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Title: PORPHYRY COPPER LIFE CYCLES: CHALLENGES AND OPPORTUNITIES IN SOUTHWESTERN NORTH AMERICA

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Abstract: Porphyry copper and related deposits comprise one of the world's foremost families of ore deposits, yet many questions remain unsettled concerning their distribution and settings, their characteristics and origins, and their natural and anthropogenic fates - in sum, their life cycles. The many questions that remain are critical to future mineral resource discovery and utilization and critically influence related public attitudes and policy. Addressing these challenges requires a long-term commitment to improved science, effective communication, and sound education among all stakeholders. Here, we highlight aspects of these issues, we build on work by many people, and we use current examples from SW North America, including results from the USGS Porphyry Copper Life Cycle Project.

A major continuing scientific challenge is to understand the distribution and character of porphyry copper systems and their broader context. These magmatic-hydrothermal systems comprise only small areas within permissive terrains; the deposits themselves are even smaller and of uncertain geometry, especially in the vertical dimension; much prospective terrain is covered; and there are major post-mineral tectonic and weathering effects that are poorly understood. Although the broad genetic links with upper crustal magmatism are well established, hypogene deposit characteristics are considerably more diverse than commonly recognized. No system has been fully characterized geologically or chemically from top to bottom, and few have been thoroughly characterized at any level of exposure. We lack an adequate basis for comparing these ore-forming systems to barren systems or to contrasting deposit types, or, indeed, to the crust as a whole. We lack satisfactory predictors of why some prospective systems are barren, how many deposits form, or why they differ in grade, size, and composition. For example, why are certain terrains and epochs more productive than others? Lastly, documentation of what is

observed, moved, and processed during exploration and mining remains thin despite both economic and societal needs that should compel their assembly.

These challenges pose opportunities. Better scientific understanding of the characteristics, genesis, distribution, and post-mineral changes of porphyry systems could be of great value in efficiently assessing, exploring, and mining, particularly under cover or at depth. Perhaps most important, societal needs require a more complete understanding of the characteristics and distinctions among deposits, their natural and anthropogenic detritus, and especially non-mineralized areas, as the starting point for an appreciation of the value and trade-offs that come with long-term decisions concerning these extraordinary geological systems. Will there be the people and means committed to make the most of these opportunities?