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Structural Mapping for Mineral Resources using Geospatial Techniques: A Case Study in and Around a Part of YSR District, Andhra Pradesh, India

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Abstract

Asbestos minerals are fibrous silicate mineral with different physical properties and chemical composition among the other silicate minerals. It is formed in the vicinity of ultrabasic intrusives by the hydrothermal alteration of rocks composed of iron and magnesium viz., peridotites, dunites, pyroxenes, or dolomites. They are classified into two groups as 1) Serpentine group and 2) Amphibole group. Serpentine group comprises of only crysotile variety of asbestos, whereas the Amphibole group consists of i) Amosite, ii) Anthophyllite, iii) Cocido lite, iv) Tremolite and v) Actinolite. The YSR district enriched with the asbestos minerals of crysotile variety. These deposits are confined to the Vempalle dolomite formation of Papaghni group of lower Cuddapah Supergroup of rocks. The source rock for the genesis of asbestos in the present study area is dolomite which is altered due to the dolerite intrusives in the form of sills in between the Vempalle formation of Papaghni group and Pulivendla formation of Chitravathi group. Asbestos is known to occur in number of localities in Kadapa, Kurnool districts of Andhra Pradesh, the stretch between Brahmanapalle-Lingala in Pulivendla taluka of YSR district is more important because of its of more economic potentiality of the deposit. The asbestos deposits of YSR district occur in Brahnmanapalle - Lingala over about 14 kilometers in a northwest-southeast direction. Brahmanapalle village of Pulivendla taluka is located 3 kilometer's due west of Pulivendla town and the Lingala village lies 14 kilometers northwest of Pulivendla town. At present no mining activity is going along the Brahmanapalle-Lingala stretch due to exhaust of the mineral deposit. At the instance the asbestos deposit is at the verge of its exhaust and no mining work is going on at the entire 14 km stretch of earlier findings. Fresh exploration work is needed to be instigated to find more structures that control mineralization in this area.

***Key words*:** Multispectral, LISS III, Satellite imagery, Remote sensing, GIS

Remote Sensing and GIS interpretations are significantly cost-effective techniques in mineral exploration programs. The data interpreted from the satellite imagery is analyzed in a GIS software environment and analysis can be made about the prognostication of mineral occurrences. It can further be used as a guide for similar deposits in the region by identifying prospective zones. Among such techniques, lineament analysis is a significant tool in mineral exploration that has been used by many workers in the execution of an exploration program. The first usage of the term lineament in geology is probably by Hobbs [1] who defined that lineaments are significant lines of the landscape caused by fractures and faults revealing the configuration of the basement rocks. The type and composition of minerals determine the spectral response of the rock type. Satellite imagery exhibits tonal variations and linear features, in general, show a definite contrast within a background of country rock. Interpretation of lineaments will provide an understanding of the structural setup of the area.

The mine regions along lineament, and facture frameworks brought out by satellite information understanding are of colossal utilization of for taking up fake re-energize structures. The areas which are suggested for counterfeit re-energize structures (check dams) are upstream of the flooded regions, and some re-energize pits are proposed in and around the town settlement areas for re-energize the groundwater through the surface overflow which helps support the mineral exploration. To the extent of the investigation part, the geologist has been worried in direct highlights of the world's hull since the time the almost immediately age. The direct attributes, as overlaps, reprimands, and breaks give hints about the inside for investigation of minerals assets. Utilizing visual understanding on the satellite picture, deciding the lineaments is troublesome

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and at times passionate yet with experienced arbiter [2]. Regardless, there are customizing models and progressed planning which simplifies it to get lithological and primary information reasonably; this can be cultivated on the ground using lineament examination. Lineaments are the scene surface verbalization of breaks, jointing, and other straight geological marvels that happen at any spot from the domain surface down to possibly grind profundities [3]. Concerning Remote Sensing, the Lineaments are long, liner plans of various geological, apparent, topographical, and surprisingly geophysical and geochemical features [4]. The distant identifying technique gives an approach to a nearby understanding of groundwater structure. Its data gives information on spatial model's groundwater subordinate vegetation or salinization. The comprehension of distantly recognized data for direct features planning is an essential piece of earth resource examination programs in the hard rock area. Remote Sensing with its focal points of spatial, nature, and fleeting availability of data covering gigantic and in open locales inside a short time frame has transformed into an incredibly helpful mechanical assembly in looking over, checking, and saving mineral resources. The point of convergence of this work is related to lineament examination using remote sensing and GIS techniques to recognize the areas of mineral irregularities and prospecting study parts of Kadapa, Andhra Pradesh.

RESULTS AND DISCUSSION

Study area

Asbestos deposits in YSR district occur within the longitudes of 77^{0}56`50.47``E, $78^{0}$18`29.565``E and latitudes of 14^{0}19`52.026``N, $14^{0}$34`15.835``N. The area forms the western margin of the Cuddapah basin. The asbestos mineralization extends for an area of 15km in YSR district. Villages like Lingala, Ramanuthalapalle, Chinnakudala, Brahmanapalle are enriched with the asbestos mineralization. The contact of dolerite sill with dolomitic limestones has given rise to serpentinization and a narrow zone of the asbestos of crysotile variety in the form of cross fibre is formed at the contact of serpentine and dolerite sills. The thickness of serpentinite zones between quartz dolerite and dolomitic limestone is about 1m thickness and asbestos mineralization is about 30cm thick occurring in the bottom beds of serpentine. The serpentine zone occurs above the doleritic sills over a thickness of 1m. The length of asbestos fibre is varying from 2mm to 60mm. The contact of siliceous dolomitic limestone with the basic skills of basalts has not given rise to serpentinization. Only upper contact of dolomitic limestone with quartz dolerite is noticed in the study area, but the lower contact of dolerite with dolomitic limestone has also given rise to serpentinization but this phenomenon is observed for away i.e., towards the south-west of the study area. The total strike length of quartz dolerite and dolomite limestone contact is about 1,500m. The serpentine was occurring in lemon yellow, green and black in colours. The mineralized areas are generally in the shape of elongated lenses with the long axis being the direction of the trend line (Fig 1).

Availability of geological information and image enhancement techniques provide more flexible methods to analyze reliable lineament patterns in the study area. Methodology adopted in this paper for the identification lineaments with possible mineralization of structural origin [5-6]. Is initially by edge enhancement technique through ERDAS Imagine software and then delineation of lineaments using ArcGIS 9.2. Lineament map is prepared by detecting lineaments from satellite imageries on the basis of visual interpretation aided digitization [7-8] and compared with geological maps of the study area. Then the lineaments have been eliminated after comparing the lineament map with the corresponding SOI Toposheets (57J/03) and field verification leaving the 'geologic lineaments are prepared by visual interpretation of the satellite imageries and field investigation [9].

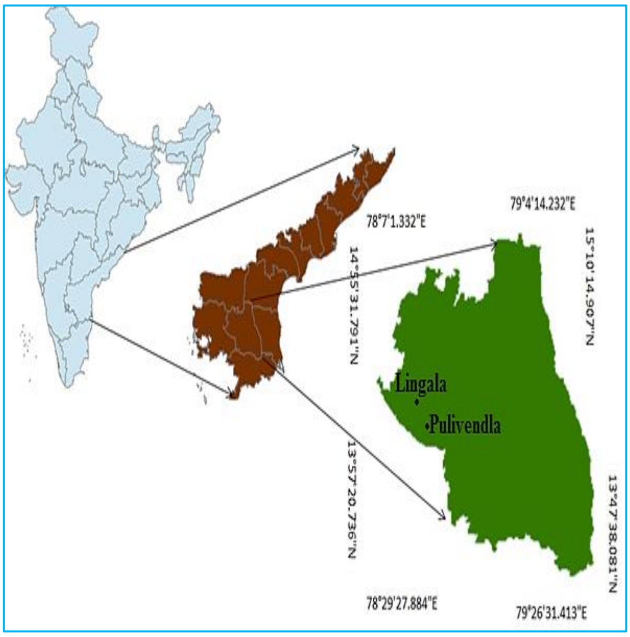

Fig 1 Location map of the study area

RESULTS AND DISCUSSION

Geology of the study area

The study area associated with the asbestos mineralization is the part of Cuddapah basin and consists of alternate sedimentary formations of arenaceous, carbonaceous and argillaceous rocks. This area is primarily composed of quartzites, limestones, dolomites, shales and ultrabasic igneous intrusive. The lower most formation of this area is quartzite belonging to the Gulcheru formation of Papaghni group of lowermost Cuddapah Supergroup of rocks. Overlying this formation, there are dolomites related to the Vempalle formation of the Papaghni group of Cuddapah Supergroup of rocks which are principal source rocks for asbestos mineralization in the entire study area. Above which there are quartzites belonging to the Vempalle formation (Table 1). These rocks are followed by quartzites of Pulivendla formation of Chitravati group of middle Cuddapah Supergroup of rocks and in turn followed by Shales of Tadipatri formation of Chitravati group of Cuddapah Supergroup of rocks. The Vempalle dolomites, Pulivendla quartzites and Tadipatri shales contain intruded ultrabasic igneous intrusions in the form of sill bodies (Fig 2).

Geomorphology of the study area

Geomorphology of asbestos mineral location includes Pediment, Pediplain, Residual hill, Structural hill and Structural valley. Almost ¾th of the total mineralized zone in the present study area is occupied by Pediplain, remaining land has been shared by the other geomorphological features. Second largest occupant geomorphological feature is structural hill. Entire southern to western margin, central portion of the study area is occupied by the structural. The structural valley is present in between these structural hills in the western and central portion is occupied by the structural valley. Pediment and residuals hills are very sparse and occur within the Pediplains (Fig 3).

Table 1 Pulivendula and Lingala Formation

Formation	Lithology	Age
Tadipatri Fm	Shale/Tuff, Dolomite/Limestone Quartzite, Basic Sills.	
Pulivendula Fm	Quartzite with Shale/Limestone Dolomite, Basic flows.	
Vempalle Fm	Dolomite/Chert/Mudstone/Quartzite.	Middle Proterozoic
Gulcheru Fm	Quartzite/Conglomerate.	
Basement	Granite-Gneisses, Basic Dykes.	

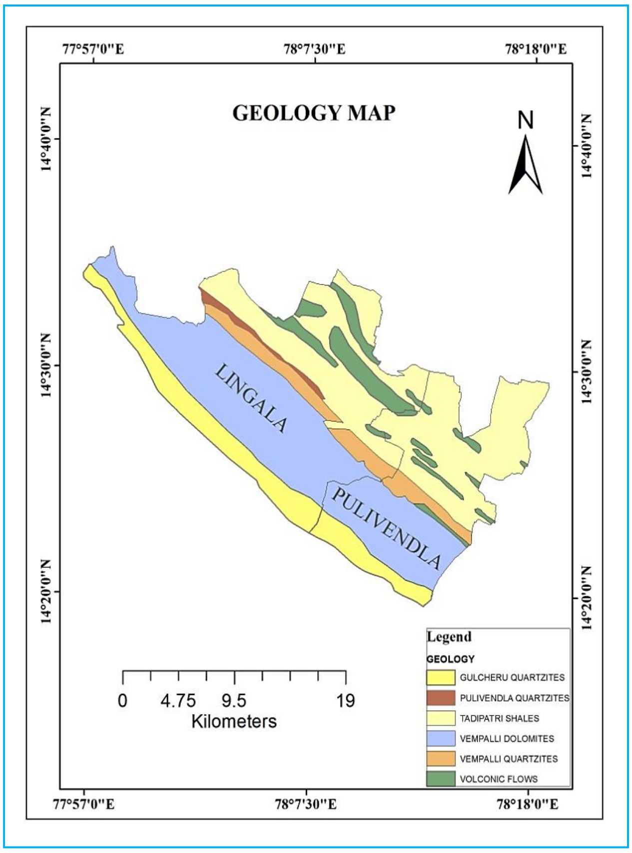

Fig 2 Geological map of the study area

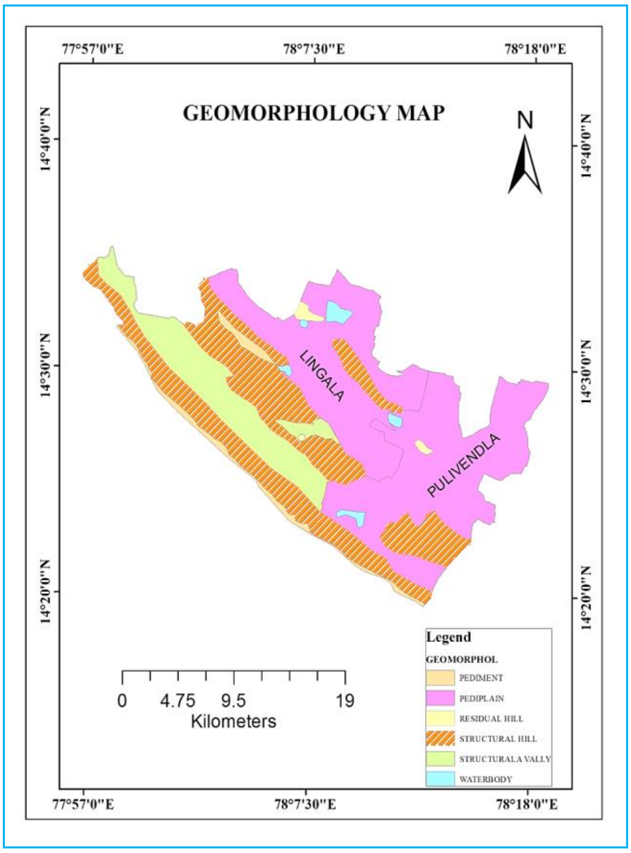

Fig 3 Geomorphology map of the study area

Lineaments

Lineaments are faults, fractures and joints that can be defined as probable surface features, which distinct from the patterns of adjacent features and presumably reflect subsurface phenomena [10]. Satellite image data along with lineament information are widely used to extract different studies. The study of lineaments has been applied successfully in geological regime in the field of mineral exploration. The lineament map of the present study area shows all the existing asbestos mines and barites mines are falling along the fault/fracture/joint planes (Fig 4). Such consequences reveal that this kind of thematic maps prepared in a location definitely supports the Mineral exploration.

Extraction of lineaments

Initially the visual interpretation technique is used to extract and map the lineaments. Later the digital interpretation is done by application of ERDAS Imagine and Arc GIS software. Primarily the satellite image of the study area is subjected to edge enhancement technique in ERDAS imagine. Then the resulting map is taken to the Arc GIS and the lineaments layer is prepared. This layer is projected over the location map of the study area, to show the lineaments (Fig 4).

Structural controls

It is observed that certain structural conditions have favoured localization of asbestos fibre concentrations. The most important one is the flexural pattern on the upper contact of the dolerite with the dolomitic limestone. These flexures are in the form of eastwards plunging synforms of very low amplitude. The long axis of mineralization within the synforms is sympathetic to the direction of the plunge of the synforms axis of the flexure. Generally, the longer fibres are nearer to the synforms axis. The ratio bites the length and width of the mineralized zone varies between 3:1 to 5:1. The flexural axis may continue or it may taper off and given rise to fresh set of synforms flexure in an enechlon manner, resulting in another zone of mineralization with intervening barren zone. The mineralized areas are elongated Lense like bodies on the study area.

Controls of mineralization

There are several factors noted with reference to the controls on the formations of asbestos fire. They are lithological, structural and compositional giving raise to relationship with associated mineral.

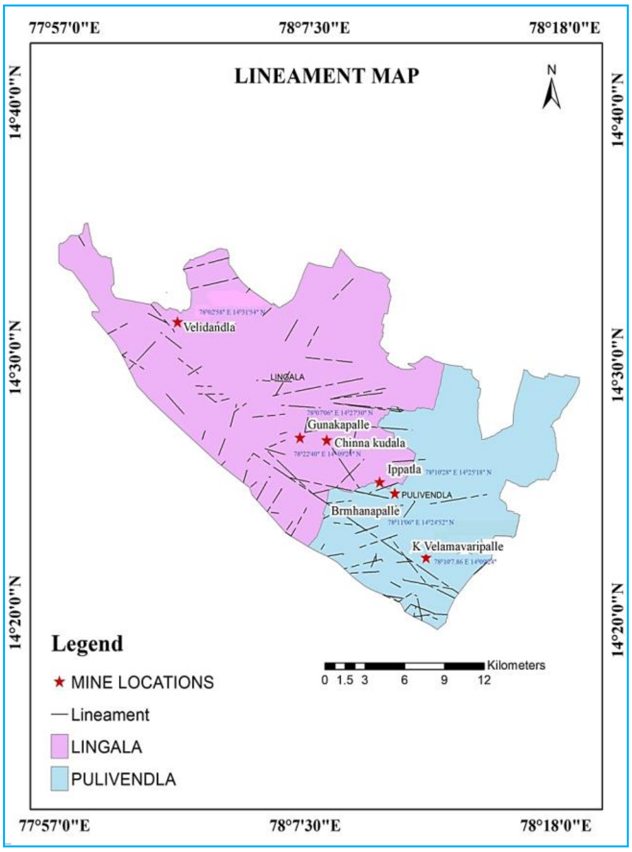

Fig 4 Lineament map of the study area

Lithological controls

Mineralized zone is a marker horizon. It is the upper contact of dolerite sill with the dolomitic limestone. It is generally a meter in thickness above the dolerite sill. The dolerite-dolomite contact is serpentinites. The lower contact of the same sill is also serpentinites. Asbestos is formed within this serpentinised zones. Mineralization for commercial exploitation is only on the upper contact of dolerite sill. Where the dolerite composition is rich with mineral olivine, the asbestos mineralization is better. When the composition is of the intruded rock is dolomitic limestone, the serpentinization is massive and the formation of asbestos mineral is better than otherwise. The regions where the dolerite had intruded into the argillaceous dolomite or into dolomitic mudstone, there had been poor serpentinization and no formation of asbestos. Thus, the composition of the intruding dolerite sill and the composition of intruded dolomitic limestone determine the degree of serpentinization. Greater the degree of serpentinization, greater the chances of asbestos fibre formation. The magmatic emanations that came at the time of emplacement of the dolerite sill had serpentinised the dolomitic limestone. The same emanations had formed the asbestos fibre under certain conditions of temperature and pressure.

Composition controls

- Green serpentine is and indicator for increase in asbestos yield compared to yellow serpentine.
- The larger quantity and greater purity of serpentine is congenial for asbestos formations.
- Massive serpentine zones are more hospitable for asbestos formation than otherwise.
- When the dolerite is emplaced in dolomitic limestone, asbestos formation is better than when emplaced in dolomites only.
- When the emplacement of dolerite is within or in contact with argillaceous or alluminous dolomites there is no formation of asbestos.
- The richness of dolerite with olivine mineral help formation of asbestos. It is more so when olivine rich dolerite is emplaced in dolomitic limestone.
- When the thickness of the serpentine zone is more, the greater is the formation of asbestos and vice-versa.
- When the thickness of the steatite zone of the roof is more, the greater are the number of asbestos veins formed with increase in fibre formation and vice-versa.
- It is noted that sometimes, when there is good formation of asbestos in the mineralized zone, in the steatite of the roof above such zone, thin bands of graphite like matter are seen.

Nature of the mineral veins of asbestos

Asbestos veins vary laterally within wide limits of a few centimeters to 20m. They are invariably almost parallel to the dolerite upper contact and the bedding plains. The asbestos fibre is of cross-fibre variety. The veins vary in thickness from hair like thin stringers to 50mm and rarely more. These sheets like veins may occur in multiples more or less parallel to one another [11]. But so, times they taper off and bulge in different directions.

Nature of asbestos fibre

The colour of the fibre range from pale yellow to pink translucent green when in bundles or when in inset with silky lustre. But thin fibres are colourless and silky in appearance. Fibres associated with black serpentine are generally harsh i.e., less flexible and break, whereas fibres occurring within green and other coloured serpentine are more flexible and silkier [12]. The more flexible the fibre is, the more is its tensile strength (Table 2).

Table 2 Asbestos fiber length

Grade		Length of fibre
A.	Special	Above 32mm
A.	Grade	19 mm - 32 mm
B.	Grade	6.35mm - 19.5mm
C.	Grade	Below 6.35 Milled fibre

CONCLUSION

Crysotile asbestos is used in making paper blocks, cement products, brake lining and other automobile spare parts, insulating materials, paints and roofing's. Serpentine is useful for reduction of fluorine content in fluoride rich water (GSI report 2015). Industrial uses for asbestos increased as well, with some of it being used to filter beer, wine, and pharmaceuticals. The producer countries consume only a fraction of the asbestos that they mine and export the rest. As a result, considerable use of asbestos has continued in much of Asia, Africa, and in some countries in Latin America. China has been a major consumer of asbestos as has been India. India produces little or no asbestos but has become a major importer with exponential growth in manufacture of asbestos cement and pipes. Although safer substitutes are available, deliberate actions have been taken, such as is the case in India, where tariffs have been kept modest on asbestos but raised on artificial materials that are safer. Asbestos fiber counts obtained from human lung tissue are now recognized to be a highly insensitive measure of past exposure to chrysotile asbestos. Chrysotile asbestos fibers are now well documented to have only a short residence time in lung tissue, and therefore their measurement in the lung cannot be used as a measure of cumulative past exposure.

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