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Resource Depletion Scenarios – How should we address the limitations?

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Society is dependent upon access to geologic resources to maintain our current economic system and societal wellbeing. However, the past several decades have seen a range of studies that have raised concerns that the long-term material needs of society may exceed what is potentially recoverable from presently known geologic resources.

A series of studies that explored the concept of 'peak minerals' were completed as part of the Mineral Futures Collaboration Cluster, a collaborative research programme between six Australian universities and the CSIRO that ran from 2009 to 2013. Scenarios were developed for primary copper [1], steel [2] and lithium [3] production, using the Geologic Resource Supply-Demand Model (GeRS-DeMo) developed by Mohr [4]. The models were calibrated using datasets of known mineral resources, historic mine production levels and estimates of future demand. The scenarios indicated that: copper production could grow for at least the next twenty years, with further exploration success required to sustain production levels beyond that [1]; growth in iron ore production may slow by the end of the decade, with production possibly plateauing until 2100 [2]; and, lithium resources appear sufficient to supply batteries for a high market penetration of electric vehicles [3]. Due to the exhaustion of available resources, all scenarios displayed a peak in total production at some stage in the next 20 to 100 years. Increases in assumed resources through exploration efforts would only delay these production peaks.

Using cumulative grade-tonnage curves combined with GeRS-DeMo results, the potential rate of ore grade decline was assessed for copper production [1]. From this, only two conclusions could be reached: 1) there is still considerable copper present in mineral deposits at grades above the current global average mined grade, and 2) the rate of decline of mined ore grades may slow as the average resource grade of large-scale porphyry copper systems is approached. Although global Cu grades are in terminal decline [6], this is the combination of major technology improvements (e.g. flotation, haul trucks), economies of scale, growing markets as well as geologic factors. For many Cu deposits, especially porphyry systems, as ore grades decline the total size of the deposit increases markedly, offsetting the decline in ore grade and leading to considerably more Cu available. Thus declining ore grades are not a sign of growing scarcity per se, but a reflection of the ongoing changes in the mining industry – which is often misunderstood in the sustainability literature. Overall, although Cu ore grades can be expected to decline very gradually, when applying 'peak minerals' thinking, it is clear that future constraints are environmental, social and economic in nature.

It is important to note that when metals are used they remain in anthropogenic stock – unlike coal, oil or gas, which are consumed in the process. Whilst recycling of these metals is attractive in concept, the ability to recycle a metal depends on its use. Metals used in pure form or alloys (e.g. iron, copper, gold) are relatively easy to recycle; whereas metals with diffuse or dissipative uses (e.g. nickel, rare earths) are comparatively harder to recycle. Overall, as more mining occurs, the total stock builds up in society and may eventually be comparable to the scale of remaining geologic resources. At present, GeRS-DeMo and peak models cannot reflect the complex interplay between a geologic resource, its mining and use, economics, environmental issues and social expectations such as recycling. Some thoughts on how best to address this complexity will be presented.

References:

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