At-Source Control of AMD: A Progress Report

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The Bureau of Mines is responsible for three AMDTAC research projects: (1) an evaluation of surface geophysical methods for locating acid mine drainage source areas in mine spoil; (2) refinement and evaluation of bactericidal control technology: and (3) development and evaluation of methods to control acid seeps and associated "burnout" of vegetation on reclaimed mine lands.

The principal surface geophysical methods being evaluated is electromagnetic induction terrain conductivity (EC), which works similarly to electrical resistivity (ER) but is simpler and faster to use. EC equipment is completely portable, can be operated efficiently with only two people, and requires one-third to one-sixth the time of an ER survey for a comparable area. However, ER is better suited for defining vertical variations in electrical properties and can be used in mine spoils of greater thickness.

EM has been used for a long time in mineral exploration, but only recent advances in instrumentation have made the technology adaptable to ground water pollution studies. We believe EM can be used to track acid water underground to acid source areas, identify flow paths and locate areas of ground water storage within the spoil material. Such information is vital if we are to control acid production in mine spoil.

To date, we have conducted EM and ER surveys at two sites in Upshur and Randolph County. At each site, significant variations in conductivity were observed; when contoured, these variations produced well-defined concentric grading. Wells are being drilled this month to determine proper data interpretation and to confirm the accuracy of the method; results will be discussed at the meeting in Clarksburg.

The second research project utilizes recently developed technology to inhibit the activity of *Thiobacillus ferrooxidans,* an iron-oxidizing bacteria, in active and abandoned surface mines. An anionic surfactant, sodium lauryl sulfate (SLS), has proven to be effective in killing *T. ferrooxidans* and reducing acid formation by 60-90 pct in coal refuse. Two potential problems prevent the simple transferal of the method to mine spoil:

1. The SLS treatment must be repeated three times a year to prevent repopulation of the bacteria. This is simple on exposed coal refuse but virtually impossible for buried mine spoil.
2. Intervening material such as topsoil or non-pyritic overburden adsorbs the surfactant and prevents the SLS from reaching the pyrite. Additional SLS can be used to compensate if the cover is thin, but in most cases, the extent of overtreatment required makes this impractical.

One possible approach is to bury a slowly-soluble form of the surfactant along with the spoil. We have developed and tested surfactant-rubber formulations which, in pilot-scale field tests, gradually released SLS for a prolonged time period, reducing acid production 67-95 pct. A full-scale field test is now underway in Upshur County on a hydrologically isolated 14 acre ridge which has been mined and reclaimed using state-of-the-art practices. One third of the pyritic mine spoil was treated with SLS solution, one third was treated with SLS solution and the slow-release pellets, and one third was left untreated. Unfortunately, only the pyritic material in the control section was covered with clay before the wet weather of last November and December stopped operations. Reclamation resumed in February and the SLS treatments were applied then. In the interim, the exposure of the pyritic material caused acidification; preliminary results indicate that the combination of the SLS treatments and the clay cover have allowed the sections to recover.

At inactive mine sites where the pyritic material is dispersed and buried, the SLS treatment may or may not be applicable. One mine in Pennsylvania is currently injecting an alkaline SLS solution in an attempt to treat such a site; we intend to use an infiltration trench. Our test will be conducted at Upshur County mine site discussed earlier, where the geophysical survey and drilling will provide information on the source of recharge, the acid producing zone, flow rates and flow paths. The initial test, planned for late spring, will use the surfactant solution; if effective, we may also test the slow release pellets there this summer.

Acid seepage and "burnout" of vegetation on reclaimed mine lands are in some cases simply low flow variants of the mine spoil problem addressed earlier, but alternatively may represent a more localized problem. Specifically, three types of acid problems exist: the first is a localized problem caused typically by pyritic material placed too near the surface; the second results from oxidation of buried pyrite over a large area with subsequent acid discharge; the third is a result of an acid recharge which flows through the material and emerges as an acid seep or spring.

In the first case, since the problem is local, treatment procedures which would be too expensive to use over a large area can be considered. Chemical sealants which react with either the acid or the iron in the drainage can be used to coat the pyritic material and reduce flow between the pyrite and the land surface.

If the problem is not localized, it is necessary to identify the source and quality of recharge. Under these circumstances the oxidation site of the pyrite must be modified or armored to inhibit the oxidation process.

We have evaluated a number of potential chemical ameliorants. Since in many cases it cannot easily be determined whether the problem is primarily hydrological or geochemical, we are concentrating on compounds which have the potential to both reduce pyrite oxidation and redirect flow away from the current discharge area. We have identified several organic acids which react with iron to form a slimy precipitate while at the same time inhibiting .1. ferrooxidans, thereby retarding pyrite oxidation. Comparative field tests will start this summer.

An interesting offshoot of this research is that it may lead to bactericidal control of acid formation in underground mines. Unlike SLS, which would simply wash away, these organic acids would remain as a bacteriostatic surface to prevent repopulation. We are investigating the feasibility of fogging an underground mine, so that the inhibitor can reach the acid forming environments throughout the mine)and are currently looking for acid-producing auger holes for a small-scale field test. If the technique proves effective there, we plan to test it in a small underground mine this summer.

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