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Airborne Radioactivity Surveys for Phosphate in Florida

By R. M. Moxham

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AIRBORNE RADIOACTIVITY SURVEYS FOR PHOSPHATE IN FLORIDA*

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This preliminary report is distributed without editorial and technical review for conformity with Geological Survey standards and nomenclature.

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ABSTRACT

Airborne radioactivity surveys totalling 5,600 traverse miles were made in ten areas in Florida, which were thought to be geologically favorable for the occurrence of uraniferous phosphate deposits. Abnormal radioactivity was recorded in eight of the ten areas surveyed. The anomalies are located in Bradford, Clay, Columbia, DeSoto, Dixie, Lake, Marion, Orange, Sumter, Taylor, and Union Counties.

Two of the anomalies were investigated briefly on the ground. One resulted from a deposit of river-pebble phosphate in the Peace River valley; samples of the river pebble contain an average of 0.013 percent equivalent uranium. The other anomaly resulted from outcrops of leached phosphate rock containing as much as 0.016 percent equivalent uranium. Several anomalies in other areas were recorded at or near localities where phosphate deposits have been reported to occur.

INTRODUCTION

Deposits of phosphate in Florida, located beyond the limits of known producing areas, have been reported by prospectors and mining companies. Much of the information has been based upon prospecting and exploration which was undertaken many years ago and as a result the published data relating to the occurrence of these deposits are fragmentary, and few details relating to specific locations and extent are available.

In view of the present interest in uranium as a by product of phosphate production, it seemed desirable to make a reconnaissance of some of those areas which appeared geologically most favorable for the occurrence of phosphate. Airborne radioactivity surveys, a means of undertaking rapid low-cost reconnaissance of large areas, seemed to be particularly suited to this work. It was recognized at the outset, however, that one serious limitation existed -- the presence of a variable thickness of overburden covering much of the potential phosphate areas. This absorbing layer would reduce the radiation intensity from underlying source rocks and where sufficiently thick, could reduce the radiation intensity to an undetectable level. As the overburden is generally thinnest in stream valleys, most of the areas surveyed were chosen to take advantage of this feature.

Our present knowledge of phosphate distribution in Florida, outside of the present productive areas, is summarized in a report by Mansfield (1942) which served as one of the guides in selecting the areas to be surveyed.

The selection of areas was made by J. B. Cathcart of the U. S. Geological Survey; J. L. Meuschke was in charge of flight operations. The surveys were made from April 22 - May 19, 1953. The work was undertaken on behalf of the Division of Raw Materials of the Atomic Energy Commission.

The surveys were made with scintillation-detection equipment mounted in a Douglas DC-3 aircraft. Parallel traverse lines, spaced at quarter-mile intervals, were flown approximately 500 feet above the ground.

Aerial photographs were used for pilot guidance, and the flight path of the aircraft was recorded by a gyrostabilized, continuous-strip-film camera. The distance of the aircraft from the ground was measured with a continuously recording radio altimeter.

Extent of coverage

At 500 feet above the ground, the width of the zone on the ground from which anomalous radioactivity is measured varies with the tenor and areal extent of the source and the spatial relationship of the aircraft to the source. For strong sources, the width of the zone scanned would be as much as 1,400 feet. Quarter-mile spacing of the flight paths of the aircraft should be adequate to detect anomalies from strong sources of radioactivity. However, small areas of considerable radioactivity midway between flight paths may not be noted.

Ten areas requiring about 5,600 useful traverse miles were surveyed. These locations are shown on figure 1. Abnormal radioactivity was recorded in eight of the ten areas.

RADIOACTIVITY MEASUREMENTS

The locations of the areas of anomalous radioactivity are shown on figures 2 through 9. In some areas the radiation intensity is of the same general amplitude throughout, that is, there are no localities of markedly greater intensity within the anomalous area. The ratio between the maximum anomalous and background radiation intensities shown at each such anomaly refers therefore to the entire anomalous area. In other areas distinct peak intensities were recorded within the limits of

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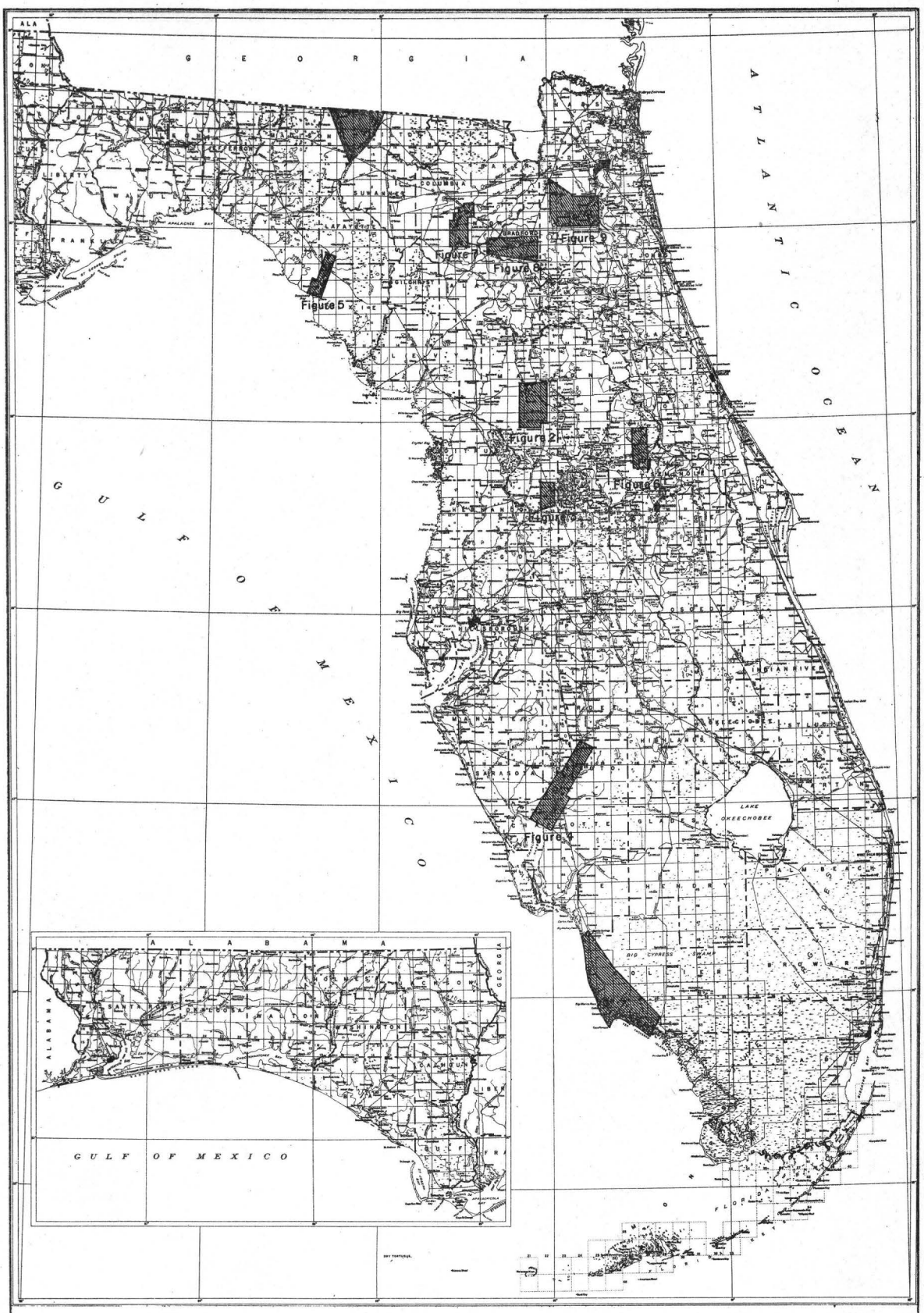

FIGURE 1
INDEX MAP OF FLORIDA SHOWING THE LOCATIONS OF AREAS SURVEYED

Scale

the anomalous areas, and in nearly all places the peak intensities tend to be grouped. The general limits of the areas of peak intensities have been indicated in an arbitrary fashion. The ratio of maximum radiation intensity to background radiation intensity, indicated for each area of peak intensity, affords a qualitative measure of evaluating the relative merits of such areas.

The background radiation intensity measurements mentioned herein refer to radiation from the ground minus the cosmic and contamination components.

Marion County

The area surveyed in the central part of Marion County (fig. 2) is underlain by the Ocala limestone of Eocene age and outliers of sandy phosphatic limestone of the Hawthorn formation of Miocene age (Cooke, 1945).

No phosphate deposits have previously been reported in this area. The eastern limit of the hardrock phosphate area, as delineated by Mansfield (1942), lies a few miles west of the surveyed area.

Abnormal radioactivity was recorded by the airborne equipment in several areas within a belt about 5 miles in width which extends for a distance of approximately 13 miles southward from Ocala. The orientation of the belt parallels the axial trend of the Ocala Uplift. The airborne radioactivity anomalies appear to conform in a very general way, to the Hawthorn outcrop area.

Background radioactivity at the 500-foot flight level over the Ocala limestone areas averaged about 0.25 μr/hr. The peak intensities of the anomalies recorded over the Hawthorn (?) outcrop reached a maximum of 2.75 μr/hr.

One of the anomalies recorded in south-central Marion County is in secs. 13 and 24, T. 17 S., R. 22 E. A brief ground investigation was made on the Hatcher farm, in sec. 24, about 1½ miles southwest of Summerfield. Leached phosphatic rock crops out at several localities near the crest of a low north-trending ridge. The exposures are relatively small -- on the order of a few square feet. At two such localities, the maximum radioactivity recorded at the surface was 0.11 mr/hr; background radioactivity, measured several hundred feet from the outcrop, was 0.01 mr/hr. Float of leached phosphatic rock was found over a soil-covered area of several acres, contiguous to the outcrops. In general the radiation intensity in the soil-covered area was relatively low -- on the order of 0.03 mr/hr.

One hand specimen of leached rock, collected from an outcrop of maximum radiation intensity (0.11 mr/hr), contains 0.016 percent equivalent uranium (by beta-gamma counting).

Sumter County

The area surveyed in Sumter County (fig. 3) is underlain by the Suwannee limestone (Oligocene) and is near the crest of the Ocala Uplift. The north-south axis of the area is alined roughly with that of the area surveyed to the north in Marion County.

No previous record of phosphate deposits in this area has been published.

Two small anomalies were recorded by the airborne equipment, one 2 miles south of Center Hill, the other 4 miles southeast of Webster. Background radioactivity at 500 feet was about 0.25 μr/hr, and the peak intensities of the anomalies were 3 and 4 times this value, respectively.

There is no apparent relationship between the anomalies and obvious geologic features.

Charlotte, DeSoto, and Sarasota Counties

The survey in Charlotte, DeSoto, and Sarasota Counties was confined to the Peace River valley and immediately adjacent areas (fig. 4). The areas adjacent to the Peace River valley are occupied by the Caloosahatchee formation comprising marine and shell marl, and by marine and estuarine phosphatic sand, clay, and gravel of the Bone Valley formation of Pliocene age. The river valley is underlain by Quaternary alluvium.

Deposits of river-pebble phosphate were mined at a number of localities in the early 1900's, chiefly in the Arcadia and Ft. Ogden areas, but little detailed information relating to the locations of these deposits has been published (Mansfield, 1942, pp 24-27).

Background radiation at the 500-foot flight level in areas adjacent to the alluvial deposits in the Peace River valley was about 1.25 μr/hr. The Peace River alluvium was in general slightly more radioactive than the contiguous formations, and two obvious anomalies were recorded. The peak intensities were between 2.1 and 2.5 μr/hr.

The radioactivity anomaly located north of Arcadia, DeSoto County, was investigated briefly on the ground. The investigation showed that the anomaly at this locality is due to river-pebble phosphate contained in the alluvium of the Peace River. The phosphatic nodules were found over an area of several acres on the southeast shore of the river and were concentrated in topographic lows apparently by the removal of sand by wind.

The radiation intensity in the area of the anomaly averaged about 0.03 mr/hr; background radiation was about 0.01 mr/hr. Local concentrations of phosphatic nodules showed intensities of approximately 0.05 to 0.10 mr/hr. Grab samples were collected at three such concentrations having an areal extent of as much as a few tens of square feet each. The average equivalent uranium content of the samples is 0.013 percent by beta-gamma assay.

During the course of the ground survey it was learned from local residents that at least a part of the deposit north of Arcadia was dredged for river pebble sometime before 1910.

The anomaly southwest of Arcadia is also situated in an area of Peace River alluvium. It appears likely that conditions similar to the Arcadia deposit prevail.

Dixie, Lafayette, and Taylor Counties

The area surveyed in Dixie, Lafayette, and Taylor Counties includes the lower part of the Steinhatchee River valley and immediately contiguous areas (fig. 5). The greater part of the area adjacent to the valley is underlain by the Ocala limestone (Eocene); the extreme northeastern limit

of the area includes outcrops of the Alachua formation (Pliocene) comprising largely unconsolidated sand and clay. The floor of the Steinhatchee River valley is covered by Quarternary alluvial deposits.

Nearly all of the area surveyed is within the Steinhatchee phosphate district as described by Mansfield (1942, pp 48-49), but only fragmentary information is available on deposits reported to be present in this area.

Only one anomalous area was detected by the airborne survey. It is for the most part within the limits of the Steinhatchee valley, extending along the course of the stream, from Jena, northward for a distance of about 5½ miles. The radiation intensity is relatively low; the maximum intensity was approximately 3 times the background level at the 500-foot altitude.

Lake and Orange Counties

The area surveyed in Lake and Orange Counties (fig. 6) covers a part of the Wekiva River and Blackwater Creek drainage basins. The lowland areas along these drainages are underlain by late Pleistocene marine and estuarine deposits. Higher elevations adjacent to the river valleys are occupied by the Caloosahatchee (Pliocene) marine sand and shell marl.

Pebble phosphate deposits have been reported (Mansfield, 1942, p. 6) along Blackwater Creek in the vicinity of Cassia and "north and east" of Rock Springs Run. They are said to be covered by "light overburden". No details as to the location of the deposits are given.

Anomalous radioactivity was recorded during the airborne surveys in three areas near Blackwater Creek and in one area at Rock Springs. In all four areas the surficial deposits are late Pleistocene sands and clay.

Mansfield states that the phosphate deposits are "under light overburden" presumably Pleistocene deposits. The maximum radiation intensity, about 0.8 μr/hr at 500 feet, was recorded over the Rodriguez Grant, northwest of Cassia Station.

Alachua, Columbia, and Union Counties

The area surveyed in Alachua, Columbia, and Union Counties (fig. 7) includes part of the Olustee Creek valley and contiguous areas. The southern half of the region is underlain by sand and phosphatic sandy limestone of the Hawthorn formation (Miocene); the northern part of the area is occupied by early Pleistocene marine terrace deposits.

According to reports quoted by Mansfield (1942, p. 34) rock containing an abundance of light and dark-colored phosphatic pebbles is found on Olustee Creek near Lulu. Deposits of river pebble are also said to occur along Olustee Creek but the locations of these deposits are not given.

Two anomalies were recorded during the airborne survey. One is in the Olustee Creek valley, 2 miles south of Lulu, where the surficial material is early Pleistocene sand. The other anomaly is 4½ miles south of Lulu, in the Hawthorn outcrop area. Background radiation during the airborne survey was about 0.25 μr/hr; the anomalies reached a peak intensity of about 0.75 μr/hr.

Both anomalies described above are located approximately at the level of the Wicomico shore line (MacNeil, 1949). In addition to phosphate as a possible source of the activity, the occurrence of beach concentrations of heavy minerals along the shoreline must be considered as potential source materials.

Alachua, Bradford and Union Counties

The area surveyed includes most of the southern half of Bradford County and very small parts of Alachua and Union Counties (fig. 8). The Hawthorn formation (Miocene) occupies most of the western part of the area and also crops out along the southern limit of the area surveyed. The remainder of the region is mantled by early Pleistocene sands.

A report by Sellards (1915, p. 39) states that in a deep sink about 3 miles southeast of Brooker, 39 feet of "matrix" lies beneath 37 feet of shell marl and covered slopes. Mansfield (1942, p. 6) reports an area of 16,000 acres of pebble phosphate north of the Santa Fe River between the towns of Brooker, Hampton, and Sampson.

Two airborne radioactivity anomalies were recorded, both in the vicinity of Brooker. Background radiation in the area at the 500-foot flight altitude was about 0.6 μr/hr. The maximum anomalous radioactivity was 1.2 μr/hr recorded at Brooker.

Clay and Duval Counties

The area surveyed in Clay and Duval Counties (fig. 9) is underlain by unconsolidated deposits of Miocene and Pleistocene age. The Duplin marl (Miocene) comprising argillaceous and arenaceous shell marl occupies portions of the valley of Black Creek and its south fork, in the western part of the surveyed area. Most of the eastern portion is underlain by late Pleistocene marine and estuarine deposits. A report cited by Mansfield (1942, p. 6) states that pebble phosphate under "light" overburden occurs in an area 15 miles long by 10 miles wide, with Black Creek about centrally located.

One large area of slightly anomalous radioactivity was recorded by the airborne survey. The radiation intensity is low, approximately twice the background level throughout the anomalous area; no localities of peak intensity above the general anomalous level were detected. The western portion of the anomaly is over the Duplin marl but abnormal radioactivity extends eastward into the area of Pleistocene deposits. The northern limit of the anomalous area conforms roughly to the Pamlico shoreline (MacNeil, 1949), so that the possibility exists that the anomaly may be due at least in part to beach concentrations of heavy minerals.

Madison, Hamilton and Collier Counties

The areas surveyed in Madison and Hamilton Counties, and in Collier County are shown on figure 1.

Pebble phosphate has been found at several localities between the Withlacoochee and Allapaha Rivers in western Hamilton County, bu no radioactivity anomalies were recorded during the airborne survey in this area.

Phosphate has been reported to occur near Naples, on the Gulf Coast in western Collier County, but no anomalous radioactivity was detected in this vicinity.

CONCLUSIONS

At least two of the airborne radioactivity anomalies described above have been caused by deposits of uraniferous phosphatic materials. Most of the other anomalies were detected in areas in or near which phosphate has been reported to occur, so it would appear that the anomalies are in some manner related to uranium associated with phosphatic materials.

However, it should be pointed out that, at nearly every locality at which phosphate has been reported, the material is said to be covered by as much as 50 feet of overburden. Generally speaking, if radioactive source rocks of the tenor with which we are dealing are covered by more than one foot of inert overburden, the radiation intensity should be reduced to an undetectable level at the 500 foot surveying altitude. So, if the anomalies described above are to be attributed to phosphatic materials, we must assume that 1) the deposits are at or near the surface of the ground or 2) radioactive materials are somehow being transported to surface from buried deposits.

The results of the surveys indicate that the phosphate deposits of Florida contain sufficient uranium to be detected by airborne radioactivity detection equipment provided there is some surface expression of the deposits. The significance of the radioactivity anomalies in the areas of buried phosphate deposits cannot be ascertained until adequate exploration work is undertaken.

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