DEPARTMENT OF THE INTERIOR
UNITED STATES GEOLOGICAL SURVEY

TO ACCOMPANY MAP MR-29

TITANIUM 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 titanium minerals in the United States (excluding Alaska and Hawaii). Four broad geologic categories of deposits have been distinguished on the map by the shapes of the symbols, and relative importance is indicated by their size. The smaller deposits and the deposits for which adequate data are lacking can only be rated as "potential, unevaluated, or small". The deposits placed in the next category have been characterized by modest production or can be described as having "significant potential". The larger deposits, for which more information is available, are divided into two categories, based on estimated production plus reserves: those containing 1,000,000 to 10,000,000 tons of TiO_2, and those having more than 10,000,000 tons of TiO_2.

The symbols are numbered consecutively in each State and identified in the Index. The geographic coordinates represent the centers of the symbols, and thus the same coordinates are assigned to all deposits covered by a single symbol. For the larger districts that are shown by a dotted pattern the coordinates represent the approximate center of the area.

The map was compiled from published reports and from data in the files of the U.S. Geological Survey and the U.S. Bureau of Mines. The names of deposits, geographic coordinates, brief geologic descriptions, and abbreviated literature references, if any, are given in the Index. Complete references to the literature are listed in the section Selected References.

Various sections of the map were reviewed by R. A. Laurence and A. E. Weissenborn of the Geological Survey, and A. H. Reed, Jr., W. T. Millar, W. T. Benson, M. M. Gilkey, and D. C. Holt of the U.S. Bureau of Mines.

Geology

The principal sources of titanium, and the only titanium minerals currently being mined in the conterminous United States, are ilmenite ($FeTiO_3$) and rutile (TiO_2). In the older placer deposits the ilmenite may be stongly weathered and often includes a considerable proportion of leucoxene. Ilmenite and rutile are partly primary in origin and partly secondary. The secondary deposits were derived by weathering of the bedrock deposits and generally represent a considerable enrichment in the titanium-bearing minerals.

The major primary deposits of ilmenite are associated with gabbroic and anorthositic rocks, such as those occurring in the Sanford Lake district of New York, the Duluth gabbro of Minnesota, the Iron Mountain district of Wyoming, and the San Gabriel Mountains of southern California. These deposits are mixtures of ilmenite and magnetite and must generally be mined for both minerals. In part, they are marginal or submarginal, and at the present time (1961) only the Sanford Lake deposits are being exploited. Numerous small gabbroic masses in other areas contain pods and lenses of magnetite and ilmenite. However, these are generally too small to be mined. Also, the ilmenite content is often relatively low, and the two minerals may occur in fine intergrowths that present difficult metallurgical problems.

Important ilmenite and rutile deposits are associated with anorthosite in Virginia. They may be coarsely disseminated through the rock or may be concentrated in dikelike and lenticular masses of nelsonite, which occur both within the anorthosite and in the neighboring country rock. Nelsonite is composed essentially of apatite and ilmenite, with variable amounts of rutile. The Roseland and Montpelier districts are both important producers of this type of ore.

A few primary titanium deposits of modest size occur in other geologic environments. These include the Magnet Cove deposits in Arkansas, where rutile, brookite, and perovskite are associated with carbonatite and nepheline syenite, and the Richlands Cove deposit in North Carolina, where a sizeable ore body consisting of ilmenite and chlorite is contained in Precambrian metamorphic rocks.

The most important secondary deposits are marine placers containing ilmenite, leucoxene, rutile, and various other heavy minerals, such as monazite, zircon, staurolite, and kyanite. These deposits are particularly abundant in the Southeastern States and have been exploited on a large scale in Florida. The older deposits in Florida are Pleistocene in age, and some lie far inland, where they are partly buried by younger sands. Stream placers containing similar suites of heavy minerals are common in the Southeastern States but have a much smaller potential. All these deposts have been derived by weathering of the crystalline rocks of the Piedmont and Blue Ridge provinces. Small concentrations of ilmenite are present in the stream gravels of Idaho, where they have been derived from the Idaho batholith, and titaniferous stream placers occur in a few other States.

In the Coastal Plain of New Jersey very large deposits of heavy minerals, consisting chiefly of ilmenite and altered ilmenite or leucoxene, with a little rutile, zircon, staurolite, kyanite, and sillimanite, occur in the Miocene Kirkwood formation, the overlying Cohansey sand of Miocene(?) age, and the Cape May formation of late Pleistocene age.

Black sand deposits containing ilmenite and chromite, with smaller amounts of magnetic, zircon, and garnet, occur in the beach and dune sands at many localities along the Oregon coast and in terrace deposits extending a short distance inland.

Numerous fossil placers (black-sand deposits) of ilmenite,

with smaller quantities of zircon, monazite, and other heavy minerals, have been found in the Western States. They are most abundant in Montana and Wyoming, and in the San Juan Basin of Colorado and New Mexico. The deposits occur for the most part in well indurated Upper Cretaceous sandstones derived from the ancestral Rocky Mountains. Many of these deposits were discovered recently by airborne radioactivity surveys (because of the thorium in the monazite) and are as yet little known.

Some secondary titanium deposits are residual or lateritic in origin. Among these are the basaltic residual clays of northern Idaho and eastern Washington and the ferruginous bauxites of Oregon. These deposits contain a small to moderately large percentage of finely disseminated ilmenite.

TITANIUM INDEX

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Locality	Lat. N.	Long. W.
ARIZONA		
1. Black Mountain Trading Post area. Ilmenite in ancient beach placers in Upper Cretaceous sandstone. Murphy, 1956	36°13′	109°52′
2. Eureka district (Bagdad area); Boulder Creek and Mulholland Wash. Magnetite and ilmenite in small lenses and dikes in gabbro. Anderson and others, 1955; Ball and Broderick, 1919	34°36′	113°15′
3. Pig Iron deposits. Ilmenite finely intergrown with hematite in large body in Precambrian quartzite.	34°00′	111°09′
4. Pinal County deposits. Titaniferous magnetite in extensive alluvial sand deposits.	32°44′	111°06′
ARKANSAS		
1. Arkansas bauxite region. Ilmenite and anatase occur in bauxite deposits and are concentrated in waste products left by processing of the ore. Calhoun, 1950; Gordon and others, 1958.	34°34′	92°21′
2. Magnet Cove. Magnet Cove rutile deposit: rutile in veins and irregular bodies of feldspar-carbonate in nepheline syenite and related rocks. Christy and Kilpatrick (Hardy-Walsh) brookite deposits: brookite forms primary deposits in quartzite and occurs as enriched secondary deposits in residual clay. Mo-Ti Corporation property: rutile, brookite, and molybdenite in veins cutting rock that consists of pyroxene and magnetite, with subordinate amounts of nepheline and perovskite. Kimsey calcite quarry area: perovskite disseminated in coarse-grained calcite rock. Fryklund and others, 1954; Fryklund and Holbrook, 1950; Holbrook, 1947; Reed, 1948a, 1948b; Spencer, 1946.	34°28′	92°51′
3. Potash Sulphur Springs area. Moderate amount of titanium in heavily weathered syenitic rock and quartzite; minerals not identified. Fryklund and others, 1954.	34°30′	92°54′
4. Pink Green and Beulah Green deposits. Ilmenite in ancient placer deposits in loosely consolidated Upper Cretaceous sands. Holbrook, 1948.	33°53′	93°56′
CALIFORNIA		
1. Crescent City. Ilmenite with magnetite, chromite, zircon, garnet, and monazite in beach sands. Hornor, 1918.	41°45′	124°11′
2. Aptos area. Ilmenite and magnetite, with minor amounts of chromite, garnet, zircon, platinum, and gold in beach placers and on older marine terraces behind the present shoreline. Hubbard, 1943; Youngman, 1930.	36°59′	121°55′
3. Johnson and Vogt rutile deposit. Rutile in quartz lens enclosed by schist. Lydon, 1957; Wright and others, 1953; Youngman, 1930.	34°52′	117°11′
4. Western San Gabriel Mountains. Sand Canyon, Pacoima-Gold Creek, and Mill Creek areas: magnetite-ilmenite lenses in anorthosite and gabbro. Sand Canyon-Pacoima Canyon placer deposits; magnetite and ilmenite in stream placers. California Dept. Natural Resources, 1956. Lydon, 1957; Oakeshott, 1948, 1954, 1958.	34°24′	118°13′
5. Clifton area (Hermosa Beach, Redondo, Palos Verdes). Magnetite and ilmenite in beach placers. Baughman, 1927; Tucker, 1927; Youngman, 1930.	33°52′	118°23′
COLORADO		
1. Caribou Hill deposit. Magnetite and ilmenite in pockets and lenses in small irregular bodies of gabbro within a monzonite stock. Jennings, 1912; Singewald, 1913.	40°00′	105°32′
2. Grand Mesa deposit. Ilmenite in ancient beach placers in Upper Cretaceous sandstone. Murphy, 1956; Murphy and Houston, 1955.	39°04′	108°16′
3. Godsey claims. Titaniferous iron deposit reported to contain up to 10 percent TiO_2.	38°43′	105°12′
4. Iron Mountain. Magnetite and ilmenite lenses in gabbro and anorthosite. Singewald, 1913.	38°21′	105°20′
5. Iron Hill (Cebolla district, Powerhorn district). Perovskite and subordinate amounts of ilmenite and sphene in alkalic igneous complex and associated carbonate rock. Larsen, 1942; Olson and	38°15′	107°03′

Wallace, 1956; Rose and Shannon, 1960; Singewald, 1912, 1913.

6. Southwest Mesa Verde Area. Ilmenite in ancient beach placers in Upper Cretaceous sandstone. Chenoweth, 1957; Murphy, 1956 — 37°06′ 108°38′

FLORIDA

1. East Bay north. Ilmenite and rutile with zircon, kyanite, and staurolite in beach sands. Matthews, 1945; Miller, 1945. — 30°33′ 87°02′
2. Pensacola Bay. Ilmenite and rutile with zircon, kyanite, and staurolite in beach sands. Matthews, 1945; Miller, 1945; U.S. Bur. Mines, 1943. — 30°23′ 87°06′
3. East Bay south. Ilmenite and rutile with zircon, kyanite, and staurolite in beach sands. Matthews, 1945; Miller, 1945; U.S. Bur. Mines, 1943. — 30°24′ 87°01′
4. Camp Navarre area. Ilmenite and rutile with zircon, kyanite, and staurolite in beach sands. Matthews, 1945; Miller, 1945; U.S. Bur. Mines, 1943. — 30°24′ 86°46′
5. Santa Rosa Island. Ilmenite and rutile probably present in thin lenses of heavy minerals that occur in beach sands on north shore of island. Martens, 1928. — 30°23′ 86°36′
6. Walton County area. Ilmenite and rutile in beach and dune sands. — 30°20′ 86°07′
7. Philips Inlet area. Ilmenite and rutile in heavy mineral concentrations that occur in many places along present beach. Martens, 1928. — 30°16′ 86°00′
8. Crooked Island. Ilmenite, rutile, and zircon in thin concentrations of heavy minerals along inner and outer beaches of the island. Martens, 1928. — 29°59′ 85°31′
9. Cape San Blas. Ilmenite, rutile, and zircon in thin layers of heavy minerals along outer beach. Martens, 1928. — 29°46′ 85°23′
10. Yulee area. Ilmenite in unconsolidated sands. Gillson, 1959. — 30°37′ 81°37′
11. Amelia Island. Ilmenite and rutile with some zircon and monazite in beach sands. American Metal Market, 1957; Martens, 1928. — 30°37′ 81°27′
12. Talbot Island. Heavy minerals deposits located by airborne radioactivity survey; probably contain ilmenite and rutile. Moxham and Johnson, 1953. — 30°29′ 81°27′
13. Atlantic Beach. Heavy mineral deposits located by airborne radioactivity survey; probably contain ilmenite and rutile. Moxham and Johnson, 1953. — 30°21′ 81°24′
14. Mineral City area (Ponte Vedra Beach, Pablo Beach, Jacksonville Beach). Ilmenite, rutile, monazite, and zircon in beach and dune sands. Calver, 1957; Martens, 1928; Moxham and Johnson, 1953. — 30°14′ 81°23′
15. Jacksonville area. Ilmenite in old beach deposits with subordinate amounts of rutile, leucoxene, zircon, and monazite. Calver, 1957; Cannon, 1950; Detweiler, 1952; Matthews and others, 1947; Miller, 1945. — 30°18′ 81°33′
16. Cambon area. Rutile and leucoxene in unconsolidated sands, with comparatively little ilmenite. Thoenen and Warne, 1949. — 30°21′ 81°51′
17. Trail Ridge district (Starke and Lawtey deposits). Ilmenite, leucoxene, rutile, zircon, and staurolite in old partly buried beach sands. Calver, 1957, Cannon, 1950; Carpenter and others, 1953; Mining World, 1955; Roberts, 1955; Spencer, 1948. — 30°03′ 82°02′
18. Camp Blanding area. Rutile, leucoxene and ilmenite in old partly buried beach sands. Cannon, 1950; Thoenen and Warne, 1949. — 29°52′ 81°56′
19. Interlachen area. Rutile, leucoxene, and ilmenite in old partly buried beach sands. Thoenen and Warne, 1949. — 29°40′ 81°53′
20. Anastasia Island. Heavy mineral deposits located by airborne radioactivity survey; probably contain ilmenite and rutile. Moxham and Johnson, 1953. — 29°49′ 81°17′
21. Flagler Beach. Heavy mineral deposits located by airborne radioactivity survey; probably contain ilmenite and rutile. — 29°27′ 81°07′
22. Ocala National Forest and Mineola-Orlando areas. Parts of this large area are known to include extensive low-grade heavy mineral deposits containing rutile and leucoxene, with relatively little unaltered ilmenite. Thoenen and Warne, 1949. — 28°50′ 81°44′
23. Melbourne (Palm Bay). Deposits extend for about 12 miles along shore, from north of Eau Gallie to south of Palm Bay. Ilmenite, rutile, and zircon in beach sands. Calver, 1957; Martens, 1928; Vernon, 1943. — 28°04′ 80°37′
24. Vero Beach. Ilmenite, rutile and zircon in deposits lying along present shore between Vero Beach and Wabasso, and in dune sands lying a short distance inland. Calver, 1957; Miller, 1945. — 27°38′ 80°23′
25. Sebring-Childs area. Parts of this area are known to include extensive low-grade heavy mineral deposits containing — 27°24′ 81°24′

rutile and leucoxene, with relatively little unaltered ilmenite. Thoenen and Warne, 1949.

26. Gardner area. Heavy mineral deposits located by airborne radioactivity survey; probably contain ilmenite and rutile. Meuschke, 1955a. 27°19′ 81°57′

27. Venice area. Ilmenite, rutile, and zircon along present beach. Martens, 1928. 27°06′ 82°28′

28. Manosota Peninsula. Heavy mineral deposits located by airborne radioactivity survey; probably contain ilmenite and rutile. Meuschke and others, 1953. 27°02′ 82°26′

29. Punta Gorda Beach. Heavy mineral deposits located by airborne radioactivity survey; probably contain ilmenite and rutile. Meuschke and others, 1953. 26°57′ 82°22′

30. Don Pedro Island. Heavy mineral deposits located by airborne radioactivity survey; probably contain ilmenite and rutile. Meuschke and others, 1953. 26°52′ 82°18′

31. Fort Myers area. Heavy mineral deposits located by airborne radioactivity survey; probably contain ilmenite and rutile. Meuschke, 1954. 26°42′ 81°44′

GEORGIA

1. Graves Mountain. Large crystals of rutile in quartzite and quartz veins. Hurst, 1959; Watson and Taber, 1913. 33°47′ 82°32′

2. Savannah Beach. Heavy mineral deposits located by airborne radioactivity survey; probably contain ilmenite and rutile. Moxham and Johnson, 1953. 31°59′ 80°53′

3. Skidaway Island. Heavy mineral deposits located by airborne radioactivity survey; probably contain ilmenite and rutile. Moxham and Johnson, 1953. 31°53′ 80°59′

4. Ossabaw Island. Heavy mineral deposits located by aerial reconnaissance and by airborne radioactivity survey; probably contain ilmenite, rutile, zircon, and monazite. McKelvey and Balsley, 1948; Moxham and Johnson, 1953. 31°47′ 81°06′

5. St. Catherine's Island north. Heavy mineral deposits located by airborne radioactivity survey; probably contain ilmenite, rutile, zircon, and monazite. Moxham and Johnson, 1953. 31°40′ 81°08′

6. St. Catherine's Island south. Heavy mineral deposits located by aerial reconnaissance and by airborne radioactivity survey; probably contain ilmenite, rutile, zircon, and monazite. McKelvey and Balsley, 1948; Moxham and Johnson, 1953. 31°35′ 81°10′

7. Sapelo Island. Ilmenite, magnetite, monazite and zircon in beach sands. McKelvey and Balsley, 1948; Moxham and Johnson, 1953; Teas, 1921. 31°26′ 81°15′

8. Long Island. Ilmenite and zircon with minor amounts of rutile and monazite in beach sands. Martens, 1928. 31°18′ 81°18′

9. Sea Island Beach. Heavy mineral deposits located by airborne radioactivity survey; probably contain ilmenite and rutile. Moxham and Johnson, 1953. 31°12′ 81°20′

10. St. Simons Island. Ilmenite and zircon with minor amounts of rutile and monazite in beach sands. McKelvey and Balsley, 1948; Martens, 1928; Teas, 1921. 31°08′ 81°23′

11. Jekyll Island. Heavy mineral deposits located by aerial reconnaissance and by airborne radioactivity survey; probably contain ilmenite, rutile, zircon, and monazite. McKelvey and Balsley, 1948; Moxham and Johnson, 1953. 31°03′ 81°24′

12. Cumberland Island. Heavy mineral deposits along present beach. 30°52′ 81°26′

13. Folkston area. Heavy mineral deposits located by airborne radioactivity survey; contain ilmenite and rutile. Gillson, 1959; Moxham, 1954. 30°52′ 82°00′

IDAHO

1. Stockton Clay deposits. Ilmenite in basaltic residual clay. Scheid, 1952. 47°42′ 116°43′

2. Canfield-Rogers clay deposits. Ilmenite in basaltic residual clay. Scheid and Hosterman, 1951b. 46°45′ 116°58′

3. Stanford clay deposits. Ilmenite in basaltic residual clay. Scheid and others, 1951a. 46°50′ 116°39′

4. Bovill clay deposits. Ilmenite in basaltic residual clay. Scheid and Hosterman, 1951a. 46°50′ 116°26′

5. Olson clay deposits. Ilmenite in basaltic residual clay. Scheid and others, 1951b. 46°47′ 116°38′

6. Deary Clay deposits. Ilmenite in basaltic residual clay. Scheid and others, 1952. 46°46′ 116°34′

7. Camas Prairie clay deposits. Ilmenite in basaltic residual clay. Scheid, Sohn, and Hosterman, 1951.. 45°59′ 116°10′

8. Elk City region. Ilmenite, brookite, rutile, sphene, monazite, zircon, and allanite in stream placers; rutile, brookite, monazite, and zircon in Tertiary basin gravels and sands. Reid, 1960. 45°51′ 115°29′

9. Grouse Creek. Ilmenite, monazite, garnet, and zircon, with minor amounts 45°29′ 116°00′

of magnetite, allanite, xenotime, and sphene in stream placers. Eilertsen and Lamb, 1956.

10. Squaw Meadows. Ilmenite, magnetite, and monazite in stream placers. Eilertsen and Lamb, 1956; Kauffman, 1954. 45°10′ 116°00′

11. Ruby Meadows. Ilmenite, magnetite, garnet, and zircon in stream placers. Kauffman, 1954. 45°14′ 115°53′

12. Secesh Meadows. Ilmenite, magnetite, garnet, and zircon in stream placers. Eilertsen and Lamb, 1956; Kauffman, 1954. 45°16′ 115°50′

13. Lake Creek. Magnetite, ilmenite, garnet, and zircon in stream placers. Eilertsen and Lamb, 1956. 45°17′ 115°55′

14. Kelly Meadows. Ilmenite, magnetite, and monazite in stream placers. Eilertsen and Lamb, 1956. 45°19′ 115°49′

15. Warren Meadows. Sphene ilmenite, monazite, garnet, magnetite, and zircon in stream placers. Eilertsen and Lamb, 1956; Kauffman, 1954. 45°17′ 115°42′

16. Mineral Hill district. Niobium-bearing rutile with monazite, thorite, and allanite in carbonate rock. Anderson, 1960; Kaiser, 1956. 45°26′ 114°13′

17. Gold Fork. Ilmenite, magnetite, garnet, sphene, monazite, and zircon in stream placers. Kauffman, 1954; Storch, 1958a. 44°43′ 116°02′

18. West Mountain area. Ilmenite and magnetite, with smaller amounts of garnet, rutile, zircon, and monazite, in stream placers. Eilertsen and Lamb, 1956. 44°31′ 116°06′

19. Cascade district (Long Valley) (includes Beaver Creek, Pearsol Creek, Big Creek, Corral Creek, and Clear Creek deposits). Ilmenite and monazite with small amounts of garnet, magnetite, and zircon in stream placers. Eilertsen and Lamb, 1956; Kauffman, 1954; Kline and Carlson, 1954; Kline and others, 1951b; 1955; Storch and Robertson, 1954. 44°29′ 116°00′

20. Scott Valley and Horsethief Basin. Ilmenite and monazite with small amounts of garnet, zircon, and altered rutile in stream placers. Kauffman, 1954; Kline and others, 1951a. 44°34′ 115°54′

21. Stolle Meadows. Ilmenite, magnetite, and monazite in stream placers. Eilertsen and Lamb, 1956. 44°34′ 115°41′

22. Peace Valley. Ilmenite, magnetite, and monazite in stream placers. Eilertsen and Lamb, 1956. 44°20′ 115°47′

23. Deadwood placer. Ilmenite and magnetite with minor amounts of sphene, monazite, and euxenite in stream placers. Storch, 1958b. 44°23′ 115°36′

24. Bear Valley. Ilmenite, magnetite, and garnet with small amounts of monazite, zircon, columbite, and euxenite in stream placers. Kauffman, 1954; Kline and others, 1953; Macklin and Schmidt, 1953. 44°21′ 115°25′

25. Meadow Creek and Valley Creek. Magnetite, ilmenite, monazite, zircon, garnet, and radioactive opaque minerals in stream placers. Eilertsen and Lamb, 1956. 44°19′ 115°04′

26. Kelly Creek and Stanley Creek. Ilmenite, magnetite, monazite, zircon, and garnet with minor amounts of other radioactive minerals and gold in stream placers. Eilertsen and Lamb, 1956. 44°16′ 114°57′

27. Gold Creek and Williams Creek. Magnetite and ilmenite with small amounts of monazite and sphene in stream placers. Eilertsen and Lamb, 1956. 44°06′ 114°51′

28. Hoodoo Creek. Ilmenite and other heavy minerals in stream placers. 43°53′ 114°45′

29. Alexander Flats. Magnetite, with smaller amounts of ilmenite, garnet, sphene, zircon, and monazite, in stream placers. Eilertsen and Lamb, 1956. 43°45′ 115°32′

30. Rabbit Creek. Garnet, ilmenite, magnetite, monazite, and zircon in stream placers. Eilertsen and Lamb, 1956. 43°50′ 115°40′

31. Boise Basin. Ilmenite, magnetite, garnet, monazite, zircon, and minor amount of rutile in stream placers. Kauffman, 1954; Kline and others, 1950. 43°54′ 115°52′

32. Garden Valley. Ilmenite, magnetite, and monazite in stream placers. Eilertsen and Lamb, 1956, Kauffman, 1954. 44°05′ 115°58′

33. Johnson Creek. Ilmenite, magnetite, garnet, zircon, monazite, and gold in stream placers. Eilertsen and Lamb, 1956. 43°54′ 116°21′

34. Mud Flats. Magnetite, ilmenite, garnet, zircon, and monazite in stream placers. Eilertsen and Lamb, 1956. 43°19′ 115°45′

35. Camp Creek. Some sphene with magnetite, hematite, altered uranothorite, and small amounts of allanite, garnet, and ilmenite in stream placers; sphene contains columbium, tantalum, yttrium, and thulium. Robertson and Storch, 1955b. 43°22′ 114°34′

36. Rock Creek. Sphene in stream placers, with magnetite and allanite, and small amounts of ilmenite, zircon, garnet, cyrtolite, columbite, and thorite or uranothorite; sphene contains columbium, tantalum, titanium, yttrium, and other rare metals. Robertson and Storch, 1955a. 43°22′ 114°24′

37. Poverty Flats, Reed Creek, and Dead Sheep Creek. Magnetite, sphene, ilmenite, zircon, thorite, and monazite in stream placers. Eilertsen and Lamb, 1956. 43°24′ 114°18′

MARYLAND

1. Dinning rutile mine. Small concentrations of rutile in serpentine. Ostrander, 1942; Tomlinson, 1946. 39°42′ 76°23′

2. Cove Point deposits. Thin lenses of ilmenite, rutile, zircon, and other heavy minerals in beach sands. Eng. Mining Jour., 1955. 38°23′ 76°24′

3. Assateague Island. Lean concentrations of ilmenite, rutile, and zircon in beach sands. Kuster, 1959. 38°16′ 75°07′

MINNESOTA

1. Duluth gabbro belt. Ilmenite and magnetite in lenses, dikes, and irregularly shaped bodies in the Duluth gabbro. Grout 1949–50, Grout and others, 1959. 48°03′ 90°56′

MONTANA

1. Milk River deposits. Ilmenite in ancient beach placers in Upper Cretaceous sandstone. Murphy and Houston, 1955; Stebinger, 1914. 48°57′ 112°50′

2. South Fork Milk River. Ilmenite in ancient beach placers in Upper Cretaceous sandstone. Stebinger, 1914. 48°47′ 113°12′

3. Rimrock Butte deposits. Ilmenite in ancient beach placers in Upper Cretaceous sandstone. Murphy and Houston, 1955; Stebinger, 1914. 48°44′ 112°49′

4. Area northwest of Browning. Ilmenite in ancient beach placers in Upper Cretaceous sandstone. Stebinger, 1914. 48°38′ 113°06′

5. Area west of Browning. Ilmenite in ancient beach placers in Upper Cretaceous sandstone. Stebinger, 1914. 48°33′ 113°12′

6. Area north of Badger Creek. Ilmenite in ancient beach placers in Upper Cretaceous sandstone. Murphy and Houston, 1955; Stebinger, 1914. 48°21′ 112°58′

7. Badger Creek southwest. Ilmenite in ancient beach placers in Upper Cretaceous sandstone. Murphy and Houston, 1955; Stebinger, 1914. 48°20′ 112°52′

8. Area northeast of Heart Butte. Ilmenite in ancient beach placers in Upper Cretaceous sandstone. Murphy and Houston, 1955; Stebinger, 1914. 48°17′ 112°49′

9. Badger Creek northeast. Ilmenite in ancient beach placers in Upper Cretaceous sandstone. Murphy and Houston, 1955. 48°24′ 112°45′

10. Area east of Four Horns Lake. Ilmenite in ancient beach placers in Upper Cretaceous sandstone. Murphy and Houston, 1955. 48°23′ 112°37′

11. Area northeast of Choteau. Ilmenite in ancient beach placers in Upper Cretaceous sandstone. Murphy and Houston, 1955. 47°57′ 112°20′

12. Area west of Choteau. Ilmenite in ancient beach placers in Upper Cretaceous sandstone. Mining World, 1952; Murphy and Houston, 1955; Wimmler, 1946. 47°47′ 112°33′

13. Lennep area. Ilmenite in ancient beach placers in Upper Cretaceous sandstone. Murphy and Houston, 1955. 46°26′ 110°30′

14. Victor Creek and McCalla Creek. Magnetite, ilmenite, monazite, garnet, sphene, zircon, and xenotime in stream placers. Eilertsen and Lamb, 1956. 46°26′ 114°10′

15. Rye Creek. Magnetite and ilmenite, with small amounts of garnet and zircon, and minor amounts of monazite and other radioactive minerals in stream placers. Eilertsen and Lamb, 1956. 45°59′ 114°04′

16. Trail Creek. Ilmenite and magnetite, with minor amounts of monazite, xenotime, and allanite in stream placers. Eilertsen and Lamb, 1956. 45°01′ 113°13′

17. Price Gulch and Powder Gulch. Magnetite, ilmenite, zircon, sphene, monazite, and thorite(?) in stream placers. Eilertsen and Lamb, 1956. 45°58′ 112°43′

NEVADA

1. Corral Canyon mine. Anatase-bearing altered feldspathic dikes in diorite. Ferguson, 1939. 39°56′ 117°52′

2. Blue Metal corundum property. Rutile associated with corundum and andalusite in shear zones in highly altered andesite. Binyon, 1946. 38°58′ 119°22′

NEW JERSEY

1. Hager deposits. Titaniferous magnetite in Precambrian gneiss. Bayley, 1910, 1941; Singewald, 1913. 40°36′ 75°08′

2. Bloom Farm deposit. Titaniferous magnetite in Precambrian gneiss. Bayley, 40°36′ 75°06′

1910, 1941; Singewald, 1913.

3. Church (Van Syckle) deposit. Titaniferous magnetite in Precambrian gneiss. Bayley, 1910, 1941; Singewald, 1913. 40°40′ 74°59′

4. Johnson Farm deposit. Titaniferous magnetite in Precambrian gneiss Bayley, 1910, 1941; Singewald, 1913. 40°41′ 74°56′

5. Shafer deposit. Titaniferous magnetite in Precambrian gneiss. Bayley, 1910; Singewald, 1913. 40°49′ 74°55′

6. Day deposit. Titaniferous magnetite in Precambrian gneiss. Bayley, 1910; Singewald, 1913. 40°52′ 74°51′

7. Bayard deposit. Titaniferous magnetite in Precambrian gneiss. Bayley, 1910; Singewald, 1913. 40°55′ 74°49′

8. Cramer deposit. Titaniferous magnetite in Precambrian gneiss. Bayley, 1910, 1941; Singewald, 1913. 40°51′ 74°48′

9. Nauright deposit. Titaniferous magnetite in Precambrian gneiss. Bayley, 1910, 1941; Singewald, 1913. 40°49′ 74°45′

10. Beers deposit. Titaniferous magnetite in Precambrian gneiss. Bayley, 1910; Singewald, 1913. 40°50′ 74°30′

11. Burlington-Ocean-Monmouth Counties area. Extensive heavy mineral deposits containing ilmenite, leucoxene, and some rutile, occur in the Miocene Kirkwood formation, the overlying Cohansey sand of Miocene(?) age, and the Cape May formation of late Pleistocene age. Eng. Mining Jour., 1958b; Johnson and others, 1959; Owens and others, 1960. 40°03′ 74°21′

NEW MEXICO

1. Hogback monocline (Shiprock area). Ilmenite in ancient beach placers in Upper Cretaceous sandstone. Chenoweth, 1957; Murphy, 1956. 36°53′ 108°30′

2. Barker dome. Ilmenite in ancient beach placer in Upper Cretaceous sandstone. Chenoweth, 1957. 36°49′ 108°15′

3. Chaco River area. Ilmenite in ancient beach placer in Upper Cretaceous sandstone. Chenoweth, 1957; Murphy, 1956. 36°37′ 108°36′

4. Sanostee area. Ilmenite in ancient beach placer in Upper Cretaceous sandstone. Chenoweth, 1957; Murphy, 1956. 36°28′ 108°55′

5. Toadlena area. Ilmenite in ancient beach placer in Upper Cretaceous sandstone. Chenoweth, 1957; Murphy, 1956. 36°12′ 108°51′

6. Torrivio anticline (Gallup area). Ilmenite, brookite, rutile, anatase, leucoxene, magnetite, and zircon in ancient beach placer in Upper Cretaceous sandstone. Allen, 1956; Chenoweth, 1957; Murphy, 1956. 35°30′ 108°50′

7. Standing Rock Trading Post area. Ilmenite in ancient beach placer in Upper Cretaceous sandstone. Chenoweth, 1957; Murphy, 1956. 35°44′ 108°15′

8. Herrera Ranch. Ilmenite in ancient beach placers in Upper Cretaceous sandstone. Chenoweth, 1957. 35°13′ 107°05′

9. Miguel Creek dome. Ilmenite in ancient beach placers in Upper Cretaceous sandstone. Chenoweth, 1957; Murphy, 1956. 35°33′ 107°27′

10. Hovey Ranch. Ilmenite in ancient beach placer in Upper Cretaceous sandstone. Chenoweth, 1957; Murphy, 1956. 35°41′ 107°15′

11. Star Lake Trading Post area. Ilmenite in ancient beach placers in Upper Cretaceous sandstone. Chenoweth, 1957; Murphy, 1956. 35°53′ 107°24′

12. Stinking Lake. Ilmenite in ancient beach placers in Upper Cretaceous sandstone. Chenoweth, 1957. 36°37′ 106°49′

NEW YORK

1. Burnham Estate. Titaniferous magnetite in gabbroic anorthosite gneiss. 44°26′ 73°27′

2. Split Rock mine. Magnetite and ilmenite lenses in highly garnetiferous gabbro. Hartnagel and Broughton, 1951; Newland, 1908; Singewald, 1913. 44°13′ 73°23′

3. Little Pond and Tunnel Mountain mines. Little Pond deposits: Small lenses of fine-grained magnetite and ilmenite in gabbro. Tunnel Mountain deposits: Lean magnetite-ilmenite bodies in gabbro. Hartnagel and Broughton, 1951; Newland, 1908; Singewald, 1913. 44°11′ 73°34′

4. Ledge Hill mines. Magnetite deposits, probably titaniferous, associated with gabbro. Hartnagel and Broughton, 1951. 44°11′ 73°29′

5. Lincoln Pond (Kent) mine. Small bodies of magnetite and ilmenite in gabbro and norite. Hartnagel and Broughton, 1951; Newland, 1908; Singewald, 1913. 44°07′ 73°36′

6. Dalton deposit. Magnetite and ilmenite in irregular schlierenlike masses and veins in gabbro. Singewald, 1913. 44°06′ 73°37′

7. Moriah Township (Mineville district). Reported occurrences of titaniferous magnetite. Hartnagel and Broughton, 1951. 44°04′ 73°33′

8. Moose Mountain deposit. Lenticular masses of magnetite and ilmenite in gabbro. Hartnagel and Broughton, 1951; Newland, 1908. 43°57′ 73°37′

9. Sanford Lake area. MacIntyre mine (Sanford Hill): Large deposit of coarse-grained magnetite and ilmenite in gabbro and anorthosite of the main Adirondack anorthosite massif. Iron Mountain (Ore Mountain) deposit: Large deposit of magnetite and ilmenite lying between gabbro and anorthosite. Calamity-Mill Pond deposit: Large deposit of coarse-grained magnetite and ilmenite in gabbro and anorthosite. Cheney Pond deposit: Large disseminated deposit of magnetite and ilmenite in gabbro. Balsley, 1943; Gillson, 1956; Lynd, 1960; Newland, 1908; Singewald, 1913; Stephenson, 1945, 1955. 44°03′ 74°03′

10. Harris property. Titaniferous magnetite in gabbroic anorthosite gneiss. 44°19′ 74°08′

11. Griffin Ore Bed. Titaniferous magnetite deposit. 44°26′ 74°02′

12. Port Leyden deposit. Magnetite and ilmenite in quartzose gneisses. Hartnagel and Broughton, 1951; Newland, 1908. 43°35′ 75°21′

NORTH CAROLINA

1. Sunbury area. Titanium minerals in unconsolidated sands. Broadhurst, 1955. 36°25′ 76°35′

2. Belvidere area. Titanium minerals in unconsolidated sands. Gillson, 1959. 36°16′ 76°33′

3. Albemarle Sound area. Titanium minerals in unconsolidated sands. Broadhurst, 1955; Gillson, 1959. 35°57′ 76°25′

4. Aurora area. Titanium minerals in unconsolidated sands. Broadhurst, 1955; Gillson, 1959. 35°17′ 76°47′

5. Bogue Banks. Black sand deposits discovered by aerial reconnaissance; probably contain ilmenite, rutile, and zircon. McKelvey and Balsley, 1948. 34°39′ 77°05′

6. New River Inlet. Black sand deposits discovered by aerial reconnaissance; probably contain ilmenite, rutile, and zircon. McKelvey and Balsley, 1948. 34°32′ 77°21′

7. Ashe Island. Black sand deposits discovered by aerial reconnaissance; probably contain ilmenite, rutile, and zircon. McKelvey and Balsley, 1948. 34°27′ 77°29′

8. Rich Inlet Black sand deposits discovered by aerial reconnaissance; probably contain ilmenite, rutile, and zircon. McKelvey and Balsley, 1948. 34°17′ 77°45′

9. Myrtle Sound. Black sand deposits discovered by aerial reconnaissance; probably contain ilmenite, rutile, and zircon. McKelvey and Balsley, 1948. 34°07′ 77°50′

10. Cape Fear River. Black sand deposits discovered by aerial reconnaissance; probably contain ilmenite, rutile, and zircon. McKelvey and Balsley, 1948. 33°56′ 77°57′

11. Long Beach. Black sand deposits discovered by aerial reconnaissance; probably contain ilmenite, rutile, and zircon. McKelvey and Balsley, 1948. 33°55′ 78°07′

12. Holden Beach. Black sand deposits discovered by aerial reconnaissance; probably contain ilmenite, rutile, and zircon. McKelvey and Balsley, 1948. 33°54′ 78°20′

13. Tuscarora and Shaw belts. Numerous small lenses of magnetite with ilmenite and some rutile in small masses of gabbro; ore bodies occur in two belts that can be traced for about 30 miles and may join at the northeast end. Bayley, 1923; Broadhurst, 1955; Cross, 1949; Singewald, 1913. 36°12′ 79°47′

14. J. A. Allen farm. Titaniferous magnetite in vein in hornblende-rich country rock. Bayley, 1923; Singewald, 1913. 35°55′ 80°28′

15. Maxwell place. Medium-grained titaniferous magnetite with little gangue can be traced for about 2.5 miles. Bayley, 1923; Singewald, 1913. 35°48′ 80°33′

16. Richlands Cove deposit (Yadkin Valley). Ilmenite in micaceous and talcose gangue forms series of lenses in mica schist and quartzite. Bayley, 1923; Broadhurst, 1955; Cross, 1949; Lynd, 1960; Singewald, 1913. 36°04′ 81°33′

17. Alleghany County titaniferous magnetite belt. Granular magnetite containing variable but generally rather small amount of ilmenite in a belt of hornblende schists that in many places are altered to steatite or soapstone. The magnetite is rather disseminated but locally forms small lenses Bayley, 1923; Singewald, 1913. 36°32′ 81°01′

18. Ashe County titaniferous belt. Titaniferous magnetite lenses occur in a belt of partly altered hornblende gneiss and can be traced 2.5 miles. The titanium minerals are ilmenite and rutile. Bayley, 1923; Broadhurst, 1955; Singewald, 1913. 36°33′ 81°31′

19. Avery and Mitchell Counties titaniferous magnetite area. Small scattered deposits of titaniferous magnetite. Bayley, 1923; Singewald, 1913. 36°04′ 82°07′

20. D. M. Hampton place. Titaniferous magnetite in gangue of chlorite, quartz, feldspar, and a brown mineral that may be rutile or brookite. Bayley, 1923; Singewald, 1913. 36°01′ 82°17′

21. Ivy Creek area. Titaniferous magnetite; probably contains rutile. Bayley, 1923; Singewald, 1913. 35°51′ 82°29′

22. New Found Mountain. Titaniferous magnetite in small vein. Bayley, 1923; Singewald, 1913. 35°43′ 82°53′

23. Silver Creek and Catawba River. Ilmenite with monazite and zircon in stream placers. Hansen and White, 1954. 35°45′ 81°42′

24. South Muddy Creek. Ilmenite with monazite and zircon in stream placers. Hansen and White, 1954. 35°40′ 81°45′

25. Knob Creek. Ilmenite with monazite and zircon in stream placers. Griffith and Overstreet, 1953b. 35°32′ 81°32′

26. Buffalo Creek. Ilmenite and rutile with monazite and zircon in small stream placers. Griffith and Overstreet, 1953a. 35°27′ 81°28′

27. First Broad River and tributaries. Ilmenite and rutile with monazite and zircon in stream placer. Hansen and Cuppels, 1954. 35°27′ 81°38′

28. Sandy Run Creek. Ilmenite and rutile with monazite in small placer. Griffith and Overstreet, 1953c. 35°22′ 81°43′

29. Culasagee Creek. Massive titaniferous magnetite in quartz-chlorite gangue; forms heavy surface float. Bayley, 1923; Singewald, 1913. 35°11′ 83°19′

30. Shooting Creek deposit. Rutile occurs in residual deposits overlying rutile-bearing mica schist, and in small placers. Broadhurst, 1955; Gillson, 1949. 35°03′ 83°45′

OKLAHOMA

1. Wichita Mountains. Pods and irregularly shaped dikes of magnetite and ilmenite in anorthosite and gabbro. Chase, 1951; Merritt, 1940. 34°43′ 98°47′

2. Lake Lawtonka. Ilmenite in heavy-mineral deposits in the beach sands and bottom sediments of Lake Lawtonka. Chase, 1952. 34°45′ 98°30′

3. Otter Creek Valley. Ilmenite in extensive stream placers. Hahn and Fine, 1960. 34°38′ 99°00′

OREGON

1. Sand Island deposit. Magnetite and ilmenite in beach placers. Twenhofel, 1946b. 46°16′ 124°01′

2. Trestle Bay deposit. Magnetite and ilmenite in beach placers. Twenhofel, 1946b. 46°13′ 124°00′

3. Hammond deposit. Magnetite and ilmenite in terrace deposit. Kelly, 1947. 46°12′ 123°56′

4. Portland area. Ilmenite in ferruginous bauxite deposits formed by laterization of Miocene basalt. Libbey and others, 1945, 1946. 45°50′ 122°56′

5. Netarts Bay deposit. Ilmenite and chromite with small amounts of zircon, magnetite, and garnet in beach placers. Twenhofel, 1946b. 45°34′ 123°55′

6. Salem area. Ilmenite in ferruginous bauxite deposits formed by laterization of Miocene basalt. Corcoran and Libbey, 1956; Libbey and others, 1946; Roedder, 1956. 44°52′ 123°02′

7. Newport area. Newport Beach and Big Creek Bay deposits: ilmenite and chromite with small amounts of zircon, magnetite, and garnet in beach placers. Yaquina Bay deposit: ilmenite and chromite with small amounts of zircon, magnetite, and garnet in dune sands. Twenhofel, 1946b. 44°38′ 124°03′

8. Muriel O. Ponsler Memorial Wayside Park deposit. Ilmenite and chromite with small amounts of zircon, magnetite, and garnet in beach placers. Twenhofel, 1946b. 44°10′ 124°07′

9. Heceta Beach deposit. Ilmenite and chromite with small amounts of zircon, magnetite, and garnet in beach placers. Twenhofel, 1946b. 44°04′ 124°07′

10. Fivemile and Threemile Creek area. Chromite and ilmenite with small amounts of zircon, magnetite, and garnet in beach placers and in terrace deposits lying inland. Griggs, 1945; Hornor, 1918; Hundhausen, 1947; Twenhofel, 1943, 1946a. 43°15′ 124°22′

11. South Slough area. Chromite and ilmenite with small amounts of zircon, magnetite, and garnet in terrace deposits. Griggs, 1945; Hornor, 1918; Twenhofel, 1946a. 43°16′ 124°18′

12. Shepard and Seven Devils mines area. Chromite and ilmenite with small amounts of gold, platinum, magnetite, garnet, rutile, zircon, and monazite in terrace deposits. Griggs, 1945; Hornor, 1918; Hundhausen, 1947; Stephenson, 1945; Twenhofel, 1946a. 43°14′ 124°22′

13. Eagle and Pioneer mines (Lagoons deposit) area. Chromite and ilmenite with small amounts of gold, platinum, magnetite, garnet, rutile, zircon, and monazite in terrace deposits. Griggs, 1945; Horner, 1918; Stephenson, 1945; Twenhofel, 1946a. 43°12′ 124°22′

14. Ferry Creek area. Chromite and ilmenite with small amounts of zircon, magnetite, and monazite in terrace deposits. Griggs, 1945; Hornor, 1918; Stephenson, 1945; Twenhofel, 1946a. 43°07′ 124°22′

15. Johnson and China Creeks area. Chro- 43°05′ 124°25′

mite and ilmenite with small amounts of zircon, magnetite, and garnet in beach sands and in terrace deposits extending several miles inland. Griggs, 1945; Hornor, 1918.

16. Cape Blanco area. Chromite with small amounts of ilmenite, zircon, magnetite, and garnet in present beach sands and in terrace deposits extending several miles inland. Griggs, 1945; Hornor, 1918; Stephenson, 1945; Twenhofel, 1943, 1946a. 42°50′ 124°33′

17. Port Orford deposit. Chromite and subordinate amount of ilmenite in present beach sands. Twenhofel, 1943. 42°45′ 124°28′

18. Euchre Creek-Ophir Beach deposit. Chromite and subordinate amount of ilmenite in present beach sands. Twenhofel, 1943, 1946a. 42°33′ 124°23′

19. Rogue River deposits. Chromite and subordinate amount of ilmenite with magnetite in present beaches at the mouth of Rogue River. Griggs, 1945; Twenhofel, 1943, 1946a. 42°27′ 124°26′

20. Meyers Creek-Pistol River deposits. Chromite and subordinate amount of ilmenite with magnetite in present beach sands at the mouths of Meyers Creek and Pistol River. Twenhofel, 1943; 1946a. 42°18′ 124°24′

PENNSYLVANIA

1. Nicholas deposit. Titaniferous magnetite in Precambrian gneiss. Bayley, 1941. 40°34′ 75°13′

2. Boyer (Kohl) deposit. Titaniferous magnetite in Precambrian gneiss. Bayley, 1941. 40°33′ 75°15′

3. Chester County area. Small residual deposits of rutile formed by the weathering of Lower Paleozoic schist and limestones. Watson and Taber, 1913. 39°57′ 75°50′

RHODE ISLAND

1. Iron Mine Hill. A large body of cumberlandite, consisting of olivine and labradorite grains embedded in a fine-grained matrix of intergrown ilmenite and magnetite, occurs in a coarse-grained gabbro. Johnson, 1908; Singewald, 1913; Warren, 1908. 42°00′ 71°28′

2. Block Island. Ilmenite in beach placers. 41°12′ 71°33′

SOUTH CAROLINA

1. Broad River. Ilmenite with subordinate amounts of rutile, monazite, and zircon in stream placers. Hansen and Theobald, 1955. 35°08′ 81°33′

2. Thicketty Creek. Ilmenite with subordinate amounts of monazite and rutile in stream placers. Hansen and Theobald, 1955. 35°00′ 81°42′

3. North Tyger and Middle Tyger Rivers. Ilmenite with subordinate amounts of rutile, monazite, and zircon in stream placers. Hansen and Cuppels, 1955. 34°52′ 82°00′

4. Rabon Creek. Ilmenite with subordinate amounts of rutile, monazite, and zircon in flood-plain deposits. Hansen and Caldwell, 1955. 34°29′ 82°08′

5. Big Generostee Creek placer area. Ilmenite with subordinate amounts of rutile, monazite, and zircon in flood-plain deposits. Hansen and Caldwell, 1955. 34°24′ 82°46′

6. Horse Creek. Rutile, ilmenite, monazite, and zircon in coarse deltaic sand. American Metal Market, 1955; Gillson, 1959. 33°28′ 81°53′

7. Hollow Creek. Ilmenite, rutile, monazite, and zircon in stream placers. Kline and others, 1954. 33°21′ 81°51′

8. Kitching's Mill area. Rutile, ilmenite, monazite, and zircon in stream placers along Shaw Creek and South Branch of the Edisto River. 33°34′ 81°30′

9. South Edisto River. Ilmenite, rutile, zircon, monazite, and staurolite in stream placers. 33°30′ 81°23′

10. Wateree River placer. Ilmenite in flood-plain sediments. Shufflebarger, 1958. 34°03′ 81°37′

11. Myrtle Beach. Black sand deposits discovered by aerial reconnaissance; probably contain ilmenite, rutile, and zircon. McKelvey and Balsey, 1948. 33°47′ 78°45′

12. Murrells Inlet. Black sand deposits discovered by aerial reconnaissance; probably contain ilmenite, rutile, and zircon. McKelvey and Balsley, 1948. 33°33′ 79°01′

13. Debidue Beach and Pawleys Island. Black sand deposits discovered by aerial reconnaissance; probably contain ilmenite, rutile, and zircon. McKelvey and Balsley, 1948. 33°26′ 79°07′

14. North Island. Black sand deposits discovered by aerial reconnaissance; probably contain ilmenite, rutile, and zircon. McKelvey and Balsley, 1948. 33°17′ 79°10′

15. Santee River Mouth. Black sand deposits discovered by aerial reconnaissance; probably contain ilmenite, rutile, and zircon. McKelvey and Balsley, 1948. 33°08′ 79°14′

16. Cape Romain. Black sand deposits discovered by aerial reconnaissance; probably contain ilmenite, rutile, and zircon. McKelvey and Balsley, 1948. 33°02′ 79°20′

17. Bull Island. Ilmenite and small amounts of leucoxene, rutile, zircon, and monazite in beach placers. McKelvey and Balsley, 1948; Neiheisel, 1958a. 32°54′ 79°36′

18. Capers Island. Ilmenite and small amounts of leucoxene, rutile, zircon, and monazite in beach placers. Neiheisel; 1958a. 32°52′ 79°40′

19. Dewees Island. Ilmenite and small amounts of leucoxene, rutile, zircon, and monazite in beach placers. Neiheisel, 1958a. 32°50′ 79°42′

20. Isle of Palms. Ilmenite and small amounts of leucoxene, rutile, zircon, and monazite in beach and dune sands. Neiheisel, 1958a, b. 32°48′ 79°45′

21. James Island. Titanium minerals in unconsolidated sands. Gillson, 1959. 32°43′ 79°58′

22. Folly Beach. Ilmenite with subordinate amounts of rutile, zircon, and monazite in beach placers. McKelvey and Balsley, 1948; Martens, 1935. 32°39′ 79°55′

23. Kiawah Island. Heavy mineral deposits discovered by aerial reconnaissance and by airborn radioactivity survey; probably contain ilmenite, rutile, zircon, and monazite. McKelvey and Balsley, 1948; Meuschke, 1955b. 32°37′ 80°04′

24. Adams Run. Titanium minerals in unconsolidated sands. Gillson, 1959. 32°45′ 80°21′

25. Edisto Island. Ilmenite, and small amounts of leucoxene, rutile, zircon, and monazite in beach placers. Neiheisel, 1958a. 32°32′ 80°12′

26. Hunting Island. Ilmenite, and small amounts of leucoxene, rutile, zircon, and monazite in beach placers. McKelvey and Balsley, 1948; Neiheisel, 1958a. 32°22′ 80°25′

27. Fripps and Prichards Islands. Ilmenite, and small amounts of leucoxene, rutile, zircon, and monazite in beach placers. McKelvey and Balsley, 1948; Neihesel, 1958a. 32°18′ 80°30′

28. Hilton Head Island. Ilmenite with subordinate amounts of zircon, rutile, and monazite in beach placers. Gillson, 1959; McCauley, 1960; McKelvey and Balsley, 1948; Neiheisel, 1958a. 32°11′ 80°43′

TENNESSEE

1. Camden area. Ilmenite, rutile, and monazite in ancient placer deposits in Cretaceous sandstone. Hardeman and Miller, 1959; Lynd, 1960; Mining World, 1959. 36°08′ 88°08′

2. Natchez Trace State Park north. Ilmenite, rutile, and monazite in ancient placer deposits in Cretaceous sandstone. Hardeman and Miller, 1959; Lynd, 1960; Mining World, 1959. 35°55′ 88°12′

3. Natchez Trace State Park south. Ilmenite, rutile, and monazite in ancient placer deposits in Cretaceous sandstone. Hardeman and Miller, 1959; Lynd, 1960; Mining World, 1959. 35°51′ 88°12′

4. Lexington area. Ilmenite, rutile, and monazite in ancient placer deposits in Cretaceous sandstone. Hardeman and Miller, 1959; Lynd, 1960, Mining World, 1959. 35°39′ 88°23′

5. Piney Creek area. Ilmenite, rutile, and monazite in ancient placer deposits in Cretaceous sandstone. Hardeman and Miller, 1959; Lynd, 1960; Mining World, 1959. 35°35′ 88°23′

6. French Broad River. Ilmenite, rutile, and other heavy minerals in flood-plain deposits. 36°03′ 83°11′

7. Cocke County deposit. Rutile and ilmenite in ancient beach placers in Precambrian rock. Hardeman and Miller, 1959. 35°48′ 83°03′

TEXAS

1. Mueller prospect. Rutile disseminated in hard silicified volcanic tuff and ash; locally concentrated in shear zones. Vogel, 1942. 30°32′ 104°15′

2. Barringer Hill deposit. Rutile and ilmenite in large pegmatite dike. Hess, 1908. 30°51′ 98°25′

3. First Yegua Creek area. Ilmenite and zircon in ancient beach placers in the Eocene Wellborn sandstone. Eng. Mining Jour., 1958a. 30°22′ 96°48′

UTAH

1. Rock Creek area. Ilmenite and sphene(?) in ancient beach placers in Upper Cretaceous sandstone. 37°20′ 111°22′

VIRGINIA

1. Buena Vista area. Rutile and ilmenite in thin sandstone layers; represent ancient placer deposits in the Cambrian(?) Unicoi formation. Bloomer and DeWitt, 1941. 37°42′ 79°20′

2. Roseland district. Numerous deposits of rutile and ilmenite occur in the Roseland anorthosite, which underlies an area of about 25 square miles. These minerals are disseminated in the anorthosite and occur in dikelike masses of nelsonite, which is composed essentially of ilmenite and apatite with variable 37°45′ 79°00′

amounts of rutile. The largest deposits occur at Roseland, where rutile is the predominant mineral, and at Piney River, where ilmenite predominates. Barksdale, 1949; Davidson and others, 1946; Gillson, 1949; Hillhouse, 1959; Lynd, 1960; Moore, 1940; Ross, 1941; Watson and Taber, 1913; Youngman, 1930.

3. Lovingston district. Several small to large bodies of nelsonite, containing variable amounts of magnetite, ilmenite, apatite, biotite, and hornblende, occur in biotite quartz monzonite gneiss. Watson and Taber, 1913. 37°46′ 78°52′

4. Montpelier district. Rutile and subordinate amount of ilmenite in saprolite and underlying anorthosite. Mining Eng., 1958; Watson and Taber, 1913. 37°46′ 77°43′

5. Nuckols farm. Rutile and minor amounts of ilmenite in saprolite and underlying pegmatite(?). Brown, 1937; Watson and Taber, 1913. 37°41′ 77°41′

6. Willis Mountain. Disseminated fine-grained rutile in amounts less than one percent in extensive deposits of kyanite quartzite. Espenshade and Potter, 1961; Watson and Taber, 1913. 37°28′ 78°27′

7. Baker Mountain. Rutile sparsely disseminated in kyanite quartzite. Espenshade and Potter, 1961; Pegau, 1950. 37°14′ 78°38′

8. Charlotte County area. Fine-grained rutile disseminated in kyanite schist. Watson and Taber, 1913. 37°12′ 78°42′

9. Hudson farm. Ilmenite-quartz rock in float; deposit not explosed. Steidtmann, 1931. 37°18′ 79°07′

10. Teels Mill area. Rutile and ilmenite in quartz vein that is conformable with enclosing mica schist. Watson, 1922. 37°10′ 79°43′

11. Roanoke area (Bush-Hutchins deposit). Several dikelike masses of nelsonite consisting of ilmenite, apatite, and magnetite occur in syenite and greenstone. Hickman, 1947; Watson and Taber, 1913. 37°16′ 79°52′

12. Chestnut Knob. Monazite, ilmenite, and zircon concentrated in magnetite-rich layer in biotite-kyanite-quartz schist. Mertie, 1955; Stow, 1955. 36°38′ 79°55′

13. Grayson County area. Small deposits of titaniferous magnetite in hornblende schist. Holden, 1907. 36°35′ 80°54′

WASHINGTON

1. Shi Shi Beach (Lovelace) placer. Ilmenite with gold, platinum, iridosmine, magnetite, and zircon in beach placer. Huntting, 1956; Pardee, 1929. 48°15′ 124°41′

2. Yellow Banks placer. Ilmenite with magnetite in beach placer. Huntting, 1956; Pardee, 1929. 48°05′ 124°41′

3. Cedar Creek placer. Ilmenite with gold, platinum, magnetite, chromite, and zircon in beach placer. Huntting, 1956; Pardee, 1929. 48°00′ 124°39′

4. Sedro Woolley deposit. Ilmenite and magnetite in stream placer. Youngman, 1930. 48°28′ 122°14′

5. Pilchuck Creek deposit. Rutile and magnetite in ancient placer occurring in basal beds of the Eocene Chuckanut formation (McLellan, 1927). Glover, 1942; Huntting, 1956. 48°17′ 122°08′

6. Fuller deposit. Titaniferous magnetite in veins and thin lenses in amphibole-biotite rock. Glover, 1942; Huntting, 1956. 48°02′ 119°53′

7. Similkameen Falls placer. Ilmenite with magnetite, hematite, and gold in stream placer. Huntting, 1956; Pardee, 1929. 48°58′ 119°30′

8. Wilmont Bar placer. Ilmenite with magnetite, monazite, zircon, and gold in stream placer. Huntting, 1956; Pardee, 1929. 48°03′ 118°17′

9. Excelsior clay deposit. Ilmenite in high-alumina residual basaltic clay. Huntting, 1956; Scheid and others, 1945. 47°33′ 117°15′

10. Damons Point placer. Ilmenite with zircon and gold in beach placer. Huntting, 1956; Pardee, 1929. 46°57′ 124°10′

11. Elma (Dennis) deposit. Ilmenite and magnetite in stream placer. Glover, 1942; Huntting, 1956. 47°01′ 123°20′

12. Winlock placer. Ilmenite in stream placer. Huntting, 1956. 46°29′ 122°56′

13. Beards Hollow and Fort Canby placers. Beards Hollow deposit: ilmenite with magnetite, zircon, and platinum in beach placer. Fort Canby deposit: ilmenite with magnetite and gold in beach placer. Huntting, 1956; Pardee, 1929. 46°18′ 124°03′

14. McGowan placer. Ilmenite with magnetite and zircon in terrace deposit. Glover, 1942; Huntting, 1956; Kelly, 1947. 46°15′ 123°53′

15. Brush Prairie placer. Ilmenite with magnetite and gold in stream placer. Huntting, 1956; Pardee, 1929. 45°42′ 122°27′

16. Camas placer. Ilmenite in auriferous stream placer. Huntting, 1956; Pardee, 1929. 45°36′ 122°19′

17. Clarkston placer. Ilmenite with gold, magnetite, and zircon in stream placer. Huntting, 1956; Pardee, 1929. 46°25′ 117°03′

WYOMING

1. Cowley deposit. Ilmenite in ancient beach placers in Upper Cretaceous sandstone. Osterwald and others, 1959. 44°52′ 108°29′
2. Lovell deposit. Ilmenite in ancient beach placers in Upper Cretaceous sandstone. Osterwald and others, 1959. 44°45′ 108°21′
3. Bald Mountain district. Ilmenite in ancient placers in the Cambrian Deadwood formation. Eilertsen and Lamb, 1956; McKinney and Horst, 1953. 44°48′ 107°47′
4. Grass Creek deposit. Ilmenite in ancient beach placers in Upper Cretaceous sandstone. Houston, 1955; Murphy and Houston, 1955; Osterwald and others, 1959. 43°57′ 108°37′
5. Cottonwood Creek deposit. Ilmenite in ancient beach placers in Upper Cretaceous sandstone. Houston, 1955; Murphy and Houston, 1955; Osterwald and others, 1959. 43°51′ 108°27′
6. Mud Creek deposit. Ilmenite in ancient beach placers in Upper Cretaceous sandstone. Osterwald and others, 1959. 43°46′ 107°47′
7. Dugout Creek deposit. Ilmenite in ancient beach placers in Upper Cretaceous sandstone. Osterwald and others, 1959. 43°50′ 107°30′
8. Gibbs Creek deposits. Ilmenite in ancient beach placers in Upper Jurassic sandstone. Houston and Love, 1956; Osterwald and others, 1959. 43°12′ 110°30′
9. Coalbank Hills deposit. Ilmenite in ancient beach placers in Upper Cretaceous sandstone. Osterwald and others, 1959. 42°58′ 107°23′
10. Poison Spider deposit. Ilmenite in ancient beach placers in Upper Cretaceous sandstone. Houston, 1955; Murphy and Houston, 1955; Osterwald and others, 1959. 42°53′ 106°50′
11. Clarkson Hill deposit. Ilmenite in ancient beach placers in Upper Cretaceous sandstone. Osterwald and others, 1959. 42°39′ 106°42′
12. Cumberland Gap deposits. Ilmenite in ancient beach placers in Upper Cretaceous sandstone. Houston, 1955; Murphy and Houston, 1955; Osterwald and others, 1959. 41°31′ 110°33′
13. Red Creek deposit. Ilmenite in ancient beach placers in Upper Cretaceous sandstone. Houston, 1955; Murphy and Houston, 1955; Osterwald and others, 1959. 41°02′ 109°14′
14. Salt Wells Creek deposit. Ilmenite in ancient beach placers in Upper Cretaceous sandstone. Houston, 1955; Murphy and Houston, 1955; Osterwald and others, 1959. 41°12′ 109°02′
15. Black Butte deposit. Ilmenite in ancient beach placers in Upper Cretaceous sandstone. Osterwald and others, 1959. 41°29′ 108°50′
16. Sheep Mountain deposit. Ilmenite in ancient beach placers in Upper Cretaceous sandstone. Houston, 1955; Murphy and Houston, 1955; Osterwald and others, 1959. 41°17′ 106°00′
17. Deposits 5, 6, and 7. Lenses of magnetite-ilmenite in anorthosite. Diemer, 1941; Newhouse and Hagner, 1951, 1957; Osterwald and others, 1959. 41°38′ 105°29′
18. Deposit 9. Lenses of magnetite-ilmenite in anorthosite. Diemer, 1941; Newhouse and Hagner, 1951, 1957; Osterwald and others, 1959. 41°36′ 105°26′
19. Shanton deposit, and Deposits 12 and 13. Lenses of magnetite-ilmenite in anorthosite. Diemer, 1941; Frey, 1946a; Newhouse and Hagner, 1951, 1957; Osterwald and others, 1959. 41°33′ 105°22′
20. Deposit 15. Lenses of magnetite-ilmenite in anorthosite. Diemer, 1941; Newhouse and Hagner, 1951, 1957; Osterwald and others, 1959. 41°29′ 105°24′
21. Deposits 1 and 2. Lenses of magnetite-ilmenite in anorthosite. Diemer, 1941; Newhouse and Hagner, 1951, 1957; Osterwald and others, 1959. 41°47′ 105°19′
22. Taylor deposit, and Deposits 3 and 4. Lenses of magnetite-ilmenite in anorthosite. Diemer, 1941; Newhouse and Hagner, 1951, 1957; Osterwald and others, 1959. 41°44′ 105°18′
23. Deposit 8. Lenses of magnetite-ilmenite in anorthosite. Diemer, 1941; Newhouse and Hagner, 1951, 1957; Osterwald and others, 1959. 41°37′ 105°18′
24. Iron Mountain deposit, and Deposits 10 and 11. Lenses of magnetite-ilmenite in anorthosite. Diemer, 1941; Frey, 1946b; Hild, 1953; Newhouse and Hagner, 1951, 1957; Osterwald and others, 1959. 41°36′ 105°19′
25. Deposit 14. Lenses of magnetite-ilmenite in anorthosite. Diemer, 1941; Newhouse and Hagner, 1951, 1957; Osterwald and others, 1959. 41°32′ 105°18′

SELECTED REFERENCES

Allen, J. E., 1956, Titaniferous Cretaceous beach placer in McKinley County, New Mexico (abs.): Geol. Soc. America Bull., v. 67, no. 12, pt. 2, p. 1789.

American Metal Market, 1955, Cramet expects to attain full output of titanium by "56" [Aiken, S. C.]: Am. Metals Market, v. 62, no. 59, p. 1.

_____, 1957, U. C. [Union Carbide] to mine Florida inland ore for Electromet's new titanium plant: Am. Metals Market, v. 64, no. 77, p. 1.

Anderson, A. L., 1960, Genetic aspects of the monazite and columbium-bearing rutile deposits in northern Lemhi County, Idaho: Econ. Geology, v. 55, p. 1179–1201.

Anderson, C. A., Scholz, E. A., and Strobell, J. D., Jr., 1955, Geology and ore deposits of the Bagdad area, Yavapai County, Arizona: U.S. Geol. Survey Prof. Paper 278, p. 13, 48.

Ball, S. H., and Broderick, T. M., 1919, *Magnetic iron ore in* Arizona: Eng. Mining Jour., v. 107, no. 8, p. 353–354.

Balsley, J. R., Jr., 1943, Vanadium-bearing magnetite-ilmenite deposits near Lake Sanford, Essex County, New York: U.S. Geol. Survey Bull. 940–D, p. 99–123.

Barksdale, Jelks, 1949, Mineral deposits that yield titanium, *in* Titanium, its occurrence, chemistry, and technology: New York, Ronald Press Company, p. 15–34.

Baughman, Will, 1927, The utilization and metallurgy of titanium: California Mining Bur. 23d Rept. State Mineralogist, v. 23, no. 3, p. 299–313.

Bayley, W. S., 1910, Iron mines and mining in New Jersey: New Jersey Geol. Survey, State Geologist Rept., v. 7, p. 89–512.

_____, 1923, Magnetic iron ore of East Tennessee and western North Carolina: North Carolina Geol. and Econ. Survey Bull. 32, 252 p.

_____, 1941, Pre-Cambrian geology and mineral resources of the Delaware Water Gap and Easton quadrangle, New Jersey and Pennsylvania: U.S. Geol. Survey Bull. 920, p. 76–77.

Binyon, E. O., 1946, Exploration of the Blue Metal corundum property, Douglas County, Nevada: U.S. Bur. Mines Rept. Inv. 3895, 7 p.

Bloomer, R. O., and DeWitt, Wallace, Jr., 1941, Titaniferous sandstone near Buena Vista, Virginia: Econ. Geology, v. 36, p. 745–747.

Broadhurst, S. D., [1955], The mining industry in North Carolina from 1946 through 1953: North Carolina Dept. Conserv. Devel., Div. Mineral Resources Econ. Paper 66, p. 25–27.

Brown, C. B., 1937, Outline of the geology and mineral resources of Goochland County, Virginia: Virginia Geol. Survey Bull. 48, County Ser. 1, p. 34–35.

Calhoun, W. A., 1950, Titanium and iron minerals from black sands in bauxite: U.S. Bur. Mines Rept. Inv. 4621, 17 p.

California Department of Natural Resources, Div. Mines, 1956, Titanium: California Dept. Nat. Resources, Div. Mines, Mineral Inf. Service, v. 9, no. 3, 6 p.

Calver, J. L., 1957, The heavy mineral industry, *in* Mining and mineral resources: Florida Geol. Survey, Geol. Bull. 39, p. 15–31.

Cannon, H. B., 1950, Economic minerals in the beach sands of the Southeastern United States, *in* Snyder, F. G., ed., Symposium on mineral resources of the Southeastern United States: Knoxville, Tennessee, Univ. Tennessee Press, p. 202–210.

Carpenter, J. H., Detweiler, J. C., Gillson, J. L., and others, 1953, Mining and concentration of ilmenite and associated minerals at Trail Ridge, Florida: Mining Eng., v. 5, no. 8, p. 789–795.

Chase, G. W., 1951, Titaniferous magnetite in basic rocks of the Wichita Mountains, Oklahoma: Hopper, v. 11, no. 1, p. 11–20.

_____, 1952, Ilmenite in alluvial sands of the *Wichita Mountain system, Oklahoma: Oklahoma* Geol. Survey Circ. 30, 44 p.

Chenoweth, W. L., 1957, Radioactive titaniferous heavy-mineral deposits in the San Juan Basin, New Mexico and Colorado, *in* New Mexico Geol. Soc. Guidebook, 8th Field Conf., Southwestern San Juan Mts., Colorado: p. 212–217.

Corcoran, R. E., and Libbey, F. W., 1956, Ferruginous bauxite deposits in the Salem Hills, Marion County, Oregon: Oregon Dept. Geology and Mineral Industries Bull. 46, p. 1–44.

Cross, H. C., 1949, Why the great interest in titanium?: Eng. Mining Jour., v. 150, no. 7, p. 119–123.

Davidson, D. M., Grout, F. F., and Schwartz, G. M., 1946, Notes on the ilmenite deposit at Piney River, Virginia: Econ. Geology, v. 41, p. 738–748.

Detweiler, J. C., 1952, Jacksonville plant produces titanium from beach deposits: Mining Eng., v. 4, no. 6, p. 560–562.

Diemer, R. A., 1941, Titaniferous magnetite deposits of the Laramie Range, Wyoming: Wyoming Geol. Survey Bull. 31, 23 p.

Eilertsen, D. E., and Lamb, F. D., 1956, A comprehensive report of exploration by the Bureau of Mines for thorium and radioactive black mineral deposits: U.S. Bur. Mines, U.S. Atomic Energy Comm. RME–3140, 46 p.

Engineering and Mining Journal, 1955, Probing Maryland's beaches for rich titanium sands: Eng. Mining Jour., v. 156, no. 4, p. 126.

_____, 1958a, [Giddings, Texas]: Eng. Mining Jour., v. 159, no. 6, p. 152.

_____, 1958b, Reserves of titanium sands in southern New Jersey: Eng. Mining Jour., v. 159, no. 4, p. 182.

Espenshade, G. H., and Potter, D. B., 1960, kyanite, sillimanite, and andalusite deposits of the Southeastern States: U.S. Geol. Survey Prof. Paper 336.

Ferguson, H. G., 1939, Nickel deposits in Cottonwood Canyon, Churchill County, Nevada: Nevada Univ. Bull., v. 33, no. 5, Geology and Mining Ser. 32, 21 p.

Frey, Eugene, 1946a, Exploration of the Shanton iron-ore property, Albany County, Wyoming: U.S. Bur. Mines Rept. Inv. 3918, 5 p.

_____, 1946b, Exploration of Iron Mountain titaniferous magnetite deposits, Albany County, Wyoming: U.S. Bur. Mines Rept. Inv. 3968, 37 p.

Fryklund, V. C., Jr., and Holbrook, D. F., 1950, Titanium ore deposits of Hot Spring County, Arkansas: Arkansas Res. Devel. Comm., Div. Geology Bull. 16, 173 p.

Fryklund, V. C., Jr., Harner, R. S., and Kaiser, E. P., 1954, Niobium (columbium) and titanium at Magnet Cove and Potash Sulphur Springs, Arkansas: U.S. Geol. Survey Bull. 1015-B, 57 p.

Gillson, J. L., 1949, Titanium, *in* Industrial minerals and rocks: New York, Am. Inst. Mining Metall. Engineers, 2d ed., chap. 49, p. 1042-1073.

_____, 1956, Genesis of titaniferous magnetites and associated rocks of the Lake Sanford district, New York: Mining Eng., v. 8, no. 3, p. 296-301.

_____, 1959, Sand deposits of titanium minerals: Mining Eng., v. 11, no. 4, p. 421-429..

Glover, S. L., 1942, Washington iron ores, a summary report: Washington Dept. Conserv. Devel., Div. Mines and Mining Rept. Inv. 2, 30 p.

Gordon, MacKenzie, Jr., Tracey, J. I., Jr., and Ellis, M. W., 1958, Geology of the Arkansas bauxite region: U.S. Geol. Survey Prof. Paper 299, p. 89-91.

Griffith, R. F., and Overstreet, W. C., 1953a, Buffalo Creek monazite placer, Cleveland and Lincoln Counties, North Carolina: U.S. Bur. Mines and U.S. Survey, U.S. Atomic Energy Comm. RME-3113, 17 p.

_____, 1953b, Knob Creek monazite placer, Cleveland County, North Carolina: U.S. Bur. Mines and U.S. Geol. Survey, U.S. Atomic Energy Comm. RME-3112, 30 p.

_____, 1953c, Sandy Run Creek monazite placer, Rutherford County, North Carolina: U.S. Bur. Mines and U.S. Geol. Survey, U.S. Atomic Energy Comm. RME-3114, 27 p.

Griggs, A. B., 1945, Chromite-bearing sands of the southern part of the coast of Oregon: U.S. Geol. Survey Bull. 945-E, p. 113-150.

Grout, F. F., 1949-50, The titaniferous magnetites of Minnesota: St. Paul, Minnesota, Commissioner Iron Range Res. and Rehabilitation, 117 p.

Grout, F. F., Sharp, R. P., and Schwartz, G. M., 1959, The geology of Cook County, Minnesota: Minnesota Geol. Survey Bull. 39, 163 p.

Hahn, A. D., and Fine, M. M., 1960, Examination of ilmenite-bearing sands of Otter Creek Valley, Kiowa and Tillman Counties, Oklahoma: U.S. Bur. Mines Rept. Inv. 5577, 77 p.

Hansen, L. A., and Caldwell, D. W., 1955, Monazite placers on Rabon Creek, Laurens County, and Big Generostee Creek, Anderson County, South Carolina: U.S. Bur. Mines and U.S. Geol. Survey, U.S. Atomic Energy Comm. RME-3118, 26 p.

Hansen, L. A., and Cuppels, N. P., 1954, Monazite placer on the First Broad River and its tributaries, Cleveland County, North Carolina: U.S. Bur. Mines and U.S. Geol. Survey, U.S. Atomic Energy Comm. RME-3116, 27 p.

_____, 1955, Monazite placer at the junction of the North Tyger River with the Middle Tyger River, Spartanburg County, South Carolina: U.S. Bur. Mines and U.S. Geol. Survey, U.S. Atomic Energy Comm. RME-3117, 23 p.

Hansen, L. A., and Theobald, P. K., Jr., 1955, Monazite placers of the Broad River and Thicketty Creek, Cherokee County, South Carolina: U.S. Bur. Mines and U.S. Geol. Survey, U.S. Atomic Energy Comm. RME-3126, 30 p.

Hansen, L. A., and White, A. M., 1954, Monazite placers on South Muddy Creek, McDowell County, and Silver Creek, Burke County, North Carolina: U.S. Bur. Mines, U.S. Atomic Energy Comm. RME-3115, 27 p.

Hardeman, W. D., and Miller, R. A., 1959, Mineral resources and mineral industries of Tennessee: Tennessee Dept. Conserv. and Commerce, Div. Geology, map with text, scale 1:500,000.

Hartnagel, C. A., and Broughton, J. G., 1951, The mining and quarry industries of New York State, 1937 to 1948: New York State Mus. Bull. 343, p. 113-117.

Hess, F. L., 1908, Minerals of the rare-earth metals at Baringer Hill, Llano County, Texas: U.S. Geol. Survey Bull. 340-D, p. 286-294.

Hickman, R. C., 1947, Bush-Hutchins ilmenite, Roanoke County, Virginia: U.S. Bur. Mines Rept. Inv. 4112, 5 p.

Hild, J. H., 1953, Diamond drilling on the Shanton magnetite-ilmenite deposits, Albany County, Wyoming: U.S. Bur. Mines Rept. Inv. 5012, 7 p.

Hillhouse, Neil, 1959, Preliminary report on the geologic investigations of the Roseland anorthosite and associated titanium deposits: Virginia Acad. Sci. Proc. for 1958-1959, v. 10, New Ser. 4, Geology Sec., p. 293.

Holbrook, D. F., 1947, A brookite deposit in Hot Spring County, Arkansas: Arkansas Res. Devel. Comm., Div. Geology Bull. 11, 21 p.

_____, 1948, Titanium in southern Howard County, Arkansas: Arkansas Res. Devel. Comm., Div. Geology Bull. 13, 16 p.

Holden, R. J., 1907, Iron, *in* Watson, T. L., Mineral resources of Virginia: Lynchburg, Virginia, Virginia Jamestown Exposition Comm., p. 476-477.

Hornor, R. R., 1918, Notes on the black sand deposits of southern Oregon and northern California: U.S. Bur. Mines Tech. Paper 196, 39 p.

Houston, R. S., 1955, Petrography of Wyoming titaniferous sandstone (abs.): Geol. Soc. America Bull., v. 66, no. 12, pt. 2, p. 1676.

Houston, R. S., and Love, J. D., 1956, Titaniferous sandstone in marine rocks of Late Jurassic age, northwestern Wyoming, *in* Wyoming Geol. Assoc. Guidebook, 11th Ann. Field Conf. 1956: p. 72-74.

Hubbard, H. G., 1943, Mines and mineral resources of Santa Cruz County [California]: California Jour. Mines Geology, v. 39, no. 1, p. 35-36.

Hundhausen, R. J., 1947, Chromiferous sand deposits in the Coos Bay area, Coos County, Oregon: U.S. Bur. Mines Rept. Inv. 4001, 13 p.

Huntting, M. T., 1956, Inventory of Washington minerals, part 2, Metallic minerals: Washington Dept. Conserv. Devel., Div. Mines and Geology Bull. 37, v. 1, p. 340-342; v. 2, locality map, scale 1 inch = 26 miles.

Hurst, V. J., 1959, The geology and mineralogy of Graves Mountain, Georgia: Georgia Geol. Survey Bull. 68, p. 19, 30-31.

Jennings, E. P., 1912, A titaniferous iron-ore deposit in Boulder County, Colo.: Am. Inst. Mining Engineers Bull. 70, p. 1045–1056.

Johnson, B. L., 1908, Notes on the history and geology of Iron Mine Hill, Cumberland, Rhode Island, *in* Contributions to the geology of Rhode Island: Am. Jour. Sci., 4th ser., v. 25, p. 1–12.

Johnson, M. E., Markewicz, F. J., and Parrillo, D. G., 1959, Titanium sands of southern New Jersey: New Jersey Bur. Geology and Topography Pamph., 15 p.

Kaiser, E. P., 1956, Preliminary report on the geology and deposits of monazite, thorite, and niobium-bearing rutile of the Mineral Hill district, Lemhi County, Idaho: U.S. Geol. Survey open-file report, 43 p.

Kauffman, A. J., Jr., [1954], The potentiality of titanium and zirconium from the alluvial sands of Idaho, *in* Mining industry of Idaho for 1953: Idaho State Inspector Mines 55th Ann. Rept., p. 49–51.

Kelly, J. V., 1947, Columbia River magnetite sands, Clatsop County, Oregon, and Pacific County, Washington, Hammond and McGowan deposits: U.S. Bur. Mines Rept. Inv. 4011, 7 p.

Kline, M. H., and Carlson, E. J., 1954, Pearsol Creek monazite placer area, Valley County, Idaho: U.S. Bur. Mines, U.S. U.S. Atomic Energy Comm. RME-3134, 24 p.

Kline, M. H., Carlson, E. J., and Griffith, R. H., 1950, Boise Basin monazite placers, Boise County, Idaho: U.S. Bur. Mines, U.S. Atomic Energy Comm. RME-3129, 37 p.

Kline, M. H., Carlson, E. J., and Horst, H. W., 1955, Corral Creek monazite placer area, Valley County, Idaho: U.S. Bur. Mines, U.S. Atomic Energy Comm. RME-3135, 22 p.

Kline, M. H., Carlson, E. J., and Storch, R. H., 1951a, Scott Valley and Horsethief Basin monazite placers, Valley County, Idaho: U.S. Bur. Mines, U.S. Atomic Energy Comm. RME-3133, 22 p.

Kline, M. H., Carlson, E. J., and Storch, R. H., 1951b, Big Creek monazite placers, Valley County, Idaho: U.S. Bur. Mines, U.S. Atomic Energy Comm. RME-3131, 24 p.

Kline, M. H., Carlson, E. J., Storch, R. H., and Robertson, A. F., 1953, Bear Valley radioactive mineral placers, Valley County, Idaho: U.S. Bur. Mines, U.S. Atomic Energy Comm. RME-3130, 23 p.

Kline, M. H., Griffith, R. F., and Hansen, L. A., 1954, Hollow Creek monazite placer, Aiken County, South Carolina: U.S. Bur. Mines, U.S. Atomic Energy Comm. RME-3127, 29 p.

Kuster, W. V.; 1959, Titanium minerals in the heavy sand deposits of Assateague Island, Maryland: U.S. Bur. Mines Rept. Inv. 5512, 22 p.

Larsen, E. S., 1942, Alkalic rocks of Iron Hill, Gunnison County, Colorado: U.S. Geol. Survey Prof. Paper 197-A, p. 1–64.

Libbey, F. W., Lowry, W. D., and Mason, R. S., 1945, Ferruginous bauxite deposits in northwestern Oregon: Oregon Dept. Geology and Mineral Industries Bull. 29, 97 p.

_____, 1946, Ferruginous bauxite deposits in northwestern Oregon: Econ. Geology, v. 41, p. 246–265.

Lydon, P. A., 1957, Titanium, *in* Mineral commodities of California: California Dept. Nat. Res., Mines Bull. 176, p. 647–654.

Lynd, L. E., 1960, Titanium, *in* Industrial minerals and rocks: New York, Am. Inst. Mining, Metall., Petroleum Engineers, p. 851–880.

McCauley, C. K., 1960, Exploration for heavy minerals on Hilton Head Island, South Carolina: South Carolina State Devel. Board Bull. 26, 13 p.

McKelvey, V. E., and Balsley, J. R., Jr., 1948, Distribution of coastal black-sands in North Carolina, South Carolina, and Georgia, as mapped from an airplane: Econ. Geology, v. 43, p. 518–524.

McKinney, A. A., and Horst, H. W., 1953, Deadwood conglomerate monazite deposit, Bald Mountain area, Sheridan and Big Horn Counties, Wyoming: U.S. Bur. Mines, U.S. Atomic Energy Comm. RME-3128, 40 p.

McLellan, R. D., 1927, The geology of the San Juan Islands: Washington Univ. Pub. in Geology, v. 2, 185 pp.

Mackin, J. H., and Schmidt, D. L., 1953, Reconnaissance geology of placer deposits containing radioactive minerals in the Bear Valley district, Valley County, Idaho: U.S. Geol. Survey open-file report, 32 p.

Martens, J. H. C., 1928, Ilmenite, zircon, and rutile in Florida: Florida Geol. Survey 19th Ann. Rept. for 1926–27, p. 124–154.

_____, 1935, Beach sands between Charleston, South Carolina, and Miami, Florida: Geol. Soc. America Bull., v. 46, no. 10, p. 1563–1596.

Matthews, A. F., 1945, Titanium: U.S. Bur. Mines Mineral Yearbook for 1943, p. 807–815.

Matthews, A. F., Ralston, O. C., and Ross, C. S., 1947, Titanium, *in* Investigation of natural resources, p. 299–300: U.S. 80th Cong., 1st sess., Senate Hearings Subcomm. of Comm. on Public Lands.

Merritt, C. A., 1940, Iron ores: Oklahoma Geol. Survey Mineral Rept. 4, 34 p.

Mertie, J. B., Jr., 1955, Ancient monazite placer [Virginia] (abs.): Geol. Soc. America Bull., v. 66, no. 12, pt. 2, p. 1692–1693.

Meuschke, J. L., 1954, Airborne radioactivity survey of the Fort Myers area, Charlotte and Lee Counties, Florida: U.S. Geol. Survey Geophys. Inv. Map GP-121.

_____, 1955a, Airborne radioactivity survey of the Gardner area, De Soto, Hardee, Manatee, and Sarasota Counties, Florida: U.S. Geol. Survey Geophys. Inv. Map GP-122.

_____, 1955b, Airborne radioactivity survey of the Edisto Island area, Berkeley, Charleston, Colleton, and Dorchester Counties, South Carolina: U.S. Geol. Survey Geophys. Inv. Map GP-123.

Meuschke, J. L., Moxham, R. M., and Bortner, T. W., 1953, Airborne radioactivity survey of the Gulf of Mexico Beach between Sanibel Island and Caladesi Island, Florida: U.S. Geol. Survey TEM-678, open-file report with accompanying map, scale 1:500,000.

Miller, Roswell, III, 1945, The heavy minerals of Florida beach and dune sands: Am. Mineralogist, v. 30, nos. 1-2, p. 65-75.

Mining Engineering, 1958, New domestic rutile source [Hanover County, Virginia]: Mining Eng., v. 10, no. 1, p. 25, 28.

Mining World, 1952, Notes on titanium in Teton and Pondera Counties, Montana: Mining World, v. 14, no. 3, p. 94.

_____, 1955, Du Pont acquires more Florida acreage to substantially increase ilmenite holdings: Mining World, v. 17, no. 10, p. 105.

_____, 1959, Du Pont finds ilmenite district in Tennessee: Mining World, v. 21, no. 1, p. 31.

Moore, C. H., Jr., 1940, Origin of the nelsonite rocks of Amherst County, Virginia: Econ. Geology, v. 35, p. 629-645.

Moxham, R. M., 1954, Airborne radioactivity survey in the Folkston area, Charlton County, Georgia, and Nassau County, Florida: U.S. Geol. Survey Geophys. Inv. Map GP-119, scale about 1:63,360.

Moxham, R. M., and Johnson, R. W., 1953, Airborne radioactivity survey of parts of the Atlantic Ocean Beach, Virginia to Florida: U.S. Geol. Survey TEM-644, open-file report with accompanying map, scale 1:633,600.

Murphy, J. F., 1956, Preliminary report on titanium-bearing sandstone in the San Juan Basin and adjacent areas in Arizona, Colorado, and New Mexico: U.S. Geol. Survey open-file report, 8 p.

Murphy, J. F., and Houston, R. S., 1955, Titanium-bearing black sand deposits of Wyoming, *in* Wyoming Geol. Assoc. Guidebook, 10th Ann. Field Conf. 1955: p. 190-196.

Neiheisel, James, 1958a, Heavy mineral beach placers of the South Carolina coast: South Carolina Div. Geology, State Devel. Board, Mineral Industries Lab. Monthly Bull., v. 2, no. 1, p. 1-7.

_____, 1958b, Origin of the dune system on the Isle of Palms, South Carolina: South Carolina Div. Geology, State Devel. Board, Mineral Industries Lab. Monthly Bull., v. 2, no. 7, p. 46-51.

Newhouse, W. H., and Hagner, A. F., 1951, Preliminary report on the titaniferous iron deposits of the Laramie Range, Wyoming: U.S. Geol. Survey open-file report, 45 p.

_____, 1957, Geologic map of anorthosite areas, southern part of Laramie Range, Wyoming: U.S. Geol. Survey Mineral Inv. Field Studies Map MF-119, scale 1:63,360.

Newland, D. H., 1908, Geology of the Adirondack magnetic iron ores: New York State Mus. Bull. 119, p. 146-170.

Oakeshott, G. B., 1948, Titaniferous iron-ore deposits of the western San Gabriel Mountains, Los Angeles County, California, *in* Iron resources of California: California Dept. Nat. Res., Div. Mines Bull. 129-P, p. 245-266.

_____, 1954, Geologic map of the western San Gabriel Mountains, California: California Dept. Nat. Resources, Div. Mines Bull. 170, Map Sheet 9 with text, scale 1:125,000.

_____, 1958, Geology and mineral deposits of San Fernando quadrangle, Los Angeles County, California: California Dept. Nat. Resources, Div. Mines Bull. 172, p. 109-110.

Olson, J. C., and Wallace, S. R., 1956, Thorium and rare-earth minerals in Powderhorn district, Gunnison County, Colorado: U.S. Geol. Survey Bull. 1027-O, p. 693-723.

Osterwald, F. W., Osterwald, D. B., Long, J. S., Jr., and Wilson, W. H., 1959, Mineral resources of Wyoming: Wyoming Geol. Survey Bull. 50, p. 175-178.

Ostrander, C. W., 1942, The Dinning rutile mine [Harford County, Maryland]: Maryland Nat. History Soc. Bull., v. 12, no. 5, p. 73.

Owens, J. P., Minard, J. P., Wiesnet, D. R., and Markewicz, F. J., 1960, Concentrations of "ilmenite" in the Miocene and post-Miocene formations near Trenton, New Jersey, *in* U.S. Geological Survey, Short papers in the geological sciences: U.S. Geol. Survey Prof. Paper 400-B, p. B57-B59.

Pardee, J. T., 1929, Platinum and black sand in Washington: U.S. Geol. Survey Bull. 805-A, pt. 1, p. 11-15.

Pegau, A. A., 1950, Geology of the titanium-bearing deposits in Virginia, *in* Snyder, F. G., ed., Symposium on mineral resources of the Southeastern United States: Knoxville, Tennessee, Univ. Tennessee Press, p. 49-55.

Reed, D. F., 1949a, Investigation of Christy titanium deposit, Hot Spring County, Arkansas: U.S. Bur. Mines Rept. Inv. 4592, 10 p.

_____, 1949b, Investigation of Magnet Cove rutile deposit, Hot Spring County, Arkansas: U.S. Bur. Mines Rept. Inv. 4593, 9 p.

Reid, R. R., 1960, Placer deposits of the Elk City region: Idaho Bur. Mines and Geology Pamph. 121, 26 p.

Roberts, A. E., 1955, How new $3,000,000 Highland plant recovers titaniferous minerals: Mining World, v. 17, no. 11, p. 52-55, 72.

Robertson, A. F., and Storch, R. M., 1955a, Rock Creek radioactive mineral placer area, Blaine County, Idaho: U.S. Bur. Mines, U.S. Atomic Energy Comm. RME-3139, 25 p.

_____, 1955b, Camp Creek radioactive mineral placer area, Blaine and Camas Counties, Idaho: U.S. Bur. Mines, U.S. Atomic Energy Comm. RME-3136, 27 p.

Roedder, Edwin, 1956, Report on the mineralogy of the titanium in bauxite from the Salem Hills, Oregon: Oregon Dept. Geology and Mineral Industries Bull. 46, App. p. 45-53.

Rose, C. K., and Shannon, S. S., Jr., 1960, Cebolla Creek titaniferous iron deposits, Gunnison County, Colorado: U.S. Bur. Mines Rept. Inv. 5679, 30 p.

Ross, C. S., 1941, Occurrence and origin of the titanium deposits of Nelson and Amherst Counties, Virginia: U.S. Geol. Survey Prof. Paper 198, 59 p.

Scheid, V. E., 1952, Stockton and Stanley Hill clay deposits, Kootenai County, Idaho: U.S. Geol. Survey open-file report, 26 p. [1954].

Scheid, V. E., and Hosterman, J. W., 1951a, Bovill clay deposits, Latah County, Idaho: U.S. Geol. Survey open-file

report, 30 p. [1954].

_____, 1951b, Canfield-Rogers high-alumina clay deposit, Latah County, Idaho: U.S. Geol. Survey open-file report, 21 p. [1954].

Scheid, V. E., Hosterman, J. W., and Sohn, I. G., 1945, Excelsior high-alumina clay deposit, Spokane County, Washington: U.S. Geol. Survey open-file report, 73 p. [1954].

Scheid, V. E., Hosterman, J. W., and Sohn, I. G., 1951a, Stanford clay deposit, Latah County, Idaho: U.S. Geol. Survey open-file report, 21 p. [1954].

_____, 1951b, Olson high-alumina and high-iron clay deposits, Latah County, Idaho: U.S. Geol. Survey open-file report, 213 p. [1954].

Scheid, V. E., Sohn, I. G., and Hosterman, J. W., 1951, Camas Prairie clay deposits, Lewis and Idaho Counties, Idaho: U.S. Geol. Survey open-file report, 22 p. [1954].

_____, 1952, Deary high-alumina clay deposit, Latah County, Idaho: U.S. Geol. Survey open-file report, 27 p. [1954].

Shufflebarger, T. E., Jr., 1958, Titanium minerals in the valley of the Wateree River, Kershaw, Richland, and Sumter Counties, South Carolina: South Carolina Div. Geology, State Devel. Board, Mineral Industries Lab. Monthly Bull., v. 2, no. 4, p. 23–32.

Singewald, J. T., Jr., 1912, The iron ore deposits of the Cebolla district, Gunnison County, Colorado: Econ. Geology, v. 7, p. 560–573.

_____, 1913, The titaniferous iron ores in the United States: U.S. Bur. Mines Bull. 64, 145 p.

Spencer, R. V., 1946, Exploration of the Magnet Cove Rutile Co. property, Magnet Cove area, Hot Spring County, Arkansas: U.S. Bur. Mines Rept. Inv. 3900, 23 p.

_____, 1948, Titanium minerals in Trail Ridge, Florida: U.S. Bur. Mines Rept. Inv. 4208, 21 p.

Stebinger, Eugene, 1914, Titaniferous magnetite beds on the Blackfeet Indian Reservation, Montana: U.S. Geol. Survey Bull. 540-H, p. 329–337.

Steidtmann, Edward, [1931], Some observations on titanium occurrences in Virginia [abs.]: Virginia Acad. Sci. Proc. 1930–31, p. 39.

Stephenson, E. L., 1945, Magnetometer surveys on black sands of the Oregon Coast: U.S. Bur. Mines Rept. Inv. 3814, 18 p.

Stephenson, R. C., 1945, Titaniferous magnetite deposits of the Lake Sanford area, New York: New York Mus. Bull. 340, 95 p.

_____, 1955, Titanium, *in* Industrial minerals in 1954: Mining Eng., v. 7, no. 3, p. 275–276.

Storch, R. H.., 1958a, Ilmenite and other black-sand minerals in the Gold Fork placer deposit, Valley County, Idaho: U.S. Bur. Mines Rept. Inv. 5395, 15 p.

_____, 1958b, Ilmenite and other black-sand minerals in the Deadwood placer deposit, Valley County, Idaho: U.S. Bur. Mines Rept. Inv. 5396, 15 p.

Storch, R. H., and Robertson, A. F., 1954, Beaver Creek monazite placer area, Valley County, Idaho: U.S. Bur. Mines, U.S. Atomic Energy Comm. RME-3132, 15 p.

Stow, M. H., 1955, Report of radiometric reconnaissance in Virginia, North Carolina, eastern Tennessee, and parts of South Carolina, Georgia, and Alabama: U.S. Atomic Energy Comm. RME-3107, 33 p.

Teas, L. P., 1921, Preliminary report on the sand and gravel deposits of Georgia: Georgia Geol. Survey Bull. 37, app. 8, p. 376–377.

Thoenen, J. R., and Warne, J. D., 1949, Titanium minerals in central and northeastern Florida: U.S. Bur. Mines Rept. Inv. 4515, 62 p.

Tomlinson, W. H., 1946, Rutile in Harford County, Maryland: Am. Mineralogist, v. 31, nos. 5-6, p. 322–325.

Tucker, W. B. 1927, Titaniferous iron deposits, Los Angeles, California: California Mining Bur. 23d Rept. State Mineralogist, v. 23, no. 3, p. 296–299.

Twenhofel, W. H., 1943, Origin of the black sands of the coast of southwest Oregon: Oregon Dept. Geology and Mineral Industries Bull. 24, 25 p.

_____, 1946a, Beach and river sands of the coastal region of southwest Oregon with particular reference to black sands: Am. Jour. Sci., v. 244, no. 3, p. 200–214.

_____, 1946b, Mineralogical and physical composition of the sands of the Oregon coast from Coos Bay to the mouth of the Columbia River: Oregon Dept. Geology and Mineral Industries Bull. 30, 64 p.

United States Bureau of Mines, 1943, Beach sands near Pensacola: War Minerals Rept. 141, 20 p.

Vernon, R. O., 1943, Ilmenite, rutile, and zircon, *in* Florida mineral industry: Florida Geol. Survey Bull. 24, p. 139–146.

Vogel, F. A., Jr., 1942, Preliminary report on the rutile and kaolin deposits of the Medley district in Jeff Davis County, Texas: Texas Univ., Bur. Econ. Geology Mineral Res. Survey Circ. 53, 8 p.

Warren, C. H., 1908, The petrography and mineralogy of Iron Mine Hill, Cumberland, Rhode Island, *in* Contributions to the geology of Rhode Island: Am. Jour. Sci., 4th ser., v. 25, p. 12–38.

Watson, T. L., 1922, Geology of a vein occurrence of rutile-ilmenite in a new locality [Amelia County, Virginia]: Washington Acad. Sci. Jour., v. 12, no. 20, p. 447–454.

Watson, T. L. and Taber, Stephen, 1913, Geology of the titanium and apatite deposits of Virginia: Virginia Geol. Survey Bull. 3A, 308 p.

Wimmler, N. L., 1946, Exploration of Choteau titaniferous magnetite deposit, Teton County, Montana: U.S. Bur. Mines Rept. Inv. 3981, 12 p.

Wright, L. A., Stewart, R. M., Gay, T. E., Jr., and Hazenbush, G. C., 1953, Tabulated list of mines and mineral deposits in San Bernardino County, *in* Mines and mineral deposits of San Bernardino County, California: California Jour. Mines and Geology, v. 49, nos. 1-2, p. 110.

Youngman, E. P., 1930, Deposits of titanium-bearing ores: U.S. Bur. Mines Inf. Circ. 6386, p. 1–18.