

Appendix B

Glossary

- ADIT:** Underground mine entrance.
- ALLOY:** A material composed of two or more metals (or a metal and nonmetal).
- ALLUVIUM:** Deposits of silt or silty clay laid down during floods in relatively recent times (geologically).
- ANODE COPPER:** The product of fire refining, termed anode because it is the positive terminal in the electrolytic cell for electrowinning.
- AUTOGENOUS:** Occurring or produced without external influence or aid; ore grinding is said to be autogenous when it is done using pieces of ore without the use of steel balls or rods or other grinding media.
- AZURITE:** A deep-blue to violet-blue mineral: $\text{Cu}_3(\text{CO}_3)_2(\text{OH})_2$. A common secondary mineral associated with malachite in the upper (oxidized) zones of copper veins.
- BENEFICIATION:** Improvement of the grade of ore by milling, flotation, or other processes.
- BLISTER COPPER:** The product of smelting, called "blister" because the residual sulfur and oxygen form bubbles on the surface as the metal cools.
- BORNITE:** A mineral, Cu_5FeS_4 , isometric, reddish-brown, readily tarnishing to iridescent blue or purple "peacock ore".
- BRASS:** An alloy of copper and zinc.
- BRONZE:** An alloy of copper and tin.
- BYPRODUCT:** A metal (e.g., molybdenum, gold, silver, cobalt) or other substance (such as sulfuric acid) produced in addition to the principal product, and whose value is substantially less than that of the principal product.
- CALCINE:** The partially oxidized copper resulting from roasting.
- CARBONATES:** Mineral compounds characterized by the fundamental anionic structure of CO_3^{2-} .
- CATHODE:** The product of electrowinning, the most common primary copper product.
- CHALCOCITE:** A black or dark lead-gray mineral: Cu_2S .
- CHALCOPYRITE:** A bright brass-yellow tetragonal mineral: CuFeS_2 (copper pyrite).
- CHRYSOCOLLA:** A mineral, $(\text{Cu}, \text{Al})_2\text{H}_2\text{Si}_2\text{O}_5(\text{OH}) \cdot n\text{H}_2\text{O}$, that usually occurs as green to blue-green incrustations and thin seams in the oxidized zone of copper sulfide deposits.
- COMMUNITION:** The reduction of ore to a fine powder (pulverization) to prepare it for further processing.
- CONCENTRATE:** The valuable fraction of ore that is left after worthless material is removed in processing. In copper production, concentrates are the result of beneficiation, and are sent to the smelter for further processing.
- CONDUCTIVITY:** The quality or power of conducting or transmitting, usually heat or electricity.
- ELECTRICAL CONDUCTIVITY:** The ratio of the electric current density to the electric field in a material.
- MASS CONDUCTIVITY:** The measurement of electrical conductivity based on the mass of the conducting material.
- VOLUMETRIC CONDUCTIVITY:** The measurement of electrical conductivity based on the volume of the conducting material.
- CONGLOMERATE:** A coarse-grained rock composed of fragments larger than 2 mm in diameter set in a fine-grained matrix of sand or silt; the consolidated equivalent of gravel.
- CONVERTING:** The chemical conversion, using heat, of matte to blister copper, slag, and sulfur dioxide.
- COPPER:** A reddish or salmon-pink isometric mineral, the native metallic element Cu.
- CO-PRODUCT:** A metal (e.g., molybdenum, gold, silver, cobalt) or other substance (such as sulfuric acid) produced in addition to the principal product, and whose value is roughly equal to that of the principal product.
- COUNTRY ROCK:** The rock enclosing or traversed by a mineral deposit or vein, or by an igneous intrusion.
- COVELLITE:** An indigo-blue hexagonal mineral: CuS . It is a common secondary mineral and an ore of copper.
- CUPRITE:** A red isometric mineral Cu_2O .
- DENSITY:** The mass or quantity of a substance per unit volume, usually expressed in grams per cubic centimeter.
- DEPOSITION:** The laying down of rock-forming material by any natural agent, such as the settling of sediment from water.
- DRIFT:** A horizontal underground passage driven along a mineral vein.
- DUCTILE:** Said of a rock that is able to sustain 5-10 percent deformation before fracturing or faulting.
- ELECTROMETALLURGY:** The branch of process metallurgy dealing with the use of electricity for smelting or refining of metals. The electrochemical effect of an electric current brings about the reduction of metallic compounds, and thereby the extraction of metals from their ores (electrowinning) or the purification of the metals (electrorefining).
- ELECTROREFINING:** A purification process in which an impure metal anode is dissolved electrochemically in a solution of a salt of the metal being re-

- fined; the pure metal is recovered by electrodeposition at the cathode.
- ELECTROWINNING:** The recovery of a metal from its ore by dissolving a metallic compound in a suitable electrolyte and reducing it electrochemically through passage of a direct electric current.
- EXOTHERMIC:** Pertaining to reactions that generate heat.
- EXPLORATION:** The search for and discovery of new mineral deposits, plus the evaluations necessary to make a decision about the size, initial operating characteristics, and annual output of a potential mine.
- FAULT:** A fracture or fracture zone along which there has been displacement of the sides relative to one another and parallel to the fracture.
- FLOTATION:** The separation of materials by agitation in a chemical solution.
- GANGUE:** The valueless rock or mineral aggregates in an ore; that part of an ore that is not economically desirable but cannot be avoided in mining. It is separated from the ore minerals during concentration.
- GEOBOTANY:** The visual study of plants and their distribution as indicators of soil composition and depth, bedrock lithology, the possibility of ore bodies, and groundwater conditions.
- GEOCHEMISTRY:** The study of the distribution and amounts of the chemical elements in minerals, ores, rocks, soils, water, and the atmosphere.
- GEOLOGIC MAP:** A map on which is recorded the distribution, nature, and age relationships of rock units and the occurrence of structural features.
- GEOLOGIC STRUCTURE:** The attitude and relative positions of the rock masses of an area; the sum total of structural features resulting from such processes as faulting, folding, and igneous intrusion.
- GEOPHYSICS:** Study of the physical properties of the earth (e.g., magnetism) by quantitative physical methods. The geophysical properties and effects of subsurface rocks and minerals that can be measured at a distance with sophisticated electronic equipment include density, electrical conductivity, thermal conductivity, magnetism, radioactivity, elasticity, specific gravity, and seismic velocity.
- GEOSTATISTICS:** The use of statistical methods to describe or analyze geological data.
- GLANCE:** A mineral that has a splendid luster.
- GOSSAN:** An iron-bearing weathered product overlying a sulfide deposit. Gossan is formed by the oxidation of sulfides and the leaching-out of the sulfur and most metals, leaving hydrated iron oxides and, rarely, sulfates.
- GREEN FIELD:** A new project or facility.
- HALO:** A circular or crescent-shaped distribution pattern about the source of a mineral or ore. A halo is encountered principally in magnetic and geochemical surveys.
- HOST ROCK:** Rock that is older than rocks or minerals introduced or formed within it.
- HYDROCYCLONE:** A centrifugal device for separating materials according to weight or size.
- HYDROMETALLURGY:** The extraction and recovery of metals from their ores by processes in which aqueous solutions play a predominant role. Two distinct processes are involved in hydrometallurgy: transferring the metal values from the ore to solution via leaching; and recovering the metal values from solution.
- HYDROTHERMAL ALTERATION:** Alteration of rocks or minerals by the reaction of hot water.
- IGNEOUS:** Describing a rock or mineral that solidified from molten or partly molten material, i.e., from a magma; also, applied to processes relating to the formation of such rocks. Igneous rocks constitute one of the three main classes into which rock is classified, the others being metamorphic and sedimentary.
- INTRUSIVE:** 1) Describing the emplacement of magma in pre-existing rock, or the rock mass so formed; 2) describing an injection of sedimentary material under abnormal pressure, or a rock or structure so formed.
- LEACHATE:** A solution obtained by leaching.
- LEACHING:** 1) The extraction of soluble metals or salts from an ore by means of slowly percolating solutions; e.g., the separation of copper by treatment with sulfuric acid. 2) The dissolving of soluble constituents from a material by the natural action of percolating water; e.g., the leaching of metals from mine wastes.
- LINEAMENT:** A linear topographic feature of regional extent that is believed to reflect the underlying structure of the earth's crust.
- LITHOLOGY:** The description of rocks on the basis of characteristics such as color, mineralogic composition, and grain size; the physical character of a rock.
- MALACHITE:** A bright green mineral, $\text{Cu}_2\text{CO}_3(\text{OH})_2$. A common secondary mineral associated with azurite in the oxidized zone of copper sulfide deposits.
- MALLEABLE:** Capable of being extended or shaped (e.g., by pressing with rollers or beating with a hammer).
- MASSIVE SULFIDE DEPOSITS:** Any mass of unusually abundant metallic sulfide minerals.
- MATTE:** The molten product of smelting.
- METALLURGY:** The science and art of separating metals from their ores and preparing them for use, as by smelting and refining.
- METRIC TONNE:** A unit of weight equal to 1000 kilo-

grams. 1 metric tonne = 1.1 short tons = **2204.6 pounds.**

MOLYBDENITE: A lead-gray hexagonal mineral: MoS_2 . It is the principal ore of molybdenum, Molybdenite generally occurs in foliated masses or scales, and is found disseminated in porphyry.

MOLYBDENUM: An element, Mo, often produced as a byproduct of copper mining.

ORE GUIDES: Associations of geologic and other factors such as rock types, geologic structures, or alteration zones that may indicate the presence of an ore body.

OUTCROP: That part of a geologic formation or structure that appears at the surface of the earth.

OXIDATION: The addition of oxygen to a compound or the removal of an electron from an atom, ion, or element (opposite of reduction).

OXIDE: A mineral compound characterized by the linkage of oxygen with one or more metallic elements, such as cuprite (Cu_2O).

OXIDIZE: To add oxygen to a compound, or otherwise cause an atom, ion, or element to lose an electron (opposite of reduce).

PHENOCRYSTS: One of the relatively large and ordinarily conspicuous crystals of the earliest generation in a porphyritic igneous rock.

PHOTO GEOLOGY: The geologic interpretation of aerial photographs.

PORPHYRY: An igneous rock of any composition that contains conspicuous phenocrysts in a fine-grained ground mass.

PORPHYRY COPPER DEPOSIT: A large body of rock, typically porphyry, that contains disseminated chalcopyrite and other sulfide minerals. Such deposits are mined in bulk on a large scale, generally in open pits, for copper and byproduct molybdenum. Supergene enrichment has been very important at most deposits, as without it the grade would be too low to permit mining.

PREGNANT LEACHATE: Leachate laden with mineral values and ready for further processing.

PROSPECT: An occurrence of minerals of potential value before that value has been determined by exploration and development.

PUDDING-STONE: A conglomerate consisting of well-rounded pebbles whose colors are in marked contrast with the surrounding matrix.

PYROMETALLURGY: The extraction of metals from ores and concentrates through processes employing chemical reactions at elevated temperatures.

REAGENT: A substance used because of its chemical or biological activity, such as the reagents used in froth flotation to make the copper minerals water repellent (hydrophobic) without affecting the other minerals.

RECONNAISSANCE: A general, exploratory examination or survey of the main features of a region.

REDUCE: To remove oxygen from a compound, or otherwise cause an atom, ion, or element to gain an electron (opposite of oxidize).

REDUCTION: The removal of oxygen from a compound or the addition of an electron to an atom, ion, or element (opposite of oxidation).

ROASTING: In pyrometallurgical processes, the treatment of ore or concentrates to dry and/or preheat the material prior to smelting, and/or to partially oxidize the sulfur content to sulfur dioxide for environmental control. In hydrometallurgical processing, roasting converts sulfide minerals to more easily leachable oxides and sulfates, and generates sulfuric acid for leaching. The product of roasting generally is called calcine.

SEDIMENTARY: Pertaining to or containing sediment, or formed by its deposition.

SEMI-AUTOGENOUS: Occurring or produced with only partial external influence or aid; ore grinding is said to be semi-autogenous when it is done using pieces of ore mixed with a minimal amount of pebbles, steel balls or rods, or other grinding media.

SHAFT: A vertical passage drilled to gain access to a mineral deposit or vein for underground mining.

SILICATES: Compounds whose mineral structure contains SiO_4 tetrahedral, either isolated or joined through one or more of the oxygen atoms to form groups, chains, sheets, or three-dimensional structures with metallic elements.

SMLTER: A plant or section of a plant where roasting (optional), smelting, and converting take place.

SMLTING: The chemical conversion, using heat, of copper concentrates or calcines to matte, slag, and sulfur dioxide.

SOLUTION MINING: The dissolving of mineral components from an ore (i.e., leaching). In situ solution mining leaching solution trickles downward through the fractured ores or old mine workings to a deeper collection point.

SOLVENT: A usually liquid substance capable of dissolving or dispersing one or more other substances.

SOLVENT EXTRACTION: The separation of materials of different chemical types and solubilities by selective solvent action (some materials are more soluble in one solvent than in another, hence there is a preferential extractive action).

STOPE: An underground excavation formed by the extraction of ore.

STOPING: Extraction of ore in an underground mine by working laterally in a series of levels in the plane of a vein.

STRATA-BOUND: Mineral deposits confined to a single stratigraphic unit. The term can refer to a strati-

form deposit, to variously oriented orebodies contained within the unit, or to a deposit containing veinlets and alteration zones that may or may not be strictly conformable with bedding.

STRATIFORM: Having the form of a layer or bed.

SULFIDES: Mineral compounds characterized by the linkage of sulfur with one or more metals (e.g., galena—PbS; pyrite—FeS₂; chalcocite—Cu₂S).

SUPERGENE ENRICHMENT: The near-surface processes of mineral deposition, in which oxidation produces acidic solutions that leach metals, carry them downward, reprecipitate them, thus enriching sulfide minerals already present.

THERMAL CONDUCTIVITY: The rate of heat flow by conduction per unit area per unit temperature gradient.

TROY OUNCE: A unit of weight. 12 troy ounces = 1 pound.

WEATHERING: The physical disintegration and chemical decomposition of rock through exposure to atmospheric agents, producing an in-place mantle of waste and preparing sediments for transportation.

Appendix C

Acknowledgments

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Robin Adams Resource Strategies Inc.	James Cooney British Columbia Office of the Federal Economic Development Coordinator	David Glancy U.S. Department of Commerce
Jon K. Ahlness U.S. Bureau of Mines	John Cordes Colorado School of Mines	John Gracey JACA Corp.
T S Ary U.S. Bureau of Mines	Philip Crowson Rio Tinto Zinc Corp.	William Grant Utah International Inc.
Kenneth J. Barr Cyprus Minerals Inc.	James W. Curlin Office of Technology Assessment	Sidney Green TerraTek
Aldo Barsotti U.S. Bureau of Mines	Roger Dewey Denver, Colorado	Dorothy Gusler AMAX inc.
Gary Baughman Colorado School of Mines	Denny Dobbin U.S. Public Health Service	Graham Haclin Brook Hunt and Associates, Ltd.
Julie Beatty Resource Strategies Inc.	Phil Drury U.S. Department of Commerce	Frank Harris Magma Copper Co.
Harold Bennett U.S. Bureau of Mines	Daniel Edelstein U.S. Bureau of Mines	George M. Hartley Copper Development Association
John Bennett U.S. Bureau of Mines	Roderick Eggert Colorado School of Mines	Thomas Henrie Salt Lake City, Utah
Sandy Blackstone University of Denver	Herman Enzer U.S. Bureau of Mines	Clifford Hicks Arizona Department of Mines and Mineral Resources
James Boyd Newmont Mining Corp.	Brian E. Felske Brian E. Felske & Associates Ltd.	James Hill New Mexico Department of Energy and Minerals
John Breslin U.S. Bureau of Mines	Frank Fisher U.S. Bureau of Mines	Dale Huff man Cyprus Minerals Corp.
Keith Brewer Canadian Department of Energy, Mines and Resources	Patricia Foley CRU Consultants Inc.	Simon Hunt Brook Hunt and Associates, Ltd.
David Brown U.S. Bureau of Mines	Michael Fraser Cyprus Minerals Inc.	Garret R. Hyde U.S. Bureau of Mines
Charles S. Burns Phelps Dodge Corp.	R.J. Fraser AM&S Mining Pty., Ltd.	Wayne Jackson U.S. Bureau of Mines
Audrey B. Buyn Office of Technology Assessment	Robert Friedman Office of Technology Assessment	Kenan Jarboe Office of Senator Bingaman
Duane Chapman Cornell University	Bernard Gelb Congressional Research Service	Warren Jenkins Copper Range Co.
David Cole Colorado Mining Association		

¹Affiliations given in that at the time of consultation with OTA staff

Jeremy Johnson
Chase Manhattan Bank

Janice Jolly
U.S. Bureau of Mines

Dan Kimball
 National Park Service

Keith Knoblock
 American Mining Congress

Frank Kottowski
 New Mexico Bureau of Mines
 and Mineral Resources

Judy Kowalski
 Office of Technology
 Assessment

Jerry Krim
 U.S. Bureau of Mines
 Philip Lapat
 Newmont Services Ltd.

Gordon Lister
 BP Minerals America

David Litvin
 The Standard Oil Co. (Ohio)

John McIver
 Magma Copper Co.

Stanley Margolin
 Network Consulting Inc.

Chuck Marshall
 JACA Corp.

Dan Maxim
 Everest Consulting Associates
 Inc.

Joe Mayer
 Copper and Brass Fabricators
 Council

P.K. Rana Medhi
 Cyprus Johnson Copper Co.

Stanley Miller
 U.S. Bureau of Mines

Gordon Miner
 U.S. Bureau of Mines

Paul Musgrove
 Noranda Inc.

Richard Newcomb
 University of Arizona

Nyal Niemuth
 Arizona Department of Mines
 and Mineral Resources

Anthony Oprychal
 U.S. Bureau of Mines

Allan Oshiki
Magma Copper Co.

F. Taylor Ostrander
AMAX Inc.

Krishna Parameswaran
 Asarco Inc.

David Parker
 Asarco Inc.

David Parker
 Government of Western
 Australia

Jack Parry
 Magma Copper Co.

Richard Pendleton
 Phelps Dodge Corp.

Kenneth Porter
 U.S. Bureau of Mines

Tom Probert
 BP Minerals America

R.J. Pursley
 Arizona Mining Association

Paul Queneau
 Hazen Research Inc.

Martin Robbins
 Colorado School of Mines
 Foundation, Inc.

Elizabeth Robinson
 Morgan Guaranty Trust Co.

Emil Romagnoli
 Asarco Inc.

Matthew Scanlon
 Phelps Dodge Corp.

Tom Scartaccini
 Asarco Inc.

John J. Schanz, Jr.
 Congressional Research Service

Randall Scott
 Pincock, Allen & Holt, Inc.

William Shafer
 House interior Committee

Monte B. Shirts
 U.S. Bureau of Mines

Pamela Smith
 U.S. Bureau of Mines

Louis Sousa
 U.S. Bureau of Mines

Richard Sparks
 Inspiration Consolidated Copper
 co.

William Stewart
 U.S. Bureau of Mines

David Stonfer
 U.S. Department of Commerce

Simon D. Strauss
 New Rochelle, New York

George Swisko
 U.S. Bureau of Mines

Paul Thomas
 Economics Institute

Gordon Thompson
 Cominco Ltd.

John E. Tilton
 Colorado School of Mines

Jake Timmers
 Inspiration Consolidated Copper
 co.

Al Tittes
 Inspiration Consolidated Copper
 co.

Thomas Terries
 Terries & Associates

William A. Vogely
 The Pennsylvania State
 University

John L. Way
 EXXON Minerals Corp.

Alfred Weiss
 Mineral Systems Inc.

Dan Welker
 Phelps Dodge Corp.

Robert Wilson
 National Critical Materials
 Council

J. Burgess Winter
 BP Minerals America

Harry J. Winters, Jr.
 Tucson, Arizona

Brian R. Woolfe
 Magma Copper Co.

Robert Yuhnke
 Environmental Defense Fund

Klaus Zwilski
 National Materials Advisory
 Board