COMPARATIVE ASSESSMENT OF GROUNDWATER CHEMISTRY EVOLUTION AT THREE ABANDONED MINES AND ITS PRACTICAL IMPLICATIONS

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Abstract: The reclamation effort typically deals with consequences of mining activity instead of being planned well before the mining. Detailed assessment of principal hydro- and geochemical processes participating in pore and groundwater chemistry evolution was carried out at three surface mine localities in North Dakota—the Fritz mine, the Indian Head mine, and the Velva mine. The geochemical model MINTEQUA2 and advanced statistical analysis coupled with traditional interpretive techniques were used to determine site-specific environmental characteristics and to compare the differences between study sites. Multivariate statistical analysis indicates that sulfate, magnesium, calcium, the gypsum saturation index, and sodium contribute the most to overall differences in groundwater chemistry between study sites. Soil paste extract pH and EC measurements performed on over 3700 samples document extremely acidic soils at the Fritz mine. The number of samples with pH <5.5 reaches 80%-90% of total samples from discrete depth near the top of the soil profile at the Fritz mine. Soil samples from Indian Head and Velva do not indicate the acidity below the pH of 5.5 limit. The percentage of samples with EC > 3 mS cm^{-1} is between 20% and 40% at the Fritz mine and below 20% for samples from Indian Head and Velva. The results of geochemical modeling indicate an increased tendency for gypsum saturation within the vadose zone, particularly within the lands disturbed by mining activity. This trend is directly associated with increased concentrations of sulfate anions as a result of mineral oxidation. Geochemical modeling, statistical analysis, and soil extract pH and EC measurements proved to be reliable, fast, and relatively cost-effective tools for the assessment of soil acidity, the extent of the oxidation zone, and the potential for negative impact on pore and groundwater chemistry. Interpretive techniques used in this project can be used in premining environmental characterization to allow for better mining and reclamation design and reduce costs associated with improperly designed material deposition.

Additional key words: reclamation design, environmental impact

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