Field Relations and Petrochemistry of the Jeli Igneous Complex, North Kelantan: Preliminary Observations

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Abstract

The Jeli Igneous Complex is located about 1 km north of Jeli town, Kelantan which is part of the Jeli granite. Four main rock types occur in the area namely (in decreasing age) coarse grained foliated biotite granite (CFBG), grey microgranite (GM), medium grained foliated biotite granite (MFBG), and hornblende biotite basaltic dyke (HBBD). The field evidence suggests that both GM and MFBG magmas are synplutonic. The CFBG, MFBG and GM consists of typical granitic (s.l) mineral that is quartz, plagioclase, K-feldspar, biotite, zircon, apatite, sphene, allanite and opaque phase whereas the HBBD contains hornblende, quartz, plagioclase, biotite, apatite, sphene and opaque phases. Petrographic study shows that the rocks in the area have undergone both magmatic and high temperature solid-state deformation.

INTRODUCTION

A preliminary observation on the field relation, petrography and major element geochemistry of the igneous rock (Jeli IGneous Complex) found at kilometer 1.5 East-West highway is reported in this paper. The outcrop is located about 1 km north of the Jeli town, Kelantan (Fig. 1). The igneous rock is part of the Jeli granite (Singh et al., 1984). The granite is bordered by the Stong Complex to the southwest and the Kemahang granite to the east. General geology of the area has been studied by Husin (1993) and he suggested that the area is underlain by several granitic types include granodiorite and porphyritic granite.

FIELD RELATION

At least four main rock types are found in the study area. They are coarse grained foliated biotite granite (CFBG), medium grained foliated biotite granite (MFBG), grey microgranite (GM) and hornblende biotite basaltic dyke (HBBD). Minor leucogranite and quartz veins occur everywhere intruding all the four rocks types.

CFBG is the oldest rock type and is characterised by coarse grained size (0.2 cm to 2 cm across) and alignment of biotite clots. It is cut by all the three main rock types with sharp contacts. The contact between the CFBG and MFBG can be seen in the lower part of the outcrop and is shown in Figures 3, 4 and 5. The structures vary considerably from cm scale streaky intermingling to discrete pillowlike structure (meter scale). In term of the volume, MFBG is more dominant and the GM tends to form a ‘enclave’ structure in the MFBG. However at the upper part of the outcrop, both rocks form a ‘dykelike’ structure in which the GM ‘dyke’ is cut by the MFBG ‘dyke’ (Fig 6).
PETROGRAPHY

Mineral composition and textures of all the four rock types is given in Table 1. The CFBG, MFBG and GM consists of typical granitic (s.l.) minerals that is quartz, plagioclase, K-feldspar, biotite, zircon, apatite, sphene, allanite and opaque phases. The proportion of the minerals are different, thus in the CFBG plagioclase, K-feldspar and quartz constitutes about 90% of the modal composition whereas in both MFBG and GM, K-feldspar content is much less (<10%). Total modal of plagioclase + quartz in the latter two rocks is about 80%. The HBBD contains hornblende and biotite as the main mafic phases in contrast to the other three rocks which only contain biotite.

The main difference between the rocks are:
1. Grain size: CFBG is coarse grained and other three are fine to medium grained size.
2. Foliation: Only the GM does not show any foliation, the other three rocks contain prominent foliation, which is homogenously distributed within the rocks, and
3. Foliation mineral: The foliation in the three rocks is made up of different minerals, that is, CFBG: biotite and fine grained re-crystallised quartz-feldspar, MFBG: fine grained recrystallised quartz and HBBD: thinly stretched biotite.

GEOCHEMISTRY

Analytical procedure

Major element oxides were analysed by X-ray fluorescence (XRF) at the Department Mineral and Geoscience Malaysia, Ipoh. The equipment used was a Phillips PW 1480 X-ray spectrometer. Glass fusion disc were used for the analysis of major elements. The discs were prepared by fusing a mixture of 1 g of rock sample with 6 g of flux (lithium tetraborate + lithium metaborate) at about 1000°C and casting the melt on an aluminium platten.

Representative geochemical analysis of the rocks is given in Table 2. Average SiO$_2$ content for the rocks are CFBG (67.11%), GM (65.25%), MFBG (71.22%) and HBBD (51.47%). Elemental variation is shown by Al$_2$O$_3$, Fe$_{tot}$, CaO and MgO. HBBD has the highest Al$_2$O$_3$, Fe$_{tot}$ and CaO content (19.27%, 8.15% and 9.72% respectively; see table 2) compared to the other three rocks.

Interestingly large elemental variations are also shown by the three granitic rocks (s.l) (CFBG, GM, MFBG). They are:
1. SiO$_2$ content indicate GM is the most basic composition compared to the CFBG and MFBG.
2. Total alkali content gradually decrease from CFBG to MFBG to GM.
3. Na$_2$O + CaO content is higher in both GM, MFBG compared to the CFBG
4. K$_2$O content is higher in the CFBG compared to the GM and MFBG.
Figure 3: Field sketch of the lower part of Figure 2 showing the nature of the contact between medium grained foliated biotite granite (MFBG) and grey microgranite (GM). The contact between both rocks is characterized by irregular outline suggesting that the magmas are synplutonic.

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Figure 6: The ‘dyke-like’ GM rocks with inclusions of CFBG rocks.

Table 1: Summary of the petrographic characteristics of the four main rock types found in the Jeli Igneous Complex.

<table>
<thead>
<tr>
<th>Rock Type</th>
<th>Coarse grained foliated biotite granite (MFBG)</th>
<th>Fine grained foliated biotite granite (MFBG)</th>
<th>Grey Microgranite (GM)</th>
<th>Hornblende biotite basaltic dyke (HBBD)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mineralogy</td>
<td>Quartz, plagioclase, k-feldspar, biotite, zircon, apatite, sphene, opaque</td>
<td>Quartz, plagioclase, biotite, k-feldspar, apatite, zircon</td>
<td>Quartz, plagioclase, biotite, allanite, k-feldspar, apatite</td>
<td>Quartz, plagioclase, biotite, hornblende, apatite, sphene, opaque</td>
</tr>
<tr>
<td>Grain size</td>
<td>Coarse (0.2-2cm)</td>
<td>Medium to fine (0.1-0.5cm)</td>
<td>Medium to fine (0.1 -0.3cm)</td>
<td>Fine (less than 0.1mm)</td>
</tr>
<tr>
<td>General texture</td>
<td>Foliated (visible in hand specimen)</td>
<td>Weakly foliated (visible only in hand specimen); recrystallised quartz</td>
<td>non foliated and slightly porphyritic in thin section</td>
<td>Foliated (visible only in thin section)</td>
</tr>
<tr>
<td>Foliation mineral</td>
<td>Biotite &amp; fine grained recrystallised quartz-feldspar</td>
<td>Fine recrystallised quartz</td>
<td>Thin stretch biotite</td>
<td></td>
</tr>
<tr>
<td>Plagioclase</td>
<td>Subhedral, wrap by biotite foliation, twinning, irregular outline</td>
<td>Zoning</td>
<td>Zoning &amp; twinning, phenocrystic with black rim</td>
<td>Fine grain &amp; same size with other minerals</td>
</tr>
<tr>
<td>Quartz</td>
<td>Clusters of anhedral grains with lobate boundaries</td>
<td>2 types: Anhedral and form interconnected network &amp; fine grained recrystallised</td>
<td>Anhedral and scattered</td>
<td>Anhedral fine grained</td>
</tr>
<tr>
<td>K-feldspar</td>
<td>Coarse grain and rarely perthitic</td>
<td>Small amount</td>
<td>Small amount</td>
<td></td>
</tr>
<tr>
<td>Biotite</td>
<td>2 types: coarse grain foliated and fine grained foliated (recrystallised)</td>
<td>Weakly foliated and anhedral</td>
<td>Anhedral, bladed shape, sometimes very weakly foliated</td>
<td>2 types: subhedral non-foliated and stretch foliated (thin) crystals</td>
</tr>
<tr>
<td>Hornblende</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>Euhedral-anhedral. Usually smaller than non-foliated biotite</td>
</tr>
<tr>
<td>Accessory</td>
<td>Zircon, apatite and sphene associated with biotite clot. Opaque associated with scattered and rarely associated with foliation</td>
<td>Zircon, apatite</td>
<td>Apatite and allanite</td>
<td>Apatite, sphene, opaque</td>
</tr>
<tr>
<td>Other textures</td>
<td></td>
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</tbody>
</table>
DISCUSSION AND CONCLUSION

Relative Age

The field relations suggest that the relative age of the rocks in decreasing order are: CGBG-GM/MFBG-HBBD.

Magmatic and High-Temperature Solid-State Deformation

The rocks from study area display a variety of magmatic structures. On a large scale, there are numerous examples of sharp contacts between different rock types. Other igneous features include 'stretched' enclaves (Berger and Pitcher, 1970; Marre, 1987), occurrence of leucocratic dykes cutting the CFBG, GM and MFBG (Miller and Paterson 1994) and blocks of CFBG in GM. However in thin section, much of textural features favour high-temperature solid state deformation. Microstructures within the zone of solid state deformation include undulatory extinction of quartz and subgrains development in quartz with lobate boundaries, bending of biotite, fractured plagioclase (Guglielmo Jr, 1993) and occurrence of myrmekite intergrowth parallel to the foliation (in CFBG) (Vernon, 1991). Evidence of magmatic deformation in the thin section is scant. Thus, the rocks in the area have undergone both magmatic and high temperature solid state deformation.

Magma Interaction Between MFMG and GM

Field relations described in the earlier section suggest that MFMG and GM are synplutonic. Both magmas probably intruded the CFBG at about the same time. Interestingly only MFMG show foliation compared to the weakly porphyritic texture in the GM. The different rocks texture indicate that the magmas intruded at different viscosity. Van der Molen & Paterson (1987) showed that a magma mush with less than 70% crystals is incapable of recording solid state deformation. Thus, the GM magma probably contained less than 70% crystals compared to MFMG, which presumably contained more than 70% crystals when they came into contact with each other. This allowed mingling and mixing between the two magmas. Evidence of the processes have been recorded in both field and in thin section. In the field, mingling of both MFBG and GM is shown in Figures 3, 4 and 5. In the thin sections, magma mixing is evident from corroded plagioclase with thin mantle layers (Table 1).

Geochemical Interpretation

All the four main rock types in the study area have distinct chemical compositions. Higher CaO + Na2O content in both MFBG (7.12%) and GM (9.60%) compared to the CFBG (6.20%) may be reflected by the higher lower modal proportion of K-feldspar in the MFBG and GM. On the other hand, the CFBG has higher K2O content (3.81%) compared to the other granitic rocks (MFBG: 2.69% and GM: 1.88%). This may reflect the higher modal K-feldspar content in the rock. Chemical analysis also confirmed the basaltic nature of the HBBD.
REFERENCES


