DEPARTMENT OF THE INTERIOR

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Road reconnaissance of anomalous radioactivity in the Early Proterozoic Roraima Group near Santa Elena de Uairen, Estado Bolivar, Venezuela

by

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INTRODUCTION

Radioactive anomalies are known in several regions of Venezuela and occurrences of uranium are known in clastic rocks of Jurassic age in western Venezuela; however, there are no uranium deposits in Venezuela (Rodriguez, 1986). The International Uranium Resources Evaluation Project (1980) considered the Early Proterozoic Roraima Group as a possible setting for Proterozoic unconformity and quartz-pebble conglomerate deposits. Apparent similarity of the geologic setting of the basal Roraima Group of southeastern Venezuela to unconformity U-Au deposits and quartz-pebble conglomerate Au-U deposits indicates that the Roraima Group may be an exploration target for uranium. This study reports the results of a carborne scintillometer survey and analyses of samples taken in basal units of the Roraima Group exposed in roadcuts north of Santa Elena de Uairen in southeastern Venezuela.

This reconnaissance was conducted during regional fieldwork in southeastern Venezuela in April 1988. This work was part of the five-year Venezuelan Cooperative Project, which began in 1987, between the Corporacion Venezolana de Guayana-Compania Tecnica Minera, C.A. (CVG-TECMIN) and the U.S. Geological Survey.

REGIONAL GEOLOGY

Sedimentary rocks of the Roraima Group were deposited in fluvial, deltaic, shallow marine, and lacustrine or epicontinental environments on the Guayana Shield. The Guayana Shield in Venezuela is composed of five lithotectonic provinces: (1) an Archean amphibolite- to granulite-facies gneiss terrane; (2) an Early Proterozoic greenstone-granite terrane(s); (3) an Early Proterozoic unmetamorphosed volcano-plutonic complex; (4) Early to Middle Proterozoic continental sedimentary rocks; and (5) Middle Proterozoic anorogenic rapakivi granite. Early to Middle Proterozoic continental tholeiitic dikes, sills, and small intrusive bodies, and Mesozoic dikes emplaced during the opening of the Atlantic Ocean cut all of the lithotectonic provinces (Sidder and Mendoza, 1991). Unmetamorphosed volcanic and plutonic rocks of the Early Proterozoic Cuchivero Group, diabase dikes of Early to Middle Proterozoic and (or) Mesozoic age, and rocks of the Roraima Group crop out in the study area (Salazar and others, 1987a; 1987b).

Regional stratigraphy of the Roraima Group has been described by Reid (1972), Reid and Bisque (1975), Ghosh (1985), Yanez (1985), and Alberdi and Contreras (1989). Four formations are recognized in the Roraima Group by Reid (1972), which are, from oldest to youngest: the Uairen, the Kukuenan, the Uaimapue, and the Mataui. The Uairen Formation is an 850 m thick basal sequence of conglomerate, gravel, and pebbly sandstone with well-rounded pebbles (~10 cm) of quartz, quartz porphyry, and quartzite in conglomerate beds that are 30 cm to 1 m thick (Wyant and others, 1953). The Kukuenan Formation consists of 50-100 m of fissile shale and is overlain by the Uaimapue Formation, a 250 m section of jasper, chert, siltstone, and sandstone. The youngest unit is the Mataui Formation, a crossbedded, massive sandstone unit of unknown thickness with no jasper or chert.

The Uairen Formation is known for its placer gold and diamond production, and the Mataui Formation forms prominent plateaus with vertical cliffs, or "tepuis," in the region. Relatively unmetamorphosed Cuchivero Group and other pre-Roraima rocks are unconformable beneath the Roraima Group. The pre-Roraima rocks include deformed quartzite, schist, and conglomerate (McCandless, 1962; Briceno, 1982; Ghosh, 1985). Regional thickness of the Roraima Group in Venezuela, Guyana, Suriname, and northern Brazil is estimated to be 2600 m (Dalton *in* Reid and Bisque, 1975). Sidder and Mendoza (1991) have compiled dates for the Roraima Group and consider the Roraima to be as young as 1,500 Ma or as old as 1,900 Ma.

RADIOACTIVITY IN THE RORAIMA GROUP

A radiometric anomaly (2-3 times background) was found near Santa Elena de Uairen (fig. 1) in a laterite that caps the Uairen Formation and crops out for approximately 10 km in hills north of Santa Teresa (fig. 2) by Reid and Bisque (1975). However, during previous studies of uranium potential in Venezuela, Wyant and others (1953) found no appreciable radioactivity in the Santa Elena de Uairen area.

Because of the regional structural setting and reports of radioactivity in the Santa Elena de Uairen area, we routinely carried a scintillometer (Exploranium Model GR-101A with a 3.8 cm detector) in order to locate possible anomalous roadside radioactivity. During our traverse, which began at the town of Km 88, the instrument was held outside the car window for a qualitative assessment of radioactivity. Our average speed was 30-50 kph over improved to unimproved roads. Whenever the count was ~30 cps or more (counts per second)(a functional background of 10 cps was used for the area based on relatively low readings in the Gran Sabana), we stopped, briefly traversed the area, with the scintillometer held waist high, to locate the highest reading. Approximately 1 kg of sample was taken at each of five localities shown on figure 2. Samples were collected from low relief areas (to avoid mass effect) for description and geochemical analysis and locations were based on odometer readings. Scintillometer readings, sample descriptions, and locations are compiled in table 1 and analytical results are compiled in table 2.

The uranium content of these five samples (1.51-9.26 ppm) is slightly elevated in comparison to the crustal average of 1.8-2 ppm (Mason, 1966; Premoli, 1983); the crustal average of granite, 3.7 ppm (Mason, 1966); and the crustal average of sandstone, 0.45 ppm (Turekian and Wedepohl, 1961). Thorium, another possible source of the anomalous radioactivity, is also elevated (23.6-79.8 ppm) when compared to the crustal average of 7.2 ppm (Mason, 1966); the crustal average of granite, 52 ppm (Mason, 1966); and the crustal average of sandstones, 1.7 ppm (Turekian and Wedepohl, 1961). Samples analyzed for this reconnaissance have a uranium content (1-9 ppm) far below the 500-1000 ppm concentration that might be considered economic (Premoli, 1983).

CONCLUSIONS

Neither the results of analytical work nor the geology of the Roraima Group, within the limited area of the Santa Elena de Uairen reconnaissance, indicate potential for a uranium deposit. It is unlikely that an unconformity U-Au deposit (Dahlkamp and Adams, 1981; Grauch and Mosier, 1986) will be found due to the absence of pre-Roraima sediments in the area, and regionally, no evidence for the necessary reducing environment or a carbonaceous/carbonate component in the pre-Roraima rocks has been described.

It is unlikely that a quartz-pebble conglomerate U-Au deposit will be found in the Santa Elena de Uairen area despite similarities between the quartz-pebble conglomerate Au-U model (Cox, 1986) and the Santa Elena de Uairen setting because sites with anomalous radioactivity (1-9 ppm) in the Roraima Group are in the Uaimapue Formation, which is above the basal conglomerates of the Uairen Formation. No anomalous radioactivity was found by Wyant and others (1953) and uranium analyses for samples taken for this study are only slightly above crustal averages. Also, the Roraima Group, with an age of 1,500-1,900 Ma (Sidder and Mendoza, 1991), is younger than the ideal age of 2,200-3,100 Ma for major quartz pebble conglomerate Au-U deposits (Pretorius, 1981; Cox, 1986).

The presence of placer-like concentrations of heavy minerals, such as zircon or monazite which contain uranium or thorium (Young, 1984), is the likely source of the anomalous radioactivity in the Roraima Group near Santa Elena de Uairen.

REFERENCES CITED

Alberdi, Magarita, and Contreras, Gloria, 1989, Estratigrafia del Grupo Roraima al NE del Parque Nacional Canaima: VII Congreso Geologico Venezolano, Tomo 1, Caracas, p. 14-39.

Briceno, H.O., 1982, Application of remote sensing to diamond placer exploration in a tropical jungle environment, Caroni River, Venezuela: Golden, Colorado School of Mines, Ph.D. thesis (T-2672), 140 p.

Cox, D.P., 1986, Descriptive model of quartz pebble conglomerate Au-U (model 29a), *in* Cox, D.P., and Singer, D.A., eds., Mineral Deposit Models: U.S. Geological Survey Bulletin 1693, 379 p.

Dahlkamp, F.J., and Adams, S.S., 1981, Geology and recognition criteria for veinlike uranium deposits of the Lower to Middle Proterozoic unconformity and strata-related types: U.S. Department of Energy, National Resource Evaluation GJBX-5(81), 253 p.

Ghosh, S.K., 1985, Geology of the Roraima Group and its implications: V Congreso Geologico Venezolano, Caracas, Memoria, v. 1, p. 33-50.

Grauch, R.I., and Mosier, D.L., 1986, Descriptive model of unconformity U-Au (model 37a), *in* Cox, D.P., and Singer, D.A., eds., Mineral Deposit Models: U.S. Geological Survey Bulletin 1693, 379 p.

International Uranium Resources Evaluation Project, 1980, World uranium, geology and resource potential, Chapter G, South and Central America, p. 415-478.

Mason, Brian, 1966, Principles of geochemistry: New York, John Wiley and Sons, 329 p.

McCandless, G.C., 1962, Reconnaissance geology of the northwest region of the state of Bolivar, Venezuela: Caribbean Journal of Science, v. 2, n. 4, p. 145-155.

Premoli, Camillo, 1983, Exploration for uranium, *in* Woakes, Michael, and Carman, J.S., eds., Geosciences in International Development: Association of Geologists for International Development Report no. 10, p. 329-356.

Pretorius, D.A., 1981, Gold and uranium in quartz-pebble conglomerates: Economic Geology, 75th Anniversary Volume, p. 117-138.

Reid, A.R., 1972, Stratigraphy of the type area of the Roraima Group, Venezuela: Ministerio de Minas E Hidrocarburos, Boletin de Geologia, Publicacion Especial n. 6, p. 343-353.

Reid, A.R., and Bisque, R.E., 1975, Stratigraphy of the diamond-bearing Roraima Group, Estado Bolivar, Venezuela: Quarterly of the Colorado School of Mines, Geochemical Studies in Venezuela, v. 70, n. 1, p. 61-82.

Rodriguez M., S.E., 1986, Recursos minerales de Venezuela: Ministerio de Energia y Minas Boletin de Geologia, v. 15, no. 27, 228 p.

Salazar, E., Briceno, C., Sardi, G., Estanga, Y., and Moreira, A., 1987a, Informe de avance de geologia, Hoja NB 20-12, Proyecto Inventario de los Recursos Naturales de la Region Guyana, CVG Tecnica Minera, 1:500,000 scale.

_____1987b, Informe de avance de geologia, Hoja 20-16, Proyecto Inventario de los Recursos Naturales de la Region Guyana, CVG Tecnica Minera, 1:500,000 scale.

Sidder, G.B., and Mendoza, S., Vicente, 1991, Geology of the Venezuelan Guayana Shield and its relation to the entire Guayana Shield: U.S. Geological Survey Open-File Report 91-141, 59 p.

Turekian, K.K., and Wedepohl, K.H., 1961, Distribution of elements in some major units of the earth's crust: Geological Society of America Bulletin, v. 72, p. 175-192.

Wyant, D.G., Sharp, W.N., and Ponte R., C., 1953, Radioactive source materials in Los Estados Unidos de Venezuela: U.S. Geological Survey Trace Elements Investigations Report 222, 116 p.

Yanez, Galo, 1985, Geology and geomorphology of the Roraima Group, southeastern Venezuela: VI Congreso Geologico Venezolano, Memoria Tomo II, p. 1243-1303.

Young, R.G., 1984, Uranium deposits of the world, excluding Europe, *in* DeVivo, B., Ippolito, F., Capaldi, G., and Simpson, P.R., eds., Uranium geochemistry, mineralogy, geology, exploration and resources: London, Institution of Mining and Metallurgy, p. 117-139.

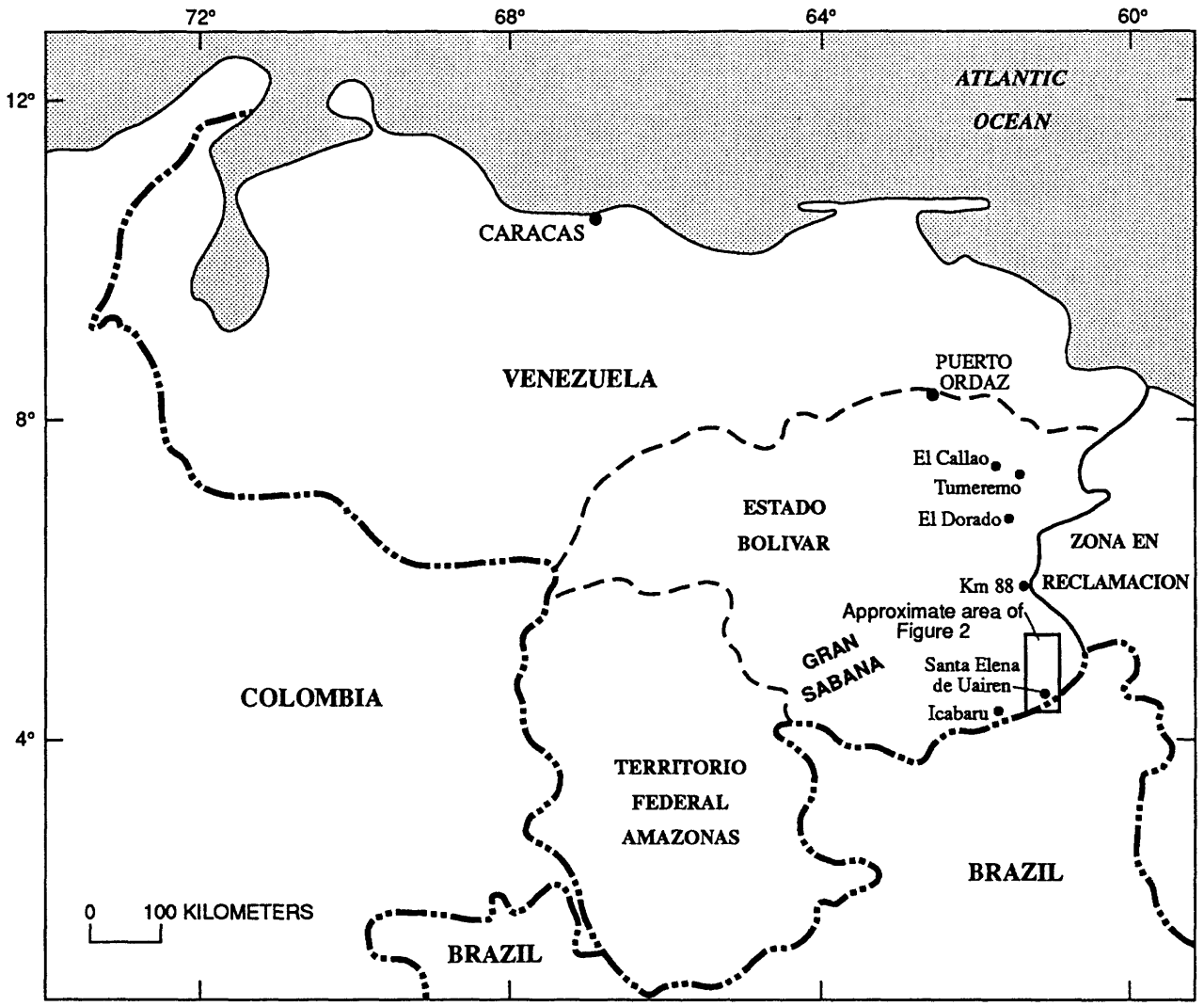

Figure 1.--Venezuela location map showing sites discussed in text.

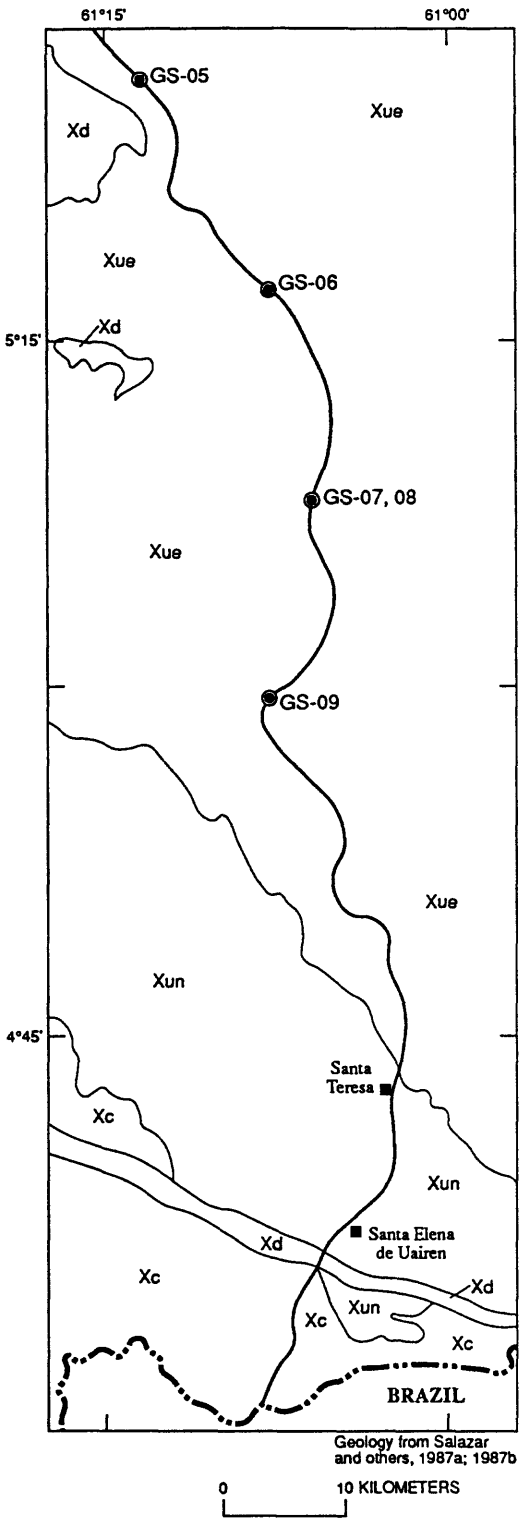

Figure 2.--Sample locality map, Santa Elena de Uairen area.

EXPLANATION

Xd **Diabase, (Early to Middle Proterozoic?)**—Medium to fine grained, dark gray to green, exposed as dikes and sills

Xue **Uaimapue Formation, Roraima Group (Early to Middle Proterozoic)**—Jasper, chert, siltstone, and sandstone

Xun **Uairen Formation, Roraima Group (Early to Middle Proterozoic)**—Sandstone, gravel, and quartz pebble conglomerate

Xc **Cuchivero Group (Early Proterozoic)**—Felsic to intermediate volcanic and plutonic rocks

MAP SYMBOLS

Road

GS-05 **Sample location**

Table 1.--*Scintillometer reading and sample description from localities with ~30 or more cps (counts per second) near Santa Elena de Uairen, Estado Bolivar, Venezuela*

GS 05

40-50 cps, Uaimapue Formation; red to maroon, fine-grained (0.02-0.3 mm), well-sorted, angular quartz sandstone with limonite or hematite cement

~110 km north of Santa Elena de Uairen

GS 06

28-32 cps, Uaimapue Formation; maroon, fine-grained (0.3 to 0.5 mm), poorly sorted, sub-to well rounded quartz sandstone with hematite cement

~91 km north of Santa Elena de Uairen

GS 07, 08

35 to 100 cps, Uaimapue Formation; red to yellow to orange hematite-stained siltstone with minor quartz

~69 km north of Santa Elena de Uairen

GS 09

60-100 cps, Uaimapue Formation; yellow to red hematite- stained siltstone

~47 km north of Santa Elena de Uairen

Table 2.--*Analytical data for samples with ~30 or more cps (counts per second) near Santa Elena de Uairen, Estado Bolivar, Venezuela*

[Instrumental neutron activation analysis by R.B. Vaughan. CV (coefficient of variance), measure of error; -, not determined due to spectral interference or low abundance]

Lab No.----	D-316957	D-316958	D-316959	D-316960	D-316961
Field No.--	GS 05	GS 06	GS 07	GS 08	GS 09
Fe %	2.48	2.28	8.19	7.92	7.61
CV/Fe %	1	1	1	1	1
Na %	0.0309	0.0332	0.0167	0.0246	0.014
CV/Na %	3	11	10	11	20
Ba ppm	189	871	130	125	96.6
CV/Ba %	2	2	2	2	7
Sr ppm	30	95.1	36	<30	42
CV/Sr %	25	10	29	-	29
Co ppm	2.12	4.45	1.56	1.47	1.46
CV/Co %	1	2	2	2	2
Ni ppm	-	30	9.6	-	10
CV/Ni %	-	20	29	-	29
Cr ppm	9.30	18.7	67.6	56.0	55.2
CV/Cr %	4	6	2	3	3
Cs ppm	2.30	3.73	0.895	1.36	2.08
CV/Cs %	1	1	4	1	1
Hf ppm	13.5	10.4	31.7	38.0	33.9
CV/Hf %	3	2	1	1	1
Rb ppm	105	159	18.2	27.2	67.6
CV/Rb %	1	1	3	6	1
Sb ppm	2.00	2.29	3.01	3.20	6.48
CV/SB %	10	5	10	10	5
Ta ppm	1.99	1.46	5.47	6.33	5.31
CV/Ta %	2	2	1	2	2
Th ppm	23.6	25.2	72.6	73.3	79.8
CV/Th %	1	2	1	1	2
U ppm	1.51	6.94	7.46	9.26	5.98
CV/U %	5	1	2	2	3
Zn ppm	62.0	77.4	-	-	-
CV/Zn %	5	5	-	-	-
Zr ppm	540	452	962	1180	1040
CV/Zr %	10	10	5	10	5
Sc ppm	10.8	11.4	13.0	14.1	14.5
CV/Sc %	1	2	1	1	1
La ppm	31.3	130	68.4	68.6	98.4
CV/La %	1	1	1	3	1
Ce ppm	61.8	322	91.6	78.6	52.3
CV/Ce %	3	1	5	5	1
Nd ppm	20.7	157	44.5	42.7	41.9
CV/Nd %	1	1	1	2	3

Table 2.--*Analytical data for samples with ~30 or more cps (counts per second) near Santa Elena de Uairen, Estado Bolivar, Venezuela*--Continued

Lab No.----	D-316957	D-316958	D-316959	D-316960	D-316961
Field No.--	GS 05	GS 06	GS 07	GS 08	GS 09
Sm ppm	4.27	33.1	7.58	7.27	6.64
CV/Sm %	1	1	1	1	1
Eu ppm	0.570	5.73	1.08	1.07	0.946
CV/Eu %	1	1	2	3	3
Tb ppm	0.475	2.68	0.803	0.897	0.960
CV/Tb %	1	1	1	1	5
Yb ppm	3.80	3.58	5.34	6.23	6.71
CV/Yb %	2	2	1	1	1
Lu ppm	0.610	0.480	0.875	1.04	1.17
CV/Lu %	1	2	1	1	1