A typical Chiastolite–Margarite occurrences in carbonaceous phyllitefrom the Neoproterozoic Sirohi Group

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Abstract

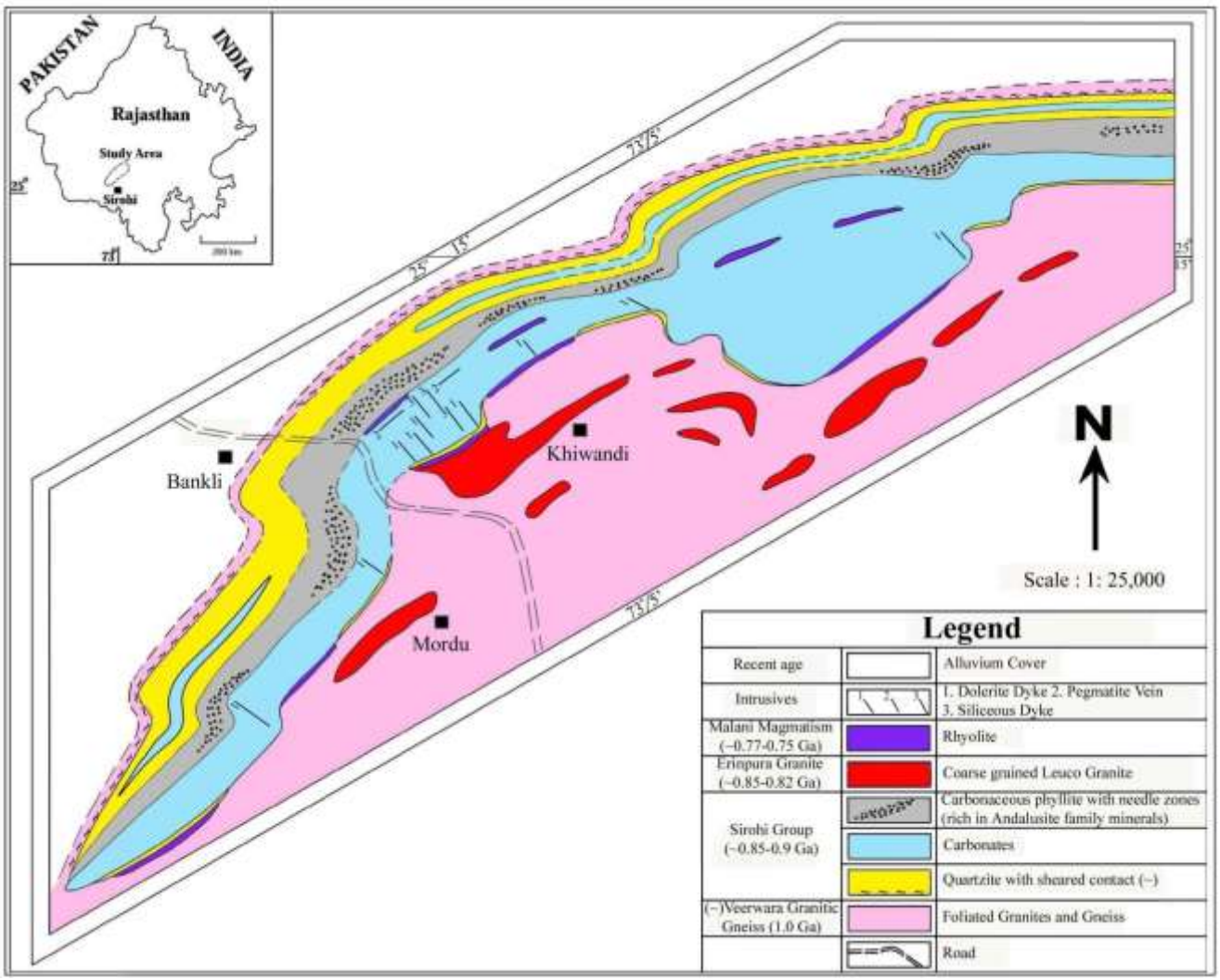
Type area of the Sirohi Group lies on the south-western flanks of the Aravalli Mountain Belt in the Sirohi district of Rajasthan. The metasedimentary sequences of the Sirohi Group include quartzites, calc-silicates and carbonaceous phyllites. We communicated in this paper a typical occurrences of chiastolitewithin carbonaceous phyllites. The chiastolite is associated with andalusite, staurolite, margarite, muscovite, sericite and paragonite. Chiastolite occurrences are reported rarely and have metamorphic significance. This association is the outcome of basic intrusions in carbonaceous phyllite form of dolerite dykes in the country rocks, followed by pseudomorphic replacement of chiastolite by margarite and alterations to white mica.

Keywords: Sirohi Group, Carbonaceous Phyllite, Chiastolite, Margarite

1. Introduction:

The Sirohi Group is distinguished from the Delhi Supergroup on the basis of single phase of deformation and lower grade of biotite facies metamorphism as compared to the Delhi Supergroup, which shows polyphase deformation and higher grade of granulite facies metamorphism(Roy and Jakhar, 2002; Roy and Sharma, 1999; Roy and Purohit, 2018). Sharma (1996) described distinguishing characteristic features of the Sirohi Group metasediments, after studying the 'Type area' near Sirohi town. Purohit et al (2012) estimated an age of ~900-800 Ma for the Sirohi Group metasediments on the basis of the underlying basement rocks of the Veerwara Granitic Gneisses of ~1000 Ma and the intrusive of Erinpura Granite *Sensustricto* denoting the basin closing event at ~820Ma. The last thermal activity reported in the region is of Malani Magmatism (~0.77-0.75 Ma) (Roy and Jakhar, 2002). The metasediments of the Sirohi Group strike NE-SW parallel to the Aravalli Mountain Belt and form a set of dismembered outcrops aligned in a linear belt of almost 100 km length. The outcrops are separated from each other by E-W disjoins, parallel to the river traces denoting the fault lines.

The metasedimentary outcrops are intruded by leucogranites (equivalent to Erinpura Granite), rhyolites (equivalent to Malani Magmatism), dolerite dykes, pegmatites and quartz veins.Dolerite dykes are mainly intruded in all the metasediments in irregular fashion west of Khiwandi village (Map 1). Dykes are running N-S and NNW-SSE. The dykes are almost parallel to each other while in some outcrops these are irregularly placed.Thickness varies from 3 feet to 2 meter(Fig.1). Two prominent dykes of dark brown colour, parallel to N-S running shear zone are seen close to Morli village. The dolerite dykesare mainly composed of plagioclase, augite (pyroxene) and hornblende as major constituents. Biotite and opaque minerals occur as accessory minerals. It shows ophitic texture, where fine laths of plagioclase are embedded within large grains of pyroxenes.



Map 1 Lithological map around Khiwandi village, District Sirohi, showing outcrop pattern of various stratigraphic lithounits and intrusive dolerite dykes. Dotted areas denote chiastolite zones which are proximal to the dolerite dykes.

2. Carbonaceous Phyllite:

On the basis of outcrop appearances the carbonaceous phyllites are divided into -

A. Massive carbonaceous phyllite lacking needles,
B. Foliated carbonaceous phyllite with numerous needles

Carbonaceous phyllites are characterized bymoderately high rising ridges with moderate slope and are dark greyish to black in appearance. The phyllites are fine grained and soils the finger black on rubbing.They are mainly composed of carbonaceous matter and silica. The outcrops frequently show yellowish colour due to limonitic staining as a result of secondary iron leaching. Thickness of bands varies from 10-15 meters in Morli while few meters at Khiwandi. Weakly radiating and irregular needles are present in carbonaceous phyllite (Fig.2).Most of these are highly weathered.Presence of needles is seen in those outcrops which have proximity with the dolerite dyke intrusions.Pseudomorphs of margarite moulds are also observed in these rocks.

In thin sections, fine grained and well foliated phyllitic banding is seen in carbon rich rocks hence named as carbonaceous phyllite. The rocks are mainly composed of carbonaceous matter and quartz which show alternate banding evident in thin sections also. Both carbon rich bands and silica-rich bands are very fine to fine grained, exhibiting dark-grey to black foliated fabric. It essentially comprises quartz, carbonaceous matter (which is dark and opaque) and accessory minerals like muscovite and sericite. Quartz constitutes about 85% of the total volume of the rock and other minerals attribute about 15% (which include carbonaceous matter). Sericitization occurs along grain boundaries of feldspar.

3. Chaistolite Needles and Margarite Moulds:

Needles of various size and shape are seen in hand-specimen in some of the carbonaceous phyllite. These needles when studied under microscope are identified mainly as andalusite while a few of them which are oblong in shape are of staurolite and squat-shaped are of chiastolite (Fig.3). Chiastolite which is a variety of andalusite, is also seen occurring as euhedral crystals of nearly square shape, showing dark inclusions of carbonaceous matter. This is a very important and semi-precious variant of andalusite (Fig.4). It is colourless in thin section, with moderate relief and shows first order grey birefringence (Fig.5). It is formed by basic/alkali metamorphism which in present study area is likely to be the result of diorite intrusion. The feature of needles in carbonaceous phyllite is highly localized proximal to dyke


Fig. 1


Fig. 2

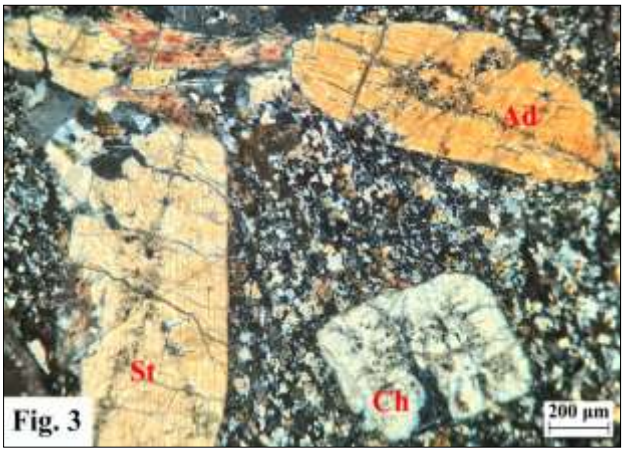


Fig. 3

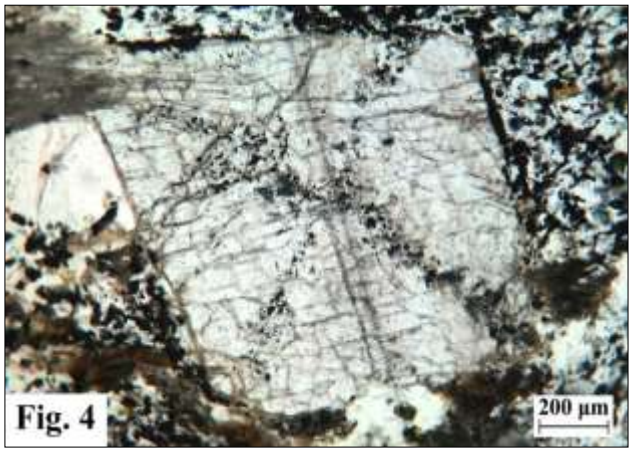


Fig. 4

Fig. 1: Field photograph showing dark brown and green coloured weathered dolerite dykes parallel to N-S shear zone, south of Morli.

Fig. 2: Weakly radiating, irregular shaped needles of Andalusite family minerals.

Fig. 3: Photomicrograph of carbonaceous phyllite shows Andalusite (Ad), Staurolite (St) and Chiastolite (Ch) minerals.

Fig. 4: Photomicrograph shows square shaped, euhedral crystals of Chiastolite with dark inclusions of carbonaceous matter (in PPL).

intrusion so possibly it is the result of contact metamorphism. Dark inclusions of carbonaceous matter are arranged symmetrically to form a kind of cross (Fig.4) which makes it semi-precious in nature as it has been treated similar to holy-cross.

Chiastolite needles or squats observed in the carbonaceous phyllite are mostly altered. Chiastolite shows alteration to sericite along the margins as well as along the fractures wherein the carbonaceous matter is included. The altered groundmass also shows presence of muscovite and paragonite white micas.In some casespseudomorphic replacementsof chiastolite occur as coarse-grained moulds which are identified asmargarite mica (Fig.6). Margarite is also a product of metamorphism of carbonaceous metapelites. The shape of pseudomorphs suggests that due to brittle tenacity the micas have survived the ductile shearing and appear like perfect rhombus shaped crystals (Fig.7).Fairly coarse margarite plates and laths are oriented perpendicular to the carbonaceousfoliations. In some cases the length of the coarse margarite laths decreases progressively, so that the growth tapers and forms a pattern similar to that of a feather (Fig.8). These feather-likepatterns of margarite laths are portions of the pseudomorphismin which margarite laths are not oriented.These consist of irregular aggregates of margarite, muscovite and paragonite. Later two are associated with the pseudomorphs and locatedin the carbonaceous bands forming the crosseswithin the chiastolite.

4. Summary:

The sediments deposited in Sirohi-Pali region represents dominantly calcareous and siliceous facies which closed by carbon-rich sedimentation. Carbon phyllites and iron rich carbonates of Sirohi Group are significant of the change in of oxygen levels in the Sirohi Cycle during early Neoproterozoic period. The metasediments of Sirohi Group exhibit single phase of regional green-schist facies metamorphism and local contact metamorphism due to intrusion of dolerite dykes and granite in metasediments. The contact metamorphism led to

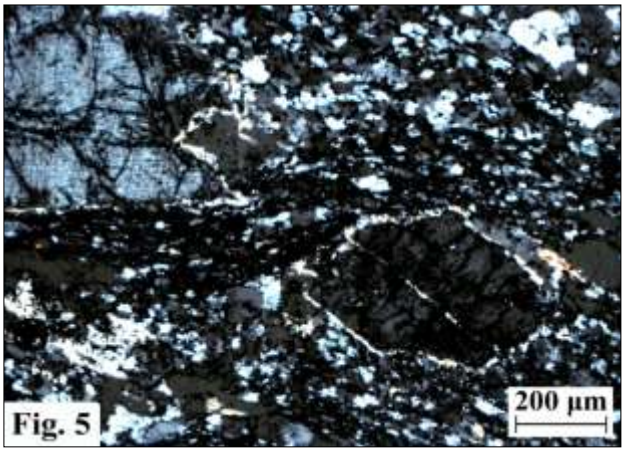


Fig. 5

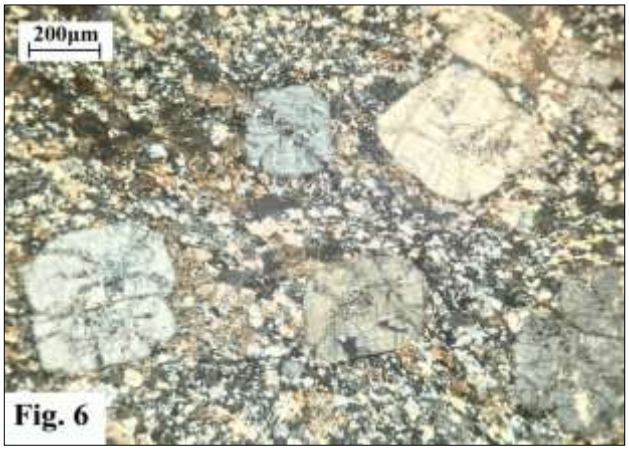
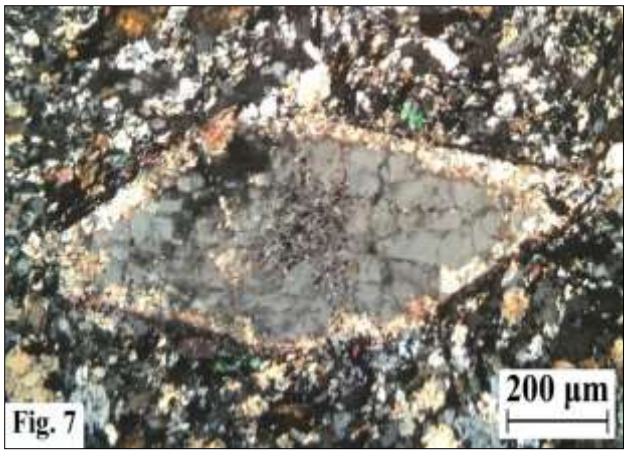


Fig. 6



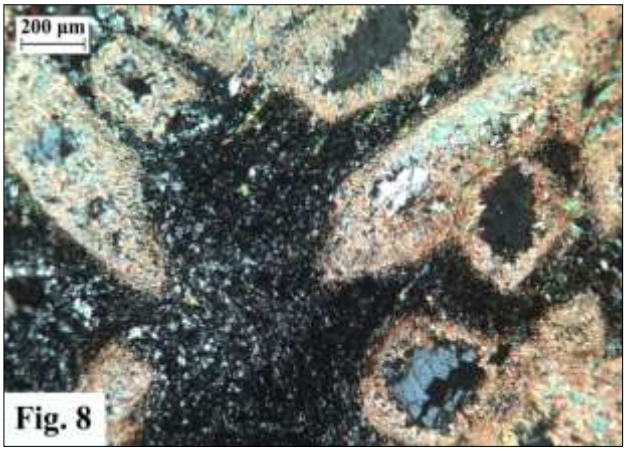


Fig. 5: Photomicrograph showing andalusite crystal with moderate relief and shows 1st order grey birefringence.

Fig. 6: Photomicrograph of carbonaceous phyllite, in which carbonaceous matter is arranged symmetrically to form a kind of cross characterizing Chiastolite (under cross-nicol).

Fig. 7: Photomicrograph is under cross-nicol showing margarite rhomb oriented perpendicular to the carbonaceousfoliations.

Fig. 8: Photomicrograph showing feather like features denoting alteration around chiastolite in carbonaceous phyllite. Pseudomorphic replacement is seen in some grains showing formation of mica moulds.

localized development of andalusite, chiastolite, sillimanite, staurolite, garnet assemblages. These minerals ooutcrop as unoriented needles in carbonaceous phyllite in close proximity with the occurrence of dykes.

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