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IDENTIFICATION OF IRON OXIDES MINERALS IN WESTERN JAHAJPUR REGION, INDIA USING AVIRIS-NG HYPERSPECTRAL REMOTE SENSING

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KEYWORDS: AVIRIS-NG, Iron-oxide, Limonite, Western Jahajpur belt, Hyperspectral remote sensing.

ABSTRACT:

Hyperspectral remote sensing is being considered as an advanced technique for mineral identification of surficial deposits. In this research different iron oxides minerals such as limonite, goethite has been identified using AVIRIS-NG airborne hyperspectral remote sensing covering the Omkarpura, Itwa, and Chhabadiya mines area in Jahajpur Bhilwara, Rajasthan, India. AVIRIS-NG has shown robust performance in iron oxide identification in the study area. Mineral spectral signatures of the AVIRIS-NG data were compared with spectra of USGS spectral library, and field investigated mineral spectra of iron oxides and found very promising. The results allow us to conclude that due the high signal to noise ratios of the AVIRIS-NG, it is capable to identify the different iron bearing minerals in the visible and infrared portion of the electromagnetic spectrum.

1. INTRODUCTION

"The Airborne Visible-Infrared Imaging Spectrometer - Next Generation (AVIRIS-NG) has been developed to provide continued access to high signal-to-noise ratio imaging spectroscopy measurements"(JPL NASA, 2015). Joint mission of ISRO-NASA has made an execution plan on February 04, 2016 to capture the surficial mineraldeposits in Jahajpur group belt of Bhilwara super group Rajasthan(SAC, 2016, JPL NASA, 2015). The surface mineralogy mapped and identify through characteristic absorption features which are located in the range of visible to shortwave-infrared range(Bell et al., 2010).The minerals which associated with $Fe^{3+,}$ Al- OH, Mg-OH, CO_3^{2-}, and SO_4^{2-} can be mapped and discriminated by hyperspectral remote sensing data, smoothly (Clark et al., 1990, Crósta et al., 2003, Farooq and Govil, 2014, Jing et al., 2014, Clark, 1999, Eduardo et al., 2011).* According to Parashar (2015) the hydrothermally developed hydroxyl minerals such as clay group of minerals and K-micas allow for remote identification which show the diagnostic absorption in infrared region(Parashar, 2015). The presence of mineral containing iron, such as goethite, jarosite, limonite and hematite due to erosion and weathering of hydrothermally developed sulphide deposits have various different absorptions in VNIR/SWIR regions(Parashar, 2015, Dhara, 1978).There are two major spectral intervals which is used for mineral identification and mapping in range of 0.4-2.5 µm of EMR spectrum. The 0.4-1.1 µm of VNIR region are ubiquitous Fe^{2+} and Fe^{3+} have multispectral absorptions related to electronic transitions. The $Fe^{2+,}$ Fe^{3+} have shown charge-transfer absorptions are at around 0.6 µm band width. There are various distinct electronic absorption features near 0.6 µm and 0.9 µm by Limonite and Goethite (Roberto and Filho, 2000). The Fe^{3+} have shown absorption at 0.43, 0.5 and 0.6 µm, and Fe^{2+} have shown absorption features in 0.9 -1.2 µm(Magendran and Sanjeevi, 2014, Murphy and Monteiro, 2013, Govil et al., 2018, Cloutisa et al., 2006, Bell et al., 2010, Pour and Hashim, 2015).

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2. GEOLOGICAL SETTINGS OF THE STUDY AREA

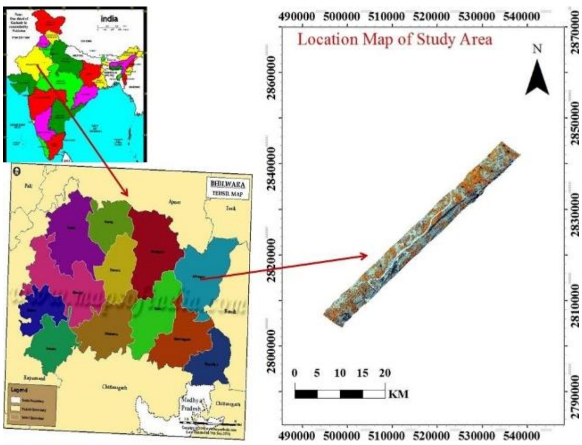

Figure 1. Location map of the study area

The basement rock of Jahajpur group of Bhilwara supergroup are archaean age. There are two parallel ridges of dolomitic limestone and quartzite striking in north east direction along and across the Banas river. The quaternary sediments are exposed in the river channels. The western part of Jahajpur group is intruded with Mangalwar complex and in east surrounded by Hindoli groups of rocks. There are four types of rocks are reported by various scientist and researchers such as dolomite, phyllite, quartzites, banded iron formation (BIF), and quaternary sediments. The identified minerals which is reported by geological society of India are iron, clay , talc, and soapstone(Geological Survey of India-District Report., 1977, Sinha-Roy, 1984, Sinha Roy and Malhotra, 1988, Sinha-Roy, 2001, Saxena and Pandit, 2012, Heron, 1935, Srivastava, 1968, Yadav et al., 2001, Shekhawat and Sharma, 2001) .

3. DATA AND METHODOLGY

The acquired date of AVIRIS NG hyperspectral image is 04/02/2016 for Jahajpur region of Bhilwara district Rajasthan. AVIRIS-NG have 427 contiguous channels with 5nm and 8.1 spectral and spatial resolution respectively in spectrum region 0.3 -2.5 51µm of EMR(Hamlin et al., 2011, JPL NASA, 2015, SAC, 2016).The concepts and instruments of AVIRIS-NG are completely free from keystone and smile error distortions.The AVIRIS-NG data have highest signal to noise ratio. The adopted approach of methodology is that preprocessing and determination of AVIRIS-NG airborne hyperspectral data, Image calibration, atmospheric correction, bad band removal, and dark subtraction method related to preprocessing of image, and extraction spectral features are related to determination process of approach. The extracted mineral spectra are correlated and compared with USGS spectral library, and field spectra(King and Clark, 2000). Minerals are identified through absorption and reflectance in a particular bandwidth for particular minerals through interpretation(Molan et al., 2014) and compared with mineral spectral library of USGS..

Sensor Altitude	4-8 km	Spectral Range	380 nm to 2510 nm
Spatial Resolution	8.1 m	Spectral Coverage	Continuous
Swath Width	4-6 km	Spectral Resolution	5nm ± 0.5 nm
VNIR Range	400nm-1000nm	SWIR range	900nm-2500nm
IFOV (mrad)	1.0 mrad	Total number of bands	425

Table 1. The specified parameters of AVIRIS-NG (Hamlin et al., 2011, Bhattacharya, 2016, JPL NASA, 2015)

4. RESULT AND DISCUSSION

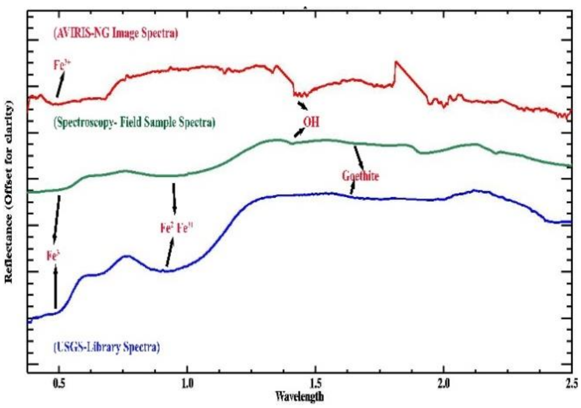

Figure 2:Spectral features of goethite minerals.

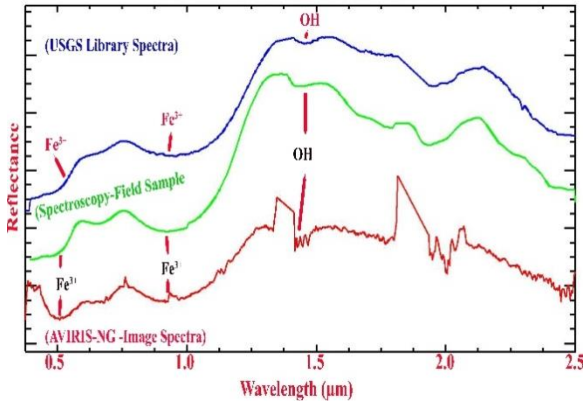

Figure 3: Spectral features of goethite/limonite minerals

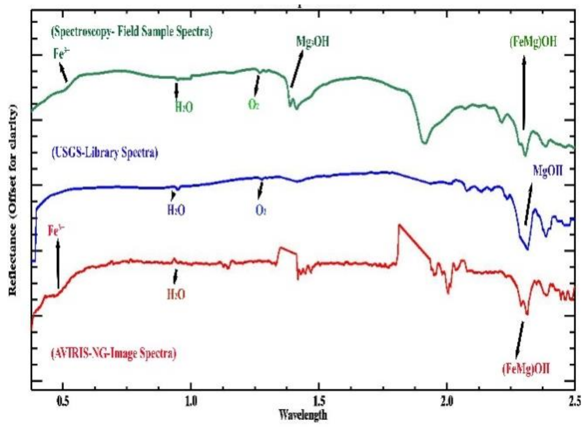

Figure 4: Spectral features talc minerals and associated goethite minerals

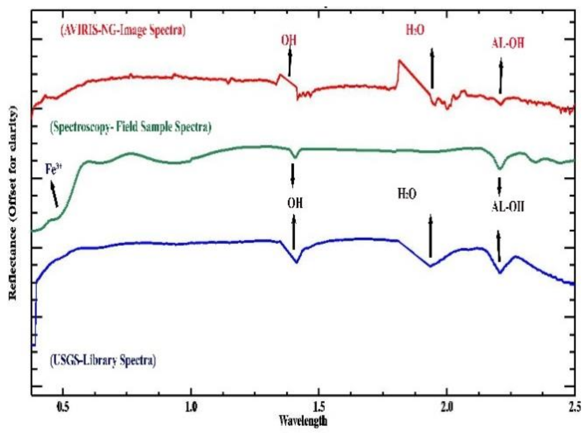

Figure 5: Spectral features of montmorillonite and goethite /limonite

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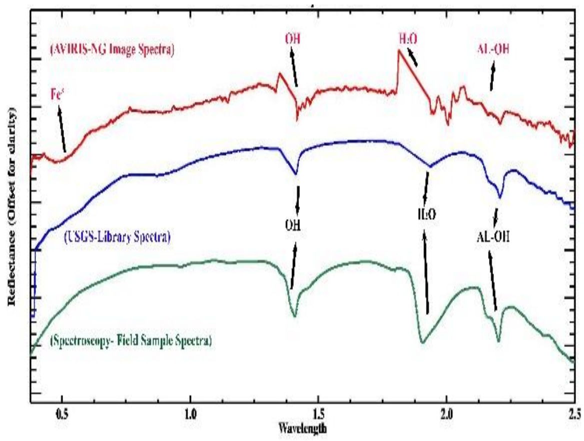

Figure 3: Spectral features of kaosmec and goethite minerals

The hydrothermal alteration product limonite ($Fe^{+3}O(OH)$. nH_2O) iron oxide minerals are identified in dolomitic rocks, near Itwa/Omkarpura village (Figure 2 and 3) andnear Ghevaria talc mines (Figure 4), Chhabadiya village (Figure 5), Omkarpura village (Figure 6) of Jahajpur, Bhilwara, Rajasthan. The image spectra of limonite at location Itwa and Omkarpura, showing distinct absorption features at bandwidth of image spectra such as at 0.5417, 0.9274 µm with presence of OH absorptions at 1.331-1.4182 µm and 1.8080-1.934 µm, but at location Chhabadiya and Ghevaria iron oxides are present as minor content as impurity in clay and talc minerals.There is similarity between field measured spectra of limonite, USGS mineral spectral library, and image spectra. Field measured spectra have shown absorptions at 0.5070 µm, 0.6260 µm, 0.9310 µm, 1.4132 µm, 1.8080 µm.(Magendran and Sanjeevi, 2014, Murphy and Monteiro, 2013, Mielke et al., 2016, Roberto and Filho, 2000, Govil et al., 2018, Pour and Hashim, 2014, Pour and Hashim, 2015, Zhang et al., 2016, Boesche et al., 2015).

5. CONCLUSION

The interpretation and identification of iron oxides/hydroxide(Highway, 1991) minerals Limonite/Goethite measured through field spectra using spectroradiometer, and image spectra of AVIRIS-NG and compared with USGS mineral spectral library, which have shown absorptions at 0.46, 0.54 (Grebby et al., 2014) 0.76, 0.92 (Pour and Hashim, 2014), 2.0, 2.2, 2.35 and 2.39 µm in VNIR-SWIR indicates association of oxides/hydroxides, clay, talc, and carbonate minerals. This result shows that the AVIRIS-NG data have robust performance and capability in mapping and identification of the alteration zones because association of these mineralsare indicating phyllic, argillic (Lagat, 2009, Zhang et al., 2016) and supergene product of gossan(Ramakrishnan and Bharti, 1996) and alteration of oxidation and reduction, and weathering environment. The conclusion is that AVIRIS-NG have better capability to differentiate and identify the oxides minerals and facies alteration.

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