

Uranium-Bearing  
Deposits  
West of Clancey  
Jefferson County  
Montana

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GEOLOGICAL SURVEY BULLETIN 988-F





# Uranium-Bearing Deposits West of Clancey Jefferson County Montana

By WAYNE A. ROBERTS and ARTHUR J. GUDE 3D

A CONTRIBUTION TO THE GEOLOGY OF URANIUM

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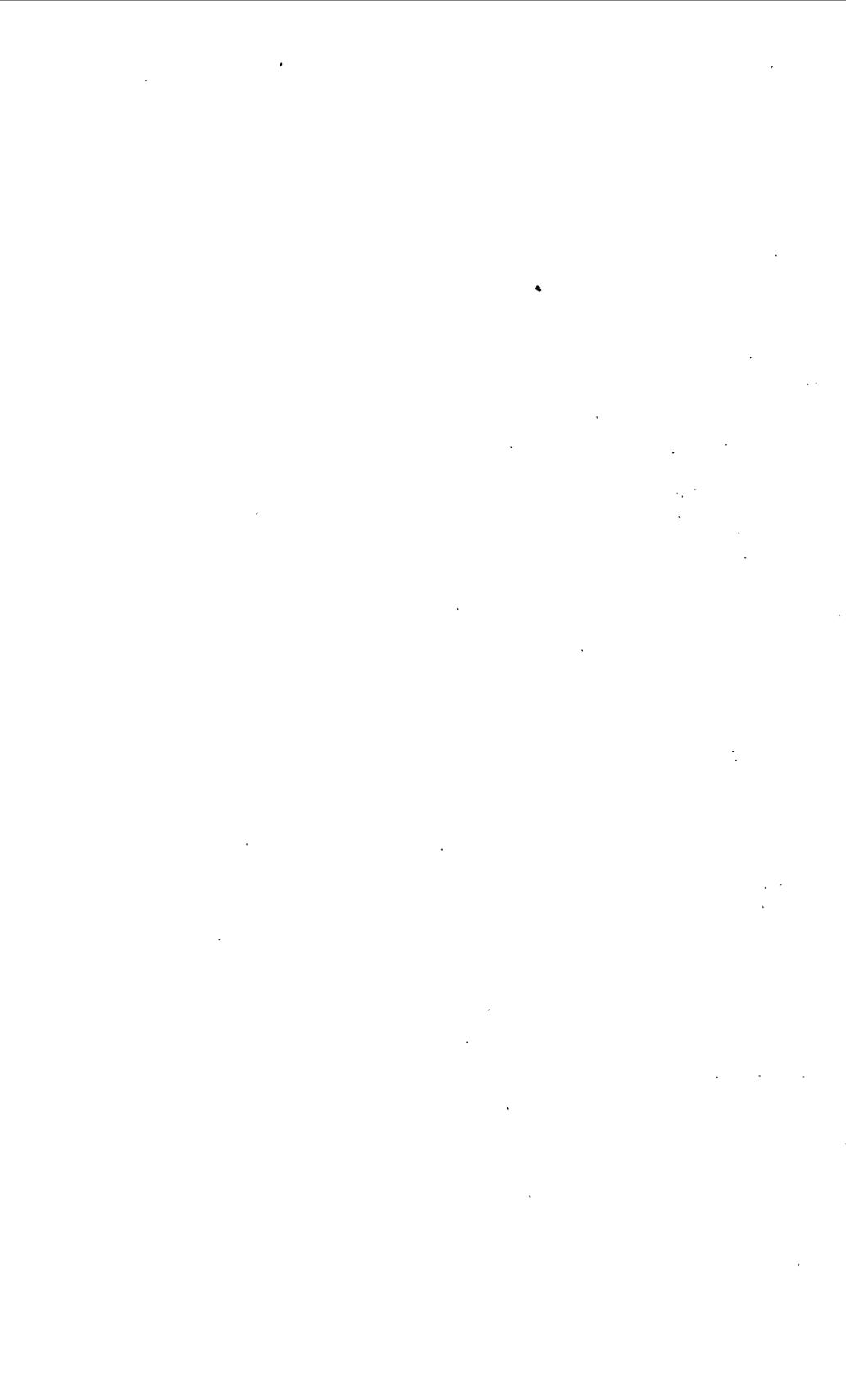
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## URANIUM-BEARING DEPOSITS WEST OF CLANCEY, JEFFERSON COUNTY, MONTANA

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### 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 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.

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 the deposits.

### INTRODUCTION

Uranium-bearing mineral deposits near Clancey, Jefferson County, Mont. (fig. 34), were investigated in the 1950 field season. This 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 of ore deposits in and around the Boulder batholith that was begun by the Geological Survey in 1949. After field reconnaissance by geologists of the Geological Survey and the Atomic Energy Commission, an area of about 9 square miles in T. 8 N., R. 3 W., was selected for detailed geologic study. The geology of this area (pl. 18) was mapped by the writers under the general direction of Montis R. 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 report.<sup>1</sup> In the present report the areal geology is summarized, and 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 35. The

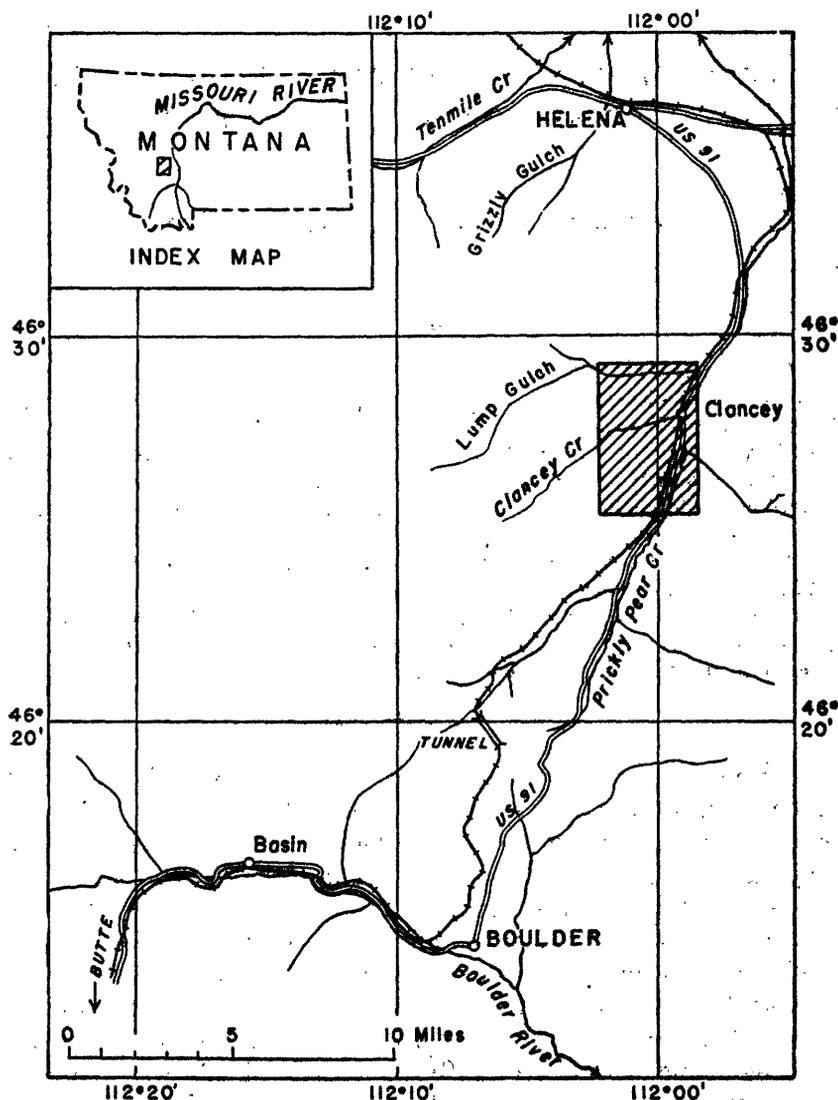


FIGURE 34.—Index map showing area mapped near Clancey, Jefferson County, Mont.

<sup>1</sup> Roberts, W. A., and Gude, A. J. 3d 1950, Preliminary report on the uranium-bearing deposits near Clancey, Jefferson County, Mont. [Memo. rept. in files of U. S. Geol. Survey.]

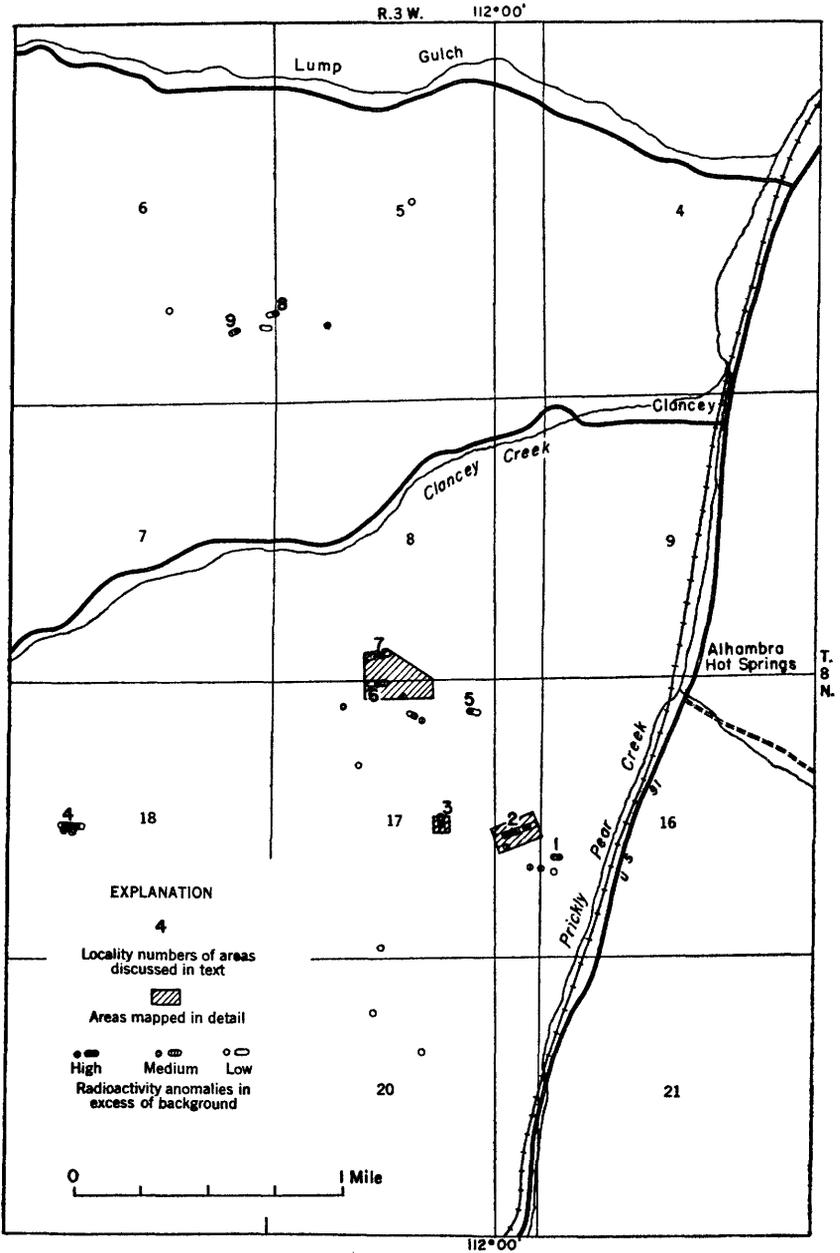


FIGURE 35.—Index map showing areas mapped in detail and radioactivity anomalies.

deposits at localities 2 and 6 were chosen for detailed study because they appeared to contain 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 on a scale of 1:24,000. The geology of the four selected deposits was mapped in detail by 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 a Geiger counter with 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. 34). U. S. Highway 91 and a branch of the Great Northern Railway 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.<sup>2</sup>

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 were 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. During November 1950, Newmont Mining Corp. signed leases with both Mr. Hinman and the Haynes estate and commenced development at locality 2.

Mr. Hinman was most helpful to the writers during the field work. Laboratory analyses given in this report were made by the Trace Elements Laboratory of the Geological Survey.

## GEOLOGY

The area mapped (fig. 34) 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 sheetlike masses of alaskitic composition having aplitic, granitic, porphyritic, and pegmatitic textural facies. Nearly all these younger intrusive

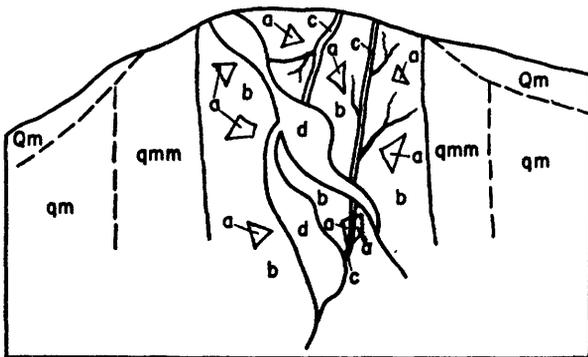
<sup>2</sup> Knopf, Adolph, 1913, Ore deposits of the Helena mining region, Montana: U. S. Geol. Survey Bull. 527, pp. 103-107. Pardee, J. F., and Schrader, F. C., 1933, Metalliferous deposits of the greater Helena mining region, Montana: U. S. Geol. Survey Bull. 842, pp. 227-232.

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 individually on the maps and have been mapped as an undivided unit called aplite, granite porphyry, granite, and 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, locally called reefs, commonly form ridges that are prominent features of the topography. 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 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 dark-gray cryptocrystalline silica that probably contains a disseminated primary uranium mineral. Most zones have been somewhat brecciated after silicification.

Four periods of silicification (fig. 36) have been recognized from the relationship of veinlets of cryptocrystalline and opaline silica occurring at one locality in an intensely brecciated and silicified zone.



FIGURES 36.—Diagrammatic section 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.

One dacite porphyry dike has been silicified, indicating that at least locally one period of silicification postdated the intrusion of the dacite porphyry.

## IGNEOUS ROCKS

### QUARTZ MONZONITE

The principal rock in the Clancey area is quartz monzonite in which the quantity of ferromagnesian 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 are common in the quartz monzonite. These inclusions probably are recrystallized Cretaceous volcanic rocks 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 dikelike 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 the origin of the altered quartz monzonite. 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 monzonites have been differentiated on the detailed maps.

**APLITE, GRANITE PORPHYRY, GRANITE, AND PEGMATITE**

The aplite, granite porphyry, granite, and pegmatite unit shown on the map 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 granite porphyry facies. There is some evidence 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 to crystallize.

The alaskitic rocks are composed essentially of quartz and potash feldspar.<sup>3</sup> Biotite occurs in small amounts in the granite and 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 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.

Usually most of the alaskite outcrops cannot be represented on 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 has been mapped separately.

**QUARTZ MONZONITE PEGMATITE**

Two small pegmatites of quartz monzonitic or granodioritic composition were mapped (pl. 18, center sec. 4 and center N½ 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, hill wash, talus, and mantle.

<sup>3</sup> For simplicity this rock unit will be referred to as alaskite in the remainder of the report.

Two levels of terrace gravels are found along Prickly Pear Creek (pl. 18). Both terraces consist of stream-worn 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, hill wash, 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 obtained from ores of silver, gold, lead, and copper. These ores are 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 are generally 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

reefs 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 (pls. 19 and 21). 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  $\frac{1}{8}$  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 half an 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 (pls. 19, 20, and 21) 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 primary uranium possibly was deposited from ascending emanations of epithermal character during one of the periods of silicification.

The secondary uranium minerals enclosing small remnants of pitchblende are colloform and appear to replace the pitchblende. These uranium minerals occur in what appear to be tectonic cavities in silica breccia. This suggests that the uranium mineralization is younger than some of the silicification and brecciation. 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,<sup>4</sup> a primary uranium mineral, was found only at 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 Geology Survey Trace Elements Laboratory.<sup>5</sup> At all the numbered localities (fig. 35) a green mineral which has been identified as torbernite-zeunerite was present. 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

<sup>4</sup> Identified by Joseph Berman, U. S. Geological Survey Trace Elements Laboratory report TWX-178 on a sample submitted by M. R. Klepper.

<sup>5</sup> Identified by M. N. Girhard, U. S. Geological Survey Trace Elements Laboratory report TWM-178.

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 disintegration products.

#### DESCRIPTION OF INDIVIDUAL DEPOSITS

There are about 25 localities in the area (fig. 35) 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 these 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 in 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 which averages 0.25 percent uranium 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 localities having 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. Finman and is entirely on the Haynes homestead. The geology of

this locality was mapped on a scale of 1 inch=40 feet (pl. 19). 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-grey cryptocrystalline silica is present in all but one of the five small uranium-bearing lenses. Silica that is similar in appearance but nonradioactive 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,<sup>6</sup> "gives an X-ray pattern of pitchblende with  $a_0 = 5.46 \pm .01$ . 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 about  $\frac{1}{4}$  to  $\frac{1}{2}$  inch in diameter.

<sup>6</sup> U. S. Geological Survey Trace Elements Laboratory report TWX-178 on mineral sample MRK-1.

Chemical assays on samples from locality 2 show a range of 0.007 to 9.58 percent uranium. The locations sampled and the percent of uranium in each sample are shown on plate 19 scattered along 1,200 to 1,300 feet of silicified zone and adjoining spurlike structures.

*Locality 3.*—Locality 3 is part of the Harry S. claim of Mr. Hinman. The geology of this locality was mapped on a scale of 1 inch=20 feet (pl. 20).

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 plate 20, 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 (pl. 20) show a range of 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 on a scale of 1 inch=50 feet (pl. 21).

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 silification cut both of the 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, in the western part of the locality (pl. 21), where samples R-O-38 to R-O-41 were collected. (See table, p. 82.) There 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.

*Analyses of samples from uranium deposits near Clancey, Jefferson County, Mont.*

Sample no.	Length (feet)	Uranium (percent)	Equivalent uranium (percent)	Local- ity <sup>1</sup>	Remarks
R-O-2	-----	9.58	9.50	2	Grab sample, high-grade.
R-O-3	0.8	2.29	2.44	2	Hanging walls of gouge.
R-O-4	.7	2.55	2.66	2	Footwall of gouge.
R-O-5	1.7	.46	.47	2	Gouge parallel to structure.
R-O-6	1.5	.042	.038	2	Across reef outcrop.
R-O-7	1.5	.009	.014	2	Across reef outcrop.
R-O-8	.7	.41	.40	2	Small pit, across exposed rock.
R-O-9	.5	.44	.44	2	Small pit, composite.
R-O-10	.5	.15	.13	2	Small pit, dark-gray silica.
R-O-11	1.1	.22	.24	2	Across altered quartz monzonite.
R-O-12	1.9	.14	.13	2	Across silicified quartz monzo- nite.
R-O-13	1.8	.15	.16	2	Across silicified quartz monzo- nite.
R-O-14	1.8	.035	.037	2	Across silicified quartz monzo- nite.
R-O-15	-----	.20	.21	2	Grab sample, silica.
R-O-16	.8	.016	.014	2	Altered quartz monzonite.
R-O-17	1.0	.007	.011	2	Quartz monzonite wall rock.
R-O-18	.6	.071	.083	2	Silica.
R-O-19	.3	.040	.032	2	Altered quartz monzonite.
R-O-20	-----	.17	.16	2	Grab sample, shows secondary.
R-O-21	5.0	.22	.19	2	Across exposed reef.
R-O-22	-----	1.27	1.37	2	Grab sample, mineralized rock.
R-O-23	-----	.20	.18	2	Grab sample, dark-gray silica.
R-O-24	.4	.36	.24	3	Across mineralized zone.
R-O-25	3.7	.093	.065	3	Composite.
R-O-26	.8	.067	.067	3	Silica vein.
R-O-27	1.0	.016	.026	3	Altered quartz monzonite.
R-O-28	1.0	3.18	3.12	2	Across pit, more mineralized.
R-O-29	.25	.30	.29	2	Across pit, less mineralized.
R-O-30	-----	.058	.070	2	Grab sample.
R-O-31	-----	.058	.070	2	Soil.
R-O-32	-----	.19	.16	6	Grab sample, footwall.
R-O-33	-----	.010	.011	6	Grab sample, silica vein.
R-O-34	-----	.12	.13	6	Grab sample, hanging wall.
R-O-35	-----	.091	.075	6	Grab sample, dump.
R-O-36	-----	.044	.051	6	Grab sample, silica.
R-O-37	.5	.18	.19	6	Across silica vein.
R-O-38	.25	.14	.12	6	Across silica vein.
R-O-39	4.5	.024	.027	6	Composite across altered zone.
R-O-40	5.0	.023	.022	6	Composite across altered zone.
R-O-41	1.2	.21	.20	6	Across silica vein.
R-O-42	.7	.026	.020	7	Across silica vein.
R-O-43	4.7	.011	.016	7	Composite across altered zone.
R-O-45	-----	.18	.19	5	Grab sample, silica.
R-O-46	3.5	.071	.062	5	Across silica zone.
R-O-47	8.0	.027	.027	5	Along silica zone.

See plates 19, 20, and 21 for location of samples.

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 half a foot thick along 540 feet of the zone. No evidence of enrichment by concentration of uranium minerals was seen. Chemical assays of samples show a range of 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 is shown on plate 21.

Locality 7 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 (pl. 21). 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. 35) occur in silicified zones that trend approximately east and dip steeply south to vertically. Localities 8 and 9 are within an eastward-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 occurrences of uranium minerals 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 eastward-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 eastward-trending zone with two smaller northeastward-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 eastward-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. Hinman 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 that the structures which are nonuraniferous at the surface are 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. It is probable that the dark-gray cryptocrystalline silica 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. The analyses show that it 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 seem to be smaller but they might be worth developing.



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