RESEARCH REVIEW JOURNALS
Volume-03
Issue-09
September-2018

ISSN: 2455-3085 (Online)
RESEARCH REVIEW International Journal of Multidisciplinary
www.rrjournals.com [UGC Listed Journal]

Hyperspectral and Petro - Chemical Signatures study on Corundum Bearing Amphibolite Schist of Magadi Area, Ramanagara District, Karnataka, India

[1]Maruthi N.E & [2]Basavarajappa H.T

[1,2]Department of Studies in Earth Science, Centre for Advanced Studies in Precambrian Geology, University of Mysore, Manasagangothri, Mysuru, Karnataka (India)

ARTICLE DETAILS

Article History
Published Online: 07 September 2018

Keywords
Hyperspectral Signatures, Geochemistry, Corundum bearing amphibolites, Magadi

Corresponding Author
Email: *maruthi.shree999[at]gmail.com*
Basavarajappaht[at]gmail.com

ABSTRACT

Corundum is best known for its gem varieties, Ruby and Sapphire. Corundum is a very hard, tough, and stable mineral. For all practical purposes, it is the hardest mineral after Diamond, making it the second hardest mineral. Precambrian basement rocks of Karnataka composed of active and dynamic geological settings with economic mineral deposits and variety of gemstones. These gemstones were noticed all along the lithological contacts of Green stone & Schist Belts, adjesent to younger granites and granitoids of Dharwar Craton of southern Karnataka. Magadi area comes to Ramanagara district, it has three kinds of litho units with economically viable minerals including gemstones varieties particularly in contact zones of ultramafics, amphibolite schist with gneiss and younger granites. Random samples were collected such as gneiss, and corundum bearing Amphibolite schist through GTC (Ground Truth Check). The study carried out by geological, petrochemical and Hyperspectral signature using advent high-tech tools of Spectro- Radiometer (Spectral Evolution SR-3500) instrument, DARWin SP.V.1.3.0 and GIS software's. The spectral signatures of the collected samples were derived in laboratory environment to achieve better accuracy. Hyperspectral (350-2500nm) were developed as works mainly on physico-chemical and optical properties of the litho units which help in mapping of precious gemstones at lithological contacts and mineralized zones. The present study aims to charactrize the spectral behavior of Corundum and associated rocks of the study area. Spectral radiometer instrument bring out diagnostic features on lithological contact for better discrimination of verity gemstones and altered minerals. The final results highlight the spectral characters of corundum and associated rocks for better mapping of Magadi area of Ramnagara district in Precambrian Amphibolite schist rocks and similar terrains of Karnataka State.

1. Introduction

Corundum is a very hard, tough, and stable mineral. Ruby is distinguished for its bright red colour, being the most famed and fabled red gemstone. Besides, its bright colour, it is a most desirable gem due to its hardness, durability, luster and rarity (Basavarajappa et al., 2018). Transparent rubies of large sizes are even rarer than diamonds and ruby is found in hexagonal prisms and blades forms. For thousands of years, the ruby has been considered one of the most valuable gemstones on Earth (Maruthi et al., 2018). Corundum occurs as a mineral in mica schist, gneiss, and some marbles in metamorphic terranes. It also occurs in low silica igneous syenite and nepheline syenite intrusives. Other occurrences are as masses adjacent to ultramafic intrusives, associated with lamprophyre dikes and as large crystals in pegmatites (Basavarajappa and Maruthi, 2018). The study area Magadi comes to Ramanagara District. The district exposes mainly comprise rocks belong to Sargur group, Peninsular gneissic complex (PGC), Closepet granite, and basic and younger intrusives of the precambrian era (Ramakrishnan and Vaidyanadhan., 2008). The spectral signatures of the field samples were compared with mineral spectra of USGS spectral library to record the spectral behavior (Basavarajappa and Maruthi, 2018). The absorption and reflection features are studied as described by Hunt and Salisbury (1970), Hunt et al., (1971), Hunt and Ashley (1979) and (Graham Hunt 1977), the fresh or weathered surface of iron metallic elements causes strong absorptions in Visible and Near Infrared region of electromagnetic wavelength.

2. Study Area

The study area is located in between $12^0$40.0' to $13^0$0.0' North latitude and $77^0$0.0' to $77^0$20.0' East longitude with an aerial extent of 1030 sq km (Fig.1). Magadi taluk is bounded by Bangalore and Nelamangala taluks towards east and to the west by Kunigal taluk to the south by Ramanagaram taluk, to the north by Nelamangala and Tumkur taluks,. The taluk has two major basins Arkavathi and Kanva and enjoys a beautiful natural uneven topography comprising of the hilly and plateau regions. Among the major hill ranges are the Savandurga (1226 meters above MSL), Chilurbetta (1055 meters), Bairanabetta (1050 meters), Siddeshwarabetta (931 meters) and Basavana betta (859 meters). The general area covering mainly red & block soils associated with metamorphosed granitic gneiss composition, ultramafics, Corundum bearing Amphibolite schist rocks (CGWB, 2013).

Table.1. Samples collected and its Location

Sl No	Samples Name	Villages name	Latitude	Longitude
CM-1.	Corundum	Huthridurga	$12^0$56.764'	77^0 07.143'
CM-2	Corundum	Varthehalli	$12^0$53.311'	77^0 08.403'
CM-3	Corundum	Akkur	$12^0$49.398'	77^0 09.966'
CM-4	Corundum	Hosahalli	$12^0$52.658'	77^0 02.182'
CM-5	Corundum	Lakkashettypura	$12^0$49.402'	77^0 03.596'
CM-6	Corundum bearing amphibolites schist	Byranaikanahalli	$12^0$46.710'	77^0 02.061'

*Note: **CM- C**orundum at **M**agadi*

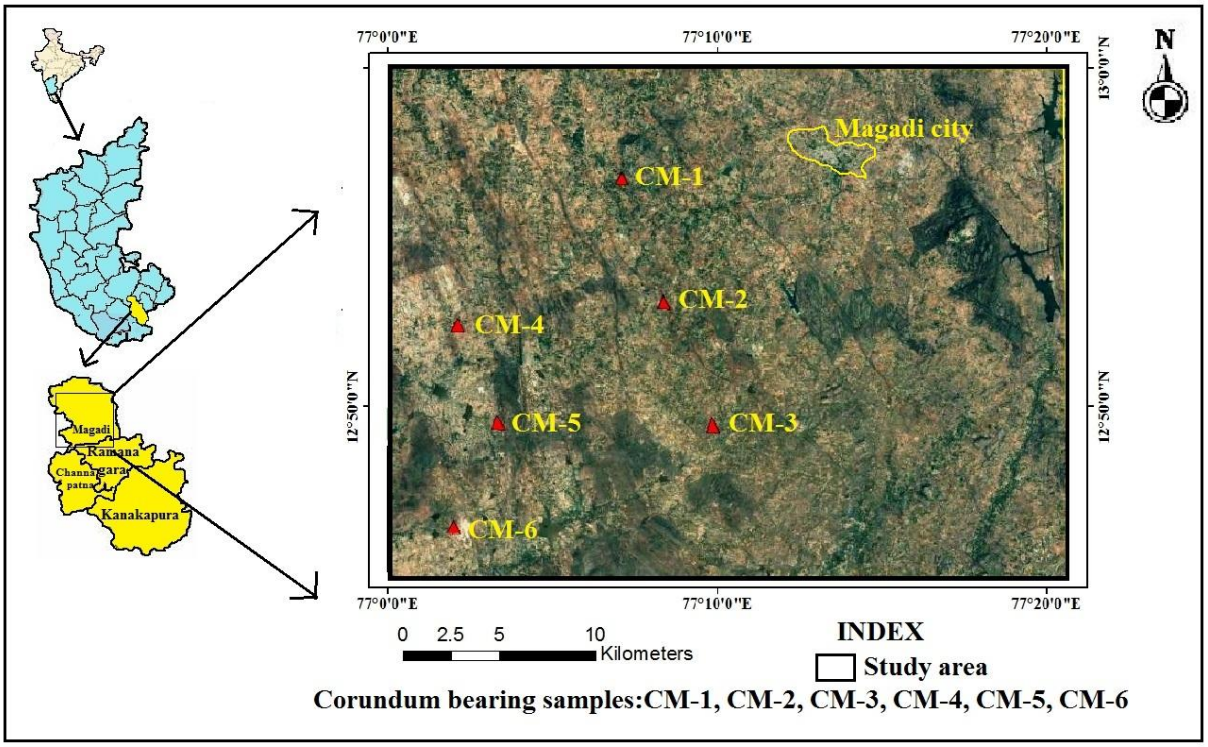


Fig.1. Google Earth image showing the location of the study area

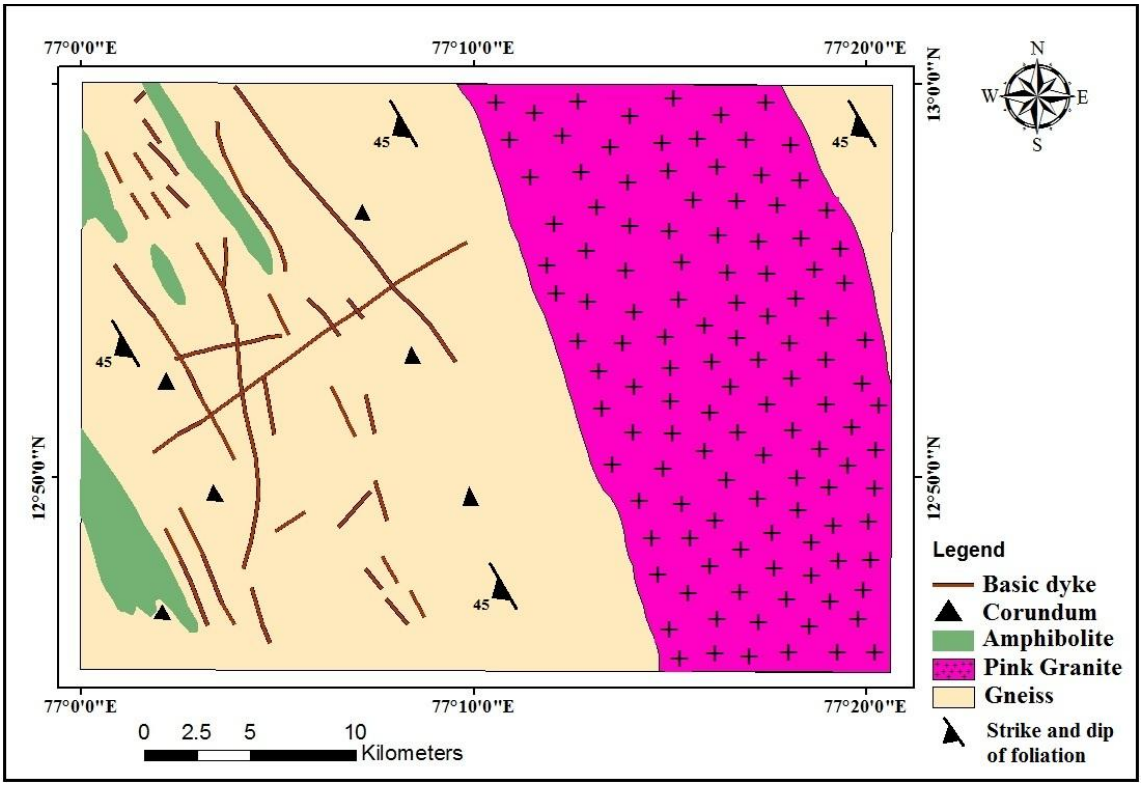


Fig.2. Geological map of the study area

3. Geology

The study area Magadi comes to Ramanagara District. The district mainly comprise rocks belong to Sargur group, granulite group, Peninsular gneissic complex (PGC), Closepet granite, and basic and younger intrusives of the Precambrian era (Ramakrishnan and Vaidyanadhan., 2008). Granulite and migmatites, Sargur group comprises ultra mafic rocks, amphibolites, banded magnetite quartzites, occurring as small bands, and lenses within the migmatite and gneisses (Radhakrishna and Naqvi, 1986). The PGC includes granites, gneisses and migmatite and occur to the east and west of Closepet granite. Transformation of PGC into Charnokite is reported locally in the district (Radhakrishna., 1983). The Closepet granite occurs as intrusive bodies trending nearly N-S within the gneisses over a distance of 50km and with a width of 15-20km (Naqvi and Rogers, 1983). The granitic rocks found in the taluk include, quartz magnatite granulite and the garnetiferous - cordiorite biotite granulite. The Closepet granite contains enclaves of migmatites, gneisses, quartzites and amphibolites and is reported to be of variable composition.The basic intrusives are represented by dolerite, gabbro, occasionally norite and pyroxenite. The dolerite is dominant among the basic dykes. There are three major lineaments in the district trending NNW-SSE direction. These lineaments range in length from 45 km to 70 km. Interpretation of this data revealed the presence of deep seated fault trending NNW-SSE, which cuts across the Closepet granites (Swaminath and Ramakrishnan, 1981).

4. Methodology

Field based samples were collected and carried carefully to the laboratory for Petrographic study using Petrological, Mineralogical research Microscope; while geochemical data was received through XRF Minerals, Materials Science & Technology Division NIIST Thiruvananthapuram, Kerala. Hyperspectral signatures analyses for all samples were carried out using Lab Spectro-radiometer instrument (Spectral Evolution SR-3500) at Department of Earth Science University of Mysore, Manasagangothri, Mysuru. (Basavarajappa and Maruthi., 2018). DARWin SP.V.1.3.0 software is well utilized in analyzing each spectral curves obtained from the collected samples (average of 4 spectral curves from each samples) and well correlated with the standard curves of USGS, JPL and JHU. Survey of India (GSI) topo map and Geological quadrangle map (57H) of 1:2.50.000 scale is used during the field work to study corundum bearing litho units. Garmin-12 GPS is used to record the exact locations of each sample with an error of 9 mts during field visits (Basavarajappa et al., 2017).

5. Petrography

5.1 Corundum:

The corundum optical properties show Color: pink to blood-red colored (some time spotted in red – Ruby or blue-Sapphire) The red color is caused by the mineral chromium and shows brownish tone due to the presence of iron. Relief shows high to very high. Prismatic, tabular or skeletal crystals and Rhombohedral parting/ cleavages are common. pleochroism is very strong in ordinary light and shows deep red color when viewed in the direction of vertical axis and a much lighter color to nearly colorless in view at right angles to this axis. Birefringence weak, Uniaxial negative. but often up to low II order due to extra thickness of ultra-hard corundum (Fig.3).

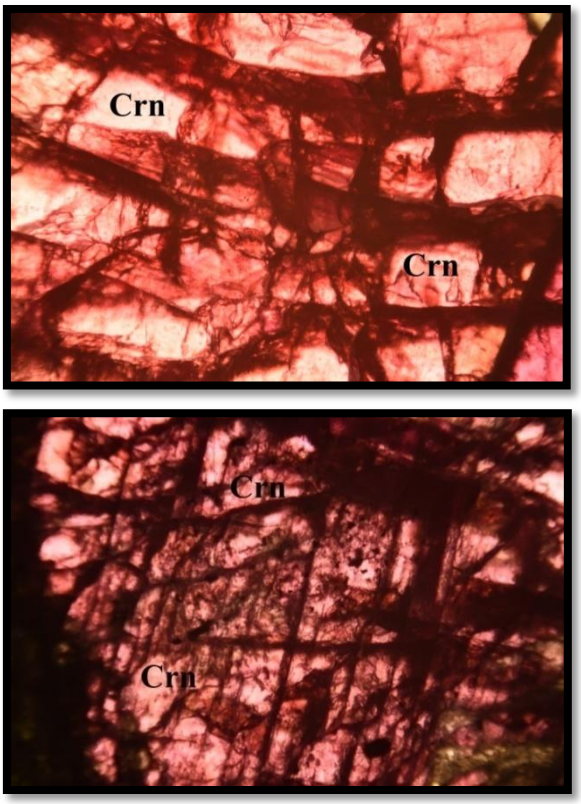
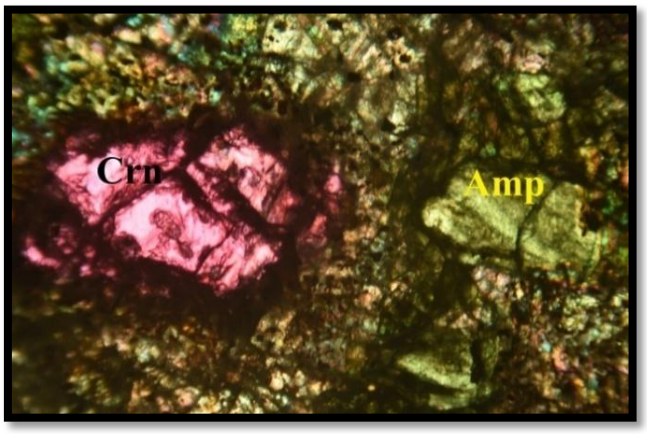


Fig.3. Corundum sample of Microphotographs.

5.2 Corundum bearing Amphibolite schist:

The central part is associated corundum which pink to blood-red colored; uniaxial; low birefringence and surface relief is high. Amphibole is usually strongly green in coloure, yellow-blue, blue-green and brown. It shows strong pleochroic, moderate relief, high cleavage, birefringence biaxial and pleochroic appears in various shades of green and brown. In plane polarized light, the mineral colour of amphibole ranges from yellowish green to dark green in Colour (Fig.4).



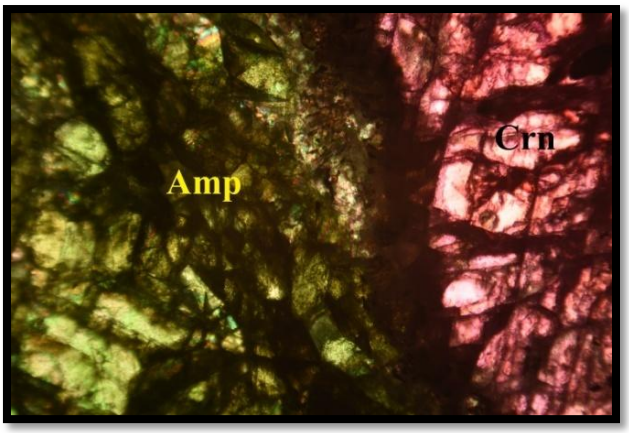


Fig.4. Corundum bearing Amphibolite schist samples of Microphotographs.

6. Hyperspectral Signaturs

Spectral signature measures all types of wavelengths that reflect, absorb, transmit and emit electromagnetic energy from the objects of the earth surface (Ali M. Qaid et al., 2009). Specral Evolution (SR-3500) Spectro-radiometer instrument has the ability to measure the spectral signatures of different rocks/ minerals. The SR-3500 operate in the wavelength range of 350–2500 nm with three detector elements: a 512-element Si PDA (Photodiode Array) covering the visible range and part of the near infrared (up to 1000nm) and two 256-element InGaAs arrays extending detection to 2500nm.The spectral signatures of the representative samples were compared with mineral spectra of USGS spectral library in DARWin SP.V.1.3.0 (Hunt et al., 1971). Absorption spectral values obtained from the DARWin software lab Spectra is the one character helps in the study of major and minor mineral constituents.

7. Result and Discussion

Major element composition of samples of corundum bearing rocks were determined at the chemical division and geochemistry its using XRF method. Corundum bearing rocks were determined at the using spectral signatures. The spectrometer component is a crossed Czerny-Turner configuration using ruled gratings as the dispersive elements. Energy enters the spectrometer and is collimated before being reflected off the gratings and refocused onto the PDA (Photodiode Array) detectors. There are three detectors. The first is a 512-element silicon array covering the spectral range from 350 to 1000 nm (280–1000nm). Two thermoelectrically cooled InGaAs (Indium Gallium Arsenide) arrays of 256 elements each extend the spectral range up to 1900nm and 2500nm respectively. The spectroradiometer and controlling electronics are contained in the housing. International standards for minerals such as USGS were compared along with the major elements for the field samples to check precision and accuracy of measurement. The certified and analyzed values of USGS are given in the figures along with major element abundances of samples to check the error limits of measurement (Hunt et al., 1971).

Corundum Al_2O_3 mineral type - Oxide this sample prepared from crystals that were brownish near the surface and bluish – green near in the interior. Very sharp corundum reflections suggest excellent crystallinity and compostional homogeneity (Maruthi et al., 2018). composition discussion analysis showed the sample to contain 0.18% Cr. 1.7% Fe and 0.2% Si with traces of Ti, V, Mn, Mg, Ca and Cu the iron appears to be present on both ferrous (0.55. 0.45 and 1.1um absorption features) and ferric (0.7. 0.45 and near 0.4um) from the Cr^{3+} ion contributes to the 0.4. 0.55 and 0.7um (emission) features. Spectral discussion Sample plots are correlated with standard USGS Spectral Library using absolute reflectance v/s wavelength which provide strong absorption range in 2.20 µm and 0.65 µm representing the mineral corundum shows intense absorption feature in 2.40 µm of the electromagnetic spectrum (Hunt et al., 1971). Absorption anomalies at wavelength regions of 0.55 µm and 0.9 µm of Fe3+ and Fe2+ ions are observed respectively with low reflectance in the VNIR region (Ali M. Qaid et al., 2009) (Fig.5). Major element content as Al_2O_3 content shows high range imparts a corundum character with that of high aluminum content. Library spectrum corundum correlation score 0.861 percent match the curve (Fig-5)

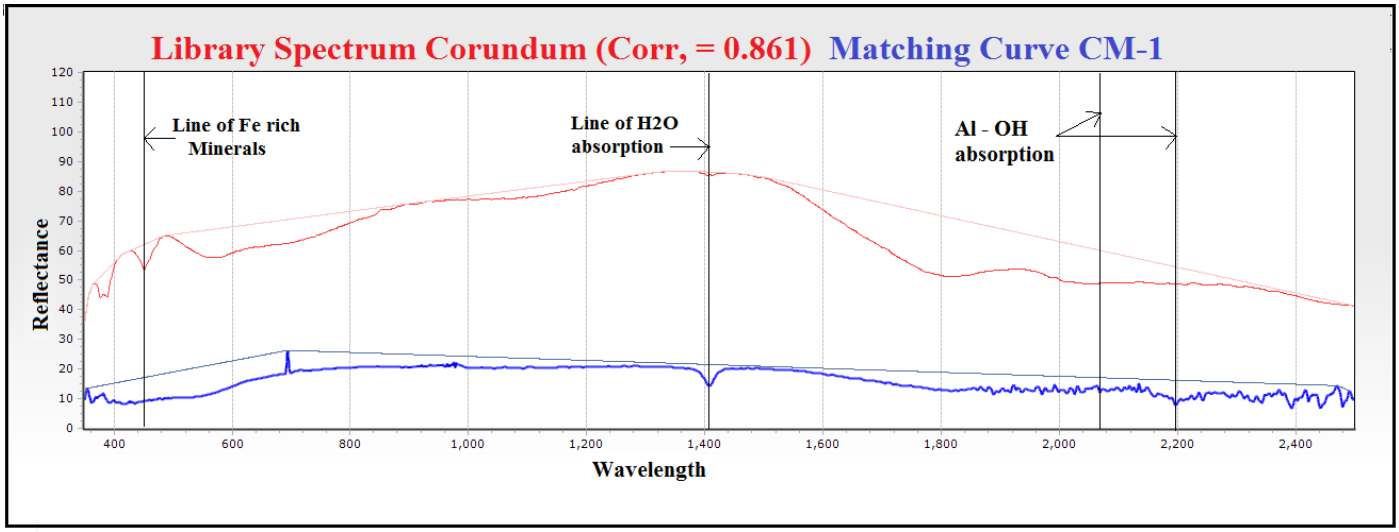


Fig.5. Lab Spectral signatures of Corundum, Magadi area

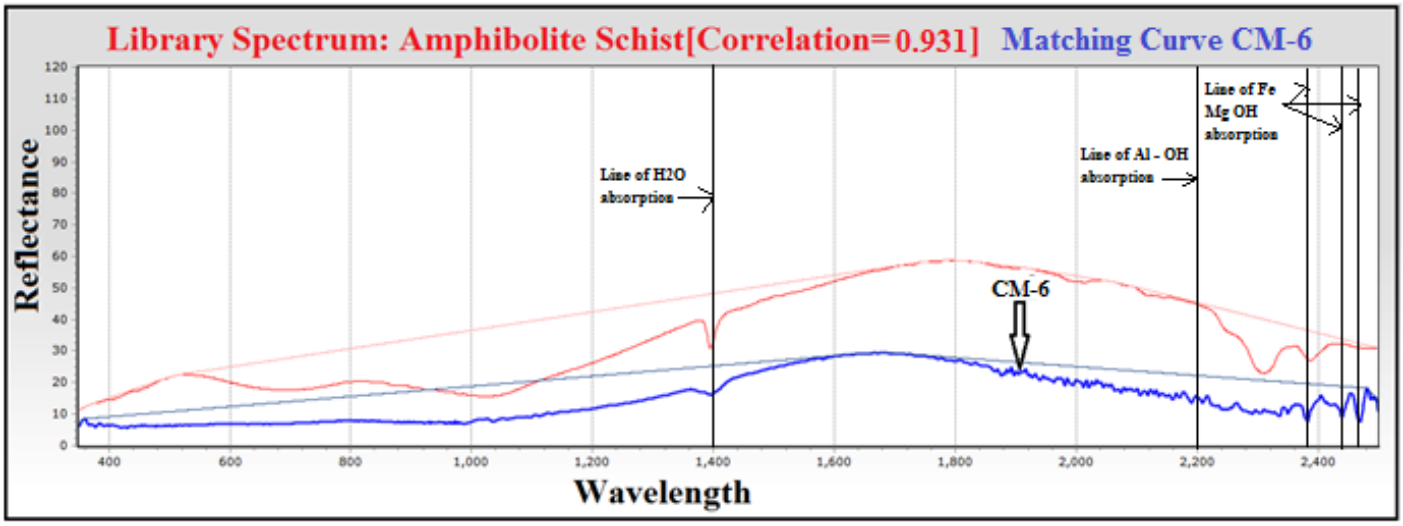


Fig.6. Lab Spectral signatures of Amphibolite Schist, Magadi area

Amphiboles are found principally in metamorphic and igneous rocks. They occur in many metamorphic rocks, especially those derived from mafic igneous rocks (those containing dark-coloured ferromagnesian minerals) and siliceous dolomites. Major and minor element content of amphibolite schist shows SiO_2 ranging between 31.8% and 39.59%; MgO content is fairly low and ranges from 10.47% to 11.8%; Al_2O_3 content high ranges from 24.80% to 31.11%; CaO content is 10.56% to 6.43%; K_2O content of ranges from 0.14% to 0.12%; TiO_2 content is fairly low and varies from 0.38% to 0.87% and P_2O_5 ranges from 0.56% to 0.7% (M. Qasim Jan 1988). Spectal discussion Sample plots provide strong absorption range from 2.0 – 2.25 µm representing the mineral corundum whereas amphibole shows intense absorption feature in 2.35 µm of the electromagnetic spectrum (Hunt et al., 1971). Absorption anomalies at wavelength regions 0.55 µm and 0.9 µm of Fe^{3+} and Fe^{2+} ions are observed respectively (Fig.6). Absorption range 1.4µm are noticed due to the presence of water and hydroxyl molecules in the present sample (Ali M.Qaid et al., 2009). library spectrum Amphibolite Schist correlation score 0.931 percent match the curve (Fig-6). Lab spectra of corundum strong absorption range identified in the wavelength of 2.10 µm and 2.20 µm and 0.65 µm representing the mineral corundum shows intense absorption feature in 2.40 µm of the electromagnetic spectrum (Hunt et al., 1971) (Fig-6).

Table.2. Major, minor Elements and Spectral analysis data of the study area

Chemical Elements		Samples			
		CM-1	**CM-2**	**CM-5**	**CM-6**
Elements (wt%)	SiO_2	9.72	11.89	31.80	39.59
	Al_2O_3	***83.35***	***81.07***	***24.80***	***31.11***
	Fe_2O_3	2.50	1.93	12.12	7.72
	MgO	N.D	N.D	10.47	11.8
	CaO	1.10	1.45	10.56	6.43
	K_2O	0.23	0.23	0.14	0.12
	TiO_2	1.80	1.13	0.38	0.87
	MnO	0.085	0.02	0.17	0.05
	P_2O_5	0.75	0.72	0.56	0.7
	Cr_2O_3	0.27	0.41	8.55	2.34
	NiO	0.002	0.006	0.17	0.21
	Total	**99.72**	**98.85**	**99.72**	**99.64**
Rock type		Corundum	Corundum	Amphibolite Schist	Amphibolite Schist
Spectral Analysis					
Absorption spectra (µm)	Lab spectral signature	0.45, 0.7 2.100 2.200	0.45, 0.7 2.100 2.200	0.700, 0.950, 1.400 1.910, 2.200, 2.310, 2.400	0.470, 1.400 1.910, 2.200, 2.250, 2.350
Best matches to	USGS	Corundum	corundum	Amphibole, Corundum	Amphibole, Corundum

Fig.7. Hand specimen of Corundum bearing Amphibolite schist rock Collected samples Magadi area of Ramanagara district

8. Conclusion

Geological, Petrographic, Physical and Chemical characteristics are studied and discrimination shows purity of the mineral present in the Precambrian rock. Analyzed and Studies for the selected samples were carried out and identified mineral assemblage of corundum bearing rocks. The perfect tabular texture and pink to red, pale blue pleochroic character reveal the presence of corundum mineral present in the collected samples. Lab spectra of corundum identified in the wavelength of 2.10 µm and 2.20 µm regions through the absorption curve matches the USGS standard shows the purity of mineral present in the rock. Hyperspectral signature data were analyzed for the same part of corundum bearing sample using Lab Spectro-radiometer which shows best match with that of USGS Spectral Library Standards. corundum purity amphibolite schist and corundum is best curve matches to compare the Spectral Evolution (SR-3500) instrument.

Acknowledgment

The authors are indepthly acknowledged Prof. K.G Asha Manjari, Chairman, DoS in Earth Science, Centre for Advanced Studies in Precambrian Geology (CAS), Manasagangothri, University of Mysore, Mysuru; heartily acknowledged Dr. M. Sundarajan Senior Scientist, Minerals, Materials Science & Technology Division NIIST Thiruvanthapuram, Kerala, India and Geological Survey of India, Bengaluru and UGC, New Dehli. This study is supported by the UGC NFHE.

References

1. Ali M. Qaid, Basavarajappa H.T. and Rajendran S. (2009). Integration of VNIR and SWIR Spectral Reflectance for Mapping Mineral Resources; A case study, North East of Hajjah, Yemen, J. Indian. Soc. Remote Sens, Vol.37, Pp: 305-315.
2. Basavarajappa H.T, Maruthi N.E and Manjunatha M.C (2017). Hyperspectral Signatures and Field Petrography of Corundum bearing litho-units in Arsikere band of Haranahalli, Hassan District, Karnataka, India. International Journal of Creative Research Thoughts, Volume5, Issue4, Pp.3791-3798.
3. Basavarajappa H.T and Maruthi N.E (2018). Petrochemical characteristics and Hyperspectral signatures on Corundum bearing Precambrian litho-units of Varuna area, Mysuru district, Karnataka, India. International Journal of Creative Research Thoughts, Volume6, Issue1, Pp.998-109.
4. Basavarajappa H.T, Maruthi N.E, Jeevan L and Manjunatha M.C (2018). Physico-chemical charectristics and hyperspectral signature study using geomatics on gem verity of corundum bearing precambrian litho-units of Mavinahalli area, Mysuru district, Karnataka, India. International Journal of Computer Engineering and Technology(IJCET) Volume 9, Issue 1, pp. 102-112.
5. Basavarajappa H.T, and Maruthi N.E (2018). Hyperspectral Signature Study Finds Corundum Alters To Diaspore Influeance Of Climate Change Of Dharwar Craton Arsikere Band Of Haranahalli, Hassan District, Karnataka, India. Journal of Environmental Science, Computer Science and Engineering and Technology (JECET) Volume 7, Issue 2, Pp.238-246.
6. Basavarajappa H.T and Maruthi N.E (2018). Petro – Chemical And Spectral Signatures On Corundum Bearing Precambrian Amphibolites In Sullia Area, Dakshina Kannada District, Karnataka, India. Journal of Emerging Technologies and Innovative Research (JETIR) Volume 5, Issue 7, pp. 75-83.
7. Basavarajappa H.T and Maruthi N.E (2018). Hyperspectral And Petro - Chemical Signatures Study On Shear Zone Controlled Corundum Bearing Pelitic Rocks Of Budipadaga Area, Chamarajanagara District, Karnataka, India. International Journal of Research and analytical Reviews (IJRAR) Volume 5, Issue 3, pp. 906-913.
8. Graham R. Hunt (1977). Spectral Signatures of particulate minerals in the visible and near infrared. Geophysics, Vol. 42. No.3, Pp: 501-513.
9. Hunt G.R, JW. Salisbury, C.J, Lenhoff (1971). Visible and Near Infrared Spectra of minerals and Rocks III oxides and Hydroxides,mod, Geo, 2 pp 195-205.

10. Hunt and Ashley (1979) Spectra of Altered Rocks in the Visible and Near infrared. Journal of Economic Geology, Volume 74 number 7, Pp1613-1629.
11. Maruthi N.E, Basavarajappa H.T, Jeevan .L and Siddaraju M.S (2018). Hyperspectral Signatures On Corundum Bearing Litho-Units Of Precambrian Basement Rocks Around Closepet Granite Pavagada Area, Karnataka. International Journal of Computer Engineering and Technology (IJCET) Volume 9, Issue 3, pp. 86-94.
12. Naqvi SM, Rogers JJW (1983). Introduction In: Naqvi S M and Rogers JJW (eds). Precambrian of South India. Geological Society Memorandum, 4, 6-16.
13. Ramakrishnan M. and R. Vaidyanadhan. (2008). Geology of India, Volume-1, Pp: 108-120
14. Radhakrishna BP (1983). Archean granite-greenstone terrain of the South Indian Shield. In: Naqvi S W and Rogers J J W (eds.), Precambrian of South India. Geological Society of India Memorandum, 4, 1-46.
15. Radhakrishna BP, Naqvi SM (1986). Precambrian continental crust of India and its evolution. Journal of Geology, 94, 145-166.
16. Swaminath J, Ramakrishnan M (1981). Present classification and correlations. In: Swaminath J and Ramakrishnan M (eds.), Early Precambrian supracrustals of southern Karnataka. Geological Survey of India Memorandum, 112, 23-38.

