	2200	2334	6	
	MUHEZA		15	45	60	25	
	TOTAL		586	14774	15360		
MOROGORO	ULANGA		6	20	26	23	
MBEYA	TUNDURU		15400	38000	53400	29	
	MBINGA		1730	4096	4826	37	
	TOTAL		17130	40956	58086		
MTWARA	LIWALE		150	700	850	18	
TOTAL 3			17866	56430	74296		
<b>SALT</b>							
ARUSHA	TANGA		10	6	16	63	
MOROGORO	KINONDONI		89	19	88	78	
MTWARA	MTWARA(U)		9800	7580	17380	57	
TOTAL			9879	7585	17464		
<b>AGGREGATE</b>							
MOROGORO	KINONDONI		14	37	62	38	
<b>DIMENSION STONE</b>							
ARUSHA	TANGA (U)		3	70	73	4	
	MOSHI (R)		15	30	45		
TOTAL 4			9920	7699	17619		
<b>GRAND TOTAL</b>			<b>36709</b>	<b>10644</b>	<b>143153</b>		

Appendix 1C

EDUCATION LEVEL - MINE WORKERS

MINERAL COMMODITY		GOLD				GEMSTONES			DIAMOND			
		MWANZA	SHINYANGA	SINGIDA	MBEYA	ARUSHA	MORO	MBEYA	SHINYANGA	MWANZA	TOTAL	%
1.	Never Attended School	4			3	12	10		5		34	13
2.	Primary School	20	6	6	42	44	22	35	6	6	187	72
3.	Secondary School	6	3		4	5	3	12			33	13
4.	High School						3	3			6	2
TOTAL		30	9	6	49	61	38	50	11	6	260	100

MINERAL COMMODITY		SALT	LIME	AGGR.	SAND	G.STONE	GYPS.	SAND	SALT	AGGR.	SALT	LIME		
		ARUSHA						MOROGORO			MTWARA		TOTAL	%
1.	Never Attended School										2		2	3
2.	Primary School	8			8	4	5	8			7		40	67
3.	Secondary School			4		4		4			3		15	25
4.	High School										3		3	5
TOTAL		8	-	4	8	8	5	12	-	-	15		60	100

Note: According to the nature of operations and for security reasons, pit owners/pit sub-contractors work closely with miners when mining precious minerals. Therefore, they are included in mine workers list. There are no pit owners/pit sub-contractors for non-precious minerals.

Appendix 1C

EDUCATION LEVEL - CLAIM HOLDERS

MINERAL COMMODITY		GOLD				GEMSTONES			DIAMOND			
ZONE		MWANZA	SHINYANGA	SINGIDA	MBEYA	ARUSHA	MORO	MBEYA	SHINYANGA	MWANZA	TOTAL	%
1.	Never Attended School		4			8					12	8
2.	Primary School	12	10	4	9	26	12	12	10		95	62
3.	Secondary School	4	4		6	4	11	3		4	36	24
4.	High School		4			8					12	8
<b>TOTAL</b>		<b>16</b>	<b>18</b>	<b>4</b>	<b>15</b>	<b>41</b>	<b>23</b>	<b>17</b>	<b>10</b>	<b>8</b>	<b>152</b>	<b>100</b>

MINERAL COMMODITY		SALT	LIME	AGGR.	SAND	G.STONE	GYPS.	SAND	SALT	AGGR.	SALT	LIME		
ZONE		ARUSHA					MOROGORO			MTWARA		TOTAL	%	
1.	Never Attended School										2		2	3
2.	Primary School	8	3		8	4	5	8			7		43	68
3.	Secondary School			4		4		4			3		15	24
4.	High School										3		3	5
<b>TOTAL</b>		<b>8</b>	<b>3</b>	<b>4</b>	<b>8</b>	<b>8</b>	<b>5</b>	<b>12</b>			<b>15</b>		<b>63</b>	<b>100</b>

Note: Financiers/entrepreneurs are included in claim holders list.

**WORK ORGANIZATION AND MONTHLY PRODUCTION  
(Pit Owner, Claim Holders and Mine Workers)**

Appendix 1D - a

COMMODITY ZONES DISTRICTS LOCATIONS	GOLD							
	MPANDA							
	MPANDA							
	IBINDI	SOUTH	MAGULA	CHEMCHAM	KATSUNGA B	KATSUNGA B		D - REEF
Reef	Alluvial	Reef	Reef	Alluvial	Alluvial	Reef	Reef	
a) Active working groups ( a / b ) at the mine site visited (only 80% active)	37/38	36 & 12	56	74	320	115	24	75/75
No. of working group per type of operational organization								
- informal tributing	94	60	70	93	400	144	30	187
- Coopertive								
- Formal enterprise								
b) Size of group (No. of miners)	30	3	20	10	5	5	7	7
Formal								
Informal	2820	180	1400	930	2000	720	210	1310
c) Duration of one production (No. of days)	28	4	7	20	8	3	21	14
d) Estimates of group production per month (gms) per group	215	110	100	80	112	120	1150	280
e) Average Selling Price (Tsh.)/gm	5000	4000	4000	4180	4700	5000	5000	4700
f) Average group income (TShs) a	1075000	440000	400000	334400	526400	600000	575000	1316000
g) Average group income (TShs) b	537500	293000	-	-	-	-	-	658000
Location production (Tshs. mill.)	60.2	19.356	22.4	24.7456	168.448	69	13.8	148.05
Location production (kg)	12.04	4.839	5.6	5.92	35.84	13.8	2.76	31.5

**Note:**

- a and b are types of groups in a location with different incomes.
- Information on income difference of mining groups was given by mining operators.
- Average groups income (f) was assumed to be the same to all groups in mine locations with small income differences.



**WORK ORGANIZATION AND MONTHLY PRODUCTION  
(Pit Owner, Claim Holders and Mine Workers)**

Appendix 1D - c

COMMODITY	GOLD								
	ZONES	MBEYA				SHINYANGA			
		CHUNYA		MBINGA		KAHAMA	SHINYANG	NZEGA	
		MAKONGOLOS	RIFT VALLEY	LUNYERE	MPEPO	KATENTE	ITILIMA	LUSU	NZEGA NDOGO
a) Active working groups ( a / b ) at the mine site visited (only 80% active)	267/267	2	468	456	11/36	30	170	27 & 78	
No. of working group per type of operational organization									
- informal tributing	667	3	585	570	52	38	212	131	
- Coopertive									
- Formal enterprise									
b) Size of group (No. of miners)	12	8	4	5	8	5	5	20	
Formal									
Informal	8004	24	2340	2850	416	190	1060	2620	
c) Duration of one production (No. of days)	10	7	4	3	30	7	30	7	
d) Estimates of group production per month (gms) per group	300	840	40	42	1792	40	32	330	
e) Average Selling Price (Tsh.)/gm	5000	5000	6000	6000	6000	6000	4800	5430	
f) Average group income (TShs) a	1500000	420000	240000	252000	1075200	240000	153600	1791900	
g) Average group income (TShs) b	750000	-	-	-	537600	-	-	1343900	
Location production (Tshs. mill.)	600.75	0.84	112.32	114.912	31.23	7.2	26.1	153.2	
Location production (kg)	120.15	0.168	18.72	19.152	8.422	1.2	5.437	28.214	

**WORK ORGANIZATION AND MONTHLY PRODUCTION  
(Pit Owner, Claim Holders and Mine Workers)**

Appendix 1D - d

COMMODITY ZONES DISTRICTS LOCATIONS	GOLD							
	SHINYANGA		SINGIDA	MWANZA				
	IGUNGA		IRAMBA	MUSOMA		GEITA		MGUSU
	MATINJE 6	MATINJE. 2	SEKENKE	IKUNGU	SIRORI SIMBA	MAWEMERU	BUSOLWA	
a) Active working groups ( a / b ) at the mine site visited (only 80% active)	53/162	69/70	165	3	3 & 11	18 & 18	61/61	276/554
No. of working group per type of operational organization								
- informal tributing	269	174	206	4	18	45	152	1038
- Cooperative								
- Formal enterprise								
b) Size of group (No. of miners)	10	5	5	9	10	20	5	10
Formal								
Informal	2690	870	1030	36	180	900	760	10380
c) Duration of one production (No. of days)	30	30	30	10	30	30	14	30
d) Estimates of group production per month (gms) per group	1500	220.8	112	70	825	420	146	800
e) Average Selling Price (Tsh.)/gm	6000	6000	5000	6000	5000	6000	6000	4500
f) Average group income (TShs) a	9000000	1324800	560000	420000	4125000	2520000	876000	3600000
g) Average group income (TShs) b	4500000	662400	-	-	2062500	1260000	657000	900000
Location production (Tshs. mill.)	1206	137.78	92.4	1.26	35.06	68.04	93.51	1492.2
Location production (kg)	201	22.963	18.48	0.252	7.012	11.34	15.585	331.6

**WORK ORGANIZATION AND MONTHLY PRODUCTION  
(Pit Owner, Claim Holders and Mine Workers)**

**Appendix 1D - e**

COMMODITY ZONES	GOLD				DIAMOND	
	MWANZA				SHINYANG	MWANZA
DISTRICTS	GEITA	BIHARAMU	SERENG	TARIME	KAHAMA	MISUNGWI
LOCATIONS	MWALOLELA	IMWERU	KIMALAMBO	NYANGOTO	NYANG'WALE	MABUKI
a) Active working groups ( a / b ) at the mine site visited (only 80% active)	12/34	66 & 22	14 & 15	51/153	6	70/211
No. of working group per type of operational organization						
- informal tributing	58	110	36	255	8	351
- Cooperative						
- Formal enterprise						
b) Size of group (No. of miners)	15	8	15	16	10	4
Formal						
Informal	870	880	540	4080	80	1404
c) Duration of one production (No. of days)	14	21	7	30	12	180
d) Estimates of group production per month (gms) per group	490	100	313.1	1008	28	50
e) Average Selling Price (Tsh.)/gm	3000	6000	4000	5000	50000	80000
f) Average group income (TShs) a	1470000	600000	1252400	5040000	1400000	4000000
g) Average group income (TShs) b	735000	300000	626200	1260000	1400000	1000000
Location production (Tshs. mill.)	42.63	46.2	26.92	449.82	8.4	491
Location production (kg)	14.21	7.7	6.73	89.964	168 CAT.	6137.5 CAT



**WORK ORGANIZATION AND MONTHLY PRODUCTION**  
(Pit Owner, Claim Holders and Mine Workers)

Appendix 1D - g

COMMODITY ZONES DISTRICTS LOCATIONS	GEMSTONE							
	ARUSHA		MOROGORO			MBEYA		
	KOROGWE		ULANGA			TUNDURU		
	KALALANI	KIGWASI	LUKANDE	KITONGAJUU	KITONGACHINI	MUHWESI	MAKARATASI	MAJIMAJI
a) Active working groups ( a / b ) at the mine site visited (only 80% active)	16	160	16	2	14	79/237	1/11	99/889
No. of working group per type of operational organization								
- informal tributing	20	200	20	3	18	395	15	1235
- Coopertive								
- Formal enterprise								
b) Size of group (No. of miners)	8	2	12	4	6	18	12	14
Formal								
Informal	1200	400	240	12	108	7110	180	17290
c) Duration of one production (No. of days)	2	2	60	30	30	2	2	3
d) Estimates of group production per month (gms) per group	5467	4200	840	2800	2800	90	90	90
e) Average Selling Price (Tsh.)/gm	60	60	1000	130	130	100000	150000	150000
f) Average group income (TShs) a	328620	252000	840000	364000	364000	9000000	13500000	13500000
g) Average group income (TShs) b	-	-	-	-	-	2250000	6750000	6750000
Location production (Tshs. mill.)	5.258	40.32	13.44	0.728	5.096	1244.25	87.75	7337.8
Location production (kg)	87.6	672	13.44	0.412	0.0255	12.443	0.585	48.92



**WORK ORGANIZATION AND MONTHLY PRODUCTION**  
(Pit Owner, Claim Holders and Mine Workers)

**Appendix 1D - i**

COMMODITY ZONES DISTRICTS LOCATIONS	SALT			AGGREGATE		
	ARUSHA			MOROGORO		
	TANGA	KINONDONI	KINONDONI	TANGA	KINONDONI	
	SANGE	RAS KILOMONI	MTONGANI	KIOMONI	KUNDUCHI	BOKO
a) Active working groups	40	2	3	1	1	4
at the mine site visited (only 80% active)						
No. of working group per type of operational organization						
- informal tributing	50				1	5
- Coopertive						
- Formal enterprise		2	4	1		
b) Size of group (No. of miners)	8	8	10	13	7	2
Formal		16	40	13		
Informal	400				7	2
c) Duration of one production (No. of days)	24	14	21	1	1	10
d) Estimates of group production per month (kg) per group	10000	10500	16000			
Per tonne per group				900	149.3	28
e) Average Selling Price (Tsh.)/kg/ton	40	40	40	1429	2143	2143
f) Average group income (TShs)	400000	420000	640000	1286000	320000	60000
g) Location Production (TShs. million)	16	0.84	19.2	1.28	0.32	0.24
Location production (Tons)	400	21	480	895.73	149	111.99

**WORK ORGANIZATION AND MONTHLY PRODUCTION  
(Pit Owner, Claim Holders and Mine Workers)**

**Appendix 1D - j**

COMMODITY	LIME	GYPSUM	D. STONE	SANDS		
	ARUSHA			MOROGORO		
ZONES						
DISTRICTS	TANGA(U)	SAME	MOSHI(R)	TEMEKE	ILALA	
LOCATIONS	KIOMONI	MAKANYA	UCHIRA	CHAMAZI	KITUNDA	MWAKANGA
a) Active working groups (a / b) at the mine site visited (only 80% active)	1	12	12	3	8	8
No. of working group per type of operational organization						
- informal tributing		15		4	10	10
- Coopertive			15			
- Formal enterprise	1					
b) Size of group (No. of miners)	20	6	5	3	8	3
Formal	20		90			
Informal		90		12	80	30
c) Duration of one production (No. of days)	7	7	2	1	1	1
d) Estimates of group production						
per month (kg) per group	24416	56	6000	292	300	294
Per tonne per group						
e) Average Selling Price (Tsh.)/kg/ton	45	16000	150/Brick	1429	1429	1429
f) Average group income (TShs)	109870	896000	900000	417300	428700	420000
g) Location Production (TShs. million)	1.0987	10.75	10.8	1.25	3.43	3.36
Location Production (pieces)of bricks			6000			

## Appendix 1E

### PRELIMINARY INFORMATION REGARDING MEMBERS AND ACTIVITIES OF REGIONAL MINERS ASSOCIATION (REMA'S)

NAME OF MINING/AREAS	MWANZA	SHIN-YANGA	MARA	SINGIDA	ARUSHA	MORO GORO	TANGA	MTWARA	LINDI	RUVUMA	K/NJARO	DSM	PWANI	TOTAL	%
<b>1. Services Offered to Members</b>															
a) Unite members with the Government	✓	✓	✓	-	✓	✓	✓	-	✓	✓	✓	✓	✓	11	33
b) Settle disputes in miners	✓	✓	✓	-	✓	✓	✓	-	✓	✓	✓	✓	✓	11	34
c) Find markets and represent members at meetings, congress with Government and mines offices	✓	-	-	-	✓	✓	-	-	-	✓	✓	✓	-	7	22
d) Iodation plants	-	-	-	-	-	-	✓	✓	✓	-	-	-	-	3	9
e) Potassium iodate	-	-	-	-	-	-	-	✓	-	-	-	-	-	1	3
<b>TOTAL</b>														<b>33</b>	<b>100</b>
<b>2. Major problems hindering REMA'S activities.</b>															
a) Lack of communication between members, Government and miners Offices.	✓	-	✓	✓	✓	✓	-	✓	✓	-	✓	✓	✓	10	42
b) Lack experts and modern mining equipment.	✓	-	✓	-	✓	-	-	-	✓	-	✓	✓	✓	8	33
c) Shortage of funds to run Associations.	✓	-	-	-	✓	-	-	✓	-	-	✓	✓	-	4	17
d) Migration of members.	-	-	✓	-	-	✓	-	-	-	-	-	-	-	2	8
<b>TOTAL</b>														<b>24</b>	<b>100</b>
<b>3. Sources of revenue and current projects for the Associations</b>															
a) Associations entry fees	✓	✓	-	-	✓	-	✓	✓	✓	✓	✓	✓	-	19	41
b) Fees from mineral sales, business in members' areas, vehicles etc.	✓	-	-	✓	✓	-	-	-	✓	✓	✓	-	✓	7	32
c) Associations projects initiated by e.g. transport facilities, drilling	✓	-	-	-	-	✓	-	-	-	-	-	-	-	2	9
d) Donation from financiers & members	✓	✓	-	-	-	-	-	-	✓	-	✓	-	-	4	18
<b>TOTAL</b>														<b>22</b>	<b>100</b>
<b>4. Associations' present liquidity</b>															
a) Bonds/Assets	10,000,000	-	-	-	-	MILL	-	Iodation Plant	-	-	2000 Ton gypsum	-	-		
b) Cash	1,000,000	800,000	-	-	-	50,000	-	100,000	-	100,000	A/C1670	-	150,000		
<b>5. Co-operation with non-members in mine rush areas</b>															
a) Yes	✓	✓	✓	✓	✓	✓	✓	-	-	-	-	-	-	7	54
b) No.								✓	✓	✓	✓	✓	✓	6	46
<b>TOTAL</b>														<b>13</b>	<b>100</b>

Note: Most of the report given by REMA, leaders. Contradicted with the field survey data from Mines Offices and Interview with Miners. Some REMA leaders dont differentiate mine Workers and registered miners who are suppose to be REMA Member.

## MONTHLY INCOMES OF MINING PARTICIPANTS

(Pit owners, Claim Holders and Mine workers)

Appendix 1F - a

COMMODITY ZONE DISTRICTS LOCATION	GOLD							
	MPANDA							
	MPANDA							
	IBINDI SOUTH		MAGULA	CHEMCH	KATSUNGA A.	KATSUNGA B.		D - REEF
Reef	Alluvial	Reef	Reef	Alluvial	Alluvial	Reef	Reef	
1. Average size of a working group (Number of miners)	30	3	20	10	5	5	7	7
Average location production sharing ratios								
- Claim owners Tsh. to every gram or (%)	Tsh.450	Tsh. 1000	Tsh.1000	Tsh. 1000	50	50	50	1000
- Pit financier in (%)	50	50	50	50	25	25	25	30
- Mine workers in (%)	50	50	50	50	25	25	25	70
- Average costs.	-	-	-	-	-	-	-	-
5. Monthly Group income (Tshs.)	1075000	440000	400000	334400	526400	600000	575000	1316000
6. Average income of participant (Tshs.)								
a. Workers/members as a group	978250	165000	300000	254400	131600	150000	143750	725200
b. Pit owner/financiar	-	165000	-	-	131600	150000	143750	310800
c. Claim owners (from one pit only)	96750	110000	100000	80000	263200	300000	287500	280000
d. Individual worker income	33700	55000	15800	28300	43900	50000	28800	145000

### NOTE:

- Where claim owners are taking Commissions of TSh. 1000 or 450/= to every gram of sold there is also additional income from "Return system". This system allow claim owner to extract ore from a period of once a week or a fixed portion of the vein. All the recovered minerals belongs to him and his assistants.
- The sharing arrangements differs from one pit to another also depends on contributions of participants and ore reserve. The given rations are those mostly use in that particular mine location.
- For Convinience incomes of individual participants are presented in round figures of hundreds. This explain a slite difference in the total figure to that of group income.

**MONTHLY INCOMES OF MINING PARTICIPANTS**  
(Pit owners, Claim Holders and Mine workers)

Appendix 1F - b

COMMODITY ZONE DISTRICTS LOCATION	GOLD							
	MPANDA			CHUNYA				ITUMBI
	KASAKALawe	NTUMBA		MANYANGA	SAFARI MINE	MATUNDS	ITUMBA	Reef
	Reef	Alluvial	Reef	Reef	Reef	Reef	Reef	Reef
1. Average size of a working group (Number of miners)	6	2	5	7	12	10	3	3
Average location production sharing ratios								66
- Claim owners Tsh. to every gram or (%)	Tsh. 1000	Tsh.1000	Tsh. 1000	50	Tsh. 1000	Tsh. 1000	50	17
- Pit financier in (%)	50	30	30	25	50	50	25	17
- Mine workers in (%)	50	70	70	25	50	50	25	-
- Average costs.	-	-	-	-	90100	-	-	-
5. Monthly Group income (Tshs.)	320000	150000	336000	500000	2703000	1166000	216000	980000
6. Average income of participant (Tshs.)								
a. Workers/members as a group	120000	70000	156800	125000	646000	477000	54000	166600
b. Pit owner/financiar	120000	30000	67200	125000	646000	477000	54000	166600
c. Claim owners (from one pit only)	80000	50000	112000	250000	510000	212000	108000	646800
d. Individual worker income	30000	35000	52300	25000	64600	59600	18000	55500

## MONTHLY INCOMES OF MINING PARTICIPANTS

(Pit owners, Claim Holders and Mine workers)

Appendix 1F - c

COMMODITY	GOLD									
	ZONE	MBEYA				SHINYANGA				
		DISTRICTS	CHUNYA		MBINGA		KAHAMA	SHINYANGA	NZEGA	
			LOCATION	MAKONGOLOSI	RIFT VALEY	LUNYERE	MPEPO	KATENTE	ITILIMA	LUSU
1. Average size of a working group (Number of miners)		12	8	4	5	8	5	5		
Average location production sharing ratios									20	
- Claim owners Tsh. to every gram or (%)	Tsh. 1000	Tsh.1000	Tsh. 1000	Tsh. 1000	66	30	Tsh. 1000	40		
- Pit financier in (%)	50	50	50	50	17	35	50	597300		
- Mine workers in (%)	50	50	50	50	17	35	50			
- Average costs.	325000	-	-	-	27000	20000	-	1791900		
5. Monthly Group income (Tshs.)	1500000	420000	240000	252000	1075200	240000	153600		477840	
6. Average income of participant (Tshs.)									477840	
a. Workers/members as a group	437500	168000	100000	105000	174700	77000	60800	238920		
b. Pit owner/financiar	437500	168000	100000	105000	174700	77000	60800	23900		
c. Claim owners (from one pit only)	300000	84000	40000	42000	698800	66000	32000			
d. Individual worker income	43800	28000	50000	35000	29100	25700	20700			

**MONTHLY INCOMES OF MINING PARTICIPANTS**  
(Pit owners, Claim Holders and Mine workers)

Appendix 1F - d

COMMODITY ZONE DISTRICTS LOCATION	GOLD							
	SHINYANGA		SINGIDA	MWANZA				
	IGUNGU		IRAMBA	MUSOMA		GEITA		
	MATINJE	MATINJE 2	SEKENKE	IKUNGU	SIRORISIMBA	MAWEMERU	BUSOLWA	MGUSU
1. Average size of a working group (Number of miners)	10	5	5	9	10	20	5	10
Average location production sharing ratios								
- Claim owners Tsh. to every gram or (%)	Tsh.1000	Tsh 1000	30	Tsh. 1000	75	30	30	30
- Pit financier in (%)	80	50	35	50	12.5	35	35	35
- Mine workers in (%)	20	50	35	50	12.5	35	35	35
- Average costs.	500000	678600	350000	50000	25000	756000	40000	500000
5. Monthly Group income (Tshs.)	9000000	1324800	560000	420000	4125000	2520000	876000	3600000
6. Average income of participant (Tshs.)								
a. Workers/members as a group	1400000	212700	73500	150000	203125	6174000	292600	1085000
b. Pit owner/financiar	5600000	212700	73500	150000	203125	617400	292600	1085000
c. Claim owners (from one pit only)	1500000	220800	63000	70000	1218750	529200	250800	930000
d. Individual worker income	175000	70900	24500	21400	25400	34300	97500	135600

## MONTHLY INCOMES OF MINING PARTICIPANTS

(Pit owners, Claim Holders and Mine workers)

Appendix 1F - e

COMMODITY ZONE DISTRICTS LOCATION	GOLD				DIAMOND	
	MWANZA				SHINYANGA	MWANZA
	GEITA	BIHARAMUL	SERENGETI	TARIME	KAHAMA	MISUNGWI
	MWALOLELA	IMWERU	KIMALAMBO	NYANGOTO	NYANG'WALE	MABUKI
1. Average size of a working group (Number of miners)	15	8	15	16	10	4
Average location production sharing ratios						
- Claim owners Tsh. to every gram or (%)	30	30	40	50	66	50
- Pit financier in (%)	35	35	30	25	17	25
- Mine workers in (%)	35	35	30	25	17	25
- Average costs.	-	330000	559115	-	-	-
5. Monthly Group income (Tshs.)	1470000	600000	1252420	5040000	1400000	4000000
6. Average income of participant (Tshs.)						
a. Workers/members as a group	514500	94500	207990	1260000	233330	1000000
b. Pit owner/financiar	514500	94500	207990	1260000	233330	1000000
c. Claim owners (from one pit only)	441000	81000	277320	2520000	933330	2000000
d. Individual worker income	39600	15800	16000	18000	29200	500000

**MONTHLY INCOMES OF MINING PARTICIPANTS**  
(Pit owners, Claim Holders and Mine workers)

Appendix 1F - f

COMMODITY ZONE DISTRICTS LOCATION	GEMSTONES ARUSHA							
	SIMANJIRO				MUHEZA		HANDENI	
	MERELANI	LANDABAN	TIRIRI	KANGALA	NGOMBENI	MWAKJEMB	SEZAKOFI	KWEDIRIMA
1. Average size of a working group (Number of miners)	40	6	9	4	2	2	8	10
Average location production sharing ratios								
- Claim owners Tsh. to every gram or (%)		81	Tsh. 100/gm	40	Tsh. 2/gm	75	5gm/week	50
- Pit financier in (%)		9.5	50	30	50	12.5	50	25
- Mine workers in (%)		9.5	50	30	50	12.5	50	25
- Average costs.	3500000	-	-	-	-	-	-	-
5. Monthly Group income (Tshs.)	8535000	448000	2100000	1500000	100000	240000	320000	280000
6. Average income of participant (Tshs.)								
a. Workers/members as a group	2535000	42560	945000	450000	45000	30000	150000	70000
b. Pit owner/financiar	-	42560	945000	450000	45000	30000	150000	70000
c. Claim owners (from one pit only)	2500000	362880	210000	600000	10000	180000	20000	140000
d. Individual worker income	65000	10600	135000	225000	22500	15000	25000	8800

## MONTHLY INCOMES OF MINING PARTICIPANTS

(Pit owners, Claim Holders and Mine workers)

Appendix 1F - g

COMMODITY ZONE DISTRICTS LOCATION	GEMSTONE							
	ARUSHA		MOROGORO			MBEYA		
	KOROGWE		ULANGA			TUNDURU		
	KALALANI	KIGWASI	LUKANDE	KITONGA(JUU)	KITONGA(CHN)	MUHWESI	MAKARATASI	MAJIMAJI
1. Average size of a working group (Number of miners)	8	2	12	4	6	18	12	14
Average location production sharing ratios								
- Claim owners Tsh. to every gram or (%)	50	50	50	34	34	50	50	50
- Pit financier in (%)	-	25	25	33	33	25	25	25
- Mine workers in (%)	50	25	25	33	33	25	25	25
- Average costs.	-	-	-	120120	120120	-	-	-
5. Monthly Group income (Tshs.)	328000	252000	840000	364000	364000	9000000	13500000	13500000
6. Average income of participant (Tshs.)								
a. Workers/members as a group	164000	63000	210000	160960	160960	2250000	3375000	3375000
b. Pit owner/financiar	-	63000	210000	160960	160960	2250000	3375000	3375000
c. Claim owners (from one pit only)	164000	126000	420000	82919	82919	4500000	6750000	6750000
d. Individual worker income	20500	31500	21000	80480	40240	140625	337500	337500

**MONTHLY INCOMES OF MINING PARTICIPANTS**  
(Pit owners, Claim Holders and Mine workers)

Appendix 1F - h

COMMODITY ZONE DISTRICTS LOCATION	GEMSTONE MBEYA						
	TUNDURU				MBINGA		
	NAMANGO	NGAPA	MSUMBIJI	MSINJI 8	MSINJI 6	NGENDAMB	MASUGULU
1. Average size of a working group (Number of miners)	11	4	7	8	20	5	10
Average location production sharing ratios							
- Claim owners Tsh. to every gram or (%)	50	50	50	50	50	50	
- Pit financier in (%)	25	25	25	25	25	25	20
- Mine workers in (%)	25	25	25	25	25	25	80
- Average costs.	-	-	-	-	-	-	-
5. Monthly Group income (Tshs.)	3412000	2700000	10500000	7000000	7000000	950600	223900
6. Average income of participant (Tshs.)							
a. Workers/members as a group	853000	675000	2625000	1750000	1750000	237700	179100
b. Pit owner/financier	853000	675000	2625000	1750000	1750000	23700	44800
c. Claim owners (from one pit only)	1706000	1350000	5250000	3500000	3500000	475300	-
d. Individual worker income	94700	337500	525000	291600	291600	79900	19900

## MONTHLY INCOMES OF MINING PARTICIPANTS

(Pit owners, Claim Holders and Mine workers)

Appendix 1F - i

COMMODITY ZONE DISTRICTS LOCATION	SALT			AGGREGATE		
	MOROGORO			ARUSHA	MOROGORO	
	PANGANI	KINONDONI		TANGA	KINONDONI	
	SANGE	RES KILOMONI	MTONGANI	KIOMONI	KUNDUCHI	BOKO
1. Average size of a working group (Number of miners)	8	8	10	13	7	2
Average location production sharing ratios						
- Claim owners Tsh. to every gram or (%)						
- Pit financier in (%)					50	50
- Mine workers in (%)	Salary	Salary	Salary	Salary	-	-
- Average costs.					50	50
5. Monthly Group income (Tshs.)	400000	420000	640000	1286000	320000	60000
6. Average income of participant (Tshs.)						
a. Workers/members as a group	160000	160000	250000	325000	80000	30000
b. Pit owner/financiar	-	-	-	-	80000	-
c. Claim owners (from one pit only)	240000	260000	390000	961000	160000	30000
d. Individual worker income	20000	20000	25000	25000	16000	15000

**MONTHLY INCOMES OF MINING PARTICIPANTS**  
(Pit owners, Claim Holders and Mine workers)

Appendix 1F - j

COMMODITY ZONE DISTRICTS LOCATION	LIME	GYP SUM	D. STONE	SAND		
	ARUSHA			MOROGORO		
	TANGA	SAME	MOSHI	TEMEKE	ILALA	
	KIOMONI	MAKANYA	UCHIRA	CHAMAZI	KITUNDA	MWAKANGA
1. Average size of a working group (Number of miners)	20	6	5	6	8	6
Average location production sharing ratios						
- Claim owners Tsh. to every gram or (%)		50	20	33	37	33
- Pit financier in (%)	Salary	25	15	-	-	-
- Mine workers in (%)		25	15	67	63	67
- Average costs.			50% (450000)	-	-	-
5. Monthly Group income (Tshs.)	1098700	896000	900000	417300	428700	420000
6. Average income of participant (Tshs.)						
a. Workers/members as a group	520000	224000	90000	279500	270000	281400
b. Pit owner/financiar	-	224000	90000	-	-	-
c. Claim owners (from one pit only)	578700	448000	270000	137700	158600	138600
d. Individual worker income	26000	56000	30000	55900	38500	56200

# PROFESSIONAL BACKGROUNDS OF SOME OF ARTISANAL/SMALL SCALE MINERS

Appendix 1G

MAIN MINERAL COMMODITY		GOLD															GEMSTONE		Total
		MWANZA					SHINYANGA					MBEYA			MPANDA		SINGIDA		
SELECTED DISTRICTS		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	
1.	Ex-Teacher	15	30	5	5	4	8	4	1	10	15	124	-	10	1		53	2	287
2.	Security forces	30	20	-	25	10	-	-	4	5	-	-	-	2	1	2	-	-	99
3.	Drivers	2	10	-	4	1	-	-	4	-	10	65	1	4	2		34	-	137
4.	Police	20	8	3	-	-	-	2	-	2	-	10	-	6	1		27	4	83
5.	Accountants	-	2	-	-	-	8	2	1	-	-	-	-	2	-		4	1	20
6.	Health Officers	3	8	-	1	-	1	2	4	2	-	3	-	5	2		6	2	39
7.	Doctors	-	-	-	-	-	-	2	4	2	-	2	-	-	-	1	2	3	8
8.	TPDF Soldiers	4	-	2	3	1	-	-	-	-	6	-	-	-	5	5	15	2	43
9.	Electrical Engineer	3	-	1	-	-	-	-	-	-	-	-	-	-	-		1	-	5
10.	Mining Engineer	1	2	-	-	-	-	-	-	-	1	-	-	1	-	2	-	1	8
11.	Mechanical Engineer	2	-	-	-	-	-	-	-	-	-	-	-	-	-		2	-	4
12.	Mining Technicians	-	-	-	2	-	-	3	-	-	2	-	-	-	-	3	4	2	16
13.	Geologist	-	-	1	1	-	-	-	-	-	-	-	1	-	-	1	-	-	4
14.	Laboratory Technician	-	-	-	-	-	-	-	-	-	-	-	-	1	-	4	-	-	5
15.	Mechanics	2	5	-	2	-	4	3	4	10	27	32	-	6	-	2	30	-	127
16.	Administrators	-	2	-	2	-	-	-	2	-	-	-	-	-	-	2	5	-	13
17.	Rural Medical Aid (RMA)	2	3	4	-	-	2	-	-	-	-	-	-	1	-		8	3	27
18.	Preachers	1	-	1	-	-	-	-	-	-	-	-	-	-	-		-	-	2
19.	Pilot	1	-	-	-	-	-	-	-	-	-	-	-	-	-		1	-	2
20.	Carpenters	-	4	-	-	3	6	1	2	3	37	30	-	4	-		4	-	94
21.	Game Scouts	-	-	-	-	3	-	-	-	-	-	-	-	2	-		6	-	11
22.	Salesman	-	-	-	-	-	-	-	-	-	-	-	-	-	4	3	9	-	16
23.	Welder	-	4	-	1	-	-	-	-	-	-	-	-	2	-		2	-	9
24.	Gemstones Sorter	-	-	-	-	-	-	-	-	-	-	-	-	-	-		5	-	5
25.	Nurse	-	4	-	-	-	-	2	-	-	-	-	-	1	-		6	-	13
26.	Electrician	-	-	1	-	-	-	-	-	-	-	-	-	-	-		3	-	4
27.	Lecturer (Ardhi Institute)	-	-	-	-	-	-	-	-	-	-	-	-	-	-		-	-	-
29.	Manager (Hotel Management)	-	-	-	-	-	-	-	-	-	-	-	-	-	-		2	-	2

## DISTRICTS ARE NUMBERED AS FOLLOWS:-

1. BIHARAMULO
2. GEITA
3. MUSOMA
4. TARIME
5. SERENGETI
6. NZEGA
7. SHINYANGA
8. IGUNGA
9. KAHAMA
10. CHUNYA

11. MBINGA
12. MBEYA (R)
13. MPANDA
14. SEKENKE
15. DODOMA (U)
16. TUNDURU
17. MBINGA
18. ARUMERU
19. MOROGORO (R)
20. ULANGA

21. SIMANJIRO
22. HANDENI
23. KOROGWE
24. MUHEZA
25. MONDULI
26. KAHAMA
27. MISUNGWI
28. TANGA (U)
29. PANGANI
30. SAME

31. KINONDONI
32. ILALA
33. TEMEKE

NOTE:- S - SAND  
D .STONE - DIMENSION STONE  
GEM - GEMSTONE  
SHY - SHINYANGA  
MZA - MWANZA

## PROFESSIONAL BACKGROUND OF SOME OF ARTISANAL/SMALL SCALE MINERS

Appendix 1G - b

MINERAL COMMODITY	SAND	GEMSTONES								DIAMOND	LIME	AGGR	SALT	GYPS	SALT	AGGR	SAND	TOTAL	GRAND TOTAL	%
	ARUSHA	MOROGORO		ARUSHA				SHY	MZA	ARUSHA				MOROGORO						
SELECTED DISTRICTS	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33				
TYPE OF PROFESSION																				
1. Ex-Teacher	1	6	8	10	1	10	1	-	-	5	-	-	5	-	1	-	-	49	336	24
2. Security forces	-	1	12	18	-	4	-	-	5	3	-	-	-	-	-	-	-	43	142	10.2
3. Drivers	-	-	6	10	-	-	2	-	-	-	-	-	-	1	-	3	43	65	202	14.5
4. Police	-	-	-	5	-	1	-	-	-	-	-	-	-	2	-	-	-	8	91	6.5
5. Accountants	-	-	-	1	-	-	-	-	-	-	-	-	-	-	2	-	-	3	23	1.6
6. Health Officers	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	1	40	3.0
7. Doctors	-	-	-	-	-	-	1	-	2	-	-	-	-	-	-	-	-	3	11	0.8
8. TPDF Soldiers	-	-	-	-	2	-	-	-	-	1	-	-	-	-	-	-	3	6	49	3.5
9. Electrical Engineer	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	5	0.4
10. Mining Engineer	-	-	-	-	-	-	-	-	2	-	-	-	-	-	-	-	-	2	10	0.7
11. Mechanical Engineer	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	1	5	0.4
12. Mining Technicians	1	-	-	-	-	5	1	-	-	1	-	-	-	-	-	-	-	8	24	1.7
13. Geologist	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	4	0.3
14. Laboratory Technician	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	5	0.4
15. Mechanics	4	-	3	20	2	5	2	3	-	-	-	-	-	4	3	5	51	178	13	
16. Administrators	1	-	2	3	-	-	-	-	1	-	1	-	1	-	-	2	11	24	1.7	
17. Rural Medical Aid (RMA)	-	2	3	4	-	2	1	-	-	-	-	-	-	-	-	-	-	12	39	2.8
18. Preachers	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2	0.1
19. Pilot	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2	0.1
20. Carpenters	-	-	2	4	-	-	-	-	1	-	-	-	1	-	2	-	-	10	104	7.5
21. Game Scouts/warden	-	1	2	-	-	-	1	-	-	-	-	-	-	-	-	-	-	4	15	1.1
22. Salesman	-	-	1	6	-	-	-	-	-	-	-	-	-	-	-	-	-	7	23	1.6
23. Welder	-	-	1	2	-	-	-	-	-	-	-	-	-	-	-	-	-	3	12	0.9
24. Gemstones Sorter	-	-	2	4	-	4	2	-	-	-	-	-	-	-	-	-	-	12	17	1.2
25. Nurse	-	-	3	1	-	1	-	-	-	-	-	-	-	-	-	-	-	5	18	1.3
26. Electrician	-	-	2	1	-	-	-	-	-	-	-	-	-	-	-	-	-	3	7	0.5
27. Lecturer (Ardhi Institute)	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	1	1	0.1
29. Manager (Hotel Management)	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	1	3	0.2

The artisanal/small scale sub - sector now attracts people with skill and better education who can be incorporated in the implementation of project activities.

- (a) Teachers mainly from primary schools, accounts for 24% of active professionals in the sub-sector. Most of them join the mining activities because they work in the rural areas near mining sites and they always face the problems of getting their meager salaries from the district headquarters.
- (b) Few of the above professions are directly practiced in the mining communities. Number of drivers is higher in active mining areas (Dar es Salaam - Sand mining, Merelani and Tunduru). Carpenters are active in timbering works mainly in gold mining areas (Nzega, Chunya ect.)
- (c) Medical personnel especially rural medical assistants are practicing in privacy as they cannot secure licences from district authorities.

## **Appendices 2: INSTITUTIONAL ASPECTS**

- A - Mining Claim Titles Issue 1991/1995
- B - Valid Mining Titles 1995/1996
- C - Applications Pending Registration as at 31st  
December, 1994
- D - Frequency of Mining Inspectors Visits
- E - Technical Personnel of the MRD
- F - District/Zone Mine Production per MRD Staff
- G - Mineral Revenue Receipts

MINING CLAIM TITLES ISSUE 1991 - 1995

Appendix 2 A

TYPE OF MINING CLAIM	GOLD					DIAMOND					COLOURED GEMSTONE					INDUSTRIAL MINERALS					
	1991	1992	1993	1994	1995	1991	1992	1993	1994	1995	1991	1992	1993	1994	1995	1991	1992	1993	1994	1995	
MINES OFFICE																					
SONGEA (RMO)	3/-	-	-	6/10	1716	-	-	-	-	-	-	-	-	-66	80/35	-	-	-	-	-	
CHUNYA (DMO)	24/91	17/53	48/27	50/28	8/9	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
MBEYA (ZMO)	36/50	20/23	52/17	58/9	37/97	-	-	-	-	-	1	-	-	-	-	-	-	-	1	-	
MBEYA ZONE TOTAL	36	20	52	58							1	-	-	1	81/8	3	7	6	11	1/6	
KAYANGA(RMO)														1	81	3	7	6	11	1	
MUSOMA (RMO)	-	-	1	12/6	84/33	-	-	-	-	-	-	-	-	-	-	3	-	-	-	-	
TARIME (DMO)	5	-	-	6	38																
GEITA(RMD)	2/42	-/45	42/49	21/99	254/336	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
MWANDA(ZMO)	7/203	-/129	45/275	41/228	376/21	-/3	-/2	367/36	428/14	429/5						1	3/6	-/2	-/1	-/4	-/3
MWANZA ZONE TOTAL	7	-	45	41	376			367	428	429						1	3	-	-	-	-
KIGOMA																5	1	4	-	3	
MPANDA (ZMO)	19/-	7/-	14/-	66/-	12/-											5	1	4	-	3	
MPANDA ZONE TOTAL	19	17	14	66	12						5	5	-	-	-	5	1	4	-	3	
TANGA (RMO)	-	-	-	-	-						53	17	59	59	55	7	3	2	3	5	
ARUSHA (ZMO)	-	-	-	-	-						26	21	51	80	49	12	8	8	7	5	
ARUSHA ZONE TOTAL	-	-	-	-	-						79	38	110	139	104	12	8	8	7	5	
SINGIDA	8	-	5	11	17						1	1	-	-	4	7	2	2	14	-	
DODOMA	-	-	11	3	1						1	4	2	3	10	2	-	-	-	1	
SINGIDA ZONE TOTAL	8	-	16	14	18						1	5	2	3	14	9	2	2	14	1	
DSM (RMO)	-	-	-	-	-						-	-	-	-	-	-	2	2	1	1	
MOROGORO(ZMO)	-/-	-/-	-/-	-/10	-/2	-	-	-	-	-	85/42	63/60	112/92	112/134	24/40	20/7	4/3	-/2	9/1	10/1	
MOROGORO ZONE TOTAL	-	-	-	-	-						85	63	112	112	24	20	4	2	9	10	
LINDI	-	-	-	-	-						-	-	-	-	15	-	-	-	-	-	
MTWARA(ZMO)	-	-	-	-	-						-	-	-	3	15	-	-	-	-	-	
MTWARA ZONE TOTAL	-	-	-	-	-						-	-	-	3	15	-	-	-	-	-	
KAHAMA (DMO)	1	-	2	1	18			128	180	85	-	-	-	-	-	-	-	-	-	-	
SHINYANGA (ZMO)	14/18	6/52	57/83	22/14	7/1	-	-	128/157	180/150	85/21	-	1	1	-	-	-	-	-	-	-	
SHINYANGA ZONE TOTAL	14	6	57	22	7			128	180	85	-	1	1	-	-	-	-	6/7	-/9	-	

Source: Madini Dodoma and Zonal Mines Offices.

**MINING CLAIM TITLES ISSUE 1991 - 1995**

**Appendix 2 A**

TYPE OF MINING CLAIM	SALT					BUILDING MINERALS					PENDING APPL. BACKLE FOR REGISTER
	1991	1992	1993	1994	1995	1991	1992	1993	1994	1995	
MINES OFFICE											
SONGEA (RMO)	-	-	-	-	-	-	-	-	-	5	40
CHUNYA (DMO)	-	-	-	-	-	-	-	-	-	-	
MBEYA (ZMO)	-	-	-	-	-	-	-4	-	-	5/-	84
MBEYA ZONE TOTAL	-	-	-	-	-	-	-	-	-	5	
KAYANGA(RMO)						3	1	-	-	-	
MUSOMA (RMO)	-	-	-	-	-	-	-	-	-	-	
TARIME (DMO)						-	-	-	-	-	
GEITA(RMD)	-	-	-	-	-	-2	-2	-2	2	2	122
MWANDA(ZMO)	-1	-	-	-	-	3/20	5/23	1/9	2/20	18/19	
MWANZA ZONE TOTAL	-	-	-	-	-	3	5	1	2	18	
KIGOMA	5	-	-	-	-	-	-	-	-	-	
MPANDA (ZMO)	5	-	-	-	-	-	-	-	-	-	70
MPANDA ZONE TOTAL	5	-	-	-	-	-	-	-	-	-	
TANGA (RMO)	5	2	1	4	4	22	-	-	6	8	
ARUSHA (ZMO)	5	2	1	4	4	27	5	37	11	10	
ARUSHA ZONE TOTAL	5	2	1	4	4	27	5	37	11	10	
SINGIDA	-	-	-	-	-	-	-	-	-	-	
DODOMA	-	-	-	-	-	-	-	-	-	-	
SINGIDA ZONE TOTAL	-	-	-	-	-	-	-	-	-	-	
DSM (RMO)	1	1	1	2	-	22	48	70	76	1	
MOROGORO(ZMO)	16	1	1	10	2	23/2	48/3	118/3	88/13	6/4	
MOROGORO ZONE TOTAL	16	1	1	10	2	23	48	118	88	6	
LINDI	20	5	8	4	2	-	-	-	-	-	
MTWARA(ZMO)	42	8	21	6	2	2	-	10	-	-	
MTWARA ZONE TOTAL	42	8	21	6	2	2	-	10	-	-	
KAHAMA (DMO)	-	-	-	-	-	-	-	-	-	-	
SHINYANGA (ZMO)	-2	-		-2	-	-18	-	-1	-	-	434
SHINYANGA ZONE TOTAL	-	-	-	-	-	-	-	-	-	-	

Source: Madini Dodoma and Zonal Mines Offices.

## VALID MINING TITLES 1995/1996

MINING TITLES		CLAIMS		RECCONASSANCE LICENCE		PROSPECTING LICENCE		MINING LICENCE	
ZONE RECORDS		ZONAL	DODOMA	ZONAL	DODOMA	ZONAL	DODOMA	ZONAL	DODOMA
1		2		3		4		5	
MBEYA	RUVUMA	127	112	-	-	24	24	-	-
	CHUNYA	162	99	6	6	30	30	1	1
	TOTAL MBEYA	267	252	1	8	49	49	5	9
MWANZA	KAGERA	-	12	-	1	-	7	-	-
	MARA	46	152	-	1	9	16	-	-
	GEITA	332	323	-	3	20	23	1	1
	TOTAL MWANZA	973	1317	6	7	140	49	4	1
MPANDA	KIGOMA	-	10	-	-	-	1	-	1
	TOTAL MPANDA	296	91	-	1	-	6	-	1
ARUSHA	TANGA	197	328	-	2	9	9	5	4
	KILIMANJARO	71	176	2	-	3	3	2	1
	ARUSHA	457	-	-	-	-	-	-	-
	TOTAL ARUSHA	725	717	-	4	-	18	-	9
SINGIDA	DODOMA	-	41	-	-	-	7	-	2
	TOTAL SINGIDA	-	124	-	7	-	27	-	2
MOROGORO	DAR ES SALAAM	66	711	-	-	2	-	2	7
	PWANI	19	-	-	-	-	5	-	7
	TOTAL MOROGORO	320	930	-	-	-	22	7	22
MTWARA	LINDI	74	-	-	-	-	6	-	-
	MTWARA	53	-	-	-	-	-	-	-
	TOTAL MTWARA	127	109	-	2	-	7	-	-
SHINYANGA	TABORA	-	-	-	3	-	23	-	1
	KAHAMA	-	383	-	1	-	13	-	-
	TOTAL SHINYANGA	1130	583	6	8	37	54	1	3
TOTAL ZONE RECORD		3350	4123	21	37	183	232	28	47

Source: Mineral Resources Department

Appendix 2C

APPLICATIONS PENDING REGISTRATION AS AT 31st DECEMBER 1994

MINERAL COMMODITY												
MINING ZONE		GOLD	GEMS	DIAMOND	SALT	CLAY	GYPS	LIMES	SAND	MICA	VOLCANIC BLOCK	TOTAL
	PERIOD	1984 - 1994							1991			
MWANZA APPLICATIONS		17	-	-	-	-	-	-	1	18		
	PERIOD	1990 - 94			1991	1991		1991				
SHINYANGA APPLICATIONS		57	-	-	2	2	-	1	-	-	-	62
	PERIOD	1989 - 94	1992/93	1992		1992						
MBEYA APPLICATIONS		26	7	1	-	1	-	-	-	-	-	35
	PERIOD	1991/94	1992/93				1994					
DODOMA(SINGIDA) APPLI		68	14	-	-	-	2	-	-	-	-	84
	PERIOD	1990	1989/94	-	-	-	-	1991		1989-1994		
MOROGORO APPLICATIONS		1	61	-	-	-	-	1	-	2	-	65
	PERIOD	-	1989-1994						1989		1994	
ARUSHA APPLICATIONS		-	39	-	-	-	-	-	1	-	1	41
	PERIOD	-	1994		1994				1989			
MTWARA APPLICATIONS		-	1	-	2	-	-	2	-			5
TOTAL		169	122	1	4	3	2	2	4	2	1	310

- Data from Zonal offices. Madini Dodoma claim to have no pending registration applications

Appendix 2D

**FREQUENCY OF MINING INSPECTOR VISITS**

COMMODITY	GOLD								GEMSTONES				DIAMOND	
	MWANZA		SHINYANGA		MBEYA		SINGIDA		MORO		ARUSHA		SHINYANGA	
ZONE	Total	%	Total	%	Total	%	Total	%	Total	%	Total	%	Total	%
Frequencies of Visits														
1.. Once every Month	1	7	-	-	3	30	4	50	4	19	21	60	-	-
2. Once quarterly	5	33	4	57	7	70	-	-	10	48	3	9	12	100
3. Once every 6 months	3	20	2	29	-	-	-	-	6	29	-	-	-	-
4. Once a year	6	40	1	14	-	-	4	50	1	4	11	31	-	-
<b>TOTAL</b>	<b>15</b>	<b>100</b>	<b>7</b>	<b>100</b>	<b>10</b>	<b>100</b>	<b>8</b>	<b>100</b>	<b>21</b>	<b>100</b>	<b>35</b>	<b>100</b>	<b>12</b>	<b>100</b>

COMMODITY	SALTWORK		LIME		AGGREGATES		SAND		DIMENSION STONE		GYPSUM	
	ARUSHA											
ZONE	Total	%	Total	%	Total	%	Total	%	Total	%	Total	%
Frequencies of Visits												
1.. Once every Month	-	-	-	-	6	100	12	67	12	100	-	-
2. Once quarterly	-	-	-	-	-	-	-	-	-	-	-	-
3. Once every 6 months	8	100	-	-	-	-	6	33	-	-	-	-
4. Once a year	-	-	7	100	-	-	-	-	-	-	15	100
<b>TOTAL</b>	<b>8</b>	<b>100</b>	<b>7</b>	<b>100</b>	<b>6</b>	<b>100</b>	<b>18</b>	<b>100</b>	<b>12</b>	<b>100</b>	<b>15</b>	<b>100</b>

## TECHNICAL PERSONNEL OF THE MINERAL RESOURCES DEPARTMENT

SECTION/UNIT		STATION	STATISTICIANS	ENGINEERS	GEOLOGISTS	TECHNICIANS	TOTAL
A. GEOLOGY		DODOMA	-	-	22	46	68
B. RESEARCH & LABORATORY SERVICES		DODOMA	-	2	7	31	40
C. MINERAL DATA UNIT		DODOMA	1	-	8	4	13
D. DSM HQ (MINES & MINERAL TRADE)		DSM	-	2	10	2	14
E. MINES	1.	DODOMA HQ	-	8	5	11	24
	2.	MWANZA	-	1	2	3	6
	3.	MUSOMA	-	1	-	4	5
	4.	TARIME	-	-	-	3	3
	5.	GEITA	-	-	-	3	3
	6.	BUZIBA SS Pjt.	-	1	1	4	6
	7.	KARAGWE	-	-	-	3	3
	8.	SHINYANGA	-	-	1	3	4
	9.	KAHAMA	-	1	1	4	6
	10.	MPANDA	-	1	1	4	6
	11.	MBEYA	-	1	1	6	8
	12.	SONGEA	-	1	1	2	4
	13.	CHUNYA	-	1	1	6	8
	14.	TUNDURU	-	-	-	1	1
	15.	MOROGORO	-	1	2	8	11
	16.	DSM-UBUNGO	-	1	1	12	14
	17.	ARUSHA	-	2	1	8	11
	18.	TANGA	-	1	-	6	7
	19.	MTWARA	-	1	-	3	4
		<b>TOTAL</b>	<b>1</b>	<b>26</b>	<b>65</b>	<b>177</b>	<b>269</b>
F. ACCOUNTS ASSISTANTS		DODOMA MRD HQ - 6 ZONAL MINES OFFICES - 8					

Source: Ministry of Energy and Minerals.

## Appendix 2F

## DISTRICT/ZONE MINE PRODUCTION PER MRD STAFF

MINE OFFICE	NUMBER OF STAFF	ESTIMATE OF PRODUCTION PER MONTH (TShs. MILLION)		PRODUCTION PER MEMBER (TShs. MILLION)	
		DISTRICT	PRODUCTION	DISTRICT OFFICE	ZONAL OFFICE
ARUSHA	11	SIMANJIRO	1745.1		
		SAME	10.7		
		MOSHI (R)	10.8		
			1766.6	160.6	
TANGA	7	MUHEZA	99.2		
		HANDENI	20.56		
		KOROGWE	45.58		
		TANGA(U)	2.37		
		PANGANI	16		
		183.71	26.24		
ARUSHA ZONE	18		1950.31		108.35
MOROGORO	11	ULANGA	19.26	1.7	
DSM-UBUNGO	14	KINONDONI	20.6		
		TEMEKE	1.25		
		ILALA	6.79	2.05	
			221.4		
TOTAL MOROGORO ZONE	25		47.9		1.91
MTWARA	4	MTWARA	40.8		
		KILWA	11.6		
			52.4	13.1	13.1
MPANDA	6	MPANDA	578.84		
MPANDA ZONE				96.5	96.5
MINE OFFICE	8	CHUNYA	1052.88	131.55	
SONGEA	4	MBINGA	689.2	172.3	
TUNDURU	1	TUNDURU	2384.4	50485.14	
MBEYA ZONE	8+(13) =21		22125.9		153.6
GEITA	3	GEITA	1696.37	565.5	
KARAGWE	3	BIHARAMULO	46.2	15.4	
MUSOMA	5	MUSOMA&SERENGETI	36.32	7.3	
TARIME	3	TARIME	449	149.7	
MWANZA	6	MISUNGWI	491	81.8	
MWANZA ZONE	24		2718.9		113.28
KAHAMA	6	KAHAMA	431.23	5.205	
SHINYANGA	4	NZEGA,IGUNGA & SHY	1530.28	382.6	
SHINYANGA ZONE			1561.5		156.1
DODOMA	24	IRAMBA	92.4		
SINGIDA ZONE			115.36	3.8	3.8
	<b>GRAND TOTAL</b>		<b>29128.15</b>		

**Appendix 2G****MINERAL REVENUE RECEIPTS**

<b>ITEM</b>	<b>1993/94</b>	<b>1994/95</b>	<b>1995/96</b>
<b>1404</b> Mining Royalties	29,000,000/=	90,000,000/=	200,000,000/=
<b>1902</b> Mining Rents	20,000,000/=	80,000,000/=	441,738,700/=
<b>2125</b> Geological fees	42,700,000/=	85,400,000/=	300,000,000/=

### **Appendices 3: MINING AND PROCESSING**

- A - Labour productivity, introduction
- B - Labour productivity, District level
- C - Labour productivity, Regional level
- D - Recovery rate for gold
- E - Existing gold mining methods
- F - Gold values for selected ore and tailings
- G - Sizing assay test
- H - Existing gemstone mining methods
- I - Layout of solar salt works
- J - Geology of Tanzania and related mineralization

## LABOUR PRODUCTIVITY

**Labour productivity was calculated as follows:-**

1. During the survey, weight of ore mined and processed per shaft or pit and number of days taken to mine and process the ore were recorded.
2. The number of labor involved in the mining and processing operations was noted.
3. From the above information, amount of ore mined or processed in terms of weight (Q1 or Q2) per day was calculated by dividing weight by the number of working days.
4. Productivity (P1 or P2) is equal to weight of ore mined or processed per day divided by the number of laborers.
5. Most of the ore is hand sorted underground and milled without further sorting. In most cases, for security reasons, all the ore mined is milled instead of stockpiling. The table below shows typical results of such calculations.

### Appendix 3B

#### MPANDA DISTRICT (GOLD)

LOCALITY	ORE MINED (Kg/day/Pit) (Q1)	ORE PROCESSED (Kg/day/Pit) (Q2)	LABOURERS PER PIT (L)	PRODUCTIVITY - ORE MINED (P1=Q1 Kg/day/ L Person)	PRODUCTIVITY - ORE PROCESSED (P2=Q2 Kg/day/ L Person)
Chemchem	600	600	5	120	120
Ibindi South	1200	1200	6	200	200
Katisunga	1600	630	12	133.3	52.5
D - Reef	180	30	4	45	7.5
Ntumba	180	30	4	45	7.5
Kasakulawe	60	60	4	15	15
<b>AVERAGE</b>				93	67

<b>AVERAGE LABOUR PRODUCTIVITY - GOLD</b>			
<b>REGION</b>	<b>AVERAGE PRODUCTIVITY (ORE MINED)</b>	<b>AVERAGE PRODUCTIVITY (ORE PROCESSED)</b>	<b>REMARKS</b>
1. Mwanza	27.5	27.5	In kg/day/person
2. Kagera	40.0	40.0	
3. Mara	200.6	200.6	
4. Shinyanga	6.1	6.1	
5. Tabora	259.8	259.8	
6. Singida	4.2	4.1	
7. Dodoma	83.0	83.0	
8. Ruvuma	61.8	61.8	
9. Rukwa	93.0	67.2	
10. Mbeya	128.0	128.0	
National Average	90.4	87.8	
<b>GEMSTONES</b>			
<b>REGIONS</b>	<b>AVERAGE PRODUCTIVITY ORE MINED Kg/day/Person</b>	<b>AVERAGE PRODUCTIVITY ORE PROCESSED Kg/day/Person.</b>	<b>REMARKS.</b>
1. Morogoro	25.4	25.4	
2. Ruvuma	46.6	45.	
3. Arusha	20.3	2.0	
4. Tanga	2.3	2.3	
5. Lindi	41.6	41.6	
National Average	27.2	23.4	

**Notes: See Overleaf for explanation**

## **NOTES: A. Gold**

1. The high productivity in Tarime and Igunga districts is due to mechanisation in mining and processing operations.

At Kerende mine in Tarime district, there are compressors, jackhammers and blasting equipment in the mines and ore processing is by jaw crusher, ball mill, copper plate and crucible. Fluxes are added before melting the gold. Likewise, at Matinje in Igunga district there are compressors, jackhammers in the mines and batch mills in the processing plant.

2. The low productivity in Musoma, Shinyanga, Nzega and Iramba districts is due to rudimentary technology being used to mine and process gold. For example at Simba Sirori (Musoma District) most of rock excavation is done by picks and moil points. Crushing and grinding is done manually by hammer on stone. At Itilina (Shinyanga district), Mwaluzwila and Isungangwanda (Nzega district), crushing is done manually by hammer whereas grinding is done manually by wooden mortar and mortar vehicle axle as pestle. Grinding at Sekenke (Iramba district) is by batch mills.

## **B. Gemstones**

1. The low productivity in Monduli, Muheza, Korogwe and Handeni districts is due to the following reasons:-

(a) The gemstones are mined from veins which are hard to extract by the moil points and picks. Most of the mines do not have compressors and jackhammers. The situation is worse at Mundarara Mine in Monduli district due, to very hard zoisite rock which hosts rubies.

(b) Mining, cobbing and sometimes sorting is done in the pits before the final product, which is normally small quantity, is brought to the surface for final hand sorting.

2. High productivity is observed in Ulanga, Tunduru, Liwale and Mbinga districts where open cast mining of soft alluvial gravel and soil is carried out in river beds and banks, thus allowing large tonnages to be extracted.

3. The high productivity of ore mined in Simanjiro district is due to the fact that blasting is carried out at Merelani, Landaban, Tiriri and Kaangala, but due to the fact that gemstones occur in local fissures and pegmatites the ore processed is small.
4. Due to geological conditions and for security reasons, gemstones are mined and processed and hand sorted at the same time. Hence weight of ore mined and processed is the same.

## Appendix 3D

## RECOVERY RATES FOR GOLD

Zone	District	Location	Grade of Ore (Sample analysis) (gm/tonne)	Amount Processed (Kgs)	Expected Production (gms)	Actual Production (gms)	+ (Excess) -(Losses) (gms)	Recovery %
Mwanza	Musoma	Ikungu	31.8	100	3.18	2.5	-0.68	78.6
	Geita	Busolwa	243	125	30.38	7	-23.38	23
Shinyanga	Igunga	Matinje	58.8	92000	5409.6	4140	-1269.6	76.5
Mbeya	Mpanda	Chemchem	17.8	600	10.68	4.2	-6.48	39.3
	Chunya	Sengambi	44.4	3000	133.2	60	-73.2	45
							Average	52.5
<b>Note:</b> These figures represent major gold producing areas.								
Recovery equals actual gold production divided by expected gold production expressed as percentage.								
Gold recovery depends on geological nature of mineralisation and processing techniques used.								

## EXISTING GOLD MINING METHODS

Appendix 3E

REGIONAL / DISTRICT	MWANZA		KAGERA		MARA		SHINYANGA		TABORA		SINGIDA		DODOMA		RUVUMA		RUKWA		MBEYA		TOTAL	
8.0. LIGHTING METHODS	NOS.	%	NOS.	%	NOS.	%	NOS.	%	NOS.	%	NOS.	%	NOS.	%	NOS.	%	NOS.	%	NOS.	%	NOS.	%
1. Torch	6	86	1	50	5	50	2	50	3	60	1	50	1	100	-	-	2	25	-	-	21	45
2. Hurricane lamps	-	-	-	-	1	10	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	2
3. Vibatari (Open flame lantern)	1	14	-	-	2	20	2	50	2	40	1	50	-	-	-	-	5	63	8	100	21	45
4. Natural light	-	-	1	50	-	-	-	-	-	-	-	-	-	-	-	-	1	12	-	-	2	4
5 Electricity	-	-	-	-	1	10	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	2
6. Candless	-	-	-	-	1	10	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	2
<b>TOTAL</b>	<b>7</b>	<b>100</b>	<b>2</b>	<b>100</b>	<b>10</b>	<b>100</b>	<b>4</b>	<b>100</b>	<b>5</b>	<b>100</b>	<b>2</b>	<b>100</b>	<b>1</b>	<b>100</b>	<b>-</b>	<b>-</b>	<b>8</b>	<b>100</b>	<b>8</b>	<b>100</b>	<b>47</b>	<b>100</b>
<b>9.0 DEWATERING</b>																						
1. Pumping	3	50	-	-	3	60	-	-	-	-	-	-	-	-	2	50	2	33	5	56	15	40
2. Buckets	1	17	-	-	-	-	1	50	1	33	-	-	-	-	-	-	3	50	4	44	10	26
3. Drums, plastic Containers, none	2	33	1	100	2	40	1	50	2	67	1	100	1	100	2	50	1	17	-	-	13	34
<b>TOTAL</b>	<b>6</b>	<b>100</b>	<b>1</b>	<b>100</b>	<b>5</b>	<b>100</b>	<b>2</b>	<b>100</b>	<b>3</b>	<b>100</b>	<b>1</b>	<b>100</b>	<b>1</b>	<b>100</b>	<b>4</b>	<b>100</b>	<b>6</b>	<b>100</b>	<b>9</b>	<b>100</b>	<b>38</b>	<b>100</b>

- Notes:**
1. The survey aimed to assess the existence of particular mining methods in various mining areas visited and not aimed to determine how many miners use these methods.
  2. The figures have been compiled from localities and districts.
  3. Where there are no figures, the methods are not practiced.
  4. Where ventilation is reported "none" means that pits are deep but without ventilation measures taken.
  5. Where tramming is reported "none" means that operations are carried out in pits only.

# EXISTING GOLD PROCESSING METHODS

Appendix 3E

REGIONAL / DISTRICT	MWANZA		KAGERA		MARA		SHINYANGA		TABORA		SINGIDA		DODOMA		RUVUMA		RUKWA		MBEYA		TOTAL	
	NOS.	%	NOS.	%	NOS.	%	NOS.	%	NOS.	%	NOS.	%	NOS.	%	NOS.	%	NOS.	%	NOS.	%		
<b>1.0 CRUSHING</b>																						
1. Mechanical jaw Crusher	-	-	-	-	1	17	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	03
2. Manual hammer	4	100	2	100	5	83	2	100	3	100	1	100	1	100	-	-	4	100	8	100	30	97
<b>TOTAL</b>	<b>4</b>	<b>100</b>	<b>2</b>	<b>100</b>	<b>6</b>	<b>100</b>	<b>2</b>	<b>100</b>	<b>3</b>	<b>100</b>	<b>1</b>	<b>100</b>	<b>1</b>	<b>100</b>	<b>-</b>	<b>-</b>	<b>4</b>	<b>100</b>	<b>8</b>	<b>100</b>	<b>31</b>	<b>100</b>
<b>2.0 GRINDING</b>																						
1. Mechanical-batch mill, stamp mill.	-	-	-	-	1	17	-	-	1	33	1	100	-	-	-	-	3	33	1	11	7	18
2. Manual	5	83	1	50	-	-	2	100	2	67	-	-	1	100	-	-	6	67	8	89	25	64
3. Manual-hammer	-	-	-	-	5	83	-	-	-	-	-	-	-	-	-	-	-	-	-	-	5	13
4. Fire drying/ sun drying	1	17	1	50	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2	05
<b>TOTAL</b>	<b>6</b>	<b>100</b>	<b>2</b>	<b>100</b>	<b>6</b>	<b>100</b>	<b>2</b>	<b>100</b>	<b>3</b>	<b>100</b>	<b>1</b>	<b>100</b>	<b>1</b>	<b>100</b>	<b>-</b>	<b>-</b>	<b>9</b>	<b>100</b>	<b>9</b>	<b>100</b>	<b>39</b>	<b>100</b>
<b>3.0 CONCENTRATION</b>																						
1. Panning/Sieving	3	21	-	-	5	45	2	40	2	22	1	33	-	-	2	50	1	10	-	-	16	23
2. Sluice boxes	4	29	1	50	-	-	1	20	3	33.5	1	33	1	50	-	-	5	45	3	27	19	26
3. Washing Siewing	2	14	-	-	-	-	-	-	-	-	-	-	-	-	2	50	-	-	-	-	4	05
4. Cyanidation	-	-	-	-	-	-	-	-	1	11	-	-	-	-	-	-	-	-	-	-	1	01
5. Amalgamation	5	36	1	50	6	55	2	40	1	33.5	1	34	1	50	-	-	5	45	8	73	32	45
6. Grading/Sizing	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-
<b>TOTAL</b>	<b>14</b>	<b>100</b>	<b>2</b>	<b>100</b>	<b>11</b>	<b>100</b>	<b>5</b>	<b>100</b>	<b>9</b>	<b>100</b>	<b>3</b>	<b>100</b>	<b>2</b>	<b>100</b>	<b>4</b>	<b>100</b>	<b>12</b>	<b>100</b>	<b>11</b>	<b>100</b>	<b>72</b>	<b>100</b>
<b>4.0 REFINING</b>																						
1. Zinc shavings	-	-	-	-	-	-	-	-	1	25	-	-	-	-	-	-	-	-	-	-	1	03
2. Open heating	5	83	1	100	5	83	2	100	2	50	1	50	1	100	-	-	6	86	8	100	31	79
3. Hand Sorting	1	17	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	14	-	-	2	05
4. Mercury retort	-	-	-	-	-	-	-	-	-	-	1	50	-	-	-	-	-	-	-	-	1	03
5. Panning/Cobbing, others	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2	100	-	-	-	-	2	05
6. Crucible, furnace	-	-	-	-	1	17	-	-	1	25	-	-	-	-	-	-	-	-	-	-	2	05
<b>TOTAL</b>	<b>6</b>	<b>100</b>	<b>1</b>	<b>100</b>	<b>6</b>	<b>100</b>	<b>2</b>	<b>100</b>	<b>4</b>	<b>100</b>	<b>2</b>	<b>100</b>	<b>1</b>	<b>100</b>	<b>2</b>	<b>100</b>	<b>7</b>	<b>100</b>	<b>8</b>	<b>100</b>	<b>39</b>	<b>100</b>

## GOLD VALUES FOR SELECTED ORE AND TAILINGS

Method: AAS, Fire Assay.

Appendix 3F

ZONE	DISTRICT	LOCATION	SAMPLE (NO).	RUSULTS	REMARKS
				Au (ppm)	
Shinyanga	Igunga	Matinje	MT/25/11/9	2.43	Country rock
"	"	"	MT/25/11/18	<0.02	Country rock
"	"	"	MT/25/11/6	77.00	Country rock
"	"	"	MT/25/11/3	295.70	Country rock
"	"	"	MT/25/11/15	24.00	Country rock shaft .16
"	"	"	MT/25/11/4	10.50	Ore CL 36294 shaft .22
"	"	"	MT/25/11/1	57.77	Ore CL 36153
"	"	"	MT/25/11/16	50.90	Ore
"	"	"	MT/25/11/7	55.80	Ore CL 36294
"	"	"	MT/25/11/4	14.65	Ore Shaft No. 22
"	"	"	MT/25/11/14	13.20	Ore CL 38362
"	"	"	MT/25/11/5	63.60	Marginal Ore
"	"	"	MT/25/11/8	15.25	Marginal Ore
"	"	"	MT/25/11/2	37.97	Marginal Ore Shaft. 16
"	"	"	MT/25/11/19	2.80	Tailing
"	"	"	MT/25/11/13	3.20	Tailing
Mwanza	Tarine	Nyabigena	NYABIGENA	34.15	Country rock
Singida	Iramba"	Sekenke	SKN/30/11/1	4.67	Country rock
"	"	"	SKN/30/11/3	0.70	Ore
"	"	"	SKN/30/11/2	0.58	Marginal Ore
"	"	"	SKN/30/11/9	1.80	Tailing
"	"	"	SKN/30/11/4	32.33	Tailing
"	"	"	SKN/30/11/7	<0.02	Tailing
Shinyanga	Nzega	Nzega Ndogo	LUSU/28/11/6	10.93	Soil
"	"	"	LUSU/28/11/3	19.60	Country rock
"	"	"	LUSU/28/11/2	1.50	Marginal
"	"	"	LUSU/28/11/1	9.85	Ore
"	"	"	LUSU/28/11/5	27.00	Tailing
"	"	"	LUSU/28/11/4	28.45	Tailing
"	Shinyanga	Itilima	IT/24/11/10	3.00	Country rock
"	"	"	IT/24/11/7	1.12	Country rock
"	"	"	IT/24/11/5	0.44	Ore
"	"	"	IT/24/11/1	6.30	Ore
"	"	"	IT/24/11/2	0.71	Ore
"	"	"	IT/24/11/4	10.10	Ore
"	"	"	IT/24/11/8/A/B	14.60	Ore

- Note:**
1. Most of the tailings at Lusu are centralized. It is therefore difficult to trace the source of the high values shown in the assays.
  2. At Itilima ore values vary considerably at short distances. See Itilima ore values which range from 0.44 to 14.6 ppm. Only skillful miners can detect and follow the rich veins.
  3. Ore processing in closed ponds may cause concentration of gold, sometimes reaching grades higher than country rock or ore (see Sekenke results)

ZONE	DISTRICT	LOCATION	SAMPLE (NO).	RUSULTS	REMARKS
				Au (ppm)	
Mwanza	Geita	Buziba	BZB/11/3	<0.02	Ore
Mwanza	Musoma	Ikungu	IKN/15/11/4	6.00	Tailing
"	Geita	Mgusu	MGS/10/11/4	51.27	Tailing
"	Geita	Mwalolela	MWL/8/11/1	18.27	Ore
"	Geita	Mwalolela	MWL/8/11/3	15.67	Tailing
"	Geita	Mawemeru	MMR/5/11/4	91.33	Tailing
"	Biharamulo	Imweru	MWR/9/11/4	97.70	Tailing
"	Geita	Mwalolela	MWR/8/11/5	47.00	Tailing
"	"	"	MWR/8/11/6	56.20	Soil
"	"	Mgusu	MSG/10/11/7	0.10	2rd Tailing
"	Biharamulo	Imweru	MWR/9/11/3	34.83	Tailing
"	Geita	Buziba	BZB/7/11/4	2.30	Tailing
"	Serengeti	Kimalambo	KBM/9/11/3	<0.02	Soil
"	Geita	Busolwa	BSL/6/11/3	0.58	Tailing
"	Musoma	Ikungu	IKN/15/11/8	20.67	Tailing
"	Kahama	Katente	KTN/3/11/3	3.69	Ore
"	"	"	KTN/3/11/5	<0.02	Soil
"	"	"	KTN/3/11/6	1.65	Tailing
"	Geita	Mgusu	MGS/10/11/6	<0.02	1st Tailing
"	"	Mawemeru	MMR/5/11/6	27.00	Tailing
"	"	Mwalolela	MWL/8/11/4	70.35	Tailing
"	"	Mawemeru	MMR/5/11/3	56.33	Tailing
"	Biharamulo	Imweru	MWR/9/11/2	132.00	Tailing
"	Geita	Buziba	BZB/7/11/1	<0.02	Ore
"	"	Mgusu	MGS/10/11/8	2.50	3rd Tailing
"	"	"	MGS/10/11/3	54.67	1st Tailing
"	Musoma	Nyangoto	NYG/18/11/2	2.60	Marginal Ore
"	Musoma	Nyangoto	NYG/18/11/4	13.93	Tailing
Singida	Dodoma	Nzuguni	NZ/M/2	0.90	Soil
"	"	"	NZ/V/3	32.77	Soil
"	"	"	NZ/R/1	1.80	Country Rock
"	"	"	NZ/K/1	0.33	Country Rock
"	"	"	NZ/RO/1	235.67	Ore
"	"	"	Nzuguni	56.58	Ore
"	"	"	Nzuguni 1st	49.33	1st Tailing
"	"	"	Nzuguni 2nd	31.66	2nd Tailing
Mpanda	Mpanda	D-reef	D-r/IR/18.11/18	9.17	Country Rock
Mpanda	Mpanda	D-reef	D-r/R/18.11/19	2.90	Country Rock
"	"	"	D-r/R/18.11/17	9.30	Country Rock
"	"	"	D-r/18/11/2	5.15	Country Rock
"	"	"	D-r/R/18.11/21	40.00	Country Rock

**Notes:** The high values of tailings at Imweru, Mawemeru and others are caused by processing ores in closed ponds where spillage may cause concentration of gold.

## Method: AAS, Fire Assay.

## Appendix 3F

ZONE	DISTRICT	LOCATION	SAMPLE (NO).	RUSULTS	REMARKS
				Au (ppm)	
Shinyanga	Shinyanga	Itilima	IT/24/11/6	1.42	Marginal Ore
"	"	"	IT/24/11/3	7.10	Tailing
Mwanza	Geita	Mgusu	MGS/10/11/2	<0.02	Tailing
"	Musoma	Ikungu	IKN/15/11/6	3.83	Country rock
Shinyanga	Kahama	Nyakagwe	NYK/4/11/3	14.00	Country rock
"	"	Katente	KTN/3/11/14	0.02	Country rock
Mwanza	Tarime	Nyangoto	NYG/18/11/1	5.20	Ore
Shinyanga	Kahama	Nyakagwe	NYK/4/11/1	1.54	Ore
Mwanza	Geita	Mawemeru	MMR/5/11/5	30.17	Soil
"	Serengeti	Kimalambo	KMB/17/11/1	20.50	Country rock
"	Musoma	Ikungu	IKN/15/11/2	5.50	Marginal Ore
"	"	"	IKN/15/11/1	8.45	Country rock
"	Geita	Mawemeru	MMR/5/11/2	0.83	Country rock
"	Musoma	Ikungu	IKN/15/11/3	11.40	Ore
"	"	Simba Sirori	SSB/11/11/3	28.63	Tailing
"	Tarime	Nyangoto	NYG/18/11/3	15.20	Tailing
"	Biharamulo	Imweru	MWR/9/11/5	0.60	Soil
"	Geita	Katente	KTN/3/11/2	10.95	Ore
"	"	Mwalolela	MWL/8/11/2	0.80	Tailing
"	"	Buziba	BZB/7/11/2	<0.02	Ore
"	Serengeti	Kimalambo	KMB/17/11/3	3.40	Ore
"	Geita	Busolwa	BSL/6/11/2	8.57	Ore
Shinyanga	Kahama	Nyakagwe	NYK/14/11/4	27.67	Tailing
Mwanza	Geita	Katente	KTN/3/11/1	0.55	Ore
"	"	Mawemeru	MMR/5/11/1	0.22	Ore
Shinyanga	Kahama	Nyakagwe	NYK/4/11/2	3.01	Country rock
Mwanza	Biharamulo	Imweru	MWR/9/11/1	30.35	Ore
Mwanza	Serengeti	Kimalambo	KMB/17/11/2	57.70	Marginal Ore
"	Musoma	Majimoto	MJJ/16/11/1	14.66	Ore
"	Musoma	Ikungu	IKN/15/11/7	0.66	Marginal Ore
"	Geita	Mgusu	MGS/10/11/1	90.00	Ore
"	"	Busolwa	BSL/6/11/1	5.27	Ore
"	Musoma	Simbasirori	SSB/16/11/1	13.95	Ore
"	Musoma	Simbasirori	SSB/16/11/6	15.00	Ore
"	Serengeti	Kimalambo	KMB/17/11/5	1.45	Soil
Mwanza	Musoma	Ikungu	IKN/15/11/5	<0.02	Soil
"	"	Simbasirori	SSB/16/11/2	15.46	Soil
"	Serengeti	Kimalambo	KMB/17/11/4	8.03	Soil
"	Musoma	Nyangoto	NYG/18/11/5	27.10	Soil
"	Geita	Mgusu	MGS/10/11/5	0.68	Soil

Method: AAS, Fire Assay.

Appendix 3F

ZONE	DISTRICT	LOCATION	SAMPLE (NO.)	RUSULTS	REMARKS
				Au (ppm)	
Mbeya	Chunya	Magembe	MG/S/29.0/7	0.10	Soil
"	"	Itumbi	IT/R/18.11/47	0.41	Country rock
"	"	Itumbi	IT/R/28.11/49	11.50	Country rock
"	"	"	IT/R/28.11/48	3.71	Country rock
"	"	Jeshini	JJ/28/11/43	29.40	Country rock
"	"	"	JJ/28.11/45	1.17	Country rock
"	"	Itumbi	IT/27.11/37	0.40	Country rock
"	"	Itumbi	IT/27.11/38	3.40	Country rock
"	"	Magembe	MG/R/29.11/56	9.13	Country rock
"	"	Magembe	MG/R/29.11/54	1.90	Country rock
"	"	"	MG/R/29.11/53	0.42	Country rock
Mpanda	Mpanda	Kasakalawe	KKL/R/21.11/31	1.40	Country rock
"	"	"	KKL/R/21.11/28	16.00	Country rock
"	"	"	KKL/R/21.11/29	0.85	Country rock
Mbeya	Chunya	Twiga	TWG/S/27.11/6	21.97	Soil
"	"	"	TWG/R/27.11/34	48.93	Country rock
"	"	"	TWG/R/27.11/36	3.07	Country rock
"	Mbinga	Dar Mpcpo	DMP/R/11.11/1	0.66	Country rock
"	"	"	DMP/S/11.11/2	0.27	Soil
"	"	"	DMP/S/11.11/3	<0.02	Country rock
"	"	"	DMP/S/11.11/6	0.10	Soil
Mbeya	Mbeya (R)	Madabaga	MBG/R/1.12/6	<0.02	Country rock
"	Chunya	Rift valley	RVY/R/219.11/59	1.90	Country rock
"	"	"	RVY/R/29.11/58	22.00	Ore
"	"	"	MMO/R/27.11/33	17.88	Ore
Mpanda	Mpanda	Katisunga	KGS/S/18.11/4	0.50	Soil
"	"	"	KGS/SD/18.11/6	5.67	Soil
"	"	"	KGS/SD/18.11/7	7.65	Soil
"	"	Ntumba	NTB/SI/19.11/9	3.75	Soil
"	"	Ibindi	IBN/S/SD/17.11/4	1.00	Soil
"	"	Ntumba	NTB/R/19.11/25	<0.02	Country rock
"	"	"	NTB/R/19.11/26	18.05	Ore
"	"	Ibindi	IBN/S/R/17.11/15	<0.02	Country rock
"	"	Ntumba	NTB/R/19.11/24	2.70	Country rock
"	"	"	NTB/R/19.11/23	0.96	Ore
"	Mpanda	Ibindi	IBN/S/R/17.11/13	5.55	Country rock
Mbeya	Chunya	Manyanga	MYG/R/28.11/40	16.00	Country rock
"	"	"	MYG/R/28.11/41	0.45	Country rock
"	"	"	MYG/R/28.11/42	<0.02	Country rock
"	"	"	MYG/R28.11/39	<0.02	Country rock

Method: AAS, Fire Assay.

Appendix 3F

ZONE	DISTRICT	LOCATION	SAMPLE (NO).	RUSULTS	REMARKS
				Au (ppm)	
Mpanda	Mpanda	Magula	MGL/R/17.11/7	19.67	Country rock
"	"	"	MGL/R/17.11/8	2.85	Country rock
"	"	Chemchem	CHM/R/17.11/12	<0.02	Country rock
"	"	Kuweit	KWT/R/19.11/5	0.35	Country rock
"	"	"	KWT/R/29.11/52	0.45	Country rock
"	"	Chemchem	CHM/17.11/10	30.15	Ore
"	"	Kuweit	KWT/R/29.11/51	24.40	Ore
"	"	Chemchem	CHM/SD/17.11/02	9.52	Tailing
Mwanza	Geita	Busolwa	BSL/6/11/4	243.00	Tailing

**Note:** The high gold value in the tailings at Busolwa is due to processing of gold ores in closed ponds where spillage may cause concentration of gold.

## **SIZING ASSAY TEST**

A sizing assay test is directed toward an answer to the question of sizes at which a concentrate and/or tailing can be made in commercial quantities. It comprises a preliminary separation by size, followed by sorting of the individual sizes on the basis of valuable mineral content. Normally these tests are done on feed, concentrate and tailings, and are the basis for designing a preliminary flowsheet.

In order to carry out such tests the consultant selected two sites for gold tailings dumps at Nzuguni Dodoma, namely A and B. At each site three tailings samples were collected and labeled first tailings, second tailings and third tailings. The first tailings are those discarded after panning and sluicing, the second tailings are those discarded after the first amalgamation and the third tailings are those discarded after the second amalgamation.

The six samples were sent to the Eastern and Southern African Mineral Development Center in Dar es Salaam. A sizing test of the samples was done by using four sieves of sizes 63 microns, 150 microns, 300 microns and 600 microns. Weights of samples retained by each sieve and - 63 microns were noted. Each sample was then pulverized and fire assayed to see the amount of gold contained.

### **Observations/recommendations**

- (a) The small size in tailings in sieve size range of -63 microns and 63 microns have shown high values due to past amalgamation activities in closed ponds. These grain sizes are results of dust emission during processing. The -63 microns grain sizes are less than 8% of weight retained in the sieves.
- (b) During sieving the highest percentage of weight retained is in the 150 microns, which goes up to 45% of sieves weight retained.
- (c) Further tests are needed to determine recovery trends based on present technology of artisanal miners.
- (d) It is recommended that such tests should be carried out from time to time so that artisanal gold miners can be advised how to improve the grinding methods to get maximum gold recovery.

**NZGB/SD/11.5/04****Appendix 3G**

Sieve size (microns)	Weight retained (gm)	Weight % retained	cum. wt. % retained
600	-	-	-
300	113.2	25.40	25.40
150	200.1	44.91	70.31
63	96.3	21.61	91.92
-63	36.0	8.08	100.00
<b>Total</b>	<b>445.6</b>	<b>100.00</b>	

**NZGB/SD/11.5/05**

Sieve size (microns)	Weight retained (gm)	Weight % retained	cum. wt. % retained
600	35.6	5.29	5.29
300	277.4	41.21	46.50
150	230.0	34.17	80.67
63	93.0	13.82	94.49
-63	38.1	5.51	100.00
<b>Total</b>	<b>673.1</b>	<b>100.00</b>	

**NZGB/SD/11.5/06**

Sieve size (microns)	Weight retained (gm)	Weight % retained	cum. wt. % retained
600	191.3	19.86	19.86
300	181.4	18.83	38.69
150	302.0	31.35	70.04
63	212.1	22.01	92.06
-63	38.1	5.51	100.00
<b>Total</b>	<b>963.3</b>	<b>100.00</b>	

## EXISTING GEMSTONE MINING METHODS Appendix 3H

REGIONAL /DISTRICT	DODOMA		MOROGORO		RUVUMA		RUKWA		ARUSHA		TANGA		LINDI		TOTAL	
	NOS.	%	NOS.	%	NOS.	%	NOS.	%	NOS.	%	NOS.	%	NOS.	%	NOS.	%
<b>1.0 OPEN CAST MINING</b>																
1. Open pit	1	100	4	66	12	100	1	100	-	-	3	75	3	100	24	77
2. Trenches.	-	-	2	34	-	-	-	-	4	100	1	25	-	-	7	23
<b>TOTAL</b>	<b>1</b>	<b>100</b>	<b>6</b>	<b>100</b>	<b>12</b>	<b>100</b>	<b>1</b>	<b>100</b>	<b>4</b>	<b>100</b>	<b>4</b>	<b>100</b>	<b>3</b>	<b>100</b>	<b>31</b>	<b>100</b>
<b>2.0 UNDERGROUND MINING</b>																
1. Windlass							1	100	1	25	-	-			2	22
2. Accessibility-rope							-	-	-	-	-	-			-	-
3. Pit with ladders							-	-	1	25	-	-			1	11
4. Pit without ladders							-	-	-	-	-	-			-	-
5. Pit with rope							-	-	1	25	-	-			1	11
6. Pit without rope							-	-	-	-	2	50			2	22
7. Pit with benches							-	-	1	25	2	50			3	34
<b>TOTAL</b>							<b>1</b>	<b>100</b>	<b>4</b>	<b>100</b>	<b>4</b>	<b>100</b>	<b>-</b>	<b>-</b>	<b>9</b>	<b>100</b>
<b>3.0 MINE SUPPORT</b>																
1. Soft/hard rock					3	21			2	33	1	25			6	25
2. Artificial support					8	58			-	-	-	-			8	34
3. Timbering					1	7			1	17	-	-			2	08
4. Natural support					2	14			2	33	2	50			6	25
5. Pillars					-	-			1	17	1	25			2	08
<b>TOTAL</b>					<b>14</b>	<b>100</b>			<b>6</b>	<b>100</b>	<b>4</b>	<b>100</b>	<b>-</b>	<b>-</b>	<b>24</b>	<b>100</b>

EXISTING GEMSTONE MINING METHODS

Appendix 3H

REGIONAL /DISTRICT	DODOMA		MOROGORO		RUVUMA		RUKWA		ARUSHA		TANGA		LINDI		TOTAL	
4.0 VENTILATION			NOS.	%	NOS.	%	NOS.	%	NOS.	%	NOS.	%	NOS.	%	NOS.	%
1. Local fan									-	-	-	-	-	-		
2. Compressors									1	20	-	-	-	-	1	13
3. Natural Ventilation									3	60	2	100	-	-	5	62
4. None							1	100	1	20	-	-	-	-	2	25
5. PVC pipe									-	-	-	-	-	-	-	-
<b>TOTAL</b>							1	100	5	100	2	100	-	-	8	100
5.0 EXTRACTION																
1. Moil point	1	50	3	33	-	-	-	-	5	38	2	14	-	-	11	17
2. Pick & Shovel	1	50	4	45	11	55	1	100	4	29	6	43	3	100	30	48
3. Jackhammer	-	-	-	-			-	-	1	6	-	-	-	-	1	02
4. Blasting	-	-	2	22			-	-	3	21	2	14	-	-	7	11
5. Vehicle leaves spring hoes, hammer, axes wooden boards, chisel, buckets, pans, sieves, fork hoe.	-	-	9	45	-	-	1	6	4	29	-	-	14	22		
6. Crow bars.																
<b>TOTAL</b>	2	100	9	100	20	100	1	100	14	100	14	100	3	100	63	100
6.0 TRAMMING																
1. Shovel					1	100	4	80	2	100			7	87		
half cut drums, hoes, bucket, plastic bags, bags on shoulder, pans.					-	-	1	20	-	-			1	13		
<b>TOTAL</b>					1	100	5	100	2	100			8	100		
7.0 HOISTING METHODS																
1. Buckets			11	38	-	-	-	-	-	-	-	-	11	27		
2. Bags			-	-	-	-	1	14	-	-	-	-	1	02		
3. Shovels			11	38	1	100	4	57	2	100	3	100	21	51		
4. Rope			7	24	-	-	1	14	-	-	-	-	8	20		
5. Windlass					-	-	-	-	-	-	-	-	-	-		
6. Pans					-	-	-	-	-	-	-	-	-	-		
7. Winch							1	15	-	-	-	-	-	-		
<b>TOTAL</b>			29	100	1	100	7	100	2	100	3	100	41	100		

# EXISTING GEMSTONE MINING METHODS

Appendix 3H

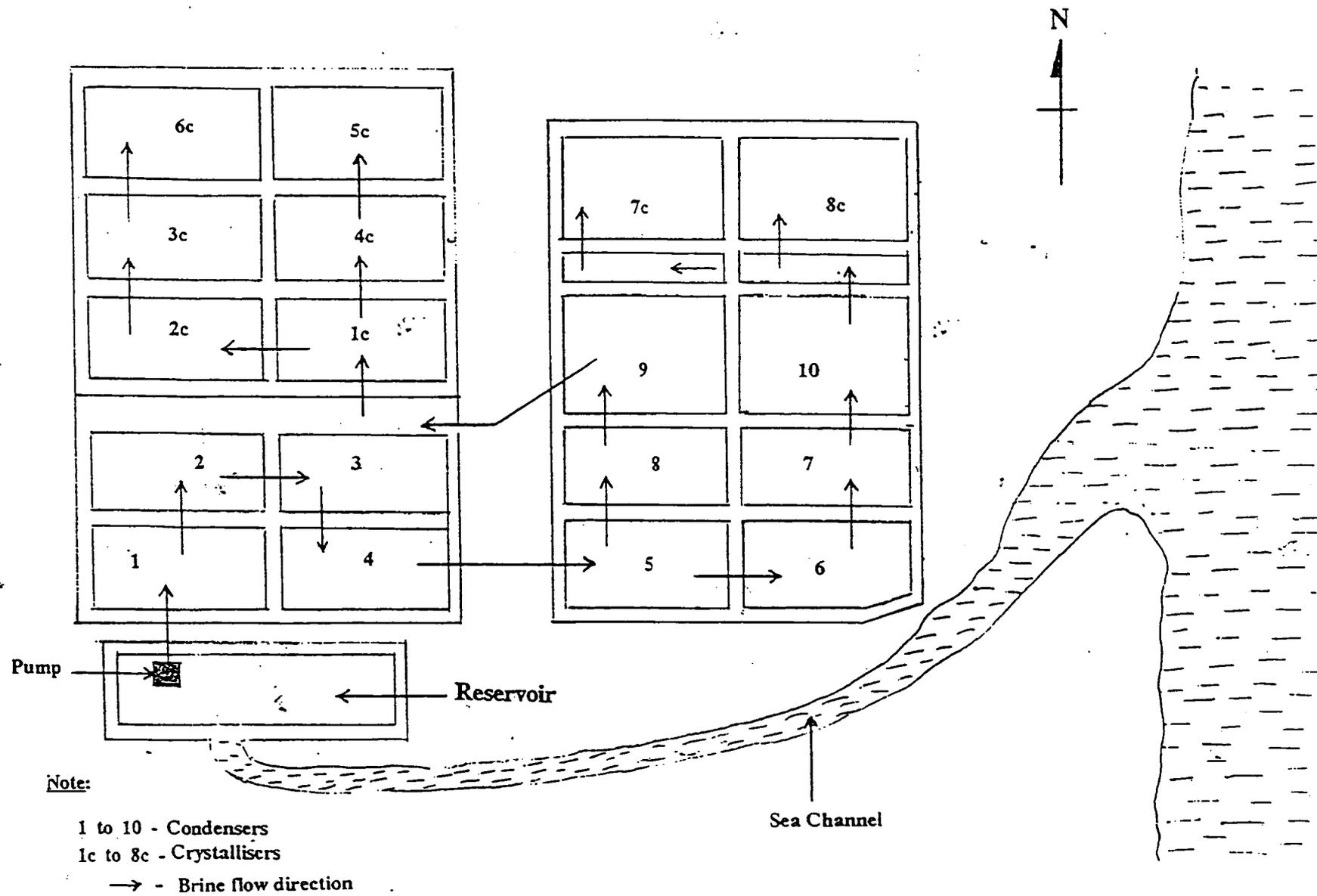
REGIONAL /DISTRICT	DODOMA		MOROGORO		RUVUMA		RUKWA		ARUSHA		TANGA		LINDI		TOTAL	
	NOS.	%	NOS.	%	NOS.	%	NOS.	%	NOS.	%	NOS.	%	NOS.	%	NOS.	%
<b>8.0. LIGHTING METHODS</b>																
1. Torch							-	-	3	75	-	-			3	50
3. Vibatari (Open flame lantern)					1	100	-	-	1	100					2	33
4. Natural light.					-	-	1	25	-	-					1	17
<b>TOTAL</b>					<b>1</b>	<b>100</b>	<b>4</b>	<b>100</b>	<b>1</b>	<b>100</b>					<b>6</b>	<b>100</b>
<b>9.0 DEWATERING</b>																
1. Pumping	-	-	1	50	2	10	1	50	-	-	1	100	2	67	7	22
2. Buckets	-	-	1	50	7	37	1	50	2	67	-	-	1	33	12	39
4. Drums, plastic Containers	1	100	-	-	10	53	-	-	1	33	-	-	-	-	12	39
<b>TOTAL</b>	<b>1</b>	<b>100</b>	<b>2</b>	<b>100</b>	<b>19</b>	<b>100</b>	<b>2</b>	<b>100</b>	<b>3</b>	<b>100</b>	<b>1</b>	<b>100</b>	<b>3</b>	<b>100</b>	<b>31</b>	<b>100</b>

**Note:**        **Comments on gold mining methods also apply for gemstone mining.**

# EXISTING GEMSTONE PROCESSING METHODS

Appendix 3H

REGIONAL /DISTRICT	MOROGORO		RUVUMA				RUKWA		ARUSHA		TANGA		LINDI		TOTAL	
	NOS.	%	NOS.	%	NOS.	%	NOS.	%	NOS.	%	NOS.	%	NOS.	%	NOS.	%
<b>1.0 CRUSHING</b>																
1. Mechanical jaw Crusher									-	-	-	-				
2. Manual hammer									1	100	-	-			1	100
<b>TOTAL</b>									<b>1</b>	<b>100</b>	<b>-</b>	<b>-</b>			<b>1</b>	<b>100</b>
<b>2.0 CONCENTRATION</b>																
1. Panning/Sieving	-	-	7	41			-	-							7	25
2. Sluice boxes	-	-	-	-			-	-							-	-
3. Washing Siewing	4	100	10	59			1	100					3	50	18	64
4. Grading/Sizing	-	-	-	-			-	-					3	50	3	11
<b>TOTAL</b>	<b>4</b>	<b>100</b>	<b>17</b>	<b>100</b>			<b>1</b>	<b>100</b>					<b>6</b>	<b>100</b>	<b>28</b>	<b>100</b>
<b>3.0 REFINING</b>																
1. Hand Sorting	4	100	11	100			1	100	5	56	6	86	3	100	30	86
3. Panning/Cobbing, others	-	-	-	-			-	-	4	44	1	14			5	14
<b>TOTAL</b>	<b>4</b>	<b>100</b>	<b>11</b>	<b>100</b>			<b>1</b>	<b>100</b>	<b>9</b>	<b>100</b>	<b>7</b>	<b>100</b>	<b>3</b>	<b>100</b>	<b>35</b>	<b>100</b>



## GEOLOGY OF TANZANIA AND RELATED MINERALIZATION

Major geologic environments of Tanzania are: An archean craton, orogenic mobile belts, platform sediments, coastal marine sedimentary deposits and various types of superficial accumulations.

### Regional Geology

The main geologic divisions in Tanzania are as shown in figure 15. Much of the central part of the country is covered by the Tanzanian craton which is of Archean age (3.0 to 2.5 Ga). A craton is an ancient, tectonically stable part of a continent that is composed of igneous and metamorphic rocks. The rock systems belonging to the Tanzanian craton include the Dodoman, Nyanzian and Kavirondian systems. The Tanzanian craton is surrounded by early, middle to late Proterozoic (2.0 to 0.8 Ga) mobile belts. These belts include the Ubendian to the West and southwest, the Karagwe - Ankolean to the northwest the Usagaran system to the south east and the Mozambique belt to the east. The extreme north western part of the craton is covered by the intra cratonic platform sediments of the Bukoban system.

The Dodoman rocks which cover the southern half of the craton include multiply deformed pelitic schists and gneisses, quartzites, granite gneisses, migmatites and granites. They have been derived by intense (upper amphibolite to granulite facies) regional metamorphism and migmatization of arenaceous and argillaceous sediments, basic volcanic and ultrabasic rocks.

The rocks of Nyanzian system occupy the northern half of the Tanzanian, craton to the south and east of Lake Victoria. It covers an area extending 360 km from east to west and 360 km from north to south. Nyanzian rocks occur as irregular - shaped patches surrounded by granites. This system is mainly made up of acid and basic volcanic rocks and banded iron formation metamorphosed at greenschist facies conditions. The metavolcanics form the greenstone formations. The banded Iron formations which are a characteristic formation of the Nyanzian system are very fine grained, laminated rocks made up of alternating magnetite/haematite and occasionally some ferromagnesian minerals and a light material consisting mainly of fine (cryptocrystalline) chert.

The Kavirondian rocks occur mainly in the Musoma District north of the Mara river. Few isolated patches have also been mapped around Kilimafedha, near Speke Gulf, at Mabale hills, east of Karumwa and in Nzega district. They consist of conglomerates, coarse arkosic and feldspathic

grit and quartzites. They rest unconformably on the Nyanzian rocks.

The Mozambique Belt, occupies much of the eastern part of Tanzania, and forms the central part of a belt with 240 to 400 km in width extending southwards into Mozambique and northwards into Kenya, Ethiopia and Saudi Arabia. The rocks of this belt which include granulite, hornblende and biotite gneisses, marble, graphitic schists and gneisses and quartzites, have undergone extensive metamorphism and deformation. The complex history of several cycles of tectonism and regional metamorphism, led to the formation of diverse varieties of lithotypes in the belt which host a wide range of gemstones and other minerals.

The palaeo proterozoic Ubendian - Usagaran Belt on the western, southern and south eastern side of the craton contains a variety of high grade (upper amphibolite to granulite facies) metamorphic rocks of both sedimentary and igneous origin. The economic minerals associated with these rocks are typically metamorphic pegmatitic and hydrothermal minerals similar to those of the Mozambique Belt but in less variety.

The most important minerals including gold, diamond and gemstones are described briefly in relation to their geological and structural controls based especially on observations of visited areas by the consultant team. Detailed description of the various lithological units in Tanzania and their mineral resource potentials are outlined separately.

## **Geological and Structural Controls on Mineralization**

### **Gold**

Genetically, gold in Tanzania is associated with either the Archean granite greenstone terrains (the Nyanzian System) or the proterozoic terrains. Gold in the Nyanzian system is found in disseminated form in the greenstones and the Banded Iron formation and as gold - silver and/or - sulphide associations in quartz reefs. There is a clear linkage between the gold - silver - sulphide mineralization and the quartz vein pattern to the tectonic features like shear zones, fractures, and faults which acted as conduits of the auriferous hydrothermal mineralizing fluids. The main Greenstone - granite terrains with gold mineralization include; Geita - Buckreef greenstone belt, Kahama - Mabale greenstone belt, Nzega - Igunga greenstone belt, Mara and Musoma greenstone belt, Iramba - Sekenke greenstone belt and Nzuguni gold prospect.

Gold associated with the Proterozoic terrain is hosted by quartz-reefs developed in amphibolite (meta - basalt) intruded by diorite, granodiorite and occasionally by porphyritic felsic dykes. The terrain is confined to the Ubendian mobile belts flanking the Dodoma craton on the southwestern margin. The terrain trends NW - SE, extending from Mpanda area through Lupa area to Mbinga - Mpepo area . This type of gold occurrence is also tectonically controlled whereby auriferous hydrothermal fluids were injected into sheared and fractured zones.

In summary the mode of occurrence of gold in both Archean greenstone terrain and Proterozoic terrains can be grouped into three deposition categories: -

- Gold disseminated in the greenstones and Banded Iron formations.
- Quartz vein deposits, where gold occurs as free dissemination in the veins and also locked in the silver and/or sulphide especially pyrites and chalcopyrite.
  
- Recent alluvial/eluvial deposits, where gold is recovered near gold bearing reefs on the lowlying relief areas and along the drainage patterns.
  
- Palaeoplacer deposits where gold was mainly derived from clastic sediments overlying the Nyanzian rocks.

## Diamonds

Diamonds in Tanzania are found in Kimberlite rocks and in superficial accumulations (residual and eluvial) close to the Kimberlites . Kimberlite itself is an igneous ultramafic rock consisting mainly of rounded phenocrysts of olivine and phlogopite in a fine matrix of serpentine phlogopite and calcite. They occur in a form of pipes intruding the granites of Archean craton. Diamond fields in Tanzania are:- (i) Mwanza diamond field (Mabuki, Mwamanga). (ii) Shinyanga diamond field (Mwadui, Galamba, Bubiki and Kizumbi pipes).

## Gemstones

High-grade metamorphic rocks of Palaeoproterozoic Ubendian - Usagaran Belt and Pan - African Mozambique Belt host diverse types of metamorphic minerals, gemstones and industrial minerals. Few important gems are highlighted below:-

### Ruby

At least three styles of primary ruby mineralization are known in Tanzania.

- Desilicated pegmatites: This involves depletion of silica and an apparent enrichment of aluminium in pegmatites when the pegmatites intrude ultramafic bodies (igneous rocks high in iron - magnesium minerals) eg. at Kigwasi (Umba valley).
- Desilicated Calc - silicates in marbles associated with red spinel, eg the Morogoro ruby- calc. silicate rocks within the marble.

The Longido ruby is in a reef of anorthite, a rock composed of opaque green zoisite with dark green to black amphibole (Hb) that occurs with opaque to transparent ruby.

### Sapphire

Sapphires like the rubies are formed in association with pegmatite veins that cut a serpentinite body in Kalalani - Kigwasi - Umba valley. Tanzanian sapphires are notable for their great range of colours including colourless, violet, purple, red-orange, blue, green, orange, yellow, yellow-orange, pink and change of colour. At Kalalani - Kipingoni blue sapphires are produced at the micaceous zones and coloured sapphires are obtained from garnetiferous zones. The unique change of colour is caused by variations in the proportions of the chromophores chromium, iron, manganese, nickel, titanium and vanadium.

### Tanzanite

Tanzanite (Zoisite) belongs to the epidote group of minerals. Its gem colour variety is purplish blue. Primary tanzanite is located at the crest of a large fold developed in metamorphic rocks (dolomite marble, graphitic gneisses and schists) at Merelani, Arusha. Hydrothermal solutions injected into

local fissures formed at the crest of the fold reacted with the bedrock to develop the Tanzanite mineralization.

One of the most notable features of Tanzanite is its strong pleochroism, which is usually grayish blue, purple and brown, green or yellow.

### **Garnet**

A number of garnets have been found in Tanzania including pyrope - spessartine (Malaya), pyrope almandine, rhodolite, green grossular (tsavorite) pyrope, and change of colour. Malaya is red-orange to yellow-orange garnet found in alluvial deposits along Mwakijembe - Uмба River valley. Tsavorite is a transparent green grossular garnet found together with Tanzanite at Merelani. They occur in graphitic gneisses.

Rhodolite has been found ranging in colour from dark red to purplish red to purple. Rhodolite at Kangala is described as "raspberry" in colour. Rounded rhodolite pebbles of darker tone commonly 1-3 gm are produced from Tiriri and Landaban in Arusha (NE Tanzania). The rhodolite of Sezakofi - Handeni are light reddish purple in colour and usually free of any silk. Rhodolite garnets occur widely in precambrian metamorphic rocks and those of Uмба river valley are from alluvial deposits. Change of colour garnets were found in Mwakijembe. Their colour changes from red to orange to pink, pink to purple and orange to yellow.

### **Tourmaline**

Tourmaline is typically found in either crystalline limestone or in pegmatites associated with limestone and/or ultramafics in northern and eastern Tanzania. Elbaite is found primarily in pegmatites whereas dravite and uvite occur in various types of metamorphic rocks. The famous type is bright green variety of dravite called "Chrome" tourmaline.

Other considerable potential gem materials are emerald, aquamarine, alexandrite, amethyst, peridot, scapolite, spinel and zircon.



**Appendices 4: ENVIRONMENTAL, HEALTH AND SAFETY ASPECTS**

A - Social, Physical and Biological Environmental

B - Reported accidents

C - Reported accidents

D - Reported accidents

E - Mercury contamination in hair samples

F - Biological contamination of drinking water

G - Results of heavy metal analyses in water bodies

H - Results of heavy metal analyses in Soil/Tailing

I - Physical parameters of water

Environmental Effects	SOCIAL ENVIRONMENT					PHYSICAL ENVIRONMENT							BIOLOGICAL ENVIRONMENT												
	Recreation	Landscape/Visual	Historical/Cultural	Existing land uses	Employment	Community Participation	Landform	Nuisance (noise, dust, smell)	Climate/Atmosphere	Agricultural soil	Surface water	Sedimentation	Erosion/Landstability	River regime	Wellands	Marine	Estuaries	Rivers/Streams	Lakes	Cropland	Sand/Rock	Grassland	Shrubland	Forest	
<b>Development</b>																									
Opencast Mining																									
- Overburden stripping		-L		+L	+M		-M	-L	-L	-L		-M	-L		-L					-L	-L	-L		-L	
- Blasting								-M																	
- Dewatering									-L									-M							
Undergroup mining																									
- Excavation				+L	+M		-M																-L	-L	-L
- Ventilation system		-L																							
- Dewatering										-L	-L	-L	-L					-L							
- Blasting								-M																	
- Construction materials																									-L
Ore processing																									
- Crushing		-L		-L	+H			-M	-L																
- Grinding								-M	-L																
- Firing amalgam								-M																	
- Stockpiling		-M								-L	-M							-L	-L						
- Water supply						-L																			
- Effluent disposal		-L													-L	-L	-L	-M	-L	-L					
Tailings																									
- Storage		-M		-L			-L																		
- Disposal		-M		-L			-L			-L	-L	-M	-L	-L	-L	-L	-M	-L	-L						
- Leaching effect																									
- Wind effect								-L													-L	-L	-L	-L	-L
Rehabilitation																									
- Land fill of pits		+L			+L																				
- Planting trees		+M				+L																			+L
- Overburden use	+L	+M																							
General																									
- Construction of shelters	+L	+L																							-L
- Energy Sources	+L																								-M

**Impact Matrix for Baseline Survey Artisanal and Small Scale Mining Activities**

Environmental Effects

H - High Effects

M - Medium Effects

L - Low Effects

+ Positive Effect

- Negative Effects

Appendix 4B

REPORTED ACCIDENTS IN 1993

MINING ZONE	DISTRICT	MINING METHOD	NUMBER OF VICTIM	MINERAL TYPE	INJURIES			CAUSE - REMARKS
					MINOR	SERIOUS	FATAL	
Mwanza	Geita	Underground	9	Gold	1	5	3	Roof Failure
	Geita	Open Cast	16	Gold	-	5	11	Roof Failure
	Musoma	Underground	6*	Gold	-	-	-	Extent of injury and cause not established
	<b>Sub total</b>		<b>31</b>		<b>1</b>	<b>10</b>	<b>14</b>	
Shinyanga	Kahama	Underground	2	Gold	-	-	-	Extent of injury and cause not established
	Nzega	"	2	Gold	-	-	-	" - "
	<b>Sub total</b>		<b>4*</b>					
Mbeya	Rungwe	Underground	3	Coal	2	-	1	Roof Collapse
	Mbinga		6	Gold	2	-	4	Wall Collapse
	Chunya		2	Gold	1	-	1	Wall Collapse due to blasting
	<b>Sub total</b>		<b>11</b>		<b>5</b>		<b>6</b>	
Arusha	Mbulu	Open Cast	2	Amerald	-	-	2	Rock slides
	Simanjiro	Underground	1	Tanzanite	-	-	1	Suffocation & hanging wall collapse
	Monduli	Underground	4		1	-	3	Slabs falling from hanging wall
	<b>Total</b>		<b>50</b>		<b>7</b>	<b>10</b>	<b>23</b>	

UNREPORTED ACCIDENTS IN 1993

MINING ZONE	DISTRICT	MINING METHOD	NUMBER OF VICTIM	MINERAL TYPE	INJURIES			CAUSE - REMARKS
					MONOR	SERIOUS	FATAL	
Morogoro	Moro/ (R)	Opencast	1	Ruby	-	-	1	Wall Collapse
	Ulanga	Opencast	5 - 10*	Ruby	-	-	-	Unsafe handling of explosives. Extent of injury not established.
	D'Salaam	Open cast	2	Stone	-	-	2	Ground fall.
	<b>Sub total</b>		<b>8 - 13</b>				<b>3</b>	
Arusha	Simanjiro	Underground	1	Tanzanite	-	-	1	Suffocation.
	<b>Sub total</b>		<b>1</b>				<b>1</b>	
	<b>Total</b>		<b>9 - 14</b>				<b>4</b>	
	<b>Grand Total</b>		<b>59 - 64</b>		<b>7</b>	<b>10</b>	<b>27</b>	

\* Not included in injury breakdown

## Appendix 4C

## REPORTED ACCIDENTS IN 1994

MINING ZONE	DISTRICT	MINING METHOD	NUMBER OF VICTIM	MINERAL TYPE	INJUSTRIES			CAUSE - REMARKS
					MINOR	SERIOUS	FATAL	
Mwanza	Geita	Underground	3	Gold	-	-	3	Suffocation due to wall collapse.
	Geita	Opencast	1	Gold	-	-	1	Fall into pit
<b>Sub total</b>			<b>4</b>				<b>4</b>	
Shinyanga	Kahama	Underground	5*	Gold				Cause not established
	Igunga	"	1*	Gold				Cause not established
<b>Sub total</b>			<b>6</b>					
Mbeya	Chunya	Opencast	2	Coal	1	-	1	Falling of Loose soil
	Rungwe	Underground	3	Coal	2	-	1	Positioning of a derailed car.
<b>Sub total</b>			<b>5</b>		<b>3</b>		<b>2</b>	
Arusha	Simanjiro	Opencast & Underground	9	Tanzanite	2	-	7	Suffocation while exiting shaft, blasting.
<b>Sub total</b>			<b>9</b>		<b>2</b>		<b>7</b>	
<b>Total</b>			<b>24</b>		<b>5</b>		<b>13</b>	

## UNREPORTED ACCIDENTS IN 1994

MINING ZONE	DISTRICT	OPENCAST OR UNDERGROUND	NUMBER OF VICTIM	MINERAL TYPE	INJURIES			CAUSE - REMARKS
					MINOR	SERIOUS	FATAL	
Mwanza	Musoma	Underground	4	Gold	4	-	-	Cause not established
<b>Sub total</b>			<b>4</b>		<b>4</b>			
Shinyanga	Nzega	Underground	3	Gold	-	-	-	Cause and extent of injury not established.
<b>Sub total</b>			<b>3</b>				<b>3</b>	
Morogoro	Morogoro (R)	Opencast	1	Sand	-	-	1	Wall Collapse
<b>Sub total</b>			<b>1</b>				<b>1</b>	
Arusha	Arumeru	Underground	4	Pozzalan	-	-	4	Hanging wall collapse
	Korogwe	Underground	6	Garnet	6	-	-	Shaft Collapse
<b>Sub total</b>			<b>10</b>		<b>6</b>		<b>4</b>	
<b>Total</b>			<b>18</b>		<b>10</b>		<b>5</b>	
<b>Grand Total</b>			<b>42</b>		<b>15</b>		<b>18</b>	

\* Not included in injury breakdown

**REPORTED ACCIDENS IN 1995**

MINING ZONE	DISTRICT	MINING METHOD	NUMBER OF VICTIM	MINERAL TYPE	INJURIES			CAUSE - REMARKS
					MINOR	SERIOUS	FATAL	
Mwanza	Geita	Underground	7	Gold	-	-	7	Suffocation and falling into pit.
	Serengeti	Underground	5	Gold	2	3	-	Roof failure
Sub total			12		2	3	7	
Shinyanga	Shinyanga	Underground (R)	1*	Gold	-	-	-	Extent of injury and cause of accident not Established.
	Igunga	- " -	2*	Gold	-	-	-	- " -
Sub total			3					
Mbeya	Chunya	Opencast	3	Gold		2	1	Wall Collapse
Sub total			3			2	1	
Arusha	Simanjiro	Underground	7	Tanzanite	-	-	-	Puffocation, Poor handling of explosives.
Sub total			7		-	-	7	
Total			25		2	5	15	

**UNREPORTED ACCIDENTS IN 1995**

MINING ZONE	DISTRICT	OPENCAST OR UNDERGROUND	NUMBER OF VICTIM	MINERAL TYPE	INJURIES			CAUSE - REMARKS
					MINOR	SERIOUS	FATAL	
Mwanza	Musoma	Opencast	4	Gold	1	3	-	Cause of accident not established
Sub total			4		1	3	-	
Morogoro	Morogoro (R)	Opencast	1	Ruby	-	-	-	Wall Collapse
Arusha	Tanga	Opencast	1	Stone	-	-	1	Falling Stones
Sub total			1		-	-	1	
Total			6		1	3	2	
Grand Total			31		3	8	17	

\* Not included in injury breakdown

## Mercury contamination in hair samples

District	Location	Operator Working Experience Years	Result (ppm)
NZEGA	Lusu	5	1.7
	Lusu	5	10.3
	Lusu	5	3.9
	Lusu	8	12.1
	Lusu	7	4.3
	Lusu	7	5.8
	Lusu	6	4.6
	Lusu	7	2.6
	Lusu	8	3.9
	Lusu	6	3.2
	Lusu	21	37.1
	Lusu	12	29.7
	Lusu	30	4.9
	Lusu	30	5.0
	Lusu	20	6.0
	Lusu	18	5.5
	Lusu	7	9.2
Lusu	5	11.3	
IRAMBA	Sekenke	3	3.8
	Sekenke	4	3.6
	Sekenke	6	1.9
	Sekenke	2	2.4
	Sekenke	5	3.6
	Sekenke	4	2.8
NZEGA	Isungangwanda	10	3.5
	Isungangwanda	8	4.5
MUSOMA (R)	Simba Sirori	5	43.5
	Simba Sirori	5	35.6
	Simba Sirori	7	39.6
	Simba Sirori	6	33.2

**NB: The maximum permissible level recommended by WHO is 6.4 ppm**

# BIOLOGICAL CONTAMINATION OF DRINKING WATER

Appendix 4F

ZONE	DISTRICT	LOCATION	SAMPLE NUMBER	RESULTS	REMARKS
Mwanza	Kahama	Katente	KTN/3/11/9	Few bacteria	Domestic water
"	Geita	Nyakagwe	NYK/4/11/6	NIL	Domestic water
"	"	Mawemeru	MMR/5/11/8	NIL	Well water
"	"	Busolwa	BSL/6/11/6	NIL	Domestic water, uphill
"	"	Busolwa	BSL/6/11/7	NIL	Domestic water, down hill
"	"	Buziba	BZB/7/11/5	NIL	Domestic water
"	"	Mgusu	MGS/10/11/9	NIL	Domestic water
"	"	Mgusu	MGS/10/11/10	NIL	Stream water
"	Biharamulo	Imweru	MWR/9/11/6	NIL	Domestic water
"	"	Imweru	MWR/9/11/7	NIL	Domestic water, Mercury Polluted
"	Musoma	Kirumbi bridge	MARA/19/11/1	Many bacteria	Entry Point to Lake Victoria; River Mara
"	Serengeti	Kimalambo	KMB/17/11/7	NIL	Well water
"	Musoma	Sirori simba	SSB/16/11/4	NIL	Domestic Water
"	"	Ikungu	IKN/15/11/10	NIL	Domestic Water
"	"	Ikungu	IKN/15/11/9	NIL	Lake Victoria Water
"	Tarime	Nyangoto	NYG/18/11/6	NIL	Well water, Domestic use
"	Musoma	Majimoto	MJT/16/11/3	NIL	Well domestic water
"	"	Majimoto	MJT/16/11/4	NIL	Well domestic water, up stream
Mtwara	Lindi	Mbwemkuru	MBKR/W/22/4/1	NIL	Mbwemkuru river, down stream
"	"	Mbwemkuru	MBKR/W/22/4/2	NIL	Mbwemkuru river, up stream
"	Liwale	Lumesule	LMSL/W/27/4/1	NIL	Lumesule river, down stream
Mbeya	Tunduru	Muhuwesi	MHWS/W/27/4/1	NIL	Muhuwesi river, up stream
"	"	Muhuwesi	MHWS/w/28/4/2	NIL	Muhuwesi river, down stream
"	"	Muhuwesi	MHWS/W/28/4/3	E. Coli Bacteria	Domestic water, taken at No.9 Tunduru - Muhuwesi tributary

# RESULTS OF HEAVY METALS ANALYSES IN WATER BODIES

Appendix 4G

ZONE	DISTRICT	LOCATION	SAMPLE NUMBER	RESULTS				REMARKS
				Hg(ppm)*	Cd (ppm)	Pb (ppm)	As (ppm)	
Mwanza	Musoma	Ikungu	IKN/15/11/9		5	5	<0.2	Lake Victoria water
Shinyanga	Kahama	Katente	KTN/3/11/9		5	13	0.19	Domestic water
Mwanza	Geita	Mgusu	MGS/10/11/9		5	8	<0.2	Domestic water
"	"	"	MGS/10/11/10		6	<5	<0.2	Stream water
"	"	Nyakagwe	NYK/4/11/5		4	<5	0.89	Mine water
"	Musoma	Majimoto	MJT/16/11/2		<3	<5	<0.2	Cyanidation water
"	Geita	Busolwa	BSL/9/11/7		5	<5	1.43	Domestic water down hill
"	"	Mawemeru	MMR/5/11/7		<3	<5	<0.2	Shaft water
"	Musoma	Simba sirori	SSB/16/11/5		<3	6	1.14	Process water
Shinyanga	Kahama	Katente	KTN/3/11/8		5	<5	<0.2	Mine water
"	"	"	KTN/3/11/7		4	<5	<0.2	Process water
Mwanza	Geita	Busolwa	BSL/6/11/6		6	<5	3.25	Domestic water Uphill
Mpanda	Mpanda	Ntumba	NTB/W/19.11/33		5	8.5	<0.2	From a ditch/pit within the dry stream at the downstream side of effluent discharge point
"	"	"	NTB/W/19.11/29		<3	<5	<0.2	At point of maximum effluent discharge.
"	"	"	NTB/W/19.11/31		3	<5	4.6	Taken 100 m downstream of effluent discharge point.
Mwanza	Biharamulo	Imweru	MWR/9/11/6		5	<5	2.4	Domestic water
"	"	"	MWR/9/11/7		3	<5	<0.2	Domestic water, Hg polluted.
Mbeya	Chunya	Mambo	MAB/W/27.11/37		<3	21	3.82	Taken from the tank before ore processing.
Mwanza	Geita	Buziba	BZB/7/11/5		<3	5	0.5	Domestic water
Mpanda	Mpanda	Ntumba	NTB/W/19.11/27		<3	9	2.1	Upstream side of effluent at Katumba River
Mwanza	Serengeti	Kimalambo	KMB/17/11/7		<3	<5	<0.2	Well water
"	"	"	KMB/17/11/8		4	<5	4.1	Process water

## RESULTS OF HEAVY METALS ANALYSES IN WATER BODIES

Appendix 4G

ZONE	DISTRICT	LOCATION	SAMPLE NUMBER	RESULTS				REMARKS
				Hg(ppm)*	Cd (ppb)	Pb (ppb)	As(ppm)	
Mpanda	Mpanda	Ibindi South	IBNS/W/17.11/18		4	20	<0.2	Taken at the point of effluent disposure.
"	"	"	IBNS/W/17.11/20		7	13	1.39	Well water, outside of the mine area (domestic water).
"	"	"	IBNS/W/17.11/21		3	10	6.43	As above
Mbeya	Chunya	Itumbi	ITB/W/28.11/47		7	19	4.6	Maximum effluent discharge point
"	"	Itumbi Jeshini	ITBJ/W/28.11/45		4	<5	1.36	Maximum effluent discharge point.
Mpanda	Mpanda	Katsunga	KTG/W/18.11/24		<3	17.5	<0.2	Well water, for domestic uses.
"	"	"	KTG/W/18.11/22		<3	21.5	<0.2	Upstream side of Mtsi River
Mwanza	Musoma	Mara	MARA/19/11/1		3	9	4.15	Entry point to Lake Victoria R. Mara.
"	Geita	Mawemercu	MMR/5/11/8		5	<5	0.38	Well water
"	"	"	MMR/5/11/9		4	<5	<0.2	Process water
"	Musoma	Majimoto	MJT/16/11/3		4	<5	<0.2	Well water.
"	"	"	MJT/16/11/4		5	-	<0.2	Well water, upstream
"	"	"	MJT/16/11/5		5	-	0.75	Process water
"	Geita	Nyakagwe	NYK/4/11/6		3	-	<0.2	Domestic water.
Mpanda	Mpanda	Chemchem	CHM/W/17.11/16		6	86	<0.2	Collected at a pond where amalgamation is performed.
Mwanza	Musoma	Simba sirori	SSB/16/11/4		7	6	<0.2	Domestic water
"	"	Ikungu	IKN/15/11/10		8	8.5	1.9	Domestic water
"	"	"	IKN/15/11/11		5	2	0.2	Process water

\* Samples were resent for another laboratory to cross - check the results.

1. Process water contains high concentrates than river/well water.

**RESULTS OF HEAVY METALS ANALYSES IN SOILS/TAILINGS**

Appendix 4H

ZONE	DISTRICT	LOCATION	SAMPLE NUMBER	RESULTS				REMARKS
				Hg (ppm)	Cd (ppm)	Pb (ppm)	As (ppm)	
Shinyanga	Igunga	Matinje	MT/25/11/9	0.8	0.10	19.25	40	Tailing
"	Nzega	Isunga	ISN/29/11/4	1.9	0.05	0.60	88	Tailing
"	"	"	ISN/29/11/5	*	0.25	87.75	97	Soil
Singida	Iramba	Sekenke	SKN/30/11/4	0.9	*	*	241	Tailing
"	"	Lusu	LSU/28/11/5	1.5	*	*	837	Tailing
"	"	"	LSU/28/11/4	1.3	0.40	5.95	990	Tailing
"	"	"	LSU/28/11/6	7.8	0.05	26.10	40	Soil
Singida	Iramba	Sekenke	SKN/30/11/4	0.9	*	*	241	Tailing
"	"	"	SKN/30/11/9**	-	-	-	-	Tailing
Shinyanga	Shinyanga	Itilima	IT/24/11/11 *	*	*	*	*	Tailing
"	"	"	IT/24/11/3	1.1	<0.04	1.80		Soil
Mwanza	Musoma	Sirori simba	SSB/11/11/3	4.2	*	*	49	Tailing
"	Musoma	Sirori simba	SSB/16/11/2	1.9	0.30	23.20		Soil
"	Tarime	Nyangoto	NYG/18/11/3	7.5	0.05	118.45	220	1st Tailing
"	Tarime	Nyangoto	NYG/18/11/5	0.7	0.15	8.20	46	Soil
"	Geita	Nyakagwe	NYK/4/11/4*	*	*	*	28	Tailing
"	Biharamulo	Imweru	MWR/9/11/1	0.9	<0.04	26.20		Ore
"	Biharamulo	Imweru	MWR/9/11.3	*	0.05	26.35	35	2nd Tailing
"	Biharamulo	Imweru	MWR/9/11/5	27.9	<0.04	9.60		Soil
"	Serengeti	Kimalambo	KMB/17/11/3 **	-	-	-	31	Tailing
"	Serengeti	Kimarambo	KMB/17/11/5	12.9	0.45	60.45		Soil
"	Serengeti	Kimarambo	KMB/17/11/4	101.1	0.30	50.35	729	Soil
"	Geita	Mwalolela	MWL/8/11/3	1.9	<0.04	<0.20	44	Tailing
"	"	Mwalolela	MWL/8/11/6	*	0.10	4.65		Tailing
"	"	Mwalolela	MWL/8/11/4	8.0	<0.04	4.15		Tailing
"	"	Mawemeru	MMR/5/11/3	*	<0.04	3.50	47	Country rock
"	"	Mawemeru	MMR/5/11/4	2.5	<0.04	6.85		Tailing
Mwanza	Geita	Mawemeru	MMR/5/11/5	1.1	0.05	<0.2	1274	Soil

## Appendix 4H

ZONE	DISTRICT	LOCATION	SAMPLE NUMBER	RESULTS				REMARKS
				Hg (ppm)	Cd (ppm)	Pb (ppm)	As (ppm)	
Mwanza	Geita	Buziba	BZB/7/11/4	11.6	0.05	4.60	108	Tailing
"	Geita	Busolwa	BSL/6/11/2	0.9	<0.04	<0.2	29	Marginal Ore
"	Geita	Busolwa	BSL/6/11/3	1.2	0.05	<0.02	32	Tailing
Mwanza	Geita	Busolwa	BSL/6/11/4	4.5	<0.04	*	40	Tailing
"	Musoma	Ikungu	IKN/15/11/4	1.8	<0.04	6.85	139	Tailing
"	Musoma	Ikungu	IKN/15/11/8*	*	*	*	15	Tailing
Shinyanga	Kahama	Katente	KTN/3/11/3	7.5	*	*	45	Ore
"	"	"	KTN/3/11/6	0.7	0.10	3.10	25	Tailing
"	"	"	KTN/3/11/5	2.5	0.05	3.65	40	Soil
Mwanza	Geita	Mgusu	MGS/10/11/6	*	*	*	23	1st Tailing
"	"	Mgusu	MGS/10/11/8	1.7	<0.04	4.95	71	3rd Tailing
"	"	"	MGS/10/11/3	127.9	0.05	<0.2	234	Tailing
"	Geita	Mgusu	MGS/10/11/4	6.8	<0.04	8.95	249	Tailing
"	Geita	Mgusu	MGS/10/11/5	1.9	<0.04	7.95		Soil
"	"	Mgusu	MGS/10/11/7	2.7	<0.04	4.05	26	Soil
"	Tarime	Nyangoto	NYG/18/11/4	0.3	0.05	16.10	43	Tailing
Singida	Dodoma	Nzuguni	Nzuguni	0.3	*	*		Ore
"	"	"	NZ/M/2	0.4	<0.04	7.10	31	Country rock
"	"	"	NZ/2nd	19.10	*	*	13	Tailing
"	"	"	NZ/1st	80.90	0.05	10.55	26	Tailing
"	"	"	NZ/V/3	2.4	<0.04	<0.20	39	Soil
"	"	"	NZ/K/1	1.4	*	*	24	Soil
Mbeya	Chunya	Magembe	MG/S/29.11/7	0.3	0.05	11.40	25	Soil
"	"	Twiga	TWG/S/27.11/6	2.1	0.05	4.05	40	Soil
"	Mbinga	Mpepo	DMP/S/11.11/2	0.10	0.05	24.40	21	Soil
Mpanda	Mpanda	Katsunga	KTG/S/18.11/4	1.20	0.05	8.55	20	Soil
"	"	"	KTG/SD/18.11/6	9.4	<0.04	381.0	<2	Soil
"	"	"	KTG/SD/18.11/7	*	*	*	42	Soil
"	"	Ntumba	NTB/SD/19.11/9	0.5	<0.04	78.90	29	Soil
"	"	Ibindi	IBN/S/SD/17.11/4	4.8	0.25	368.0	22	Soil
"	"	Chemchem	CHM/SD/17.11/02	*	2.05	7110.0	15	Soil

\* Samples were resent to cross - check the results

PHYSICAL PARAMETERS OF WATER

Appendix 4I

ZONE	DISTRICT	LOCATION	SOURCE OF WATER	PHYSICAL DATA				
				Conductivity µS	Dissolved Oxygen ppm	Temp °C	pH	TDS ppm
Mwanza	Tarime 1.	Nyabigena	River	400	4	26		200
"	"		Mine	1,300	4	23		700
"	"		Process	1,000	4	28		600
"	"	2. Msamba (Nyabirama)	Open pit	800	7	25		500
"	"		Underground	700	3	23		400
"	Musoma	3. Ikungu	Lake Victoria (washing point)	900	5	23		115
"	"		Intake water (100m)	300	5	22		60
"	"	4. Maji Moto	Stream	250	4	22		200
"	"		Process	1,400	4	28		900
"	"	5. Sirori Simba	Stream	500	4	26		400
"	"		Process	1,400	4	28		900
"	"	6. Ling'wani	Process	1,200	4	25		1,000
"	Geita 7.	Rwamagaza	Mine	500	3	20	4.5	200
"	"	8. Busolwa	Mine	6,000	4.4	17	2	900
"	"		Stream	200	5.5	22	5	200
"	"	9. Nyaruguru	Mine	3,000	4	19	3.5	300
"	"		Stream	800	4	21	6.5	300
"	"	10. Mgusu	Process	1,400	2.7	25	4.5	900
"	"		Stream	100	5.1	21	6	100
"	"		(up stream)					
"	"		Down stream	300	3.3	22	6	400

## Appendix 4I

ZONE	DISTRICT	LOCATION	SOURCE OF WATER	PHYSICAL DATA				
				Conductivity μS	Dissolved Oxygen ppm	Temp °C	pH	TDS ppm
Shinyanga	Kahama	11. Nyakagwe	River	160	5.5	24	6	200
			Process	800	3	22	5	700
			Mine	400	4	21	4	600
"	"	12. Nyangh'wale	Pond	279	2.2	24	7.2	140
"	"		Process	850	3	26	6.5	600
"	"	13. Ushirombo	Pond	115	2.6	28	5.8	58
Shinyanga	Nzega	14. Lusu	Well	350	3.2	21	6.7	200
"	"	15. Isungangwanda	Well	200	3	20	6.2	200
Singida	Iramba	16. Sekenke	Pond	600	3	26.5	8	350
"	"	17. Kibululu	Pond	580	2.8	28	8.5	315
Morogoro	Mahenge	18. Lukande	Stream	400	4	22	7.2	250
"	"	19. Kitonga	Stream	320	3.5	20	6.9	300
"	Morogoro(R)	20. Mwalazi	Stream	380	4	19	6.5	400
"	"	21. Ng'ong'olo	Stream	220	5	17	7.4	200

pH values in mine sulphides areas were low.

Physical data of rivers/streams water were at acceptable levels.

**Appendices 5: COMMERCIAL ASPECT**

- A - Production capacities of solar saltworks visited
- B - Mineral production 1989 - 1995
- C - Mineral export 1989 - 1995
- D - Gold purchases and its price
- E - Mineral market channels
- F - Sales in gemshows 1992/1996
- G - Problems faced by claim holders
- H - The condition arrangement for the loans
- I - Incentive given to mine workers
- J - Type of work co-operation preferred by claim holders

## Appendix 5 A PRODUCTION CAPACITIES OF SOLAR SALTWORKS VISITED

<u>REGION</u>	<u>DISTRICT</u>	<u>SALTWORKS/ LOCATION</u>	<u>NO. OF CONDENSERS.</u>	<u>NO. OF CRYSTALLISERS</u>	<u>PRODUCTION (TONNES/YEAR)</u>
Dar es Salaam	Kinondoni	Ras Kilomoni	5 (150m x 50m)	7 (200m x 100 m)	1500
Dar es Salaam	Kinondoni	Mtongani	32	15	1920
Tanga	Pangani	Sangc	2	25	20
Tanga	Pangani	Mwakaja	-	2	6
Mtwara	Mtwara	Mtwadeco	14	32	100
Mtwara	Mtwara	Sinde	2	42	150
Mtwara	Mtwara	Mtawanya	16	4	200 - 400
Mtwara	Mtwara	Damoder/Mikindani	2	10	100 - 125
Mtwara	Mtwara	Chilongo	9	3	200
Mtwara	Mtwara	Makonde	17	6	330
Mtwara	Mtwara	Yakubu Ali	4	3	50
Lindi	Kilwa	Abdala Poa/Mpara	2	8	25
Lindi	Kilwa	Ally Timani/K. Masoko	6(200ftx200ft)	20	175
				200ft x 100ft (6)	
				150ft x 100ft (4)	
				100ft x 50ft (4)	
				100ft x 100ft (6)	
Lindi	Kilwa	Shutro Trading/Mpara	4	16	50
Lindi	Kilwa	Saidi Abdalla/K. Masoko	4	6	20
Lindi	Kilwa	Mandawa	3 (120ft x 120ft)	36 (60ft x 60ft)	20
<b>TOTAL</b>					<b>4866 - 5091</b>

### SUMMARY:

1. Dar es Salaam Region	-	3,420	Tonnes
2. Tanga Region	-	26	Tonnes
3. Mtwara Region	-	1130 - 1355	Tonnes
4. Lindi Region	-	290	Tonnes
<b>TOTAL</b>		<b>4866 - 5091</b>	<b>Tonnes</b>

**MINERAL PRODUCTION 1989 - 1995**

**Appendix 5B**

MINERAL	UNIT	1989	1990	1991	1992	1993	1994	1995
Diamonds	Carats	75885	84598	99762	67304	40847	17177	49538
Gold	Kg	112	1643	3779	4525	3370	2861	320
Gemstones	Kg	11389	38700	59625	48938	32979	48507	111404
Salt	Tonnes	20010	39315	64419	77281	83400	84289	6686
Phosphate	Tonnes	8541	25066	2419	4948	2219	nil	1110
Tin ore	Tonnes	15	14	6	8	12	9	2.7
Gypsum	Tonnes	5895	36115	5263	15031	52243	53000	1052
Silica Sand	Tonnes	13101	6365	4263	0	916	607	
Coal	Tonnes	15829	16929	33213	31140	40248	45027	5648
Kaolin	Tonnes	1021	2021	1738	1360	477	541	596
Limestone	Tonnes	0	0	0	0	1617991	1740000	1062081

**Source: Ministry of Energy and Minerals**

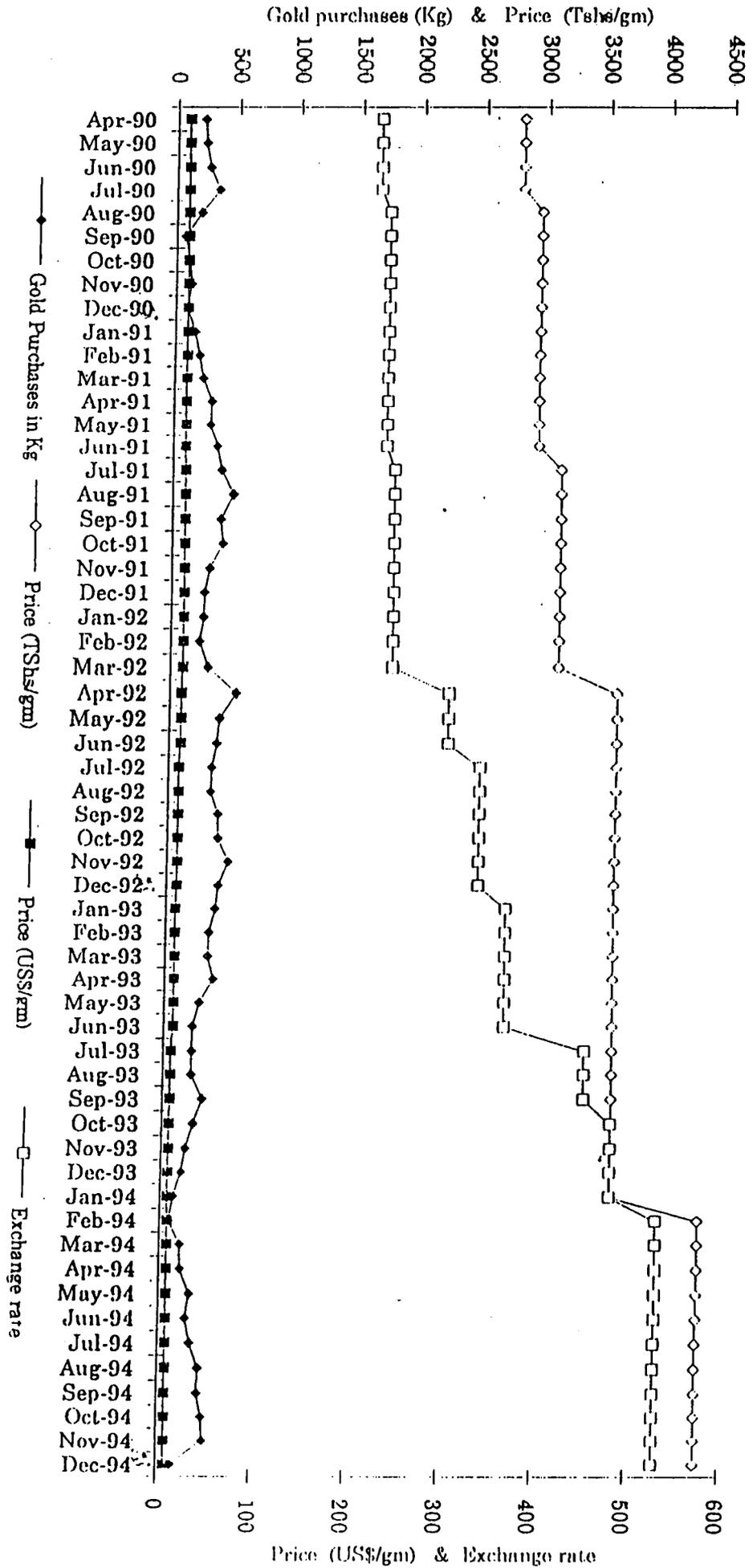
Appendix 5C

MINERAL EXPORT 1989 - 1995

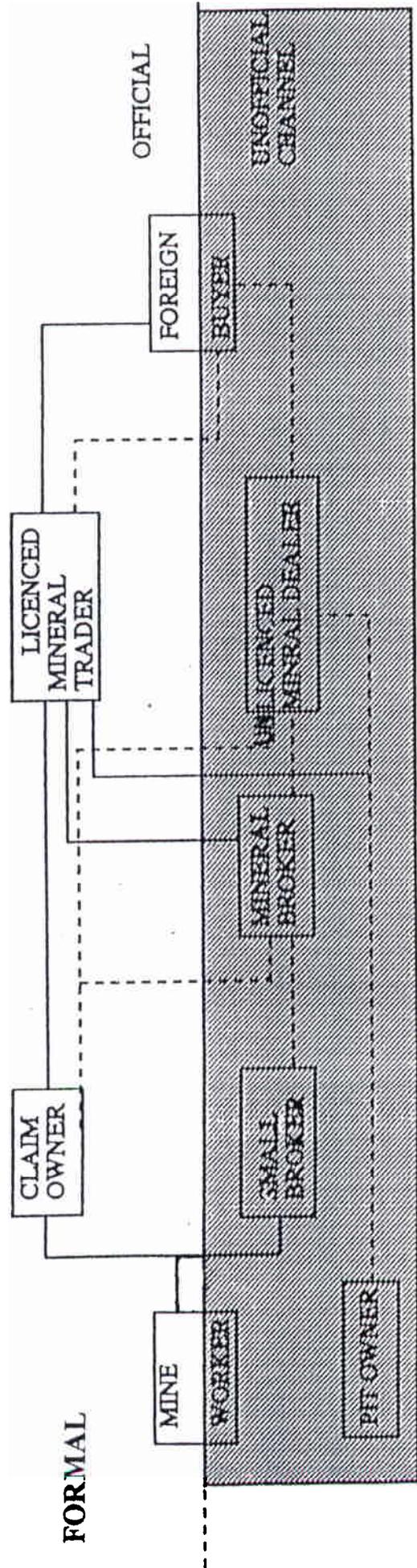
Mineral	Unit	1989		1990		1991		1992		1993		1994		1995	
		Quantity	Value (US\$)	Quantity	Value (US\$)	Quantity	Value(US\$)	Quantity	Value(US\$)	Quantity	Value(US\$)	Quantity	Value (US\$)	Quantity	Value (US\$)
Diamonds	Carats		9,752,721	75,979	7,393,459	90892	10,030,157	70,706	8,300,500	39885	5,265,188	22,567	2,898,383	44,491,98	4,341,31.3
Diamond (Cut)	Carats	10,276	4,461,747	7,947	2,648,223	3,214	1,303,252	-				87	6,023	-	-
Diamonds (Contract goods)	Carats	-	-			648,139	610,943	8,918	107,007	73,674	126,084	1,703	115,302	-	-
Gold	Kg	111,707	1,152,057	1,643	13,635,060	3,779,048	29,099,700	4,525	40,380,000	3,364	31,450,800	2,803	25,679,000	320	3,268,800
Gemstones	Kg	24,621	784,063	32,292	1,584,873	59,625	1,759,192	26,678	3,236,700	32,979	3,914,763	48,507	6,464,846	94,296	7,279,929
Salt	Tonnes	2,968	506,643	7,081	906,047	9,831	1,484,363	8,590	1,022,513	6,755	607,858	1,596	107,832	-	-
Phosphate	Tonnes	2,529	55,716	3,582	101,031	3,334	1,06,656	3,900	144,300	3,541	109,660	0	0	1149.2	42,060
Tin ore	Tonnes	6	34,013	7	25,118	6	19,179	6	25,773	11	46,250	6	15,816	2.72	3,536
Gypsum	Tonnes	-	-	-	-	-	-	2,320	15,871	3,000	8,942	400	2,826	500	7,500
TOTAL (in million US\$)			16.75		26.29		44.40		53.23		41.53		35.29		14.94

Source: Ministry of Energy and Minerals

# Appendix 5 D Gold purchases and its Price



# Appendix 5E MARKET CHANNELS



SALES IN GEMSHOWS - 1992/1996

NO. Of Shows	Unit	1	2nd	3rd	4th	5th	6th
		1992	1992	1993	1994	1995	1996
Sales US \$	US \$	163,142	240,947	329,938	560,000	846,000	531,000
Cut and Rough- Stones	gms	472,742.9	206,597.25	264,551	895,000	250,000	150,000
Royalty (in millions)	Tshs	-	2.81	5.8	29	90	200
Participants Local	No.	39	29	37	32	46	32
Foreign	No.	24	29	53	-	52	50

Source: Ministry of Energy and Minerals; TAMIDA

**PROBLEMS FACED BY CLAIM HOLDERS:  
CONSTRAINTS HINDERING MINING ACTIVITIES**

**Appendix 5G**

	COMMODITY	GOLD				GEMSTONE			
		MWANZA		SHINYANGA		MOROGORO		ARUSHA	
		Total	%	Total	%	Total	%	Total	%
	CONTRAINTS HINDERING								
	MINING								
1	Operation funds	43	21	11	21	21	25	38	17
2	Capital investment -equipment	37	19	13	25	24	28	39	18
3	Lack of technical services	27	14	11	21	3	3	20	9
4	Poor marketing system	20	10	7	13	-	-	-	-
5	Epidemic outbreaks	7	4	4	8	16	19	22	10
6	Poor infrastructures	4	2	4	8			25	11
7	Breakdown of law and order			3	4	4	5	27	12
8	Use of old technology/Methods	23	12			8	9	9	4
9	Unskilled labour	17	9			5	6	28	13
10	Dewatering	17	9			4	5	7	6
	<b>TOTAL</b>	<b>195</b>	<b>100</b>	<b>53</b>	<b>100</b>	<b>85</b>	<b>100</b>	<b>215</b>	<b>100</b>

In most mining areas visited it was observed:-

- (a) Lack of insufficient investment capital and operation funds are the major constraints facing both gold and gemstone mining operators (above 17%).
- (b) Epidemic outbreaks have less impact in mining activities in established mining villages (Mwanza and Shinyanga less than 9%) but they have higher impact in gemstone alluvial workings (Morogoro with 19%).
- (c) Poor marketing system is not a major problem to gemstone claim holders but affects performance of most small producer gold claim holders. Bank of Tanzania gold buying operations reduced their income margins as their mine workers demand bank rates.
- (d) Most gold miners acknowledge the importance of professional experts especially in underground mining but gemstone miners don't easily appreciate the importance of technical services (only 3% in Morogoro and 9% in Arusha). This is because there are no modal successful mines discovered or operated by professionals.

# THE CONDITION/ARRANGEMENTS FOR THE LOANS

Appendix 5H

COMMODITY	GOLD				GEMSTONES				SALT		SAND		GYPSUM		DIAMOND	
	MINE ZONE		MBEYA		SHENYANGA		MOROGORO		ARUSHA		ARUSHA		ARUSHA		MWANZA	
When securing credit what are the condition /arrangements for the loans	Total	%	Total	%	Total	%										
1. Put assets as collateral	2	8	-	-	-	-	-	-	2	16	3	3	-	-	-	-
2. Third party collateral arrangements	8	30	11	34	4	15	2	4	3	25	2	20	-	-	-	-
3. Production sharing agreements	4	15	8	25	2	9	8	4	2	17	1	10	-	30	3	50
4. Production exclusive buying purchase rights	2	8	2	7	12	46	-	-	-	-	-	-	-	-	3	50
5. Personal guarantee and interest rate payment	4	15	4	12	4	15	12	21	2	17	4	10	5	1	-	-
6. Mortgage claim title/Colateral					-	-	-	-	-	-	-	-	-	-	-	-
7. Dont Seek loans	6	23	7	22	4	15	34	61	3	25	3	30	-	40	-	-
<b>TOTAL NUMBER INTERVIEWS</b>	<b>26</b>	<b>100</b>	<b>32</b>	<b>100</b>	<b>26</b>	<b>100</b>	<b>56</b>	<b>100</b>	<b>12</b>	<b>100</b>	<b>10</b>	<b>100</b>	<b>5</b>	<b>100</b>	<b>6</b>	<b>100</b>

- (a) More than 20% of all claim holders don't seek any kind of loan as they are not sure when they will be in a position to payback as present production is uncertain.
- (b) Third party collateral arrangement is the most favored system of lending where the informal creditors are guaranteed by credit worth claim holder partners.
- (c) Mortgage of claim titles as collateral is not accepted by many creditors. At present creditors don't have any legal rights and the claim title life is only 12 months.

## INCENTIVES GIVEN TO MINE WORKERS

Appendix 5I

COMMODITY ZONE	GOLD								GEMSTONES			
	MWANZA		SHINYANGA		MBEYA		SINGIDA		MOROGORO		ARUSHA	
	Total	%	Total	%	Total	%	Total	%	Total	%	Total	%
Incentives offered to mine workers												
a) Medical bills	14	30	3	18	9	31	1	17	19	30	34	21
b) Credits	11	23	2	12	10	34	-	-	14	22	34	21
c) Free shelter	4	9	2	12	4	14	-	-	15	24	34	21
d) Supply water	2	4	-	-	-	-	-	-	1	2	23	15
e) Compansate food Cost	9	19	5	28	1	4	5	83	9	14	27	17
f) Allow them processing tailings on weekends.	5	11	2	12	2	7	-	-	-	-	3	2
g) Better working tools and uniforms.	1	2	3	18	-	-	-	-	-	-	2	1
h) Free allowance	1	2	-	-	3	10	-	-	5	8	3	2
<b>TOTAL</b>	<b>47</b>	<b>100</b>	<b>17</b>	<b>100</b>	<b>29</b>	<b>100</b>	<b>6</b>	<b>100</b>	<b>6.3</b>	<b>100</b>	<b>160</b>	<b>100</b>

COMMODITY ZONE	DIAMONDS				LIME		AGGREGATES		SALT WORKS		GYPSUM	
	SHINYANGA		MWANZA		ARUSHA		ARUSHA		ARUSHA		ARUSHA	
	Total	%	Total	%	Total	%	Total	%	Total	%	Total	%
Incentives offered to mine workers												
a) Medical bills	4	58	4	58	-	-	1	25	2	29	5	50
b) Credits	2	29	2	29	1	50	1	25	3	42	5	50
c) Free shelter	-	-	-	-	-	-	-	-	-	-	-	-
d) Supply water	-	-	-	-	-	-	-	-	-	-	-	-
e) Compansate food Cost	1	13	-	-	1	50	1	25	2	29	-	-
f) Allow them processing tailings on weekends.	-	-	-	-	-	-	-	-	-	-	-	-
g) Better working tools and uniforms.	-	-	-	-	-	-	1	25	-	-	-	-
h) Free allowance	-	-	1	13	-	-	-	-	-	-	-	-
<b>TOTAL</b>	<b>7</b>	<b>100</b>	<b>7</b>	<b>100</b>	<b>2</b>	<b>100</b>	<b>4</b>	<b>100</b>	<b>7</b>	<b>100</b>	<b>10</b>	<b>100</b>

## **Incentives offered to mine workers.**

Claim Holders and pit financiers normally don't pay salaries to mine workers but they extend various incentives which are aimed mainly to retain miners to work in their pits.

- (a) The most favoured incentives include compensation in food cost, support in medical treatment and credit support "posho"
- (b) The incentives vary from one place to another, and also depends on the type of mining activity and season of the year. The claim holders in Singida offered more food support to their workers (83% of the incentive) during the November/December months due to food shortages in the mining areas by them.
- (c) Most mine workers accept these incentives as the simplest way to survive in mining areas while hoping to produce minerals. Miners will leave the group/claim if there is no production for a long time while the nearby pits are producing. In this situation claim holders offer more incentives (see incentives at Morogoro and Arusha mining zone).
- (d) In non precious mineral works there are less incentives offers. Medical and credit support are the major incentives in lime, aggregates and salt works. In rich producing areas miners beg to be accepted in mining groups, hence claim holders give less incentives. Diamond alluvial works claim holders support immedegency medical costs and offer cash credit to miners. This is the same tendency in gemstones producing pits in Tunduru, Mahenge and Kalalani - Tanga.

# TYPE OF WORK COOPERATION PREFERRED BY CLAIM HOLDERS

Appendix 5/J

COMMODITY	GOLD						GEMSTONES				LIME		SAND	
	ZONE		MWANZA		SHINYANGA		SINGIDA		MOROGORO		ARUSHA		ARUSHA	
	Total	%	Total	%	Total	%								
Prefered size of Cooperation group														
1. Big size group	4	20	16	62	3	33	-	-	4	11	-	-	-	-
2. Small size group	16	80	10	38	6	67	22	100	32	89	5	100	8	100
3. Total NO.														
<b>TOTAL</b>	<b>20</b>	<b>100</b>	<b>26</b>	<b>100</b>	<b>9</b>	<b>100</b>	<b>22</b>	<b>100</b>	<b>36</b>	<b>100</b>	<b>5</b>	<b>100</b>	<b>8</b>	<b>100</b>
A small cooperative society group is prefered:														
1. To eliminate parasite Management members	6	32	2	20	4	50	4	19	1	2	2	50	2	25
2. To ensure mutual trust among members	7	36	4	40	4	50	8	36	22	51	-	-	2	25
3. Only committed members with same objective are invited to join	6	32	4	40	-	-	10	45	20	47	2	50	4	50
<b>TOTAL</b>	<b>19</b>	<b>100</b>	<b>10</b>	<b>100</b>	<b>8</b>	<b>100</b>	<b>22</b>	<b>100</b>	<b>43</b>	<b>100</b>	<b>4</b>	<b>100</b>	<b>8</b>	<b>100</b>
Big Cooperative Society has advantage of:														
1. It will be strong from members contribution	4	50	6	42	1	17	-	-	4	67	-	-	-	-
2. Better division of Labour	2	25	4	29	2	33	-	-	-	-	-	-	-	-
3. Minimum risk to individual members.	2	25	4	29	3	50	-	-	2	33	-	-	-	-
<b>TOTAL</b>	<b>8</b>	<b>100</b>	<b>14</b>	<b>100</b>	<b>6</b>	<b>100</b>	<b>-</b>	<b>-</b>	<b>6</b>	<b>100</b>	<b>-</b>	<b>-</b>	<b>-</b>	<b>-</b>
How will you choose your members/partner to form a Cooperative group?														
1. Same Commitments and Objectives	16	62	12	67	10	67	18	43	24	60	5	62	8	80
2. Family ties	-	-	-	-	-	-	6	14	8	20	-	-	-	-
3. friendship	5	19	-	-	-	-	6	14	2	5	-	-	-	-
4. Village mate relationship	-	-	-	-	-	-	-	-	-	-	-	-	-	-
5. Serious and resourceful partner	5	19	6	33	5	33	12	29	6	15	3	38	2	20
NO. of claim holders interviewed.														
<b>TOTAL</b>	<b>26</b>	<b>100</b>	<b>18</b>	<b>100</b>	<b>15</b>	<b>100</b>	<b>42</b>	<b>100</b>	<b>40</b>	<b>100</b>	<b>8</b>	<b>100</b>	<b>10</b>	<b>100</b>

**TANZANIA**  
**Terms of Reference**  
**For**  
**Baseline Survey & Development Strategy**

1. **Background:** The Mineral Resources Department (MRD) of the Ministry of Water, Energy and Minerals (MWEM) has established an Artisanal and Small-Scale Mining Development Office (SSMO) for the implementation of the Artisanal and Small Scale Mining Development Program aimed at promoting the continued envelopment of the sub-sector on a sustainable basis. The objective of the program are to (i) further legalize the informal segment of the sub-sector and to progressively transform artisanal operations health and safety standards and to eliminate undesirable environmental practices in all high-density artisanal and small-scale mining district, (iii) establish a reliable and competitive channel of supply of appropriate mining and processing equipment in the country, (iv) enhance productivity and mineral recovery through the introduction of appropriate mining and processing equipment combined with basic technical and business training, and (v) transform Regional Miners Associations into efficient and sustainable self-help organizations and training centers.

2. The principal initial step for the implementation of the Artisanal and Small-Scale Mining Development Program will be a baseline survey. The purpose of this baseline survey is to provide reliable quantitative information on the current position and performance of the artisanal and small-scale mining activities in Tanzania. The survey will thus have to encompass relevant economic, social, organizational, technical, marketing, environmental, health and safety as well as institutional aspects, as outlined below. This will be followed by the detailed design of promotional initiatives and support programs in the form of a sub-sector development strategy and related action, based on the results of the baseline survey.

3. **Consultant's Tasks:** In this context, consulting services are required to support the SSMD in the implementation of the Artisanal and small-Scale Mining Development Program. More specifically, the consultant will be required to undertake the following:

**a. Sub-sector Census**

- (i) Estimate the number of persons involved in informal, artisanal and formal small-scale mining by locations/district/zones and mineral commodity groups (notably gold, diamonds and colored gemstones);
- (ii) determine the approximate number and role of women directly and indirectly active in the sub-sector;
- (iii) provide estimates of production quantities and values by locations/districts/zones and commodity groups;
- (iv) establish average income of participants at different organizational levels (workers, pit owners/pit contractors, claim-holders) by district/zone and commodity group.

**b. Organizational Structure**

- (i) Provide an estimate approximate number and type of operational organizations (informal tributing system, cooperative, formal enterprise) active in the sub-sector by locations/district/zones;
- (ii) determine the average number of members/workers by types of organization;
- (iii) record the number, location and membership of regional and national miners associations;
- (iv) investigate and describe the functions, activities and resources of regional and

national miners associations.

### **C. Mining and Processing**

- (i) Determine the average labor productivity of artisanal mining operations in ore extraction and processing in terms of kilograms of ore mined and milled per person-day;
- (ii) examine typical valuable mineral recovery rates/losses of artisanal operations through spot sampling and sample analysis;
- (iii) establish average grade of ore processed and of waste material discarded based on spot sampling and sample analysis;
- (iv) investigate typical education level of workers, pit sub-contractors/pit owners and claim/holder/entrepreneurs.

### **d. Product Marketing**

- (i) Establish and comment on time series of sales of gold, diamonds and colored gemstones through official outlets;
- (ii) relate 5-year time series data of official gold sales to world market gold price development to test price elasticity of official artisanal gold supply;
- (iii) provide estimates of current share of parallel market by district/zone and commodity group;
- (iv) estimate number of participants in parallel market system on buying side by district/zone and commodity sub-group.

**e. Environmental Impact**

- (i) Provide best estimate of land areas affected by past and current artisanal and small-scale mining activities, by district/zone;
- (ii) carry out initial assessment of damage caused including destruction of vegetation, land degradation and related effects on water, fauna and habitat;
- (iii) establish estimate of quantity of toxic substance released to the environment annually;
- (iv) provide preliminary quantification of costs associated with damage repair and land rehabilitation.

**f. Health and Safety**

- (i) Review and comment on 3-year time series of reported mine accidents, injuries and fatalities by district/zone;
- (ii) provide estimate of non-reported mining-related accidents and injuries in this period;
- (iii) conduct preliminary assessment of the effects of the use of mercury on the health of miners through random sampling and mercury level detection;
- (iv) assess the availability of safe drinking water and sanitation facilities in mining communities by location/district/zone;
- (v) provide a preliminary assessment of the incidence of AIDS in mining communities.

### **g. Institutional Aspects**

- (i) Survey and comment on 5-year time series of mining claims issued by district/zone;
- (ii) provide estimate of average time required for claim registration by district/zone;
- (iii) determine current backlog of pending mining title application per zone;
- (iv) determine current number and validity of mining titles (small claims and large licenses);
- (v) determine average number of inspection visits carried out by officers/technicians per year by district/zone;
- (vi) provide estimate of formal and informal mine production per member of district/zonal office.

### **h. Development Strategy**

Based on the quantitative results of the baseline survey, including tasks (a) through (g) above:-

- (i) identify options suitable to improve social, technical, economic and environmental performance of small-scale mining and to encourage the process transformation of informal artisanal mining into formal mining operations;
- (ii) combine options identified to specific development strategies for different commodity sub-groups (gold, diamonds, colored gemstones);

# MINING AREAS VISITED DURING THE BASELINE SURVEY

Appendix 7

PERIOD	LOCALITY	DISTRICT	MINERAL SORT
October, 1995	1. Nzuguni	Dodoma Urban	Gold
November, 1995	2. Nyangh'walc	Kahama	Diamonds
	3. Ushiroambo (Katentc)	"	Gold
	4. Mapinduzi (Muhuwesi)	Tunduru	Gemstones
	5. Dar - Muhuwesi (Mabox)	"	Gemstones
	6. Dar - Majimaji	"	Gemstones
	7. NO. 9 - Majimaji	"	Gemstones
	8. Dar - Ngapa	"	Gemstones
	9. Lukandc - Ngapa	"	Gemstones
	10. Zanzibar- Ngapa	"	Gemstones
	11. Msinji NO. 8	"	Gemstones
	12. Msinji NO. 6	"	Gemstones
	13. Nyakagwe	Kahama	Gold
	14. Mawe Meru	Geita	Gold
	15. Busolwa	"	Gold
	16. Rukarakata	"	Gold
	17. Buziba	"	Gold
	18. Rwamagaza (Mwalolela)	"	Gold
	19. Mgusu	"	Gold'
	20. Imweru	Biharamulo	Gold
	21. Dar- Lunyale (Mpepo)	Mbinga	Gold
	22. Mpepo	"	Gold
	23. Mkako	"	Gemstones
	24. Lindi Masunguru	"	Gemstones
	25. Ikungu	Musoma	Gold
	26. Maji moto	"	Gold
	27. Simba Sirori	"	Gold
	28. Ling'wani (Kimalando)	Serengeti	Gold
	29. Nyabirama/Nyangoto	Tarime	Gold
	30. Kerende (Mara Mine)	"	Gold
	31. Magula	Mpanda	Gold
	32. Chemchem	"	Gold
	33. Ibindi South	"	Gold
	34. Katisunga	"	Gold
	35. D - Reef	"	Gold
	36. Ntumba	"	Gold
	37. Kasakalawe	"	Gold
	38. Mpanda	Sumbawanga	Gemstones
	39. Namwele	"	Coals
	40. Mabuki	Kwimba	Diamonds
	41. Itilima	Shinyanga	Gold
	42. Matinje No. 6	Igunga	Gold
	43. Sengambi	Chunya	Gold
	44. Twiga Mines	"	Gold
	45. Itumba Mines	"	Gold
	46. Manyanga	"	Gold
	47. Jeshini Itumbi	"	Gold
	48. Itumbi	"	Gold
	49. Kuwait	"	Gold
	50. Magembe	"	Gold
	51. Rift Valley	"	Gold
	52. Mwaluzwila (Lusu)	Nzegu	Gold
	53. Isungangwanda (Nzegu Ndogo)	"	Gold
	54. Sekenke	Iramba	Gold

# MINING AREAS VISITED DURING THE BASELINE SURVEY

## Appendix 7

December, 1995	55. Kibululu	"	Salt
	56. Mafene (Songambale)	Mpwapwa	Gemstones
	57. Lukande	Mahenge	Gemstones
	58. Kitonga	"	Gemstones
	59. Mwalazi	Morogoro Rural	Gemstones
	60. Ng'ong'olo	"	Gemstones
	61. Mtongani Saltworks	Kinondoni	Salt
	62. Kunduchi Quarries	"	Aggregate
	63. Boko Mageraze	"	Dimension Stones
	64. Bunju a Quarry	"	Aggregate
January, 1996	65. Ras Kilomoni Saltworks	"	Salt
	66. Mirongo minne	Arumeru	Sand
	67. Les Mundarara (Longido)	Monduli	Gemstones
	68. Merelani	Simanjiro	Gemstones
	69. Msitu wa Tembo	"	Sand
	70. Landaban	"	Gemstones
	71. Tiriri	"	Gemstones
	72. Lemshuku	"	Gemstones
	73. Kaangala	"	Gemstones
	74. Uchira	Moshi Urban	Dimension Stones
February, 1996	75. Kisangiro	Mwanga	Sand
	76. Chankonko (Makanya)	Same	Gypsum
	77. Sange	Pangani	Salt
	78. Mnyanjani Saltwork	Tanga Urban	Salt
	79. Kiomoni Limeworks	"	Lime
	80. Kiomoni Quarry (C.I.C)	"	Aggregate
	81. Ng'ombeni	Muheza	Gemstones
	82. Mwakijembe (Migomani)	"	Gemstones
	83. Mwakijembe (Mimbeni)	"	Gemstones
	84. Kipingoni (Kalalani)	Korogwe	Gemstones
April, 1996	85. Kigwasi (Umba)	"	Gemstones
	86. Sezakoffi	Handeni	Gemstones
	87. Kwedirima (Kwamkonje)	"	Gemstones
	88. Kitunda Quarry	Ilala	Sand
	89. Mwakanga Quarry	"	Sand
	90. Dovya (Chamazi) Quarry	Temcke	Sand
	91. Saidi Abdalla (Kilwa Masoko)	Kilwa	Salt
	92. Ally Timani (Kilwa Masoko)	"	Salt
	93. Abdalla Poa (Mpara)	"	Salt
	94. Shutro (Mpara)	"	Salt
95. Said Nalinga (Mandawa)	"	Salt	
96. Damoder Saltworks(Mikindani)	Mtwara	Salt	
97. Chilongo Saltworks	"	Salt	
98. Makonde Saltworks	"	Salt	
99. Yakubu Ali Saltworks	"	Salt	
100. Mtwadeco Saltworks	"	Salt	
101. Sinda Saltworks	"	Salt	
102. Mtawanya Saltworks(Kirumbi)	"	Salt	
103. Muyaga's claim (kitowero)	Liwale	Gemstones	
104. Lufulenge's claim (Kitowero)	"	Gemstones	
105. Mwinjamingu's claim (Kitowero)	"	Gemstones	