UNITED STATES ATOMIC ENERGY COMMISSION

RME-4002

PRELIMINARY REPORT OF RECONNAISSANCE IN THE CAMERON AREA, ARIZONA

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June 1953
[Site Issuance Date]

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Technical Information Service, Oak Ridge, Tennessee

GEOLOGY AND MINERALOGY

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AEC, Oak Ridge, Tenn.-W37427

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IN THE CAMERON AREA, ARIZONA

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ABSTRACT

An airborne reconnaissance was conducted during the winter of 1953 in eastern Coconino County, Arizona. The area flown lies mainly in the valley of the Little Colorado River between Leupp and a point about 15 miles north of Cameron.

Triassic horizons, the Shinarump and Chinle, were the uranium-bearing formations in the area. All production at the date of this report had come from the Chinle. Anomalies found in the Shinarump were not very promising.

Chinle uranium deposits resemble Colorado Plateau deposits but contain very little vanadium and a large assortment of rarer trace elements. The deposits are usually associated with carbonaceous matter around logs or carbonaceous matter disseminated in thin beds.

INTRODUCTION

A radiometric airborne reconnaissance of the Cameron, Arizona, district was conducted in the late fall of 1952 and early winter of 1953.

Flying was carried out under the direction of the Salt Lake Exploration Branch of the Atomic Energy Commission, Division of Raw Materials. Airborne equipment and ground personnel were provided through the Technical Services Branch of the Grand Junction Exploration Division.

GEOGRAPHY

Cameron district (not an organized mining district) lies in northeastern Coconino County, Arizona, in the valley of the Little Colorado River. It is roughly co-extensive with the Painted Desert of this region. Most of the productive claims are on the Navajo Indian Reservation and within 20 miles of Cameron, which town is on U. S. Highway 89, about 50 miles north of Flagstaff.

GEOLOGY

Physiography

Cameron district lies along the southwest limb of the Black Mesa Basin where gently dipping beds of Triassic rocks form a broad valley between two cliffs. The lowermost cliff is formed by the Moenkopi formation capped with Shinarump conglomerate. The upper cliff is the Chinle formation. Between the two cliffs on the 1° to 2° slope of Shinarump and Moenkopi beds are badlands which are remnants of the Chinle Petrified Forest member. Some miles north of Cameron in the vicinity of The Gap Trading Post, the dips of the Triassic and overlying Jurassic beds become steeper. Here the several separate cliffs combine to form one -- the Echo Cliffs. Southeast from Cameron toward Winslow and Holbrook, the beds lie nearly flat, wherefore the area of possible uranium deposits is much broader. To the west and south of Cameron is the Coconino Plateau.

Stratigraphy

The stratigraphic section exposed in the Cameron district consists, in ascending order, of Kaibab limestone of Permian age, which is overlain unconformably by the chocolate-brown Moenkopi shales and sandstones. Filling channel-like depressions in the Moenkopi is the Shinarump conglomerate, and resting on the Shinarump and Moenkopi formations are the grey and pink beds of the Chinle formation. In places, especially to the south of the district, Pleistocene lava flows cover part of the area. The region between Cameron and Flagstaff is punctuated by numerous small cinder cones which mark the source of the lava flows.

URANIUM OCCURRENCES

Previous work

Discovery of uranium by a Navajo Indian, Charlie Huskon, working for the Atomic Energy Commission, two miles northeast of Cameron, early in 1952 led to the systematic prospecting of the area by the Arrowhead Uranium Company of Grand Junction, Colorado. This company, which employed Charlie Huskon as its Indian prospector, obtained a prospecting permit from the Navajo Council to stake claims on the Navajo Indian Reservation.

Production from these claims began shortly before the airborne program started. The grade of ore is low and all material to be shipped is carefully monitored with a Geiger counter to maintain the grade. All the ore shipped during the period the airborne program was in operation came from the Petrified Forest member of the Chinle formation. Some claims were staked on the Shinarump but the showings were poor and they may be abandoned.

GEOLOGY OF THE CAMERON URANIUM DEPOSITS

The uranium ore deposits at Cameron are unique in some respects although they do have several features in common with other deposits on the Colorado Plateau. One of the most generally recognized features of Colorado Plateau deposits is the association of uranium with carbonaceous matter. This is also true in the Cameron district, where partially petrified logs and thin beds of carbonaceous matter are one of the principal ore guides. Alteration, which occurs in various forms near the ore deposits of the Plateau, also indicates the possible presence of ore in the Cameron district. In the grey Petrified Forest member of the Chinle formation, the presence of uranium is indicated by a change from the characteristic grey color to a light tan or yellowish brown.

Uranium tends to occur in local basins or the bottoms of folds in Chinle. These structures are superimposed on the broad slope structure of the region, which also may have played a part in the localization of the Cameron deposits. The presence of structure or dip in the mineralized beds seems to be an important factor in other areas of the Colorado Plateau. The structures observed in the Cameron area parallel the strike of the beds. Minor structures at right angles to the strike do not carry mineralization.

The Cameron uranium deposits differ from Salt Wash and Shinarump deposits in that they occur in a silty mudstone or clay material with sand scattered through it. Although it has been known for some time that uranium occurred in the Silver Reef sandstone member of the Chinle formation, the discovery of uranium in the Petrified Forest member of the Chinle has established the Chinle as one of the important producing horizons in the Colorado Plateau, largely because of the much greater area covered by this latter member.

In the Cameron district, the Petrified Forest member lies on the Shinarump conglomerate. In some places a sandstone, which is apparently equivalent to Gregory's Chinle "D" bed, is present between the Shinarump and the Petrified Forest member. Where the Shinarump is missing, the ore horizon rests directly on the Moenkopi.

MINERALOGY OF THE CAMERON URANIUM DEPOSITS

Trace elements in the Cameron deposits differ somewhat from those in the rest of the Plateau province. Copper stain is often present but in minor amounts; it is frequently seen at Huskon No. 1 mine. In the Shinarump conglomerate, copper stains are more common but have little or no uranium associated with them. Vanadium has been recognized in a spectrographic analysis on a sample from Huskon No. 2 mine in the order of 0.01 to 0.1 percent, along with Ni, Nd, Sr, Th, Ti, Gd, Yb, Dy, Er, and Zr. Uranium in the same sample assayed a little over 14.0 percent eU_3O_8. In addition, the same sample contained 1.0 to 10.0 percent barium and 0.1 to

1.0 percent lead, manganese, yttrium, arsenic, and cobalt. It is apparent that vanadium is not important in the Cameron district. The high-grade sample from Huskon No. 1 mine, examined by the mineralogical laboratory, Division of Raw Materials, New York, was reported to consist largely of black carbonaceous material and uraninite (14.0% cU_3O_8). Pyrite, smaltite, gypsum, and calcite occurred in veinlets with abundant quartz grains. A minor amount of carnotite was also observed and a fluorescent uranium carbonate occurred superficially. Barite crystals also appeared in the sample.

In a sample from Huskon No. 2 mine, a pink material occurring in thin veinlets, which is common to high-grade specimens throughout the district, was identified by the New York mineralogical laboratory as an intergrowth of calcite and gypsum probably stained with manganese rather than cobalt.

The paragenesis of the Huskon No. 2 material is reported to be as follows; there seems to be no overlap in the sequence of deposition.

1. Plant matter
2. Pyrite
3. Uraninite
4. Carbonate
5. Gypsum, barite, smaltite
6. Secondary uranium

AIRBORNE INVESTIGATIONS

Favorable areas

As a preliminary to the proposed airborne radiometric survey of eastern Coconino County, a ground reconnaissance was made of the area by R. F. Winkle and D. C. Barrett during December 1952.

Starting near Winslow, and working north, all accessible roads were traversed and outcrops were examined to determine the stratigraphy of the area.

It became apparent that the Shinarump formation, a uranium-producing horizon in other parts of the Colorado Plateau, was non-existent throughout the southern part of the area. However, since mineralization was known to occur in the base of the Chinle formation near Cameron, it was believed that radioactive anomalies might be found in other localities of eastern Coconino County where the lower Chinle is exposed. Some Shinarump does occur in thin channel-like deposits near Cameron but is poorly mineralized.

From a point near Leupp in the Navajo Indian Reservation, the Chinle formation is exposed in a cliff face and in a broad band of badlands occupying the valley of the Little Colorado River, which runs northwesterly to an area roughly 15 miles north of Cameron. North of this area, the Chinle is exposed only at the base of a cliff which is formed by the red shales and sandstones of the Kayenta formation and the tan or reddish Navajo sandstone to make up the so-called Echo Cliffs.

A cliff face of similar lithology and age, called the Vermillion Cliff, occurs from Navajo Bridge westward and changes to a northerly direction at House Rock, Arizona. In the area near Navajo Bridge and up the Paria River at Lee's Ferry, a thick section of Shinarump conglomerate is exposed forming the cap rock on a lower bench of the main cliff.

Neither the Echo Cliff nor the Vermillion Cliff was flown under this project because of lack of time.

Some outlying areas near the Cameron district were considered favorable for airborne radiometric reconnaissance. Southwest of Winslow, two small mesas capped with volcanics were flown on the chance some Shinarump was exposed immediately beneath the volcanics. Further south, a few outlying patches of Shinarump were explored on the ground. In the vicinity of Sycamore Canyon, a similar situation exists where some Shinarump may be exposed below volcanic cappings. It was recommended but could not be flown due to lack of time.

North of Williams, between Willaha and Valle on the road to Grand Canyon, are some copper prospects in the Kaibab limestone which contain traces of uranium. This area was not flown.

Problems involved in flying the Cameron area

It was originally planned to fly all the areas listed above, but only the Cameron area and two small mesas south of Winslow were actually flown.

The Cameron area includes the Chinle cliff, starting at a point near Leupp and running northwesterly to a point about 15 miles north of Cameron, and the badlands in the valley of the Little Colorado River which parallels it. Also included in the same area are exposures of Shinarump in the vicinity of Cameron.

Because of the rather broad expanse of badlands covered by the favorable Petrified Forest member of the Chinle southeast of Cameron, the flying took considerably longer than anticipated. The extent of the favorable ground could not be determined easily from the ground reconnaissance. It was necessary to grid-fly most of this area, which involves considerably more time than rim flying.

RESULTS OF AIRBORNE RADIOMETRIC RECONNAISSANCE

Airborne radiometric reconnaissance began in eastern Coconino County late in December 1952. Flying started in the area around Leupp, northwest of Winslow and continued northwestward toward Cameron. The program was completed on March 2, 1953.

Anomalies were found at two horizons, the Petrified Forest member of the Chinle and the Shinarump conglomerate, both of Triassic age. When the Atomic Energy Commission ground parties first entered the area, uranium was being produced from the Chinle but the Shinarump had no promising showings. Showings of mineralization known then in the Shinarump consisted mostly of copper stain with only a little anomalous radioactivity.

Altogether, 43 anomalies were reported as a result of the airborne work. (See attached map). In one place about 15 miles north of Leupp, the anomalies were so numerous, small, and close-spaced, that the entire area, about one-half mile long and one-fourth mile wide, was designated as a single anomaly. However, wherever practical, individual anomalies are differentiated on the map.

It is possible that some of the 43 anomalies had already been located by the Arrowhead Uranium Company, which was the only company active in the area before the Atomic Energy Commission program began. However, any anomaly which had prospect pits or monuments on it was eliminated from the official anomaly map. Some of the small, not too promsing anomalies may have been discovered before the Atomic Energy Commission found them, and because of their poor production possibilities were not staked, in which case they would be included on the anomaly map.

Characteristics of Chinle anomalies

One of the most common type of anomaly in the Chinle consists of a broad zone enclosing a cluster of radioactive fossil logs with aureoles of radioactive clayey sand around them. The radioactive zones generally lie in a bleached or altered area where the characteristic grey color of the lower Chinle is changed to light tan or yellowish brown. The typical topographic site of this type of anomaly is in badlands or occasionally broad mud flats. The high-grade mineralization occurs in logs, or occasionally stumps, surrounding which for a distance of one to several feet is a zone of disseminated low-grade material. Anomalies of this type can be expected in many cases to contain a few tons of workable ore. However, selective hand mining is necessary to prevent dilution. Huskon No. 2 is this kind of deposit.

Another type of anomaly similar to and often associated with the first type consists of carbonaceous material in thin beds or seams. Occasional fragments of woody material contain high-grade uranium. However, most of

the ore in this type of deposit lies in thin beds which thicken in places to form fairly large workable deposits. Most of the production in the Cameron area has come from this kind of deposit, of which the Huskon No. 1 is the best example.

A third type of anomaly, found in association with the log type of deposit, is in hard, brittle jasperoid slabs red to brown in color which are weathered out on the surface. They contain no aureole of mineralization in the sand around them and show no uranium minerals. Anomalies of this type will probably not lead to workable uranium deposits.

Characteristics of Shinarump anomalies

The Shinarump anomalies all fall into one type. Anomalous radioactivity occurs in fossil wood buried in flaggy or cross-bedded coarse-grained, well cemented sandstone in layers ranging from 1 to 10 feet thick. They are often underlain by a variegated mudstone which in some places shows a chunky parting. At one anomaly, the mineralization extended down into the underlying Moenkopi formation.

Assays from high-grade grab samples taken from the Shinarump anomalies ran from a trace to 0.22 percent cU_3O_8; the average was about 0.02 to 0.03 percent cU_3O_8. Almost all of the samples contained some vanadium. Generally, the vanadium content is a little higher than the uranium content in the same sample.

SUMMARY

Further work in the Cameron area will be supervised by the Grand Junction Exploration office. Most exploration to be done now will be on a local scale and will consist of drilling favorable claims.

In the area between the Chinle and the Moenkopi cliffs there seems to be no need for further reconnaissance. The area has been thoroughly explored by the Arrowhead Uranium Company, the Atomic Energy Commission, and a few other private concerns.

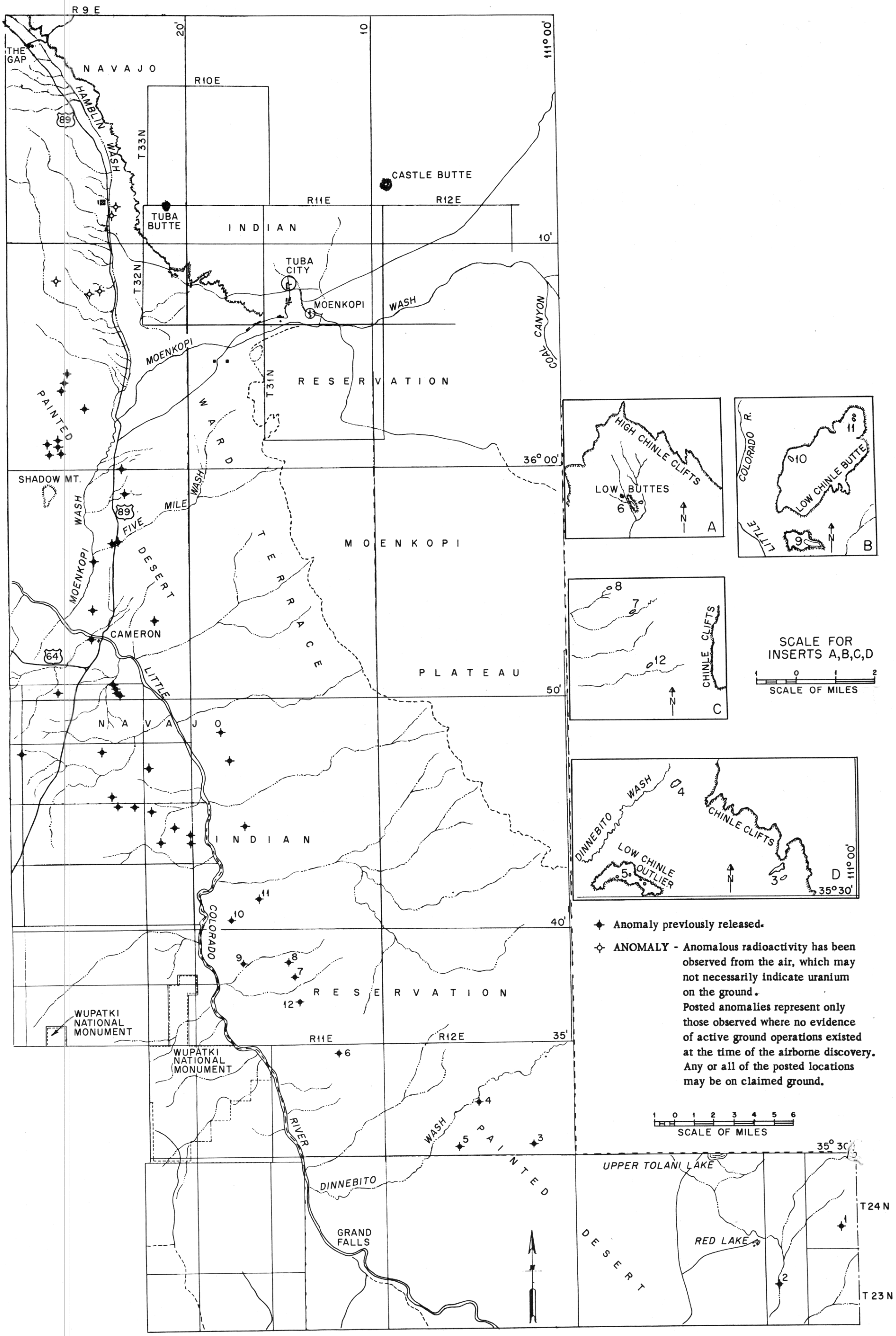

Fig. 1—Airborne anomaly location map, Cameron Area, Arizona.