



Geology and mineralogy of the Cerrillos copper deposit, Santa Fe County, New Mexico

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GEOLOGY AND MINERALOGY OF THE CERRILLOS COPPER DEPOSIT, SANTA FE COUNTY, NEW MEXICO

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INTRODUCTION

The Cerrillos copper deposit is located in the north half of section 8 and the south half of section 5, T14N, R8E in the Cerrillos Hills two mi (3 km) north of the old mining village of Cerrillos and approximately 14 mi (23 km) southwest of Santa Fe, Santa Fe County, New Mexico (fig. 1). The deposit can be reached by way of an unmaintained dirt road heading in a northerly direction from the village of Cerrillos across San Marcos Arroyo and through a narrow rocky canyon (fig. 2). The San Marcos Arroyo should be crossed with caution during the summer flash-flood season.

The deposit was discovered by Bear Creek Mining Company in 1959 in the course of geological, geochemical and geophysical surveys in the area (Wargo, 1964). Subsequent exploration revealed the deposit to be too small and too low grade for conventional mining and extraction techniques. The project ultimately was dropped by Bear Creek. Occidental Minerals Corporation acquired the section 8 portion of the deposit in 1973 to further evaluate the deposit and the applicability of modern insitu-leaching techniques for extraction of the copper. The project is currently on a stand-by basis.

Most of the geology and mineralogy of the Cerrillos deposit, as discussed in this paper, are limited to that portion of the deposit occurring in section 8. Because of different owner-

ships, that portion of the deposit extending into section 5 has not been explored and detailed data are not available. Approximately two-thirds of the deposit occur in section 8, with the remaining one-third in section 5. Although the section 5 portion of the deposit has not been explored, surface mapping indicates similar geology and mineralogy, and no section-line fault is postulated.

GEOLOGY

Copper mineralization in the Cerrillos deposit occurs in an intensely fractured zone of potassically altered Tertiary monzonite porphyry surrounding a younger barren stock. The barren stock consists of coarse-grained monzonite porphyry and monzonite intrusive. Intrusion of the barren stock caused the intense fracturing and potassic alteration of the surrounding rocks, and was the probable source of the copper mineralization. The inner boundary of the doughnut-shaped copper deposit is defined sharply, and coincides well with the contact between the mineralized porphyry and the younger stock. The outer boundary of the mineralized zone is gradational, with copper values decreasing outward from the barren stock. A portion of the doughnut-shaped mineralized zone in the north-east quadrant has been faulted, uplifted and eroded, leaving

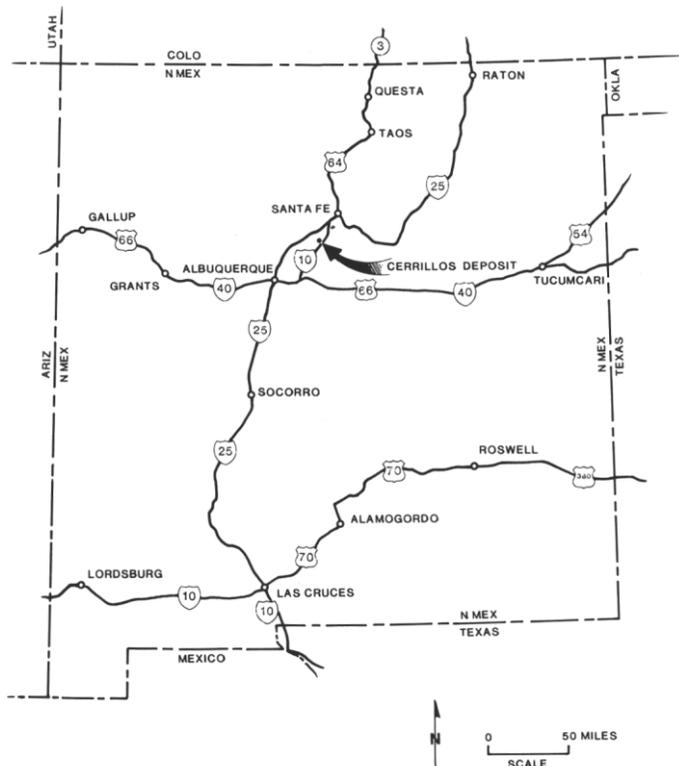


Figure 1. Location map of Cerrillos deposit.

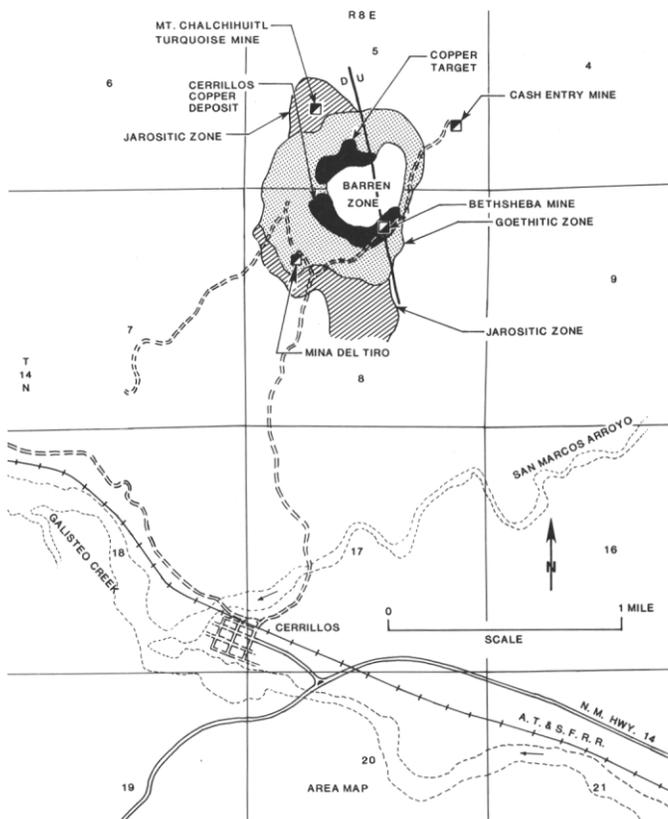


Figure 2. Map of Cerrillos area.

only thin remnants of the original deposit. Dikes younger than the stock occur locally along the fault zone (fig. 3).

The copper deposit is zoned vertically, with a supergene oxide zone at the surface, a primary sulfide zone at depth and a mixed oxide-sulfide zone at the interface of the oxide and sulfide zones. Essentially all primary sulfides in the oxide zone have been oxidized. The mixed oxide-sulfide zone is a zone of partial oxidation of the upper limits of the sulfide zone. The depth of the oxide zone ranges from less than 100 ft (30 m) to nearly 400 ft (122 m). Variations in the depth of the oxide zone are the result of post-oxidation faulting (figs. 4, 5, 6).

MINERALOGY

Copper mineralization in the Cerrillos deposit is typical of a low-total-sulfide, high-chalcopryite/pyrite-ratio deposit. Total sulfides in the deposit range from 0.75 to 1.75 weight percent. During oxidation, this type of deposit generates very little acid, with the result that the oxide minerals formed are either in place or have been transported only a very short distance. This results in an oxide copper zone with approximately the same grade as the primary sulfide zone. With oxide minerals

being formed essentially in place, and with very little migration of copper, it is predictable that no chalcocite-enrichment blanket would be found beneath the oxide zone. This is the case in the Cerrillos deposit.

Copper minerals in the oxide zone, in the order of frequency of occurrence, are: neotocite [approximate formula (Fe, Mn, Cu) S103 1, brochantite [CuSO₄•3Cu(OH)2]1, chrysocolla [CuSiO₃•2 H₂O]1 and pitch limonite. Pitch limonite, also called copper pitch, is goethite [Fe2O₃•1-2H₂O] with varying amounts of copper, and is formed by the in-place oxidation of chalcopryite. Unoxidized remnants of chalcopryite commonly are found in pitch limonite. Locally in the oxide zone, brochantite is the most abundant copper mineral. Goethite, formed by the oxidation of a small amount of primary pyrite and chalcopryite, is found throughout the oxide zone.

The mixed oxide-sulfide zone, at the base of the oxide zone, contains minerals found in the oxide zone in addition to chalcopryite [Cu FeS₂], pyrite [FeS₂], bornite [Cu₅FeS₄] and minor quantities of covellite [CuS] and chalcocite [Cu₂S]. Chalcocite in the mixed oxide/sulfide zone is a result of minor supergene enrichment of copper values. The occurrences of chalcocite are very limited and erratic, and do not form a

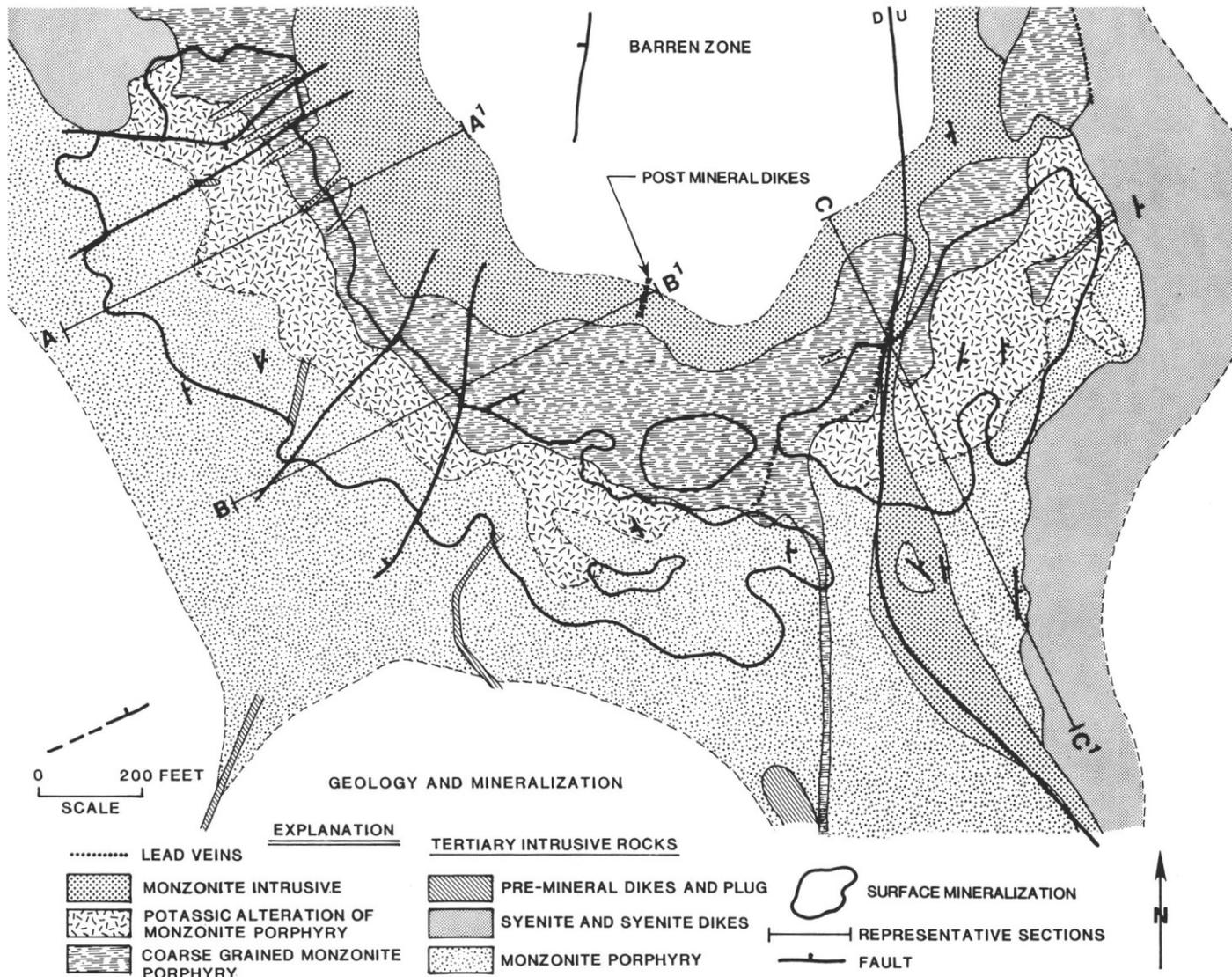


Figure 3. Map showing geology and mineralization of Cerrillos deposit, with cross-section locations (figs. 4, 5, 6).

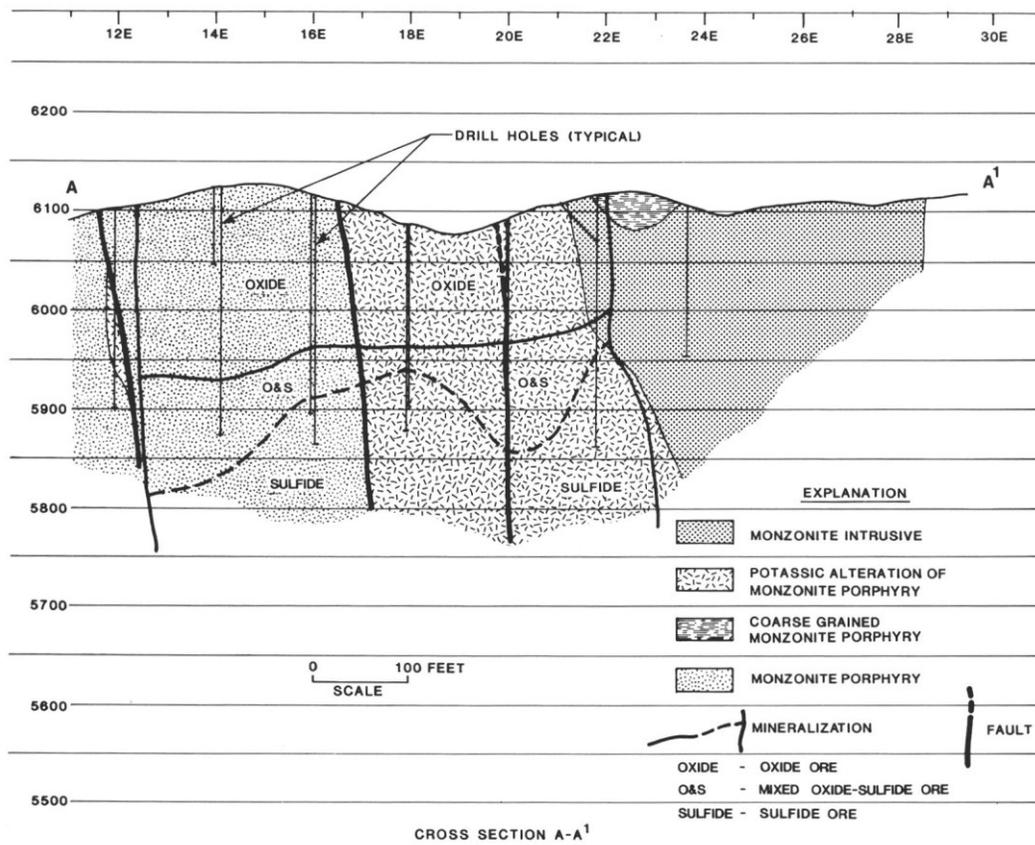


Figure 4. Cross section A-A', see fig. 3 for location.

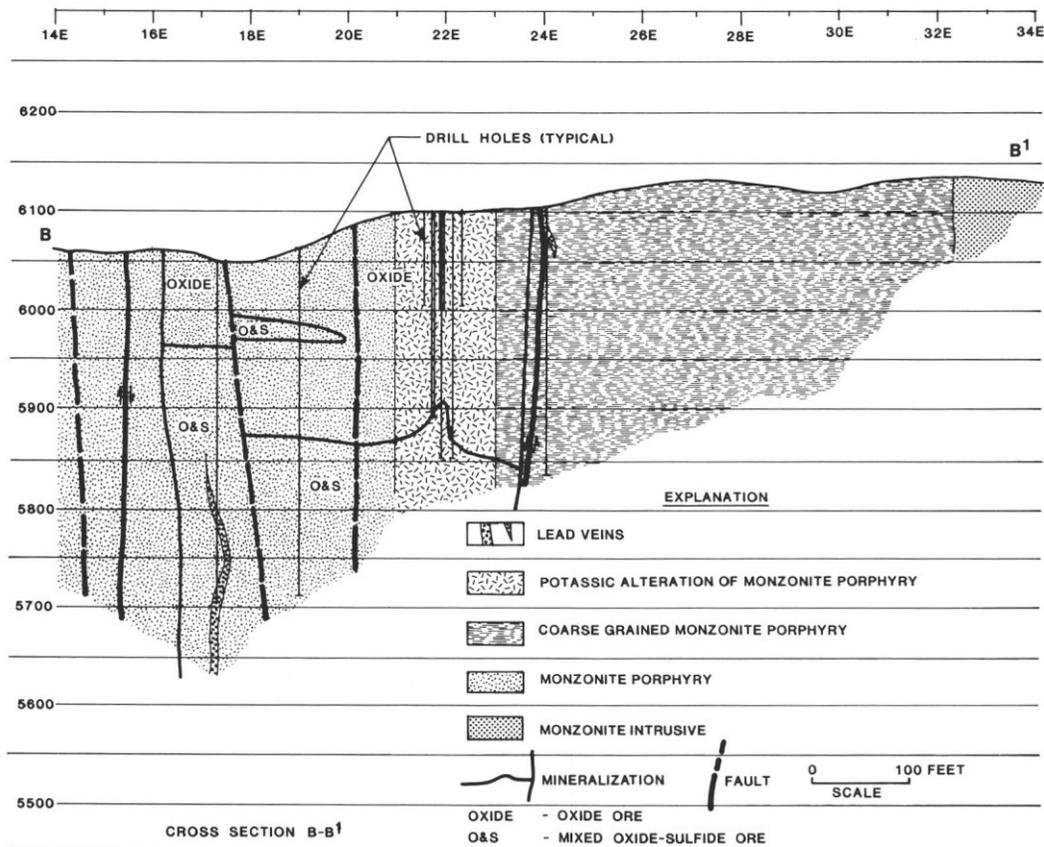


Figure 5. Cross section B-B', see fig. 3 for location.

blanket of enrichment as might be found in a stronger copper system.

The principal minerals in the primary sulfide zone beneath the oxide and the mixed oxide-sulfide zones are chalcopyrite and pyrite with minor amounts of bornite and traces of molybdenite [MoS₂]. Traces of gold also are found in the primary sulfide zone.

Both primary and supergene copper minerals occur on fracture planes rather than being disseminated throughout the host rock. Fracture frequency ranges from 10 to 15 fractures per foot (0.3 m) and is locally more intense. The fracture control of mineralization can be demonstrated graphically by observing copper mineralization on many fracture planes of broken ore samples, which is not apparent before breaking.

Three narrow, argentiferous-lead fissure veins occur at the surface, and several have been intersected at depth by drill holes. The principal vein minerals are galena [PbS], pyrite, quartz and calcite. Silver content of the galena is variable, and neither the galena nor the silver offers an economically attractive mining target in today's market. Minor quantities of sphalerite [ZnS] and wulfenite [PbMoO₄] also are found in the fissure veins. Several similar veins were mined in the past (fig. 2). The Cash Entry mine in section 5 was mined as early as 1890 and as late as 1910. The Mina Del Tiro vein, also called the Mina del Tierra in old reports, is located south of the copper deposit in section 8. It was mined between 1910 and 1934. Evidence was uncovered in the Mina Del Tiro mine which indicated that the vein also was mined prior to 1680 by Rio Grande Pueblo Indians. Galena from the Bethsheba vein, in the eastern part of the copper deposit, was mined about 1,000 A.D. by the Pueblo Indians for pottery glaze. The vein was mined again during the Spanish colonial period for lead.

The copper deposit is within a large circular zone of weak

chloritic alteration with goethite. This zone has been designated the goethitic zone (fig. 2). The goethite is the oxidation product of a very low concentration of primary pyrite. The chlorite is a supergene alteration product resulting from weak sulfuric acids generated by the oxidation of the pyrite.

To the north and to the south of the goethitic zone are bleached areas of argillic alteration with numerous small turquoise occurrences. These zones have been designated as jarositic zones on the area map (fig. 2). Jarosite [K₂Fe₆(OH)₁₂(SO₄)₄] can be observed throughout these areas and represents oxidation of a high concentration of primary pyrite. The original total-sulfide content of the rock in these zones ranged from 7.5 to 9.0 weight percent. The alteration and bleaching of the rock are the result of strong sulfuric acid which was formed during the supergene oxidation of the pyrite. Turquoise was formed in these zones by the combination of minor amounts of copper with alumina and phosphorus, which were liberated during the supergene alteration of the rock by strong sulfuric acid from oxidized pyrite. Phosphorus is the key element in this process. Turquoise has been mined from these areas for many years. At the Mt. Chalchihuitl mine in section 5, turquoise was mined as early as 950 A.D. by Rio Grande Pueblo Indians (Disbrow and Stoll, 1957). There is no commercial production of turquoise from these areas today, but occasionally specimen-grade pieces of turquoise can be found at the surface.

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 Wargo, J. G., 1964, Geology of a primary disseminated copper deposit near Cerrillos, New Mexico: Geological Society of America Special Paper 76, p. 296.

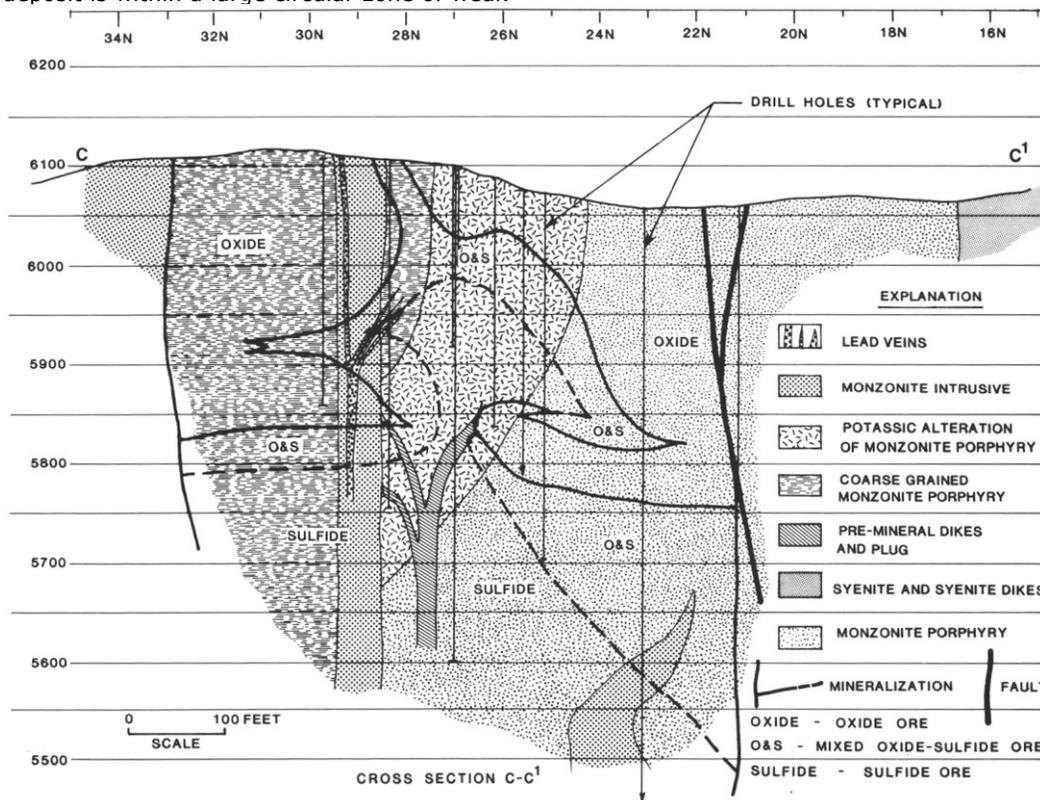


Figure 6. Cross section C-C', see fig. 3 for location.