Geochemical Modeling at Mine Sites: Applications, limitations, and potential opportunities

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Geochemical modeling at mine sites has been used, misused, and not used to assist in characterization, permitting, and remediation. Unfortunately, practitioners have not been sufficiently aware of the limitations of modeling and the importance of field and lab data to constrain the modeling results. Nordstrom and Nicholson (2017) provide an updated overview of geochemical modeling for mine site characterization and remediation with examples and case studies. This report is based on their overview.

Don't confuse codes with models, they are not the same thing. The fundamental basis of all modeling is the conceptual model – which cannot be derived from using a code – begins with the modeler's training and experience in chemistry, mineralogy, geology, hydrogeology, microbiology, and mining and mineral processing. Models are not unique, not "true" nor "correct," they are approximations that represent our thinking about reality. Treat them as such. Saturation indices reflect the "tendency" of a water to be super- or under-saturated or at solubility equilibrium. They are not sufficient evidence that a particular mineral solubility actually controls the water chemistry. Such a conclusion must be supported by field and lab data . Calcite is supersaturated in both deep limestone aquifers and in deep granitic groundwaters according to saturation indices, which raises the question of equilibrium applicability. More important are mass balances, which must be consistent with interpretations from saturation indices. For mass balances or "inverse modeing" at mine sites, the inescapable conclusion is that substantial amounts of silica precipitate along with iron phases during acid mine drainage formation. The most powerful modeling applications use both inverse modeling and forward modeling and do not necessarily assume equilibrium. When planning lab experiments, or remediation strategies, or bench scale testing, geochemical modeling can be a powerful tool to simulate reactions and processes to plan a study or pilot scale testing. It has been used to interpret humidity cell tests and to provide a more meaningful concept of how wastes might behave in the field. It should not be used as a primary means of justifying permits or making policy decisions.

Nordstrom and Nicholson (2017) Geochemical Modeling for Characterization and Remediation of Mine Sites, SME, Englewood.