STAFF REPORT ON PHOSPHATES

By V. E. McKelvey and James B. Cathcart

Trace Elements Investigations Report 94

UNITED STATES DEPARTMENT OF THE INTERIOR

GEOLOGICAL SURVEY

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Mineral Deposits Branch

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TRACE ELEMENTS INVESTIGATIONS REPORT 94

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STAFF REPORT -- FLORIDA PHOSPHATE
by James B. Cathcart

General Geology

Three types of phosphate are found in Florida: land pebble, hard rock, and river pebble. Only the first type contains any significant amounts of uranium and only this first type has been investigated by the Geological Survey.

The rocks in the land pebble field are nearly flat- lying sedimentary rocks, which are a part of the Gulf Coastal Plain. They dip very gently to the south. The oldest rocks exposed are phosphatic limestones, marls, and clastics of the Hawthorn formation (lower middle Miocene). The Bone Valley Formation (lower Pliocene) rests unconformably on the Hawthorn, and is in part derived from it. The Bone Valley has been divided into a lower zone (basal gravel) and an upper zone (the "leached" zone). Resting unconformably on the Bone Valley are the sands of the Pleistocene terraces. Phosphate is mined from both the Hawthorn and Bone Valley Formations.

Uranium content.-- Practically no uranium (.001- .002% U) is present in the fresh Hawthorn formation. However when the lime has been leached from the Hawthorn, the amount of uranium is slightly higher, with an average of .003% U and it may run as high as .010% U.

The lower zone of the Bone Valley is significantly higher than the Hawthorn in uranium, with an average of .01% U, and as much as .02% U. When the upper zone of the Bone Valley is leached it is nearly always significantly higher in uranium content than the unleached or lower zone, and contains the highest uranium concentrations known in

the Florida phosphate. The average of the upper leached zone is .02- .03% U, and locally it is as high as .06% U.

In the Pleistocene very little uranium is found and most analyses report less than .001% U. Occasionally, when reworked phosphate nodules are present in the overburden, analyses are as high as .017% U.

Reserves of phosphate rock

Measured reserves are listed below, based upon data from about 60% of the area of high grade ore indicated on the accompanying sketch, all grades. Present commercial cut-off is generally at 70 BPL:

BPL	Reserves	
	Pebble	Flotation
75 +	19,560,162	60,791,453
70-75	114,531,054	118,371,904
65-70	231,810,174	25,998,986
60-65	25,403,459	1,574,664
60	8,000,876	216,496
No grade	51,508,805	168,000
	450,813,730	207,121,503

Grand total . . . . 657,935,233 short tons, all grades.

In computing the above ore, only measured ore, that is, generally at least 4 drill holes per 40 acres and in most cases 16 holes per 40 acres, was used. At least 1/3 of the area is covered only by drilling done prior to 1934 (before the introduction of flotation) and the flotation tonnages will possibly be increased by an additional 50-100 million tons in the area already covered through further exploration (see figure 1).

The above reserves have already been discounted for slime loss,

but are still subject to an additional discount of about 10% for mining loss. Slimes, which make up about 1/3 of the rock in the ground and contain, in many areas, approximately 1/3 of the phosphate content of the original rock, are not included since as yet no method for recovering phosphate in the slimes has been devised.

Objectives

The objectives of the Florida phosphate project are as follows:

A. Compilation of all company data on reserves, thickness of matrix and overburden, and a study of the phosphate in the district. This work is about 60% complete. One company, Virginia-Carolina Chemical Corporation, a large land holder, has not given any data as yet. Study of all the remaining companies is essentially complete except for recent prospecting.

B. Study of the relation of phosphate and uranium in the district. Some 2000-3000 samples per month are sent in on current prospecting to determine the amount, thickness, and grade of uranium in both the lower and upper zone.

C. Study of the leached zone. All pits have been examined and sampled. The old records give no indication of this zone, so considerable drilling will have to be done to outline this zone accurately. This would necessitate a long term project.

D. Origin of phosphate and uranium. This work is being carried on concurrently with the economic studies.

E. Investigation of slime ponds. This study will be finished about August 1, 1949.

Possible reserves of uranium

From the lower zone of the Bone Valley about 6,000,000 tons of finished product are shipped per year, with an approximate average grade of .009% U, which is equal to 540 tons of uranium per year. Mansfield estimated total reserves of all grades of measured, indicated, and inferred ore at approximately 2 billion tons of phosphate, which would then give about 200,000 tons of contained uranium. This includes the large area of low grade phosphate (55-70 BPL) shown on the accompanying sketch in Manatee and Hardee Counties. The outline shown is based upon geologic inference supported in some cases by at most one drill hole per section.

As yet the tonnage in the leached zone of the Bone Valley is completely unknown, since so very little drilling has been done. The bed, where present, varies from 1.0' to about 8.0' thick. The range is probably from .02% or .03% U up to .06% U.

There are very large tonnages of phosphatic slimes which may contain in places significant concentrations of uranium. This problem is being investigated at present, but as yet no figures are available.

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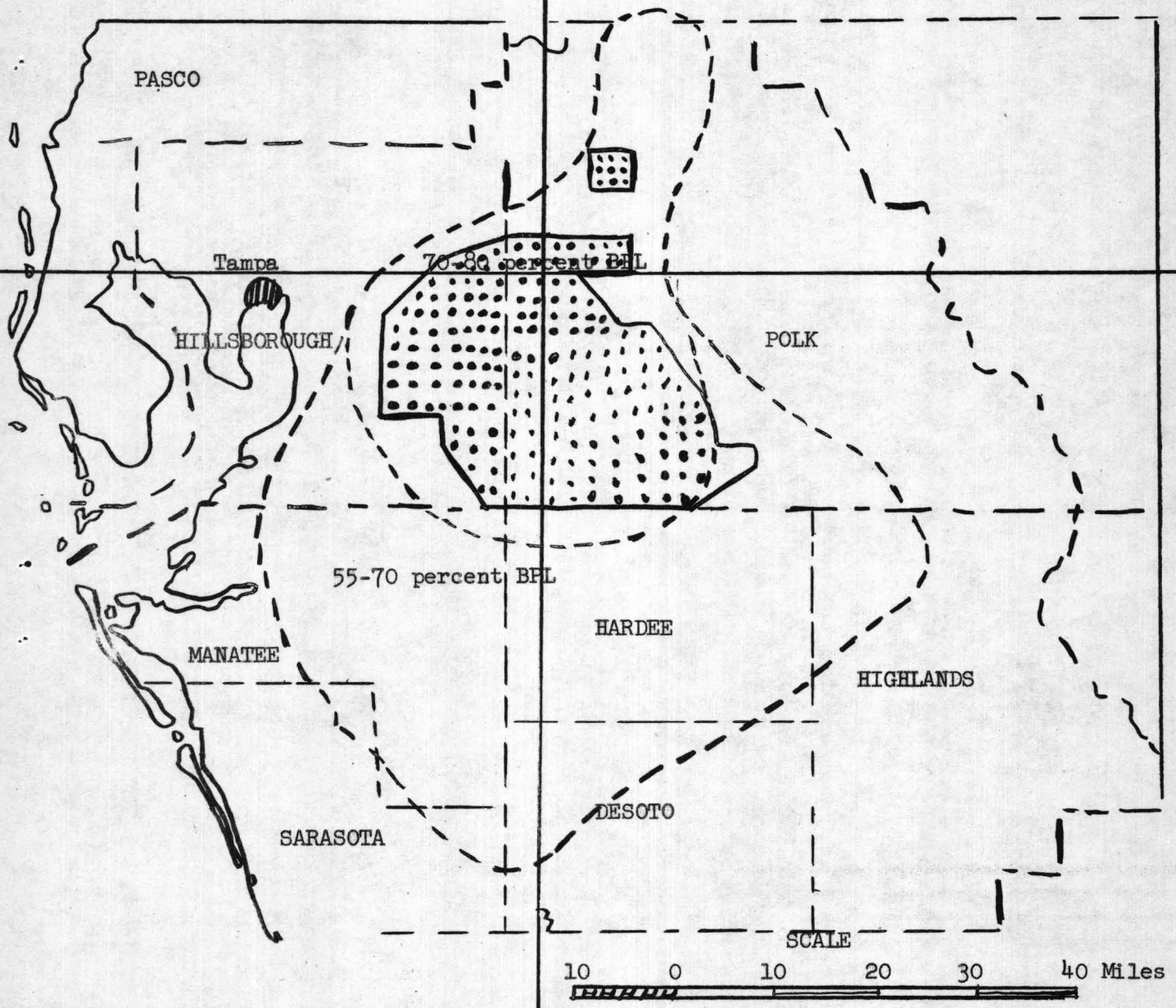
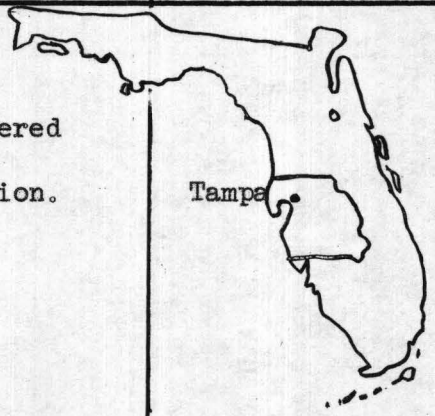


EXPLANATION

Approx. area covered by company prospecting information.



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PROGRESS REPORT OF THE INVESTIGATIONS OF URANIUM IN THE WESTERN PHOSPHATE FIELD

By V. E. McKelvey

Geology

Uraniferous phosphate deposits in the Permian Phosphoria formation, and its close stratigraphic equivalents are found over an area of about 100,000 square miles in Montana, Idaho, Wyoming, and Utah. In the eastern part of the field, the geologic structure is simple; the folds are the open dome and basin type, the beds generally dip less than 25°, and, although some large faults are found, large areas are unfaulted. The phosphatic beds in this area are thin and minable thicknesses of beds contain 20-25 percent P_2O_5. The uranium content is likewise low--phosphates containing 20-25 percent P_2O_5 average only about 0.02-0.03 percent U.

The whole complexion of the western part of the field (i.e. west of a line roughly approximating meridian 111°) is different. The geologic structure there is complex; many of the folds are isoclinal and overturned, the beds generally dip more than 45°, and both large and small faults are abundant--in fact, many of the phosphate deposits are so broken and masked as to be unsuitable for mining. The phosphate beds, however, are much thicker and of higher quality than in the eastern part of the field. In the Bear River region of southeastern Idaho 10 to 20 feet of beds, including two minable zones in many areas, contain more than 31 percent P_2O_5 and 20 to 30 feet of beds contain more than 25 percent P_2O_5. Minable phosphate beds containing more than 31 percent P_2O_5 are also present in western Montana, westernmost Wyoming, and northern

Utah, but their total thickness is not as great as in southeastern Idaho. The minable phosphate zones in most of the western part of the field contain about 0.007 to 0.02 percent uranium. The most uraniferous beds yet found are those of the upper phosphate zone along the Wyoming border; they contain 0.015 to 0.035 percent uranium.

Reserves

Plainly the reserves of highly uraniferous and phosphatic rocks are restricted to the western part of the field. Because of the tight folds, steep dips, and numerous faults many of the deposits are not suitable for mining, however, and of those that are minable most must be mined by underground methods.

Reliable estimates of minable reserves cannot be made in advance of detailed geologic mapping and, in some places, detailed sampling. This is not because the grade and thickness is difficult to establish, but because in many places it is generally a moot question as to whether or not the phosphatic beds are faulted out, or so mashed by folding as to be unminable. The following estimates are therefore no more than an indication of the general order of magnitude of reserves.

Preliminary and incomplete estimate of reserves of phosphate rock suitable for mining in Permian rocks of the Western Field 1/
(millions of short tons)

Suitable for open-cut mining		Suitable only for underground mining (above entry level)	
≠ 31% P_2O_5	24-31% P_2O_5	≠ 31% P_2O_5	24-31% P_2O_5
25-50	75-250	350-1,000	1,100-4,000

1/ The estimates are of rock in the ground; no allowance is made for loss due to dilution or unfavorable structural conditions beyond those that can be judged from surface outcrops. Minimum mining width is assumed to be 3 feet in both open-cut and underground mining. The minimum figure stated for each class is based upon estimates of deposits

with which the Geological Survey is familiar; the maximum figure is a guess as to the total reserves, including those that may exist in areas as yet largely unappraised even in preliminary fashion.

It is not possible to estimate the uranium content of these reserves accurately, but it is safe to assume that the bulk of the phosphate rock contains at least 0.008 percent and probably 0.01 percent uranium.

Status of the Geological Survey's investigations of the western phosphate field

The Geological Survey has aimed at an appraisal of the resources of the Phosphoria formation of a type that will enable government to evaluate its resource-potential, not only as regards uranium, but phosphate, vanadium and other minor elements as well; that will allow industry to make a preliminary selection of deposits suitable for mining; and that will encourage the companies to recover elements of possible by-product value.* Although our purposes are thus much broader than those of the Atomic Energy Commission, which has paid about a third of the cost of the investigation since it was renewed in 1947, the field work required to achieve the goals of both agencies is about the same. In other words, the deposits must be mapped and sampled, no matter whether the search is for one element or twenty.

We originally planned to map (on a scale of 1:62,500) every quadrangle in the western field known to contain phosphate; to re-map (on a scale of 1:12,000) those areas containing the most valuable deposits; and to sample the phosphatic shale member of the Phosphoria formation

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*Information acquired will not serve as a basis for measuring reserves or for planning specific mining operations. The detailed mapping, drilling, and sampling necessary for that must be done by industry, not government.

at intervals of 3 to 6 miles over the field. It appears now that all of the quadrangle mapping and sampling originally planned will not be needed to achieve the broad objectives stated above, for, as previously described, the significant deposits appear to lie only in the western part of the field. Therefore, we intend to continue the original sampling program only in the Bear River region and western Montana, though we will sample a few additional sections at widely spaced intervals in the eastern part of the field (in Wyoming and northern Utah) to place our preliminary conclusions as to the merits of the deposits there on a firmer footing. After the close of the 1949 or 1950 season, when the five quadrangles now in progress are completed, we will continue quadrangle mapping at the rate of about one party a season (i.e. one quadrangle every two or three years).

Of the total estimated cost of the project, approximately 60 percent will have been paid for at the close of fiscal '50. All of the sampling will be completed by the close of the 1951 season, and all of the 1:12,000 mapping (contemplated only in the Aspen Range-Dry Ridge area in the Bear River region and in the Centennial Range in Montana) likely will be completed at the end of the 1953 season. Much more time, possibly two years, will be required to complete all the reports that will be required, but it is likely that a final appraisal of the uranium reserves can be completed in the winter of fiscal 1954.

June 17, 1949
Montpelier, Idaho

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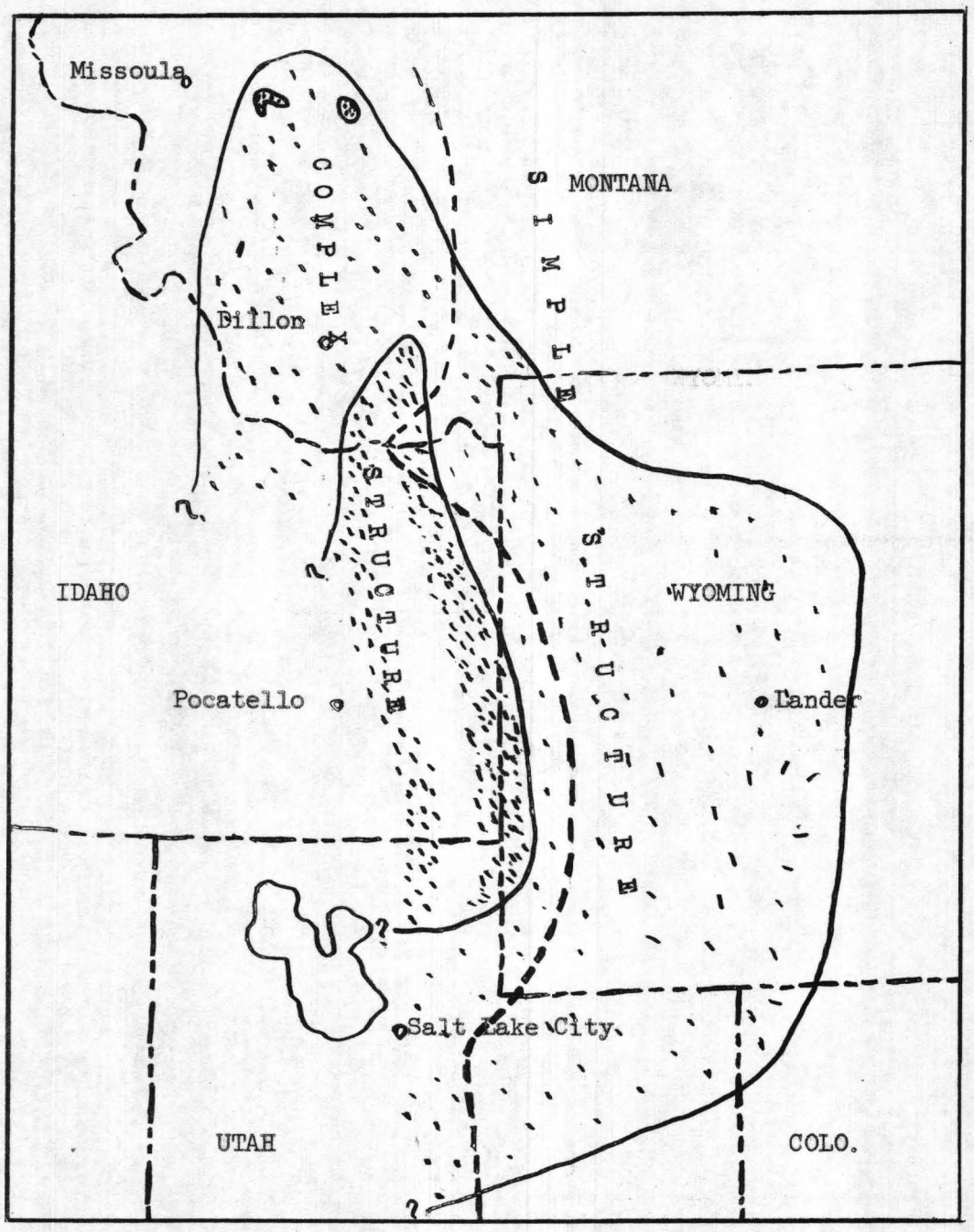

THE WESTERN PHOSPHATE FIELD

Phosphate in the Phosphoria formation and close stratigraphic equivalents extends over stippled area. Minable deposits containing more than 31 percent P_2O_5 are limited to heavily stippled area. Boundary between areas of simple and complex structure shown by heavy dashed line.