

Evolution of Mine-Pool Chemistry at the Sydney Coalfield, Nova Scotia, Canada, and Its Implications for Mine Decommissioning*

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ABSTRACT

The Sydney Coalfield is the largest in Atlantic Canada in which about 100 coal mines with varied lifespan have been opened since 1720. In the Glace Bay sub-basin, the coal seams subcrop close to the Atlantic coast and dip seaward north and northeast at -4° to -15° . Coal has been mined at >1200 m depth and 11 km from the coastline. Deposited possibly under a marine influence, the coals are enriched in pyrite. During mining abundant acidic sulfates such as melanterite, rozenite, copiapite and halotrichite have accumulated in the underground workings due to pyrite oxidation. The dissolution of these efflorescent salts upon mine flooding at closure gives rise to acidic mine pools wherever insufficient acid-neutralizing materials are present. A major challenge of mine decommissioning in the area is to prevent the discharge of this acidic water into the open ocean.

Water monitoring in the 1B Hydraulic System, which consists of ten mines connected at various depths by natural or man-made conduits, shows that the mine pool chemistry varies with the mining practice employed. Although coal has invariably been mined by the room and pillar method in the Glace Bay area, the extent of pillar removal varies from mine to mine. In mines with minimal pillar removal, coal extraction could be as low as 45%, leaving much pyrite for oxidation prior to eventual flooding and an acidic mine pool invariably occurs. In contrast, in mines with extensive pillar removal, coal extraction could amount to 85%, leaving much less pyrite for oxidation. Moreover, the extensive pillar removal caused the collapse of the overlying strata which include some limestone. The infilling of mine workings with carbonate-rich material counteracts the effects of acidic efflorescent salts and a mine pool with near-neutral pH results. Geochemical modeling has affirmed the control of local water chemistry by the prevalent mineral assemblage.

Taking advantage of the hydraulic connection among mine pools in the 1B Hydraulic System and the local variation in water chemistry, the discharge of acidic water from a major outfall has been arrested by artificially withdrawing clean water from an adjacent mine pool. The longevity of such a temporary action depends on whether continual water withdrawal will eventually upset the chemical equilibrium established in the system. It appears that the extent of chemical stratification within the mine pools will determine whether pump-and-treat or establishment of a fresh water lens on top of denser acidic water is more appropriate for mine decommissioning.

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