RECONNAISSANCE FOR URANIUM IN THE IQUIQUE AREA, PROVINCE OF TARAPACA, CHILE

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October 1958

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ABSTRACT

The Iquique area of northern Chile was investigated for uranium in 1958 by personnel of the Instituto de Investigaciones Geológicas de Chile and the U. S. Atomic Energy Commission. The bedrocks are Jurassic marine and continental sedimentary rocks and interstratified andesitic volcanics intruded by the Andean diorite complex. The rocks are cut by major north-trending faults as well as by east-trending faults, andesite dikes, and veins. The radioactivity of all rock units was low, with the highest reading associated with a cupiferous manto in limestone. Additional exploration in the Iquique area probably is not warranted.

INTRODUCTION

The Iquique area, Province of Tarapacá, Chile, was investigated for uranium in August 1958 by geologists of the U. S. Atomic Energy Commission (USAEC) and the Instituto de Investigaciones Geológicas de Chile (IIG) under a cooperative agreement between the United States and Chile.

The area was selected for uranium reconnaissance on the basis of favorable geologic features noted through literature research (Hague, 1958). The seven days of field work was done by two parties, each equipped with four-wheel-drive vehicles. The work center was Iquique. Liberal use was made of aerial photographs of the U. S. Army Map Service Tri-Metrogon type. Both scintillation and Geiger counters were used in the work.

This exploratory work was undertaken as a preliminary evaluation of the area's uranium potential, and was limited to reconnaissance for favorable geologic indications of uranium, which included visits to selected localities and mining districts.

Geography

Location and accessibility

The Iquique area (fig. 1) in the Department of Iquique, Province of Tarapacá, Chile, is bounded by latitudes 20° 00' to 20° 30' S. and longitudes 69° 45' to 70° 10' W. The coastal port of Iquique, accessible by boat, plane, rail or auto, is near the center of the western boundary of the rectangular,
Figure 1. Index map, Iquique area, Province of Tarapacá, Chile

Figura 1. Mapa índice, área de Iquique, Provincia de Tarapacá, Chile
north-elongated 40- by 50-kilometer area. A network of roads and quebrada trails fan out in the high ground east of Iquique making the area readily accessible by four-wheel-drive vehicles.

**Topography, vegetation and climate**

Elevations in the Iquique area range from sea level to 1500 meters in the coastal mountains. The western slope of the mountains is steep; a vertical relief of 700 meters is common over a horizontal distance of 2 kilometers. The coastal mountains, in an early mature stage of erosion, slope gradually to the east and merge into the broad, rainless Pampa del Tamarugal, a true desert, the western margin of which marks the eastern limit of figure 2. The entire Iquique area has only sparse vegetation and precipitation is negligible, being measurable only over a span of many years. The climate is hot in summer and cool in winter; strong westerly winds are common, and the area is subject to coastal morning fogs. Drinking water is provided by a pipeline running to springs located at Pica, on the eastern edge of the Pampa del Tamarugal 80 kilometers to the east. Rock exposures are good only in the mountains, as alluvium fills the broad Coast Range interior valleys and extends well up on the slopes in merging alluvial fans.

**Exploration and mining history**

The Iquique area is known principally for the Bonanza Huantajaya silver mines located in the Coast Range, 7 kilometers east of Iquique. These mines were extensively worked to the close of the 18th century, then reopened in 1873 and produced for an additional 50 years. Two other groups of silver mines formerly prominent are the Santa Rosa, 13 kilometers southeast of Iquique, and the Huantaca, 6 kilometers northeast of Iquique. Unlike most silver districts in Chile, there are relatively few other silver, silver-copper, or silver-lead mines in the area and only three small, locally known former copper producers: the Reginas, the Isabel and the Abundancia. There is at present no organized metal mining in the area.

**Acknowledgements**

The writers wish to acknowledge the kind assistance of several persons who supplied valuable map information, guidance and personal knowledge. Among these are Srs. Carlos Mordojovic K., Ramon Laval and Giovanni Cecioni, all of the Empresa Nacional del Petroleo, Iquique. Sr. Mordojovic kindly supplied the writers with the geologic information on which most of figure 2 is based. Aid was also furnished by Srs. Oscar Flores, Humberto Lizardy, Orlando Gaete, Alberto Weidmaier and Luis F. Buch of the Corporacion de Fomento de la Produccion (CORFO), Iquique. Sr. Flores' interest in and knowledge of radioactive minerals and occurrences in this area was of great help to the writers.
GENERAL GEOLOGY

Stratified rocks

The stratified volcanic and sedimentary rocks shown in figure 2 are dated as Middle and Lower Jurassic on the basis of fossils collected by geologists of the Empresa Nacional de Petróleo as well as by a geologic study of part of the area (Biese, 1956). Marine sedimentary rocks are well exposed in the western half of the outcrop area and include limestones, impure limestones, mudstones and sandstones.

Andesitic volcanic rocks include mainly gray, brown or red-gray porphyries and breccia with occasional units of interstratified continental tuffaceous sandstones and tuffs.

Locally near the contacts of the sedimentary rocks with the Andean diorite, contact metamorphism has produced skarn zones in limey rocks, mica and mudstones, and recrystallized quartz in sandstones.

Recent alluvium is widely exposed in fans, intermontane valleys and the interior desert.

Intrusive igneous rocks

The plutons shown in figure 2 intrude the Jurassic rocks and have been correlated with the widespread Andean diorite complex. The intrusions range in composition from granodiorite to diorite, are medium to coarse grained, gray to reddish gray, and of both Late Jurassic and Middle Cretaceous ages.

Structure

The Iquique area is characterized by a broadly linear north alignment of stratification with a prominent warp to an easterly trend in the center of the area, major faults of a north trend, and minor faults and veins of a general west trend. The faults shown in figure 2 were studied by Biese (1956). It is interesting to note that most of the mines in the area, including the important ones, occur in the warped, structurally disturbed zone.

RECONNAISSANCE FOR URANIUM

Prior to our visit there had been no reports of uranium occurrences in the area. After the writers arrived in Iquique, Sr. Oscar Flores of the CORFO staff informed us of the presence of radioactivity in the San Oscar mine, 30 kilometers northeast of Iquique; this was the first reported occurrence of radioactivity in the area.

Most of the usable roads and jeep trails were traversed in the reconnaissance, with the objectives of determining the radioactivity and character
of rock units, contacts, structures and metallization. There were no pro-
nounced variations in background radioactivity but, in general, mineralized
structures within the intrusions and their contact zones were slightly more
radioactive than the average. The radioactivity of the rock units and their
mineralized structures is given below.

Radioactivity (in milliroentgens per hour)

<table>
<thead>
<tr>
<th>Rock type</th>
<th>Background radioactivity (range)</th>
<th>Radioactivity of mineralized structures</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alluvium (including salitre deposits)</td>
<td>0.003 - 0.006</td>
<td></td>
</tr>
<tr>
<td>Intrusions (Andean diorite)</td>
<td>0.005 - 0.01</td>
<td>0.01 - 0.025</td>
</tr>
<tr>
<td>Metamorphic rocks</td>
<td>0.004 - 0.007</td>
<td>0.007 - 0.1</td>
</tr>
<tr>
<td>Volcanic rocks</td>
<td>0.003 - 0.006</td>
<td>0.005 - 0.01</td>
</tr>
<tr>
<td>Marine sedimentary rocks</td>
<td>0.004 - 0.006</td>
<td>0.005 - 0.009</td>
</tr>
<tr>
<td>Continental clastic sedimentary rocks</td>
<td>0.004 - 0.006</td>
<td>Not observed</td>
</tr>
</tbody>
</table>

**Santa Rosa district**

The Santa Rosa district is 13 kilometers southeast of Iquique. The
bedrock is north- to east-trending Jurassic limestone with minor chert,
mudstones and sandstones interbedded with andesite porphyry, tuffaceous
sandstones and volcanic breccias. The rocks are cut by east-trending
andesite dikes, veins and faults. Mine workings consist of extensive sur-
face diggings, an old plant site, at least five surface-collared shafts, and
crosscuts. Limestone is the favored host for rich deposits of silver minerals,
the principal mine product. None of the mineralized structures nor specimen
ore samples displayed radioactivity significantly above normal background for
the rocks. The maximum radioactivity recorded was 0.008 mr/hr.

**Huantajaya district**

This district includes a famous group of bonanza silver mines located
7 kilometers east of Iquique. A cluster of abandoned surface and underground
workings covers an area of approximately one square kilometer. East-striking
limestones, minor interbedded mudstones, and andesite porphyries have been
mineralized along east- to northeast-trending veins. Andesite dikes of east
trend are also present. Limestone is the host for rich shoots of native
silver, cerargyrite and embolite. Copper, another mine product, was taken
principally from separate, though parallel, veins. No radioactivity above
0.008 mr/hr was encountered in vein structures, dumps or small scattered ore
piles.
Huantaca district

The Huantaca district is approximately 5 kilometers northwest of the Huantajaya. Faults of north trend cut limey sandstones and impure limestone, and host silver and copper minerals. The Huantaca mine is reported to have produced cobalt, but none was seen in the dumps, ore piles or workings. No radioactivity above 0.007 mr/hr was observed.

San Oscar-Regina district

This district is 30 kilometers northeast of Iquique and 5 kilometers southwest of Cerro Constancia. It is reached by a 20-kilometer dirt road running north from the railroad-highway crossing, which is 2 kilometers north of Cerro La Isla, shown near the center of figure 2.

The bedrock is a garnetized and silicified impure limestone in a contact-metamorphic zone bordering an intrusion of Andean diorite, which crops out half a kilometer to the east. The district includes four surface copper prospects in a linear arrangement over 2 kilometers. The Regina mine, an abandoned copper producer, is at the south end of the group and consists of numerous shallow surface workings and irregular, shallow underground openings. Secondary copper minerals, along with iron oxides, quartz, gypsum and calcite, occur near the crest of an anticline as "mantos," which are conformable with the generally flat bedding here. The prospects follow the north-trending axis of the fold in a linear arrangement. The mineralized manto zone appears to be more or less continuous over the 2-kilometer distance and ranges from 0.30 to 0.61 meters in thickness. The mineral occurrences are of a replacement type, associated with hematitic and limonitic iron. The manto is locally broken by north-trending faults. Radioactivity is associated directly with the copper and ranged from 0.01 to 0.1 mr/hr, with the average being 0.07 mr/hr. No uranium minerals were observed, although the geologic occurrence suggests the possibility of uranium mineralization. Samples taken from the deposits are too low in radioactivity to be useful for chemical analyses.

Other localities

Cerro Constancia intrusion: The Cerro Constancia pluton, east of the San Oscar-Regina district, is the largest mass of Andean diorite in the Iquique area. The intrusion and its contacts with Jurassic sedimentary rocks were traversed; the radioactivity ranged from 0.005 to 0.007 mr/hr.

Pampa Perdiz: The road running north from the Huantajaya mine passes two exposures of Andean diorite. The radioactivity of the small mass exposed in Cerro El Toro was 0.01 mr/hr, higher than that of other intrusions in the area. Tourmalinized zones registered up to 0.025 mr/hr. North of Cerro El Toro quartz stringers in metamorphosed volcanics read up to 0.03 mr/hr.

A small copper prospect on a west-trending shear at the diorite contact, 3 kilometers east of Iquique, registered 0.02 mr/hr.
Huemul area: Traverses in this area, 10 kilometers southeast of Santa Rosa mine, disclosed scattered outcrops of friable sandstone. These rock units were very low in radioactivity, approximately 0.004 mr/hr.

Ore piles at the Caja de Crédito de Fomento Minero buying station at Iquique and mineral collections at the CORFO offices were not anomalous.

In the course of this reconnaissance the radioactivity level for an exposure of Andean diorite at Pisagua, 70 kilometers to the north of Iquique, was checked and found to be the same as the plutons in the Iquique area -- 0.005 to 0.01 mr/hr.

CONCLUSIONS

On the basis of this reconnaissance the following observations are made:

(1) Intrusive bodies and their contacts, where checked, do not display significant radioactivity; the maximum reading recorded was only 0.01 hr/hr. This might indicate that the Late Cretaceous to early Tertiary intrusions in this area were low in original uranium content.

(2) No significant radioactivity was found in the volcanic, sedimentary (including continental-type sandstone), or metamorphic rock units checked.

(3) The highest radioactivity observed in the area - 0.10 mr/hr - is associated with a cupriferous manto zone in metamorphosed limestone. This amount of radioactivity, although ten times greater than the highest background level of radioactivity observed for any rock unit in the area, is not significant in terms of uranium potential, as there are no local "hot spots" that might suggest the presence of commercial-grade uranium. This occurrence of moderate radioactivity in a metallized zone is unusual - the only one observed in the area. Other mineralized structures had a maximum of only 0.025 mr/hr, with an average of less than 0.01 mr/hr.

Our preliminary work suggests that, although favorable host rocks, structure and metallization are present in the Iquique area, the mineralizing solutions generally lacked uranium ions. Therefore, additional uranium reconnaissance in the area is probably not warranted.
SELECTED REFERENCES


Figure 2. Geologic sketch of Iquique area, Province of Tarapaca, Chile

Figure 2. Bosquejo geológico del área de Iquique, Provincia de Tarapaca, Chile

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IG de Chile: Mario Serrano C. and Erik Klohn H.

Legend

- Quaternary: Alluvium
- Cretaceous: Cretaceous rocks
- Jurassic: Jurassic rocks
- Ao: Mine showing mineral produced
- Fault: Fault line
- Strike and dip of strata—low angle: Strike and dip of strata
- Strike and dip of strata—high angle: Strike and dip of strata
- Road: Road
- Railway: Railway
- Trail: Trail

Geology modified from maps of:
1) Empresa Nacional del Petróleo, Iquique
2) Walter A. Biese (1956)

Topography: Instituto Geográfico Militar de Chile

Map No. 2070

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