Identification and Mapping of Copper Mining Area in Singhbhum Copper Belt Using Advance Image Processing Techniques

Krishnendu Banerjee[1], Surajit Panda[2], Dr. Manish Kumar Jain[3]

[1]Jharkhand Space Applications Center,
Dept. of Information Technology, Govt. of Jharkhand, Ranchi-834004, Jharkhand, India.

[2]Jharkhand Space Applications Center,
Dept. of Information Technology, Govt. of Jharkhand, Ranchi-834004, Jharkhand, India.

[3]Indian School of Mines, Dept. of Environmental Science & Engineering
Dhanbad -826004, India.

Abstract: ***Singhbhum shear zone is known as a mineral rich and potentially economic zone of India. Its mineral storage has a great potentiality in terms of economic development. According to GSI (Geological Survey of India) several the outcrops of copper ores severally are seen in singhbhum thrust zone. This paper describes PCA; Filtering and Logical operators can be used for identification of outcrop of copper ores of mosabani areas of East Singhbhum, Jharkhand. Principal component analysis (PCA) is an orthogonal transformation of bands that provides new dimensionality of bands using covariance calculation. This method may retain the characteristics of multispectral data, which contribute most to its variance. In this study, PCA was employed to process ASTER visible and shortwave infrared band. The PCA of ASTER bands 1, 2, 3, and 8 were used to extract areas of OH altered rocks. The hydrothermal altered zones identified by image processing were analyzed in detail along with geological maps. Finally result of analysis was compared with the out crop of GSI map***

Keywords: FLAASH, PCA, Filtering, Copper ore mines, Kernel etc.

1. Introduction

Identification of copper mining area or finding the outcrop of ore bodies of copper like cuprite veins using Satellite remote sensing technique is a challenging task. Geological history of the singhbhum belt shows the presence of hydro-thermally altered zone. Phyllic and argillic-altered rocks are the result of hydrothermal alteration and are typically associated with porphyry copper and other vein-alteration ore deposits (Lowell and Guil-bert, 1970; Cox and Singer, 1986). Estimation of mineral resources involves the modeling of spatial distribution of mineralization from a limited set of known data that is governed by many and complex geological processes. A major focus of modern exploration methods is to target and search for concealed mineral deposits. In advancement of modern spectroscopy and mathematical methods, it is possible to identify the outcrop of ore bodies severally formed in large areas. PCA is one of the most advance techniques that have capability to analysis a set of samples in term of DN values of hyperspectral or multispectral images and thus helpful to identify the target areas.

Copper is a important base metal, its uses and value in different field like engineering, construction and public sector is very important. Ore exploration using field survey is very accurate but time taking technique. Remote sensing is a technique which reduces human effort through advance image analysis and feature identification, so this new approach is helpful for copper ore exploration through remote sensing.

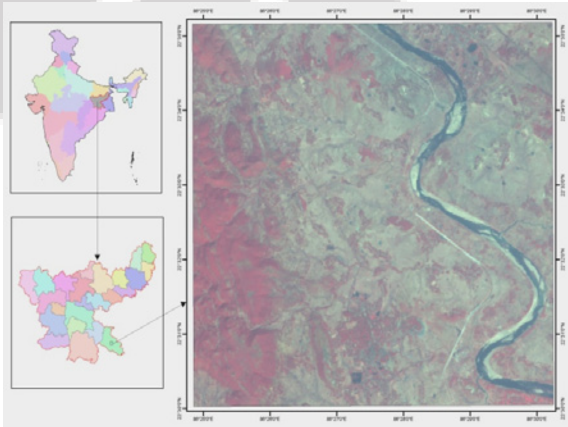
2. Objectives

The main objectives of the present study are mentioned as follows:

- Identify the area of outcrop of cuprite vein bodies.
- Mapping of copper mining area in singhbhum shear belt.

3. About study area

The Study area falls in three blocks of East singhbhum District of Jharkhand state. These are Musabani, Dhalbhumgarh and Ghatsila. The major portion of the study area falls in Musabani block and some part falls in Dhalbhumgarh and Ghatsila blocks. The Latitude and Longitudinal extent of the Study area is 22^0 30’ 10.95” N to 22^0 35’ 02.07” N and 86^0 24’ 54.72” E to 86^0 30’ 10.95” E respectively. The area falls under the survey of India Toposheet No.73 J/6.



3.1 Regional Geology

The Singhbhum Copper Belt is located in Jharkhand, Eastern India. It forms an arcuate highly deformed linear zone in the Singhbhum Crustal Province and known as one of the most potential sulphide bearing stretch of India. The Singhbhum Shear Zone marks the boundary between a southern platform and a northern mobile belt. The Singhbhum Shear Zone is developed along the southern fringe of the Proterozoic Fold Belt of North Singhbhum. This fold belt is sandwiched between the Early Archean Cratonic Nucleous represented by Singhbhum and Bonai Granite in the south and Proterozoic Chottanagpur Granite Complex to the north. A curvilinear belt of meta sedimentaries belonging to Dhanjori and Singhbhum Group of Proteropzoic age occupies the intervening gap area between the Singhbhum and Chottanagpur crustal province. The Singhbhum shear zone, which has developed in this Proterozoic belt, is a northery dipping arcuate ductile shear zone (Ghosh and Sengupta, 1987) marked by lenticular mylonite zone. The width and trend of the shear zone is 10Km & SW-NE in the western part, gradually narrows down to 1 km & E-W in the central part and again widens to more than 5 Km & NW-SE in southeastern part. In the southeastern part the shear zone splits into a number of N-S trending narrow shear zones (Banerji, 1981).

The copper mineralization along Singhbhum Copper Belt is located along the Dhanjori Group of rocks south of shear zone and Singhbhum Group of rocks north of shear zone. The copper sulphide mineralization is considered to be associated mainly with the meta-volcanics and meta-tuff sequences of the above mentioned Groups (Anon, GSI, 1991). The predominant chalcopyrite – pyrite – pyrrhotite and cuprite ore mineral assemblage is concentrated along massive to braided veins, stringers, dissemination, discordant to sheet like bodies (GSI Topomap number 73J/6)

4. Methodology

Aster image has done atmospheric correction using FLAASH module. Some Parameters has been used for atmospheric correction (Table 1). PCA and other image processing techniques have been implemented for the study. Visible near inferred (B1, B2, B3) and shortwave inferred bands (B8) of ASTER has been chosen for PCA. PC2 shows negative eigenvector loading in band 2 and 8. A high pass median filter (3*3 kernel size) has been run in PC2 for smoothing of brighter values. Histogram stretching of filtered image in specific range enhances the target areas. Logical operators have been used for extraction of the target areas. A flow chart of methodology has been given bellow.

Table 1: Details of FLAASH parameter using for atmospheric correction

Scene canter location	22 33 36.72 86 27 26.27	Initial visibility	: 40km
Sensor Altitude	: 705km	Spectral Polishing	: Yes
Ground elevation	: 0.30	Width of bands	: 9
Pixel size9(m)	: 30	Wavelength calibration	: No
Flight date	: May11 2007	Aerosol scale height(km)	: 2
Flight time(HH:MM:SS)	: 6:02:03	Co_2 mixing ratio(ppm)	: 390
Atmospheric Model	:Sub-Arctic Summer	Use adjacency correction	: No
Water retrieval	: No	Modtran Resolution	: 15 cm-1
Water absorption features	: 1	Modtranmulti scatter Model	: Scaled DISORT
Aerosol model	: Rural	No of Disort streams	: 8
Aerosol Retrieval	: None	Output reflectance scale factor	: 10000
Azimuth Angle	:111.872439	Title Size	: 600

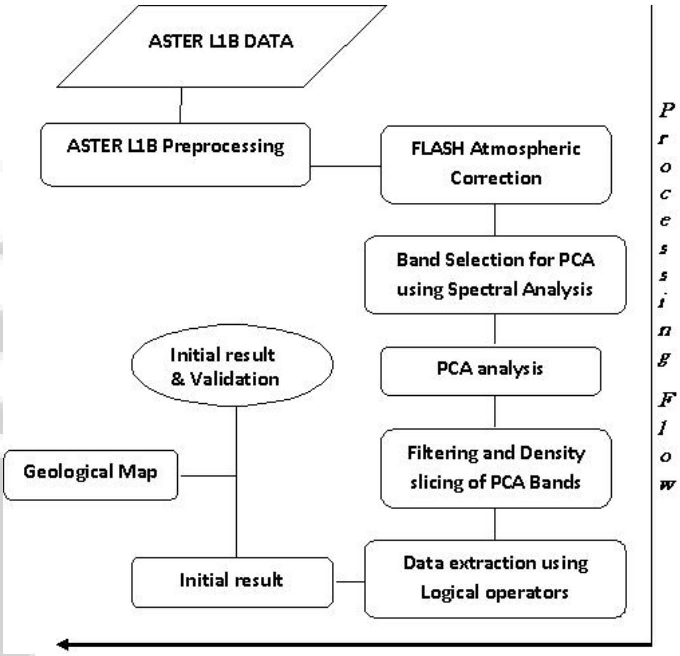


Figure 1: Methodology Flow diagram

4.1 Data Analysis

The principal component analysis is vastly used for hydrothermal alteration mapping in metallogenic belts. The analysis of the values can only identify spectral information about specific minerals, as well as the contribution of each of the original bands to the components. This technique only presents the bright or dark pixels according to their corresponding magnitude of eigenvector loadings. PCA analysis is applied for ASTER data (Table 1). **Figure 2** shows principal component analysis images (PCl to PC4). The first PC shows the green vegetation as the albedo reflection is high in vegetated portion of the area. PC2 enhances the cuprites bearing areas (Fig.1) as this PC has higher loadings of band 1 and 3 (for ASTER band 2 and 8). PC3 enhances the large water bodies as this PC has negative loadings of band 2 and 3 (**Figure 1**). PC4 indicates the bear surfaces as this PC has higher loadings of band 1 and 3

Principal component analysis is done using four ASTER image 123 and 8 band as input Bands (Table 2). The first principal component does not contain spectral information about mineral analysis, as it is a combination of all Bands. This component contains 78.90% of the variance of four bands (table2). This PC1 gives information mainly on albedo and topography. Analysis of PC2 shows that the most important contributions come from Band 2 (0.076942) and Band 8 (-0.584611). Based on spectral characteristics of cuprites, it shows that cuprites veins those are mined or the outcrop will be mapped by bright pixels. cuprites content image is obtained by using eigenvector loadings of PC2.But when inverse PCA has been run using covariance matrix PC3 shows that the most important contributions come from Band 1(0.454519) and band 3(0.667624) **Figure 3**. Principal component analysis can also be used to distinguish lithological differences of various types.

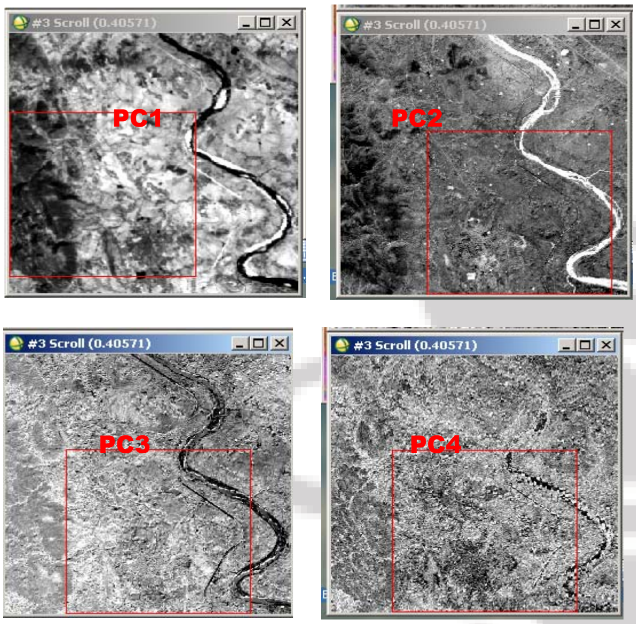


Figure 2: PCA of Four Bands (1, 2, 3, 8)

Table 2: Eigenvalue statistics

Axis	Eigenvalue	Percentage	Cumulative
1	127169.35	78.903729	78.90373
2	26231.448	16.275613	95.17934
3	6749.9189	4.1880672	99.36741
4	1019.5494	0.6325915	100

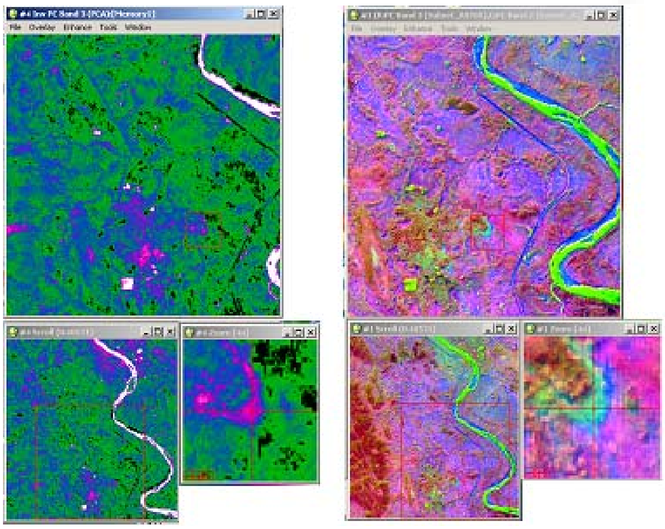


Figure 3: Colour Mapped PC2 And RGB of PCA 3, 2, 1

Table 3: Two dimensional representation of PCA statistics

Eigenvector	PC1	PC2	PC3	PC4
Band 1	0.292835	0.454519	0.245871	0.804492
Band 2	0.060616	0.076942	-0.96816	0.230358
Band 3	0.503471	0.667624	-0.04547	-0.54656
Band 8	0.810611	-0.58461	0.011815	0.031619

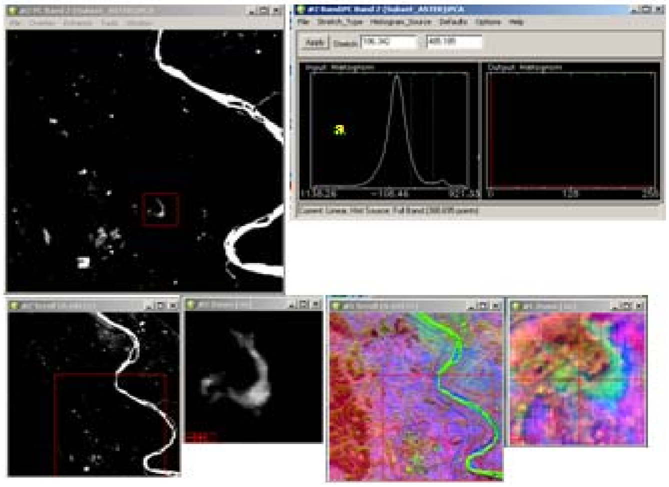


Figure 4: Histogram straching of PC2 and RGB of PCA 3, 2, 1

5. Result and discussion

Aster bands (1,2,3 and 8) has been chosen for analysis.Labrotary testing has proved that hydrothermal altered minerals have higher reflectance in band 1 (0.5560) and 3 (0.8070) and great absorption in band 2 (0.6610) and 8 (2.33). Same charactersticks can be seen in table no.1. Methods like band ratio is used in TM bands of (5/7) to find clay minerals.Same methods are used in aster band 4 and 6 for validation of PCA methods but results are found quite confusing.So geological maps supplied by geological survey of india has been used for validation **Figure 5**. Mainly four zones has been identified. Zone one and two can be seen along with the singhbhum sheer zone.Three and fourth zone can be found both side of subarnarekha river.East side of singhbhum sheer zone has been formed by ultrabasic rock of Gorumahisani Group and age group is Archaean.Weather the west side of sheer zone is formed by Mica schist and phyllite and its agegroup is lower proterozoic.Schist and quarzites are discritely seen in the entire area. Mica schist and phyllite are the indicator of copper occourance as these are associated with cuprite ore bodies. The Figure 4-a shows the absorption of water molicules by clay minerals. The values (186 to 485) of absorption feature of water molicules are extracted by using logical operation which shown in Figure 6.

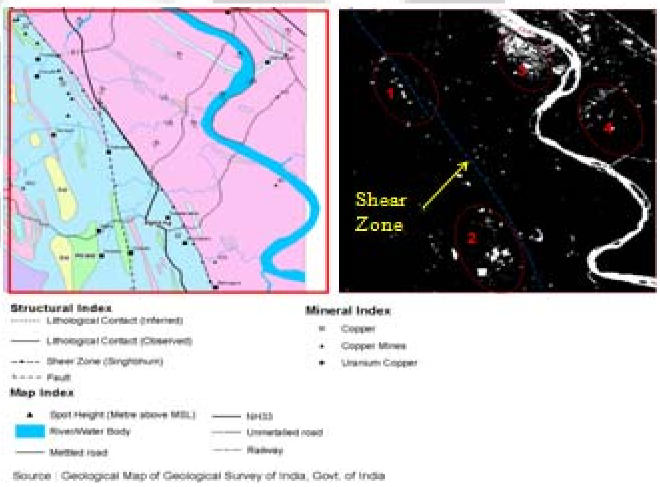


Figure 5: Comparision the Initial cuprite outcrop with GSI map (Left: GSI map and Right: cuprite outcrops)

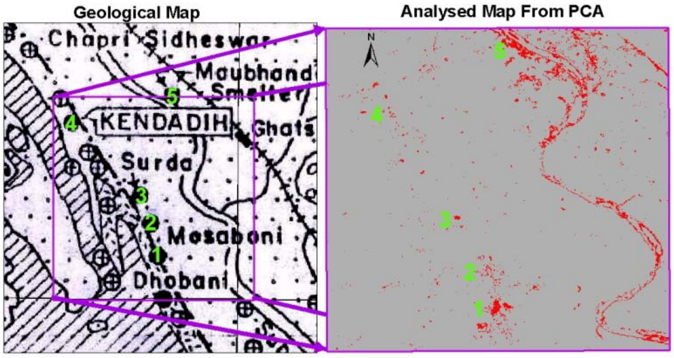


Figure 6: Final cuprite map (Left: HCL geological map and Right: final cuprite outcrops)

6. Conclusion

Analysis of ASTER VNIR and SWIR bands for mineral identification is found very helpful. Natural environmet effects the mineral composition and water content of molicules of cuprite ore body but hydothermally altered clay minerals have some common charactersticks like high reflectance in near infrared region and high absorption in shirtwave infrared region.These charactersticks playes key role in identification of cuprite.Validation this results with geological maps find confidance level of the output.Some part of cuprite ore outcrop signatures are found in subarnerakha river because of presence of gold and higher silica content in sand. Reflactance of gold is nearly similar to the cuprite. Possibly new outcrop of cuprite veins can be seen in N-E corner of the study area.

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Author Profile

Krisknendu Banerjee received the M.Sc in Remote sensing & GIS from Vidyasagar University in 2010 and B.A. degree in Geography (Hons) from Barddawan University in 2008. He is now Junior research Fellow (JRF) at Jharkhand Space Application Center (JSAC), Dept. of Information Technology, Govt. of Jharkhand and registered at Indian School of Mines (ISM), Dhanbad for PhD.

Surajit Panda received the M.Sc in Remote sensing & GIS from Vidyasagar University in 2010 and B.Sc. degree in Geography (Hons) from Haldia Govt. College, Vidyasagar University in 2008. He is now Junior research Fellow (JRF) at Jharkhand Space Application Center (JSAC), Dept. of Information Technology, Govt. of Jharkhand and registered at Indian School of Mines (ISM), Dhanbad for PhD.

Manish Kumar Jain received his Ph.D, from IIT-Kharagpur. He is Associate professor of Department of Environmental Science & Engineering, ISM Dhanbad, Jharkhand. He published several research papers in International Journals and conferences.