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Geological Characteristics and Petrography of Granite of Baru Area, Malakand, Pakistan

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Granites are the key rocks of the continental crust which occur in almost all the orogenic belts of the world. This research paper is focusing on the mineral resources and structural elements of granitic rock of Baru area of Malakand Agency of Pakistan. Petrographical study and Geological mapping of the study was carried out in several rock units. The study is emphasizing on the regional and local geological setting as well as origin and evaluation of different granitic rock units in the area of Baru, Malakand Agency, Pakistan. The mineralized fractures are in the form of a single fracture or group of fractures with convergence and divergence phenomena. The mineralized fractures hosted by the fine-med. grained foliated granite are more pronounced as compared to the fractures in the fine-grained sheared granite/aplite.

Keywords: Orogenic belts; Geological setting; Petrographical; Structural Elements

Introduction

Pakistan is prolific in granitic rocks where several continental scale belts traverse the northern parts of the country in Himalayas and Trans-Himalayas. They include, from north to south, Khunjerab Pamir granitic belt, Karakoram belt, Kohistan granitic belt and Higher Himalayan granitic belt [1]. Their broad mineralogical and geochemical characterizations are done to varying degrees [1]. The Malakand granite and granite gneiss are well exposed in the Baru village of Malakand District, KP, NW Pakistan. The Baru village is located at a distance of 15km to the West of Dargai Town and 150 km from Peshawar, the provincial capital (Figure1). The area is well accessible through the Peshawar-Dargai-Kot road. Geologically, the study area is a part of the Higher Himalayan internal zones constituting the westernmost part of the Higher Himalayan granitoid belt.

1. Regional Geology

In order to fully grasp the tectonic framework of north Pakistan as a prerequisite in understanding the tectonic setting of Malakand granite and granite gneiss complex, a comprehensive note on pre- and post-Himalayan history is being presented:

First Karakoram Plate collided with the southern margin of the Indian Plate followed by Afghan Block and finally the Kohistan Island Arc came in contact with the system [4, 5, 6, 7] which is bounded in the north by Main Kharakhoram Thrust (MKT) and in the south by Main Mantle Thrust (MMT) (Figure 2). The Himalayan orogenic belt is being considered to be the youngest mountain chain in the world, which came into existence as a result of collision between the Indian Plate in the south and the Eurasian Plate in the north (Figure 2). The MKT is a major tectonic feature in N.Pakistan formed as a result of collision between Karakoram Plate in the North and Kohistan island arc in the south [8, 9, 10]. Several micro continents mostly of Gondwana affinity [2] and more than one island arcs are involved in this collision, [3] which developed in the North of the Indian Plate during Mesozoic Era.

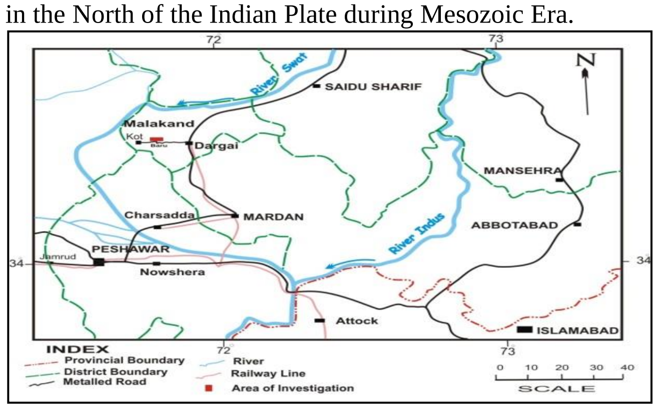

Figure 1: Location map of Baru area Malakand.

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MMT or Indus - Tsangpo Suture Zone (ISZ) was formed as a result of collision and subduction of Indian Plate underneath the Kohistan Island Arc during Eocene time [8, 9, 12] and the ocean between the two closed in Eocene at the site of MMT or ISZ. To the southwest in India and Tibet, the MMT and MKT join together to form the Indus-Tsangpo Suture, while to the southwest in N.Pakistan the MKT and MMT merge to form the Right Lateral Sarobi-Chaman fault system (Figure 2). Due to major collisional zones (MMT and MKT), the northern Pakistan is considered as tectonically active area.

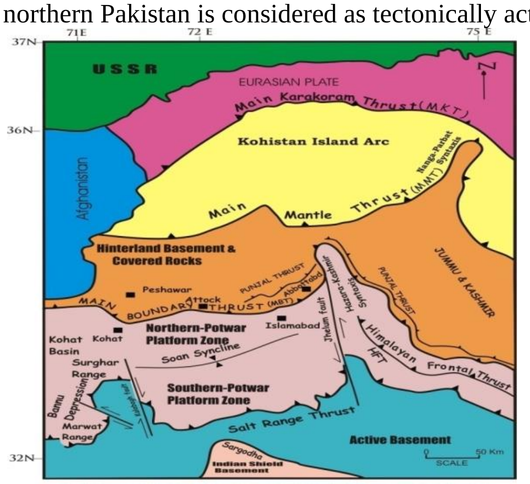

Figure 2: Regional tectonic map of the northwest Himalayas of Pakistan (after Baig and Lawrence, 1987; Monalisa and Khawaja, 2004).

This convergence resulted in the internal deformation of Indo-Pak subcontinental crustal Plate giving rise to the Himalayan foreland fold and thrust belt of northern Pakistan. This deformed belt is located to the south of MMT and is about 300 km wide which also contains the Malakand granite and granite gneiss complex (Figure 3). The Main Boundary Thrust and the Salt Range Thrust are the major members of this fault system [13, 14, 15].

The foreland basin is bordered by the MBT in the NW Pakistan where it runs east west but turns northwards near Jehlum River in the form of a major band known as the Hazara-Kashmir Syntaxis (Figure 3). In Central Himalaya, the foreland fold and thrust belt is internally cut by two north-dipping thrust faults i.e., MCT in the North and the MBT in the south (Figure 3). The SRT in the southwestern part of the Pakistani Himalaya is the lateral equivalent of the Main Frontal Thrust of the Central Himalaya. The Panjal and Nathiagali faults mark the western limit of the Hazara-Kashmir Syntaxis [16]. Different areas of the active deformational front like Salt Range, southern Potwar and Bannu, lesser seismic activity (≥4.0 Mw) could be due to the misting result of the thick Precambrian salt [17]. At the same time, clustering of events in precise parts along the facade faults shows that some fault segments, particularly in the Hinterland zone are more active. The comprehensive seismological study of the area indicates that seismicity (≥4.0 Mw) appears to be associated with both the surface and blind faults.

2-Local Geology

According to the regional tectonic classification of Himalayas, the Malakand granite and granite gneiss complex belong to the Lesser Himalayan domain [18]. These are intracratonic rocks, which are involved in the Cenozoic Mobile Belt of Himalayas.

The age data also summit out that the fission-track age of 29.40 ± 1.47 Ma of this research is the age of interruption of the carbonatitic magma of Sillai Patti carbonatite complex to superficial, near-surface level.Comparison of the uplift induced denudation rates of the region with the world data obviously reflects the presence of a post collisonal extensional environment in the region south of Main Mantle Thrust during Oligocene time. This strongly negates the idea of the earlier workers of emplacement of the carbonatite multifaceted of the Loe-Shilman and Sillai Patti areas beside thrust faults throughout Oligocene [19].

2. Petrography

Total 50 rock samples have been collected. The samples have been collected with 50 to 200 meters interval along two geological cross sections (Figure 4). Thin sections (Figure 5) of standard of 30 microns thickness were prepared with the help of rock cutting and polishing machines for petrographic analyses with the help of polarizing microscope.

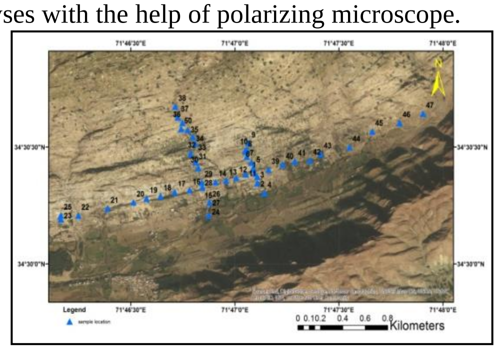

Figure 4: Landsat Image of the study area, showing location of the samples, Baru area, Malakand.

Mineralogical Compassions

4.1.1. Quartz

Quartz is most dominant constituent of the rock and range from 35% to 70%. It is monocrystalline and show wavy to uniform extinction. Moreover, it is anhedral to subhedral. It is highly resistant mineral and does not show any alteration.

4.1.2. Alkali Feldspar

Alkali Feldspar is second in abundance in thin section study. It ranges from 20% to 47%. It includes potash feldspar and microcline. Potash feldspar show carlsbad twining whereas microcline are cross hatch twin. Sericitization of feldspar has been observed in some samples, as it is susceptible to alteration. One sample was collected from feldspar plug that contains 60% feldspar.

4.1.3. Plagioclase

Plagioclase ranges from 1% to 13%. It is subhedral in shape and shows polysynthetic twining. It also shows alteration into sericite.

4.1.4. Micas

Muscovite ranges from <1% to 30%. It is elongated in shape and colorless in nature. Biotite ranges from <1% to 5%, it is elongated in shape and brown in color and pleochroic in nature.

4.1.4. Opaque Minerals

Opaque minerals are <1%, they consist of magnetite and hematite. Other accessory minerals include chlorite, zircon and epidote.

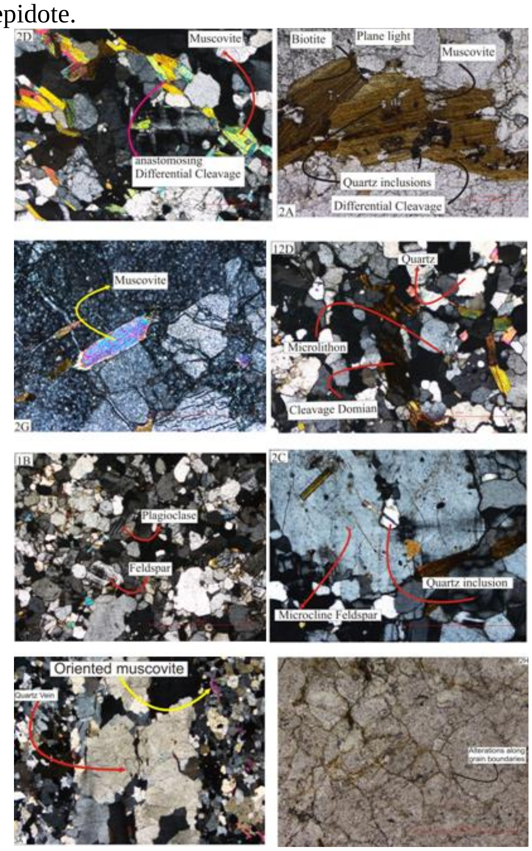

Figure 5: Photomicrographs of thin sections from Baru area. With 5X magnifications, showing quartz, muscovite, biotite with some alterations alog grain boundries of quartz.

a. Rocks Description

The rocks samples of Malakand Granite are generally light grey to dark grey foliated/ non foliated rock, occasionally brownish coloration is also visible due to hematization. Texturally both medium to fine grained and medium to coarse grained are present. Quartz and quartzofeldspathetic veins have been observed.

The lithological compositions of all 50 collected samples are given in the Table 1. By using Streekcisen QAP ternary diagram (Figure 6), the samples assigned in different rock types mainly of Granite Gneiss and Alkali Feldspar Ganite.

4.2.1. Granite Gniess

Granite Gniess is a crystalline metamorphic rock, found dominantly in the area of Baru, Malakand Agency, Pakistan . In the study area after analysing the mineralogical and textural characteristics of all collected rock samples, 58% of samples are found Granite Gniess. Texturally, fine to course grained, foiliated and non-foliated, equigranular hypidiomorphic Granite Gniess is exposed in the area. Mineralogical composition of Granite Gniess consist of Quartz, Alkali Feldspar (Potash feldspar, microcline), Plagioclase, muscovite, biotite, Chlorite, subordinate amount of zircon, opaque and rare ore minerals.

4.2.1. Alakali Feldspar Granite

Alkali Feldspar Granite is the second most abundant rock found in the study area, with about 30% of abundance. Subheudral, euhedral and perthitic crystals of Alkali Feldspar Granite are present in the Baru Area. Chessboard texture is well developed. In the deformed cataclastic and protomylontic facies fined grained microcline and perthitic megacrysts are present. In micrograntic and massive facies subhederal to euhederal mesopert form from Alkali Feldspar Granite. Mineralogical composition of Alakali Feldspar Granite consist of Quatz (41% to 68%), Alakali Feldspar (15% to 49%), Pagioclase (1% to 5%), Muscovite (1% to 10%), Biotite (1% to 5%) and very minor trace of Hmatite.

4.2.1. Granite

Granite rock sample according to IUGS Classification (Le maître,) is present in 0.06%. The textural properties of Granite rock is fine to medium grained granular form. Its mineralogical composition is of Quartz (40% to 46%), Alkali Feldspar (40% to 4%), Plagioclase (10% to 11%), Muscovite (2% to 4%) and Biotite (2% to 3%).

4.2.1. Other Minor Rock Elements

Other minor rock elements in the study area are present in 0.06%. Medium to coarse grained granular and pseudomorphed grains of these monir rock elements are present. Rock elements in minor amount in the study area are consist of Quarts Mica Schist (0.02%), Garnet Mica Schist (0.02%) and a Feldspar Vein (0.02%). Garnet Mica Schist are pseudomorphed garnet grains with Altered Garnet grains and mica flakes. While the texture of Feldspar vein is coarse granular with mineralogical composition of Quartz (2%), Alkali Feldspar (60%), Muscovite (1%) and Biotite (37%).

3. Geological Structure:

a. Folds

Due to ductile behavior on action of compressional forces acting in opposite direction of rock, bend like structures of folds are formed. On the outcrop different types of folds have exposed. These are commonly observed in granite gneiss. Folding structure have also been observed in feldspar veins. Open folds, tight folds, ptygmatic folds and simple folds types have observed in the study area.

b. Faults

Due to regional tectonic force action in opposite direction of deposited sediments, faulted structures have formed. These faulted structures are of different types from major regional faults to minor faults.

c. Lineation

Because of extensional forces in the area Joint structure have found. As a results of extensional forces cracks in the deposited rocks increases and cause displacement in rock due to further tectonic action. These joints then also filled with derived deposits and form veins. As observed in feldspar veins.

d. Foliation

Foliation is the planner structure of metamorphic rock. Typical dark gray to light gray foliated granite gneiss is present in the Baru area of Malakand agency. That formed due to sub-parallel to parallel alignment of minerals of similar chemical and physical characteristics.

e. Intrusion

Many instrusive bodies have observed in the study area, that indicates the presence of geothermal activity in the past. Xenoliths and discordant igneous bodies including leccoliths, apatite and pegmatite veins have observed in Malakand granite deposits.

4. Rock Units of Malakand

The area comprises the following rock units: **Metasediments; Malakand granite gneiss; Malakand granite.** An extract of the geology of Malakand and adjacent areas in the light of the work of above investigators is presented below:

a. Metasediments

Metasediments exposed in the area were previously considered as part of the Lower Swat Buner schistose group. [20] termed them as “The Indian shelf sediments” which have been divided into Alpurai Group, which includes Marghazar, Kashala, Saidu and Nikanai Ghar Formations. Metasediments exposed in the Malakand area were termed as Mekhband Formation [20], which is composed of dark grey weathered biotite-calcite schist, garnet-muscovite schist, epidote-biotite schist, amphibolites, calcite marble and rare graphitic schist. Near the Malakand Pass, it is composed of siliceous schist and amphibolite in the north, whereas in the south, the rocks are in green schist facies (green schist, quartzofeldspatic schist). The Mekhband Formation overlies structurally the Saidu Formation and is intruded by the Chakdarra granite gneiss.

b. Malakand Granite Gneiss

The Permian age Malakand granite gneiss is a light gray to dark gray foliated rock. Texturally it is medium to coarse grained and locally rich in quartz veins. Plotting of rock compositions [21, 22] in the Streakeisen’s triangle shows granitic nature of majority of rocks with minor reporting in the granodioritic field.

According the research of [23], the southwestern part of Malakand granite gneiss located in the southwest of Mekhband locality is not gneissic but it dominantly consists of fine-to mediumgrained imperceptibly foliated granite with patches of granite gneiss at places. On the basis of present studies we, therefore, measured this part of Malakand granite gneiss as a phase of granite, which is almost certainly younger than the granite gneisses lying northeast of Meqband and it is alder than the Malakand correct granite and it has been named as "The Hazarnao granite".

c. Malakand Granite

The Malakand granite of Tertiary age is relatively a small intrusive body having discordant relationship with the country rocks and usually exhibits the xenoliths and screens of the country rock. Backing, chilling and thermal effects can be easily observed along the contact zone of the granite.

It is leucocratic, fine to medium grained in texture and undeformed. Pegmatite and aplite veins are abundant and anatomizing. Fluorite, calcite pods as well as tourmaline are present in some pegmatite [24].

Conclusion

The study was carried out in Baru area of Malakand agengy of Pakistan. Geological setting of the area shows that the Malakand granite and granite gneiss complex occurs in the Higher Himalayan Internal zone south of the Main Mantle Thrust/Indus Suture Zone and constitute a part of the Alpurai Nappe which is one of the six nappe forming the Hiamalayan internal zones in north Pakistan. Petrography has also done on the 50 collected samples at the study area in order to determine the mineral composition and rock types present in the Baru area. After detained petrographyical analysis its has found that rocks of malakand granite are mainly composed of quartz, k-feldspar and plagioclase with trace amount of muscovite, biotite, hematite and opaque minerals. Structural features are also well developed in the study area As the region is tectonically active from past, this results in formation of many complex structural features including folds, faults, lineation, foliation, joints and igneous intrusion. On the basis of structural and petrographical research study Malakand Granite is divided into three major rock units Metasediments, Malakand granite gneiss and Malakand granite.

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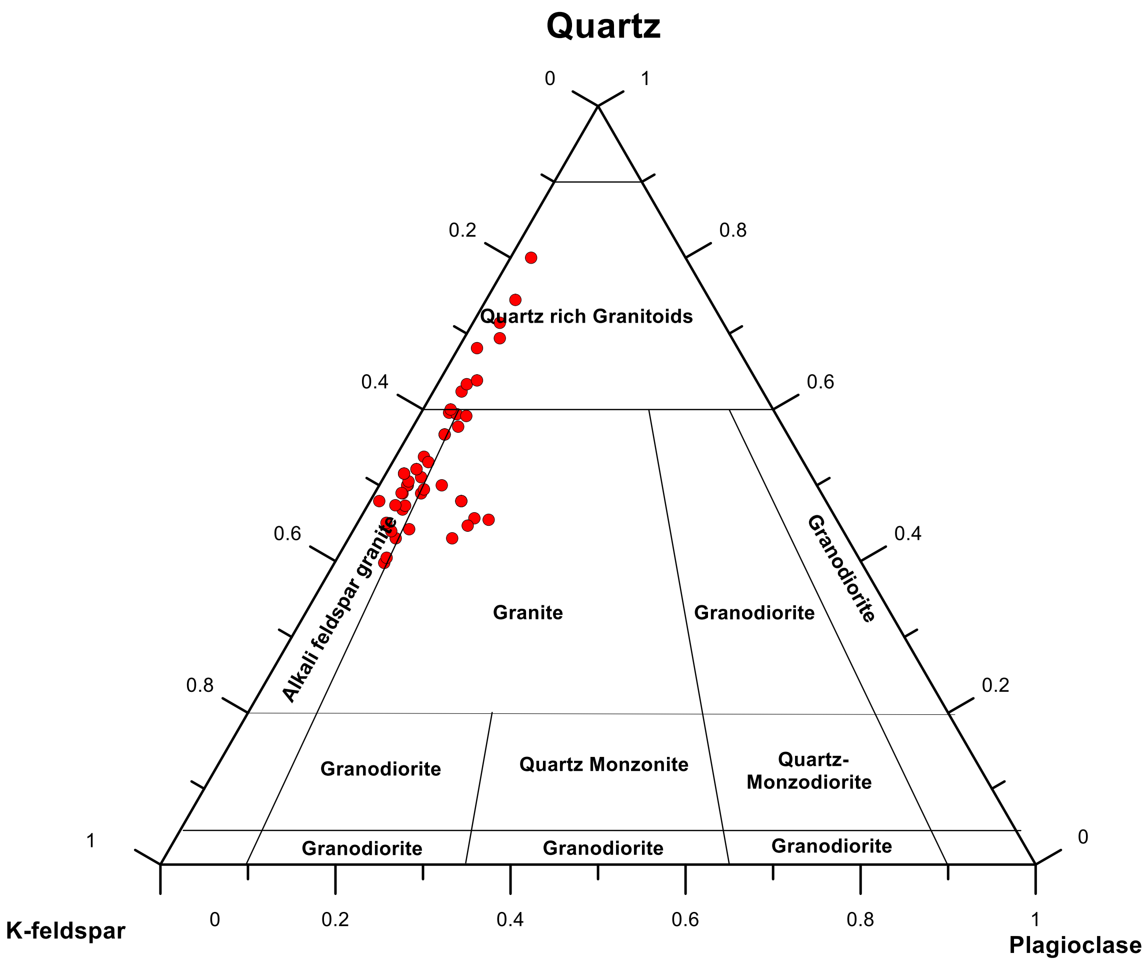
Table 1: Petrographic Results of Rock Samples Collected from Malakand Granite, Baru Area, Malakand.

Sr. No.	Sample No.	Mineralogy & Percenatges	Textural description	Rock Name
1	MB-1/17	Quartz, Alkali Feldspar (Potash feldspar, microcline), Plagioclase, muscovite, biotite and rare ore minerals	Granular, fine to medium grained	Granite Gneiss based on mineralogy & texture
2	MB-2/17	Quartz (35%), Alkali Feldspar (48%), Plagioclase (5%), Muscovite (8%) and Biotite (2%) Chlorite is in accessory amount, rare opaque minerals along the cleavages.	Foliated, medium grained	Granite Gneiss based on mineralogy & texture
3	MB-3/17	Quartz (36%), Alkali Feldspar (48%), Plagioclase (5%), Muscovite (7%) and Biotite (2%), rare opaque minerals along the cleavages.	Foliated, weakly gneissic	Granite Gneiss based on mineralogy & texture
4	MB-4/17	Quartz (70%), Alkali Feldspar (25%), Plagioclase (3%), Muscovite (2%) and Biotite (<1%)	Foliated, weakly gneissic coarse grained	Granite Gneiss based on mineralogy & texture
5	MB-5/17	Quartz (68%), Alkali Feldspar (26%), Plagioclase (4%), Muscovite (2%) and Biotite (<1%)	Foliated, weakly gneissic, medium grained	Granite Gneiss based on mineralogy & texture
6	MB-6/17	Quartz (55%), Alkali Feldspar (38%), Plagioclase (4%), Muscovite (2%) and Biotite (1%), opaque minerals (<1%), zircon is in accessory amount.	Foliated, weakly gneissic, coarse grained	Granite Gneiss based on mineralogy & texture
7	MB-7/17	Quartz (40%), Alkali Feldspar (35%), Plagioclase (13%), Muscovite (8%) and Biotite (4%), opaque minerals (<1%).	Foliated, well developed gneissosity medium grained	Granite Gneiss based on mineralogy & texture
8	MB-8/17	Quartz (55%), Alkali Feldspar (38%), Plagioclase (4%), Muscovite (2%) and Biotite (1%).	Granular, Medium to fine grained	Alkali Feldspar Granite, based on IUGS Classification (Le maître, 1986)
9	MB-9/17	Quartz (56%), Alkali Feldspar (35%), Plagioclase (3%), Muscovite (4%) and Biotite (2%), opaque minerals (<1%).	Foliated, weakly gneissic, coarse grained	Granite Gneiss based on mineralogy & texture
10	MB-10/17	Quartz (42%), Alkali Feldspar (38%), Plagioclase (12%), Muscovite (5%) and Biotite (3%).	Foliated, weakly gneissic	Granite Gneiss based on mineralogy & texture
11	MB-11/17	Quartz (46%), Alkali Feldspar (40%), Plagioclase (10%), Muscovite (2%) and Biotite (2%).	Granular, Medium grained	Granite, based on IUGS Classification (Le maître,)

12	MB-12/17	Quartz (42%), Alkali Feldspar (40%), Plagioclase (12%), Muscovite (3%) and Biotite (3%).	Foliated, weakly gneissic, anhedral	Granite Gneiss based on mineralogy &texture
13	MB-13/17	Quartz (40%), Alkali Feldspar (42%), Plagioclase (11%), Muscovite (4%) and Biotite (3%).	Granular, Medium to fine grained	Granite, based on IUGS Classification (Le maître,)
14	MB-14/17	Quartz (40%), Alkali Feldspar (48%), Plagioclase (5%), Muscovite (3%) and Biotite (2%), opaque minerals (<1%).	Foliated, weakly gneissic, Medium grained	Granite Gneiss based on mineralogy & texture
15	MB-15/17	Quartz (46%), Alkali Feldspar (40%), Plagioclase (10%), Muscovite (2%) and Biotite (2%).	Granular, Medium grained	Granite, based on IUGS Classification (Le maître,)
16	MB-16/17	Quartz (44%), Alkali Feldspar (46%), Plagioclase (4%), Muscovite (4%) and Biotite (2%).	Foliated, fine to medium grained	Granite Gneiss based on mineralogy & texture
17	MB-17/17	Quartz (44%), Alkali Feldspar (45%), Plagioclase (4%), Muscovite (2%) and Biotite (4%), chlorite (<1%).	weakly Foliated, Medium to coarse grained	Granite Gneiss based on mineralogy & texture
18	MB-18/17	Quartz (48%), Alkali Feldspar (42%), Plagioclase (4%), Muscovite (2%) and Biotite (4%), opaque minerals (<1%).	weakly gneissic, medium grained	Granite Gneiss based on mineralogy & texture
19	MB-19/17	Quartz (46%), Alkali Feldspar (43%), Plagioclase (5%), Muscovite (2%) and Biotite (4%).	Gneissic, medium grained	Granite Gneiss based on mineralogy & texture
20	MB-20/17	Quartz (46%), Alkali Feldspar (43%), Plagioclase (3%), Muscovite (5%) and Biotite (2%).	weakly gneissic, medium grained	Granite Gneiss based on mineralogy & texture
21	MB-21/17	Quartz (49%), Alkali Feldspar (42%), Plagioclase (3%), Muscovite (4%) and Biotite (2%).	weakly gneissic, Fine to medium grained	Granite Gneiss based on mineralogy & texture
22	MB-22/17	Quartz (46%), Alkali Feldspar (42%), Plagioclase (5%), Muscovite (4%) and Biotite (3%).	Gneissic, Fine grained	Granite Gneiss based on mineralogy & texture
23	MB-23/17	Quartz (50%), Alkali Feldspar (40%), Plagioclase (3%), Muscovite (4%) and Biotite (3%) opaque minerals in traces.	weakly gneissic, medium grained	Granite Gneiss based on mineralogy & texture
24	MB-24/17	Quartz mica schist		Quartz mica schist
25	MB-25/17	Quartz (35%), Alkali Feldspar (30%), Plagioclase (5%), Muscovite (30%) and Biotite (< 1%).	Gneissic, Coarse grained	Granite Gneiss based on mineralogy & texture

26	MB-26/17	Quartz (57%), Alkali Feldspar (35%), Plagioclase (4%), Muscovite (3%) and Biotite (1%).	Very weakly gneissic, medium to coarse grained	Granite Gneiss based on mineralogy & texture
27	MB-27/17	Quartz (67%), Alkali Feldspar (20%), Plagioclase (3%), Muscovite (10%) and Biotite Nil.	weakly gneissic, Fine to medium grained	Granite Gneiss based on mineralogy & texture
28	MB-28/17	Quartz (58%), Alkali Feldspar (32%), Plagioclase (3%), Muscovite (6%), opaque minerals (<1%) and no Biotite.	Gneissic, medium to coarse grained	Granite Gneiss based on mineralogy & texture
29	MB-29/17	Quartz (46%), Alkali Feldspar (45%), Plagioclase (3%), Muscovite (2%), Biotite (3%), secondary calcite (1%).	Weakly gneissic, Fine to medium grained	Granite Gneiss based on mineralogy & texture
30	MB-30/17	Quartz (40%), Alkali Feldspar (47%), Plagioclase (4%), Muscovite (3%), Biotite (4%).	Weakly gneissic, medium to coarse grained	Granite Gneiss based on mineralogy & texture
31	MB-31/17	Quartz (47%), Alkali Feldspar (44%), Plagioclase (3%), Muscovite (4%), Biotite (2%), opaque minerals (<1%).	Weakly gneissic, Fine to medium grained	Granite Gneiss based on mineralogy & texture
32	MB-32/17	Quartz (57%), Alkali Feldspar (30%), Plagioclase (3%), Muscovite (10%), Biotite in traces.	Granular medium grained	Alkali Feldspar Granite, based on IUGS Classification (Le maître,)
33	MB-33/17	Quartz (48%), Alkali Feldspar (47%), Plagioclase (3%), Muscovite (<1%), Biotite (1%).	Granular medium grained	Alkali Feldspar Granite, based on IUGS Classification (Le maître,)
34	MB-34/17	Quartz (46%), Alkali Feldspar (49%), Plagioclase (1%), Muscovite (2%), Biotite (2%).	Granular medium grained	Alkali Feldspar Granite, based on IUGS Classification (Le maître,)
35	MB-35/17	Quartz (52%), Alkali Feldspar (42%), Plagioclase (4%), Muscovite (1%), Biotite (1%).	Weakly gneissic, Fine to medium grained	Granite Gneiss based on mineralogy & texture
36	MB-36/17	Quartz (49%), Alkali Feldspar (42%), Plagioclase (3%), Muscovite (3%), Biotite (3%).	Granular medium grained	Alkali Feldspar Granite, based on IUGS Classification (Le maître,)
37	MB-37/17	Quartz (41%), Alkali Feldspar (47%), Plagioclase (3%), Muscovite (5%), Biotite (4%).	Granular medium grained	Alkali Feldspar Granite, based on IUGS Classification (Le maître,)
38	MB-38/17	Quartz (49%), Alkali Feldspar (45%), Plagioclase (3%), Muscovite (2%), Biotite (1%).	Weakly gneissic, Fine to medium grained	Granite Gneiss based on mineralogy & texture
39	MB-39/17	Quartz (56%), Alkali Feldspar (36%), Plagioclase (5%), Muscovite (2%), Hematite (1%).	Granular fine grained	Alkali Feldspar Granite, based on IUGS Classification (Le maître,)

40	MB-40/17	Quartz (45%), Alkali Feldspar (47%), Plagioclase (3%), Muscovite (4%), Biotite (1%).	Granular fine grained	Alkali Feldspar Granite, based on IUGS Classification (Le maître,)
41	MB-41/17	Quartz (42%), Alkali Feldspar (47%), Plagioclase (6%), Muscovite (1%), Biotite (3%), opaque minerals in traces.	Weakly gneissic, medium grained	Granite Gneiss based on mineralogy & texture
42	MB-42/17	Quartz (60%), Alkali Feldspar (30%), Plagioclase (4%), Muscovite (2%), Biotite (4%).	Granular fine grained	Alkali Feldspar Granite, based on IUGS Classification (Le maître,)
43	MB-43/17	Quartz (57%), Alkali Feldspar (35%), Plagioclase (3%), Muscovite (1%), Biotite (4%).	Granular fine to medium grained	Alkali Feldspar Granite, based on IUGS Classification (Le maître,)
44	MB-44/17	Quartz (50%), Alkali Feldspar (45%), Plagioclase (2%), Muscovite (1%), Biotite (2%).	Granular fine grained	Alkali Feldspar Granite, based on IUGS Classification (Le maître,)
45	MB-45/17	Quartz (50%), Alkali Feldspar (45%), Plagioclase (2%), Muscovite (1%), Biotite (2%).	Granular fine grained	Alkali Feldspar Granite, based on IUGS Classification (Le maître,)
46	MB-46/17	Quartz (64%), Alkali Feldspar (28%), Plagioclase (2%), Muscovite (3%), Biotite (3%).	Granular medium grained	Alkali Feldspar Granite, based on IUGS Classification (Le maître,)
47	MB-47/17	Quartz (55%), Alkali Feldspar (33%), Plagioclase (5%), Muscovite (2%), Biotite (5%).	Granular fine grained	Alkali Feldspar Granite, based on IUGS Classification (Le maître,)
48	MB-48/17	Altered Garnet grains, mica flakes.	Pseudomorphed garnet grains.	Garnet mica schist
49	MB-49/17	Quartz (68%), Alkali Feldspar (15%), Plagioclase (2%), Muscovite (5%), Biotite (1%).	Granular fine grained	Alkali Feldspar Granite, based on IUGS Classification (Le maître,)
50	MB-50/17	Quartz (2%), Alkali Feldspar (60%), Muscovite (1%), Biotite (37%).	Granular coarse grained	Feldspar Vein


Quartz
0
1
0.2
0.8
0.4
0.6
0.6
0.4
0.8
0.2
1
0
Quartz rich Granitoids
Alkali feldspar granite
Granite
Granodiorite
Granodiorite
Granodiorite
Quartz Monzonite
Quartz-
Monzodiorite
Granodiorite
Granodiorite
Granodiorite
K-feldspar
0
0.2
0.4
0.6
0.8
1
Plagioclase