UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY
WASHINGTON 25, D. C.

IN REPLY REFER TO:

MAR 2 0 1953

AEC-329/3

Dr. Phillip L. Merritt, Assistant Director
Division of Raw Materials
U. S. Atomic Energy Commission
P. O. Box 30, Ansonia Station
New York 23, New York

Dear Phil:

Transmitted herewith are six copies of TEI-307, "An air concentrator for very low grade Colorado Plateau uranium ores," by L. R. Stieff and E. S. Erickson, Jr., January 1953.

We plan to publish this report, possibly in the Engineering and Mining Journal, and are asking Mr. Hosted to approve this plan for the Division of Raw Materials.

Sincerely yours,

V. E. McKelvey
for W. H. Bradley
Chief Geologist

UNCLASSIFIED

Geology - Mineralogy

This document consists of 13 pages.
Series A.

UNITED STATES DEPARTMENT OF THE INTERIOR

GEOLOGICAL SURVEY

AN AIR CONCENTRATOR FOR VERY LOW GRADE COLORADO PLATEAU URANIUM ORES*

By

L. R. Stieff and E. S. Erickson, Jr.

January 1953

Trace Elements Investigations Report 307

This preliminary report is distributed without editorial and technical review for conformity with official standards and nomenclature. It is not for public inspection or quotation.

*This report concerns work done on behalf of the Division of Raw Materials and the Division of Research of the U. S. Atomic Energy Commission

USGS - TEI Report 307

GEOLOGY - MINERALOGY

Distribution (Series A)	No. of copies
American Cyanamid Company, Winchester	1
Argonne National Laboratory	1
Atomic Energy Commission, Washington	2
Battelle Memorial Institute, Columbus	1
Carbide and Carbon Chemicals Company, Y-12 Area	1
Division of Raw Materials, Grants	1
Division of Raw Materials, Denver	1
Division of Raw Materials, Hot Springs	1
Division of Raw Materials, New York	6
Division of Raw Materials, Salt Lake City	1
Division of Raw Materials, Richfield	1
Division of Raw Materials, Butte	1
Division of Raw Materials, Washington	3
Division of Research, Washington	1
Dow Chemical Company, Pittsburg	1
Exploration Division, Grand Junction Operations Office	6
Grand Junction Operations Office	1
Technical Information Service, Oak Ridge	6
Tennessee Valley Authority, Wilson Dam	1
U. S. Geological Survey:	
Mineral Deposits Branch, Washington	1
Geochemistry and Petrology Branch, Washington	15
Geophysics Branch, Washington	1
Alaskan Geology Branch, Washington	1
Fuels Branch, Washington	1
V. E. McKelvey, Washington	1
L. R. Page, Denver	2
R. P. Fischer, Grand Junction	2
A. E. Weissenborn, Spokane	1
C. B. Hunt, Plant City	1
J. F. Smith, Jr., Denver	1
N. M. Denson, Denver	1
R. W. Swanson, Spokane	1
L. S. Gardner, Albuquerque	1
J. D. Love, Laramie	1
A. H. Koschmann, Denver	1
E. H. Bailey, San Francisco	1
A. F. Shride, Tucson	1
W. P. Williams, Joplin	1
C. E. Dutton, Madison	1
R. A. Laurence, Knoxville	1
R. J. Roberts, Salt Lake City	1
TEPCO, Washington:	
Resource Compilation Section	2
Reports Processing Section (Including master)	3
	80

CONTENTS

ILLUSTRATIONS

TABLE

AN AIR CONCENTRATOR FOR VERY LOW GRADE COLORADO PLATEAU URANIUM ORES

By L. R. Stieff and E. S. Erickson, Jr.

ABSTRACT

An air concentrator, for use on sandstones containing from 0.005 to 0.1 percent uranium, consists of an air scrubbing unit, an air elutriating column, and a Cottrell precipitator. The concentrates obtained contain more than ten times as much uranium as the original sandstone. Several modifications are suggested to improve materially the performance of the concentrator. The application of air-concentration methods in the beneficiation of very low grade uranium-bearing Colorado Plateau sandstones is suggested.

INTRODUCTION

As a part of the lead isotope studies of Colorado Plateau uranium ores begun in 1950, a small air concentrator was designed for use on samples of Plateau sandstone containing less than 0.1 percent uranium. A preliminary concentration of these low-grade samples was desirable because of the serious problems in chemical extraction of the lead for isotope analysis and in the quantitative analysis of these samples for both lead and uranium. It was soon found, however, that the very low grade ores were generally unsuitable for age determinations because in many of them the uranium had apparently been selectively leached by surface and ground waters. In spite of the limited use of this concentrator in geologic age problems of the Colorado Plateau, this report has been prepared to indicate the possible application of a modification of this concentrator to problems of enrichment of low-grade Plateau ores prior to shipment of the ore from the mine and to other problems of separating extremely fine grained particles from poorly sorted sediments.

The operation of this air concentrator is based on two facts:

1. The uranium in the low-grade ores occurs almost entirely as fine-grained interstitial material, fine particles adhering tightly to sand grains, or asociated with the limonitic stains on the sand grains.

2. Most of the low-grade uranium-bearing sandstones of the Plateau consist of quartz grains which are themselves essentially free of uranium. These quartz grains constitute from 80 to nearly 100 percent of the sample.

It was found in sieving the low-grade sandstones that the particles adhering to the sand grains were only partly removed, that some of the massive interstitial material did not disaggregate, and that the sieve losses, particularily in the finest sizes, were excessive.

In order to overcome some of the difficulties in concentrating the fines from the low-grade Plateau ores by sieving, a concentrator was built in which the disaggregated, but not crushed, sample was spun and abraded in a circular chamber by means of radially mounted air jets. The fines removed from the samples were elutriated by air in a vertical column connected to the top of the scrubbing chamber. A Cottrell precipitator mounted directly above the elutriator was used to remove the fines from the vertically moving column of air.

It should be stressed that this concentrator was not designed to handle high-grade ores, very well cemented sandstones, or low-grade ores containing large amounts of clay. There may be, however, sufficient tonnages of friable sandstone containing from 0.005 to 0.1 percent uranium available on the Plateau to justify serious consideration of a simple and inexpensive method of concentration of these ores at the mine.

DESCRIPTION OF THE CONCENTRATOR

The air concentrator, shown in figure 1, consists of three parts: a scrubbing chamber, an elutriating column, and a Cottrell precipitator.

The scrubbing unit is a cylindrical chamber 12 in. in height and approximately 6 3/4 in. in inside diameter. The chamber is split and flanged to facilitate introduction of the sample and cleaning of the unit between runs. Four air jets are arranged radially at the base of the scrubber (fig. 2). These jets are connected by means of a manifold to a tank of compressed air. To increase the abrasive action, part of the interior of the scrubber was lined with a No. 180C silicon carbide abrasive paper.

Several modifications of the arrangement of the abrasive papers and of abrasive-lined baffles have been tried. They will not be described because sufficient data have not been obtained on the differences in performance of the scrubbing unit. The principal objective of this report is to draw attention to the advantages of air concentration rather than to describe the minor details of the concentrator built in this laboratory.

The elutriating column, only one segment of which is shown in figure 1, is connected to the scrubbing unit with a 55/50 standard taper glass joint. The length of the column shown is 12 in. and the diameter of the tubing is 2 in. The elutriating column was included in this unit to improve the sizing of the particles permitted to reach the Cottrell precipitator. A column with

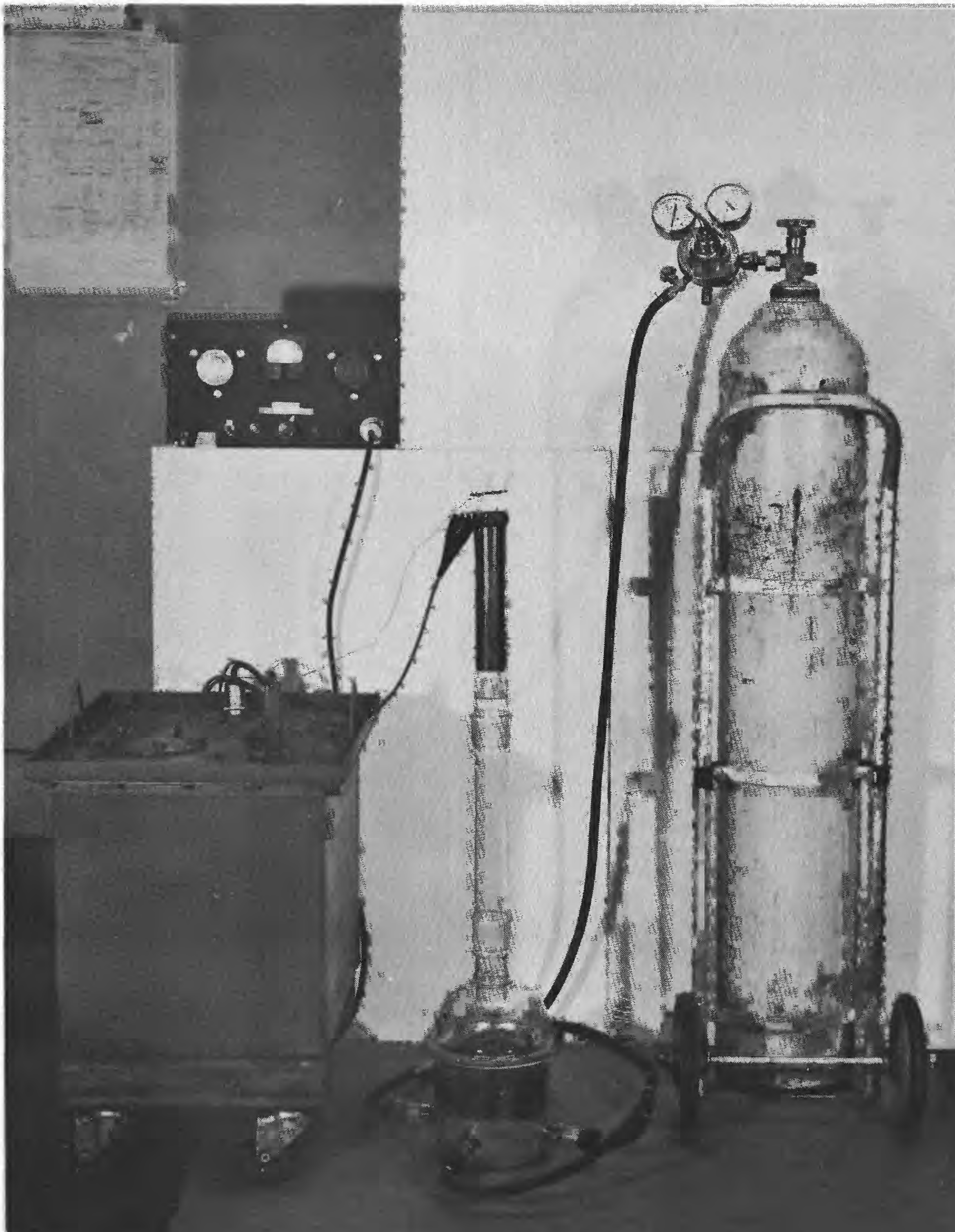

Figure 1.--Air concentrator consisting of scrubbing unit, air elutriating column, Cottrell precipitator, high voltage supply, and source of compressed air.

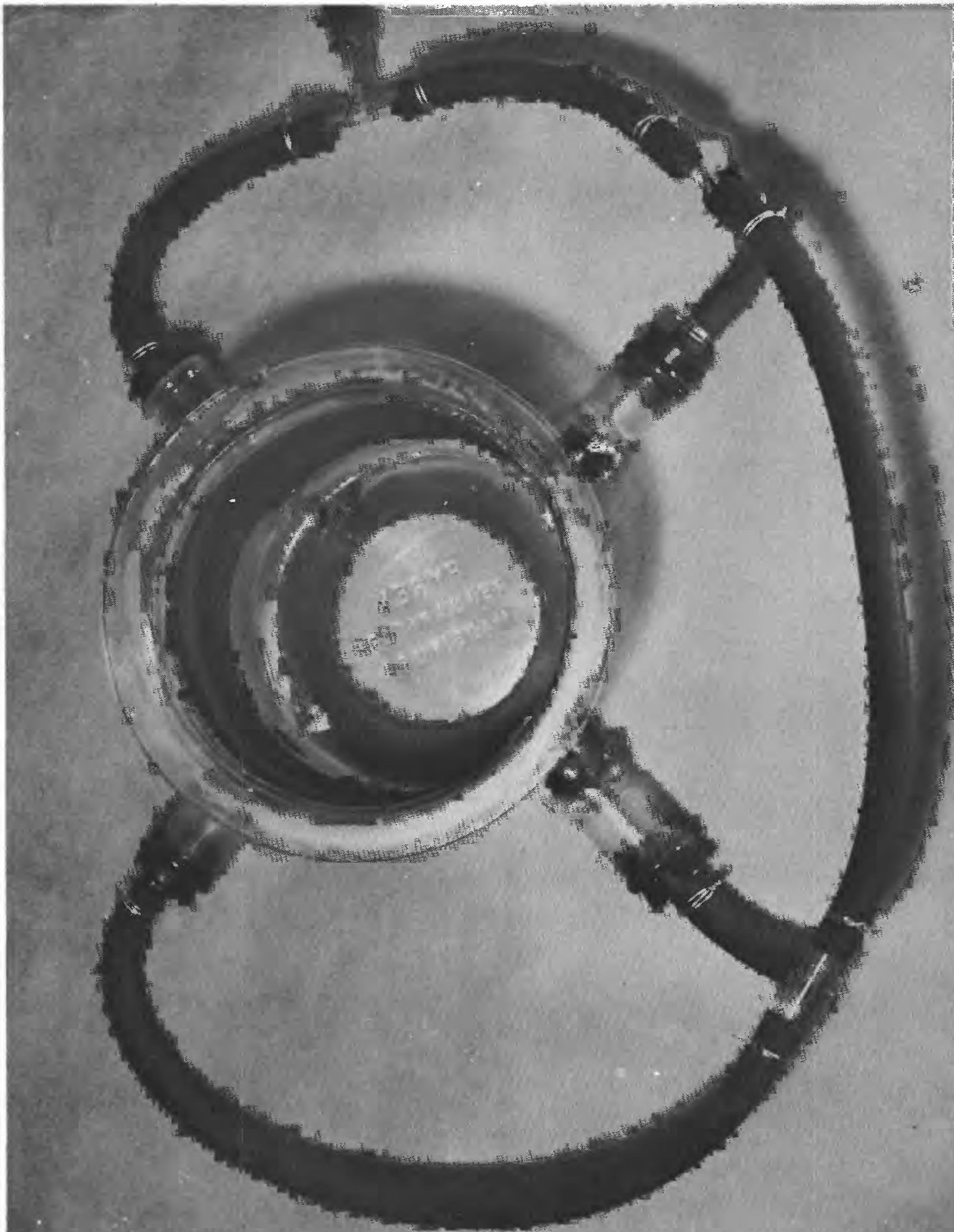

Figure 2.--Scrubbing unit of concentrator showing radial arrangement of four air jets.

a maximum length of 36 in. has been used.

The air used to elutriate the fines is provided by the four radial jets mounted in the scrubbing unit. The maximum size of the particles permitted to reach the precipitator can be controlled by changing either the length of the elutriating column or the air pressure.

The Cottrell-type electrostatic precipitator used in this unit is 12 in. in length and 2 in. in diameter. It is connected to the elutriating column by a 55/50 standard taper glass joint. The central electrode of the precipitator is connected to the high voltage source. The collector consists of a sheet of copper foil 0.004 in. thick rolled into the form of a cylinder. This collector is grounded. The concentrate is removed from the copper collector by unrolling the sheet and brushing the concentrate off with a camel's hair brush.

The high voltage source used was built by the Carpco Engineering Corp., Arlington, Fla. Between 20,000 and 25,000 volts was applied to the central electrode. The efficiency of this precipitator seems to be very high. Only a very small percentage of the fines escapes to the atmosphere.

OPERATION OF THE CONCENTRATOR

The preparation of the samples used in the preliminary runs of this concentrator has been limited to the simple disaggregation of the sandstone into individual grains. The only additional sample requirement is that it be dry.

Operating pressures of approximately 45 psi are required to scrub a 50-g sample. Satisfactory yields have been obtained from as little as 10 g of sample with operating pressures of approximately 10 psi. In practice it has been found desirable to begin the run at pressures of 2 to 4 psi. This pressure is maintained for the first five minutes or until most of the fine interstitial material that is mixed with the disaggregated sandstone is removed and collected. The pressure is then rapidly increased until the entire sample is in motion. The position and location of most of the sample in the scrubber can be controlled by increasing the pressure. The greater the pressure, the greater the velocity of the sample and the higher above the floor of the scrubbing unit most of the sample can be kept.

In running all the samples on which this report is based, 40 cu ft of air per run have been used. This represents an average of about 25 minutes of scrubbing time. No effort has been made to establish the minimum amount of air required to remove completely all of the attached fines nor to determine the cut-off point required to obtain an optimum yield of concentrate against the amount of uranium remaining in the tailings. These problems can best be answered by an ore dressing engineer if the general method of air concentration is considered to be worthy of further investigation.

RESULTS

The quantitative analyses for uranium of three samples of uranium-bearing sandstone, the heads, tailings, and concentrates are given in table 1.

Table 1.--Quantitative analyses for uranium of heads, tailings, and concentrates from three Plateau sandstones.

Sample	Percent uranium		
	Heads	Tailings	Concentrates
1	0.001 or less	0.001 or less	0.007
2	0.008	0.003	0.16
3	0.27	0.14	3.1
4 (mill pulp)	0.12	0.07	0.61

We have found that the uranium remaining in the low-grade tailings in the concentrator is from 20 to 40 percent of the original uranium content of the heads. Limited experience with this concentrator indicates that relatively simple changes in the design of the scrubbing unit would materially reduce the uranium content of the tailings. These modifications would include the introduction of baffles to increase the scrubbing action, the addition of secondary air jets to eliminate areas of low velocity and to prevent the accumulation of fine material in top of the scrubbing unit, and increases in the pressure and amounts of air used.

Measurements of the yield of the concentrates indicate that approximately 15 to 25 percent of the uranium removed from the sandstone is collected in the Cottrell precipitator. The modifications mentioned in the previous paragraph to reduce the uranium content of the tailings, combined with more efficient design of the Cottrell precipitator, would also greatly increase the total yield of concentrates. Under optimum operating conditions the weight of the concentrate shipped would be from 5 to 8 percent of the weight of the ore mined.

The small number of samples concentrated precludes any generalizations about the grade of concentrates that might be expected. If, however, the average low-grade sandstone ores are similar to the two sandstones studied, a minimum of a tenfold enrichment in uranium in the concentrates can be expected.

APPLICATION

The application of the principle of air concentration to the large-scale beneficiation of low-grade sandstone ores may be possible. Both the scrubbing and precipitating units can be designed for continuous operation.

The concentrator should be relatively small in size, low in both initial, as well as operating cost, and easily transportable. In addition, rock-moving and rock-crushing equipment and an air compressor would be required. The latter is standard equipment in almost all the mining districts of the Plateau. Of particular importance in Plateau mining is the fact that water is not required in any of the steps of concentration.

The sandstones included in this report were collected because they seemed to be typical of the low-grade specimens to be found in the mines of the Uravan mineral belt. If the sandstone, which has been mined as waste and used as backfill, or dumped, contains amounts of uranium similar to the samples mentioned above, very large tonnages of ore suitable for concentration are now available. The cost of concentrating this type of ore would be at a minimum and would consist of handling the rock and disaggregating it.

The following additional factors might also improve the economics of the very low grade uranium ores in the Colorado Plateau:

1. The concentrates would not require additional crushing at the mill.
2. A less expensive method of chemical extraction of uranium from the low-grade ores might be used.
3. The extraction of vanadium and other metals present in the concentrates might help to pay the cost of concentration.

SUMMARY

The very limited experience which has been gained with this small air concentrator strongly suggests that the principle of air concentration of the very low grade uranium-bearing sandstones of the Plateau could be successfully applied. The large tonnages of sandstone containing 0.005 to 0.1 percent

uranium that are available in the dumps and in the as yet undeveloped mines of the Plateau may justify the further examination and possible construction of an air concentrator for sandstone-type ores. The large number of factors affecting the economic feasibility of such a method of ore treatment, on which the authors are not able to make even an approximate estimate, precludes any positive statement on the practicability of the method. It seems possible, however, that the application of air concentration methods might increase materially the recovery of uranium from the Colorado Plateau.