NIOBIUM AND TANTALUM IN THE UNITED STATES

(Exclusive of Alaska and Hawaii)

By

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Introduction

The accompanying map shows the location of the principal known deposits of niobium and tantalum minerals in the United States, exclusive of Alaska and Hawaii. Symbols of different shapes are used to depict deposits of different geologic types, and large symbols denote deposits with a record of production. Small symbols denote known occurrences of the minerals. Individual symbols may represent districts or groups of deposits too closely spaced to permit them to be distinguished separately because of scale limitations. Some districts or areas of widespread occurrences are shown by a shaded pattern.

The deposits are numbered by states on the map and identified by number in the index, which also gives the geographic coordinates of the deposits, brief geologic descriptions, and references to the principal published reports if such exist. Both published information and unpublished data gathered by the U. S. Geological Survey were used in preparing the map and text.

Chemistry and mineralogy

Niobium _/ and tantalum are closely related elements that tend to occur together in nature. They have the same valence and similar ionic radii, and they substitute readily for each other in minerals. Some of their properties are:

	Niobium (Nb)	Tantalum (Ta)
Atomic number	41	73
Atomic weight	92.91	180.9
Specific gravity	8.4	16.6
Valence	5	5
Ionic radium	Nb^{+5} =0.69A	Ta^{+5} =0.68A
Melting point	2500°C	2996°C

Niobium and tantalum occur in nature mostly in combination with oxygen and one or more other elements such as calcium, sodium, iron, manganese, aluminum, rare earths, uranium, thorium, lead, titanium, tin, zirconium, and tungsten to form numerous niobate-tantalate minerals. Niobium and tantalum also occur as minor constituents in titanium, tin, zirconium, or tungsten minerals. The most common niobium-tantalum minerals are described below:

Columbite-tantalite series.--Columbite-tantalite, $(Fe,Mn)(Nb,Ta)_2O_6$, forms a gradational series from nearly pure columbite to tantalite which contains only a little niobium. Because tantalum has a density much greater than that of niobium, the specific gravity increases from 5.2 for columbite to 7.95 for tantalite, and this property is useful in determining the proportions of the two elements. Pure columbite contains 78.9 percent Nb_2O_5, and pure tantalite contains 86.1 percent Ta_2O_5. The series crystallizes in the orthorhombic system.

Tapiolite-mossite series.--Tapiolite-mossite, $(Fe,Mn)(Ta,Nb)_2O_6$, is a mineral series with composition similar to columbite-tantalite but which crystallizes in the tetragonal system. Tapiolite is the tantalum-rich member; mossite contains about equal proportions of niobium and tantalum.

Pyrochlore-microlite series.--The pyrochlore-microlite series embraces a number of minerals that are essentially columbates and tantalates of sodium and calcium. Titanium, tungsten, tin, and iron can substitute for niobium and tantalum, and rare-earth elements, thorium, uranium, zirconium, and others commonly substitute for part of the sodium and calcium. Pyrochlore is the niobium-rich member and microlite is the tantalum-rich member. The general formula for pyrochlore is $NaCaNb_2O_6F$ and that for microlite is $(Na,Ca)_2Ta_2O_6(O,OH,F)$. The series crystallizes in the isometric system.

Pyrochlore theoretically contains 73.05 percent Nb_2O_5, and microlite contains 82.14 percent Ta_2O_5, but substitution of other elements commonly reduces the $(Nb,Ta)_2O_5$ content to the range of 55 to 70 percent. Intermediate compositions are not common; most pyrochlore has less than 2 percent Ta_2O_5, and microlite generally has little niobium. Varieties with appreciable quantities of other elements have been given various names, among them koppite (with cerium) and hatchettolite (with uranium).

Fergusonite-formanite series.--Minerals of the fergusonite-formanite series are niobates and tantalates, principally of yttrium and erbium. Fergusonite, $(Y,Er,Ce,Fe)(Nb,Ta,Ti)O_4$, is the predominantly niobian member and formanite, $(U,Th,Zr,Ca)(Ta,Nb,Ti)O_4$, is the predominantly tantalian member. Considerable ionic substitution occurs in the series. The $(Nb,Ta)_2O_5$ content ranges from 42 to 58 percent, and the series crystallizes in the tetragonal system. Yttrotantalite is an iron-yttrium tantalate-niobate with many minor constituents that is similar to minerals of the fergusonite-formanite series but crystallizes in the orthorhombic system.

Euxenite-polycrase series.--Minerals of the euxenite-polycrase series are titanate-niobate-tantalates of rare earths, calcium, uranium, and thorium.

_/ The name niobium has superceded the name columbium in modern chemical terminology.

Polycrase is the titanium-rich member of the series, and euxenite is the niobium-tantalum-rich member. Most euxenite contains a greater proportion of niobium than tantalum, with $(Nb,Ta)_2O_5$ ranging from 20 to 50 percent. The series crystallizes in the orthorhombic system.

Samarskite is a niobate-tantalate consisting principally of rare earths, calcium, iron, uranium, and thorium. Its formula is $(Y,Er,Ce,U,Fe,Th)(Nb,Ta)_2O_6$, and it crystallizes in the orthorhombic system.

Niobium and tantalum are contained in small amounts in other minerals, principally those of titanium. Perovskite, $CaTiO_3$, commonly contains a little niobium and tantalum, and niobium-rich perovskite, called dysanalite, is known to contain up to 26 percent Nb_2O_5. Niobium substitutes for titanium in some rutile and brookite (TiO_2). Niobian rutile, called ilmenorutile, contains up to 32 percent Nb_2O_5, and as much as 13 percent Nb_2O_5 occurs in some brookite. Tantalum-rich brookite, called strueverite, contains up to 36 percent Ta_2O_5. Most sphene, $CaTiSiO_5$, contains traces of niobium and tantalum; some varieties contain as much as 3.3 percent Nb_2O_5, and some containing 3.5 percent Ta_2O_5 have been reported. Ilmenite may contain up to 1 percent of combined niobium and tantalum, but most exploited ilmenite contains less than 0.1 percent of these elements.

Geologic occurrence

Deposits of niobium and tantalum, like those of thorium and rare earths, are of two principal types: deposits in which the elements were concentrated at depths in the earth's crust mainly through chemical processes related to the formation or modification of the enclosing rocks, and deposits formed at the earth's surface, mainly by mechanical concentration of minerals during erosion and transportation.

Niobium is by no means a rare element in the earth's crust; it is about as abundant as cobalt and half again as plentiful as lead. Tantalum probably ranks with molybdenum and tungsten in total abundance. Concentrations of niobium and tantalum are rare, however, and are largely restricted to pegmatites, alkalic rock complexes and carbonatites, riebeckite granites, and placer accumulations.

Until the discovery of niobium in carbonatites and alkalic rock complexes, the sole source of niobium and tantalum was pegmatites or placers derived from pegmatites or columbite-bearing granites. Pegmatites (or placers derived from them) still constitute the only known deposits of tantalum. Niobium-tantalum-bearing pegmatites are widespread in the United States, but the most prominent ones are in western Arizona, northern New Mexico, central Colorado, western South Dakota, western North Carolina, and central Virginia. The most common niobium-tantalum minerals in the pegmatites are columbite-tantalite, microlite, euxenite, fergusonite, samarskite, and pyrochlore. Most concentrations of niobium-tantalum minerals in pegmatites are small and restricted in their distribution, and are recovered only as by-products or co-products with other valuable minerals.

Niobium is most abundant in alkalic rocks and carbonatites, and future supplies of the metal will no doubt come from this source. (These rock types, however, contain low concentrations of tantalum.) The common niobium mineral is pyrochlore, though in some alkalic rocks niobium is contained in titanium minerals. Deposits of niobium in carbonatites occur near Powderhorn, Colo., in the Rocky Boy Indian Reservation near Havre, Mont., and at Magnet Cove, Ark.

Niobium occurs in the bauxite deposits of Arkansas, which were derived from alkalic rocks. The niobium is closely associated with titanium minerals. Although the concentration of niobium ranges from only 0.03 to 0.05 percent, the great quantity of bauxite processed renders this a potential by-product source of large tonnage.

Carbonate bodies of uncertain origin in the Bitterroot River-Salmon River area in Ravalli County, Montana, and Lemhi County, Idaho, contain columbite, fersmite (a rare niobate mineral), and ilmenorutile. These deposits are closely related to amphibolites, gneisses, and schists along the eastern border of the Idaho batholith.

The Conway Granite, which underlies several areas in New Hampshire, contains an anomalously high amount of niobium as compared with other granites. A riebeckite-bearing variety of the Conway Granite contains 0.015 to 0.03 percent niobium and closely resembles the pyrochlore-bearing riebeckite granite of Nigeria. A biotite-rich variety of the Conway Granite contains 0.007 to 0.014 percent niobium. Another riebeckite granite containing 0.02 to 0.11 percent niobium occurs near Woonsocket, R. I. The distribution of these granites are shown on the map by a shaded pattern.

Probably the most important niobium deposit in the United States is the placer deposit at Bear Valley in central Idaho. This deposit supplied nearly all the domestically produced ore during the period 1956-1959, reaching a peak production of 428,347 pounds of niobium-tantalum concentrates in 1958. Euxenite and columbite-tantalite are the niobium-tantalum minerals recovered. Other placers which contain niobium-tantalum minerals have been discovered in the central Idaho region. The minerals in these deposits were derived from granitic rocks and pegmatites of the Idaho batholith.

A few deposits or occurrences cannot be readily assigned to any of the previously discussed types of deposits, or they have not been sufficiently studied to permit their classification.

Index

Locality	Lat. N.	Long. W.
Arizona		
1. Hillside and Quartz Mountain claims. Euxenite, polycrase(?) and other rare-earth minerals in pegmatites.	35°51'	113°58'
2. White Cap pegmatite. Euxenite in pegmatite.	35°44'	113°58'

3. Kingman feldspar mine group. Euxenite in pegmatites. Olson and Hinrichs, 1960. 35°16' 114°05'

4. Mineral X claim. Fergusonite in pegmatites in schist and granite. 35°07' 114°05'

5. Rare Metals mine. Yttrotantalite and euxenite in pegmatites in Precambrian granite. Heinrich, 1960. 34°50' 113°35'

6. Signal district. Euxenite and samarskite in pegmatites. 34°32' 113°33'

7. White Picacho. Columbite-tantalite in quartz-rich inner zones, and pyrochlore and microlite in quartz-perthite intermediate zones of pegmatites. Jahns, 1952. 33°58' 112°38'

8. Buckeye area. Euxenite in biotite granite. 33°17' 112°35'

9. Ligurta area. Samarskite as an accessory mineral in pegmatites. 32°40' 114°18'

Arkansas

1. Fourche. Niobium content (0.01 percent) of parent nepheline syenite has been concentrated 2½ times in bauxite (0.03 percent). Niobium currently is not recovered. Nieberlein and others, 1954; Gordon and others, 1958. 34°41' 92°14'

2. Hurricane. Niobium content (0.02 percent) of parent nepheline syenite has been concentrated 2½ times in bauxite (0.05 percent). Niobium currently is not recovered. Nieberlein and others, 1954; Gordon and others, 1958. 34°34' 92°30'

3. Potash Sulfur Springs. Anomalously high niobium content in saprolite mantling alkalic rocks similar to those at Magnet Cove. Fryklund and others, 1954. 34°29' 92°59'

4. Magnet Cove. Alkalic igneous complex including carbonatite intrudes Paleozoic sedimentary rocks; niobium in rutile, brookite, and perovskite. Fryklund and others, 1954. 34°27' 92°52'

California

1. Mountain Pass. Rare occurrence of niobium-bearing minerals with rare-earth minerals in carbonatite. Olson and others, 1954. 35°30' 115°33'

2. Hoerner-Ross pegmatite. Pegmatite in quartz monzonite contains betafite, strueverite (tantalian ilmenite) and cyrtolite. Hewett and Glass, 1953. 34°53' 116°19'

3. Rock Corral area. Minor amounts of samarskite and euxenite in pegmatite. Moxham and others, 1955. 34°16' 116°28'

4. Pala (Stewart, Vanderburg-Katrina, and Tourmaline King pegmatites). Columbite-tantalite and microlite as minor constituents of some pegmatites. Jahns and Wright, 1951. 33°22' 117°05'

Colorado

1. Red Head claim. Columbite-tantalite with monazite and beryl in pegmatite. 40°53' 105°28'

2. Buckhorn, Crystal Silica, and Tantalum prospects. Columbite-tantalite and tantalite (Tantalum prospect) in pegmatites. Hanley and others, 1950. 40°32' 105°24'

3. New Girl prospect. Columbite-tantalite and beryl as minor accessory minerals in pegmatite. Hanley and others, 1950. 40°08' 105°18'

4. Beryl No. 1 prospect. Columbite-tantalite and beryl in pegmatite. Hanley and others, 1950. 40°04' 105°22'

5. Little Abner pegmatite. Samarskite in beryl-bearing pegmatite. 39°47' 105°22'

6. Grover mine. Columbite-tantalite, muscovite, and beryl in intermediate zone of pegmatite. Hanley and others, 1950. 39°42' 105°25'

7. Burroughs (Sunrise Peak). Columbite-tantalite, euxenite, and samarskite in pegmatites. Boos, 1954. 39°41' 105°20'

8. Bigger mine. Columbite-tantalite in pegmatite. Hanley and others, 1950. 39°34' 105°09'

9. White Cloud. Fergusonite in pegmatite. Haynes, 1958. 39°21' 105°11'

10. Lone Pine pegmatite. Pyrochlore and thorite in pegmatite. 39°09' 105°04'

11. Trout Creek Pass area. Euxenite, and monazite in quartz-microcline cores of pegmatites. Heinrich, 1948. 38°52' 106°02'

12. Meyers Ranch mine. Columbite-tantalite with muscovite and beryl in pegmatite. Hanley and others, 1950. 38°48' 105°36'

13. Guffey area. Euxenite, monazite, and allanite in pegmatites. Heinrich and Bever, 1957. 38°45' 105°30'

14. St. Peter's Dome area. Pegmatites in northwest-trending belt contain columbite-tantalite and pyrochlore along with rare-earth and beryllium minerals. 38°46' 104°55'

15. Mica-Beryl mine. Columbite-tantalite in pegmatite. Hanley and others, 1950. 38°41' 105°58'

16. Rock King prospect. Columbite-tantalite with beryl in pegmatite. Hanley and others, 1950. 38°38' 105°59'

17. Phantom Canyon prospect. Columbite-tantalite in pegmatite. Hanley and others, 1950. 38°36' 105°07'

18. Quartz Creek (Brown Derby, White Spar and Bucky pegmatites). Microlite and columbite-tantalite in zoned pegmatites. Staatz and Trites, 1955. 38°33' 106°36'

19. Devils Hole mine. Columbite-tantalite in intermediate zone of pegmatite. Hanley and others, 1950. 38°29' 105°33'

20. Mica Lode and Meyers mines. Columbite-tantalite in pegmatites. Hanley and others, 1950. 38°29' 105°18'

21. Cotopaxi area. Samarskite, euxenite, xenotime, gadolinite, and allanite in pegmatites. Hanley and others, 1950. 38°24' 105°40'

22. Benton prospect. Euxenite with gadolinite, xenotime, monazite, cyrtolite, and allanite in pegmatite. 38°20' 105°45'

23. Powderhorn (Iron Hill). Pyrochlore in carbonatite associated with alkalic igneous complex. Olson and Wallace, 1956. 38°17' 107°06'

24. Villa Grove, Euxenite, cyrtolite, monazite, and xenotime in pegmatites. Brown and Malan, 1954. 38°17' 105°52'

25. Crestone area. Columbite-tantalite, euxenite, cyrtolite, and monazite in pegmatites. Brown and Malan, 1954. 38°03' 105°44'

26. Antrim prospect. Altered rhyolite porphyry with anomalously high content of niobium. 38°08' 105°19'

Connecticut

1. Hollister Mica-Beryl. Accessory columbite-tantalite in pegmatite. Cameron and others, 1954. 41°43' 72°38'

2. Spinelli prospect. Samarskite in quartz-perthite-plagioclase zone in pegmatite. Cameron and others, 1954. 41°42' 72°37'

3. Hale-Walker Beryl. Accessory columbite-tantalite in quartz-perthite-plagioclase - muscovite zone in pegmatite. Cameron and others, 1954. 41°35' 72°39'

4. Strickland-Cramer. Columbite-tantalite in scattered small crystals in plagioclase-quartz intermediate zone in pegmatite. Cameron and others, 1954. 41°36' 72°36'

5. Seldon. Rare accessory columbite-tantalite in pegmatite. Cameron and others, 1954. 41°35' 72°30'

6. Tollgate Mica-Feldspar. Accessory columbite-tantalite in quartz-perthite intermediate zone in pegmatite. Cameron and others, 1954. 41°32' 72°38'

7. Flatrock quarry. Reported occurrence of eschynite and monazite in granite. Foye, 1949. 41°23' 72°10'

8. Branchville Mica mine. Accessory columbite-tantalite in cleavelandite-spodumene zones in pegmatite. Cameron and others, 1954. 41°20' 73°26'

Idaho

1. Elk City (Red River Valley). Jig bed concentrates from placer operation contain betafite(?), euxenite, samarskite, niobium-bearing (?) ilmenite, and brannerite. Armstrong and Weis, 1957. 45°48' 115°28'

2. Mineral Hill. Niobium-bearing rutile and thorium and rare-earth minerals in carbonate bodies in amphibolite and gneiss. Anderson, 1958. 45°26' 114°10'

3. Deadwood. Minor amounts of columbite and ilmenorutile in placers derived from granitoid rocks and pegmatites of the Idaho batholith. Storch, 1958; Savage, 1961. 44°22' 115°37'

4. Bear Valley. Euxenite and columbite-tantalite in alluvial gravels derived from granitoid rocks of the Idaho Batholith. Mackin and Schmidt, 1956; Mining World, 1958; Savage, 1961. 44°21' 115°25'

5. Columbite mine. Columbite and samarskite in intermediate zone of pegmatite. Fryklund, 1951. 44°01' 115°55'

6. Dismal Swamp. Columbite, samarskite, ilmenite, and rutile in placer deposit derived from deeply weathered granodiorite. Armstrong, 1957; Savage, 1961. 43°44' 115°22'

7. Camp Creek. Radioactive black sands from placers contain niobium-bearing sphene and minor amounts of columbite and rutile. Robertson and Storch, 1955a; Savage, 1961. 43°22' 114°31'

8. Rock Creek. Niobium-tantalum in sphene in radioactive sands from placer. Robertson and Storch, 1955b; Savage, 1961. 43°22' 114°24'

Illinois

1. Hicks Dome. Up to 0.15 percent niobium reported from drill core from deep hole in possible cryptovolcanic structure. Brown and others, 1954; Trace, 1960.	37°32'	88°22'

Maine

1. Newry mines. Columbite-tantalite in the inner parts of pegmatites. Cameron and others, 1954.	44°32'	70°44'
2. Black Mountain quarries. Columbite-tantalite in cleavelandite replacement zone in pegmatite. Cameron and others, 1954.	44°35'	70°35'
3. Bennett feldspar quarry. Columbite-tantalite in replacement zones in pegmatite. Cameron and others, 1954.	44°17'	70°25'
4. Litchfield. Alkalic rock complex in places contains 0.1 to 0.3 percent niobium. Niobium present in accessory pyrochlore(?).	44°12'	69°55'
5. Russell Brothers mica mine. Accessory columbite-tantalite in perthite-quartz wall zone of pegmatite. Cameron and others, 1954.	43°55'	69°55'
6. Coombs feldspar quarry. Columbite-tantalite in pegmatite at contact of inner zone of perthite and outer zone of graphic granite and biotite. Cameron and others, 1954.	44°02'	69°55'

Montana

1. Rocky Boy Stock (Vermiculite mine). Uranian pyrochlore in altered syenite bordering carbonatite. Pecora and others, 1957.	48°10'	109°42'
2. Sand Basin. Euxenite, sphene, monazite, and allanite in placer. Heinrich and Conrad, 1960.	46°12'	113°43'
3. Crystal Mountain fluorspar. Minor fergusonite in part of the south fluorite ore body. Weis and others, 1958.	46°00'	113°53'
4. Sappington. Reported occurrence of fergusonite(?) in pegmatite. Heinrich, 1949.	45°46'	111°45'
5. Sheep Creek area. Columbite and fersmite in carbonate bodies that are mostly in amphibolite. Crowley, 1960.	45°32'	114°19'
6. California Gulch. Reported occurrence of fergusonite in gold placer. Cooke and Perry, 1945.	45°21'	112°03'

Nevada

1. Lucky Susan No. 1. Euxenite or samarskite in small radioactive lenses in schist and gneiss; probably in pegmatite.	37°55'	118°25'
2. Hilltop claim. Samarskite in pegmatite. Lovering, 1954.	36°16'	114°12'

New Hampshire

1. Pattuck mica mine and Smith mica mines. Columbite-tantalite in core-margin and intermediate zones of pegmatites. Cameron and others, 1954.	43°38'	71°50'
2. Conway Granite and related rocks. Anomalously high niobium content in granites: biotite granite ranges from 70 to 140 ppm; riebeckite granite ranges from 150 to 300 ppm.	Shaded areas	
3. Weeks mine. Columbite and samarskite in pegmatite. Olson, 1950; Cameron and others, 1954.	43°39'	71°01'
4. Parker Mountain mine. Columbite-tantalite in pegmatite. Olson, 1950; Cameron and others, 1954.	43°18'	71°10'
5. Allen and George Porter mines. Columbite-tantalite in pegmatite. Olson, 1950.	43°08'	72°20'
6. Corson mine. Columbite-tantalite in pegmatite. Olson, 1950.	43°05'	71°07'
7. Smith, Chandler, Welch, and Blake mines. Columbite-tantalite in pegmatite. Olson, 1950.	43°00'	71°13'

New Jersey

1. Pattenburg quarry. Metamict uranian fergusonite as scattered grains in granite gneiss. Markewicz and others, 1957.	40°38'	75°01'

New Mexico

1. Blasted Pine claim. Shear zone in Dakota Sandstone below a thick phonolite sill contains in places as much as 0.6 percent Nb; niobium minerals not identified.	36°36'	104°13'
2. Petaca. Columbite-tantalite and samarskite in pegmatites. Jahns, 1946.	36°31'	106°02'
3. Ojo Caliente. Columbite-tantalite and minor amounts of samarskite in pegmatites. Jahns, 1946.	36°23'	106°03'
4. Harding. Microlite and columbite-tantalite in zoned lithium-beryllium-rich pegmatite. Montgomery, 1950.	36°12'	105°48'
5. Pidlite. Microlite, betafite, hatchettolite and columbite-tantalite in lithium-rich pegmatite. Jahns, 1953.	35°53'	105°32'

6. Elk Mountain. Hatchettolite, samarskite, euxenite, monazite, uraninite, and gadolinite in pegmatites. Jahns, 1946. 35°46' 105°33'

7. Sparks-Stone mine. Euxenite-type mineral in pegmatite. 35°40' 105°30'

8. High Noon No. 1. Euxenite in pegmatite. 32°32' 108°25'

9. Gold Hill area. Euxenite and samarskite in pegmatites. 32°23' 108°29'

New York

1. Day pegmatite. Sparse amounts of polycrase in pegmatite. Smith and Kruesi, 1947. 43°16' 73°56'

North Carolina

1. Spruce Pine (Randolph mine). Reported occurrence of columbite-tantalite and samarskite in pegmatite. Parker, 1953; Kesler and Olson, 1942. 35°59' 82°16'

2. Spruce Pine (Pink, Deake, and Wiseman deposits). Reported occurrence of columbite-tantalite and samarskite in pegmatites. Parker, 1953; Kesler and Olson, 1942. 35°56' 82°03'

3. Spruce Pine (Ray mine). Reported occurrence of niobium-tantalum minerals in pegmatite. Parker, 1953. 35°53' 82°17'

4. Spruce Pine (McKinney mine). Columbite-tantalite and samarskite associated with replacement units in pegmatite. Parker, 1953; Kesler and Olson, 1942. 35°53' 82°07'

5. Foote Mineral Company property. Columbite-tantalite in pegmatite. Griffitts, 1954. 35°14' 81°21'

6. Cashiers. Samarskite in pegmatites. Olson, 1952. 35°05' 83°05'

Pennsylvania

1. Chester area. Reported occurrence of euxenite in pegmatites. Cooper, 1958. 39°55' 75°20'

Rhode Island

1. Woonsockett area. Riebeckite granite contains 0.02 to 0.11 percent niobium. 42°00' 71°27'

South Dakota

1. Tinton (Giant-Volney and Rough and Ready claims). Columbite-tantalite (averaging 45 percent Ta_2O_5) in albite-quartz lenses and stringers in quartz-spodumene intermediate zone of pegmatite. Page and others, 1953; Smith and Page, 1941. 44°23' 104°02'

2. Keystone (Bob Ingersoll, Dyke Lode, Dan Patch, Edison, Etta Hardestey, Hugo, and Peerless pegmatites). Columbite-tantalite in wall, intermediate, and core zones of pegmatites. Tantalum content is variable; Ta_2O_5 content may rarely exceed 50 percent in some wall or intermediate zones rich in cleavelandite, quartz, and beryl. Bob Ingersoll mine contains microlite associated with lepidolite in addition to columbite-tantalite. Page and others, 1953. 43°53' 103°24'

3. Hill City (High Climb and Tin Queen pegmatites). Columbite-tantalite in pegmatites. Page and others, 1953. 43°52' 103°35'

4. Custer (Beecher Lode, Buster Dike, Crown, Climax, Custer Mountain, Dakota feldspar, Highland Lode, New York, Old Mike, and Tin Mountain mines or prospects). Columbite-tantalite in wall, intermediate, and core zones of pegmatites. Tantalum content is variable; Ta_2O_5 content may rarely exceed 50 percent in some wall or intermediate zones rich in cleavelandite, quartz, and beryl. Microlite associated with lepidolite at the Tin Mountain mine; tantalite and tapiolite at the Old Mike mine. Page and others, 1953. 43°46' 103°37'

Tennessee

1. Walnut Mountain. Niobium, thorium, and rare-earth minerals in veins. 36°17' 82°04'

Texas

1. Baringer Hill. Fergusonite with rare-earth minerals in pegmatite. Hess, 1907. 30°47' 98°25'

2. Medley. Niobium-bearing rutile in silicified zones in volcanic rocks of Tertiary age. 30°32' 104°08'

Utah

1. Sheeprock area. Samarskite in pegmatites. 39°58' 112°33'

Virginia

1. Little Friar Mountain area. Reported occurrence of fergusonite in vein(?) (probably pegmatite). Mallet, 1877. 37°46' 79°06'

2. Herbb No. 2 (Goochland-Powhatan area). Tantalite-columbite and microlite in pegmatite. Griffitts and others, 1953. 37°36' 77°50'

3. Amelia (Champion, Rutherford, and Morefield mines). Tantalite-columbite and microlite chiefly in cleavelandite-rich parts of pegmatites. Lemke and others, 1952. 37°21' 77°59'

4. Wheatley mine. Minor amounts of tantalite in pegmatites. Griffitts and others, 1953. 37°11' 79°37'

Wisconsin

1. Wausau area. Niobium-bearing zircon and pyrochlore in pegmatite that is related to nepheline syenite. One small radioactive area contains yttrian pyrochlore. Vickers, 1956. 44°57' 89°47'

Wyoming

1. Rainbow claims. Euxenite in pegmatite. 44°58' 107°53'

2. Bear lodge Mountains. Niobium and rare-earth minerals in iron-manganese-rich veins in Tertiary igneous rocks. 44°29' 104°26'

3. Copper Mountain (Whippet No. 1 and Whippet No. 8 prospects). Tantalite-columbite in beryl-bearing pegmatites. Hanley and others, 1950. 43°24' 107°58'

4. Platt Pegmatite. Euxenite in pegmatite. 41°07' 106°30'

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