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Research Article

Hyperspectral Signature Study Finds Corundum Alters to Diaspore Influence of Climate Change of Dharwar Craton Arsikere Band of Haranahalli, Hassan District, Karnataka, India

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Abstract: Arsikere of Hassan District, western Dharwar Craton is composed of Precambrian basement rocks and active dynamic geological setting with prospects of many different kinds of economic mineral deposits, including variety of gemstones particularly in different Cratonic Archaean group of lithological contact zone of Green Schist belts and younger granites and granitoids of the Karnataka. Corundum is a rock-forming mineral occurs in igneous, metamorphic and sedimentary rocks. Corundum (Al_2O_3) is a different precious and rare mineral species with high water content influence of climate change due to arid condition in nature Corundum alters to Diaspore $[\text{Al}(\text{OH})\text{O}]$. its defect-induced weaknesses such as fragility, splintering, and cracking become apparent since the temperature of the mineral species may be increased to high temperatures during the process. These deformations may be broadly related to water loss (molecular(H_2O) and hydroxyl(OH) group). In this study thermal properties and thermal stability as dehydration behaviors of gem quality diaspora, including some associated mineral inclusions, were studied by petrochemical and spectral signature study using advanced high-tech tools of Spectro- Radiometer (Spectral Evolution SR-3500) instrument. These patterns indicated that the weight losses of the diaspora were due to the water loss only and that these losses occur in the temperature ranges between about about 592°C and

718°C in diaspore. The present study aims to characterize the spectral behavior of Diaspore and associated rocks. Spectral radiometer instrument bring out diagnostic features on lithological contact for better discrimination of gemstones and altered minerals. The final results Highlight the spectral characters of corundum and associated rocks for better mapping in similar terrains of Arsikere band of Haranahalli on Precambrian basement rocks of Karnataka State.

Keywords: Hyperspectral Signature, Corundum, Diaspore, Arsikere band of Haranahalli, Hassan.

INTRODUCTION

Diaspore is an aluminum oxide hydroxide mineral and crystallizing in the orthorhombic system and isomorphous with goethite, diaspore is also known as empholite, diasporite, kayserite, or tanatarite, It occurs sometimes as flattened crystals, but usually as lamellar or scaly masses, the flattened surface being a direction of perfect cleavage on which the lustre is marked pearly in character¹. Field sample shows colorless or greyish-pink, sometimes violet in color, and varies from translucent to transparent, It may be readily distinguished from other colorless transparent minerals with a perfect cleavage and pearly luster like mica, talc, brucite, and gypsum by its greater hardness of 6.5 - 7. The specific gravity is 3.4. When heated before the blowpipe it decrepitates violently, breaking up into white pearly scales².The diaspore occurs as an alteration product of corundum or emery and is found in granular limestone and other crystalline rocks, Well-developed crystals are found in the corundum deposits of the Arasikere. If obtainable in large quantity, it would be of economic importance as a source of aluminium³.The study area under metamorphic conditions corundum alters readily to other aluminous mineral particularly Diaspore and Margarite, danouritezoisitesillimanite, cyanite less commonly diaspore gibbsite andalusite spinel and tourmaline all these minerals except andalusite have been reported with the corundum deposits in Arsikere. The corundum is of interest because of its occurrence in amphibolite and the fact that it is always enclosed in a complex envelope of secondary minerals these envelopes also occur devoid of corundum crystals⁴. Diaspore, along with gibbsite and boehmite, is a major component of the aluminum ore bauxite⁵. Diaspore occurs as platy masses in highly aluminous metamorphic rocks associated with corundum⁵. It is a common component of emery. Diaspore also is a common component of bauxite, aluminous soils and clays. Diaspore is cut into all different types of facets for jewelry use, and is used in rings, earrings, and necklace pendants. diasporeused in making high alumina refractory material, by bonding with flint or plastic clay according to aluminum content needed in the finished product, It is also used as a fuller in pesticide industry¹. The spectral signatures of the field samples were compared with mineral spectra of USGS spectral library to record the spectral behavior⁶. The absorption and reflection features are studied as described by Hunt and Salisbury (1970)⁷, Hunt et al., (1971)⁸, Hunt and Ashley (1979)⁹and (Graham Hunt 1977)¹⁰, the fresh or weathered surface of iron metallic elements causes strong absorptions in Visible and Near Infrared region of electromagnetic wavelength.

STUDY AREA

The study area is located in between 13°12'30" to 13°15'0" North latitude and 76°13'0"to 76°16'30" East longitude with an aerial extent of 3,435 hectares (**Fig.1**). The general elevation is of 807 mts above MSL

covering mainly red & block soils associated with metamorphosed leucocratic pelitic gneiss, ultramafics, Corundum and Diaspore (CGWB, 2007).

Table 1: Samples collected and its Location

SI No	Samples Name	Villages name	Latitude	Longitude	Trending directions
CH-1.	Diaspore	S-Maknalli	13°13.868'	76° 14.762'	NNW
CH-2.	Amphibolite Schist	Kodimata	13°13.747'	76°14.873'	N20°W
CH-3.	Hornblende Gneiss	Harnalli	13°13.945'	76° 14.239'	N50°E
CH-4.	Chlorite Schist	Guttigehalli	13°14.301'	76° 14.512'	N24°W

Note: CH- Corundum at Haranahalli

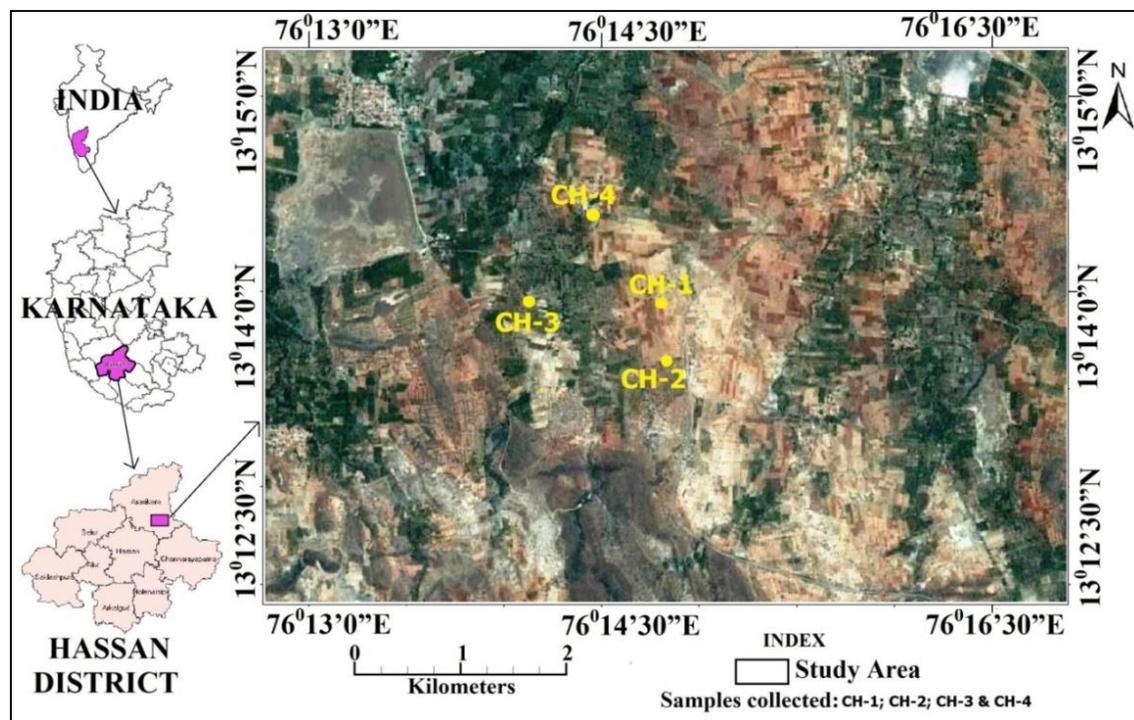


Fig. 1: Google Earth image showing the location of the study area

GEOLOGY SETTINGS

The Archaen rocks of South India are developed in Karnataka, where they are commonly described as the Dharwar Craton, the study area comes under Nuggihalli schist belt of Western Dharwars, which extends for a strike length of 50 Km in a NNW-SSE trend from Arsikere in the north to Kempinkote in the south. the schist belt is prominent linear belt of medium to high grade schists belonging to Sargur Complex¹¹. The schist belt consists of amphibolites and quartzites of metaultramafites (serpentinites), meta pyroxenites, tremolite-actinolite-chlorite schist's, meta-peridotites and dunite with bands of chromite and anorthosites, titanomagnetite and gabbro belonging to ultramafites¹¹. The belt is enclosed by peninsular gneiss with basic dykes cutting across all the formations, and forms a narrow tightly folded

synclinal structure. The regional strike of the schistose rocks is N20° W - S20° E to N-S with a dip of 50° to 60° towards east¹¹. the study area occurrence of economically important elements in the maficultramafic enclaves around the major Arsikere-Tavarkere lineament and surrounding gneissic terrain adjoining local shear zones that occur as discontinuous areas between Arsikere and Chennagiri¹². Amphibolite are predominantly exposed and are closely associated with ultra-basics, trending North 30°W with a dip of 30°-80° towards E and NE direction. Granitic Gneisses exposed predominantly and has in contact with Schist Belt in the Western part of the study area, trending North 20° E direction¹¹. The gneisses are banded in nature with gray to white gray in color.

METHODOLOGY

All the Field based collected samples were carried carefully to the laboratory for Petrographic study using Petrological, Mineralogical research Microscope. 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, Mysuru⁶. 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. Garmin-12 GPS is used to record the exact locations of each sample with an error of 9 mts during field visits¹³.

PETROGRAPHY

5.1 Diaspore Shows Transparent to translucent. White, pale gray, colorless, brown, pale yellow, pink, colors may vary with viewing direction in the same sample, may show a color change from brownish green in daylight to raspberry pink in artificial light colorless in thin section. Luster: Adamantine, vitreous, pearly on cleavage faces. Optical Class Biaxial. Pleochroism In thick plates, may be reddish brown to reddish violet, grayish green to green and blue. When viewed with the aid of polarizing microscopes Diaspore is commonly found having single perfect cleavage on one direction, imperfect prismatic cleavage on another two direction, and a single poor cleavage on another one direction. The extinction of the mineral Diaspore is parallel to the trace of the cleavage in the principal sections. The elongate sections may be either length fast or length slow. This is however depending on how the crystal was cut. The vivid third-order interference colors in thin sections are usually produced by the high birefringence of the mineral. The interference figures of the mineral are often difficult to obtain due to small grain size. When viewed between crossed nicols of the polarizing microscopes, the cleavage flakes usually yield flash figures. The optic axis dispersion is usually found weak. Diaspore is generally not altered although there can be possible conversion to mineral corundum. This can be possible when Diaspore is heated and dehydrated, or may be with the addition of silica it may form kaolinite or other clay minerals. It can be also produce by weathering of aluminum-bearing minerals. and hydrothermal alteration of aluminous rocks(**Fig.2**).

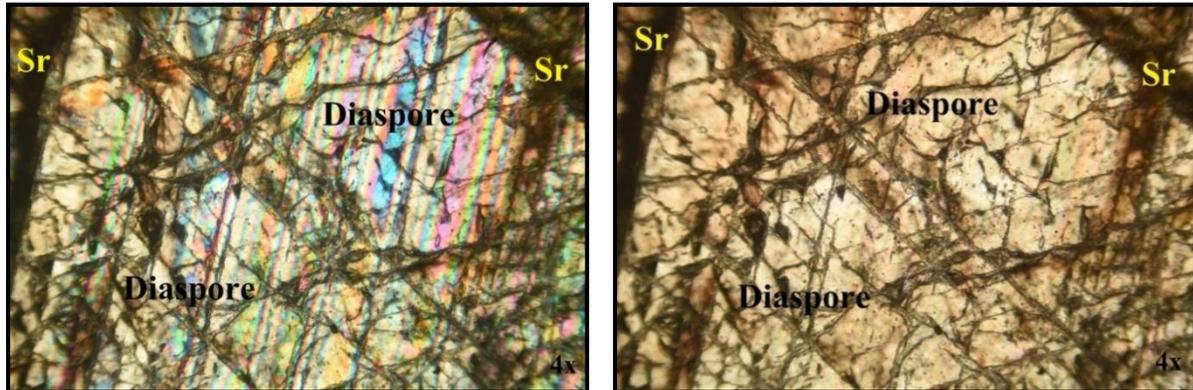


Fig.2: Diaspore under PPL and XPL

This thin section has a diaspore and Sericite. Sericite optical properties shows Color Brown or pale greyish, Monoclinic system, anisotropic, Pleochroism nil Relief weak, Cleavage very good in one direction in basal sections have no cleavage and biaxial⁶. High birefringence sericite also fills the micro fractures in plagioclase, but it does it in elongated crystals, unlike the rather equant hematite crystals. Sericite is a fine-grained variety of muscovite, with the same composition $KAl_2(AlSi_3O_{10})(OH)_2$. It usually forms by hydrothermal alteration of K-feldspars, which provide the necessary potassium⁶. It grows in pre-existing microfractures where the fluids can penetrate, or in fractures created by the fluid pressure. Sericite fills cracks around and across plagioclase crystals, sericite that probably has replaced feldspar¹⁶ (**Fig.2**).

HYPER SPECTRAL SIGNATURES

Spectral signature measures all types of wavelengths that reflect, absorb, transmit and emit electromagnetic energy from the objects of the earth surface¹⁴. Spectral Evolution (SR-3500) Spectroradiometer 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.1.3.0⁸. Absorption spectral values obtained from the DARWin software lab Spectra is the one character helps in the study of major and minor mineral constituents.

RESULT AND DISCUSSION

Major element composition of one sample of corundum altered Diaspore 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 measurement⁸.

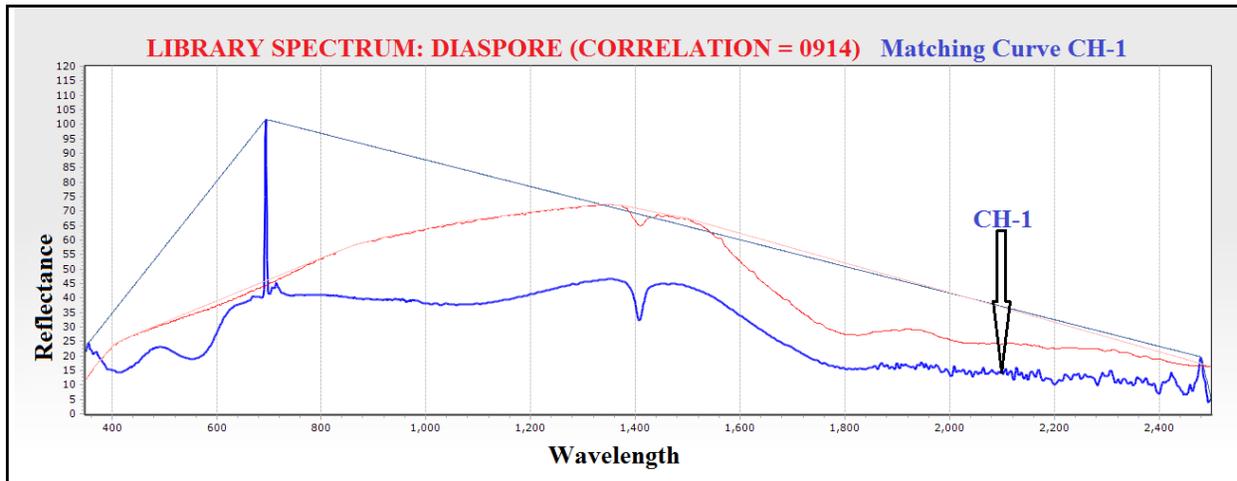


Fig.3: Lab Spectral signatures of Diaspore, Arsikere area, Hassan

Diaspore mineral type Hydroxide and its formula $\text{AlO}(\text{OH})$. Dimorph. with Boehmite. This sample is impure and is a mixture of bauxite minerals including gibbsite, kaolinite and a very small amount of a ferruginous material. Longward of $1.3\mu\text{m}$ the reflectance of the sample decreases. The sample has a $1.4\mu\text{m}$ absorption (overtone of the hydroxyl) and a $1.8\mu\text{m}$ absorption which is believed to be a displaced $1.9\mu\text{m}$ resulting from the presence of a free H_2O molecule. composition discussion analysis showed the sample to contain 0.01% Cr, 0.5% 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 $1.1\mu\text{m}$ absorption features) and ferric (0.7, 0.45 and near $0.4\mu\text{m}$) from the Cr^{3+} ion contributes to the 0.4, 0.55 and $0.7\mu\text{m}$ (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 $2.20\mu\text{m}$ and $0.65\mu\text{m}$ representing the mineral Diaspore shows intense absorption feature in $1.3\mu\text{m}$ of the electromagnetic spectrum⁸. Absorption anomalies at wavelength regions of $0.55\mu\text{m}$ and $0.9\mu\text{m}$ of Fe^{3+} and Fe^{2+} ions are observed respectively with low reflectance in the VNIR region¹⁴ (**Fig.3**). Major element content as $\text{AlO}(\text{OH})$ content shows high range imparts a Diaspore character with that of high aluminum content. library spectrum Diaspore correlation score 0.914 percent match the curve (**Fig-3**)

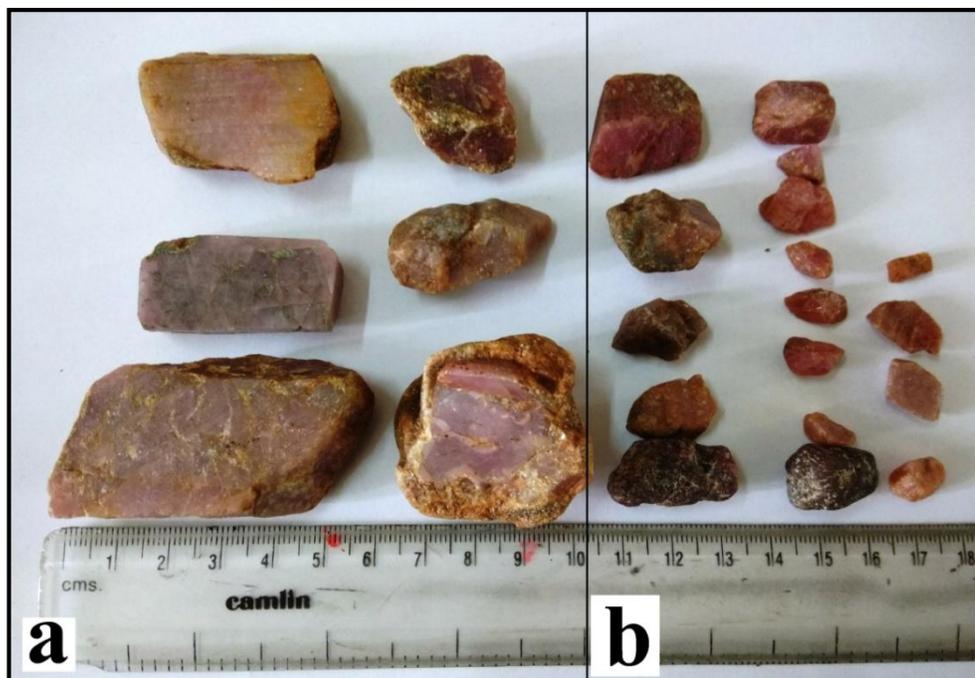


Fig.4: Hand specimen of (a) Diaspore and (b) Ruby (Corundum) collected samples Arsikere band of Haranahalli, Hassan.

CONCLUSION

Petrographic, Physical and Chemical characteristics are studied and discrimination shows purity of the mineral present in the Precambrian rock. Studies for the selected sample were carried out and identified mineral assemblage of Corundum altered Diaspore. The perfect tabular texture and colorless to red, pale blue pleochroic character reveal the presence of Diaspore mineral present in the collected samples. Diaspore is commonly found in corundum deposits and other aluminous metamorphic rocks formed by the tropical weathering of alumino-silicate rocks from hydrothermal alteration of aluminous rocks. Diaspore also is a common component of bauxite, aluminous soils and clays Diaspore is cut into all different types of facets for jewelry use, and is used in rings, earrings, and necklace pendants. It is used in making high alumina refractory material, by bonding with flint or plastic clay according to aluminum content needed in the finished product. It is also used as a fuller in pesticide industry Lab spectra of Diaspore identified in the wavelength of 1.4 μm and 1.8 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.

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