FIELD EXCURSION GUIDE TO KOTHAGUDEM AND ADJOINING PLACES, BHADRADRI-KOTHAGUDEM DISTRICT, TELANGANA

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GEOSITES

The erstwhile Khammam district of Telangana, which is now divided into two or more districts, is bestowed with a complex geology ranging in age from Archaean to Recent. This district is a storehouse of many metallic and non-metallic mineral resources and is a mining hub of the state. The non-metallic minerals include barytes, calcite, corundum, garnet, kyanite, tourmaline, quartz and others. This district is also well known for several open-cast and underground mines of coal, dolomite, building stones etc. Among the mineral commodities, garnet and kyanite at Rudrampur-Garibpet and, calcite at Sujathanagar occur close to Kothagudem town, the district headquarters of the Bhadradri Kothagudem district. This article, presents a field tour guide to these two occurrences and other geologically significant sites nearby.

Location and accessibility:

The Kothagudem town (*known as Bhadrachalam Road railway station*) can be reached either by road or rail from Hyderabad, Vijayawada and other main junctions in Andhra Pradesh and Telangana (Fig.1). The area for present field sites lies between 17°25'48"E 80°41'24"N and 17°34'12"E 80°31'48"N within the Survey of India toposheet 65C/11 (1:50000).

Fig.1 Location map showing places of geological interest near Kothagudem.

The location where garnet and kyanite deposits are situated in between villages Rudrampur, Garibpet and Kakarla near Kothagudem and is easily accessible. The villages Rudrampur and Garibpet are situated at about 10 km south east of Kothagudem and is well connected by road. The village, Sujathanagar (17°28'12"E 80°34'12"N) is situated at about 9 km towards south west on the Kothagudem-Tallada road. 80º38'30"and 17º28'30". The calcite is exposed at Raghavapuram, Manchinenipeta, Peddatanda, Ratnatanda,

Regulamadugu and Sujathanagar villages. There is an exposure of garnet-mica-kyanite schist also within the hornblende gneisses and schists at a distance of 1 km SW of Raghavapuram.

Geological setting:

The area comprises a variety of rock formations ranging in age from Archaean to Recent (Fig.2). The garnet-muscovite-kyanite schist belt occurs as two independent linear patches at Rudrampur and Kakarla separated by a stretch of hornblende schist. The area around Rudrampur is occupied by gneisses and hornblende schists of Archaean age that forms the basement and overlain by garnet-kyanite-muscovite schists. In Rudrampur area, garnet and kyanite bearing schists are locally traversed by quartz-kyanite veins. Randomly traversing quartz veins, devoid of kyanite are also seen in some places in this area but at Kakarla they are rare.

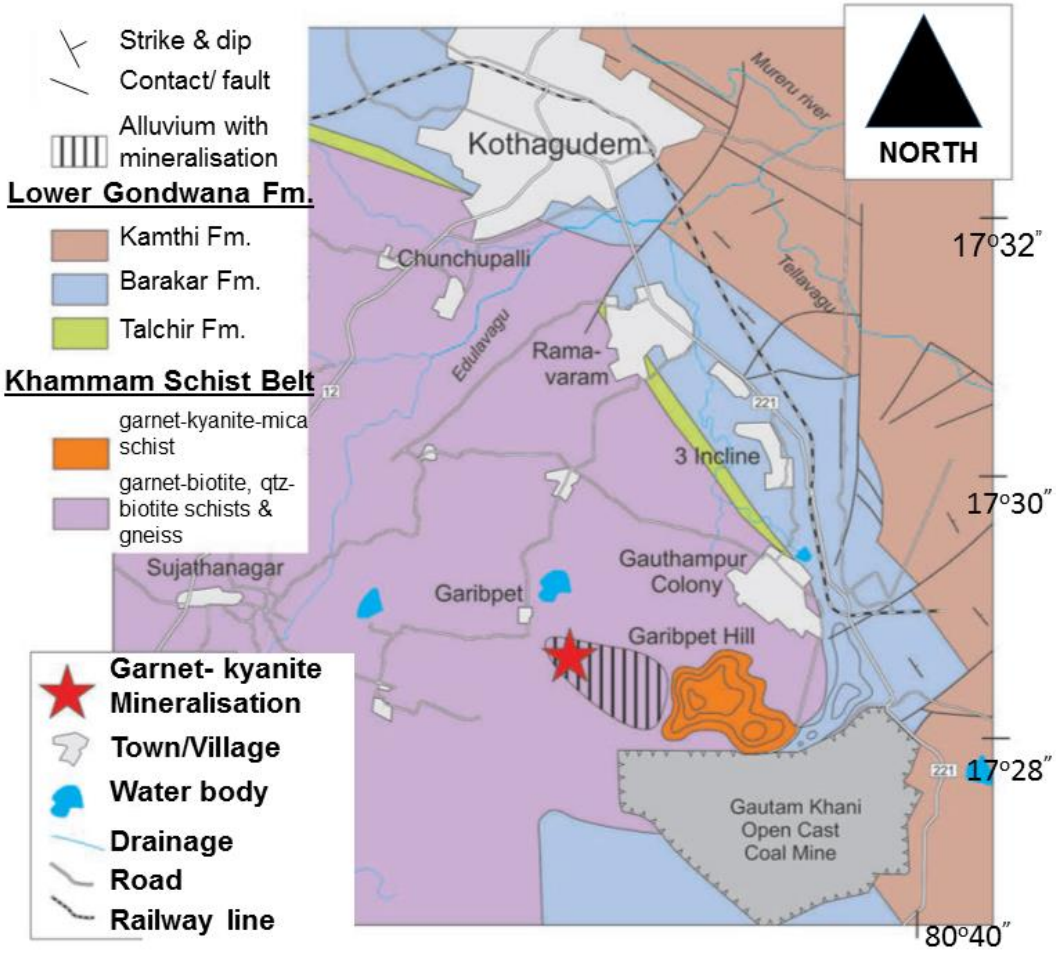

Figure 2. General geological map of Kothagudem and adjoining area (Phani, 2014).

The Permo-carboniferous Gondwana formations occur towards the north eastern and south eastern sides of the area forming a semi-arcuate outcrop. Due to oxidation, the outcrop surfaces are black and in some places brown in colour. The contact between hornblende schist and garnet-kyanite-muscovite schist is sharp. However, within the garnet-muscovite-kyanite schist, the contacts between the individual mineral bearing zones is gradational.

The schists being friable, minerals like garnet and kyanite are easily dislodged from the formations by weathering and densely scattered all over the hill slopes. Kyanite occurs in two different associations, one with garnet-kyanite schist and the other along with quartz veins forming quartz-kyanite veins traversing the schistose rocks. The general lithological sequence is shown in Table 1.

Table 1. The geological succession in the area.

Gondwana Supergroup (Permo-carboniferous)	Kamthi Formation
	Barakar Formation
Unconformity	
Dharwars (Archaean to Proterozoic)	Metadolerite (intrusive)
	Ferruginous quartzites
	Garnet –kyanite-muscovite schists
	Hornblende schist
	Gneisses

The schistose rocks at Rudrampur-Garibpet area form a synformal hill trending NNE-SSW, whereas at Kakarla they occur as small mounds and sheets. The beds in Boligundu hill at Rudrampur strike NNW-SSE, dipping 55^{o}-65^{o} towards east, while the beds on the eastern and south eastern parts of the hill show NNE-SSE trend south westerly and westerly dips of 35^{o}-55^{o}.

A perfect zonal sequence has been observed in the syn-formal hill from the periphery to the center by the appearance of biotite zone, biotite-garnet zone with gradual increase of garnet content, grading into kyanite zone towards the center with a concomitant reduction in the amount of garnet.

The rocks of the schistose belt were classified under Sargur super group however; they have also been correlated them with Dharwars. On the basis of their mineralogical variation the garnet-muscovite-kyanite schists near Rudrampur and Kakarla have been classified into i) mica schist, ii) garnet-mica schist, iii) garnet-kyanite-mica schist and kyanite-garnet-mica schist. The schistose rocks which are characterized by a diagnostic mineral assemblage of mica, garnet and kyanite with traces of staurolite are suggestive of the kyanite-almandine-muscovite sub-facies of the almandine-amphibole facies of regional metamorphism.

At Sujathanagar area, hornblende gneisses and schists form the basement with a soil cover of 2-3 meters. The hornblende gneisses exhibit well developed foliation, trending ENE-WSW to NW-SE. Three types of igneous intrusives are identified in the area; i) dolerite with magnetite ii) pink granite or syenogranite in stream and well cuttings and iii) quartz reef trending NW-SE between Degulamadugu and Manchinenipeta. In addition, innumerable NE-SW quartz veins occur in the gneisses.

The calcite mineralization occurs in close contact with quartz reef. The crystalline calcite mineralization occurs as veins trending NW-SE and also as disseminated crystals at certain places. The calcite is semi-transparent to translucent, white to pinkish colour. The mineralization is associated with clays, ferromagnesian minerals forming box-work like structure. At the contact of quartz and calcite, impure greenish cryptocrystalline variety

(calc-flinta) is formed. The size of calcite crystals is more than 6 inches near calc-flinta while it decreases away from it. The contact zone is observed to be brecciated. The enrichment and proximity of calcite mineralization at the contact of quartz reef shows that the quartz reef intrusion is responsible for the crystallization of early formed calcite.

Economic minerals:

Garnet is purple to pink coloured and extensively fractured due to deformation. The mineral is usually found associated with kyanite quartz and mica. The garnets are classified as almandine ($Fe^{+2}_3\ Al_2Si_3O_{12}$) pyrope ($Mg_3Al_2Si_3O_{12}$) (Fig.3a to d).

Kyanite mostly occurs as sky blue coloured rectangular, bladed and stumpy crystals with well-developed cleavage. In general, the mineral is found associated with garnet, mica and quartz however, rarely with staurolite.

Muscovite and biotite occur as big elongated flakes with conspicuous basal cleavage. Staurolites found oriented parallel to the cleavage planes of kyanite.

Crystalline calcite occurs as honey yellow to semi-transparent perfect rhombohedral aggregates in the form of lumpy, vein and fracture fillings.

Figure 3. Photographs showing garnet occurrences at Rudrampur and Garibpet. (a) Field photograph showing excavations for garnet. (b) River gravel bed with garnet gravel. (c) and (d) Picked and washed grains of naturally polished almandine crystals.

Economic uses:

Purple and red garnets are commonly used gemstones as a substitute to rubies. Garnet sand is used as an abrasive, and it is a common replacement for silica sand in sand blasting. Alluvial garnet grains which are rounder are more suitable for such blasting treatments. Mixed with very high pressure water, garnet is used to cut steel and other materials in water jets. For water jet cutting, garnet extracted from hard rock is suitable since it is more angular in form, therefore more efficient in cutting. Kyanite is used in refractory, ceramic, electronics, electrical and abrasive industry. Kyanite has also been used as a semiprecious gemstone, which may display chatoyancy like cat's eye, based on its anisotropism and perfect cleavage. In geosciences, both garnet and kyanite are used as index minerals to estimate the temperature, depth, and pressure at which a rock undergoes metamorphism. The calcite is used in building materials, earthenware tiles, iron ore purification, paints, toothpastes, cosmetics, pharmaceuticals, decorative artefacts.

Although these deposits were known since last few decades, authentic information on estimation of these resources is not available, other than information of a small area mining lease in recent times. Furthermore, illegal mining prevails in the area leaving these deposits vanished. There were several incidents on illegal export of semi-precious garnets to lapidaries in Rajasthan and Surat. The garnet and kyanite resources worth to initiate and encourage abrasive and gem stone industry in the area, thus generating local employment.

Basic amenities and other places of interest:

The district head-quarters has good quality hotels to stay with multi-cuisine restaurants. Upon prior request, Singareni Collieries may also provide accommodation in their guest houses based on availability. Local transportation facilities are plentiful. Khammam town is another option for base camp. Several coal mines such as Gautam Khani Open-cast mine, 8 incline, 7th shaft etc. are present in Bhadradri Kothagudem district (Fig.4a and b). To visit these mines, a prior permission and approval from the Singareni Collieries Co.Ltd. is necessary.

At Yenambailu village near Paloncha, a medium scale irrigation project, Kinnerasani dam (80^{o}39$^{'}$30 E 17^{o}41$^{'}$00$^{"}$ N) is situated at 35 km from Kothagudem. At this location, the phyllites, dolomites and dolomitic limestones of Proterozoic Pakhal Supergroup are exposed. On the way, to Paloncha, Navabharat Ventures Pvt. Limited, and Kothagudem Thermal Power Station (KTPS) may also be visited to understand the utility of minerals in sponge iron and power industry. The ancient Hindu shrine, Bhadrachalam on the banks of River Godavari, is situated at a distance of 55 km from Kothagudem. A number of amphibolite dykes transversely cut the Godavari river course at Bhadrachalam (Fig.5a to d).

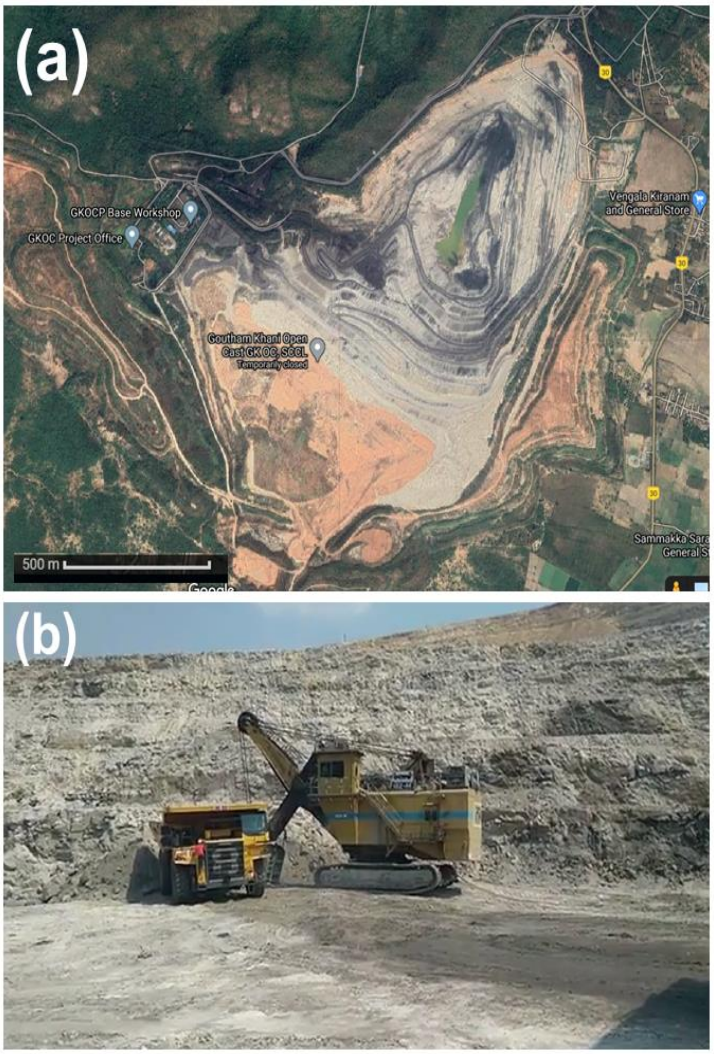

Figure 4. (a) Google Earth image showing the extents of Gautam Khani open-cast mine (GKOC). (b) Mining operations of the GKOC coal bearing Barakar strata in the background.

The erstwhile Khammam district of Telangana state is endowed with a complex geology and as many as ten to eleven types of mineral resources. The field sites of these mineral occurrences provide useful knowledge to enthusiastic students in geoscience and allied branches. At Kothagudem town of Bhadradi-Kothagudem district, garnet-kyanite and calcite mineralisations at Rudrampur- Garibpet and Sujathanagar are reported. Although these deposits are getting exhausted by illegal mining, their presence offers valuable understanding of their mode of occurrence, origin and other field relations to the geoscientists. The location also natural cultural and spiritual places to visit.

Figure 5. (a) Kothagudem thermal power plant. (b) Navabharat Ferro Alloys industry. (c) Kinnerasani dam at Yenambailu, near Paloncha. (d) Historical Hindu shrine of Lord Sri Rama at Bhadrachalam.

Further Reading:

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