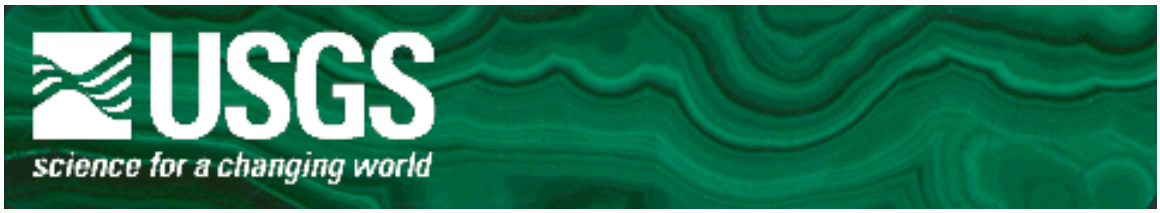

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Giant Porphyry-Related Metal Camps of the World — A Database

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Introduction

Porphyry-related metal deposits are large-tonnage, generally low-grade, hydrothermal deposits related to igneous intrusions emplaced at high crustal levels. Mineralization may be confined to pluton-hosted disseminations, stockworks, vein sets, and breccias and (or) occur in skarns, replacements, veins, and disseminated deposits peripheral to the inferred source pluton. Coeval epithermal precious metal-dominated deposits may occur above, or be telescoped onto, porphyry systems. This spectrum of deposit types includes many of the world's largest accumulations of Cu, Mo, Au, Ag, Sn, and W. As such the deposits represent critical economic resources and important exploration targets (Gilmour et al., 1995; Kirkham and Sinclair, 1996; Singer, 1995).

To prospect efficiently for undiscovered mineral deposits, or to speculate about future metal supply, it is useful to define the size, distribution, and geologic characteristics of known deposits. It is to that end that we have compiled this database, the release of which is part of a larger effort to characterize the world's largest and most important porphyry-related deposits. We hope that this compilation can be of aid to researchers, explorationists, and students alike. We also recognize that any compilation effort is, by its very nature, incomplete, as well as out-of-date as soon as it is released. Thus, we welcome any corrections or updates to the data presented here and request that you direct any communications to Felix Mutschler (fmutschler@mail.ewu.edu, 509-359-2854) or Steve Ludington (slud@usgs.gov, 650-329-5371).

Definitions

In this database, the geographic unit used for reporting data is a "camp." A camp may include one or more "mining districts" established by law or defined by literature usage. Further, a camp may include one or more "mineral deposits" representing a single "deposit type" (see below), or several genetically related deposit types, in close enough proximity to be exploited with a common infrastructure and administrative unit. We recognize that in some cases we may have included some genetically or temporally unrelated deposits in a camp, and any inferences we make are subject to this caveat. A "giant camp" has a gross metal endowment exceeding one or more of the threshold values described below.

Terms such as "giant" and "world-class", as applied to mineral deposits, have been defined in many ways. See, for example, Singer (1995) and Laznicka (1999). For this database, we chose the following metal endowments (production + reserves + resources at the lowest reported cutoff values) as thresholds: Cu, 1,000,000 mt; Mo, 250,000 mt; Au, 155,000 kg (ca. 5,000,000 troy oz); Ag, 7,750,000 kg (ca. 250,000,000 troy oz); Sn, 200,000 mt; W, 100,000 mt; Pb, 1,000,000 mt; and Zn, 1,000,000 mt. These values are generally similar to those used by Singer (1995) to define giant or world-class deposits, and to those used by Laznicka (1999) to define large accumulations.

These thresholds were chosen to represent large deposits, with potentially long mine lives, and that would be of potential interest to major mining companies. Using the thresholds as a guide, we compiled information for 234 mining camps worldwide that meet one or more of these thresholds. In addition, the database contains 49 further deposits that were included because some have metal endowments closely approaching giant status, some represent extensions of metallogenic provinces that contain giant deposits, and some provide important data useful for defining giant deposit types.

Deposit descriptions and classification

To provide capsule descriptions of the porphyry-related deposits in the database, we have adopted a tri-partite classification nomenclature based on deposit type, metal commodities, and source/host pluton chemistry.

Deposit type

Porphyry deposits consist of stockwork, disseminated, and breccia-hosted mineralization that is restricted to plutons and their immediate wall rocks. Examples of porphyry copper deposits are El Salvador, Chile, and Bingham, Utah. Examples of porphyry molybdenum deposits are Climax, Colorado, and Buckingham, Nevada. An example of a porphyry tungsten-molybdenum deposit is Logtung, Yukon. Examples of plutonic porphyry gold

deposits include Fort Knox and Pogo, Alaska, which are more deeply emplaced than subvolcanic porphyry gold deposits, like Refugio, Chile.

Greisen deposits consist of stockwork, vein, pipe, and breccia-hosted greisen mineralization (ore minerals + quartz, muscovite, topaz, fluorite) in or near the roof of a granite pluton. An example of a greisen tin deposit is Pitinga, Brazil. Kara-Oba, Kazakhstan, is a greisen tungsten-molybdenum deposit.

Skarn deposits consist of pyrometasomatic and contact metasomatic mineralization, typically hosted by carbonate-rich rocks in close proximity to a pluton. The Nambija district, Ecuador, is an example of a skarn gold deposit. Mactung, Yukon, is a skarn tungsten deposit.

Epithermal deposits are high-crustal level vein, stockwork, breccia pipe, and hot-spring deposits, primarily of precious metals. Some of them occur above or peripheral to porphyry metal systems (Hedenquist and others, 1996). They are commonly divided into high-sulfidation types (the most common around porphyry systems), such as El Indio, Chile, and Goldfield, Nevada, and low-sulfidation types, such as Cripple Creek, Colorado, and the Emperor mine in Fiji.

Mesothermal manto deposits are fault zone-hosted veins and stratabound, or breccia-hosted replacement, iron oxide-copper sulfide deposits. Their origin is debated, but may be related to both apatite-bearing magnetite deposits and porphyry copper deposits. In this database, we restrict the designation to copper sulfide and hematite-rich deposits according to the usage of Espinoza R. and others, 1996; Marschik and Fontboté, 1996; and Vila and others, 1996, who describe these deposits in Chile. We specifically exclude polymetallic base and precious metal carbonate-hosted deposits that are often referred to as manto deposits in North America. Those deposits are here classified as polymetallic replacement deposits and are defined below. Examples of mesothermal manto deposits include Mantos Blancos, Chile, and the Superior-Magma mine, Arizona.

Replacement and vein deposits consist of hydrothermal polymetallic, conformable to crosscutting, replacement bodies (blankets, lenses, pipes, and chimneys) in carbonate rocks, and fissure veins in non-reactive rocks. Examples include the polymetallic replacement deposits at Bisbee, Arizona, and Tintic, Utah, and the vein deposits at Butte, Montana.

Bolivian-type polymetallic vein deposits are veins, stockworks, and sheeted vein complexes hosted by subvolcanic dacite intrusions and characterized by significant endowments of tin and (often) silver (Ludington and others, 1992). Largely restricted to the central Andes, this class includes the porphyry tin deposits of Sillitoe and others (1975). Examples include Cerro Rico de Potosí and Llallagua, Bolivia. Kori Kollo, Bolivia, is a gold-rich example.

Metal commodities

To standardize the listing of metal commodities for porphyry-related metal camps, we adopted the following conventions. Where different tonnages of ore and (or) metals are reported for the same camp, we follow Cox and Singer (1986), and use the largest tonnages reported, or the tonnages associated with the lowest cutoff grades. In the deposit descriptions, metals are listed in decreasing order of their contribution to the total value of the camp's estimated endowment; metals contributing more than 10 percent of the value are listed first, with multiple metals separated by hyphens; metals contributing less than 10 percent, but more than 1 percent of the value are listed next, in parentheses, followed by metals (in italics) which are reported to be present, but for which no numeric values are available. Some examples of these conventions, used in deposit descriptions in

the database are: San Manuel-Kalamazoo, Arizona - Porphyry Cu (Mo,Au,Ag), and Climax, Colorado - Porphyry Mo (Sn,W).

Source/host pluton chemistry

Source/host pluton chemistry is also compiled in the database. Because of differing rock nomenclature used in the literature by various authors, we have, whenever possible, based our characterization of rock chemistry on standardized rock names applied to major element analyses of rocks from the mining camps. We have classified the camps petrochemically into the following groups: C-A (calc-alkaline); which may be subdivided into: GRD (granodiorite to low-silica granite), HSR (high-silica rhyolite/granite), and PDC (strongly peraluminous dacite); ALK (alkaline); and TRN (transitional, which includes substantial amounts of coeval mixed alkaline and calc-alkaline rocks). Where the designation is followed by an asterisk, we have compiled rock chemical data to support the designation; otherwise we have depended on descriptions in the literature.

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