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Field and Petrographic Study of Rocks from Vada Mamandur, Vilupuram District, Tamil Nadu, India

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Abstract

The work demonstrates the yield of field observation for identification of rocks, structural features, weathered and sheared zones. The hosted minerals in different rock types are identified due to the efficiency of light microscope to examine both mineral composition and texture. We argue in this paper that there is S-Z sheared zone along with major minerals of hornblende, pyroxenes, Biotite. The zone of mineralisation is found to possess ore mineral malachite, galena, chalcopyrite, haematite, molybdenite, anglesite and azurite. The area is subjected to the metamorphic agents of high temperature, pressure and chemicals that transform the pre-existing rock to metamorphic rocks while introducing new minerals of kaolinite, chlorite, actinolite and mica. The area hosting these minerals was mined since long time but it is currently a mined out area. It is evident that the thin section petrographically prepared can efficiently be used to mineral identification, texture and rock type.

Keywords: Field, petrographic, rocks, vada mamandur, Vilupuram.

Introduction

The field and petrography are extensively used to yield information on the structural features, mineral composition and texture. Petrography is defined as science of describing and classifying rocks. it relies on observations made with petrographic microscope while determining rock composition, and textural relations between grains.

Mineralogy as the subject of earth science deals with mineral studies. It involves the mineral processes of formation, origin, distribution, classification and uses. Magmatic ore deposits are formed by magma crystallization near the surface and deep underground. The host rock types are mineralized with a range from ultrabasic to acidic. The mineral deposit can consist of rock massive hosting ores in some cases and with disseminations of rare minerals in others. The mineralisation takes place with the enrichment of secondary sulphide mineralisation triggered by the process of weathering[1].

The mamandur polymetal deposit is an interesting area as one of the most fragile, complex, mineral and productive area. Since their characteristic features, photographs and field studies. The various changes at the study area during the Quaternary period reveal effects of past geological processes. A widely varying nature of lithological alteration, folding and sharing zones represents the successive phases of mineral formation by metamorphism, transgression and regression of mineralogical composition. the change in pressure and temperatures around the globe as a consequence of lithological alteration that are expected to influence changes in mineral composition from unstable at such conditions to stable at certain temperature and pressure[2].

It is necessary to assess the lithological description and ore mineral identification[3]. it is also important to know about the changes that have taken place along the area in the past in general and in the recent past in particular.

The prescribed study illustrates the lithological description, mineral identification from vada mamandur polymetal deposit, India. The work has been taken up with the main objective of assessing petrography and Mineralogy of rock types from vada mamandur polymetal deposit.

Methodology

Field study: The area ranges about 1.5 square kilometres used to study the lithology while observing the characteristic features of rock types, geological structures including folding, sheared zones, weathered formations. Geological mapping was compiled with the help of Brunton compass survey in scale of 1:1000, base map was taken out on the top sheet No 57 P/4 from the survey of India. During the detailed field work and geological mapping of recordable features were efficiently compiled in the field note with the Geographic coordinates of latitudes and longitudes using GPS, photographs were captured, samples bags were appropriately labelled and field notes were also ensured.

Field photography: Detailed geological photographs were taken appropriately and give us the various evidences relating to structural features, shearing and metamorphosed formations. Each and every mappable feature was photographed systematically.

Laboratory technique: More than 6 micro sections have been prepared from representative Rock types for observing mineral grains and textural relations between them. For micro section, the small pieces of rock taken and grinded all sides and polished to obtain plain surface by using 700 mesh carborundam powders. Again grinded, in glass plate the 1000 mesh carborundam powder to obtain much smoother surface then mounted that piece upon slide by Canada basalt.

Again grinded these mounted slides in order to reduce the thickness to 0.03mm. The megascopic and microscopic studies were carried out. The micro structures of the area were studied by using petrographic microscope.

Mineral identification technique: There mineral identification utilized appropriately by the petrographic light microscope while observing the prepared thin section under both plane polarized and crossed nichol light. The study of color, form and other optical properties of minerals present demonstrated precise identification of minerals. A detailed petrographic study was done in which texture, mineralogy, microstructure alteration of mineral was identified.

The appropriate methodology was carried out for assessing the results obtained as following (figure-1).

Results and Discussion

Petrographic Description and Mineral Identification of Rock Types from Vada Mamandur: Petrography reveals the mineral identification and relationship between mineral grains of a rock with petrographiclight microscope. Mineralogy involves in mineral studies, the processes of origin, formation, classification of minerals, their utilization as well as geographical distribution[4].

The table-1 shows the Prospected host rocks from vada mamandur that have been studied and found to have the following mineral compositions and rock types.

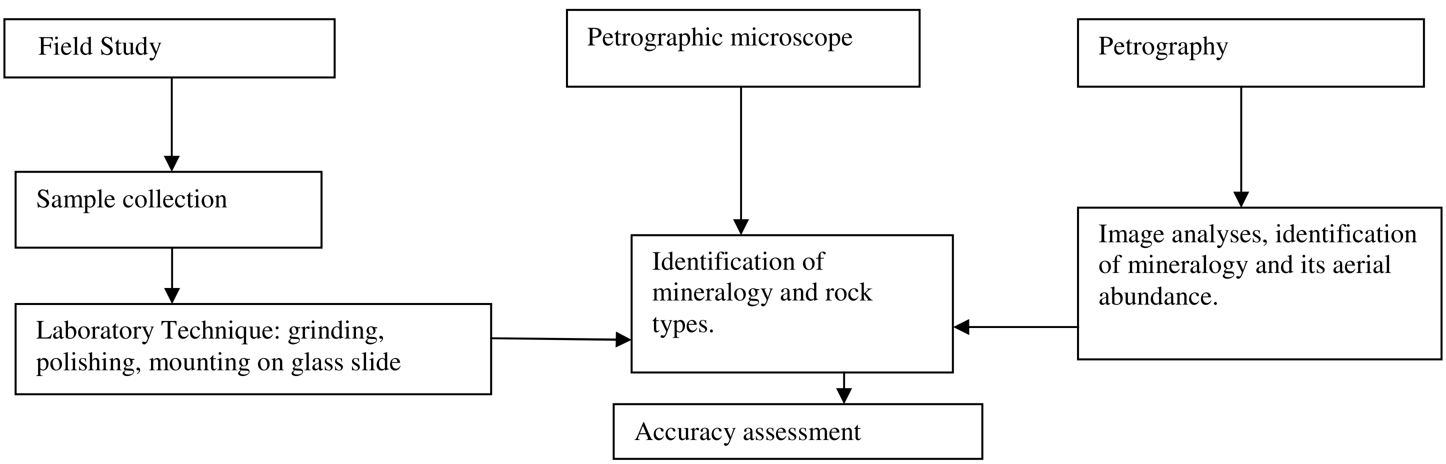

Figure-1
Flow chart depicting the adopted methodology

Table-1
The table showing the mineralogical composition of host rocks of study area

Sample No	Minerals	Rock type
S1	Quartz, plagioclase, clinopyroxen	Charnockite
S2	olivine, biotite, pyroxenes	olivine biotite gneiss
S3	Quartz, Plagioclase, hornblende, biotite	Biotite gneiss
S4	Olivine, plagioclase, pyroxenes, hornblende, quartz	Biotite granite gneiss
S5	Plagioclase, quartz	Granite gneiss
M7	Plagioclase, quartz, pyroxenes, hornblendes	Dolorite

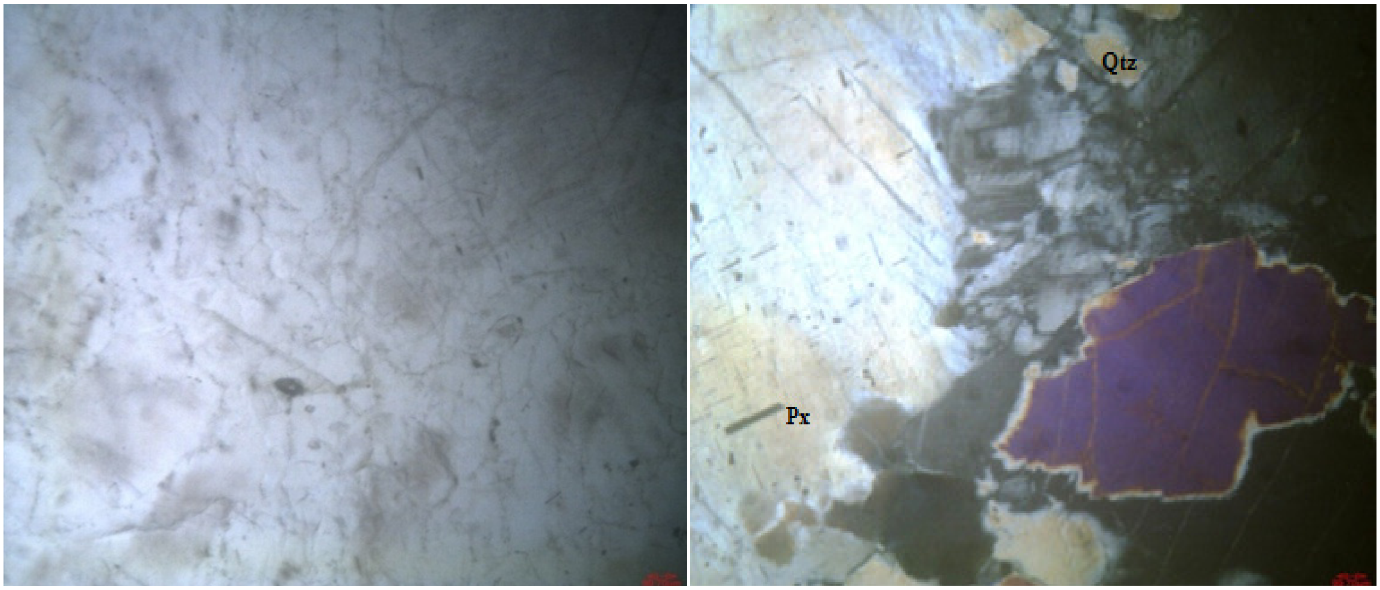

Figure-2
Petrographic microscope photo indicating the mineralogy and texture of charnockite, (a) under plane polarized light and (b) under crossed nichol

Section No S1: Charnockite
Texture
Crystallinity: The grains in thin section are entirely of crystalls. Hence it is holocrystalline.

Granularity: Grains are visible with unaided eye, since it is phaneric

Shape of the crystals: Most of the grains are subheudral in nature.

Mutual relationship: Grains are sharp contact with another and equigranular in nature

Texture: The rock section is holocrystalline with equigranular and most of grains are subheudral, hence it shows hypidiomorphic texture

Cooling history: Hypidiomorphic texture indicates that it is produced due to slow cooling of magma.

Mineralogy
Under plane polarized light: Colorless, non pleochroic,cleavage absent, low relief.
U**nder crossed nichol**: Anisotropic, 1st order grey Interference color, low birefringence, wavy extinction. Hence the mineral is known as quartz.

Under plane polarized light: Mineral likes colorless,2 sets of cleavage, nonpleochroic, low relief.
Under crossed nichol: Anisotropic, 1st order grey Interference color, low birefringence, simple twining, since the mineral is testified as orthoclase.

Under plane polarized light: Colorless, cleavage indistinct, nonpleochroic, low relief.
Under Crossed Nichol: Anisotropic, 1st order grey Intereferencecolor, low birefringence, polysynthetic twinning, inclined extinction. Hence the mineral is known as Labradorite.

Under plane polarized light: high pink colour, pleochroic, cleavage 2 sets, high relief.
Under crossed nichol: Anisotropic, first order yellow Interference colur, paralleleextinction, strong birefringence. Hence the mineral is identified as hypersthene.

Under plane polarised light: Redish brown in color, one set of cleavage, high relief and refractive index, non pleochroic.
Under crossed nichol: anisotropic, higher order Interefencecolour, parallele extinction, strong birefringence. hence the mineral is identified as biotite.

Petrogically Interesting Features: The intergrowth between Quartz and feldspar, and zoning of plagioclase is formed.

Name of the Rock: As the rock is composed of Quartz. Orthoclase, labradorite, biotite with pyroxene exhibiting hypidiormorphic texture. It can be named as charnockite.

Note on origin: Rock is originated by slow cooling of the magma. Hence it is plutonic in origin.

Origin and Occurrence and Associated Rocks: Charnockite is associated with garnet gneiss, hypersthene gneiss and varieous types of quartz-feldspar gneiss. They are found to occur in peninsular India, as batholits.

Figure-3
Petrographic microscope photos indicating the mineralogy and texture of olivine biotite gneiss, (c) under plane polarized light and (d) under crossed nichol

Section No S2: Olivine Biotite Gneiss
Texture
Shape of Mineral: Most of the mineral are subhedral in nature.

Mode of growth: All the minerals are completely recrystallized so it is crystalloblastic in nature.

Degree of recrystallization: Most of the mineralisation in lenticularized, they are granoblastic.

Order of recrystallization: As most of the minerals are recrystallized simulaneously, so first order of recrystallisation.

Mineralogy
Under plane polarised light: the mineral is colorless, no pleochroic, cleavage absent.
Under crossed Nichol: Anisotropic, first order interference color, wavy extinction. So the mineral is quart.

Under plane polarised light: the mineral is light green,pleochroic, and has 2 sets of cleavage.
Under crossed nichol: Anisotropic, higher order Intereferencecolor, so the mineral is known as hornblende.

Under plane polarized light: Brown in colour, highrelief, one set of cleavage.
Under Crossed nichol: Anistropic, higher order intereferencecolour, straight extinction, these properties may identify a mineral as biotite

Petrographically Interesting Feature: Alterration band of feldspar, a pyroxen group of minerals, biotite changes to second order form of crystal, and pyroxen to amphibole.

Name of the Rock: Most of the minerals are recrystallized simultaneously granoblastic texture exhibiting gneissosity of alternate bonds of newly formed mineral. Hence the rock can be named: biotite gneiss.

Metamorphic facie and Grade: The mineralogical composition and the textural components reveal that the rock is from a high grade metamorphic rock of granulitic facies.

Occurrence and Origin: As the rocks are of regional metamorphism. They are formed in large area in peninsular India as well as in south part of the India.

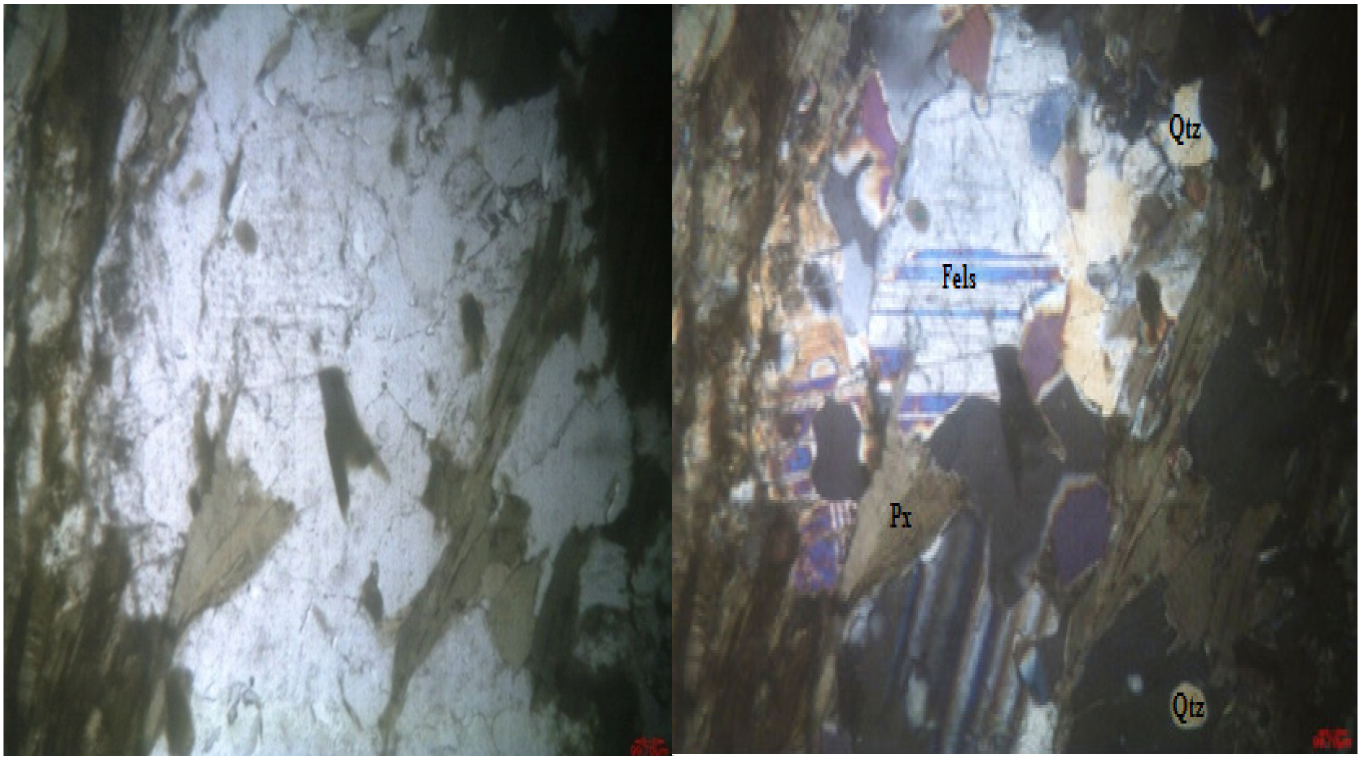

Figure-4
petrographic microscope photos indicating the mineralogy and texture of biotite gneiss, (e) under plane polarized light and (f) under crossed nichol

Section No S3: Biotite Gneiss
Texture
Shape of Mineral: Most of the mineral are subhedral in nature.

Mode of Growth: All the minerals are completely recrystallized, so it is crystalloblastic in nature

Degree of Recrystallization: Most of the mineralisation in lenticularized so they are granoblastic

Order of Recrystallization: As most of the minerals are recrystallized simulaneously, so first order of recrystallisation.

Mineralogy
Under plane polarised light: The mineral is colorless, no pleochroic, cleavage absent.
Under crossed Nichol: Anisotropic, first order interference color, wavy extinction, so the mineral is quartz.

Under plane polarised light: The mineral is light green, pleochroic, and has 2 sets of cleavage.
U**nder crossed nichol:** Anisotropic, higher order Intereference color, so the mineral is known as hornblende.

Under plane polarized light: brown in colour, high relief, one set of cleavage.
Under crossed nichol: anistropic, higher order intereference colour, straight extinction, these properties may identify a mineral as Biotite.

Under plane polarized light: Pale green in color, pleochroic, 2 sets of cleavage.
Under crossed nichol: Anisotropic, higher order interferences color, parallel extinction, so the mineral is identified as pyroxene

Petrographically Interesting Features: Alterration band of feldspar, a pyroxen to amphibole group of minerals, biotite changes to second order form or crystal.

Name of the rock: Most of the minerals are recrystallized simultaneously granoblastic texture exhibiting gneissosity of alternate bonds of newly formed mineral. Hence the rock can be named olivine biotite gneiss.

Metamorphic facie and grade: The mineralogical composition and the textural components reveal that the rock is from a high grade metamorphic rock of granulitic facies.

Occurrence and Origine: As the rocks are of regional metamorphism. They are formed in large area in peninsular india as well as in south part of the India.

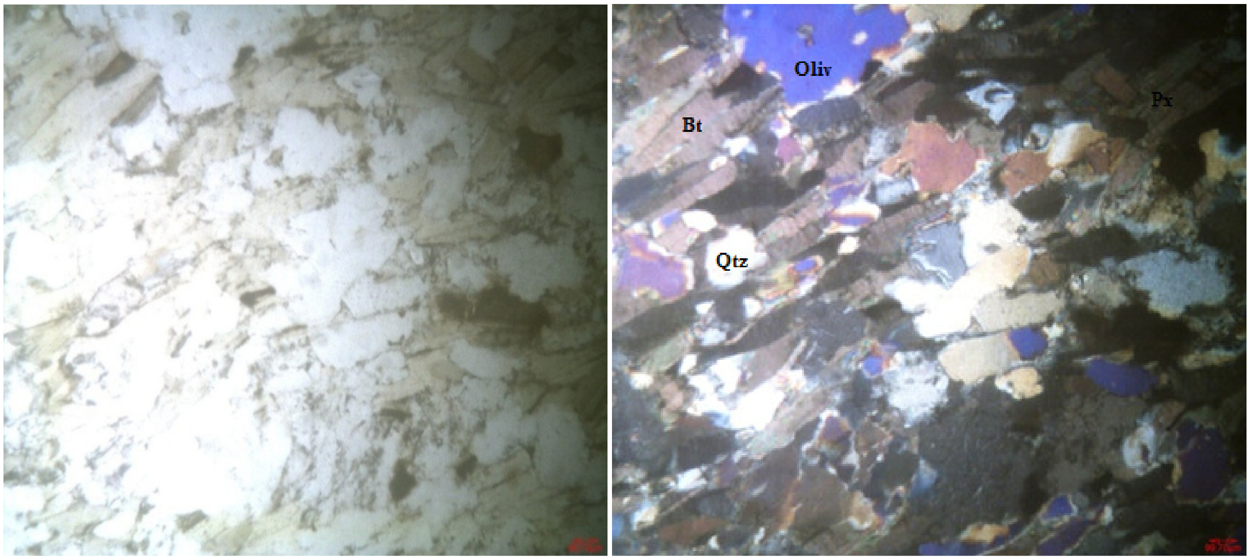

Figure-5
petrographic microscope photos indicating the mineralogy and texture of biotite granite gneiss, (g) under plane polarized light and (h) under crossed nichol

Section No S4: Biotite Granite Gneiss
Texture
Shape of mineral: Most of the mineral are subhedral in nature.

Mode of growth: All the minerals are completely recrystallized, so it is crystalloblastic in nature.

Degree of recrystallization: most of the mineralisation in lenticularized so they are granoblastic.

Order of recrystallization: As most of the minerals are recrystallized simulaneously, so first order of recrystallisation.

Mineralogy
Under plane polarised light: The mineral is colorless, no pleochroic, cleavage absent.
Under crossed Nichol: Anisotropic, first order interference color, wavy extinction, so the mineral is quartz.

Under plane polarized light: Mineral is colourless, non pleochroic, 2 sets of cleavage.
Under crossed Nichol: Anisotropic, 1st order grey interference color, the mineral is plagioclase.

Under plane polarized light: Mineral colorless to pale yellow, cleavage absent, no Pleochroic, relief moderate to high.
Under crossed nichol: Anisotropic, high intereference color, high birefringence, these properties identify mineral as olivine.

Under plane polarised light: The mineral is light green, pleochroic, and has 2 sets of cleavage.
Under crossed nichol: Anisotropic, higher order Intereference color, so the mineral is known as hornblende.

Under plane polarized light: Brown in colour, high relief, one set of cleavage.

Under crossed nichol: Anistropic, higher order intereference colour, straight extinction, these properties may identify a mineral as biotite.

Under plane polarized light: Mineral colorless to pale yellow, cleavage absent, no Pleochroic, relief moderate to high.
Under crossed nichol: anisotropic, high intereference color, high birefringence, these properties identify mineral as olivine.

Under plane polarized light: Pale green in color, pleochroic, 2 sets of cleavage.
Under crossed nichol: Anisotropic, higher order intereference color, parallel extinction, so the mineral is identified as pyroxene

Petrographically Interesting Feature: Alterration band of feldspar, a pyroxen to amphibole group of minerals, biotite changes to second order form or crystal.

Name of the rock: As most of the minerals are recrystallized simultaneously granoblastic texture exhibiting gneissosity of alternate bonds of newly formed mineral. Hence the rock can be named olivine biotite gneiss.

Metamorphic facie and grade: the mineralogical composition and the textural components reveal that the rock is from a high grade metamorphic rock of granulitic facies.

Occurrence and origine: As the rocks are of regional metamorphism. They are formed in large area in peninsular India as well as in south part of the India.

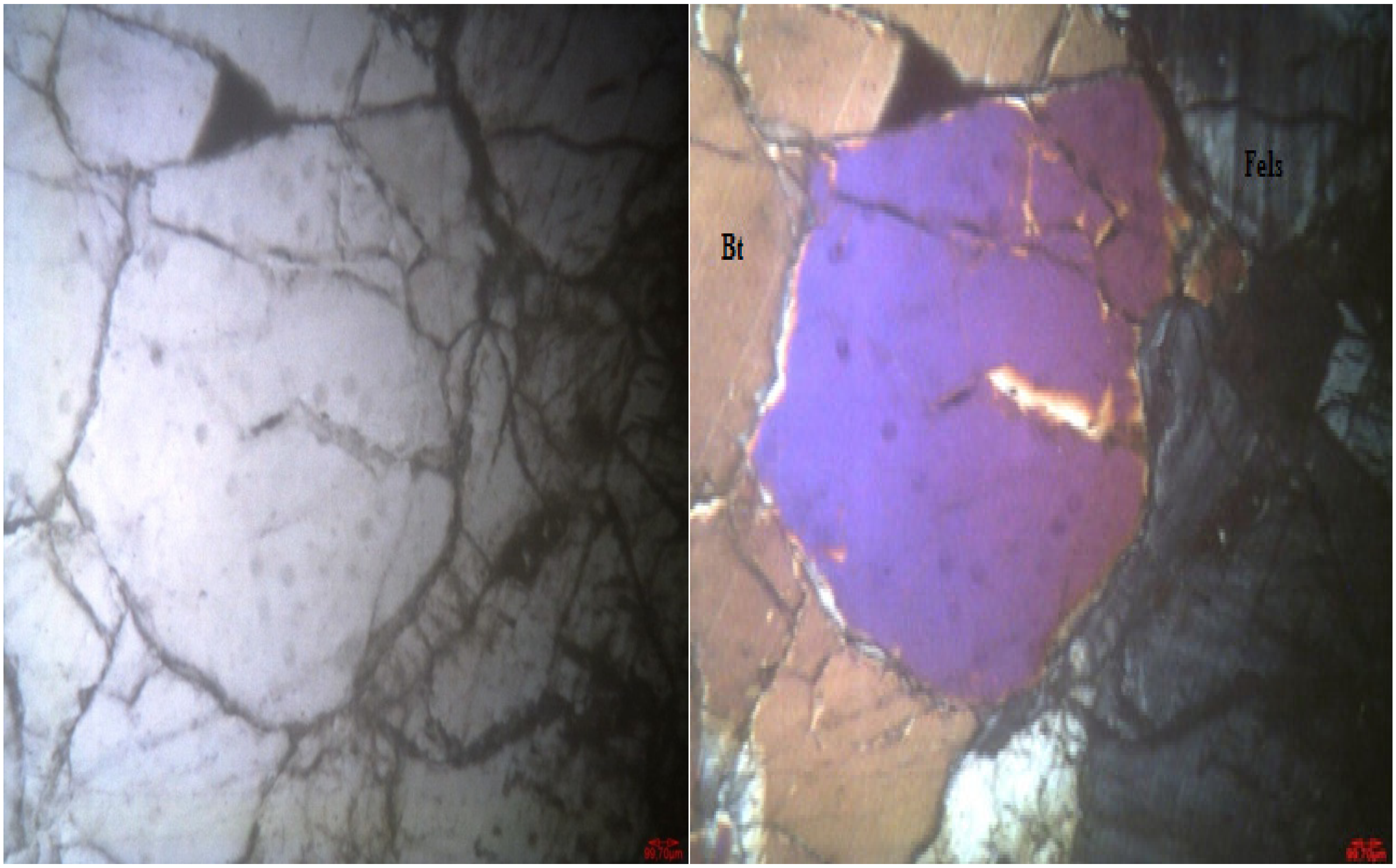

Figure-6
petrographic microscope photos indicating the mineralogy and texture of granite gneiss, (i) under plane polarized light and (j) under crossed nichol

Section No S5: Granite Gneiss
Texture
Shape of Mineral: Most of the mineral are subhedral in nature.

Mode of growth: All the minerals are completely recrystallized, so it is crystalloblastic in nature.

Degree of Recrystallization: Most of the mineralisation in lenticularized so they are granoblastic.

Order of Recrystallization: As most of the minerals are recrystallized simulaneously, so first order of recrystallisation.

Mineralogy
Under plane polarised light: The mineral is colorless, no pleochroic,cleavage absent.
Under crossed Nichol: Anisotropic, first order interference color, wavy extinction, so the mineral is Quartz**.**

Under plane polarized light: Mineral is colourless, non pleochroic, 2 sets of cleavage.
Under crossed Nichol: Anisotropic, 1st order grey interference color, the mineral is plagioclase.

Under plane polarized light: Brown in colour, high relief, one set of cleavage.
Under crossed Nichol: Anistropic, higher order intereference colour, straight extinction, these properties may identify a mineral as BIOTITE.

Petrographically Interesting Feature: Alteration band of feldspar while introducing newly formed minerals due to metamorphism, biotite changes to second order form or crystal.

Name of the Rock: As most of the minerals are recrystallized simultaneously granoblastic texture exhibiting gneissosity of alternate bonds of newly formed mineral. Hence the rock can be named olivine biotite gneiss.

Metamorphic facie and Grade: The mineralogical composition and the textural components reveal that the rock is from a high grade metamorphic rock of granulitic facies.

Occurrence and Origine: As the rocks are of regional metamorphism. They are formed in large area in peninsular india as well as in south part of the India.

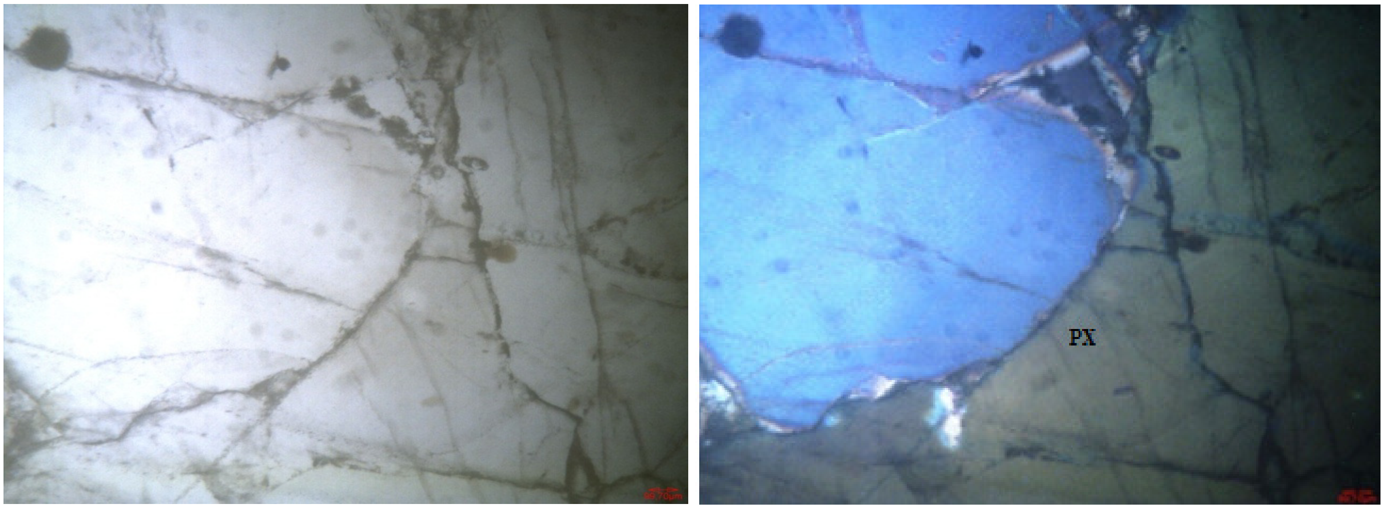

Figure-7
petrographic microscope photos indicating the mineralogy and texture of dolorite, (k) under plane polarized light and (l) under crossed nichol.

Section No M7: Dolerite
Texture
Crystallinity: The grains in thin section are entirely crystals, hence it is holocrystalline.

Granularity: Most of the grains are practically distinguished. so it is aphaneric.

Shape of the crystals: Most of the grains are subheudral in nature

Mutual relationship: Grains have sharp contact within another

Texture: The texture of dolorite varies each other, the fine grained doloreite indicates the OPHITIC texture.

Cooling history: The ophitic texture reveals that it cooled a little more slowly than basalt, equigranular in nature

Mineralogy
Under plane polarised light: The mineral is colorless, no pleochroic, cleavage absent, low relief.
Under crossed Nichol: Anisotropic, first order interference color, wavy extinction, so the mineral is Quartz**.**

Under plane polarized light: Mineral is colourless, non pleochroic, 2 sets of cleavage.
Under crossed Nichol: Anisotropic, 1st order grey interference color, the mineral is Plagioclase.

Under plane polarized light: Pale green in color, pleochroic, 2 sets of cleavage.
Under crossed nichol: Anisotropic, higher order intereference color, parallel extinction, so the mineral is identified as pyroxene

Petrographically Interesting Features: The intergrowth between Quartz, plagioclase bearing pyoxenes reveals the Dolerite

Name of the Rock: The rock constitutesubheudral grains and shows ophitic texture, the rock commonly contains Quartz, Plagioclase bearing pyroxenes. So the rock known as dolerite.

Note on Origin: The rock constitute of fine grains due to fast cooling of magma, so it is subvolcanic rock.

Occurrence and Origine: They are found at various forms of igneous rocks like dykes, sills in many places of peninsular India[5].

The pathfinder of galena is usually used to locating the metamorphosed sulphide deposits[6].

Field mapping, sampling and chemical and mineralogical studies are used to assess ore mineralization.

The figures from (a) to (l) show that the prospected host rocks have been studied and found to have the mineral compositions as shown in the table-1, Mineralogy, alteration zones and host rocks from petrographic microscope studies (table-1) reveals host rocks highly metamorphosed, the texture showing elongated crystals.

The investigated rocks developed biotite, chlorite zones, alteration of feldspar into kaolinite and pyroxenes into amphiboles like actinoloite and tremolite. To realize rock types, mineralsin lithological classification. Alumina-Calcium-Ferromagnesium (ACF) triangular diagramhas been used to present the results[7].

Based on molar proportional formula of A($[Al_2O_3 + Fe_2O_3]$ –

$[Na_2O + K_2O]$), C ($[CaO] - 3.33[P_2O_5]$) and F ($[FeO + MgO]$), rockshave beenaccordingly grouped into classes of quartzo-feldspathic, pelitic, calcareous and basic. The ACF diagram (figure 8) illustrates basic granulites, amphibolite and dolerite fall into class of basic rocks. Similarly, granite gneiss, migmatite and charnockite fall into class of quartzo-feldspathic rocks. The diagram for charnockite overlaps classes of quartzo-feldspathic and basic rocks.

Elevated percentage greater than 40% of Fe–Mgminerals such as hypersthene and cordierite reveals that these could be intermediate Charnockites[8].

It is clear that the dolerite rock sample M7 lies into the basic class, Similarly S1, S2, S4, whereas S3 rock lies into the class of Quartzo feldpathic rocks[8].

The samples studied show that the area has been subjected to high metamorphism as shown in their change in mineralogical components (elongated crystals) as well as their textures, this is due to the zones altered for long time due to metamorphic agents such as temperature, pressure and chemically active fluid to make the pre-existing rocks (mostly granites) to change to metamorphic rocks. The process is also accompanied with the formation of new formed minerals during the metamorphism, some of newly formed minerals have been changed from pyroxenes to amphibolites, muscovite to cholorite, and sericite, feldspars into kaolinite.

Conclusion

With the aid of adopted methodology, field study, field photographs, and mineral identification techniques revealed that the mamandur area contains host rock types subjected to high grade metamorphism while introducing newly formed minerals[9].

The sulphide mineralization and associated alteration zones has been delineated and mapped. Mineralogical composition of rock types, country rocks and S-Z zoneshave been recognised due to their typical geological characters and mineral identification techniques[11]. Field observation and laboratory techniques are corresponding well with the results produced by conventional procedures. Processing on the field stimulated the efficient identification of ore, alteration, rock type, mineralogical composition, and other geological features subjected on the area.

According to the outcome results, it revealed that the study area has mainly consisted of the mafic rocks containing some minerals like, olivine, pyroxene and plagioclase[10].

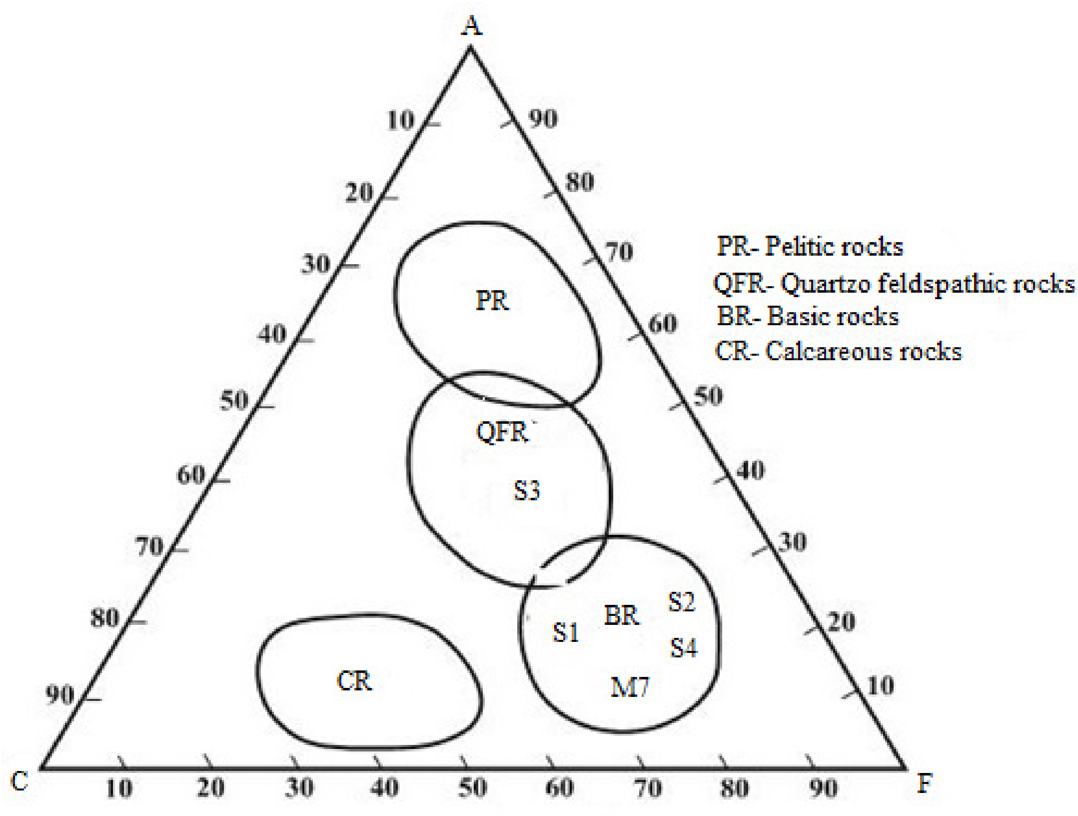

Figure-8
ACF triangular diagram for host rocks and their corresponding mineral constituents

The other characteristic minerals in the area were ca_pyroxene, amphibole, Mica and quartz, almost Mamandurpolymetal deposit area has been changed to newly formed minerals due to high grade metamorphism that stimulated the formation of metamorphic rocks derived from the pre-existing rocks[12].

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