GRANITIC PEGMATITES OF KORADI-KOLAR SECTOR, NAGPUR DISTRICT, CENTRAL INDIA: FIELD, PETROGRAPHIC AND MINERALOGICAL FEATURES

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ABSTRACT Several bodies of pegmatites have been located within the rocks of Sausar Group (Precambrian) occurring in the Kolar valley, north of Koradi, in Nagpur district of Central India. The XRD and the chemical data have shown that these pegmatites are mostly potassic ($K_2O = 15.58$ to 16.31% and $Na_2O = 2.50$ to 3.12%) and are barren of economic mineral deposits. The pegmatites range from a few cm to more than 50 m in width with a maximum extension of about one kilometre. Several mappable pegmatite bodies trend roughly EW and NS, and many good outcrops are encountered in the Kolar Valley and Suradevi Hills. Based on the field and petrographic studies, the pegmatites of this area are characterised in terms of size, shape and mode of emplacement. They are mostly tabular, lenticular, branching and irregular bodies, localised along bedding, foliation, fault planes, tension joints and fold axis. Structurally they can be subdivided into concordant and discordant types on the basis of their relationship with the country rocks. Mineralogically, pegmatites are grouped into (1) Simple Pegmatite, containing quartz, feldspar, biotite, apatite, garnet and (?) monazite, and (2) Complex Pegmatite comprising in addition muscovite, tourmaline and epidote. However, common mineral variation is observed at different places within the same body of pegmatite. In these pegmatites, muscovite, quartz, tourmaline and feldspar seem to have developed mainly in two distinct generations, for example, the muscovite of earlier generation forms tiny "books" while later crystals occur as small disseminated flakes in the groundmass of less coarser quartz. The earlier quartz is strongly deformed, while the later occurs as veins of variable dimensions. The black tourmaline of earlier generation is represented by schorlite and of later origin has been identified as dravite. It may be concluded that these pegmatites were formed by the influx of fluids rich in silica, Al and K that filled the fractures and other planes of weakness (foliation) in the host rocks. The alkali components while migrating towards the wall of the country rocks, crystallised as muscovite and feldspar. In larger pegmatite bodies of Suradevi Hills, the development and concentration of muscovite along their contact with the mica schist is probably due to the migration of Al and K and volatiles towards the border of the intrusion. This crystallization of muscovite in preference to potash-feldspar may be due to the presence of high contents of volatiles.

Key words: Central India, pegmatites, classification, mineral chemistry, XRD data, genesis

INTRODUCTION The extensive belts of pegmatites in India of Precambrian age are those of the three mica-producing fields of Bihar, Rajasthan and Nellore (Babu 1969, Bhola 1971, Datta 1973). The Bastar-Koraput belt of Madhya Pradesh and Orissa is well known for its rare met al (Sn, Ta, Be and Li) bearing minerals, such as cassiterite, columbite, tantalite, beryl, lepidolite, amblygonite, etc. (Ramaswamy *et al* 1976, Lamba and Khanna 1981, Babu 1993). These pegmatite belts are localised in metamorphic terrains and are generally associated with granitic rocks. Pegmatites are also common in the Sausar Group of Chhindwara and Nagpur districts of central India (West 1933, Fermor 1936).

At a distance of about 15 km to the north of the city of Nagpur, the pegmatites of Koradi-Kolar Valley are localised in highly deformed Precambrian rocks of the Sausar Group. Unlike the aforesaid four major belts, the pegmatites of the present area neither contain commercial mica nor rare met al deposits. They occur as large solitary bodies or in swarms of minor intrusives (dykes, sills and veins) extending from west of Koradi Mata Temple to the east of Suradevi Hills (Latitude: $21^\circ 20' N$ and Longitude: $79^\circ 7' E$, Survey of India Toposheet Nos. 55: 0/3 & 0/4).

Except for a few published papers (Kilpady 1954, Gwalani *et al.* 1997), no significant literature is available on the pegmatites of this area. The present work includes new geological map of the area (Fig. 1), and preliminary evaluation of about 15 major outcrops of pegmatites. An attempt has been made to describe their field, petrographic and mineralogical features.

GEOLOGICAL SETTING Geology of Koradi-Kolar Valley is presented in Fig. 1, and a summary of rock types encountered is given in Table 1. The Precambrian rocks exposed in this sector belong to the Sausar Group comprising metasedimentary and metabasic rocks, which are at places profusely intruded by acidic phases (pegmatites, quartz veins and gneissic granite/orthogneiss) (Gwalani & Dalai 1988). The upper part of the Sausar Group sequence of rock Formations consists of (from the older to the younger): Chorbaoli Formation (quartzites and associated quartz-mica schist); Jenewani Formation (muscovite-biotite schist), and Bichua Formation (mostly dolomitic marbles), meta-amphibolites, orthogneiss/ gneissic granite and pegmatites and quartz veins.

In the neighbouring districts of Bhandara and Drug, the K-Ar ages of muscovite and biotite from the schists (Sausar Group) have indicated that the regional metamorphism and granitization had closed during the period 244-996 million years ago (Sarkar *et al.* 1967). The sequence of rocks (Table 1), which is the extension of the type Sausar area (Kumar 1992), observed in this sector are described below in relation to their structural characteristics favourable for pegmatite emplacement.

Quartzites and Schists (Chorbaoli and Junewani Formations) Mica-schist is an important rock for the pegmatite emplacement. The rock shows well-developed schistosity and multiple sets of joints. At places, the schist is interbedded with quartzite bands of variable thickness, size and extent. The thickly bedded quartzite is not favourable locale for the pegmatite emplacement. However, along the contact of mica-schist and quartzite, the concordant pegmatite intrusions are observed (e.g. Western Suradevi Hills).

Dolomitic Marbles (Bichua Formation) Marbles occur as scattered outcrops (bedded or massive) and they range in colour (white to dirty white to light greenish), texture (fine- to coarse sacchroidal) and mineralogy. They are mostly dolomitic containing tremolite, actinolite, calcite, serpentine etc. At places, near the contact with pegmatite, the marbles show baking effects and superficial patches of hard pegmatitic material that stands out from the weathered surface of a comparatively softer marble.

Amphibolites and Streaky Gneisses The amphibolites are emplaced by many aplitic and pegmatitic bodies. These intrusive bodies cut across and also occur within the planes of schistosity of amphibolites (Figs. 2-A and B). These amphibolites appear banded due to aplitic layers of roughly about a centimetre thick, and often, in about one metre of thickness, there occur at least 20 aplitic layers. This composite rock with banded appearance have been termed streaky-gneiss (West 1933, Fermor 1936).

Gneissic Granite/Orthogneiss Outcrops of gneissic granite (orthogneiss) have limited aerial extent and are seen prominently in the Kolar Valley (e.g. near Chhindwara road) where they are closely associated with amphibolites, marbles and schists. But the pegmatites have emplaced within the orthogneiss and amphibolites. The rock generally has shades of pinkish white to reddish brown colour owing to abundant presence of K-feldspar (microcline). In the Kanhan river, near the railway bridge, the coarse granitic gneiss is exposed. It comprises feldspar, quartz and black mafic minerals (biotite and hornblende).

PEGMATITES Field Characteristics Haidenger (1845) and many later workers used the term "pegmatite" for describing very coarse-grained feldspar-rich granites. Throughout this paper the term pegmatite usually means granitic pegmatites unless otherwise specified.

Mode of Emplacement The emplacement of pegmatites without the development of apophyses in the wall rocks, indicate the smooth flowage of pegmatite magma through the available planes of weakness (schistosity, tension joints, fold-axis and fault planes) in the country rocks. Structural control of the emplacement of a few pegmatite sills

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Figure 1 - Reconnaissance geological-map of Koradi-Kolar sector, north of Nagpur, central India (modified after Gwalani et al, 1997). Note that a few outcrops of the country rocks and pegmatites are slightly exaggerated in their dimensions for the convenience of plotting. There are many minor intrusions of pegmatite not shown in this map. Inset map shows locality of Nagpur in central India.

was afforded by contacts between dissimilar rock types, as for example between quartzite and quartz-mica schist in Suradevi Hill and between biotite-schist and amphibolite in Kolar Valley. Such concordant pegmatites may show a marked gradational contact and contain partly digested rock inclusions (Fig. 5A) which indicate that the emplacement was effected by replacement of country rock. Ptygmatic folding observed at a few places is due to deformation (migmatization) and not because of infilling of tortuous fractures by pegmatitic (aplite) melt in the amphibolite.

Wall Rock Alteration The pegmatites usually have sharp contact with the host rocks but are in places separated by a narrow zone of wall rock alteration. The alteration involves development of new minerals, such as tourmaline and epidote, and recrystallization of mica, and also silicification of wall rocks. Tourmalinization of wall rock (e.g. amphibolite) has led to the formation of tourmaline-rich cluster with schistose structure along the wall rock, even when the pegmatites are completely devoid or contain sparse tourmaline.

The nature and extent of wall rock alteration mainly depends upon mineralogical composition of wall rock and the attitude of the pegmatite body. The alteration is well observed along the concordant pegmatites which have been emplaced in foliated rocks (e.g. southern bank of Kolar river), which facilitates permeation and flow of fluids along the planes of foliation.

Size and Shape The pegmatites show wide variation in size and shape. They mostly are tabular or long and narrow sinuous bodies intermittently disappearing under the soil cover, others are branching and irregular. Thus, they vary from insignificant stringers to bodies about one kilometre in length and more than 15 m in width. The size and shape of pegmatites are controlled by structure and nature of the rock into which they have been emplaced. Many pegmatite bodies are parallel to sub-parallel to the bedding and foliation in the schistose country rock (mica-schist and amphibolite). Some pegmatites deviate from such concordant attitude and cut across the bedding and foliation in the country rocks (orthogneiss and quartzite).

Structural Classification Classifications of Indian pegmatites are predominantly based on form, size, and relationship with the host

rock, texture and internal structure (e.g. Datta 1973), mineral and chemical composition (e.g. Babu 1969), mode of development (e.g. Soman & Nair 1986, Singh & Sharma 1997); and mineral paragenesis and rare metal mineralization (e.g. Babu 1963), etc. With reference to the structural relationship with the host rocks, the pegmatites of Koradi-Kolar sector are broadly distinguished as concordant and discordant types. However, they can be also sub-divided on the basis of their texture and mineralogy as described in the next section.

CONCORDANT PEGMATITES Pegmatites concordant with the bedding and foliation generally show tabular and lenticular form. Though they follow the structure of the host rock, they show variation in dip (55° to 90°) and strike (trend) which correspond to the structural deviation observed in the host rocks. At many places the tabular sheets of pegmatites are emplaced concordantly within the planes of schistosity of amphibolites to form banded or "streaky" gneiss (Fig. 2-B). Lenticular pegmatites are broader but gradually pinch out either at one end or at both the ends.

DISCORDANT PEGMATITES Although the pegmatitic injections follow the bedding or foliation of the pre-existing host rocks; at many places, they generally follow joint planes that cut sharply across the bedding and foliation (Fig. 2a). Such pegmatites at times show branching pattern with irregular margins, or they occur as dykes exhibiting a narrow and straight course with regular margins. Branching pegmatites (e.g. in a major tributary of the Kolar river) often exhibit a number of small concordant offshoots (apophyses) from the larger discordant body hosted in the amphibolites possessing well developed schistose structure. In the eastern part of Suradevi Hill range, the quarry section shows a series of almost vertical pegmatite dykes in micaceous quartzites (Fig. 3B).

Petrographic Features Many pegmatites of the studied area exhibit more or less uniform texture and mineralogy from wall to wall and along their entire length. They are medium (2.5 to 10 cm) to coarse (10 to 30 cm) grained (Cameron et al 1949), and mainly composed of quartz, K-feldspar, muscovite and tourmaline with variable accessory minerals such as biotite and epidote. On the basis of mineralogical variations, the pegmatites of this sector may be classified into:

Table 1 - Summary of Sausar rocks present (metasedimentary, metabasites and associated acid intrusions) within the Koradi-Kolar sector of the Nagpur District, India.

Locality (examples)	Rock type/ Formation	Field characteristics	Mineralogy
Kolar, southern bank	Pegmatite (younger acid intrusive rocks)	a) concordant, medium to coarse grained (10-30 cm, Cameron <i>et al.</i> 1949) trend almost EW.	Quartz, pink K-feldspar, tourmaline, muscovite, biotite, epidote, magnetite, garnet
Koradi, Suradevi Hill, Kolar and its main tributary		b) discordant, medium to coarse (10-30 cm, Cameron <i>et al.</i> 1949) trend almost NS	Quartz, pink microcline, muscovite, tourmaline, magnetite
Kolar river, northern bank	Gneissose granite/ orthogneiss (older acid intrusive rock)	Coarse and weakly gneissose, spheroidal weathering	Microcline, quartz, sodic plagioclase, biotite, magnetite, zircon
Kolar river	Amphibolite (metabasic rocks)	Medium to coarse grained, schistose structure well developed, trend generally almost EW, at places pegmatitic folding prominent	Amphibole (green), quartz, calcic plagioclase, epidote, magnetite and sericite and chlorite as products of alteration
Kolar and its major tributary	Streaky gneiss (composite gneiss)	Composite structure marked by dark and light coloured bands of mafic (amphibolite) and felsic (aplite).	Dark bands with schistose structure contain same minerals as amphibolite, lighter bands comprise granitoid quartz and K-feldspar (mostly microcline)
Koradi	a) dolomitic marble a) ophiolite - Bichua Formation	Massive medium to coarse saccharoidal, trend variable due to folding, faulting, silicified at places. Medium to fine grained, massive, olive green and white	Dolomite $\pm$ calcite + tremolite $\pm$ actinolite Green serpentine and white calcite
Koradi & Kolar	Muscovite biotite schist - Junewani Formation	Highly foliated schistose structure, generally showing EW trends	Muscovite, biotite with minor feldspar $\pm$ quartz
Suradevi Hills	Quartzite and quartz mica schist - Chorbhuli Formation	Massive quartzitic bands alternate with thinly foliated schistose bands, or mostly quartzitic and schistose	Quartz, muscovite, feldspar $\pm$ tourmaline, minor magnetite

- i) Simple: Consisting of quartz, feldspar, biotite and apatite, and
- ii) Complex: Containing in addition muscovite, tourmaline and epidote.

Graphic intergrowths of quartz and feldspar (Fig. 4A), and tourmaline and quartz are also characteristics of complex pegmatites. Based on the dominant mineral content, the Koradi-Kolar pegmatites can be distinguished as quartz-rich and feldspar-rich pegmatites. Considering the mineralogical association observed, we have classified these pegmatites into the following types: - (a) Microcline-Quartz-Muscovite Pegmatite, (b) Tourmaline-Quartz with or without Feldspar and Mica, (c) Quartz-Muscovite Pegmatite, (d) Eutectic Quartz and Microcline (Graphic granite /Runite). (e) Massive Quartz Pegmatite. The petrographic characteristics of each of the above 5 types of variations are described in the next paragraphs.

MICROCLINE-QUARTZ-MUSCOVITE PEGMATITE This unit comprises microcline, which is generally pink in colour and occurs either as (a) large blocks present in the groundmass of quartz aggregates and muscovite, or as (b) large crystals interlocked with quartz. The concentration of giant feldspar phenocrysts (large blocks of microcline) is so much that in patches these larger pegmatitic bodies appear as monomineralic rock. The feldspar patches are invariably surrounded by comparatively finer aggregates of a quartz (+ muscovite). These pegmatites have sharp contacts with the country rocks (orthogneiss and amphibolites).

TOURMALINE-QUARTZ WITH OR WITHOUT FELDSPAR AND MICA This unit range in composition from dominant quartz and tourmaline ($\pm$ mica) to dominant microcline and tourmaline ($\pm$ mica). The black striated tourmaline occurs as solitary ditrigonal crystals, or branching crystals or as clusters of radiating finer needles and coarser columns in the extensive concordant bodies of pegmatite in Kolar valley (Fig. 4B). Many of the larger crystals of tourmaline, identified as schorlite and dravite (Kilpady 1954), have been deformed by stresses induced during post-tourmaline formation. Such crystals are often curved and show a large number of closely spaced transverse fractures (Fig. 5). Tourmaline crystals as large as 10 to 15 cm in length

with a diameter of 5 cm have been recorded from these pegmatites (Kilpady 1954).

Five different mineral association observed in this unit are: (a) Quartz and Tourmaline, (b) Microcline and Tourmaline, (c) Quartz - Tourmaline and Microcline. (d) Muscovite and Tourmaline ($\pm$ Quartz) (e) Tourmaline and Biotite ($\pm$ Muscovite and Quartz).

Inclusion of one or more minerals such as feldspar, biotite and muscovite (Fig. 5) are often noticed in the tourmaline crystals.

QUARTZ AND MUSCOVITE This unit almost entirely comprises massive, milky white or colourless quartz and flaky aggregates of muscovite. Quartz generally occurs as sutured or coarse aggregates of anhedral grains. This type of pegmatites is generally encountered in amphibolites and metasedimentary rock. These pegmatites are emplaced at the contact of quartz-mica schist and amphibolite at a few places in the Kolar valley. In Suradevi Hills, they are seen along the quartz-muscovite schist and quartzite contact.

EUTECTIC QUARTZ AND MICROCLINE (GRAPHIC GRANITE/RUNITE) This unit is almost entirely composed of quartz and microcline. The minerals show typical graphic texture (Fig 4A). Such pegmatitic bodies occur as minor intrusions (e.g. in a major tributary of Kolar River) or are seen as patches in the larger pegmatites rich in quartz and feldspar. This unit also shows sharp contact with the country rocks.

MASSIVE QUARTZ PEGMATITE It generally consists of milky white quartz and occasionally encloses mica and tourmaline, and when these minerals are present, they are confined to the margin of the quartz

Figure 2 - (a) • Small fracture controlled discordant pegmatite (P) bodies in amphibolite (A) exposed in a major tributary of the Kolar river, northeast Koradi. (b) -Amphibolite (A) intimately and concordantly penetrated by aplite-pegmatite (P) to form composite streaky gneiss exhibiting light and dark bands. The resistant lighter leucocratic bands of aplitic material stand out due to differential weathering of comparatively softer amphibolite bands.

body. The quartz-pegmatites also occur as veins within the other pegmatite units and the country rocks. They show sharp contact with host rocks and generally occupy irregular fractures in the pegmatite units and gneissose granite.

Mineralogical Features X-RAY DIFFRACTION STUDIES

The X-ray Diffraction profile of the pegmatites from Kolar valley was obtained by using Phillips PW1840 X-ray generator system operated at 30 kV and 20 mA with Cu ($K\alpha$) radiation. The sample was scanned between 4° to 43° , 2θ range with 1° , 2θ per minute scanning speed. The peak angles and spacings obtained were compared with the values compiled in the KWIC Guide to the Powder Diffraction File data records published by the American Society for Testing and Material (ASTM) and by Joint committee on Powder Diffraction Standards (JCPDS) (1974). The XRD Diffraction Tables (1954) published by Feffir and Simons, Inc. London/Amsterdam were also used during this investigation.

The diffraction patterns of the feldspar-rich pegmatite from the Kolar valley are given in Fig. 6 and interplanar spacings ('d') and 'hkl' or mineral indices number, along with mineral names are given in Table 2. The X-ray diffraction (XRD) studies have revealed that the dominant minerals of the Kolar Valley pegmatites include potash-feldspars (mostly microcline and some orthoclase) and illite along with accessory ilmenite and magnetite.

MINERAL CHEMISTRY Samples of pink feldspar (microcline) and muscovite were analysed by modern techniques (Gwalani *et al.* 1993) in the chemical laboratories of Universidad Complutense de Madrid (UCM), Spain. The results are presented in Table 3 along with an analysis of microcline micropertite from Bihar mica-belt, India reported by Deer *et al.* (1963). Both microcline and muscovite of the present area are rich in K_2O and comparatively poorer in Na_2O . In the feldspar samples, the K_2O content varies between 15.80 % to 16.31 % and in muscovite it is 11.34% which clearly indicate that the pegmatites of the present area are potassic in nature, and perhaps they are even more potassic than the pegmatites of Bihar mica-belt. The microcline micropertite from Bihar is comparatively low in K_2O content (13.2%) but shows similarity in the Na_2O values (Table 3).

GENESIS OF MICA AND TOURMALINE Muscovite and tourmaline occur as important components of a few pegmatites of this area; each of these minerals appear to be of different origin as described below:

Genesis of Muscovite According to Cameron *et al.* (1949), mica is derived by direct crystallisation from pegmatitic magma rich in Na_2O , K_2O , Al_2O_3 , SiO_2 , and volatiles. Experimental work of Eugster & Yoder (1954) has shown that the mica is formed as a result of reaction between potash feldspar and the co-existing fluid during the crystallisation of pegmatite. Many earlier workers such as Landes (1933), Holland (1902), Biswas (1929) supported the view that mica is formed from the assimilation of rocks by the pegmatitic melt followed by recrystallization, and that the mica content of pegmatite depends upon the nature of the country rock. According to Galpin (1918) and other later workers, the origin of mica in pegmatite is due to metasomatic replacement (hydrothermal solution and pneumatolysis) of country rocks during the post-crystallisation phase of pegmatite formation. Another view suggested by Quirke & Kramers (1943), is that a post crystallisation hydrothermal alteration of feldspar, which results in the replacement of Si by Al and accommodation of (OH) ions, in pegmatite can lead to formation of mica.

Muscovite in pegmatite occurs in all the petrographic types of Koradi-Kolar sector, except in the units comprising quartz-microcline feldspar with a graphic texture and massive quartz-tourmaline. Muscovite is seen as disseminated flakes and small books and does not form commercial lodes in these pegmatites. It is either absent or is present in negligible amount in the potash-feldspar pegmatites. It generally occurs in the pods containing granular aggregates of coarse quartz. In Suradevi Hill range muscovite as tiny books and disseminated flakes usually occur in larger concentration near the mica-schist wall. The presence of comparatively more muscovite in the wall rock mica-schist is probably the result of recrystallization of country rocks under the influence of pegmatitic fluids (Cameron *et al.* 1949). However, the sharp contact of the country rock with many pegmatites does support a purely magmatic origin of mica in pegmatite. The earliest solution may have been silica rich and appear to have had varying contents of alkalis and alumina, resulting in the formation of a massive quartz body on the one hand, and muscovite-quartz-pegmatite on the other hand. The presence of such contrasting mineral composition

Figure 3 - (a) - Feldspar-rich pegmatite (P) containing partially digested inclusion of altered amphibolite (A). The pegmatite has concordant relation of planes of schistosity fillings that can be traced in micaschist encountered in close association with amphibolite exposed on the southern bank of the Kolar river, (b) - Series of dykes (two seen in this photograph) of pegmatite (P) emplaced within the vertical tension joints in the thinly bedded micaceous quartzites (Q) near west end of the main quarry, Suradevi Hills, Kolar valley.

support that the pegmatite of present area under study have developed by the process of fractional crystallisation in a restricted or closed system as suggested for the pegmatites of Madhya Pradesh (Singh and Sharmal997, Babu 1993).

Genesis of Tourmaline Migration of some amount of fluids are not only instrumental for the formation of comparatively more muscovite in the wall rock mica-schist by the process of "Muscovitization" but "tourmalinization" of the original minerals (biotite and pink feldspar) in the pegmatites has also been suggested by Kilpady (1954).

On the basis of megascopic and microscopic characters, black tourmaline of two distinct varieties, namely schorlite and dravite have been identified (Kilpady 1954, Gwalani 1969). The coarse crystals of schorlite have abundant inclusions of muscovite (Fig. 5) and quartz; it also shows subgraphic intergrowths with quartz, and fractures filled by muscovite, microcline and quartz. The schorlite crystals are of earlier generation and they have been derived from original biotite either during pre-emplacement or at the time of emplacement of pegmatite.

The dravite variety of tourmaline is formed at latter stage by the pneumatolitic action on the pink feldspar during the post solidification stage of pegmatite. The conversion of feldspar (microcline/orthoclase) was largely effected by molecular diffusion process, and this process is similar to the process of formation of Luxullianite described by Wells (1956). During the replacement of pink feldspars by tourmaline lot of quartz was released and the various stages of alteration are observed. The massive irregular patches as well as well developed crystals, which often contain relict microcline, are obviously derived from the feldspar (Kilpady 1954).

SUMMARY AND CONCLUSION The coarse to very coarse granitic pegmatites of Koradi-Kolar sector show simple to complex

Figure 4 - (a) - Specimen (scale = half the natural size) of eutectic pegmatite showing graphic intergrowths of quartz and microcline. (b) - Dispersed crystals, patches and sheaves of black tourmaline (T) in the concordant pegmatite comprising mainly pink microcline feldspar (F) and quartz (Q). Locality: Kolar valley.

mineral assemblage (quartz, feldspar, mica, tourmaline, epidote, etc.). Most bodies are emplaced (concordant and discordant) within the schistose rock (mica-schist and amphibolites) along (a) bedding planes, (b) joint planes (c) fault planes and (d) contact of metasedimentary and metabasic (amphibolite) rocks. Deformation and metamorphism of rocks have taken place prior to the pegmatitic activity. However, post pegmatite folding (ptygmatic) and pinch-and-swell structure in aplitic pegmatite in the amphibolites are noticed locally.

The pegmatites occur mostly as swarms, and show variation in size (length < 1 km, and width < 1 m to 15 m) and shape (tabular, lenticular and vein like bodies). As mention above, variation is also observed in their mineralogy, and on the basis of this character, important pet-

Figure 5 - Fractured tourmaline (T) plate contains a few coarse and rosette-shaped muscovite (M) inclusions that have somewhat radiating form. This photomicrograph of a portion of a large tourmaline crystal from quartz-pegmatite was taken under polarised light (x 32).

Table 2 - XRD Data (peak angle in degrees 2 θ and the 'd' spacing) of the minerals of feldspar-rich pegmatite from Kolar valley, Nagpur district, Central India. References for converting the peak 2 Theta (θ) angles into the interplanar spacings (d) used are: Johnson Jr & Vand (1968), Fang & Bloss (1966); and Joint Committee on Powder Diffraction Standards, 1974.

Peak angle in degree (θ) theta	Interplanar spacing-dÅ	hkl	Mineral name
13.90	6.370	--	--
14.10	6.280	--	--
15.10	5.867	11 $\bar{1}$	Orthoclase
19.50	4.552	110	Illite
21.30	4.171	022	Illite
22.40	3.968	11	Microcline
22.60	3.934	1 $\bar{1}$ 1	Microcline
22.90	3.883	113	Illite
23.50	3.785	---	--
23.85	3.730	102	Ilmenite
24.30	3.662	13 $\bar{1}$	Microcline
24.60	3.168	13 $\bar{1}$	Orthoclase
25.00	3.561	22 $\bar{1}$	Microcline
25.80	3.453	--	--
26.70	3.338	220	Microcline
27.70	3.220	--	--
28.20	3.164	--	--
29.70	3.007	131	Microcline
30.40	2.940	22 $\bar{2}$	Microcline
30.80	2.902	022,041	Microcline, orthoclase
32.40	2.763	3 $\bar{1}$ 1,13 $\bar{2}$	Microcline, orthoclase
32.70	2.738	104	Ilmenite
34.50	2.599	20 $\bar{2}$	Illite
35.20	2.549	3 $\bar{1}$ 0	Microcline
35.40	2.535	3 $\bar{1}$ 1	Magnetite
35.80	2.508	310	Microcline
36.20	2.481	240	Orthoclase
37.20	2.416	15 $\bar{1}$	Orthoclase
37.90	2.373	33 $\bar{1}$,20 $\bar{3}$	Orthoclase
38.80	2.320	1 $\bar{1}$ 3	Microcline, orthoclase
40.85	2.208	151,330	Microcline, orthoclase
42.10	2.146	20 $\bar{6}$	Illite

nated flakes in the groundmass of less coarser quartz. In larger bodies of pegmatites, for example Suradevi Hills, the development and concentration of muscovite has taken place along its contact with the micascist, and it is probably due to the migration of Al, K and volatiles towards the border of the pegmatite intrusion. This crystallisation of

Table 3 - Chemical analyses of the pink-feldspars and muscovite (tr = traces, nd= not detected) GF-1 & GF- 2: Microcline from pegmatites, Kolar Valley, Nagpur district, India.(2)Deer et al. 1963: Microcline micropertthite, Graphite-bearing pegmatite, Bihar state, India. (3) CM-6: Muscovite from pegmatite, Kolar Valley, Nagpur district, India.

Sample	GF-1	GF-2	Deer et al. (1963)	GM-06
SiO ₂	60.05	61.04	64.26	44.68
TiO ₂	0.10	Tr	--	0.54
Al ₂ O ₃	21.20	19.92	19.72	32.82
Fe ₂ O ₃	Tr	Nd	0.10	3.34
MnO	Tr	Nd	--	0.07
MgO	0.13	0.96	Tr	0.72
CaO	Tr	Tr	0.31	Nd
Na ₂ O	3.11	2.50	2.28	0.72
K ₂ O	15.80	16.31	13.20	11.34
H ₂ O+	tr	tr	0.18	5.46
Total	100.39	100.73	100.05	99.69

muscovite, which is of later generation, is in preference to feldspar, and is due to the presence of higher volatile contents in the fluids. The earlier quartz is strongly deformed while the later occurs as veins of variable size and length. Black tourmaline belonging to two distinct types, schorlite and dravite are of different origin. The schorlite crystals have been derived from original biotite (either pre-emplacement or during emplacement) where as dravite appears to belongs to a second or later generation and is derived from pink feldspar by the late process of pneumatolysis. Field evidences have indicated that the influx of pegmatitic fluids sometimes associated, with structural deformation of the earlier rock units of Sausar Group (Chorbaoli, Junewani and Bichua Formations) and subsequently these fluids occupied the fractures and other planes of weakness (foliation: bedding and schistosity) in the host rocks. From the optical, XRD and mineral chemistry, it has been concluded that the pegmatites of Koradi-Kolar sector are mostly potassic in composition.

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