Mine wastes: mineralogical treasures, environmental impacts

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Modern society requires metals, metalloids and other mineral products to maintain industrial and domestic activities. The extraction of these products generates enormous quantities of mine wastes, because the economic commodities generally make up a small proportion of the material extracted. It has been estimated that several thousand million tonnes per year are currently generated; the same amount of Earth materials moved by global geological proceseses [1, 2]. Liquid mine wastes including basic (pH 8-12), circumneutral (pH 6-8) and acid mine drainage (AMD, pH 0-5) are also abundant and voluminous [3].

Mine wastes impact on the Earth's surface environment in many ways. Large volumes of waste fill tailings ponds, form piles at mine sites and cause excessive sedimentation of rivers. Solid mine wastes contain potentially toxic components that can be leached into waters or taken up by plants and humans [4]. AMD can cause acidification of water bodies and death of organisms.

Despite these environmental impacts, mine wastes are one of Earth's treasure troves of minerals and of spectacular mineral reactions. The wastes contain a wide range of primary sulphide and oxide minerals that consistute the economic ores [5]. When exposed to Earth surface conditions, these minerals can undergo biogeochemical dissolution reactions, yielding secondary oxyhydroxides, oxyhydroxysulfates and other complex phases [6]. Products of mineral processing in the mine wastes (e.g., cyanide and high-temperature roasting phases) can also undergo such reactions and yield such secondary phases. Despite decades of research on these processes and products, there is still a wealth of information yet to be discovered and understood, especially given the new types of mine wastes that are constantly being generated. This information is essential to enable geoscientists to contribute to new mine development and for environmental and human health protection.

[1] Fyfe (1981) *Science* **213**, 105-110. [2] Förstner (1999) In Azcue (ed) *Environmental Impacts of Mining Activities: Emphasis on Mitigation and Remedial Measures*. Springer, Heidelberg, pp 1-3. [3] Nordstrom (2011) *Elements* **7**, 393-398. [4] Plumlee & Moran (2011) *Elements* **7**, 399-404. [5] Jamieson (2011) *Elements* **7**, 381-386, [6] Kossoff *et al* (2012) *Min. Mag.* **76** 1209-1228.