Mining environments: the good, the bad and the ugly

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The objective of this paper is to review some of the geochemical characteristics, environmental impacts and rehabilitation methods pertaining to mining environments. The paper will draw predominantly on "the good", "the bad" and "the ugly" examples from Australia and overseas, many of which have not previously been reported, to illustrate our advances in knowledge and the challenges ahead.

Mankind is feeling the limitations of its science and technology despite all the advances in knowledge on mining environments and the improved practices in mine site rehabilitation and mine waste management. Tailings dams continue to fail and leak; waste rock dumps erode; capping designs of mine waste repositories do not succeed; mine-derived contaminants are dispersed into the biosphere, hydrosphere, pedosphere and atmosphere; predictions on the long-term kinetic behaviour of mine wastes turn out to be incorrect; and the long-term costs of mine site rehabilitation can be staggering. As the perturbations have become recognised, our lack of knowledge of fundamental environmental processes at many mine sites has become obvious. The time has come to drastically improve our scientific efforts to understand these processes on all scales.

More than ever, environmental geochemists have important contributions to make as they provide the data necessary for rational decision-making in critical areas such as resource development, waste management and mined land rehabilitation. The most urgent problem facing environmental geochemists working on mining environments is quantification of the interactions that control the distribution of contaminants. Firstly, we must precisely describe the chemistry and mineralogy of contaminants and understand their long-term behaviour. We must improve our predictions on mine drainage, aquifer and final void water quality. Also, we must search for innovative, cost-effective remediation and rehabilitation technologies. The rehabilitation of mine sites and secure disposal of mine wastes require a new precision in the total description of mine sites and an understanding whether our current practices will be sustainable in the long term. Evaluations of recently rehabilitated mine sites are producing data on the successes and failures of existing rehabilitation practices. Such studies should sharpen our ideas on the factors leading to contaminant dispersal and the development of new remediation technologies.

There is reason for optimism that the required progress is possible. Such optimism is based on the phenomenal advances in our ability to observe and describe mining environments. However, detailed geochemical studies of natural, mined and rehabilitated environments are necessary if we are to quantify the variables controlling the containment and dispersal of contaminants and if we are to develop innovative remediation protocols. Our efforts could ensure that the 21st century goes down in history as that of "green technologies".