DEPARTMENT OF THE INTERIOR
UNITED STATES GEOLOGICAL SURVEY

TO ACCOMPANY MAP MR-28

THORIUM AND RARE EARTHS IN THE UNITED STATES

(Exclusive of Alaska and Hawaii)

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Introduction

The accompanying map shows the location of the principal deposits of thorium and rare-earth minerals in the United States (excluding Alaska and Hawaii). Symbols of different shapes are used to depict deposits of different geologic types, and sizes of symbols denote the relative importance of the deposits. Because of scale limitations a symbol may represent groups of deposits too closely spaced to permit them to be distinguished separately. Some districts of considerable extent are shown by a shaded pattern.

The deposits are numbered by states on the map and identified in the locality index. The index gives the geographic coordinates of the deposits, brief geologic descriptions, and references to the principal published reports if such exist. Unpublished data of the U.S. Atomic Energy Commission and the U.S. Geological Survey have also been used in compiling the map.

Chemistry and mineralogy

Thorium and the rare-earth metals have certain properties in common, such as similar ionic radii, causing them to be generally associated in minerals and rocks; hence they are treated together on the accompanying map.

The rare-earth metals comprise 15 elements having atomic numbers 57 to 71, including lanthanum (La), cerium (Ce), praseodymium (Pr), neodymium (Nd), promethium (Pm), samarium (Sm), europium (Eu), gadolinium (Gd), terbium (Tb), dysprosium (Dy), holmium (Ho), erbium (Er), thulium (Tm), ytterbium (Yb), and lutetium (Lu). The first seven elements listed above are included in the cerium group of rare earths. Promethium does not occur in nature. Yttrium, with atomic number 39, is also classed with the rare earths because of its chemical similarities and geochemical affinities, particularly with the heavier lanthanides. Yttrium and the remaining 8 lanthanides listed above are commonly referred to as the yttrium group. The properties of the members of these two groups of rare earths are sufficiently distinct to cause one group to predominate over the other in most minerals, even though all or nearly all are ordinarily present.

Thorium and the rare earths form, in combination with other elements, a great number of minerals. Only those that have economic importance or potential importance are listed here, by chemical group:

Phosphates

Monazite	$(Ce,La,Th,Y)PO_4$
Xenotime	YPO_4
Apatite	$Ca_5(PO_4)_3F$ (normally has little or no rare earths, but in places rare earths substitute for calcium)

Oxide

Thorianite	ThO_2

Fluorides

Yttrian fluorite	CaF_2
Fluocerite	$(Ce,La,Nd)F_3$

Silicates

Allanite	$(Ca,Ce,Th)_2(Al,Fe,Mg)_3.Si_3O_{12}(OH)$
Stillwellite	$(Ce,Ca)B\ (Si,P)(O,OH)_5$
Thalenite	$Y_4Si_4O_{13}(OH)_2$
Gadolinite	$Be_2FeY_2Si_2O_{10}$
Thorite	$ThSiO_4$
Thorogummite	$Th(SiO_4)_{1-X}(OH)_4X$
Cerite	$(Ce,Ca)_2Si(O,OH)_5$
Lovchorrite	$Ce_2(TiO_3)_3.10CaSiO_3.2CeF_3$

Multiple oxides containing niobium, tantalum, and titanium

Euxenite-polycrase series

Euxenite	$(Y,Ca,Ce,U,Th)(Nb,Ta,Ti)_2O_6$
Polycrase	$Y,Ca,Ce,U,Th)(Ti,Nb,Ta)_2O_6$

Fergusonite-formanite series

Fergusonite	$(Y,Er,U,Th)(Nb,Ta,Ti)O_4$
Formanite	$(Y,Er,U,Th)(Ta,Nb)O_4$

Eschynite-priorite series

Eschynite	$(Ce,Ca,Fe,Th)(Ti,Nb)_2O_6$
Priorite	$(Y,Er,Ca,Fe,Th)(Ti,Nb)_2O_6$
Samarskite	$(Y,Er,Ce,U,Fe,Th)(Nb,Ta)_2O_6$
Perovskite	$CaTiO_3$ (Cerian varieties known)
Brannerite	$(U,Ca,Fe,Th,Y)_3Ti_5O_{16}$
Yttrotantalite	$(Fe,Y,U,Ca)(Ta,Nb,Zr,Sn)O_4$

Pyrochlore-microlite series

Pyrochlore	$NaCaNb_2O_6F$
Microlite	$(Na,Ca)_2Ta_2O_6(O,OH,F)$ (Cerian and thorian varieties known)

Carbonates and fluocarbonates

Bastnaesite	$CeFCO_3$
Parisite	$2CeFCO_3.CaCO_3$
Ancylite	$(Ce,La)_4(Sr,Ca)_3(CO_3)_7(OH)_4.3H_2O$
Synchisite	$CeFCO_3.CaCO_3$
Doverite(?)	$YFCO_3.CaCO_3$

Geologic occurrence

Deposits of the thorium and rare-earth minerals are of two principal types: primary deposits where concentration has occurred in magmas or rocks through chemical processes; and secondary deposits formed by mechanical concentration of the minerals during erosion and transportation.

Thorium- and rare earth-bearing minerals, although widely distributed in igneous and metamorphic rocks, are most abundant in alkalic rocks and carbonatites, in syenites and granites, in gneisses, and in veins, especially those associated with alkalic rocks. In the thorium- and rare earth-bearing vein deposits of the Western States, thorogummite or thorite is commonly the most important mineral.

A few deposits are known where rare-earth- and thorium-bearing minerals, such as monazite and xenotime, have been concentrated in metamorphic rocks, and have been detected because of their radioactivity due to thorium. Other similar deposits may have escaped notice, particularly if the radioactivity is low.

Many pegmatites contain sparse rare-earth- and thorium-bearing minerals and have yielded small quantities of minerals that contain some of the less abundant lanthanides of the yttrium group.

The minerals of thorium and rare earths are relatively insoluble in water, and these elements do not tend to migrate or be concentrated by supergene chemical processes. For the same reason these minerals are generally resistant to weathering and, as they are heavier than the common rock forming minerals, they accumulate in placer concentrations in streams and on beaches. These detrital accumulations have formed at many times and places during geologic history, and have been incorporated in sedimentary rocks of various ages. Many of these placer deposits are extensive; they are easily mined, and may have other valuable products such as gold, zircon, and niobium and titanium minerals. Consequently, much of the world supply of thorium and rare earth minerals comes from placer deposits.

Geographic distribution

The outstanding rare-earth deposits of the conterminous United States is at Mountain Pass, Calif., where large reserves of bastnaesite-rich carbonatite of Precambrian age are known. In this deposit the cerium group of elements predominates, and the thorium content is very low, although thorite and thorogummite occur in veins associated with potassium-rich rocks. Numerous smaller occurrences of a variety of geologic types in southern California and western Arizona, together with Mountain Pass, seem to constitute a rare-earth thorium-rich province.

Deposits of various types are numerous in the Rocky Mountain region. In the Wet Mountains and the Powderhorn district, Colorado, and the Lemhi Pass district, Idaho-Montana, hundreds of thorium-rich veins are known. One of the most important areas is that of the Idaho batholith where monazite- and euxenite-bearing stream placers have been worked, most extensively at Bear Valley and near Cascade. Elsewhere, from Idaho to Texas, thorium and rare-earth minerals occur in geologic environments that range from Precambrian gneisses and pegmatites to Tertiary alkalic igneous rocks and veins to modern placers.

In the Southeast, monazite has been produced from stream placers in North Carolina and South Carolina. Beach placers containing titanium minerals and small amounts of monazite extend along the coast, chiefly between South Carolina and central Florida. Some of the black sands of the Southeast are second generation deposits derived from reworking of older Coastal Plain formations.

The metamorphic and igneous rocks of the Appalachian region contain minor concentrations of thorium and rare-earth minerals at many places. In addition, many of the magnetite deposits in the northeastern states contain minerals such as rare-earth-bearing apatite, monazite, bastnaesite, doverite(?), and thorite.

Scattered deposits also occur in the midcontinent region at Hicks Dome, Illinois, and with alkalic rocks at Wausau, Wisconsin, and Magnet Cove, Arkansas.

Locality Index

Locality	Lat. N.	Long. W.
ALABAMA		
1. Baker Hill. Rare earths in lignitic clay. Warner and others, 1959	31°53′	85°14′
ARIZONA		
1. Virgin Mountains. Monazite and xenotime in linear zone in Precambrian gneiss.	36°43′	114°01′
2. Blendina claims. Monazite in metamorphic rocks.	35°48	114°38′
3. Hillside and Quartz Mountain claims. Pegmatites contain pods of euxenite, polycrase(?), monazite, and allanite(?).	35°51′	113°58′
4. Black Mountain Trading Post area. Monazite in ancient titaniferous beach placers in Upper Cretaceous sandstone. Murphy. 1956.	36°13′	109°52′
5. Kingman feldspar mine group. Pegmatites contain allanite. Heinrich, 1960.	35°16′	114°05′
6. Mineral X claim. Pegmatite contains fergusonite, thalenite, and allanite.	35°07′	114°05′
7. Cottonwood Creek. Quartz, albite, gadolinite, and wolframite fill fractures in pegmatites. Cameron and others, 1949.	35°19′	113°28′
8. Aquarius Cliffs area. Pegmatites in aplitic granite contain monazite, yttrotantalite, gadolinite, xenotime, euxenite,	34°49′	113°28′

chevkinite, and allanite. Moore, 1953; Heinrich, 1960.

9. Cottonwood area. Thorium-bearing quartz-limonite-hematite veins in Precambrian metavolcanic and metasedimentary rocks. 34°43′ 112°06′

10. Signal district. Pegmatites contain euxenite, samarskite, and allanite. 34°32′ 113°33′

11. Rawhide Mountains-McCracken Mountains area. Thorium and rare earths associated with pegmatites and fault zones in Precambrian schist and granite. 34°22′ 113°46′

12. Willbanks prospect. Minor thorium, associated with hematite, limonite, and barite, in fine-grained mafic dike in Precambrian granite. 34°04′ 112°22′

13. Cave Creek area. Altered thorite in biotite granite. 33°54′ 111°58′

14. Quartzsite area. Thorium sparsely distributed in Precambrian schist adjacent to quartz vein. 33°40′ 114°17′

15. Hope area. Radioactive minerals, probably monazite and zircon, disseminated in granitic rock. 33°43′ 113°42′

16. Buckeye area. Biotite granite contains magnetite, euxenite, and xenotime. 33°17′ 112°35

17. Ligurta area. Samarskite and allanite occur sporadically in pegmatites. 32°40′ 114°18′

18. Papago Wells. Monazite in pegmatites. Flagg, 1958. 32°07′ 113°18′

19. Quijotoa Mountains. Davidite and allanite in contact zones between metaspessartite dike and quartz monzonite. Pabst and Thomssen, 1959; Williams, 1960. 32°08′ 112°09′
32°08′ 112°12′

ARKANSAS

1. Potash Sulfur Spring area. Rare earths in altered syenite. Fryklund and others, 1954. 34°26′ 92°58′

2. Magnet Cove. Rare earths in apatite, perovskite, and monazite associated with carbonatite. Fryklund and Holbrook, 1950; Rose and others, 1958. 34°27′ 92°52′

CALIFORNIA

1. Gorman area. Radioactivity, due chiefly to thorium, found along shear zones in granite; also associated with biotite-rich layers and pegmatitic zones. 34°39′ 118°57′

2. Jackrabbit prospect. Radioactivity, probably due to thorium, found along fault in granite. 34°44′ 118°42′

3. Pacoima Canyon. Allanite, apatite, zircon, beryl, and uranothorite in pegmatite in norite. Neuerburg, 1954. 34°20′ 118°15′

4. Roll prospect. Thorium-bearing allanite in granitic detritus. Walker and others, 1956. 34°48′ 117°38′

5. Hoerner-Ross pegmatite. Pegmatite in quartz monzonite contains cyrtolite and betafite. Hewett and Glass, 1953. 34°53′ 116°19′

6. Rainbow claims. Monazite and thorite associated with hematite and magnetite in pegmatite. Walker and others, 1956. 35°13′ 115°55′

7. Marl Spring area. Thorium-bearing gneiss in area of Precambrian metasediments cut by pegmatites and granite. 35°11′ 115°43′

8. Mountain Pass district. Bastnaesite, parisite, thorite, thorogummite, allanite, cerite, sahamalite, and barite in carbonatite and veins in Precambrian gneiss, associated with potash-rich igneous rocks. Olson and others, 1954. 35°28′ 115°33′

9. Winchester pegmatite. Xenotime and monazite in pegmatites. Murdoch and Webb, 1956. 33°45′ 117°05′

10. Alger Creek. Pegmatitic zone in gneiss contains uranothorite, allanite, and zircon. Hewett and Stone, 1957. 34°06′ 116°56′

11. Lucky Seven and Birthday No. 4 prospects. Thorium-bearing allanite and monazite disseminated in biotite-rich pods in granite. Walker and others, 1956. 34°17′ 116°38′

17. Old Woman Spring brannerite locality. Brannerite and minor euxenite sparsely distributed in gneiss. Hewett, Stone, and Levine, 1957. 34°21′ 116°40′

13. Rock Corral area. Allanite, monazite and zircon in biotite-rich inclusion in quartz monzonite; monazite and allanite in small vein; minor samarskite, euxenite, allanite, monazite in pegmatite. Moxham and others, 1955. 34°16′ 116°28′

14. Steiner prospect. Radioactivity, probably due to monazite and allanite, found along small fault in biotite schist. Walker and others, 1956. 34°13′ 116°19′

15. Copper Mountain area. Thorite, uranothorite, and allanite in shear zone in diorite and gneiss; monazite and allanite localized in biotite-rich parts of gneissoid granite. Walker and others, 1956. 34°09′ 116°11′

16. Live Oak Tank area. Monazite, xenotime, and allanite(?) in granite gneiss, biotite schist, and monzonite, and in black sands derived from these rocks. Walker and other, 1956. 34°02′ 116°01′

17. Lost Angel prospect. Thorium associated with chloritic schist in a complex of banded gneiss, migmatite, and granitic rocks. 33°53′ 116°06′

18. Desert View. Radioactivity, probably due to monazite, found in Precambrian gneiss; associated chiefly with biotite schist. Walker and others, 1956. 33°42′ 115°58′

19. Eureka prospect. Monazite in small zone of biotite schist in Precambrian complex. 33°35′ 115°28′

COLORADO

1. Timberlake area. Monazite-bearing placers. Day and Richards, 1906. 40°47′ 107°44′

2. Mt. Zirkel area Monazite, cyrtolite(?), uraninite, and beryl in pegmatite 40°50′ 106°44′

3. Red Head claim. Monazite and cyrtolite, associated with beryl, columbite-tantalite, and topaz in pegmatite. 40°53′ 105°28′

4. Storm Mountain area. Thorium-bearing mineral in pegmatite. 40°28′ 105°23′

5. Jamestown. Cerite, bastnaesite, and allanite in pods in aplite dikes; in adjacent areas uranothorite occurs in fluorite breccias. Goddard and Glass, 1940; Phair and Shimamoto, 1952. 40°08′ 105°22′

6. Ralston Creek area. Rare earths in pegmatite. Sheridan and others, 1958. 39°52′ 105°23′

7. Central City area. Xenotime and monazite in gneiss and migmatite; some pegmatite in area contains thorium minerals. Young and Sims, 1958. 39°48′ 105°30′

8. Roscoe. Gadolinite, xenotime, monazite, and yttrian garnet in pegmatite. Hanley and others, 1950. 39°44′ 105°22′

9. Burroughs (Sunrise Peak). Euxenite, allanite, xenotime, monazite, gadolinite(?), beryl, and columbite-tantalite in pegmatite. Boos, 1954. 39°41′ 105°20′

10. Climax molybdenum mine. Monazite sparsely disseminated in molybdenum ore body. U.S. Inter-Agency Comm. Arkansas-White-Red River Basins, 1955. 39°21′ 106°10′

11. South Platte district. Cyrtolite, gadolinite, allanite, monazite, bastnaesite, and doverite in pegmatites. Haynes, 1958. 39°24′ 105°12′

12. Lone Lode. Monazite, associated with ilmenite and leucoxene, in pegmatite. 39°20′ 105°25′

13. Palisade-Grand Mesa area, north. Monazite an ancient titaniferous beach placers in Upper Cretaceous sandstone. Murphy and Houston, 1955. 39°06′ 108°16′

14. Palisade-Grand Mesa area, south. Monazite in ancient titaniferous beach placers in Upper Cretaceous sandstone. Murphy and Houston, 1955. 39°01′ 108°14′

15. Lake George area. Yttrofluorite, gadolinite, xenotime, monazite, allanite, samarskite(?), euxenite(?), and possibly thorite in pegmatites. Glass and Rose, 1958. 38°59′ 105°23′

16. Black Cloud. Fluocerite, monazite, xenotime, samarskite, thorite, fergusonite, allanite, gadolinite, and yttrotantalite in pegmatite. Heinrich and Gross, 1960. 38°57′ 105°12′

17. Trout Creek Pass. Euxenite, allanite, and monazite in pegmatites. Heinrich, 1948. 38°52′ 106°02′

18. Turret area. Thorium and rare earths locally in granitic gneiss. 38°40′ 105°59′

19. Guffey area. Euxenite, monazite, and allanite in pegmatites. 38°45′ 105°30′

20. St. Peter's Dome (Stove Mountain) area. Rare-earth minerals, thorite, and columbite in pegmatites. 38°45′ 104°55′

21. Olhio prospect. Xenotime and Monazite in dike of granitic rock. 38°36′ 105°25′

22. Quartz Creek district. Sparse monazite in 24 pegmatites, notably Brown Derby No. 1. Staatz and Trites, 1955. 38°34′ 106°38′

23. White Pine area. Thorium-bearing altered rock along probable fault zones in granite adjacent to small area of Sawatch quartzite. Dings and Robinson, 1957. 38°32′ 106°24′

24. Whitecross area. Thorium-bearing vein material, containing galena, sphalerite, quartz, and rhodochrosite, found on dump of flooded shaft. Pierson and others, 1958. 37°57′ 107°28′

25. Powerhorn district. Thorite and thorogummite occur in veins in Precambrian complex; minor bastnaesite, synchisite, and cerite (?) reported in carbonate veins. Olson and Wallace, 1956. 38°19′ 107°07′

26. Cochetopa Creek-Razor Creek area. Thorium-bearing veins along shear zones in Precambrian granite. Burbank and Pierson, 1953. 38°19′ 106°40′

27. Jacks Creek area. Thorium-bearing vein containing hematite and jasperoid in hornblende-biotite schist. Brown and Malan, 1954. 38°13′ 106°19′

28. Villa Grove area. Xenotime, euxenite, and cyrtolite in pegmatite. Brown and Malan, 1954. 38°17′ 105°52′

29. Cotopaxi area. Samarskite and (or) euxenite, xenotime, allanite, and gadolinite in pegmatites. Hanley and other, 1950. 38°24′ 105°40′

30. Texas Creek area. Thorium-bearing veins in Precambrian gneisses. 38°20′ 105°35′

31. Wet Mountains district. Thorite, thorogummite, hematite, sulfides, and rare earths in quartz-barite-feldspar veins in Precambrian gneisses. Singewald and others, 1955.	38°14′	105°20′
32. Crestone area. Euxenite, monazite, and cyrtolite in pegmatite. Brown and Malan, 1954.	38°03′	105°44′
33. Mancos River area. Monazite in ancient titaniferous beach placers in Upper Cretaceous sandstone. Murphy, 1956.	37°06′	108°38′

CONNECTICUT

1. Salisbury area. Rhabdophane in Scoville iron ore. Hildebrand, and others, 1957.	42°00′	73°26′
2. Glastonbury district. Allanite, monazite, xenotime, yttrotantalite, and samarskite in pegmatite. Sohon, 1951.	41°43′	72°37′
3. Yantic Falls and Norwich areas. Monazite in sillimanite schist. Foye, 1949.	41°36′	72°08′
4. Flatrock quarry. Aeschynite and monazite reported to occur in granite. Foye, 1949.	41°23′	72°09′

FLORIDA

1. Amelia Island. Monazite-bearing beach placers. Eilertsen and Lamb, 1956; Moxham, 1958.	30°37′	81°27′
2. Talbot Island. Monazite-bearing beach placers. Eilertsen and Lamb, 1956. Moxham, 1958.	30°28′	81°26′
3. Atlantic Beach. Monazite-bearing beach placers. Eilertsen and Lamb, 1956; Moxham, 1958.	30°21′	81°24′
4. Jacksonville. Monazite-bearing beach placers. Eilertsen and Lamb, 1956; Moxham, 1958.	30°18	81°33′
5. Jacksonville Beach. Monazite-bearing beach placers. Eilertsen and Lamb, 1956; Moxham, 1958.	30°15′	81°23′
6. Anastasia Island. Monazite-bearing beach placers. Eilertsen and Lamb, 1956; Moxham, 1958.	29°50′	81°17′
7. Flagler Beach. Monazite-bearing beach placers. Eilertsen and Lamb, 1956; Moxham, 1958.	29°27′	81°07′
8. Melbourne (Palm Bay). Monazite-bearing beach placers. Calver, 1957.	28°07′	80°37′
9. Winter Beach (Wabasso). Monazite in dune deposit. Calver, 1957.	27°45′	80°26′
10. Vero Beach. Monazite in dune deposit. Calver, 1957.	27°38′	80°23′
11. Manasota Peninsula. Radioactive beach sands. Meuschke and others, 1953.	27°03′	82°26′
12. Punta Gorda Beach. Radioactive beach sands. Meuschke and others, 1953.	26°57′	82°22′
13. Don Pedro Island. Radioactive beach sands. Meuschke and others, 1953.	26°51′	82°18′

GEORGIA

1. Elberton area. Allanite in Elberton granite; altered to bastnaesite, huttonite (?), and other minerals. Silver and Grunenfelder, 1957.	34°06′	82°50′
2. Savannah Beach. Monazite-bearing beach placers. Moxham and Johnson, 1953.	31°59′	80°53′
3. Skidaway Island. Monazite-bearing beach placers. Moxham and Johnson 1953.	31°53′	80°58′
4. Ossabaw Island. Monazite-bearing beach placers. Moxham and Johnson, 1953.	31°47′	81°06′
5. St. Catherine's Island north. Monazite-bearing beach placers. Moxham and Johnson, 1953.	31°40′	81°08′
6. St. Catherine's Island south. Monazite-bearing beach placers. Moxham and Johnson, 1953.	31°35′	81°10′
7. Sapelo Island. Monazite-bearing beach placers. Moxham and Johnson, 1953.	31°26′	81°15′
8. Sea Island Beach. Monazite-bearing beach placers. Moxham and Johnson, 1953.	31°12′	81°21′
9. Jekyll Island. Monazite-bearing beach placers. Moxham and Johnson, 1953.	31°03′	81°24′
10. Cumberland Island. Monazite-bearing beach placers. Moxham and Johnson, 1953.	30°52′	81°26′

IDAHO

1. Porthill district. Thorite (?) in thorium-bearing veins in Belt series rocks U.S.A. Purcell dioritic sills Canada. Weis ond others, 1958.	48°58′	116°24′
2. Erickson property. Thorium in radioactive biotite gneiss.	49°59′	115°32′
3. Elk City district and Red River placers. Monazite-bearing placers. Armstrong and Weis, 1957; Eilertsen and Lamb, 1956; Mackin and Schmidt, 1956.	45°51′	115°25′
4. Grouse Creek. Monazite-bearing placers. Eilertsen and Lamb, 1956; Mackin and Schmidt, 1956.	45°29′	116°00′
5. Lake Creek. Monazite-bearing placers. Eilertsen and Lamb, 1956; Mackin and Schmidt, 1956.	45°17′	115°54′

6. Kelly Meadows. Monazite-bearing placers. Eilertsen and Lamb, 1956; Mackin and Schmidt, 1956. 45°18′ 115°48′

7. Warren Meadows. Monazite-bearing placers. Eilertsen and Lamb, 1956; Mackin and Schmidt, 1956. 45°17′ 115°42′

8. Secesh Meadows. Monazite-bearing placers. Eilertsen and Lamb, 1956; Mackin and Schmidt, 1956. 45°15′ 115°48′

9. Squaw Meadows. Monazite-bearing placers. Eilertsen and Lamb, 1956; Mackin and Schmidt, 1956. 45°10′ 116°00′

10. Mineral Hill district. Monazite in carbonate rock or marble; thorite in schist; allanite and monazite in pegmatite. Abbott, 1954; Anderson, 1958; Kaiser, 1956. 45°26′ 114°11′

11. Diamond Creek area. Monazite, thorite, and xenotime (?) in shear zones and gold-quartz veins in Belt series and granite. Anderson, 1958. 45°17′ 113°57′

12. Big Jureano Creek. Thorium-bearing allanite in pegmatites. Shockey, 1957. 45°10′ 114°14′

13. Sandy Creek area. Thorium and rare earths with quartz and specular hematite in veins in Belt series. 45°05′ 113°35′

14. Lemhi Pass district. Thorite and minor monazite in quartz-hematite and and quartz-hematite-barite veins in Belt series. Anderson, 1958; Sharp and Cavender, 1953; Weis and others, 1958. 44°58′ 113°34′

15. West Mountain. Monazite-bearing placers. Eilertsen and Lamb, 1956; Mackin and Schmidt, 1956. 44°41′ 116°09′

16. Gold Fork. Monazite-bearing placers. Eilertsen and Lamb, 1956; Mackin and Schmidt, 1956; Storch, 1958. 44°43′ 116°02′

17. Stolle Meadows. Monazite-bearing placers. Eilertsen and Lamb, 1956; Mackin and Schmidt, 1956. 44°37′ 115°41′

18. Scott Valley and Horsethief Basin. Monazite-bearing placers. Eilertsen and Lamb, 1956; Kline and others, 1951a; Mackin and Schmidt, 1956. 44°34′ 115°54′

19. Cascade district (Long Valley). Monazite-bearing placers. Eilertsen and Lamb, 1956; Kline and Carlson, 1954; Kline and others, 1955, 1951b; Mackin and Schmidt, 1956; Storch and Robertson, 1954; Weis and others, 1958. 44°29′ 116°00′

20. Peace Valley. Monazite-bearing placers. Eilertsen and Lamb, 1956; Mackin and Schmidt, 1956. 44°22′ 115°47′

21. Bear Valley. Placers containing euxenite, monazite, and columbite. Eilertsen and Lamb, 1956; Kline and others, 1953; Mackin and Schmidt, 1956. 44°21′ 115°25′

22. Meadow Creek and Valley Creek. Monazite-bearing placers. Eilertsen and Lamb, 1956; Mackin and Schmidt, 1956. 44°18′ 115°05′

23. Stanley Creek and Kelly Creek. Monazite-bearing placers. Eilertsen and Lamb, 1956; Mackin and Schmidt, 1956. 44°15′ 114°55′

24. Gold Creek and Williams Creek. Monazite-bearing placers. Eilertsen and Lamb, 1956; Mackin and Schmidt, 1956. 44°07′ 114°51′

25. Garden Valley. Monazite-bearing placers. Eilertsen and Lamb, 1956; Mackin and Schmidt, 1956. 44°06′ 116°02′

26. Columbite group. Monazite, samarskite, and columbite in pegmatites in Idaho batholith. 44°02′ 115°56′

27. Johnson Creek. Monazite-bearing placers. Eilertsen and Lamb, 1956; Mackin and Schmidt, 1956. 43°56′ 116°20′

28. Boise Basin. Monazite-bearing placers. Eilertsen and Lamb, 1956; Kline and others, 1950; Mackin and Schmidt, 1956. 43°54′ 115°51′

29. Rabbit Creek. Monazite-bearing placers. Eilertsen and Lamb, 1956; Mackin and Schmidt, 1956. 43°49′ 115°41′

30. Alexander Flats. Monazite-bearing placers. Eilertsen and Lamb, 1956; Mackin and Schmidt, 1956. 43°45′ 115°31′

31. Dry Creek. Monazite-bearing placers. Eilertsen and Lamb, 1956; Mackin and Schmidt, 1956. 43°43′ 116°13′

32. Mud Flats. Monazite--bearing placers. Eilertsen and Lamb, 1956; Mackin and Schmidt, 1956. 43°18′ 115°45′

33. Camp Creek. Uranothorite and rare-earth-bearing sphene. Eilertsen and Lamb, 1956; Robertson and Storch, 1955b. 43°22′ 114°34′

34. Rock Creek. Uranothorite and rare-earth-bearing sphene. Eilertsen and Lamb, 1956; Robertson and Storch, 1955a. 43°22′ 114°24′

35. Poverty Flats, Reed Creek, and Dead Sheep Creek. Monazite-bearing placers. Eilertsen and Lamb, 1956; Mackin and Schmidt, 1956. 43°22′ 114°18′

ILLINOIS

1. Hicks Dome. Thorium, yttrium, and other rare earths in clays and fault(?) breccia associated with domal (cryptovolcanic?) structure in Paleozoic sedimentary rocks. Bradbury and others, 1955; Brown and others, 1954. 37°32′ 88°21′

MAINE

1. Standpipe Hill quarry. Monazite and samarskite in pegmatite. Maine Geological Survey, 1957. 43°57′ 69°57′

MASSACHUSETTS

1. Cape Ann. Pegmatites, associated with alkalic granite, contain sparse yttrocerite, allanite, gadolinite, cyrtolite, thorite, fergusonite, and other minerals. Warren and McKinstry, 1924. 42°38′ 70°38′
2. Blueberry Mountain area. Pegmatites, associated with granodiorite, contain allanite, cyrtolite, and thorite. Richmond, 1937. 42°28′ 71°12′
3. Worcester area. Biotite gneiss and pegmatite contain up to 0.032 percent ThO_2, probably in monazite. Johnson, 1951. 42°14′ 71°48′
4. Southbridge area. Pegmatite in hornblende gneiss contains up to 0.03 percent ThO_2. Johnson, 1951. 42°03′ 72°08′
5. Quincy. Pegmatites in riebeckite granite contain parisite, octahedrite, and fluorite. Warren and Palache, 1910. 42°16′ 71°02′

MICHIGAN

1. Palmer area. Monazite in Precambrian pebble conglomerate and quartzite. Vickers, 1956a. 46°26′ 87°33′
2. Gwinn area. Monazite in arkosic quartzite. Vickers, 1956a. 46°17′ 87°29′

MONTANA

1. Milk River deposits. Monazite in ancient titaniferous beach placers in Upper Cretaceous sandstone. Murphy and Houston, 1955; Stebinger, 1941. 48°57′ 112°51′
2. South Fork Milk River. Monazite in ancient titaniferous beach placers in Upper Cretaceous sandstone. Murphy and Houston, 1955; Stebinger, 1914. 48°47′ 113°12′
3. Rimrock Butte deposits. Monazite in ancient titaniferous beach placers in Upper Cretaceous sandstone. Murphy and Houston, 1955; Stebinger, 1914. 48°44′ 112°49′
4. Area northwest of Browning. Monazite in ancient titaniferous beach placers in Upper Cretaceous sandstone. Murphy and Houston, 1955; Stebinger, 1914. 48°38′ 113°07′
5. Area west of Browning. Monazite in ancient titaniferous beach placers in Upper Cretaceous sandstone. Murphy and Houston, 1955; Stebinger, 1914. 48°33′ 113°12′
6. Area north of Badger Creek. Monazite in ancient titaniferous beach placers in Upper Cretaceous sandstone. Murphy and Houston, 1955; Stebinger, 1914. 48°21′ 112°58′
7. Badger Creek Southwest deposits. Monazite in ancient titaniferous beach placers in Upper Cretaceous sandstone. Murphy and Houston, 1955; Stebinger, 1914. 48°19′ 112°52′
8. Area northeast of Heart Butte. Monazite in ancient titaniferous beach placers in Upper Cretaceous sandstone. Murphy and Houston, 1955; Stebinger, 1914. 48°18′ 112°49′
9. Badger Creek Northeast deposits. Monazite in ancient titaniferous beach placers in Upper Cretaceous sandstone Murphy and Houston, 1955; Stebinger, 1914. 48°24′ 112°46′
10. Area east of Four Horns Lake. Monazite in ancient titaniferous beach placers in Upper Cretaceous sandstone. Murphy and Houston, 1955. 48°22′ 112°37′
11. Area northeast of Choteau. Monazite in ancient titaniferous beach placers in Upper Cretaceous sandstone. Murphy and Houston, 1955. 47°57′ 112°19′
12. Area west of Choteau. Monazite in ancient titaniferous beach placers in Upper Cretaceous sandstone. Murphy and Houston, 1955; Wimmler, 1946. 47°47′ 112°33′
13. Rocky Boy area. Carbonate veins and carbonatite in shonkinite and syenite contain burbankite, calkinsite, lanthanite, ancylite, pyrochlore, and thorium; minor smoky quartz vein contains thorium associated with galena and sphalerite. Jarrard, 1957; Pecora, 1956; Pecora and Kerr, 1953. 48°10′ 109°44′
14. Eightmile Creek. Pyrite and parisite disseminated in loosely coherent white material (decomposed rhyolite or trachyte). Penfield and Warren, 1899. 46°39′ 113°56′
15. Victor and McCalla placers. Monazite bearing placers. Eilertsen and Lamb, 1956. 46°26′ 114°06′
16. Duck Creek Pass area. Thorite in and adjacent to aplitic dikes in argillite and limestone of Belt series. Jarrard, 1957; Moen, 1957. 46°31′ 111°19′
17. Lennep area. Monazite in ancient titaniferous beach placers in Upper Cretaceous sandstone. Murphy and Houston, 1955. 46°26′ 110°30′
18. Rye Creek placers. Monazite-bearing placers. Eilertsen and Lamb, 1956. 45°59′ 114°03′
19. Crystal Mountain fluorspar mine. Fergusonite occurs locally in fluorspar ore body in biotite granite. Weis and others, 1958. 46°01′ 113°52′
20. Darby area. Samarskite in pegmatite in Belt series. 45°52′ 114°05′
21. Sheep Creek columbite locality. Columbite, monazite, and a rare earth 45°32′ 114°21′

mineral in dike or vein of carbonate rock. Sahinen, 1957.

22. Trail Creek placers. Monazite-bearing placers. Eilertsen and Lamb, 1956. 45°39′ 113°45′

23. Silver Bow, German Gulch, Price and Power Gulch placers. Monazite-bearing placers. Eilertsen and Lamb, 1956. 45°57′ 112°42′

24. Janney pegmatites. Allanite in small pegmatites in quartz monzonite. Heinrich, 1949. 45°55′ 112°29′

25. Sappington area. Samarskite and (or) euxenite in pegmatite. Heinrich, 1949 45°47′ 111°47′

26. Norris area. Unidentified radioactive mineral in veinlets in granite gneiss; monazite, and minor thorianite and xenotime in placer. Sterrett, 1908. 45°39′ 111°42′

27 Lemhi Pass district. Thorium-bearing veins in Belt series contain rare earths. Trites and Tooker, 1953. 44°57′ 113°25′

28. Deer Creek district. Monazite, allanite, and yttrian fluorite in pegmatites and a fluorite replacement body. Jarrard, 1957; Trites and Tooker, 1953. 44°52′ 112°56′

29. Elk Creek. Thorium mineral in shear zone in Flathead(?) formation, near contact with Precambrian granite. 45°14′ 110°18′

30. Thom property. Monazite and uranocircite in gneissic layer near granite contact, may represent ancient placer. 45°11′ 109°19′

NEVADA

1. Contact district. Allanite reported to occur along contact between granodiorite and Paleozoic sedimentary rocks. Schrader, 1912. 41°44′ 114°40′

2. Dolly Varden district. Radioactivity, due largely to thorium, associated with pegmatites, fractures, and contact areas of quartz monzonite stock. Davis, 1954. 40°25′ 114°35′

3. Red Rock Road area. Allanite in pegmatites in fine-grained biotite granite. Olson and Hinrichs, 1960. 39°45′ 119°56′

4. Fitting district. Uranothorite and huttonite(?) in radioactive fault zones in granite. 38°37′ 118°18′

5. Lucky Susan No. 1 prospect. Small radioactive lenses contain euxenite or samarskite; probably in pegmatite. 37°55′ 118°23′

6. Gold Butte district. Monazite and samarskite in pegmatites. Lovering, 1954. 36°16′ 114°12′

7. Crescent Peak area. Monazite and bastnaesite(?) with apatite and zircon in granite gneiss. 35°28′ 115°09′

8. Superfluous No. 1 claim. Radioactive zone near contact of Jurassic(?) granite with Precambrian metasediments. 35°13′ 114°50′

NEW JERSEY

1. West Milford. Monazite in biotite-rich granite gneiss; magnetite and allanite present in some layers. Markewicz and others, 1957. 41°07′ 74°22′

2. Dover district. Magnetite deposits contain the rare earth-bearing minerals doverite, bastnaesite, monazite, xenotime, chevkinite, and apatite. Klemic and others, 1957; Smith and others, 1960. 40°55′ 74°34′

3. Chester. Rust-brown rock contains monazite and zircon as principal constituents. 40°48′ 74°41′

4. Marble Mountain. Thorium silicate grains in serpentine schist; thorian uraninite in marble; thorium in sericite-quartz schist. McKeown and Klemic, 1953; Montgomery, 1957. 40°44′ 75°11′

NEW MEXICO

1. Shiprock area. Monazite in ancient titaniferous beach placers in Upper Cretaceous sandstone. Murphy, 1956. 36°53′ 108°30′

2. Chaco River area. Monazite in ancient titaniferous beach placers in Upper Cretaceous sandstone. Murphy, 1956. 36°37′ 108°36′

3. Sanostee area. Monazite in ancient titaniferous beach placers in Upper Cretaceous sandstone. Murphy, 1956. 36°28′ 108°55′

4. Toadlena area. Monazite in ancient titaniferous beach placers in Upper Cretaceous sandstone. Murphy, 1956. 36°12′ 108°52′

5. Petaca and Tusas Mountains districts. Monazite and samarskite in pegmatites. Jahns, 1946. 36°32′ 106°02′

6. Ojo Caliente district. Monazite and samarskite in pegmatites. Jahns, 1946. 36°21′ 106°03′

7. Chico Hills. Thorium, rare earths, and columbium in veins in Dakota sandstone and, in lesser amounts, in Tertiary phonolite. 36°36′ 104°13′

8. Crown Point area. Monazite in ancient titaniferous beach placers in Upper Cretaceous sandstone. Murphy, 1956. 35°43′ 108°14′

9. Gallup area. Monazite in ancient titaniferous beach placers in Upper Cretaceous sandstone. Murphy, 1956. 35°30′ 108°50′

10. Chacra Mesa. Monazite in ancient titaniferous beach placers in Upper Cretaceous sandstone. Murphy, 1956. 35°52′ 107°24′

11. Arroyo Torreon area. Monazite in ancient titaniferous beach placers in Upper Cretaceous sandstone. Murphy, 1956. 35°41′ 107°15′

12. San Miguel Creek area. Monazite in ancient titaniferous beach placers in Upper Cretaceous sandstone. Murphy, 1956. 35°32′ 107°28′

13. Pidlite mine. Lithium-bearing pegmatite contains betafite, cyrtolite, and monazite. Jahns, 1953. 35°53′ 105°32′

14. Elk Mountain district. Monazite, gadolinite, samarskite and (or) euxenite in Precambrian metamorphic rocks. Jahns, 1946. 35°46′ 105°33′

15. Sparks-Stone property. Pegmatite contains minor amount of euxenite-type mineral. 35°40′ 105°30′

16. Gallinas Mountains district. Bastnaesite in fluorite veins in Permian Yeso formation; small amounts of thorium found in radioactive veins containing limonite, fluorite, barite, quartz, and magnetite. Glass and Smalley, 1945. 34°12′ 105°45′

17. Capitan Mountains. Thorium-bearing veins in fractures and breccia zones in quartz monzonite laccolith. Nininger, 1954. 33°37′ 105°24′

18. High Noon No. 1. Pegmatite contains euxenite. 32°32′ 108°25′

19. Gold Hill pegmatite area. Euxenite, allanite, samarskite, and beryl reported in pegmatites. 32°29′ 108°33′

20. Gold Hill thorium-bearing deposits. Radioactivity, probably due to thorium, associated with altered zones in basic dikes. 32°23′ 108°29′

21. Wind Mountain (Cornudas Mountains) Rare earths in eudialite in pegmatites in and adjacent to nepheline syenite laccolith. Warner and others, 1959. 32°02′ 105°30′

NEW YORK

1. Duane locality. Radioactive pyrite, zircon, and xenotime containing thorium in pegmatite. Narten and McKeown, 1952. 44°44′ 74°15′

2. Rutgers mine. Magnetite deposit contains rare earth-bearing apatite and zircon. McKeown and Klemic, 1953. 44°31′ 73°40′

3. Benson mines. Magnetite-hematite ore in granite contains allanite. McKeown and Klemic, 1953. 44°11′ 75°01′

4. Mineville district. Magnetite deposits contain rare earth-bearing apatite, monazite, and bastnaesite. McKeown and Klemic, 1956. 44°07′ 73°29′

5. Graphite locality. Pegmatites contain about 0.02–0.03 percent ThO_2. Narten and McKeown, 1952. 43°44′ 73°39′

6. Day pegmatite. Pegmatite contains sparse polycrase. Smith and Kruesi, 1947. 43°17′ 73°56′

7. Mount Adam. Yttrocerite and allanite reported, probably in granite and pegmatite. Hoadley, 1928; Kemp and Hollick, 1894. 41°17′ 74°25′

8. Yorktown Heights. Sillimanite-mica schist contains monazite. Bodelsen, 1948. 41°15′ 73°47′

NORTH CAROLINA

1. Jefferson area. Allanite in radioactive gneiss and schist. Stow, 1955. 36°27′ 81°29′

2. Spruce Pine district. Pegmatites contain allanite, samarskite, monazite, and euxenite. Maurice, 1940; Olson, 1944. 35°57′ 82°07′

3. Mars Hill. Monazite in pegmatitic Cranberry gneiss; allanite reported from other small pegmatites in gneiss and schist. Pratt, 1916. 35°48′ 82°33′

4. Silver Creek and Catawba River. Monazite-bearing placers. Eilertsen and Lamb, 1956; Hansen and White, 1954; Mertie, 1953; Overstreet and others, 1956; 1959. 35°45′ 81°42′

5. South Muddy Creek. Monazite-bearing placers. Eilertsen and Lamb, 1956; Hansen and White, 1954; Mertie, 1953; Overstreet and others, 1956; 1959. 35°40′ 81°46′

6. Knob Creek. Monazite-bearing placers. Eilertsen and Lamb, 1956; Griffith and Overstreet, 1953b; Mertie, 1953; Overstreet and others, 1956; 1959. 35°32′ 81°32′

7. Buffalo Creek. Monazite-bearing placers. Eilertsen and Lamb, 1956; Griffith and Overstreet, 1953a; Mertie, 1953; Overstreet and others, 1956; 1959. 35°28′ 81°28′

8. First Broad River and tributaries. Monazite-bearing placers. Eilertsen and Lamb, 1956; Hansen and Cuppels, 1954; Mertie, 1953; Overstreet and others, 1956; 1959. 35°27′ 81°38′

9. Sandy Run Creek. Monazite-bearing placers. Eilertsen and Lamb, 1956; Griffith and Overstreet, 1953c; Mertie, 1953; Overstreet and others, 1956; 1959. 35°22′ 81°43′

10. Zirconia district. Pegmatites contain xenotime, polycrase, and auerlite. Olson, 1952. 35°14′ 82°24′

11. Cashiers district. Samarskite noted in two pegmatites. Olson, 1952. 35°05′ 83°05′

OKLAHOMA

1. Wichita Mountains pegmatite. Large, zoned zircon crystals in Precambrian pegmatite. Larsen and others, 1953. 34°43′ 98°48′

2. Osage Lake granite. Thorium and rare earths in veinlets in riebeckite granite. 34°42′ 98°39′

PENNSYLVANIA

1. Easton. Thorium-rich uraninite, thorogummite, zircon, and other minerals in serpentinized dolomite-diopside-tremolite rock. Montgomery, 1957.	41°43′	75°14′
2. Chester area. Numerous occurrences of rare earth-bearing monazite, allanite, euxenite, and xenotime in pegmatites and metamorphic rocks. Cooper, 1958.	39°53′	75°24′

RHODE ISLAND

1. Redstone quarry. Granite contains bastnaesite and monazite. Smith and Cisney, 1956.	41°23′	71°49′

SOUTH CAROLINA

1. Broad River. Monazite-bearing placers. Hansen and Theobald, 1955; Overstreet and others, 1959.	35°08′	81°33′
2. Thicketty Creek. Monazite-bearing placers. Hansen and Theobald, 1955; Overstreet and others, 1959.	35°01′	81°42′
3. North Tyger and Middle Tyger Rivers. Monazite-bearing placers. Hansen and Cuppels, 1955; Overstreet and others, 1959.	34°52′	81°59′
4. Rabon Creek. Monazite-bearing placers. Hansen and Caldwell, 1955; Overstreet and others, 1959.	34°29′	82°08′
5. Big Generostee Creek. Monazite-bearing placers. Hansen and Caldwell, 1955; Overstreet and others, 1959.	34°25′	82°46′
6. Horse Creek. Monazite-bearing placers. Eilertsen and Lamb, 1956.	33°28′	81°54′
7. Hollow Creek. Monazite-bearing placers. Kline and others, 1954.	33°20′	81°51′
8. Hilton Head Island. Monazite-bearing placers. Eilertsen and Lamb, 1956.	32°10′	80°43′

SOUTH DAKOTA

1. Bald Mountain district. Six radioactive areas containing thorium and rare earths reported; chiefly of vein type in sedimentary and igneous rocks. One area contains thorium-bearing diatreme material. Vickers, 1954.	44°20′	103°50′
2. Rochford area. Thorium and probable rare earths in limonitic basal conglomerate of Cambrian Deadwood formation.	44°08′	103°50′

TENNESSEE

1. Walnut Mountain. Veins containing magnetite and zircon, with columbium, thorium, and rare earth minerals.	36°17′	82°04′

TEXAS

1. Duncan-Elmore. Euxenite(?) and monazite(?) in pegmatites.	31°57′	106°28′
2. Cermin claim. Thorium and possibly rare earths in pegmatites and shear zones.	31°49′	106°29′
3. Llano area. Gadolinite, yttrocrasite, allanite, and cyrtolite in pegmatites; notable occurrence at Barringer Hill. Paige, 1912.	30°46′	98°24′

UTAH

1. Willard group. Cyrtolite in pegmatites in Precambrian complex.	41°24′	112°02′
2. Sheeprock area. Samarskite in pegmatites, and a thorium-bearing mineral occurs with biotite, smoky quartz, and magnetite in pods in aplitic granite.	39°58′	112°33′
3. Wah Wah Mountains. Radioactive zone due to disseminated thorium-bearing mineral in agglomerate with associated tuffaceous material.	38°13′	113°35′
4. San Francisco district. Thorium and rare earths in radioactive vein material from dump of metal mine. Butler, 1913.	38°27′	113°14′
5. Sunrise property. Allanite in oxidized vein material in Carboniferous limestone and quartzite.	38°22′	112°46′
6. Monroe area. Thorium associated with iron and manganese oxides that occur along fracture zones in volcanics.	38°36′	112°04′
7. Smith mine. Rare earth-bearing apatite in magnetite deposits and tactite zone. Mackin, 1954.	37°46′	113°11′

VIRGINIA

1. Old Bowers estate. Monazite(?) irregularly distributed in Precambrian gneiss. Stow, 1955.	38°28′	78°07′
2. Charlottesville area. Radioactive zone in granite gneiss, presumably monazite-bearing. Stow, 1955.	38°07′	78°26′
3. Kelly Bank mine. Manganiferous limonite coated by weinschenkite. Milton and others, 1944.	37°54′	79°13′
4. Irish Creek. Rare parisite in greisen associated with cassiterite-bearing veins. Glass and others, 1958.	37°52′	79°09′
5. Little Friar Mountain. Fergusonite with magnetite and zircon in vein(?) deposit; allanite common in area. Mallet, 1877.	37°48′	79°06′
6. Amelia district. Monazite in pegmatites. Glass, 1935.	37°22′	77°59′
7. Chestnut Knob. Monazite, ilmenite, and zircon concentrated in magnetite-rich layer in biotite-kyanite-quartz schist. Mertie, 1955; Stow, 1955.	36°39′	79°56′

WASHINGTON

1. Happy Hill. Monazite, presumably in metamorphic rocks. Huntting, 1956. 48°27′ 119°38′
2. Sanpoil claims. Samarskite and radioactive fluorite in pegmatite. Huntting, 1956. 48°28′ 118°53′
3. Sherman Creek Pass. Monazite in biotite-rich segregations near contact of granite with gneiss and schist. Huntting, 1956. 48°36′ 118°28′
4. Peterson claims. Allanite, euxenite, cyrtolite, and brannerite in pegmatite. Huntting, 1956. 47°55′ 119°00′

WISCONSIN

1. Wausau area. Thorium, zirconium, and rare earth minerals in pegmatite and syenitic rocks. Vickers, 1956b. 44°58′ 89°47′

WYOMING

1. Beartooth Plateau. Gadolinite and possibly other rare earth minerals in pegmatites. 44°54′ 109°28′
2. Ralston area. Allanite and other rare earth minerals in pegmatites. 44°48′ 109°20′
3. Cowley deposit. Monazite in ancient titaniferous beach placers in Upper Cretaceous sandstone. Murphy and Houston, 1955. 44°52′ 108°30′
4. Lovell deposit. Monazite in ancient titaniferous beach placers in Upper Cretaceous sandstone. Murphy and Houston, 1955. 44°45′ 108°21′
5. Bald Mountain district. Monazite in ancient placers in the Cambrian Deadwood formation. Eilertsen and Lamb, 1956. 44°48′ 107°48′
6. Bear Lodge Mountains. Rare earths and thorium in Fe–Mn veins and altered Tertiary igneous rocks. Buck, 1957; Wilson, 1960. 44°29′ 104°26′
7. Grass Creek deposit. Monazite in ancient titaniferous beach placers in Upper Cretaceous sandstone. Murphy and Houston, 1955. 43°56′ 108°34′
8. Cottonwood Creek deposit. Monazite in ancient titaniferous beach placers in Upper Cretaceous sandstone. Murphy and Houston, 1955. 43°51′ 108°27′
9. Mud Creek deposit. Monazite in ancient titaniferous beach placers in Upper Cretaceous sandstone. Murphy and Houston, 1955. 43°46′ 107°47′
10. Dugout Creek deposit. Monazite in ancient titaniferous beach placers in Upper Cretaceous sandstone. Murphy and Houston, 1955. 43°50′ 107°30′
11. Crazy Woman Creek area. Allanite, with associated calcite, diopside, and garnet, in lenticular body in granite. Hose, 1955. 43°58′ 106°53′
12. Gibbs Creek deposit. Monazite in ancient titaniferous beach placers in Upper Jurassic sandstone. Murphy and Houston, 1955. 43°12′ 110°30′
13. Allie claim area. Allanite in pegmatites. Osterwald and Osterwald, 1952. 43°21′ 107°20′
14. John Paul No. 5. Black radioactive mineral in granite. Love and Weitz, 1950. 42°44′ 109°36′
15. Coalbank Hills deposit. Monazite in ancient titaniferous beach placers in Upper Cretaceous sandstone. Murphy and Houston, 1955. 42°58′ 107°24′
16. Poison Spider deposit. Monazite in ancient titaniferous beach placers in Upper Cretaceous sandstone. Murphy, and Houston, 1955. 42°53′ 106°50′
17. Clarkson Hill deposit. Monazite in ancient titaniferous beach placers in Upper Cretaceous sandstone. Murphy and Houston, 1955. 42°39′ 106°42′
18. Gafco claims. Rare earths and thorium in ancient placer(?) in Tertiary sediments. 42°20′ 106°32′
19. Cumberland Gap deposits. Monazite in ancient titaniferous beach placers in Upper Cretaceous sandstone. Murphy and Houston, 1955. 41°32′ 110°33′
20. Red Creek deposit. Monazite in ancient titaniferous beach placers in Upper Cretaceous sandstone. Murphy and Houston, 1955. 41°01′ 109°14′
21. Salt Wells Creek deposit. Monazite in ancient titaniferous beach placers in Upper Cretaceous sandstone. Murphy and Houston, 1955. 41°12′ 109°02′
22. Black Butte deposit. Monazite in ancient titaniferous beach placers in Upper Cretaceous sandstone. Murphy and Houston, 1955. 41°29′ 108°50′
23. Platt pegmatite. Euxenite and xenotime(?) in pegmatite. 41°07′ 106°30′
24. Albany-Foxpark area. Minor fergusonite and allanite in pegmatite. Hanley and others, 1950. 41°07′ 106°08′
25. Sheep Mountain deposit. Monazite in ancient titaniferous beach placers in Upper Cretaceous sandstone. Murphy and Houston, 1955. 41°18′ 106°01′
26. Tie Siding area. Allanite in pegmatites. Osterwald and Osterwald, 1952. 41°04′ 105°26′

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