# Knowledge-Driven Approach to Finding the New Potential Area for Base Metal Mineralization around Potulapalle Area in Cuddapah Basin

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Abstract

The area is mostly covered by rocks belonging to Cuddapah Supergroup of Meso-Proterozoic to Neo-Proterozoic in age. The study area forms part of the Chitravati Group, where quartzite, shale, chert, dolomite and siltstone of the Tadpatri Formation are exposed along with basic sills and acid volcanics. Knowledge and data-driven approaches are two major methods used to integrate various evidential maps for mineral prospectively mapping (MPM). Geological maps, geochemical data and geophysical data of toposheet no 57J/6 nearby mudunuru area Andhra Pradesh was used to generate mineral potential map and this method helps in identifying prospective areas in terms of mineralization. Moreover. In addition, it has been found that the mineral predictive map generated using weighted overlay Analysis

**Keywords : Tadpatri Formation, Geographic information system (GIS), basic sills, Chitravati Group, Cuddapah super group , Mineral prospectivity mapping (MPM)**

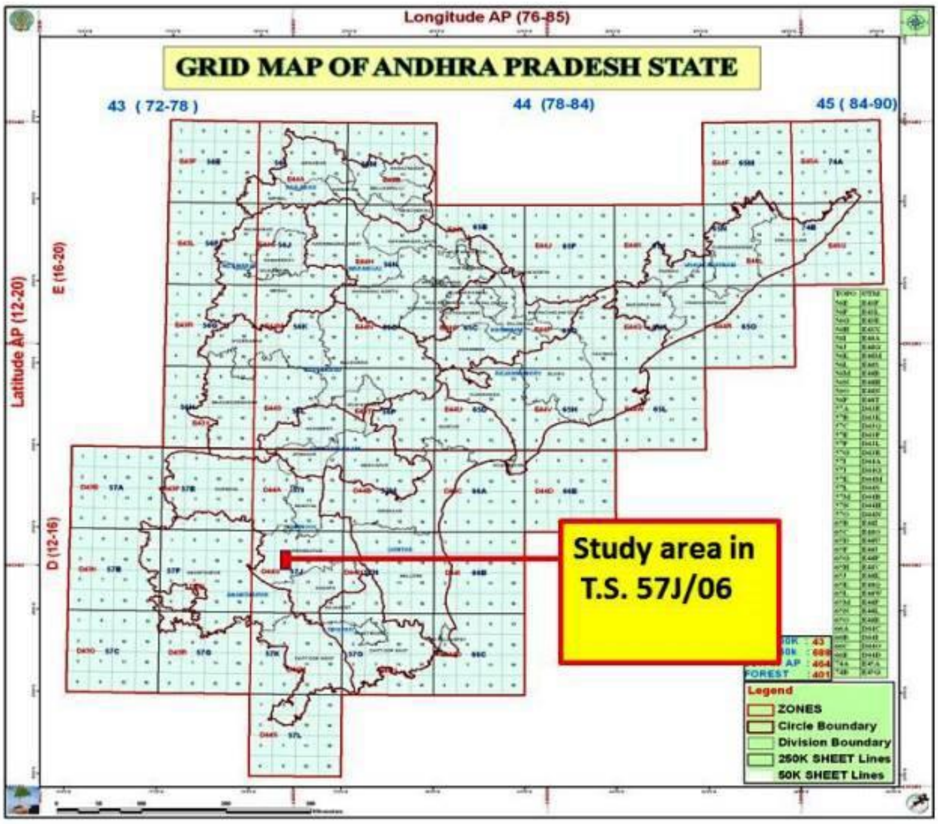
## INTRODUCTION :

Mineral exploration is a sophisticated process that seeks to discover new mineral deposits in an area of interest. Mineral prospectively mapping (MPM) is used as a tool to delineate target areas that most likely contain mineral deposits of a particular type. Knowledge and data-driven are two major types of approaches, which assign evidential weights and integrate various evidential maps for MPM. Examples of data Mineral prospectively mapping with weights of evidence and fuzzy logic methods driven methods include weights-of-evidence, fuzzy weights-of-evidence, logistic regression, neural networks, Bayesian networks, and support vector machines. In knowledge-driven techniques. Importance of spatial evidence as meaningful decision support. Several mineral potential mapping methods are classified as knowledge-driven techniques, including Boolean logic, index overlay, fuzzy analytical hierarchy process

**GEOLOGY :**

(I) The area falls under Toposheet no 57J/6 falls in the Cuddapah district of Andhra Pradesh. The area lies between the North latitudes 14°31'20'' to 14°38'00'' and East longitudes 78°19'08'' to 78°24'00''.. The area is approachable from Muddanuru railway station situated in broad gauge line of South Central Railway. Tadipatri-Muddanuru- Chittoor railway line passes through the north central part of the toposheet. The area is well connected by State Highways like Tadipatri- Cuddapah and Jamalamadugu- Pulivendula. Both the highways intersect at Muddanuru which lies in the north central part of the toposheet. Muddanuru, Mallela, Thondur, Mangapatnam and Chilamakuru are the important places

**Figure 1: Figure 1: Location map of the Study Area**



(II) Regional geology

The study area is covered by rocks belonging to Cuddapah Supergroup and Kurnool Group of Meso-Proterozoic to Neo-Proterozoic in age. Cuddapah Supergroup in this area is represented by rocks belonging to mostly Chitravati Group followed by Kurnool Group. The geology and stratigraphy of the Cuddapah. and Kurnool Groups is discussed in detail by Nagaraja Rao et al. (1987).

**(III) Geology of Study Area**

The Tadpatri Formation is usually under a cover of either a black cotton soil or a brown loamy soil ranging in thickness from a few centimetres to 3 metres. The shale in the lower part is devoid of arenaceous intercalations, whereas they are prominent in the upper part. Greenish black chert, and jasper associated with chert and porcellanite, varying thickness from a few centimeters to as much as 50 cm, are present as thin bands in this sequence. A brownish chert breccia, the resultant of penecontemporaneous deformation is present in the locality north of Rajupalem. Bands of white to brownish, medium-grained, thick bedded quartzite are noticed to form miner ridges at Cherajupalle, south of Nidizuvvi and Kottapalle. They are intruded by dolerite sills at Cherajupalle. Tadpatri Formation comprises of shale, dolomite / limestone and basic flows. A large extent of the area is occupied by Tadpatri shale which is brown, purple and grey coloured, splintery in nature with intercalations of quartzite at places. Dolomite / limestone are occurring along with basic flows in NE and NW part of Mallela village. Quartzites occur in the area to the west of Uppaluru and east of Chirajupalle.

A large number of sills, varying in thickness from about a metre to 50 metres, intruding the argillaceous pile of rocks have been recognised. The mafic sills within the Tadpatri Formation occur at various stratigraphic levels. The thicker sills form NW-SE trending ridges with steep slope towards south and very gentle slope towards north. From south to north, intervening areas in between the successive ridges are characterised by low grounds which are chiefly occupied by shale. The differentiated sills in the lower part of the Tadpatri Formation, the doleritic sills at different stratigraphic horizons and basaltic sills in the upper part of the formation have been identified by a number of workers (Reddy, 1989; Lakshminarayana et al, 2001; Chatterjee and Bhattacharji, 2001; Anand et al, 2003; Sesha Sai, 2011, Mukhopadhyaya and Chakraborty, 2012 and references therein). Based on mineralogy and texture, at least five different types of gabbro/dolerite sills have been recognised within the Tadpatri Formation (Mukhopadhyaya and

Chakraborty, 2012). These basic sills/ bodies also bear signature of sulphide mineralisation at places.

The area forms part of the Chitravati group and the different lithologies recorded during the course of fieldwork are quartzite, shale, chert, acid volcanics, dolerite, trachytoid gabbro, dolomite, siltstone. These rocks are intruded by quartz and carbonate baryte veins of later phases. The quartz and carbonate baryte veins are very thin and unmappable at most of the places.

**i) Shale** The shale in the lower part is devoid of arenaceous intercalations, whereas they are prominent in the upper part. Greenish black chert, jasper associated with chert and porcellanite, varying thickness from a few centimetres to as much as 50 cm, are present as thin bands in this sequence. Signatures of contact metamorphism observed in brownish purple shale near Chinnakattaripalle , Potulapalle, , near Mallela and Thandaplli.

**ii) Chert** is a cap rock over the shale it occur as thin band over the shale .near Chinnakattaripalle a band of chert is observed which was folded and huge variation of dip amount observed in the chert band

**iii) Basic sill**

3 variant of Basic sill were identified in the study area .

a) Dolerite dolerite sills are composed of clinopyroxene and plagioclase with minor proportion of magnetite and chalcopyrite . the texture is medium grained sub ophitic . chloritisation of pyroxene and sassuritisation of plagioclase were observed in thin section as wellas in hand specimen.

Figure 2A)Dolerite outcrop near cherlopalli with quenched margin B) Sub ophitic texture

b) Fine grained Dolerite these sill are constituted of pyroxene and plagioclase with minor magnetite the texture is fine grained intergranular dominantly. some subhedral grain of pyroxene were observed they were highly altered to chlorite

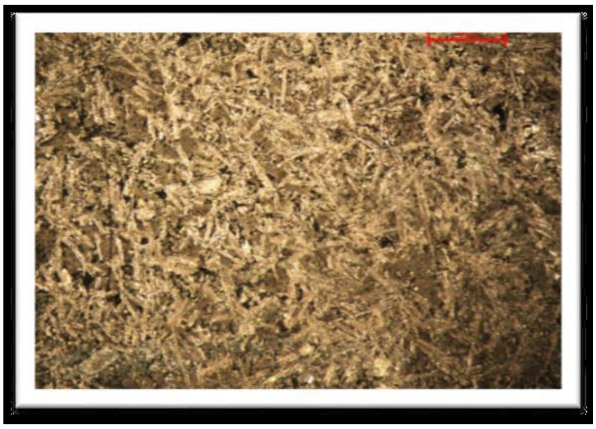
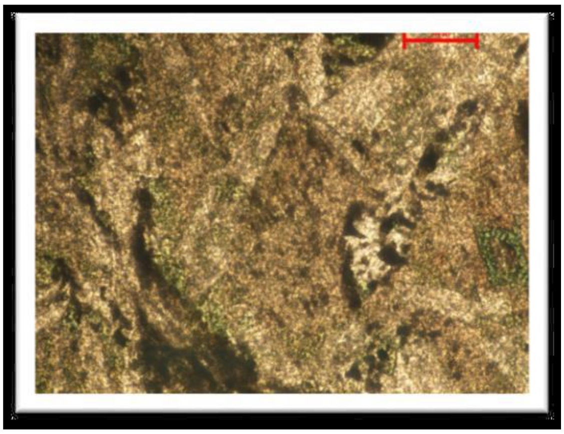



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Fig 3A) Pictomicrograph of Fine-grained Dolerite B) Intergrannular texture in fine grained dolerite

c) Trachytoid Gabbro the sill is constituted of plagioclase ,pyroxene,medium to coarse grained plagioclase laths show preferred alignment defining trachytoid texture and representing magmatic foliation .the rock show chloritisation of pyroxene and sassuritisation of plagioclase.minor quartz also present .


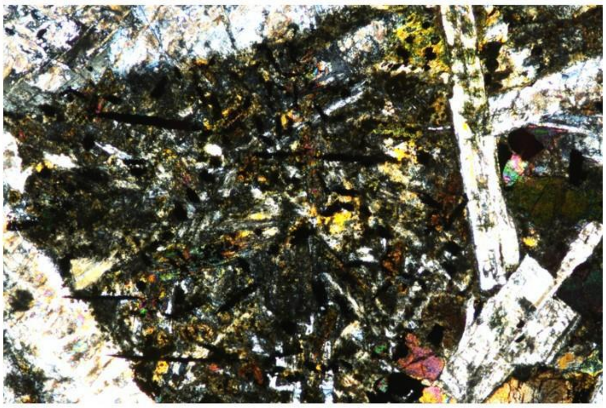

Figure 4A) photograph of trachytoid gabbro from chinnakattaripalli B) petrographic image of trachytoid gabbro

iv) **Carbonate-barite vein** carbonate and barite veins were intruted within the trachytoid gabbro which has sulfide mineralisation like galena, chalcopyrite etc. some asbestos and actinolite association with veins indicate low grade metamorphism.

v) **Dolomite** pink to grey colour carbonate rock which show positive reaction with acid some band of acid volcanic were present in the dolomite indicate that at peak time of carbonate deposition this acid volcanics comes into pictutre. spherulitic balls were common structure in the dolomite.

vi) **Acid Volcanics** The typical pyroclastic rocks generally contain more than 75% by volume of pyroclastic fragments; the remaining materials are generally of epiclastic, organic, chemical sedimentary or authigenic origin. Therefore, bedded tuff has been observed carefully to differentiate on the basis of an average pyroclast size of 1–0.5 mm embedded on fine clay size groundmass. In the study area, most of the fine grained tuffaceous shale are confirmed and demarcated as volcano sedimentary sequence and differentiated from sedimentary non-volcanic shale on the basis of detail field observations Spherulites, lithophysae and thunder eggs have been found at places (e.g. Chinnakattaripalle, Mallella, etc.). Spherulites are typically rounded or spherical aggregates of acicular crystals radiating from a single point. Lithophysae are generally radial or concentric cavities that is hollow, or partly to completely filled with later minerals and are associated with spherulites.

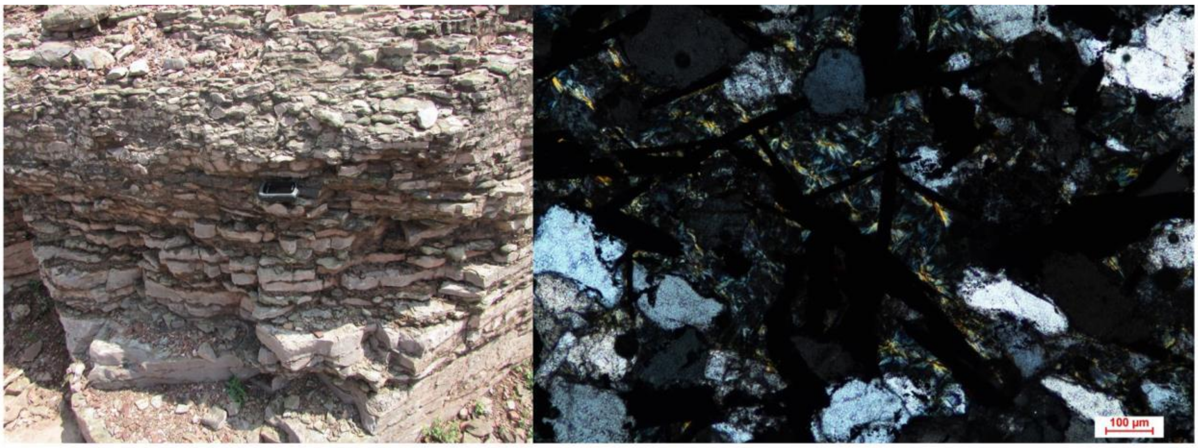


Fig 5A) Spherulitic dolomite outcrop near chinnakatarri palli B) petrographic image of Spherulite

**Gandikota Formation:** The Gandikota Formation overlies Tadpatri Formation, extends in NW direction from NE of Muddanuru to Petnikota, with a distance of 65 km. It is comprised of intercalated purple shales, within thick bedded orthoquartzites and ferruginous quartzites and succeeded by the main unit of Quartzite which gives the range its present configuration. The lower most beds are purple or flesh coloured quartzite containing thin beds of

orthoquartzites. These are succeeded by purple shales, ferruginous quartzites and orthoquartzite. Except orthoquartzite, all other units bear glauconite. The shale-quartzite intercalated succession is overlain by a major current bedded orthoquartzite which often weathers into number of pinnacles. This quartzite is succeeded by ferruginous quartzite and finally by a purple, khaki brown splintery siliceous shale. This shale unit pinches off in the NW direction indicating its lentoid nature, within the quartzite. This shale unit is also glauconite bearing

## METHODOLOGY

A group of methodologies applied in optimal site selection or suitability modelling is referred to as overlay analysis. It is an approach for assigning a common scale of values to varied and dissimilar inputs to create an integrated analysis. Suitability models define the best or most preferred locations for a specific phenomenon. Overlay analysis most often entails the examination of many different factors. For instance, selecting a site suitable for Base metal mineralization means assessing parameters relevant to Cu & Ni mineralization within the locality. Such parameters may include lithology, geochemical data, and geological structures among others. The factors in the analysis may not have equal importance. Geochemical Data may show a good correlation to base metal mineralization than the distance to geological structures. The importance of these parameters is determined by the modeller and shown as weights that sum up to 100% or 1. Since the input criteria, and layers will be in different numbering systems with different ranges, to combine them in a single analysis, each cell for each criterion must be reclassified into a common preference scale such as 1 to 10, with 10 being the most favourable. An assigned preference on the common scale implies the phenomenon's preference for the criterion. The preference values are on a relative scale. That is, a preference of 10 is twice as preferred as a preference of 5. The preference values not only should be assigned relative to each other within the layer but should have the same meaning between the layers.

weighted average of map/ spatial layer Score can be calculated from the formula given below

Xi = spatial layer /map score

Wi = weight of the spatial layer or map

N= number of spatial layer or map

$$W^{total} = \sum_{i=0}^{n} \frac{Xiwi}{N}$$

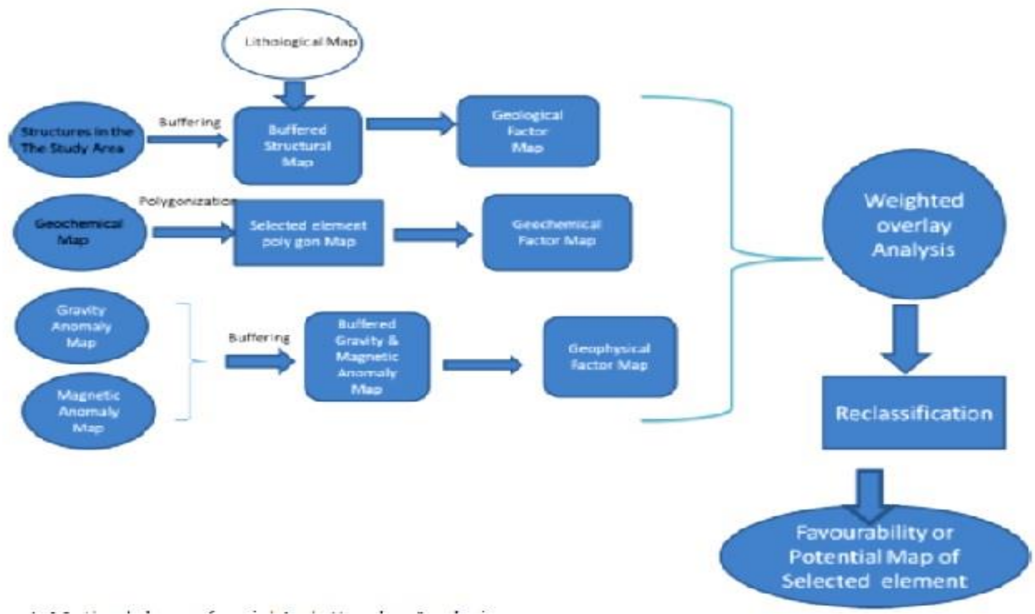


Fig 6:Methodology of weighted Overlay Analysis

**1. Geological database**

Lithology in the geological map is given a weight and the geological map has its own weight in contribution toward the mineralization, as per knowledge from earlier deposit amount of buffer given to selected structural features and it has its own weight for mineral prospectively

**2. Geophysical Map:** geophysical spatial map has its contribution in mineral prospectively in form of Gravity and magnetic anomaly and both have equal weightage toward the contribution of mineral prospectively because barite quartz vein has specks of chalcopyrite, pyrite and other sulfide-bearing minerals

**3. Geochemical Maps**

In the case of the geochemical factor map, most of the anomalous cells in the geochemical map contribute toward the prospective anomalous zone by the use of Thiessen polygons anomalous Cu (copper) and Ni (nickel) zone were buffered. and the desired polygon was extracted .

Table 1: lookup table for Score and weight of Layers and maps

| Factor Map /spatial layer | Map | Components of Map | A score of component map | Score of Map | Calculated Score of component map |
|---|---|---|---|---|---|
| Geological Factor Map | 1. Lithological Map | Basic sill | 7 | 8 | 56 |
| | | Shale | 3 | 24 | |
| | | Dolomite | 2 | 16 | |
| | | Quatz-baryte vein | 8 | 64 | |
| | | Acid volcanic | 5 | 40 | |
| | | Chert | 2 | 16 | |
| | 2. Structural map | Fault ( buffered 100m) | 6 | 7 | 42 |
| | | Fracture ( | 5 | 35 | |

| | | | | | |
|---|---|---|---|---|---|
| | | buffered 200 m) | | | |
| Geochemical Factor map | Geochemical map | Anomalous Cu Cells | 9 | 8 | 72 |
| | | Anomalous Ni Cells | 9 | 8 | 72 |
| Geophysical Factor Map | Geophysical maps | (gravity and magnetic ) Anomalous buffer geophysical zone | 8 | 6 | 48 |

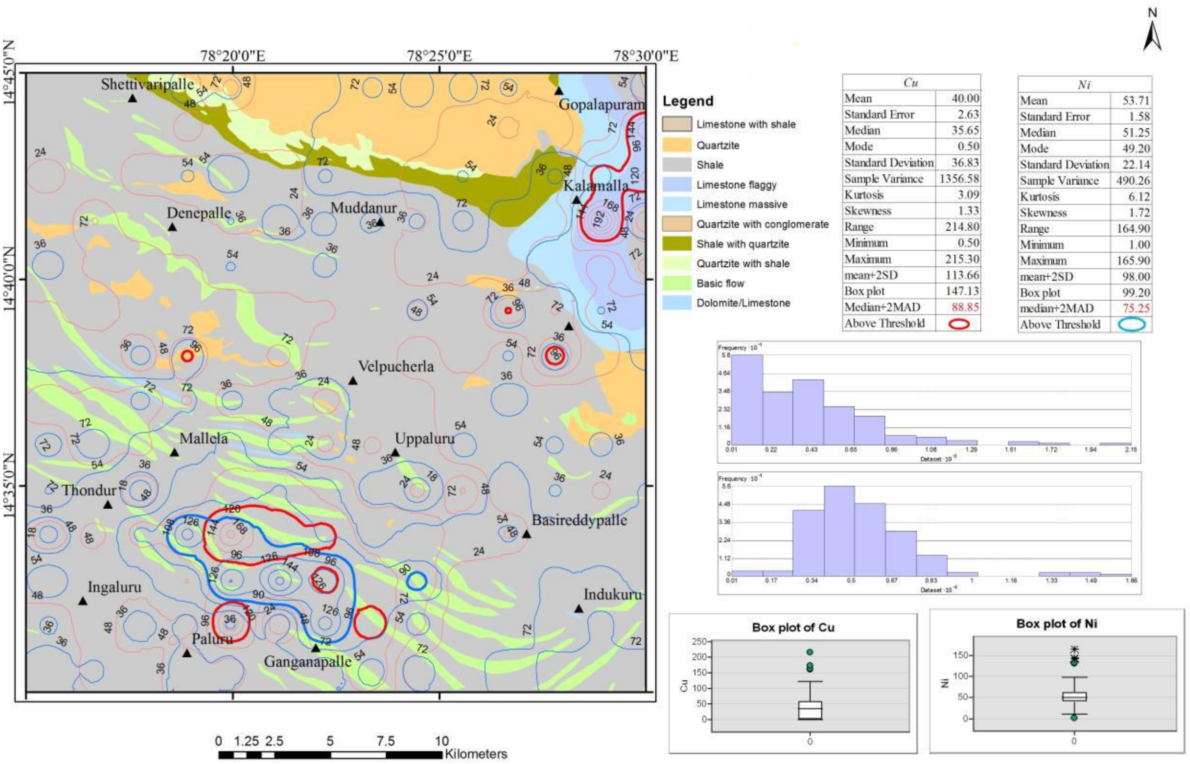


**Figure 7: Geochemical map of Cu and Ni ( NGCM 2014-15, W.Akram and S.Barik )**

From the National Geochemical mapping maximum value of Cu and Ni were given 215 ppm and 165 ppm respectively and above threshold values such as 88.25 for Cu and 75.25 for Ni taken into consideration for extraction of anomalous cell

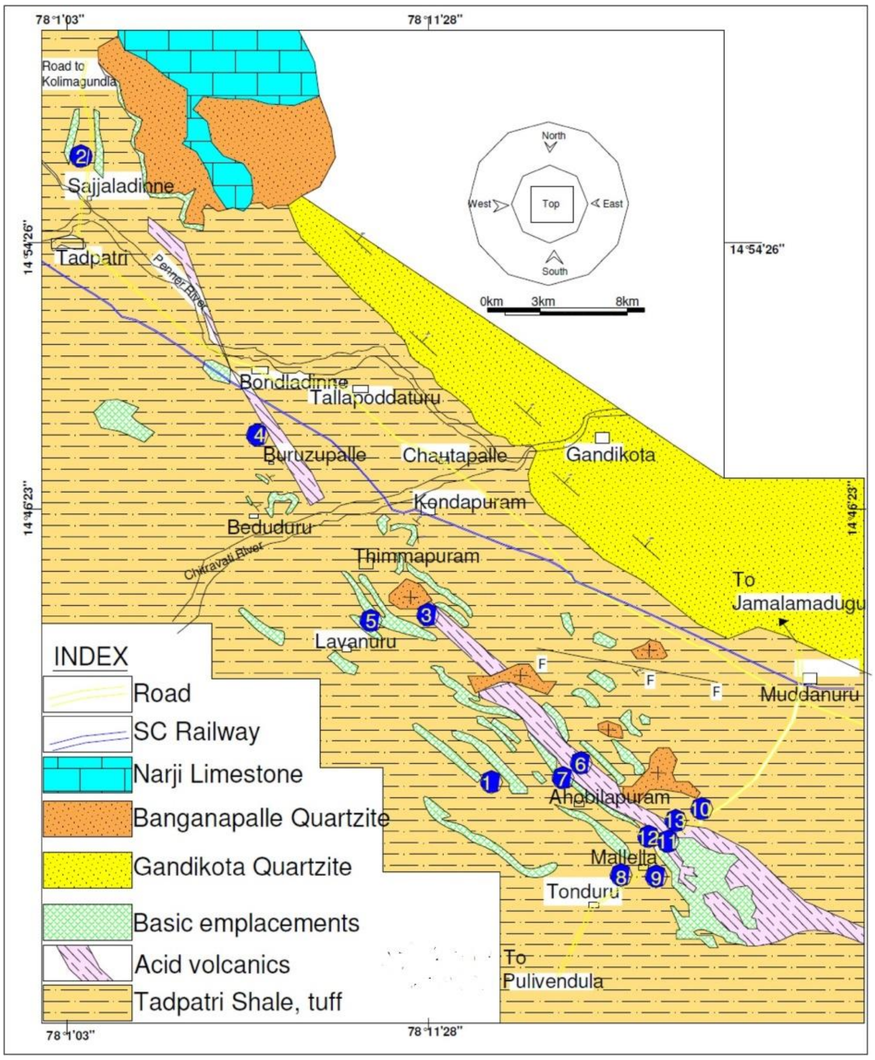


Fig 8: Geological Map of the Study Area ,TS 56J/6 (After S.Goswami etal)

MPM ( Mineral prospectivity/Favourability Map ) favourability map or prospectiivity maps were prepared by the weighted overlay analysis method and reclassified with color code to easy identification of favourability / potential zones

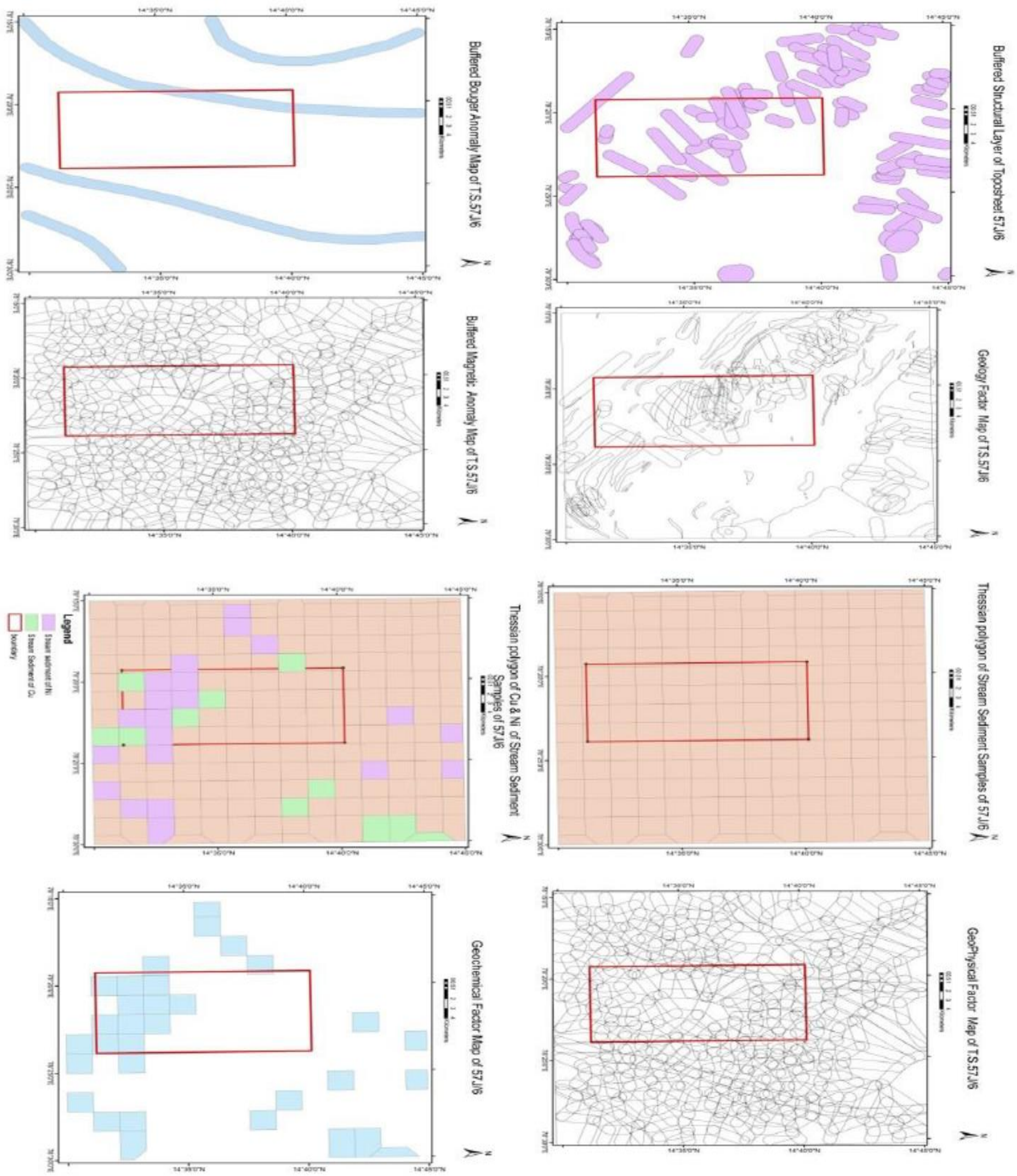


Figure 9: Spatial maps for weighted average overlay Analysis

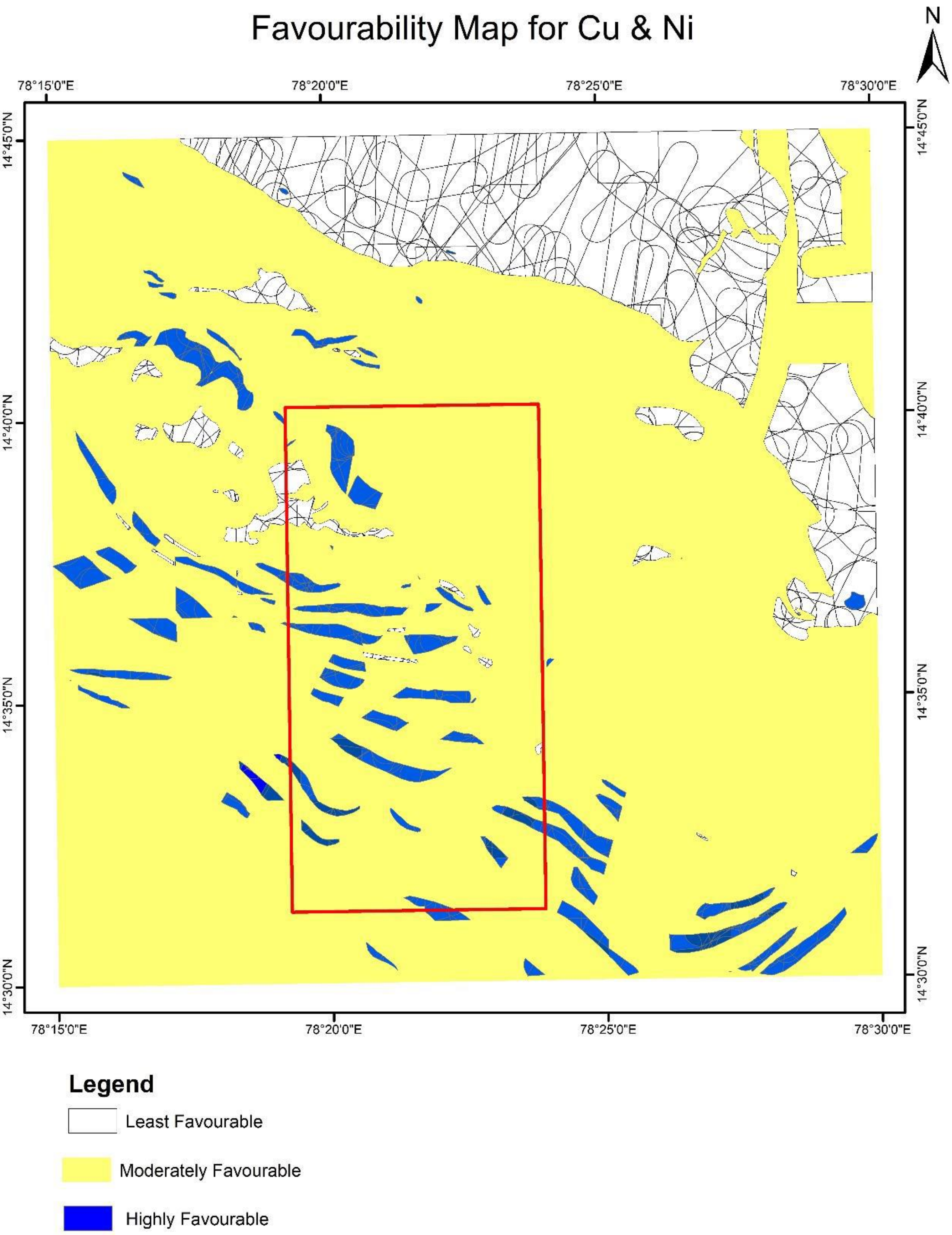
Favourability Map for Cu & Ni
N
78°15'0"E
78°20'0"E
78°25'0"E
78°30'0"E
14°45'0"N
14°40'0"N
14°35'0"N
14°30'0"N
Legend
Least Favourable
Moderately Favourable
Highly Favourable

Figure 09: MPM (mineral prospectivity / Favourability map) prepared by weighted overlay technique on ARC GIS environment

### Validation of favourability map

BRS sample locations were plotted over the favourability map (prepared by the weighted average overlay Analysis) and from the ground check and the statistical model **is** true to the ground scale

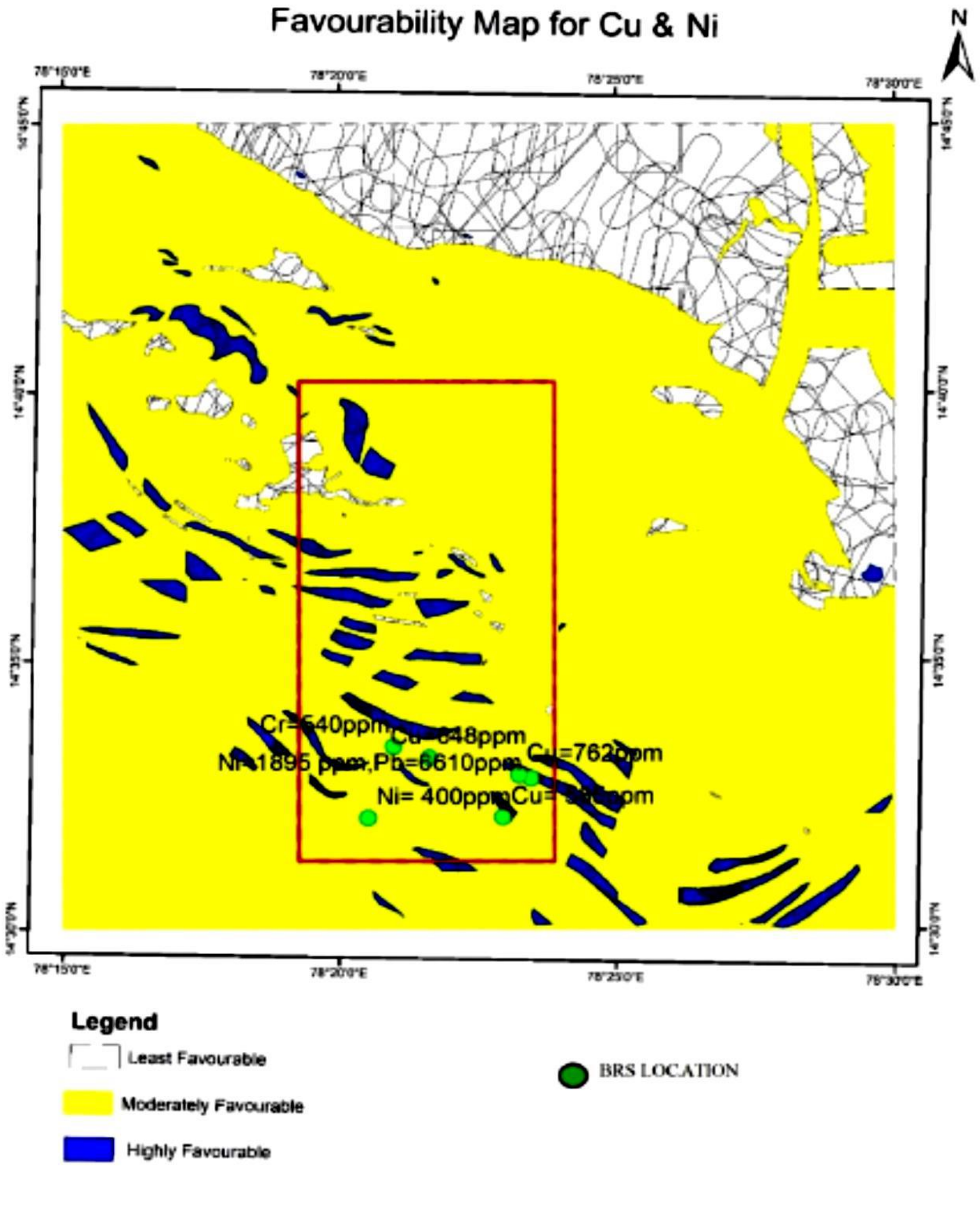


Figure 10: BRS point over the MPM (mineral prospectivity / FavourabilityMap),

Conclusion :

Quantitative evaluation of the spatial relationships between geological features and mineral deposits provides a simple yet effective method for mapping the potential for mineralization to have formed in a given area. Validation of the mineral potential maps is a critical part of the analysis. The ability to accurately predict the locations of known Cu and Ni deposits is used to validate the mineral potential maps generated by the weights of evidence

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