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PHOSPHATIC ROCK IN THE NIZAMPUR AREA OF THE KALA CHITTA HILLS, PAKISTAN

by

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U. S. Geological Survey

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(Survey of Pakistan topographic sheet 43 C/1)

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ABSTRACT

Two phosphatic zones have been found in Cretaceous rocks and one in Jurassic rocks near the village of Nizampur in the Kala Chitta Hills of northern West Pakistan. The upper zone consists of a 2-foot nodular conglomerate in limestone averaging 7 feet thick. The middle zone is a thin-bedded, glauconitic, calcareous sandstone with an average thickness of 55 feet generally containing less than 5 percent P_2O_5 , but in places as much as 12 percent P_2O_5 . The lower zone is 10 to 15 feet of gray shale and glauconitic sandstone with phosphatic nodules. Channel samples of this zone contain 5 to 15 percent P_2O_5 .

INTRODUCTION

Phosphatic nodules from the basal part of the Lower Cretaceous-Upper Jurassic Chichali Formation in the Kohat Range-Kala Chitta Hills were reported by Fatmi (verbal communication) and later investigated by Stanin and Mirza (unpub. data). Stanin and Mirza recommended that the Chichali Formation be examined in detail in Wuch Khwar, southeast of the village of Nizampur (fig. 1), where selected nodules contained 15 to 25 percent P_2O_5 . M. A. Wahid G.S.P. spent about six weeks in the Nizampur area including Wuch Khwar during the Fall of 1964. He reported high percentages of P_2O_5 in a nodular limestone (verbal communication). This phosphatic zone did not correspond with the description of phosphate

zones in the Chichali Formation and was apparently a new zone. Meissner and Sethi examined Wahid's discovery in the field during February 14-21, 1965.

PROSPECTING METHODS

Prospecting was done by scanning with a scintillator to detect anomalous radioactivity which is often associated with phosphate. Normal "background" radioactivity, using a portable LaRoe scintillator, was .005 mR/hr for limestone, .009 mR/hr for shale, and .011-.013 mR/hr for black shale. Phosphatic rock contained .013 + mR/hr to .025 mR/hr. When a radioactivity anomaly was detected a spot test for phosphate was made on a powdered sample of the rock using a solution of ammonium molybdate and nitric acid. If the solution turned yellow the presence of P_2O_5 was suspected. Concentrated hydrochloric acid was placed on the rock sample and if, upon drying, a white or yellow "bloem" formed 12-18 percent or more of P_2O_5 was present. Channel samples of the phosphatic rocks were taken for laboratory analyses (table 1). Promising areas were investigated for phosphate nodules, pellets, and grains.

GENERAL DESCRIPTION OF PHOSPHATIC ZONES

Two phosphatic zones were detected in Cretaceous rocks and one was found in rocks of Jurassic age. The upper zone, discovered by M. A. Wahid, is a limestone bed with an average thickness of 7 feet, at the top of which is a nodular, conglomeratic layer ranging in thickness from half a foot to 2 feet. This layer is phosphatic and contains 10-15 percent P_2O_5 . In part of the Nizampur area (Khware Khwar, etc.) this limestone bed contains two phosphatic lenses, and nodules below the top layer (fig. 2). The lenses range in thickness from half an inch to 6

inches and are about $1\frac{1}{2}$ feet apart. The nodules are from half an inch to 12 inches in diameter and occupy about one fourth of the limestone bed. A lense fragment contained 28 percent P_2O_5 which is the highest percentage of P_2O_5 registered for samples taken by Meissner and Sethi in the Nizampur area.

The middle zone (approximately 50 feet below the upper zone), detected for the first time, is thin-bedded, glauconitic, and in places calcareous sandstone with an average thickness of 55 feet. A small percentage (less than 5 percent) of P_2O_5 was found throughout this sandstone zone. At one place in the Nizampur area a sample from the upper 3 feet of the sandstone zone contained 12 percent P_2O_5 .

The bottom zone (100± feet below the middle zone) has been described by Stanin and Mirza. It is from 10-15 feet thick at the base of the Chichali Formation. Phosphatic nodules half an inch to 4 inches in diameter are scattered through gray, or greenish-gray shale, sandy shale, and sandstone. The zone is glauconitic, contains iron concretions, and abundant guards of Belemnites. The phosphatic nodules represent only a small percent of the zone, and the shale or sandstone is slightly phosphatic. Channel samples of this zone contained from less than 5 percent to 15 percent P_2O_5 .

AREAL EXTENT OF THE PHOSPHATIC ZONES

1. The nodular limestone (upper zone) is exposed at five localities in the Nizampur area:

The first locality extends from an outcrop of nodular limestone on the road about 2 miles southwest of Nizampur, eastward, to Wuch Khwar and the Indus River (fig. 1). This is a distance of about

1 1/2 miles along which the phosphatic layer at the top of the limestone bed ranges in thickness from half a foot to 2 feet and contains from 10-15 percent P_2O_5 . Southwest of Nizampur the dip of the limestone bed is $70^{\circ}N$. and it is overturned dipping $60^{\circ}S$. in Wuch Khwar. In Wuch Khwar the limestone bed is repeated by folding in a small anticline about .7 mile north of the exposure which is on strike with the exposure southwest of Nizampur.

The second locality is about 1 mile southeast of Shagai where two outcrops of the limestone bed .15 mile apart, are each about half a mile long. The strike of the beds is generally east-west. The phosphatic layer at the top of the limestone bed dips $75-80^{\circ}S$., is half a foot to 2 feet and contains 10-15 percent P_2O_5 . The limestone bed here is stratigraphically in the same position as the one in the first locality, but it has been repeated to the north by a combination of folding and strike faulting.

The third locality extends from Khwari Khwar eastward to Wuch Tangai Khwar and to about half a mile south of Shawangai. The limestone bed occupies the same stratigraphic position as it does at localities 1 and 2, but has been repeated to the north by a combination of folding and strike faulting. At several places the limestone bed not only contains a half to 2-foot phosphatic layer at the top of the bed, but also contains two phosphatic lenses and phosphate nodules in a 5-foot interval below the top (fig. 2). A sample of a lens in Khwari Khwar contained 28 percent P_2O_5 . The limestone bed strikes east and is repeated three times by strike faulting in Khwari Khwar. The southernmost outcrop of the phosphatic limestone

bed in Khwari Khwar strikes eastward for about 1.3 miles to Wuch Tangai Khwar. The bed is not exposed but probably extends another 2 miles south of Shawangai. This bed dips 70-80°N. and is 4 to 8 feet thick. Channel samples contained from less than 5 percent to 13 percent P_2O_5 . The phosphatic limestone bed to the north in Khwari Khwar extends eastward about $1\frac{1}{2}$ miles to Wuch Tangai Khwar. It is about 8 feet thick and contains 10-15 percent P_2O_5 . The northernmost exposure of the bed in Khwari Khwar apparently strikes eastward 1.7 miles to Wuch Tangai Khwar. The vertical bed is as much as 8 feet thick and contains 10-28 percent P_2O_5 .

At the fourth locality, .8 mile southeast of Gandab, the limestone bed is about 10 feet thick, but only the top nodular conglomeratic layer is phosphatic. This uppermost vertical top layer is a half to 1 foot thick, and probably contains at least 10 percent P_2O_5 . From the exposure south of Shawangai this bed strikes east for $2\frac{1}{2}$ miles; however it does not contain phosphatic lenses or nodules below the top layer.

The fifth locality is about .4 mile east of Bagh; the limestone bed dips 40°S., is 8 feet thick and extends east-west along strike for at least 1 mile. The top $1\frac{1}{2}$ -foot layer contains 15 percent P_2O_5 . The remainder of the limestone bed contains less than 5 percent P_2O_5 . This bed is probably on strike with the second locality 7 miles westward.

2. The glauconitic sandstone bed (middle zone) is thick in places but has a very low (less than 5 percent) P_2O_5 content. The areal extent of the glauconitic sandstone is described below:

Five exposures of nodular-phosphatic limestone described above also contain glauconitic sandstone.

In the first locality the sandstone is exposed from about 2 miles southwest of Nizampur, eastward, to Wuch Khwar and the Indus River (fig. 1). The sandstone dips 70°N. to 60°S. (overturned), is 35 to 80 feet thick and contains less than 5 percent P_2O_5 . In Wuch Khwar the glauconitic sandstone bed which dips $75\text{--}85^{\circ}\text{N.}$ is repeated twice in a small fold about .6 mile north of the exposure in Wuch Khwar which is on strike from southwest of Nizampur. The thickness ranges from 30 to 60 feet for .7 mile, and the P_2O_5 content is less than 5 percent.

In the second locality, about 1 mile southeast of Shagai, a 50-foot thick glauconitic sandstone strikes east and is exposed for half a mile. These beds dip 80°S. and the P_2O_5 content is less than 5 percent. This zone is repeated approximately .7 mile west-southwest.

In the third locality, along Khwari Khwar, the glauconitic sandstone is repeated 3 times by east-west strike faults. The maximum thickness here is 35 feet, as seen in the southern outcrop, but is less in the other two exposures because part of the zone has been faulted out. Apparently the beds are not traceable eastward to Wuch Tangai Khwar, a distance of about $1\frac{1}{2}$ miles, and are covered by alluvium westward. The P_2O_5 content is less than 5 percent, and the dip from 70°N. to vertical. A 10-foot bed of glauconitic sandstone crops out south of Shawangai. Apparently part of the section has been faulted. Cretaceous rocks can be traced nearly 3 miles eastward

to the fourth locality, south of Gandab, where the glauconitic sandstone is 40 feet thick. This same zone, or parts of it, may be traced to half a mile east of Gandab Khwar where the beds are vertical. The P_2O_5 content is less than 5 percent.

In the fifth locality, east of Bagh, the glauconitic sandstone is 33 feet thick, and is exposed east-west along strike for at least 1 mile. Most of the zone contains less than 5 percent P_2O_5 , but a sample taken from the uppermost 3 feet, contained 12 percent P_2O_5 , which is higher than the other zones. This bed should be traced laterally to determine thickness and grade.

3. The nodular shale (lower zone) with abundant Belemnites is poorly exposed in the Nizampur area. It is often covered with scree from the adjacent Jurassic limestone, and in many places is completely faulted-out.

There is a small isolated outcrop in Wuch Khwar, about 1.7 miles southeast of Nizampur. The section is faulted and folded and the thickness is unknown. The zone is composed of gray shale containing black phosphatic nodules which are half an inch to 2 inches in diameter. The nodules occupy possibly 10 percent of the mass. A channel sample of the shale and nodules contained 15 percent P_2O_5 . Probably the high P_2O_5 content is due to the nodules, whereas the surrounding shale contains a lower percentage of P_2O_5 . The shale zone is exposed again about 100 yards west of this outcrop. Extensive outcrops of black carbonaceous shale in Wuch Khwar gave no positive reaction in testing for phosphate.

Approximately 1.3 miles southeast of Shagai the phosphatic shale bed is exposed for about half a mile. Thickness could not be determined and P_2O_5 content is unknown.

In Khwari Khwar, about .9 mile east-southeast of Assu Khel, a thin slice of the phosphatic shale zone is faulted against rocks of Paleocene age. This zone extends approximately 1 mile east-west along strike. Southward, at Khwari Khwar, .7 mile from the above mentioned outcrop a complete section of the Chichali Formation is apparently in normal contact with the underlying Jurassic Samana Suk Limestone. The Chichali Formation dips $80^{\circ}N.$, is 90 feet thick, and the basal phosphatic bed, if it is present, is completely covered by scree and sediments. Trenching and pitting would be necessary to sample the bed.

Two miles east of Wuch Tangai Khwar and south of Shawangai, is an isolated exposure of the shale bed containing phosphatic nodules. The bed is 8 feet thick and nodules comprise 25 percent of the total mass. A sample of the zone contained 15 percent P_2O_5 . The bed is overturned and dips $80^{\circ}S$. In the area between Wuch Tangai Khwar and south of Shawangai the nodular shale is covered with alluvium. Another outcrop of the nodular shale is found in the Gandab Khwar, eastward along strike about 3 miles from the outcrop south of Shawangai. Here the vertical bed is 15 feet thick containing nodules a half to 1 inch in diameter. The zone is composed of glauconitic sandstone, shale, shaly sandstone, and sandy shale. Samples of the zone contained 10 percent P_2O_5 .

Because of the presence of several exposures of the bottom, nodular shale, phosphatic zone, it is possible that the zone continues from Khwari Khwar 6 miles to Gandab Khwar. Trenching and pitting in the covered areas would corroborate this interpretation.

There is an isolated exposure of the nodular shale in a small nala $2\frac{1}{2}$ miles east of Bagh. Ten feet of the vertical bed is exposed containing nodules a half to 4 inches in diameter; however, samples contain less than 5 percent P_2O_5 .

COMMENTS AND RECOMMENDATIONS

The most promising locality for the discovery of useful amounts of phosphate in the upper, nodular limestone zone in the Nizampur area is a belt from Khwari Khwar, south of the Nizampur-Attock bridge road, to the nala south of Shawangai (fig. 1). This phosphatic zone is north of the Indus River, and is connected by a good gravel road with the Rawalpindi-Peshawar Grand Trunk road. The nodular limestone contains not only the top phosphatic layer, but also nodules and lenses within the bed. In order to estimate reserves of phosphate in this locality, channel samples should be taken and analyzed, and thickness of the phosphate zone determined in the area between Khwari Khwar and Wuch Tangai Khwar, and between Wuch Tangai Khwar and the Shawangai nala. If laboratory analyses show that the grade is 10-15 percent P_2O_5 or more, the area should be mapped in detail (1 inch=500 feet scale or larger) in order to estimate the reserves and to plan mining methods. In this area 6 miles of limestone outcrop average 7 feet in thickness. Possibly half of this limestone contains 10-15 percent or more P_2O_5 .

The most promising locality in the Nizampur area for phosphate in the lower, nodular shale zone is in the area from Khwari Khwar, beginning about 1 mile south of Nizampur-Attock bridge road at the contact with the Jurassic limestone, and extending eastward to Gandab Khwar. The zone (approximately 10 feet thick) may be present over a distance of 6 miles but is mostly covered by overburden. Trenching and pitting would be required to obtain fresh samples for P_2O_5 analyses and to measure thicknesses. At least part of the zone contains 10-15 percent or more of P_2O_5 .

The top 3 feet of the glauconitic sandstone zone, which contained 12 percent P_2O_5 in an outcrop .3 mile east of Bagh, should be traced and sampled laterally to determine thickness and the percentage of P_2O_5 .

Table 1.—Chemical analyses of phosphatic samples collected from the Chichali Formation and the Lumshiwal Sandstone of the Nizampur area

<u>Sample No.*</u>	<u>Type of sample</u>	<u>P₂O₅ (percent)</u>	<u>Locality</u>
65-CRM-1	Nodular limestone	10	2.4 miles southwest of Nizampur (outcrop location no. 1, fig. 1).
65-CRM-2	Glaucinitic sandstone	Less than 5	Same as above.
65-CRM-3	" "	" " "	" " "
65-CRM-4	" "	" " "	" " "
65-CRM-5	Calcareous glauconitic sandstone	" " "	" " "
65-CRM-6	Shale, with phosphatic nodules	15	Wuch Khwar, 1.7 miles southeast of Nizampur (outcrop location no. 3, fig. 1).
65-CRM-7	Glaucinitic sandstone	Less than 5	Wuch Khwar, 1.8 miles southeast of Nizampur (outcrop location shown by two parallel black lines, fig. 1).
65-CRM-8	" "	" " "	Same as above.
65-CRM-9	" "	" " "	" " "
65-CRM-10	Nodular limestone	15	" " " (At north line)
65-CRM-11	" "	10	Wuch Khwar, 1.1 miles southeast of Nizampur (outcrop location no. 4, fig. 1).
65-CRM-12	" "	15	1.2 miles southeast of Shagai (outcrop location no. 6, fig. 1).
65-CRM-13	" "	10	1.3 miles southeast of Shagai (outcrop location no. 8, fig. 1).
65-CRM-14	Glaucinitic sandstone	Less than 5	.8 mile south-southeast of Shagai (outcrop location no. 9, fig. 1).

Table 1.—Chemical analyses of phosphatic samples collected from the Chichali Formation and the Lumshiwal Sandstone of the Nizampur area—Continued

<u>Sample No.*</u>	<u>Type of sample</u>	<u>P₂O₅ (percent)</u>	<u>Locality</u>
65-CRM-15	Nodular limestone	15	Khwari Khwar, .8 mile east-southeast of Assu Khel (outcrop location no. 10, fig. 1).
65-CRM-16	Phosphatic lenses in limestone	28	Same as above.
65-CRM-17	Nodular limestone	10	" " "
65-CRM-18	" "	Less than 5	Khwari Khwar, 1.4 miles southeast of Assu Khel (outcrop location no. 12, fig. 1).
65-CRM-19	" "	" " "	Wuch Tangai Khwar, 1.5 miles south of Kahi (outcrop location no. 14, fig. 1).
65-CRM-20	" "	13	Wuch Tangai Khwar, 1.7 miles south of Kahi (outcrop location no. 16, fig. 1).
65-CRM-21	" "	Less than 5	.5 mile south of Shawangai (outcrop location no. 18, fig. 1).
65-CRM-22	Glauconitic sandstone	" " "	Same as above.
65-CRM-23	Shale, with phosphatic nodules	15	.5 mile south-southwest of Shawangai (outcrop location no. 19, fig. 1).
65-CRM-24	Glauconitic sandstone	Less than 5	.5 mile southwest of Kahi (outcrop location no. 20, fig. 1).
65-CRM-25	Nodular limestone	" " "	Gandab Khwar, .8 mile south-east of Gandab (outcrop location no. 21, fig. 1).

Table 1.—Chemical analyses of phosphatic samples collected from the Chichali Formation and the Lumshiwal Sandstone of the Nizampur area—Continued.

Sample No.*	Type of sample	P ₂ O ₅ (percent)	Locality
65-CRM-26	Sandy shale and sandstone with phosphatic nodules	10	Gandab Khwar, 1 mile south-east of Gandab (outcrop location no. 22, fig. 1).
65-CRM-27	Glaucinitic sandstone	Less than 5	Gandab Khwar, .9 mile south-east of Gandab (outcrop location no. 23, fig. 1).
65-CRM-28	" "	" " "	1.4 mile south-southeast of Nizampur (outcrop location no. 25, fig. 1).
65-CRM-29	" "	" " "	Same as above.
65-CRM-30	" "	" " "	" " "
65-CRM-31	" "	" " "	" " "
65-CRM-32	Top of nodular limestone	15	.4 mile east-southeast of Bagh (outcrop location no. 26, fig. 1).
65-CRM-33	Limestone, sandstone	Less than 5	Same as above.
65-CRM-34	Calcareous glauconitic sandstone	" " "	.3 mile east of Bagh (outcrop location no. 27, fig. 1).
65-CRM-35	Calcareous glauconitic sandstone	" " "	Same as above.
65-CRM-36	Calcareous glauconitic sandstone	" " "	" " "
65-CRM-37	Calcareous glauconitic sandstone	" " "	" " "
65-CRM-38	Calcareous glauconitic sandstone	" " "	" " "
65-CRM-39	Calcareous glauconitic sandstone	" " "	" " "
65-CRM-40	Calcareous glauconitic sandstone	" " "	" " "

Table 1.—Chemical analyses of phosphatic samples collected from the Chichali Formation and the Lumshiwal Sandstone of the Nizampur area—Continued

<u>Sample No.*</u>	<u>Type of sample</u>	<u>P₂O₅ (percent)</u>	<u>Locality</u>
65-CRM-41	Calcareous glauconitic sandstone	Less than 5	.3 mile east of Bagh outcrop location no. 27, fig. 1).
65-CRM-42	Calcareous glauconitic sandstone	Less than 12	Same as above.
65-UB-X	Shale, sandy shale with phosphatic nodules	Less than 5	2.4 miles east of Bagh (outcrop location no. 28, fig. 1).

*Samples in storage with the mineralogy laboratory of the Geological Survey of Pakistan.