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Integration of Litho-Units Derived From Satellite Data

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ABSTRACT

Remote sensing techniques were applied to demarcate lithological and structural features of the area around Mahabubnagar district of Telangana and parts of Gulburga district of Karnataka of eastern Dharwr craton Through Spectral Geological techniques like False Color Composition (FCC)/ Band Combination, Band Indices/ Band Ratios, Principle Component Analysis (PCA), Minimum Noise Factor (MNF), Spectral Curve Matching – mainly to identify MgOH rich soils, which are weathered from kimberlites, Spectral Angle Mapper (SAM), End-Member identification etc. are used to discriminate the lithology of the study area using LANDSAT 8 and ASTER VNIR, SWIR and TIR wavelengths. Surface structures, which could be probable subsurface indicators of faults, intersections of these are main source of kimberlite emplacement are also identified with various techniques, these are penetrated into deep-seated.

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I. INTRODUCTION

In this study remote sensing investigations have been applied to study the area in and around Mahabubnagar district of Andhra Pradesh and parts of Gulburga district of Karnataka. The study area lies in-between geographic coordinates of 16° 50’ 25”N, 77° 04’ 41”E and 16° 29’ 39”N, 77° 35’ 26”E and falls in parts of the Survey of India (SOI) 1:50,000 scale toposheets of 56 H1,2,3,5,6,7,9,10 and 11. The total area is about 1933 sq. km. Study area covered two towns those are Narayanpet of AP and Yadgir of Karnataka (Figures 1) which are well connected with state high-ways to major cities. Narayanpet is connected by road about 165 km distance and Yadgir is connected by road about 210 km distance from Hyderabad. Narayanpet Road and Yadgir railway stations are on Chennai-Mumbai rail route (Figure 1).

The terrain represents a gentle undulatory plain with few dissected hills in the north and inselbergs of granitic rocks many places in a scattered manner. The highest elevation is 639 m about 8.6Km NE of Narayanpet town. Krishna River passes through extreme south-east corner of this study region. Bhima River, one of major tributary of Krishna River is flowing in the South-West portion of the study area.

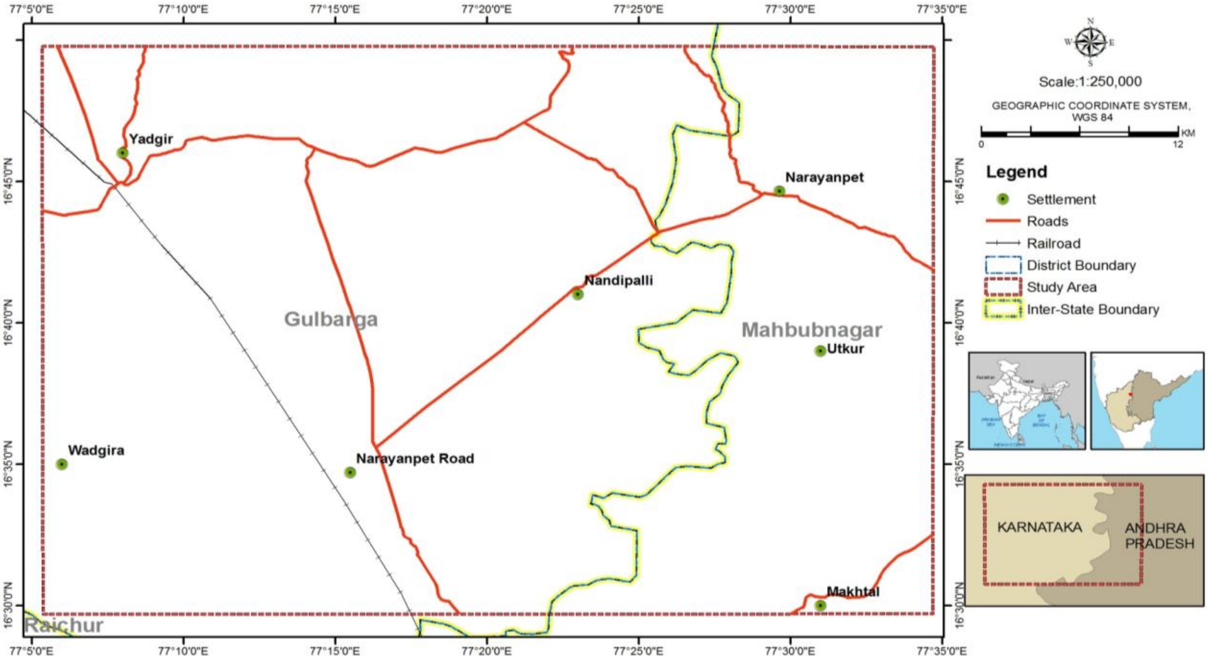

Figure 1.:Location of the Study Area

II. GEOLOGY OF STUDY AREA

The area is lying at geologically and tectonically interest the geology of Narayanpet area (Figure 2) north of Krishna River is represented by grey granite and gneiss with minor pink feldspar bands representing the Peninsular Gneissic Complex (PGC). The zone east of Yadgir is marked by metabasic schists and amphibolites bands within the PGC as basic enclaves (Figure.2) and shows lineaments and litho-units of the study area. This area is very well demarcated in the imagery as light grey color with small bands of dark tone which could be corroborated to the rafts of amphibolites within PGC.

According to [1] the mantle xenoliths in NKF are recorded from pipes NK – 3 and MK-8 of which the NK-3 contains fairly good number of nodules. The xenoliths identified are lherzolite, MARID (Mica, Amphibole, Rutile, Ilmenite, Diopside) suite, glimmerite and pyroxenite, which are highly altered. In the lherzolites, grass green pyroxene (diopside to chrome diopside) is in good amount in a base of mostly altered olivine. Light pink and reddish brown garnets and spinels are recorded and based on the mineral assemblage these xenoliths are considered as spinel lherzolite ([2], [3]). The MARID suite of rocks is the dominant xenolith type in the NK-3 body. They consist of phlogopite, diopside, ilmenite and rutile. The MARID suite of xenoliths are essentially made up of phlogopite (~45%), pale green pyroxene (15%), both set in a groundmass material made up of carbonate (30%) along with opaques (ilmenite) and other altered material. In the NKF chrome diopside is the common indicator mineral. Garnet and chromite are in very small proportions.

The Narayanpet Kimberlite Field (NKF) is characterized by two main fracture domains: an E-W trending strike slip fault associated NE-SW trending fractures in the Maddur-Kotakonda area, and a predominantly E-W trending strike-slip fault set with associated NNW-SSE trending fractures west of Narayanpet. All the known kimberlites of the NKF are located either along the E-W trending faults or at their intersection with the NNWSSE trending or NE-SW trending fractures ([2]). All the kimberlites of NKF are emplaced into migmatitic gneisses, and granitoids.

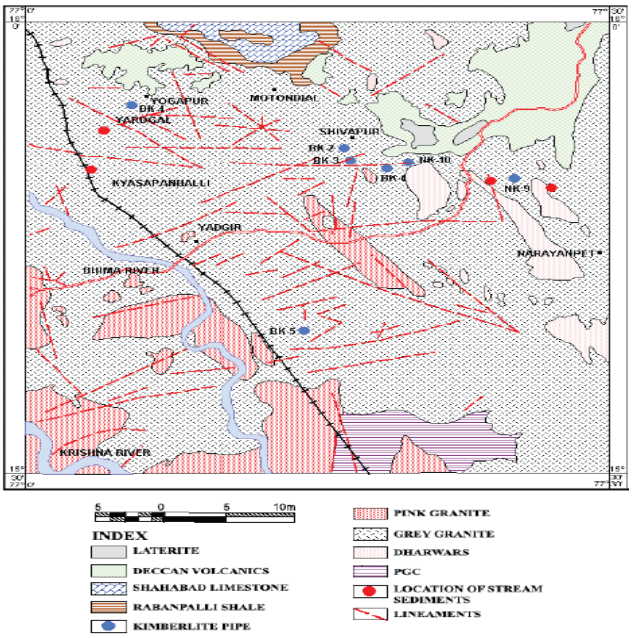

Figure 2: Geological Map showing Narayanpet Kimberlite Field (NKF) (after GSI, 2011).

III. IDENTIFICATION OF LITHO LOGICAL AND STRUCTURAL LINEAMENTS

Lithological discrimination has been done with various spectral geological techniques using Landsat 8 and ASTER (Figure 3, 4) satellite images. Various types of FCC image were prepared using several band combinations and as many band rationing/ indexing techniques mentioned by several authors ([4], [5], [6], [7], [8]) were used to correlate the available lithology of the study area as well as to find new litho-units of the study area.

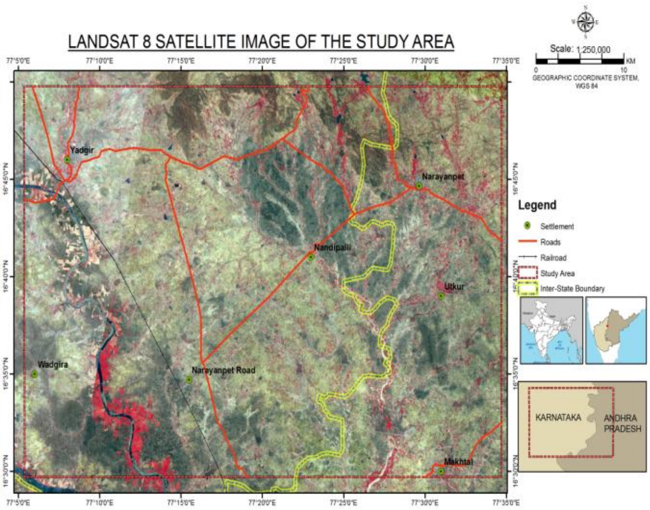

Figure 3: Landsat 8 satellite image of the Study Area

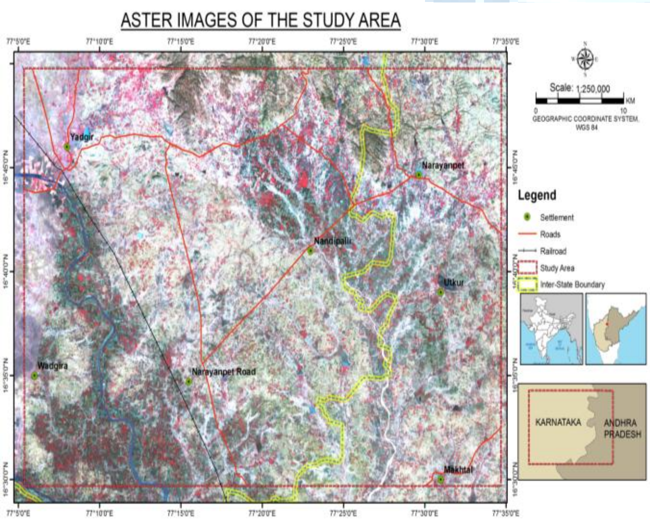

Figure 4: ASTER satellite image of the Study Area

A mixed approach has been adopted for geological map preparation. [2], [9] and [10] maps were integrated and prepared the geological map where the correlation has been matching with spectral techniques of the study area (Figures 5 to 7).

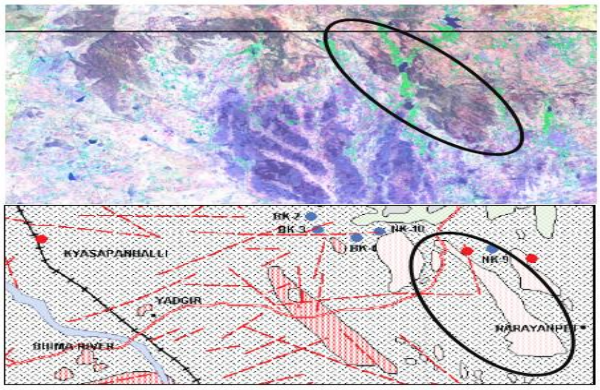

Figure 5.:(Top) Green Schist belt shown in 7,4,1 (RGB) FCC Landsat 8 satellite image high-lighted. (Bottom) GSI, (2011) identified this as Dharwars

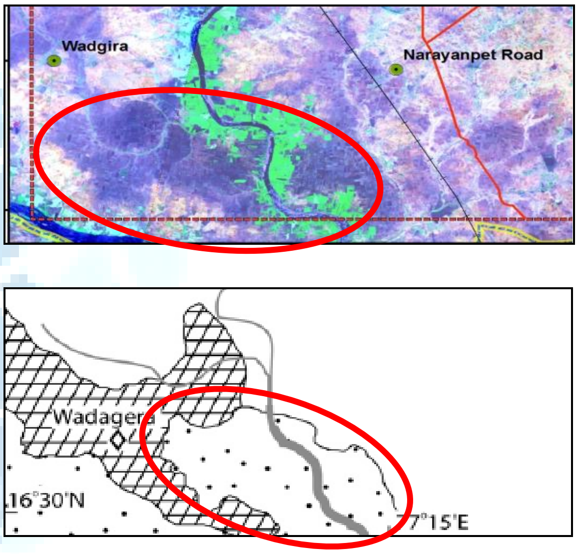

Figure 6: (Top) high-lighted with red black soils shown in 7,4,1 (RGB) FCC Landsat 8 satellite image. (Bottom) Paton et al.(2009) identified this as Black Soil plains derived from Deccan Traps and black hatched portion identified by Archean/ Proterozoic Granitoids, where the shape of the same is matching with image.

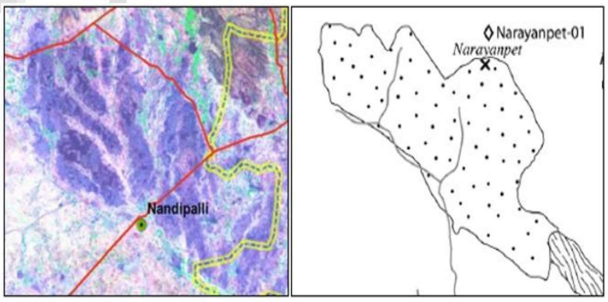

Figure 7: (Left) black soils shown in 7,4,1 (RGB) FCC Landsat 8 satellite image. (Right) Paton et al. (2009) identified that these soils are derived from Basaltic Deccan Traps

IV. IDENTIFICATION OF KIMBERLITES INDICATOR

Alteration of kimberlites immediately after emplacement is common, resulting in extensive serpentinisation of olivine and monticellite (Mg rich olivine) via reaction with meteoric and ground waters. Rapid emplacement and cooling of kimberlites or lamproites limits development of alteration haloes in surrounding country rock. The high CO_2 content of magmatic fluids can result in widespread calcite crystallisation during early alteration. Clinopyroxene is altered to chlorite and continued supergene weathering of kimberlite generates a series of alteration products that include talc, vermiculite, dolomite and Mg-Fe smectite, which under intense or prolonged weathering are reduced to kaolin and Fe oxy-hydroxides. Highly weathered terrains with deep kaolin profiles are therefore unlikely to preserve sufficient MgOH minerals at the surface to be diagnostic of kimberlite. Early and intermediate alteration products of primary silicate minerals are potentially the most useful for surface spectral mapping, especially where these contrast with predominantly AlOH mineralogy in adjacent country rock. The spectral absorption characteristics of a variety of minerals found in altered kimberlite are shown in Figures 8 and 9.All these minerals have in common, a strong absorption feature in the 2300-2330 nm wavelength range.

To find out the Mg-rich soils, which are main indicator minerals of kimberlites, spectral curve matching, Spectral Angle Mapper (SAM), finding Endmember etc., techniques were used.

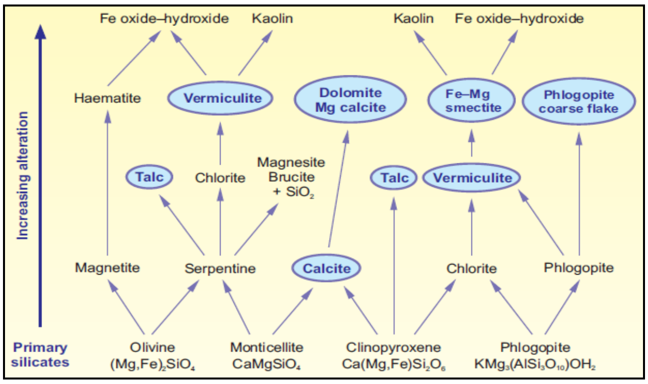

Figure 8: Possible pathways and secondary mineral phases formed during supergene alteration of primary kimberlite minerals (after [11])

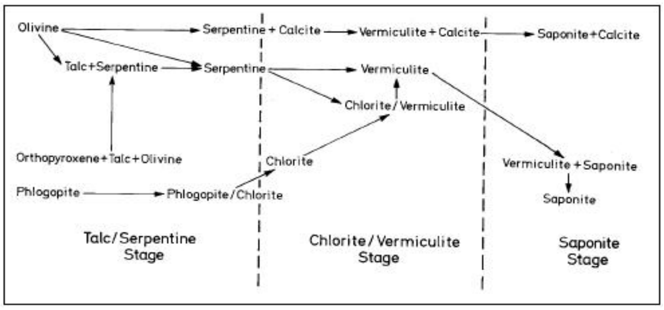

Figure 9:Schematic diagram showing the alteration of olivine, pyroxene and Mica ([12])

All indicator minerals of Kimberlite are a common strong absorption feature in the 2300-2330 nm wavelength range. The differentiation of these minerals through ASTER spectral band 8 (2.295 to 2.365 μm) is limited when compared with hyper-spectral images. Hence the end-member for these minerals has run on ASTER band 8 is not giving desired results. Figure 10 showing broad range.

Mg-rich soils of the current study area are derived from Basaltic traps, which were reported in the western and north-western portion and transported by major rivers like Krishna and Bhima as well as small streams. Tried to differentiate these transported soils from in-situsoils, which were formed due to weathering of green-schist belts and Kimberlites.

According to [13], laboratory spectral profiles of kimberlites are convolved to ASTER bandwidth of SWIR channels for spectral mapping of kimberlite using sub-pixel algorithm as the exposure of Narayanpet (NE portion of the current study area) kimberlites, which are very small in size in comparison to the pixel size of ASTER data. ASTER convolved laboratory spectral profiles of serpentinised and carbonate rich kimberlites are characterised with an absorption feature at around 2.33 micrometer. Hence, mean of ASTER convolved spectral profile carbonate and serpentine-rich kimberlite is used as a single end member for targeting the kimberlite based on sub-pixel mapping algorithm. The resultant output is shown in Figures 10 and 11.

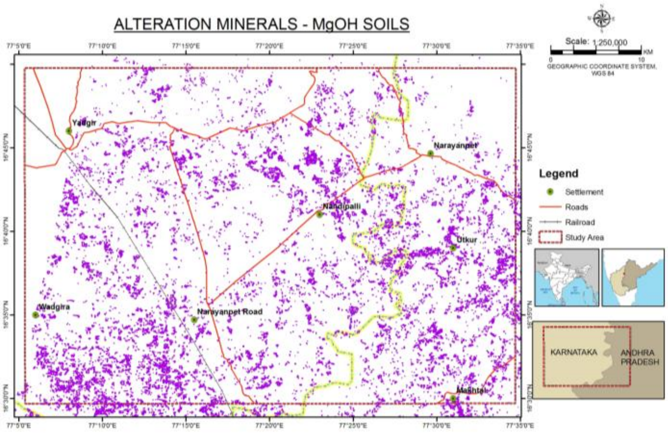

Figure 10: Mg-Rich Soils derived from spectral end-member method

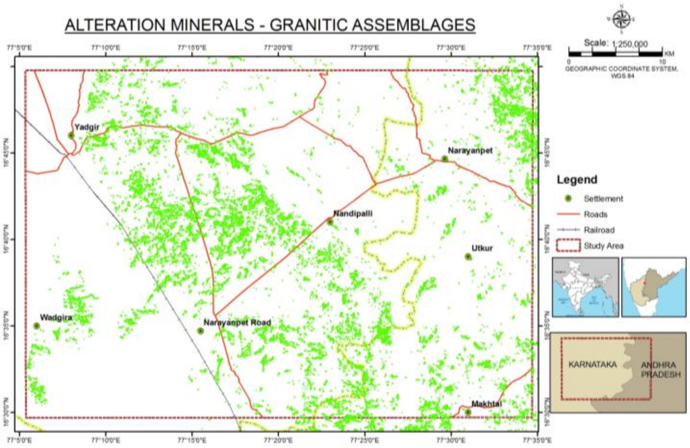

Figure 11:Soils derived from Granitic (Grey & Pink Granites, Migmatites and Gneisses etc) rocks weathering

V. SUMMARY AND CONCLUSIONS

Current study focuses basically identification and/ or updating of lithological boundaries through various spectral band methods (indicator mineral identification, alteration mapping –like in-situ MgOH soil identification, which are main kimberlite indicator minerals through weathering) using satellite images, where kimberlite assemblages are found. Surficial lineaments (joints, fractures, faults etc) identification and updations through satellite remote sensing is another task to identify kimberlites, where these structures and their intersections are main source of kimerlite emplacement. Geomorphological (along with digital elevation models) and topological (along with drainage pattern etc) anomalies also studied to support the evidences. ASTER and LANDSAT 8 satellite images are used to discriminate the lithological boundaries. Various attempts have been made to do such lithological boundaries using spectral geological methods (is part of satellite remote sensing for geology) like band combinations, band indices/ band ratios, principle component analysis (PCA), minimum noise fraction (MNF), spectral angle mapper (SAM), curve matching etc. Based on the available geology (Peninsular Gneissic Complex – PGC rocks of Granite Gneisses, Migmatites etc, Dharwar Schists – Amphibolite, Horbblende Schist, Chlorite Schist etc. Pink and Grey Granites as well as younger dykes) all possible attempts have been made to differentiate the litho-units. An attempt has been made for identification of kimberlite indicator minerals like serpentines, carbonates, phlogopite, scapolite etc as in-situ MgOH rich soil concentrations.

This study has clearly concluded that the remote sensing technologies display surface lineaments like joints, fractures; faults etc. also delineated using various spectral geological techniques, intersections of these are main source of kimberlite emplacement, if those are penetrated into deep-seated.

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