NOTES, ABSTRACTS AND REVIEWS

Geol. Bull. Univ. Peshawar, Vol. 6, 1971, pp. 114—*00.*

HYDROTHERMAL GRAPHITE IN TIRAH, KHYBER AGENCY

INTRODUCTION

During recent years, some samples of graphite from Tirah, Khyber Agency, which were analysed in various laboratories in Pakistan, have yielded over 50% fixed carbon. This created special interest for the authors to conduct investigations concerning the origin and economic potentials of the mineralization. The graphite is located near Spinkai (Lat. 33° 55½′, Long. 70°41′) in Tirah tribal territory and is accessible through Chora, Bazar, Bara and Rajgal Valleys. The area can also be approached from Kohat *via* Sra Mela and Maidan. The mineralized area is along the northern slope of Bijor Sar (ca. 9,000 feet) at an elevation of about 6,500 feet.

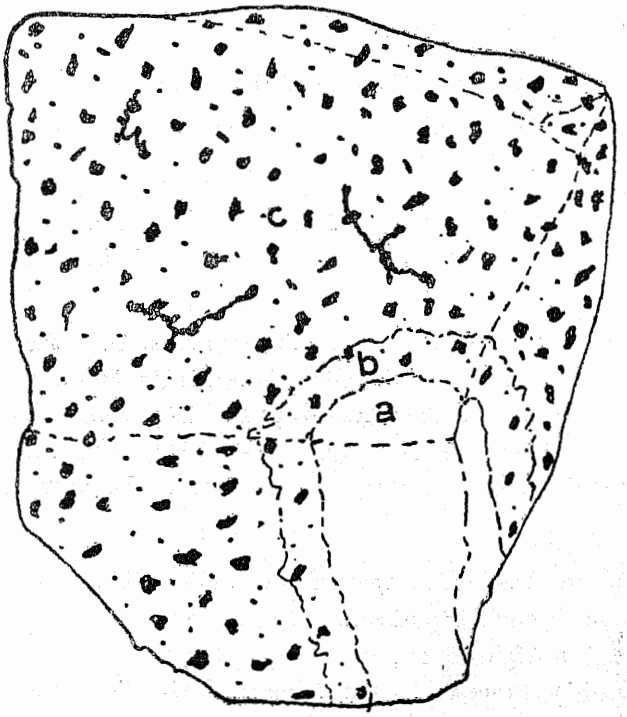
THE GEOLOGY OF GRAPHITE DEPOSIT

The mineralization has taken place in granitic rocks near the contact with Palaeozoic sediments which have a general east-west trend and moderate northerly dip. The sedimentary rocks comprise of contact marble, light grey and greenish-grey limestones overlying brown, white, grey and yellow grey quartzites. Underlying the latter are slate and phyllitic slate which overlie variously coloured limestones with associated slates (Tahirkheli, in preparation).

The graphite-bearing rocks consist of medium-grained granite, pegmatite and quartz veins. Graphite also occurs in minor quantity in locally developed contact skarns. The granite and pegmatite are mainaly composed of microcline/perthite, sodic plagioclase and quartz, with minor epidote, chlorite, iron ore and sphene. The skarn is composed of calcite, tremolite, epidote, sphene, graphite, chlorite, quartz and corroded feldspar (Jan, in preparation). The mineralization is located very closed to the contact with white, light grey, at places green, marble composed of carbonate, chlorite, ore and dark mica but at places also having patches of serpentine. The marble, however, is surprisingly free of graphite. Closer examination reveals that the marble is recrystallized by the heat of igneous intrusion for a distance of about 50 feet from the contact, beyond which it passes into non-recrystallized limestone. Near the contact, it is highly contorted and folded.

Graphite mineralization appears to be the result of hydrothermal or gaseous emenations and occurs mainly in thin fractures and openings in the igneous rocks. Thus, it commonly forms thin lamellar coatings and films of a few millimetres thickness. In some parts, the fractures are fairly abundant and the graphite concentration is locally high. In one of the polished sections (Fig. 1) of granites, the graphite has been found disseminated for a depth of $1\frac{1}{2}''$. It tends to decrease away from the fracture, passing into an irregular zone of iron leaching (up to 0.2″ thick and having little graphite), before a graphite-free core is met with. The graphite content in the outer zone is about 20% and it is possible that thicker zones may be present. At places, graphite and igneous rocks are intermixed in a "confused" mass. In some polished sections, the graphite films tend to extend inwards from the fractures in the form of thin, irregular tongues. These observations show that the graphite was not present in the magma that crystallized as granites and pegmatites, but has been introduced by hydrothermal or gaseous emenations that made their way along fractures in the igneous rocks. The carbon may be magmatic in origin or it may be a reduced form of CO_2 or CO_3 acquired from the marble on contact.

Thus the graphite of spinkai area has two types of prominent occurrences, (*a*) as dissemination in igneous rocks, and (*b*) as thin films and lumps along fractures in these rocks. No vein or seam of graphite has been found. On the whole, the graphite roughly constitutes about 10 to 15% of the total outcrop containing visible graphite.



Fug. 1. Polished section of granite containing graphite ($1\frac{1}{2}$ natural size).

(a) Graphite-free core.

(b) Zone of iron-leaching with some graphite.

(c) Graphite-rich with marginal films of graphite concentration along fractures.

ECONOMICS OF THE DEPOSIT

No prospecting work was allowed to ascertain the quantity of graphite precisely. Therefore, the evaluation of the deposit is based on surficial observation of the mineralized area, coupled with the production figures reported by the mine owner. The dimensions of the area opened up for mining is $20 \times 20 \times 10$ feet (*i.e.*, 4,000 cubic feet). About 120 maunds of graphite has been reportedly extracted from this pit. A total of about 500×75 feet of area is recorded at this spot to be mineralized. If the above estimate of 120 maunds from 4,000 cubic feet is taken as a base figure, then a reserve of 4,000 tons of graphite, up to a depth of 100 feet, is inferred at this spot. The mine owner has also reported graphite along strike direction at two more places, east and west of this spot.

The mine owner got analysed, at various places, many samples collected at random and, thus, reflecting upon the overall tenor of fixed carbon. The results suggest that the average content of fixed carbon is over 40%; some smaples have a much high percentage.

Graphite occurs in mineable reserve in Spinkai area of Tirah. The average fixed carbon content makes it of commercial grade. However, the major drawback, which disqualifies this deposit to become competitive in the Pakistan market, is the remoteness of the mine from the truckable roads.

From Ali Masjid the deposit is located at a distance of about 80 miles. The terrain is rugged and unsympathetic, especially within a radius of six to seven miles from the mine where the climb is steep, at places unfit even for the ponies. Another possible route for transporting graphite is Sra Mela which is connected with Kohat by a partly metalled truckable road. Sra Mela is located from the mine at a distance of about 40 miles and the route mostly passes through difficult mountainous terrain.

The cost on transportation of one maund of graphite by mules from the minehead to Ali Masjid and Sra Mela, as told by the mine owner, is Rs. 30/- and Rs. 27/- respectively. The mining cost varies from Rs. 5/- to Rs. 6/- per maund. If the profit of the mine owner and the government taxes are added, then the cost of one maund of graphite delivered at Peshawar is worked out to be about Rs. 40/.

The mine owner has also discussed with the authors the possibilities of transporting graphite to Torkham through Afganistan. By this route, graphite would be carried by ponies to Kai in Afghanistan, located at a distance of about 20 to 22 miles from the mine. Kai is connected by truckable road with Torkham.

The transportation cost up to Torkham by this route would range from Rs. 20/- to Rs. 25/- per maund. If this route is to be adopted, then permission is to be sought from the Pakistan Government for concessions in custom duty.

According to Pakistan Battery Manufacturing Company Limited, Karachi, the exact C & F cost of the imported Chinese graphite is Rs. 25-31/- per maund and thus the landed cost of the material including 50 percent custom duty will work out to be about Rs. 46-75/- at Karachi. The fixed carbon content of the Chinese graphite is about 60 percent. On the basis of this information the Spinkai graphite of Tirah shows development potentials to be commercially exploitable for utilization in various indigeneous industries. Open-cut mining techniques are to be adopted to exploit the graphite deposit. Due to high elevation, the graphite deposit is under snow for two months, mostly during January and February. Therefore, the mine can remain under operation for 10 months in a year

ACKNOWLEDGEMENT

The authors are thankful to the mine owner, Mr. Dost Mohd Khan, of village Bragat in Rajgal area of Tirah for planning this trip and affording all the facilities.

REFERENCES

JAN, M. QASIM, in preparation—The igneous rocks of Spinkai and adjacent areas of Tirah, Khyber Agency.

TAHIRKHELI, R. A. K., in preparation—Geological traverses in Tirah, Khyber Agency.

R. A. Khan Tahirkheli,
M. Qasim Jan
Ihsanullah Mian.

Geol. Bull. Univ. Peshawar, Vol. 6, 1971, pp. 117—119.

PHOSPHATIC MINERALIZATION AS A BASIS FOR STRATIGRAPHIC CORRELATION

The Infra - Triassic bed of Middlemiss (1896) in Hazara district, has been studied in detail by several workers during recent years and all of them have suggested new classifications. Marks and Ali (1962) named these rocks as the

Abbottabad Formation. Gardezi and Ghazanfar (1965) included the overlying dominantly pelitic rocks, the Hazira calcareous shales, in the Abbottabad Formation and elevated it to Abbottabad Group. Latif (1967) in his latest publication, differentiated four lithological units which comprised the Abbottabad Group. These four units have been distinguished on the basis of their distinct lithological characteristics and are arranged in the following sequential order :

4. Hazira Formation.
3. Galdanian Formation.
2. Sirbon Formation.
1. Kakul Formation.

The later two formations which have been examined by the author in detail, show phosphorite mineralization. The Kakul Formation contains a 10 feet thick band of phosphorite, with phosphorite content varying from 18 to 40 percent. In the Sirbon Formation the siliceous dolomitic limestone with cherty bands and lenses is also phosphorite - and its content in the rock ranges from 2 to 12 percent. A complete section of the Abbottabad Group has so far not been located elsewhere except in the vicinity of Abbottabad which extends for some distance towards east and north east.

The author during geological mapping of Gandghar Range in the western Hazara, Cherat Range east of Peshawar, and the Rajgal area of Tirah in Khyber Agency has located a thick sequence of siliceous dolomitic limestone which was considered identical to Sirbon Formation on lithological grounds. To further authenticate this correlation, the author had collected scattered samples from each section, for chemical examination, to confirm whether phosphorite mineralization of same type as in the Kakul and Sirbon Formations in their type sections, is also present.

On the basis of chemical assays, it was found that samples, collected from all the above mentioned sections that is Gandghar Range, Cherat Range, and Rajgal area, were phosphatic and yielded from 2 to 7 percent P_2O_5. The higher values of phosphorite content had erratic distribution, pointing out to localized concentrations.

A few samples from dolerite sills were also collected which indicated the presence of phosphorite. The content of P_2O_5 in these samples ranged from 3 to 7 percent. Only two samples yielded 9 percent of P_2O_5. In thin sections dolerite did not reveal much development of apatite as an accessory mineral -

which is suggestive of the fact that phosphate in the intrusions was derived from the phosphate - bearing country rocks.

Beside considering the lithological characteristics of the rocks, the phosphate mineralization has considerably helped to authenticate the following correlation.

Abbottabad	Gandghar Range	Cherat Range	Rajgal area
Sirbon Fm.	Pirthan Fm.	Shakhai Fm.	Spinkai Fm.

REFERENCES

GARDEZI, A.H. and GHAZANFAR, M. 1965—A change of facies at the base of Jurassic in district Hazara, Geol. Bull. Punjab Univ. 5, 53-56, Lahore.

LATIF, M.A. 1970—Explanatory notes on the geology of south eastern Hazara, to accompany the revised geological map, Jb. Geol. Sond. 15, 5.5-20, Wein.

MARKS, P., and ALI M. 1962—The Abbottabad Formation: a new name for Middlemiss, Infra - Triassic, Geol. Bull. Punjab. Univ. 2, 56, Lahore.

MIDDLEMISS, C.S. 1896—The geology of Hazara and Black Mountains, Mem. G.S.I. 26, 1-302, Calcutta.

TAHIRKHELI, R.A.K. 1971—Phosphate occurrences in Hazara and other contiguous area in N.W.F.P. and tribal areas. Directorate of Industries and Mineral Development, Govt. of N.W.F.P., Peshawar.

(*Dr. R. A. Khan Tahirkheli*)
Department of Geology,
University of Peshawar.