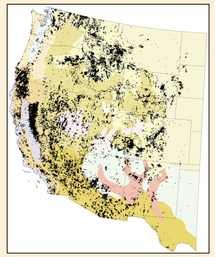
Abandoned Mine Lands Initiative - *Providing Science for Watershed Issues*

USGS science for a changing world

USDA United States Department of Agriculture

The Problem of Abandoned Mines



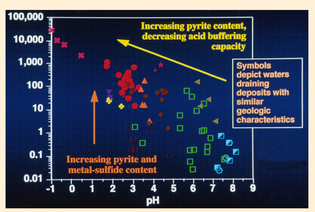
There are more than 25,000 inactive mine sites and numerous exploration prospects in the western U.S., many of which are on Federal lands

Historical mining activities in the western U.S. have resulted in contaminated stream reaches in the headwaters of more than forty percent of the watersheds in and west of the Rocky Mountains. Acidic drainage and elevated metal concentrations affect water quality and the biota that live in these stream reaches, thereby damaging aquatic and riparian habitats, impacting human health, limiting recreational use, and lessening the aesthetic qualities of our public lands. Weathering of waste rock associated with inactive mines is one of the major sources of metals, but natural sources also affect the watersheds. The Abandoned Mine Lands (AML) Initiative is a collaborative U.S. Department of Interior - U.S. Department of Agriculture effort to provide a science-based watershed-scale approach to the problems caused by inactive and abandoned mines.

Goals of the AML Initiative

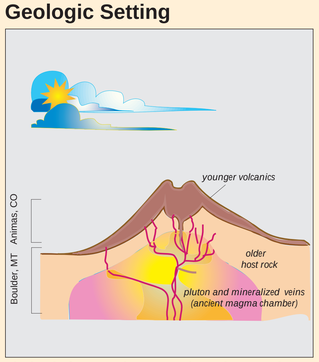
- Develop multi-disciplinary methods of investigation that integrate geologic, hydrologic, geochemical, and ecological data that can be transfered to Federal land managers
- Provide Federal land managers with a scientific basis for effective watershed scale mitigation strategies
- Create an integrated science database for use by the public, private entities, and government agencies to make land use decisions

Acidic mine drainage



Relationship between pH and metal concentrations released by weathering of different mineral deposit types (Plumlee and Nash, 1995)

Geologic Setting



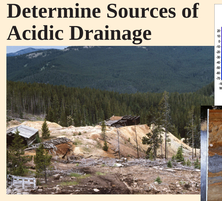
The level of erosion determines the rock type and mineralization exposed at the surface. Exposed rock type and mineralization, in turn, controls water-rock interaction and resultant water chemistry

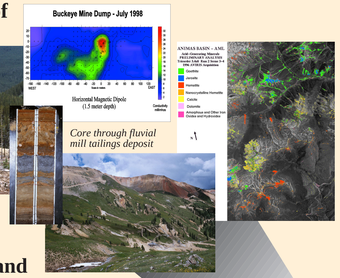
The AML Initiative Watershed Strategy

- Identify major sources of contaminants within the watershed
- Determine the physical, chemical, hydrologic, and biological processes that control the dispersal of contaminants
- Determine the adverse effects on aquatic and riparian ecosystems
- Determine pre-mining watershed conditions to allow establishment of realistic restoration goals

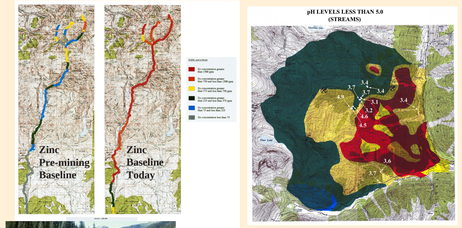
Methods of Investigation - A Multi-Disciplinary Approach

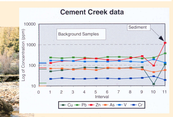
Determine Sources of Acidic Drainage





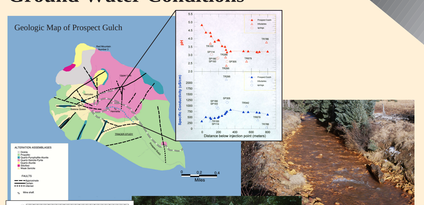
Define Pre-Mining Conditions



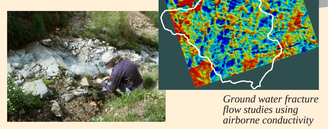


Stratigraphic interval indicated on photo

Characterize Surface and Ground Water Conditions

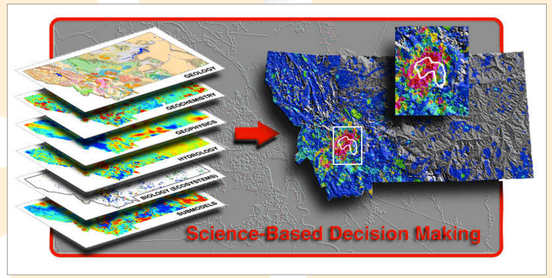


Using tracer-dilution and synoptic sampling methods provides a detailed picture of metal loading in Cement Creek, Colorado

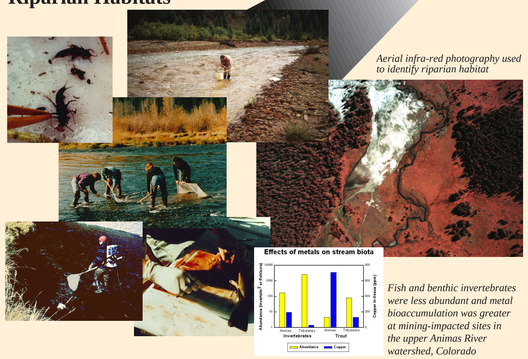


Ground water fracture flow studies using airborne conductivity

Use Geospatial Analysis to Integrate Scientific Data



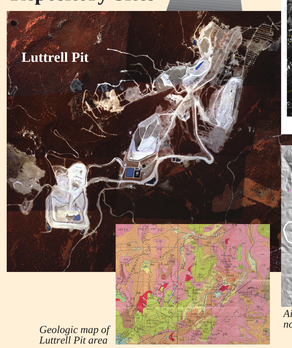
Evaluate Aquatic and Riparian Habitats



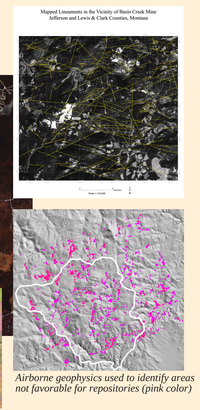
Aerial infra-red photography used to identify riparian habitat

Fish and benthic invertebrates were less abundant and metal bioaccumulation was greater at mining-impacted sites in the upper Animas River watershed, Colorado

Assess Suitable Repository Sites

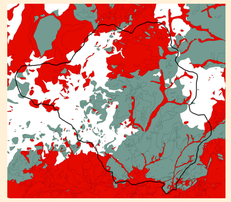


Geologic map of Luttrell Pit area



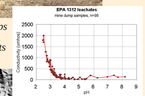
Airborne geophysics used to identify areas not favorable for repositories (pink color)

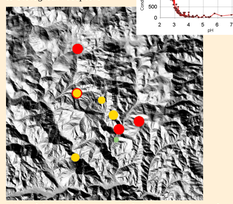
Science-Based Strategies for Watershed Restoration



Environmental geology map showing ability to buffer acidic water (red = no buffering capacity, grey = moderate buffering capacity)

Ranking of mine waste dumps is based on leach chemistry and pathway of contaminants to biological receptors



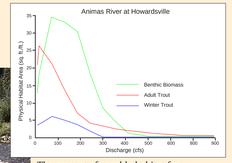


Map of the Boulder watershed showing ranking of dumps for removal on a priority basis (red sites are highest priority, green sites need not be removed)

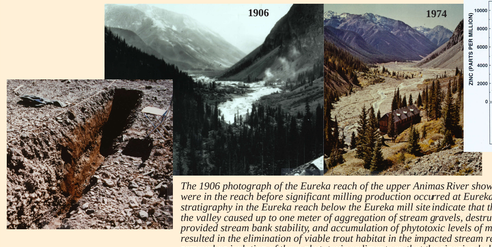
Successful watershed-scale restoration strategies should be developed with a knowledge of the topography, climate, geology, hydrology, and biological habitat needs of the specific environment. An understanding of the physical, geochemical, hydrologic, and biological processes must be articulated to the public in a way that balances human technical capabilities, economic limitations, and realistic restoration goals and timeframes. USGS scientists are working directly with stakeholders, including local and state agencies, private landowners and industry, and other Federal agencies including BLM, NPS, USFS, and EPA to address the restoration issues at the watershed scale and provide scientific data on our nation's clean water supply. In a science-based approach to restoration, our work provides data needed to:

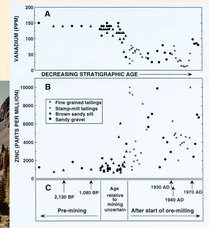
- Characterize metal loads from sources within watershed
- Prioritize inactive mine sites for cleanup
- Define attainable in-stream water quality standards
- Determine feasible restoration scenarios for aquatic and riparian habitats
- Provide predictive models for cost effective analysis of mitigation options

Products are posted on our AML website:
http://amli.usgs.gov/amli/



The amount of useable habitat for fish and invertebrates is related to stream discharge. Stream conditions during the winter appear to limit trout populations





The 1906 photograph of the Eureka reach of the upper Animas River shows what the habitat conditions were in the reach before significant milling production occurred at Eureka. Multi-disclipinary studies of the stratigraphy in the Eureka reach below the Eureka mill site indicate that the dumping of mill tailings into the valley caused up to one meter of aggregation of stream gravels, destruction of the willow carrs that provided stream bank stability, and accumulation of phytotoxic levels of metals in the sediments. This resulted in the elimination of viable trout habitat in the impacted stream reach. Restoration will require removal or isolation of these phytotoxic sediments so that the riparian habitat can be restored before trout can return to the reach.