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RME-4514

RECONNAISSANCE FOR URANIUM IN THE OLMOS DISTRICT, NORTHERN PERU

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October 1957

Division of Raw Materials, AEC
Washington, D. C.

and

Junta de Control de Energia Atomica
Lima, Peru

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U. S. ATOMIC ENERGY COMMISSION
DIVISION OF RAW MATERIALS
IN COOPERATION WITH THE
JUNTA DE CONTROL DE ENERGIA ATOMICA DEL PERU

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RECONNAISSANCE FOR URANIUM IN THE
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ABSTRACT

In 1957 lithologic studies, a radiometric survey, and general geologic mapping in the Olmos district of northern Peru were conducted in search of favorable host rocks for uranium. This district lies in the Cordillera Occidental, and includes small portions of the departments of Piura, Cajamarca and Lambayeque.

The rocks studied included Paleozoic schists, Triassic and Jurassic sediments and volcanics, and Cretaceous sediments, which have been intruded by igneous rocks of the dacite-quartz diorite and andesite-diorite clans. The region has undergone several stages of subsidence, uplift with associated folding and faulting, and erosion, resulting in a broad faulted anticline and two major unconformities. Two major joint patterns are present, trending northeast-southwest and northwest-southeast.

There is some indication that mineralizing solutions may have passed through the northeast-southwest joints, but none of the rocks examined is considered favorable for uranium occurrence, and further investigation of the area is inadvisable.

INTRODUCTION

The purpose of the investigation was to determine whether geologic conditions favorable for the occurrence of uranium-bearing minerals existed in the areas adjacent to small Cretaceous and Tertiary intrusives in northern Peru. The reconnaissance was done between August 14 and September 5, 1957, and covered about 3500 square kilometers.

Topographic maps on a scale of 1:200,000 were used as base maps; these were studied in conjunction with the geologic map of Peru (Bellido, Narvaez and Simons, 1956) prior to departure for the field. Major contacts were sketched on the base maps, using topographic contours to aid in placing contact zones. It was assumed that the northwest-southeast and northeast-southwest drainage patterns expressed the predominant structural trend of the area and that the streams occupy fracture zones; therefore, reconnaissance was planned to emphasize work in the northeastern part of the region where the Triassic and Jurassic rocks cropped out and were cut by the predominant structural pattern.

Geography

Location and accessibility

The area lies in northern Peru in the departments of Piura, Cajamarca and Lambayeque (fig. 1). The nearest important town, Chiclayo, has no railroad connection but is served by Faucett Airlines; it also is on the North Panamerican Highway and only 13 kilometers from Puerto Etén on the Pacific Ocean. A graded road, joining the North Panamerican Highway 106 kilometers north of Chiclayo, passes through the area. The road is dry and dusty in winter but impassable during the rainy summer season. Areas away from the road were reached on mules and on foot.

Topography, vegetation and climate

The two major topographic features are a low rolling plain in the west and high mountains on the east. The plain lies at about 200 meters above sea level, with small hills up to 1200 meters in elevation. The mountains rise to about 4000 meters, and the many streams which cut through to the Pacific Ocean have their sources here. The crest of the mountain system forms the Continental Divide in this part of Peru, and is about 120 kilometers from the Pacific. The youthful mountain system has produced extreme relief, which makes working conditions difficult; and travel is restricted to the roads and a few trails.

Four distinct climatic zones exist: (1) on the extreme west is the Sechura Desert having neither rainfall nor vegetation; (2) on the western slope of the mountain rainfall is abundant during the summer, and vegetation is heavy; (3) the mountain crest and part of the eastern slope have a typical Andean climate, with rainfall during the summer and vegetation consisting of short grasses and shrubs; and (4) at the lower elevations to the east where summer rainfall is heavy in the hilly country and vegetation is luxuriant, but rainfall is less abundant in the valleys where vegetation consists of grasses and cacti. In some parts of the area machetes are required to cut through the undergrowth.

Water is scarce on the western flank of the Continental Divide, and the streams are seasonal in flow. All available water has been allotted to the farmers in the district, and it is controlled strictly by the "water rights" law. Many wells supply water for irrigation and domestic use; however, because of the heavy withdrawal the water table has fallen, and the initial output has decreased. On the eastern side of the Continental Divide there are more streams, and the available water is more than adequate for power and domestic purposes.

Good rock exposures are rare as a heavy soil mantle and thick debris hide and obscure many outcrops. The best exposures are found along streams, trails and roads. In the valleys landslides occur frequently, and it is sometimes difficult to determine whether an outcrop is in place or was brought in by a landslide.

Exploration and mining history

The region was explored by the Spanish colonists searching for gold and silver, and later by prospectors seeking base-metal ores. There are no producing mines and only a few prospect pits. A 1956 airborne radiometric survey by geologists of the U. S. Atomic Energy Commission and the Junta de Control de Energía Atómica de Peru detected no anomalous radioactivity.

Acknowledgements

The writers wish to thank the members of the Civil Guard and other government employees who assisted in obtaining animals and guides, as well as the many local inhabitants who provided useful information on the area.

GENERAL GEOLOGY

Figure 2 is a generalized geologic map of the Olmos district in which sedimentary rocks represent an incomplete stratigraphic section of Mesozoic deposition. The exact ages and regional correlation of the Triassic-Jurassic sedimentary and volcanic rocks and the Cretaceous sedimentary rocks are unknown. The Triassic-Jurassic rocks are separated from the Paleozoic metamorphic rocks by an angular unconformity which was not traced out in detail. In most instances, the basal portion of the Triassic-Jurassic series contains fragments of Paleozoic metamorphic rocks; this suggests that the surface between the Triassic-Jurassic rocks and the Paleozoic metamorphic rocks was a topographic feature with considerable relief rather than a peneplane. The contact zone between the Triassic-Jurassic series and the Cretaceous sedimentary rocks was obscured by debris.

Sedimentary and extrusive igneous rocks

Triassic-Jurassic

Bellido and Simons (1957) measured a section along the Río Leche, adjacent to the southwestern part of the mapped area. This section consisted of 2700 meters of volcanic tuffs, agglomerates and flows interbedded with impure marine limestones and shales; it was studied in greater detail than the other systems in the area although all the outcrops could not be investigated within the limited time allotted to the project.

A traverse from Saulaca on the Rio Huancabamba, in the northeastern part of the area, to San Felipe cut across the strike of the Triassic-Jurassic rocks from the Paleozoic metamorphic rocks to the Cretaceous sedimentary rocks (see appendix for a detailed lithologic log along this route). No one type of rock predominates, and the thickness of the units ranges from less than 1 meter in shales to 100 meters in white volcanic tuffs.

Figure 2

GENERALIZED GEOLOGIC MAP OF OLMOS DISTRICT

The Triassic-Jurassic system was observed in other localities in the southeastern and southwestern parts of the area, but no correlation could be made with the principal section. It is believed that horizontal as well as vertical changes occur in the Triassic-Jurassic system; if this is correct, it would indicate the oscillatory nature of the Triassic-Jurassic seas in this area.

Limestones are the most abundant of the sedimentary rocks; they range from black to white and are only a few meters thick. They grade from hard and siliceous to soft and marly, and probably were deposited under shallow, stagnant marine conditions. Shales and sandstones form only a minor part of the Triassic-Jurassic system. The very siliceous shales range from white to black and from soft and friable to hard and brittle. Most of the sandstones are fine grained, well sorted and well cemented, and are white to pink. In one thin sandstone bed the grains appeared to be frosted, denoting wind abrasion. Since no crossbedding was observed, it is possible that the particles were transported by wind but were deposited in a marine environment.

Fragmental volcanic ejecta in this section are represented by andesite tuffs and agglomerates; they are more abundant in the upper part but are found throughout the stratigraphic column. The most distinctive unit is a white tuff interbedded with shales and gray limestones; it is about 100 meters thick and was not observed elsewhere in the region. The agglomerates contain a large amount of hematite, both as cement and as a constituent mineral. The agglomerates are well cemented and range from red to black.

Cretaceous

Only the lower part of the Cretaceous stratigraphic section was examined; this was just east of San Felipe (fig. 2) where a 4-kilometer traverse was made. Cretaceous rocks consist of limestones, marls, shales and sandstones. The limestones range from white to black and from pure to siliceous; the siliceous limestones sometimes contain pyrite. The marls are white to tan and are interbedded with red and gray shale lenses which may contain nearly pure calcite concretions. Shales are less abundant and mostly black, thin bedded and carbonaceous, with small siliceous concretions and thin seams of calcite. The light-colored sandstones are clean, well sorted and cemented, and fine to coarse grained, with well-rounded quartz grains. They show no crossbedding or stream channels, and contain no carbon trash, mudstone or pyrite.

Metamorphic rocks

Large areas of schists are exposed throughout the mapped region; their exact age is unknown, but most writers place them in the middle Paleozoic. The schists are dark gray green, very hard and compact; with their high content of quartz in veinlets and augen, they are classified as quartzose schists. The quartz veinlets cut across the planes of schistosity in

whorls and straight lines, and the quartz augen lie in the planes of schistosity, giving the rock a knotty appearance. In rare instances, in the western part of the district near the Panamerican Highway, there are small areas in which the metamorphic rocks closely approach talc schist; their stratigraphic position is near the base of the Triassic-Jurassic sedimentary-volcanic series.

Very little quartzite was found; it was restricted to small lenses within the quartzose schist. On the plain to the east of Motupe this schist is cut by numerous small dikes which radiate from common centers and, owing to their resistance to erosion, form small, well-rounded hills. The mountain front to the east is composed of Triassic, Jurassic and Cretaceous sediments, and the schist does not occur here. The plain that lies on the Paleozoic schist could be the old erosional surface of the Paleozoic unconformity that has been uncovered by erosion. Outliers of Triassic-Jurassic rocks cap small hills to the west of this plain and have preserved the contact zone, which is at about the correct elevation for a western continuation of the Paleozoic erosional surface.

Intrusive igneous rocks

Igneous rocks within the section between Sualaca and San Felipe are acidic to intermediate; andesite is the predominant type. Both felsitic and porphyritic textures were observed. The felsitic rocks are probably syngenetic with the sediments, while the porphyritic rocks represent later intrusions in the form of dikes and sills. Along the main traverse highly altered granodiorite was observed within the Triassic-Jurassic rocks, but its true relation to them could not be determined.

There are three large Cretaceous-Tertiary intrusives in the Olmos district; only the two northern plutons were examined. A cross-section through these plutons, using the car odometer and topographic maps for control, is shown in figure 3. The plutons consist chiefly of diorite porphyry with a high biotite content, and probably constitute a single body at depth; they can be termed stocks. In the easternmost stock several well-defined cupolas project upward as fingers into the Paleozoic quartzose schist. The diorite porphyry makes contact principally with the Paleozoic schist and the Triassic-Jurassic sedimentary-volcanic rocks. On the west side of the western stock the contact is with a highly altered, friable, coarse-textured quartz diorite which may be a remnant of an older intrusion. Small bodies of the same quartz diorite along the Río Huancabamba have been intruded by an andesite porphyry dike. A small pluton of dacite porphyry is about 10 kilometers east of Olmos, along the Río Olmos, and is a separate intrusion. It is dated as Tertiary by Bellido and Simons (1957).

Along the Río Tacto north of Olmos the authors examined a small stock of diorite porphyry which is similar to the larger stocks to the southeast and appears to be part of the same intrusion. Many dikes and small plutons

Figure 3

GENERALIZED SECTION THROUGH MAPPED AREA

were observed along the peripheries of the stocks extending into the surrounding formations. These dikes and stocks penetrate all the sedimentary, metamorphic and igneous rocks in the region; they trend northwest-southeast and northeast-southwest, but the strike of an individual dike varies within these patterns. The rock types in these apophyses include andesite, andesite porphyry, quartz monzonite porphyry, dacite, dacite porphyry, and possibly trachyte. On the eastern side of the Continental Divide the small intrusives have a hematite content higher than normal.

Structure

Figure 2 shows that the major structural feature is an anticline, with an axial trend of N. 40° W. On this complex structure are superimposed smaller anticlines and synclines. Cretaceous-Tertiary intrusives occupy the nose and axial line of the anticline and the nose of the adjacent syncline. Normal faults with varying dips and low-angle thrust faults were observed. A normal fault between Saulaca and San Felipe strikes N. 45° E. and dips 25° SE.; it is on the eastern limb of a small anticline whose axis nearly parallels the fault line. The fault zone is marked by a small valley occupied by one of the tributaries of the Río Huancabamba. Abundant limonite occurs in the fault gouge where the hanging wall is exposed. There are several small faults along the lower part of the Río Huancabamba; in all cases the east side of the fault is the downthrown block. At the extreme eastern edge of the mapped area the road cuts through a section of an overthrust fault plane, trending N. 5° W. and dipping 20° W. In this fault andesite is thrust over the Triassic-Jurassic sedimentary-volcanic series.

Too few joints were measured to establish definitely the relations between structure and the direction of the forces that effected folding and uplift. Those joints that were observed showed two definite patterns: in the sedimentary rocks northwest-southeast and northeast-southwest trends seem to be the major joint pattern; in the intrusive bodies a conjugate pattern with a north-south trend was observed. Regional streams have trends nearly identical to those of the sedimentary joints, and probably their initial emplacements were structurally controlled by this joint pattern.

Geologic history

Northern Peru was a stable landmass during the early Paleozoic era. No sedimentation occurred until the middle Paleozoic when clastic sediments, derived from a landmass to the west of the present Pacific coastline, were deposited. It is the authors' belief that the Paleozoic schists now present are only a part of a much thicker sequence of sediments deposited during the Paleozoic and indurated, uplifted and eroded before deposition of the Mesozoic sediments. These events are represented by the angular unconformity between the Paleozoic schists and the Triassic-Jurassic series. Metamorphism of these sediments probably was well advanced prior to the beginning of the Mesozoic and was completed before the start of the Cretaceous period.

Triassic-Jurassic seas advanced from the south, but the inundation never was complete or prolonged. The volcanic and clastic debris evidently came from the west. The igneous flows in the Triassic-Jurassic series are likely an expression of the worldwide Nevadian orogeny, which in the Western hemisphere was accompanied by intense igneous activity. This orogeny uplifted the continental landmass, subjecting it to erosion prior to the transgression of the Cretaceous seas.

The first complete inundation of the Andean geosyncline occurred in the Cretaceous. This geosyncline was connected with other geosynclines in North America (Steinmann, 1929). The heterogeneity of the sediments indicates that the seas were cyclic. At times abundant vegetation covered the landmass and was present in the near-shore stagnant waters; coal beds and carbonaceous shales formed in these at the later date. The end of the Cretaceous period was gradual, the continental mass rising slowly with only minor folding, which Steinmann (1929) calls "Peruvian Folding." This was followed by a period of quiescence during which the early Eocene sediments were deposited along the coast and in the interior basins of the continent.

The "Inca Folding," correlating roughly with the Laramide revolution, began in the late Eocene with strong compression and folding of the sediments. During this time the Cretaceous-Tertiary intrusions, which may have been triggered by the Peruvian Folding, were fully developed and emplaced. The ultimate formation of the Andean mountain system was accompanied by the "Quichano Folding" in the late Miocene or early Pliocene, which uplifted the Andes to their maximum height. Subsequent erosion and glaciation shaped the present topography.

Mineralization

Mineralization is restricted to a few base-metal deposits, which were not examined in this survey. The joints and fractures showed little evidence of having served as conduits for mineralizing solutions. Both the sedimentary and igneous rocks in the eastern part of the area had a very high content of hematite, but the distribution was general; we observed no hematite haloes around a mineralized zone.

The two mines in figure 2 were located through information obtained from inhabitants of the region. Samples from the northern mine contain small amounts of chalcopyrite, pyrite, galena and limonite. The azimuth of a line connecting the prospects is N. 30° E., which coincides with one of the dominant joint patterns in the sedimentary rocks and with the trend of the streams. The joint pattern here may have been sufficiently open to serve as a conduit for solutions containing small quantities of metals.

SUMMARY

In February 1956 a airborne radiometric survey from Olmos eastward across this area disclosed no abnormal radioactivity although the background count varied over the different types of rock.

In our investigation of the Olmos district's uranium potential the authors sought a favorable host rock with stratigraphic and sedimentary structures that could have served as conduits and traps for mineralizing solutions and precipitated uranium ions therefrom. The rocks examined lacked such features, and there was no evidence that any highly concentrated mineral-bearing solution was associated with the local intrusions. No additional work in the work is recommended unless it is desired to establish conclusively whether the joints in the Mesozoic rocks, especially the Cretaceous sediments, served as conduits for mineralizing solutions.

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APPENDIX

Generalized lithologic log of principal Triassic-Jurassic sedimentary-volcanic section between Sualaca and San Felipe

1. Black to gray impure limestone
2. Multicolored siliceous shale cut by quartz monzonite dike
3. Black to grayish-brown shale and interbedded limestone; shale very compact and brittle
4. Thin-bedded, white marly limestone
5. Yellow to brown cherty limestone
6. Gray andesite flows
7. Red to purple volcanic agglomerate
8. Black limestone
9. Red to dark-gray siliceous shales with some hematite stain and calcite fracture-fillings
10. Gray-green siliceous shale
11. Very fine-grained red sandstone
12. Gray to white limestone
13. Weathered granodiorite
14. Gray to tan limestone and interbedded shale
15. Pink volcanic tuffs
16. Light-gray to brown siliceous shales
17. White volcanic tuffs, gray siliceous shales and dark-gray limestone
18. Tan to light-gray limestone and brown tuffs with calcite concretions and hematite stain
19. Gray andesite flows
20. Dark-gray to black volcanic agglomerate with andesite flows

21. Fine-grained white to tan sandstone, well cemented and well sorted, with frosted quartz grains
22. Andesite porphyry
23. Interbedded gray-brown siliceous shales and trachyte flows
24. Fine-grained quartz sandstone
25. Gray volcanic agglomerate
26. Rhyolite porphyry, agglomerate, fine-grained sandstone and andesite flows.