NAJIM AND COMPANY LIMITED

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DAR ES SALAAM

FEASIBILITY STUDY REPORT FOR GOLD MINING PROJECT IN MASAGALU, KILINDI DISTRICT TANGA REGION TANZANIA

SUBMITTED TO:

MINISTRY OF ENERGY AND MINERALS

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As a Partial Fulfillment for the Application of Mining Licence.

SEPTEMBER 2016

EXECUTIVE SUMMARY

This Feasibility Study is made for Masagalu Gold Mining Project owned by M/S Najim and Company Limited (NCL). The NCL is local registered company in Tanzanian owning 10 Primary Mining Licenses (PML) currently amalgamated into one area (Amal-20/2016EZ) for gold mining at Mfyarimi area in Masagalu Village, Kilindi District in Tanga Region. The submission of this report to the Ministry of Energy and Minerals is a mandate in the application for Mining License. The total area applied for Mining License is 0.94 square kilometers.

This report describes the status of the geological, engineering, economic, socially and environmentally studies of the Masagalu Gold Mining Project (MGP) based on the present state of knowledge with respect to the deposit. It remains possible, however, that the conclusions reached in the continuing studies may result in changes to the various project parameters described in this report. This report has been compiled by Liganga Consultancy Limited based on information supplied by NCL.

Profit mining requires an independent, long-term technical and economic perspective to evaluate the ore deposit in terms of its short-medium and long term feasibility conducted by an independent party. Whether it's advice on project feasibility, property acquisitions or disposals, financing, geotechnical stability or mine closure , Liganga Consultancy Limited has knowledgeable and extensive experience to ensure that the client obtain the proper advice without any conflict of interest.

The Masagalu gold deposit in the Kilindi Handeni Superterrane shows mineralization styles typical of medium to high grade metamorphic Proterozic age which is classified as part of the Proterozoic Usagaran System that occurs east of the Archaean Tanzanian Craton. It has been believed that the mineralization style of Kilindi Handeni is similar to the one of Lake Victoria Gold Field (LVGF) after a study showing the rocks of Handeni – Kilindi Superterrane (KHS) is the product of reworked greenstone rocks of LVGK. The rocks of KHS are characterized by flat or steeply dipping quartz lodes and silicified garnetiferous reef carrying arsenopyrites, pyrite and gold with minor base-metal sulphides and carbonate alteration of wall rocks, and are apparently related to region fault. Regional an aeromagnetic survey results indicate the large potential concealed magnetic body across the Aml-20/2016EZ. Shafts and pits excavations revealed a very interesting geological setting that led to the discovery of a graphitic zone at the edge of the mineralization at the boudins of the Quartz biotite gneisses. Also high grade gold mineralization intersecting in the silicified garnetiferous reef crosscutting the gneisses.

The average thickness of the ore body is 0.9 m while the average grade is estimated to be 13.0 g/t. The ore resource at the area applied for Mining License is estimated to be 778,842 tons of ore at an average grade of 13.0 g/t over a strike length of 800 m and a vertical depth of 600 m. The resource is therefore estimated to be 357,804 ounces. A dilution factor of 10% of the tones mined has been applied with these tones containing a grade of 13.0 g/t. The MGP is intended of using gravity separation method to recover gold. Recoverable resource is estimated at 322,024 ounces from the 700,958t with annual production is 28,713 ounces. Total amount of waste per year is estimated at 37,500 tones.

It is anticipated that at full production, the mine will employ approximately 105 persons. The average cash cost of producing gold, over the life of the project, is estimated at approximately US$564 per ounce. The total preproduction capital expenditure in developing the underground mine and constructing the surface facilities for a rated capacity of 250 tons of ore per day is estimated at US$39, 000,500.00.

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DECRALATION

Liganga Consultancy Limited declare this Feasibility Study is compiled from the limited data produced by Najim and Company Limited on the mineral right no Amal-20/2016EZ located at Masagalu Gold Project in Kilindi District, Tanga Region Tanzania. Liganga Consultancy Limited made extensive use of the academic and technical aspects of exploration and mining reports and other recognized source. Where possible the work of other were used by acknowledging them intent. This study is non-compliant with NI 43-101, JORC and SAMREC on mineral reserve: It should be noted that, volume and grade are hypothetical and estimates are conceptual.

CHAPTER 1 INTRODUCTION

M/S Najim and Company Limited (NCL) is a local registered company in the United Republic of Tanzania through the Ministry of Industry and Trade. NCL owning Licence No. Amal-020/2016EZ issued on 19th August 2016 by the Ministry of Energy and Minerals through its Eastern Zone Mines Office in Dar es Salaam. The Amal-20/2016EZ amalgamated from 10 Primary Mining Licenses (PML) Nos. 012717EZ – 012726EZ respectively held by NCL. This Amal-20/2016EZ issued for metallic minerals at Mfyarimi area in Masagalu Village at Kilindi District in Tanga Region.

The Amal-20/2016EZ which is referred as Masagalu Gold Project (MGP) in this report, has a total area of 0.94 km^2 resulted from the 10PML's (Nos. 012717EZ to 012726EZ) equivalent to 94 ha or 232 acres. The amalgamated area of 0.94km^2 is what M/S Najim and Company Limited applied for Mining Licence.

1.1PROPERTY DESCRIPTION, LOCATION AND ACCESSIBILITY

The proposed project area is located about 350 km North West of Dar re Salaam though the tarmac road from Dar es Salaam to Handeni District and about 105 km west of Handeni District to Kilindi District though a paved gravel road. Songe is the town centre of the Kilindi District, both Handeni and Kilindi Districts are among the other districts of Tanga Region. From Songe town drive south of the town via the Songe – Mziha road about 55 km of drive turn left to Mfyarimi sub-village a distance of 2.5 km drive to the north direction.

Artisanal mining activities are conducted by neighbor's owner of PML's Mining Licences contiguous to the Amal-20/2016EZ of NCL. In most of the PML's, artisanal workings are conducted in shallow pits at a maximum of 15 m depth of the shaft and underground tunnels following the quartz vein or reefs rich in gold. There couples of shafts within the MGP which were excavated by the Artisanal previous which are at an average depth of 10 m. An underground mining will be developed at a strike length of about 1 km within the existing artisanal mine workings after a detailed ground work.

Figure 1 shows a location map of the MGP in relative to the map of Tanzania. The project boundaries are defined by the corner coordinates shown on Table 1 taken in Arc 1960 coordinate system similarly to those given by the Ministry of Energy and Minerals on the Amal-20/2016EZ document.

Table 1 Corner coordinates of the applied Mining License (Amal-20/2016EZ) in Arc 1960

Corner	Latitude (S)			Longitude (E)		
	Deg	Min	Sec	Deg	Min	Sec
1	5	42	4.75	37	21	37.64
2	5	42	78.70	37	22	25.23
3	5	43	0.69	37	22	25.23
4	5	43	9.69	37	21	37.40

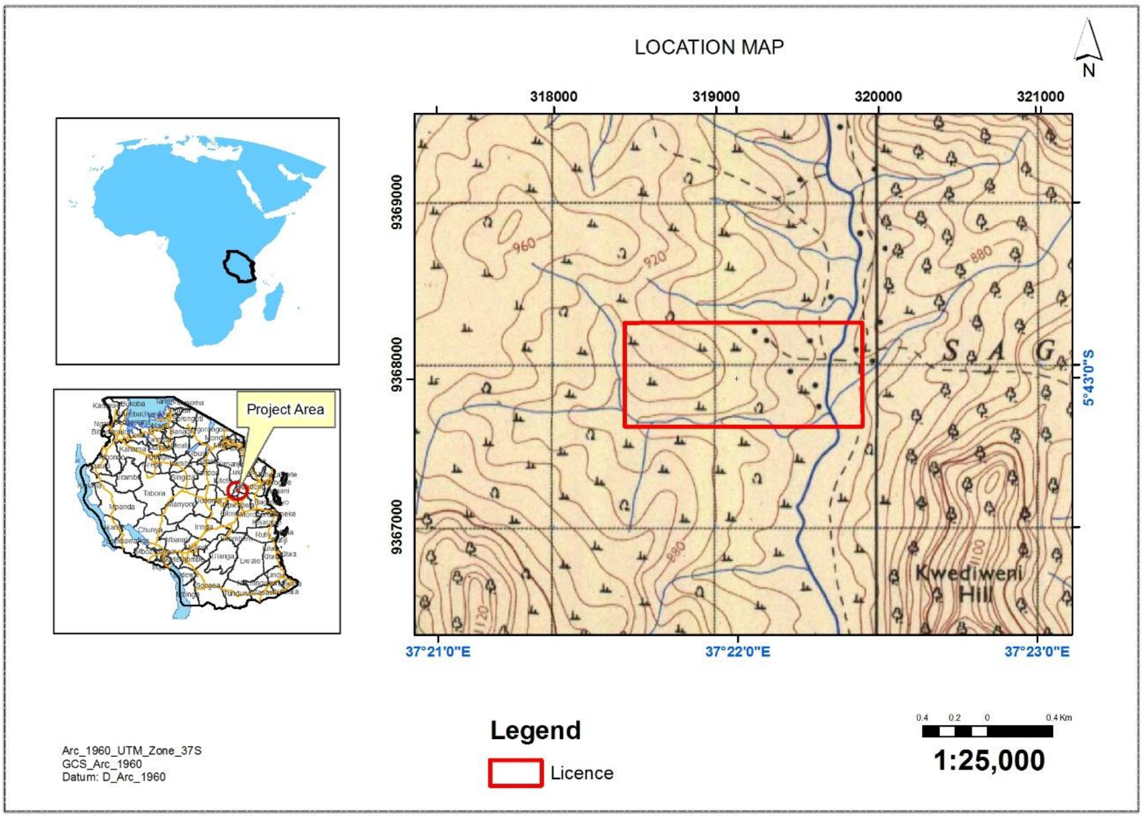


Figure 1. Location of MGP applied Mining Licence area

1.2TOPOGRAPHY

Tanga Region is generally lying between the medium to high grade metamorphic rocks forming the ridges and hills and couple of valleys and streams with the general flow of northwest to southeast. Tanga Region is characterized by a very heterogeneous topography:

- ❖ The coastal plain extends inland in a varying width of between 20 km and 30 km. In the west it is bordered by a small escarpment rising up to 200 m.

- The northern part of the region features the Umba plains which extend far into Kenya. It gently slopes from north to south towards the Umba River, which originates from the northern part of the West Usambara Mountains and drains the entire plain. The average altitude of the plain is about 500 meters.
- The Southern part of the Umba Plains and the Usambara Mountains form, a massive mountain range rising in the south-west to an altitude of more than 2,000 m. The Lwengera River which is a tributary of the Pangani River divides within its north-south valley of the Usambaras into an eastern and western part. The East Usambaras rise to about 1,000 m to form a central 28 plateau. Several large rivers divide the West Usambaras into topographic sub-areas.
- The valley of the Pangani River extends south of the Usambaras in a north-west/south-east direction.
- The central Handeni Area bordered in the north by the Masai Steppe is an undulating bush savannah with average elevations between 400 m and 600 m.
- The Masai Steppe reaching far into Tanga Region in its north-western part, is a gently undulating plain, with scattered elevations between 700 m in the north-east and 1,200 m in the south-west. The area is relatively dry (average annual precipitation approx. 600 mm) and drained by some minor seasonal rivers which flow into the Pangani River.
- The Nguu Mountains almost in the extreme West of Tanga Region are a narrow mountain range which rises up to nearly 2,000 m and borders the Central Handeni Area and continues into Morogoro Region.

Tanga Region is part of the largest Indian Ocean drainage basin and it drains mainly through the Pangani River and its tributaries (e.g. Mkomazi, Soni River and Lwengera). The extreme northern parts of the region are drained by the Umba river, whereas drainage in the coastal belt is made possible by a number of short coastal rivers e.g. Sigi river, most of them with seasonal discharge only.

Despite of being the fourth gold producer in Africa continent, Tanzania as among the other African countries, its economy depends heavily on agriculture, which accounts for almost half of GDP, provides 85%of exports, and employs 80% of the work force. Topography and climatic conditions, however, limit cultivated crops to only 4% of the land area. Industry traditionally featured the processing of agricultural products and light consumer goods. The World Bank, the International Monetary Fund and bilateral donors have provided funds to rehabilitate Tanzania's out of date economic infrastructure and to alleviate poverty.

1.3PROJECT BACKGROUND AND RATIONALE

The demand for gold is quite high and prospects are high that the price may continue to remain above the US$ 1200 per ounce for the next several years in the future (www.goldprice.org). The reason for this high demand is that the major sources of supply sales which are central banks over the last few years have dried up. That means a pathway from the central banks into the hands of investors, a shift in ownership. If investor demand continues, gold supply will depend on gold mining. This means that areas which could not be profitably mined when the price was below US$ 300 per ounce in the late 1990's to early years of 2000's can now become profitable prospects. Figure 2 shows the trend of gold price over the past twenty years.

Through this venture the company will be able to generate profits to the company's shareholders and communities surrounding the project and can also create additional revenues to the Government through payment of royalty, corporate taxes, import duties and many other taxes that are resulting from various business transactions. Other benefits include employment, develop the life of the people around the project and improve infrastructure and other social services like health and education.

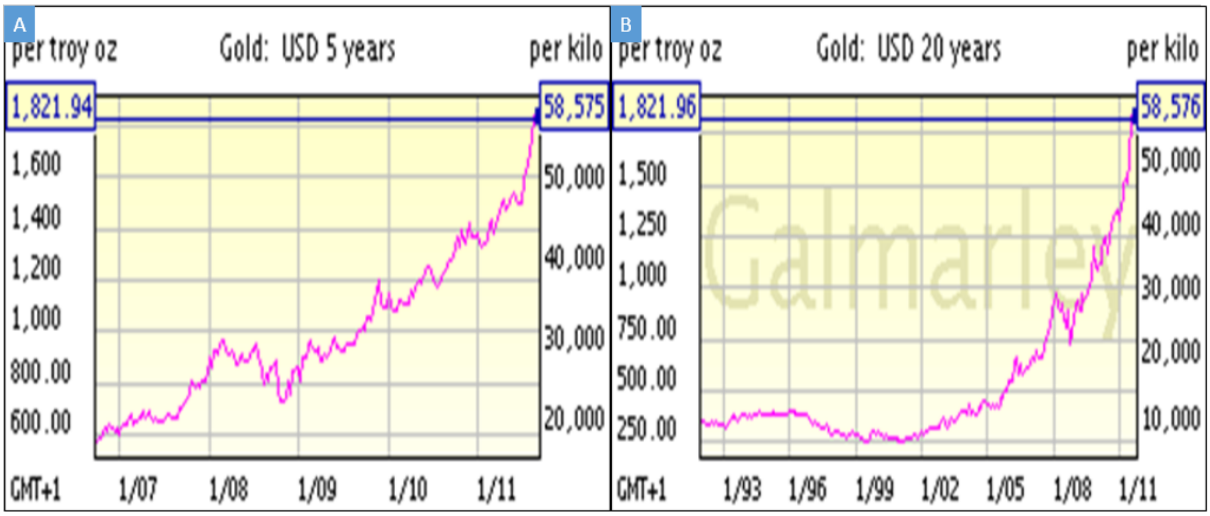


Figure 2. A) Gold price trend for the past five years and B) for the past twenty years.

1.4 CLIMATE SOIL AND VEGETATION

1.4.1 CLIMATE

Due to close proximity to the equator and the warm Indian Ocean, the Region experiences tropical climatic conditions similar to all Tanzanian coastal Regions. The Region experiences hot and humid weather throughout much of the year and has a tropical wet and dry climate as based on Koppen's climate classification. Annual rainfall is approximately 1,290 mm (51 in), and in a normal year there are two rainy seasons: "the long rains" in April and May and "the short rains" in November and December (Table 2).

The dominant climate in Tanga Region is warm and wet. It is found along the coast and in the inland. In the Western plateau of Handeni district a hot and dry climate dominates and in the Usambara Mountains a temperate climate. In most cases, there is no big variation of temperature at the coast due to the influence of the Indian Ocean. However, during the hot months (December to March) the average temperature in Tanga is approximately 30°-32°C during the day and about 26°-29° C during the night. While, during the cool months (May to October) temperatures are approximately 23°-28° C in the day and 20° C -24° C in the night.

Another characteristic of the coastal climate is the high atmospheric humidity, which often goes up to 100% maximum and 65 to 70 percent minimum. In Tanga region most areas get rainfall of at least 750 mm. per year. The amount of rainfall is about 1,100 to 1,400 mm. along the coast, decreasing inland but with the exception of the Usambara Mountains, where, depending upon slope position and height, the amount of rainfall may exceed 2000 mm. per year. In the Maasai Plains (North West of Handeni) and in the dry plains of Korogwe, the average rainfall is below 600 mm. In a nutshell one would say that the annual pattern of mean monthly rainfall is bi-mode with maximum monthly occurring in April and May throughout the region. Some areas in the West Usambaras 23(e.g. south-facing slopes) tend to have their maximum rainfalls during November/December. Mean annual rainfall ranges from 600 -800 mm (most parts of Handeni district, northern Lushoto and Muheza district) and 1,200 -1,400 mm (coastal belt, Western and Eastern Usambaras), during peak periods, amount exceeding 2,000 mm/p.a. may occur in the Usambara Mountains. (Malocho, 1997).

Table 2. Climate Condition of Tanga Region

CLIMATE DATA FOR TANGA REGION													
Month	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**Year**
Average high °C (°F)	32.30	33.00	33.30	31.10	29.70	29.30	28.50	28.60	29.20	30.20	31.20	32.20	30.72
	-90.10	-91.40	-91.90	-88.00	-85.50	-84.70	-83.30	-83.50	-84.60	-86.40	-88.20	-90.00	-87.30
Daily mean °C (°F)	27.80	28.20	28.40	27.10	26.00	25.10	24.30	24.20	24.60	25.60	26.80	27.70	26.32
	-82.00	-82.80	-83.10	-80.80	-78.80	-77.20	-75.70	-75.60	-76.30	-78.10	-80.20	-81.90	-79.38
Average low °C (°F)	23.40	23.40	23.60	23.20	22.30	20.90	20.10	19.80	20.10	21.10	22.40	23.20	21.96
	-74.10	-74.10	-74.50	-73.80	-72.10	-69.60	-68.20	-67.60	-68.20	-70.00	-72.30	-73.80	-71.52
Average precipitation mm (inches)	30.00	27.00	98.00	225.00	294.00	84.00	69.00	63.00	78.00	106.00	140.00	76.00	1290.00
	-1.18	-1.06	-3.86	-8.86	-11.57	-3.31	-2.72	-2.48	-3.07	-4.17	-5.51	-2.99	-50.78

1.4.2 SOIL

Tanga Region has four major types of soils are closely related to the physiography and can be identified as follows:-

- Well drained, deep to moderately deep, red and yellowish red clays, sandy clays, loams and clays, mainly on Usagaran rock within the mountainous areas;
- Well to medium drained, shallow, moderately deep to deep red and brown sandy loams, loamy sands and clays in the upland areas;
- Well to moderately well drained, light colored sands and yellowish brown to yellowish red loams and clays in the coastal areas;
- Poorly to imperfectly drained, grey to black clays and sands (partly saline) in the alluvial plains as well as minor valleys and depressions.

1.4.3 VEGEGATION

The outstanding feature of the vegetation is its complexity. The coastal area is dominated by bushland, palm gardens, village cultivations and estates (mainly sisal). The upland plateaus are covered with bushland and shrub thickets interrupted by swampy low-lands and river swamps as well as village cultivations, estates and palm gardens. The prevailing vegetation in the Umba Plains and the Maasai Steppe is open savannah grassland with scattered trees and scrub thickets. Mainly the mountain areas (West and East Usambara, Nguu Mountains) still feature considerable areas under primary forest (approx. 5% of total regional surface); however, as a result of the high population density in these areas the forests are endangered and land and wood have become scarce. In the less populated bushland areas, thicket development as secondary vegetation prevails.

1.5 SOCIAL SERVICES

In Tanga Region, the basic means of economic are agriculture, fisheries, livestock farming, mining and bee keeping. Farmers in Tanga Region are similar to other regions in Tanzania, both grow cash crops as well as food crops. They earn income through selling live animals meat, milk (goats) & eggs (poultry). Some of the farmers are also part time fishermen and others are artisanal miners. The existence of natural resource based activities as well as non-natural resource based activities which are used by farmers to achieve their livelihood outcomes.

Major economic activities among the societies surrounding the project site include farming; Livestock keeping and artisanal mining.

1.6 ECONOMIC ACTIVITIES

According to various consultations made with stakeholders from village level to district level, the major economic activities among the societies surrounding the project site include farming (maize, beans, cassava, vegetables, sisal, potatoes, banana, honey and timber), Livestock keeping, fishing, trading, tourism and small scale gold mining. Trading includes transportation and selling of farming products.

1.7 DEMOGRAPHY

The population of Tanga region has been increasing since 1957 and more than doubled in 1988. In 1957 its population was 579,382 people and in 1988 it rose to 1,283,592 people. Population of Tanga in 1988 was about 6 percent of the total Tanzania mainland's population and makes Tanga region the Seventh populous region after Mwanza, Shinyanga, Mbeya, Dar-es-Salaam, Kagera and Arusha. The population of Tanga is projected at 1,644,849 people in the year 2000 and this will increase population density by 28 percent from 48.1 persons per Sq. Kms. in 1988 to 60 persons per Sq. Kms. Higher population densities may sometimes be associated with widespread poverty and other serious social problems, let alone unsustainable use of natural resources.

1.8 ETHNIC GROUPS

In terms of ethnic composition, Lushoto Handeni and Kilindi districts have the most homogenous population while Muheza, Korogwe, Tanga and Pangani feature a very heterogeneous tribal composition where no single ethnic group accounts for more than 20% of the total district population. The main ethnic groups in terms of their numbers are Sambaa, Zigua, Bondei and Digo. Sambaa are the main ethnic group in the Usambara Mountains and low lands of Muheza, in Korogwe and Lushoto they account for nearly 40% of the region's total population. The Zigua are the main ethnic group in Handeni district and partially Korogwe and Pangani districts, while Bondei are mainly in Muheza district and part of Pangani. Digo are the main ethnic group in Tanga district and part of Muheza district. Both Bondei and Digo depend on livestock keeping and fishing along the coast. There are other small ethnic groups such as Segeju, Duruma, Mbugu and Pare. Asians and Europeans mostly occupying the urban centres in the region, account for a very small population. The 1978 census showed the composition of ethnic groups by district as follows:

- Handeni – Kilindi District - Zigua 66.1%, Nguu 17.9%, Others 16.0%.
- Korogwe District - Sambaa 42.8%, Zigua 18.1%, Others 39.1%.

- Lushoto District - Sambaa 78.3%, Pare 14.0%, Others 7.7%.
- Muheza District - Bondei 16.5%, Sambaa 15.8%, Digo 13.8, Zigua 6.8%, Segeju 6.1%, Makonde 5.6%, Others 35.4% 5
- Pangani District- Zigua 22.5%, Makonde 14.0%, Yao 6.5%, Others 57.0%.
- Tanga District - Digo 18.0%, Sambaa 13.9%, Bondei 10.7%, Zigua 7.6%, Segeju 7.5%, Others 42.3%.

1.9 INFRASTRUCTURE NETWORK

Tanga Region has a total of 3,907 km. of road network, of which 352 km. are trunk roads, 939 kms are Regional roads and 2,716 km are District/feeder roads. Recently Handeni and Korogwe Districts are tarmac road connected to the main Dar es Salaam – Tanga / Kilimanjaro high way. Three District centres, Tanga, Muheza and Korogwe are located directly along the main tarmac road, while the others, Kilindi, Lushoto and Pangani are connected with the trunk road network.

The commercial air service to the region is on occasional basis. Although the electrical power grid is reaching most areas of Tanzania it does not extend to the area of the Masagalu Gold Project whereas the National Grid network ending at Songe town the centre of the district “the District headquarter”. Within the area, several mobile telephone networks (Vodacom, Airtel, Halotel, Tigo and TTCL) and internet communication is available via mobile hotspots or one local internet café which its service is not reliable due to lack of customers.

CHAPTER 2 GEOLOGY AND MINERALIZATION

2.1BACKGROUND OF GOLD MINING IN TANGA

The gold mining and exploration in Tanga Region has a historical history. It has been mining and explored in various areas in Tanga especially in Handeni, Kilindi, Lushoto and Muheza Districts. The gold activities took a serious steps in Handen and Kilindi Districts in recently years. Talking gold mining and exploration in Tanga Region, nowadays you have to look the history of Handeni and Kilindi Districts previous known as Handeni District.

The Handeni District (Handeni and Kilindi Districts) in eastern Tanzania is a target for Proterozoic gold deposits. Although gold mineralization was described in the area since the early 1950's, it was only at the end of the previous century that artisanal miners focused on the area following the successful exploration for gold in the Lake Victoria Gold district. Since the late 1990's, several localities within the Handeni region, including the Magambazi gold occurrence, became the focus of small scale gold mining. In addition to Magambazi, Kwadijava and several other high grade, typically visible gold prospects were located in Handeni and Kilindi Districts are controlled by major, medium and small scale miners.

At Kilindi District there several major medium and small scale miners who are exploring and mining for gold, to mention few of them are; Canaco (now East African Metals), Handeni Gold Inc, Benzui Resources, Mojar One Company Ltd, Garland Group (T) Ltd, MEIS Industries Company Ltd, Jubilee Resources Ltd and many other induvial local Tanzanian.

Recent attention by the exploration and mining community on the Handeni and Kilindi Districts has been mainly due to the successful drilling campaign conducted by East Africa Metal at Magambazi which has greatly expanded and improved on the original discovery. Further impetus for gold exploration in the Handeni and Kilindi District followed from the work of the University of Western Australia, which found that the Proterozoic rocks in this region were derived from Archaean material similar to those in the Lake Victoria region. The study concluded that the Handeni – Kilindi Archaean age rocks may yield significant gold finds of world class scale. The excellent results obtained at Magambazi Hill and its surroundings seem to corroborate the high gold potential of the region. Additional to this, a regional geophysical work conducted by Geological Survey of Tanzania reveal the potential of the Handeni Kilindi Superterrane. The Kilindi Handeni Superterrane (KHS) is believed to be of the same age as that of the Archaean lithologies ~2.7 Ga (Figure 3). The recent work from Kabete (2008) cited in Groves (2010) entails that the KHS lies on the same regional structural trend at NW – SE as the Sukumaland Corridor of the LVG. The rocks from this area believed to be overprinted by high grade metamorphic event caused by regional tectonic effects (Groves, 2010 & Kabete *et al*, 2012).

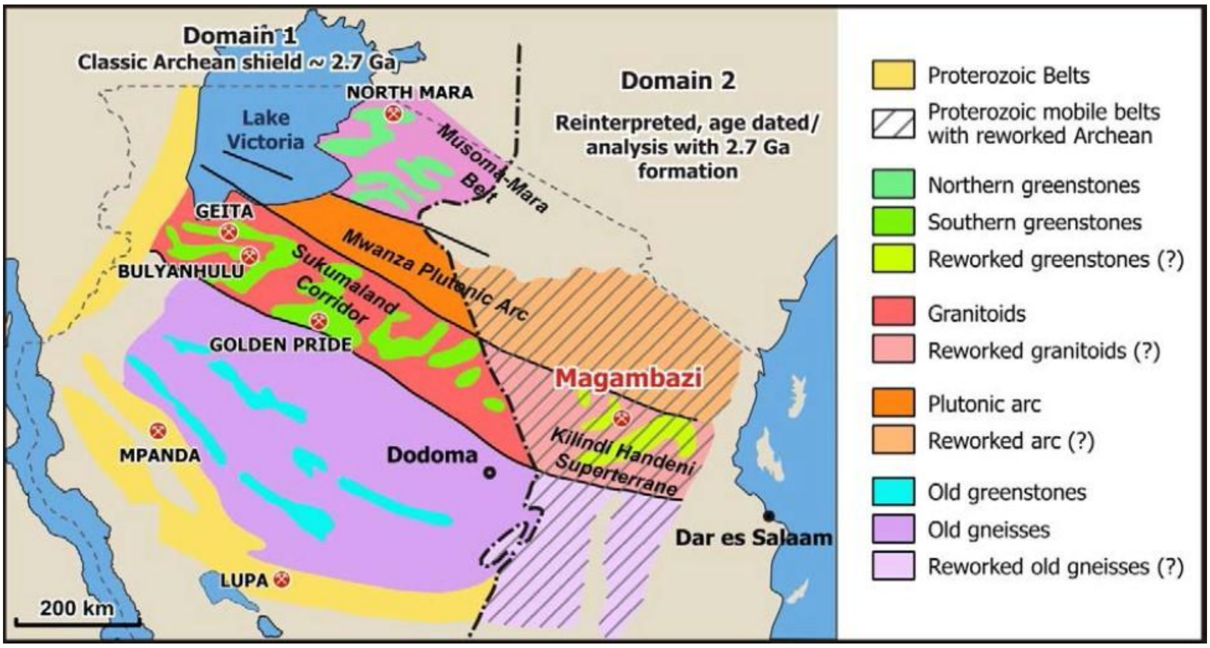


Figure 3. Schematic map of tectonic subdivisions of the Tanzania Craton with interpreted reworking concept model (Groves, 2010).

2.2GENERAL GEOLOGY

The geology of Tanzania represents the geological framework of the African continent; its present appearance is a result of a series of events that start from the evolution of Archaean shields “Dodoma shields” to its modification through metamorphic reworking and accretion of other continental rocks, which later on covered by the sediments derived from continent (Quenelle *et al*, 1956; Harpum, 1970 & Semkiwa *et al*, 2005). Its landscape is influenced by pre-rift magmatism followed by active rifting both in the eastern and western sides of the country. It consists of rocks from the Archaean age, Proterozoic rocks from Ubendian and Usagaran and the Phanerozoic sedimentary rocks from the Bukoban and the Karoo series.

The Tanzania Craton covers most of the central and one third of the western part of the country, it is roughly bounded by the EARS and the Proterozoic Usagaran and Ubendian belts. The Archaean rock hosts the kimberlitic pipes and one of the biggest kimberlite in Africa where host the diamond deposits “Mwadui” (Figure 4), also the major source of the lode gold deposits “greenstone belts – Nyanzian system” (Semkiwa et al, 2005).

The Archaean basement terrain is bounded by the series of the Proterozoic mobile belts, the Usagaran belt to the east and the Ubendian belt to the west. The Proterozoic rocks from the Usagaran System host most of the colorful gemstones including ruby and tanzanite, and newly discovered gold deposits. Recent work by Kabete (2008) in Groves (2010) interprets that the portion of the Usagaran belt which may contain Archaean crustal rocks which underwent high grade metamorphism may contain gold as well. The Ubendian belt is an example of the economic potential for base metals and gold deposits as exemplified by the Lupa gold field in Chunya area (Semkiwa *et al*, 2005).

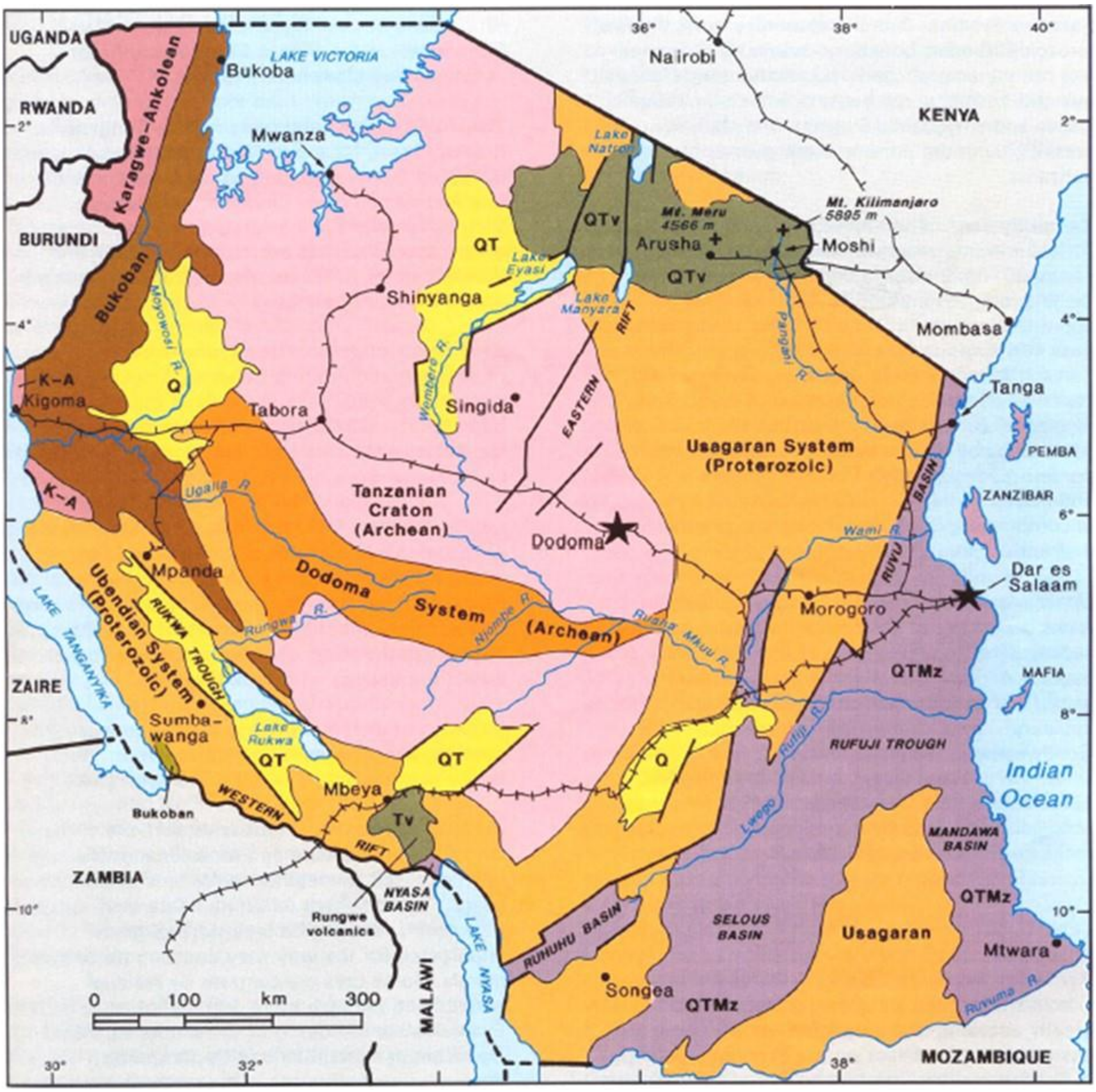


Figure 4.Generalized geology of Tanzania (Semkiwa et al, 2005).

According to Semkiwa *et al* (2005), **Phanerozoic** rocks are represented by a series of sedimentary units of Paleozoic to Mesozoic age, which is followed by a pre – rift period of kimberlitic and related alkali mantle – derived intrusive and extrusive activity that presaged active rifting. Rocks related to this event intrude up to Upper Mesozoic and Lower Cenozoic sedimentary formations which include the Karoo formation, which are rich in coal and uranium deposits. A period of rift-related intrusive and extrusive activity followed, concentrated in the Arusha area – to the northeast and Mbeya area – to the southwest, which is responsible for mountain-sized volcanoes such as Mt. Meru and Mt. Kilimanjaro. Harris (1981) documented that placer gold; diamond and colored gemstone deposits found across the country resulting from a wide variety of recent and largely semi to unconsolidated wind, water, and weathering-derived recent formations.

2.3GENERAL STRATIGRAPHY

The lithological structural provinces in Tanzania cover from the Archaean, Proterozoic to Phanerozoic eons including the Paleozoic, Mesozoic and Cenozoic era (Quenelle et al, 1956; Harpum, 1970; Harris, 1981). Stratigraphic sequence of the geology of Tanzania is represented in Figure 5.

Archaean rocks older than 2.5 Ga form the oldest unit. It consists of granite – greenstone belts in which linear belts of greenstones (volcano-sedimentary) sequences, are found within a larger region of predominantly granitic rocks (Harpum, 1970). The Archaean consists of the Dodoman System, Nyanzian System, Buganda Toro system (the granite gneiss system which is not well documented in Tanzania) and the Kavirondian system (Quenelle et al, 1956). Rammlmair et al (1990) suggesting four generations of the granitoid in relation to Archaean rocks of Tanzania. It ranges from the Nyanzian basement granites, granitic gneisses and migmatites (G3) to synorogenic granites, granodiorites (G4 and G5) and post orogenic alkali granites and syenites (G6).

Dodoman System is the oldest basement. Its rocks have the age of about 3 Ga older than the greenstone 2.7 Ga and its surrounding granites, forms an east - southeast trending of the lowermost Archaean rocks in the country. It consists mainly of rocks originated from the sedimentary sequence, mafic volcanics and ultra – mafic intrusive. Also, they contain rocks from low to high grade metamorphic facies (Quenelle *et al*, 1956 and Thomas *et al*, 2013).

The Nyanzian System aged at 2.7 Ga. It consists of a series of typical volcano – sedimentary sequences or greenstone belts within a much larger area of granite – gneiss complexes. It evolved complex volcanics from mafic to felsic sub aerial volcanic rocks derived from volcaniclastic rocks. The iron formations and associated intrusive of a variety of intermediate to felsic compositions are present as well. All of these comprises the greenstone belts of Nyanzian System (Harpum, 1970). Harris (1981) divided the Nyanzian into two series, the upper and lower series. The lower series consists of; primary basalt, andesite, dacite pillow lava, banded iron formation (BIF), recrystallized chert, shale, and conglomerate. The upper series consists of felsic lava assemblages, tuffs, ferruginous cherts, BIF and meta-pelites. The greenstones are generally metamorphosed to greenschists facies and are folded with abundant structures developed. It is of major economic importance due to its gold deposits from small to large scale mining and the diamondiferous kimberlite.

Kavirondian System is the youngest system in the Archaean of Tanzania. It is located in the northern part of the country. It consists mainly of conglomerates, coarse arkosic, feldspathic grits and quartzites along with minor granitic and volcanic rocks. It is unconformably with the Nyanzian System (Harpum, 1970).

Proterozoic rocks of Tanzania are divided into two systems, the Usagaran belt and Ubendian belt aged between 2 Ga and 1.8 Ga. The Usagaran belt covers the eastern part of Tanzania, characterized by rocks of high grade metamorphism of both sedimentary and igneous origin. Sommer *et al* (2005) documented that, Usagaran belt consists of deformed and metamorphosed rocks characterized by post Usagaran granitoids and minor supracrustal successions at its northern part. At its southern part, it consists of weakly deformed and nearly unmetamorphosed rocks. These rocks include the rhyolite, dacitic and andesitic volcanic rocks, which overlie the older Usagaran basement. Moller *et al* (1995) documented that the Usagaran belt characterized with amphibolitized eclogites intercalated with other layers of pelites (metapelites and semipelites) and occasionally carbonate.

According to Harpum (1970); Stern (1994) and Moller et al (2000), the metamorphic assemblages of the **Usagaran System** resulted from the Pan African tectonothermal event that affected the MB resulted to the amphibolite granulite facies related to granitisation and migmatisation origin. Part of the Usagaran belt contains the same rocks as the Nyanzian System, which overprinted by high grade metamorphic events caused by tectonic activities. This raises the economic importance of the system; apart from rich in colored gemstone but also it contains gold deposits (Groves, 2010; Kabete et al, 2012; Reddy et al, 2003; 2004, Kroner et al, 2004).

The Ubendian System located to the south west of the country, is characterized by the rocks of lower Proterozoic to Archaean mobile belt that bound the Archaean Craton. Harris (1981) suggests that the Ubendian belt contains variety of high-grade metamorphic rocks of both sedimentary and igneous origin as the Usagaran belt, whereas gneisses; minor mafic and ultramafic intrusive are the dominant lithology. The lithologies are folded and trending northwest to southwest. Its economic importance are colored gemstone deposits, gold and base metals.

Karagwe-Ankolean System dated 1.3 to 1.4 Ga years extends west of Lake Victoria, and is found along the northwest boundary of Tanzania with Burundi, Rwanda, and Uganda. It is younger than the other two system in Proterozoic, consisting mainly of argillaceous and arenaceous formations. Harpum (1970) suggests that the sedimentary features of the Karagwe-Ankolean rocks replicate shallow-water deposition. Low-grade metamorphism has transformed many of these units to sericite schists and quartzites. Its economic importance comes from the intrusion of granites which host the tin and tungsten mineralization.

Phanerozoic rocks of Tanzania consist of Bukoban System, Karoo System and Mesozoic Kimberlite Pipes. The Bukoban System is the recent cover overlying the Nyanzian System rocks at the northwestern part of Tanzania bordering the Uganda, Kenya and Burundi (Figure 5) (Semkiwa *et al*, 2005). The system comprises with the following rocks, sandstones, quartzites, shales, red beds, dolomitic limestone and chert along with the amygdaloidal basalts, and gabbroic to doleritic sills and dykes. The economic importance of the Bukoban System is the association of mafic rocks containing copper deposits (Harris, 1981).

The Karoo System covers nearly the eastern coast of Tanzania, the southwest to northeast flanks and overlies the Usagaran to the immediate eastern part whereas there is no Karoo, which covers to the western side; though Harpum (1970) reported that there are series of dolerite dyke swarms concentrated on the Iramba Plateau and the Crater Highlands, both shoulders of the Eyasi graben and in the Musoma area. Harris (1981) suggested that the Karoo system comprises of continental sediments ranging from Late Permian to Jurassic in age, these include coarse sandstones, shales and siltstones, structurally the Karoo lies unconformably upon the

Precambrian basement. Economic importance of the Karoo system is the coal formation and the secondary uranium deposits.

Mesozoic rocks, kimberlite pipes, Harpum (1970) documented six provinces of kimberlites in western Tanzania. These are the Shinyanga - Mwadui, Mabuki, Speke Gulf, Lake Eyasi and Iramba Plateau kimberlite provinces; several carbonatite intrusive complexes have been recognized and mapped. Cenozoic is the youngest unit characterized by sedimentary and extrusive volcanics. It includes the marine and continental sedimentary rocks of the coastal plain and inland basins as well as Miocene to modern alkali and sub alkalic extrusive related to rifting.

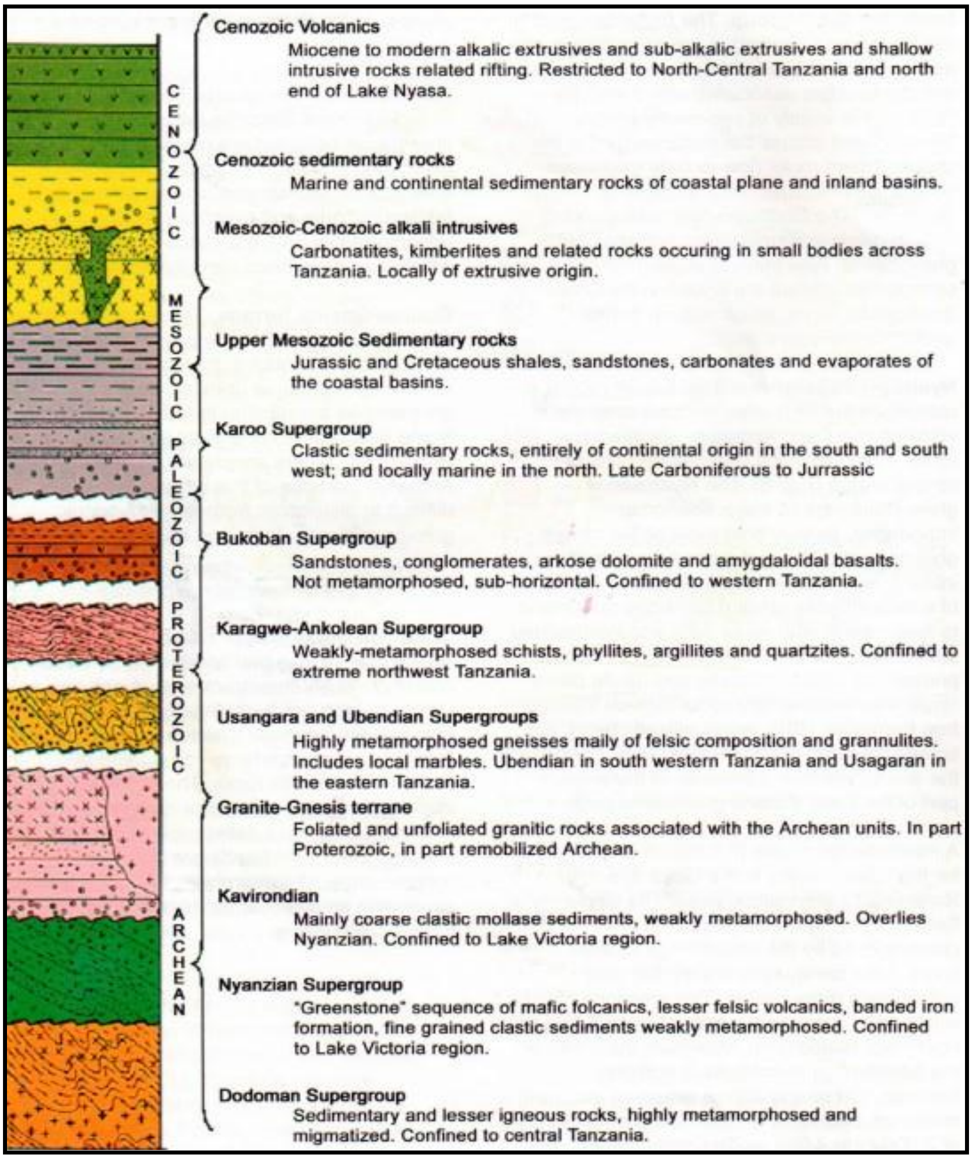


Figure 5.Simplified stratigraphic sequence of Tanzania geology and its economic significance (Semkiwa et al 2005).

2.4GEOLOGY OF HANDENI KILINDI SUPERTERRANE

The geology of Handeni and Kilindi Districts represents the geology of Kilindi Handeni Superterrane which is classified as part of the Proterozoic Usagaran System that occurs east of the Archaean Tanzanian Craton. The Usagaran System is oriented north – south and dominated by high grade metamorphic rocks of amphibolite to granulite facies. It is characterized by a sequence of ultramafic to felsic volcanic flows, black shales and quartz bearing sedimentary rocks (Scheepers, 2010).

The Masagalu Gold Project is characterized by the following lithological units: the granulite gneiss as the basement overlain by paragneiss and interleaved para-amphibolite rocks. These are overlain by amphibolite-mafic gneiss with abundant quartz veining. Garnet containing mafic rocks overlie the orthogneiss and rafts of amphibolite. The post kinematic intrusions are covered by saprolite and thick soil derived from weathered metamorphic rocks (Figure 6) (Groves, 2010; Kabete *et al*, 2012).

Scheepers (2010) and Howard (2011) suggested that high grade metamorphism has converted the original lithologies to a variety of metamorphic equivalents including: biotite-hornblende-garnet-pyroxene gneiss, migmatitic augen garnet hornblende- pyroxene gneiss, quartzo-feldspathic hornblende-biotite-pyroxene gneiss, pyroxene-hornblende-biotite-garnet granulite.

The geology of KHS represents a non-traditional exploration environment dominated by the high grade metamorphic rocks trending NW-SW. Historically the region has a potential for colored gemstones until early 2003 where artisanal miners discovered alluvial gold within the area. This was followed by a recent re-interpretation of the regional structural data (Kabete *et al,* 2012) which suggested that, the rocks from KHS lie on the same trend NW-SW as that of Nyanzian System hosting gold mineralization.

The main host rocks are silicified garnet bearing amphibolite enclosed within a sequence of interbedded paragneiss and amphibolite as well as within the siliceous or quartz veins, (Scheepers, 2010; Archibald, 2011). Major and micro structures including ENE trending thrust faults, NW-SE shear zones, folds and NE-SW trending brittle and ductile faults zones are developed (Scheepers, 2011).

The country rocks dominated within the MGP are mainly Quartz Feldspathic Gneiss of fine to course grained with strong foliation. It composes of quartz, biotite, plagioclase, occasionally Muscovites and/or phlogopite, garnet (red and pick) graphite and sulphides minerals. These rocks experience different episode of tectonic activities which evidenced by fold at large and small scale, faults and shearing with s-fabric and a shear indicators. These units have a general strike ranges between 80 and 110 with an average strike of 095^{o} and the plunge of 180^{o} with a dip of 30^{o} to 40^{o}.

The ore geology (host rocks) of the area characterized by the series of garnet to amphibolitic rocks, these include garnet silica rock, garnet rich bearing amphibolite and quartz veins and commonly develop in a course grained Quartz Biotite Feldspathic Gneiss rocks in association of graphite minerals.

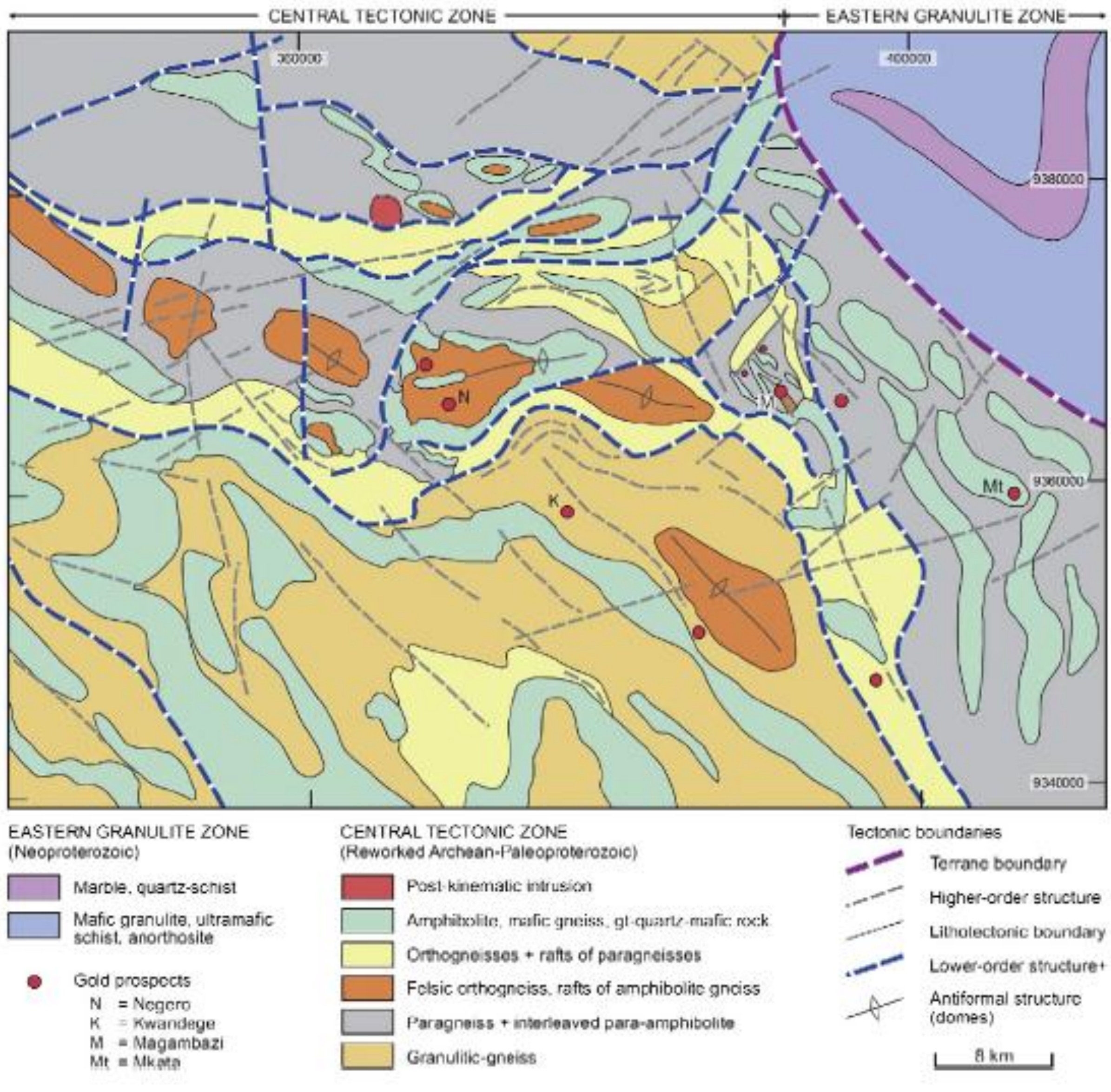


Figure 6.Geology of the Kilindi–Handeni Superterrane in the Southern East African Orogen. A result of qualitative interpretation of high-resolution magnetic and radiometric imagery interpreted in terms of geology (Kabete et al, 2012a).

2.5 MINERALIZATION AT HANDENI KILINDI SUPERTERRANE

Gold mineralization in Handeni Kilindi Superterrane is categorized into four deposits types as; (a) free gold in relation to vein stringers and reef hydrothermal transported" (b) gold related with shear and fault zones (c) gold deposited earlier in the sediments and remobilized during regional deformations and (d) gold in association of alluvial deposits.

Groves *et al* (1998) categorized gold mineralization controlled by structure as orogenic gold deposit which has been affected by the metamorphism. The gold mineralization occurs in both native state and associated with sulphides such as pyrrhotite arsenopyrites and is geometrically often in quartz veins, veinlets and scattered pods (Scheepers, 2010 and Archibald, 2011). Sulphide minerals related to gold mineralization include pyrrhotite, chalcopyrite and arsenopyrite (Scheepers, 2010). Other minerals related to gold mineralization are galena and locally graphite (Howard, 2011 and Groves, 2010) as develop in MGP of NCL.

There are two zones of mineralization style in MGP. The first type is the free gold develop in boudin system of the fold limbs associated with course grained Quartz Biotite Feldspathic Gneiss with major minerals include; quartz graphite phlogopite and plagioclase. Mineralization take place within the thin shear zone and in boudins. Second type of gold mineralization in MGP is the one associated with sulphide minerals which basically develop in the garnet silicified rocks across the Quart Feldspathic Gneiss in association with fault zones.

The close association of gold mineralization with these faults and the boudins along the fold limbs resulted in a projections along a strike distance of nearly 1000 m (1 km) with a suggestive a genetic relationship, which was not recognized during the period of prospecting and mining activity prior to 1950. Recognition of this association provides a useful exploration tool for newcomers.

2.6GEOTECHNICAL INFORMATION

The potentially hazardous nature of underground mining requires the application of sound geotechnical engineering practice to determine the ground conditions, the ground support and reinforcement requirements, as well as the size, shape and orientation of all the openings that can be safely and economically excavated in a particular rock mass. It is recognized that underground mining experience and professional judgment are important aspects of geotechnical engineering that are not easily quantified, but which do have the potential to contribute significantly to the formulation of a variety of equally acceptable and potentially viable solutions to a particular situation.

Geotechnical engineering is one of the tools that the mining industry is encouraged to apply in the continuing endeavor to achieve safe, cost effective mines. The requirement to rehabilitate extensive areas of a mine, due primarily to a failure to address the prevailing geotechnical issues, exposes the workforce to potentially hazardous ground conditions.

Planes of weakness divide the rock mass up to a collection of potential blocks the size, shape and orientation of which strongly influence rock stability conditions in underground mines. This assemblage of discontinuities is an important characteristic of any given rock mass. The following are parameters to put into consideration;

- ❖ Geological structure can have a range of characteristics including;
- ❖ Orientation - usually specified by dip angle and dip direction;
- ❖ Spacing;
- ❖ Persistence or continuity;
- ❖ Roughness;
- ❖ Wall strength;
- ❖ Aperture;
- ❖ Filling;
- ❖ Seepage; and
- ❖ Number of sets.

A geotechnical domain is a volume of rock with generally similar geotechnical rock mass properties. The geotechnical properties that should be considered when defining the geotechnical domains include: Similar geotechnical characteristics of the planes of weakness – particularly orientation, spacing, persistence and shear strength properties;

- ❖ Degree of weathering and/or alteration;
- ❖ Intact rock uniaxial compressive strength;
- ❖ Deformation modulus of the rock mass;
- ❖ Rock stress field (pre-mining and induced stress fields); and
- ❖ Permeability of the rock mass.

Rock mass classification methods may be useful in determining the extent of geotechnical domains in a mine. The three main rock mass classification systems that are used in geotechnical engineering are:

1. Rock Mass Rating system or RMR system;
2. Rock Quality System or RQ-System; and
3. Mining Rock Mass Rating system or MRMR system.

Table 3. Some Rock Stress Measurement Methods

Absolute Stress Measurement	Stress Change Monitoring
CSIRO Hollow Inclusion cell (3D)	CSIRO Yoke gauge (2D)
Borehole slotter stress meter (2D)	CSIRO Hollow Inclusion cell (3D)
USBM borehole deformation gauge (2D)	Vibrating wire stress meter (1D)
Hydraulic fracturing method (2D)	Flat or cylindrical pressure cell (1D)
CSIR "doorstopper" (2D)	Seismic monitoring of a rock volume
Flat or cylindrical pressure cell (1D)	

The strength of the rock mass is controlled by the complex interaction of a number of factors including:

- Intact rock substance compressive strength;
- Geological structure (planes of weakness) - particularly orientation, persistence, spacing and shear strength parameters;
- Groundwater; and
- Alteration of minerals on exposure to air and/or water with time.

The hard rocks (cores) from Masagalu Gold Project has been sent to South Africa for geotechnical testing and the result will be incorporated in the Feasibility Studies report during mine design.

2.7DETAILED EXPLORATION

The Masagalu Gold Project lies within the Kilindi Handeni Superterrane about 75 km west of the discovery of 1Moz of the coming new gold mine to commence production soon (East African Metals). About 1000 artisanals miners were active in the MGP between 2008 and 2010 before NCL took over from the local owner of the ground. NCL asked the artisanals to stop working and the company commence detail exploration work resulting to the identification of the potential four zones of gold mineralization within the area. The exploration conducted by

NCL and mining done by the artisanal within the applied mining area Amal-20/2016EZ resulted into identifying four potential gold mineralization zones; three zones lie parallel to the strike of the fold limbs about a 1 km strike length and one gold rich zone cross-cutting the fold limbs.

2.7.1 GEOLOGICAL MAPPING

Geological mapping of the MGP conducted on the Amal-20/2016EZ (applied mining licence area) reveal potential medium grade metamorphic rocks which is part of the Proterozoic Usagaran System that occurs east of the Archaean Tanzanian Craton. The local geology of the MGP characterized with the main five lithological units namely; i) Amphibolite, ii) Garnet Quartz Amphibolite -QG iii) Quartz Graphitic Feldspathic Gneiss – QGFGn iv) Quartz Kyanite Feldspathic Gneiss QKFGn v) Biotite Quartz Feldspathic Gneiss varies in grain size – BQFGn. Regolith cover are categorised into three types; alluvial sediments deposited in the river and streams, residual soil from the weathered BQFGn units (light to dark greyish brown in colour) and the residual soil from weathered QGFGn and GA or Amphibolite units (medium to deep reddish brown in colour). Detailed geological mapping were conducted to identified lithological units develop within the mine applied area (Figure 7).

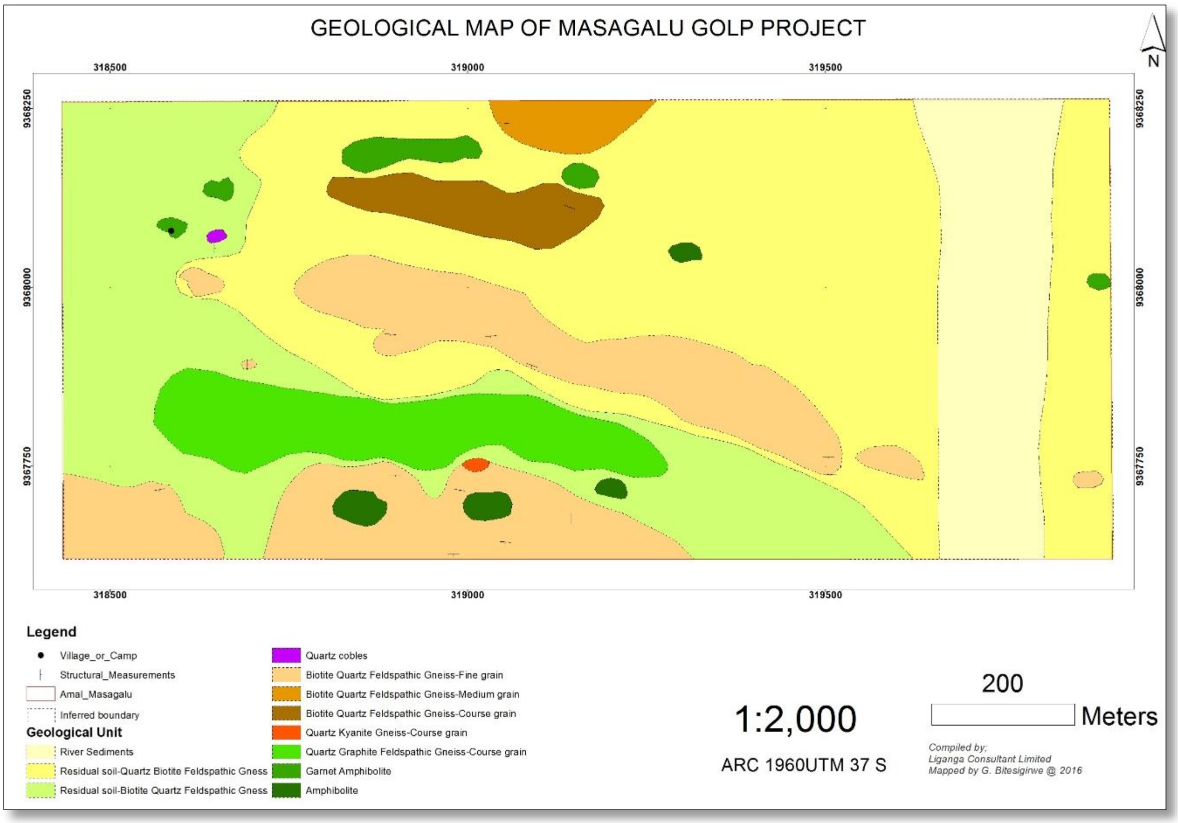


Figure 7. Local geology of Masagalu Gold Project (applied mining licence area).

2.7.2 LOCAL STRATIGRAPHY

Main lithological units and detailed logging on a specific unit for the representative deep shafts within the MGP were identified. Descriptions of the core are also presented in Figure 8.

Figure 8. Mineralized potential units develop in the MGP as cropped from the deepest shaft within the applied mining licence area.

From the deep shaft excavated within the MGP a generalized lithological sequence for rocks encountered has been constructed (Figure 9).

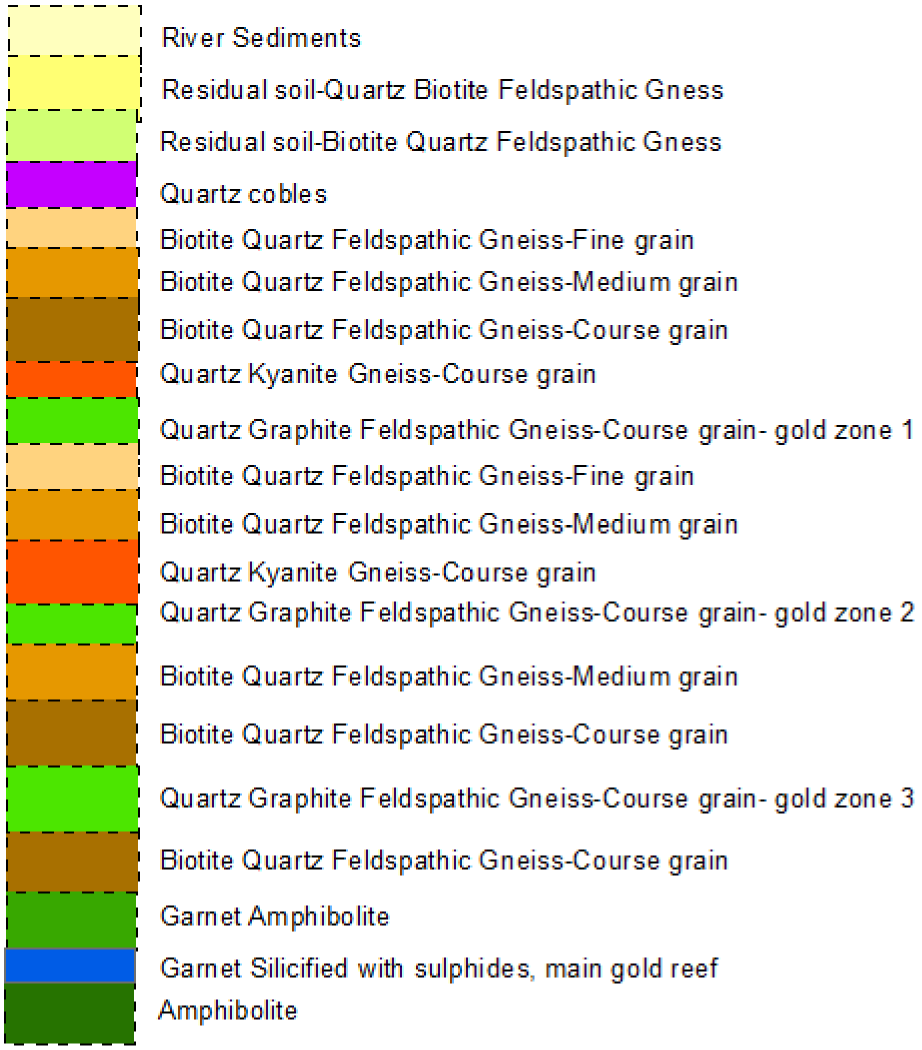


Figure 9.Generalized section showing the interpreted potential lithological sequences of the MGP rocks/units.

2.7.1 STRUCTURES

MGP also characterised with potential structural features like fault, shear, boudins and veins, reef and stringers. The main quartz vein develops are less than 10 cm wide and occasionally cross-cut the BQFGn units. Pegmatitic veins are also developed in the MGP especially in a course grained BQFGn units. Boudins develop well in QGFGn unit in parallel with the regional fold limbs interpreted within the MGP. All the geological units develop within the MGP have almost the same plunge direction 180^o and the general strike range between 080^o and 110^o with the dip magnitude range from 30^o to 45^o (Figure 10).

Figure 10.A) Structural measurement on the BQFGn exposed on the northern part of the MGP at 319096E/9368207N photo looking north B) foliations from the fine grained saprock of QBFGn unit exposed after an excavated shaft within the MGP at 319504E/9367762N photo looking west.

The general interpretation of the MGP is likely the project is sitting in a subduction zone of the regional fault develop in the area as observed by the standing ridges on the east and west of the MGP (Figure 11).

Figure 11.A) Looking north to the MGP, B) Looking East from the MGP, a clear view of the south dipping of the lithological units on the standing hill outside the MGP 15 m away from the eastern boundary of the applied mining licence area.

2.7.2 MINERALIZATION

The mineralization at the MGP are main associated with graphite means resulted to free gold and the one with high grade associated with sulphide. Quartz vein-type gold mineralization in strongly silicified altered rocks within a brittle-ductile shear zone were develop and interpreted within the project area. The sulphide mineralization in the project area is strongly associated with arsenopyrite and occasionally with chalcopyrite. The boudins structure with graphite and quartz crystals with plagioclase as matrix carries gold mineralization within the MGP (Figure 12).

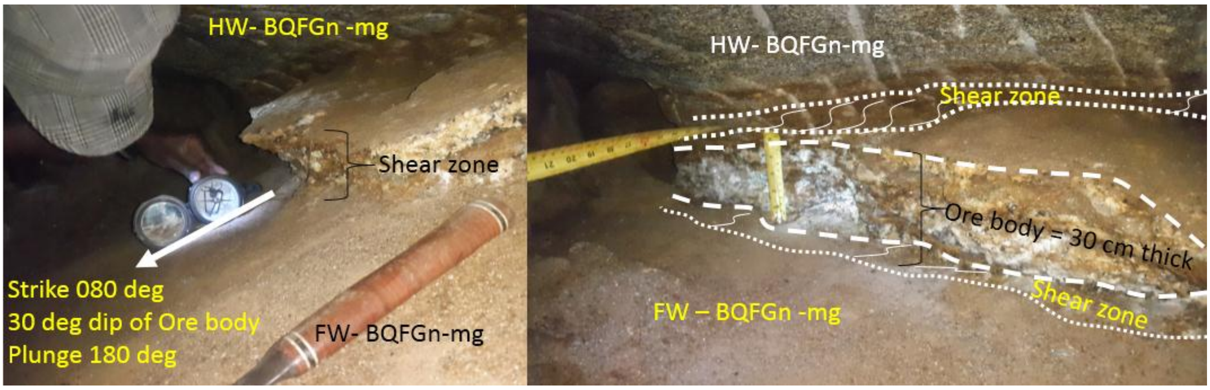


Figure 12.Structure measurement on the QGFGn gold ore zone at the 15 m deep from the active artisan shaft (319066E/9367804N). Graphite and shearing create a good indicator for mineralization in this area as well, shearing develop a well-defined s fabrics. Hanging wall – HW, Footwall- FW, Biotite Quartz Feldspathic Gneiss – BQFGn, ore body – Quartz Graphite Feldspathic Gneiss.

2.7.3 GRADE AND RESOURCE

The geochemical analysis for gold samples from the potential mineralized ore bodies (zones; 1-3 and reef) conducted by Liganga Consultant Limited outlined a resource of 356,578 ounces of gold from zones 1, 2 and 3 as well as a resource of 34,776 ounces of gold from silicified garnetiferous reef. Intersections of interest are of 28 g/t from the main silicified garnetiferous reef of this dimension 3 m wide and 0.3 m thick with plunging southward at a dip of 40°. Also the other potential intersections are from the three mineral zones (0.3m, 0.2 m and 0.1 m) averaging 13 g/t gold along 800 m strike length plunging southward to approximately 600 m mineable depth. Aeromagnetic regional data indicate the potential zones and reef extend southward for at least several kilometers before the regional trough of the fold. The work done to date indicates that the Masagalu Kilindi mineralization occurs in two types;

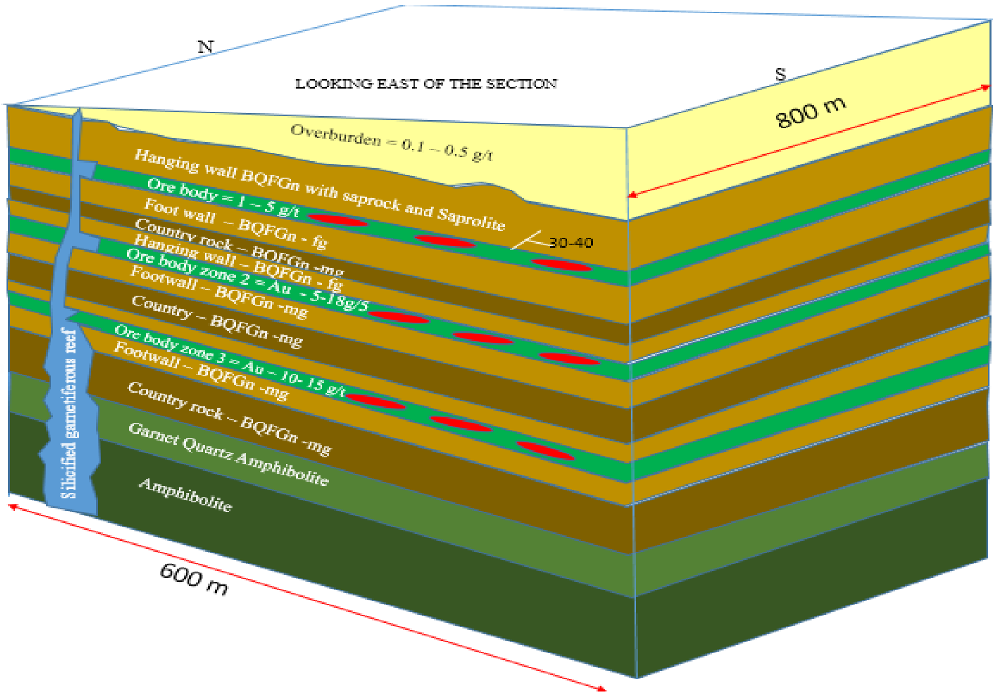
- ❖ Free gold at the boudins along the strike of the fold limbs at the shear zone during ductile deformations.
- ❖ Gold in association with sulphide occurs in the silicified garnetiferous reef which crosscut the host rocks for mineral zone 1-3 and other country rocks.

Detail geophysical work has to be done to increase the resource and reserve for further production and to increase the life of the mine. The plunging of the ore body to south could be easily study by employing ground geophysical survey like Magnetic, Electromagnetic or Induced Polarization to help define the drill target for resource increment. The interpretation of the magnetic data will enable the drilling program to take place so that the understanding of the mineralization at MGP will be cleared. So far the available estimated resource enable the long term mining plan of the MGP as it. The regional geophysics data and regional geological interpretation correlate well with the local geological mapping of the MGP. The downhole shaft mapping" revealed a very interesting geological setting that led to the discovery of a graphitic zone which defined as the ore body for the gold mineralization in association with the boudinage develop in a fold limbs. The intersection of the silicified garnetiferous reef and graphitic zone clearly correlate well with the stratigraphic sequence of the Magambazi gold deposit defined by the East Africa Metal Inc (more than 1 Moz of Au estimated).

2.8RESOURCE ESTIMATION

2.8.1 GRADE ESTIMATION

Grade was interpolated directly in the blocks using ordinary Kriging (OK) with parameters derived from the semi-variogram analyses described above. The grade was interpolated separately into the low and high grade envelopes where applicable. Extreme low-grade and high-grade values also subject to manipulation.



Conceptual estimates of the Masagalu Gold Project on applied mining licence area.

Exploration conducted in the Masagalu Amal-20/2016EZ (applied mining licence area) to date indicates that the Masagalu gold mineralization occurs at two potential zones; as intrusion of silicified garnetiferous reef and in the boudinage zones within the downward slope of the large fold limbs striking at east (080° – 110°) plunging to southward direction. To some extend mineralization of the second type occurs as the pockets in those boudins. The deepest exploration shaft sunk was 18 m deep and there are about 16 shafts.

The excavation of the shafts managed define the thickness of the ore body as varying from 0.1 m to a maximum of 0.3 m with multiple layers forming one thick solid layer of ore body to be equivalent to 0.9 m with high gold contents ranging from 1.5 g/t to 35 g/t.

2.8.2 TONNAGE ESTIMATION

Information on the size, shape, and attitude of a deposit and information for estimating the tonnage and grade of the ore is taken from excavated shaft within the MGP.

Ore body volumes were constrained using the high and low-grade envelopes resulting in the reporting of geological volumes as opposed to block volumes. The average thickness of the ore body is close to 0.5 m while the average grade is estimated to be 13.0 g/t from the three ore zones (zone 1-3) and an average of 28 g/t from the main silicified garnetiferous reef. The total ore resource at the area applied for Mining License is estimated to be 777,600 tons of ore at an average grade of 13.0 g/t over a strike length of 800m and a vertical depth of 600 m with a thickness of 0.6m. Adding the reef mineable tonnage of approximately 1,242 t of ore at an average grade of 28 g/t over a strike length of 3 m width 0.3 m thick and a vertical depth of 600 m. The resource is therefore estimated to be 391,354 ounces.

- A dilution factor of 10% of the tones mined has been applied with these tones containing a grade of 13.0 g/t and 28 g/t separately.
- To simplify the calculation the following parameters were used.
- Average width of the gold bearing 3 ore zones is 0.6 m and ore reef is 0.3 m are taken into consideration;
- Nominal depth of operation 600 m thus mining levels will start at 10 m to the shaft bottom at 600 m;
- Strike length to be mined 800 m for the 3 ore zones and 3 m for the reef.
- Working days per Year is 250 days;
- Density of the ore at Masagalu area is estimated as 2.7 g/cm^3 for the 3 zones and 2.3 g/cm^3 for the silicified garnetiferous reef.
- Ore recoverable, thus leaving the pillars and support of the container in the sublevel stopping method 90%;
- Dilution factor estimated at 10%;
- Ore tonnage at MGP is calculated as 0.6x800x600x2.7 = 777,600 tons, plus the reef ore which is calculated as 0.3x3x600x2.3 = 1,242 tons. Thus total tonnage will be 778,842 tons.
- Mineable ore estimation is 778,842 x 90%= 700,957.80 tones;
- Annual tonnage is 250 tons a day *250 days a year = 62,500 tones;
- Recoverable resource is calculated as follow;
    1. 3 ore zones 699,840 x 13 = 9,097,920g = <u>320,919.95 </u>Oz whereas
    2. Reef ore is calculated as 1117.8 x 28 = 31,298.4g = <u>1,104.02</u> Oz.

Thus the total recoverable resource is <u>322,024</u> ounces <u>= 9,129.22 kg</u> of gold.

- At the mining rate of 62,500t per year the production will be calculated as; total minable tonnage/mining rate in a year = 700,957t / 62,500t = 11.21 years. Thus with the available tonnage the estimated LOM will be 11 years if there is no natural hazards.
- Annual production is estimated to be 29,274.9 ounces = 829.9 kg ~ 830 kg.

Total amount of waste per year is calculated as 150 tons per day*250 days a year =37,500 tones. Table below summarize the resource estimate for the MGP.

Table 4. The calculation of the resource estimates for MGP.

ORE BODY PARAMETERS			
Density	g/cm3	2.7	
Width	m	0.6	
Length - Lateral Strike	m	800.0	Zones 1, 2 and 3
Height - Down Dip - Strike	m	600.0	
Grade	g/t	13.0	
Recovery	%	90	
Reef	wxt (m)	0.3x3	

RESERVE CALCULATION					
Volume	WxLxH	288,000,000,000	cm3	= m3	288,000
Tonnage (Mass) - t	Density x Volume	777,600,000,000	g	= t	699,840
Reserve - Au- g	Tonnage x Grade	9,097,920	g of Au =kg		9,097.92
		Au - gm	Au - Oz		Au - kg
1. Gold Reserve from zones 1, 2 and 3		9,097,920.00	320,919.95		9,097.92
Reef dimension with 28 g/t	0.3m x 3m x 600m x 2.3 g/cm3		Tonnage		1,117.80
	Au - Grade g/t	Au -gm	Au - Oz		Au - kg
2. Gold Reserve from the Reef	28	31,298	1,104.02		31.30
	Tonnage -t	Au -gm	Au - Oz		Au - kg
Total Reserve	**700,958**	**9,129,218**	**322,024**		**9,129.22**

PRODUCTION				
Mining rate	T/day	Working days/y	Total t	Years
	250	250	62,500	11.22
	Yrs	Ounces	Au -gm	Au - kg
Production Rate per annam	11	28,713	813,995	814

2.8.3 SELECTION OF THE OPTIMUM PRODUCTION SCENARIO

Based on the quantities of resources of approximately 700,95t @ 13 g/t defined through an exploration program at Masagalu project, there are several alternatives of exploiting this resource. These alternatives can be categorized based on the following major criteria:

- The production rate that should prevail,
- The mining method that should be used to exploit the deposit,
- The mineral recovery method that should be used for maximum gold recovery, etc.

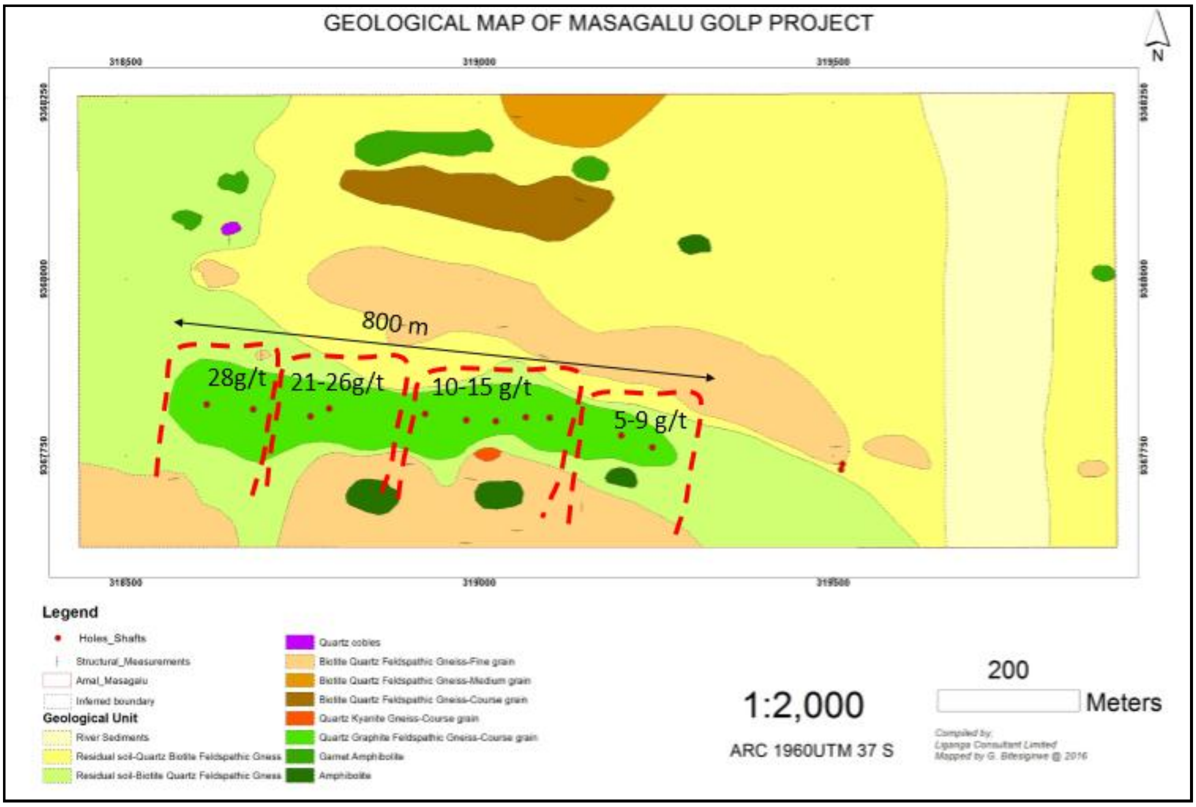


Figure 13.The geochem results from the deepest excavated shafts

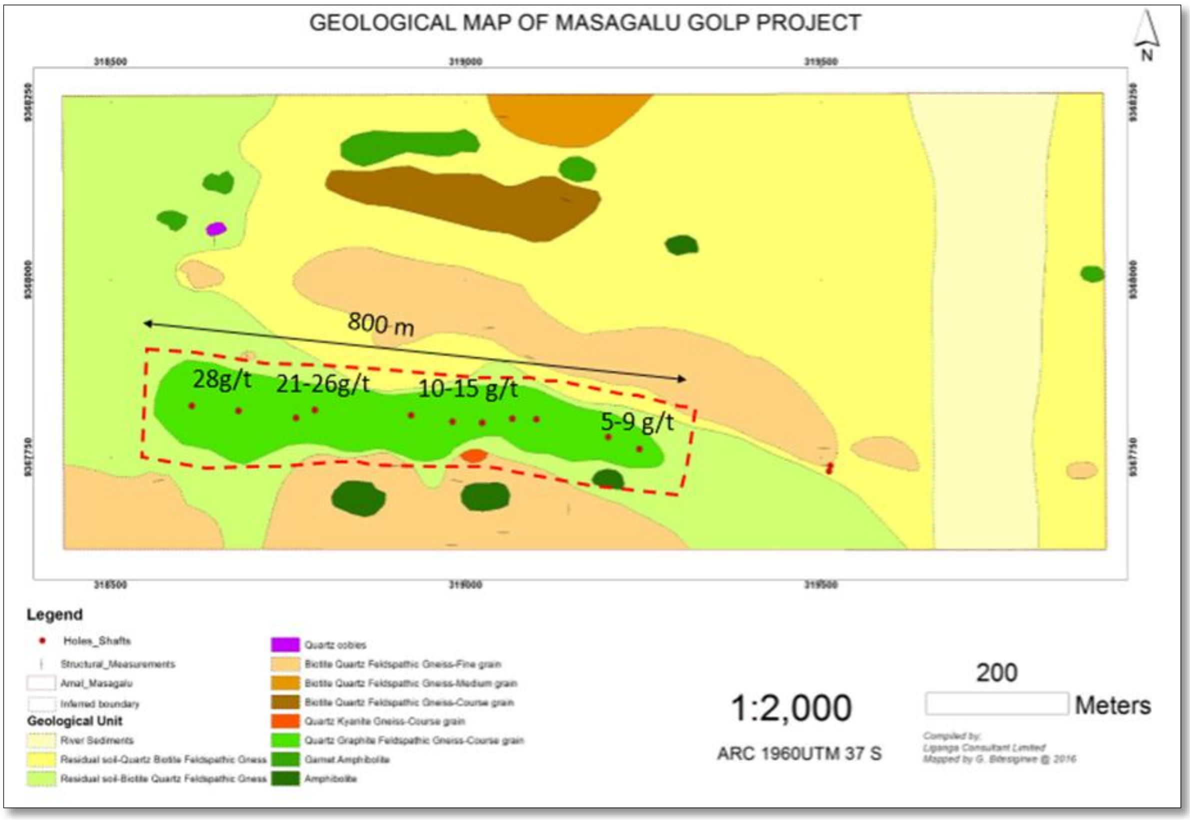


Figure 14.Resource definition block

Table 5. Summary of excavated shafts results.

SHAFT No	Results g/t	Strike Length (m)
SH 09	30.0	
SH 08	24.0	
SH 07	18.0	315.0
SH 06	12.0	
SH 12	15.0	
SH 04	7.0	
SH13	12.0	156.0
SH10	4.0	
SH 11	1.6	110.0
SH 05	1.0	95.0
SH 03	0.3	

2.8.4 HYDROLOGY AND HYDROGEOLOGY

The hydrology and hydrogeology was conducted on the area utilizing the resistivity sounding technique was applied by using a SYSCAL JUNIOR instrument, connecting cables and crocodile clips, stainless steel non-polarizing current and potential electrodes. The overall purpose of the whole Study is to determine conditions of both surface and underground water. For surface water, the aim was to determine the following:-

- Origin and flow direction of water;
- Quantity of water flow during Dry and rainy seasons;
- Quality of water (parameter measured is salinity).

Hydrological condition on the Masagalu proposed project area was done to determine underground water condition as follows:-

- Location of water table;
- Depth of water table;
- To estimate the Quantity of underground water; and
- Flow Direction of underground water.

CHAPTER 3 MINE DESIGN AND EQUIPMENT SELECTION

3.1 INTRODUCTION

Geotechnical Data Collection which is underway on the site will assist mine designers to analyses the geologic regime, rock fabric, rock strength and other properties. Geotechnical data information is been collected by cell mapping, shafts logging and sample testing and reduction of data for rock mass classification purposes The outcome of data analysis will rock mass classification, based on rock mass rating schemes, failure modes and their relevance to reinforcement design. The data will provide underground mines with the tools required to make on site pillar and opening stability assessments. Empirical methods for considering the complex interaction of stress, opening geometry, structure, and rock mass will be considered in mine design.

3.2 SELECTION OF THE MINING METHOD

Underground mine planning involves coming up with the optimum layout for the underground workings that get at most of the ore, at the lowest cost, and with the greatest safety. Underground mine planning is a multi-disciplinary activity. It requires the geological information, hydrological conditions to be known and plan in ventilation and rock support.

The primary activities that constitute underground mine planning are:-

1. Mineable Reserves - ore deposit grade model, dilution, ore losses, cut-off grades, long-term metal price forecasts and by-product credits etc.
2. Production Capacity - orebody geometry, mineable reserves, economics and marketing, life of operation.
3. Mining Method - orebody geometry, geotechnics, economics and costs, selectivity, backfill, safety, country skills available and location, trackless or rail methods.
4. Mine Design - stope layouts, access development, shafts/hoisting, haulages, x-cuts, inclined development, ground stress, stope and development support, infrastructure, ground handling, drill and blast, mining cycles, shift times, efficiencies, utilization's, equipment requirements.
5. Mine Transport - ore and waste requirements, storage capacity, primary crushing design and operation, economics and costs.

6 Ventilation - regulations, underground personnel, equipment, local conditions and geothermal gradients, fire safety and rescue bays, development and stopping methods, main fan locations, and distribution systems.

7 Mine Services - water supply, electricity supply and reticulation, compressed air, pumping and dewatering, materials and explosives supply, maintenance procedures.

8 Manpower - complements for development and operation, supervisory and managerial structures and requirements, labor and skills availability, selection, recruitment and training, salary levels, bonuses, conditions of employment.

9 Surface Facilities - stores, offices, change rooms, lamp house, explosives magazine, security and administration.

10 Capital Costs - development, equipment and machinery, infrastructure, construction requirements, development and production programmers, on-going capital replacement.

11 Operating Costs - labor, equipment running costs, materials and consumables.

12 Production and Economic Model - life of mine production programmed, treatment and recoveries, metal or commodity prices, capital and operating costs, working capital, royalties, taxes and depreciation, cash flows, NPV and IRR analysis.

13 Risk Assessment - project sensitivities, price and economic forecasts, exchange rates, ranges for key variables, location, main project risks, mitigating action plans.

Masagalu gold deposit will be mined by underground mining methods. This is a standard operating procedures in the orebody that is dipping steeply despite the shallow dip of the Masagalu ore the challenge of small area do not support open pit mining. The gold bearing zones are frequently intersected, creating pronounced displacements to the left (sinistral). This indicates high-grade gold mineralization is located below 10 m dipping at 30^o to 40^o for the 3 ore zones and about 50^o for the reef.

In general, the method of exploitation of ore is influenced by the mode of occurrence of the mineral deposit in the ground, geological, engineering and technical limitations, environmental considerations, and the mineral economics of the project. Basically however, there are two major classifications of mining methods, which are open pit mining and underground mining.

Unit operations for the two mining methods are similar in nature though may necessitate having different designs to suit a planned method of exploitation. These unit operations include:

- Drilling & Blasting;
- Loading.
- Haulage of waste and ore
- Waste dumping
- Ore stockpiling
- Crushing
- Processing of ore which may also have sub-units of
- Crushing
- Grinding
- Classification/screening
- concentrating
- leaching
- Process water storage facility
- Tailings disposal

The mine also will require support facilities to make it operational, which will include:

- Office administration facilities
- Laboratory facility
- Workshop facility
- Fresh water reservoir structures,
- Staff housing units and recreational areas,
- Health facilities, etc.

3.2.1 Open Pit Mining

Is a mining method in which the sought minerals are exploited from the surface downward after stripping out the top-soil which may not be part of the useful mineral composition material. The method utilizes heavy-duty equipment such as bulldozers, loading shovels, rear dump trucks, drilling rigs, etc., to recover the ore from the ground before sending it to the processing plant for beneficiation. The minerals are mined in sequence of benches, which are staged to conform to schedules of exploitation and to the general layout of the mineral deposit.

3.2.2 Underground Mining

Is a method of mining in which the ore deposit is accessed through narrow openings/passage ways, which may either be shafts, inclines, ramps or adits. Exploitation by underground mining retains the upper ground surface intact, with the exception of few mining methods that may cause surface ground subsidence. Main attributes or unit operations for the Underground mining method are the same as for open pit mining but with some variations in design layout.

Considering that the deposit has been estimated to be between 20 m to a depth of 600 m in phase 1, an underground mining method is feasible for exploiting the inferred mineral resource. The shape of the orebody should be considered for making the decision whether the resource may be mine economically by the use of underground mining methods as it dips almost vertical or not. A choice of mining method is determined by the strength of the ore and wall rocks. Strong ore and rock permit relatively low-cost methods with naturally supported openings or with a minimum of artificial support. Weaker ore and wall rock necessitate more costly methods requiring widespread temporary or permanent artificial support such as rock bolting.

3.3UNDERGROUND MINING MODEL

Underground mining is done where mineral deposits are situated beyond the economic depth of open pit mining; it is generally applied to steeply dipping or thin deposits and to disseminated or massive deposits for which the cost of removing the overburden and the maintaining of a slope angle in adjacent waste rock would be prohibitive. Figure 15 demonstrate the underground model.

3.4ORE ACCESS

Levels are excavated horizontally off the decline or shaft to access the ore body. Stopes are then excavated perpendicular (or near perpendicular) to the level into the ore. Development workings, corridors for gaining access to the orebody from stations on individual mine levels, called drifts if they follow the trend of the mineralization, and cross-cuts if they are driven across the mineralization will be a developed after the shaft sinking is completed.

Other important workings on successive mine levels will be connected by raises, passageways that are driven upward and winzes that are corridors sunk downward, from a lowermost mine level. Stopes will be developed in a mine with a network of levels, sublevels, and raises for access, haulage, pumping and ventilation. Pillars of unmined material will be left between stopes and other workings for temporary or permanent natural support. The host rocks at Masagalu gold deposit are gneisses and granulite with felsic to mafic intersection and high tensile strength thus confirming a self-supporting structure.

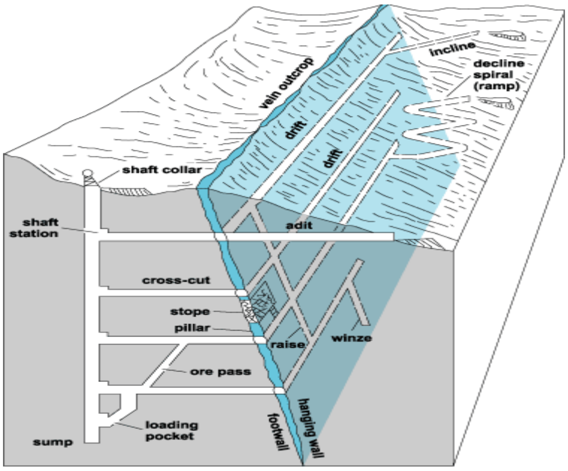


Figure 15. Underground mining development and workings.

3.5DEVELOPMENT MINING AND PRODUCTION MINING

3.5.1 PRINCIPAL OF UNDERGROUND MINING

There are two principal phases of underground mining:

3.5.1.1 ***Development mining***

Development mining is composed of excavation mostly in non-valuable waste rock in order to gain access to the orebody. There are six steps in development mining: remove previously blasted material (muck out round), Scaling (removing any unstable slabs of rock hanging from the roof and sidewalls to protect workers and equipment from damage), support excavation, drill rock face, load explosives, and blast explosive.

3.5.1.2 ***Production mining***

There are several methods of production mining. In this case the production will be done by sublevel mining. Typically sublevel mining which is the same as short holes blasting requires two excavations within the ore at different elevations below surface, (15 m – 30 m apart). Holes are drilled between the two excavations and loaded with explosives. The holes are blasted and the ore is removed from the bottom.

3.5.2 BLAST HOLE DRILLING

Blast hole are drilled at an angle to the face in a uniform wedge formation so that the axis of symmetry is at the centre line of the face. The cut displaces a wedge of rock out of the face in the initial blast and this wedge is widened to the full width of the drift in subsequent blasts, each blast being fired with detonators of Capped safety fuse and igniter cord (burning speed of 18 s/m) make the carrier of the initiating system. The igniter cord is usually fired by an electric starter for igniter cord. In the Masagalu project fan cut will be applicable in narrow in a narrow drive as shown on Figure 16.

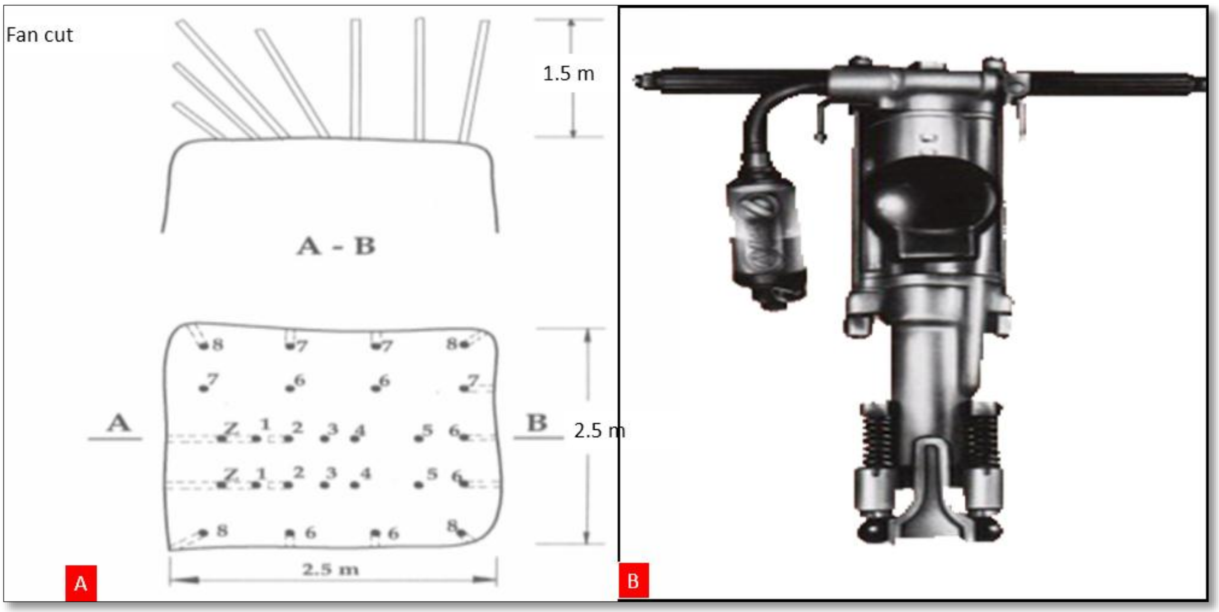


Figure 16. A) Fan cut drilling and blasting applicable to Masagalu project, B) A typical handheld drilling machine for the Masagalu project.

3.5.3 DRILLING EQUIPMENT

The in-situ rock material will be blasted to reduce its size into sizable material that will be suitable as a feed to the size reduction processes. Drilling will be done by a hand held drilling jackhammer shown on figure 16 B.

The drilling pattern at Masagalu mine has been designed both primary and secondary development. The mining contractor will develop primarily shaft sinking and construction and haulage ways. Production will be done by the company’s workforce.

3.5.4 UNDERGROUND BLASTING

The production work will be done by Short-hole blasting method. This type of blasting is usually used in breast stopping for narrow, tubular ore bodies such as the Silicified garnetiferous reef of Masagalu gold project. The diameter and length of shot holes are usually limited to 43 mm and 4 m respectively. Figure 17 is an example of blasting arrangement in breasts stopping in gold mines.

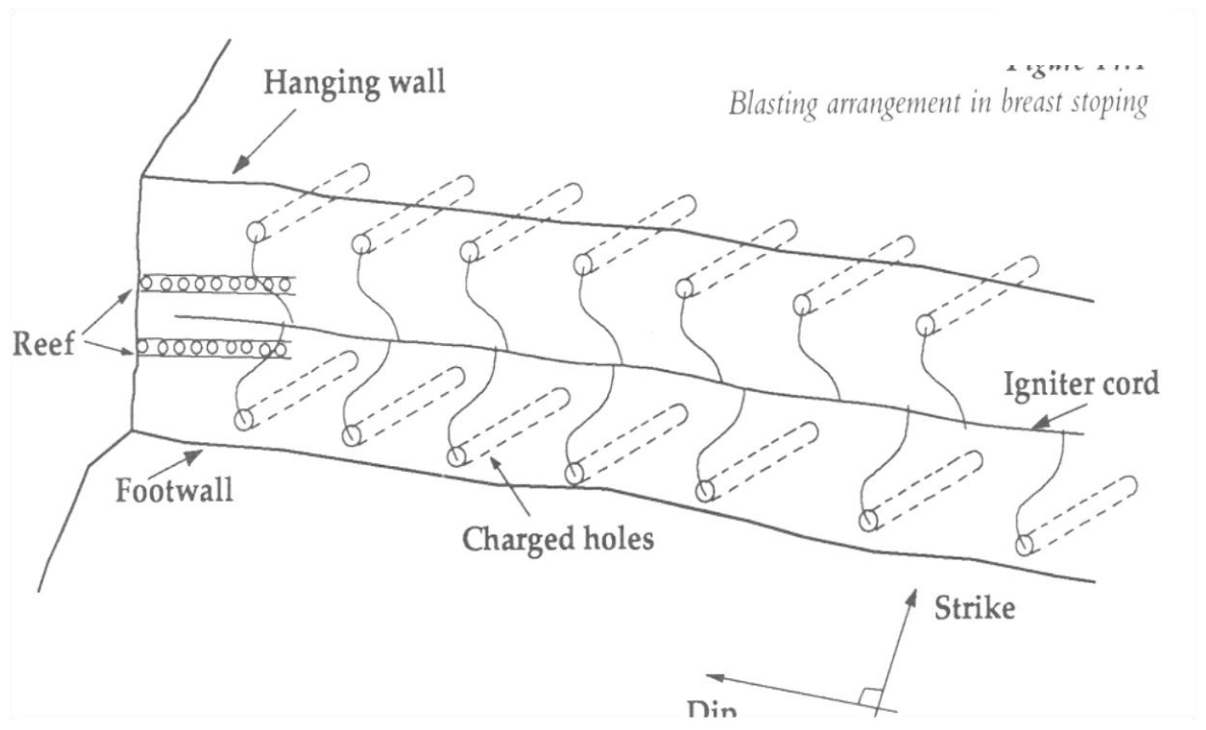


Figure 17. Blast arrangements in Underground workings

3.5.5 EXPLOSIVE USE CALCULATION

Calculations are based on the minimum cost per hole based on insitu material to be blasted (price may change):

- ❖ One hole of 38mm, 1.8m deep will consume 2.5kg of Anfo=4,200/=;
- ❖ Cortex 4m plus 3=7mx500= 3,500/=;
- ❖ Pc high explosives (from a carton of 25kg) =4500/=,
- ❖ Nonel tubes or fuses 1 pc plus detonating cord =2000/=
- ❖ Subtotal 14,200/=
- ❖ Explosive acquisition and transport 10%, Secondary blast 10% and Labor and expertise 10% =4,260/=
- ❖ Grand Total = 18,460/=
- ❖ For hard rock such as amphibolite, four holes will blast 2 cubic meters of rock. That will cost 4x18,460= 73,840/=

Therefore cost per cubic meter will be 39,920/=

Taking the density of insitu material to be 2.5 (average of 2.7 and 2.3), cost per ton on explosives will be 15,968/= or US$ 7.3 per ton.

3.5.6 VENTILATION

The most important aspect of underground hard rock mining is ventilation. Ventilation is required to clear toxic fumes from blasting and cooling the workplace for miners. Ventilation raises will be excavated to provide ventilation for the workplaces, and will be used as emergency escape routes. The primary sources of heat in underground hard rock mines are virgin rock temperature, machinery, auto compression, and fissure water. Other small contributing factors are human body heat and blasting.

3.5.7 GROUND SUPPORT

Mechanical bolts or Point anchor bolts or roof bolts or expansion shell bolts are a common style of area ground support suitable for Masagalu project. A point anchor bolt is a metal bar between 20 mm – 25 mm in diameter, and between 1m – 4 m long (the size is determined by the mine's engineering analysis of the condition of the area to be supported). There is an expansion shell at the end of the bolt which is inserted into the hole. As the bolt is tightened by the installation drill the expansion shell expands and the bolt tightens holding the rock together as shown on Figure 18.

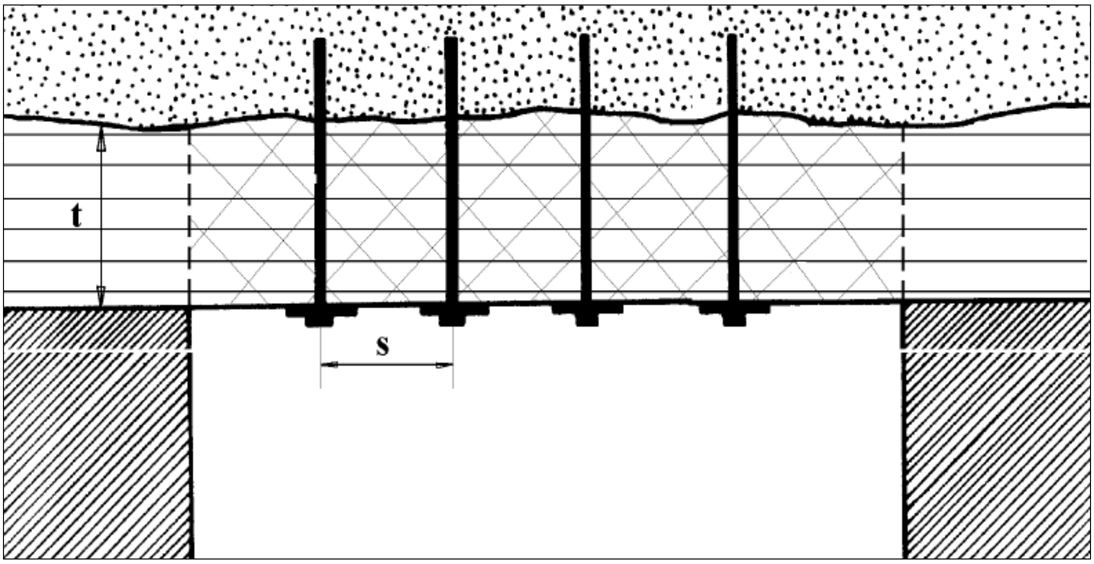


Figure 18. Suspension effect of roof bolting

3.5.8 SHAFT SINKING

A mining contractor will be appointed to sink four interconnected shafts to access the underground workings at Masagalu project. The agreed shaft location will be leveled and a safe working area is established. One shaft will be used as downward air passage while the other will be used as exhaust. The shafts will be developed using liners and finally backfilled by concrete. The shafts will be installed with the head frame and ore/man skips with counter balance weights (Figure 19) and hoisting system.

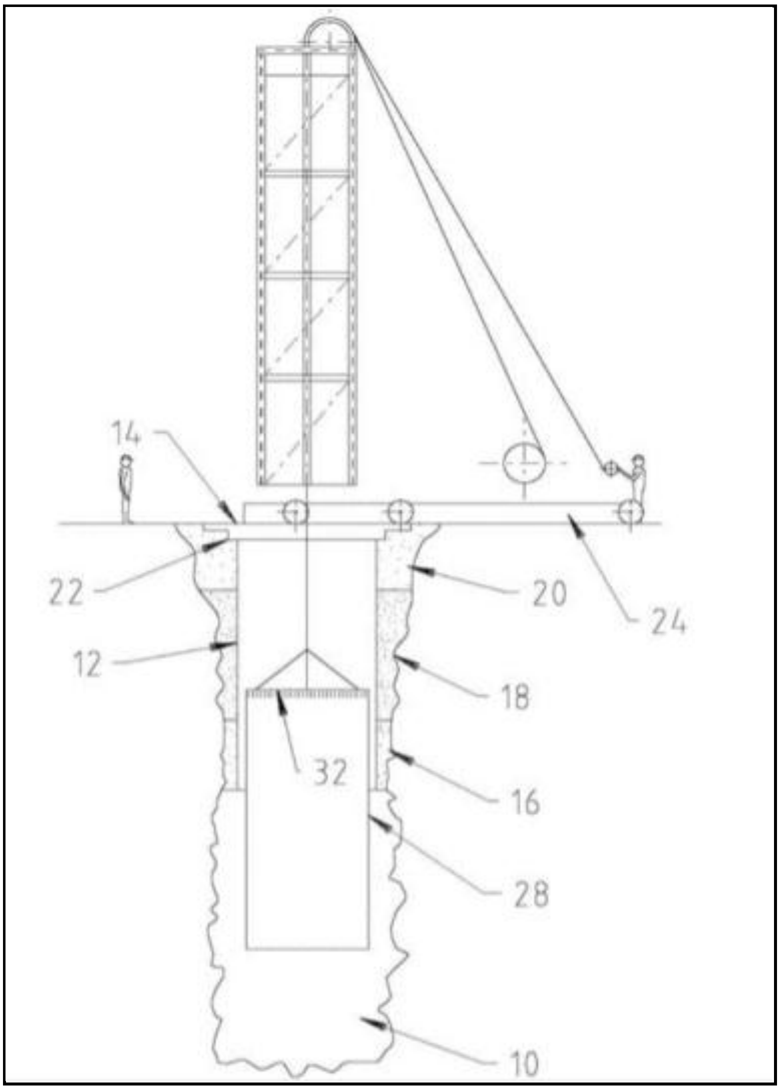


Figure 19. Construction of vertical shaft to be sunk at Masagalu

3.5.9 ROCK MASS STRENGTH

Two main important properties used to classify rocks in Masagalu project are a uniaxial compressive strength and modulas ratio. Three main lithological units have been defined, namely Quartz Feldspathic Gneisses, Quartz Garnet Amphibolite and Amphibolite (massive granulites). The classification also included the lithological description of the rocks. There is, however, a general increase of strength with depth and representative rock mass strength and density values have therefore been developed for different weathering zones and within each ore body, area rather than for different rock types as shown on Table 6.

Table 6.Table 3: Rock mass strength of lithological rocks at Masagalu project.

Rock type ID	Uniaxial compressive strength result (Mpa)	Rock description	Rock depth (m)
A	42	Low strength	1-20
B	75	Medium strength	20-40
C	145	High strength	40-70
D	177	High Strength	70-90
E	248	Very High Strength	90-120

The main structural discontinuities comprise:-

- ❖ A foliation dipping steeply to the south
- ❖ Major, sub-vertical, orthogonal joint sets striking northeast- southwest and southeast - northwest
- ❖ Minor, sub-vertical joint sets striking north-south; and
- ❖ Low to moderate angle joint sets striking northeast - southwest and southeast - northwest and dipping to the southeast and southwest respectively.

The main features controlling structural instability of the pit walls will be the foliation, which may give rise to bench scale toppling failures where open foliation planes dip into the face.

3.6 ORE PRODUCTION ESTIMATES

The parameters to be considered are as follows:-

- ❖ The amount of ore per day is designed to be 350 tones and waste is estimated to be 150 tones.
- ❖ In the tunnel end either for production or development, a single blast will give 5 tons of material.
- ❖ There will be only one blast per day.
- ❖ For 250 tones, there will be at least 10 ends to be blasted per day. i.e. (250-150= 100/5= 20 for both ends).

- Drilling and blasting crews will be 3 persons in 2 two ends per shift per day; thus there will be 10 crews of total of 30 persons.
- Scrapers will be used to scrap material to ore chutes that requiring 4 persons per 4 ends, therefore 5 crews will be required making a total of 20 persons.
- Every crew will have a single or two drilling jackhammers, with compressed air been supplied by surface plant.
- Average width of the gold bearing vein is taken as 3.0m;
- Nominal depth of operation 600m thus mining levels will start at 10m to the shaft bottom at 650m;
- Strike length to be mined 800m;
- Working days per month is 22 days;
- Density of the ore at Masagalu is estimated at 2.3 (reef) and 2.7 (3 zones).
- Ore recoverable, thus leaving the pillars in the sublevel stopping method 90%;

There will be two shifts, one morning shafts for drilling and blasting while back shift will be for lashing/mucking and hoisting. Mine operation schedule is shown on Table 7.

Table 7. Production/shift system

ITEMS	PROD./SHIFT
Shifts per day	2
Hours per shift	9
Working days per month	22
+ 1 hr. lunch etc.	10 hr. paid
Total Avail hrs. per week	120
Mechanical Availability	90%
Mining Utilization	85%
Total Work Hrs. per month	440

CHAPTER 4 METALLURGY AND ORE PROCESSING

4.1 METALLURGICAL TESTING

M/S Najim and Company Limited intends to install a processing plant that will process gold ore at 62,500 tons per year. Ore will be transported within a short distance within the applied mining licence at Masagalu project. A program of metallurgical testing was completed using samples representing each of the major mineralized zones identified in the Masagalu property. The metallurgical testing provided data for selection of metallurgical unit operations, development of an efficient process flow sheet, design criteria, process engineering and development of associated operating and capital cost estimates.

Metallurgical tests were conducted at a number of well-known and respected geochemical laboratories (SGS and Setpoint Laboratories) and testing facilities in South Africa and in Tanzania.

The metallurgical tests on samples included physical and chemical characterization studies as well as process evaluation investigations. The physical and chemical measurements included chemical analyses, in-situ bulk density, specific gravity and Bond grinding work indices. The process evaluation tests included gravity separation, flotation, cyanidation and heap leach amenability. Other tests conducted were a series of gravity recoverable gold (GRG) characterization tests, the flotation and gravity recovery response of gold carriers, such as pyrite, arsenopyrite and iron oxides in tailings. Comminution work indices determinations were carried out. The results of this program of work have been used to establish the criteria for the plant design and its subsequent costing study.

In addition to the gravity, flotation and cyanide leaching test work, a number of column cyanide leach tests were conducted to determine the feasibility of using heap leaching to recover the values in the near surface material.

4.2 ORE PROCESSING

4.2.1 PROCESS DESIGN AND FLOWSHEET SELECTION

The results of the metallurgical testing suggest that the optimum flow sheet for the Masagalu Gold Mining Project would include crushing, SAG milling, gravity separation with intensive cyanidation and cyanide leaching. Selection of a modern and simple leaching process suggests the use of CIL and carbon elution for final gold recovery.

The process design was done by AMOREF Plant and Beneficiation specialist in South Africa, also another is in China. The selection of equipment, flow sheets and cost estimation at plus/minus 15 % accuracy. The process flow sheet development, metallurgical balance, water balance, process equipment selection and sizing are based on process design criteria, which were developed from the metallurgical test work results. Figure 20 shows how the design and setup of the processing facilities will be at Masagalu Gold Project.

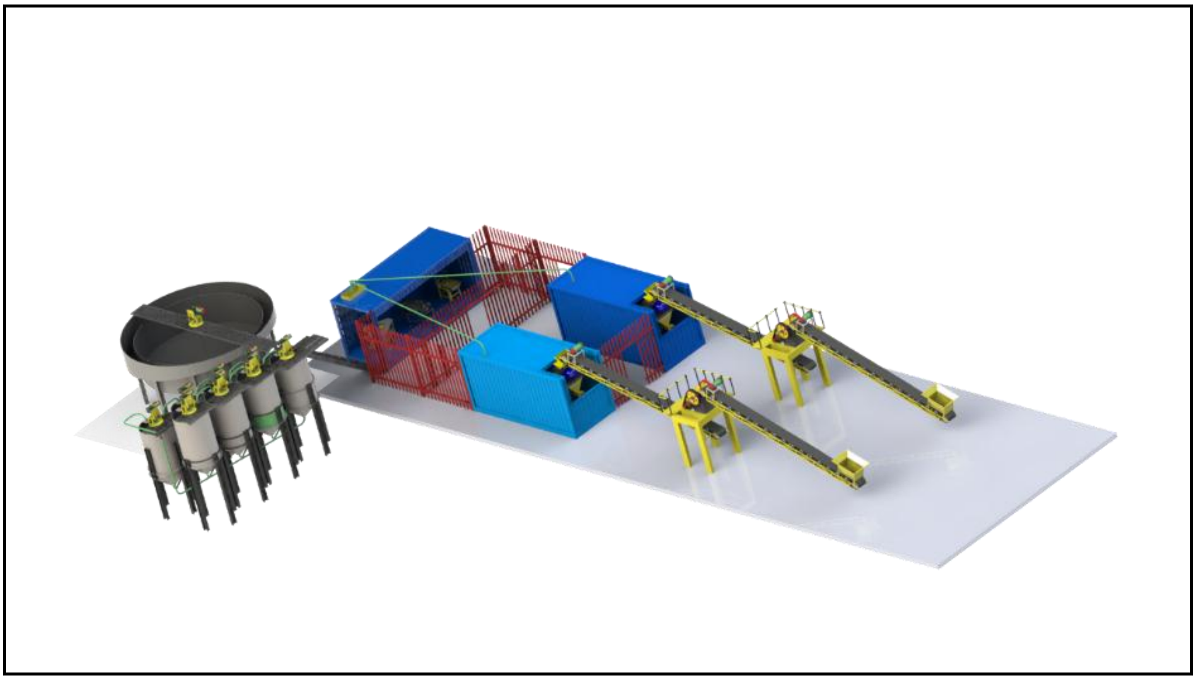


Figure 20. Processing flow plan for hard rock gold mining and processing for Masagalu Gold Mining Project.

The flow sheet selected comprises primary crushing, single stage SAG milling with pebble crushing, and gravity separation with intensive cyanidation reactor, CIL circuit, elution circuit and tailings thickening. Process design criteria are shown on Table 8.

Table 8. Process Design Criteria

Criteria	Units	Value
Total life of mine ore feed	t	3,000,000.00
Average feed grade	gold g/t	13.00
Nominal throughput rate	dry t/d	250.00
Average ore type distribution	rubble %	5.00
Average ore type distribution	saprolite %	28.00
Average ore type distribution	primary rock %	67.00

4.2.2 PROCESS FLOW SHEET

The circuit consists of four main areas. These areas are;

I. Primary Crushing Circuit
II. Screening Circuit
III. Secondary Crushing Circuit'
IV. Dust Collection System.

4.2.2.1 ***PRIMARY CRUSHING CIRCUIT***

Ore from the mine is fed to the primary crushing circuit (Figure 21) from the ROM Pad by a Front End Loader to the Ore ROM Bin. The ROM Bin has a static grizzly mounted on the top to ensure material greater than 500mm does not pass though into the ore crushing circuit.

The ore is then delivered from the ROM Bin to the Primary Ore Jaw Crusher by an Apron Feeder and Vibrating Grizzly a fines chute is installed to catch fines material which slip through the flight bar of the Apron Feeder and similarly underneath the Vibrating Grizzly which has an aperture of 75mm. These chutes direct the fines onto the Scalping Screen Feed Conveyor. The Primary Jaw Crusher reduces the size of the ROM ore to -150 mm. The crushed ore falls directly onto the Scalping Screen Feed Conveyor and is delivered to the Scalping Screen for classification.

Figure 21. Crushing circuit.

4.2.2.2 *SCREENING CIRCUIT*

The circuit consists of a double deck scarping screen its function is to produce a crushed ore product which passes 31.5mm, which is the aperture of the bottom of the two decks. The intermediate product (-65mm + 31.5mm) is discharged off the surface of this bottom 20 deck, and merges with the top deck oversize (+65mm) in the Scalping Screen Product Chute, from where it is deposited onto the Surge Bin Feed Conveyor for processing in the Secondary Crushing Circuit.

4.2.2.3 *SECONDARY CRUSHING CIRCUIT*

This is a secondary cone crusher it is responsible for the reduction in oversize ore classified in the screening circuit to as size of -37.5mm which is the product to the fine ore stockpile, which in turn is processed in the Grinding Circuit (Figure 22).

Figure 22. Secondary crushing unit.

4.2.2.4 *DUST COLLECTION SYSTEM*

All transfer points in the Ore Crushing Circuit are covered and enclosed. The suction is these enclosures are controlled by the Dust Collector Fan through the duct pipes. Dust recovered from these areas travels through the duct pipes to the Dust Collector. The Dust Collector separates the particulate dust from the clean air through the use of the internal contained excited bags. The collected dust is removed from the Dust Collector by the Rotary Valve Feeder and slurred through the addition of water in the Dust Collector Hopper. The product slurry is pumped to the Mill Feed Chute in the Grinding Circuit for processing by the Dust Slurry Pump. Water sprays for the purpose of dust suppression are installed on the ROM Bin, and Fine Ore Stockpile, and are operated in manual as required.

4.2.2.5 GRAVITY CIRCUIT

The gravity circuit feed stream will be screened to remove plus 1.7 mm material and fed to two Knelson centrifugal concentrators (or equivalent), operating in parallel. The Knelson tailings will be returned to the cyclone pump box. Gravity gold concentrate will be periodically flushed from the two Knelson concentrators. The processing plant design for Masagalu gold project won't use any hazardous chemicals like cyanide. It is design for the free gold and sulphide mineralization simple gravitation and washing technology (Figure 23 - 24).

Figure 23. Gravitation circuit

Figure 24. Leaching processing circuit.

4.2.2.6 WATER SYSTEMS

Make-up water will be pumped from underground aquifers using boreholes and submersible pumps. Borehole water will supply the fire water tank and the gold room, and, following treatment, the potable water tank. Potable water will be used at the campsite and supply the safety showers and emergency eyewash stations situated in the plant. The fire water system will comprise of a tank, diesel-powered centrifugal pump with jockey pump and a network of fire water piping. Raw water, used for pump seals and process water makeup, will be supplied from Madenge River flowing south of the MGP.

CHAPTER 5 INFRASTRUCTURE AND SITE FACILITIES

5.1SITE LOCATION AND LOGISTICS

The criteria used to select the location of the site for plant and ancillary facilities include:

- ❖ Short but safe distance to underground mine.
- ❖ Good position to access road for consumable deliveries etc.
- ❖ Ground conditions appropriate for building requirements.
- ❖ Drainage from plant site away from main project facilities and easily diverted to the storm water management pond.

The stratigraphy of the project area is dominated by a variable thickness of fine grained residual soils including saprolite originating from the weathering of the underlying rocks. The residual soils are overlain by colluvium soils and quartz pebbles. A thin layer of topsoil, with an average thickness of about 10 cm overlies the site. The topsoil will be removed from construction areas and stockpiled to be used at a later date during progressive rehabilitation.

The colluviums soils will be of limited use during the construction of site facilities and infrastructure. They will mainly be used as random fill in the downstream side of embankments and as a sacrificial protection layer overlying low permeability fill.

The residual soils should provide good foundations and will be used as low permeability embankment fill and as a compacted low permeability (<10-8 m/s) soil liner. The quartz pebbles and pisolitic soil, which will be excavated during the development of the underground and certain trenches, has engineering properties suitable for use as general fill, embankment walls, terrace earth fill and selected road layers. Site facilities will comprise the underground and processing plant, ROM stockpile, waste rock facility, tailings storage facility, water storage dam, storm water management pond, power station, construction camp and permanent camp to accommodate approximately 120 people on site during operation.

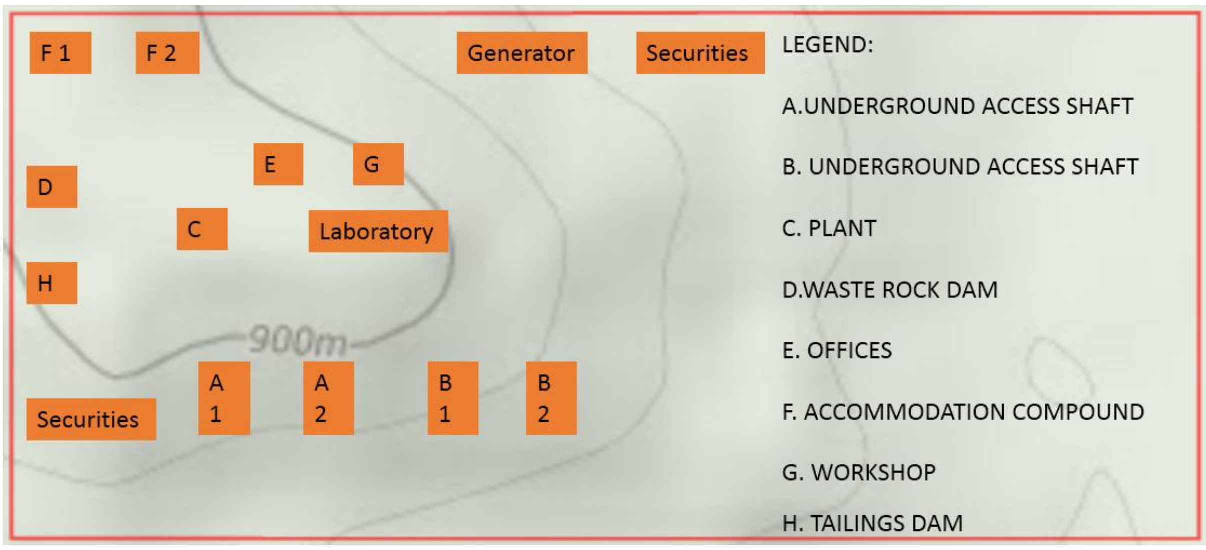


Figure 25.Site layout plan for Masagalu Gold Project

5.2SECURITIES

Camp facilities will be located at the northern side of the property. Access to the mine site will be controlled by a 2.5-m high razor wire fence enclosing a total project area. The fence will encompass all mining associated facilities with the exception of the river intake and pump house structures. The fence will be installed in a clear corridor about 6 m wide. The site security gatehouse will be located at the entrance of the new access road (to the east of the existing road).

5.3BUILDINGS

Plant buildings will comprise a number of demountable and prefabricated steel-framed units, and the existing site exploration office will be relocated and refurbished for use as the mine administration building and plant crib room.

5.4DEMOUNTABLE BUILDINGS

Demountable buildings are proposed for a number of functions, described as follows:-

- Plant operations office comprising nine offices;
- Change room;
- Three separate ablutions units to be located in the administration and plant areas;
- Plant control room, to be located within the process plant; and
- Gold room security office, located adjacent to the gold room.

5.5LABORATORY

A purpose-built unit is planned to house on-site laboratory facilities. The facility will be operated by the laboratory contractor. The laboratory will be able to perform approximately1500 fire assay analyses per month during operation. The equipment that will be used in the laboratory includes crushers, splitters and sample preparation equipment; muffle assay furnaces and balances.

5.6ACCOMMODATION

Accommodation facilities will comprise permanent camps for mine management and onsite employees. This camp will also include a combined kitchen/mess building, laundry/utility building, recreational building and camp manager's office and additional recreational facilities. Power for the accommodation camps will be provided by dedicated diesel generator sets. Potable water will be reticulated from the process plant potable water treatment plant.

Chemical sewage disposal will be used. Fire water supply will be from the camp potable water storage tanks. It is proposed that an on-site first aid clinic (including a purpose-built ambulance) be established as part of the construction facilities manned by an expatriate paramedic. The facility will be capable of servicing construction-related injuries and incidents, and will provide the coordination of medical evacuation of patients, as necessary.

5.7STAFF SCHEDULE

Site labor living off-site will work on a 6 days, 8 hours shift. Mining contractors will have a work schedule of 6 days on and 1 day off (Sunday). Staffing rotation will be 4 weeks on site and 4 week out.

5.8POWER SUPPLY

Power will be generated on-site using diesel-fueled generators. To start with two 350 KVA generators will be installed while arrangements to connect to National Grid are been done.

The following standards will be used for the site power and control system:

- ❖ Plant high voltage distribution: Three phase, 6.6 kV, 50 Hz, impedance earth system.
- ❖ High voltage motor supply: Three phase, 6.6 kV, 50 Hz.
- ❖ Low voltage supply: Three phase, 415 V, 50 Hz, solidly earthed neutral.
- ❖ Control supply: Single phase, 110 V, 50 Hz, neutral earthed.
- ❖ Lighting/small power: Single phase, 240 V, 50 Hz, solidly earthed neutral.

- Overhead lines will be used for power distribution to remote areas of the site, except for major road crossings, where buried cables will be used.

5.9WATER SUPPLY

Total average site water consumption has been estimated at 40,000 -60,000 liters/day. This amount will be drawn from the river crossing the licence at the eastern border of the MGP after analyzing the ph. of it.

5.10 MOBILE EQUIPMENT AND TRANSPORTATION FACILITIES

A range of mobile equipment will be provided to maintain the surface areas of the project site. This will include:-

- 45 to 50-t rough terrain hydraulic crane.
- 10 to 12-t yard crane.
- IT carrier/rough terrain forklift, with lifting and rigging equipment.
- Backhoe.
- 7-t flatbed truck and truck crane.
- 10 Four-wheel drive light vehicles.

Transportation options for shipping goods and equipment to Masagalu Kilindi District are in the following routes:-

- From Dar es Salaam port to Kilindi by the tarmac and paved road;
- From Kilindi District to Masagalu mining site by using a well paved gravel road.
- No airstrip around the Masagalu project area.

5.11 FUEL AND LUBRICANT STORAGE

Fuel consumption for power generation is estimated to be 6,000 liters per month. The reservoir tank of 60,000 liters will be mounted on site for both power generation and other uses including the contractors. 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. Waste oil will be blended with diesel fuel and directed to both the mine contractor's dispensing system and the power plant feed system.

5.12 HEALTH AND SAFETY HAZARDS AT THE MINE

5.12.1 JOB SAFETY ANAYSIS

Job Safety Analysis (JSA) is a safety management tool in which the risks or hazards of a specific job in the workplace are identified, and then measures to eliminate or control those hazards are determined and implemented.

Masagalu Gold Mining Project job safety analysis will be a systematic evaluation of certain jobs, tasks, processes or procedures and eliminate or reduce the risks or hazards to as low as reasonably practical in order to protect workers from injury or illness.

The JSA process will be documented and used in the workplace or at the job site to guide workers in safe job performance. It will therefore begin with identification of the potential hazards or risks associated with a particular job. Once the hazards are understood, the consequences of those hazards are then identified, followed by control measures to eliminate or mitigate the hazards. Job will be broken into steps and identifying specific hazards and control measures for each job step, providing the worker with a documented set of safe job procedures. To maintain safety in jobs the following shall be adhered:-

5.12.2 IDENTIFICATION OF JJOBS THAT REQUIRE SAFETY ANALYSIS

Priority to identify jobs that require JSA more urgently than others should go to the following:

- Jobs with the highest injury or illness rates;
- Jobs with the potential to cause severe or disabling injuries or illnesses, even if these is no history of previous accidents;
- Jobs in which one simple human error could lead to a severe accident or injury;
- Jobs that are new to your operation or have undergone changes in processes and procedures; and
- Jobs complex enough to require written instructions.

5.12.3 NECESSITY FOR JOB SAFETY ANALYSIS

Protecting safety and health is critical to employee lives, jobs and business. M/S Najim and Company Limited will systematically look at workplace operations, establish proper job procedures and ensure all employees are properly trained so as to mitigate and prevent workplace injuries and illnesses. This will result in fewer worker injuries and illnesses, effective work methods, reduced workers' legal claims, increased productivity and fewer injury and lost time costs.

5.12.4 JOB SAFETY ANALYSIS IN INCIDENT INVESTIGATION

In the event of an incident in Masagalu Gold Mining Project, documentation of the job safety analysis will be critical to the team investigating the incident. By reviewing the process and understanding the hazards, controls, job steps and safe practices defined and implemented, incident investigators can gain valuable insight, leading to a better incident investigation, and in turn, better process, safer controls and safer work practices.

5.12.5 SAFETY CONTROL

Safety control is by either by preventing the hazard from occurring or minimizing its impact if it does occur. If a hazard cannot be eliminated, steps should be taken so that the consequences of the hazard are as low as reasonably practical. Controls can be categorized into the following ways:

- Engineering design of the working system in a place of work by altering the hazard or access to the hazard, NCL will ensure regular training programs on health and safety matters ;
- Administrative design by altering the way in which the job is performed and ensure that the health and safety regulations that comply with the "Mining (Safe Working and Occupational Health) Regulations 2010" are instituted and enforced on site.
- Personal Protective Equipment (PPE) by altering the worker and his/her contact with the hazard. NCL will provide and enforce on the use of personal protective equipment (PPE), e.g., helmets, boots, goggles, earplugs, gloves and others.

5.12.6 EMERGENCY PREPAREDNESS

An emergency such as fire can occur at any time and can result in a partial or total evacuation of mine or working place personnel and the loss of lives. In any emergency, time is the critical element. Prompt detection, timely and accurate warnings to those potentially affected, and a proficient response by workers can have a tremendous impact on the social and economic consequence of a small emergency such as fire. Preparedness and response have components of technology and people. These components can work synergistically to reduce the time it takes to bring the system back in balance. The nature of underground mining requires NCL to have on-site workers to be well trained and prepared, especially in the early stages of emergency response. The early stage is critical. Decisions and actions greatly influence the outcome. When fire does occur, escape is often complicated and may not always be a viable option. Thus, the concept of fire preparedness for the Masagalu Gold Mining Project site will be an ongoing process. Fire preparedness is a subset of emergency preparedness and has logical components of both proven. NCL will set unit to be trained for emergency and rescue purposes. Training will be conducted to all miners to respond to underground emergency.

5.12.7 EMERGENCY PREPAREDNESS PLAN

Emergency Preparedness Plan will be well designed, properly implemented and periodically reviewed, so as to enhance NCL ability to respond effectively and efficiently to most underground emergencies and significantly reduce the potential loss or injury of workers and property.

The core elements of the plan are planning, prevention, preparation, response and recovery actions. The planning process is a key element that forces mine management and labor to explore viable options that can be employed to prevent or reduce the consequences of an emergency. A major component of the prevention phase is risk assessment and analysis.

5.12.8 FIRE PROTECTION

Water for fire protection will be drawn from the storage tank for the potable water treatment plant. The tank will be designed with a dedicated reservoir to feed a diesel powered high pressure pump that will start automatically if pressure drops in the firewater ring main. Eighteen hose reels/hydrants will be located around the plant site area. The power station, substations and plant buildings will be equipped with a fire detection system linked to the main alarm panel within the administration and/or security office. Fire extinguishers will be installed in plant buildings. Fire alarms will be located in the following locations:-

- Wet plant main control room;
- Power station main control room;
- Main control room;
- Plant office;
- Ablutions, crib, first aid station;
- Administration building; and
- Laboratory

CHAPTER 6 ENVIRONMENTAL AND SOCIO – ECONOMIC CONSIDERATIONS

6.1 INTRODUCTION

The environmental issues associated with development of the Masagalu Gold Mining Project are addressed in the Environmental Impact Assessment (EIA) prepared and submitted to NEMC (National Environmental Management Council). A certificate of compliance has been issued. The EIA was prepared in accordance with the generally accepted practices of the EIA process in Tanzania, as well as with international standards. The scope of work for the EIA was based on the Terms of Reference approved by NEMC, and included the following principal work areas:

- Detailed project description.
- Review of regulatory framework.
- Environmental baseline studies (physical and biological environment).
- Socio-economic baseline studies.
- Public consultation.
- Impact assessment.
- Impact mitigation, monitoring and management.

6.2 IMPACTS AND MITIGATION

The key environmental issues associated with the Masagalu property include the following:

- Water quality issues related to seepage from waste rock and tailings and expected water quality of the underground in the closure and post-closure phases;
- Groundwater drawdown around the underground area as a result of its excavation to a depth of some 400 m below ground level;
- Use and storage of cyanide; and
- Ecological issues related to impacts on vegetation and the potential presence of a new species of tree frog in the proximity of the project.
- Based on experience at similar sites, it is considered that with good project design and the incorporation of best management practices, the air quality, noise and blasting issues are of low significance for potential impacts.

6.3 LAND ACQUISITION

M/S Najim and Company Limited has settled the issue of mineral right with the previous owners. Other areas within the project expansion will need to be acquired from the owner by compensation. The issue of the land tenure (if any) shall be dealt with later in accordance with Section 95(1) (b) on restrictions of rights of entry of holder of the minerals right.

6.4COMMUNITY EXPECTIONS

It is the expectation of the local population that the project will comply with the investment policy that requires investors to contribute to villages' community development in improvement of social services such as education, health, and infrastructure.

Specific contributions expected by the community include building of school, support to the small-scale miners on improved technology, mine rescue services, health and safety training and environmental issues and Health facilities especially building of dispensaries and health centres with their associated medical equipment.

6.5MANAGING COMMUNITY EXPECTATIONS

Managing expectations of the local community will seek to address many of social issues which may lead to provisional agreements with the proponent on:-

- ❖ Local community employment and training;
- ❖ Local community business opportunities and development;
- ❖ CSR and Empowerment to the local community and the District development; and
- ❖ Financial support to the community projects to be arranged depending on priorities and District development plans.

It is anticipated that Mining activity should contribute to sustainable development in all levels from local community, district and national. However, the question is to what how and to what extent the surrounding communities will benefit from the proposed investment? The contribution is not mentioned in the law except for those projects with Mineral Development Agreements with the Government. As the need for mining to contribute to sustainable development continues to be recognized, NCL will consider possible alternatives t that better support positive economic, social and environmental outcomes at all levels in consultation with relevant communities with major focus being on the following issues.:

- ❖ Financial benefits to the local community;

- ❖ Environmental protection;
- ❖ Sacred site protection;
- ❖ Employment, business and training opportunities;
- ❖ Other economic opportunities; and
- ❖ A relationship.

6.6 GENERAL COMMUNITY WELL BEING

The management of Masagalu Gold Mining Project is committed to institute effective operating procedures on CSR for the purpose of maintaining community well-being. Some key issues that will be address in the CSR procedures are:-:

Improved income-generating opportunities. In a situation where employment opportunities are limited, and general agricultural production is declining, stakeholders anticipated employment opportunities for local people, and a boost in the local economy due to increased trade and supply of services.

Depending on the project's community outreach programs, there would be some improvement of community social services in the area in respect of education, health, agriculture, poverty reduction programs, etc.

6.7 CO-EXISTENCE WITH OTHER LAND USERS

Around the project area there are peasants, livestock keepers, bee keepers and small-scale miners who use adjacent land for their livelihood. It is important to establish a relationship between NCL and the other land users especially group of artisanal and small-scale miners (ASM).

The plan will be made to accommodate ASM operators on their licensed areas, create employ opportunity to those who lost jobs due to changing hands on the PML and examine the sustainability of the approach as well as the lessons to be learnt from it.

6.7.1 OBJECTIVE OF THE CO-EXISTANCE PLAN

The problematic and ongoing conflicts between the Artisanal and Small Scale Mining (ASM) and the Large Scale Mining (LSM) sector in Tanzania are now reasonably well documented particularly by some advocacy NGOs and the Ministry of Energy and Minerals. NCL will have a plan to establish a relation between these stakeholders. The objective of the plan is to create a move beyond reiterating the problems, and instead focus on identifying realistic opportunities for forging mutually beneficial and lasting relationships. The plan will focus on defining workable concepts and stakeholder roles/responsibilities that reflect the current issues on mining operations, the inherent constraints of Governance and legislation, and the differing and divergent agendas of the various stakeholders

6.7.2 BUILDING CO-EXISTANCE RELATIONSHIPS

Building relationship in co-existence plan is a process that requires understanding the responsibilities of all stakeholders involved. Important aspect to deal with at Masagalu Gold Mining Project Co-existence plan will be as follows:-

- Analyzing the problems, opportunity and challenges in the Plan;
- Identifying the reasons for historic conflict in the country in which most likely is caused by uncomfortable neighbors;
- Defining the roles of NCL, Governments at all levels, ASM, civil society, NGOs and interested and affected parties; and
- Managing the Challenge, having the knowledge on the relationships and
- Building communication, social programs and community relations.

6.8ENVIRONMENTAL POLICIES

NCL is committed to sound environmental management.

Specific commitments undertakes to:-

- Comply with relevant legislation and adhere to standards of responsible environmental practice for the mining industry;
- Maintain a monitoring and audit program to ensure ongoing environmental management, compliance with corporate policy and with government laws and regulations;
- Reclaim disturbed areas in accordance with site-specific criteria and applicable regulations and permits;
- Provide employees with a safe and healthy work environment in accordance with mining industry practice;
- Cooperate with governments and other stakeholders in connection with the formulation of environmental laws, regulations and standards affecting the mining industry;
- Support industry associations which promote good environmental practices and which advance environmental protection in mining and mineral processing;

- Communicate this policy to NCL employees, the public, government agencies, suppliers and customers;
- Conduct periodic audits and reviews to guide its environmental management programs;
- Design, construct and operate exploration, mining and processing facilities to mitigate environmental impacts to the extent technically and economically feasible;
- Monitoring of surface water, groundwater, and wildlife and air quality will be undertaken during all phases of the project, i.e., construction, operations and closure, in order to ensure that significant environmental impacts are avoided; and
- Regular meetings at the local level, throughout the development, operation and reclamation phases.

CHAPTER 7 MINE FACILITIES

7.1INTRODUCTION

All mines produce two types of waste material - finely-ground particles of sand called tailings which derive from the processing plant and much coarser-sized waste rock extracted from the mine itself in order to access the ore.

- Two major issues in storing mine wastes relate to:
- The chemical reactivity of the waste with the environment; and
- The physical safety and long-term stability of the storage facility.
- Waste materials may contain sulfide minerals which on exposure to air and water will eventually begin to produce acid and subsequently leach metals into solution to be dispersed into aquatic environments.

The waste rock storage dump will be located on the northeast side of the underground. It will be adjoined to the southeast by the tailings storage facility, water storage dam and storm water management pond. The Waste Rock Dump (WRD), the Tailings Storage Facility (TFS), Water Storage Dam (WSD) and site water management facilities have been designed by Hard Rock Gold Mining.

7.2WASTE ROCK STORAGE

Over the life of the mine, approximately 0.8 million t of waste rock will be accumulated for long term storage. The location of the waste rock storage facility was selected on the basis of two principal objectives:

- Long term stability of the waste rock facility; and
- Optimization of the haulage distance.
- In summary the following steps have been involved in the design of a waste rock dump:
- Establishment of the mine rock, overburden characteristics and quantities to be disposed;
- A review of the disposal site information and site selection has been done;
- Potential impacts of the dump on the environment has been discussed in the EIS document;
- Plan for disposal for disposal, operation, and closure are underway.

7.2.1 DESIGN CRITERIA

The following issues were addressed in the design of the waste rock dump:

- Surface water management facilities;
- Groundwater protection features including
- Stability
- Closure geometry
- Closure cover to control air entry, limits water infiltration, and hence limits seepage.

In designing a waste rock dump, the performance of the dump at various stages of its proposed life may be modeled using numerical and/or computer models. This will include:

- Water balance studies of the site and the dump;
- Geochemical modeling of potential acid rock drainage;
- Groundwater impact modeling;
- Slope stability modeling of static, seismic, and run out performance; and
- Long-term geomorphic studies to establish how the dump will behave in the long-term as an integral part of the topographic of the site.

Once the mine operation starts, part of the design of a waste rock dump is the preparation of the following documents that relate specifically to the waste rock dump:

- Operations Plan,
- Health and Safety Plan,
- Instrumentation and Monitoring Plan,
- Emergency Response Plan,
- Closure Plan ; and
- Post-Closure Monitoring and Maintenance Plan.

7.2.2 CONSTRUCTION

Construction of a waste rock is considered to entail the preparation of the site to receive the waste rock as part of the overall mining process. A contractor will be employed to construct access roads, strip the site, prepare foundations, place under drains, and install surface water management facilities. Figure 26 shows the design of the final shape of the waste damp. The heap fill consist of mounds of waste with slopes formed on all sides. Foundation slopes are generally flat or gently inclined. The overall slope during operation will be 380, with a 10-m wide safety berm between each lift. After closure, the dump will be re-sloped to an overall slope of 200. The access ramp will be 20 m wide at a gradient of 10 %.

Run-off water from the slope of the pile will be intercepted by a storm water ditch located upstream of a 2 m to 3 m high, 10 m wide perimeter dyke road.

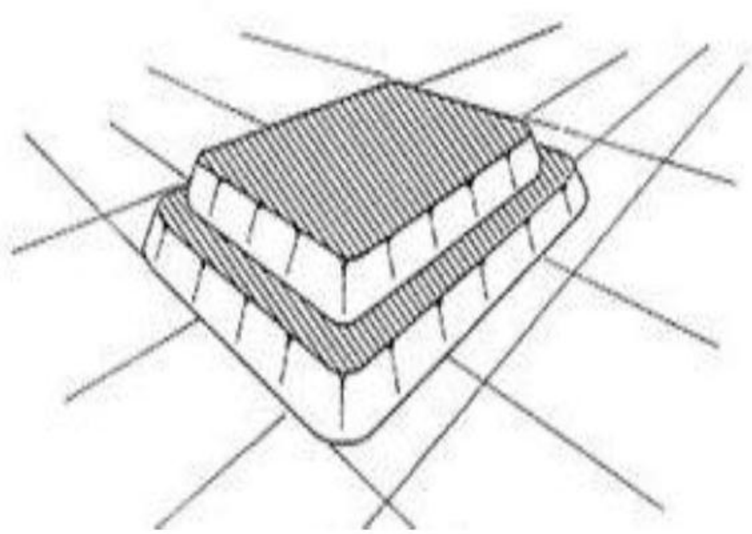


Figure 26. Design of the heaped waste dam with thick layer of lining to avoid seepage of acid rock draining.

7.2.3 ACID MINE DRAINAGE (AMD or ARD).

Due to the nature of ore (potentially Silicified garnetiferous) which is the high grade gold ore, the ore composition (pyrite, arsenopyrite and occasionally chalcopyrite) its waste from the plus other country rocks (Feldspathic gneisses) may results into acid mine due to the reaction of Pyrite (a significant sulphide in the Masagalu project) with rainwater in an oxidizing environment, i.e.:

1 --- $FeS2 + O_2 + H_2O^- > Fe + H_2SO_4$

2 --- $Fe + O_2 + H^- > Fe + H_2O$

3 --- $Fe + H_2O^- > Fe(OH)_3 + H$

As is evident from the above three reactions the production of sulphuric acid (Reaction 1) as well as the formation of insoluble iron hydroxide (Reaction 3) is inherent in the breakdown reaction of pyrite. Four potential areas could probably produce the acid mine drainage on the Masagalu operations are:

a) The Mine dumps.
b) The Plant tailings.
c) The vicinity of the shaft entrances.
d) Spillage from transport of the mine material.

Controlling of Acid Mine Drainage (AMD) from the operations is evidently an environmental problem that needs to be solved. The most problem seems to be related to the mine dump. By using a thick lining material under the waste rock dump could effectively solve the problem and thus the acid generated will be collected in ponds designed to neutralize the seepage acid to avoid land and water sources contamination. The permanent solution for treating the AMD which will be resulted from the seepage of the waste rock material at the waste dump is to design a proper control system i. e. an aerobic condition which will automatically neutralize the acid before entering into the ponds (Figure 27). Neutralize the highly toxic acid waste water in the settling pond by adding finely ground dolomite to the pond (Ponds 1-3) as shown in Figure 27.

4 ---- $CaCO3(s) + H+$ ------ $HCO3- + Ca_2+$

5 --- $HCO_3- + H+$ ------ $H2CO3$

6 --- H_2CO_3 ----- $H2O + CO_2$

These reactions produce H_20 and CO_2 as well as solid material in the form of Gypsum ($CaSO_4$).

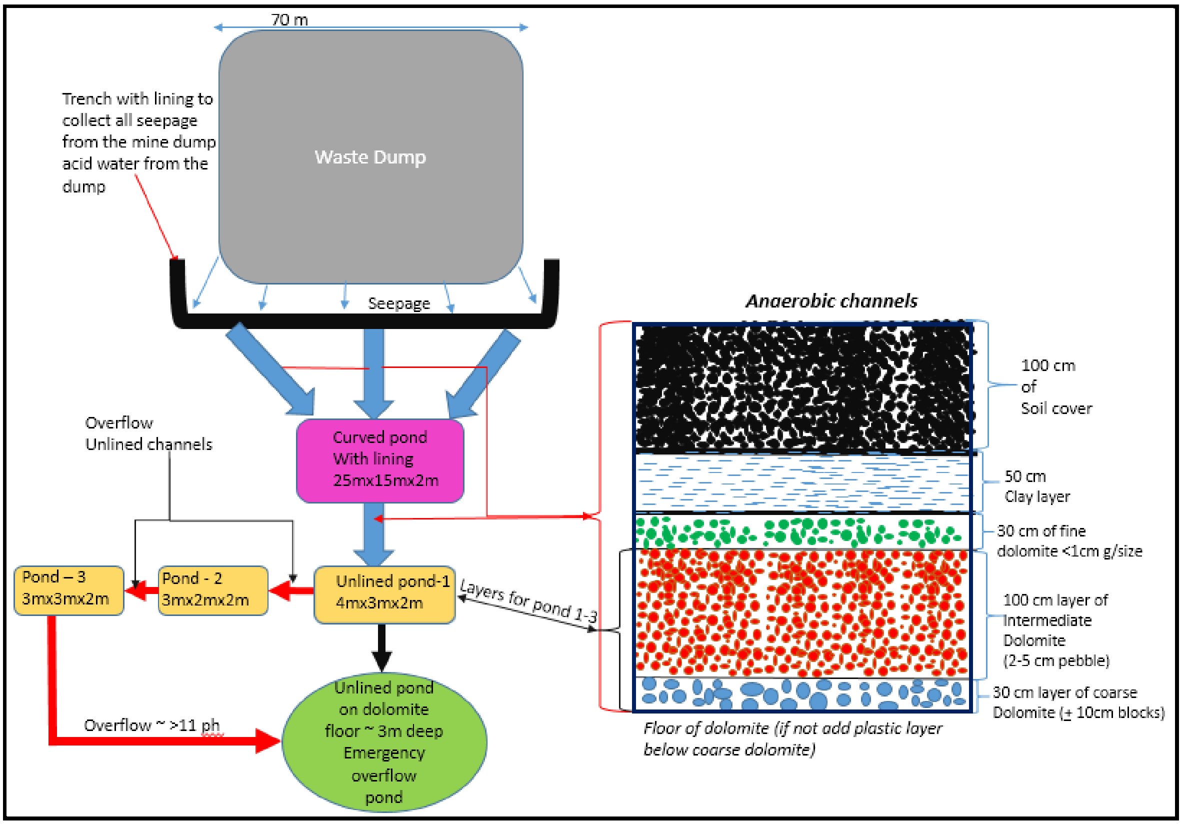


Figure 27. Sketch plan of the acid mine drainage settling ponds as the quickest renovation action to stop the overflow of the acid water during the rainy season. Small pond at 4mx4mx1.5m while large pond estimated dimension size to be 15mx15mx2m depend on the depth of dolomite from the surface.

7.2.4 OPERATION

Operation of the waste rock dump will be done by the mining employees, involves these activities:

- ❖ Ore transport from the mine and-or mill to the dump;
- ❖ Off-loading of the ore at the dump in accordance with the planned dump development and operating plans, including lift height and location;
- ❖ Access road construction and maintenance;
- ❖ Clearing of new areas for dumping, foundation preparation and drain construction as required in new areas;
- ❖ Maintenance, upgrade, and expansion of surface water management facilities
- ❖ Environmental monitoring of conditions at the dump including seepage water, surface water, groundwater quantities and quality; and
- ❖ Dump performance monitoring and documentation including stability, erosion, consolidation and creep.

7.2.5 CLOSURE

At closure of an individual trench (or temporary closure of a trench) a minimum of two feet of cover will be placed over it within 60 days of the last solid waste being placed in the trench. This cover will be sloped to deter infiltration and cause surface water to drain away from the area over the trench.

At closure of the mine or closure of a waste rock dump containing landfill surface reclamation will be performed in conformance with the Reclamation and closure plan according to Mining Regulation, 2010. Growth medium will be applied as necessary to promote natural re-invasion by native vegetation.

7.3TAILINGS STORAGE FACILITY

Gold Mine tailings are the crushed and milled rock residue that remains after mineral extraction. These tailings must be deposited for storage in a cost effective way that also meets environmental guidelines and mandates. Dams, dumps, and other types of surface piling are some of the more common tailings deposition methods used today. However, these all pose serious environmental concerns, as tailings often contain trace and sometimes substantial quantities of the metals found in the host ore, as well as certain amounts of chemicals and compounds used in the mining processes. As a result, establishing and maintaining tailings dumps represent a significant cost for mining companies.

Site selection is the most important aspect in affecting the tailings storage facility design. Different sites have different characteristics and a suitable location is sort that is most practical in terms of cost and proximity to the mining and milling operations. The tailings characteristics will have an effect on the type of storage impoundment area, and therefore the site location.

Primarily the site selection is dependent on the storage capacity required of the facility, the site availability, the construction, operating and closure costs, geotechnical and geological conditions, the hydrology of the area, and the ease of the day to day operations. Some secondary site selection considerations are:

- ❖ Land ownership, rights and boundaries;
- ❖ Location of future ore bodies;
- ❖ Rare or protected flora and fauna;
- ❖ Borrow materials available and locality;
- ❖ Surface water management and flood/river diversion;
- ❖ Environmental hazards;
- ❖ Impoundment area available and expansion potential;
- ❖ Proximity to local residents/infrastructure;
- ❖ Proximity to local drinking water;
- ❖ Distance and elevation from processing plant;
- ❖ Seepage control;
- ❖ Climate;
- ❖ Suitability of reclaim pond;
- ❖ Geology and seismic conditions;
- ❖ Legislation requirements; and
- ❖ Historical site data.

7.3.1 DESIGN OBJECTIVES AND CRITERIA

The objectives of the design of the tailings storage facility, water storage dam and storm water/sediment management pond were to achieve the following:

- ❖ Permanent and secure containment of all solid waste materials;
- ❖ Maximization of tailings density using sub-aerial and dry concept deposition;
- ❖ Removal and reuse of free water;
- ❖ Minimization of seepage;
- ❖ Containment of rainwater from extreme storm events;

- ❖ Secure water supply throughout the dry season and extreme drought conditions by using a water storage dam;
- ❖ Containment of storm water run-off from the plant site, underground and waste rock dumps;
- ❖ Ease of operation; and
- ❖ Rapid and effective rehabilitation.

The principal parameters upon which the selected design for the tailings storage facility was based are:

- ❖ Total storage required: 3.0 million tones
- ❖ Average annual throughput: 150,000 t/y
- ❖ Average slurry solid content: 55 %

The total storage capacity includes an allowance of 20 % above the tailings to be generated from the mineable reserve. Processing plant availability was assumed to be 91.5 %, equivalent to 8,000 h/y.

The tailings characterize the following materials:

- ❖ Rubble (commination sample).
- ❖ Saprolite (commination composite sample).
- ❖ Transition zone (commination sample).
- ❖ Fresh rock (commination sample).

7.3.2 CONSTRUCTION

The tailings storage facility will comprise of paddock storage with a zoned main embankment to the west constructed using mine waste and fill sourced from the key trench. The northern embankment will be constructed adjacent to the waste rock dump to retain tailings and supernatant water. A basin under drainage system will reduce seepage and a drain located at the upstream toe of the embankment will lower the phreatic surface passing through it. The toe drains and under drainage system will drain under gravity to collection sump located at the upstream toe of the south embankment. Supernatant water will be decanted from the facility via a decant tower located within the impoundment area. Solution recovered from the under drainage and decant systems will be pumped back to the plant for re-use in the process circuits.

The tailings storage facility is fully enclosed by embankments and the extreme storm events can be accommodated by providing sufficient freeboard. Therefore, an emergency spillway is not envisaged during operations. The embankment for the tailings storage facility will be constructed in a single stage. During construction, this will be excavated using mine equipment and the pit as a borrow area. Equipment from the mining fleet will place embankment material on a continuous basis. Compaction equipment, such as a Cat 825dozer/compactor, will be required to achieve the correct technical specification.

7.3.3 SEEPAGE CONTROL

The design of the tailing dam requires engineers to evaluate how groundwater flow may influence the cost and safety of tailings containment by considering practical engineering methods.

In order to control water loss by seepage, maximize water return to the plant and to increase the settled density of the tailings, the following features have been incorporated into the design of the tailings storage facility:

- Thick lining material as well as low permeability soil liner.
- Basin underdrainage collection system.
- Under drainage collection tower.
- Embankment toe drain.

7.3.4 DECANT AND RETURN WATER POND SYSTEM

The tailings storage facility will operate with a water return decant system. The first decant tower will operate for the first six months, until the supernatant pond level reaches the permanent decant tower. Recycled water from the tailings facilities decant will be reused in the ore processing plant.

7.3.5 SEEPAGE ASSESSMENT

The seepage analysis program Seep/W was used to evaluate seepage through the tailings embankment. The results of this analysis are summarized as follows:

- The proposed arrangement of the embankment and tailings basin drainage will result in the phreatic surface remaining well below the outer face of the embankment.
- The proposed drainage system will reduce the volume of water that would otherwise flow in the soil strata downstream of the tailings storage facility by more than 89 %.

- ❖ Under normal conditions, the reduction in flow in the downstream soil strata using the drainage system is from 4.0 L/s to 0.44 L/s at the final stage of the tailings facility

7.3.6 TAILINGS STORAGE FACILITY MANAGEMENT

Tailings will be delivered from the plant to the tailings storage facility through a pipeline to multiple spigots inserted along the tailings line on the south embankment. Deposition locations will be moved along the delivery line on a daily basis, or as necessary in order to control the location of the supernatant pond. Once the tailings beaches have been established, tailings will be deposited evenly around the perimeter of the facility in order to maintain the location of the supernatant pond at the decant tower and the formation of tailings beaches.

Sub-aerial deposition allows the formation of large beaches for draining and drying the tailings. The size of the supernatant pond will be kept to a minimum in order to increase the settled density of tailings and maximize both storage potential and efficiency. De-watering of the tailings will be achieved principally by evaporation as well as via the under drainage system.

7.3.7 MONITORING

A comprehensive monitoring program will be developed in order to check seepage into groundwater, the stability of the embankment and the performance of the tailings storage facility. Six groundwater quality monitoring stations have been recommended in order to detect seepage from the tailings storage facility. Each station will comprise one shallow holes (5-10 m) and one deep hole (25 m). Baseline data will be collected if these are installed prior to commissioning the tailings storage facility.

Continuous monitoring of the tailings storage facility will comprise the following:

- ❖ Solids tonnage to the facility.
- ❖ Water volume to the facility.
- ❖ Rainfall and evaporation.
- ❖ Water return from the facility.
- ❖ Flow through the under drainage sump pump.

It is recommended that monitoring of tailings moisture content and density, and surveying of the tailings beach and supernatant pond locations four times per year.

For control of emergency situations, under normal operating conditions, the following systems will be in place in order to ensure that no uncontrolled spillage occurs:

The tailings pipeline will be located on the upstream crest of the embankment with a minimum cross fall to the tailings beaches of 2 %. Any leakage from the pipeline will, therefore, flow towards the tailings storage facility; and

Between the plant site and the storage facility, the tailings pipeline and water return lines will be contained within a bounded easement and equipped with an automatic pressure drop cut-out.

7.3.8 REHABILITATION

The downstream profile will be stable under both static and seismic loading conditions and will allow for re-vegetation. Progressive re-vegetation can be undertaken during operation so that, at closure, the slope is completely re-vegetated. Re-vegetation will control dust generation and erosion due to rainfall and will provide an aesthetic appearance.

Low permeability soil fill is proposed in order to provide a long term cover for the tailings storage facility. Rehabilitation of the surface of the tailings storage facility will commence upon termination of tailings deposition. Following removal of the supernatant pond, drying of the tailings is expected to take several months and may, possibly, entail completion of the capping in the following dry season. The under drainage system will continue to operate for several years after completion of capping and re-vegetation.

7.4WATER STORAGE DAM

A water storage dam (WSD) will be constructed to store water pumped from the Madenge River. In the first two years of the project, two concrete tanks of 20,000 each will be constructed and used on site. The design of the water storage dam will be done depending on the additional water requirement at that time.

7.4.1 WATER MANAGEMENT

The development of a detailed site water management model, comprising the tailings storage facility, waste rock dump, underground, water storage dam, River pumping station, plant site, storm water management pond and associated pumps and pipe work systems will be done when the mine is commissioned. The principal water flows are:

- ❖ Slurry to the tailings storage facility.
- ❖ Water recycled from the tailings storage facility to the plant.
- ❖ Pumping of river water to the water storage dam.
- ❖ Water pumped from the water storage dam to the plant.

- UG dewatering flows discharged to the water storage dam.
- Surface run-off from the waste rock dump.

7.4.2 PUMPED UNDERGROUND WATER/SEDIMENT MANAGEMENT POND

The pumped water from underground and sediment management pond will be used as the secondary source of clean water for the plant and for making up any shortfall in process water supply from the tailings storage facility. The water storage dam will be used as the tertiary source, as a back-up to the tailings storage facility and the storm water management pond. Water management and sediment control will be required to deal with the following:

- Plant site rainfall run-off.
- Waste rock dump run-off.
- Pit dewatering.

The major design parameters of the storm water management pond are similar to the water storage dam, with the following exceptions:

The maximum dam height will be about 5 m above natural ground level.

Prior to construction, 1.3 m of sandy colluviums will be stripped from the footprint of the facility. The excavation will increase the pond capacity and will provide the majority of the dam construction material.

A spillway will be constructed, designed for a 500-y per 24-h storm event (135 mm in 24 h).

The 1.0 m thick saprolite basin liner will be extended beneath the saprolite core of the embankment.

CHAPTER 8 PERSONNEL AND TRAINING PROGRAMS

8.1 INTRODUCTION

Najim and Company Limited, founded on solid experience, has a strong and dynamic management team as well as a number of highly qualified and experienced professional earth scientists, all of whom have been involved with interpretation, defining and development of the Masagalu Gold Project. Most of these professional are local and few are expertise used as a consultants when needed.

8.2 PERSONNEL REQUIREMENTS

It is estimated that the project will require a workforce of about 105 persons including those with special skills. A list of requirement is shown in Table 9.

Table 9. Labor requirement at Masagalu Gold Mine Project site

Position	Expatriate Number	National Number	Total Number
Mine			15
Mine Manager	1		1
Senior Mining Engineer	1		1
Mining Engineers	1	2	3
Geologists	2	2	4
Mine Technician/Draftsman		2	2
Underground Technologists/Samplers		4	4
Mill			47
Mill Manager	1		1
Senior Metallurgist	1		1
Metallurgist		2	2
Shift Supervisors		6	6
Maintenance Supervisor		1	1
Electrical Supervisor	1		1
Mechanical	2	10	12
Process Operators		15	15
Electrical Technicians		5	5
Instrumentation Technicians		3	3
Training and Administration			43
Training and Safety Supervisor	1		1
Health Clinician		2	2
HR	1		1
Information Technology Manager		1	1
Training and Safety Officer		1	1
Information Technology Technician		1	1
Stores/Administration Supervisor		1	1
Storemen		3	3
Senior Administration Staff	1		1
Administration Staff		2	2
Environmental Technical/General		3	3
Security Manager	1		1
Security Supervisor		3	3
Security Guards Supervisor		12	12
Security Guards		10	10
TOTAL	14	91	105

8.3TRAINING PROGRAMS

Training and professional development programs will be installed at Masagalu Village centre. 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 Masagalu Gold Mine 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 those who are qualified people.

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.

Monies and bursaries will be made available to selected employees for educational development scholarships. The type of profession development programs that will be available include:

8.3.1 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.

8.3.2 HIGH LEVEL EDUCATION 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 OPERATING COSTS AND CAPITAL EXPENDITURES

9.1 OPERATING COSTS

9.1.1 ESTIMATED DIRECT OPERATING COSTS

Table 10 below highlight the costs estimates before commencing of the production and off site/

Table 10. Pre – Production Project Capital Cost Estimate.

ITEM	COST - USD
2 Shaft sinking to 400 m plus the hoisting system	18,500,000.00
Primary development to 20 underground workings	4,200,000.00
Ventilation and dewatering systems	1,700,000.00
Tailings and waste dams	1,700,000.00
Power station/Sub station	1,150,000.00
Offices, warehousing and workshops	1,400,000.00
Camp and accommodation	1,300,000.00
Processing Plant	150,500.00
Owner's costs	3,500,000.00
Contingencies	2,500,000.00
TOTAL	**36,100,500.00**

Below is the estimated direct operating costs in the first five years are estimated as follows:-

- Blasting of ore and waste per ton is US$ 12;
- Labor on mining, lashing, hauling, ventilation and dewatering is US $ 25
- Lashing, hauling and hoisting of material per ton is US$10;
- Conveying of ore and waste to ROM pad and waste dams respectively is US$ 10
- Processing of ore is US$35;
- Ventilation, dewatering and ground support is US$ 15;
- Administration costs related to mining is US$ 35; and
- Royalties and taxes on various levels US$ 35.

Therefore average direct cost is approximately US$127/t mined over the first five.

- It is estimated that average grade of ore mined is 13.0 grams per ton with plant recovery of 90% to produce 11.7 g/tone mined which is equivalent to 0.4 oz.
- The life-of-mine average cost of producing gold is estimated atUS$564/oz.

9.1.2 ADMINISTRATION AND MISCELLANEOUS MINING COSTS

A summary of the administration and miscellaneous mining and processing unit operating costs is US $55.53per tone mined as listed in Table 11 and 12 respectively. The main cost items are labor, power and consumables. This amount is equivalent to US$ 185.10/oz. produced. Therefore the Production total cost is US$564/oz. + US$ 185.10/oz. = US$74.1/oz.

Table 11. Summary of administration and miscellaneous mining unit operating cost.

Item Unit Cost	(US$/t mined)
Mine administration	1.60
Administration	2.10
IT and communications	1.20
Safety, health and training	1.70
Security	1.50
Camp and aviation	1.30
Contingency	1.00
Miscellaneous mining costs	1.30
Total	**11.70**

Table 12. Summary of Process Unit Operating Cost

ITEM	Consumption (kg/t milled)	Unit Cost (US$/t milled)
Process labor		7.6
Crusher and mill liners		1.73
Grinding steel balls	1.20	1.72
Lime	1.80	1.3
Cyanide	1.06	2.7
Other reagents		1.57
Total Consumables		16.62
Maintenance		3.7
Mobile equipment		2.6
Power	46.2 kWh/t	7
Contract laboratory		1.89
Total		**48.43**

9.1.3 PROCESS LABOUR

The labor portion of the total process operating cost is approximately 30 %. The average process labor complement is 83 full time employees. The labor requirements and associated costs are based on an organizational structure developed by NCL using other developed projects in Tanzania as a basis. The annual salaries and appropriate payroll burdens included in the labor costs are based on other mining projects as well.

9.1.4 POWER

The average process unit power cost is $7.16/t milled, which corresponds to about 27 % of the total processing costs. A rate of $1.7 /kWh is used in the calculation of power cost, which is based on site generated power using diesel generators. The average estimated power consumption of 46.2 kWh/t processed is based on the annual average power load, which is estimated from the equipment load list and the operational utilization for the various plant areas.

9.1.5 PROCESS CONSUMABLES

The cost of plant consumables makes up about 23 % of the total processing costs. These costs include all reagents, crusher and mill liners and grinding balls used in the process. The unit consumption rates are based on metallurgical test work results and the unit supply costs are based on quotes from local suppliers, supplemented by experience at other gold project in Tanzania.

9.1.6 CAPITAL EXPENDITURES

The capital costs for all processing and infrastructure facilities proposed for the Masagalu Gold Project have been estimated based on budgetary quotations received from contractors.

The capital costs to be incurred following the decision to proceed with the project, in underground development and construction for a production rate of 250 t/d ore, are estimated at US$ 36,100,500.00 inclusive of central processing plant.

Table 13. Provides a breakdown of the pre-production project capital cost estimate.

ITEM	COST - USD
2 Shaft sinking to 400 m plus the hoisting system	18,500,000.00
Primary development to 20 underground workings	4,200,000.00
Ventilation and dewatering systems	1,700,000.00
Tailings and waste dams	1,700,000.00
Power station/Sub station	1,150,000.00
Offices, warehousing and workshops	1,400,000.00
Camp and accommodation	1,300,000.00
Processing Plant	150,500.00
Owner's costs	3,500,000.00
Contingencies	2,500,000.00
TOTAL	**36,100,500.00**

9.1.7 BASIS OF CAPITAL COST ESTIMATE

The basis used in the development of the capital cost estimate was considering a ± 15% includes the following:

- Material quantities were estimated from general arrangement drawings.
- Labor component was based on a schedule of rates by trade.
- Material component was based on a schedule of rates by discipline.
- Equipment pricing was based on budget estimates for major items and an in-house cost database for minor equipment.
- Equipment labor installation hours were estimated using comparative data compiled from similar completed projects.
- Piping was estimated from a piping price in India.
- The electrical and instrumentation supply and installation cost estimates were based on a similar recently completed project.
- Mobile equipment costs were based on budget quotes for new and used vehicles.
- The estimate for freight costs was based on an analysis of equipment and material packages, assessment of country origin and dimensional limitations.
- Factorized spare parts allowance was included.

- ❖ Allowance for commissioning and vendor representation was based on similar Tanzanian projects.
- ❖ An allowance was included for first fill process reagents, consumables, fuel and lubricants.

Table 14.Off-Site/Indirect Project Capital Cost Estimate

COST AREA	**COST - USD**
Raw and potable water	210,000.00
Tailings and process water ponds	210,000.00
Airstrip and roads	700,000.00
Workshop tools and equipment	250,000.00
First fill reagents	320,000.00
Spares	400,000.00
Process commissioning	300,000.00
Tailings and hydrogeology design	350,000.00
First aid	140,000.00
Non hazardous chemicals	300,000.00
Exchange rate adjustment	220,000.00
Community Social responsibility	400,000.00
TOTAL	**3,800,000.00**

Total capital cost is estimated at US $**36,100,500.**00 + US $3,800,000.00 = **US $39,900,500.00**

CHAPTER 10 REVENUE ESTIMATES

10.1 REVENUE ESTIMATES

Table 15. Summaries the general revenue estimates for Masagalu Gold Project

ORE BODY PARAMETERS			
Density	g/cm3	2.7	
Width	m	0.6	Zones 1, 2 and 3
Length - Lateral Strike	m	800.0	Zones 1, 2 and 3
Height - Down Dip - Strike	m	600.0	Zones 1, 2 and 3
Grade	g/t	13.0	
Recovery	%	90	
Reef	wxt (m)	0.3x3	

RESERVE CALCULATION				
Volume	WxLxH	288,000,000,000	cm3 = m3	288,000
Tonnage (Mass) - t	Density x Volume	777,600,000,000	g = t	699,840
Reserve - Au- g	Tonnage x Grade	9,097,920	g of Au =kg	9,097.92
		Au - gm	Au - Oz	Au - kg
1. Gold Reserve from zones 1, 2 and 3		9,097,920.00	320,919.95	9,097.92
Reef dimension with 28 g/t	0.3m x 3m x 600m x 2.3 g/cm3		Tonnage	1,117.80
	Au - Grade g/t	Au -gm	Au - Oz	Au - kg
2. Gold Reserve from the Reef	28	31,298	1,104.02	31.30
	Tonnage -t	Au -gm	Au - Oz	Au - kg
Total Reserve	**700,958**	**9,129,218**	**322,024**	**9,129.22**

PRODUCTION				
Mining rate	T/day	Working days/y	Total t	Years
	250	250	62,500	11.22
	Yrs	Ounces	Au -gm	Au - kg
Production Rate per annam	11	28,713	813,995	814

REVENUE ESTIMATES				
Estimated Gold Price	1 kg of Gold =	USD	42,000	
Total Gold Revenue	USD	**383,427,173**		

NOTE

1. This value is the first phase of 230 acres.
2. Total Revenue Estimated is calculated before; Tax, Capital Investment, Operation Cost and other
3. The tonnage size depends on the size of the mineable area which need to be increased.

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APPENDICES

APPENDIX 1 – MEMORANDUM AND ARTICLE OF ASSOCIATION

APPENDIX 2 – ENVIRONMENTAL IMPACT ASSESMENT

APPENDIX 3 – CERTIFICATE OF INCORPORATION

APPENDIX 4 – CERTIFICATE OF AMALGAMATION

APPENDIX 5 - EIA