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Global Resource Assessments of Primary Metals: An Optimistic Reality Check

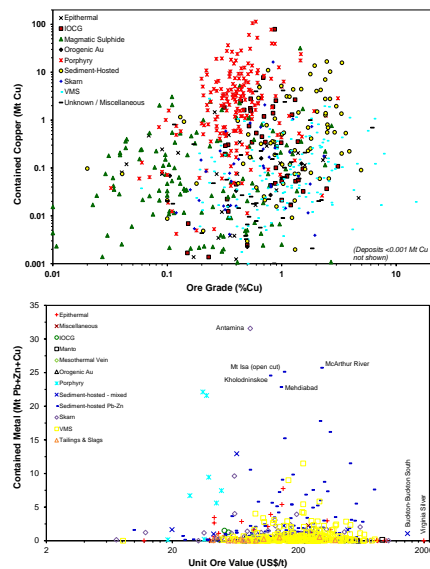
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Metals are fundamental to the modern world, our lifestyles and the complex myriad of technologies and services we use – directly or indirectly – on a daily basis. The mining of numerous metals occurs across the world, with some being concentrated in particular regions or countries. Although the ability for mining to continue to meet growing demands is a perennial concern, there is very little research which assesses in detail the potentially mineable global resources of various metals. For many metals, they are the main target for extraction, such as copper (Cu), nickel (Ni), lead (Pb)-zinc (Zn), platinum group elements (PGEs), rare earth elements (REEs, more commonly known as rare earth oxides, REOs), uranium (U, or its oxide U_3O_8) and gold (Au), while others such as silver, cobalt, tellurium or indium are by-product metals and present minor value to a mining project or company.

Here, we summarise our recent research across a range of primary metals, namely Cu [1], Ni [2], PGEs [3], Pb-Zn [4], REEs [5], U [6] and Au [7], including key aspects such as deposit types, contained metals, average ore grades, case studies of numerous mines or fields as well as the variety factors which can affect whether a deposit is likely to be developed (or not). Our databases are built from reported mineral resources by deposit or project, mostly from formal code-based reported data (e.g. JORC, SAMREC, NI43-101, PERC, etc.) but where other sources are available these may be included (but given a lower reliability). Examples of some relationships between contained metals and ore grade or unit ore value by mineral deposit types are given in Figure 1 for Cu, Pb-Zn and U, with the main mineral resource data summarised in Table 1.



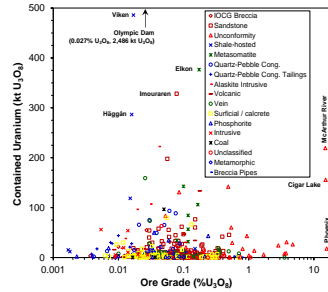


Figure 1: Examples of mineral resource relationships: contained Cu and ore grade (left); contained Pb-Zn-Cu metal and unit ore value (middle); contained U versus ore grade (right)

Mt Cu
Mt Ni
t PGEs
Mt Pb
Mt Zn
Mt REOs
kt U ₃ O ₈
t Au
Our Resources
1,861.3
296.2
90,733
179.0
536.9
619.5
11,798
187,752
USGS Reserves#
630
80
71,000
87
230
130
8,370
55,000
2014 Global Production (~)
18.7
2.4
~425
5.46
13.3
0.11
66.3
2,860

Table 1: Comparison of our global mineral resources assessment to other sources and 2014 global annual production [8] (# data USGS Reserves for Cu, Ni, PGEs, Pb, Zn, REOs, Au but IAEA for U₃O₈)

Overall, the resources compiled show that there is sufficient known metals to meet likely global demands for at least a few decades (and often much more), showing that other factors will be more important in coming decades in controlling the supply of metals to meet reasonable global technological needs. These include social issues (e.g. opposition to mining, equity, benefits sharing), environmental risks and impacts (especially concerns over land use, acid mine drainage, mine rehabilitation, water resources issues, air pollution) and economic cycles and issues (especially new technology, demand, prices, etc.). In short, mining will continue to face a variety of complex challenges – but strict ‘resource depletion’ will be much less important than social-economic-environmental issues.

References:

[1] Mudd G M et al. (2013) *Econ Geol* 108:1163-1183; [2] Mudd G M and Jowitt S M (2014) *Econ Geol* 109:1813-1841; [3] Mudd G M (2012) *Ore Geol Rev* 46:106-117; [4] Mudd G M et al. (2013) *Ore Geol Rev* (under review); [5] Weng Z et al. (2015) *Econ Geol* 110:1925-1952; [6] Mudd G M (2014) *Sci Total Change* 472:590-607; [7] Jowitt S M and Mudd G M (2014) In: *"Gold14 @ Kalgoorlie"*: October 2014, 56-58 (including updated data); [8] USGS (2015) *Mineral Commodity Summaries 2015*. US Geological Survey, Reston, VI, USA

