Geol. Bull. Univ. Peshawar, 1985, Vol. 18, pp. 75–81

DISCOVERY OF BLUE BERYL FROM ILUM GRANITE AND ITS IMPLICATIONS ON THE GENESIS OF EMERALD MINERALIZATION IN SWAT DISTRICT

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ABSTRACT

Geological mapping of toposheet 43 B/6 in Buner Valley, District Swat is presented. Petrographic and mineralogical data on veins associated with Ilum granite have revealed a complex assemblage produced by multiphase hydrothermal activity. Some of these veins have been cataclastically deformed alongwith the granite body, whereas others show minor or no cataclasis and are hosted in post-cataclasis joints.

A genetic relationship between the granite and associated veins is proposed from field criteria. Hydrothermal veins associated with Ilum granite contain blue beryl. A granitic source for the beryl and possibly for spatially associated emerald mineralization is postulated.

INTRODUCTION

A reconnaissance map of the Lower Swat-Buner area, published by Martin *et al.* (1962), shows that the Ilum granite is intrusive into the Swat-Buner schistose group. The present work comprises a detailed mapping of toposheet No. 43 B/6 (Fig. 1). Detailed compass-clinometer mapping was conducted on 1:50,000 scale to define the granite-country rock contacts, and special attention was paid to the hydrothermal activity in and around the pluton.

GEOLOGY

Martin *et al.* (1962) divided the rocks between the Lower Swat and Indus river into the following units:

1. Upper Swat hornblendic group.
2. Lower Swat-Buner schistose group.
3. Swat granite gneiss.
4. Ambela granite.
5. Shewa formation.
6. Swabi Chamla group.

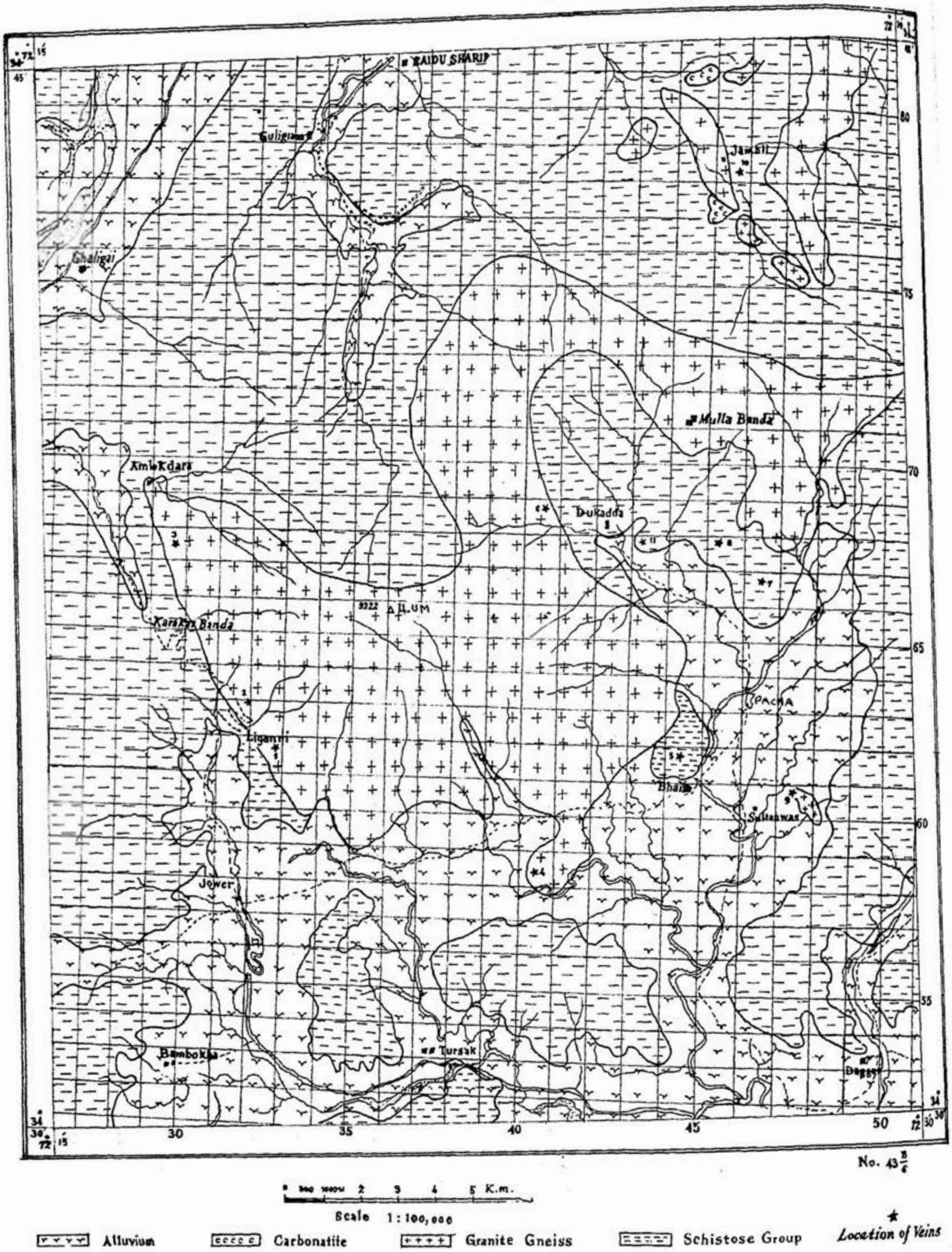

Fig. 1. Geological map of the area

The area under investigation is largely underlain by the Swat-Buner schistose group and Swat granite gneiss. A sheet-like body of granitic gneiss, hereafter designated as Ilum granite, is the main unit of interest of this study. Three main units have been mapped in the area :

1. Swat-Buner schistose group.
2. Ilum granite gneiss.
3. Carbonatites.

Swat-Buner Schistose Group

Swat-Buner schistose group exposed in the area has three distinct lithologies :

a. Hornblende Schists.
b. Siliceous Schists.
c. Biotite Schists.

Hornblende schists, biotite schists and siliceous schists are interbedded and do not constitute separate mappable units. In addition to these lithologies garnet-biotite schists, quartz-mica schists, calcareous and graphitic schists are also encountered within these rocks.

The siliceous schist are fine- to coarse-grained rocks consisting mainly of quartz, muscovite, biotite, feldspar and garnet in decreasing order. Accessories include calcite, tourmaline, epidot, clinozoisite and opaque minerals. Both biotite and garnet have been retrograded to chlorite, possibly due to cataclastic deformation of granite and country rocks close to it. At places, the pelitic content of these schists increases to produce biotite dominated schists.

The hornblende schists are medium- to coarse-grained schistose rocks. Constituent minerals include hornblende, clinozoisite, sphene, epidote, feldspar and garnet. Minor quartz was also observed at places. Chloritization of biotite and garnet represents a retrogressive event due possibly to contact metasomatism or mylonitization or both. Intimate interbedding of such rocks with pelitic and pssamatic compositions and occurrence of such schists in close proximity of granitic rocks suggests that a contact rather than a regional event has caused this metamorphism with the introduction of alkalies etc., to produce amphibolites. Where siliceous schists are in contact with granite, the alkali introduction to the country rocks is reflected in their extensive feldspathization and development of porphyroblasts of alkali feldspar. Away from the contact, calcareous rocks show only recrystallized calcite with a possible introduction of tourmaline from granite-related hydrothermal solutions. The presence of impure marble layers within the hornblende schists suggest that the latter are metamorphosed impure calcareous sediments.

The metamorphic history of these rocks can be interpretted from pelitic portions of these units. Outside the contact aureole, these rock are phyllites to chlorite schists, whereas in the contact aureole, recrystallization and development of biotite and garnet is prominent.

Ilum Granite Gneiss

The Ilum granite gneiss is an isolated sheet-like body exposed at the Ilum peak and the surroundings. It is coarse-grained and porphyritic, with an overall light gray colour. Gneissosity is well-developed and feldspar and quartz augens are characteristic. Both these minerals exhibit extensive stretching parallel to dominant foliation direction. Quartz and microcline make the bulk of the rock with minor muscovite and biotite. Magnetite, limonite, garnet and tourmaline are the accessories. Xenoliths of the country rock are common. Modal estimates on granite suggest a potassic character being dominated by microcline in the groundmass as well as phenocrysts.

In addition to gneissic granite which makes the bulk of the pluton, undeformed gray granite with a minor fracture cleavage was also encountered near Amluk Derra (Fig. 1). The granite is medium- to coarse-grained, hypidomorphic granular. It is a non-porphyritic phase but contains essentially the same constituents as described for the gneissic rocks. Field data was not sufficient to establish it to be intrusive into the Ilum granite gneiss.

The granite is characterized by a distinct lack of pegmatitic facies as opposed to its alleged counterparts across the Indus, i.e. Mansehra granite gneiss (Shams, 1961). However, a variety of hydrothermal veins, filling the joint systems, have been found. The following types of veins have been encountered within the contact aureole of Ilum granite.

1. Pure quartz veins.
2. Feldspar veins and irregular pods.
3. Quartz-feldspar veins.
4. Quartz-feldspar-epidot-muscovite veins.
5. Quartz-feldspar-muscovite-beryl veins.
6. Quartz-feldspar-monazite-zircon veins.
7. Quartz (smoky)-uranothorite veins.
8. Base metal sulphides-monazite-thorite-huttonite veins.
9. Magnetite-uranothorite veins.
10. Quartz-muscovite-microcline-hematite-biotite, thorite-allanite-monazite-zircon veins. (Thorite, uranothorite, zircon, huttonite and monazite have been identified by X-ray difraction powder method).

Mutual age relationships of these veins was not established due to non-availability of a single area where all these veins are present. In the absence of crosscutting relations and due to similarity of their mode of occurrence it is believed that they are synchronous. A variety of mineral parageneses may be related to changing PTC conditions of hydrothermal system formed by the intrusion of the granite pluton. Boudinage stretching of these veins is common and a changing paragenesis is sometimes encountered in detached parts of what was previously a single veins.

Carbonatites

Two small carbonatite bodies have been mapped in the northwestern corner of the area mapped (Fig. 1). Similar bodies were also observed further north near village Jhambil. Based on field observations, these carbonatites can be classified in to two type.

1. Sugary white carbonatites with minor mafic minerals at places.
2. Earthy brown carbonatites with more uniformly distributed mafic minerals.

Sugary white carbonatites are sparsly radioactive, whereas the brown variety shows more consistent radioactivity in them. Dominantly carbonate composition, a plug like shape and a possible association of anomalous radioactivity with the mafic content of the rocks suggest their carbonatitic nature. Detailed chemical and mineralogical analyses would be required to confirm this identification.

DISCUSSION

Beryl has been reported in north Pakistan from younger granites of Karakorum as well as Mansehra complex (Shams, 1961, Ashraf and Chaudhry, 1976). Shams (1963) reported a blue beryl from Swat but its location was not reported. However, hydrothermal veins intimately associated with the Ilum granite contain a blue beryl. This is the first report of a blue beryl from what is collectively known as Swat granites and granite gneisses. Swat area is also known for its emerald mineralization and various sources of Be have been postulated. Jan *et al.* (1981) suggested that subduction-related metamorphism and associated fluids from trench environments may have been the source of Be in Swat emeralds. Jan *et al.* (1981) contested the previously suggested granitic source of Be on the grounds that the spatially associated granitic rocks belong to Paleozoic and that emerald bearing Shangla-Mingora rocks (Mesozoic) are over thrusted onto these rocks.

Data available in literature does not support the development of Be-rich fluids within a trench environment, whereas association of Be-rich fluids with granitic and alkaline magmatism is a well-established fact. One is, therefore, compelled to look for a granitic source of Be for emerald mineralization in Swat. Since the emerald host rocks belong to the obducted block (Jan *et al.,* 1981; Kazmi *et al.,* 1984), post-obduction magmatism which could have affected this block is to be sought.

Evidence of post-Eocene granite magmatism is provided by such bodies as Warsak granite (41 M.Y., Kemp, 1973) and Ambela synite (55 M.Y. (N.J. Snelling, personal Comm. to Siddique 1971). Maluski and Matte (1984) suggested that younger K/Ar and $^{39}Ar/^{40}Ar$ ages obtained on Warsak granite and Ambela Syenite represent a late thermal event and may not be the cooling ages of these plutons. However, an age on primary muscovite from Malakand granite was accepted to be the cooling age of granite suggesting the possibility of young plutonism in the area. It may be mentioned that most granitic plutons in Swat and Buner areas are composed of two distinct facies i.e. a gneissic phase and an undeformed phase e.g. Malakand, Mura, Chinglai and Ilum. A 22.8 ± 2.2. Ma age from undeformed Malakand granite (Maluski and Matte, 1984) attest to a magmatic activity younger than the proposed collision of plates. Thus it is possible that post-thrusting magmatism affecting both the overthrust and underthrust blocks could have provided the Be source.

Ilum granite, Mingora granite and Malakand granite constitute an east-west trending belt of granitic rocks. Both Malakand and Ilum granites have associated carbonatites. Malakand granite is considered to be an alkaline soda granite (Chaudhry *et* al., 1976) whereas associated carbonatitic activity confirms to alkaline magmatism in the area. Kempe (1983) interpretted the alkali magmatism to have initiated 50 M.Y. ago with Warsak being the youngest, i.e. 41 M.Y. Alkali granites are generally characterized by higher contents of rare lithophile elements such as Be, RE, Zr, Nb and Ta than the average composition of granites. Ilum granite is also enriched in Be and rare earths as evidence by mineralized veins associated with it. Considering Kempe's interpretation (1983) as well as an age of 22.8 ± 2.2. Ma on Malakand granite one can expect post collision magmatism amongst Swat granites. Chaudhry (personal communication) suggests a south-dipping subduction along MMT. If so, it could have led to the intrusion of younger granites in the area.

Gubelin (1982) observed that quartz-calcite-beryl (emerald) mineralization in Mingora mine originated from a granodiorite which accompanies talc schists. The quartz-calcite-blue beryl veins of Ilum granite, which is within the Swat-Buner schistose group, represents an identical occurrence, strongly suggesting a granitic source for beryl. It is therefore, proposed that Swat granite magmatism may have continued after collision and such post-collision magma may have intruded the overthrust block as well to provide Be-rich fluids for emerald mineralization. Alternatively, obduction of ultramafics occurred long before the collision (Lawrence, 1984) and were folded alongwith the underlying rocks of Swat-Buner schistose group during collision, followed by magmatism and volcanism affecting both the overthrust and underthrust blocks. A south dipping subduction zone along MMT (Chaudhry, pers. comm.), coupled with early obduction of ophiolites (Lawrence, 1984), may provide a mechanism for granite-related source of Be in the area.

REFERENCES

Ashraf, M. & Chaudhry, M.N., 1976. Geology and classification of acid minor bodies of Mansehra and Battagram area, Hazara Division, Pkistan. Geol. Bull. Punjab Univ. 12, 1—16.

Chaudhry, M.N., Ashraf, M. & Hussain S.S., 1976. Geology and petrology of Malakand and part of Dir (toposheet 38 N/4). Geol. Bull. Punjab Univ. 12, 17—39.

Gubelin, E.J., 1982. Gemstones of Pakistan: Emerald, Ruby and Spinel. Gems & Gemmology, 123—139.

Jan, Q.M., Kamal, M. & Khan M.I., 1981. Tectonic control over emerald mineralization. Geol. Bull. Univ. Peshawar 14, 101—109.

Kazmi, A.H., Lawrence, R.D., Dawood, H., Snee, L.W. & Hussain, S.S., 1984. Geology of the Indus suture zone in the Mingora-Shangla area of Swat, N. Pakistan. Geol. Bull. Univ. Peshawar 17, 127—144.

Kempe, D.R.C., 1973. The petrology of Warsak alkaline granite and their relationship to other alkaline rocks of the region. Geol. Mag. 110, 385—404.

——— 1983. Alkaline granites, syenites and associated rock of the Peshawar Plain alkaline igneous province, N.W. Pakistan. In Granites of Himalayas, Karakorum and Hindukush (Ed F.A. Shams) Inst. Geol. Punjab Univ.

Lawrence, R.D., 1984. Suture tectonics of Pakistan. Vol of Abstracts, Ist Pak. Geol. Cong. 49.

Martin, N.R., Siddiqui, S.F.A. & King, B.H., 1962. A geological reconnaissance of the region between the lower Swat and Indus rivers of Pakistan Geol. Bull. Punjab Univ. 2, 1—14.

Shams, F.A., 1961. A preliminary account of the geology of Mansehra area, district Hazara, West Pakistan. Geol. Bull. Punjab Univ. 1, 7—18.

———, 1963. An Inky blue beryl from Swat State. Geol. Bull. Punjab Univ. 3, 31.

Maluski, H. & Matte Ph., 1984. Ages of alpine tectonometamorphic events in the northwestern Himalaya (northern Pakistan) by $^{39}Ar/^{40}Ar$ method. Tectonics 3, 1—18.