Introduction

Lead and zinc ores were mined for many decades in northwestern Illinois (Figure 16-1), southwestern Wisconsin, and northeastern Iowa, a region collectively referred to as the Upper Mississippi Valley Lead-Zinc District (Willman et al. 1946, Willman and Reynolds 1947, Bradbury 1959, Heyl et al. 1959). Lead was obtained from the mineral galena, or lead sulfide (PbS), and zinc was obtained from sphalerite, or zinc sulfide (ZnS). Galena and sphalerite were not useful in their dispersed natural form. The ore-bearing host rock had to be milled, and galena and sphalerite concentrates had to be sent to smelting plants, which separated the lead and zinc metals from the sulfur-bearing ore minerals.

The search for lead ore extended into southeastern Illinois and western Kentucky in the 1830s and led to the discovery of highly valuable fluorite deposits in what is now referred to as the Illinois-Kentucky Fluorspar District (e.g., Bradbury et al. 1968, Fulton and Montgomery 1994, Goldstein 1997). Fluorite, or calcium fluoride (CaF$_2$), also known as fluorspar in the mining industry, is a glassy mineral consisting of calcium (51%) and fluorine (49%). Along with the lead and zinc ores, great quantities of fluorite came out of the mines. Initially the fluorite was discarded because there were no known uses for it. Commercial fluorite production in Illinois did not begin until the late 1800s, when it began to be used in industry. For many years, Illinois was the largest producer of fluorite in the United States, but domestic production began to decline in the 1950s, largely due to competition from foreign sources. The closing of the last mines in southern Illinois in 1995 ended more than a century of active exploration and mining in the region (Masters 1987, Goldstein 1997, Reinertsen and Masters 1997).

Origin of Lead-Zinc Ores and Fluorite

It is thought that lead and zinc ores and fluorite formed in Illinois about 270 million years ago during the early Permian Period. These minerals were once thought to have been deposited from warm or hot water that originated deep within the Earth (Currier 1923, Grogan and Bradbury 1968). Some people still think that groundwater circulating deep in the Earth along major fractures or faults brought the metals to near-surface sites of deposition, where cooling and decreased pressure led to precipitation of the ores.

Most geologists, however, now think that a regional gravity flow system drove hot, metal-rich fluids from south to north in the Illinois Basin about 270 million years ago (Bethke 1986, Rowan and Goldhaber 1996, Pitman et al. 1997). Fluid migration appears to have begun during the late Pennsylvanian and continued through the early Permian, originating from the deep part of the Illinois Basin. Tectonic uplift of the Appalachian fold belt to the east and the Ouachita fold belt to the south of the Illinois Basin provided the relief necessary to create the large-scale, gravity-driven flow system (Figure 16-2). The Cambrian-Ordovician aquifers, such as the Mt. Simon and St. Peter Sandstone, and porous and permeable dolomite provided conduits for this large-scale flow system. Metal-rich fluids migrated to shallower areas at the margin of the Basin in southeastern and northwestern Illinois where the aquifers came closer to the surface. For the Upper Mississippi Valley District, of which the northwestern Illinois Lead-Zinc