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Study of Karst Topography Development in the Aranyak/Madarkonta Cave Area, Bastar Division, Chhattisgarh, India

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Abstract: *The study area belongs to Kanger formation of Indravati basin. The cave named as Aaranyak/Madarkonta cave is situated approximately 26km from Jagdalpur, Headquarter of Bastar Division. This cave is mainly developed in the limestone area. No systematic Geological study has been done regarding this cave. Therefore, an attempt has been made to collect proper and authentic Geomorphologic, Lithological and Structural information about the cave. The Coordinates of Aranyak/madarkonta cave are 18°56´2.51´´N, 81°51´33.01´´E. And it lies at altitude of 545m.above sea level. Hear we also observed some Stustural signature such as highly inclined Jagdalpur shale conglomerate outcrops, well jointed limestone formation, presence of tirathgarh fault and minor folding in Jagdalpur shale. Adjoining areas of Aranyak cave is mainly occupied by Kanger Limestone and overlying Jagdalpur shale belonging the Indravati group of Neo-Proterozoic age. From the mapping of the cave one more pattern which is being revealed is that most of the chambers are aligned is almost N-S direction and major joints and speleothems within the cave also are aligned in the same direction. Therefore, structural control during the cave development is quite is evident*.

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I. Introduction

Presence of thick carbonate rocks at or near the surface, presence of joints, movement of water upon the surface of exposed carbonate rocks and migration of surface water along the planes of weaknesses to the subsurface and pronounced solution activity are the prerequisites for any karst development. All of these activities ultimately lead to sub terranean turbulent flow and formation of gigantic chambers, tickling down of ground water through joints and formation of exotic speleothems in the carbonate rocks. All these structures are very well preserved in this region. Apart from that several parallel solution valleys, folds, faults and joints are common in this area. Indravati Basin usually does not show these kinds of structural peculiarities in most parts of the basin. Tirathgarh Sand stone, cherakur shale and sandstone, Kanger lime stone and Jagdalpur shale and dolomite members are usually undisturbed and undeformed and very gently dipping but in this region these members are highly disturbed i.e., Folded faulted and jointed. (Gupta, S., 2021)

II. Methodology

Our main objectives are collection of lithological, structural, fluvial, and speleological information. From the study of previous research papers, study of satellite imageries, and field visits; we collected lithological, fluvial, and speleological information, and also collected significant structural information which might have played vital role in the development of this relatively unexplored cave. Geological mapping of some significant portions have been done in 1:200 scale. speleological investigation has been done by the geological mapping of the underground cave. Speleological investigation includes direction, height, width, nature of roof and floor of different chambers and information regarding passageways have been collected, and underground speleothems study has been done. For the proper understanding of the ancient land form and processes involved our team has collected some valuable information. These findings may help to know much about the palaeogeography and developmental processes of the past. (Guhe, R.,2017)

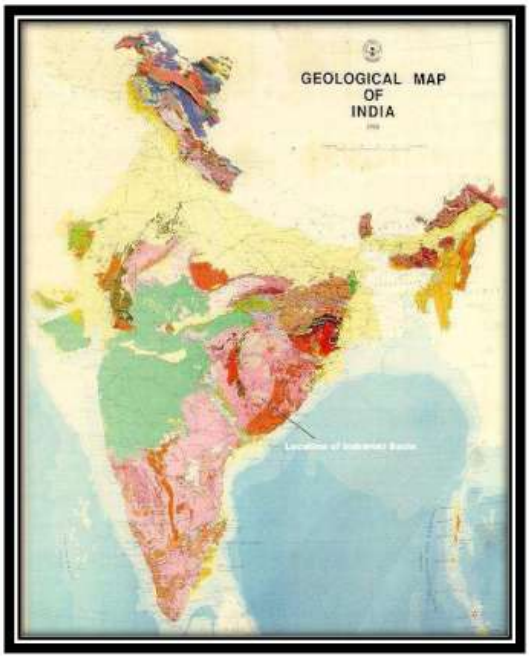
INDRAVATI BASIN

The Late Proterozoic (approximately 570 to 880 million of year back), Intra-cratonic Indravati basin has a roughly concentric distribution of ortho-quratzite –shale –carbonate suite resting non-conformably on the

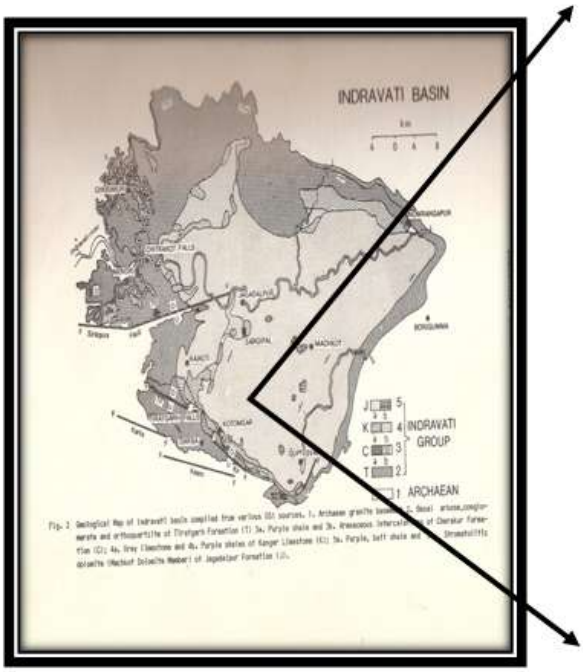
Archaean granitic (Granite is a coarse-grained igneous rock consisting essentially of quartz, alkali feldspar and mica) terrain of the Central Indian Craton. (Sankhyan, A.R, 2011)

Litho-stratigraphic analysis of the 500 m thick, flat –lying sediments have favoured a fourfold classification of the Indravati Group in to Tirathgarh and Cherakur formation, Kanger limestone and Jagdalpur formation in the ascending order. The Tirathgarh formation is divided into a lower Mendri Member (basal arkose and conglomerate) and an upper Chitrakot sandstone Member (quartz arenite). Cherakur Formation encompasses a shale sand stone facies derived from a modified definition of the older lithologic units. Kanger limestone is broadly divisible into three informal units of lower, middle and upper members. Jagdalpur formation is predominantly shaly with stromatolitic (Stromatolytes are organosedimentary structures; they were formed in the Indravati Basin during Neo-proterozoic period 1100-700 million years back, when this portion was occupied by shallow sea water. Intertidal palaeo-environmental condition favored the luxuriant growth of blue green algae and as a consequence of it favored the formation of massive stromatolytic features in this region.) dolomite mounds of the Machkot Dolomite Member. (Shah, R.A.,2018)

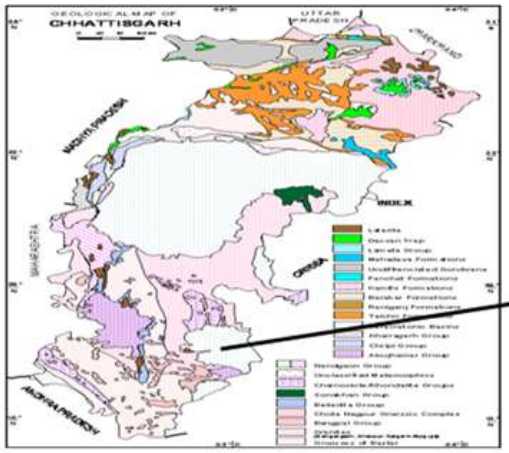
These lithologies are grouped into five sedimentary facies representing a shallow shelf with relict shoreline facies, near shore heterolithic facies and carbonate platform facies, finally culminating in a muddy to carbonate tidal flat. Inter tidal environments have not yet been demonstrated for the lower terrigenous clastics of Indravati Group. Pro-grading shelf to shore profile typical of the modern beach face was also not identifiable. These sedimentary facies, therefore, favour a shallow shelf sea depositional model for the Proterozoic Epeiric Basin. The Indravati and Sukma basin represent faulted and eroded remnants of the Bastar Chattisgarh Super Basin. It links with the Purana basin of Cuddapah, Kaladgi and Pakhal remain to be explored. This super basin appears to have evolved by crustal down warping associated with the anorogenic thermal event of the continent around 800 Ma after the ressation of the Satpura Cycle. (Jha, A.S.,2015)



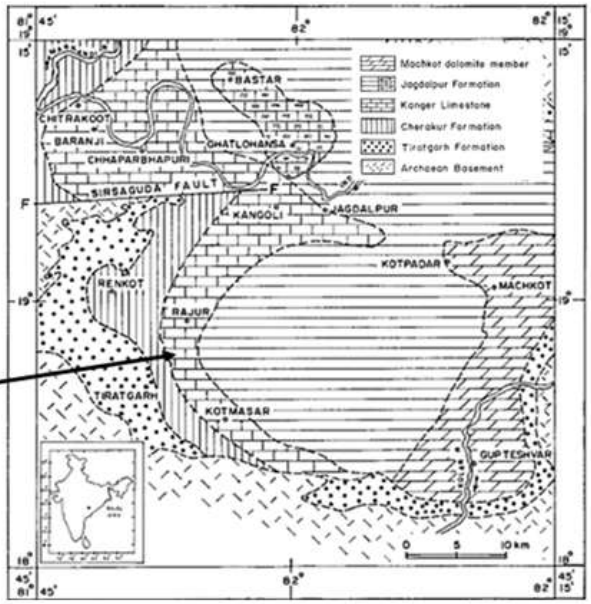
LOCATION OF THE INDRAVATI BASIN IN MAP OF INDIA



GEOLOGICAL MAP OF INDRAVATI BASIN



LOCATION OF THE STUDY AREA IN INDRAVATI BASIN



GEOLOGIACAL MAP OF INDRAVATI BASIN AFTER MAHESHWARI et al. (2005)

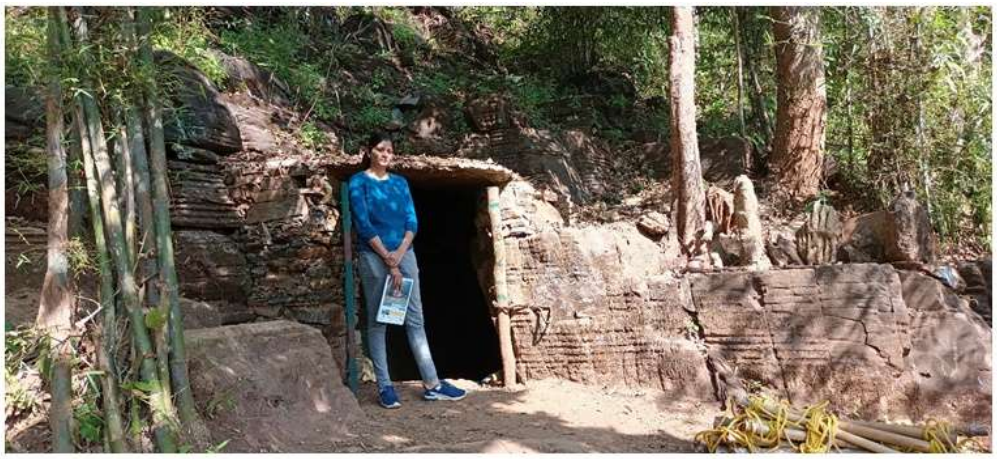
LITHOSTRATIGRAPHY

In the present state of stratigraphic knowledge of Indravati basin, however, it is expedient to adopt a more flexible approach, keeping in view the fundamental guiding principle of nomenclatural stability and clarity of defined units, while leaving sufficient room for later detailed classification. The current stratigraphic revision is backed by the geological map of the entire basin (Fig. 2) (Ramakrishna, M., 1987)

STRATIGRAPHICAL COLUMN OF INDRAVATI BASIN	
Jagdalpur Formation(200m)-	**Purple shale with purple and grey stromatolitic dolomite (Machkot Dolomite Member).**
Kanger Limestone (150-200m)-	• **Purple limestone and shale** • **Grey limestone**
Cherakur Formation-	**Purple shale with arkosic sandstone, chert, pebble, conglomerate, grit**
Tirathgarh Formation-	• **Upper Member-Quartz arenite (Chitrakot Sandstone Member)** • **Lower Member - Subarkose and conglomerate (Mendri Member)**
Granite and Supracrustals	

STUDY AREA

The Aranyak cave is nearly 26 km away from the Jagdalpur city on Jagdalpur – Sukma road. One has to take a turn from the Neganar village. study area covers the toposheet no. 65F/13. The entrance coordinates of Aranyak cave are 18°56´2.51´´N, 81°51´33.01´´E and it lies at altitude of 545 m. above sea level. Here we also observed some structural signatures such as highly inclined Jagdalpur shale, conglomerate outcrops and well jointed limestone formation, presence of tirathgarh fault and minor folding in Jagdalpur shale. This cave developed in the limestone member of Kanger limestone formation belonging to the Indravati group of neo-Proterozoic age. This cave system indicates extension of karst landscape beyond the Kanger national park region. Mentioned cave is not very famous but several names have been given to this cave, a few names are Rani cave, Aranyak cave, Mal cave, madarkonta cave.



ENTRANCE OF CAVE

SPELEOTHEMS

INFORMATION ABOUT CAVE

Topography

Several isolated patches of hillocks and ridges are spread all across the region. Apart from that karst topography is clearly evident in this area. several ridges of different dimensions are seen in this area. The first ridge strikes ENE and WSW direction. Dimension of this ridge is 415 m length and 100 m width and cave lies in this ridge. Second ridge strikes parallel to the first ridge. Dimension of this ridge is 424 m length and 95 m width. Third ridge strikes parallel to the first and second ridge. Dimension of this ridge is 470 m length and 75 m width. Lineament of several solution valleys and ridges indicates presence of some kind of structural control. Apart from that very interesting arrangement of rectangular arrangement of solution valleys is clearly seen is this region.

SATELLITE IMAGERY OF THE AREA

A tributary is flowing in the WNW and ESE direction which is adjacent to the Aranyak cave probably this tributary controlled by some (tirathgarh fault) structural lineament. Alluvial deposits in the foot hill of the cave and presence of tributary indicates that this tributary is responsible for the subterranean flow inside the cave in the geological past and now it has shifted to the present position (18°56´0.58´´N, 81°51´28.69´´E)

ALLUVIAL DEPOSIT

Lithology

Adjoining areas of the Aranyak cave is mainly occupied by Kanger limestone and overlying Jagdalpur shale belonging the Indravati group of neo- Proterozoic age. Limestone is thick bedded and well jointed and mainly gray coloured but a section near road cutting located in 18°56´9.30´´N, 81°51´13.79´´E coordinates, which is white coloured. (Ruggieri, R., 2011)

Contact of Kanger limestone and Jagdalpur shale is seen 18°57´25.49´´N, 81°51´4.73´´E. Jagdalpur shale is thin bedded, loose, friable and weathered. Structural signature such as folding, faulting and jointing is seen in the approach road to the Aranyak cave.

a) Folding is seen in the Jagdalpur shale along a road cut the geographic location 18°57´25.65´´N, 81°51´3.07´´E

b) Faulting is seen in an approach road 18°56’4.36’’N, 81°51’48.68’’E in the Jagdalpur shale.

A very interesting feature; a pocket of well cemented fragments of sand stone and shale (polymictic conglomerate) is seen along the river Bank near the cave. Location --18°55´57.25´´N, 81°51´33.63´´E

CONGLOMERATE

LIMESTONE

Structures

The Karst topography developed in this region has close relationship with the various structural events which took place inside and outside this cave. (Gautam, P.K., 2014)

A) STUCTURAL INFORMATON GATHERED NEAR THE CAVE

I) INCLINED BEDS (JAGDALPUR SHALE)

S. No.	ALTITUDE	LOCATION	STRIKE DIRECTION	DIP	
				DIP DIRECTION	DIP AMOUNT
1.	592	N 18°57'25.49'' E 81°51'4.73''	170°-350°	260°	3°
2.	615	N 18°56'21.79'' E 81°51'57.76''	130-310°	40°	7°

INCLINED BEDS (JAGDALPUR SHALE)

II) CONTACT OF KANGER LIMESTONE AND JAGDALPUR SHALE
GPS LOCATION- 18°57´25.59´´N, 81°51´4.28´´E, ALTITUDE-595

III) FOLDS

FOLD-I

G.P.S. LOCATION	**FOLD AXIS**	**DIP DIRECTION**		**DIP AMOUNT**	
		Right Limb	**Left Limb**	**Right Limb**	**Left Limb**
18°57´25.65´´N, 81°51´3.07´´E Altitude- 595	180-0	90	270	38°	38°

FOLDING IN JAGDALPUR SHALE

FOLD-II (MAJOR FOLD IN JAGDALPUR SHALE)

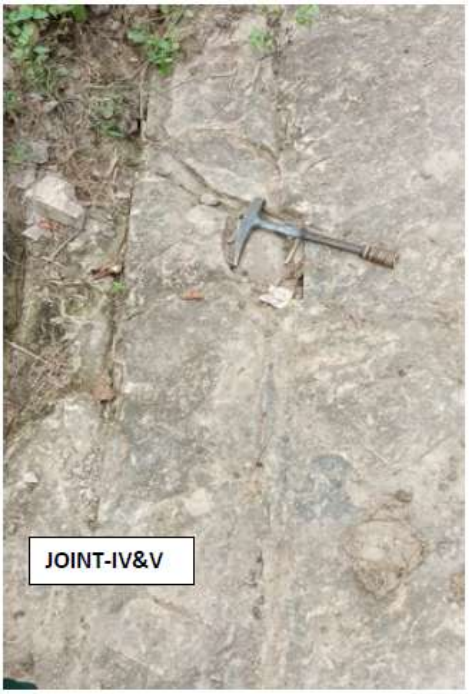
G.P.S. LOCATION	FOLD AXIS	DIP DIRECTION		DIP AMOUNT		JOINTS ASSOCIATED WITH FOLD TENDS
		Limb-I	Limb-II		Limb-II	I)60°-240°
18°56'14.95" N 51°51'51.52'' E Altitude - 560	270°-90°	0°	180°	20°	12°	II)70°-250°

FOLD-III (MINOR FOLD IN JAGDALPUR)

G.P.S. LOCATION	FOLD AXIS	DIP DIRECTION		DIP AMOUNT	
		Limb-I	Limb-II	Limb-I	Limb-II
18°56'13.96'' N 81°51'51.57" E Altitude-557	335°-155°	245°	65°	20°	12°

FOLD-IV (MAJOR FOLD IN JAGDALPUR)

G.P.S. LOCATION	FOLD AXIS	DIP DIRECTION		DIP AMOUNT		JIONTS ASSOCIATED WITH FOLD TRENDS
		Limb-I	Limb-II	Limb-I	Limb-II	I)270°-90°, II)250°-70°, III)240°-60°
18°56'12.72'' N 81°51'51.08" E ALTITUDE- 551	90°-270°	15°	180°	20°	10°	IV)265°-85° V)335°-150°



IV) OTHER JOINTS SETS (VERTICAL JOINTS IN JAGDALPUR SHALE)
G.P.S. LOCATION- 18°56'8.83''N, 81°51'52.46'' E
ALTITUDE-546
TRENDS -----I) 150°-330°, II) 90°-270°

V) FAULTS

- **POSSIBLE FAULT LINE SCARP AND CONTACT OF SHALE AND LIMESTONE**
  GPS LOCATION- 18°56'4.36''N, 81°51'48.68'' E
  ALTIDUDE- 527, TREND- 330°-150°

- **FAULT II (TIRATHGARH FAULT)**
  GPS LOCATION- 18°55'54.91''N, 81°51'25.21'' E
  ALTIDUDE- 518

DISLODGED PORTION OF TIRATHGARH SANDSTONE

TIRATHGARH FAULT

B) STRUCTURAL, GEOLMORPHOLOGICAL AND LITHOLOGICAL INOFORMATION INSIDE CAVE

I) JOINTS

LOCATION- GALLERY	JOINTS	TRENDE
CHAMBER 1	1.	170°-350°
	2.	262°- 82°
CHAMBER 2	1.	N-S
	2.	265°-85°
CHAMBER 3	1.	65°-245°
	2.	30°-210°
	3. MAJOR JOINT. STALACTITE ASSOCIATED WITH THIS JOINT	250°-70°
CHAMBER 4	1.	185°-5°
	2. MAJOR JOINT. STALACTITE ASSOCIATED WITH THIS JOINT	260°-80°
CHAMBER 5	1.	180°-360°
	2.	68°- 248°
	3.	85°-65°
FROM 5TH CHAMBER TO PASSAGEWAY	1.	20°-200°
	2.VERTICAL JOINT	130°-310°

II) GEOMORPHOLOGY

Stalactites, Solution Holes, and Drip Stones/Cave Columns all these speleothems are very common in this cave.

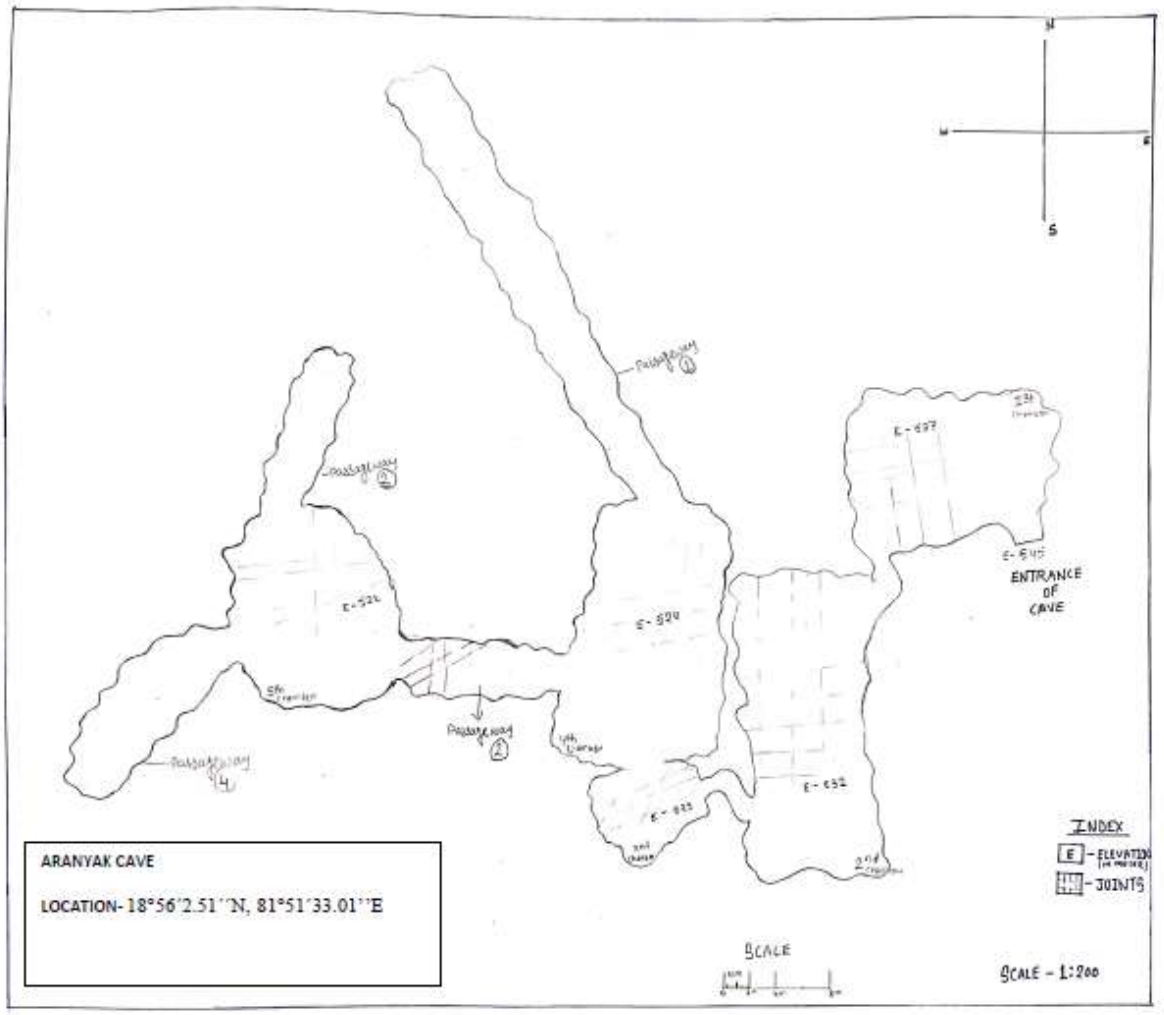
III) LITHOLOGY

HORIZONTAL BEDS – Thick horizontal limestone beds are seen in the cave

INTERCALATED SHALES- Intercalation of limestone and calcareous shale is very evident in this cave. Approximately 1 cm thick shale is observed.

INTERCALATED SHALES IN LIMESTONE

DIAGRAM OF CAVE



Speleological information: - information regarding, direction, height, width, nature of different chambers and passages have been collected and an underground speleological study has been done.

INFORMATION ABOUT THE CAVE

Probably this is the very first serious attempt to map this beautiful cave. This cave is made up of several chambers and interconnected passageways.

The cave entrance is connected with a chamber. This first chamber is nearly 13.90 meters length. Its maximum width is nearly 11 meters and lies at an altitude of 537 from M.S.L. This chamber has prominent joints in its roof. The first joint trends 170°-350 direction and second joint aligned in 262°-82°direction. A cave pillar is also developed in this chamber. One interesting feature which is also associated with this chamber is the presence of a solution hole like structure in its roof. (Ruggieri, R., 2011)

CAVE PILLAR

ROOF SOLUTION HOLE AND JOINTS

The second chamber is somewhat low laying and has an altitude of 532 meters from the M.S.L.; it has a length of 22 meters and maximum width is 8 meters. This chamber strikes almost N-S direction and has prominent joints in its roof. Joints have the following trends: -
The first joint trends almost N-S, and second joint trends 265°-85°. A cave pillar and stalactites developed along joints in this chamber.

CAVE PILLAR

JOINTS AND STALACTITES

The third chamber has an elevation of 529 meters from M.S.L. The length of this chamber is 8.2 meters and maximum width is nearly 5.9 meters. This chamber strikes 250°-70°. This chamber has several joints in its roof. The first joint trends 65°-245, second joint trends 30°-210°, and third joint which is major joint trends 250°-70°. The joint which trends 250°-70° has developed very beautiful and prominent stalactite. And interesting feature also associated with this chamber is solution hole like structure in its roof which is almost maximum 6ft long.

LONG ROOF SOLUTION HOLE

STALACTITE

The fourth chamber has an elevation of 524 meters from M.S.L. The length of this chamber is 20.05 meters and maximum width is nearly 11.25 meters. This chamber strikes 10°-190°. This chamber has joints in its roof. The first joint trends 185°-5°, second joint trends 260°-80° which is major joint and very beautiful and prominent stalactite developed in this joint.

The fourth chamber has two passages. One prominent passageway is aligned in 330°-150° direction. This passage has length of 38.2 meters whereas it has 3 meters width. Second passageway connects this chamber

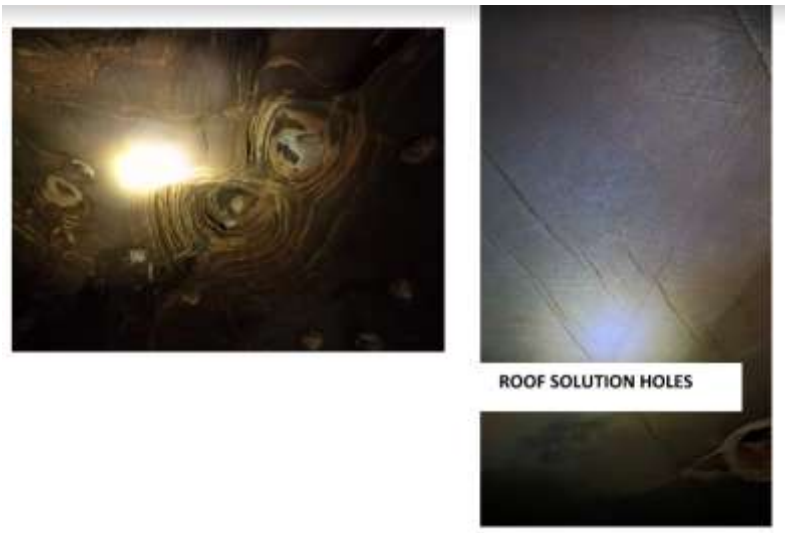
with the fifth chamber. This passageway has 11.95. meters length and 3.8 meters width. Here percolation of ground water is very evident and beautiful speleothems are forming.

JOINTS

STALACTITES

PERCOLATION OF GROUND WATER

The 5th chamber has an elevation of 522 meters from M.S.L. The length of this chamber is 14.4 meters and maximum width is nearly 12.65 meters. This chamber strikes 240°-60°. This chamber has several joints in its roof. The first joint trends 180°-360°, second joint trends 68°-240° and third joint trends 85°-65°. Here solution holes like structures are present in its roof.



JOINTS

The fifth chamber also has two passages. One passageway is aligned in 20°-200° direction. This passage has length of 11.1 meters whereas it has 3 meters width. Second passageway is aligned 40°-220°. This passageway has 15 meters length and 7 meters width.

Conclusion

On the basis of the study of satellite imageries, previous geological maps of this area, detailed field work and collection of structural, lithological and geomorphological information; we conclude that-

- The Parallel alignment of limestone ridges, valleys, presence of joints, folds, and faults indicates some kinds of structural control.
- Geological mapping of this cave indicates presence of several chambers and heights of these chambers varies from 545meters- 522meters. In our view; probably solution action might have made more space in the down flow side of the cave and some small waterfalls might have formed within this cave. This kind of small waterfalls are not uncommon in the formative stages of the cave development.
- From the mapping of the cave one more pattern which is being revealed is that most of the chambers are aligned in almost N-S direction and major joints and speleothems within the cave also are aligned in the same direction. Therefore, structural control during the cave development is quite evident.
- The major Tirathgarh fault trending WNW-ESE direction lies hardly 500 meters away from this cave. And adjoining river also following the same trend. Here Tirathgarh sandstone member forms a ridge which indicates up throw movement in comparison to the Kanger limestone. Nearly 200 meters away from the cave there is an abrupt contact of Kanger limestone and Jagdalpur shale which indicates step fault like signature near this cave. Apart from that, adjoining areas are folded and very well jointed. All these structural evidences support the vital role of structural events and related forces during the origin and development of this karst topography.

SATELLITE IMAGERY OF AREA

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