GEOLOGY, HISTORY, AND ECONOMICS OF THE SUNNYSIDE MINE, EUREKA MINING DISTRICT, SAN JUAN COUNTY, COLORADO

1968

By

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A Thesis submitted to the Faculty and the Board of Trustees of the Colorado School of Mines in partial fulfillment of the requirements for the degree of Doctor of Science.

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ABSTRACT

The Sunnyside mine is located approximately seven miles north of Silverton, Colorado. The mine includes eight separate ore shoots and has yielded over $85,000,000 in gold, silver, lead, copper, and zinc since first opened in 1873, approximately 60 percent of the total production of San Juan County. Metal values are contained in galena, sphalerite, chalcopyrite, and tetrahedrite with an approximate 1:1.5 lead/zinc ratio in the ores.

The veins are located within the Ross Basin-Sunnyside fault system, the northern-bounding faults of the Treasure Mountain graben. The graben is a northeasterly-trending, boot-shaped block connecting the Silverton caldera with the Lake City caldera approximately eight miles to the northeast. The graben, which intersects the concentric fault system of the Silverton caldera, has subsided approximately 800 feet relative to its frame.

The aims of the present study are: 1) to define the regional geology and structural relationships of the ore bodies; 2) to investigate metal zonations within the Washington vein; 3) to study the relationship between

metal prices and production as reflected by historical production in San Juan County and the Sunnyside mine; and 4) to define a mine valuation model for medium-size, vein type mines.

Structural analysis of flow layering in the host rocks of the Silverton Volcanic Group indicates that the block has subsided partly by rotational movement on a horizontal, northeast axis coaxial with the graben and the major San Juan volcano-tectonic depression. This relationship indicates that collapse of the graben, which occurred after eruption of the Silverton rocks, may be related to resurgent activity within the depression.

Analysis of joint pole maxima indicates that radial and concentric directions of fracturing associated with doming and collapse of the caldera are present both outside and inside the graben. That no rotation of joint maxima within the graben was noted suggests that graben subsidence occurred before doming and resulting joint formation.

That the veins may have been formed during rotational subsidence before doming is suggested by the fact that joint maxima recorded in the vein material are similar to those in the wall rocks. The veins of the Sunnyside mine may have formed before veins outside the caldera rim and have been reactivated during this later period of mineralization.

Through-going faults which are transverse to the radial and concentric directions of jointing and veining, and are not rotated within the graben, offset the veins and are considered to be associated with domal collapse.

District zoning displayed by the various ore bodies of the Sunnyside mine is indicated by: 1) decreasing copper and silver content of ores from west to east; 2) increasing lead and zinc content of ores towards the east; 3) increasing Pb/Zn ratios in ores towards the east; and 4) increasing manganese content of the veins towards the east.

The veins of the Sunnyside mine are structurally controlled, and conversely, wall rock appears to have exerted little chemical or physical control over ore deposition. The primary control of deposition is interpreted to be changes in pressure and temperature relative to the paleo-ground surface. With the exception of the Washington vein, the ore bodies are unproductive below 11,800 feet; metal values drop off rapidly laterally beyond established "ore limits." Ore bodies range in strike length from 400 feet for the Spur to almost 2000 feet for the Noname and vary in vertical dimension from 300 feet for the Spur and Belle Creole veins to 2000 feet for the Washington vein.

Comparison of contour diagrams of vein width and grade of mineralization for the Washington vein shows that 1) ore grade increases in wider zones in the vein; 2) down-

dip bifurcations in the vein are unfavorable loci for ore deposition; 3) conversely, bifurcations along the strike of a vein in which the line of intersection rakes steeply appear to localize ore deposition; 4) faults clogged with gouge which cross cut the open structures may serve as baffles to circulating ore-bearing solutions and thereby influence the orientation of the resulting ore body; 5) ore grade decreases rather consistently with depth on both the hanging wall and footwall portions of the vein but rapidly decreases laterally; 6) the ore body rakes almost vertically; and 7) the H.W. vein, mineralogically the extension of the vein above H Level, may have formed before the F.W. portion of the vein.

Ore-body zonation in the Washington vein expressed by Pb/Zn and Pb/Ag ratio contour diagrams are at variance and indicate that zinc, occurring as sphalerite, may have been deposited in two distinct periods of mineralization. The Pb/Ag zonal pattern represents primary zoning, whereas the Pb/Zn diagram represents paragenesis rather than zoning.

Regression, or trend-surface, analyses of metal distribution in the Washington vein show: 1) the distinct similarity in distribution of gold, silver, and lead; and 2) a similar compatibility of zinc and copper. Exploration of an unstoped area above E Level to the west of 19,800 E is suggested by this method.

Chemical analysis of DDH 97 for trace- and minor-element dispersion patterns reveals a relative enrichment of Pb, Zn, Cu, Ag, Mg, Ni, and Cr and a decrease of Na, Ca, Mn, Sr, and V in wall rock adjacent to the Belle Creole vein. These patterns suggest that the former group of elements were introduced from solutions ascending the fault while the latter elements were redistributed during pre-ore alteration. Manganese may have been leached into the vein to form the manganese-bearing gangue minerals.

Examination of production records for San Juan County reveals: 1) a general decline in metal assays with time, reflecting increased depth of mine workings; 2) that technological advances in milling techniques, which gave new life to base-metal mines in the Silverton area, are faithfully recorded in increased metal assays; 3) that decreases in metal prices are generally followed closely by decreased production; and 4) that the present period of high metal prices and relatively favorable ore grade represents ideal circumstances for mine operators.

Analysis of production figures for the Sunnyside mine shows that: 1) ore grade has declined considerably over the life of the mine; 2) erection of the Eureka mill, the first selective-flotation mill in North America, caused a radical increase in metal recoveries from the ores; 3) periods of mill closure are followed by substantially lower mill

recoveries after resumption of operations; and 4) attempts to maintain a constant net profit in periods of declining metal prices usually take the form of increases in rates of production rather than increasing grade by selective mining.

Outline of an economic mine valuation model provides the framework for evaluation of mines similar to the Sunnyside, thereby providing a proper guide as to the feasibility of starting or resuming operations.

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