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Potential of Chakdara granite gneiss for fluorite mineralization, an assessment study, district Dir, northern Pakistan

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Abstract

Chakdara granite gneiss, covering an area of 60 km^2, is located north of Malakand granite. Its eastern part has been investigated for fluorite mineralization. During this investigation 18 occurrences of fluorite were found in association with blue beryl. The important occurrences are present at Chatpat, Jaba Banda and Badwan localities as fracture fillings in sheared zones in granite gneiss, in pegmatites and in younger batches of albitized friable granite. Subsurface investigation, of fluorite bearing zones at Chatpat and Jaba Banda, through shallow trenching and drilling reveals that these occur in the form of small pods with swelling and pinching characters and do not make any significant and viable economic fluorite deposit for large scale mining and exploitation. However, fluorite occurrences of Badwan valley located in zones of sericitic alteration are of economic significance due to their large size.

1. Introduction

This paper describes the data collected during investigations regarding the prospects of Chakdara granite gneiss for fluorite mineralization of economic significance. The eastern part of Chakdara granite gneiss (Fig. 1) was investigated and 18 fluorite-bearing zones were discovered at various localities. The newly discovered fluorite bearing zones were studied in detail through shallow subsurface exploration for assessing their continuity and economic significance. In total 14 shallow trenches were excavated and 16 Winkie holes were drilled at selected sites for subsurface investigation.

2. General geology of Chakdara area

Covering an area of 60 km^2, the Chakdara granite gneiss is located north of Malakand granite and is considered to be the extension of Swat granite gneiss (Martin et al., 1962). Chaudhry et al. (1974) considered this granite gneiss to be older than Malakand granite. According to Jan et al. (1981) the close association of two granites was merely accidental and not an undisputed proof of similar age and common parentage. According to DiPietro et al. (1993) the Chakdara orthogneiss is a major intrusive body in Mekhband Formation. The rocks of Chakdara granite gneiss are homogeneous, medium to coarse-grained biotite-muscovite- plagioclase- quartz- feldspar granite gneiss; locally with local patches of magnetite.

Recent studies based on field relationship of Khaliq et al. (2003) indicate that the Chakdara granite gneiss is an older phase of Malakand granite and shows continuity with former across river Swat at Matkani locality where its exposures can be seen along river beds. Moreover, it also shows similarity to the western part of Malakand granite (recently named as Hazar Nao granite by Khaliq et al., 2003) in Kot area because both contain younger batches of granite intruding the older granite gneisses and have similarity in the mineralogy of their pegmatites.

During present investigation, a geological map (Fig. 1) was prepared for the eastern part of Chakdara granite gneiss and surrounding areas on 1: 25,000 scale. This map covers Chatpat, Shamlai, Ramial and Badwan valleys, which are the main areas of interest for present investigation.

3. Prospecting methodology

To avoid time-consuming and expensive methodology generally used for prospecting and exploration of fluorite, a new "Hit and Trial" methodology was established for this project to get quick and meaningful results. Pre-requisite parameters for the mentioned methodology are as under:

(i) Visual scanning and identification of host rocks
(ii) Identification of specific features of host rocks indicative of sought mineral (s).
(iii) Examination of associated mineral (s) in hand specimen.
(vi) Hitting and smashing of selected rock for finding out sought mineral (s).

This methodology worked successfully with a success rate of 80%.

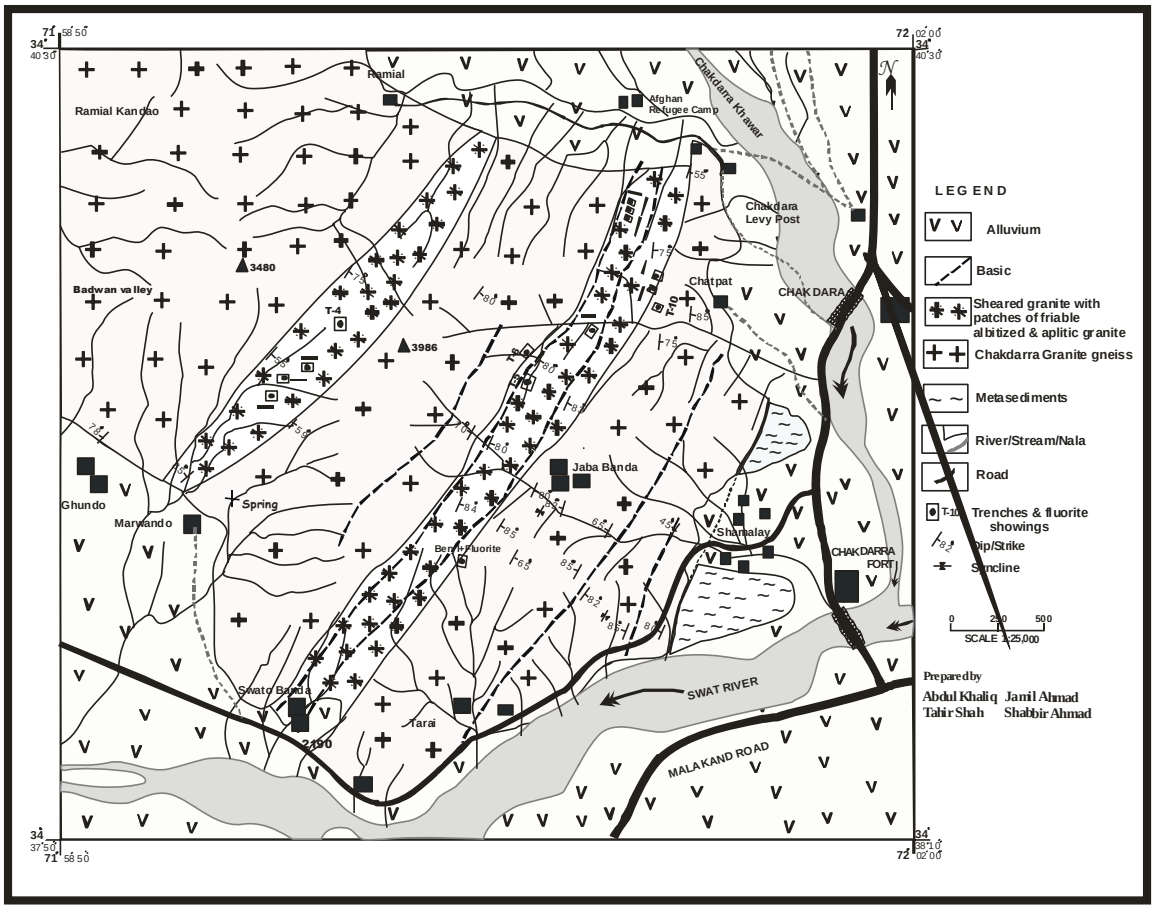

Fig. 1. Geological map of the eastern part of Chakdara granite gneiss with locations of fluorite showings (modified after Khaliq et al., 2006).

4. Results and discussion

After developing the prospecting methodology, survey was initiated from the surroundings of old abandoned fluorite mines at Chatpat locality during which a detailed study of old fluorite mines was conducted to understand the characteristics of fluorite mineralization and its geological setting in the area. Prospecting survey in the area resulted in locating 18 new fluorite occurrences mostly in the eastern part of Chakdara granite gneiss at Chatpat, Jaba Banda and Badwan valley. Chatpat is located at the eastern contact of Chakdara granite gneiss near Chakdara town. A total of 5 new fluorite occurrences have been found at NGR 015702, 023682, 024685, 024686 and 029693 as patches and zones in albitized friable granite and in sheared zones in gneisses (Topo- sheet No. 38-N/14). Albitized friable granite constitutes irregularly shaped distinct zones of variable dimensions. At some places this granite also occurs as un-mapable units. Fluorite bearing zones at Chatpat invariably contain blue beryl with fluorite.

Jaba Banda is located at about 2 km southwest of Chatpat. At Jaba Banda fluorite showings are found both in albitized friable white granite and in sheared zones as that of Chatpat area. At this locality a total of 4 fluorite bearing zones are present at NGR 016690, 019690, 014692 and 018686 (Topo sheet No. 38-N/14). An extensive sheared zone along a stream controls the main fluorite zone at this locality while the remaining zones are found inside the albitized granite characterized by extensive hydrothermal activity characterized by albitization, quartz veining and patchy haematization.

Badwan valley is located further west of Jaba Banda. Along this valley three fluorite zones were discovered at NGR 008692, 009691 and 007691 (Topo sheet No. 38-N/14). Fluorite showings at Badwan Valley are dominantly located in sericitized zones and pegmatites. Distinct zones with high concentration of sericite are the main sites having the major fluorite zones. Moreover, several small showings of insignificant nature are also found in thin pegmatites and quartz veins. Small sized and insignificant fluorite bearing zones at Ramial and Shamlai areas are also present at NGR 022700, 022698 and 026683, 025683 respectively (topo-sheet No.38N/14).

Newly discovered fluorite mineralization generally occurs in fracture fillings, in pegmatites and as patches and pods in friable granite. Fracture filling fluorite is found in sheared and fractured zones in the form of micro-veinlets (4-10 cm) in Chatpat and Jaba Banda localities. Fluorite is also occurring in deformed and un-deformed pegmatites. Deformed pegmatites occur as irregularly shaped pods ranging in size from a few cm to over 20 cm across which contain fluorite and beryl. Un-deformed pegmatites occur as small veins which follow the regional trend of lithologies in the area. The former type is found at Chatpat while the latter is common in Badwan valley. Fluorite is also found in the form of patches and pods in albitized friable granite, which constitutes irregularly shaped bodies inside granite gneiss. Blue beryl invariably occurs with this type of fluorite. Fluorite showings of this type are found at Chatpat and Jaba Banda sites.

4.1. Subsurface exploration

Subsurface investigations through trenching and shallow drilling were conducted at selected fluorite zones at Chatpat and Jaba Banda to find out their subsurface continuity both along strike and at depth. During this investigation 14 of trenches were excavated and 16 numbers of Winki holes were drilled. Details of these investigations are as under:

4.1.1. Investigation through trenching:

Four trenches in Chatpat and seven in Jaba Banda were excavated at selected sites for the subsurface extension of these fluorite zones. This excavation reveals that there is a continuity of the fluorite-bearing zones in these trenches.

4.1.2. Investigation through drilling:

Shallow Winkie drilling was conducted at several fluorite-bearing zones after having confirmed their subsurface continuity in trenches. The objective of this exploratory drilling was to confirm fluorite bearing zones at deeper levels and understand their nature and behavior for making viable fluorite deposits in the area. A total of 16 numbers of shallow Winki drill holes were drilled with a total depth of 397.42 m. Details of 4 drill holes have been given in Table 1.

Twelve holes were drilled at Chatpat site with a total depth of 278.98 m. Drilling data reveal that the fluorite bearing zones at this site occur in the form of small pods and lenses, which probably have little economic significance regarding their nature to make sizable economic deposits. In almost all of the holes drilled at Chatpat site, pinching and swelling phenomenon was observed in one form or another, which probably led to the formation of podiform fluorite bodies at deeper levels. This conclusion can also be confirmed from the old mines in the area where small-scale mining was conducted. The drilling data indicate that fluorite-bearing zones at Chatpat site make little or no significant fluorite deposits of economic nature for large-scale mining and exploitation.

Drilling at Jaba Banda site was aimed at finding whether the fluorite bearing zones consisting of micro-fluorite veinlets at surface, change into veins of significant thickness at deeper levels to make viable vein- type fluorite deposits or not. At Jaba Banda fluorite zones a total of 4 numbers of drill holes were drilled with a total depth of 118.44 m. Drilling data of Jaba Banda is somewhat different from Chatpat site in the sense that the fluorite bearing zones of this site show the same nature at deeper levels as found at surface. It was expected that the scattered and disseminated nature of fluorite grains and veinlets found in fluorite bearing zones at surface may change into economically exploitable fluorite bodies with depth. The drilling data, however, reveal that the nature and size of fluorite bearing zones do not change with depth to warrant a workable deposit.

Present investigation conducted on Chakdara granite gneiss and its surroundings for fluorite mineralization indicates that this granite gneiss contains a large number of fluorite showings in the form of small pods and lenses occurring in sheared zones, pegmatites and patches of albitized granite. Majority of these occurrences are located in the eastern part of Chakdara granite gneiss. Data regarding the continuity of fluorite bearing zones at surface indicate that some of them show continuity along strike for several tens of meters with large barren parts in between in a swelling and pinching fashion; the fluorite showings located in friable albitized granite, in sheared granites and pegmatites are dominantly found as irregularly shaped bodies with little extension along strike.

Subsurface investigations consisting of trenching and shallow drilling reveal that in subsurface the fluorite bearing zones have swelling and pinching behavior and do not make zones of economic concentrations for developing viable fluorite deposits for large scale mining and exploitation. Small size pods and lenses of fluorite of insignificant nature were encountered at various depths in the drilling but no fluorite-bearing zone of economic concentration was noted in any drill hole during this investigation. Moreover, core recovery in the fluorite bearing zones occurring in patches of friable albitized granite was very poor and it was very difficult to have a realistic assessment of the fluorite bearing zones at the mentioned type of geological environment.

Table 1. Showing details of representative drill holes for fluorite at Chatpat and Jaba Banda sites, Chakdara granite gneiss, Dir.

Hole No	Location at grids lines	RL (m)	Angle	Depth Drilled (m)	Fluorite zones encountered at depth (m)	Remarks
CCWK-4/04	263.40 N 03.64 E	728.30	55°	**29.10**	6.10 7.60 10.40 10.85 12.95 21.00 22.20 22.60 25.30	Fluorite disseminated grains Fluorite disseminated grains Fluorite disseminated grains Fluorite vein Fluorite vein Fluorite vein Fluorite vein Disseminated fluorite grains Disseminated fluorite grains
CCWK-10/04	80 N 1.63E	795.47	75°	30.00	8.75 9.75 13.80 15.44 21.40 27.60	Very fine-grained fluorite in disseminated form has been noticed at all these depths
CJWK-02/04	482.35 S 686.08 W	891.25	75°	30.60	2.20 4.60 6.65 8.90 10.45 19.95	Patch of fluorite Patch of fluorite Disseminated fluorite grains Disseminated fluorite grains Fluorite micro-veinlet Fluorite micro-veinlet
CJWK-03/04	501.62 S 690.04 W	899.45	89°	33.65	2.50 5.40 6.75 7.50 9.90 11.70 12.80 14.55 18.25 18.60	Patch of fluorite Fluorite micro-veinlet Fluorite micro-veinlet Patch of fluorite Fluorite micro-veinlet Fluorite micro-veinlet Fluorite micro-veinlet Fluorite micro-veinlet Fluorite micro-veinlet Fluorite micro-veinlet

5. Conclusions

(1) A total of 18 new fluorite bearing zones/ showings were discovered.
(2) Subsurface investigations of newly discovered fluorite bearing zones through shallow trenching indicate their subsurface continuity.
(3) Shallow exploratory drilling indicates a pinching and swelling phenomenon leading to the formation of small podiform fluorite bodies of insignificant nature.
(4) Small size pods and lenses of fluorite have little economic significance to make viable economic deposits for large scale mining and exploitation.

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