TECHNO ECONOMIC FEASIBILITY REPORT ON MINING AND PROCESSING OF QUARTZITE AND FELDSPAR IN MKALANGA, MTONDO, RUANGWA, TANZANIA

Prepared for

Classic Mining Company Limited

By

Ameta Mineral Exploration and Geotechnical Services (AMEGTS)

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PROJECT AT A GLANCE

Promoters	Classic Mining Company Ltd. has businesses focused on Mining and Exploration for Industrial Minerals in Tanzania.	
Project	Ore mining and processing plant to process 160 TPD (12K tons of Ore) quartzite which shall produce 39,000 TPA of finished quartzite lumps, 2500 TPA of Quartzite blocks & 6000 TPA finished feldspar lumps in the initial years. In the later phases, CMCL intends to scale up the production based on the market demand.	
Plant location	The locating co-ordinates of the proposed plant are: • Latitude : 39°02'14"E • Longitude : 09°50'12"S The considered mine and plant site is around 170 Km West of Lindi, around 260 Km North West of Mtwara and around 400 Km South of Dar es Salam. Location is near Mkalanga, Mtondo village.	
Markets	India, UAE, China, South Korea, etc.	
Water requirement	400 m^3/day and which shall be met through tube wells around Plant Periphery.	
Envisaged raw material cost	Main Raw Material shall be Quartzite Ore and its recurring cost to the plant shall be approximately USD $ 4 per ton.	
Maximum power demand & source	Total installed load for initial phase of the projects is approximately 0.5 MW. It shall be met through TANESCO supply with backup of 2 numbers Diesel Generators.	
Suggested manpower	The manpower requirement for plant operation is approximately 40-60 persons in initial years.	
Storages Capacities	**Item**	**Days**
	ROM Quartzite	30
	Crushed Cherty quartzite Ore	2

Project implementation	An implementation period of **6 months** from the date of signing/ effectiveness of the main equipment supply contract is foreseen.

Item	**Amount (In USD)**
	Phase I
Mine and Site Development	350,000
Building & Infrastructure	674,100
Plant for pulverizing quartzite	1,147,000
Miscellaneous Fixed Assets	1,185,200
Electrical Infrastructure	167,600
Pre-Operative Expenses	500,000
Contingencies	352,400
Working Capital Requirement	1,000,000
Total Investment Cost	**5,376,300**

	Item	**Value**
Financial Indicators	Post-Tax IRR on total unlevered investment (%)	***20.11%***
	Post-Tax Net Present Value @ 10.0% (USD Mio)	***15.02***
	Pay Back Period	*6 Years and 6 Months*
Conclusion	**Based on the performance indicators, it is concluded that the project is Financially Viable.**	

EXECUTIVE SUMMARY

Introduction

Ameta Mineral Exploration and Geotechnical Services (AMEGTS) was retained by Classic Mining Company Limited (CMCL), Tanzania to carry out the Feasibility Study of the Quartzite, Quartz vein and Feldspar deposits in PL-12274/2023, PL-12273/2023, PL-12297/2023, PL-12302/2023 and PL-12298/2023, Ruangwa, Lindi Region, Tanzania. The Feasibility Study summarized in this Independent Technical Report resulted from all the data and reports available with the CMCL Company. In March 2025 AMEGTS was contracted to prepare the Feasibility Study with support from experienced and AusIMM members. This technical report has been prepared in compliance with JORC standard for all practical purpose.

The CMCL intends to develop an open pit Quartz vein, Quartzite and Feldspar mining and processing plant in the PL-12274, PL-12273, PL-12297, PL-12302 and PL-12298, Ruangwa property, Lindi Region. The conversion of PL area into ML area is under process with the Government of Tanzania.

This report describes the status of the geological, engineering and economic studies of the Quartzite, vein quartz and feldspar project for the viability of the deposit. The results of all work undertaken to date with respect to the design of the project it is observed that this lump mining and block mining and processing of quartzite and feldspar project is economical viable.

The PL area, is located approximately 135 kilometers west of Lindi and 240 km west of Mtwara. It is accessible by 100 km tarmac road from Lindi town connecting all weather road via Ruangwa township (head quarter of Ruangwa District) and about 35 km seasonal road north east of Ruangwa township. The property is access-able from Dar-es-Salaam by 620 km road, however shorter rout of 400 km is via Kitumbini - Mandawa settlement but this is not passable during the rainy season. The nearest commercial airport and harbour is located at Mtwara. Temperature varies from 10^0 to 40^0 but most of the time temperature remains between 24^0 and 34^0. Average rain fall is around 1000 mm/year.

Geological Setting

Regionally area comprises Neoarchean-Proterozoic metamorphic gneisses and volcano sedimentary rocks and is located in the eastern most tectonic plate of Tanzania. The various lithounits exposed in the PL are Amphibolites, Gneisses, Quartzites, dolomite and pegmatite (containing mineable feldspar) along with Quartz veins, and Aplites. The depth of high weathered zone is up to 10 m where as in gneisses it goes up toto 20 m depth. The main trends of rocks are NNE-SSW to NE-SW dipping due E between 30^0 and 60^0. Three phases of deformations are identified out of which first two generation are coaxial with NNE-SSW axial trend and third is almost perpendicular to first two. Folds of first generation are tightly appressed and rootless whereas second phase folds are overturned type. Folds of third

phase are open and wavering type with wide angle. Faults with WWN-EES and WWS-EEN are recorded around and in the area. Fold geometry is observed in the dolomite.

Mineralization

1. **Mineable Quartz Vein** (QV) occurs mainly in PL 12274 within the gneisses. The milky white quartz veins vary size from 30m Long X 15m width X 20 m vertical depth to 10 m X 5 m X 10 m. There are number of veins in PL 12302, PL 12273 & PL 12274 are mostly with NNE –SSW trend. These veins are easily mineable and can be processed in nearby plant.
2. **Cherty Quartzite** is continuing for about 5 km length and forms about 120 m high ridge from general ground level with NNE-SSW to NE – SW trend. In present PL area this is exposed for 3 km with the highest point of 340 m RL, whereas ground level is at 220 m RL. There are different bands of quartzite with white, light grey, grey and dark grey color. At places it shows banded nature with good looking decorative stone. It is massive in nature, however it is highly fractured at places with medium frequency of joints. Therefore, this can be mined as lumps and blocks using wire saw. PL 12297 & PL 12298 contain huge deposit of silica quartzite.
3. **Feldspar:** All the pegmatite body occurring in both the PL contain pegmatite, however in PL 12302, PL 12273 & PL 12274 it occurs in small pockets, where as in PL 12298 it occurs as 1.5 km long body with about 0.5 km width. In this area huge boulders and fragments of pegmatite are located at various place. In this area feldspar is of whitish grey color, whereas in PL 12273 & PL 12274 mostly feldspar is of pink in colour. This forms a mineable unit with a good deposit.

   The Quartz Veins, cherty quartzite and pegmatite occurs in the gneiss.

Exploration

Detailed exploration carried out in these PL areas includes large scale mapping, pitting, drilling, logging, sampling, determination of assay of samples and processing of data. The details are as follow.

1. At initial stage the area was mapped on 1:20000 scale.
2. Large scale mapping using GPS on 1:5000 and on 1:2000 scale of both PL area after identification of its quality.
3. Collection of Grab samples = 38
4. Chemical Analysis =16 quartzite samples, 9 dolomite samples
5. Pitting is carried out at 4 places almost about 10m X 10m X 3 to 5m. Out of these1 pit was in dolomite and other 3 were in the quartzite.
6. Diamond Core Drilling =157.31 m in 3 boreholes (RQDH-1 to3).

7. Drilling was carried out using HQ and NQ bit and the average core recovery in mineralized zone is 91%.
8. Collection of Grab samples = 38
9. Chemical Analysis =16 quartzite samples and 9 dolomite samples

Mineral Resource Estimation

For the estimation of resources of quartzite and feldspar mainly physical characters are considered, besides the chemical analysis. All the grab samples of quartzite analyzed (5 samples). Similarly, the resources of feldspar are calculated on the geometry of out crop, its quality and chemical analysis. Feldspar is exposed within pegmatite and comprises almost 60% of pegmatite. The width of pegmatite is almost 500 m in width and for safe purpose the width or thickness is considered as 100 m. The details of strike length, dip length, thickness and bulk density along with resources are detailed in following table.

Sr. no	Section	Category	BH ID	Strike length m	Dip length	Apparent thickness m	True thickness m	Tonnage factor	Tonnage ton
1	Pit-8	Probable	RQDH-2	200	60	66	65	2.5	1,950,000
2	Pit-8	Possible	RQDH-2	200	80	66	65	2.5	2,600,000
3	Pit-9	Possible	Exposure	200	65		80	2.5	2,600,000
4	QV2	Probable	Exposure	30	20	8-12	10	2.5	15,000
5	5 QV	Possible	Exposure	15	15	10	10	2.5	28,125
6	Feldspar	Possible	Exposure	200	30	200	100	2.5	1,500,000

Probable category resources of cherty quartzite = 1.95 mn t.
Possible category resources of cherty quartzite = 5.2 mn t.
Total resources of cherty quartzite = 7.15 mn t

Possible category Resources of quartz vein QV1 to 6 = 43,125 ton.
Besides this there are exposures of a number of quartz vein and that can be mined.
Resources of Pit-9 quartzite + QV 1 to 6 = 2,600,000 + 43,125 = 2,643,125 ton

Possible category of feldspar deposits = 1.5 mn t.

The working periods are as follow.

Mine working days	:	300 days per annum
Mine working days per week	:	6 days
No of operating shifts / day	:	1 shift of 8 hours duration
Effective working hours/ shift	:	8 hours +2 hours of break

CMCL has proposed to mine lumps of quartzite, QV and further blocks of quartzite. For first 5 years, year wise ROM and final products as proposed are detailed in the following table.

Commodity	**Block**	**Year-I** Month 3	**Year-II**	**Year-III**	**Year-IV**	**Year-V**
Ore Mining		**ton**	**ton**	**ton**	**ton**	**ton**
Quartzite	M - Pit 9 & QV2	24,000	150,000	240,000	450,000	450,000
Per Day Mining		320	500	800	1500	1500
Feldspar Peg	Pegmatite	-	-	30,000	75,000	75,000
Per Day Mining				100	250	250
Quartzite Blocks	O - Pit 8	-	14,400	19,200	24,000	24,000
Per Day Mining			48	64	80	80
Plant Feed (50%)						
Quartzite Lumps	M - Pit 9 & QV2	12,000	75,000	120,000	225,000	225,000
Per Day Prod.		160	250	400	750	750
Feldspar Lumps	Pegmatite	-	-	15,000	37,500	37,500
Per Day Prod.		_	_	50	125	125
Quartzite Blocks (12.5%)	O - Pit 8	-	1,800	2,400	3,000	3,000
Per Day Prod.			6	8	10	10
Final Finish Product (90% recovery)						
Quartzite Lumps	M - Pit 9 & QV2	10,800	67,500	108,000	202,500	202,500
Feldspar Powder	Pegmatite	-	-	13500	33,750	33,750
Final Finish Production (100% recovery)						
Quartzite Blocks	O - Pit 8	-	1,800	2,400	3,000	3,000

Mining

Mining will be done open cast mining with 6 m bench height involving blast hole drilling, blasting, excavation, transportation to the plant site by dumper. In first five years mining will be done in PL-12274 & PL-12302 for quartz vein at various outcrops of Quartz Veins. The lump mining of cherty quartzite will first commence at Pit-9 in PL-12298 whereas Block mining of this will be taking place at Pit-8 (PL-12297, PL-12298) using diamond wire saw. The lumps of feldspar will be mine developing an open cast mined along quartz veins. Per day mine production will be as detailed in above given table.

Processing Plant

The quartzite processing plant will consist of crushing, sizing, cleaning, sorting and loading. The quartzite block will consist of cutting, cleaning, vacuum packing and loading. The quartzite block will cut in the mine itself using diamond wire saw and that will be transported directly from the mine. The 80% of washing/cutting water will be recycled for the reuse in the plant for quartzite blocks. The feldspar plant will consist of crushing, sizing, sorting, milling and packaging.

Water supply is possible through bore wells by constructing water tank for supply for domestic and industrial use. Small pond has to be constructed to accumulate water and for reuse.

Diesel Generators are recommended to two diesel generate of 250 kva power for mine and plant, workshop and colony as there is no electricity in the nearby area. However, it is expected that TANESCO shall supply electricity for all the activities.

Conclusion

1. The project economics, as summarized herein, are positive and indicate that the quartzite and feldspar, Ruangwa, Lindi Region, Tanzania Project as portrayed in the Study, is feasible and can be advanced to the basic and detailed engineering stages.
2. The project will have many positive impacts to the country and surrounding communities of the Ruangwa area. The Tanzanian local economy will benefit through payment of royalties, taxes and several other statutory payments as demanded by laws. The injection of US$ 4.38 million as direct investment, during First year, in to the economy through Ruangwa Quartz Project will boost many secondary economic activities in Ruangwa District, Lindi Region and Tanzania as a whole through supply of local products and inputs and consumables to the mine and its workforce. There will be an expanded market of the agricultural products cultivated in the surrounding villages of the Ruangwa areas due to increased population in the area.

Recommendation

The detailed investigation in Prospecting License areas will enhance the resources of quartzite and feldspar and the life of project may increase up to 30 years.

CHAPTER 1: INTRODUCTION

1.1 THE PROJECT

Classic Mining Company Ltd. (**CMCL**) has an industrial minerals mining area which is situated west of Mtondo village and south of Mkalanga village under Prospecting Licenses PL-12298/2023, PL-12274/2023, PL-12302/2023, PL-12297/2023 & PL-12273/2023 respectively. The villages are located near in Ruangwa district, Lindi Region of Tanzania. For 5 years mining will be initially carried out in 4 open pits, 3 in PL-12298/2023 and one for quartzite in PL-12274/2023. In PL-12298/2023 two pits will be in ridge part for quartzite and on pit in plane area east of ridge for feldspar (Fig-1.1).

CMCL will develop open pit mines within PL-12273, PL-12297, PL-12302, PL-12298 and PL-12274. In these PL area the resource of 7.15 million ton (MT) (for a strike length of 1.5 km) of quartzite ore has been estimated up to a vertical depth of 50m.The detailed exploration by drilling has estimated a probable category resources of 1.95 mt. The Classic Mining Company has applied for mining licence and will start mining after getting approval from Government of Tanzania.

CMCL quartzite, will extensively be used for manufacturing glass, ramming mass, foundry materials, abrasives, refractory, tiles, engineered stones etc.

CMCL intends to setup a processing plant including crushing and sizing to process 548 TPD of quartzite, ore in initial year to 1830 TPD in 5th year and feldspar powder plant starting in year 3, and that will continue in further years of ore which may increase in due course. The plant shall produce quartzite lumps & feldspar powder, quartzite blocks for which market is available in the Tanzania and in the nearby countries including India, China, UAE etc. Further production will be increased on the basis of demand in the market.

The mining operation shall be performed within the said PL areas and the plant shall be setup in an indigenous zone near to mine zone. The plant will be set up near the mine within PL.

CMCL team is also supported by local reputed consultants i.e. Certified Public Accountants, Advocates, Technical consultants, Liaison Consultants. Technical Team includes senior professional(s) viz. Geologists, plant Engineers, Consultants, sales executives and other experienced mining experts.

Project has reached a stage where resources are certified by Dr. S.S. Ameta, retired Director, GSI and member of Australian Institute of Mines and Metals (IMM-322324 member). Main promoter Mr. Vikas Bardiya belongs to a reputed Indian business conglomerate. The conglomerate has been in business for over 15 years. Number of institutional investors are also queuing up for investment in the project.

1.2 PROPERTY DESCRIPTION, LOCATION & ACCESSIBILITY

1.2.1 Properties of Classic Mining Company Ltd.

The CMCL property is approximately 170 kilometres west of Lindi and 260 km west of Mtwara. It is accessible by 135 km tarmac road from Lindi town connecting all weather road via Ruangwa township (head quarter of Ruangwa District) and about 35 km seasonal road North east of Ruangwa township (Fig.-1.1). The property may also be accessed by a shorter route from Dar-es-Salaam via Kitumbini - Mandawa settlement approximately 100 km north of Lindi town for approximately 400 km from Dar-es-salaam. The route, however, is not passable during the rainy season.

Lindi Region is one of the three regions forming Southern Zone of United Republic of Tanzania, the other regions being Mtwara and Ruvuma. The Mtwara and Ruvuma regions border northern Mozambique and eastern Malawi.

The main road from Dar-es-Salaam to the southern regions passes through the Coastal, Lindi, Mtwara and Ruvuma regions. The road connects to northern Mozambique and eastern Malawi via the Mtwara and Ruvuma regions. Recently funding from external donors and the central government have significantly improved the road from Dar-es- Salaam to the Lindi and Mtwara regions from gravel to tarmac level, covering a total distance of about 700 Kilometers, including the construction of 1 Km long bridge across the Rufiji River.

The Lindi Region is served by 4 airstrips, in Lindi, Nachingwea, Liwale and Kilwa Masoko. These gravel strips are capable of supporting small to medium size planes only. There is no commercial air service to the region.

Although the electric power grid is reaching in most areas of Tanzania, but it does not extend to the area of the CMCL property, however power is available at Ruangwa, the District head quarter around 40km from the mining site.

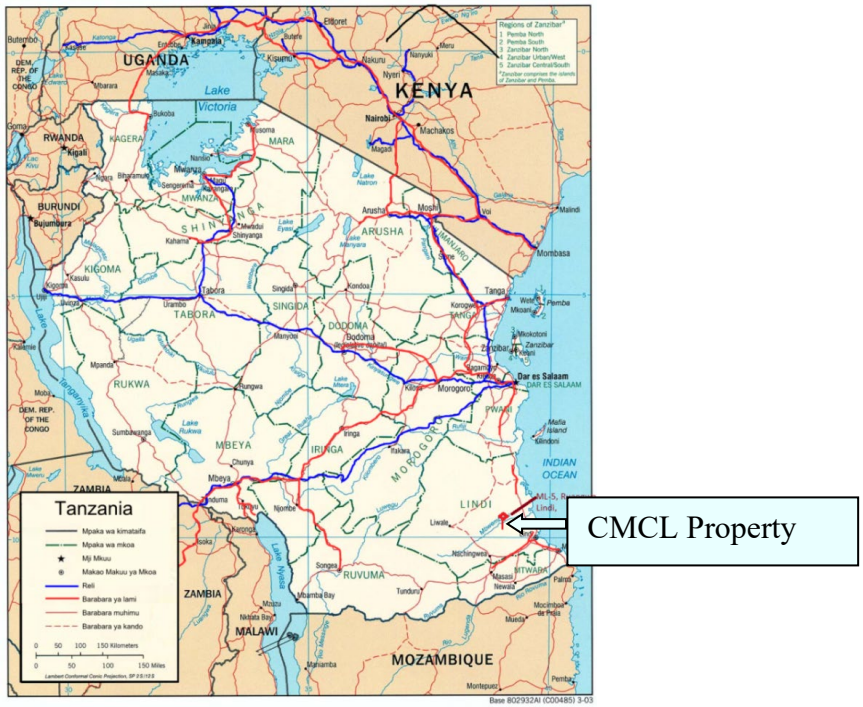


Fig.-1.1 Location of CMCL property with respect to Dodoma, Dar es Salaam, Lindi and Mtwara.

The main road from Dar-es-Salaam to the southern regions passes through the Coastal, Lindi, Mtwara and Ruvuma regions. The road connects to northern Mozambique and eastern Malawi via the Mtwara and Ruvuma regions. Recently funding from external donors and the central government have significantly improved the road from Dar-es- Salaam to the Lindi and Mtwara regions from gravel to tarmac level, covering a total distance of about 700 Kilometers, including the construction of 1 Km long bridge across the Rufiji River.

The proposed mining blocks are located within CMCL properties along with other Prospecting Blocks (Fig.-1.2). The CMCL Property is situated at villages of Nanjaru, Nambilanje, Mtondo and Mkalanga, falling under the jurisdiction of the Nambilanje ward in Ruangwa District, Lindi Region of the United Republic of Tanzania. CMCL property comprises 8 PL (Fig.-1.2) for detailed industrial minerals. Mineable quartzite and feldspar areas are found under PL-12302, PL-12273, PL-12274, PL-12297 and PL-12298 blocks therefore, below demarcated 2 mining blocks are required to be converted in M (Fig 1.3).

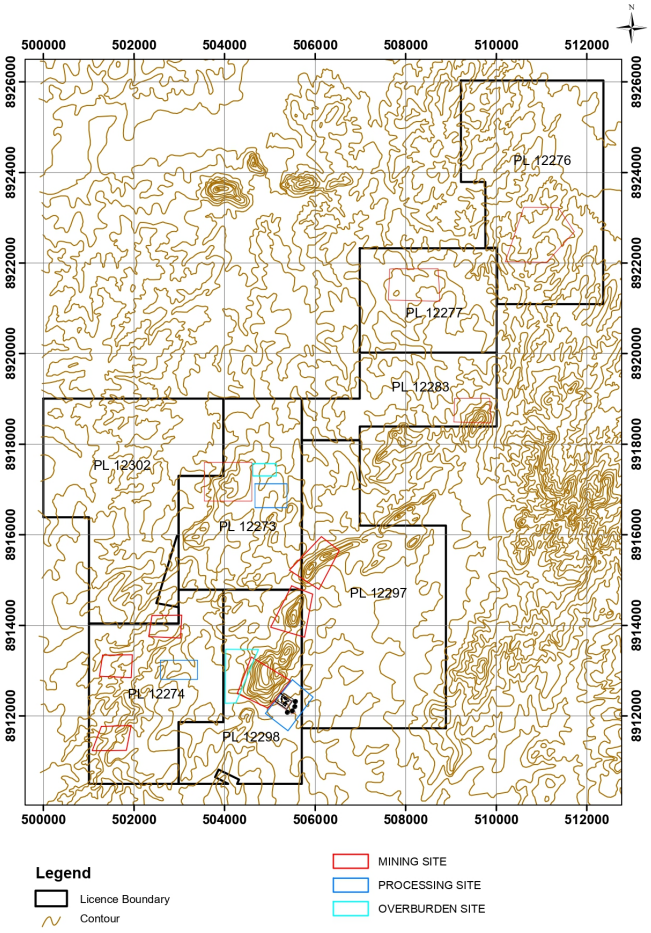
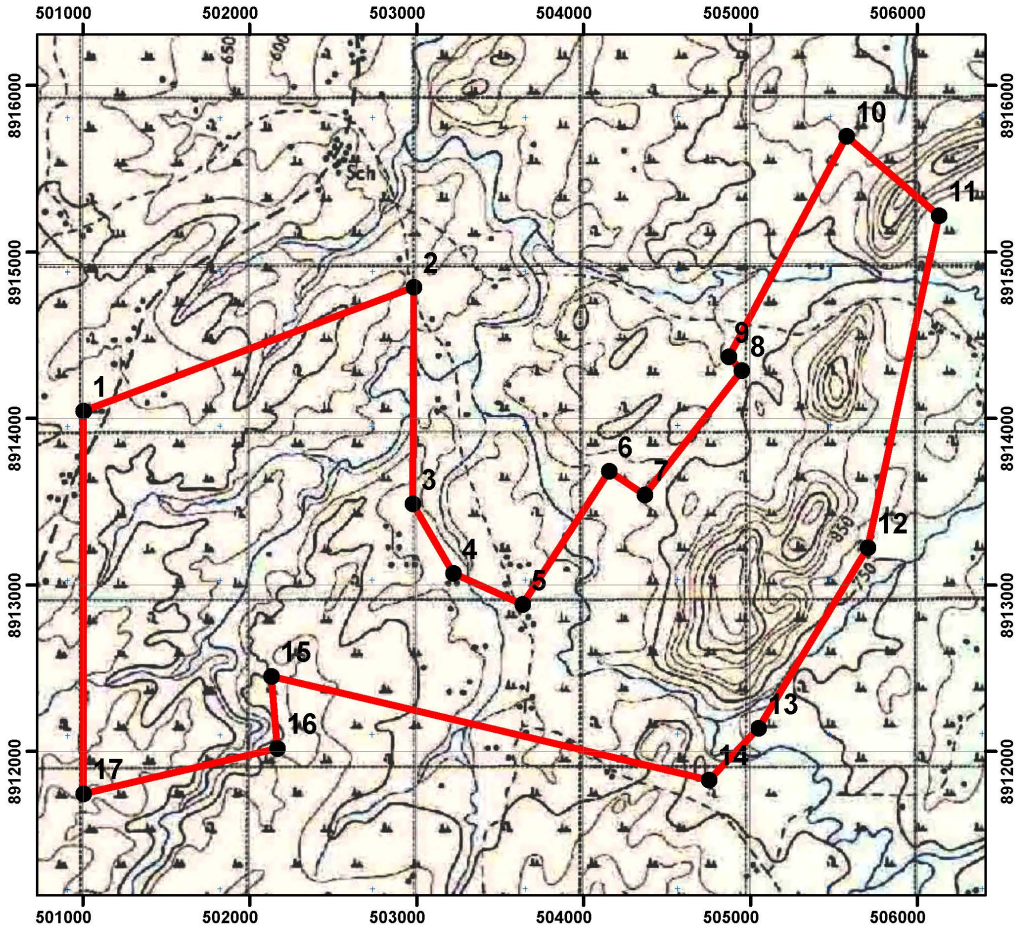


Fig.- 1.2: Location of Block PL-12274/2023 and PL-12298/2023 within CMCL property, Ruangwa district, Lindi Region, Tanzania.

1.2.2 PL-12274/2023

The tenement area is defined by the DMS coordinates (Arc 1960) listed in Table 1.1 to 1.4. Figure 1.3 shows relative position of the CMCL project (Fig.-1.2) in the Southern part of Tanzania along with roads and important cities. Figure 1.2 shows the boundaries of all 8 Mining Blocks with respect to CMCL property.

Within the area, several mobile telephone networks (Vodacom, Airtel, Zantel, Tigo and TTCL) and internet communication is available in local internet cafes in Ruangwa or mobile internets



Po.	Latitude	Longitude
1	9°49' 29.660" S	39°0' 33.000" E
2	9°49' 5.430" S	39°1' 38.000" E
3	9°49' 47.766" S	39°1' 37.769" E
4	9°50' 1.344" S	39°1' 45.762" E
5	9°50' 7.477" S	39°1' 59.313" E
6	9°49' 41.352" S	39°2' 16.405" E
7	9°49' 45.969" S	39°2' 23.424" E
8	9°49' 21.705" S	39°2' 42.462" E
9	9°49' 19.017" S	39°2' 39.890" E
10	9°48' 35.866" S	39°3' 3.093" E
11	9°48' 51.371" S	39°3' 21.232" E
12	9°49' 56.303" S	39°3' 7.280" E
13	9°50' 31.665" S	39°2' 45.807" E
14	9°50' 41.798" S	39°2' 36.010" E
15	9°50' 21.542" S	39°1' 9.905" E
16	9°50' 35.603" S	39°1' 11.156" E
17	9°50' 44.496" S	39°0' 33.000" E

Area: 9.87 Sq km

Fig. 1.4 - Topographical map of Proposed ML Area in Classic Mining Company

1.3 TOPOGRAPHY

The height of the PL-12298 area ranges between 212m to 340m and is relatively moderately rugged to the central, west and the southwest, and flat to the eastern part. In the PL block NNE-SSW trending ridges are located in the middle of the area, which are sloping towards west and east. Many streams which are flowing to the south, east and west are seasonally dry. The main Mbwemkuru River, which is about 10 km north remains dry during dry season, however water is available at 0.5 to 1.0 m depth, therefore water availability for all aspects of the exploration and development program, will not be a problem. River Lindadwe originates from this area as it acts as water divide. The area is densely vegetated with thick bushes along the rivers and streams valleys. Drainages show dendritic combine with trellis pattern indicating the imprints of structure and active slopes.

1.4 CLIMATE

There are four main climatic zones that can affect the whole of Tanzania: the coastal area where conditions are tropical; the Central Plateau, which is hot and dry; the semi-temperate highland areas; and the high moist lake regions.

The climate of Ruangwa District is more-or-less uniform throughout the year. Temperature ranges from 10^0 to 40^0 however a daily average of 24^0C in the dry season to a daily average of 34^0C in the rainy season, with an annual average of 26^0C.

The District enjoys monsoon winds from the northeast from June to October, and south-east wind from November to May of each year. It rains from mid-November to May, with most parts of the District receiving between 800 mm and 1200 mm per year. The slopes of the Rondo Mountains get more rain than other parts of the District, with over 1000 mm/year. In general, rainfall decreases from east to west. There are two rainy seasons in the North, from November to January and from March to May.

1.5 VEGETATION

The area is covered by trees and bushes. The most predominant natural vegetation is Miombo wood land. Common vegetative species include those of *ranchystigea, dalbegia,* and *Pteracarpus*. Other common vegetative species include *Bamboo, Miombo, Mikongo, mibuyus, miyale, misufi, Mipingo, miunga*in the highlands and species like cashew-nut trees, simsim, mango trees, which are cultivated in the lowlands.

CHAPTER 2: QUARTZITE MARKET

2.1 QUARTZITE APPLICATIONS

Quartz/quartzite is a hard, crystalline mineral composed of silicon and oxygen atoms (silica dioxide). It is basically one of the most famous and the second most abundant mineral with many uses found on earth. It is a major component of rocks (igneous, metamorphic and sedimentary rocks) and forms in all temperatures. Quartz in its purest form is clear or white in color but different impurities within the atomic lattice can cause the color to change to purple, pink, brown, black, gray, green, orange, yellow, blue, or red and in some cases, multi-color. There are various varieties of quartz with different uses. The following are the major properties of quartz which makes it one of the most useful naturally occurring minerals.

1. Some Quartz crystals possess piezoelectric property, which is the ability to generate electric potential when subjected to mechanical stress.
2. Quartz is one of the hardest naturally occurring minerals and hence cannot be corroded easily.
3. It has a very high melting point and can withstand critically high temperatures.
4. It is chemically stable and does not react with other chemicals and substances.
5. Quartz crystals are visually attractive and can be found in different colors. Although naturally transparent, they are found in various colors according to the presence of impurities.

Therefore, due to its abundance, crystalline nature, high thermal, and chemical properties, quartz is employed in many large-scale applications.

2.1.1 Jewellery and gemstones

For centuries, quartz has been used in jewellery production and as gemstones. The hard, polishable, crystalline and durable nature of quartz make it an excellent material for this purpose. The varieties of quartz popularly used as jewellery and gemstones include Citrine, Amethyst, Ametrine, rose quartz, Aventurine, and Opal. Quartz with microcrystalline (cryptocrystalline) structures like Agate and Jasper is also used as gemstones.

2.1.2 Glassmaking

Glassmaking is one of the primary uses of quartz/quartzite. Glass is manufactured from a chemical compound known as Silica dioxide (SiO_2) (a colorless crystalline compound found as quartz/quartzite, sand or flint). This silica dioxide is melted and allowed to cool down into whichever shape or dimension desired. Optical-based quartz crystals are used in the manufacture of lasers, microscopes, telescopes, sensors, and scientific instruments.

In India, almost half of the quartz/quartzite consumption is in the glass industry. Quartz sand is commonly used in the Indian glass industry for making container glass, flat glass, plate glass, specialty glass, fiberglass, bottles, table glassware, and other glassware. Quartz supplying industries such as Unique Crystal minerals LLP supply a large amount of quartz sand which is widely used in the Indian Glassmaking Industry.

2.1.3 Watches and clocks

Quartz crystals contain oscillators that possess the ability to vibrate at precise frequencies that helps to regulate the movement of the watch or clock, thereby making them accurate timepieces. Quartz crystals possess the piezoelectric effect (the ability to produce electricity when subjected to mechanical stress) which is also used to keep a tab on time.

2.1.4 Foundry materials (Metal Casting Industry)

Quartz sand is often blended with cohesive agents such as clay, resin sodium silicate, and oil, and used for the purpose of molding and metal casting. The properties of quartz sand such as high melting point, high strength and refractoriness help in the process of metal casting. Also, microcrystalline quartz is used to smoothen out crude edges on metals after they are cut, cast or drilled.

In the metal casting industry, Quartz sand is also added to molten metals for the process of removing impurities. The sand is then easily removed.

2.1.5 Refractory industry

Quartz sand is used in the production of refractory bricks because of its sheer strength and resistance to heat. It is also used as a flux to smelt out crude edges on metals after they have been cast, cut or drilled.

2.1.6 Abrasives

Due to its hardness (it is harder than most natural minerals), and resistance to corrosion, quartz sand is considered a wonderful abrasive. Also, it is used for sandblasting, glass grinding media, scouring cleansers (powder), and sanding and sawing grit.

2.1.7 Petroleum industry

Silica sand, alongside water and other chemicals under high pressure, is forced down into a bedrock formation via a well. The high pressure fractures the bedrock, the silica sand injects into the fractures and holds it in place, creating a passage for the flow of natural gas from the bedrock formation into the well. This process is known as hydraulic fracturing.

2.1.8 Kitchen Countertops

Engineered quartz stones, which are industrially made from raw quartz/quartzite, are popularly used as countertops and slabs in residential and commercial buildings.
Certain characteristics of engineered quartz stones distinguish them from natural stones such as granite and marble. The non-porous property of quartz makes it resist retaining stains. Hence, quartz countertops are easy to clean, does not retain stain, attractive, and luxurious.

2.1.9 Sharpening tools

Novaculite, a form of cryptocrystalline or microcrystalline quartz, is used in making medical incision devices, cutting weapons, and sharpening cutting tools for thousands of years even

up to this day. Hones are used to sharpen razor, while whetstone or smooth stone is used to sharpen the edges of tools and knives.

2.1.10 Filler

Quartz sand and ground quartz (quartz in powder state) are used as filler in the manufacture of adhesives, putty, paint, and rubber. This powder provides properties such as durability, chemical inertness, strength, and wear-resistance.

Quartz sand is used in the manufacture of traction in railroad and mining industries due to its durability and large grains so as to minimize fracture. It is also used in the recreation of golf courses, volleyball courts, baseball fields, children's sandbox, and beaches.

2.1.11 Ceramic Industry

Quartz sand is used in the ceramic industry for making ceramic tiles. The silica present in the sand helps in providing white color to the ceramic ware and helps in making the ceramic body.

2.1.12 Tripoli

Also known as rottenstone, it is high-quality crystalline silica usually in powder form. It is used to polish the jewellery, buff out stains from wood, as a filler, in plastics, paint, and rubber, and in toothpaste and soap production. Tripoli particles are rounded rather than sharp; thus, it is considered a mild abrasive.

CHAPTER 3: GEOLOGY

3.1 REGIONAL GEOLOGY

The Tanzania Craton extends from Dodoma in central Tanzania northwards into Kenya and Uganda, and westwards to Rwanda and Burundi. The craton is bordered by, and in tectonic contact with, three Proterozonic mobile belts: the Ubendian, the Usagaran and the Mozambique Belts (Lenoir et al., 1994). The Tanzanian craton is divided between the high-grade metamorphic terrain called Dodoma Belt and low-grade granite greenstone terrain that constitutes the Nyanzian and Kavirondian Supergroups. The former is made of granite, granodiorite, granitic gneiss, migmatite and high-grade metamorphic supracrustal rocks that cover the central portion of Tanzania. The Nyanzian Supergroup is subdivided between lower Nyanzian and Upper Nyanzian. The lower Nyanzian is composed of chemical (iron formation) and clastic sedimentary rocks and metavolcanic rocks that are mainly acid volcanic rocks (Borg, 1992). The Kavirondian Supergroup comprise thick clastic sedimentary rocks (Harpum, 1970) overlying the Nyanzian rock sequences, representing the upper most unit of Archaean stratigraphy of the Tanzania Craton (Barth, 1990) According to Borg and Shackleton (1997), Nyanzian supergroup can be divided into six granite-greenstone belts namely, the Sukumaland, Shinyanga-Malita, Musoma-Mara, Kilimafedha, Nzega and Iramba Senkenke. The ML area belongs to Mozambique belt of Neoproterozoic age.

3.2 GEOLOGY OF CMCL PROPERTY

The whole property of 84.77 sq. km. has been initially mapped on 1:20,000 scales with detailed surveys done thereafter in areas of interests (Fig. 3.2). The various lithounits exposed in the property are Amphibolites, Gneisses, Graphitic Schists, Marble, Quartzites & Ultramafic Dykes of various ages along with Quartz veins, Pegmatites and Aplites.

Proterozoic
- Quartz vein
- Aplite
- Pegmatite
- Ultrabasics
- Amphibolite
- Marble
- Quartzite
- Graphite Schist
- Schist
- Gneiss

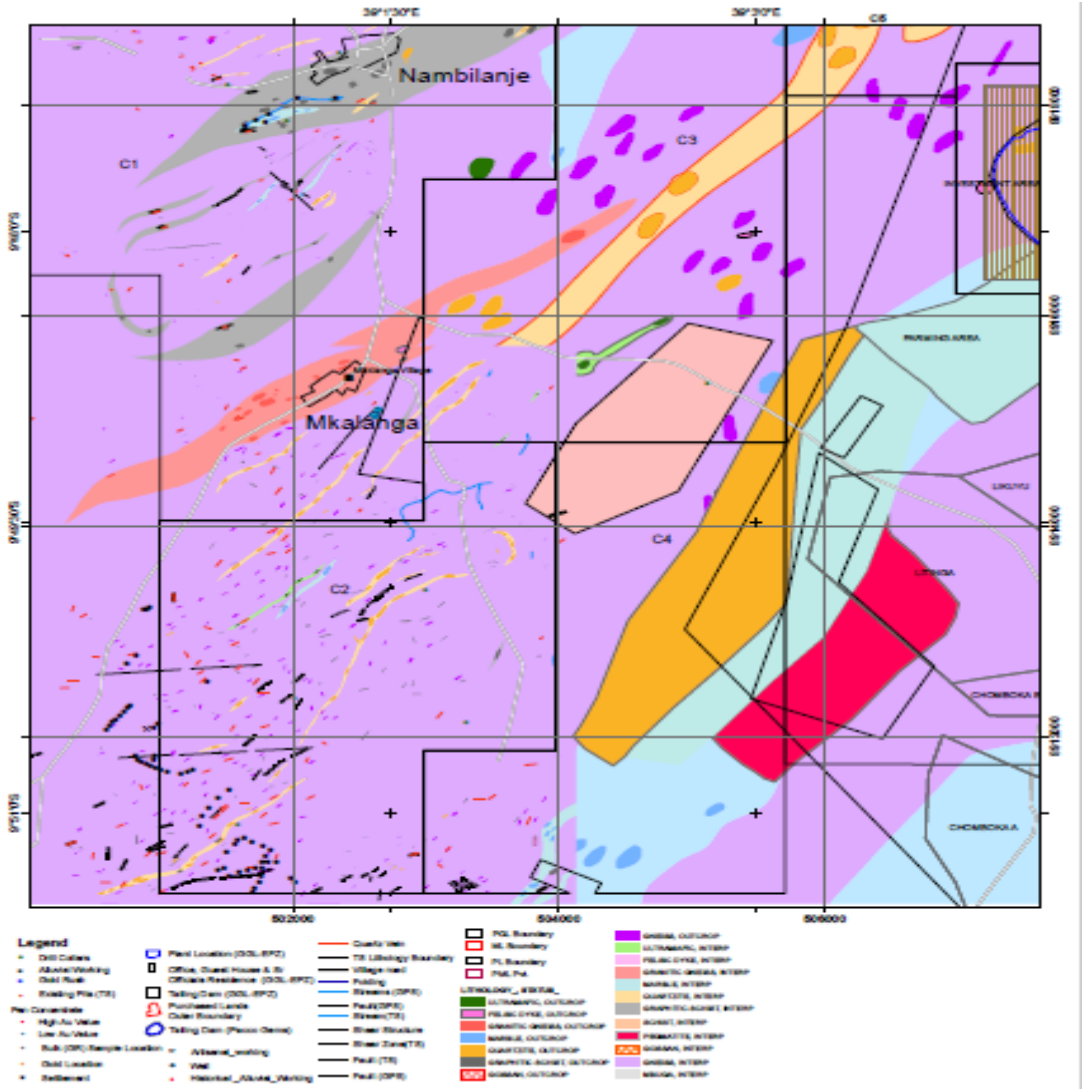


Fig.-3.2 Geological map of CMCL properties and surrounding area, Ruangwa, Tanzania

During mapping it was observed that general foliation trends are dominantly NNE – SSW dipping due SE at 20^{0} - 50^{0}. Fold geometry indicates three phases of deformations.

3.2.1 Folds

The folds of First phase (F1) are tightly appressed with extended hinges and rootless folds whereas folds of second (F2) phase are overturned with NE-SW axial trend plunging due NE and SW. The axial plane trends NE-SW and that dips due SE with 20^{0}- 40^{0}. It appears that the folds of first and second phase are coaxial with NE-SW trend. The axis of third (F3) phase folds is almost perpendicular, with NW-SE trend to folds of second phase forming doubly plunging folds. Thesetypes of folds are observed in the NW part of the area. It forms basin and dome structure at places. The folds of third phase are open and symmetrical to asymmetrical in geometry.

Mkalanga – Nanjaru Macro Fold (F2)

The rocks of the area are folded along second generation macro fold the axis of which trends NE-SW and along this a major shear zone is marked. Along this shear zone the airborne geophysical map shows comparatively high radio activity. The northwestern limb falls at Nambilanje – Likakata area whereas as south eastern limbs is located in Mtondo and Lindadwe area.

Meso Folds

Likakata Folds (F1)

In Likakata area quartzite outcrops show anticline and syncline tightly appressed overturned folds. The axis of these fold trends NE – SW and both limbs dips due SE at varying dip from 25^0 to 50^0.

Bahati area Fold (2)

This is meso to macro doubly plunging fold as deciphire by the variation in dip and dip direction. This is a tightly appressed NE-SW trending overturned fold which is refolded by almost perpendicular NW-SE trending open folds forming overturned basin structure. The axial plane of overturned fold trends almost NE-SW and axial plane dips due SE at 25^0-35^0. In SW end this fold plunge due NE at 25^0 -30^0 whereas towards NE end it plunges due SW at 15^0 to 20^0. Along the axis of this overturned fold the shear zone has developed.

Here is of the view that this is not a fold, and quartzite strata are bounded by the number of thrust / fault planes.

Mtondo Fold (F1)

East of Mtondo a NNE-SSW trending fold axis has been traced for more than 8 km and that axis also passes through ML-5 and ML-8 area. This is also an overturned fold and both limbs dip due SSW at 20^0 - 30^0. This is a meso to macro fold.

3.2.2 Faults

The area falls at indicated major thrust of older rocks to the NW and younger rocks to the SE possibly falling along the shear zone which crosses the property diagonally from SW to NE.

Two set of shear zones are observed in the area one is trending, NNE-SSW to NE-SW, parallel or sub parallel to the axial plane of F2 fold and other at smaller scale trends NW-SE to WNW-ESE. Along these shear zones in the area displacement is also observed as faults at many places. Along WNW-ESE shear zones displacements are prominent as fault in the NW and SW part.

3.3 DETAILED STUDY OF PHOTO IMAGERY

Satellite photo imagery study was carried out by Bakliwal (2010) and his observations are

as follow. Many of the folds, faults, lineaments and shear zones marked by him are observed in the field while geological mapping of the area on 1:20000, 1:5000 and 1:2000 scales. His observations are summarized as follow.

3.3.1 Structures

Structures deciphered in the area from interpretation may be classified as structural trends on lithology, folds, major fractures, faults, shears and lineaments.

Trendlines

The area is mostly covered by thick regolith and as such at few places lithological trend wherever either thin cover or exposures are available. Folds were inferred in the west of Mkalanga village and also in the east of Nambilanje village. Other trend lines indicate strike of the rocks with NNE-SSW to ENE-WSW trend.

Faults

A few high angle faults were inferred based on sharp toner linearity. These are seen associated with quartz/pegmatite activity. A few faults of varying dips were inferred in the north of the area near the river which seems to have a control on the shape of the river and probably neo-tectonic. The faults are generally trends in NNE to almost east directions. A group of faults with indicative graben structure have been inferred between Nambilanje and river with cross faults within the structure.

Major lineaments/shears

One shear zone almost across the area runs in NE-SW direction. Another shear zone is in NW-Se direction from the northwestern portion of the area, passes in between Mkalanga and Nambilanje and continues to the southeastern end of the area. The third major lineament as shear is in the north of Nambilanje in almost East- West direction. Other high angle shear (fault) is in the west of Mkalanga village in NNE-SSW trend and important for mineralization localization. Another N-S trending major lineament was inferred in NW part of the area.

Lineaments/fractures

Numerous lineaments of varying lengths and trends were interpreted from the image in the area. Most pronounced trend is NE-SW easterly directions followed by NW-SE trending lineaments. These lineaments represent subsurface shears/fractures/faults difficult to classify from present data base of very poor quality.

3.3.2 Observations

- Area is covered by metamorphic terrain with matured rolling topography
- Many major regional shears traverse across the area and are important target zones for search for gold mineralization.
- Numerous faults are present, probably associated with magmatic activity.
- Intersections of shears are favorable targets for gold exploration.

- Database in the form of very poor quality FCC image was hindrance in interpretation of detailed lithology and precision structures.
- Conventional mapping in this terrain of paucity of exposures need assistance of base map prepared from remote-sensing studies, if undertaken on good quality high resolution satellite data.

3.4 GEOLOGY OF PL Areas

3.4.1 QUARTZ VEINS

White colored rock occurs in the scattered vein shape throughout the PL-12274 area with different orientation. Three generation of quartz veins are observed in the area out of this first generation smoky quartz veins contain gold whereas milky white quartz veins are good for industrial purpose.

3.4.2 PEGMATITE

This whitish grey and pink coarse-grained rock is mostly exposed in the lower part of the area, especially in the south eastern side of ridge in PL-12298 this is widely scattered in the PL-12274. It shows scanty and discontinuous outcrop in NNE-SSW trend that is along the foliation plane. Generally, pegmatite are seen dipping due ESE at varying angle from 70^0 to 50^0. This rock comprises large size of quartz, feldspar crystals with small flakes of mica and tourmaline. It occurs mostly as concordant body. In PL-12298 this is exposed with 2 km in length and more than 0.5 km in width and comprises white feldspar.

3.4.3 Dolomite

The dolomite in the area is greyish white to grey and is medium to coarse grained. Primarily, the dolomite occurs as fresh outcrops, locally foliated at the contact with the cherty quartzite and gneiss. It occurs with 1 m to 100 m width outcrop. Dolomite occurs at eastern and western contact of the cherty quartzite in the PL-12298 area. Rock dips due ESE at 40^0 to 45^0 (Fig.-3.3).

3.4.4 Cherty Quartzite

On the top of ridge outcrops of quartzite are observed in the NNE-SSW aligned ridge Fig.3.3). The thickness of quartzite varies from a few meters to 100 m. The cherty quartzite show crystallization at places due to regional metamorphism of Almandine- Amphibolite grade. The metamorphic minerals include graphite, tremolite, actinolite (at the contact with dolomite in the gneiss), garnet and kyanite. It is also found to occur parallel to all the litho-units with NNE-SSW trend. This is white, whitish grey, grey and dark grey in color. At places this appears as banded quartzite with dark grey, grey and white bands, especially towards western contact. This is fine to medium grained rock. At places it appears as quartz arenite coarse grained granular rock. It mainly comprises quartz with silica as cementing material, which crystalized as quartz grains. The other miner minerals observed are biotite, graphite, pyrite etc.

Its core shows glassy and vitreous lusters. The quartzite is also intruded by quartz veins and that enhances its quality. This is opaque to partially transparent.

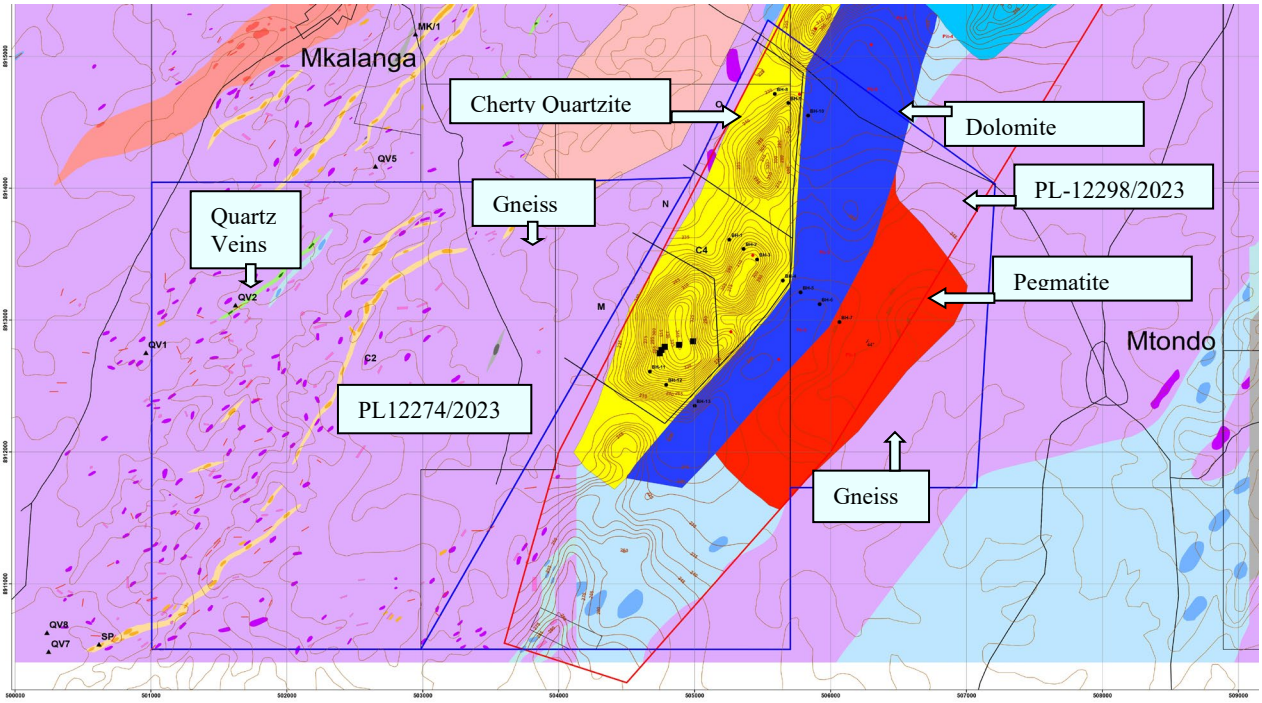


Fig.-3.3 Geological map of quartzite area, PL-12298 and PL-12274 (within blue lines) near Mtondo and Mkalanga village, Ruangwa, Tanzania.

3.4.5 Schist

Thin bands of schist are intersected in the boreholes at the western contact between quartzite and gneiss.

3.4.6 Gneiss

This is grayish to whitish pink, brown medium to coarse-grained, banded, and weakly to strongly foliated rock. This comprises quartz, feldspar, mica, garnet, tourmaline, pyrite and altered minerals like chlorite, hematite etc. This is also intersected at the bottom of the drill holes RQDH-1 and 2.

3.4.7 Soil

The area is covered with brown to yellowish brown soil which varies in thickness from 0.25 m to 2.0 m however in valley part thickness varies from 3.0 m. The quartzite outcrops are masked by soil and boulders, however at the top of ridge quartzite outcrops are observed

3.5 LOCAL GEOLOGICAL STRUCTURE

In the block presence of neutral folds (Fig.-3.4) and linear structures indicate that the area has undergone multi phases of deformation giving rise to folds, faults and shear zones. Folds of three generation are recognized in the area. This block falls along the major NNE-SSW fold axis and lineament. The main trend of quartzite, dolomite and gneiss is NNE-SSW and dips due East at 35^0 to 55^0.

Fig.3.4 shows folded dolomite, Eastern part of ridge at lower area, near Mtondo village. These are sub vertically plunging folds.

CHAPTER 4: EXPLORATION AND RESOURCES

The cherty quartzite in the area occurs mainly in bedded form with intrusive quartz vein and that is trending NNE, dipping at an average of 45^0-50° towards ESE. For detailed investigation after carrying out detailed geological mapping on 1:5000 scale using GPS, 8 Pits and 14 drill holes were planned as detailed below.

4.1 GEOLOGICAL MAPPING

3In the area the regional mapping was carried out on 1: 20000 scale during the period of 2010-11 and in the PL-12297/2023 & PL-12298/2023 pegmatite, gneiss, dolomite and quartzite was mapped. PL-12274/2023, PL-12273/2023, PL-12302/2023 comprises gneisses with small quartz veins and pegmatite bodies. Subsequently detailed geological map on 1:5000 scale was prepared using GPS along with collection of grab samples and structural data. The detailed geology of the area is described in chapter-3.

4.2 PITS

The planning of 8 pits was done however out of that pittings were carried out only at 5 places i.e. at Pit-1, Pit-2, Pit-3, Pit 5 and Pit-8. Pit digging was done using JCB. The cherty quartzite ridge extends for more than 3 km along strike in this ML with varying apparent widths of more than 80 m. The spacing was between pits is about 1 km along strike length, almost at the ridge top or at central part of the ridge. Pit-1 is in dolomite at the foot of the ridge in the eastern part (Fig-4.3.). The details of all the pits are described in table-4.1.

Table-4.1 Details of the Pits in PL -4 of CMCL Property, Ruangwa District, Tanzania.

Sr.no.	Pit no.	E- UTM	N- UTM	Approx. seize	Lithology
1	Pit-1	505697	8912824	10x10x4 m^3	Whitish Gray coarse grained Dolomite
2	Pit-2	505267	8912910	8x10x4 m^3	Greyish white fine to medium grained vitreous cherty quartzite.
3	Pit-3	505427	8913489	10x10x5 m^3	Greyish white fine to medium grained glassy cherty quartzite.
4	Pit-5	505889	8915210	7x8x3 m^3	Whitish grey fine to medium grained vitreous cherty quartzite.
5	Pit-8	505771	8914711	10x10x4 m^3	Greyish white fine to medium grained vitreous aerinite quartzite.

4.3 CHEMICAL ANALYSIS

The grab samples collected from field and pit area varying with whitish grey, grey and banded greyish white and dark grey quartzite. (Table-4.4).

Besides quartzite the samples of dolomite and feldspar are also collected and a few are analyzed. The results of these sample are encouraging and calls for mining the commodity (Table – 4.5).

SUMMARY OF EXPLORATION

1. Geological mapping on 1:200000 scale =186 sq km
2. Geological mapping on 1:5000 scale = 9.42 sq. km. (Using GPS), whereas a few traverses were taken in PL-12274 to locate quartz veins.
3. Pitting is carried out at 4 places almost about 10m X 10m X 3 to 5m. Out of these, 1 pit was in dolomite and other 3 were in the quartzite.
4. Diamond Core Drilling =157.31 m in 3 boreholes (RQDH-1 to3).
5. Drilling was carried out using HQ and NQ bit and the average core recovery in mineralized zone is 91%.
6. Collection of Grab samples = 38
7. Chemical Analysis =16 quartzite samples, 9 dolomite samples and 1 Feldspar samples

Table-4.4 Results of chemical analysis of quartzite and dolomite collected from PL-12298/2023, Ruangwa.

Quartzite & Dolomite samples

Sample ID	LO.I	SiO2	Fe2O3	Al2O3	MgO	CaO	P2O5	S	Ba	W
DOL 03	44.78	4.04	0.13	2.46	19.88	28.59	0.03	474	170	128
DOL 05	38.08	24.91	0.17	0.65	12.21	22.95	0.05	389	130	142
DOL 11	44.5	11.62	0.55	1.41	15.91	25.07	0.07	661	167	104
DOL 14	44.24	13.75	0.16	0.89	15.75	25.02	0.03	349	154	110
DOL 17	43.93	5.23	0.09	1.24	19.7	28.79	0.03	462	137	84
DOL 19	42.92	3.08	0.17	1.1	20.53	31.84	0.05	390	200	126
DOL 21	43.83	5.46	0.1	1.34	19.13	27.57	0.05	392	140	111
DOL 23	44.82	7.09	0.16	2.4	18.63	25.57	0.04	618	131	115
QTZ 03	-	99.2	0.03	0.05	0.02	0.15	0.02	265	79	60
QTZ 09	-	99.08	0.02	0.02	0.07	0.24	0.02	247	51	76
QTZ 13	-	99.3	0.03	0.14	0.18	0.26	0.01	233	143	84
QTZ 18	-	99.92	0.01	0.86	0.31	0.66	0.04	227	58	73
QTZ 22	-	99.01	0.04	0.28	0.03	0.52	0.02	256	69	53
Method Code	LO01	XRF01	XRF01	XRF01	XRF01	XRF01	XRF01	XRF	XRF	XRF01
Units	%	%	%	%	%	%	%	ppm	ppm	ppm
Detection Limit	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.1	0.1	0.1
Method	GST	GST	GST	GST	GST	GST	GST	GST	GST	GST

Table -4.5 Analytical results of Feldspar sample

Feldspar sample no. GPRS 1-3 Potash Feldspar

Sr.no	Chemical analysis %	Weight in percentage
1	SiO_2	66.86
2	Al_2O_3	16.29
3	Na_2O	3.25
4	Fe_2O_3	0.18
5	K_2O	11.99
6	CaO	0.29
7	Ca	0.21
8	$CaCO_3$	0.52
9	MgO	<0.01
10	P_2O_5	0.1
11	SO_3	<0.01
12	BaO	0.65
13	LOI	0.38

The summary of the detailed exploration carried out within PL 12298/2023 is given in Table 4.6.

Table-4.6 Summary of pitting and drilled drill holes, PL-12298/2023, CMCL Property.

PL Area	Activity	Quantum	Used in Resource estimation	Meters*
PL-12298/ 2023	Pits	5	2	570 m^3
	Drill holes	3	1	108.11 m

4.4 RESOURCES

For resource estimations first lode has to be defined and then its geometry i.e. its length, width and thickness. Its correlation from one intersection to other intersection. The correlations are considered on the basis of at least two positive or interpreted intersections control points as far as possible. However, during this stage of exploration, two to three control points has been obtained as in most of the cases boreholes were planned for two to three level intersection. In present case surface and drillhole intersections are considered as mostly quartzite is exposed on the surface and at places pits excavation was carried out. Here resources are estimated on the basis of Pit-8 and 9 along with surface sampling and two boreholes. Quartzite is exposed on the top of ridge along strike from Pit -8, 3 to 9 and

beyond on both the sides, thus total strike length is about 3.2 km. Southeast of quartzite ridge pegmatite is exposed with 2 km strike length and 0.3 km width.

4.4.1 Cut-off Grade

In the case of quartzite its quality with lustre grain seize and crystallinity is more important along with its composition especially % of SiO_2, Fe_2O_3 as it is used in various industries. The quartzite found in the area is usable for crucible, ceramics, building purpose, etc. Therefore, fine grained recrystalized, white to grey quartzite is preferred.

The quartz veins are milky white and of very good grade so all are mineable.

Pegmatite show good grade of feldspar and usable as abrasive, rubber-plastic, ceramic and glass industries.

4.4.2 Strike length

In the case of cherty-quartzite maximum strike length 100 m is taken either side of the intersection/ sampling point for Probable and another 100 m for Possible category resources. For first stage of exploration the distance between pits and boreholes is kept about 800 m to 1000m as the grab sample analysis show perfect homogeneity. However, at the second stage drilling and pitting will be done at 400 m interval. The strike length of the lode is taken as half the distance between two Pits or adjacent drillholes, which have intersected the lode along strike for inferred category. Thus, strike length of each category is as follow.

i) Probable category strike length = 200 m (100 m either side of the intersection)
ii) Possible category strike length = 200 m (100 m either side after Probable category)
iii) Inferred category strike length = 400 m (200 m either sides, (besides Possible category), on the basis of exposed outcrops and grab samples results.

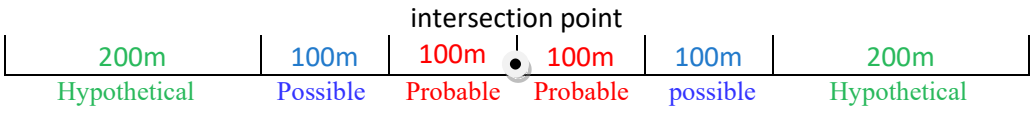


Fig. 4.2 Showing strike length between Pits for different category of resources.

The strike length of **Quartz veins QV2** is considered 30 m as it is exposed on the surface.

Feldspar in pegmatite is exposed for 2 km, however the maximum strike length is considered for 100 m either side of the intersection for Probable and another 100 m is considered for possible category.

4.4.3 Dip length

In the case of **cherty quartzite** presently resources are determined up to a vertical depth of 70 m from the surface as the borehole has intersected the cherty quartzite up to a depth of about 30 m. The Probable resources are determined up to 50 m vertical depth and possible up to 70m vertical depth from surface. Up to 50 m vertical depth the dip length of quartzite

is approximately 60 m and up to 70 m vertical depth is 80 m. (Fig.-5.1). The dip length is determined from the geological cross section as depicted in the fig.-5.1 and verified with the formula.

For quartz vein- QV exposed on surface for more than 5 m along strike are considered for mining. Small and discontinues Quartz veins are exposed at 5-6 places in PL-12274/2023, PL-12302 & PL-12273/2023 area. The QV2 is exposed up to the height of 5 m and another 15 m is considered below the surface thus it has a dip length of 20 m.
Feldspar in pegmatite is exposed forming 10 to 20 m high undulating topography (Fig.-3.4). Here its depth is observed as 15 m. Thus over all dip length is considered 30 m.

4.4.4 True thickness

The cherty quartzite dips at the place are about 50^0 (varying from 60^0 to 40^0) and the drillhole angle is at 50^0, therefore intersected quartzite shows apparent dip length intersected along the trench and borehole gives apparent thickness as both are not perpendicular to each other, therefore angle corrections are applied. For this the true dip is measured in the pits and intersection angle of cherty quartzite, though the dip angle changes very much as the area folded forming asymmetrical folds (Fig.-3.4). The quartzite true thickness varies from 60 to 80 m. All the details of strike length, dip length and thickness are given in the attached table-6.3.

Quartz veins varies from 2 m to 10 m in PL-12274/2023, PL-12302/2023 & PL-12273/2023. The true thickness of **QV2** varies from 8m to 12 m and here true thickness is considered as 10m (table-6.3).

Feldspar is exposed within pegmatite and comprises almost 60% of pegmatite. The width of pegmatite is almost 500 m in width and for safe purpose the width or thickness is considered as 100 m. mass

4.4.5 Tonnage Factor (Bulk Density)

The drilled drillhole intersected massive cherty quartzite producing core of more than 2.5 m in length, therefore at present the density is considered as 2.65, however as bulk density it is considered as 2.5 and the resources have been estimated taking 2.5 bulk density.

4.4.6 Resource Estimation

The apparent thickness of cherty quartzite along with its quality is determined by drillhole RQDH-2 and the dip length by preparing cross section (Fig.-5.1). Strike length is measured from map and tonnage factor is considered as 2.5, therefore the resources of cherty quartzite intersected by RQDH-2 intersection and surface outcrops is as follow.

Probable category resources of cherty quartzite = 1.95 million tons.
Possible category resources of cherty quartzite = 5.20 million tons.

Total resources of cherty quartzite = 7.15 million tons

Possible category Resources of quartz vein QV2 = 43,125 ton.
Besides this there are exposures of a number of quartz vein and that can be mined.
Possible category of feldspar deposits = 1.50 million tons

Table- 4.1 Details of category wise resources, strike and dip length along with true thickness, tonnage factor and tonnage.

Sr.no	Section	Category	BH ID	Strike length m	Dip length	Apparent thickness m	True thickness m	Tonnage factor	Tonnage ton
1	Pit-8	Probable	RQDH-2	200	60	66	65	2.5	1,950,000
2	Pit-8	Possible	RQDH-2	200	80	66	65	2.5	2,600,000
3	Pit-9	Possible	Exposure	200	65		80	2.5	2,600,000
4	QV2	Probable	Exposure	30	20	8-12	10	2.5	15,000
5	5 QV	Possible	Exposure	15	15	10	10	2.5	28,125
5	Feldspar	Possible	Exposure	200	30	200	100	2.5	1,500,000

CHAPTER 5: MINING CONSIDERATION

The cherty quartzite is exposed on the ridges with NNE to NE strike dipping at 60° to 40° towards east forms an ideal situation for open cast mining method. This is intersected in drill hole RQDH-2

A total resource of Possible and Probable categories is estimated to 7.15 million ton up to vertical depth of 70 m and that extend more than 500 m along strike length with 105 m width across the strike.

5.1 MINING PROPOSAL

This is proposed by the CMCL to produce quartzite, feldspar lumps and blocks of quartzite with increasing rates of production per year for first 5 years. The rates of mining and final production is as per details tabulated in table 5.1.

Table-5.1 Details of proposed year and per day wise Mine production and final finish final production.

Commodity	**Block**	**Year-I** Month 3	**Year-II**	**Year-III**	**Year-IV**	**Year-V**
Ore Mining		**ton**	**ton**	**ton**	**ton**	**ton**
Quartzite	M - Pit 9 & QV2	24,000	150,000	240,000	450,000	450,000
Per Day Mining		320	500	800	1500	1500
Feldspar Peg	Pegmatite	-	-	30,000	75,000	75,000
Per Day Mining				100	250	250
Quartzite Blocks	O - Pit 8	-	14,400	19,200	24,000	24,000
Per Day Mining			48	64	80	80
Plant Feed (50%)						
Quartzite Lumps	M - Pit 9 & QV2	12,000	75,000	120,000	225,000	225,000
Per Day Prod.		160	250	400	750	750
Feldspar	Pegmatite	-	-	15,000	37,500	37,500
Per Day Prod.		_	_	50	125	125
Quartzite Blocks 12.5%	O - Pit 8	-	1,800	2,400	3,000	3,000
Per Day Prod.			6	8	10	10
Final Finish Production (90% recovery)						
Quartzite Lumps	M - Pit 9 & QV2	10,800	67,500	108,000	202,500	202,500
Feldspar Powder	Pegmatite	-	-	135,00	33,750	33,750
Final Finish Production (100% recovery)						
Quartzite Blocks	O - Pit 8	-	1,800	2,400	3,000	3,000

5.1.1 Daily production

In a year 300 days are considered as production days and rest 65 days are included for holidays and maintenance days. Thus in half year there will be 150 production days. Thus per day production of each item is tabulated in table-5.1.

5.2 MINING

Quartz, cherty quartzite and feldspar will be mining in the form of lumps whereas cherty quartzite will be also mined in the form of blocks using wire saw. The year wise production rates and other details are tabulated in table-5.1. For mining the working periods are detailed below.

Working Days

Mine working days	:	300 days per annum
Mine working days per week	:	6 days
No of operating shifts / day	:	1 shifts of 8 hours duration
Effective working hours/ shift	:	8 hours +2 hrs of break

5.2.1 Lump mining of quartz vein (QV2)

During first year it is proposed to mine quartz of quartz vein exposed in PL-12274/2023 for 3 months at the rate of 320 tons per day (Table-5.2) and in subsequent years it will increase as detailed in Tab-5.1 and Table-5.2 from nearby PLs. The Main lode is in QV2 (lode QV2) about 15,000 ton and that will be sufficient for two year. For subsequent years other 5 Quartz Vein (lode QV1, 3 to 6) will be mined, the details are tabulated in table- 5.3 and 5.4. Further exploration in the area adds substantial amount of quartz veins for the future mining. During mining overlying fertile soil will be removed and piled up stocked and preserved separately in the dump area, west of ridge, for use after complete mining of the area to grow bushes and trees etc. Besides soil overburden rocks will be generated as over burden (OB) and that will be also stocked in the dump area as marked on the map in PL-12274. At the time of closing the pits will be filled up by the OB.

5.2.2 Lump mining of cherty quartzite at Pit-9 in PL-12298/2023, PL-12297/2023

According to above proposal (Tab.-5.2) mining will take place in the ridge part for cherty quartzite and will first start at Pit-9 during 1st year in the PL-12297/2023 & PL-12298/2023. It is planned to exploit around 18,000 ton (from Probable category) during 1st year of Cherty quartzite to produce the lumps of cherty quartzite or the powder. In future the production may be increased in multiples. During mining, overlying fertile soil will be removed and piled up stocked and preserved separately in the dump area, west of ridge

(Fig.-5.1), for use after complete mining of the area to grow bushes and trees etc. Besides soil overburden rocks will be generated as over burden (OB) and that will be also stocked in the dump area as marked on the map in PL-12298/2023. At the time of closing the pits will be filled up by the OB.

Table-5.5 Details of bench height, width, length and bench wise resources of Cherty quartzite in Pit-9 area, PL-12298/2023 along with resources of QV1 to QV6 of PL-12264/2023

Bench RL m		Bench	Length	width	Thick	BD	Resources	Resources ton
From	To	No.	m	m	m		Quartzite Ton	Cumulative Quartzite+ Quartz
Cumulative resources of PL12274 QV1+QV2+Q3(Tab.5.3)							24,750	24,750
Cumulative resources of PL12274 QV4+QV5+Q6(Tab.5.3)							15,750	40,500
340	334	1	333	185	6	2.5	924,075	964,575
334	328	2	344	222	6	2.5	1,145,853	2,110,428
328	322	3	351	255.3	6	2.5	1,346,069	3,456,497
322	316	4	370	292.3	6	2.5	1,622,265	5,078,762
310	304	5	388	318.2	6	2.5	1,854,311	6,933,073

Working Days

Mine working days	:	300 days per annum
Mine working days per week	:	6 days
No of operating shifts / day	:	1 shift of 8 hours duration
Effective working hours/ shift	:	8 hours + 2 hours of break

MATERIAL HANDLING

During 1st year mining will start to mine quartz and quartzite in PL-12274 and PL-12298/2023 and that is tabulated in **Table- 5.6.**

Table-5.6 Year wise ore of quartz and quartzite and over burden (OB) material handling in PL-12274/2023 and 12298/2023 (Pit-9). In first year mining will take place for 3 months only.

Year	OB Soil	OB	Ore (ton)	OB+Ore ton	Ore:OB
Year – 1	1,800	990	24,000	24,990	1:0.041
Year – 2	2,790	12,261	150,000	162,261	1:0.081
Year – 3	49,950	16,783	240,000	256,783	1:0.069
Year – 4	91,390	42,063	450,000	492,063	1:0.093
Year – 5	75,000	35,531	450,000	485,531	1:0.078
Total	220,930	107,628	1,314,000	1,421,628	1:0.820

5.2.3 Lump mining of Feldspar

In the east of ridge at lower level between RL 260 m and 225 m white color feldspar is exposed in the pegmatite with 2 km strike length and 650 width. In most of the part of pegmatite feldspar is exposed. Mining of feldspar will start in the 2nd year of mining in PL-12298/2023, PL-12274/2023 and it is proposed to mine 30,000 ton in third year or 100 ton per day (Tab.-5.1 and Table-5.2). In subsequent years production rates will increase as detailed in Table-5.1. During mining overlying fertile soil will be removed and piled up to preserve separately in the dump area, west of ridge (Fig.-5.1), for use after complete mining of the area to grow bushes and trees etc. Besides soil overburden rocks will be generated as over burden (OB) and that will be also stocked in the dump area as marked in the southern part of PL-12298/2023. At the time of closing the pits will be filled up by the OB. The details of soil over burden, rock over burden and ore, which will be transported are tabulated in table-5.7. The open cast bench wise mining will be carried out, therefore, material handling including ore, soil over burden and rock over burden, will be generated year wise is tabulated in table-5.7.

Table-5.7 Details of year wise ore, soil overburden and rock over burden material handling amount for pegmatite in PL-12298/2023 area.

Year	OB Soil	OB	Ore	Ore : OB	Ore+OB
	Ton	Ton	Ton		Ton
Year – 1	-	-	-	-	-
Year – 2	-	-	-	-	-
Year – 3	5,820	3,000	30,000	01:00.1	33,000
Year – 4	15,600	7,500	75,000	01:00.1	82,500
Year – 5	9,000	7,500	75,000	01:00.1	82,500
Total	**30,420**	**18,000**	**180,000**	**01:00.1**	**198,000**

5.2.4 Block mining of cherty quartzite at Pit-8 in PL-12298/2023 & PL-12297/2023

In PL-12298/2023 & PL-12297/2023 is proposed to mine blocks of cherty quartzite around Pit-8. Mining of blocks will start during 2nd year with 14,400 ton of mining and that will increase in subsequent year (Table-5.1).

Though the cherty quartzite is exposed up to 320 m RL, but in this section mining will start at 270 m RL. Considering soil depth and deep weathering up to 2 m depth, therefore the RL of the top of first bench will be at 268 m.

During mining overlying fertile soil will be removed and piled up to preserve separately in the dump area, west of ridge (Fig.-5.1), for use after complete mining of the area to grow bushes and trees etc. Besides soil overburden rocks will be generated as over burden (OB)

and that will be also stocked in the dump area as marked in the southern part of PL-12298. At the time of closing the pits will be filled up by the OB. The details of soil over burden, rock over burden and ore, which will be transported are tabulated in table-5.5..

5.3 METHOD OF MINING

Several mining methods have been developed for exploitation of rock. The selection of mining method depends upon the topography, geological setting, and physical characteristics of the deposit such as shape, grade and the required production of the rock.

The geological investigation and the tests carried out in the area indicates that the cherty quartzite, quartz vein and pegmatite of the area are hard massive and can be used in multiple of industries in the powder form or as lumps and blocks/tiles etc. This occurs forming the ridge in the area, therefore on the basis of topography, environmental aspects and mining considerations, the deposit is best suited for open cast mining methods. The mining operations shall be carried out by conventional method of drilling & blasting, loading and can be excavate and transport by excavator and tipper combination.

The ROM ore after mining shall be transported to the crushing plant by tipper for further processing. The blocks will be transported for further cutting etc. The overburden soil shall be scrapped and stacked separately and later it will be utilized for plantation purposes. The overburden consisting of gneiss, schist, quartzite and pegmatite are proposed to stock separately in designated dumps area west of the ridge. During processing of ROM in the crushing plant, about 50% will be transported to the market and 50% as overburden or loss are proposed to be stacked in dump area.

5.4 MINING EQUIPMENT

The availability of the equipment depends on type of equipment, standard of operation and maintenance, nature of operations involved and ground conditions. The utilization of the equipment depends on standard of operation, skill of the operator and optimum utilization when complete system works but drops substantially when any component of chain action (loading, transportation etc.) is idle/ not working.

Arriving at optimum number of mining equipment relates directly to the capability of the equipment and their optimum utilization in the given conditions for achieving the task. The equipment required can be quantified based on the following approaches:

- Geological set-up
- Working condition
- Capability of the equipment
- Availability and utilization of the equipment
- Material Handling

5.4.1 Capability of Equipment

This has been arrived at on the basis of the design specifications and average performance achieved in the field as observed.

Details of year wise total requirement of Hydraulic Excavator for all commodity with 2 m^3 capacity.

Requirement of excavator for all the three commodities					
Item	**1st year P/D**	**2nd year P/D**	**3rd year P/D**	**4th year P/D**	**5th year P/D**
Quartzite +QV ore + OB/day ton	333	541	856	1640	1618
Feldspar ore + OB/day ton			110	275	275
Total ton of all three commodity	**333**	**541**	**966**	**1915**	**1893**
Excavation loading capacity/day ton	1152	1152	1152	1152	1152
Requirement no.	**1**	**1**	**2**	**2**	**2**

The transport load in case of QV and feldspar is very less so the 1 tipper can handle the mined material of both commodity at different time as detailed in table.

Item	**1st year P/D**	**2nd year P/D**	**3rd year P/D**	**4th year P/D**	**5th year P/D**
Quartzite ore + OB/day ton	333	541	856	1640	1618
Feldspar ore + OB/day ton			110	275	275
Total ton of all three commodity	333	541	966	1915	1893
Transportation capacity ton/shift	380	380	380	380	380
Requirement no.	1	2	4	6	6

5.4.2 Miscellaneous Service equipment

In addition to the above, equipment is also proposed to be provided for dozing, maintenance of haul roads, dust suppression by water spraying, field maintenance, supply of diesel to HEMM in the field, transport of men and material, communication etc.

The summary of mining and miscellaneous equipment required are detailed in **Table 5.22.**

Table 5.22: Requirement of Mining & ancillary machinery

S. No.	Type	Size /	Year wise requirements noumber				
		Capacity	1st yr	2nd yr	3rd yr	4th yr	5th yr
1	Blast hole drill machine Common	105 -115 mm	1	1	1	1	1
2	Hydraulic Excavator	2.7 m3 bucket	1				
3	Tipper Trucks	20 ton payload	2				
4	Water Sprinkler	10 KL	1				
5	Mobile service van		1				
6	Jeep (4 x 4)		1				
7	Ambulance		1				
8	Explosive van	1-ton capacity	1				
9	Fuel Bowser	2 KL	1				
10	Mobile Portable Tower Lights		1				
11	Tyre Changer		1				
12	Diesel Generator	250 KVA	1				

The mining equipment of the above capacities are adequate for total material handling requirements for the proposed production of cherty quartzite area, Quartz veins & Feldspar area during the initial five years of mine operation.

5.5 LIFE OF MINE

On the basis of present resources of probable and possible category and the year wise consumption of the ore the life of all the mines indicates that the life of quartz and quartzite mine (PL-12298 +QV (PL-12274) is 14 years. Life of lump mining of feldspar is 20 years. Life of block mining is not certain as it more depend on fracture pattern and crushing nature of cherty quartzite at Pit-8 in PL-12298/2023 area, however at least it will last for more than 20 years at this rate of mining otherwise life is 109 years (Table-5.24).

5.6 FUEL

5.6.1 Diesel

Diesel will be used as fuel for DG Sets, vehicles etc therefore diesel will be stored in 3x100m^3 capacity tanks for both power generation and the mining equipment fleet. The daily consumption rate during operation, the majority of which will be for power generator and mining equipment and other vehicles, will be approximately 1,500 litres. The storage tanks will be contained within a lined, bounded compound, with all fuel loading and unloading

conducted within concrete aprons. All potential fuel spills will be contained by the overall fuel storage area containment system. Waste oil will be blended with diesel fuel to dispensing system and the power plant feed system.

5.6.2 Gasoline

There will be a 5m^3 capacity gasoline storage tank and pump, which will be used for gasoline operated vehicles and machines. The main storage tank will be contained within a lined, bounded compound, with all fuel loading and unloading conducted within concrete aprons. All potential fuel spills will be contained by the overall fuel storage area containment system.

5.6.3 LPG/Natural Gas

It is proposed to use LPG/ Natural Gas as fuel for the project. An external agency will bring LPG/ Natural Gas pipeline up to the plant vicinity. In plant area a storage facility will be created for gas and then this gas will be metered and fed to rotary drying oven. However, if the TANESCO supply is constant then there will be not be any need for gas operating engines. This shall be decided in Phase-I.

5.7 SURFACE MINING OPERATIONS

For first 5 years it is proposed to increase the ore production per year/per day to produce the 50% final sale-able product. Further production will continue as per fifth year production. There are two types of commodity namely cherty quartzite and feldspar which are need to be crushed in two separate plants. The day wise ore production and final saleable productions are tabulated in table-5.27. The ore crushing plant with 0.225 mt/year or 750 ton/day capacity is proposed for cherty quartzite and 37,500 ton/year or 125 ton/day is proposed for feldspar. However, the ore feeding will gradually increase from 320 ton/day to 1,500 ton/day and 50 ton/day to 125 ton/day respectively for quartzite and feldspar within 5 years. According to this the mining of readily available and mineable reserve in open-pit, loading equipment, and efficient milling requirements is planned. The final production is considered at 90% of feeding tonnage of quartzite will be, assuming 300 days in a year, 10,800 ton during 1st year and 202,500 ton in 5th year and this will continue in further years. Similarly Feldspar's final production will be 18,000 ton in 3rd year (First year for feldspar mining) and 33,750 ton in 5th year and that will continue in further years. The mill design takes into consideration of central milling station for a number of open pits.

For mining operations, the site preparation, haul road construction and maintenance, excavation and haulage of ore to the crusher and waste to the waste dumps, oversize breakage and equipment, consisting of hydraulic excavators (nominally in a backhoe configuration) loading into off-highway rear dump trucks has to be carried out.

5.8 MINE SCHEDULE

The mining schedule has been developed to ensure both flexibility and stability of mining operations. The mining of cherty quartzite is scheduled to commence with the mining along strike with 6 m bench height, 10 to 80 m bench width. The strike trends NNE-SSW direction.

Table 5.27: Production/shift system

ITEMS	Prod/shift SSB
Work Days per week	7
Shifts per day	1
Hours per shift	8
Working per year	300 days
+ 2 hr lunch etc	10 hr
Total Available hrs. per week	56
Mechanical Availability	90%
Mining Utilization	90%
Total Work Hrs per Week	50
Total Work Hrs per Year	2413

5.9 GEOTECHNICAL DATA

The rocks exposed in the PL-12298/2023 block are gneisses, schist, dolomite, pegmatite, quartzite, and quartz vein as detailed in Chapter-3 under sub heading. Out of these rocks' gneiss and schist are comparatively soft then dolomite, quartzite and pegmatite. Quartzite, dolomite and pegmatite are hard and medium hard which will need blasting.

5.9.1 Rock Quality Designation (RQD)

RQD of each rock intersected in the bore holes are determined while logging of the boreholes and recorded. In the core the length of core pieces is recorded along with the number of core pieces. The core pieces with more than 10 cm length are considered for determination of RQD.

The RQD of quartzite, which is intersected in drill hole RQDH-2, is determined by logging the drill core. At places the core of quartzite is recovered with more than 2 m length. The overall RQD of quartzite is around 70 varying from 35% to 100%, besides weathered zone up to 15 m depth.

CHAPTER-6: PROCESSING PLANT

CMCL has proposed to mine quartzite, quartz vein and feldspar in PL-12302/2023, PL-12273/2023, PL-12274/2023, PL-12297/2023 and PL-12298/2023 area located in the Ruangwa district of Tanzania. Quartzite will be mined at Pit- 8 and Pit-9 along with feldspar (Pegmatite) in PL-12298/2023. There are many quartz vein in PL-12302/2023 & PL-12274/2023 and these will be also mined. The quartzite at Pit-9, quartz veins and feldspar will be mine in the form of lumps whereas at Pit-8 quartzite will be mined in the form of blocks using multi wire saw machine. The lumps will be further processed to form the powder by setting up crushing and ball mill plant. Since there are two different commodity i.e. feldspar and quartzite, therefore two crushing plants will be setup. The capacity of plant will depend upon the year wise daily production of ore and final production as tabulated in table-6.1. The crushing plant will produce the following products.

1. Powder for ceramic, crucible, glass and other use.
2. Use in manufacturing the ramming mass.
3. Blocks, tiles etc decorative stones.

Besides this there are many uses of quartzite in construction. For grinding a crusher with 150 ton/hr tons per day capacity will be required along quarry diamond wire saw block cutting machine.

6.1 DETAILS OF PLANT

The proposed plant for quartzite-quartz in stages will be of capacity 0.36 million ton per annum in 5th year. The year wise increase of plant capacity is detailed below.

Table: 6.1 Details of yearly and daily production of lumps of quartzite and feldspar in PL-12298/2023 with 90% recovery.

Name Sub Block	1st year*	2nd year	3year	4th year	5th year
Pit-9 in PL-12298+ QV PL-12274	0.011mt	0.067 mt	0.108 mt	0.202mt	0.202mt
Ore daily production	144 t/d	225 t/d	360 t/d	675 t/d	675 t/d
Feldspar PL-12298 & 12274/y			13500 t/y	33750 t/y	33750 t/y
Ore daily			45 t/d	112.5 t/d	112.5 t/d

*In first year production will be for 3 months.

Fifth year and onward the production of ore and processing of ore will be around 0.265 mt per year or 1000 ton per day (Table-6.1) or 125 ton per hour.

6.2 PLANT COMPONENT

6.2.1 Crushing Unit

This plant will have the following crushing systems

a) Raw ore bin – This shall be made by civil work.
b) Vibrating feeder
c) Primary Jaw crusher
d) Secondary Jaw crusher

6.2.2 Milling Unit (For Feldspar)

It comprises two parts

a) Ball Mill
b) Spiral Classifier

6.2.3 Packaging and Warehousing

a) Screening: The material will be screened into different sizes
b) Packaging: The product will be packed in different bags of sizes from 25 kg to 100 kg bags.
c) Warehousing: These bags will be arranged in the big warehouses as per different specifications of the client.

6.3 OPERATION OF THE PLANT

6.3.1 Stock Yard

The raw material of different grades of ores shall be transported from the mine pits to the stock by dump trucks. These shall be stock piled before the raw ore bins and stock piles shall be made according to the grades of ores. A wheel loader shall be placed here which shall collect the ores from the pile.

A slope of 200 m length of 3.2°gradient shall be made till the top of the raw ore bin.

6.3.2 Raw ore bin

A Raw ore bin shall be constructed in civil with RCC structure which shall have the capacity to hold 100 ton (for feldspar unit) and 500 Tons of ore (for quartzite) in it. The ore shall be dumped by the trucks on the rail grid which is of 6 m x 6 m having beams spacing 350 mm x 350 mm grids. This is placed so that the big rock boulders of over 350 mm should not pass from the grid. In case there are big boulders, then a rock breaker, placed near the raw ore bin shall break it into small pieces.

The rail grid is in placed on the top and the material is stored in the middle of the raw ore bin. The ore bin is designed as a sturdy RCC structure having one side vertical edge and another side having a slope of 50° to give the natural push to the ores stored in.

Below the bin, a Vibrating feeder of capacity 40 Tons per hour (TPH) is placed which shall take feed from the ore bin and supply the ore to the primary crusher.

6.3.3 Crushing Unit

The main purpose of the crushing plant is to crush the rock boulders into small 6 mm pieces and feed to the ball mill. This entire plant is connected with belt conveyors.

6.3.4 Primary Jaw Crusher

The capacity of the primary jaw crusher (Fig.-6.1) is 150 TPH (for quartzite) and 10 TPH (for feldspar). The raw ore input size is 350 mm. output size will be from 75 to 200 mm. The dimension of the crusher will be 2400 (L) x 2300 (w) x 2400mm.

6.3.5 Double Deck Vibrating Screen

The primarily crushed ore directly fed on to the double deck vibrating screen Fig.-6.2, having the capacity 10 TPH (for feldspar) and 150 TPH (for quartzite) and the spacing in the screen/deck will be 200x 200 mm. This material is conveyed through conveyor belt in a closed loop. The under size (-200 mm) of the double deck screen is directly fed on to the conveyor no.3 and transported in to the fine ore bunker in a closed loop.

6.3.6 Secondary Jaw Crusher

The oversized (+200 mm) material pass on to the secondary jaw crusher (Fig.-6.3) having the capacity will be 10 TPH (for feldspar) and 150 TPH (for quartzite). The input and output size of the ore in secondary jaw crusher is 250mm and 90 mm respectively. The output size of the secondary jaw crusher is 90 mm, is directly fed on to the conveyor no.2 in a closed loop and directly pass on to the cone crusher through conveyor belt.

6.3.7 Fine Ore Bins

The fully steel structure constructed bin having the capacity of 10 TPH (for feldspar) and 150 TPH (for quartzite) each will be constructed which will be equipped with electric vibration feeder and belt feeder capacity is 10 TPH (for feldspar) and 150 TPH (for quartzite). The main function of the belt feeder to control the feed to the Primary ball Mill.

6.3.8 Milling Unit

Milling (grinding) makes the sizes of the fine ore into microns to make it for different uses or purpose in the market.

Ball mill is the key equipment to mill the fine ores into small microns. For better recoveries of grades, the material needs to be milled more.

For grinding to feldspar there are number of factors which are taken care of like the optimization of the ball size, RPM of the ball mill flow rate of the material etc. Based on this optimization, ball mill should be designed accordingly.

6.3.9 Ball Mill

It is around steel cylindrical structure mill constructed in vessel lined. Inside of this has manganese steel liners having the thickness of 40 mm to 80 mm and has the effective volume of 11.8 m^3 with maximum load of balls is 26 ton at a time. The various sizes of the ball used inside the ball mill as a grinding medium.

The purpose of this ball mill is to grind the fine ores to small fractions using big balls and high energy index. This will be used for feldspar to make powders.

6.3.10 Packaging and Warehousing Unit

Screens of different silica color and quality shall be used here. The material is sent here from the ball mill screened as per the grains sizes and then they are packed in 40 kg and 100 kg bags. If required in 1ton pack.

These bags will be sent to the warehouse where they will be kept as per different grades, sizes and as per special requirements of the customers.

A ware house shall be built to take up to 2 months of finished stock. It is planned to make a shed of about 2000 square meters.

6.3.11 Transportation/Logistics

The crushed and sized quartz lumps/blocks will be transported in open trucks to Mtwara port. At the Mtwara, the material will be stored in a designated warehouse. From there, it will be exported to customers via break-bulk vessels. Similarly, Feldspar powder will be packed in Jumbo bags and exported in container vessels from Mtwara/Dar port.

6.4 RUN OF MINE (ROM) ORE STOCKPILE

Ore will be stocked according to the variation of grades and quality on the ROM pad. However, before the rainy season, mining operation will be done in two shifts so as to have double production of ore per day. The stockpile of minimum 7,200 ton for feldspar and 12,000 ton for cherty quartzite will be created (sufficient for 90 days for plant feed). This will be worked on during the intense rainy season when access to the pit will be limited.

6.5 GRADE CONTROL AND RECOVERY ESTIMATE

The grade and quality of lumps of feldspar and cherty quartzite will be checked and classify at the ROM level and finally after ball mill level. Final recovery estimate will also be done at powdering level. The grade, quality and color of quartzite blocks will be done in the mine itself so it can be dispatched right from the mine.

6.6 PLANT OPERATION

The process plant will be operated and maintained by local suitably qualified staff, under the direction of the engineering manager, according to procedures detailed in the maintenance manuals which will be supplied with all installed equipment. A database will be developed to facilitate planned maintenance. All staff will use proper lock-out and safety procedures when working on plant equipment. In total, it is envisaged that the plant will have over 70-80 full time staff including specialist.

6.7 Seismicity

Determining the stability of a tailings structure under earthquake loading is of critical importance to tailings dam design. Mines often produce loose, saturated sands. These are highly susceptible to liquefaction under earthquake loadings. Liquefaction of tailings in the impoundment, places an additional sudden shear force on the dam embankment, which does not occur in conventional water storage dams. The result is an increase in pore pressures along each failure surface as well as an additional internal force against the dam. Consequently, all dynamic analyses for tailings dams, including pseudo-static, simplified, and complex state-of the- art analysis, must account for this extra shear force. Procedures used for the analyses of a conventional water dam must be adjusted.

Historical earthquake records and the influence of faulting or other tectonic features on the estimate of probability of occurrence, magnitude and location of possible seismic activity have been carefully examined to evaluate seismic potential in the Project area. The Eastern and Southern Africa covers a region, which is prone to significant levels of seismic hazard due to the presence of the East African rift system. The Ruangwa district, where the project is located, is situated outside the Rift Valley area and is in the low risk zone for seismic activities. Figure-6.6 shows the earthquake intensity and degree of risks in Tanzania (PL-12274/2023, PL-12273/2023, PL-12302/2023, PL-12297/2023 and PL-12298/2023). This provides for careful design of the open pit, waste dump, tailings storage dam, structures and buildings to account for risk of earthquakes that can cause potential failures of the pit slopes, dam embankments, etc.

CHAPTER 7: ENVIRONMENTAL AND SOCIOECONOMIC CONSIDERATION

Classic Mining Company Limited has engaged Consultant, Eng, Jones P. Mushi, NEMC/EIA 0468, P.O. BOX 36195, Dar Es Salaam and that has carried out the study on "Environmental Impact Statement for Classic Quarts and Feldspar Mining and Processing Project at Mtondo, Nambilanje and Mkaranga Village, Nambilanje Ward in Ruangwa District - Lindi Region".

Mining activities will have definite impact on environment therefore remedial measures will be taken to eliminate the ill effect or minimize to the extent possible.

7.1 Management of Air Pollution:-

(A) DRILLING: -The major source of dust production in the mine is drilling, blasting and vehicle movement. Drilling will be done by wet drilling method by providing water injection system and also dust extractors which are fitted at the collar level to collect the dust. Dust extractors will be cleaned regularly to maintain their efficiency.

(B) BLASTING:-Continuous work on improving the powder factor will be done to produce minimum quantity of dust. Similarly, drilling pattern will be adopted which produces minimum fines.

(C) MUCKING:-After blasting, the muck will be sprayed with water so that fines become wet and will not rise during mucking.

(D) GRINDING:-Before the mineral is fed to the crusher and grinding unit, water will be sprayed to quench the dust.

(E) TRANSPORT:-The haul roads will be sprayed with water by water tankers, three to four times a day, so that the fines lying on the haul road become wet and will not be raised by movement of dumpers or trucks.

(F) MONITORING:-For monitoring the dust concentration (SPM) in the air at various points quarterly, adequate no. of High Volume Air Samplers will be procured. One for two pits and air samples will be collected at the following points:

1. Mine office
2. Each pit rest shelter
3. Colony entrance
4. Haul road entrance to each pit

Monitoring will be done quarterly.

7.2 Water Pollution Control Measures

Water is required at the mine for spraying on roads, muck and domestic use. The water sprayed on roads gets soaked on road and that on muck is in a very small quantity which wets the muck and gets evaporated within few hour of dumping in dump yard.

Domestic water will be discharged as waste in the mine office or colony. It will be treated in septic tank and soak pits to be provided in adequate numbers in office premises and in the staff colony.

7.3 Management Of Noise Pollution

The noise produced by machinery will be minimized by the following measures:-

a) Proper maintenance of all machinery,
b) Only trained operators will be allowed to operate,
c) All machines will be used at optimum capacity,
d) Plantation of trees around grinding units, haul roads will be done to minimize the noise,
e) Monitoring will be done quarterly,
f) Workers and operators working new D.G. Sets, Crushers and Drilling sites will be provided with ear muffs.
g) The monitoring of noise level will be done quarterly at Mine Office, Pit Shelter and Haul road entrance to pits.

7.4 Management of Top Soil

Before drilling and blasting near the surface, the top soil layer will be scrapped and stacked on a ground level and will be used for plantation every year if suitable for the same.

7.5 Management of Land By Reclamation And Rehabilitation

The deposits of industrial minerals is sufficient for more than 30 years period, hence reclamation of pits will be done after about 30 years by back filling with overburden from the dumping yard. However this resource is expected to increase more pertaining to further detailed exploration which shall be done on timely basis leading to increase in deposit life. The top soil stacked and available at that time will be laid over the fill to convert it into agricultural or social forestry use. In present 5 year planning the mining will be done on hill slope surface only.

7.6 Management of Dumps

The dumps will be provided with stonewalls with 2 m height all around except the haul roads to check the rolling of boulders. After the second lift is started, the slope of the first lift will be planted with shrubs for its stabilization.

7.7 Management of Flora And Fauna

The area is devoid of water body. The area falls in tropical region, which supports in the growth of vegetation. Minimum cutting will be done and from 1st year itself plantation will be done to maintain the ecosystem around the mine area. Mostly mining activity will be done during day time therefore wild animals will not be disturbed. Besides this there is no water body therefore wild animals do not come this side as water available far below the present area towards NE. In day time hare, fox and birds are seen in the area

7.8 Afforestation Program

During five years about 500 saplings of local varieties of trees will be planted every year at the following places

a) PLANTATION BEYOND 5th YEAR

Plantation will be carried out at the foot of the dump and slope every year by using local shrubs. 100 trees will be planted along the periphery, non mineralized zone and along the slope of mine which is gentle and terrace type every year.

b) POST PLANTATION CARE

Post plantation care will be an important aspect to be taken care for better survival rate of plantation. The following care will be taken:-

(I) Protection from Grazing and Fire: Fencing will be provided around the area where mass plantation has been proposed. These fencing will comprise of 1.5 m high fencing wire and at places stone wall. This will help in preventing and protecting from unauthorized entry of out-side person and fire. Due care will be taken to protect plantation as well as the fencing.

(II) Watering during Dry Spell: During dry spell, water will be sprinkled using water tanker provided with 20-30m long hose pipes.

(III) MANURING: Initially, fertilizer /manure will be given to the pits before and after plantation. Thereafter manuring will be continued on reduced scale till the plant attains growth of 2 to 3 m height. Provision of utilizing bio-manure will also be made within the lease area.

(IV) WEEDING AND SOIL WORKING: Man power will be engaged in mulching the soil frequently along with removal of weeds.

(V) REPLACEMENT OF CAUSALITY: About 20% of saplings are unable to adjust at a new habitat and some are destroyed away by animals. It is essential to replace the causality regularly.

7.9 Socio-Economic Benefits

The nearby area is covered by scanty population and they depend on agriculture and animals. The study of the buffer zone reveals that the area is moderately backward where majority of people depend on agriculture. The area will provide job to around 30 workers in first year and that will increase to 50 employed for mining work and other work earning 3 to 5 USD per day for unskilled and semi- skilled persons as against 5 to 7 USD per day. Technical and other qualified people will earn much more than the above wage.

Schools, private as well as Government, will run in the buffer zone. Market, Carpentry, Black-smithy and vehicle repair shops will come up giving indirect employment to a large number of persons. Thus, the mining will benefit directly and indirectly about 500-1000 persons in the area.

The EIA carried out indicated that there will be more positive impact and growth due to coming of mining industry in the area rather than negative impact. However, negative impact can be minimized or removed by taking proper care.

CHAPTER-8: STAFFING REQUIREMENTS

8.1 Total Personnel Requirements

8.1.1 Mine Supervisory, Process Plant and Other Personnel

CMCL estimates that its workforce will amount to 50-80 persons, including expatriates.
These personnel will be employed in mine management, process management and operations, and administrative positions.
Including those employed by the mining contractor, the total personnel complement for the Ruangwa project, under steady-stage operating conditions, is estimated at approximately 50-80 people.

8.1.2 Construction Personnel

CMCL forecasts that a peak of 50-80 construction management and contract people will be on site during the construction of the processing plant and project infrastructure.

8.2 Training Programs

Training and professional development programs will be installed at Ruangwa. One of the primary aims of these training programs is to employ and continuously train Tanzanian staff, with the objective of developing them into future senior managers of the Classic Mining Company Limited or other Tanzanian mining organizations. Areas that will be covered by the professional training programs include:-

- Health, safety and environmental awareness training;
- Training and development of all employees;
- Operator training and multi-tasking;
- Graduate training;
- Supervisor training; and
- Blasting training.

Professional development programs will be open to all employees within the organization but will be primarily directed towards the development of national employees to higher levels of professional competence and qualification. The type of profession development programs that will be available include:

- **Practical skill advancement**. This will result in selected employees being given the opportunity to develop increased levels of skill and advancement in their existing classification or job.

- **Higher level educational development**. This will apply to employees who work in a position requiring a higher education or academic standards. Examples include geologists, surveyors, metallurgists and engineers.

Tanzanian personnel will be trained in the operation and maintenance of mining and process equipment, and in administrative functions.

CHAPTER - 9: CAPITAL AND REVENUE ESTIMATES

9.1 CAPITAL COST ESTIMATES

The capital cost is required to purchase the mining equipment, the processing plant equipment, power generation system, administration structures, etc. A list of the mining equipment, processing plant machinery, buildings and other assets to support the project, etc., is summarized in below tables. The equipment are purchased in stages as the Plant grow year wise, additions of units are there and accordingly the mining equipment will be also purchased in stages as the ore production also will be at same pace.

The life of mine is 25+ years and the life of machines is 10 years. Therefore, subsequently new equipment may be purchased.

CLASSIC MINING - SUMMARY OF INVESTMENT COST ESTIMATE
Quartzite & Feldspar Mining and Processing Project
(In USD Unless Specified Otherwise)

Sn	Description	P1	P2	P3 (Feldspar)	Total
1	Mine and Site Development	350,000	30,000	30,000	410,000
2	Building and Infrastructure	674,100	260,300	110,000	1,044,400
3	Process Plant including EPCM	1,147,000	500,200	781,000	2,428,200
4	Miscellaneous Fixed Assets	1,185,200	371,700	712,100	2,269,000
5	Electrical Infrastructure	167,600	131,550	131,550	430,700
6	Pre-Operative Expenses	500,000	-	150,000	650,000
7	Contingencies	352,400	129,400	176,500	658,300
	Sub-Total	**4,376,300**	**1,423,150**	**2,091,150**	**7,890,600**
8	Working Capital Requirement	1,000,000	-	250,000	1,250,000
	Total Investment	**5,376,300**	**1,423,150**	**2,341,150**	**9,140,600**

9.2 REVENUE ESTIMATES

Quartz lumps and Block

Since there is a growth of demand of natural quartz therefore, there is a probability of increasing of prices. At present the medium quality price of quartz varies from $50 to $150 according to the qualities of quartz. The prices of re-crystalized quartzite block varies from USD$ 250 to USD$ 400 per ton according to it's designed and polish.
Observing the quality and quantity of quartzite and QV here the saleable price is considered for quartz lumps as 95 USD$/ ton, whereas for block it is 290 USD$/ton.

Feldspar

Export data shows prices of feldspar fluctuating between $47 and $110 per ton. Therefore, on the basis of quality of feldspar exposed in the area is considered to USD$ 110 for all calculation and economic analysis purpose.

9.3 ECONOMIC ANALYSIS

9.3.1 Economic Indicator Cash Flow Analysis

Evaluation of the project's costs and revenues has been undertaken. A discounted Cash flow analysis that has generated a positive Net Present Value (NPV) and an Internal Rate of Return (IRR) of the project has been cumulatively (price) presented in Table 9.3. The following important economic parameters have been used in generating a discounted cash flow analysis:

A discounted Rate of Return on the Project of 10%

Income Tax rate of 30% applicable for Tanzania.

Interest on a Long-Term Bank loan of 10%

Tax exemption on fuel, oils, and other imported supplies have not been considered and when incorporated will also greatly boost the cash flow of the project.

Based on the above parameters the project has shown to have good potential to generate cash as summarized in some of the important economic indicators shown in Table 10.3

9.3.2 Sensitivity Analysis

Sensitivity of the cash flow or cash flow deviations from the planned projections provides a picture of the level of risk the project will be undertaking when some economic parameters of the project changes. Some of the parameters such as price of the product, price of inputs, exchange rates, market interest rates, etc., greatly influence the profitability of the project.

Sensitivity analysis for the quartz, feldspar project is conducted to see how the discount rate, price of quartzite and feldspar, and changing interest on the bank loan affects the Net Present Value of the project.

TABLE 9.3 Important Economic Indicators of the Project

No.	Items	Value
1.	Net Present Value of the Project (NPV) @ 10%	$15.12 Million
2.	Post Tax Internal Rate of Return of the Project (IRR)	20.11%
3.	Discount Rate of the Project	10.00%
4.	Payback Period	6 years 6 months

	Proposed SPV - Classic Mining Company at Tanzania													
	Projected Financials of Quartzite & Feldspar Processing Plant													
ECONOMIC PARAMETERS		Grade of Finished Quartzite/Feldspar			100%									
		Royalty for Quartzite/Feldspar (%)			3% + 1.5%									
Average Grade of Quartzite/Feldspar in Ore	100%	Average Inflation Rate			5%									

549,000 TPA Quartzite & Feldspar Ore Input Plant

1830 TPD Processing

239,250 TPA Finished Quartzite & Feldspar Production

QUARTZITE/FELDSPAR PROCESSING PLANT							Sale 90%	Sale 95%						Quantity
Year			Year 1 (3months)	Year 2	Year 3	Year 4	1	2	3	4	5	6	7	10
Quartzite/Feldspar Ore Mine Production (tonnes)			25,000	164,400	309,200	549,000	25,000	164,400	309,200	549,000	549,000	549,000	549,000	549,000
Quartzite/Feldspar Content in Ore Mined (In-situ)	Grade	100.0%					12,500	89,400	164,200	286,500	286,500	286,500	286,500	286,500
Total Finished Quartzite (Blocks) tons per annum							**0**	**1,800**	**2,400**	**3,000**	**3,000**	**3,000**	**3,000**	**3,000**
Total Finished Quartzite (Lumps) tons per annum							**11,250**	**67,500**	**112,500**	**202,500**	**202,500**	**202,500**	**202,500**	**202,500**
Total Finished Feldspar (Powder) tons per annum							**0**	**0**	**18,000**	**33,750**	**33,750**	**33,750**	**33,750**	**33,750**
Total Finished Quartzite Sold (tonnes)- Blocks							0	1,710	2,366	2,968	2,998	2,998	2,998	2,998
Total Finished Quartzite Sold (tonnes)- Lumps							10,125	65,194	110,135	197,882	202,269	202,269	202,269	202,269
Total Finished Feldspar Sold (tonnes)- Lumps							0	0	17,100	32,918	33,708	33,708	33,708	33,708
Total Finished Quartzite in Stock (tonnes)- Blocks							0	90	125	156	158	159	161	166
Total Finished Quartzite in Stock (tonnes)- Lumps							1,125	3,431	5,797	10,415	10,646	10,877	11,108	11,800
Total Finished Feldspar in Stock (tonnes)- Lumps							0	0	900	1,733	1,774	1,816	1,857	1,982
TOTAL SALES QUARTZITE (BLOCKS)		$290	**0**	**1,710**	**2,366**	**2,968**	**$0**	**$521**	**$756**	**$996**	**$1,057**	**$1,110**	**$1,165**	**$1,349**
TOTAL SALES QUARTZITE (LUMPS)		$95	**10,125**	**65,194**	**110,135**	**197,882**	**$962**	**$6,193**	**$9,940**	**$18,799**	**$20,176**	**$21,185**	**$22,244**	**$25,751**
TOTAL SALES FELDSPAR (LUMPS)		$109	**0**	**0**	**17,100**	**32,918**	**$0**	**$0**	**$2,055**	**$4,154**	**$4,466**	**$4,689**	**$4,924**	**$5,700**
CLOSING STOCK (Valuation at cost)							$72	$176	$300	$426	$459	$492	$528	$648
Less: Brokerage & Commissionon on Sales	5% of Sales						$48	$336	$638	$1,197	$1,285	$1,349	$1,417	$1,640

LESS COSTS

QUARTZITE/FELDSPAR PROCESSING PLANT ($ 000)			Quantity - Tons per Annum				Amount in USD in Thousands ('000)							
			Year 1	Year 2	Year 3	Year 4								
(A) Quartzite/Feldspar Mining Cost	**14.47%**	$4.00	25,000	164,400	309,200	549,000	**$100**	**$690**	**$1,364**	**$2,542**	**$2,669**	**$2,803**	**$2,943**	**$3,407**
Cost of Ore	**$12**													
(B) Administration Costs	**13.57%**						**$167**	**$942**	**$1,278**	**$1,378**	**$1,447**	**$1,520**	**$1,596**	**$1,847**
Cost of Administration per ton on Finished Concentrate	**$11**													
(C) Processing Plant Operating Costs	**58.63%**						**$424**	**$2,833**	**$5,524**	**$9,177**	**$9,801**	**$10,283**	**$10,789**	**$12,464**
Cost of Production per ton of Finished Goods	**$48**													
(D) Other Misc. Costs	**13.33%**						**$285**	**$750**	**$1,255**	**$1,952**	**$2,083**	**$2,187**	**$2,296**	**$2,658**
Cost of Misc. per ton of Finished Concentrate	**$11**													
			Quantity - Tons per Annum											
Total Cash Cost of Production ex Plant	per ton		11,250	69,300	132,900	239,250	**$64**	**$50**	**$44**	**$35**	**$37**	**$38**	**$40**	**$46**
Total Cash Cost of Production FOB at Dar/Mtwara Port	per ton						**$89**	**$76**	**$72**	**$64**	**$67**	**$70**	**$74**	**$85**
TOTAL DIRECT OPERATING COSTS (A+B+C+D)	**100.00%**						**$976**	**$5,216**	**$9,421**	**$15,049**	**$16,000**	**$16,792**	**$17,624**	**$20,376**

				239 K										
QUARTZITE/FELDSPAR PROCESSING PLANT	**Year 1**	**Year 2**	**Year 3**	**Total**										
(F) COST OF PROJECT	Amount in USD Thousand ('000)													
Mine and Site Development	$350	$30	$30	**$410**										
Building and Infrastructure	$674	$260	$110	**$1,044**										
Process Plant including EPCM	$1,147	$500	$781	**$2,428**										
Miscellaneous Fixed Assets	$1,185	$372	$712	**$2,269**										
Electrical Infrastructure	$168	$132	$132	**$431**										
Pre-Operative Expenses	$500	$0	$150	**$650**										
Contingencies	$352	$129	$177	**$658**										
Working Capital Requirement	$1,000	$0	$250	**$1,250**										
Total Capital Cost	**$5,376**	**$1,423**	**$2,341**	**$9,141**										

QUARTZITE/FELDSPAR PROCESSING PLANT PROFITABILITY														
Quartzite/Feldspar Processing Plant EBIT							**$10**	**$1,338**	**$938**	**$3,974**	**$4,408**	**$4,646**	**$4,897**	**$5,731**
Total EBDIT							**$10**	**$1,338**	**$938**	**$3,974**	**$4,408**	**$4,646**	**$4,897**	**$5,731**
Less: Depreciation							$875	$1,160	$1,578	$1,578	$1,578	$703	$418	$0
Less: Interests on Working Capital Loan		Avg. Rate	10.0%				$25	$100	$125	$125	$109	$68	$26	$0
Less: Interests on Debt		Avg. Rate	10.0%				$219	$745	$789	$690	$427	$164	($0)	$0
Profit Before Tax (EBT)							**($1,109)**	**($667)**	**($1,555)**	**$1,581**	**$2,293**	**$3,711**	**$4,452**	**$5,731**
Less: Taxes @ 30%		Rate	30.0%				$0	$0	$0	$474	$688	$1,113	$1,336	$1,719
Profit After Tax							**($1,109)**	**($667)**	**($1,555)**	**$1,107**	**$1,605**	**$2,598**	**$3,117**	**$4,012**
Add: Depreciation							$875	$1,160	$1,578	$1,578	$1,578	$703	$418	$0
Cash Profit Available for Repayment / Appropriation							**($234)**	**$493**	**$24**	**$2,685**	**$3,183**	**$3,301**	**$3,535**	**$4,012**
Less: Repayment of Working Capital Loan							$0	$0	$0	$0	$417	$417	$417	$0
Less: Repayment of Debt							$0	$0	$0	$2,630	$2,630	$2,630	$0	$0
Surplus							**($234)**	**$493**	**$24**	**$55**	**$136**	**$254**	**$3,118**	**$4,012**
Less: Re-investment in Project CAPEX														
Net Cash Surplus							**($234)**	**$493**	**$24**	**$55**	**$136**	**$254**	**$3,118**	**$4,012**
Less: Dividend Tax @ 10%		Rate	10.0%								$47	$25	$312	$401
Net Cash Distributed											**$426**	**$228**	**$2,806**	**$3,611**
Less: Government's Equity @ 16%		Rate	16.0%								$68	$37	$449	$578
Net Profit							**$0**	**$0**	**$0**	**$0**	**$358**	**$192**	**$2,357**	**$3,033**
Opening Cash Balance						$0	$0	$0	$0	$0	$0	$426	$654	$10,138
Closing Cash Balance						$0	$0	$0	$0	$0	$426	$654	$3,461	$13,749
Internal Rate of Return (IRR) of Project	**20.11%**													