Developing a geoenvironmental model for Canadian orogenic lode gold deposits

M.B. Parsons[1], A.J. Desbarats[2], J.B. Percival[2], Y.T.J. Kwong[3], and J.L. Bates[1]
1. Geological Survey of Canada (Atlantic), Natural Resources Canada, P.O. Box 1006, Dartmouth, NS, Canada B2Y 4A2 <Michael.Parsons@NRCan.gc.ca> ¶ 2. Geological Survey of

Atlantic Geology, 2009, Volume 45, Number 1

Canada, Natural Resources Canada, 601 Booth St., Ottawa, ON, Canada K1A 0E8 ¶ 3. CANMET Mining and Mineral Sciences Laboratories, Natural Resources Canada, 555 Booth St., Ottawa, ON, Canada K1A 0G1

Without appropriate environmental management controls and regulatory guidelines, the mining and milling of gold can result in significant risks to the environment and human health. Orogenic lode gold deposits, in which gold is hosted mainly by quartz-carbonate veins, occur in deformed greenstone and metasedimentary terranes around the world. These deposits are the main source of gold in Canada, and are presently the focus of considerable exploration and development. The purpose of this study is to develop a geoenvironmental model to describe the environmental behaviour of orogenic lode gold deposits through the exploration, mining, and post-closure phases of their development.

From 2006 to 2008, samples of stream water, sediment, waste rock, tailings, and mine drainage were collected around the past-producing Bralorne, King, and Pioneer gold mines in British Columbia. Together, these three mines represent the largest historical gold producer in the Canadian Cordillera (>4.15 million ounces Au between 1932 and 1971). Samples were also collected from several antimony (Sb) and mercury (Hg) deposits in the Bridge River Mining District, which may represent the epizonal portions of the Bralorne-Pioneer gold system. Metal (loid) concentrations in waters and sediments upstream and downstream of historical mine sites throughout the district demonstrate that the environmental impacts of past operations are generally restricted to the immediate vicinity of former mines. Background concentrations of arsenic (As), Hg, and Sb in stream sediments range from 3–82 mg/kg, 9–2700 µg/kg, and 0.16–2.0 mg/kg, respectively. In contrast, historical tailings and rock flour associated with recent mining have much higher concentrations of As (220–13 000 mg/kg), Hg (49–29 000 µg/kg), and Sb (2–700 mg/kg). The highest Hg concentrations occur in tailings at former mill sites where Hg was used for gold amalgamation, and in stream sediments at an abandoned Hg mine (Hg>100 000 µg/kg). Background concentrations of As, Hg, and Sb in filtered stream waters throughout the district ranged from <0.1–2.6 µg/L, 0.56–3.3 ng/L, and 0.03–0.43 µg/L, respectively. Dissolved concentrations of As and Sb were typically much higher in waters draining from mine workings, whereas the concentrations of Hg were relatively low (<12 ng/L) in all waters sampled. Drainage from the main portal of the Bralorne Mine contains high concentrations of As (~2300 µg/L). Ongoing measurements of the effluent chemistry and flow rates are providing a better understanding of processes controlling As release from this mine.

The results of this study will be combined with data from recent studies of gold mines in Nova Scotia and across Canada to develop a geoenvironmental model for orogenic lode gold deposits. This model will assist industry and regulators in understanding the key environmental characteristics of this type of ore deposit, and will help to minimize the environmental impacts associated with past, present, and future gold extraction.