Geol. Bull. Univ. Peshawar, 1987, Vol. 20, pp. 153–160

PETROLOGY OF KAKUL PHOSPHORITES, DISTRICT ABBOTTABAD, N.W.F.P., PAKISTAN

VIQAR HUSSAIN, M.A. QAISER, NISAR AHMAD and RUBINA BILQEES
Pakistan Council of Scientific and Industrial Research Laboratories, Peshawar.

ABSTRACT

Two basic types of phosphorite have been recognized within the Kakul stratigraphic sequence: 1) authigenic microcrystalline phosphorite mud (microsphorite) or orthochemical phosphorite which has precipitated either biochemically or physicochemically, and 2) pelletal phosphorite or allochemical phosphorite which has been modified into discrete clastic particles from microsphorite mud. Microscopically, the primary component is the carbonate fluorapatite matrix with cryptocrystalline dolomite, calcite and quartz. Also there are detrital grains of quartz, dolomite, and calcite with disseminated ferruginous matter.

INTRODUCTION

Palaeozoic phosphate occurrences at Kakul-Mirpur area of Hazara division were first discovered by Latif (1970). A number of other deposits were later discovered in the same litho-tectonic setting in and around Abbottabad city. Significant contributions to the geoolgy of Hazara have been made by a number of workers (Vercheres, 1966; Weagen and Wyne, 1962; Davies and Gardezi, 1965). Calkins and Martin (1968) were the first to work on the mineral resources of the Garhi Habibullah and Kakul areas of the Hazara division. Detailed work on the geology and phosphate resources of district Abbottabad was carried out by Latif (1974), Bhatti and Hasan (1972), Ghaznavi and Karim (1978), Ashraf and Malik (1983).

The Kakul-Mirpur, Lagarban and Dalola areas occur within the east longitudes 73°16′ and 73°30′ and north latitude, 34°12′ and 34°15′. The southern part of the area is accessible via Kakul which is linked with Abbottabad city by 5 km metalled road, while the northern part of the area is 7 km from Abbottabad on the Mansehra road. Of the known deposits around Abbottabad, only those at Kakul are being commercially exploited.

The phosphorite deposits of Kakul-Mirpur area occur in the Kakul Formation of Abbottabad Group (Tahirkheli, 1971; Bhatti, 1972). Total reserves have been estimated as 1.08 million metric tonnes. The main phosphate horizon, having an average thickness of 4.5 metres, is truncated by faults on both sides (Latif, 1974). Tight folding and subsequent faulting are the normal features of the area which have adversely affected the deposits (Hasan and Ghaznavi, 1980).

Recent advances in phosphate geology research have made it easier to understand phosphorite system more comprehensively. A well-defined terminology has been introduced by Riggs (1979), Prevot (1981), Cook and Shergold (1986), and Slansky (1986) to describe any phosphorite system in terms of its petrography, mineralogy and genesis, and deciphering an ancient sedimentary environment which can act as a tool in discovering new phosphorite deposits both onshore and offshore.

In the present paper, an attempt has been made to study some Kakul phosphorite samples and their associated rocks for their petrological characters.

MODE OF OCCURRENCE

The phosphate-rich beds in the region are located near Kakul, Lagarban, Dalola and Sirbun. Samples were collected about 1 km east of Kakul village. Sampling was done mostly from trenches in order to obtain hard and unweathered material from the outcrops. Kakul phosphorite deposits are found in the upper most part of the cherty dolomite of the Abbottabad Formation, at the contact zone of Hazara Formation and also about 30 metres to 45 metres below this horizon in the dolomitic limestone of the Abbottabad Formation. Thus, in the area there are two well-defined stratigraphic horizons of phosphorite deposition (Hasan and Ghaznavi, 1980). At the bottom of the sequence is exposed a greyish coloured dolomite, 5–6 metres in thickness. Overlying is phosphate-bearing dolomitic limestone, a massive, dark coloured rock rich in P_2O_5 content. This lithological unit is about 7 metres thick which is overlain by phosphate-bearing cherty dolomite with low concentration of P_2O_5. Other lithologies exposed vertically in quick succession are siltstone and dolomitic limestone, having a total thickness of about 20 metres (Latif, 1974).

PETROGRAPHY

In the Kakul phosphorite samples described here, pelletal and microsphorite types of phosphorite are dominent. This apatite is apparently isotropic but recrystallized bands of apatite are anisotropic (Fig. 1).

Cryptocrystalline calcite and dolomite are the next most important minerals occurring either as matrix or as detrital grains. Some calcite veins out across the microsphorite grains.

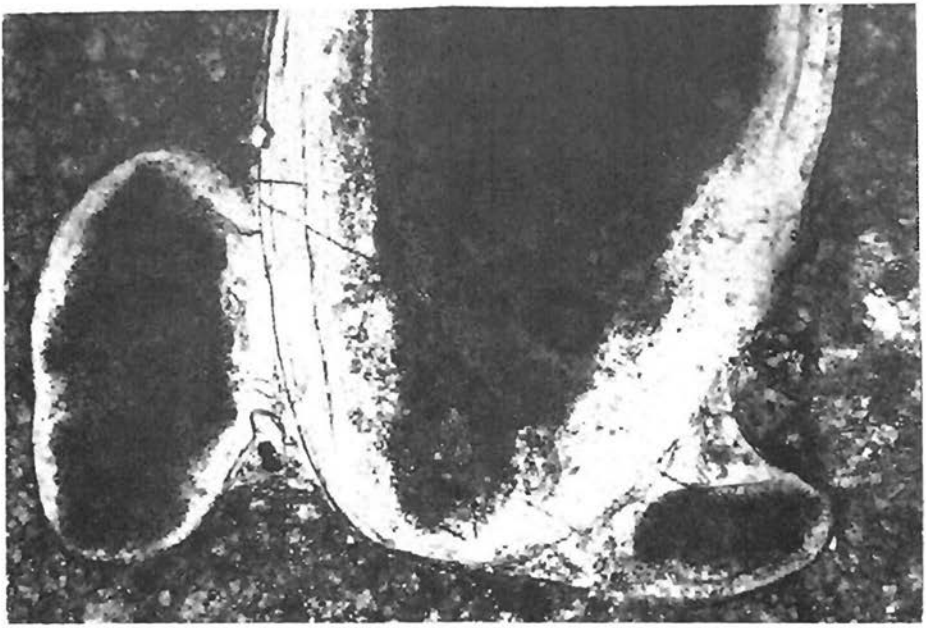

Fig. 1. Photomicrograph showing recrystallized bands of apatite (cross Nicols, x 40).

The medium-sized detrital grains of quartz are also common (Fig. 2). Cryptocrystalline chalcedony some times occurs intimately mixed with microsphorite. Ferruginous minerals (goethite, pyrite and hematite) are also present in minor amounts (Fig. 2).

Diagenetic Features

Irregular to oval-shaped pellets with rims of recrystallized, banded apatic indicate common diagenetic features. The associated micrite and microspars show evidences of authigenic development, while the sparry calcite in the fractures and veinlets is either a recrystallization product or is of secondary origin. Three distinct and some times overlapping phases of diagnetic changes have been noticed.

i. Calcitization: Carbonate mud or micrite has replaced pre-existing primary microsphorite layers and entered the cracks and fractures of phosphate grains and pellets. It is difficult to differentiate the primary calcite from the secondary by normal petrographic methods.

ii. Phosphatization: Recrystallized veinlets of carbonates have been further replaced by microcrystalline apatite, possibly during later phases of diagnesis as indicated by irregular distribution of microcrystalline apatite layer within a carbonate groundmass.

iii. Silicification: Occassionally phosphate pellets have been partially replaced by micro-crystalline quartz. Silicification remained a relatively minor event.

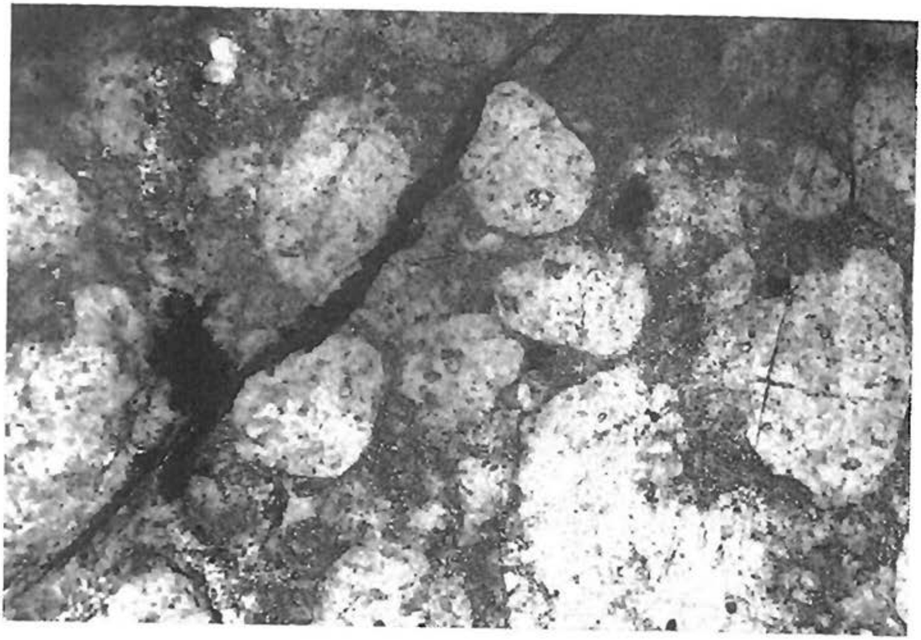

Fig. 2. Photomicrography showing detrital quartz and ferruginous minerals. (Plane, Light, x 25).

MINERALOGY

X-ray diffraction method was used to study the mineraogy of the phosphorite samples. Natural samples were irradiated with CuK radiation of 6 hours at 35KV and 20mA. The summary of the minerals identified is shown in Table 1.

The identified phosphate minerals are mostly carbonate fluorapatite and rarely chlorapatite. Other minerals include calcite, dolomite, quartz, chert, feldspare, glauconite and pyrite. The irregularly distributed droplets of iron oxide seen under the microscope are of hematite.

DISCUSSION

The petrological studies indicate that the Kakul phosphorite is of two types — pelletal phosphorite and microsphorite. Their close association suggests little difference in sedimentary environments. The pelletal phosphorite is indicative of marginally agitated basinal waters, the microsphosite layers show evidences of authigenic precipitation in quite shallow marine environment.

Two phosphatic horizons are noticed in Kakul, the lower one is hosted in dolomitic limestone. There are underformed pellets of uniform size, which are oval in shape and light brown in colour (Fig. 3). While the upper phosphate horizon is restricted to cherty dolomite. The pellets show variation in their shape

TABLE I : X-RAY DIFFRACTION ANALYSES OF THE PHOSPHORITE SAMPLES.

	1	2	3	4	5	6	7
Fluorapatite	Y	—	Y	Z	—	—	Y
Chlorapatite	—	Z	Z	—	—	—	Y
Calcite	—	Y	Z	Z	—	—	Z
Dolomite	Z	—	—	Y	Y	X	—
Siderite	Z	—	—		—	—	Z
Quartz	Z	—	Z	—	Y	—	—
Pyrite	Z	—	Y	—	—	—	—
Illite	Z	—	—	—	—	—	—
Hematite	—	—	—	Z	—	Z	—
Feldspar	—	—	—	Z	—	Z	—

Explanation : Numbers from 1 to 7 are sample numbers, X, Y and Z indicate the presence of mineral in major, minor and trace quantities, respectively.

and size. Mostly the pellets are elliptical in nature and are aligned (Fig. 4). The recrystallized and secondary minerals are present in large amounts. These features indicate regional deformation.

Fig. 3. Photomicrography showing uniform distribution of oval shaped pellets (Plane Light, x 25).

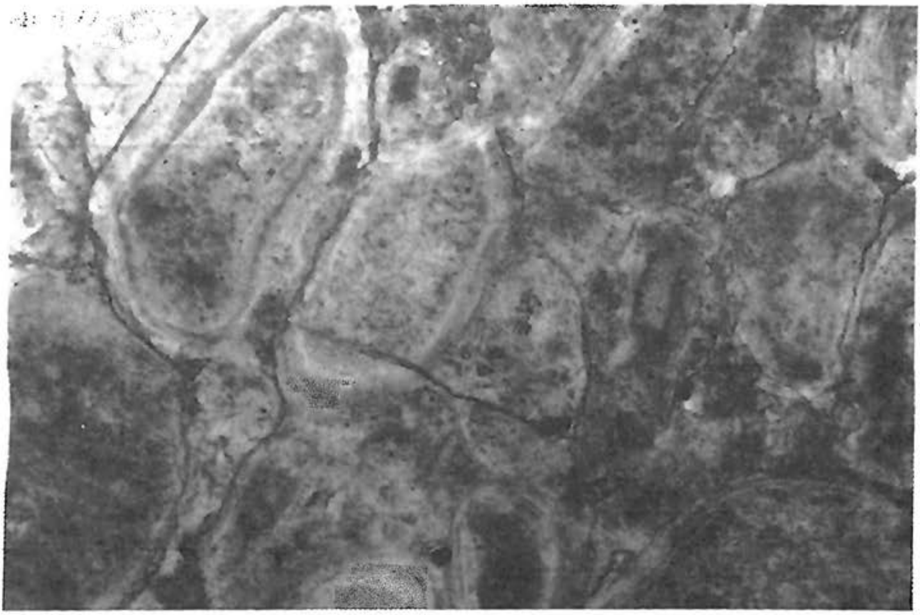

Fig. 4. Photomicrography of elliptic pellets showing allignment (Plane Light, x 25).

The diagenetic effects suggest that primary microsphorite has been replaced by secondary calcite. Some of the primary calcite has also been phosphatized. The process of calcitization of primary phosphate has dominated over the processes of phosphatization of carbonates. The associated silica occurring as cryptocrystalline quartz could have formed as diagenetic inclusions or even as primary silica precipitate.

Acknowledgements: The authors are grateful to the Director and Head of Mineral Technology Division, P.C.S.I.R. laboratories, Peshawar for providing necessary facilities. Thanks are due to Messrs. Khalid M. Qureshi and Ali Zaman for their assistance in the field. We extend our deep gratitudes to Messrs. Fazal A. Siddiqi and Abdul Ghani for their useful suggestions. We also thank Messrs. Syed Ali Shah, Moinuddin and Shaukat Khan for micro-photography, cartography and typing, respectively. The paper benefitted from reviews of two anonymous referees.

REFERENCES

Ashraf, M. & Malik, M.I. 1983. Prospects and development of Phosphate deposits of Lagarban area Abbottabad, Pakistan. Kashmir Jour. Geol. 1, 77—83.

Bhattai, N.A. 1972. Phosphate deposits of Kakul-Mirpur area, Hazara District, North West Frontier Province, Pakistan. Geol. Surv. Pak., Inf. Rel. 50, 4p.

Bhattai, N.A. Hasan, M.T. & Hussain, M. 1972. Phosphate deposits of Kakul-Mirpur area, Hazara District, North West Frontier Province, Pakistan. Geol. Surv. Pak. Inf. Rel. 51, 33p.

Calkins, J.A. & Martin, A.S. 1968. The Geology and Mineral resources of the Garhi Habibullah Quadrangle and Kakul area, Hazara District West Pakistan. United States Geol. Surv./Geol. Surv. Pak. (IR) PK—38, 54p.

Cook, P.J. & Shergold, H.H. 1986. Phosphorite deposits in the world, Proteerozoic and Cambrian Phosphorites. 386p. Cambridge Univ. Press. London.

Davies, R.G. & Gardezi, A.H. 1965. The presence of Bouleceras in Hazara and its geological implications. Geol. Bull. Punjab Univ. 5, 23—30.

Ghaznavi, M.I. & Karim, T. 1978. Phosphorite deposits of Kalu-di-Bandi, Lagarban area, Hazara District, North West Frontier Province, Pakistan. Inf. Rel. 103, 34p.

Hasan, M.T. & Ghaznavi, M.I. 1980. Phosphate deposits of Hazara Division NWFP. Rec. Geol. Surv. Pakistan. 50.

Latif, M.A. 1970. Explanatory note on the geology of southern Hazara to accompany the revised geological map. Jahrb. Geol. Bund. Astria, 15, 5—19.

Latif, M.A. 1970. An occurrence of Paleozoic Phosphate rock in Hazara, West Pakistan. Inst. Mining and Metall. London, 81, 850—853.

Latif, M.A. 1974. A cambrian age for the Abbottabad Group of Hazara, Pakistan. Geol Bull. Punjab Univ. 10, 1—20.

Marks, P. & Ali, C.M. 1961. The Geology of the Abbottabad area, with special reference to the infra-trias. Geol. Bull. Punjab Univ. 1, 47—55.

Marks, P. & Ali, C.M. 1962. The Abbottabad Formation; A new name for Middlemiss, infra-trias. Geol. Bull. Punjab Univ. 2, 56p.

Middlemiss, C.S. 1896. The Geology of Hazara and the Black Mountains. Geol. Surv. India, Memoir 26, 302p.

Prevot, L. 1981. Proposal for a normalized easy description of the so-called pelletal phosphorites. 4th International Field Workshop and Seminar on Phosphorite. Int. Geol. Correl. Programme, Project 156, Odaigur, India.

Riggs, S.R. 1979. Petrology of the Tertiary phosphorite system of Florida. Economic Geol. 74, 195—220.

Slansky, M. 1986. Geology of Sedimentary Phosphates, North Oxford Academic Publishers Ltd. First English Edition, 210p.

Tahirkheli, R.A. Khan. 1971. Phosphate occurrences in Hazara and other contiguous areas in North West Frontier Province and Tribal Areas. Inf. Rel. Directorate of Mineral Development, North West Frontier Province, 5, 18p.

Vercheresm, A. 1966–67, Kashmir. The Western Himalaya and the Afghan Mountains. Journ. As. Aoc., Bengal, vol. XXXVI, 1867, pt. ii, p.29.

Waagen, W. & Wynne, A.B. 1872. The Geology of Mount Sirban in the upper Punjab. Geol. Surv. India. Memoir 9 part 2, 331—350.

Wadia, D.N. 1929. Geology of India. First Edition: Tata McGraw Hill New Delhi, India, 508p.