DEPARTMENT OF THE INTERIOR
UNITED STATES GEOLOGICAL SURVEY

TO ACCOMPANY MAP MR-23

MANGANESE IN THE UNITED STATES

(Exclusive of Alaska and Hawaii)

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Introduction

The manganese deposits in the United States (exclusive of Alaska and Hawaii) are shown on the accompanying map. The deposits have been divided into several genetic types distinguished on the map by symbols. The principal distinction is between syngenetic deposits, in which the manganese was deposited contemporaneously with the enclosing rocks, and epigenetic, in which manganese was introduced into sedimentary rocks after their deposition or into igneous rocks after solidification. Because hydrothermal, metamorphic, and particularly supergene processes modify and in places concentrate manganese minerals after deposition of the element, classification of many deposits is subject to uncertainties. A third category, deposits of unknown or uncertain origin, is therefore included also. Subdivisions of these principal categories are based on the geologic history subsequent to original accumulation of the syngenetic deposits, and on gross mineralogic nature of the epigenetic ones.

Size categories are based on the total production plus estimated reserves in terms of contained manganese metal, not tons of ore at a given grade. The size categories used are: greater than 5,000,000 long tons Mn, 1,000,000 to 5,000,000 long tons Mn, 50,000 to 1,000,000 long tons Mn, and less than 50,000 long tons Mn. Size is indicated on the map by size of symbol. Deposits and districts greater than 50,000 tons are numbered and identified in the Locality Index. Most of the small ones are not, but a few that are somewhat more prominent, either because of production or special mention in the literature, are shown by slightly larger symbols, numbered, and identified. Because the great majority of the manganese deposits of the United States are relatively small, the unidentified deposits vastly outnumber those described in the Locality Index.

The map was compiled from published and unpublished information, and at least one reference is given for each locality if reports on it have been published. Crittenden prepared the western half and Pavlides the eastern half of the map.

Geology and distribution

Syngenetic deposits

Syngenetic deposits of manganese in the United States occur in a variety of sedimentary environments. Very large, low-grade accumulations of manganese took place in or near iron formation in the Precambrian Cuyuna Range, Minnesota, and in the middle-Paleozoic ferruginous shales, slates, ironstones, and siliceous carbonate rocks of Aroostook County, Maine. Various Paleozoic formations along the Appalachian Mountains from Pennsylvania to Alabama, ranging in age from Early Cambrian to Mississippian, contain fractions of a percent of manganese that has been concentrated by supergene action during prolonged erosion to form numerous commercial deposits consisting of veins, breccia fillings, and replacements in clastic rocks, and particularly of manganese-oxide nodules in clay residuum from the carbonate rocks. The Devonian novaculite of western Arkansas also contains veinlets of manganese oxides believed to have been derived by concentration of manganese deposited with the chert.

The deposits in the Batesville district, Arkansas, are believed to have a more complicated history. Originally, manganese was syngenetically deposited as manganiferous carbonate in the Fernvale limestone (about three percent contained manganese) of Late Ordovician age, and manganese was also concentrated by algae (Girvanella) in the Cason shale which overlies the Fernvale limestone. Later hydrothermal activity redistributed and concentrated and localized some of the manganese at the upper part of the Fernvale limestone as rhodochrosite, hausmannite, and some silicates. Locally, it introduced pyrite, barite, and fluorite. During late Tertiary and Recent time, weathering processes oxidized and concentrated the manganese still further to form most of the commercial deposits, in part through the removal of the enclosing limestone, whereby hard manganese oxides were left as nodules and irregular masses in clay residuum. The "button ore" of the district formed from the oxidation of the manganese carbonate in the Girvanellas.

Lenticular deposits of manganese minerals are enclosed in eugeosynclinal chert-argillite-greenstone sequences of Paleozoic to Tertiary ages in the Western States. The manganese minerals are carbonates, oxides, and silicates; in general it seems probably that the manganese was derived from nearby volcanic sources and deposited essentially contemporaneously with the enclosing rocks as relatively high-grade concentrations. Subsequent regional metamorphism has modified the deposits mineralogically but has not effected any noteworthy increase in grade. Supergene alteration has oxidized near-surface parts of some deposits and concentrated the manganese to a minor extent. The principal regions characterized by deposits of this type are: 1) the Sierra Nevada region, California, in the Paleozoic Calaveras formation and Jurassic Amador group; 2) the central Nevada region, in the Mississippian (?) or older Pumpernickel formation and the Pennsylvania and

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Permian Havallah formation; 3) the Coast Ranges of California, in the Jurassic and Cretaceous Franciscan formation; 4) the Klamath Mountains, Oregon and California, in rocks of Triassic to Cretaceous (?) age; 5) the Olympic Peninsula, Washington, in Eocene limy argillite beds in a thick sequence of spilitic pillow basalt, agglomerate, and tuff.

Large quantities of manganese are contained in impure carbonate concretions in the Cretaceous Pierre shale in the Chamberlain district, South Dakota. The concretions, which average 15.5 percent manganese and 9.1 percent iron, are enclosed in bentonitic shale that itself contains about 0.7 percent manganese. The concretions apparently developed during diagenesis, and some contain unreplaced fossil fragments.

In the Colorado River region, southernmost Nevada and western Arizona, large low-grade manganiferous alluvial-fan and playa sediments of Pliocene (?) age occur in the Lake Meade region and the Artillery Peak district. The manganese was probably derived from local hot spring sources and incorporated in the sands and silts of the basins.

Epigenetic deposits

Epigenetic deposits have been divided by various authors, especially Hewett (in Hewett and others, 1956, p. 195-207), into many types based on mineral assemblages. On the map, however, only two principal distinctions are made, the carbonate-silicate-sulfide assemblage, and the group of veins containing hypogene manganese oxides described by Hewett and Fleischer (1960). A third category of spring deposits containing manganese oxides has close affinity both for the vein deposits and for the playa basin deposits described above.

The carbonate-silicate-sulfide epigenetic deposits are widely distributed in the Western States. Most are closely related to base- and precious-metal mineralization, and the manganese in a sense forms gangue minerals to the lead-zinc-copper minerals with which it is ordinarily associated. Commonly there is at least a rude zoning, with manganese deposited in the peripheral parts of the districts as at Butte, Montana. In a number of the deposits, as at Leadville, Colorado, Pioche, Nevada, and Park City, Utah, the deposits replace thick Paleozoic carbonate formations. At Philipsburg, Montana, the manganese was deposited at the intersections of strong fissures within lower Paleozoic rocks intruded by a small Tertiary granodiorite batholith. Elsewhere, the veins are fissure fillings in acid intrusive rocks, as at Butte, or in volcanic rocks, as at Sunnyside in the San Juan Mountains of Colorado.

In the Eastern United States the principal deposits referred to this category are those at Franklin Furnace and Sterling Hill, New Jersey, where complex zinc-manganese ores in a Precambrian marble contain an extraordinary assortment of minerals. Although generally called pyrometasomatic, the geologic history is recognized as being complex, and it seems probable that the manganese was originally introduced, together with the zinc, by an epigenetic process that antedated the severe metamorphism and hydrothermal alteration which developed the minerals present today.

The hypogene oxide veins form a distinct group that extends westward from central New Mexico (the Socorro and Little Florida Mountains districts) to southeastern California, and includes scattered deposits in central Utah and Nevada. The deposits are characterized by abundance of psilomelane-like oxides in a gangue of calcite, barite, and rarely fluorite and zeolites, and by trace amounts of tungsten, strontium, lead, and copper. Most of the veins cut Tertiary volcanic rocks. As this type of deposit has only recently been recognized, many deposits presently placed in the unknown or uncertain category may eventually be grouped here also.

Locality Index

	Lat. N.	Long. W.
ALABAMA		
1. Walnut Grove district. Oxides in Fort Payne chert (Mississippian) and residuum. Burchard and Andrews, 1947, p. 258-262.	34°04'	86°20'
2. Rock Run area. Cobaltiferous oxides in Weisner quartzite (Cambrian) and clay residuum from Knox dolomite (Cambrian and Ordovician). Extends into Geogia. Pierce, 1944, p. 276-279.	33°57'- 34°03'	85°21'- 85°29'
ARIZONA		
1. Artillery Peak district. Bedded oxides in Pliocene continental deposits. Lasky and Webber, 1949.	34°23'- 34°10'	113°23'- 113°40'
2. Aguila district. Hypogene manganese oxides and carbonates in veins cutting Tertiary volcanic rocks. Hewett and Fleischer, 1960, p. 28.	33°48'- 33°40'	113°00'- 113°46'
3. Globe district.	33°25'	110°45'
4. Tombstone district. Manganese oxides after alabandite in Upper Paleozoic limestone. Rasor, 1939.	31°45'	110°05'
5. Bisbee district. Manganese oxides derived from alabandite and manganese carbonate replacement deposits in limestone. Hewett and Rove, 1930.	31°27'	109°54'
ARKANSAS		
1. Batesville district. Syngenetic manganiferous carbonate in Ordovician Fernvale limestone and overlying Cason shale; hausmannite-carbonate-silicate hydrothermal concentrations near top of Fernvale; and supergene oxides in clay residuum and placer accumulations. Miser, 1923; Miser, 1940; Straczek and Kinney, 1950.	35°59'- 35°48'	91°30'- 91°56'

ARKANSAS (cont'd.)

2. Mena district. Manganese oxide veinlets in Devonian novaculite. Miser and Purdue, 1929.	34°18'-34°28'	93°30'-94°13'

CALIFORNIA

1. Fort Seward mine. Abundant braunite in chert of the Franciscan group. Trask and others, 1950, p. 67-69.	40°12'	123°42'
2. Blue Jay mine. Chiefly hausmannite, minor rhodochrosite and hydrous silicates in chert of the Franciscan group. Trask and others, 1950, p. 309-310.	40°07'	123°15'
3. Thomas (Round Mountain) mine. Neotocite, rhodochrosite (?) and oxides in chert of Franciscan group. Trask and others, 1950, p. 142-145.	39°19'	123°10'
4. Ladd mine. Rhodochrosite and bementite in chert of the Franciscan group, overlain by high-grade supergene oxides near surface. Trask and others, 1950, p. 223-226.	37°36'	121°30'
5. Buckeye mine. Bedded carbonate, braunite, hausmannite, hydrous silicates, and metallic sulfides in chert of the Franciscan group. Trask and others, 1950, p. 287-289.	37°32'	121°24'
6. Welch mine. Hausmannite and carbonates in chert of the Franciscan group. Trask and others, 1950, p. 240-241.	35°16'	120°46'
7. Braito mine. Braunite and rhodonite in Mississippian marine metasediments; some supergene oxides. Trask and others, 1950, p. 172-173.	40°05'	120°57'
8. Ironwood district. Oxides in veins cutting Tertiary volcanic flow and fragmental rocks. Trask and others, 1950, p. 176-180.	33°48'	114°56'
9. Paymaster district. Oxides in veins cutting Tertiary (?) volcanic breccia and fanglomerate. Trask and others, 1950, p. 79-80; Hadley, 1942.	33°13'	114°48'
10. Wingate Wash. Oxides in Tertiary sedimentary rocks. Hewett and Fleischer, 1960, p. 36.	35°55'	116°46'

COLORADO

1. Leadville district. Oxides from manganosiderite replacements of Paleozoic limestone. Emmons and others, 1927; Hedges, 1940.	39°15'	106°18'

COLORADO (cont'd.)

2. Sunnyside. Rhodonite, and minor rhodochrosite in veins cutting middle-Tertiary volcanic rocks. (to general setting) Burbank, 1951; (to ore deposits) Burbank, W. S. (oral communication).	37°54'	107°36'

GEORGIA

1. Cartersville district. Manganese oxides, in places cobaltiferous, associated with barite, ocher, etc. In clay residuum of Lower Cambrian carbonate sedimentary rocks; original minerals not known. Kesler, 1950; Pierce, 1944, p. 271-275.	34°07'-34°21'	84°40'-84°48'

IDAHO

1. Lava Hot Springs. Hewett and Fleischer, 1960, p. 30.	42°37'	111°59'
2. Cleveland. Manganese oxides in Pleistocene sedimentary beds, probably derived from manganiferous spring waters. Hewett, 1928; Hewett and Fleischer, 1960, p. 37.	42°20'	111°42'

MAINE

Bedded Paleozoic ferruginous and manganiferous marine sediments.

1. Northern district. Miller, 1947.	46°40'-46°56'	68°15'-68°05'
2. Central district (Maple and Hovey Mts. area). Pavlides, 1952; in press.	46°23'	68°03'
3. Southern district. Miller, 1947; Pavlides, 1955; Eilertsen, 1958.	46°00'-46°10'	67°47'-68°00'
4. Greenfield area. Manganiferous sediments of Aroostook County type.	45°03'	68°27'

MASSACHUSETTS

1. Taconic mine. Rhodonite and rhodochrosite in schist.	43°30'	72°56'

MINNESOTA

1. Cuyuna district. Manganiferous iron ores, plus large low-grade unoxidized and oxidized manganiferous Precambrian iron formation. Grout and Wolff, 1955.	46°34'-46°25'	93°53'-94°05'

MISSOURI

Southeastern Missouri area. Vein deposits containing braunite in igneous rocks of Precambrian age (low in cobalt); deposits of manganese oxide cementing chert breccia (high in cobalt) and oxides in clay residuum. Grawe, 1943.

MONTANA

1. Butte district. Rhodochrosite in base-metal vein deposits in quartz monzonite. Wayland, 1942. — 46°01' 112°31'
2. Philipsburg district. Rhodochrosite replacements in lower Paleozoic carbonate rocks at intersections of vein fissures. Goddard, 1940. — 46°21' 113°15'

NEVADA

1. Three Kids. Manganese wad and oxides in Pliocene (?) Muddy Creek formation; derived from hot-spring sources? McKelvey, Wiese, and Johnson, 1949. — 36°04' 114°53'
2. Boulder City. Manganese wad and oxides in Pliocene (?) Muddy Creek formation; derived from hot-spring sources? McKelvey, Wiese, and Johnson, 1949. — 35°56' 114°48'
3. Pioche district. Manganoan siderite replacement deposits in Cambrian limestone. Shibler, Agey, and Ipsen, 1947. — 37°55' 114°28'
4. Nevada district. Oxides derived from manganese carbonate-sulfide (?) replacement and vein deposits in Mississippian limestone. Roberts, 1942. — 39°11' 114°45'
5. Black Diablo. Braunite and manganoan chert and carbonate in late Paleozoic chert-greenstone sequence. Hewett and others, 1956, p. 189. — 40°13' 117°30'
6. Black Rock. Braunite, manganoan chert and carbonate, and supergene oxides in late Paleozoic chert-greenstone sequence. Hewett and others, 1956, p. 189. — 40°13' 117°15'
7. Gibellini. Manganese oxides with appreciable Zn, Ni, Co, V, Cu, and Mo in Paleozoic limestone. Binyon, 1948. — 39°11' 116°02'

NEW JERSEY

1. Franklin Furnace-Sterling Hill. Two "pyrometasomatic" zinc-manganese deposits in marble; numerous manganese minerals, including tephroite and franklinite. Palache, 1935. — 41°06' 74°36'

NEW MEXICO

1. Boston Hill. Oxidized manganoan siderite. — 32°43' 108°17'
2. Little Florida Mountains district. Veins of manganese oxides and black calcite in fanglomerate. Lasky, 1940. — 32°10'-32°15' 107°33'-107°35'

3. Luis Lopez district. Veins and breccia fillings of manganese oxides in rhyolite. Jicha, 1956; Hewett and Fleischer, 1960, p. 28. — 33°58' 106°58'
4. Lake Valley district. Oxides from manganese carbonate (?) replacements of Mississippian limestone. Creasey and Granger, 1953. — 32°43' 107°35'

NORTH CAROLINA-SOUTH CAROLINA

1. Gaffney-Kings Mountain area. Manganese oxides residual after spessartite in the Battleground schist. White, 1944; Keith and Sterrett, 1931. — 35°17'-35°02' 81°13'-85°38'

OKLAHOMA

1. Bromide district. Replacement deposits of manganese carbonates, oxides, and minor silicates in Silurian limestone. Ham and Oakes, 1944. — 34°27' 96°29'

SOUTH DAKOTA

1. Chamberlain district. Manganese carbonate concretions in Cretaceous Pierre shale. Pesonen, Tulles, and Zinner, 1949. — 44°05'-43°05' 99°35'-98°45'

TENNESSEE

1. Shady Valley district. Oxides in clay residuum from Lower Cambrian Shady dolomite. King and others, 1944, p. 72-112. — 36°29'-36°37' 81°57'-81°48'
2. Mountain City district. Oxides in clay residuum of Shady and Rome formations. King and others, 1944, p. 112-143. — 36°35'-36°23' 81°43'-81°51'
3. Butler district. Oxides, principally in clay residuum of Shady and Rome formations, minor amounts of brecciated underlying Erwin quartzite. King and others, 1944, p. 143-175. — 36°27'-36°18' 81°53'-82°02'
4. Stony Creek district. Oxides in clay residuum of Shady dolomite. King and others, 1944, p. 176-215. — 36°28'-36°20' 82°03'-82°12'
5. Hampton district. Oxides in clay residuum of Shady dolomite. King and others, 1944, p. 215-235. — 36°19'-36°15' 82°08'-82°18'
6. Unicoi district. Oxides, principally in clay residuum of Shady and Rome formations, one prospect in residuum of overlying Honaker dolomite. King and others, 1944, p. 236-256. — 36°15'-36°05' 82°17'-82°27'
7. Embreeville district. Oxides in residuum of Shady dolomite. King — 36°15'-36°08' 82°22'-82°30'

TENNESSEE (cont'd.)

and others, 1944, p. 256-271.

8. Boatman Ridge district. Oxides in clay residuum and brecciated chert of the Knox dolomite. Reichert, 1942, p. 146, 199-200.	36°17'- 36°13'	83°12'- 83°19'
9. Rutledge district. Oxides in clay residuum and chert fragments of the Knox dolomite. Reichert, 1942, p. 147-148, 200.	36°14'	83°33'
10. Haysville district. Oxides in clay residuum of the Shady dolomite. Reichert, 1942, p. 137-139, 199.	36°00'	82°51'
11. Del Rio district. Oxides in clay residuum of Shady dolomite and in underlying quartzose formations. Reichert, 1942, p. 140-143, 199.	35°58'- 35°54'	82°55'- 83°04'
12. Newport district. Oxides in clay residuum of the Shady dolomite. Reichert, 1942, p. 143-145, 199.	35°57'	83°15'
13. Knoxville district. Oxides in Ordovician Tellico (Chapman Ridge) sandstone and in clay residuum at contact of underlying Holston marble. Reichert,	35°55'	84°01'
14. Chilhowee Mountain district. Oxides in Lower Cambrian (?) Hesse (?) sandstone. Reichert, 1942, p. 156-157, 200.	35°38'- 35°33'	83°55'- 84°01'
15. Greenback district. Oxides in clay residuum and chert of the Knox dolomite. Reichert, 1942, p. 157, 200.	35°40'	84°08'
16. Sweetwater district. Oxides in Ordovician rocks and clay residuum; principally at the Tellico sandstone-Holston marble contact; also in Knox dolomite. Reichert, 1942, p. 166-172, 175-176, 201, 202.	35°40'- 35°33'	84°24'- 84°30'
17. Tellico Plains district. Oxides in various Cambrian and Ordovician sedimentary rocks and their clay residuum. Reichert, 1942, p. 173-175, 202.	35°23'- 35°19'	84°19'- 84°22'
18. White Oak district. Cobaltiferous manganese oxides in Mississippian Fort Payne chert. Reichert, 1942, p. 189-193, 203; Pierce, 1944, p. 274, 275-276.	35°12'- 35°08'	84°58'- 85°01'
19. Cleveland district. Oxides in Tellico (?) sandstone and in clay residuum. Reichert, 1942, p. 179-189, 202-203.	35°03'- 34°59'	84°53'- 84°55'

TEXAS

1. Spiller mine. Braunite, minor	30°50'	99°05'

hausmannite, and garnet in Precambrian metasedimentary rock Hewett and Schaller, 1937.

UTAH

1. Utah Hot Springs. Manganese oxides in travertine spring apron. Hewett and Fleischer, 1960, p. 40, 43.	42°37'	111°59'
2. Park City district. Oxides from manganese carbonate in base-metal deposits in Mississippian limestone. Boutwell, 1912.	40°37'	111°31'
3. Cottonwood-American Fork district. Rhodochrosite in base-metal deposits. Calkins and Butler, 1943.	40°35'	111°38'
4. Bingham district. Rhodochrosite in base-metal deposits. Boutwell, 1905.	40°32'	112°11'
5. Erickson district. Rhodonite and rhodochrosite with sulfides in quartz veins cutting lower Paleozoic clastic rocks. Crittenden, 1951, p. 39-44.	39°55'	112°59'
6. Drum Mountains (Detroit) district. Oxides from rhodochrosite bedding replacements of Cambrian (?) dolomite. Callaghan, 1938; Crittenden, 1951, p. 27-31; Crittenden, Straczek, and Roberts, 1961.	39°33'	113°03'
7. Abraham Hot Spring. Manganese oxides in travertine spring apron. Callaghan and Thomas, 1939; Crittenden, 1951, p. 24-25; Hewett and Fleischer, 1960, p. 40, 42-43.	39°35'	112°45'
8. Richfield district. Oxides, in part from hot springs, in part probably epigenetic in volcanic rocks. Hewett and Fleischer, 1960, p. 43; Crittenden, 1951, p. 36.	38°42'- 38°33'	112°05' 112°07'
9. Grand County district. Manganese oxides, principally as beds and lenses in Jurassic Summerville and Morrison formations. Baker, Duncan, and Hunt, 1952.	38°57'- 38°40'	109°23'- 110°12'

VIRGINIA

1. Cedar Creek Valley district. Oxides in Devonian sedimentary rocks and their clay residuum. Monroe, 1942.	39°04'- 38°57'	78°28' 78°33'
2. Elkton area. Oxides in clay residuum of lower Cambrian rocks. King, 1950.	38°34'- 38°17'	78°30' 78°45'
3. Crimora mine. Oxides in clay residuum of lower Cambrian rocks. Stose and others, 1919.	38°08'	78°48'

4. Lyndhurst-Vesuvius district. Oxides in clay residuum of lower Cambrian Tomstown dolomite; minor amounts in underlying quartzite beds. Knechtel, 1943.	38°02'- 37°53'	78°56'- 79°13'
5. James River-Roanoke River district. Oxides in clay residuum of Mount Athos formation metamorphosed Paleozoic (?). Espenshade, 1954.	37°42'- 37°08'	78°43'- 79°23'
6. Sweet Springs district (Va. and W. Va.) Oxides in residuum of Ordovician, Silurian, and Devonian rocks. Ladd, 1944.	37°36'- 37°31'	80°13'- 80°22'
7. Flat Top Mountain district. Oxides in Devonian Becraft sandstone and Silurian Clinton formation. Ladd and Stead, 1944.	37°15'- 37°12'	80°53'- 80°56'
8. Round Mountain district. Oxides in Devonian Becraft sandstone and clay residuum of underlying Tonoloway limestone. Ladd and Stead, 1944.	37°11'- 37°08'	81°09'- 81°20'
9. Lick Mountain district. Oxides in brecciated Cambrian and Precambrian (?) Erwin quartzite and in transitional beds to overlying Shady dolomite. Stead and Stose, 1943.	36°55'- 36°51'	80°55'- 81°08'
10. Glade Mountain district. Oxides, principally in clay residuum of Shady dolomite, lesser amounts in Erwin quartzite and Rome formation. Miller, 1944.	36°52'- 36°45'	81°15'- 81°33'

WASHINGTON

1. Olympic Peninsula. Lenticular bedded oxides, silicates, and carbonates in limy argillite layers interbedded in thick Tertiary submarine volcanic sequence. Park, 1942; Park, 1946.	47°23'- 48°14'	123°00'- 124°30'
2. Crescent mine. Principal deposit of the Olympic Peninsula. High-grade ore, chiefly hausmannite. Park, 1942, p. 443-445.	48°06'	123°56'

References Cited

Baker, A. A., Duncan, D. C., and Hunt, C. B., 1952, Manganese deposits of southeastern Utah: U. S. Geol. Survey Bull. 979-B.

Binyon, E. O., 1948, Gibellini manganese-zinc-nickel deposits, Eureka County, Nevada: U. S. Bur. Mines Rept. Inv. 4162.

Boutwell, J. M., 1905, Economic geology, Bingham mining district, Utah: U. S. Geol. Survey Prof. Paper 38, p. 71-385.

___________, 1912, Geology and ore deposits of the Park City district, Utah: U. S. Geol. Survey Prof.

Paper 77.

Burbank, W. S., 1951, The Sunnyside, Ross Basin, and Bonita fault systems and their associated ore deposits, San Juan County, Colorado: Colorado Sci. Soc. Proc., v. 15, no. 7, p. 285-304.

Burchard, E. F., and Andrews, T. G., 1947, Iron ore outcrops of the Red Mountain formation in northeast Alabama: Alabama Geol. Survey, Spec. Rept. 19.

Calkins, F. C., and Butler, B. S., 1943, Geology and ore deposits of the Cottonwood-American Fork area, Utah: U. S. Geol. Survey Prof. Paper 201.

Callaghan, Eugene, 1938, Manganese deposits of the Drum Mountains, Utah: Econ. Geology, v. 33, p. 508-521.

Callaghan, Eugene, and Thomas, H. E., 1939, Manganese in a thermal spring in west-central Utah: Econ. Geology, v. 34, p. 905-920.

Creasey, S. C., and Granger, A. E., 1953, Geologic map of the Lake Valley manganese district, Sierra County, New Mexico: U. S. Geol. Survey Mineral Inv. Map MF-9, scale 1:2,400.

Crittenden, M. D., Jr., 1951, Manganese deposits of western Utah: U. S. Geol. Survey Bull. 979-A.

Crittenden, M. D., Jr., Straczek, J. A., and Roberts, R. J., 1961, Manganese deposits in the Drum Mountains, Juab County, Utah: U. S. Geol. Survey Bull. 1082-H.

Eilertsen, N. A., 1958, Investigation of manganese areas, Hammond Plantation and Hodgdon Townships, Southern district, Aroostook County, Maine: U. S. Bur. Mines Rept. Inv. 5392.

Emmons, S. F., Irving, J. D., and Loughlin, G. F., 1927, Geology and ore deposits of the Leadville mining district, Colorado: U. S. Geol. Survey Prof. Paper 148.

Espenshade, G. H., 1954, Geology and mineral deposits of the James River-Roanoke River manganese district, Virginia: U. S. Geol. Survey Bull. 1008.

Goddard, E. N., 1940, Manganese deposits at Philipsburg, Granite County, Montana, a preliminary report: U. S. Geol. Survey Bull. 922-G, pt. 1.

Grawe, O. R., 1943, Manganese deposits of Missouri: Missouri Geol. Survey 62nd Bien. Rept., App. VI.

Grout, F. F., and Wolff, J. F., Sr., 1955, The geology of the Cuyuna district, Minnesota--a progress report: Minnesota Geol. Survey Bull. 36.

Hadley, J. B., 1942, Manganese deposits in the Paymaster mining district, Imperial County, California: U. S. Geol. Survey Bull. 931-S.

Ham, W. E., and Oakes, M. C., 1944, Manganese deposits of the Bromide district, Oklahoma: Econ. Geology, v. 39, p. 412-443.

Hedges, J. H., 1940, Mineral industries survey of the United States; Colorado, Lake County. Possibilities of manganese production at Leadville, Colorado: U. S. Bur. Mines Inf. Circ. 7125.

Hewett, D. F., 1928, A manganese deposit of Pleistocene age in Bannock County, Idaho: U. S. Geol. Survey Bull. 795-H.

Hewett, D. F., Crittenden, M. D., Pavlides, Louis, and DeHuff, G. L., Jr., 1956, Manganese deposits of the United States, in Symposium sobre yacimientos de manganeso: Internat. Geol. Cong., 20th, Mexico, 1956, v. 3, p. 169-230.

Hewett, D. F., and Fleischer, Michael, 1960, Deposits of the manganese oxides: Econ. Geology, v. 55, no. 1, p. 1-55.

Hewett, D. F., and Rove, O. N., 1930, Occurrence and relations of alabandite: Econ. Geology, v. 25, p. 36-56.

Hewett, D. F., and Schaller, W. T., 1937, Braunite from Mason County, Texas: Am. Mineralogist, v. 22, no. 6, p. 785-789.

Jicha, H. L., Jr., 1956, Manganese deposits of the Luis Lopez district, Socorro County, New Mexico, in Symposium sobre yacimientos de manganeso: Internat. Geol. Cong., 20th, Mexico, 1956, v. 3, p. 231-253.

Keith, Arthur, and Sterrett, D. B., 1931, Description of the Gaffney and Kings Mountain quadrangles [South Carolina-North Carolina]: U. S. Geol. Survey Geol. Atlas, Folio 222.

Kesler, T. L., 1950, Geology and mineral deposits of the Cartersville district, Georgia: U. S. Geol. Survey Prof. Paper 224.

King, P. B., 1950, Geology of the Elkton area, Virginia: U. S. Geol. Survey Prof. Paper 230.

King, P. B., Ferguson, H. W., Craig, L. C., and Rodgers, John, 1944, Geology and manganese deposits of northeastern Tennessee: Tennessee Dept. Conserv., Div. Geology Bull. 52.

Knechtel, M. M., 1943, Manganese deposits of the Lyndhurst-Vesuvius district, Augusta and Rockbridge Counties, Virginia: U. S. Geol. Survey Bull. 940-F.

Ladd, H. S., 1944, Manganese deposits of the Sweet Springs district, West Virginia and Virginia: U. S. Geol. Survey Bull. 940-G.

Ladd, H. S., and Stead, F. W., 1944, Manganese deposits of the Flat Top and Round Mountain districts, Bland and Giles Counties, Virginia: U. S. Geol. Survey Bull. 940-H.

Lasky, S. G., 1940, Manganese deposits in the Little Florida Mountains, Luna County, New Mexico, a preliminary report: U. S. Geol. Survey Bull. 922-C.

Lasky, S. G., and Webber, B. N., 1949, Manganese resources of the Artillery Mountains region, Mohave County, Arizona: U. S. Geol. Survey Bull. 961.

McKelvey, V. E., Wiese, J. H., and Johnson, V. H., 1949, Preliminary report on the bedded manganese of the Lake Mead region, Nevada and Arizona: U. S. Geol. Survey Bull. 948-D.

Miller, R. L., 1944, Geology and manganese deposits of the Glade Mountain district, Virginia: Virginia Geol. Survey Bull. 61.

__________, 1947, Manganese deposits of Aroostook County, Maine: Maine Geol. Survey Bull 4.

Miser, H. D., 1923, Deposits of manganese ore in the Batesville district, Arkansas: U. S. Geol. Survey Bull. 734.

__________, 1941, Manganese carbonate in the Batesville district, Arkansas: U. S. Geol. Survey Bull. 921-A.

Miser, H. D., and Purdue, A. H., 1929, Geology of the DeQueen and Caddo Gap quadrangles, Arkansas: U. S. Geol. Survey Bull. 808.

Monroe, W. H., 1942, Manganese deposits of the Cedar Creek Valley, Frederick and Shenandoah Counties, Virginia: U. S. Geol. Survey Bull. 936-E.

Palache, Charles, 1935, The minerals of Franklin and Sterling Hill, Sussex County, New Jersey: U. S. Geol. Survey Prof. Paper 180.

Park, C. F., Jr., 1942, Manganese deposits of the Olympic Peninsula, Washington, a preliminary report: U. S. Geol. Survey Bull. 931-R.

__________, 1946, The spilite and manganese problems of the Olympic Peninsula, Washington: Am. Jour. Sci., v. 244, no. 5, pt. 1, p. 305-323.

Pavlides, Louis, 1952, Description of deposits and character of ore, in Eilertsen, N. A., Maple Mountain-Hovey Mountain manganese project, Central district, Aroostook County, Maine: U. S. Bur. Mines Rept. Inv. 4921, p. 6-9.

__________, 1955, Description of deposits and character of ore, in Eilertsen, N. A., Investigation of the Littleton Ridge manganese deposit and vicinity, Southern district, Aroostook County, Maine: U. S. Bur. Mines Rept. Inv. 5104, p. 6-9.

Pavlides, Louis, in press, Geology and manganese deposits of the Maple and Hovey Mountains area, Aroostook County, Maine: U. S. Geol. Survey Prof. Paper 362.

Pesonen, P. E., Tullis, E. L., and Zinner, Paul, 1949, Missouri Valley manganese deposits, South Dakota; part 1, General investigations, stratigraphic studies, and tonnage and grade estimates: U. S. Bur. Mines Rept. Inv. 4375.

Pierce, W. G., 1944, Cobalt-bearing manganese deposits of Alabama, Georgia, and Tennessee: U. S. Geol. Survey Bull. 940-J.

Rasor C. A., 1939, Manganese mineralization at Tombstone, Ariz.: Econ. Geology, v. 34, p. 790-803.

Reichert, S. O., 1942, Manganese resources of east Tennessee: Tennessee Dept. Conserv. Div. Geology Bull. 50.

Roberts, R. J., 1942, Manganese deposits in the Nevada district, White Pine County, Nevada: U. S. Geol. Survey Bull. 931-M.

Shibler, B. K., Agey, W. W., and Ipsen, A. O., 1947, Concentration of manganese ores from Lincoln County, Nevada: U. S. Bur. Mines Rept. Inv. 4111.

Stead, F. W., and Stose, G. W., 1943, Manganese and quartzite deposits in the Lick Mountain district, Wythe County, Virginia: Virginia Geol. Survey Bull. 59.

Stose, G. W., Miser, H. D., Katz, F. J., and Hewett, D. F., 1919, Manganese deposits of the west foot of the Blue Ridge, Virginia: Virginia Geol. Survey Bull. 17.

Straczek, J. A., and Kinney, D. H., 1951, Geologic map of the central part of the Batesville manganese district, Independence and Izard Counties, Arkansas: U. S. Geol. Survey Mineral Inv. Map MF-1, scale 1:31,680.

Trask, P. D., and others, 1950, Geologic description of the manganese deposits of California: California Dept. Nat. Resources, Div. Mines, Bull. 152.

Wayland, R. G., 1942, Composition, specific gravity, and refractive indices of rhodochrosite; rhodochrosite from Butte, Montana: Am. Mineralogist, v. 27, no. 9, p. 614-628.

White, W. A., 1944, Manganese deposits in North Carolina: North Carolina Dept. Conserv. and Devel., Div. of Mineral Resources, Inv. 2.

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