Lithostratigraphy of Ramagiri Greenstone Belt, Anantapur District, Andhra Pradesh, India

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Abstract

The lithostratigraphy of the Ramagiri Greenstone belt has been studied using IRS – P6, LISS-IV satellite data and the map has been cross checked in the field and has been further refined. This study has clearly indicated that the belt has lower Ultramafic Group followed by Greenstone Group that in turn is overlain by Sedimentary Group (located in the Karnataka state and is known as Kustigi-Hungund belt). The Ramagiri Greenstone belt is studied in association with the associated granitoid plutons and gneisses. The basement- cover relationship is not exhibited by this belt. The details about the above stated stratigraphic column are documented in detail in the thesis. Amongst the type areas, Lepakshi is in Anantapur district in Andhra Pradesh and the Ilkal and Muddenur are in Karnataka State. Since, the greenstone groups of rocks are predominant; the belts are designated as greenstone belts. The Ramagiri Greenstone belt has the Lepakshi and lower part of Ilkal Formations located in Anantapur district. Hence, the work is restricted to the two said formations only. Ilkal is located in the Karnataka State. Hence, the place called Polepalle located nearer to Ramagiri in Andhra Pradesh has been selected as a Proto-type area The Ramagiri Greenstone belt is known for gold mineralization. Ramagiri was popular since pre-independence days because of the occurrence of gold in the area. Gold was mined earlier by John Taylor & Company and in the recent years by Bharat Gold Mines Limited (BGML). Gold in this area is localized in the meta-basic volcanic.

Keywords --- *Ramagirischist belt, lithostratigraphy, IRS – P6, LISS –IV Satellite, distribution and lithology and Ramagi section.*

I. INTRODUCTION

Ramagiri was popular since pre-independence days because of the occurrence of gold in the area. Gold was mined earlier by John Taylor & Company and in the recent years by Bharat Gold Mines Limited (BGML). Gold in this area is localized in the meta-basic volcanic. These rocks are called Schist belts because of predominance of schists occurring in the form of a linear belt or Greenstone belts due to the green color of the meta-basalt.

A similar basic geological data base for the granite - greenstone terrain of the eastern block is a long standing need. Ramagiri located in Andhra Pradesh is replica of Kolar style. It is the most important one in Andhra Pradesh in many respects. It forms the longest belt and exhibits all the typical features in respect of litho-stratigraphy and mineralization. Grenstone belts can't be studied in isolation. They are intimately associated with granitoids. Hence, the terrain is generally called Granite-Greenstone terrain. In Ramagiri also umpteen granitoids are associated with the greenstone belt. These are discussed to the extent needed.

Hence, it is felt that the topic entitled. "Lithostratigraphy of Ramagiri Greenstone belt, Anantapur District, Andhra Pradesh, India, using Spatial Technology" will be of immense use and interest to understand the geological set up in terms of lithostratigraphy and mineralisation. These rocks being of Pre-Cambrian, the study of lithostratigraphy following the Code of Stratigraphic Nomenclature of India (1971) and International Stratigraphic Commission and Guide (1976) forms an essential aspect.

II. STUDY AREA

The village Ramagiri is located in the topographical map of 57/F11, of Survey of India. (Fig.1.1). It is at the intersection of 14^0 26' 30" North latitude and 78^0 38' 20" East longitude. The villages of the Ramagiri Mandal area are located in both the topographical maps of 57 F/ 7 & 11(1:50,000), of Survey of India.

Fig.1.1.The location map of Ramagiri (.) area

Ramagiri is accessible from Anantapur, the district headquarters. Anantapur can be reached either by South - Central Railway from Hyderabad. The town Dharmavaram and Penukonda are the nearest locations and these can be approached by South - Central Railway. The said places can also be approached from Hyderabad by road. The Andhra Pradesh Road Transport Corporation runs number of buses from Anantapur, Dharamavaram and Penukonda to all the rural areas. Ramagiri is the central place of the investigation and the adjacent villages are all well connected by all weather roads from all the places.

III. METHODOLOGY

A. Litho – Stratigraphy Of The Greenstne Belt

1) Lepakshi Formation

This formation is named after a historic place called Lepakshi of Vijayanagar Dynasty. It is situated at the intersection of 13^0 47' North latitude and $77^{0\ 37'}$ of East longitude in the Survey of India toposheet No.57 G/9. It is famous for the Lord Virupaksha temple where there is granitic pillar that almost hangs with no support at the base and also for the biggest Nandi (Bull) carved in a single granitic block in the country (monolith). Lepakshi is a small town situated on gneissic rocks. It is about 100 Km. from Anantapur, the district H.Q. and is approachable from Hindupur by road. Lepakshi is at 682 m above msl, and is easily approachable in all seasons. Geomorphologically it is situated in plains.

2) Distribution and Lithology

This unit is exposed from Gudibanda in the south to Ramagiri in the north for a distance of 75 Km.The southernmost outcrop of this formation is in the form of a rectangular block of amphibolitic enclave in gneisses. Further south, however, the area is soil covered and is mostly underlain by gneisses and granites.

This unit when traced further north from Gudibanda loses its identity completely in the midst of highly sheared augen gneisses, the latter with NNW-SSE trending foliation and steep easterly dips. In the satellite picture, the highly sheared gneiss has similar tonal expression as that of the greenstone belt lithologies giving misleading impression that the latter continues further north within the gneissic terrain but ground truth is to the contrary. The gneiss in the area is highly cleaved and is tonalitic. In the field, from a distance it gives an impression of sheared metabasalt having sharp spikes – a feature best observed 57 G/10 – 1 Km WNW of Garudacharihalli.

Lepakshi Formation has a maximum width of 1 Km along Lepakshi-Chilmattur section and the minimum width of 8 m. As noticed at 0.1 Km east of Gudibanda where it occurs as a big enclave within gneiss. The higher width is mainly due to granite intrusion which has widened the original width of the belt. This unit in the southern part occurs in two bands – the wider western band and the thin eastern band, both separated by gneissic rocks. The thin eastern band is mainly constituted by amphibolites, sometimes occurring as enclaves within the gneiss. The western one is made up of amphibolites and ultramafic unit.

3) Lepakshi-Chilmattur Section

The main lithological units of this Formation along this section are – Ultramafics and mainly schistose Amphibolites,

The type area of Lepakshi Formation of Ramagiri schist belt is designated along an ESE – WNW section, located 6.5 Km east north east of Lepakshi. The road from Lepakshi to Chilmatturu (57 G/9) runs sub-parallel to the type section, and cuts across the schist belt. It forms an elevated area, the heights ranging from 682 m to 720 m.

The Lepakshi Formation is best exposed along the small ghat section on Lepakshi – Chilmatturu road 2 Km form Lepakshi. Along this section, the schist belt is exposed in tow bands; the broader western band has a width of 1 Km, where as the eastern one is thin linear and 100 meters wide. The two bands are separated by later intrusive granitoids. The western contact of the schist is sharply defined with the younger intrusive granite (both grey & pink alkali feldspar granite) which forms high hillocks along the sections. In this section this formation has an alternating sequence of amphibolites and ultramafic rocks with minor amounts of calc-silicate rocks and intrusive gabbro and granitoid

bodies. This set up exists for over a width of 0.5 Km from the western contact. Further east, for another 500 meters predominantly ultramafics consisting of clino-chlor rock, talc-tremolite schist and talc-chlorite schist are exposed. Amphibolite is again seen over a width of 150 meters to the east, where granite comes in contact with it. The latter has small enclaves of amphibolites and ultramafic bodies. The width of granite body here is almost about 1 km. The eastern band of the schist belt is made up predominantly of amphibolite. The western contact of the amphibolites with granite is sharp and the eastern contact with granite gneiss is highly sheared. The cataclastic effects, manifested in the stretching of the feldspar crystals and mylonitization are clearly noticed along the eastern most contact.

The schistosity in the Meta volcanic trends NNW-SSE with generally steep easterly and rare westerly dips. This trend gradually swerves to N-S, northeast of .682. The landform in the Lepakshi area is mostly plain but proximal to the schist belt; on the western side granite occurs as residual hills rising to 600-700 m above msl. The landform within the schist belt again is gentle plain (700 m) in the west to undulating topography (720 m) in the eastern part of the western patch. Further east, the intrusive granite along with the eastern band of schist belt exhibits gentle slope to the east. The difference in geomorphic expression is very conspicuous along the type section.

The easternmost unit contact is marked by the gneiss intruded by younger pink granite that has been subjected to faulting.

4) South South West of Ramagiri Section:

Further, the section south south west of Ramagiri is identified as an additional reference section of Lepakshi Formation. in this section, the lowermost unit is a small lensoid amphibolite (3 m thick), followed by a fine grained cherty ortho-quartzite with well developed planar and cross-beds. This quartzite has cumulative strike length of 0.4 km and is 5 m thick and alternates with iron formation bands of 3 m thick. This followed by highly by highly sheared intrusive granite which is about 10 m thick and then by quartz-sericite schist which is about 200-300 m thick, with thin quartzite or crystal tuff bands with well developed F1 folds with S_1 schistosity. This is followed by ultramafic rock (serpentinite) of 5-20 m thick which can be traced southwards where it has maximum development i.e., in Lepakshi section.

The identity of the western band is maintained, when traced towards north from Lepakshi-Chilmattur section to south of Ramagiri. The eastern band joins the western band 2 kms south of Pattikunvapalli. North of the type section (Ramagiri section) the width of this unit including the inter-leaved gneissic granite, (within the greenstone belt) diminishes and continues along the strike. 4 Km east of Ramagiri this unit is again forked due to gneissic granite dome called Cherlopalle dome. East south east of Cherlopalle this unit is represented by mainly amphibolites and west of Ramagiri, chlorite schist and metabasalt constitute the belt. These lithologies continue along the strike further north of Ramagiri. Pinch and swell along the strike is a common feature in the amphibolite and chlorite schist bands. Amphibolites are more common along the margins of the belt.

B. Ilkal formation:

This is named after the place called Ilkal, located in the middle part of the belt in the Raichur district of northern Karnataka. It is situated at the intersection of $15^0 58' 00"$ of north latitude and $76^0 07' 00"$ of East longitude of survey of India toposheet 57 A/1. From Hyderabad it is about 500 km and from Banglore it is 600 km and is easily approachable by a network of all weather roads. NH-5, Bangalore-Bombay passes through the town. Ilkal is about 550 mts above msl and is located in plains underlain by metabasalt. Ilkal Nadi which flows on the eastern side of the town drains the area. As the place Ilkal is in Karnataka, another Proto-type section viz., Polepalle, located nearer to Ramagiri is proposed. The geographical name Ramagiri has already been used for the Greenstone Belt, the same name (Ramagiri) should not be used at the

Formation level. Hence, the nearest place to Ramagiri, i.e., Polepalle has been identified as the equivalent of Ilkal Formation. This is in accordance with the Code of Stratigraphical Nomenclature of India (1971) and International Stratigraphic Guide and Commission (1973).

C. Polepalli formation

1) Description of Polepalle

The place Polepalle is located in 57F/11 of the SOI topographical map. It is at the intersection of 140 $18' 25"$ N.Latitude and $77^0 33' 50"$ E. Longitude It is at a distance of 1.75km south of Oblesh Gutta 546. A metalled road deviating to south, from the road leading to Ramagiri leads to this place. Gemorphologically it is in plains; geologically it is on the Cherlopalle gneiss. It is easily approachable by road throughout the year. As there is no village other than Ramagiri on the greenstone belt, this has been chosen as the type area, though it is not situated on the greenstone belt, following the Code of Indian Stratigraphy.

The lithologies are occasional pillowed Meta-basalt, Chlorite schist, Ash-fall tuffs, Banded Iron Formation and Ferron dolomite.

2) Distribution and Lithology: The formation is traced from 5.5 km South-South-East of Penukonda in the south to north-east of Rupanagudi. Being about 500 meters wide in the south it gradually becomes wider in the Mustikovela and Cherlopalli areas in the north due to the intrusion of granitoids. 1 km north-east of Ramagiri this unit is forked ("A" in the Fig. 3.1) and the eastern band having a width ranging between 300 d has the general trend of NNE-SSW. The main band ("B" in the Fig. 3.1) has the general trend of NNW-SSE occurring as tentacles from the main body. This band has and continues as thin band in the northerly direction with occasional granitoids occurring as intrusives.

South of Kuderu this unit is shifted to west due to a ENE-WSW trending fault, but the unit continues in the northerly trend up to Kalegallu where it takes a NNW-SSE trend. North of Kuderu an elliptical granite gneissic dome is identified as Marutla dome, has its longer axis trending N-S. It has migmatised gneisses in the form of core that is intrusive into the schist belt and is surrounded by migmatised amphibolites.

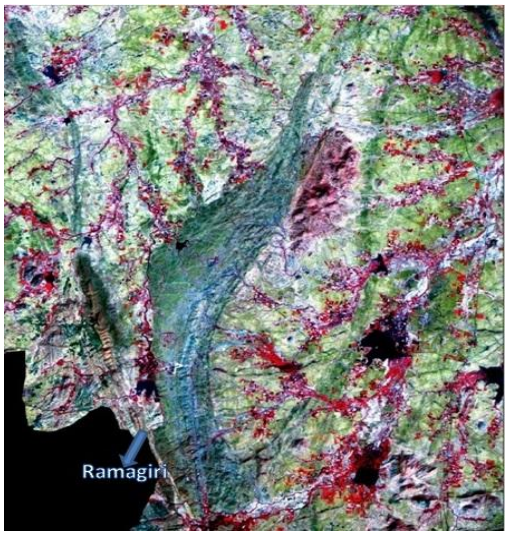

Fig.3.1.The distribution of the Polepalle (Ilkal) Formation in & around Ramagiri.

Granite diapiric structure enclosing greenstone enclaves occur at Udiripikonda and further north. The schistosity of the greenstone swerves around this granite body suggesting its emplacement is later to the development of fabric in the belt.

Away from the main belt in the Katrimala area ambhibolite of the greenstone occurs as folded enclave within the gneissic granite. The sinuous trend on the west and straight course on the east continuous up to Kampli where a westerly drag of units and the fabric in turn is noticeable. This unit in the said area occurs in the form of a broad 'U' shaped body. The eastern arm of the 'U' tapers towards north in the area north of Kamatgi in Karnataka.(personal communication from B.K.Nagaraja Rao)

3) Penukonda – Madakasira and Penukonda – Roddam Sections:

It is an east west section that cuts across the Greenstone Belt. Along this section, the "Greenstone Group" of rocks are exposed clearly. The litho unit is mainly amphibolites with well developed schistosity trending NNW-SSE with an easterly dip of + 60^0. Along the trend of the schistosity, leuco granitic intrusions are seen occurring at number of places. It is clearly seen at the Microwave station on the Penukonda - Madakasira road At places near the contact with the intrusive granite the amphibole grains reflect coarseness.

4) Ramagiri Section:

Volcaniclast:

Geologically, this area is constituted by the variant schistose rocks belonging to the 'Greenstone Group' of the Ramagiri belt. To establish the stritigraphy in a schistose terrain it is very difficult unless some primary features are recorded. In the present case, the S_0 plane in the volcaniclasts (Fig. 3.2 & 3.3) and slightly deformed pillow lavas in the schistose rocks have helped to build up the lithostratigraphy. These have suggested that the units are younging towards east. These formations viz., volcaniclasts and amphibolites extend for long distances along the strike.

Fig.3.2. Volcaniclsts reflecting S_0 plane steeply dipping to east on 'ab' plane

Fig.3.3. Volcaniclsts reflecting S_0 plane (bedding) and the S_1 plane (schistosity) that is running parallel and steeply dipping to east.

5) Chlorite schist:

The other litho unit is the chlorite schist that is the most dominant unit in the greenstone belt. In addition to this, amphibolite also forms a major unit. The chlorite schist. green in color, stands as spikes. (Fig. 3.4). If studied carefully and closely observed highly deformed pillows can be observed. The parent rock for the chlorite schist is pillowed basalt. All the lithological units reflect the spikes nature of different magnitude.

Fig.3.4. Spikes of the chlorite schist in the Ramagiri greenstone belt.

*6) **Quartz Veins:***

There are number of quartz veins traversing the Greenstone belt. Some are not sheared (Fig. 3.5) and some are highly sheared. (Fig. 3.5)

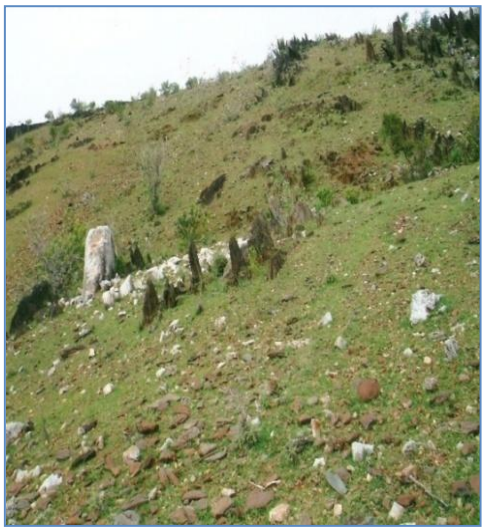

Fig.3.5. Un - sheared quartz in the greenstone belt

The sheared quartz veins conspicuous on the western side of the Nossannakota Reserved Forest area. (Fig. 3.6). They also show small warps with steep plunges

Fig.3.6. Highly sheared Quartz vein

The top Meta-Sedimentary Group is not exposed in Andhra Pradesh. It is mainly seen in the Karnataka State and the type area is identified as Mudenur Formation, named after the place, Mudenur (North Latitude $14^0\,53'\,30''$ & East Longitude $76^0\,17'00$ – 57A/5).

7) Banded Iron Formation:

Iron formation occurs in two independent blocks in the Ramagiri area. One is in the western limit

of the greenstone belt in the Reserved Forest and the other in the eastern limit of the greenstone belt

The iron formation or BIF occurs as a thick band running for nearly 8km and crowning the schistose hills of the Ramagiri West Reserved Forest. It has alternating magnetite and chert bands (Algoma type).

8) Ferron dolomite:

This is igneous in origin and is mostly associated with the greenstone belts and occurs in the form of lensoid body. It is massive, melanocratic and gives metallic sound when hit with hammer. It is not breakable easily. It can react with dilute HCl acid only when it is in the powder form.

Fig.3.7. Outcrop of Ferron- dolomite

IV. CONCLUSION

Further, many earth scientists worked in the Dharwar craton. It was Swamynath .C Ramakrishnan's work that added another new group called Sargur Group to the Dharwar stratigraphy. Subsequently the Dharwar craton was divided into western Dharwar craton and Eastern Dharwar craton, based on the distinct and clear field evidences.

Unlike the stratigraphy of the sedimentary basins, the stratigraphy of the greenstone belts is beset with many problems like division of units into different 'Formations' and clubbing of 'Formations' into 'Groups' etc. One of the best account on the lithostratigraphy was that of Anhaeusser et al, wherein they stated that the Archaean style greenstone will have the 'lower' "Ultramafic Group", the 'middle' "Greenstone Group" and the 'upper' "Meta-Sedimentary Group". In the recent years, yet another good work on the lithostratigraphy of the greenstone belts was by She Fa Chen (2003), wherein he described different formation as Bouma logs.

In the present work the Ramagiri greenstone belt has been chosen for the detailed study on the lithostratigraphy as it reflects the complete sequence of litho units.

Stratigraphically it exhibits typical triple division, viz., the lower Ultramafic Group, the middle Greenstone Group and the upper Meta-sedimentary Group. To a great extent the lower and the middle groups are exposed in Anantapur district of Andhra Pradesh. The upper Meta-sedimentary Group is in the Karnataka State. The work is concentrated mainly on the lower and middle groups. In working out the lithostratigraphy the Code of stratigraphy of nomenclature of India has been followed.

The lower Ultramafic Group is named after the place called "Lepakshi" that is famous for a monolith bull and a temple of Lord Siva. It was developed during the times of Vijayanagar Dynasty. The ghat section between Lepakshi on the west and Chilmattur on the east cuts across the strike of the lower units. Hence, this section called Chilmattur ghat section is the best to study and forms the "Type Section" (Holostratotype) of the lower Ultramafic Group. Further, the area located south of Penukonda – Madakasera road section is yet another section that can form, i.e., an auxiliary reference section (Hypostratotype). The Ultramafic sequence is designated as "Lepakshi Formation".

The middle "Greenstone Group" is best exposed in the Ramagiri area. The type area for this is the place called "Ilkal" located in Karnataka. Hence, a local place called "Polepalle" situated nearer to Ramagiri has been chosen as the "Lectostratotype" area.

The lithostratigraphy can be as follows:

Younger intrusive granitoids including the PGC
Polepalle Formation – (Greenstone Group) - Chlorite Schist, Amphibolites, Volcanic Clast.
Lepakshi Formation – (Ultramafic Group) – Ultramaffics and Amphibolites.

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