CANADA

DEPARTMENT OF
ENERGY, MINES AND RESOURCES
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OTTAWA

ORE DEPOSITS OF THE COBALT AREA

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Reprinted from Guidebook - Eastern Ontario and Western Quebec, pp. 123-136, August-September, 1967, Kingston, Canada

1867 1967

Reprint Series RS 44 Price 25 cents

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ROGER DUHAMEL, F.R.S.C.
Queen's Printer and Controller of Stationery
Ottawa, Canada
1967

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by

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ABSTRACT

The Cobalt area is underlain by Keewatin volcanic and sedimentary rocks, pre-Algoman intrusive rocks, Algoman granite, Huronian sediments, Nipissing diabase, and late Keweenawan diabase dykes. Silver deposits occur as individual veins and clusters of veins in Keewatin rocks, pre-Algoman lamprophyre dykes, Huronian sediments, and Nipissing diabase. The veins are generally nearly vertical and are up to several hundred feet in vertical and horizontal extent. They are composed of carbonate minerals and contain shoots of silver ore, cobalt arsenides, and nickel arsenides. The silver ore shoots contain up to 8,000 ounces silver per ton of vein material. The silver in them is present as masses, veinlets, and separate grains. The masses and separate grains occur in arsenides, carbonate veins, and adjacent wall rock; the veinlets occur in fractures in the veins and wall rock, and along the boundaries between the veins and wall rock.

HISTORY

Silver was discovered at Cobalt, Ontario by J.H. McKinley, E. Darragh, and Fred LaRose in 1903 during the building of a railroad to the farming area at New Liskeard. Initial reports of the discovery met with apathy, and it was not till the summer of 1904, when Tretheway shipped a load of ore containing large slabs of silver, that the mining boom at Cobalt began. Mine shafts were erected on nearly every claim within several miles of Cobalt. Production of silver from the Cobalt camp reached its peak in 1911, when 31,507, 791 ounces of silver were shipped, and continued at a high level till 1922, when 10,711,727 ounces of silver were shipped (Brown 1963). A decrease in the price of silver in the early 1920's and exhaustion of high-grade silver ore caused most mines to close. During the period 1929 to 1950 small leasing operations were undertaken in a number of mines. A demand for cobalt in the early and mid 1950's renewed interest in the camp, and many mines were reopened and mined for cobalt. By late 1950 the demand for cobalt dropped and once again the mines closed. An increase in the price of silver in 1960 brought new interest to the camp, and by 1965 ten mines had been re-established. During 1966 the Deer Horn, Glen Lake, Hi-Ho, Silverfields, Nipissing 407, and Cart Lake mines were producing silver. These mines were reported to have shipped 1,545,592 ounces of silver during the period October 1, 1965 to March 31, 1966 (The Northern Miner 1966).

GENERAL GEOLOGY

The following description of the geology of the Cobalt area is largely abstracted from reports by Knight (1922) and Thomson (1960, 1961). The Cobalt area is underlain by Keewatin rocks, pre-Algoman intrusions, Algoman granite, Huronian sediments, Nipissing diabase, and late Keweenawan diabase dykes (Fig. 1).

Keewatin Rocks

Keewatin rocks are the oldest rocks in the area. They underlie the Huronian sediments and are intruded by pre-Algoman intrusions, Algoman granite, Nipissing diabase, and the late Keweenawan diabase dykes. These rocks have steep to vertical dips, and are folded along northwest axes. They consist of andesite, rhyolite, volcanic breccia, basic to acidic tuffs, chert, and agglomerate. The tuffs, chert, and agglomerate are generally present as interflow bands up to 50 feet thick (Thomson 1960, 1961). Some interflow bands are mineralized and contain masses and disseminations of sphalerite, galena, pyrite, pyrrhotite, and chalcopyrite.

The Keewatin rocks outcrop in the southeast corner, northwest corner, and central parts of the Cobalt area (Fig. 1). Those in the southeast corner and some of those in the central parts overlie the Nipissing diabase. Those in the northwest corner and the rest of those in the central parts underlie the Cobalt Group sediments and Nipissing diabase (Fig. 2).

Pre-Algoman Intrusions

The pre-Algoman intrusions are present as small bodies in Keewatin rocks and are widespread throughout the area. They consist

Fig. 1. Map showing geology and ore veins in the Cobalt area, Ontario. (after Thomson 1960 and 1961, with minor additions to ore veins by the writer).

of biotite and hornblende lamprophyres; and coarse-grained dioritic rocks believed to represent an intrusive emplacement of the same general age as the Keewatin volcanic rocks.

Algoman Granite

The Algoman granite occurs as a batholith in the southeast corner of the area where it outcrops. It is a coarse, even-grained massive granite.

Huronian Rocks

Huronian rocks in the Cobalt area are represented by the gently dipping Cobalt Group sediments. This group lies on a pre-Huronian erosion surface and generally overlies Keewatin rocks (Fig. 2). It is up to 400 feet thick and is composed of several horizons of conglomerate, greywacke, quartzite, and slate. The conglomerate horizons show a great variation in thickness from place to place, and a great variation in nature of matrix and in the quantities, size, and nature of the boulders. The greywacke, quartzite, and slate horizons also show variations in thickness, and in the presence of bedding. Some beds are more argillaceous than others, and these argillaceous beds frequently contain large chlorite grains. Some of the chlorite grains near the ore veins contain chalcopyrite cores. The Cobalt Group sediments outcrop near the townsite of Cobalt, and in areas to the northeast, and to the west of Giroux Lake (Figs. 1 and 2).

Nipissing Diabase

The Nipissing diabase is present as a sill-like body, about 1,000 feet thick. It cuts through the Algoman granite, and across Keewatin rocks and Cobalt Group sediments. It overlies the Cobalt Group sediments in the Peterson Lake area, and intrudes Keewatin rocks in the New Lake area (Fig. 2). It forms basin-shaped bodies in the vicinities of Peterson Lake and New Lake and an arch to the northeast of Giroux Lake. The basins are referred to as the Peterson Lake and New Lake basins, respectively, and the arch as the Kerr Lake arch (Fig. 2) (Thomson 1960, 1961). The Nipissing diabase outcrops in the central and southeast parts of the Cobalt area.

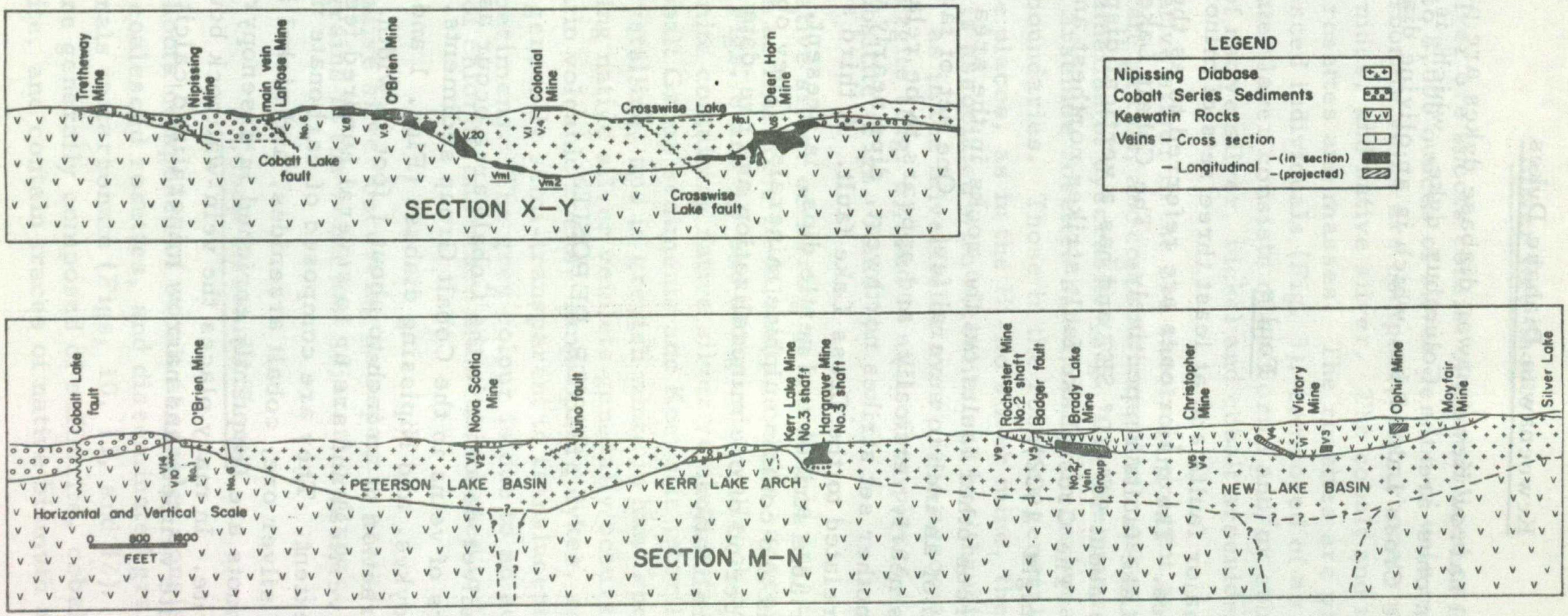

Fig. 2. Sections X-Y and M-N (See Fig. 1) showing the relationships of the rock types and of the ore veins in the Cobalt area, Ontario. (After Thomson, 1960 and 1961a-e).

Keweenawan Diabase Dykes

Several narrow Keweenawan diabase dykes are present in the area. The main ones are the Columbus dyke, which is a quartz diabase, and the Cross Lake dyke, which is an olivine diabase (Thomson 1960, 1961).

Faults

Two major faults and at least three sets of minor ones cut the rocks in the area. The major ones are referred to as the Cobalt Lake and the Cross Lake faults respectively. The Cobalt Lake fault strikes northeast, dips about 50°-70° SE, and has a vertical displacement of about 270 feet. The Cross Lake fault strikes northest and dips about 50°-75° NE (Knight 1922).

Numerous other faults cut the rocks in the area and displace them a fraction of an inch to several feet. One set of faults strikes northeast, dips nearly vertically, and appears to be related to the Cobalt Lake fault. Another set strikes northwest, dips nearly vertically, and appears to be related to the Cross Lake fault. A third set of faults, which have variable strikes and gentle dips, is present. These faults offset ore veins and contain sulphide minerals. They obviously post-date the main period of ore mineralization and pre-date a period of late sulphide mineralization.

SILVER DEPOSITS

The silver deposits in the Cobalt area occur as individual veins and as clusters of veins in the Cobalt Group sediments, Keewatin rocks, lamprophyre dykes, and Nipissing diabase (Figs. 1 and 2). The veins vary from a fraction of an inch to about 1 foot in width. They are generally nearly vertical and are up to several hundred feet in horizontal and vertical extent. They are composed of carbonate minerals and contain shoots of silver ore, cobalt arsenides, and nickel arsenides. The ends of the shoots are frequently enriched in arsenopyrite, chalcopyrite, and tetrahedrite. In many places the vein-wallrock boundaries contain narrow chlorite veinlets and narrow mineralized calcite veinlets (Petruk 1966).

Silver Ore Shoots

The silver ore shoots consist of mineralized carbonate veins, and contain up to 8,000 ounces of silver per ton of vein material. The mineralized carbonate veins are composed of carbonate minerals, cobalt and nickel arsenides, and native silver. The cobalt and nickel arsenides occur as rosettes and masses. The rosettes are present as separate and coalesced individuals (Fig. 3), composed of an outer layer and a core. The outer layer consists of safflorite and/or cobaltite, and the core consists of native silver, nickel and cobalt arsenides, and calcite.

The native silver in the ore shoots is present as masses, veinlets, and separate grains, and contains irregular masses of zeta-silver-antimony and lamellae of dyscrasite (Fig. 4). The masses of native silver occur in arsenide rosettes and masses, in carbonate, and along vein-wallrock boundaries. Those in the rosettes generally occur at the cores. In some places, as in the Hi-Ho silver mine, the native silver in the rosettes is associated with niccolite and breithauptite (Fig. 5). In other places, as in the Silverfields mine, it is associated with pararammelsbergite (Fig. 6), and in still other places it occurs in safflorite or cobaltite (Figs. 3 and 7).

The native silver occurring as veinlets is present in zones of weakness, such as fractures in dolomite, calcite, arsenides, and adjacent wallrock (Figs. 8 and 9), and along vein-wallrock boundaries. The fractured dolomite containing native silver veinlets occurs largely as veins in the Cobalt Group sediments and Keewatin interflow bands. It is generally crystalline, and is greyish white in hand specimens. The calcite containing native silver veinlets generally occurs as wide calcite veins in Keewatin volcanic rocks, lamprophyre dykes, and Nipissing diabase. It is generally semi-transparent to translucent, and is dirty grey in hand specimens. The grey colour is due to an admixture of minute grains of chlorite and other minerals related to the silver mineralization.

The native silver occurring as separate grains is present as disseminated grains in the veins and adjacent wallrock.

Cobalt Arsenide Shoots

The shoots composed of cobalt arsenides consist of masses, individual and coalesced rosettes, and disseminated grains of cobalt arsenide minerals in carbonate (Figs. 10, 11, and 12). The masses and rosettes are generally composed of safflorite, cobaltite, skutterudite, and arsenopyrite, and contain traces of native bismuth and native silver.

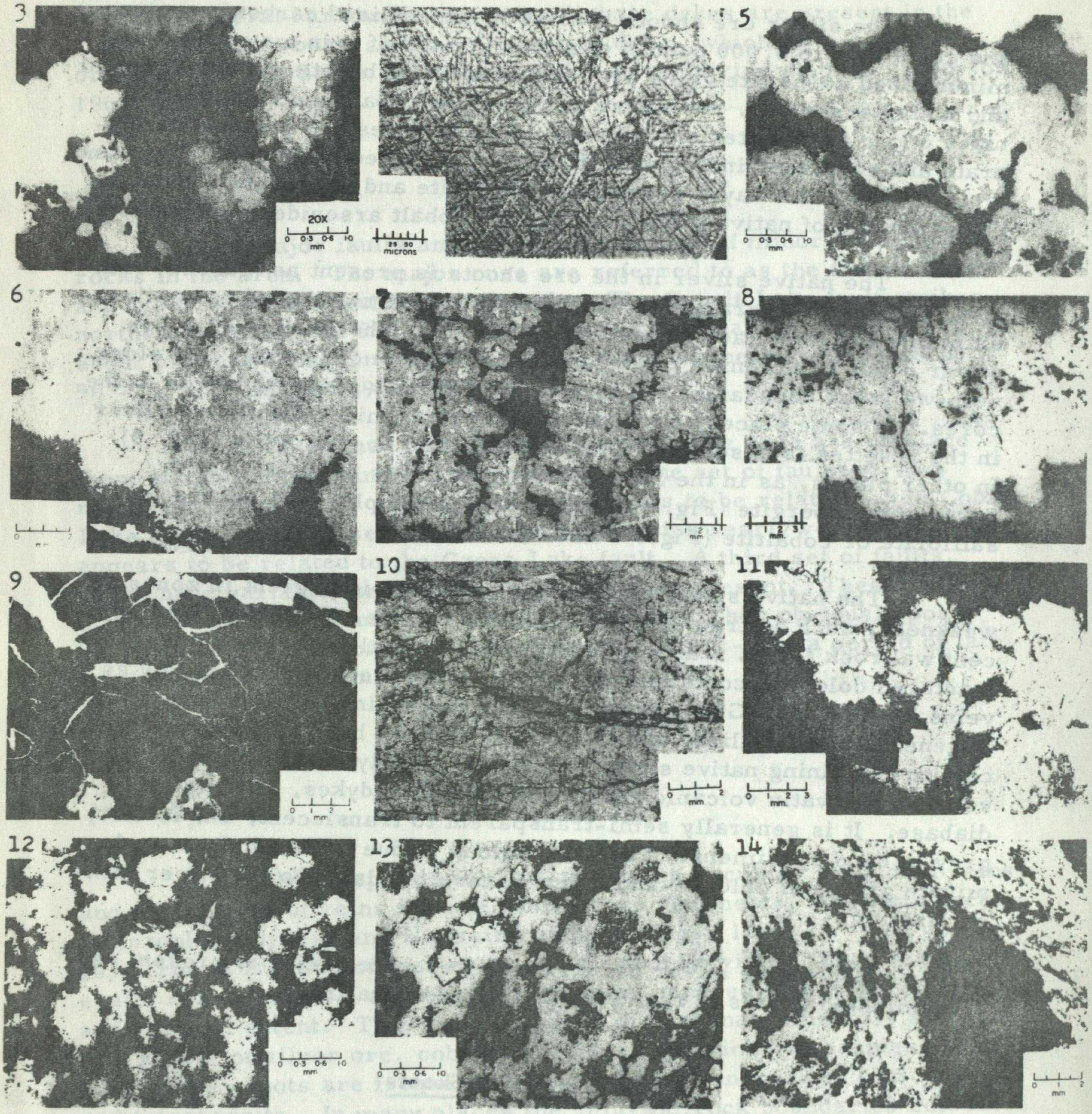

Fig. 3-14. Photomicrographs of polished sections.

FIGURES 3-14. PHOTOMICROGRAPHS OF POLISHED SECTIONS

Fig. 3. Rosettes of cobaltite with cores of native silver in a dolomite vein.

Fig. 4. Native silver (white) with an irregular body composed of dyscrasite (dark grey) and zeta-silver-antimony. The dyscrasite is present as lamellae in zeta-silver-antimony and as borders around the irregular body. This photograph was taken by using immersion oil and high contrast film to enhance the contrast.

Fig. 5. Sample from the A-17 vein in the Hi-Ho mine, showing a group of loosely combined individuals and small masses of coalesced rosettes in carbonate (black). The rosettes consist of safflorite (light grey) around cores of native silver (white) associated with niccolite (dark grey). Some native silver is present outside the rosettes.

Fig. 6. Mass of safflorite composed of a cluster of rosettes, from the Silverfields mine. The safflorite contains inclusions of native silver (white) associated with pararammelsbergite (light grey).

Fig. 7. Linear aggregates of rosettes, which consist of safflorite (grey) with cruciform cores of native silver (white).

Fig. 8. Veinlets of native silver (white) in safflorite (grey).

Fig. 9. Network of silver-bearing veinlets (white) in dolomite (black), from the A-17 vein in the Hi-Ho mine.

Fig. 10. Massive cobalt arsenides with veinlets of native bismuth (white) and carbonate (black). The arsenides are safflorite (light grey) and cobaltite (darker grey).

Fig. 11. Rosettes of cobalt arsenides in the Cadesky vein in the Hi-Ho mine. The rosettes consist largely of safflorite and contain cores of skutterudite. The skutterudite and safflorite cannot be differentiated on this photomicrograph.

Fig. 12. Vein showing safflorite rosettes and euhedral arsenopyrite crystals.

Fig. 13. Poorly developed rosettes of cobalt arsenides in the Cadesky vein in the Hi-Ho mine. The rosettes consist of safflorite and cobaltite (shades of grey), and contain euhedral skutterudite crystals. The black area represents dolomite and calcite.

Fig. 14. Massive niccolite.

The rosettes consist of an outer layer and a core (Figs. 11 and 13). The outer layer consists of masses, large crystals, and/or disseminated grains of safflorite, skutterudite, and cobaltite, in carbonate. The core consists of skutterudite crystals and/or minute arsenide grains disseminated in calcite.

Nickel Arsenide Shoots

The shoots of nickel arsenides generally consist of niccolite, breithauptite, gersdorffite, rammelsbergite, pararammelsbergite, and skutterudite intimately intergrown. In a few places, as in the west end of the Cadesky vein in the Hi-Ho mine, only niccolite and minor breithauptite are present (Fig. 14).

Arsenopyrite Zones

Zones rich in arsenopyrite occur at the ends and margins of silver ore shoots and cobalt and nickel arsenide shoots. The arsenopyrite at the ends of the shoots is present as clusters of minute grains in carbonate, and as large crystals. The clusters of minute grains generally occur in botryoidal-like forms. The arsenopyrite at the margins of the veins is present as large crystals at vein-wallrock boundaries and as disseminations in the veins and adjacent wallrock.

Chalcopyrite and Tetrahedrite Zones

Zones rich in chalcopyrite and tetrahedrite generally occur at the ends of silver ore shoots. The chalcopyrite and tetrahedrite occur as small masses and disseminated grains in carbonates.

Mineralized Calcite Veinlets

Narrow calcite veinlets at the vein-wallrock boundary in many places contain small masses, narrow layers, minute grains, and large crystals of ore minerals, such as chalcopyrite, sphalerite, galena, tetrahedrite, pyrargyrite, proustite, acanthite, stromeyerite, xanthoconite, stephanite, native silver, native bismuth, bismuthinite, marcasite, pyrite, pyrrhotite, violarite, millerite, bornite, and chalcocite. This type of mineral association is also present in late faults. Crystals of the various minerals and wire silver are found in these late faults and in the veinlets at the margins of the veins.

HI-HO MINE

The Hi-Ho mine is situated at the west end of the Kerr Lake arch. The ore in this mine is in three major and seven minor veins (see Fig. 15). The major veins are referred to as the A-17, Cadesky, and Giroux Lake veins, and the minor ones as B-18, B-21, F-13, 14S, 16S, and two unnamed veins. The A-17 vein is about 300 feet long and at least 210 feet in vertical extent. The Cadesky vein is about 240 feet long, and the Giroux Lake vein has a total length of nearly 460 feet. The A-17, Cadesky, and the minor veins occur in the Cobalt Group sediments in a pre-Huronian erosion valley and extend for short distances into the underlying Keewatin rocks (Fig. 16). They are being mined from the first (91-foot) level, and the second (183-foot) levels. The Giroux Lake vein occurs largely in Keewatin rocks below the Nipissing diabase in an area where the Cobalt Group sediments are absent. It is being mined from the third (291-foot) level.

SILVERFIELDS MINE

The Silverfields mine is situated about 1,500 feet north of the Hi-Ho mine (Fig. 15). The ore in it occurs as veins in the Cobalt Group sediments in a pre-Huronian erosion valley (Fig. 16). These veins extend for short distances into underlying Keewatin rocks and terminate in mineralized Keewatin interflow bands. This mine has 15 veins, which are referred to as vein numbers 1 to 15 (Fig. 15) inclusive. The veins vary from about 50 to 700 feet in length and are being mined from the third, fourth, and fifth levels.

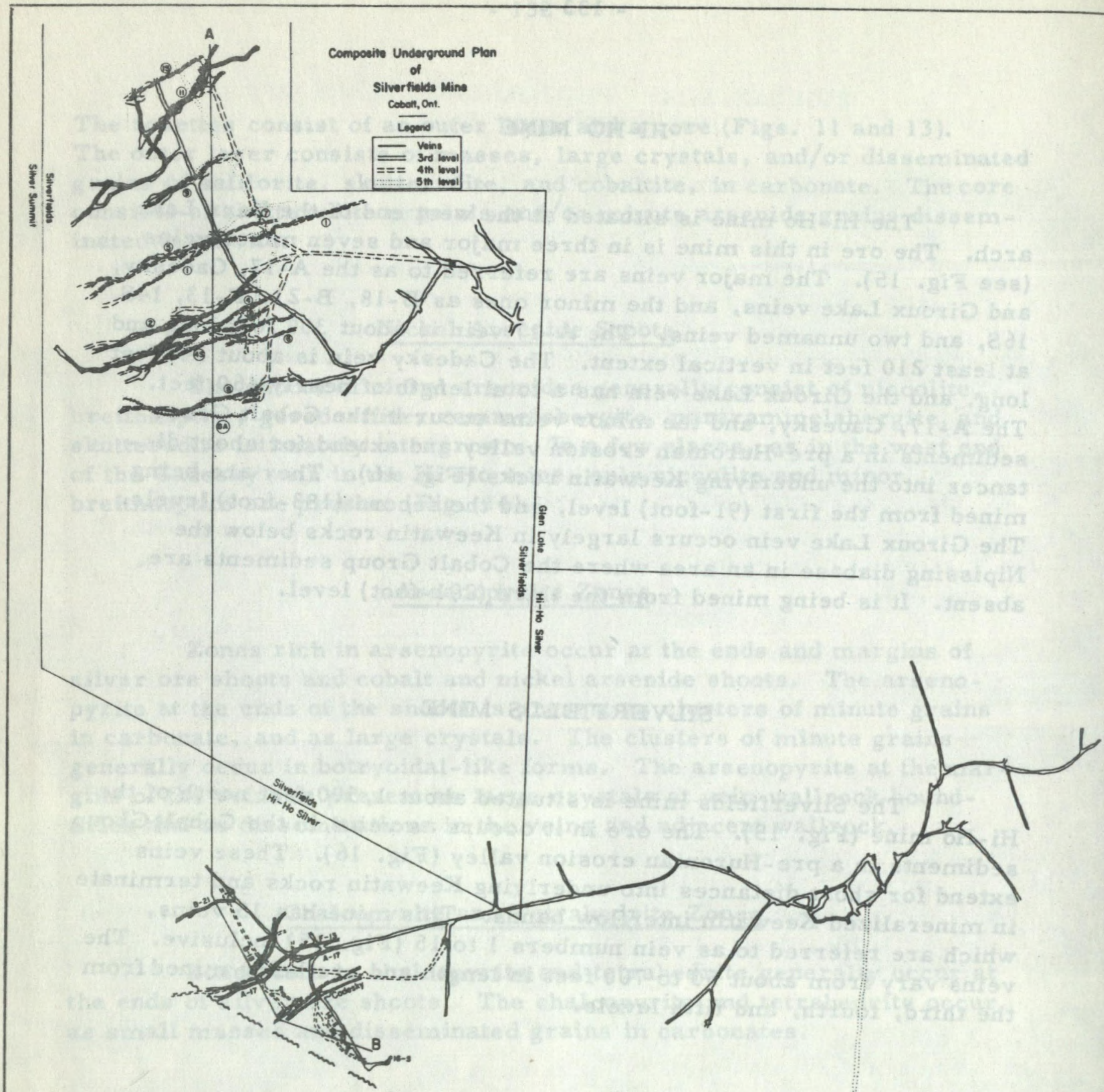

Fig. 15. Composite map showing the veins and underground workings in the Silverfields and Hi-Ho mines. (Prepared from information supplied by Silverfields Mines Limited and Hi-Ho Silver Mines Limited).

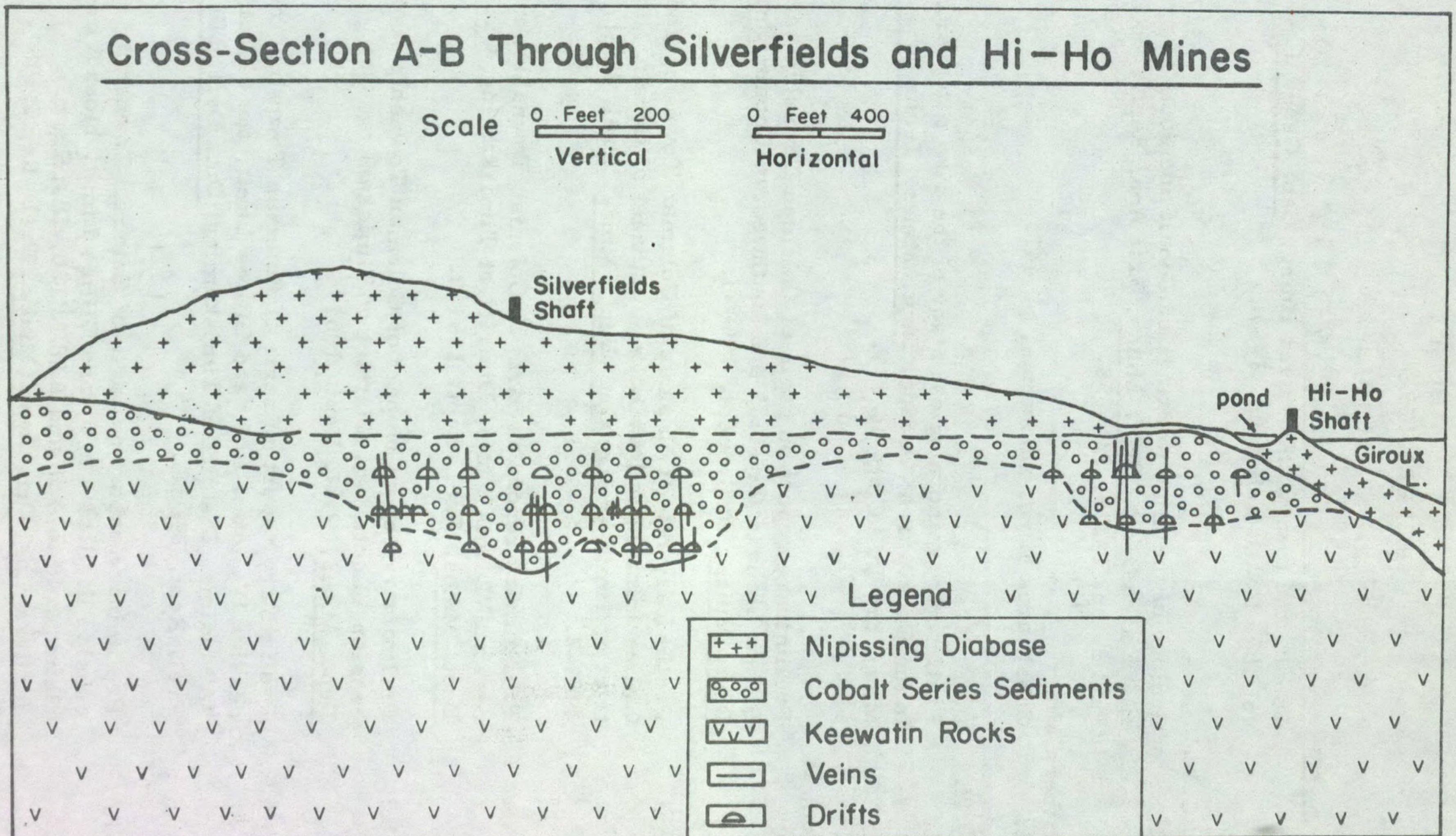

Fig. 16. Cross-Section A-B (See Fig. 15) showing the relationship between geology and ore veins in the Silverfields and Hi-Ho Silver Mines. (Prepared from information supplied by the Silverfields Mines Limited, Hi-Ho Silver Mines Limited, and from Thomson, 1960, 1961d).

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