TITLE: RESULTS OF URANIUM HYDROGEOCHEMICAL AND STREAM SEDIMENT
RECONNAISSANCE OF THE SAN JUAN AREA, SOUTHWESTERN COLORADO

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RESULTS OF URANIUM HSSR SURVEY OF THE
SAN JUAN AREA SOUTHWESTERN COLORADO

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ABSTRACT

During June-July 1976, 1706 water samples and 1982 sediment samples were collected from 1995 sites in the San Juan Mountains area and analyzed for uranium. The area includes the southern third of the Colorado mineral belt which has yielded rich ores of gold, silver, copper, lead, zinc, and molybdenum. The broadly domed mountains are capped by 2500 m of Tertiary volcanics, deeply eroded to expose a Precambrian crystalline core. Adjacent plateaus underlain by Mesozoic sedimentary rocks were included in the reconnaissance. Average value of uranium in water samples from mountains was less than 0.5 ppb, from plateaus was 1-2 ppb, and from Mancos shale areas exceeded 2 ppb. Anomalous sediment samples, 40 ppm uranium, came from near Storm King Mountain and upper Vallecito Creek. Other anomalous areas, including the Lake City mining district, were well defined by 4-30 ppm uranium in sediment and 3-30 ppb uranium in water. Above-average concentrations of uranium not previously reported indicate areas favorable for detailed exploration.

INTRODUCTION

This report describes work done by the Los Alamos Scientific Laboratory (LASL) for the US Energy Research and Development Administration (ERDA) as part of their National Uranium Resource Evaluation (NURE) program. The LASL is responsible for completing a Hydrogeochemical and Stream Sediment Reconnaissance (HSSR) of Alaska, Colorado, Montana, New Mexico, and Wyoming, an area of more than one third of the continental United States. The area of southwestern Colorado, Fig. 1, for which results are given here is bordered on the south by the New Mexico state line, on the north by 38°30' N latitude, on the east by 107° W longitude and on the west by 108°22½ W longitude. It includes parts of the Durango, Montrose, Moab, and Cortez Army Map Service 1° x 2° quadrangles, and contains 20 173 km² (7800 sq. miles). A more complete description of this study, including all sample data, is available in a Grand Junction open file report, GJBX-22(77).

The survey area includes most of the San Juan Mountains and smaller areas of the bordering Colorado Plateaus. The mountains range from 3300-4300 m above sea level, and include the Needle Mountains on the south, and the San Miguel, Rico, and LaPlata Mountains on the west. Both the Rio Grande and the Colorado Rivers originate in these mountains. On the south and west, a band of plateaus and mesas approximately 30 km wide has been included in this reconnaissance.

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The largest cities in the area, Fig. 1, are Montrose on the north, Durango to the southwest and Pagosa Springs on the southeast. Ever since gold was discovered in 1870 near what is now Silverton, mining has been a major industry in the area. By 1900 silver production had exceeded that of gold. The area includes the southern third of Colorado's famous mineral belt. Ores of silver, gold, copper, lead, zinc, sulfur, molybdenum and vanadium are produced from the area. Lumbering, ranching, tourism and outdoor recreation are the other major industries. Approximately 70% of the area lies within the San Juan, Uncompahgre, Gunnison, and Rio Grande National Forests. Another 15% along the southern border lies within the Southern Ute Indian Reservation.

GEOLOGY

The San Juan Mountains consist of an uplifted core of Precambrian crystalline igneous and metamorphic rocks flanked on the north, west, and south by gently dipping Mesozoic and Cenozoic sedimentary rocks (Fig. 2). To the east, beyond the limits of the study, the crystalline core is intruded by and buried under a thick accumulation of Cenozoic volcanic rocks. The oldest rocks in the area are Precambrian metasedimentary and metavolcanic gneisses 1800 million years (m. y.) old. These were intruded, eroded, and covered by sandstones and shales which were in turn intensely folded to form the Uncompahgre quartzite and slate. A younger series of Precambrian igneous rocks, including the 1460 m.y. old Eolus granite, intruded these older formations.

During Paleozoic time several sequences of marine limestones, shales and sandstones were deposited across the area. As the ancestral Rocky Mountains rose to the east of this area, the marine sequences were succeeded by non-marine shale and arkose in Late Paleozoic time. These were followed by continental sandstones and shales in Mesozoic time. During the Laramide orogeny of Late Cretaceous and Early Tertiary time, the central core of crystalline rocks was domed and uplifted, and several volcanic intrusive centers were formed between Ouray and Silverton. There apparently was no volcanic activity during most of the Eocene, as the early volcanic rocks were eroded and a few hundred meters of fluvial sediments were deposited. New, widespread volcanic activity began in the Oligocene and produced the great thickness of volcanic rocks that extends over most of the San Juan Mountains. The oval areas near the north edge of Fig. 2 are two of the caldera associated with these rocks. Extensive gold, silver, lead, zinc, and copper mineralization occurred with both the early and the later volcanic rocks. Pliocene stream erosion removed the volcanic rocks from the highest part of the dome, and Pleistocene glaciation produced the present spectacular landscape.

SAMPLING

During the last part of May, June, and the first half of July, 1976, 1706 water samples and nearly 2000 sediment samples were collected throughout the area. Weather was helpful during the sampling, with many sunny days, less-than-normal rainfall, and near-normal stream flow from melting snow at higher elevations. All the water samples were filtered through 0.45- μ filters and acidified to a pH of approximately 1 with nitric acid. Each sediment sample was a composite of three from a nominal 10 meter radius, and after drying was sieved to -100 mesh. All analyses were done at the LASL. The water samples were analyzed by fluorometry, except for a few which exceeded ten ppb uranium or had other interfering

Fig. 1

Location of sampled area.

Fig. 2 West half of geologic map of the Durango Quad

elements. These few water samples and all the sediment samples were analyzed by delayed neutron counting. Considerable effort has been made to standardize all field and laboratory procedures so that the resulting data is intercomparable with those from other studies in the HSSR program. The philosophy, equipment, and procedures used in the LASL sampling is discussed in more detail later in this symposium in a paper by R. R. Sharp, Jr.

RESULTS

Figure 3 shows frequency distributions of the measured concentrations of uranium in the water and sediment samples. The lower limit of measurement of the procedures used for uranium in water was 0.1 parts per billion (ppb). If lower measurements had been made, presumably a peaked distribution, similar to that shown for sediments, would have been observed. The maximum and mean uranium values measured in water were 209.5 and 1.15 ppb, and in sediment were 71.6 and 4.32 ppm respectively. Although most (1429) of the water samples were from streams, 213 were from springs (Fig. 4). Note the maximum values listed under the column headed "Range". Previous hydrogeochemical studies have shown that uranium values are generally higher in subsurface waters than in stream waters. This generality adds particular significance to the high water values (22 contained more than 10 ppb) observed in this study. Among the sediment samples, many were found to contain higher-than-average uranium content, and most of these were from areas where uranium mineralization had not been previously reported.

The largest area of highest-valued water samples is near the Uncompahgre River, from Montrose southward toward Ridgeway and eastward toward Cimmaron. Fig. 5 shows the geography of the area and Fig. 6 shows the location and uranium content of the water samples. The largest squares all have values greater than 16.0 ppb uranium. The highest-valued water sample, containing 209.5 ppb uranium, came from the headwaters of Hairpin Creek, shown at a larger scale in Fig. 7 and 8. Six km downstream on Hairpin Creek, the uranium content was 35.7 ppb. Another five km down the main stream, Cedar Creek, the content was still 26.4 ppb. The smaller squares are for samples from tributaries entering from the north side of Cedar Creek. These high-valued samples, as well as those south of Montrose, came from the area of outcrop of the Mancos shale.

The most extensive area of high-valued sediment samples is in the upper Vallecitos Creek valley, Fig. 9 and 10. The high-valued area is about 8 km northeast of Durango, shown in the lower left corner of Fig. 9. Note the location of Storm King Peak in the upper right corner of Fig. 9. A sediment sample from Tenmile Creek, which flows westward from Storm King Peak, contained 63.2 ppm uranium. The sample from Trinity Creek which flows eastward from Storm King Peak contained 24.6 ppm, substantially above average. Figures 11 and 12 show the same areas in larger scale. Further south, on the south side of Windom Mountain, Johnson Creek drains Hazel Lake. Although the sediment sample from the head of Johnson Creek contained only 7.1 ppm uranium, the content increased downstream from 26.0 to 58.0 ppm at the confluence with Vallecito Creek. From the confluence of Johnson Creek downstream to the Vallecito Reservoir all of the Vallecito Creek sediment samples contained six to eighteen times the normal amount of uranium for the area. Sediment samples from tributaries draining the east side of Vallecito Creek contained only normal amounts of uranium. One km southwest of Hazel Lake and Johnson Creek, between Emerson Mountain and Missouri Gulch, (Fig. 13 and 14), the Public Service

Fig. 3 |

Distribution of uranium concentration in water and sediment samples

NUMBER OF SAMPLES AND URANIUM CONTENT BY SAMPLE TYPE

<u>Water</u>			
<u>Type</u>	<u>No.</u>	<u>Mean ppb</u>	<u>Range ppb</u>
Streams < 1.5 m wide	878	1.51	209.5-0.1
Streams > 1.5 m wide	551	0.67	11.2-0.1
Springs	213	0.91	16.5-0.1
Wells	16	1.86	9.9-0.1
Natural Ponds	15	0.52	2.8-0.1
Artificial Ponds	33	0.84	4.3-0.1

<u>Sediment</u>			
<u>Type</u>	<u>No.</u>	<u>Mean ppm</u>	<u>Range ppm</u>
Wet Streams	1433	4.48	71.6-1.0
Dry Streams	270	3.68	12.7-1.7
Wet Springs	212	4.21	26.9-2.0
Dry Springs	19	3.82	14.2-1.9
Wet Natural Ponds	18	4.32	7.4-2.3
Wet Artificial Ponds	30	0.58	0.8-0.4

Fig. 4 Sample types and uranium content.

Fig. 6 Water samples of the Uncompahgre River region.

Fig. 7 Geography of Halpin Creek area.

Fig. 10 Sediment samples of southern San Juan Mountains.

Fig. 11. Geography of Storm King Peak area.

Fig. 12 Sediment samples of Storm King Peak area.

Fig. 13 Geography of Silver Mesa area.

Fig. 14 Sediment samples of Silver Mesa area. |

Company of Oklahoma has been drilling for uranium, as reported in the Denver Post last November. The results of their drilling have not been announced.

Another area of high-valued sediment samples was found near the Lake City mining district, Fig. 15 and 16. The highest-valued spring sample, 26.9 ppm uranium, was collected from the east side of Uncompahgre Peak, near the head of Nellie Creek. This is shown as a large diamond on Fig. 16. The spring is upstream from the Nellie M mine, where some uranium mineralization had been previously reported. Approximately two km further south, on the north side of Sunshine Peak, a stream sediment sample containing 25.1 ppm uranium was collected from a tributary of Silver Creek. Seven other samples in the same vicinity had concentrations of 12.0 to 24.0 ppm uranium.

CONCLUSIONS

The results described show that areas of higher-than-normal uranium occurrence can be recognized with the sampling techniques and density used in this reconnaissance. Sediment sampling revealed two areas of conspicuously high values of uranium, near Storm King Peak and in the upper Vallecito Creek valley. Neither of these had been previously reported. Above-average values were found in samples from the mining districts south and west of Lake City, from which small amounts of uranium ore have been produced. Several other less conspicuous anomalous areas were defined by the sampling, within the San Juan Mountains, and in adjacent plateau areas.

The water samples indicate that the Cretaceous Mancos shale generally contains more uranium than the other sedimentary rocks of this area, and may contain low-grade ore bodies southeast of Montrose and near Mancos. The waters in the swift-flowing streams in the igneous mountains contained, on the average, less than 0.5 ppb uranium even though the sediment in those streams contained, on average, more than 3.0 ppm uranium. Downstream, as those streams slow and flow across the sedimentary rocks of the plateaus, the dissolved uranium content increases.

The complete description of this study is available in an ERDA open-file report, GJBX-22(77), available from the Grand Junction office. This study would not have been possible without the kind cooperation of landowners and holders of mineral rights who gave permission for access to their lands for the purpose of sampling. Their cooperation is gratefully acknowledged.

Fig. 15 Geography of Lake City area.

Fig. 16 Sediment samples of Lake City area. |