Topic UGM-3

White Paper Topic: Predicting Long-term AMD from Above Drainage Underground Mines

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Problem Definition

The longevity of acid discharges, and changes in flow and water quality from abandoned underground mines is not well understood. Flow and chemistry determine what clean-up strategies can be used, and the short and long-term costs of treatment. Underground mines of all types generate 70 to 90% of the acid drainage in Appalachia. Above drainage discharges come mostly from abandoned mines closed prior to 1977. These pre-SMCRA mines have no continuing treatment obligations by the mining company, if in fact, the company still exists. Efficient use of public resources requires an improved capability to predict the severity and longevity of above drainage discharges and apply low cost treatment and remediation.

There are two types of underground mine discharges, "above-drainage" mines that only partially flood because they are located above creeks and rivers in hillsides of the area, and fully flooded or "belowdrainage" mines. Oxygen and water readily infiltrate above drainage mines to continue producing acid drainage for an indefinite period. Flooded below-drainage underground mines tend to have a finite life for discharging AMD because oxygen depletion limits acid generation.

Above-drainage underground mines are continually exposed to seasonal high and low water levels in the mine, or mostly unflooded conditions throughout the year, and tend to be recharged rapidly. Furthermore, the water moving into the mine voids can also be discharged rapidly. These quick recharge–discharge and breathing conditions are ideal for acid generation. During low water levels, pyrite oxidation forms iron and aluminum hydroxysulfate solids. These minerals provide short-term storage of metals, acidity, and sulfate that are soluble. When the water level rises, these acid products are dissolved, released into the mine pool, and flushed out of the mine. Acid formation continues until the mineral pyrite either becomes coated (armoring) or is used up in chemical reactions. Under these optimized oxidizing and flushing situations, it is possible that discharges could be contaminated for decades or centuries.

A reasonable estimate of the duration of acid mine drainage flowing out of above drainage underground mines is required, because that will determine the design of a particular reclamation strategy or technique for treating the discharge in watershed restoration and abandoned mine land reclamation projects.

Evidence

Lambert and Dzombak (2000) located three underground discharges in the Uniontown Syncline of Pennsylvania (Pittsburgh coal seam) with distinct flooding histories. Water quality measurements had been taken in 1974 and 1999 in each mine. Flooded below-drainage mines showed an increase in pH from 1974 to 1999, while iron decreased about 40% and the water became net alkaline. In each fully flooded, below drainage mine examined, water quality shifted from strongly acidic water to slightly acidic or net alkaline water over time. Therefore, the researchers concluded that underground mine water quality changed from acidic to alkaline within 30 yr after closure and flooding in their geologic setting.

In this same study, pH from an unflooded above-drainage mine closed in 1934 showed only slight change after 65 years. The unflooded above-drainage areas showed much less improvement in drainage quality, than below drainage mines. Other researchers have found similar results in this region (Brady et al., 1998; Capo et al., 2001).

Researchers at West Virginia University evaluated the change in quality of 44 above-drainage underground mine discharges from Pittsburgh and Upper Freeport coal seams in northern West Virginia. The original sampling occurred in 1968, and these sites were relocated in 2000. While water pH was not significantly improved, average total acidity declined 79% between 1968 and 2000 in Pittsburgh mines and 56% in Upper Freeport mines. Iron decreased an average of about 80% across all sites. The drainage from 34 out of 44 (77%) above-drainage underground mines showed significant improvement in acidity over time. Ten discharges showed no improvement (Demchak et al., 2004).

Course of Action:

The primary objective is to develop improved techniques for estimating changes in water quality from above drainage mines. How rapidly will acidity and iron decrease before achieving some acceptable water quality standard? How rapidly can above drainage mine discharges improve to allow the use of low maintenance passive treatment, rather than more intensive chemical treatment? Will low levels of pollution persist indefinitely? More information from above-drainage underground mines is needed to understand how long acid discharges will persist, how rapidly they undergo natural amelioration, and what the long term pollution levels will be. Improved understanding of these discharges will allow application of limited reclamation resources to sites most amenable to improvement. Sites with a long term history of water quality data should be sought, and these sites should be revisited and water samples analyzed. From this information, we can continue to evaluate the improvement of water quality over time.

Long term data sets will be sought from university researchers, state and federal agencies and mining companies for above drainage underground mines. These data sets will be supplemented with additional sampling and site characterization to improve our understanding and predictive capabilities for long term mine drainage quality.

Cost of Project:

Estimated cost $50,000.

Time Required:

Completion in 2 to 3 years.