CONTROLLING ACID MINE DRAINAGE FROM THE
PICHER MINING DISTRICT, OKLAHOMA, UNITED STATES

R. Bruce Sheibach*, Roy E. Williams**, and Benjamin R. Genes*


**Professor of Hydrogeology, University of Idaho, Moscow, Idaho, and President, Williams-Robinette and Associates, Inc., P.O. Box 48, Viola, Idaho.

ABSTRACT

The Picher Mining District, located principally in north-eastern Oklahoma, was one of the world's largest lead-zinc mining areas during its 55 year lifespan. The field covers an area of approximately 72 square miles (186 km²); an estimated $1.22 \times 10^8$ m$^3$ of material worth in excess of one billion dollars, has been mined.

Mining activities were typified by surface exploratory drilling identifying ore distribution and extension of underground workings to the lead and zinc deposits outlined. Exploration holes were either left unplugged or plugged at the surface with a section of a telephone pole. Low grade ore and waste rock were discarded in mined out portions of drifts. These waste piles containing pyrite and marcasite were left underground and oxidised during the many years of active mining. Upon cessation of mining activities in the mid-1960s, the drifts and shafts of the abandoned workings began to flood as the cone of depression filled in, leading to the dissolution of the oxidised sulfides and the formation of large volumes of acid mine water in the mined out openings. The resulting poor quality water, with high concentrations of cadmium, iron, lead and zinc, began discharging at the surface in 1979. Contamination of the underlying aquifer supplying local residents was first detected on a localised scale in 1980. The present surface water and groundwater contamination have lead to the area being classified as one of the top ten hazardous waste sites in the U.S. by the EPA under the superfund program.

To mitigate the current conditions we have proposed that acid mine water be collected where it currently discharges at identified springs and pumped from widely spaced wells in the workings. The water would then be treated at a 87.4 l/sec lime neutralisation/precipitation facility. Construction costs are estimated to be $3.7 million and $560,000/yr for O & M.
PROBLEM DEFINITION

As with many underground mines, groundwater inflows posed a problem during mining. To maintain unsaturated conditions in the workings, large capacity sump pumps were used. Pumpage from the ore bearing Boone formation, a Mississippian cherty limestone, varied with time and depth of mining.

During World War II (WW II), an estimated 1005 l/sec were discharged by various mining operations. As demand for lead and zinc declined after WW II, pumpage declined to about 393 l/sec as deeper workings were abandoned[1].

A conceptual cross section of the area is shown in Figure 1. An in-depth description of the local geology and hydrogeology of the area is presented elsewhere[2]. The many years of water removal from the Boone formation resulted in the formation of an extensive cone of depression. Cessation of mining in the mid-1960s, ended more than 50 years of pumpage from the Boone formation, leading to flooding of the abandoned workings as the cone of depression recovered. Mining activities exposed sulphide bearing minerals to moist, oxygen-rich air, which oxidised the iron sulphide minerals present. Waste material (gob) containing pyrite and marcasite were discarded in the mined out portions of drifts instead of hauling it to the surface. Groundwater that flooded the mine workings came in contact with the oxidation products that had formed earlier and dissolution occurred rapidly. Initially, the acid water containing high concentrations of heavy metals reacted with the carbonate host rock. This reaction neutralised some of the acid water and raised the pH to the 4 to 5 range. Eventually, the calcium carbonate host rock lost its neutralising capacity as precipitates of the reactions formed on the surface area of the carbonate rock[3]. Subsequently, acid neutralisation ceased or was retarded greatly.

Filling of the cone of depression continued with time. Recharge to the cone was occurring radially and from direct surface water inflow to the workings through abandoned exploration holes, shafts and collapse features which penetrate the overlying shaley Krebs Group. Therefore, there was little potential for the highly mineralised water to move laterally, away from the mining district; but an opportunity existed