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Cobalt in the United States

(Material compiled up to 1963)

by

J.S. Vhay

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Deposits of cobalt in the United States are shown on the accompanying map. Size category, geologic type, and approximate metal content are shown by the map symbols. Occurrences within each State are numbered on the map and identified by number in the index, where they are also listed by geographic coordinates and, where applicable, by county and section, township, and range. Both published sources and data in the files of the Geological Survey were used in compiling the map; the more important published reports are cited.

Cobalt is closely related, chemically, to iron, occurring in the same "box" with iron in the periodic table. Its average abundance in the igneous rocks of the earth's crust is 20 ppm (Unksov and Lodochuikova, 1961). However, cobalt is more abundant in more mafic rocks and is relatively depleted in more felsic rocks. The average amounts of cobalt in parts per million (ppm) in igneous rocks (in order, approximately, of increasing silica) are:

	Co
All mafic rocks	51
Basalt	41
Gabbro	43
Diabase and dolerite	31
Intermediate rocks	14
Felsic rocks	5

Most rocks are weathered before being eroded. Except for lateritic soils that develop on ultramafic rocks, the amount of cobalt in soils is surprisingly constant, with a range of between 1.5 and 18 ppm, and an average of 9 ppm. Lateritic soils are usually much richer in cobalt (up to 0.1%) which occurs mostly as a residual surface enrichment in manganese oxides (Pecora, 1944).

After erosion, most cobalt reaches areas of sedimentation in solution. It is deposited mainly with clay materials, or iron or manganese oxides, and is also concentrated to some extent in carbonaceous material. The amounts of cobalt in sandstone and limestone are very low, depending mostly on the amounts of clay, iron, and manganese present as impurities. In normal shales, the cobalt content usually is about 8 ppm, while black shales have between 5-50 ppm cobalt and carbonaceous shales about 14 ppm cobalt. The amounts of cobalt in certain special types of sediments may be considerably greater than average values; e.g., for iron-rich sediments (20-300 ppm Co), for ashed coals as much as 1,500 ppm Co, and ashed petroleum may average 920 ppm Co but contain as much as 9,000 ppm Co.

Manganese, under oxidizing conditions, has a strong affinity for a number of metals, including cobalt. Under very slow conditions of deposition, as occur on the bottoms of the oceans, manganese precipitates as a colloid which picks up cobalt ions present in solution. The manganese then coalesces and forms manganese nodules. Where deposition of other materials, siliceous, argillaceous, or carbonate, is too rapid to allow the formation of nodules, then the manganese oxides, together with other materials, will occur disseminated in the sediments in amounts that are inversely proportional to the rate of sedimentation. When these deposits are later exposed and weathered, the manganese is very insoluble, and, together with the contained cobalt, forms concentrations near the surface (e.g., in the Appalachians and Missouri); in places, these concentrations are of economic importance.

Little change in the amounts of cobalt present occurs during metamorphism. Those rocks high in cobalt (ultramafic and mafic igneous rocks) become serpentine, steatite, or chlorite schist and have the same relative amounts of cobalt as are found in the original rocks. Most other metamorphic rocks are low in these elements.

Deposits of cobalt

Cobalt is recovered from a number of different deposit types. The following are the most important.

Ultramafic and mafic rocks in many places contain deposits of pentlandite, chalcopyrite, and pyrrhotite. These deposits are often important sources of nickel and copper; the cobalt content of these deposits is usually between one-twentieth and one-thirtieth of the amount of nickel-plus-copper in the deposit. The Gap mine (Pennsylvania) and the San Julian mine (California),are examples of this type of deposit.

Contact deposits, formed by diabase intruding limestone, in places have important magnetite orebodies. These contain minor amounts of cobaltiferous pyrite. The Cornwall and Grace mines in Pennsylvania are of this type.

Hydrothermal vein deposits may also contain significant amounts of cobalt. The metal content of these deposits varies widely. Some, like the Bluebird mine (Arizona), are small deposits containing mostly only cobalt minerals. At the Standard mine (Oregon), the cobalt minerals are associated with considerable gold, and copper is present in separate ore shoots. In the Blackbird district (Idaho), the amount of copper present is greater than the amount of cobalt (Cu, 1.6 percent; Co, 0.6 percent), and minor amounts of gold, bismuth, and nickel are present. The Blackhawk district (New Mexico), is a silver-cobalt-nickel type hydrothermal vein deposit which also has some uranium.

A second type of hydrothermal deposit is the "stratabound" Mississippi Valley type deposits. These contain mostly sulfides of lead, zinc, iron, and copper, but some contain significant cobalt.

The massive sulfide deposits, such as are found in the Appalachians, are valuable mainly for the pyrite or pyrrhotite they contain, as they are mined primarily for the sulfur and iron; some by-product copper and zinc may also be produced. However, in some deposits, cobalt is present in pyrite (Ducktown, Tennessee).

Weathering is responsible for two types of deposits from which nickel and cobalt are or may be recovered. The laterites developed on ultramafic rocks under tropical conditions contain some cobalt which is usually concentrated in the upper part of the soil profile in association with manganese oxides. Lateritic deposits at Riddle, Oregon, and at Cle Elum, Washington, are examples. Cobalt also is concentrated in manganese deposits that are exposed and concentrated by weathering.

Stratabound copper deposits in shales and dolomites also contain cobalt-bearing sulfide deposits. Deposits of this type in Zaire and Zambia are the world's major sources of cobalt. Similar deposits are not known in the United States.

Brief history of production in the United States

A deposit near Chatham, Connecticut, produced minor amounts of cobalt intermittently between the years 1763 and 1853. The Gap mine, Pennsylvania, supplied nickel and cobalt to United States markets from 1860 to 1893; the deposit is described as segregated sulfides in a mafic intrusion similar to those in the Sudbury Basin. From 1893 until about 1900 small amounts of cobalt were produced both at Mine La Motte, Missouri, and from mines near Lovelock, Nevada. In the early 1900's a few shipments of cobalt-rich ore, carrying considerable gold also, were sent to France from the Quartzburg district, Oregon. During the periods 1906-1910 and 1917-1920 attempts were made to recover cobalt from the lead ore at Fredericktown, Missouri. Also in the period 1917-1920, some cobalt was produced at the Haynes Stellite mine in the Blackbird district, Idaho. In 1921 and 1922, numerous small high-grade shipments of cobalt oxide ore (heterogenite) were made from the Goodsprings district, Nevada; the total contained cobalt, however, was only about 4,650 pounds. The electrolytic zinc plant at Kellogg, Idaho, recovered some cobalt from its sludge but so far as known, this cobalt has never reached the open market. The magnetite mine, Cornwall, Pennsylvania, began producing by-product cobalt in 1940 (cobalt production ceased in 1971). The Fredericktown, Missouri, lead mine shipped nickel-cobalt concentrates for refining during the period 1941 to 1945; this ore deposit was also in production from 1955 to 1960. The Calera mine, Idaho, produced cobalt from 1952 to 1959.

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INDEX

	Locality	Lat. N.	Long W.

ALABAMA

	Locality	Lat. N.	Long W.
1.	Walnut Grove district. Blount Co. T. 11 S., R. 3 E. Manganese oxides in Fort Payne chert and overlying soil. Crittenden and Pavlides, 1962; Burchard and Andrews, 1947.	34°04'	86°20'
2.	Greasy Cove. Etowah Co. Sec. 11, T. 12 S., R. 4 E. Manganese oxides in weathered Fort Payne chert. Pierce, 1944.	34°	86°13'
3.	Harbour and Thompson prospects. Cherokee Co. Secs. 18, 20, T. 12 S., R. 10 E. Manganese oxides in soil overlying Floyd shale(?). Pierce, 1944.	33°59'	85°37'
4.	Rock Run area. Cherokee and Cleburne Cos. T. 12 S., R. 11 E. Manganese oxides in weathered Weisner quartzite and Knox dolomite. Pierce, 1944.	34°	85°25'
5.	Burke Estate. Calhoun Co. T. 14 S., R. 9 E. Manganese oxides. Pierce, 1944.	33°48'	85°41'
6.	Dulin. Clay Co. Sec. 14, T. 18 S., R. 8 E. Manganese oxides deposited in fractures in weathered Talledega slate. Pierce, 1944.	33°27'	85°46'
7.	Stone Hill. Cleburne Co. T. 17 S., T. 17 and 8 S., R. 11 E. Cupriferous iron sulfides replacing Hillabee chlorite schist. (Ross, 1935; Weed, 1911).	33°29'	85°27'
8.	Unnamed Prospect. Gosher Valley Area. Cherokee Co. Pellet-type ore. 0.14% Co. T. 12 S., R. 10 E., Sec. 20. Pierce, 1944.	33°58'	85°37'

ALASKA

	Locality	Lat. N.	Long W.
1.	Barrett property, Hot Springs Dome, Lower Tanana River. Vein in granite carries mixed sulfides. Mertie, 1934.	65°02'	150°45'
2.	Eagle district prospect. Yukon River. Cobalt-nickel sulfide vein in greenstone. Mertie, 1937.	64°48'	141°12'

Locality	Lat. N.	Long W.
ALASKA--Continued		
3. Spirit Mountain. Copper River area, Canyon Creek. Copper-nickel sulfides in peridotites sill. Kingston and Miller, 1945.	61°20'	144°16'
4. Mt. Crillon. East of Lituya Bay. Banded basic intrusion. Kennedy and Walton, 1946.	58°37'	137°15'
5. Admiralty-Alaska Gold. Funter Bay. Admiralty Island. Plunging gabbro pipe with disseminated copper-nickel sulfides. Reed, 1942.	58°14'	134°51'
6. Bohemia Basin. Yakobi Island. Norite body carrying disseminated copper-nickel sulfides. Kennedy and Walton, 1946.	57°59'	136°25'
7. North tip Fleming Island, 3 prospects. Chichagof Island. Disseminated copper-nickel sulfides in norite bodies. Pecora, 1942; Kennedy and Walton, 1946.	57°47'	136°18'
8. Snipe Bay prospect. Baranof Island. Albitized norite with copper-nickel sulfides. Reed and Gates, 1942.	56°26'	134°58'
ARIZONA		
1. Old Dick. Yavapai Co. Sec. 17, T. 14 N., R. 9 W. Copper-zinc sulfide bodies in foliated flows. Anderson, Scholz, and Strobell, 1956.	34°33'	113°14'
2. Walker prospect. Yavapai Co. Sec. 8, T. 14 N., R. 2 E. Cobaltian arsenopyrite in small vein. Vhay, 1952.	34°37'	112°11'
3. Bluebird, Graham Co. Sec. 5, T. 5 S., R. 21 E. Cobaltite, glaucodot, and chalcopyrite in vein in quartzite.	33°02'	110°12'
ARKANSAS		
1. Sugarstick. Polk and Pike Cos. Manganese oxide veinlets in novaculite. Hewett and Fleischer, 1960; Crittenden and Pavlides, 1962.	34°23'	93°50'
2. Saline Co. Nickel in soapstone and lateritic serpentine. Sterling and Stone, 1961.	34°45'	92°35'

	Locality	Lat. N.	Long. W.
	CALIFORNIA		
1.	Kane and Wilbur. Shasta Co. Sec. 24, T. 34 N., R. 4 W. Magnetite in skarn deposit; copper and nickel reported. Eric, 1948.	40°45'	122°16'
2.	Prospect. Nevada Co. Sec. 20, T. 17 N., R. 13 E. Chalcopyrite and cobaltite disseminated in schist. Lindgren, 1900.	39°20'	120°33'
3.	Digitalli. Jackson district. Amador Co. Sec. 36, T. 6 N., R. 11 E. Cobaltiferous manganese oxide in oxidized zone of gold-quartz vein. Vhay, 1952.	38°20'	120°43'
4.	Mokelumne Hill, prospect. Calaveras Co. T. 5 N., R. 12 E. "Asbolite." Murdock and Webb, 1956.	38°18'	120°41'
5.	Marjon. Sheepranch district. Calaveras Co. T. 4 N., R. 14 E. Glaucodot in fault in schist. Hess, 1927.	38°11'	120°27'
6.	Jenny Lind prospect. Calaveras Co. T. 3 N., R. 11 E. "Asbolite" reported. Murdock and Webb, 1956.	37°31'	120°46'
7.	Pine Tree and Josephine. Mariposa Co. Sec. 8, T. 4 S., R. 17 E. Gold-quartz vein on Mother Lode; Numerous sulfides. Nickel and cobalt present. Eric, 1948; Julihn and Horton, 1940.	37°36'	120°07'
8.	Green Mountain. Mariposa Co. Sec. 3, T. 8 S., R. 18 E. Pyrrhotite-chalcopyrite ore bodies in schist. Eric, 1948.	37°17'	120°00'
9.	Buchanan. Madera Co. Sec. 34, T. 8 S., R. 18 E. Pyrrhotite-chalcopyrite ore in schist. Eric, 1948.	37°11'	120°00'
10.	Jesse Belle. Madera Co. T. 9 S., R. 18, 19 E. Chalcopyrite and cobaltite in veins in schist and gneiss. Cox and Wyant, 1948.	37°09'	119°57'
11.	Daulton. Madera Co. Sec. 35; T. 9 S., R. 18 E. Pyrrhotite-chalcopyrite sphalerite ore in andalusite-schist. Eric, 1948.	37°07'	119°58'
12.	Krohn and Ward prospect. Madera Co. Secs. 23, 26, T. 10 S., R. 19 E. Pyrrhotite-chalcopyrite deposits; nickel and cobalt reported. Eric, 1948.	37°02'	119°52'
13.	Copconis prospect. Inyo Co. Sec. 23, T. 9 S., R. 31 E. Cobaltite and sulfides in shear zone in roof pendant. Tucker and Sampson, 1938, Vhay, 1952.	37°09'	118°33'

CALIFORNIA--Continued

	Locality	Lat. N.	Long. W.
14.	First Chance. San Luis Obispo Co. Sec. 27, T. 28 S., R. 11 E. Copper and nickel minerals in porphyry and granite. Eric, 1948.	35°28'	120°46'
15.	Denver group. Los Angeles Co. Secs. 10, 11, T. 3 N., R. 14 W. Copper, lead, zinc, antimony, and cobalt in quartz veins in schist. Eric, 1948.	34°21'	118°20'
16.	Old Ironsides. San Diego Co. Segregated copper-nickel sulfides in gabbro intrusion. Cornwall, 1966.	33°15'	116°45'
17.	Friday. San Diego Co. Sec. 15, T. 13 S., R. 4 E. Copper and nickel in basic gabbro. Creasey, 1946.	33°02'	116°34'

COLORADO

1.	Copper King (Gold Hill). Boulder Co. Sec. 14, T. 1 N., R. 72 W. Copper and nickel minerals in irregular mass replacing amphibolite schist. Goddard and Lovering, 1942; Lovering and Goddard, 1950.	40°03'	105°28'
2.	Horace Porter. Whiterock Mountain. Gunnison Co. Sec. 33, T. 12 S., R. 85 W. Cobalt and nickel minerals with silver, in roof pendant in diorite. Emmons, 1894; Short, 1940.	38°58'	106°53'

CONNECTICUT

1.	Near Chatham. Middlesex Co. Skutterudite, niccolite, and arsenopyrite in mica slate. Palache, 1944.	41°34'	72°33'

GEORGIA

1.	Berrong. Towns Co. Copper deposit, mostly secondary. Kinkel and Peterson, 1962.	34° 54'	83° 44'
2.	Gibson mine and Berkstreaser prospect. Floyd Co. Manganese oxide fills voids in weathered chert and as pellets in overlying red clay on Knox dolomite. Pierce, 1944.	34°07'	85°15'
3.	Gemes, Ward, Bearden and Masteller. Bartow Co. Manganese oxide in residual clay overlying Shady dolomite and Rome Formation. Pierce, 1944.	34°07'	84°40'

	Locality	Lat. N.	Long. W.
	GEORGIA--Continued		
4.	Creighton (Franklin), Swift. Cherokee Co. Auriferous pyrite and chalcopyrite in quartz stringers in schist and gneiss. Kinkel and Peterson, 1962; Pardee and Park, 1948.	34°18'	84°17'
5.	Penland Hill, Callahan, McCollum. Polk Co. Manganese oxide pellets in residual clay on Knox dolomite, Pierce, 1944.	33°59'	85°10'
6.	Tallapoosa, Smith-Candless. Haralson Co. Chalcopyrite, sphalerite, and pyrite masses in schist.	33°51'	85°05'
7.	Little Bob. Paulding Co. Massive pyrite and chalcopyrite in schist. Kinkel and Peterson, 1962.	33°54'	84°49'
8.	Reeds Mountain. Carroll and Haralson Cos. Pyrite and chalcopyrite masses in schist.	33°39'	85°05'
9.	Jenny Stone. Carroll Co. Pyrrhotite and chalcopyrite in schist. Kinkel and Peterson, 1962.	33°46'	84°55'
10.	Villa Rica. Douglas Co. Pyrite and chalcopyrite masses.	33°46'	84°53'
	IDAHO		
1.	Silver Summit. Shoshone Co. Sec. 23, T. 48 N., R. 3 E. Gersdorffite present in tetrahedrite-siderite veins. As much as 1.0% N., 0.40% Co present. Fryklund and Hutchinson, 1954.	47°30'	116°02'
2.	Franklin. Shoshone Co. Sec. 27, T. 46 N., R. E. Gersdorffite present in chalcopyrite-siderite veins. Wagner, 1949.	47°18'	115°56'
3.	Blackbird district. Lemhi Co. Secs. 22, 23, 26, 27, T. 20 N., R. 18 E. Chalcopyrite, cobaltite and safflorite in veins in schistose Belt rocks. Includes following properties (from north to south): A) Bonanza Copper, B) Tinker's Pride, C) Sweet Repose, D) Long Dike, E) Calera, F) Northfield, G) Haynes Stellite, and H) Black Pine. Vhay, 1948; Schockey, 1957; Umpleby, 1913.	45°11'- 45°03'	114°22'- 114°13'
4.	East Fork. Lemhi County. Cobalt minerals with chalcopyrite in small veins. Vhay, 1964.	45°28'	114°07'

	Locality	Lat N.	Long. W.
	MAINE		
1.	Crawford Pond. Knox Co. Pyrrhotite, chalcopyrite and pentlandite segregated in ultramafic intrusion. Ni, 0.6%; Cu, 0.28%; Co, 0.096%. Bastin, 1908; Cornwall, 1966.	44°11'	69°15'
2.	Katahdin Iron Works. Piscataquis Co. Pyrrhotite in gabbro. Young, 1968.	45°33'	69°10'
3.	Black Narrows, Moxie Lake. Somerset Co. Cu-Ni-Co in peridotite. Young, 1968.	45°19'	69°50'
4.	Alexander area, Washington Co. Cu-Ni-Co in ultramafic bodies. Young, 1968.	45°07'	67°28'
	MARYLAND		
1.	Patapsco. Carroll Co. Carrollite with chalcopyrite and other sulfides in veins in schist. Heyl and Pearre, 1965.	39°29'	76°53'
2.	Mineral Hill. Carroll Co. Magnetite, carrollite, chalcopyrite, sphalerite in chlorite gange in metagabbro. Heyl and Pearre, 1965.	39°26'	76°56'
3.	Carroll, probably similar to Patapsco and Mineral Hill deposits. Carroll Co. Heyl and Pearre, 1965.	39°23'	76°58'
4.	Bare Hills, Baltimore Co. Chalcopyrite, bornite, and magnetite (probably carrollite also) in vein in hornblende schist.	39°23'	76°40'
	MINNESOTA		
1.	Kawishiwi River area. Lake Co. Sec. 5, T.61 N., R. 11 W; secs. 25, 26, 32, 33, 34, T. 62 N., R. 11 W. Disseminated pyrrhotite, chalcopyrite, cubanite, and pentlandite along contact of Duluth gabbro. Cu 0.49%, Ni 0.14%. Grosh, 1955; Schwartz and Davidson, 1952.	47°52'	91°45'
	MISSOURI		
1.	Fredericktown. Madison Co. Sec. 16, T. 33 N., R. 7 E. Galena, marcasite, pyrite, chalcopyrite, siegneite, sphalerite, and bravoite in stratabound deposits at top of LaMotte sandstone and base of Bonneterre dolomite. Tarr, 1936; Ohle and Brown, 1954; Snyder and Odell, 1958.	37°33'	90°16'

Locality	Lat N.	Long W.
MONTANA		
1. Cherry Creek. Madison Co. Sec. 28, T. 8 S., R. 1 W. Manganese oxide deposits. Hollandite carries 2.29% Co. Hewett and Fleischer, 1960.	45°07'	111°44'
2. Mouat Nickel. Stillwater Co. Secs. 20, 29, T. 5 S., R. 15 E. Pyrrhotite, chalcopyrite and pentlandite disseminated and in masses of base of Stillwater Complex, Ni, 0.4%; Cu, 0.35%; Co, 0.025%. Cornwall, 1966.	45°21'	109°51'
NEVADA		
1. Lovelock (Table Mountain). Churchill Co. Sec. 34, T. 25 N., R. 36 E. Nickel and cobalt minerals in copper deposit in altered greenstone near diorite intrusion. Ferguson, 1939.	40°00'	117°55'
2. Gibellini. Eureka Co. Sec. 11, T. 16 N., R. 52 E. Psilomelane and pyrolusite carrying Zn, Ni, Co, and Cu. Binyon, 1948.	39°16'	116°04'
3. Copper Chief (Goodsprings). Clark Co. Sec. 35, T. 24 S., R. 57 E. Heterogenite in and around oxidized copper deposits in dolomite. Hewett, 1931.	35°49'	115°33'
4. Great Eastern and Key West. Clark Co. Hydrothermally altered magmatic differentiates of pyrrhotite, chalcopyrite and pentlandite in ultramafic dikes. One carload Cu, 2.30%; Ni. 1.79%; Co. 0.08%; Pt, 0.13 oz/ton. Needham and others, 1950.	36°40'	114°10'
NEW MEXICO		
1. Blackhawk. Grant Co. Sec. 21, T. 18 S., R. 16 W. Native silver, argentite, nickel-skutterudite, pitchblende, and less sphalerite, chalcopyrite and galena in vein in gneiss. One sample showed Ni, 8.9%; Co, 0.9%. Gillerman and Whitebread, 1956.	32°43'	108°30'
2. Manganese Valley, Luna, Killion. Luna Co. T. 24 S., R. 7 W. Manganese oxide deposit carrying some cobalt. Lasky, 1940; Hewett and Fleischer, 1960.	32°15'	107°35'

Locality	Lat N.	Long W.
NORTH CAROLINA		
1. Ore Knob. Ashe Co. Pyrrhotite, pyrite and chalcopyrite disseminated and massive in shear zone in Carolina gneiss. Cu:Co = 45.1. Egleston, 1881.	36°24'	81°22'
OREGON		
1. Standard (Quartzburg). Grant Co. Sec. 12, T. 12 S., R. 33 E. Glaucodot, safflorite, cabaltite, chalcopyrite and gold in vein cutting metavolcanic rocks. Vhay, 1959.	44°33'	118°41'
2. Nickel Mountain (Riddle). Douglas Co. Sec. 17, T. 30 S., R. 6 W. Garnierite in laterite overlying peridotite. Pecora and Hobbs, 1941. Bogert, 1960; Hotz, 1964.	42°58'	123°26'
3. Red Flats area. Curry Co. Secs. 19, 30, T. 37 S., R. 13 W. Nickeliferous laterite overlying serpentine. Ni, 0.9%; Co, 0.3%. Dole, 1948; Hundhausen, 1954.	42°21'	124°18'
4. Shamrock. Jackson Co. Secs. 19, 20, T. 14 S., R. 2 W. Pyrrhotite, pentlandite and chalcopyrite disseminated and in masses in ultramafic sills in greenstone. Cu, 1.1%; Ni, 1.3%; Co, 0.07%. Hundhausen, 1952. Shelton, 1956.	42°36'	122°59'
5. Cowboy (Takilma-Waldo). Josephine Co. Sec. 11, T. 41 S., R. 8 W. Pyrrhotite, cobaltite, chalcopyrite, cubanite and sphalerite in irregular masses in fault in serpentine near contact with greenstone. Ore boulder assayed 18.7% Cu, 0.24% Zn, 0.24% Co, 0.11% Ni. Shenon, 1933.	42°01'	123°36'
PENNSYLVANIA		
1. Gap Nickel mine. Lancaster Co. Pyrrhotite, chalcopyrite and pentlandite along contact of gabbro with mica schist. 2.3% Ni, 0.1% Co. Phemister, 1924; Knopf and Jonas, 1929.	39°57'	76°05'
2. Grace. Berks Co. Magnetite ore in skarn deposits. Sims, 1968.	40°11'	75°53'
3. Cornwall. Lebanon Co. Magnetite ore in skarn deposits. Vhay, 1952.	40°16'	76°25'

Locality	Lat N.	Long W.
TENNESSEE		
1. Scott prospect. Johnson Co. Manganese oxide deposit. Hollandite and pyrolusite in residual clay on Shady dolomite. King. 1944.	36°31'	81°57'
2. Hodge ore banks (Stony Creek). Carter Co. Old iron mines. Manganese oxide in residual clay on Shady dolomite. King, 1944, Harder, 1910.	36°26'	82°04'
3. Blue Spring. Carter Co. Manganese oxide in residual clay on Shady dolomite near contact with Erwin quartzite. King, 1944.	36°21'	82°07'
4. Proffit prospect. Johnson Co. Hard manganese oxide cements broken quartzite and jasperoid on fault(?) contact between Erwin formation and Shady dolomite. Psilomeland carries 0.3% Co.	36°23'	81°54'
5. Bumpass Cove. Unicoi and Washington Cos. Manganese oxide nodules in residual clay on Shady dolomite; 0.09% to 0.14% Co reported. King, 1944; Pierce, 1944; Stose and Schrader, 1923.	36°09'	82°31
6. Nunnelly. Hickman Co. Hard manganese oxide in seams in Fort Payne chert. One sample showed 52.9% MnO_2; 1.16% Ni; 0.64% Co. Burchard and others, 1934; Pierce, 1944.	35°49'	87°40'
7. White Oak Mountain. Bradley Co. Manganese oxides fill cracks and replace Fort Payne chert. Manganese (plus cobalt) oxides further concentrated near surface by weathering. Pierce, 1944, Stose and Schrader, 1923.	35°12'	84°59'
VERMONT		
1. Elizabethtown. Orange Co. Pyrrhotite and chalcopyrite in masses and disseminated in schist. Calcined pyrrhotite carries 0.11% Co. Kinkel and Peterson, 1962.	43°49'	72°20'
VIRGINIA		
1. Mineral Ridge. Cedar Creek Valley. Frederick Co. Manganese oxide nodules in residual clay overlying lower Paleozoic rocks. Stose and Miser, 1922; Monroe, 1942.	39°02'	78°27'
2. Cedar Creek Valley. Shenandoah Co. Manganese oxide nodules in weathered Devonian rocks and overlying residual clay. Stose and Miser, 1922; Monroe, 1942.	38°57'	78°30'

	Locality	Lat N.	Long W.
	VIRGINIA--Continued		
3.	Stanley (Eureka). Page Co. Hard manganese oxide nodules in residual clay overlying Tomstown (L€) dolomite. Stose and others, 1919; King, 1950.	$38^{\circ}34'$	$78^{\circ}31$
4.	Elkton mines. Rockingham Co. Manganese and iron oxides in residual clay derived from Tomstown dolomite and Waynesboro formation, and overlain by considerable gravel. Stose and others, 1919; King, 1950.	$38^{\circ}23'$	$78^{\circ}37'$
5.	Crimora. Augusta Co. Manganese oxide nodules in residual clay overlying Lower Cambrian rocks. Up to 0.53% Co reported. Stose and others, 1919; Pierce, 1944.	$38^{\circ}08'$	$78^{\circ}48'$
6.	Lyndhurst-Vesuvius. Augusta and Rockbridge Cos. Manganese oxide nodules in residual clay overlying Tomstown dolomite. Up to 0.95% Co reported. Stose and others, 1919; Knechtel, 1943.	$37^{\circ}53'$	$79^{\circ}13'$
7.	Paint Bank. Craig Co. Manganese oxide nodules in residual clay overlying Ordovician, Silurian and Devonian rocks. Ladd and Stead, 1944.	$37^{\circ}33'$	$80^{\circ}18'$
8.	Stange, Arms, Diamal Creek. Bland Co. Manganese oxide nodules in weathered Silurian and Devonian rocks. Up to 0.53% Co reported. Stose and Miser, 1922; Pierce, 1944; Ladd and Stead, 1944.	$37^{\circ}11'$	$80^{\circ}54'$
9.	Suitor, Round Mountain. Bland Co. Manganese oxide nodules in weathered Devonian sandstone and in residual clay overlying Silurian limestone. Up to 2.24% Co reported. Stose and Miser, 1922; Pierce, 1944; Ladd and Stead, 1944.	$37^{\circ}08'$	$81^{\circ}15'$
10.	Virginia Nickel Corporation. Floyd Co. Lenses of pyrrhotite-chalcopyrite pentlandite in a compound gabbro-pyroxenite dike. Watson, 1908; Ross, 1935.	$37^{\circ}05'$	$80^{\circ}13'$
11.	Prospects. Smyth Co. Manganese oxide nodules in residual clay overlying Shady dolomite. Stose and others, 1919; Miller, 1944.	$36^{\circ}45'$- $36^{\circ}52'$	$81^{\circ}33'$- $81^{\circ}15'$
12.	Lick Mountain. Wythe Co. Manganese oxide nodules in weathered lower Paleozoic rocks. Stose and others, 1919; Stead and Stose, 1943.	$36^{\circ}55'$	$80^{\circ}55'$

Locality	Lat N.	Long W.
VIRGINIA--Continued		
13. Gossan Lead. Carroll, Floyd, and Grayson Cos. Many large lenses of pyrrhotite, chalcopyrite and sphalerite in Carolina gneiss. Secondary copper sulfide ores. Watson, 1908; Ross, 1935; Kinkel and Peterson, 1962.	36°44'	80°56'
14. Toncray. Floyd Co. Pyrrhotite, chalcopyrite and pyrite masses in altered amphibolite dike cutting Carolina gneiss. Secondary chalcocite ore bodies. Cu:Co = 20:1. Watson, 1908; Ross, 1935.	36°49'	80°23'
WASHINGTON		
1. Mt. Vernon. Skagit Co. Secs. 4, 9, 10, T. 33 N., R. 4 E. Bravoite and other nickeliferous minerals with a little gold in brecciated silica-carbonate rock along fault between serpentine and pre-teritary rocks. Hobbs and Pecora, 1941.	48°20'	122°15'
2. Jumbo Mountain. Snohomish Co. Sec. 2, T. 31 N., R. 9 E. Pyrrhotite, pentlandite and chalcopyrite disseminated in dunite and in masses in shear zones along dunite-quartzite contact. Mills, 1960.	48°12'	121°36'
3. Mackinaw. Snohomish Co. Sec. 19, T. 29 N., R. 11 E. Lenses containing niccolite, maucherite, pentlandite, chalcopyrite, cubanite, vallerite and gold in ultramafic rock near fault with Eocene arkose. Cole, 1944; Milton and Milton, 1958.	47°59'	121°36'
4. Anderson prospect. Stevens Co. Sec. 3, T. 39 N., R. 41 E. Galena-sphalerite ore body containing Ni and Co. Vhay, 1966.	48°55'	117°38'
5. Congress (San Poil). Ferry Co. Sec. 35, T. 32 N., R. 33 E. Pockets of Ni-pyrite and chalcopyrite in quartz vein at contact of serpentine and schist. One sample gave 0.02% Cu, 1.2% Ni, 0.02% Co. Bancroft, 1914.	48°14'	118°38'
6. Shamrock (Iron Creek). Ferry Co. Sec. 35, T. 31 N., R. 33 E. Nickel and cobalt in brecciated zone in limestone near granite. Samples averaged 0.16% Ni and 0.06% Co across 90 feet. Patty, 1921.	48°09'	118°38'

Locality	Lat N.	Long W.
WASHINGTON--Continued		
7. Chelan (Dick, Winesap), Entiat. Chelan Co. Sec. 9, T. 26 N., R. 21 E. Disseminated pyrrhotite, pentlandite, chalcopyrite and pyrite in faulted coarse ultramafic rock. Huntting, 1943, Patty and Kelly, 1946.	47°46'	120°12'
WEST VIRGINIA		
1. Traynham prospect. Sweet Springs. Monroe Co. Manganese oxides in residual clay developed on weathered Ordovician and Silurian rocks. Ladd, 1944.	37°33'	80°20'