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## **PROJECT REPORT ON**

### **“A STUDY OF GEOLOGY AND MINING PROCESSES IN HUTTI GOLD MINE, HUTTI, RAICHUR DISTRICT**

**SUBMITTED FOR PARTIAL FULFILLMENT OF THE CURRICULUM PRESCRIBED**

#### **FOURTH SEMESTER**

**MASTER OF SCIENCE IN APPLIED GEOLOGY**

**BY**

**VISHNU VIJAYAN**

M.Sc. fourth Semester Applied Geology Reg. No. **GE118042**

Department of Studies in EARTH SCIENCE **UNDER THE GUIDANCE OF**

**Prof. H T. BASAVARAJAPPA**

Department of Studies in EARTH SCIENCE



**DEPARTMENT OF STUDIES IN**

**EARTH SCIENCE**

**CAS IN PRECAMBRIAN**

**GEOLOGY**

**MANASAGANGOTHR, MYSORE**

**2020**

# UNIVERSITY OF MYSORE

CENTER FOR ADVANCED STUDIES IN PRECAMBERIAN GEOLOGY

DEPARTMENT OF STUDIES IN EARTH SCIENCE

MANASAGANGOTRI, MYSORE-570006



## DECLARATION

I, VISHNU VIJAYAN, hereby declare that this project work entitled **“A STUDY OF GEOLOGY AND MINING PROCESSES IN HUTTI GOLD MINE, HUTTI, RAICHUR DISTRICT”** is an original and authentic work carried out by me under the guidance and supervision of Professor H.T BASAVARAJAPPA, in the Department of Studies in Earth Science, Centre for Advanced Studies in Precambrian Geology, University of Mysore, Manasagangotri.

Manasagangotri, Mysore

Vishnu vijayan

Date:

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DEPARTMENT OF STUDIES IN EARTH SCIENCE



## GUIDE'S CERTIFICATE

I hereby certify that the Technical Report entitled “ **A STUDY OF GEOLOGY AND MINING PROCESSES IN HUTTI GOLD MINE, HUTTI, RAICHUR DISTRICT**” submitted by **VISHNU VIJAYAN** of **IV SEMSTER M.Sc. APPLIED GEOLOGY** whose **Register no: GE118042**, Department of studies in earth science, University of Mysore, has been carried out by him under my guidance and He has completed his work successfully during the academic year 2018-2020 for the award of M.Sc., Degree in Geology.

Manasagangothri, Mysore

Date:

**Prof. H T. BASARAJAPPA**

Professor

DOS IN EARTH SCIENCE



# UNIVERSITY OF MYSORE

CENTER FOR ADVANCED STUDIES IN PRECAMBERIAN GEOLOGY  
DEPARTMENT OF STUDIES IN EARTH SCIENCE

## CERTIFICATE

This is to certify that Mr **VISHNU VIJAYAN**, Reg.No: GE118042 has satisfactorily completed the technical report entitled "**A STUDY OF GEOLOGY AND MINING PROCESSES IN HUTTI GOLD MINE, HUTTI, RAICHUR DISTRICT**" and is an original work carried out by him. He is hereby permitted to submit his technical report under the above said title in the partial fulfillment for the award of M.Sc. in Applied Geology (IV semester) at the CENTER FOR ADVANCED STUDIES IN PRECAMBRIAN GEOLOGY, DOS IN EARTH SCIENCE, UNIVERSITY OF MYSORE, Manasagangothri, Mysore during the academic year 2018-2020.

Manasagangothri, Mysore

Date

Dr. P . MADESH

CHAIRMAN OF DOS IN EARTH SCIENCE

## ACKNOWLEDGEMENT

I would earnestly like to place here in record my gratitude to all those who have helped me to complete this work throughout the course of work and at different stages.

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Manasagangotri, Mysore.

VISHNU VIJAYAN

Date :

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# INTRODUCTION



## **AIM AND OBJECTIVES**

### **Aim**

The aim of the study is to get a better understanding of the study area which is along the Hutti area of the Hutti-Maski schist belt and to understand the techniques used in the geological mapping of an area and mining methods adopted.

### **Objectives**

- To carry out the reconnaissance survey of the area around Hutti to fix the traverses in the field for mapping.
- To bring out the relationship between lithologies present in the area and associated gold mineralization.
- To study Petrographic features of different rocks types of study area to know their mineral assemblages, textures and paragenesis.
- To understand the gold mineralization in the study area based on field and lab studies.

# **METHODOLOGY**

1. Planning.

2. Field work and collection of rock samples - samples were collected by hammering and hand picking

3. Geological mapping—By referring to the latest topographic maps published by survey of India and maps of Hutti gold mines, traverses were taken.

4. Laboratory studies. – Thin section studies using microscopes Zeiss AXIO imager. A2m Transmitter microscope and Zeiss stereo discovery V.20 polarizing microscope.

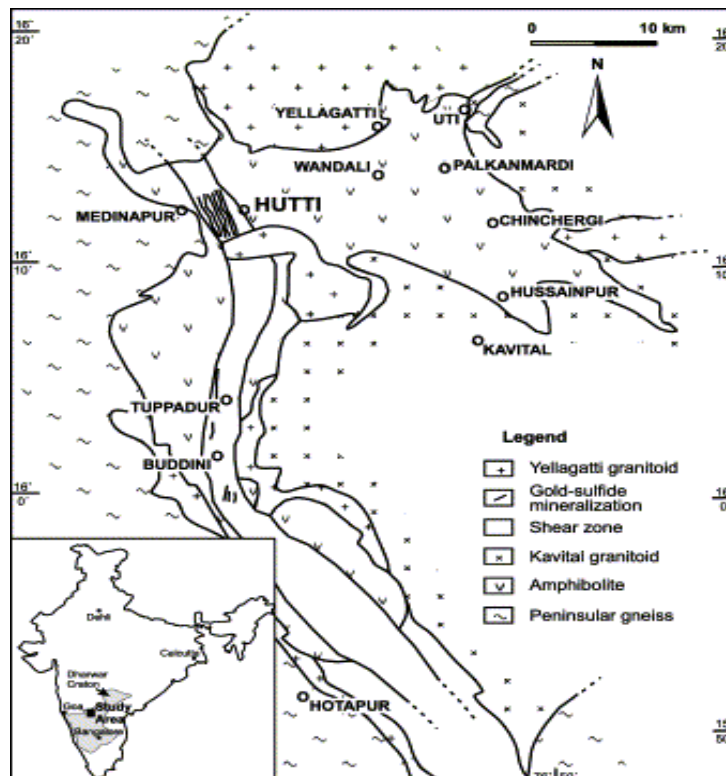
5. Preparation of final report.

# The Hutti Gold Mines

## Introduction:

The Hutti Gold Deposits is located in the northern fringe of Hutti-Maski Schist belt, Hutti-Maski greenstone belt is a very important auriferous belt in India. With the depletion of gold reserves i.e. Kolar Gold Fields. It has emerged as the premiere gold producing belt of the country. The Hutti-Maski greenstone belt comprises abundant mafic flows with subordinate acid volcanic rocks and sediments. The volcanic pile and sediment intercalation show orderly development and a decipheral sequence. There is an extensive granitoid intrusion in separate phases into the various units of the volcanic sequence. Despite this granitoid invasion, direct contact between the gneisses of the PGC and the greenstone rocks can steel be seen in several sections.

It is the only deposit producing primary gold in India in recent years, witnessing 72 years of its glorious mining history. The Hutti Gold Mine Co Ltd (HGML) is operating three eco-friendly gold mines (Hutti,Uti and Heera-Buddinni) in the Hutti-Maski Schist Belt. The Hutti Gold Mine is the one of the gold mines in India.



Fig;Hutti-Maski schist belt

## **GEOLOGY OF THE HUTTI GOLD FIELD**

The antiquity of gold mines in Karnataka is quite old and the ancient gold mines are still acting as beacons for modern-day gold mines. Majority of old workings were brought to light by Foote during his geological traverses in Karnataka. Over 300 ancient workings were identified in the Hutti–Muski schist belt, Karnataka. The deepest mine depth happens to be 200 m from ground level at Hutti. Some of the ancient workings were considered to be 3000 years old.

Evidence of ancient mining activity was observed during the course of opencast mining in Uti gold mines<sup>8</sup>. It was observed that these old workings were stretching up to a depth of 20– 25 m, and contained wood, charcoal, ash, pottery, etc. The geological cross-section of the open-pit (Figure 1 b) shows presence of amphibolites in its western face, acid volcanic rocks in its eastern section, and the lode zone. Mineralization in the mafic rocks is mainly confined to intensely silicified and feldspathized amphibolite with thin stringers, veins and veinlets of quartz, associated with the sulphides (pyrite, arsenopyrite, pyrrhotite, etc.). Mineralization is notable with a uniform impregnation of silica in the ore zone. On the basis of presence of wood, charcoal, ash, pottery, etc. in the old workings, it was interpreted that ancient miners extracted the ore through fire-setting process followed by water-cooling of the heated rock. This was evident from the presence of visible gold over the surface of charcoal coated burnt quartz in the open pit old workings<sup>8</sup>.

Based on the above said facts, the coarse and fine grained vesicular meta basalt of Buddinne formation is the host for the auriferous lodes pointing to a lithostratigraphic control of gold mineralization. The auriferous lodes can be grouped into gold-quartz lodes, gold-quartz-sulphide lodes and gold-quartz-ankerite-sulphide lodes.

The Gold mineralization in Hutti Maski greenstone belt occurs in a favorable volcanic host rock commonly basalts, andesite etc. The Hutti-Maski greenstone belt is rift related volcanic belt due to crustal distension. The genesis of the gold in the Hutti-Maski greenstone belt is by dynamo-thermal processes (Biswas, 1990, Roy, 1991, Raju and Sharma, 1991). Gold and other sulphides in Hutti-Maski greenstone belt are essentially part of the volcanic sequence with greater concentration in the coarse to fine grained tholeiitic rocks of Buddinne formation. During the first deformation gold and other metallic, fluid and gaseous elements in the original mafic volcanic rocks were mobilized and migrated into the fracture and shear systems developed in the ductile brittle regime.

The mineralization can be broadly grouped into two structural sectors, (1) Northeastern hook zone and (2) Western shear zone. In the Northeastern hood zone (Uti, Wandali, Chincherggi, Hira Buddinne and Kadoni) the deposits are generally aligned parallel to the foliation of the metabasalts and are mainly fracture controlled and are related to first deformation. The subsequent second and third deformations have affected the geometry and orientation of the gold bearing lodes as seen in Wandali. The structural regime is brittle – ductile and the metamorphic grade is green schist to lower amphibolites. The timing of mineralization coincides with that of metamorphism. Gold occurs in vein quartz and in the alteration zone. It is in the native state as well as in association with sulphide. Arsenopyrite, pyrite, chalcopyrite and scheelite are the associated

ore minerals. The wall rock alteration is seen in the form of silicification, chloritization and biotitization along with quartz, calcite, biotite and plagioclase. The alteration zone varies from 1 to 4 m and at places it is wider.

The western zone extends from north of Hutti Gold mines to the east of Harapur, which is about 45 km long trending NNW to SSE and swinging to NNE to SSW near Sanbal. The width of the zone varies from 2 to 3 km. In this zone metabasalts are extensively altered to chlorite schists and are carbonatized and epidotised. This shear zone shows mylonitisation and brecciation related to second phase deformation. The mineralization occurs in association with chlorite phyllite and carbonated metabasalts in a brittle ductile structural regime. Gold occurs with quartz as parallel to sub parallel veins with a N-S to NNW-SSE trend and steep dips. Gold is in the native form and also interlocked in arsenopyrite, pyrite, pyrrhotite, sphalerite and chalcopyrite. Quartz, ankerite, plagioclase, chlorite, biotite, sericite are important minerals in the wall rock. Scheelite is more common in the northern part of the shear zone.

### STRATIGRAPHY OF HUTTI-MASKI GREENSTONE BELT

|       |                             |  |
|-------|-----------------------------|--|
|       |                             | Black cotton soil cover  |
|       | Deccan Trap                 | Basalt   |
|       |                             | Basic dykes    Auriferous quartz vein and ankerite quartz vein.    Grey and pink pegmatoids  |
|       | Chinchergri Granophyre      | Quartz granophyres, porphyry   |
|       | Yelagatti Granite           | Coarse to medium grained pink granite  |
|       | Kavital Granitoid           | Medium to coarse grained grey biotite hornblende granodiorite and local tonalite.  |
|       | Buddinne Formation          | Massive vesicular and pillowed metabasalt, coarse – grained metabasalt. Amphibolites, local interaction diorite, phyllite locally carbonaceous, limestone, gritty calcareous quartzite. Banded Iron Formation. Quartzite, quartz sericite schist (garnetiferous) metaacid rocks, Palkanmaradi mixtite. |
| Hutti | Bullapur Formation          | Amphibolite with lensoids of meta pyroxenite, garnetiferous amphibolites, interaction diorite. Cross bedded tuffite. Diorite porphyry, nodular diorite.  |
| Group | 530 Hill Formation          | Pillowed metabasalt with lensoid amphibolites  |
|       | Hussainpur Formation        | Banded amphibolites / basic volcanic wacke streaky amphibolites. Amphibolite. Nonconformity  |
|       | Peninsular Gneissic Complex | Banded gneiss, migmatite, streaky gneiss. Granitic biotite gneiss  |
|       | Sargur Complex (?)          | Talc tremolite actinolite schist, serpentinite. (Tectonically emplaced in Greenstone belt).  |

## **Structure:**

The Hutti -Maski belt has a NNW-SSE trend with a sharp hook bent in the North towards SE. The present hook shape of the belt can be attributed to cross folds and also to the diapiric nature of two phases of granitoid intrusions into the greenstone belt. The rocks of Hutti-Maski belt have preserved primary structures. The sediments show bedding planes and the metabasalt displays vesicular layers and structures.

The secondary structures include various planar structures comprising schistosity, crenulation cleavages. Joints and fractures and pronounced linear structures defined by the axis of minor folds mineral lineations and intersection of two sets of schistosity.

The rocks of the Hutti-Maski greenstone belt have undergone three distinct phases of deformation. The first one is characteristically reflected in the development of penetrative planar structure i.e., the pervasive schistosity. The identification of the axial trend of first fold is a little uncertain due to pronounced subsequent deformation.

The second fold is the most prominent and it has resulted in the development of parallel antiforms and synforms with a NNW plunge.

The second deformation has also caused the development shear zone along the western segment, from Hutti mines area in the north to Dinnesamudra in the South, trending NNW-SSE for over 40 kms length. This shear zone is clearly ductile-brittle deformation and has resulted in two sets of fracture planes. Local brecciation and mylonitisation. Development of chlorite phyllite and quartz veins containing gold mineralisation and carbonization. There are also related shear fractures developed in the North Eastern sector.

## **Gold Mineralization:**

Gold mineralization zones occurs as parallel to sub-parallel lode zones called as ORE BODIES, in highly sheared and altered Chlorite - Biotite - Carbonate schist with deformed grey quartz veins with the country /host rock Meta- Basalt.

The main auriferous lode zones of Hutti deposit consists of nine known reefs. The reefs generally trend in NNW-SSE direction and dip steeply 60° to 70° due West.

### **Mode of occurrence of Gold:**

Generally the gold is found in the native form and refractory in nature. The invisible gold occurs in the form of Nuggets, Specks, Fracture filling in quartz veins and also as Smears. Whereas the refractory gold is locked up within the crystal lattices of other sulfides like Arsenopyrites and pyrrhotites and are invisible.

Silver is associated with gold ore, amounts about 10% of gold and being obtained as a by-product along with gold extraction.

Out of nine reefs, Strike reef and Middle reef - contain Scheelite Substitute ore for Tungsten, mineralization besides gold and silver.

## **Important Activities of Exploration Department:**

- Geological Mapping-Surface & Underground.
- Surface trenching.
- Sampling-Development, Stope & Core Samples.
- Monitoring /Guiding the UG developments.
- Preparation of Geological & Assay plans.
- Demarcation of Payable Ore Body Limits.
- Preparation of geological cross sections.
- Preparation of Bore Hole cross sections.
- Quality Control/Grade control.
- Estimation of Ore R & R (Reserves & Resources).
- Preparation & Processing of PL,ML,QL Applications
- Preparation of Mining Plan, Scheme of Mining.
- Co-ordinating the Preparation of EA & EMP Reports.
- Macro & Micro Metal Balance studies.
- Ore body Modelling (using DATAMINE software).
- Statistical and Geo-statistical studies.

## **UTI GOLD MINE**

- This mine is situated 22Kms North East of Hutti Gold Mine.
- It is a EXPLORATORY MINE.
- This deposit is explored by GSI, MECL & HGML.
- HGML has got Mining Lease over 47.96 Hectares
- 17 mineralized zones consisting of Sulphide - rich Quartz and lode matter with a cumulative strike length of 3.5 km, with individual strike length of 50 to 720m and 4-5 mts.
- This mine is having nine lodes and HGML started the project-Uti Gold Mine on three lodes, namely Lode No. 2 & 3 and Lode No. 4 (660 m strike length).
- The lode 4 is having a strike length of 700 mts of 350 mts was mined.
- Its trending N 15° W - S 15° E.
- The dipping is 82° - 85° E.
- HGML started open cast mining in Lode No. 4 and it continued up to 90 m depth over a strike length of 300 M.
- It's trending NORTH - SOUTH.
- However, open cast operation was suspended due to higher stripping ratio.
- The remaining 360 m strike length of Lode No. 4 is proposed to be worked by another open pit mine (South Pit).
- Simultaneously sinking of a new Service Shaft of 3x2 m size is established up to a depth of 270m.
- Also, the existing MECL shaft is under process of deepening.
- Both these shafts will be used for underground operation of the deposit. Lode No. 2 & 3 had been developed for underground mining through two numbers of exploratory shafts and an Inclined shaft has been sunk up to 165 m length

### **Geological environment:**

The area in general is represented by heterogeneous metamorphosed rocks along with volcano-sedimentary rocks. Metavolcanics ore metabasalt, amphibolites along with Acid Volcanic Rocks.

### **Structure:**

The rocks are highly sheared here. A East-west trending fault cut across the lode 4 and separate lode 2 and lode 3. It is a strike-slip fault. Along one side of the fault we can see oxidized mineralization of amphibolites. On the other side there is sulphide mineralization. Box work can also be observed here. Some pillow structures are also found in the metabasalts here.

### **Mineralization:**

Mostly the mineralization occurs at the contact of Acid volcanic rock and basic rock and also within coarse to fine grained oxidized amphibolites. The depth of oxidation, as of tilt now, is noticed till 100 m below surface.

### **Open cost mine Design:**

Stripping ratio or ore overburden ratio is generally 1:6 in the initial stages but at the next stages it is about 1:10. The bench height of this open cost mine is about 7m, width is about 3m which will allow the required machinery and material transport, the bench face angle is about 80° initially about 90m was dug up.

The ore is being transported and treated at Hutti.

## **GEOLOGICAL MAPPING:**

Mapping is one of the essential part of the mining. It gives directionality to the entire procedure as of in which direction mining is to be done and to which extent. Hence for the development of any underground mapping both surface mapping and underground mapping is critically essential and its accuracy costs a lot.

### **UNDERGROUND MAPPING:**

Underground mapping is basically done following a single procedure but along various positions within the developed mine. The face and roof of the crosscut and drives are mapped also.

Mapping is done for raises and winzes.

### **Mapping of the drive:**

A station at every 2m interval is taken. At each station lithology of both the hanging and footwall and roof of the drive is perfectly analyzed.

The distance between the walls is taken at chest level at every interval

Lithology is marked from HANGING WALL to FOOTWALL side with the help of tape and light and the distance is noted

At every interval the strike and dip of all the litho units are taken.



## **Mapping of the crosscut:**

Stations are taken according to the requirement as of the litho units as well as presence of structural features or disturbance.

Here also mapping is done at chest level by marking both the litho units as well as dip and strike of each litho units.

While mapping the zero point taken at the starting of the cross cut. The process is repeated on the opposite side of the crosscut as well.

After mapping they are joined in order to get the trend of the litho units

Based on the methodology of the mapping of a small area around 8 m have been mapped by us to get a more detail knowledge on the underground mapping.

## **Sampling:**

### **On lode developments**

#### ***Channel Chip Sampling:***

Till 1995 the sampling is being done at 1m interval. But over the time the statistical and geo-statistical studies have proved that if the interval of sampling is changed from 1m to 2m, then there will be hardly any change in the average grade and also economical point of view also it holds good.

So, based on this conclusion presently channel chip sampling is made at 2m interval in on lode development points. In this channel chip sampling method based on the existing lithology sampling width (Min. 30cm and max. 90cm) is decided and number of samples are collected. While collecting individual sample a channel is made across the dip of the ore body, and alongthat channel sample is collected.

In cross cuts The Channel samples are collected in the northern and southern wall covering the whole length of cross cut upto the geological limit, so as to know the width of the ore body on lateral sides.

In stopes (At times to check the quality of ore)

The main objective of collecting samples in the stopes is to maintain the quality of ore. In a stope during the shifts samples are collected in each bandies from all the corners for all the trips and then representative samples is obtained by cone and quartering method. But this method does not constitute the representative sample, it is done to know only the quality of ore.

The entire sampling result is put in the sampling table where the sample no, Width, distance, lithology, grade are written column wise then the calculation of the average grade of the ore body is done then the assay map is prepared on the basis of the result of the sampling. The weighted average grade is done calculated as

$(\text{width of the sample grade of each sample}) \div (\text{width of the sampling}) = \text{average weighted grade.}$

**Apart from the determination of the grade of ore there are many other use of sampling**

1. It determines the direction of mineralization.
2. Determines the direction of the drive.
3. Determines the width of the mineralized zone on both side of the drive.
4. Life of mine along with ore reserve.

## **SURFACE MAPPING:**

### **TRENCHING:**

Trenching is the primary method of mapping. A trench is dug across the mineralized zone is exposed. Here in Hutti gold mine a trench of length almost 0.50 km is dug which runs across strike joining all the nine reefs. The width and depth at the trench depends upon the requirement based on the true thickness and proper exposure of litho units. Here the depth is of 10ft. trenches are usually dug from east to west, as we move from east to west sequence of reefs ore SR, zone-I, MR, OR etc. Surface exposures of the ore bodies are usually not present. Hence to expose the ore body in the surface level trenches are dug. Channel sampling is done here also. On the basis of the grade of the gold, diamond drilling is proposed. Using the result of the diamond drilling further mining is carried on.

The material exposed on the trench usually contains very less amount of gold but that can give a general idea of the amount of gold present underground.

## **UNDERGROUND PLANNING AND SURVEY:**

Underground planning and survey goes hand in hand regarding importance. Surveyors survey a particular position and enhance the direction as well as the accuracy of the plans.

Plans are of various types as mentioned in the planning section for various workings ahead. The various types of plans are as follows:

- 1) Underground working plans.
- 2) Surface plans.
- 3) Surface geological plans.
- 4) Vertical section for all the reefs.
- 5) Transverse section of each map.
- 6) Water danger plan and section for all reefs.
- 7) Ventilation plans and reefs.

Each of these plans has its own importance as is evident from their name, in their own areas. Plans like ventilation plans, water danger plans gives a thorough understanding of the ventilation or water level at a particular place.

Apart from these plans and sections there are mainly three kinds of sections. These are as:

- 1) Planner sections.
- 2) Transverse sections.
- 3) Vertical sections.

Planner sections give a broad knowledge of the plan view of each level. At each level mapping is done along strike or across strike as required. Now the mapped lithology at each wall is projected on a planner view by simply joining the litho boundaries at each well. This planner section of each level is coloured by various colours depending upon the grade of gold in each litho unit.

The Transverse section is a section taken vertically passing through any one shaft transversely along the strike of the reefs.

In this section, the exposed part of the stopes are marked and colored according to the grades of the ore in each stope.

Longitudinal section is taken vertically across strike of all the reefs. In such a section almost all the shafts are passed through. Here also stopes are coloured according to their grades. Usually the colouring code is like Green for 2 -5 g/t; Blue for 5 - 10 g/t ; Red for 10- 17 g/t; etc... Below 2 g/t no colour is put as 2 gm is the cut-off grade for this mine. The stopes that are already mined are crossed.

The various data thus collected are put together to form a base map.

Certain grid system is maintained in these plans to delineate each and every point. Grids are made at each 50m interval along North-South and East-West direction. Grids along North-South are usually numbered but alphabets are used to indicate East-West direction as AE, BE, CE (along East direction) and AW, BW, CW (along West direction).

## **DRILLING AND BLASTING:**

Excavation is the next method to exploration. Both of these methods need drilling. Proving any ore body requires drilling. For proceeding with excavation blasting is another very essential procedure.

For exploration, mapping is essential. Along with mapping another very essential process is drilling.

### **DRILLING:**

Drilling has a wide field of application where it is need for sampling as well as for proceeding the mine development. The Various uses of drilling are as follows:

- 1) Determining the lithology.
- 2) Determining the extent of ore body.

3) Used for blasting. Etc.

To prove the extent of ore body diamond drilling is essential.

**Diamond Drilling:** it is a type of drilling where the core is recovered to check the extent of ore body, grade of ore etc. for further excavation purpose. it is done by a Diamond drilling machine according to the diameter required. The drill bit is made up of tungsten carbide. The core recovered is kept in a core box for determination of assay. The drilled core is kept according to depth or distance and a mark is made along the middle part of the core pieces and the same core is cut in two half, One half is sent for assay and the other is preserved for future use. On the basis of this sampling, further construction or development is proceeded with. Diamond drilling is a very costly process so it should be used in places where it is readily required otherwise there will be a loss of money.

**Procedure:** The drill bit is fixed at the end of the drill rod which rotates along with the drill bit. The drill bit which is impregnated with diamonds that cut the rock with rotary motion. The core so obtained is less than the diameter as that of the drill bit ring(core picker) .

To hold this core while hoisting the drill bit and rods, a core picker is provided which holds the core while the drill rod is taken out. Drilling fluid is used here which has several functions to perform. Mainly it

1. Keeps the drill rod and drill bit cool.
2. Accelerates the operation.
3. Cleans the drill hole.

Then the result is plotted in a logging sheet.

### **LDBH DRILLING:**

This type of drilling is usually done for stoping purpose. The drill holes are constructed along a vertical plane making various angles as decided by some computer software. There are basically two types of LDBH drilling method namely:

i) BBC,

ii) BVC.

**i) In BBC method following things is used:**

- a. Drill rod with diameter up to 57 mm, after drilling is done with 64 mm bit.
- b. Cross drill bits.
- c. Spacing between blasting planes is 1.5m.

**ii) In BVC drill rod is used of 115 mm diameter, spacing between each planes is 2.5m, this is done for longer depth.**

The drill holes are then cased with a relatively larger sized casing pipe which is of diameter 67mm. Now 2/3 of these holes are filled up with explosive and blasted.

Sub level stopping method is being used in here.

## **JACK HAMMER DRILLING:**

This Type of drilling is done for advancement of the drives as well as for secondary blasting. Smaller holes of diameter 32mm is drilled out in a suggested pattern and blasted. Each blast advances the drive by 1 to 1.2m.

In case if there is any blockage at any raises and winze mouth the secondary blasting is done to break the rock into smaller pieces. In such case also jack hammer drilling is used.

## **BLASTING:**

Blasting is the procedure of breaking the rocks. Certain patterns are used for blasting. These patterns are:

1. Wedge cut pattern,
2. Burn cut pattern.

### **1.WEDGE CUT PATTERN:**

Wedge cut pattern was used initially but in this case as there is no free space present lower amount of rock is broken, so now a days burn cut method is used as blasting pattern.

### **2.BURN CUT PATTERN:**

The holes are drilled in a pattern as the central holes are left uncharged this act as free space to increase blasting efficiency. The charged holes around the uncharged holes are arranged in a specific pattern. Now these holes are filled up with explosive in the first explosive detonator is there to initiate the blasting, then the electric wires are connected with the exploder and blasted. The explosive used is of emulsion type which is water resistant. Slurry explosives are also used in places which are basically dry

## **ORE WITHDRAWAL AFTER BLASTING:**

The broken ore is Taken from blasted area by using a loader is used which is working on pneumatic pressure. The loader may be of 2, 3, 5 ton capacity depending on requirement. A winze is a way which is used for ore transport. This loader is carrying the ore upto the inclined shaft and it is bring the ore to the surface.

## **VENTILATION:**

Ventilation is a science of bringing wholesome air below ground to the desired depth to dilute noxious gases and make the environment comfortable for working.

### **Ventilation system in Hutti gold mine:**

The ventilation of the mine is done by accessional boundary method.

From ventilation point of view the mine is divided into three ventilation districts viz.

1. SR district
2. Zone I district

### 3. Oakley's and middle reef district

Intake to the Strike reef and Oakley reefs is mainly from Malappa and Central shaft. The air goes to the lowest level and then distribute to the whole mine. Doors are kept at every level so that it can be distributed properly to every level.

The WINZES and RAISES will support the flow of air from one level to another level as a passage. The air is circulated through these.

### **Ventilation planning:**

It is being done keeping in mind the stationary requirements follows:

Maximum velocity in intake shafts - 8m/s.

Quantity requirement /man - 6m<sup>3</sup>/man.

Temperature limits -wet bulb -30.5°C.

Dry bulb-44°C.

Velocity requirements: 1 to 2m/s at working places 4m/s of load haulage

Noxious gases found below-NO-5ppm

CO<sub>2</sub> - 5000 ppm

CO - 50 ppm

Maximum number of person working in the largest shaft is 800. '

maximum quantity of air required is 4800 m<sup>3</sup>

Air coursing methods 1. Doors-air lock system, 2. Regulation, 3. Stoppings

Air quantity measurement apparatus

1. Digital portable velocity meter
2. Winding hygrometer (temp)
3. Gravimetric dust sampler ( to sample dust particle)
4. Multi gas detector-MSA
5. Flux meter

## **SURVEY:**

Survey is locating the position of on unknown location using the data with respect to a known location. The survey results are used to draw the maps and plans at various stages.

Instruments used: Usually three instruments are used for surveying. These instruments are AUTO LEVEL, THEODOLITE and TOTAL STATION.

AUTO LEVEL is a leveling instrument which is used to measure the difference in altitude between two different points. Based on this difference, horizontality or gradient of various part of the mine is determined.

THEODOLITE is an instrument which gives horizontal and vertical angle as well as the distance between two points. Using the data of two known locations on unknown location can be easily located.

TOTAL STATION is also a Theodolite sort of instrument but it is totally digitized. As a result of this report from horizontal angle, vertical angle and distance, it can acquire much other information like latitude, longitude, temperature etc.

Mr. Prashanth of SURVEY DEPARTMENT has demonstrated us the Total station instrument. It is a Digital instrument using a LASER to measure the distance between two points. On one point the instrument is placed on the other end a PRISM is placed. Based on the reflection of the LASER the distance is being calculated.

Method used: surveying is carried out in three methods.

### **1) Traversing:**

This method can be carried out on the surface or underground. It involves location of a station/place of desired interest using information obtained from previous station.

### **2) Triangulation:**

This method is carried out on the surface. It involves location of a station / place of desired interest using information from three previously known stations. intersection of the readings obtained from the three known stations encloses a triangular area which locates our place of interest.

### **3) Correlation survey:**

This method is carried out on the surface and then eventually underground. Locations of places/ stations are obtained on the surface and then transferred underground along a vertical path such that each surface reading has its corresponding underground counterpart thereby allowing us to locate stations/places when underground.

## **MINE DEVELOPMENT:**

There are usually two type of development primary and secondary. Primary development is those used to expose the ore body. It is of two types.

1. On lode where the development is made within the ore body itself.
2. Off lode where the development is made out of the ore body within the country rock.  
This is done on the basis of requirements proper technology is used and keeping in mind of the economy.

Shaft is a primary development. The shaft in this mine is rectangular where two cages are there for transport of men. At times skip is fitted in place of cage for material hoisting.

Secondary development is that development which develops from the shaft for the transport of ore, recovery of ore and to reach the ore body. Various such developments are haulage drive crosscuts raises winzes levels sublevels etc.

Levels ore 2m×1.8m in section and level interval is 100 ft or 30 m vertically. The levels are constructed or the development of stopes. There are connections between levels or sublevels through raises and winzes they are used for transportation of material. Haulage drive is drawn parallel to the strike of the reefs whereas crosscuts are driven perpendicular to the strike of the reefs. The crosscuts are the only secondary development used for the Simultaneous exploration and production of ore. These drives are of a dimension of 3m × 3m in this mine, for requirement of mining efficiency and less dilution 2.8m x 2.8m dimension of drive are maintained. Apart from the above developments plot is also considered as the secondary development which is constructed in the adjacent area of The shaft for the purpose of stoppage of men and material.

## **ESTIMATION OF ORE RESERVE:**

Ore reserve estimation is one of the most important tasks for a geologist in mine. This determines the primary mine planning and stopping of ore.

Developed ore reserve:

This category of ore occurs between two fully exposed levels. The dimension of ore body is of reasonable size to be mined out and it is under active production, development or planning phase.

### **1. Fully developed ore reserve:**

This category of ore reserve includes ore which are exposed and properly sampled and blocks are of reasonable sizes. Here minable tonnage and grade is fully assessed. The sampling interval should be in the range of 10 to 30 meter apart in both the horizontal and vertical planes. The frequency of sampling is depending on the complexity of the ore body.

### **2. Partly developed ore reserve:**

This category of ore is also fully exposed blocks and located between two mining levels. The sampling distance of bore hole can be up to 30m both vertically and horizontally for complex vein



type deposit. The mine block contain these ores must be accessible from main haulage both at the upper and the lower horizons. These ores are marked in time of initial mine planning for identification of mining block dimensions.

## **CRUSHING AND GRINDING:**

- The hoisted ore from central shaft, Malappa shaft, village shaft UTI is brought to a surface bin where they are sorted before feeding to the crusher. There are basically two unit primary unit and secondary unit
- Primary unit has 3 quaken crusher. Here the ore is reduced 10 inch size to 2 inch. These broken ore is then passed to the 3 conveyer belts present there. There is a feeder present at the mouth of the conveyor belt. If the ore is of required sized then it goes directly into the conveyor belt 1 otherwise it goes to the belt 2 from where it get recycled for further crushing to required size. These ore of smaller size then comes to conveyer belt 3 through discharge chute. The ore from UTI comes from conveyor belt 3 after passing through a swinger. This swinger is a metal plate that moves to and fro and break the ore to its required size i.e., 2mm at this stage.
- This broken ore from the primary unit goes to a 200 ton capacity bin.
- Two crusher called 3 standard symon crusher is present there from which the discharge is of inch.
- Now it comes to conveyer belt 4 which is of 30 inch width.
- Then it goes to conveyer belt 5 head pulley chute.
- From here it goes to 400 ton capacity bin. Here there are 4 crusher termed as 3 short symon crusher E to W, 4 short symon crusher E to W.
- After this stage the ore size is of 10mm to 12mm. Below this 4 crushers there are conveyor belt 8.
- The total process after passing conveyer 8 is repeated if the ore is still not broken to that desired size. Otherwise it goes to the grinding unit Where gold is extracted. .
- After grinding the ore they are passed to cyclone where the finer will go to secondary unit and the larger sized ore will be recycled.
- This is now grinded again using small cast iron balls or larger steel balls.
- After this stage the slurry is passed through cyclone from where concentrate with heavier particles is collected in the Knelson concentrator then by mechanical method the concentrate is passed through James vibrator table where the heavier particle settles down and the ore collected accordingly.

- Now the entire material is subjected to chemical method. it is carbon in pulp method.
- The carbon soaks the gold from the solution this slurry along with CIP passed through screen from which CIP fails to pass and remain behind whereas other materials passes out.
- The CIP is collected and washed thoroughly using water and acid. Now it is subjected to electrolysis.
- Electrolysis process carries on with NaCN and NaOH solution as an electrolyte.
- Steel wool is wrapped around steel cell which absorbs the gold.
- Now the steel wool is sent to refinery section where smelting is done to obtain pure gold.

### **Cyanide operation includes the following process :**

- 1) Thickeners (High Rate Thickeners)
- 2) Leaching (Agitators)
- 3) Gold adsorption by carbon (CIP)
- 4) Sand Stowing
- 5) De-Toxification and Tailing Disposal
- 6) Acid Washing Unit and Electrowinning Process.
- 7) Carbon Reactivation Process.

### **THICKENING PROCESS:**

The overflow of cyclone is fed to HRT 1 In which ground stuff with about 80% water is fed to 60x12 feet.it is working on hydraulic pressure,0.007kg/tonnage ultrafloc 6000 grams is used for the clearance pulp to maintain a pulp density and 58 to 60% kg/m<sup>3</sup> specific gravity of pulp in thickener.

#### **Reaction in agitators**

##### **Lead acetate reaction in agitator:**

The clear water from the thickener is returned to mill head tank through thickner overflow pump and thickened pulp is pumped to agitators via 4 inch slurry pump.

## **LEACHING PROCESS:**

Leaching is take place in two types of agitators 1) 6 small agitators 2) 5 (XL) big-agitators. Small agitators having the capacity of 200 tons and big agitators having the 1000 tons to store .The pulp in first small agitators mixed with the lead acetate of about 0.05kg/ton if will lead reduction of sulphate to sulphite, add  $H_2O_2$  .In the next agitators of quantity 0.40kg/ton it will dissolve gold in the solution then add 0.6kg/ton NaCN into next agitator it will helps to convert pulp into solutions and transfer to next agitators for will dissolvation and pump into big agitators of 1000 tonnage capacity here also gold is dissolved in all 5 agitators and dissolved gold solution is pumped into CIP section.

### **Gold adsorption in CIP:**

CIP (carbon in pulp) it is carbon absorption of two members of 1k tonne capacity CIP with 6 number of adsorption tanks of 25m\*25m\*25m, capacities each every tank of adsorption contain contractors with screen 20# add 850kg of activated carbon in which 800kg is rage rated carbon and 50kg is fresh carbon will added per tank the slurry transmission is carried on using compressed air, the agitator mechanism is driven by motor coupled with a reduction gear. The rpm of about 46 is given sample agitation will not allow the slurry to settle, the impeller is fixed at 1/3rd distance from bottom, the flow rate of slurry through concentrators is 1000 litres / min at 52 % solid the contact time for carbon in contractors is 12 days and contractor time in each contractor is 2hrs the loaded carbon of gold is taken into acid wash tank and the overflow is discharged to dumped through a detoxification of cyanide included solution.

### **Acid wash process:**

Loaded carbon of gold solution is pumped to acid wash tank, acid washing tank before taking illusion columns first washing is done for 2hrs then it is washed in dilute HCl (3-5%) for about 90 mins acid washing is allowed by all alkaline wash for about 90min to neutralise the same again water washing done for the purpose of acid wash to remove the lime contents in the loaded carbon, in alkaline wash NaOH is also added to remove HCl.

### **Electrowinning process:**

In Electrowinning process after completion of washing loaded is pumped to the ilution tank and clean water is taken into the dilution tank through make up water pump, NaOH and NaCN are added such that the values are maintained at 1% and 0.1% respectively. The temperature is maintained about 90-92c, the solution process continues for about 58hrs after completion ilution cycle the solution is drained at the bottom of the tank and the stripped carbon is pumped to the carbon reactivation kiln, gold loaded steel wool cathode boxes from the headside of the cell are removed manually handed to the refinery section.

## **ASSAY and R&D LAB :**

- First the ore is put in jaw crusher. The discharge has on 1/2 inch.
- This is now passed through a roller and then through dispulverizers.
- 80% of these ore now passed through 150 sized mesh. Finely powdered ore is now subjected to panning.
- To each 50gm samples one spoon each of much flux, lithic flux, and borax flux is added in a graphite crucible.
- These crucibles are kept in muffle furnace at about 1000C for 45 min - 1 hour.
- The molten material is then poured in iron crucible where led silver gold settles down in button form.
- This button is kept in cuples which is a small cup shaped container made up of mobrite powder. Now cupretion is done for 1 hour.
- In this stage some port of lead is absorbed in the cupel and the remaining evaporates out.
- Now 1:3 HNO<sub>3</sub> is kept in porting tubes made up of porcelain.
- Then it is heated and the silver and gold button is kept in it.
- At this stage the silver dissolve out from it and old left behind.
- The gold is black in color to impart golden color to gold it is subjected to annealing.
- The amount of gold is recovered is weighted in a very sensitive gold weighing machine.
- Assay is calculated the result is then sent to the exploration department for further processing of mine development.

In the assay lab the following test Works are done as follows such as:

1. Assay of underground sample.
2. Assay of sag mill sample.
3. Assay of pebble mill sample.
4. Assay of cyanide section sample.
5. Assay of tailing products.
6. Assay of electro winning liquids (Residual liquids).

# CONCLUSION

- Hutti-Maski Schist belt is one of the most important Dharwar type belts, where detailed study of different rock types including copper and gold mineralization have been studied during filed visit.
- The Archaean Hutti-Maski Schist belt (>2600 my) is ideal for the investigation of morphological and chemical remnants of early life because of the presence of distinct sedimentary units.
- It is a Hookshaped belt of supracrustal rocks, comprising both of metasediments and metavolcanics represented by carbonaceous metabasalt, amygdaloidal metabasalt, biotite – chlorite schist that belong to the Dharwar Super Group.
- Hutti Gold field suggests that it was formed as a result of tectonics and closure of a basin between two juvenile continental crustal blocks.
- Hutti mine is probably one of the most ancient metal mines in the world, dating to the preashokan period, ancient mine worked down to a depth of over 2300 feet.
- It is economically important as it consists of major minerals like Gold, Copper, Limestone, Sheelite, grey quartz, Arsenopyrite, Chalcopyrite, Azurite, Malachite, Feugolite etc...The area is covered by black cotton soil.
- The area dipping N50°W (45°-60° dip variation) and strikes NW-SE. Southern granitic contact has been occupied at E-W trending.
- The area divided into different reefs or blocks at an average length of 1.2-1.3 km and these were dips at N15°E to N30°E. There are 9 reefs came to exist in which 6 reefs are being worked.
- The main reef is at the extreme end i.e. New East Reef, which is not highly sheared. Sulfide in the form of Pyrite and arsenopyrite indicates mineralization.
- There has employed many shafts to get underground mine in which Mallappa shaft is the biggest one and Village shaft is inclined.
- From N→S there are two dolerite dyke intrusions within the reef. There has no more major fault except Oakleys Fault (70-80°), which is calcite filled one.
- The presence of biotisation indicates the shearing zone. The host rock of Au is Metabasalt, Biotite schist, Auriferous grey quartz, Acid volcanic rocks and Sheelite mineral.
- Various types of folds, faults their classifications, superposition and identification understanding of their significance formed the part of study in where the Metabasalt exhibit the structures in a spectacular way.
- 60% of Au has been recovered by crushing and Smelting process and remaining 40% by cyanide treatment in HGML.

- The satellite mines of UTI and Hira-Buddini has also taken in account for ore extraction in HGML.
- LT575 – Surface diamond bore drilling machine is used for quarrying the sample for the further excavations.
- The hutti orogenic gold deposit, in the eastern dharwar craton of south India, is located in the cusplate greenstone belt which is tectonically against tonalitiestrondhjemite-garnodiorite.

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