229

OFFICIAL USE ONLY

U. S. GEOLOGICAL SURVEY
Field Library
Albuquerque, New Mexico

Uranium-Bearing Deposits West of Clancey, Jefferson County, Montana

Trace Elements Memorandum Report 229

UNITED STATES DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

OFFICIAL USE ONLY

metadc502083

Uranium-Bearing Deposits

West of Clancy

Jefferson County, Missouri

From the report of the U.S. Geological Survey

UNITED STATES DEPARTMENT OF THE INTERIOR
BUREAU OF GEOLOGY

OFFICIAL USE ONLY

This document consists of 42 pages
plus 5 figures, Series A
Category VII (Deposits in and west of
the Rocky Mts.)

UNITED STATES DEPARTMENT OF THE INTERIOR

GEOLOGICAL SURVEY

URANIUM-BEARING DEPOSITS WEST OF CLANCEY

JEFFERSON COUNTY, MONTANA

By

Wayne A. Roberts and Arthur J. Gude, III

June 1951

When separated from Part II, handle
Part I as UNCLASSIFIED

Trace Elements Memorandum Report 229

OFFICIAL USE ONLY

USGS - TEM Report 229

The distribution (Series A) of this report is as follows:

3 copies AEC, Washington (J. C. Johnson)
 8 copies AEC, New York (P. L. Merritt)
 1 copy AEC, Denver, Colo. (C. C. Towle, Jr.)
 1 copy AEC, Spokane, Wash. (E. E. Thurlow)
 1 copy AEC, Grand Junction, Colo. (F. H. MacPherson)
 1 copy AEC, Grand Junction, Colo. (T. W. Oster)
 1 copy Columbia Univ., New York (P. F. Kerr)
 1 copy Univ. Minnesota, Minneapolis (J. W. Gruner)
 11 copies. USGS, Washington (Mineral Deposits Branch)
 1 copy USGS, Washington (Geochemistry and Petrology Branch)
 1 copy USGS, Washington (Geophysics Branch)
 1 copy USGS, Washington (Fuels Branch)
 1 copy USGS, Washington (Alaskan Branch)
 1 copy USGS, Washington (V. E. McKelvey)
 3 copies USGS, Denver, Colo. (L. R. Page)
 1 copy USGS, Denver, Colo. (J. Fred Smith, Jr.)
 1 copy USGS, Grand Junction, Colo. (R. P. Fischer)
 1 copy USGS, Spokane, Wash. (A. E. Weissenborn)
 1 copy USGS, Plant City, Fla. (J. B. Cathcart)
 4 copies USGS, Washington (TEPCO)
 (Including master copy)

CONTENTS

	Page
Abstract	6
Introduction	7
Geology.	11
General statement	11
Igneous rocks	14
Quartz monzonite	14
Aplite-granite-granite porphyry-granite pegmatite. . .	15
Quartz monzonite pegmatite	16
Andesite porphyry, dacite porphyry, and andesite . . .	17
Younger sedimentary rocks	17
Mineral deposits	18
General character and classification.	18
Mineralogy.	21
Alteration and enrichment	22
Description of individual deposits.	23
General statement.	23
Localities mapped in detail.	24
Locality 2.	24
Locality 3.	26
Locality 6.	27
Locality 7.	28

CONTENTS (Cont'd.)

	Page
Mineral deposits (Cont'd.)	
Description of individual deposits (Cont'd.)	
Other localities examined.	29
Locality 1.	29
Locality 4.	29
Locality 5.	29
Locality 8.	30
Locality 9.	30
Suggestions for prospecting.	30
Conclusions.	31

ILLUSTRATIONS

	Page
Fig. 1. Index map showing area mapped near Clancey, Jefferson County, Montana.	8
2. Geology of an area containing uraniferous deposits west of Clancey, Jefferson County, Montana	In envelope
3. Index map showing areas mapped in detail and radio- activity anomalies	In envelope
4. Sketch illustrating four ages of silica.	13
5. Geologic map of locality 2	In envelope
6. Geologic map of locality 3	In envelope
7. Geologic map of localities 6 and 7	In envelope

TABLE

	Pages
Table 1. Uranium analyses of samples from uranium deposits near Clancey, Jefferson County, Montana	32-34

URANIUM-BEARING DEPOSITS WEST OF CLANCEY
JEFFERSON COUNTY, MONTANA

by

Wayne A. Roberts and Arthur J. Gude, III

ABSTRACT

Nine uranium deposits occur in a small area west of Clancey, Jefferson County, Mont. These deposits are all in or near silicified fracture zones in quartz monzonite and related rocks of the Boulder batholith. The deposits contain pockets of uranium minerals in cavities in brecciated well-silicified rock. The primary uranium mineral pitchblende has been found in one pod. Secondary uranium minerals occur as fracture linings and in pore spaces in and adjacent to the silicified zones.

The surface concentrations of uranium minerals and the intensity of radioactivity near Clancey are much greater than at the Free Enterprise mine about 15 miles south of Clancey, where the geologically similar Free Enterprise vein is being mined for silver and uranium. This suggests that the Clancey deposits may contain material minable under present conditions.

Uranium in the Clancey district was deposited probably during one of the later of at least four periods of silicification. The quartz monzonite, rather than the younger alaskitic dike rocks, is the host rock of the deposits.

Newmont Mining Corp. has leased the properties containing the uranium deposits and has begun development of one of these deposits.

INTRODUCTION

Uranium-bearing mineral deposits near Clancey, Jefferson County, Mont. (fig. 1), were investigated in the 1950 field season. This

Figure 1. Index map of area mapped near Clancey, Jefferson County, Montana.

work is part of a general study of uraniferous deposits being carried out by the U. S. Geological Survey on behalf of the U. S. Atomic Energy Commission, and is also part of a comprehensive study that was begun by the Geological Survey in 1949 of ore deposits in and around the Boulder batholith. After field reconnaissance by geologists of the Geological Survey and the Atomic Energy Commission, an area of approximately 9 square miles in T. 8 N., R. 3 W. was selected for detailed geologic study. The geology of this area (fig. 2) was mapped by the writers under the general direction of Montis R.

Figure 2. Geology of an area containing uraniferous deposits west of Clancey, Jefferson County, Montana.

Klepper, project chief. The uranium-bearing deposits in the area were found in 1949 and early 1950 by Mr. Wayne Hinman of Clancey.

The geology of the area has been described in a preliminary

Figure 1. - Index map of area mapped near Clancey
Jefferson County, Montana

report /. In the present report the areal geology is summarized, and

/ Roberts, W. A., and Gude, A. J., III, Preliminary report on the uranium-bearing deposits near Clancey, Jefferson County, Montana.

four uranium deposits are described in detail.

The locations of the nine known uranium-bearing deposits, including the deposits investigated in detail, are shown in figure 3.

Figure 3. Index map showing areas mapped in detail and radioactivity anomalies.

The deposits at localities 2 and 6 were chosen for ~~detailed study~~ because they appeared to contain both more and higher-grade uranium-bearing material than the deposits at other localities, and localities 3 and 7 were chosen because of their proximity to the higher-grade deposits.

The geology of the area was mapped on aerial photographs at a scale of 1:24,000. The geology of the four selected deposits was mapped in detail using a plane table. Lines of equal intensity of radioactivity (isorads) were determined by continuous radiometric traversing across and along the major structures and on all outcrops. The radiometric traversing was done with an El-Tronics Geiger counter, model SGM-18A and a high-counting-rate probe consisting of six 14-inch gamma tubes connected in parallel. A search for uranium minerals was made in the areas of relatively high radioactivity.

Clancey is a village 12 miles south of Helena (fig. 1). U. S. Highway 91 and a branch of the Great Northern Railroad cross the eastern part of the mapped area. The relief is moderate; the highest hills are about 1,000 feet higher than the principal valleys.

Previous geologic work in the Clancey district was of a reconnaissance nature in connection with studies of the Helena mining region / .

 /Knopf, Adolph, Ore deposits of the Helena mining region, Montana: U. S. Geol. Survey Bull. 527, pp. 103-107, 1913.

 /Pardee, J. F., and Schrader, F. C., Metalliferous deposits of the greater Helena mining region, Montana: U. S. Geol. Survey Bull. 842, pp. 227-232, 1933.

According to Pardee and Schrader the value of the total production of silver, gold, lead, and copper from the Clancey district has been about \$3,500,000. In 1950 the only active mine in the area mapped was the New Stake mine, near Clancey, from which a small quantity of silver has been produced. Small discovery pits have been dug during 1949 and 1950 at localities 6, 7, 8, and 9. Localities 1, 6, 7, 8, and 9 are on claims located by Mr. Hinman. Localities 2, 3, 5, and parts of localities 6 and 7 are on the Haynes ranch, which is homestead land carrying mineral rights. Newmont Mining Corporation has signed leases with both Mr. Hinman and the Haynes estate and commenced development at locality 2 during November, 1950.

Valuable suggestions concerning the geology of the area were given by M. R. Klepper and A. E. Weissenborn. Mr. Hinman has been most helpful to the writers. Laboratory analyses given in this report were made by the Trace Elements Laboratory of the Geological Survey.

GEOLOGY

General statement

The area mapped (fig.2) is entirely within the Boulder batholith, a large intrusive body of quartz monzonite and related rocks. The quartz monzonite body is cut by dikes and by gently dipping sheet-like masses of alaskitic composition having aplitic, granitic, porphyritic, and pegmatitic textural facies. Nearly all of these younger intrusive bodies are composed of two or more of these textural facies. Most of the individual textural units are too small and numerous to be shown at the scale of the maps and have been mapped as an undivided unit called aplite-granite-granite porphyry-granite pegmatite. Dikes and small plugs of dacite and andesite have intruded the quartz monzonite. The plugs are generally less than 200 feet in diameter, and the dikes are generally less than 20 feet thick. The plugs and dikes are not common, and, except for the dike near Alhambra, all are near the western edge of the area.

The quartz monzonite and the alaskitic bodies have been fractured, brecciated, silicified and locally sericitized along zones of linear outcrop. These silicified zones commonly compose ridges that are prominent

features of the topography, and the zones are locally called reefs. The zones are nearly vertical, and most of them strike about N. 80° W., about N. 60° E., or nearly north. Faults cut the silicified zones with apparent offsets of as much as 50 feet.

The zones are composed of many small discontinuous, and silicified lenses and stringers of cryptocrystalline silica in altered and silicified breccia or fractured rock. These small lenses and stringers of silica are roughly parallel to the trend of the zone. Secondary uranium minerals are commonly associated with a dark-gray cryptocrystalline variety that probably contains a disseminated primary uranium mineral. Most zones have been somewhat brecciated after silicification.

Four periods of silicification (fig. 4) have been recognized from

Figure 4. Sketch illustrating four ages of silica.

the relationship of veinlets of cryptocrystalline and opaline silica occurring at one locality in an intensely brecciated and silicified zone. One dacite porphyry dike has been silicified, indicating that at least locally one period of silicification post-dated the intrusion of the dacite porphyry.

Figure 4. - Sketch illustrating four ages of silica.

Silicified breccia bordered by altered and silicified quartz monzonite (qmm) cutting unaltered quartz monzonite (qm) and partly covered by mantle (Qm). Fragments (a) of white and light brown to light gray cryptocrystalline silica are enclosed in a light brown cryptocrystalline silica matrix (b). Stringers (c) of light brownish gray and brown to yellowish brown cryptocrystalline silica cut both matrix and fragments. Light yellowish brown opaline silica (d) cuts the matrix, fragments, and stringers.

Igneous rocks

Quartz monzonite

The principal rock in the Clancey area is quartz monzonite in which the quantity of ferro-magnesian minerals differs from place to place. Microscopic study may show that ~~other~~ rocks, such as granodiorite, are present. Megascopically, the average composition appears to be 30 percent quartz, 40 percent orthoclase, 20 percent plagioclase, and 10 percent biotite and hornblende.

Inclusions in the quartz monzonite are common. These ~~in~~ clusions probably are recrystallized Cretaceous volcanics and are composed of hornblende, plagioclase, quartz, and biotite. The two largest bodies that were interpreted as inclusions are about 10 feet wide by 20 feet long, and about 30 feet wide by 120 feet long. Both of these are in the NW $\frac{1}{4}$, sec. 16, T. 8 N., R. 3 W.

Altered quartz monzonite occurs in and on both sides of most of the silicified reefs. The writers believe that this altered rock ~~was~~ formed by the action of hydrothermal solutions on the typical quartz monzonite country rock. However, the lack of mafic minerals or relict textures suggestive of replaced mafic minerals and the presence of certain textural peculiarities not found in the typical quartz monzonite suggest that these altered zones may represent younger dike-like intrusions of mafic-free or mafic-poor quartz monzonite. This problem was studied carefully but no conclusive evidence was found. Detailed petrographic work may give a clue to its origin.

The contact of the altered rock with the normal quartz monzonite is sharp where seen.

The altered quartz monzonite differs from normal quartz monzonite in the following ways: the feldspars are apparently altered almost completely to clay minerals with possibly some sericite formed from orthoclase; the ratio of orthoclase to plagioclase appears to be larger; the rock is generally hardened, possibly as the result of silicification; and yellowish-brown, brownish-red, or brown staining is common. The stains, which are probably hematite and other iron oxides, do not appear to be localized on any one mineral. In this rock the altered feldspars are usually of two colors, suggesting that the original rock had two different feldspars. Biotite and hornblende, or recognizable remnants of these minerals, are rare, but locally as much as several percent of these minerals is present. Altered and unaltered quartz monzonite have been differentiated on the detailed maps.

Aplite-granite-granite porphyry-granite pegmatite

The aplite-granite-granite porphyry-granite pegmatite map unit includes several intimately related and in part intergradational textural varieties of generally alaskitic composition. Rocks of this unit cut the quartz monzonite as plugs, dikes, and gently dipping sheetlike masses. Aplite occurs almost invariably as the border facies, but it also occurs throughout the composite bodies. The border-facies aplite generally grades into granite and/or granite

porphyry facies. Some evidence suggests that the aplite was fractured and that granite porphyry and granite cemented the aplite fragments. The pegmatites are located well within the borders of the alaskitic bodies and probably were the last rock to crystallize.

The alaskitic rocks are composed essentially of quartz and potash feldspar γ . Biotite occurs in small amounts in the granite and

γ This map unit will be referred to as alaskite for simplicity in the remainder of the report.

granite porphyry and locally is a sparse component in the aplite borders. The aplite is fine-grained and sugary-textured; the granite is medium-grained and equigranular. The granite porphyry consists of an aplitic groundmass with differing amounts of phenocrysts of rounded quartz and euhedral to anhedral feldspar. Silica appears to have replaced part of the feldspar in some outcrops of granite porphyry. The pegmatites in the areas mapped in detail are few and small. Most of the alaskitic outcrops cannot be represented at the scale of the detailed maps; however, some masses that are predominantly granite porphyry or granite pegmatite have been mapped as such. None of the other textural varieties have been mapped separately.

Quartz monzonite pegmatite

Two small pegmatites of quartz monzonitic, or granodioritic composition were mapped (fig. 2, center sec. 4 and center N $\frac{1}{2}$ sec. 7). These pegmatites consist of plagioclase, milky quartz, and orthoclase

or microcline in coarsely crystalline pegmatitic intergrowths and sparse micropegmatitic intergrowths.

Andesite porphyry, dacite porphyry, and andesite

Two plugs and several dikes of andesitic and dacitic composition occur in the area. These aphanitic rocks are dark gray, light gray, and reddish brown. The porphyries contain phenocrysts of quartz, kaolinized feldspar, and green plagioclase.

Younger sedimentary rocks

The only sedimentary rocks in the area mapped are unconsolidated terrace gravels, alluvium, hillwash, talus, and mantle.

Two levels of terrace gravels are found along Prickly Pear Creek (fig. 2). Both terraces consist of streamworn material containing boulders as much as several feet in diameter. The upper terrace, 50 to 100 feet above the present stream level, contains andesite boulders and cobbles that apparently were transported from the headwaters of Prickly Pear Creek in the Elkhorn Mountains which are southeast of the area. This terrace, which is locally cemented with caliche, may be wholly or partly Tertiary in age. Andesite erratics can be found at this level above the creek where the mantle is very thin. The lower terrace, which is about 50 feet above the present level of the stream, consists mostly of quartz monzonite and alaskite detritus and rarely contains andesite. A terrace, as much as 75 feet above the present stream level, occurs along Lump Gulch. This terrace consists of finer grained, better sorted

material than the terraces along Prickly Pear Creek and is distinctly bedded in places.

Quaternary alluvium is present in all the stream valleys in the area but was mapped only in the major valleys. Mantle, hillwash, and talus are present over most of the area and partly obscure the bedrock relationships.

MINERAL DEPOSITS

General character and classification

Most of the mineral production in the Clancey district has been from ores of silver, gold, lead, and some copper, mined from vein or placer deposits. The Little Nell, King Solomon, Dan Tucker and New Stake mines, scores of small pits, and about a dozen larger prospect pits and adits (all caved) are in deposits of this type. These were shown by the Geiger counter to have no abnormally high radioactivity, so they are not described in this report.

Uranium minerals have been found only in and adjacent to the silicified zones. These zones, which occupy fracture systems in the batholithic rocks, have both lateral and vertical continuity, whereas the silica stringers and veins within the zones generally are short and discontinuous. Silica stringers and veins seem more abundant at intersections of two zones. Uranium minerals, where present, are usually in the silica stringers, along fractures, and in pore spaces in the adjacent wall rock of either altered quartz monzonite or alaskite.

Where silica stringers have been introduced, the quartz monzonite invariably has been altered, and the zone of alteration is typically more continuous and of greater thickness than the zone of silica stringers. Apparently, the alteration of the quartz monzonite consisted of silicification and formation of clay minerals from the feldspars. The altered facies of the quartz monzonite occurs in and adjacent to the zones in the quartz monzonite. Silicification and alteration were not as effective in the alaskite as in the quartz monzonite. Alteration of the quartz monzonite wall rock adjacent to the silica stringers is believed to have been hydrothermal.

The contacts between the country rock and the silicified zones have been exposed in a few small prospect pits at localities 2 and 6 (fig. 5 and fig. 7). The contact between the soft, crumbly, weathered quartz monzonite and the harder, altered and silicified quartz monzonite is sharp. Usually a zone of iron-stained, closely spaced sheeting occurs at the contact. Contacts between silica stringers and the enclosing rock are always sharp. These silica stringers, which locally may be as much as 1 foot thick, but typically are about 1/8 to 1 inch thick, are mostly parallel to the trend of the reef.

Most of the silicified zones contain breccias, which commonly are composed of fragments of cryptocrystalline silica cemented by cryptocrystalline silica. The dark-gray cryptocrystalline silica also commonly encloses fragments of silica of different colors and, less commonly, rock fragments. In most places, such fragments are small, rarely exceeding 1/2 inch along the greatest exposed dimension. Many

of these breccias are less than 1 inch thick and are exposed for only a few inches along the trend. No evidence of movement, other than brecciation, could be found along the silicified reefs.

Where a radioactive silicified zone cuts both quartz monzonite and alaskite, the radioactivity is typically greater in the quartz monzonite than in the alaskite. No abnormally high radioactivity was found in any of the pegmatites.

Recognizable uranium minerals appear to be concentrated in lentils or pockets along the silicified zones. These pockets range from 6 inches to 18 feet in the greatest dimension and contain as much as 3 percent uranium. The outlines (figs. 5, 6, and 7.) of the radioactivity anomalies, which delimit the visible uranium minerals, are irregularly spaced along the zone, and the long axis of each lenticular outline is parallel to the enclosed zone. Dark-gray cryptocrystalline silica is at five of the nine localities that contain uranium minerals. Silica of similar appearance but showing no abnormal radioactivity is present at many other localities throughout the mapped area. A sample of radioactive silica from locality 2 that contained no visible uranium minerals was analyzed chemically and was found to contain 0.20 percent uranium. It is probable that the dark-gray cryptocrystalline silica locally contains sparsely disseminated fine-grained pitchblende.

This apparent discontinuity of uranium minerals along favorable silicified structures is probably the result of primary deposition of uranium rather than a result of enrichment and depletion by secondary processes.

The secondary uranium minerals enclosing small remnants of pitchblende are colloform and appear to replace the pitchblende. The secondary uranium minerals probably are formed by the weathering of the primary uranium deposits.

In the Boulder Batholith region at least two areas containing uraniferous deposits, the one described in this report and one near Boulder, Mont., are relatively close to abnormally radioactive hot mineral springs. This fact suggests that if the waters of a hot spring or the minerals deposited from spring waters show abnormal radioactivity, the area near the springs might be favorable for prospecting.

Mineralogy

Pitchblende /, a primary uranium mineral, was found only at

/ Identified by Joseph Berman, U. S. Geological Survey Trace Elements Laboratory report no. TWX-178 on a sample submitted by M. R. Klepper.

locality 2 where it forms clusters in cavities in brecciated, silicified rock. Pitchblende probably also is sparsely disseminated in dark-gray cryptocrystalline silica. One or more secondary uranium minerals are present at each of the localities studied. Torbernite-zeunerite, autunite or uranocircite, rutherfordine, and voglite were identified by the Geological Survey's Trace Elements Laboratory /.

/ Identified by M. Nancy Girhard, U. S. Geological Survey, Trace Elements Laboratory report no. TWM-173.

All the numbered localities (fig. 3) contain a green mineral which has been identified as torbernite-zeunerite. A yellow micaceous mineral, identified as either autunite or uranocircite has been found at localities 2, 5, 6, 8, and 9. Rutherfordine, voglite, and uranophane have been found at locality 2.

Very small grains of pyrite and galena occur sporadically in the silica of the reefs in or near most of the uranium-bearing deposits. These sulfides appear to have been introduced with the silica and uranium.

Alteration and enrichment

The uranium deposits have been seen only at or within a few feet of the surface. Halos of waxy yellow to orange-yellow secondary uranium minerals surround the few fragments of pitchblende seen at locality 2. Yellow and green secondary uranium minerals line fractures and fill pores in the wall rock adjacent to this pitchblende occurrence, indicating that some of the uranium in the primary deposits has been redistributed during weathering; however, the abundance and the dense character of the secondary uranium minerals that immediately surround the pitchblende fragments suggest that the pitchblende has been weathered in place and that only minor depletion or enrichment has occurred. The close spatial association of secondary uranium minerals with mineralized silicified zones suggests further that no substantial migration of uranium has occurred.

Chemical and radiometric analyses of samples, which were taken from these deposits, are in very close agreement, indicating that the uranium in the secondary minerals is approximately in equilibrium with its daughter products.

Description of individual deposits

General statement

There are about 25 localities in the area (fig. 3) where the radiation intensity is up to five times background. These are usually located along small silica-coated fault and fracture surfaces or associated with visible concentrations of orthoclase or microcline. Uranium minerals were found at all localities where radioactivity was greater than five times background. Only the localities where uranium minerals were found are described in the following section. These localities, numbers 1 to 9, were located with a Geiger counter. The Geiger counter was also used as an aid to locating and delimiting samples of uranium-bearing material for chemical analysis.

At the Free Enterprise mine, near Boulder and about 15 miles south of Clancey, uranium-silver ore is being mined from small high-grade pockets in the Free Enterprise vein on the 80-foot level. The uranium deposit at the Free Enterprise mine is similar to the Clancey deposits in occurrence and mineralogy except that the uranium is associated with significant concentrations of silver-bearing minerals in the Free Enterprise vein. Uranium minerals are not

found at the surface in or adjacent to the Free Enterprise vein and the intensity of radiation at the surface is low. The surface indications of all nine numbered localities as well as about five other moderate radioactivity anomalies near Clancey are more promising than the surface indications along the Free Enterprise vein at the Free Enterprise mine. This suggests that the Clancey deposits may contain material minable under present conditions.

Localities mapped in detail

Locality 2.—Locality 2 is part of the W. Wilson claim of Mr. Hinman and is entirely on the Haynes homestead. The geology of this locality was mapped at a scale of 1 inch equals 40 feet (fig. 5).

Figure 5. Geologic map of locality 2.

The radioactive deposits were located by Geiger counter and by visual inspection of the rocks.

This locality is underlain by quartz monzonite that is cut by nearly vertical, silicified zones. The main silicified zone trends N. 60° E.; small spurlike silicified zones branch from the main zone on the south side and trend east to slightly south of east. A small silicified zone crops out about 100 feet south of, and roughly parallel to the main zone.

The deposits of cryptocrystalline silica are lenticular and appear to be fissure fillings in altered quartz monzonite. The altered zone of the quartz monzonite extends several feet on either side of

the silica stringers and is probably lenticular. The silica occurs as short veins, irregular blobs, short discontinuous stringers, and as impregnations of disseminated silica in the wall rock.

Dark-gray cryptocrystalline silica is present in all but one of the five small uranium-bearing lenses. Silica that is similar in appearance but non-radioactive is present at other localities throughout the area.

No continuity of uranium-bearing rock is evident on the surface. Development work probably will establish whether or not both the dark-gray cryptocrystalline silica and the uranium-bearing rock occur as lenses.

Pitchblende, rutherfordine, uranophane, voglite, torbernite-zeunerite, and autunite or uranocircite have been identified in the samples collected. A carefully selected sample from the locality where sample R-0-2 was collected contains a black mineral which, according to Berman /, "gives an X-ray pattern of pitchblende with

/ U. S. Geological Survey, Trace Elements Laboratory report no. TWX-178 on mineral sample MRK-1.

$a_0 = 5.46 \pm .01$. Alteration products intimately associated with the pitchblende are rutherfordine (similar to U. S. N. M. no. 93291), uranophane, and other minor amounts of an unidentified material." Pyrite, although rare, is found with the uranium.

The secondary uranium minerals are derived by leaching or weathering of primary uranium minerals and by migration of uranium-bearing solutions outward for a few feet into fractures or pore spaces in the

wall rock to form autunite or uranocircite and torbernite-zeunerite. Pitchblende coated with waxy yellow to orange-yellow gummite suggests that the bulk of the secondary uranium has formed essentially in place.

The pitchblende seen at this locality occurs as remnants in weathered grains of about $1/4$ to $1/2$ inch in diameter.

Chemical assays on samples from locality 2 range from 0.007 to 9.58 percent uranium. The sampled locations and the assays are shown in figure 5 scattered along 1,200 to 1,300 feet of silicified zone and adjoining spur-like structures.

Locality 3.—Locality 3 is part of the Harry S. claim of Mr. Hinman. The geology of this locality was mapped at a scale of 1 inch equals 20 feet (fig. 6).

Figure 6. Geologic map of locality 3.

This locality is underlain by quartz monzonite. A thick breccia consisting of cryptocrystalline silica fragments cemented by cryptocrystalline silica cuts the quartz monzonite. This breccia trends N. 8° W., and has a nearly vertical dip. The altered quartz monzonite adjacent to the breccia also appears to be slightly brecciated. The breccia appears to be continuous in the area mapped. No dikes or silicified zones cut, or are recognizably offset by, this breccia zone. Silica also occurs disseminated in the wall rock as lenses and as short discontinuous stringers. A small alaskite dike, shown in the southwest quadrant of figure 6, also cuts the quartz monzonite. One small cross fault appears to offset the breccia zone about 5 feet.

Torbernite-zeunerite occurs as fracture linings and as crystals in cavities in the brecciated, altered quartz monzonite that forms the west wall of the breccia zone. Chemical assays at locality 3 (fig. 6) range from 0.016 to 0.36 percent uranium along 56 feet of reef outcrop.

Locality 6.—Locality 6 is partly on the A. Lincoln and G. Washington claims of Mr. Hinman and partly on the Haynes homestead. The geology of this locality was mapped at a scale of 1 inch equals 50 feet (fig. 7).

Figure 7. Geologic map of localities 6 and 7.

This locality is underlain by quartz monzonite and alaskite. The alaskite cuts the quartz monzonite as gently dipping sheetlike masses and as steeply dipping dikes. Fracturing and subsequent silicification cut both of the above rock types. The silicified zones are displaced up to 50 feet by cross faults that presumably dip steeply.

The cryptocrystalline silica in the quartz monzonite is surrounded by altered quartz monzonite. Within the alaskite the only alteration observed is the addition of silica.

Although the fractures that admitted the silica are surely continuous, the silica itself crops out as lenses, short veins, and discontinuous stringers. Silica also is disseminated in the alaskite or quartz monzonite within the silicified zone. The dark-gray cryptocrystalline silica is exposed at locality 6 only in the discovery pit, shown in the western part (location of samples R-0-38 to R-0-41) of locality 6 on figure 7, where the layer is more than 1 foot thick and

is continuous for 10 feet ~~across~~ the pit. In other localities this dark-gray silica occurs as stringers in the silicified zones.

Pyrite and fine-grained galena (?) are sparsely disseminated throughout the silica veins. No primary uranium minerals have been recognized at this locality. Autunite or uranocircite and torbernite-zeunerite occur as linings in fractures and as crystalline fillings in small cavities and pores in the dark-gray cryptocrystalline silica and the wall rock. The uranium minerals occur in pockets, or lenses that are usually 6 to 8 feet long and 1/2 foot thick along 540 feet of the zone. No evidence of enrichment by concentration of uranium minerals was seen. Chemical assays of samples range from 0.010 to 0.21 percent uranium.

Locality 7.—Locality 7 is part of a claim filed by Mr. Hinman adjacent to the G. Washington claim to protect the deposits at locality 6. The geology of this locality was mapped with the adjacent locality 6 and also is shown in figure 7.

This locality is underlain by quartz monzonite cut by a gently dipping alaskite sheet that is probably an extension of the gently dipping sheet exposed to the south (fig. 7). Both the quartz monzonite and the alaskite are cut by a silicified zone. This zone is apparently offset by a small cross fault near the western end of the mapped part of the zone. The deposit is small, about 40 feet long, and consists of torbernite-zeunerite as fracture linings and as crystals in cavities in the silica and altered quartz monzonite wall rock. Two samples from a prospect pit assayed 0.011 and 0.026 percent uranium.

Other localities examined

The deposits at localities 1, 4, 5, 8, and 9 (fig. 3) occur in silicified zones that trend approximately east and dip steeply south to vertically. Localities 8 and 9 are within an east-trending zone in which the silica is more abundant and more widely disseminated than elsewhere in the area. A few dark gray cryptocrystalline silica veins within the zone trend approximately N. 60° E., and dip steeply southeast to vertical. The uranium-mineral occurrences at localities 8 and 9 are along two of these N. 60° E., dark-gray cryptocrystalline silica veins.

Dark-gray cryptocrystalline silica and autunite or uranocircite have been recognized at locality 5, as well as localities 8, and 9.

Locality 1.—Locality 1 is near the junction of a fault and an east-trending zone. Sparse torbernite-zeunerite in altered quartz monzonite was observed in only one specimen at this locality.

Locality 4.—Locality 4 is at the junction of an east-trending zone with two smaller northeast-trending zones. Sparse torbernite-zeunerite occurs in silicified, altered quartz monzonite for approximately 100 feet along the zone.

Locality 5.—Locality 5 contains two small areas of uranium-bearing minerals in and adjacent to an east-trending zone. Torbernite-zeunerite and autunite or uranocircite occur as fracture linings in dark-gray cryptocrystalline silica adjacent to and north of the zone. Torbernite-zeunerite and the highest radioactivity occur in light brown

cryptocrystalline silica on the south side of the zone.

Locality 8.—Locality 8 on the Forty-Niner claim of Mr. Hirman is in and adjacent to a dark-gray cryptocrystalline silica vein about 1 foot thick. The silica vein trends about N. 70° E., and dips 80° S. The wall rock is granite porphyry. Torbernite-zeunerite and autunite or uranocircite occur as fracture linings in the dark-gray cryptocrystalline silica and wall rock.

Locality 9.—Locality 9, also on the Forty-Niner claim, is in and adjacent to a 2-foot-thick silicified zone. The silica is predominantly the dark-gray cryptocrystalline variety. The zone trends N. 60° E., and dips 60° SE. through granite porphyry. The dark-gray cryptocrystalline silica can be followed along the outcrop to the west for more than 50 feet. The vein is exposed by a discovery pit and a small adit below the discovery pit. The vein is about 4 inches thick in the adit, but decreases in thickness to 1 inch or less toward the west. Torbernite-zeunerite and autunite or uranocircite occur as fracture linings in the dark-gray cryptocrystalline silica and wall rock.

Suggestions for prospecting

For most effective uranium prospecting in the Clancey area a prospector should be equipped with a good Geiger counter, preferably one with a rate meter and a high counting rate.

The intersections of large silicified zones with smaller spurlike silicified zones and visible concentrations of dark-gray cryptocrystalline silica are thought to be particularly favorable places for finding uranium

minerals. It is known, however, that not all silicified zones, not all intersections, and not all concentrations of dark-gray cryptocrystalline silica are uraniferous. Exploration by drilling or mining may show the structures which are non-uraniferous at the surface to be mineralized at depth as at the Free Enterprise mine near Boulder. When an area of abnormal radioactivity (greater than double the count measured in the quartz monzonite near Clancey) is located with a counter, a careful check should be made for local radioactivity anomalies and secondary uranium minerals.

It is believed that the suggestions for prospecting in the Clancey area can be extended to include the batholith as a whole. Other silicified zones in the Boulder batholith similar to those near Clancey should be thoroughly prospected.

CONCLUSIONS

Pitchblende has been found at locality 2. Secondary uranium minerals found at other localities are probably leached and weathered products of pitchblende nearby. It is probable that the dark-gray cryptocrystalline silica where it is associated with most of these deposits contains finely disseminated pitchblende, the source of the secondary uranium minerals. The abnormally radioactive dark-gray cryptocrystalline silica has been analyzed chemically and contains 0.20 percent uranium at locality 2 although no secondary uranium minerals were seen.

Known bodies of silica and uranium deposits are lenticular in plan and are irregularly dispersed throughout the silicified zones.

The altered phase of the quartz monzonite appears to be the best host rock.

Although the deposits are weathered at the surface, there is evidence to suggest that only minor depletion of the deposits has occurred by leaching action of meteoric waters. There is no evidence of significant enrichment at the surface.

It is believed that the primary uranium minerals were deposited from epithermal solutions.

Localities 2 and 6 contain the most promising deposits. The other deposits appear to be smaller and should be developed after the deposits at localities 2 and 6.

Table 1.--Uranium analyses of samples from uranium deposits near Clancey, Jefferson County, Montana.

Sample No.	Length (feet)	Uranium (percent)	Equivalent uranium (percent)	Locality ¹ / ₋	Remarks
R-0- 2	-	9.58	9.50	2	Grab, high grade.
R-0- 3	0.8	2.29	2.44	2	Hanging walls of gouge.
R-0- 4	0.7	2.55	2.66	2	Foot wall of gouge.
R-0- 5	1.7	0.46	0.47	2	Gouge parallel to structure.
R-0- 6	1.5	0.042	0.038	2	Across reef outcrop.
R-0- 7	1.5	0.009	0.014	2	Across reef outcrop.
R-0- 8	0.7	0.41	0.40	2	Small pit, across exposed rock.
R-0- 9	0.5	0.44	0.44	2	Small pit, composite.
R-0-10	0.5	0.15	0.13	2	Small pit, dark-gray silica.
R-0-11	1.1	0.22	0.24	2	Across altered quartz monzonite.
R-0-12	1.9	0.14	0.13	2	Across silicified quartz monzonite.
R-0-13	1.8	0.15	0.16	2	Across silicified quartz monzonite.

Table 1.--(Continued)

Sample No.	Length (feet)	Uranium (percent)	Equivalent uranium (percent)	Locality	$\frac{1}{2}$ /	Remarks
R-0-14	1.8	0.035	0.037	2		Across silicified quartz monzonite.
R-0-15	-	0.20	0.21	2		Grab of silica.
R-0-16	0.8	0.016	0.014	2		Altered quartz monzonite.
R-0-17	1.0	0.007	0.011	2		Quartz monzonite wall rock.
R-0-18	0.6	0.071	0.083	2		Silica.
R-0-19	0.3	0.040	0.032	2		Altered quartz monzonite.
R-0-20	-	0.17	0.16	2		Grab, shows secondaries.
R-0-21	5.0	0.22	0.19	2		Across exposed reef.
R-0-22	-	1.27	1.37	2		Grab, mineralized rock.
R-0-23	-	0.20	0.18	2		Grab, dark-gray silica.
R-0-24	0.4	0.36	0.24	3		Across mineralized zone.
R-0-25	3.7	0.093	0.065	3		Composite.
R-0-26	0.8	0.067	0.067	3		Silica vein.
R-0-27	1.0	0.016	0.026	3		Altered quartz monzonite.
R-0-28	1.0	3.18	3.12	2		Across pit, more mineralized.
R-0-29	0.25	0.30	0.29	2		Across pit, less mineralized.
R-0-30	-	0.058	0.070	2		Grab.
R-0-31	-	0.058	0.070	2		Soil.
R-0-32	-	0.19	0.16	6		Grab sample, foot-wall.
R-0-33	-	0.010	0.011	6		Grab sample, silica vein.
R-0-34	-	0.12	0.13	6		Grab sample, hanging wall.
R-0-35	-	0.091	0.075	6		Grab sample, dump.
R-0-36	-	0.044	0.051	6		Grab sample, silica.
R-0-37	0.5	0.18	0.19	6		Across silica vein.
R-0-38	0.25	0.14	0.12	6		Across silica vein.
R-0-39	4.5	0.024	0.027	6		Composite across altered zone.
R-0-40	5.0	0.023	0.022	6		Composite across altered zone

Table 1.--(Continued)

Sample No.	Length (feet)	Uranium (percent)	Equivalent uranium (percent)	Locality ¹ / ₋	Remarks
R-0-41	1.2	0.21	0.20	6	Across silica vein.
R-0-42	0.7	0.026	0.020	7	Across silica vein.
R-0-43	4.7	0.011	0.016	7	Composite across altered zone.
R-0-45	-	0.18	0.19	5	Grab, silica.
R-0-46	3.5	0.071	0.062	5	Across silica zone.
R-0-47	8.0	0.027	0.027	5	Along silica zone.

¹/ See figures 5, 6, and 7 for location of samples.

OFFICIAL USE ONLY

35

USGS - TEM Report 229, Part II

The distribution (Series A) of this report is as follows:

3 copies AEC, Washington (J. C. Johnson)
8 copies AEC, New York (P. L. Merritt)
1 copy AEC, Denver, Colo. (C. C. Towle, Jr.)
1 copy AEC, Spokane, Wash. (E. E. Thurlow)
1 copy AEC, Grand Junction, Colo. (F. H. MacPherson)
1 copy AEC, Grand Junction, Colo. (T. W. Oster)
1 copy Columbia Univ., New York, (P. F. Kerr)
1 copy Univ. Minnesota, Minneapolis (J. W. Gruner)
9 copies USGS, Washington (Mineral Deposits Branch)
1 copy USGS, Washington (Geochemistry and Petrology Branch)
1 copy USGS, Washington (Geophysics Branch)
1 copy USGS, Washington (Fuels Branch)
1 copy USGS, Washington (Alaskan Branch)
1 copy USGS, Washington (V. E. McKelvey)
2 copies USGS, Denver, Colo. (L. R. Page)
1 copy USGS, Denver, Colo. (J. Fred Smith, Jr.)
1 copy USGS, Grand Junction, Colo. (R. P. Fischer)
1 copy USGS, Spokane, Wash. (A. E. Weissenborn)
1 copy USGS, Plant City, Fla. (J. B. Cathcart)
4 copies USGS, Washington (TEPCO)
(Including master copy)

OFFICIAL USE ONLY

PART II

CONTENTS

	Page
Abstract	37
Reserves	38
General statement	38
Locality 2.	38
Locality 3.	39
Locality 6.	39
Plans for development.	40
Locality 2.	40
Locality 6.	41
All other localities.	41

PART II

ABSTRACT

Rough estimates of the ore reserves of the uranium deposits near Glancey, Mont., (figs. 2, 3) are as follows: locality 2, (fig. 5) 4,000 tons of 0.20 percent uranium and 250 tons of 1.0 percent uranium; locality 3 (fig. 6), 40 tons of 0.20 percent uranium; locality 6 (fig. 7), 1,100 tons of 0.15 percent uranium. These estimates may be low for they were made from data obtained on discontinuous surface outcrops and from a few shallow pits.

The uranium deposits at localities 2 and 6 warrant immediate development. Newmont Mining Corp. has begun development work at locality 2.

RESERVES

General statement

On the basis of present information obtained from surface outcrops and a few shallow pits, the ore reserves can be estimated only roughly and incompletely. More reliable estimates of the grade and tonnage probably can be made as the development work now being conducted by the Newmont Mining Corp. progresses.

The reserve estimates have been made using the following assumptions: (1) the isorads indicate approximately the horizontal extent of the uranium-bearing rock; and (2) any horizontal section to a depth of 100 feet (25 feet at locality 3) will contain rock with approximately the same grade and distribution of uranium that is exposed at the surface. Calculations have been limited to a depth of 100 feet at localities 2 and 6, and 25 feet at locality 3. Grade estimates are based on analyses of the samples listed in table 1. The location of each sample is shown in figures 5, 6, and 7.

Reserves have been estimated for localities 2, 3, and 6. Present information is not considered adequate to permit estimation of reserves of the other localities. It is believed that the rough estimates made from the surface showings near Clancey are conservative.

Locality 2

Locality 2 has been treated as a unit although it consists of many small showings of uranium minerals and abnormal radioactivity. Reserve

estimates for locality 2 were made for rock that contains 0.20 percent or more uranium. The main mineralized zone was considered to be 3 feet thick, to have an aggregate length of approximately 130 feet, and to contain 0.20 percent uranium. Of the total length of about 380 feet of the small spurlike reefs, 70 feet were considered to contain 0.20 percent uranium and to be 2 feet thick. Using 12.5 cubic feet per ton, locality 2 contains about 4,000 tons averaging 0.20 percent uranium, or 8 tons of uranium. In addition to this low-grade ore, it is estimated that ore shoots containing better than 1 percent uranium will yield about 250 tons, or at least 2.5 tons of uranium.

Locality 3

At locality 3, a zone, which is three fourths of a foot thick, averages 0.20 percent uranium. The radioactivity as shown on figure 4 is continuous for about 56 feet. Assuming one-half this length contains uranium to a depth of 25 feet and assuming 12.5 cubic feet per ton, there are about 40 tons of material averaging 0.20 percent uranium, or a little less than a tenth of a ton of uranium.

Locality 6

Locality 6 contains several radioactive bodies. The pit dug by Mr. Hinman shown on the western part of figure 7 was located for convenience of digging, not because of unusual radioactivity. The silicified reef at the location of the pit was entirely covered. The pit exposed 1.2 feet of dark-gray cryptocrystalline silica that contained

0.21 percent uranium in the east face. Calculation of ore reserves is difficult because of the lack of exposures and lack of development beneath the surface. In this zone, which is about 540 feet long and averages 1 foot wide, an aggregate length of about 135 feet is considered to contain an average of 0.15 percent uranium. Using 12.5 cubic feet per ton, the ore reserves to a depth of 100 feet are about 1,100 tons of rock containing 0.15 percent uranium, or about 1.5 tons of uranium. High-grade pockets can be expected along the vein. It is possible that the average grade along the silicified zone will be greater below the weathered zone.

PLANS FOR DEVELOPMENT

Locality 2 is the most promising uranium property in the district examined to date, and development work was recently begun by Newmont Mining Corp. The mineralized pockets exposed at the surface are high-grade and more numerous than at any other locality. Locality 6 also warrants immediate development. Low-grade continuous mineralized rock is not seen at the surface, but in Mr. Hinman's pit, at a depth of 8 feet, continuous low-grade mineralized rock is exposed within the limits of the pit. The suggested order of development of the nine localities is as follows: 2, 6, 9, 3, 5, 7, 4, 8, and 1.

Locality 2

The best way to develop and explore locality 2 is to drift along the zone from the east. The depth of the zone below the surface will

increase toward the west. The zone should be explored at an average depth beneath the surface of at least 50 feet. The spurlike zones could be explored by crosscuts at small added expense. Long-hole or diamond drilling could be done in conjunction with the drifting to explore for continuity of silicified and mineralized rocks. Diamond drilling probably would not prove too satisfactory in blocking out ore in these erratically spaced lenticular deposits. Bulldozing along the vein would probably prove difficult because of the massive brittle character of parts of the silicified zone. Cuts made by a bulldozer across the reef between massive outcrops would give continuous surface exposures of the zone.

Locality 6

Locality 6 can best be explored by drifting along the silicified zone at an average depth beneath the surface of at least 50 feet. Diamond drilling could be used to determine the continuity of the zone structure at depth, but should not be relied upon as a complete exploration method. Cuts made by a bulldozer between the massive, siliceous outcrops would be a cheap, practical way to explore the surface.

All other localities

All other localities are small low-grade surface showings. If conditions at depth at these localities are similar to those shown

at the Free Enterprise mine, these smaller deposits could be explored by diamond drilling. A drift along the zone that contains uranium minerals would, of course, be the best, though most expensive, method of exploring these deposits. Bulldozing would be almost impossible at localities 1, 4, 5, 8, and 9.

112°00'

T.9 N.

T.8 N.

EXPLANATION

R.4 W. R.3 W.

112°00'

Topography from maps of Missouri Basin Project,
U. S. Bureau of Reclamation, prepared by
Fairchild Aerial Surveys, Inc.

FIGURE 2 - GEOLOGY OF AN AREA CONTAINING URANIFEROUS DEPOSITS
WEST OF CLANCEY, JEFFERSON COUNTY, MONTANA

0 2000 4000 6000 FEET

Contour Interval 40 feet

Geology by W.A. Roberts and A.J. Gude, 3rd.
September 1950

Figure 3.- Index map showing areas mapped in detail and radioactivity anomalies.

GEOLOGIC MAP OF LOCALITY 2
WEST OF CLANCEY, JEFFERSON COUNTY, MONTANA

**GEOLOGIC MAP OF LOCALITY 3
WEST OF CLANCEY, JEFFERSON COUNTY, MONTANA**

Geology by W. A. Roberts
Topography by A. J. Gude 3rd.
September 1950

OFFICIAL USE ONLY