DEPARTMENT OF THE INTERIOR

U.S. GEOLOGICAL SURVEY

Cobalt in the United States
(Material compiled up to 1963)

by

J.S. Vhay

1979

Open-File 79-1436
COBALT IN THE UNITED STATES

(Material compiled up to 1963)

by J. S. Vhay

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 Lodochukova, 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:

- All mafic rocks 51 Co
- 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.
References cited


Creasey, S.C., 1946, Geology and nickel mineralization of the Julian-
Cuyamaca area, San Diego County, California: California Jour.
Crittenden, M.D., and Pavlides, L., 1962, Manganese in the United
Dole, H.M. and others, 1948, Nickel-bearing laterite areas of southwestern
Egleston, T., 1881, Investigations on the Ore Knob copper process: Am.
Emmons, S.F., and others, 1894, Description of the Anthracite-Crested Butte
Eric, John H., 1948, Tabulation of copper deposits of California, in
144, p. 259, 321, 333.
Ferguson, H.G., 1939, Nickel deposits in Cottonwood Canyon, Churchill
Fryklund, V.C., Jr., and Hutchinson, M.W., 1954, The occurrence of cobalt
and nickel in the Silver Summit mine, Coeur d'Alene district, Idaho:
Econ. Geology, v. 49, no. 7, p. 753-758.
Gillerman, E., and Whitebread, D.H., 1956, Uranium-bearing nickel-cobalt-
native silver deposits, Black Hawk district, Grant County, New
Goddard, E.N., and Lovering, T.S., 1942, Nickel deposits near Gold Hill,


Shelton, J.E., 1956, Beneficiation studies of nickeliferous ores from the
Shamrock mine, Jackson County, Oregon and the Congress mine, Ferry
Shenon, P.J., 1933, Geology and ore deposits of the Takilma-Waldo district,
Oregon, including the Blue Creek district: U.S. Geol. Survey Bull.
Short, M.N., 1940, Microscopic determination of the ore minerals:
Sims, S.J., 1968, The Grace mine magnetite deposit, Berks County,
Pennsylvania, in Ore Deposits in the United States, 1933-1967,
Snyder, F.G., and Odell, J.W., 1958, Sedimentary breccias in the southeast
Missouri lead district: Geol. Soc. America Bull., v. 69, no.7,
p. 899-926.
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.
Sterling, P.J., and Stone, C.G., 1961, Nickel occurrences in soapstone
deposits, Saline County, Arkansas: Econ. Geology, v. 56, no. 1,
p. 100-110.
Stose, G.W., and others, 1919, Manganese deposits of the west foot
Stose, G.W., and Miser, H.D., 1922, Manganese deposits of western Virginia:


______ 1959, The copper-cobalt deposits of the Quartzburg district, Grant County, Oregon: U.S. Geol. Survey open-file report.


## ALABAMA


2. **Greasy Cove.** Etowah Co. Sec. 11, T. 12 S., R. 4 E. Manganese oxides in weathered Fort Payne chert. Pierce, 1944.

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.


5. **Burke Estate.** Calhoun Co. T. 14 S., R. 9 E. Manganese oxides. Pierce, 1944.


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).

8. **Unnamed Prospect.** Goshen Valley Area. Cherokee Co. Pellet-type ore. 0.14% Co. T. 12 S., R. 10 E., Sec. 20. Pierce, 1944.

## ALASKA


Locality

ALASKA--Continued


ARIZONA


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


2. Saline Co. Nickel in soapstone and lateritic serpentine. Sterling and Stone, 1961. 34°45' 92°35'
<table>
<thead>
<tr>
<th>Locality</th>
<th>Lat. N.</th>
<th>Long. W.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Kane and Wilbur. Shasta Co. Sec. 24, T. 34 N., R. 4 W.</td>
<td>40°45'</td>
<td>122°16'</td>
</tr>
<tr>
<td>Magnetite in skarn deposit; copper and nickel reported.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Eric, 1948.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2. Prospect. Nevada Co. Sec. 20, T. 17 N., R. 13 E.</td>
<td>39°20'</td>
<td>120°33'</td>
</tr>
<tr>
<td>Chalcopyrite and cobaltite disseminated in schist.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lindgren, 1900.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3. Digitalli. Jackson district. Amador Co. Sec. 36,</td>
<td>38°20'</td>
<td>120°43'</td>
</tr>
<tr>
<td>T. 6 N., R. 11 E. Cobaltiferous manganese oxide in</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4. Mokelumne Hill, prospect. Calaveras Co. T. 5 N.,</td>
<td>38°18'</td>
<td>120°41'</td>
</tr>
<tr>
<td>5. Marjon. Sheepranch district. Calaveras Co. T. 4 N.,</td>
<td>38°11'</td>
<td>120°27'</td>
</tr>
<tr>
<td>7. Pine Tree and Josephine. Mariposa Co. Sec. 8,</td>
<td>37°36'</td>
<td>120°07'</td>
</tr>
<tr>
<td>T. 4 S., R. 17 E. Gold-quartz vein on Mother Lode;</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Numerous sulfides. Nickel and cobalt present.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Eric, 1948; Julihn and Horton, 1940.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>8. Green Mountain. Mariposa Co. Sec. 3, T. 8 S.,</td>
<td>37°17'</td>
<td>120°00'</td>
</tr>
<tr>
<td>R. 18 E. Pyrrhotite-chalcopyrite ore bodies in</td>
<td></td>
<td></td>
</tr>
<tr>
<td>9. Buchanan. Madera Co. Sec. 34, T. 8 S., R. 18 E.</td>
<td>37°11'</td>
<td>120°00'</td>
</tr>
<tr>
<td>10. Jesse Belle. Madera Co. T. 9 S., R. 18, 19 E.</td>
<td>37°09'</td>
<td>119°57'</td>
</tr>
<tr>
<td>Chalcopyrite and cobaltite in veins in schist and</td>
<td></td>
<td></td>
</tr>
<tr>
<td>11. Daulton. Madera Co. Sec. 35; T. 9 S., R. 18 E.</td>
<td>37°07'</td>
<td>119°58'</td>
</tr>
</tbody>
</table>
CALIFORNIA—Continued

Locality


COLORADO


CONNECTICUT


GEORGIA


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.

Locality

GEORGIA--Continued


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.


Locality

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.


MARYLAND


4. Bare Hills, Baltimore Co. Chalcopyrite, bornite, and magnetite (probably carrollite also) in vein in hornblende schist.

MINNESOTA


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.
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%

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.

**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.

2. Gibellini. Eureka Co. Sec. 11, T. 16 N., R. 52 E.
Psilomelane and pyrolusite carrying Zn, Ni, Co,

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.

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.

**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.

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.
NORTH CAROLINA


OREGON


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.

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.


<table>
<thead>
<tr>
<th>Locality</th>
<th>Lat N.</th>
<th>Long W.</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>TENNESSEE</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2. Hodge ore banks (Stony Creek). Carter Co. Old iron mines. Manganese oxide in residual clay on Shady dolomite. King, 1944, Harder, 1910.</td>
<td>36°26'</td>
<td>82°04'</td>
</tr>
<tr>
<td>3. Blue Spring. Carter Co. Manganese oxide in residual clay on Shady dolomite near contact with Erwin quartzite. King, 1944.</td>
<td>36°21'</td>
<td>82°07'</td>
</tr>
<tr>
<td>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.</td>
<td>36°23'</td>
<td>81°54'</td>
</tr>
<tr>
<td>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.</td>
<td>36°09'</td>
<td>82°31</td>
</tr>
<tr>
<td>6. Nunnelly. Hickman Co. Hard manganese oxide in seams in Fort Payne chert. One sample showed 52.9% MnO₂; 1.16% Ni; 0.64% Co. Burchard and others, 1934; Pierce, 1944.</td>
<td>35°49'</td>
<td>87°40'</td>
</tr>
<tr>
<td>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.</td>
<td>35°12'</td>
<td>84°59'</td>
</tr>
<tr>
<td><strong>VERMONT</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1. Elizabethtown. Orange Co. Pyrrhotite and chalcopyrite in masses and disseminated in schist. Calcined pyrrhotite carries 0.11% Co. Kinkel and Peterson, 1962.</td>
<td>43°49'</td>
<td>72°20'</td>
</tr>
<tr>
<td><strong>VIRGINIA</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2. Cedar Creek Valley. Shenandoah Co. Manganese oxide nodules in weathered Devonian rocks and overlying residual clay. Stose and Miser, 1922; Monroe, 1942.</td>
<td>38°57'</td>
<td>78°30'</td>
</tr>
<tr>
<td>Locality</td>
<td>Lat N.</td>
<td>Long W.</td>
</tr>
<tr>
<td>---------------</td>
<td>--------</td>
<td>---------</td>
</tr>
<tr>
<td><strong>VIRGINIA—Continued</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3. Stanley (Eureka). Page Co. Hard manganese oxide</td>
<td>38°34'</td>
<td>78°31'</td>
</tr>
<tr>
<td>nodules in residual clay overlying Tomstown (L6)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>dolomite. Stose and others, 1919; King, 1950.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4. Elkton mines. Rockingham Co. Manganese and iron</td>
<td>38°23'</td>
<td>78°37'</td>
</tr>
<tr>
<td>oxides in residual clay derived from Tomstown</td>
<td></td>
<td></td>
</tr>
<tr>
<td>dolomite and Waynesboro formation, and overlain</td>
<td></td>
<td></td>
</tr>
<tr>
<td>by considerable gravel. Stose and others, 1919;</td>
<td></td>
<td></td>
</tr>
<tr>
<td>King, 1950.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5. Crimora. Augusta Co. Manganese oxide nodules</td>
<td>38°08'</td>
<td>78°48'</td>
</tr>
<tr>
<td>in residual clay overlying Lower Cambrian rocks.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Up to 0.53% Co reported. Stose and others, 1919;</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pierce, 1944.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Manganese oxide nodules in residual clay overlying</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tomstown dolomite. Up to 0.95% Co reported.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Stose and others, 1919; Knechtel, 1943.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>7. Paint Bank. Craig Co. Manganese oxide nodules in</td>
<td>37°33'</td>
<td>80°18'</td>
</tr>
<tr>
<td>residual clay overlying Ordovician, Silurian and</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Devonian rocks. Ladd and Stead, 1944.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>8. Stange, Arms, Diamal Creek. Bland Co. Manganese</td>
<td>37°11'</td>
<td>80°54'</td>
</tr>
<tr>
<td>oxide nodules in weathered Silurian and Devonian</td>
<td></td>
<td></td>
</tr>
<tr>
<td>rocks. Up to 0.53% Co reported. Stose and Miser, 1922;</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pierce, 1944; Ladd and Stead, 1944.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>nodules in weathered Devonian sandstone and in</td>
<td></td>
<td></td>
</tr>
<tr>
<td>residual clay overlying Silurian limestone. Up to 2.24%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Co reported. Stose and Miser, 1922; Pierce, 1944;</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ladd and Stead, 1944.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>10. Virginia Nickel Corporation. Floyd Co. Lenses of</td>
<td>37°05'</td>
<td>80°13'</td>
</tr>
<tr>
<td>pyrrhotite-chalcopyrite pentlandite in a compound</td>
<td></td>
<td></td>
</tr>
<tr>
<td>gabbro-pyroxenite dike. Watson, 1908; Ross, 1935.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>11. Prospects. Smyth Co. Manganese oxide nodules in</td>
<td>36°45'</td>
<td>81°33'</td>
</tr>
<tr>
<td>residual clay overlying Shady dolomite. Stose and</td>
<td>36°52'</td>
<td>81°15'</td>
</tr>
<tr>
<td>others, 1919; Miller, 1944.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>12. Lick Mountain. Wythe Co. Manganese oxide nodules</td>
<td>36°55'</td>
<td>80°55'</td>
</tr>
<tr>
<td>in weathered lower Paleozoic rocks. Stose and others,</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1919; Stead and Stose, 1943.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Locality</td>
<td>Lat N.</td>
<td>Long W.</td>
</tr>
<tr>
<td>-----------------------------</td>
<td>---------</td>
<td>----------</td>
</tr>
<tr>
<td>VIRGINIA—Continued</td>
<td></td>
<td></td>
</tr>
<tr>
<td>WASHINGTON</td>
<td></td>
<td></td>
</tr>
<tr>
<td>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-tertiary rocks. Hobbs and Pecora, 1941.</td>
<td>48°20'</td>
<td>122°15'</td>
</tr>
<tr>
<td>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.</td>
<td>48°14'</td>
<td>118°38'</td>
</tr>
<tr>
<td>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.</td>
<td>48°09'</td>
<td>118°38'</td>
</tr>
<tr>
<td>Locality</td>
<td>Lat N.</td>
<td>Long W.</td>
</tr>
<tr>
<td>-------------------------------------------------------------------------</td>
<td>---------</td>
<td>---------</td>
</tr>
<tr>
<td><strong>WASHINGTON—Continued</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7. Chelan (Dick, Winesap), Entiat. Chelan Co. Sec. 9,</td>
<td>47°46'</td>
<td>120°12'</td>
</tr>
<tr>
<td>T. 26 N., R. 21 E. Disseminated pyrrhotite,</td>
<td></td>
<td></td>
</tr>
<tr>
<td>pentlandite, chalcopyrite and pyrite in faulted coarse ultramafic rock.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Huntting, 1943, Patty and Kelly, 1946.</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>WEST VIRGINIA</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1. Traynham prospect. Sweet Springs. Monroe Co.</td>
<td>37°33'</td>
<td>80°20'</td>
</tr>
<tr>
<td>Manganese oxides in residual clay developed on weathered Ordovician and</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Silurian rocks. Ladd, 1944.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>