Paleomagnetic Determination of Pre-Mining Metal Flux Rates at the Iron Mountain Superfund Site, Northern California

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Iron Mountain, located near Redding in northern California, hosts a group of mines that were active from the late 1870s to the early 1960s. The mineral deposit is classified as a type-I volcanogenic massive sulfide, similar to the Noranda deposit of Ontario, Canada. Three large, isolated blocks of sulfide mineralization contain 90-95 percent pyrite and a few percent chalcopyrite (CuFeS2) and sphalerite (ZnS). Prior to mining, weathering converted parts of the massive sulfide to gossan consisting of hematite, goethite, and silica. Mining further exposed the pyritic masses to water and air, creating optimal conditions for sulfide oxidation and production of acid mine drainage. Because the acidic, metal-rich effluent reached the Sacramento River, the site has been one of the highest priorities on the US EPAs Superfund list since the early 1980s. A crucial area of scientific uncertainty that needed to be resolved was the magnitude of natural background metal flux. We collected 25 paleomagnetic samples from the gossan to determine the polarity of the Earths magnetic field during pre-mining sulfide weathering. Nineteen samples exhibited stable magnetic endpoints during thermal demagnetization; of these, four were of reversed polarity and the remainder were of normal polarity. This result established that the gossan was already forming 780,000 years ago, and this information made it possible to estimate natural, pre-mining flux rates of copper and zinc. These rates were three orders of magnitude lower than post-mining (pre-remediation) rates. Resolution of the question of the background flux led to one of the largest legal settlements in U.S. history for remediation of an inactive mine site.

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