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METALS IN THE ENVIRONMENT AND MINE WASTES

PREFACE

The thematic issue on metals in the environment and mine wastes originated from the MAC-sponsored Metals in the Environment symposium and the Environmental Studies of Mine Wastes session held at the GAC–MAC–SEG Annual Meeting, May 25–28, 2003 in Vancouver, British Columbia. The symposium and related special session brought together earth and environmental scientists to share results of recent investigations in environmental mineralogy and geochemistry that are becoming increasingly complex and multidisciplinary in nature. The thematic issue was planned for more in-depth discussion of the topics and for dissemination of the information presented to a wider audience. In addition to the papers presented at the meeting, this issue includes contributions from researchers who could not attend the Vancouver meeting.

The thematic collection of nine papers reinforces the importance of the mineralogical tools and the role that mineralogy plays in the characterization of environmental media resulting from humans' interactions with the geosphere. The subjects discussed in this issue are providing improved mineralogical tools and approaches for better characterization of mine wastes, prediction of acid mine and rock drainage, remobilization of metals from waste piles, and immobilization of radionuclides in nuclear-waste repositories.

In the article entitled "A ^{133}Cs, ^{29}Si and ^{27}Al MAS NMR spectroscopic study of Cs adsorption by clay minerals: implications for the disposal of nuclear wastes", R.B. Ejeckam and B.L. Sherriff examine the adsorption of Cs on clay minerals as a potential engineered barrier in a geological repository for long-term management of spent nuclear fuel. Montmorillonite adsorbs more Cs than vermiculite, whereas kaolinite adsorbs very little Cs. Adsorption occurs in the Gouy and Stern layers of montmorillonite, and the amount of adsorption is not affected by elevated T and P. In vermiculite, Cs is adsorbed near the tetrahedral sites having local charge-imbalances due to Al substitution for Si.

N.V. Sidenko, E.V. Lazareva, S.B. Bortnikova, A.D. Kireev and B.L. Sherriff describe the mineralogical changes that occur in mine wastes following their uncontrolled disposal in the paper entitled "Geochemical and mineralogical zoning of high-sulfide mine-waste at the Berikul mine-site, Kemerovo region, Russia". In the article entitled "Characterization of aluminum-rich phases in heap-leach pads at the Landusky gold mine, Montana, USA", N.V. Sidenko, B.L. Sherriff, H.E. Jamieson and S.C. Shaw describe transformations of Al-bearing minerals resulting from hydrothermal alteration, weathering, mining and metal extraction. The authors attribute the reduced efficiency of the treatment plant to the precipitation of amorphous aluminum hydroxides and oxyhydroxides from Al-rich aqueous solutions.

R.C. Peterson and A.H. Grant describe a sample stage and control system designed to control humidity and temperature during X-ray powder-diffraction experiments in their paper entitled "Dehydration and crystallization reactions of secondary sulfate minerals found in mine waste: *in situ* powder- diffraction experiments". The use of this set-up resulted in the assessment of dehydration reactions involving secondary sulfates.

In the paper entitled "A methodology to determine the acid-neutralization capacity of rock samples", P.A. Weber, J.E. Thomas, W.M. Skinner, and R.St.C. Smart state that molar quantities of cations such as Na, K, Mg, Ca and Mn in test solutions provide an independent assessment of the prediction of acid rock or mine drainage from solid mine-wastes. The applicability of the Net Acid Generation (NAG) test is discussed by

P.A. Weber, J.E. Thomas, W.M. Skinner and R.St.C. Smart in their paper entitled "Calculated acid–base balance for H_2O_2 oxidation of carbonate-poor pyritic mine-rock". Neutralizing cations can originate from both the carbonate and silicate minerals, and in samples containing low amounts of carbonate minerals, neutralization of acidity by the silicates can be significant. The NAG tests can fail for samples with significant concentrations of non-acid forming S and sulfide minerals such as galena.

In the manuscript by S.R. Walker, H.E. Jamieson, A. Lanzirotti, C.F. Andrade and G.E.M. Hall on the application of synchrotron micro-XRD and micro-XANES at the grain scale, the authors describe the composition and nature of the iron oxides in mine tailings. They determined that maghemite and hematite contain both As^{5+} and As^{3+} species. Persistence of As^{3+} in shallow tailings for over 50 years has led the authors to suggest that the arsenic is relatively stable under subaerial conditions.

H.E. Jamieson, C. Robinson, C.N. Alpers, D.K. Nordstrom, A. Poustovetov and H.A. Lowers describe jarosite-group minerals forming on the walls of the mine in the paper entitled "The composition of coexisting jarosite-group minerals and water at the Richmond mine, Iron Mountain, California". Compositions of jarosite-group minerals ranging from $KFe^{3+}{}_3(SO_4)_2(OH)_6$ to $Na_{0.2}H_3O_{0.8}Fe^{3+}{}_3(SO_4)_2(OH)_6$ are consistent with the equilibrium compositions based on speciation calculations.

R.L. Flemming, K. Salzsauler, B.L. Sherriff and N.V. Sidenko identified scorodite in fine-grained, high-sulfide, arsenopyrite mine-waste using micro X-ray diffraction. They describe the use of beams 50 and 500 μm in diameter for routine identification of phases in polished sections comprising <1% of bulk samples. The authors determined the presence of two texturally distinct occurrences of scorodite ($FeAsO_4 \bullet 2H_2O$) in a sulfide mine-waste rich in arsenopyrite.

We thank all the contributors for their collaborative effort to publish the thematic collection of articles issue in a timely manner, and the referees for their constructive comments. Efforts of Vicki Loschiavo, Managing Editor of *The Canadian Mineralogist* are acknowledged. Finally, our sincere gratitude goes to John L. Jambor for his earlier efforts in setting the Vancouver meeting in motion and suggesting the thematic issue.

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Coeditors of the thematic collection