Geological Report on the study of the Kaladgi-Badami Basins of Bagalkot Region in Karnataka

Prepared by

Aaron Pereira

For

Geological field mapping

10th Dec – 20th Dec 2022

Geological Report on the study of the Kaladgi-Badami Basins of Bagalkot Region in Karnataka

Prepared by

Aaron Pereira

For

Geological field mapping

10^{th} Dec – 20^{th} Dec 2022

CONTENTS

List of illustrations

ACKNOWLEDGEMENT

I am grateful to Dr Anthony Viegas, Dr. Nicole Sequiera, Dr. Poornima Sawant and all other faculties of Earth Science department who helped us during the field trip by providing us with valuable knowledge and taking care of us all throughout the field trip. I would also like to thank Mrs. Heena for being very supportive and providing us with the necessary tools required for the field trip.

I would also like to express my gratitude towards my fellow classmates for their constant support during these 10 days in Karnataka. Also, I would like to thanks my family members for their support financially and morally all throughout this field trip.

Lastly, I would like to express my profound gratitude to our college, Earth Science Department of Goa University.

Introduction

Karnataka, which is a portion of the Indian Shield, is made up of rock formations that are between 3,300 and 5,000 years old. The entire region is dominated by Archaean-Proterozoic rocks, with the exception of a small coastal strip of around 5000 sq. km. of Tertiary and Quaternary sediments and another 31,250 sq. km. of Deccan basalts.

The oldest exposed rocks in Karnataka's Hassan district are found in the Gorur area and date back to 3300 million years. Karnataka's Precambrian craton is divided into western and eastern sections. The Precambrians of Karnataka can be separated into older Dharwar supracrustals and younger Sargur supracrustals, which range in age from 3000 to 3300 million years. The Dharwar supracrustals Supergroup has also been separated into the younger Chitradurga Group and the elder Bababudan Group (about 3000 to 2700 million years) (ca.2700 to 2500 million years). The Eastern Craton's schist belts, including Kolar, Hutti, Sandur, and others, seem to be roughly comparable to the Chitradurga Group.

Granite and granitoids with an approximate age of 2600 to 2500 million years have been widely incorporated into the Dharwar craton in Karnataka. These granites and granitoid are widely distributed in eastern Karnataka. Sediments from the Kaladgi, Badami, and Bhima Group, which are around Proterozoic in age, make up the northern half of Karnataka. Massive volcanic flows from the Cretaceous to the Tertiary known as Deccan traps blanket the region further north.

Peninsular Gneiss surrounds and cuts through greenstone belts, which are essentially meta-volcano sedimentary formations. These give place to a group of rocks known as granulite at the southernmost point of the craton. A billion-year orogenic history between 3400 and 2400 million years ago is preserved in the craton. The northern half of the craton, which is also hidden by Deccan basalts, is occupied by epi-cratonic or intracratonic sedimentary basins referred to the Purana Basins.

Geological Map of Karnataka

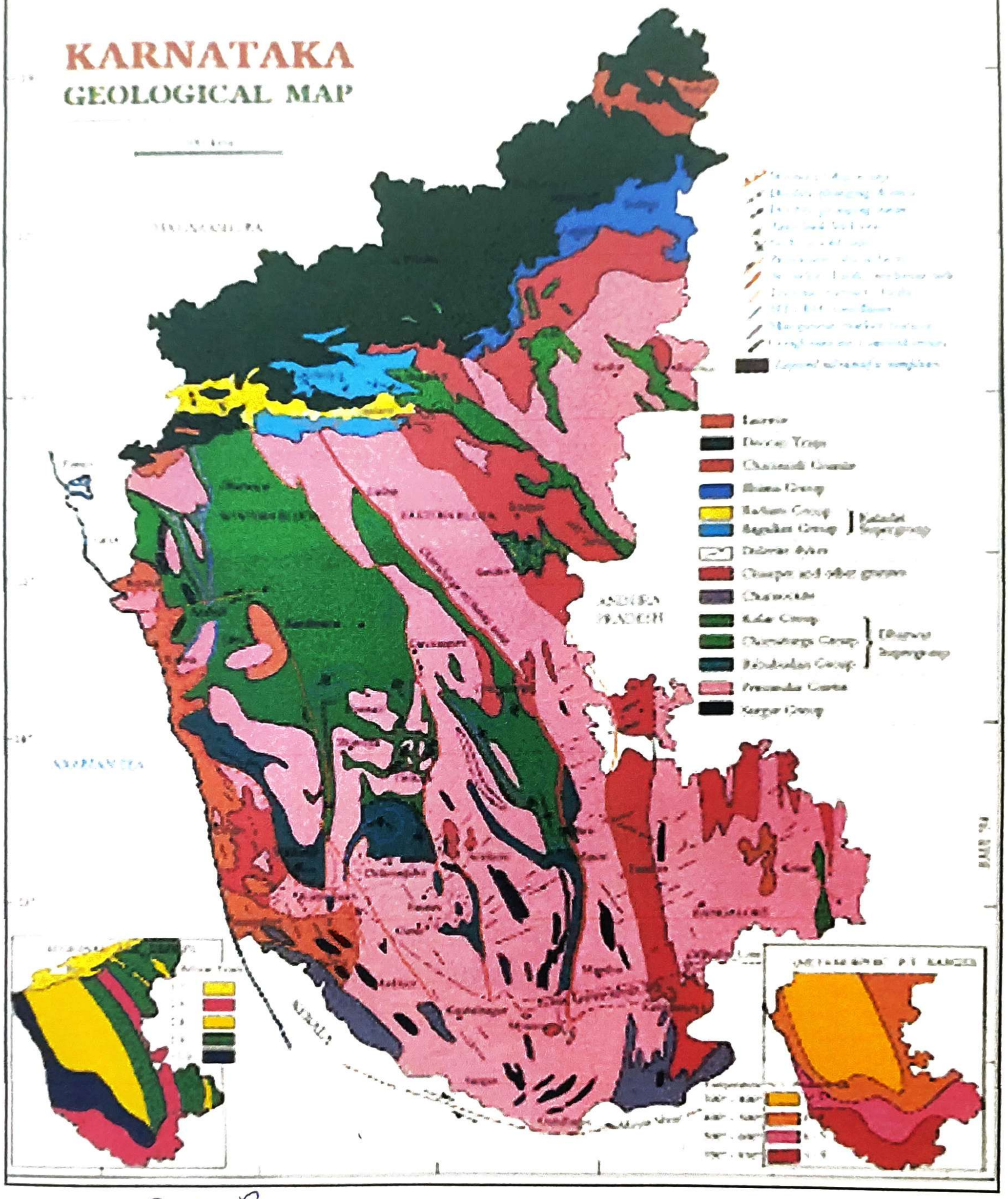

Fig 1 : GEOLOGICAL MAP OF KARNATAKA

Kaladgi Basin

Over the Archaean Dharwar craton are the Proterozoic Kaladgi-Badami and Bhima basins, which are intra-cratonic basins. The arenites, shales, and carbonates in the Kaladgi- Badami Basin were likely deposited in shallow marine, transitional, and continental environments between the late Palaeoproterozoic and Mesoproterozoic eras. The bottom portion of the succession, known as the Bagalkot Group, is deformed into elongated, double plunging synclines and anticlines that trend east-west. The Badami Group, which makes up the upper portion of the succession, rests unevenly across the bottom portion. Under an extensional stress regime, movements along east-west normal faults shaped the formation of the Kaladgi- Badami Basin. The majority of the rocks in the Bhima Basin are limestones, with lesser amounts of arenites and shales that may have been deposited in Neoproterozoic fluvial, deltaic, and tidal flat settings. Except for near faults with considerable strike-slip components, these sediments are undeformed. In various areas of the basin, the Bagalkot Group exhibits varied deformation. There has been localised deformation along faults and moderate monoclinal folding along the basin fringes (around the Saundatti-Ramdurg-Badami tract in the south and the Jamkhandi-Bilgi sector in the north). These edges had uniform strain flattening, likely as a result of the basin floor subsiding due to gravity. A causal relationship between boundary-parallel normal faults, which are essentially E-W trending and can be traced to the basement of the sediments, and the basin's expansion is suggested. The strata in the centre region, particularly north of the Shirur Shear, exhibit tight isoclinal folds that are occasionally double plunging and occasionally recumbent or overturned.

Stratigraphic map of Kaladgi supergroup

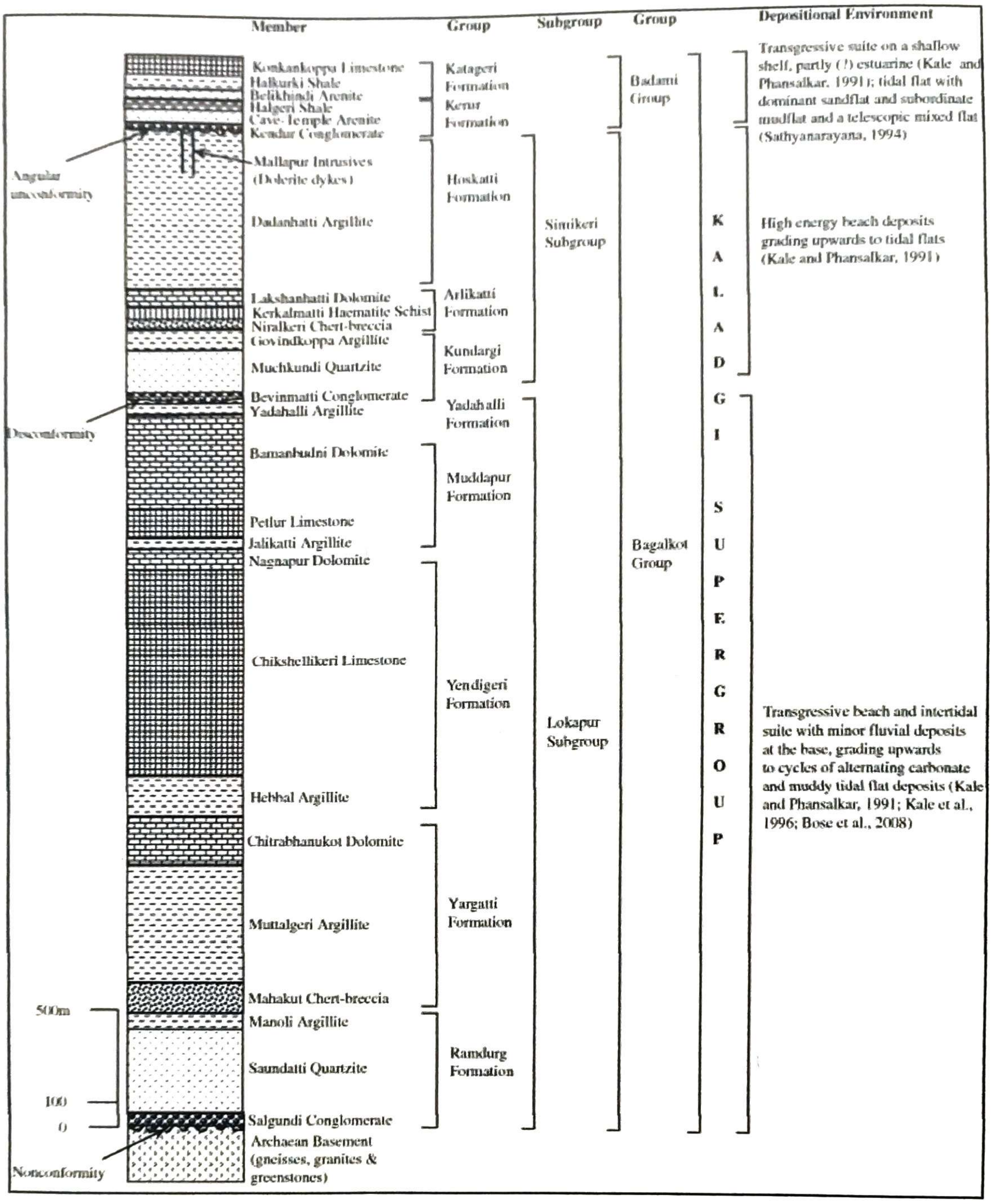

Fig 2: STRATIGRAPHIC MAP OF KALADGI SUPERGROUP

Field Observation

Day 1 - (10th December 2022)

Spot 1: Karaddi Gudda

Lat: 15°52'37'' N

Lon: 74°49'49''E

This geologic formation is a part of the Simikeri subgroup of the Bhagalkot group of rocks. There is graded bedding seen in the area. Grain/Clast size increases as we move up the hill. Deposition occurred most likely in a fluvial environment. The exposed granite has weathered on the exterior due to the intense heat of the sun. The exposed rock consists of bands of black and red minerals which contain a lot of ferrogenous minerals. The parent rock was presumably a granite because the majority of the rocks are clast supported conglomerates with spherical clasts and are composed of argillaceous sediments consisting of quartz and feldspar. Buvanmutti Conglomerate of Simikeri is the name of the conglomerate in question. The conglomerate seen in the outcrop makes the uncomformity of Simikeri and Lokapur subgroup. As we climb the slope, there is a gradational change from these conglomerates to quartzites where we come across rocks where sand-sized grains have meshed up and fused, signifying the shift from conglomerate to quartzites.

Fig 3: BUVANMATTI CONGLOMERATE

Spot2:

Lat: 15°52'37'' N

Long: 74°41'49'' E

There was a highly weathered clayey outcrop exposed on the foot of the hill beside the road. The type of weathering was identified to be that of spheroidal weathering which is a form of chemical weathering that affects jointed bedrock and results in the formation of concentric or spherical layers of highly decayed rock known as saprolite. When this saprolite is exposed to physical weathering, the layers peel off giving rise to the structure seen in the outcrop.

The rock was melanocratic, fine-grained, which contained few vesicles which were present on some rocks which were identified to be weathered vesicular basalts of the Deccan Traps. All the vesicles were not filled with secondary minerals; however some of them were with secondary minerals called amygdales. Numerous fractures were also seen in the rocks of this outcrop.

Fig 4: Spheroidal weathering in BASALT

Day 2 – Ramthal (11th December 2022)

Spot 1:

Lat: 16°05'07'' N

Lon: 75°52'31''E

On the second day we went to a place called Ramthal which is a place besides a road and the outcrop situated on the hill having moderate slope.The rocks in this area consists of metavolcanics with ultramafics which have been metamorphosed, metasediments with some acid volcanics and greywakes wth BIFs which is underlain by Hundgund schist which is the basement rock for these rock types. The rocks seen at the first spot contained bands of reddish mineral haematite alternating with quartzite. Another reddish mineral was observed within these rocks which were identified to be Jasper.

Fig 5: BANDED IRON FORMATIONS

y

Spot 2:

The second spot consisted of metapellite layers which were folded. The major fold also contains microfolds along with crenulation hinge lineation. There is a quartzite layer present along with class 3 folds of ferrugenous layer. The quartzite layer is the competant layer which is present within the rock and forms class 1B folds. There were also Sn and Sn+1 foliation seen in rock.

Fig 6 : FOLDED METAPELITE

Spot 3:

The third spot consisted of phyllitic rocks whose dip is very steep. These phyllites were striking in N165 direction and were dipping towards SW, having a dip amount of 76°.

Spot 4:

The fourth spot consisted of folded beds of BHQ which were striking in N220 direction and were dipping towards NW, having a dip amount of 60° on one of the limbs and were striking in N112 direction and were dipping towards NE, having a dip amount of 55° on the other limb of the fold which contained intrafolial folds.

Spot 5:

There were conglomerates with clast size varying from 10- 15 cm in length and approximately 9cm in width having clasts of BHQ and jasper. These conglomerates showed imbrications indicated by grain boundaries of clasts in contact with each other and showing a particular orientation.

Fig 7: Conglomerate showing imbrications

Spot 6:

There were reddish colored quartzites which were ferruginous which were moderately steeping and showed cross bedding.

Spot 7:

This rock outcrop contained non crystalline variety of $CaCO_3$ which could be of Ankerite. The presence of $CaCO_3$ was confirmed with the application of HCl on the rock surface which showed effervescence. There was no cleavage possessing minerals to hint the presence of calcite. The other minerals present were smoky quartz showing a vitreous luster and a smoky white appearance and an amorphous variety of calcite. This outcrop was that of a Calliche deposit which form under dry conditions.

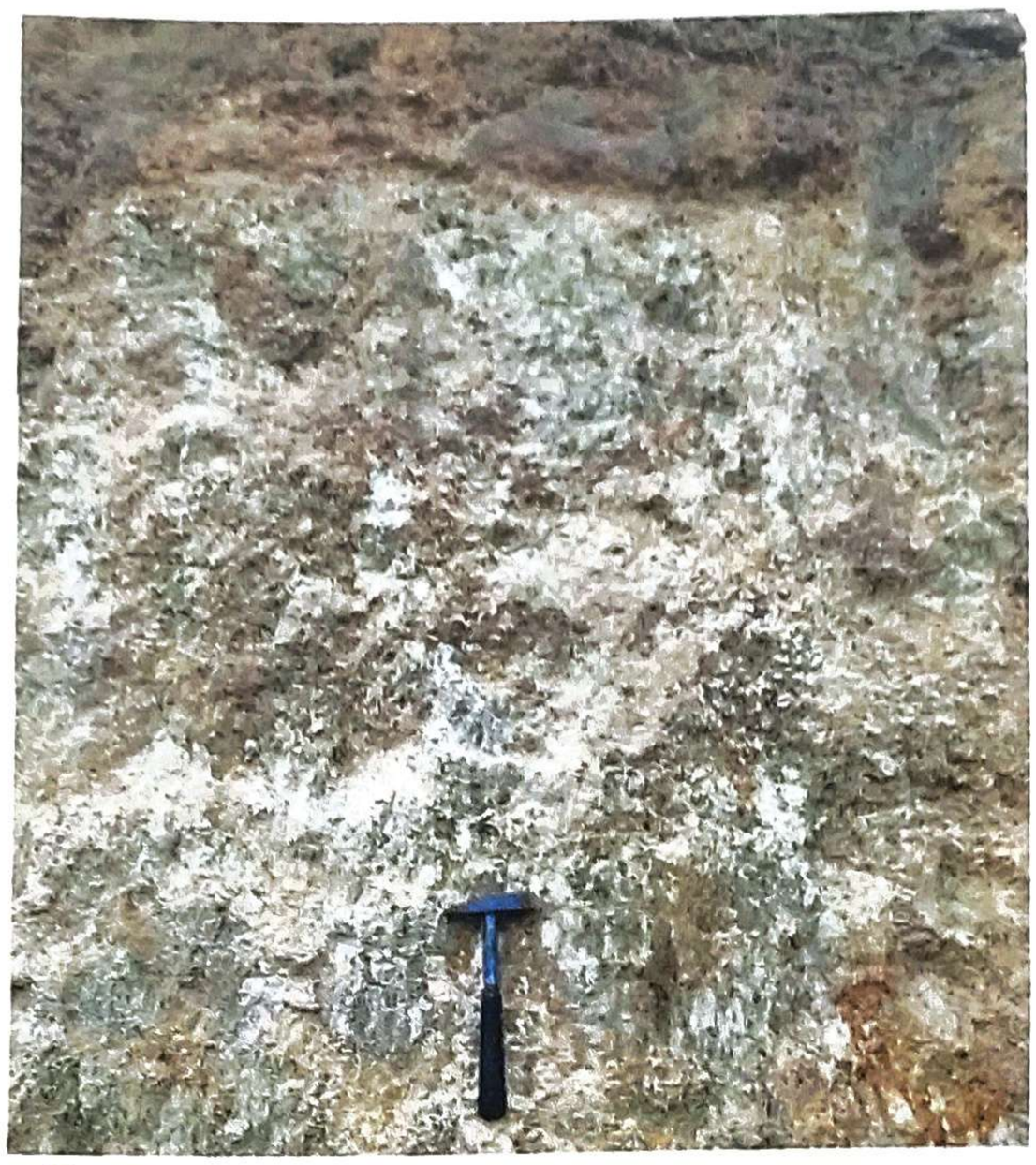

Fig 8: CALLICHE DEPOSIT

Day 3 : (12th December 2022)

Spot 1: Nargund

Lat: 15°44'23'' N

Lon: 75°22'27'' E

The exposed rock is a metamorphic rock phyllite which is intercalated with BIF. The rock is foliated which is seen by the arrangement of minerals in a particular direction. There is a broad warp in the foliation which was caused due to the intersection of Sn+1 with Sn foliation which caused the curved Sn foliation to be sub parallel at the junction where Sn+1 intersects Sn foliation. therefore the strike is changing and the dip is varying by <10°. The foliation is penetrative in nature. Quartz veins are present and show a parallel relationship with the foliation. The phyllitic rock did not undergo more than greenschist facies of metamorphism. The foliations present in the rock are weak planes and provide avenues for quartz veins to flow through. The intrusions of quartz veins were synchronous with the deformation of the rock which means that the quartz veins formed at the same time during which the rock was deformed.

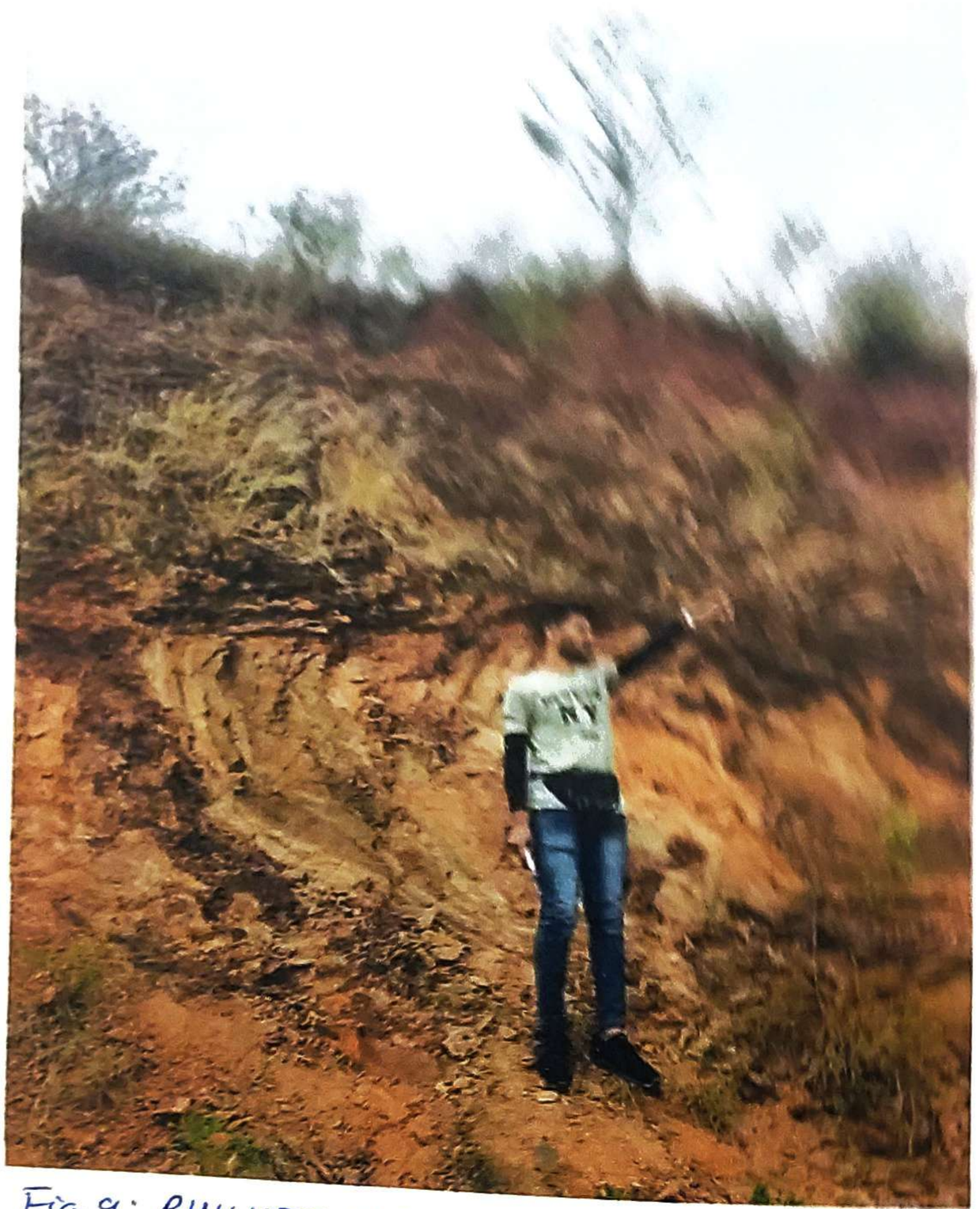

Fig 9: PHILLITE SHOWING WARP IN FOLLIATION

Spot 2: Markundi

Lat: 15°44'23'' N

Lon: 74°22'25'' E

This outcrop was present near Bhuruka Powerplant Corporation, at Markundi, on a hill where there were 9 wind mills present. The rocky outcrop which was exposed on top of the hill was that of quartzite which contained numerous fractures and joint sets. The joint set readings are N297 and N235. In some places the rock showed herring bone structure. This rock is an outlier where the younger rock formation isolated among older rocks.

Fig 10: QUARTZITE

Day 4 - Aiholle (13th December 2022)

Lat: 16°00'49'' N

Lon: 75°53'05''E

Spot 1:

The exposed outcrops present on the south side of the road are inclined beds and have undergone greenschist facies metamorphism hence; the grain boundaries are still visible. The rock is composed of sand sized grains and at some places the sand sized grains are fused together whereas at other places the grain boundaries are still visible. The rocks where the sand sized grains are fused together are called quartzites and the rocks where the sand sized grains are still visible are that of sandstone. This outcrop also possesses intraformational breccia within the beds consisting of clasts of Quartz, Agate, chert, Jasper and BIFs. The clasts of Jasper are mostly rounded while at some places they are subrounded. The clasts of BIFs are generally elongated and are banded. Thebreccias present within the beds is not basal and the clasts show a variation in grain size from 1-3 cm at the

top of the bed and 0.5-2 cm at the bottom. At places the clasts have angular to sub angular shape so we can conclude that the term breccias can be employed rather than conglomerate. The structural data from the site is strike direction was N310, dip direction is N225 and dip amount is 39. Randomly oriented quartz veins which has a thickness of 1cm and are very rarely seen in these rocks. This formation is called the Hoskatti formation of the Bagalkot Group of rocks.

Fig 11: SANDSTONE CONTAINING INTRAFORMATIONAL BRECCIA

Spot 2:

The rocky outcrop on the Northern side of the road consists of horizontal beds and is very expansive. The rocks are sandstones composed of fine sand sized grains present within a siliceous matrix. These sandstones are ferruginous and contain bands of dark colored minerals. At some places these bands are folded. The structural data from the site is strike direction was N90, dip direction is N180 and dip amount is 3. These rocks belong to the Kerul Formation of the Badami group of rocks.

Fig 12: HORIZONTAL SANDSTONE BEDS OF BADAMI

Spot 3:

This rock exposure consists of a rock that is jointed, fractured and faulted. It consists of sand sized grains and its boundaries are not well defined hence, we can call it a quartzite. The faults were identified by slickenslides as well as striations which were seen on the fault planes. The slickenslides were smoothening downward and it was rough upward. According to Andersons theory of faulting, the fault was a reverse fault and the fault was shallow dipping. There were also intraformational conglomerates seen within the rock.

Fig 13: SANDSTONE CONTAINING JOINT SETS

Day 5 - Amingad (14th December 2022)

Lat: 16°03'22'' N

Lon: 75°56'43''E

Spot 1:

This outcrop consists of boulders of granites which are pink in colour. The essential minerals present in this rock are quartz and orthoclase feldspar in association with dark colored minerals which could be hornblende or biotite. The same exposure of this granite towards the NW has not weathered whereas the granites on the NE has undergone extensive weathering with development of joint sets and fractures which are indicative of the presence of shear zones. The structural data from the granite is strike direction was N174 dipping 72 towards SW. There are also dark colored xenoliths seen in the rock which are mafic and are composed of pyroxenes and these xenoliths are of restitic type. The contact between the basement and the formation above is separated by conglomerate which is intercalated with BIF. The structural data from the plan view of sandstone is strike direction was N120, which dips 21 towards NNE direction.

Fig 14: Boulders of PINK GRANITE

Fig 15: SHEAR ZONE SEEN IN PINK GRANITE

Day 6 - Bilgi (15th December 2022)

Lat: 16°33'97'' N

Lon: 75°61'28''E

Spot 1:

This rock outcrop is the exposure of Closepet granite which is basement rock overlain by Badami rocks (saundatti quartzite/conglomerate). The essential minerals present in this rock are quartz and feldspar present along with biotite and hornblende accessory minerals. The granite is grayish granite and hence can be called grey granite. The grey granite consists of quartz and Na rich feldspar (Anorthite). There is a color variation seen in the granites within the outcrop which range from grey to pink which may be due to weathering. This granite outcrop intruded by six pegmatite veins. The trend of the pegmatite veins are N62E and N55E direction. The pegmatite veins are coarse grained and are composed of quartz and orthoclase feldspar as the essential minerals. The average thickness of the veins is 10cm -25cm. There are joints sets seen in some of the pegmatite veins trending in N30E and N64E direction. There is less biotite in the rock hence no mineral alignment and foliation cannot be identified in rock. There are also accidental xenoliths which is mafic and composed of Hornblende along with some pyroxenes.

Fig 16: XENOLITH SEEN IN CLOSEPET GRANITE

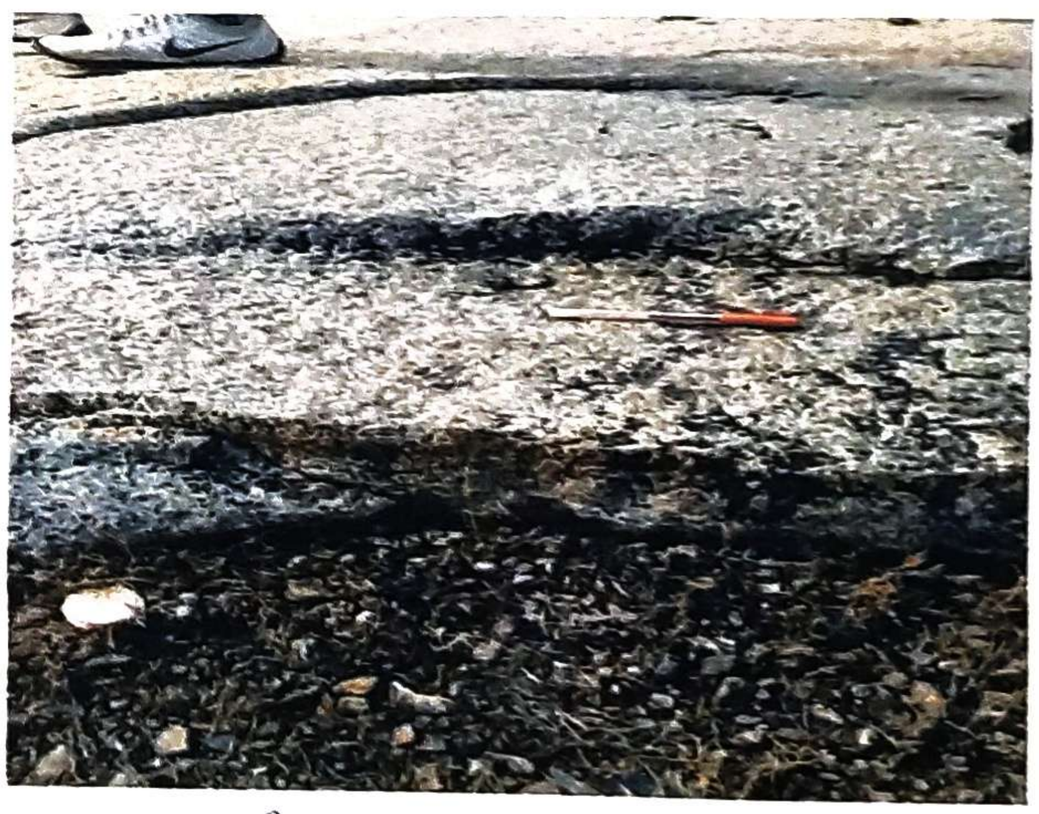

Fig 17: GREY GRANITE

Spot 2

The vast outcrop of this area has undergone low grade metamorphism and the grain boundaries could not be distinguished hence we can call this rock quartzite. The whole outcrop has two prominent sets of joints; the first joint is along the bedding plane and the other joint is vertical across the bedding plane. There is a layering of ferruginous and siliceous material within the quartzite. In between the contact planes of the beds, there are highly weathered layers that appear flaky and can easily be crushed into white powder. The bedding plane surfaces which are exposed to the atmosphere and water have undergone leaching. The bedding planes were striking in N40 direction and dips 12 towards SSE.

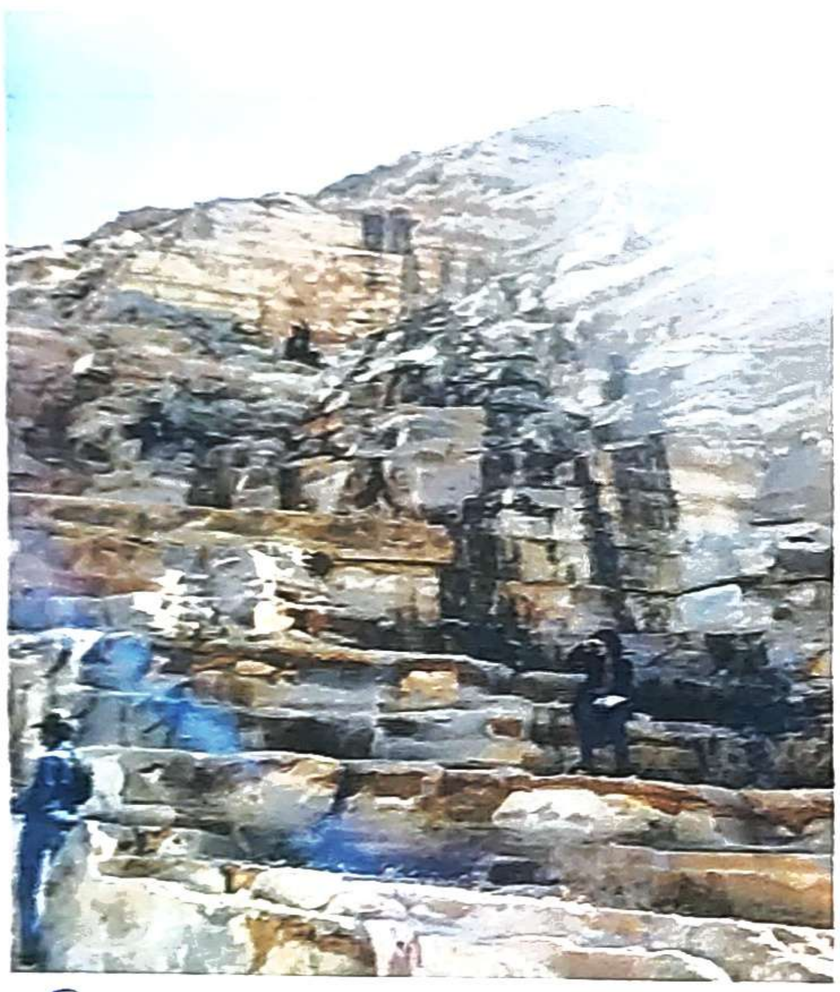

Fig 18 : QUARTZITE WITH JOINTS AND FRACTURES

Fig 19 : FERRUGENOUS AND SILICEOUS LAYERING SEEN IN QUARTZITE

Spot 3

This spot is behind Rudra Guda Patil Govt first grade college and the rock outcrop consists of sandstone which shows graded bedding and having sand sized grains with well defined grain boundaries. There is intraformational conglomerate seen within the sandstone. Grains which are present in between the conglomerate are syndepositional sedimentary structures. The sandstone shows cross bedding which is seen as pink and buff colored layers. The

intraformational conglomerate is an oligomictic conglomerate which is composed of quartz and has a clast size of 7-9 cm.

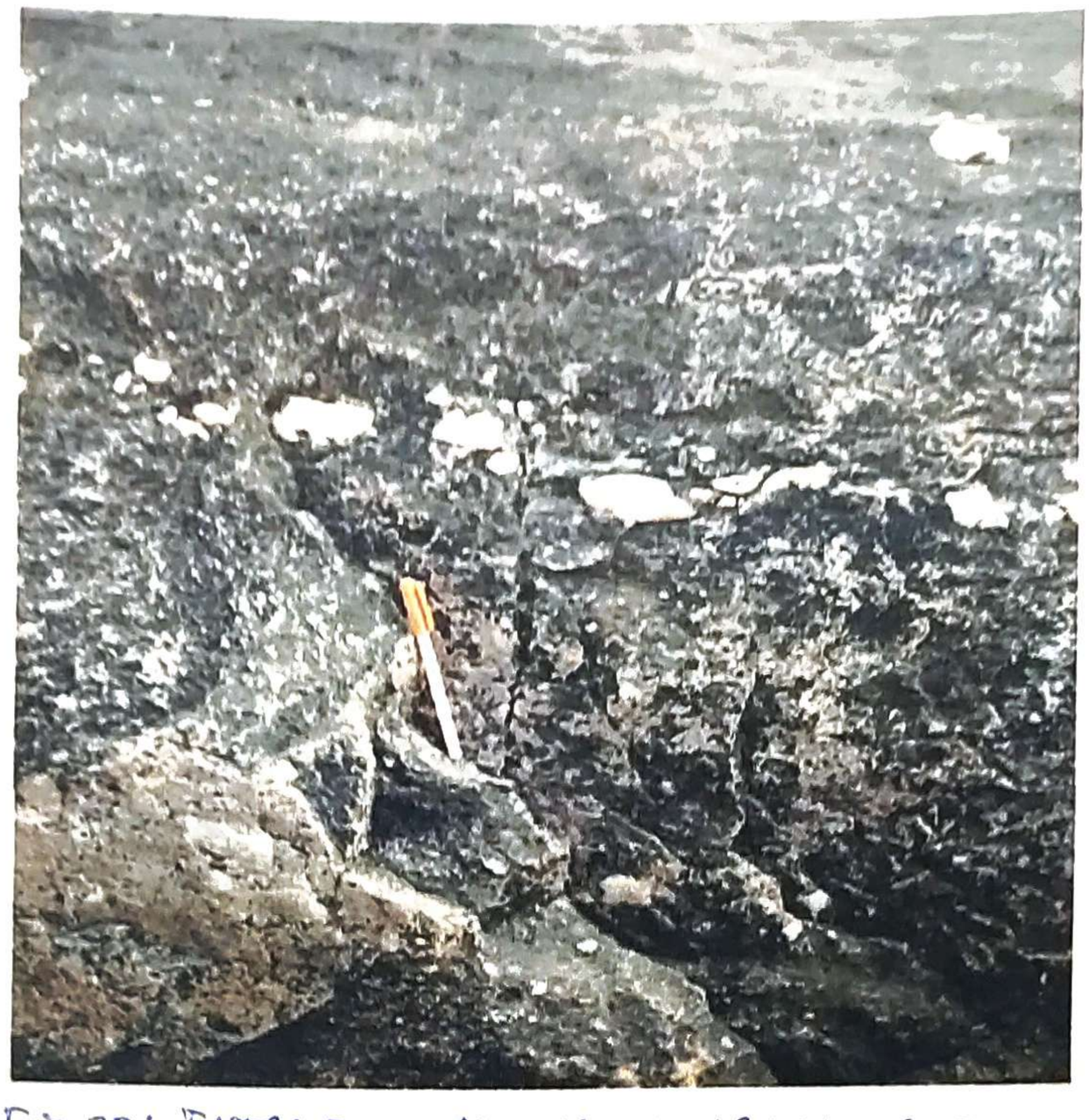

Fig 20: INTRA FORMATIONAL CONGLOMERATE IN SANDSTONE

Day 7 - (16th December 2022)

Spot 1: Bundanagad

Lat: 16°05'22'' N

Lon: 75°48'21''E

The rock exposure is that of quartzite which is jointed and fractured having joint sets perpendicular to bedding planes. The joint sets are striking N100, N220 and N226 directions. There are multiple veins seen in the rock trending in N55, N46, N49, N131, N136 directions; some of the veins are orthogonal to each other while other veins cross cut each other at an angle. The thickness of the veins varies between 8cm to 15cm. The veins are coarse, elongated and some veins have a comb structure which happens when the minerals grow perpendicular to the walls of the veins. The veins form as a result of extension and minerals fill into the gaps created; such veins are called Gash veins which are seen in the outcrop.

Fig 21: QUARTZITE HAVING JOINTS AND FRACTURES

Fig 22: GASH VEINS WITHIN QUARTZITE

Spot 2: few metres away from spot 1

Lat: 16°05'7'' N

Lon: 75°48'47''E

The rock outcrop is granite which is weathered. The granite is intruded by numerous quartz veins which vary in thickness from 1- 5cm. The veins are of 3 generations; Some of the quartz veins are curved and cross cut each other orthogonally while some intersect or cut each other at an angle. In some places there is displacement seen in the veins due to intrusion of another vein. There were joints which were seen in the rock having a trend of N40. There is also crenulation seen in the rock which tells us the direction of stress applied inorder to form these crenulations in the rock.

Fig 23: QUARTZ VEINS WITHIN WEATHERED GRANITE

Spot 3:

Lat: 16°05'8'' N

Lon: 75°48'48''E

The rock outcrop is that of a granite which is overlain by quartzite layer. The rocks were mostly boulders of granite which were fallen off from the higher elevated area. There were large xenoliths seen in rock which were dark in color of mafic composition. There are also veins present within the rock which show displacement along a shear zone. The granite is intruded into the rock.

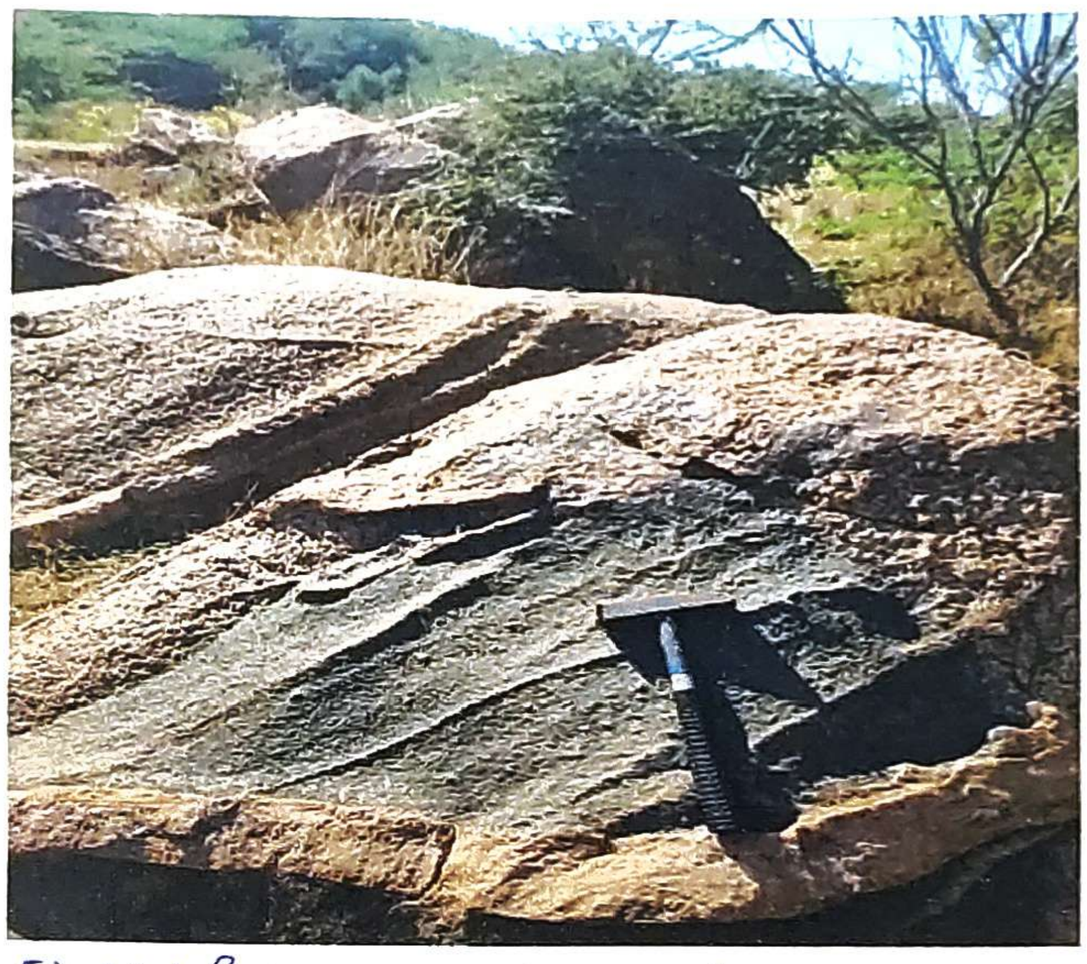

Fig 24: GRANITE OVERLAIN BY QUARTZITE LAYER

Spot 4: Murudi

Lat: 16°02'06'' N

Lon: 75°45'26''E

The rock outcrop is of white sandstones which were exposed near the canal. There were conglomerates also seen having clasts of BIF, jasper and quartz. These sandstones are the pure white sandstones which are seen as horizontal beds of the Badami group of rocks. Some of these sandstones contain clasts of basement rock and the Bagalkot group as it forms a contact with these formations by an angular unconformity.

Fig 25: WHITE SANDSTONES OF BADAMI

Spot 5: Kelawadi

Lat: 16°04'28'' N

Lon: 75°42'09''E

The rock outcrop which was exposed on the roadside was that of phyllite showing folds. The hardness of the rock is low and can break easily. The strike direction readings on one side of the road is N95, dipping 38 due south and N145 dipping 23 due south. The strike direction readings on the other side of the fold is N81 dipping 26 due NNW. The value of hinge is strike direction is N105; dipping 20 towards NNW.

Fig 26: FOLDED PHYLLITE LAYERS ON ROADSIDE

Day 8 - (17th December 2022)

Spot 1: Kagalkomb

The rock exposures are seen on the side of the road with quartz bodies on top and dolomite beds below. The quartz bodies appear vitreous with a concoidal fracture. The quartz bodies also contain joints which trend in the North East south west direction and the north south direction. There are tensional and extensional joints. There are veins seen in the rock which vary in thickness which are formed as the quartz get precipitated into the joints of fractures in the rock. The quartz bodies are horizontal which I indicative of younger Badami group.

Fig 27: QUARTZ BODIES WITH JOINT SETS

Spot 2: Lokapur

This rock outcrop consists of beds of steeply dipping dolomite beds which are highly weathered seen as we move downwards from the quartz bodies seen on top of the hill. The strike direction of these beds is N100; the dip direction of the beds is 190 and has a dip amount of 50. This dolomite belongs to the Bagalkot group which is indicative by the inclined series of beds.

Fig 28! STEEPLY DIPPING DOLOMITE BEDS

Spot 3: Konkankappa

The rock outcrop in this site consists of beds are horizontal. The strike direction of the bed is N86, dip direction is N180 and dip amount is 6. The rock has a slaty cleavage and is foliated, minerals are very fine to be identified. This rock gave effervescence on addition with dilute HCl which is indicative of carbonate in the rock. There is two set of joints which has a trend of N120 and 15. This rock is called the Konkankappa Limestone which belongs to the Katageri formation of the Badami group of rocks.

Fig 29: KONKAPPA LIMESTONE

Spot 4: Halkurki

Lat: 16°01'14'' N

Lon: 75°38'58''E

The rock exposed at this location are argillaceous, composed of clay minerals like Kaolinite, Bentonite, Montmorrilonite, illite, spessarite etc. The rocks are fine grained and the minerals can only be identified by methods like XRD used for analyzing the minerals present in the rock. There is a broad gentle warp in the lithology which is seen in the outcrop. In the previous location, the country rock was dolomite followed by limestone and then the shale indicating the movement from shallow to deeper part of the ancient sedimentary basin from dolomite (continental shelf) to shale (abyssal plains). This rock is the Halkurki shale of the Badami group which is Neoproterozoic in age.

Fig 30: HALKURIKI SHALE

Day 9 - (18th December 2022)

Spot 1: Lokapur

Lat: 16°10'06'' N

Lon: 75°21'32''E

The rock outcrop seen in this area is that of stromatolites which are deformed. The foliation planes are steeply dipping in the SW direction. The strike direction of the beds is N125 and s dipping 70° towards SW. The foliation is highly penetrative and the layers are intercalated by siliceous minerals. The strmatolites also contain the presence of impure limestone (marl) along with carbonate minerals. There are also alternating bands of CaCO3 rich and CaCO3 deficient minerals. These stromatolites belong to the kaladgi group of rocks.

Day 10 - (19th December 2022)

Spot 1: Near Almatti Dam area

Lat: 16°19'52" N

Lon: 75°53'17" E

The rock outcrop exposed in the area is that of Migmatite which is a basement rock formed around 3.6 billion years by melting of the Dharwar TTG gneisses. There were several generations of melts, granites and pegmatites produced which gave rise to rocks like coarse grained pegmatite, fine grained pink granite, fine grained grey granite, white colored granite, Banded gneiss and a dark colored rock which is the oldest rock in the area. There were also veins of pegmatite seen in the outcrop which are parallel to each other and were trending in the NW-SE direction. There are also joint sets which are seen in the rock having a strike of N144, N292, N302, and N215. Some of the joints are found to be filled with pegmatite veins.

Fig 32: MIGMATITE

Fig 33: CROSS CUTTING JOINTS IN MIGMATITE

Conclusion

The Kaladgi Basin in southwestern India is an intracratonic sedimentary basin with an Archaean basement and a Mesoproterozoic sedimentary cover that is deformed and overlain by relatively undeformed Neoproterozoic sediments separated by unconformities. The basement rocks of the Kaladgi basin consist of Archaean Peninsular Gneissic Complex (PGC), late Archaean Hungund Schist Belt (HSB) and granites (Closepet granite). The general trend of the HSB is 300°–310°, and it is defined by the regional schistosity of the metavolcanics and metapelites and the compositional banding of the BIFs which were seen at Ramthal on Day 2. The HSB, composed of Banded Iron Formations, quartzites, metapelites and mafic metavolcanics have undergone multistage deformation (D_1, D_2, and D_3 respectively) with the development of refolded plane-non-cylindrical folds, transposed compositional banding and schistosity, crenulation lineations – all of which developed during the D_1–D_2 stage. The Mesoproterozoic sedimentary cover of the Kaladgi Basin overlies the basement rocks and the basement–cover contact defines two types of unconformities. In the northern sectors, the sedimentary cover rocks overlie tectonically undeformed granite near Bilgi which was studied on day 6 where we saw rocks like sandstones having intraformational conglomerate, quartzite which had numerous joints etc which all overlie the Closepet granite and the contact is therefore a non-conformity. In the east, the Mesoproterozoic cover sediments overlie the deformed basement rocks of the Hungund schist belt which was seen near Ramthal on Day2, and the contact is an angular unconformity. Above the angular unconformity, sedimentary rocks of the Badami Group like the cave temple Arenite, Halgeri shale, Belikhindi arenites, Halkurki shale and Konkappa Limestone which were seen on Day 8. We also saw beds of sandstone on either side of the road where the beds on the south side of the road had a greater dip than the sandstone beds present on the North side of the road which were horizontal. The sandstones on the south side are that of the Hoskatti formation and the sandstones on the northern side of the road are that of the Kerul formation where both these formations are separated by an angular unconformity. Most of these rocks are concealed beneath the vast spread of Upper Cretaceous to Eocene basaltic lava flows of the Deccan Traps in the north and west.

References

- Dey, S. (2015). Chapter 19 Geological history of the Kaladgi–Badami and Bhima basins, south India: sedimentation in a Proterozoic intracratonic setup. lyell memoir, 13
- INDIA, G. S. (2006). GEOLOGY AND MINERAL RESOURCES OF INDIA. MISCELLANEOUS PUBLICATION NO. 30, 65.
- *Palaeoweathering, composition and tectonics of provenance of the Proterozoic intracratonic Kaladgi–Badami basin, Karnataka, southern India*. (n.d.). ScienceDirect.com. https://ars.els-cdn.com/content/image/1-s2.0-S1367912008001570-gr2.jpg
- *Geological map of Karnataka (After Radhakrishna and Vaidhyanadhan 2011)*. (n.d.). Researchgate. https://www.researchgate.net/profile/Radhika-Kn/publication/356940839/figure/fig1/AS:1115271905460226@1642912951200/Geological-map-of-Karnataka-After-Radhakrishna-and-Vaidhyanadhan-2011-along-with-GSI_Q640.jpg
- Mukherjee, M. K., Das, S., & Modak, K. (2016, June 11). *Basement–cover structural relationships in the Kaladgi Basin, southwestern India: Indications towards a Mesoproterozoic gravity gliding of the cover along a detached unconformity*. Precambrian Research. Retrieved January 17, 2023, from https://www.sciencedirect.com/science/article/abs/pii/S0301926816302017

References

- Dey, S. (2015). Chapter 19 Geological history of the Kaladgi–Badami and Bhima basins, south India: sedimentation in a Proterozoic intracratonic setup. lyell memoir, 13
- INDIA, G. S. (2006). GEOLOGY AND MINERAL RESOURCES OF INDIA. MISCELLANEOUS PUBLICATION NO. 30, 65.
- *Palaeoweathering, composition and tectonics of provenance of the Proterozoic intracratonic Kaladgi–Badami basin, Karnataka, southern India*. (n.d.). ScienceDirect.com. https://ars.els-cdn.com/content/image/1-s2.0-S1367912008001570-gr2.jpg
- *Geological map of Karnataka (After Radhakrishna and Vaidhyanadhan 2011)*. (n.d.). Researchgate. https://www.researchgate.net/profile/Radhika-Kn/publication/356940839/figure/fig1/AS:1115271905460226@1642912951200/Geological-map-of-Karnataka-After-Radhakrishna-and-Vaidhyanadhan-2011-along-with-GSI_Q640.jpg