

## Field and Petrographic characteristics of the Bhalla and Doda granitic bodies associated with Kaplas granite in Doda district of J&K, India

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**Abstract:** The Doda and Bhadarwah area of Doda district are covered by Salkhala rocks. The Salkhala rocks of this area are intruded by number of small granite bodies except the huge batholiths in form of the Kaplas granite. These small granite bodies associated with Kaplas granite are named as Sarkanth granite, Dedni granite, Bhala granite, Piparan granite and Pul Doda granite. The various rock types of the area are Phyllites, schists and granitic gneisses belonging to the Salkhala series and intrusive granite bodies. Bhalla granite is one of small bodies of Kaplas granite, whereas the Doda granite body is present near the Pul Doda along the Doda-Bhadarwah national highway. Both the granite bodies vary in their field characteristic. The main purpose of this paper is to publish the detailed field and petrographic data of the Bhalla and Doda granite.

**Key words:** Doda dostrict; Bhalla granite; Doda granite; Salkhala rocks.

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### 1. Introduction

The Doda and Bhadarwah area of Doda district is covered by Salkhalas, Dum Gali & Bhadarwah Formation of Precambrian to Cambrian age which is intruded by Kaplas batholith and the associated smaller granite bodies such as Sarkanth granite, Dedni granite, Bhala granite, Piparan granite and Pul Doda granite. Kaplas granite is correlatable to Piparan/Sarkanth granite of Doda district and Dalhousie granite of H. P. Its age is considered to be lower Palaeozoic possibly Cambrian (Raina & Sharma, 1987-88). The area northwest of Bhadarwah, which comprises the phyllites, schists and granitic gneisses belonging to the Salkhala series (R.K and Sundaram, 1970-71). Srikantia and Sharma (1976) have done the systematic geological mapping in Thatri-Khaleni, Dudu- Malar area Doda-Udhampur and Kathua J&K state.

Singh and Dhiman (1993) has done the large scale mapping of some selected sections and geochemical studies for basements and cassiterite in Kaplas granite body and Traverse mapping in adjoining Bhadarwah Bhallesh area, Doda, Kathua, and Udhampur districts, Jammu and Kashmir. On the northeastern side the Kaplas fault has brought the Bhaderwah slates into contact with the Kaplas granite. Bhalla granite is one of small bodies of Kaplas granite, occurring in between Kaplas pluton and Chinta granite. Both Kaplas granite and Bhalla granite appear to be co-genetic and are very coarse-grained, hard and compact porphyritic biotite granites with predominance of alkali feldspars. Ray (1981) has reported granitoid rocks in the Kaplas Mount area, Doda and Udhampur districts. This succession is represented by Salkhalas exposed in and around the Bhadarwah called Bhadarwah Formation.

Bhalla granite is one of small bodies of Kaplas granite, whereas the Doda granite body is present near the Pul Doda along the Doda-Bhadarwah national highway. Both the granite bodies vary in their field characteristic. The Geological Survey of India has done the mapping and geochemical study of the Kaplas granite and its associated plutons including the Doda and Bhalla granite. However, the published literature regarding the geochemistry and petrography of the Bhala and Doda granite is not available. Therefore the main purpose of

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this paper is to publish the detailed field and petrographic data of the Bhalla and Doda granite for the purpose the samples collected from these two area are subjected to detailed field and Petrographic study.

## Results

### Field Characteristic

The granite bodies of Bhalla and Doda are sheared shows gneissose to schistose structure, emplaced in the Bhadarwah Formation of Salkhala Group. In these granite bodies evidence of chilling effects is very commonly seen. The granite and associated metamorphites exhibit three phases of folding.

The various rock types exposed in the area are phyllites, Schist, Gneiss and quartzite. The granite body at Bhalla area is intruded into the metamorphic rocks of the Salkhala group. This granite body shows sharp contact with the surrounding country rocks (**Fig. 1a**). The granite at Bhalla contains the xenoliths of different sizes of schist (**Fig. 1b**) and quartzite is commonly seen in the granite.

**Porphyritic Granite:** This granite variety occurs at Bhala about 15 km from Doda on Doda-Bhadarwah national highway. This granite shows sharp contact with the country rock e.g. Schist. It is a mesocratic, massive, porphyritic granite (**Fig. 1c**) and is composed mainly of feldspar, biotite and quartz. The most striking field feature of this is the presence of very big randomly oriented phenocrysts of glistening white feldspar which are embedded in a coarse grained groundmass composed of feldspar, biotite, and quartz. Due to higher content of biotite (**Fig. 1d**) it is darker in colour. The phenocrysts are irregular in shape their dimensions varies from 3 to 9/16 cm in length and 1 to 10 cm in width. At places the phenocrysts are aligned parallel giving rise to primary foliation in the granite locally. Development of foliations planes are seen in this granite which gives it gneiss like character. At some places xenoliths of arenaceous mica-schist or argillaceous quartzite, auger shaped phenocrysts are seen within the granite. It is highly weathered and shattered into big boulders due to physical weathering.

### Coarse grained granite

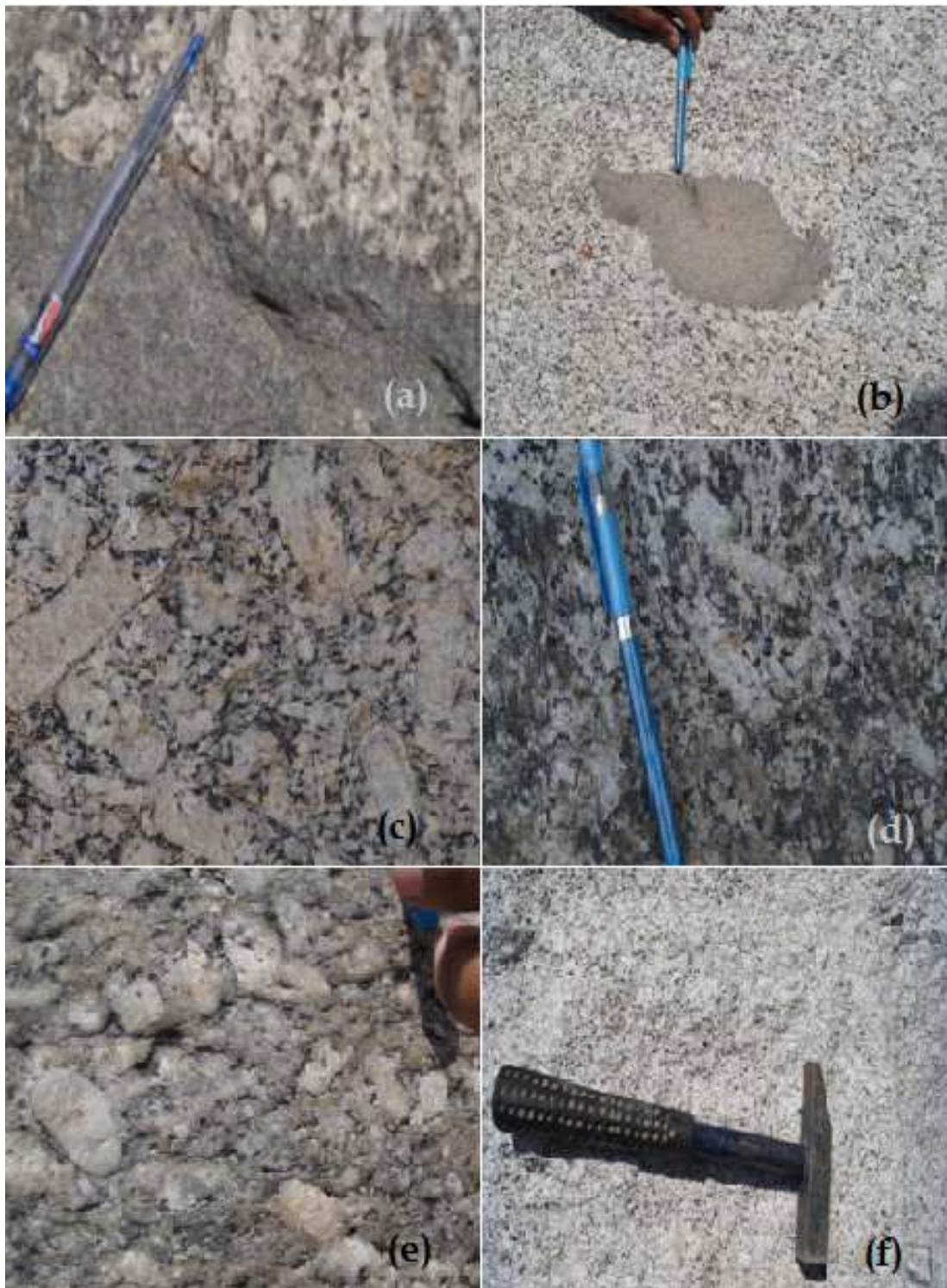
This granite variety occurs at Bhala area around 15 km from Doda. This is intruded in the metamorphic country rocks that are schist and quartzite of the Salkhala group. This is coarse grained massive leucocratic granite (**Fig. 1e**). Like Doda granite it is highly weathered into huge boulders at most of places. Feldspar is white in colour showing glassy luster and quartz is greyish white with oily luster. Another interesting feature of the rock is that it is fairly homogeneous in composition. Sometimes big lath shaped phenocrysts of potash feldspar are embedded in a medium to coarse grained, groundmass composed of plagioclase, quartz and micas, thus giving rise to porphyritic texture occasionally.

### Medium grained granite

This granite occurs near the Pul Doda along the national highway towards the Bhadarwah. This is a medium grained massive leucocratic granite (**Fig. 1f**). The rock is highly weathered at most of the places and huge boulders have been formed due to physical weathering. Feldspar is white showing glassy luster and quartz is grayish white with oily luster. Another interesting feature of the rock is that it is fairly homogeneous in composition. Sometimes big lath shaped phenocrysts of potash feldspar are embedded in a medium to coarse grained, groundmass composed of plagioclase, quartz and micas, thus giving rise to porphyritic texture.

### Petrographic characteristic

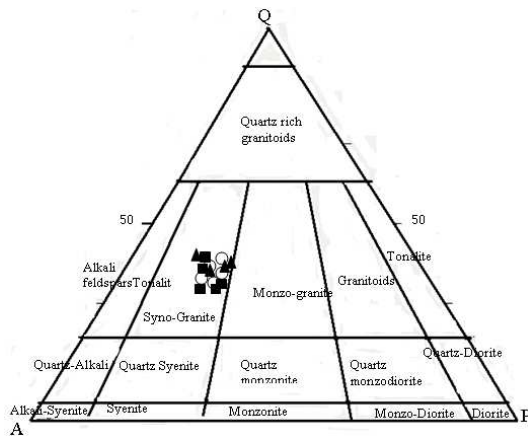
The Petrographic study of the different rock samples of Bhala and Doda granitic bodies associated with Kaplas granite is done in order to know the different mineral assemblages and textural variations in rock types. The fresh samples of the two granite bodies are collected and attempts have been made to present the petrography of these granites. The modal composition of the different rock types of these two granite bodies is given in **Table-1**. The Modal composition plot is shown in **Fig. 2**. The sample of the both granite bodies falls mostly in the syno-granite field of the Streckeisen, (973) Q-A-P classification diagram.



**Fig. 1. (a-f).** (a) Field photograph showing sharp contact between the granite and country rock, (b) Field photograph showing the xenoliths of schist within the granite, (c) field photograph of porphyritic granite showing the phenocrysts of feldspars from Bhalla area, (d) field photograph of porphyritic granite showing the phenocrysts embedded in coarse grained ground mass with dominance of biotite, (e) field photograph of coarse grained granite from Bhalla area, (f) field photograph of medium to fine grained granite from Doda area.

**Table 1.** Modal analysis of the Doda and Bhalla granite bodies.

Rock types/ sample nos./ minerals	Medium grained granite					Coarse grained granite					Porphyritic granite			
	AD-1	AD-2	AD-3	AD-4	AD-5	AB-1	AB-2	AB-3	AB-4	AB-5	AB-6	AB-7	AB-8	AB-9
Quartz	37.0	37.6	35.0	40.0	37.5	35.0	33.3	38.2	40.0	25.5	26.8	28.1	28.8	30.5
Potassic feldspars	37.0	37.5	38.4	36.7	35.0	35.6	35.0	35.1	36.4	35.5	32.0	29.7	33.1	27.2
Plagioclase feldspars	22.0	21.5	20.5	19.0	21.0	19.0	18.5	18.3	16.0	19.0	24.6	22.5	20.3	21.1
Muscovite	0.5	0.3	1.3	0.8	1.4	3.0	2.3	1.5	1.2	2.7	2.5	3.0	2.5	2.8
Biotite	2.0	1.4	2.8	1.2	2.7	6.1	7.5	6.5	5.1	1.0	1.3	1.0	2.0	1.7
Pyroxenes & Amphiboles	0.2	0.1	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Accessory minerals	0.3	0.4	1.3	0.3	0.4	0.0	0.5	0.0	0.1	0.5	0.6	0.3	0.2	0.8
Groundmass	-	-	-	-	-	-	-	-	-	13.0	12.0	14.0	12.2	14.7
<b>Total</b>	<b>98.9</b>	<b>98.8</b>	<b>99.2</b>	<b>97.9</b>	<b>97.8</b>	<b>98.7</b>	<b>97.2</b>	<b>97.6</b>	<b>98.8</b>	<b>97.1</b>	<b>99.7</b>	<b>98.6</b>	<b>99.1</b>	<b>98.7</b>
Model % recalculated to 100	<b>Q</b>	39	39	37	42	40	39	39	42	43	32	32	35	39
	<b>A</b>	38	39	41	38	38	40	40	38	40	44	38	37	40
	<b>P</b>	23	22	22	20	22	21	21	20	17	24	30	28	25



**Fig. 2.** Model analysis (QAP) plot for the Bhalla and Doda granites after Streckeisen, (1973). The filled square represents the porphyritic granite, filled triangle represents the coarse grained and empty circle represents the medium grained granite.

**Medium grained granite**

The rock shows medium grained, to xenomorphic hypidiomorphic, equigranular texture (**Fig. 3d**). Under the microscope massive granite is composed of quartz, k-feldspars represented by microcline, Perthite (**Fig. 3e**), Plagioclase, biotite, muscovite and very rarely sphere as accessory. The modal proportion of the quartz ranges between 35-40%. Often thin veins of quartz cut across the

plagioclase grains Potash feldspar is most dominant amongst the feldspars and occurs in the form of mainly microcline and often perthite (35-39.4%). They are coarse, anhedral to subhedral; lath shaped and often forms phenocrysts. Microcline grains show non-hatched twins. Perthite is present in few samples. Sericitic alteration in potash feldspar grains in the granite is a common feature. Plagioclase occurs in coarse to medium sized, subhedral, prismatic or tabular grains in the groundmass showing thin or thick lamellar twinning with symmetrical extinction. The percentage of the plagioclase feldspars is between 19-22%. The amount of micas is very less which is less than 4% and is mainly biotite. One of the important characteristics of this granite variety is the presence of fractured quartz crystals and feldspars laths. This indicates the stress condition operating on the rocks this also supported by the undulatory extinction present in the quartz of the few thin sections.

**Coarse grained granite**

The granite variety shows coarse to very coarse grained, inequigranular texture (**Fig. 3f**). The coarse grained granite is mainly composed of Quartz, alkali feldspars, plagioclase feldspar,

biotite and muscovite. The modal percentage of quartz ranges between 33.3 to 40%. Quartz is found as coarse and fine anhedral grains. They are very often fractured and show strain shadows due to local shearings. In some of the samples the quartz grains show marginal granulation. They generally exhibit irregular boundaries with the feldspars. A later generation of quartz in the form of small cathedral unstrained grains occurring in clusters or veins is found at some places which indicate a later solidification. The average composition of the granite samples indicates that the potash feldspar and quartz are present almost in same proportion except in few sections in which the percentage of k-feldspars is more than quartz. Thin veins of quartz cut across the plagioclase grains. The k-feldspars are represented by mainly microcline and rarely orthoclase. The modal percentage of k-feldspars ranges between 35 to 36.4%. The plagioclase feldspars are not fresh they show some alteration effect (**Fig. 3g**). This bluish grey mineral has been identified to be chlorite under the microscope, the chlorite being pleochroic from pale bluish to dark bluish green. The percentage of the plagioclase is 16 to 19%. The fresh muscovite flakes are observed in this granite variety. Sometimes the percentage of quartz is higher rendering the rock more siliceous, occasionally white feldspar forms phenocrysts of prismatic shape which are embedded within the groundmass. At places plagioclase grains are fractured and altered. Biotite is the chief of the micaceous minerals with muscovite being present at some places. Biotite and muscovite occur in the form of prismatic and needle shaped grains sometimes they are fibrous and concentrated in bands. Biotite is strongly pleochroic from pale brownish yellow to dark brown. The micas constitute about 6.3-10% in which biotite constitute about 5.1-7.5% and muscovite 1.2-3%. Pyroxene is found only in one sample.

#### **Porphyritic granite (K-feldspars porphyry):**

The detailed petrographic characteristics of 5 fresh samples of this granite variety are carried out and their mineral composition and textural characteristics are studied. The main mineral composition of the granite variety is quartz, potash feldspar, plagioclase, biotite, muscovite with garnet as an accessory mineral. Quartz occurs as fine to medium sized anhedral grains

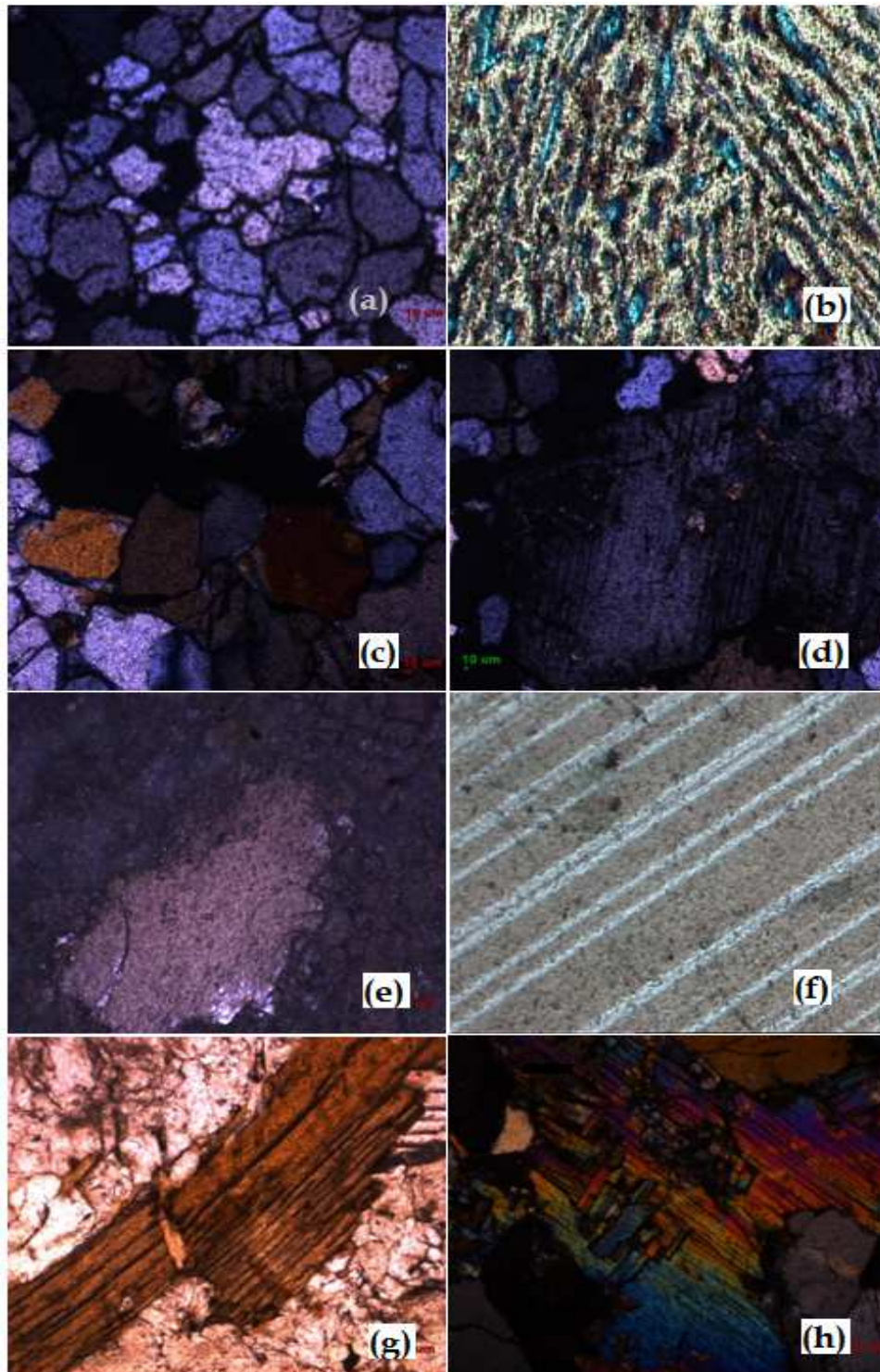
in the groundmass (**Fig. 3a**). At places the quartz grains appear to have been recrystallised. The modal percentage of quartz ranges from 25.5-30.5 volume percent. The percentage of the k-feldspars which are represented by microcline is higher than modal percentage of the quartz in most of the samples which ranges between 27.2-35.5%. Plagioclase occurs as coarse to very coarse subhedral, prismatic or tabular grains mainly as phenocrysts showing development of fine lamellar twinning (**Fig. 3b**) with a symmetrical extinction around  $12^\circ$  (Albite-Oligoclase). Sometimes two intersecting sets of lamellar twins are developed. Feldspars are often sericitized (**Fig. 3c**), modal percentage ranges between 19-24.6%. Biotite is flaky or needle shaped showing strong pleochroic from pale yellowish brown to dark brown and straight extinction modal % ranges between 1.0-2%. Muscovite occurs as primates or needle or needle shaped grains and the modal % is 2.5-3%. Garnet which occurs as accessory minerals is small rounded or anhedral shows high relief. In few samples few pyroxenes and riebeckite crystals are seen.

Phenocrysts of plagioclase are embedded in a ground mass composed of plagioclase, quartz and potash feldspar. The plagioclase phenocrysts are generally prismatic to tabular shaped and are composite grains of few plagioclase grains. The percentage of the groundmass ranges from 12 to 14.7%.

#### **Discussion**

From the above field observation and mineralogical description it reveals that the Bhalla and Doda granite has emplaced in the arenaceous micaceous schists and possibly the Bhaderwah Slates also by magmatic intrusion in the late synkinematic to late kinematic stages. However, the presence of perthite and plagioclase dominance in the porphyritic granite indicate that the Kaplas granite may be of perthite-genetic origin. The field evidences further reveals that the intrusion possibly has taken place from the southern side and continued the north.

Petrographic study of Bhalla granite which is one of the small bodies of Kaplas granite, occurring in between Kaplas pluton and Chinta granite is very coarse-grained, hard and compact porphyritic biotite granites with predominance



**Fig. 3 (a-h).** Microphotographs: (a) photograph shows equigranular texture of medium grained granite, (b) perthitic texture, (c) Microphotograph showing inequigranular texture of coarse grained granite, (d) Microphotograph showing alteration in feldspars, (e) Microphotograph showing quartz phenocrysts in medium grained matrix, (f) Fresh plagioclase feldspars, and (g) Microphotograph of biotite, Fig.3h microphotograph of muscovite.

of alkali feldspars is co-genetic with the Kaplas granite, xenoliths of arenaceous mica schist or argillaceous quartzite also indicates a magmatic of the granite. Petrographic studies of the porphyritic granite indicate that it is rich in k-feldspars. The Phenocrysts are made up of k-feldspars and plagioclase aggregates while quartz and some potash felspar are observed in the groundmass. This perhaps indicates late synkinematic intrusions. The coarse grained massive granite is rich in microcline with less frequently developed plagioclase of albite oligoclase composition. At though, generally, biotite is more common than muscovite, some local concentration of muscovite is occasionally seen. All these petrographic characters points towards alate-Kinematic emplacement of this granite (after Marmo, 1971).

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