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PHOSPHATE DEPOSITS IN NORTHERN ALASKA

By

William W. Patton, Jr.

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INTRODUCTION

Deposits of low and medium grade phosphate rock were found recently at seven localities on the Arctic slope of Alaska. They were reported by field parties of the U. S. Geological Survey during the mapping of Naval Petroleum Reserve No. 4 and adjacent areas. The deposits are sedimentary in origin and are confined to a thin zone in the Lisburne group of Mississippian age. Six of the localities are in a narrow belt along the north front of the Brooks Range between the Anaktuvuk and Okokmilaga rivers. The seventh is near the Ipnavik River about 100 miles northwest of the Okokmilaga River. At all but two of these localities the zone of soft phosphatic rocks does not crop out extensively and samples of phosphate rock were collected chiefly from float or talus. Little or nothing is known about the thickness and extent of the deposits. Near Chandler Lake on the upper Kiruktagiak River and 11 miles west of the Anaktuvuk River at the head of Tiglukpuk Creek, the phosphatic zone is well-exposed. This paper is a preliminary report on the results of a detailed examination of the phosphatic zone in these two areas during the summer of 1953.

GEOGRAPHY

The Tiglukpuk Creek and Kiruktagiak River deposits occur in barren, rugged terrain at the north margin of the Brooks Range. From the irregularly dissected foothills on the north, the mountains rise abruptly to a maximum altitude of 7,000 feet. Both the mountains and foothills are drained to the north by major rivers like the Anaktuvuk, Killik, and Chandler which flow through broad, open, glacial valleys. Tributary streams like Tiglukpuk Creek and the Kiruktagiak River, however, are entrenched locally in steep-walled canyons and narrow gorges.

Aircraft provide the only practical means of transportation into this region at the present time. The nearest rail and road systems are several hundred miles to the south. The closest settlements with permanent airfield facilities are Umiat, 80 miles to the north, and Bettles, 100 miles to the south. Both the Tiglukpuk Creek and the Kiruktagiak River deposits are accessible from nearby lakes which are suitable for landing small planes on floats in summer or on skis in winter.

GEOLOGY

General

The rocks that underlie the Kiruktagiak River and Tiglukpuk Creek areas are sedimentary and range in age from Mississippian to Jurassic. They are complexly deformed by east-west folds most of

which are overturned to the north, often isoclinally. The folds are broken by numerous, closely-spaced, high-angle, south-dipping reverse faults and offset by north-south transverse faults. In addition, the rocks of the Kiruktagiak area are part of a large overthrust sheet which has its roots far to the south in the Brooks Range.

Stratigraphy

The stratigraphic sequence has been subdivided into four formational units: the Lisburne group of Mississippian age; a formation, as yet unnamed, of Permian age; the Shublik formation of Triassic age; and an unnamed formation of Jurassic age.

The Lisburne group is composed chiefly of brownish to grayish, fossiliferous, clastic limestone with varying but subordinate amounts of light, coarsely crystalline dolomite, dark argillaceous limestone, dark shale, and dark nodular and bedded chert. The thickness of the Lisburne group is not known in the vicinity of the phosphate deposits inasmuch as the base is not exposed. Elsewhere in the central Brooks Range the group was found to have an average thickness of 2,500 feet.

The unnamed formation of Permian age disconformably overlies the Lisburne group. It consists principally of red, green, and gray shale and siltstone which locally are calcareous, cherty or ferruginous. This formation is 350 feet thick in the Tiglukpuk Creek area and thins westward to 250 feet in the Kiruktagiak River area. The Shublik formation of Triassic age disconformably overlies the

unnamed formation of Permian age and is composed largely of fossiliferous black shale, limestone, and chert. In the Tiglukpuk Creek area the Shublik is 750 feet thick but only 300 feet thick in the Kiruktagiak River area.

The unnamed formation of Jurassic age disconformably overlies the Shublik and consists of a wide variety of rock types but is dominantly greenish graywacke sandstone, dark gray shale and siltstone, and greenish bedded chert. Although elsewhere the total thickness is about 1,500 feet, only the basal few hundred feet are present in the vicinity of the phosphate deposits.

PHOSPHATE DEPOSITS

The principal phosphatic beds occur in a zone nearly 40 feet thick in the upper part of the Lisburne group. In the Tiglukpuk Creek area this zone occurs 530 feet below the base of the Permian. In the Kiruktagiak River area, however, it is only 185 feet below the Permian. The two zones are believed to be correlative and the difference in thickness of the overlying limestone sequence is attributed to differential erosion prior to deposition of the unnamed Permian formation.

The rocks of the phosphatic zone are composed chiefly of phosphate mineral, calcium carbonate, and silt and clay detritus in varying proportions. Depending upon which of these constituents is predominant, the rocks are classified as phosphate rock, limestone or mudstone. Phosphate rock containing from 14 to 23 percent P_2O_5

(phosphorous pentoxide) is classed as low grade; from 23-32 percent, as medium grade; and above 32 percent, as high grade. Nearly all of the phosphate rock samples from the Tiglukpuk Creek and Kiruktagiak River areas proved to be low or medium grade.

The phosphate rock is dark gray or black, but where it has been exposed it weathers light gray or brown and is often coated with a characteristic bluish-white bloom. Occasionally secondary purple flourite is visible on bedding-plane surfaces and in veinlets. The texture of the rock is generally granular or oolitic. Pebbles of phosphate as much as one-half inch in diameter are frequently found on the bedding surfaces. Thickness of beds ranges from a fraction of an inch in the highly argillaceous rock to two feet in the highly calcareous rock.

Sampling

The number and weight of samples collected from the Kiruktagiak and Tiglukpuk deposits were limited because it was necessary to backpack them several miles to a place where they could be picked up by small plane. About 40 samples were collected from each locality. The samples weighed about one pound each and consisted of representative chips from each bed or interval of similar lithology. In those parts of the section where two different rock types occur in thin alternating layers, only one sample representative of each type was collected.

Kiruktagiak River area

In the Kiruktagiak River area the phosphatic zone occurs on the limbs of a small west-trending anticline that lies close to the north front of the mountains. The anticline can be traced from the Kiruktagiak River westward a mile and a half along the valley of Monotis Creek to an abrupt termination against a fault. The phosphatic beds dip north and south away from the axis at angles of from 35°-50°. They are offset in many places by small north-trending transverse faults.

The best exposure of the phosphatic zone is in the canyon of Monotis Creek, 1,500 feet west of the Kiruktagiak River. The base of the zone rests upon a resistant eight-foot ledge of dark chert. Although the top is not exposed, the measured section is believed to represent nearly the full thickness of the phosphatic zone.

Detailed stratigraphic section and chemical analyses, Monotis Creek, Lat. 68° 22½' N., Long. 152° 53' W.

Bed No.	Lithology	Thickness (inches)	P_2O_5 (percent)
	(top not exposed)		
51	Mudstone	4.0	0
50	Phosphate rock	35.0	20.8
49	Phosphate rock	3.0	20.8
48	Phosphate rock	2.5	20.8
47	Phosphate rock	16.0	30 ±
46	Phosphate rock	8.5	15.5

Detailed stratigraphic section and chemical analyses,

Monotis Creek, Lat. 68° 22½' N., Long. 152° 53' W. --Continued

Bed No.	Lithology	Thickness (inches)	P_2O_5 (percent)
45	Phosphate rock	6.0	15.5
44	Phosphate rock	14.0	15.5
43	Mudstone	8.0	13.5
42	Mudstone	5.5	13.5
41	Phosphate rock	5.5	23 ±
40	Mudstone	3.0	10 ±
39	Phosphate rock	5.5	23 ±
38	Phosphate rock	3.0	23 ±
37	Phosphate rock	9.5	23 ±
36	Phosphate rock	2.0	23 ±
35	Phosphate rock	5.0	23 ±
34	Phosphate rock	2.0	23 ±
33	Mudstone	40.5	10 ±
32	Phosphate rock	18.5	25 ±
31	Phosphate rock	1.5	25 ±
30	Phosphate rock	7.0	34.0
29	Phosphate rock	9.0	15 ±
28	Phosphate rock	2.0	34.0
27	Phosphate rock	14.0	15 ±
26	Mudstone	5.5	10 ±
25	Mudstone	5.0	10 ±
24	Mudstone	5.0	10 ±

Detailed stratigraphic section and chemical analyses,

Monotis Creek, Lat. 68° 22½' N., Long. 152° 53' W. --Continued

Bed No.	Lithology	Thickness (inches)	P_2O_5 (percent)
23	Mudstone	10.0	10 ±
22	Mudstone	25.0	10 ±
21	Mudstone	10.0	10 ±
20	Mudstone	9.0	0
19	Mudstone	12.0	< 5
18	Mudstone	6.5	< 5
17	Mudstone	5.0	< 5
16	Mudstone	3.0	< 5
15	Mudstone	2.0	10 ±
14	Mudstone	6.0	10 ±
13	Mudstone	13.0	10 ±
12	Mudstone	5.0	5 ±
11	Mudstone	33.0	5 ±
10	Mudstone	1.75	5 ±
9	Mudstone	34.0	< 5
8	Mudstone	2.0	< 5
7	Mudstone	21.0	< 5
6	Mudstone	2.25	< 5
5	Mudstone	8.0	< 5
4	Mudstone	1.75	< 5
3	Mudstone	0.5	< 5
2	Mudstone	2.0	< 5
1	Mudstone (base of phosphatic zone)	1.5	< 5
	Chert		

Tiglukpuk Creek area

The phosphate zone in the Tiglukpuk Creek area crops out along a narrow, north-east trending belt at the front of the mountains. The phosphatic beds lie on the north flank of an overturned anticline and stand nearly vertical. A mile and a half west of Tiglukpuk Creek in the canyon of Skimo Creek, the phosphate zone is completely exposed. The top and bottom contacts of the phosphate zone are marked by massive beds of dark silicious limestone.

Detailed stratigraphic section and chemical analyses, Skimo Creek, Lat. 68° 16½' N., Long. 151° 53' W.

Bed No.	Lithology	Thickness (inches)	P_2O_5 (percent)
	Limestone (top of phosphatic zone)		
46	Phosphate rock	1.0	26.3
45	Mudstone	7.0	5 ±
44	Phosphate rock	1.5	30 ±
43	Mudstone	8.0	5 ±
42	Limestone	17.0	5 ±
41	Mudstone	19.0	5 ±
40	Limestone	7.5	5.2
39	Mudstone	14.0	5 ±
38	Phosphate rock	5.0	30 ±
37	Mudstone	8.5	5 ±
36	Phosphate rock	2.0	30 ±

Detailed stratigraphic section and chemical analyses,

Skimo Creek, Lat. 68° 16½' N., Long. 151° 53' W. --Continued

Bed No.	Lithology	Thickness (inches)	P_2O_5 (percent)
35	Mudstone	7.0	5 ±
34	Phosphate rock	3.0	23.8
33	Mudstone	6.0	5 ±
32	Limestone	58.0	< 5
31	Phosphate rock	5.5	21.5
30	Phosphate rock	4.0	20.8
29	Phosphate rock	2.5	21.5
28	Phosphate rock	17.0	20.8
27	Phosphate rock	14.0	20.5
26	Limestone	11.0	< 5
25	Mudstone	9.0	< 5
24	Phosphate rock	5.5	30 ±
23	Mudstone	2.5	< 5
22	Phosphate rock	4.0	30 ±
21	Mudstone	4.0	< 5
20	Phosphate rock	1.0	30 ±
19	Mudstone	5.0	10 ±
18	Phosphate rock	7.0	20.5
17	Mudstone	3.0	10 ±
16	Phosphate rock	.75	20.5
15	Mudstone	17.5	10 ±
14	Mudstone	28.5	10 ±

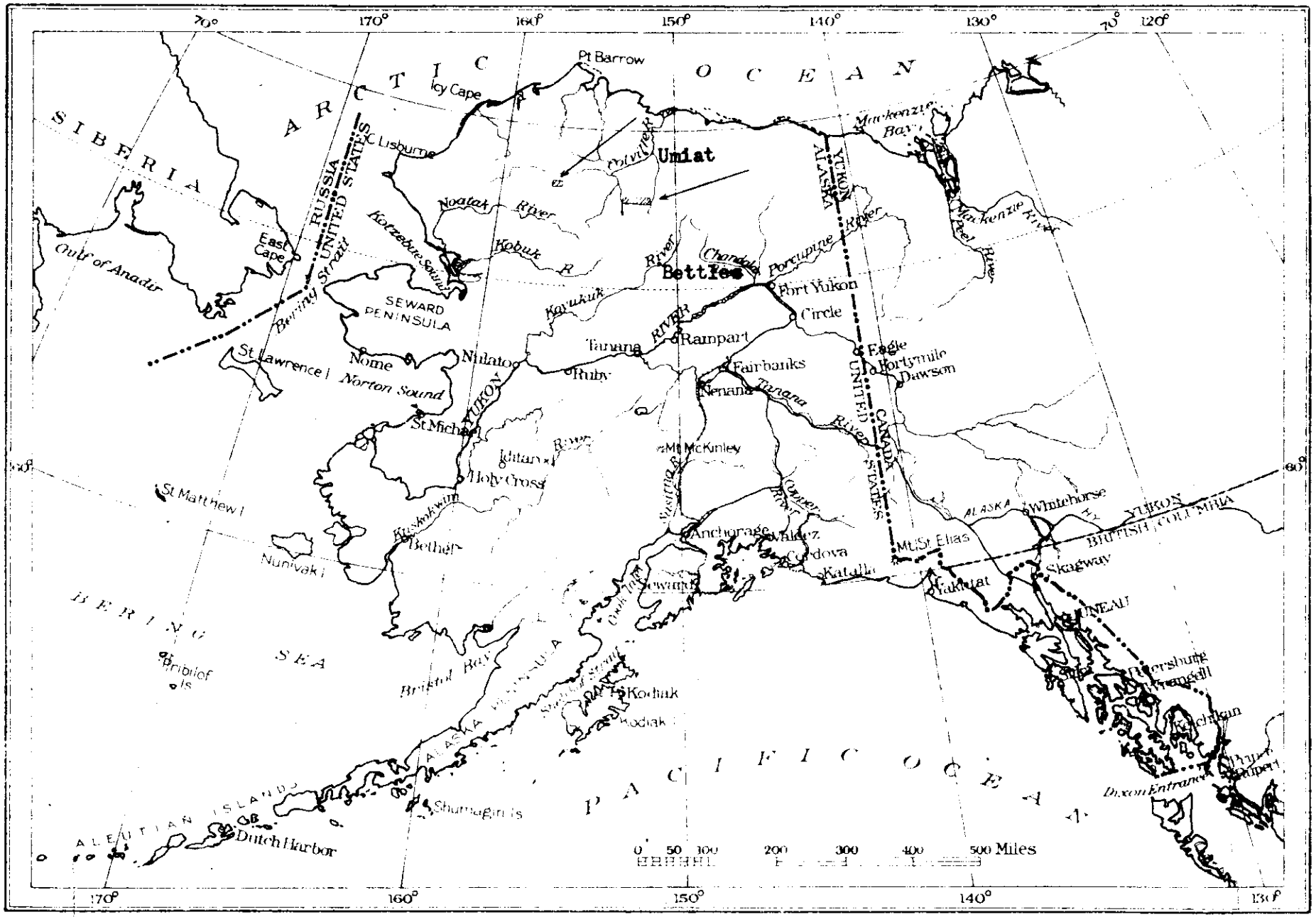
Detailed stratigraphic section and chemical analyses,

Skimo Creek, Lat. 68° 16½' N., Long. 151° 53' W. --Continued

Bed No.	Lithology	Thickness (inches)	P_2O_5 (percent)
13	Limestone	5.0	10 ±
12	Mudstone	19.0	5 ±
11	Limestone	3.0	<5
10	Mudstone	3.5	5 ±
9	Limestone	19.0	<5
8	Mudstone	4.5	5 ±
7	Limestone	3.5	<5
6	Mudstone	26.5	5 ±
5	Limestone	1.75	<5
4	Mudstone	3.5	5 ±
3	Limestone	1.5	<5
2	Mudstone	6.25	5 ±
1	Limestone	23.0	5 ±
	(base of phosphatic zone)		
	Limestone		

The measured section on Skimo Creek differs markedly in lithology as well as in phosphate content from the measured section on Monotis Creek. Even within the areas of these two deposits some lateral variations were noted. At the present time, however, there is not sufficient detailed information on the phosphate zone to permit speculation on the regional trends of these facies changes.

Because of the complex structure of the rocks along the mountain front and because of the facies changes, further work will be necessary before the phosphate deposits can be properly evaluated.



INDEX MAP SHOWING LOCATION OF NORTHERN ALASKA PHOSPHATE DEPOSITS

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