EPITHERMAL MN DEPOSITS
(MODEL 25g; Mosier, 1986a)

by Dan L. Mosier and David L. Campbell

SUMMARY OF RELEVANT GEOLOGIC, GEOENVIRONMENTAL, AND GEOPHYSICAL INFORMATION

Deposit geology
Manganese oxide concentrations are present as small veins, stringers, nodular masses, breccia-fillings, and coatings of drusy cavities in fractured, argillized or silicified, Tertiary volcanic rocks of continental origin that range in composition from rhyolite to basaltic (fig. 1).

Examples
Talamantes, Mexico; Gloryana, N. Mex.; Sardegna, Italy.

Spatially and (or) genetically related deposit types
Associated deposit types (Cox and Singer, 1986) include other epithermal gold-silver veins (Models 25b, 25c, 25d, 25e); hot spring gold-silver (Model 25a); barite veins, fluorite veins.

Potential environmental considerations
If associated with iron, elevated abundances of soluble manganese in potable water supplies may stain plumbing fixtures and laundry, and cause a foul odor or taste in water. If present at sufficient abundances, other metals, including tens of thousands of mg/l iron, trace to thousands of mg/l lead, trace to thousands of mg/l zinc, and trace to thousands of mg/l copper, that may be present in manganese ore (Wilson and Rocha, 1948; Hewett, 1964), may be present in acidic, metal-bearing water.

Exploration geophysics
Geophysical signatures for this particular deposit type have not been investigated. The lack of sulfide minerals precludes use of some geophysical methods.

References
Geology: Wilson and Rocha (1948), Hewett (1964), and Hariya (1980).
Environmental geology, geochemistry: Crerar and others (1980), Wedepohl (1980), and Abukhudair and Farooq (1989).

GEOLOGIC FACTORS THAT INFLUENCE POTENTIAL ENVIRONMENTAL EFFECTS

Deposit size
Deposits are small; known deposits can be as large as 1.4 million metric tons of ore containing 464,000 metric tons of manganese (Red Hill, N. Mex.); the median deposit is 0.025 million metric tons at a median grade of 30 percent manganese (Mosier, 1986b).

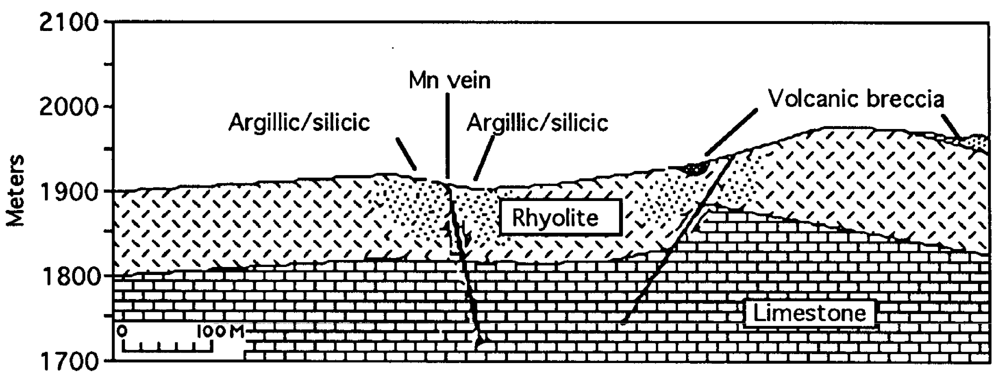

Figure 1. Schematic cross-section of a typical epithermal manganese vein in faults showing extent of argillic or silicic alteration. Modified from Wilson and Rocha (1948) showing relations at Talamantes district, Mexico.

Host rocks
Host rocks include rhyolitic, dacitic, andesitic, or basaltic flows, breccias, tuffs, and agglomerates. In most cases, manganese is more concentrated in and more rapidly leached from mafic volcanic rocks; chemical weathering causes mafic volcanic rocks to decompose more rapidly than felsic volcanic rocks.

Surrounding geologic terrane
Surrounding terrane is primarily volcanic; basement rocks may be sedimentary, metamorphic, and (or) plutonic.

Wall-rock alteration
Argillic alteration assemblages, especially those that include kaolinite, are dominant. Silicic alteration assemblages may extend over hundreds of meters along elongate zones; long axes of these altered zones may extend as much as three times the length of short axes.

Nature of ore
Ore consists of manganese oxide minerals in open-space fillings in faults, fractures, and breccias, as coatings on drusy cavities, and as stains or thin crusts on rock surfaces.

Deposit trace element geochemistry
Data for samples from the Optimo claim, Luis Lopez district, N. Mex., indicate that copper, zinc, molybdenum, tungsten, and thallium contents decrease outward in manganese crusts, whereas antimony and lead increase outward; arsenic abundances are unchanged (Hewett, 1964). Iron, barium, strontium, and phosphorous may also be present.

Ore and gangue mineralogy and zonation
Characteristic ore assemblages include psilomelane and (or) pyrolusite in calcite and quartz gangue. Ore assemblages may also include braunite, wad (hydrated manganese oxide mineral intergrowths), manganite, cryptomelane, hollandite, coronadite, ramsdellite, manganocalcite, chalcedony, opal, cristobalite, K-feldspar, barite, fluorite, gypsum, anhydrite, hematite, limonite, or zeolite. Fluorite and barite typically are present near manganese veins. Hewett (1964) observed that within a given district fluorite and barite usually extend to greater depths than manganese veins.

Mineral characteristics
Crusts of manganese oxide minerals in veins are persistently layered with psilomelane, hollandite, cryptomelane or coronadite. Psilomelane is the most widespread and abundant oxide mineral and is typically massive, sooty, and black. Hollandite, coronadite, and cryptomelane are present as distinct fibrous layers, which may be as much as 3 mm thick. Psilomelane, hollandite, and cryptomelane may be present in botryoidal forms. Less common pyrolusite and ramsdellite form layers of crystals that line drusy cavities.

Secondary mineralogy
Some manganese oxide minerals, limonite, and kaolinite may be supergene alteration products.

Topography, physiography
Most known epithermal manganese deposits are in well drained areas of moderate to high relief. Silicified rock associated with some deposits forms highs due to resistance to erosion.

Hydrology
Faults, fractures, and rock contacts are possible ground water flow channels. Underground workings down to depths of a few hundred meters also constitute water conduits. Argillic zones in adjacent altered rocks may impede or restrict water flow, whereas the highly permeable nature of some volcanic host rocks may focus flow. Enhanced permeability caused by alteration-related feldspar removal may also enhance ground water flow.

Mining and milling methods
Deposits are mined in open cuts, shafts, and adits. Mining is generally shallow, usually less than 200-m depths, and individual veins are followed for less than 1,000 m in most districts. Ore is usually concentrated by hand sorting or by jig to grades as much as 40 weight percent manganese. Concentrated ore is shipped to off-site plants.

ENVIRONMENTAL SIGNATURES

Drainage signatures

No data specifically pertaining to epithermal manganese deposits is available. More studies concerning geochemical signatures around manganese epithermal veins are required. Water and mine waste sampling and analysis of metals from many sites need to be conducted before quantified findings can be presented.

Metal mobility from solid mine wastes

Manganese oxide minerals have low solubility and normally do not represent an environmental concern. No data specific to metal mobility from epithermal manganese mine wastes are available.

Soil, sediment signatures prior to mining

Manganese is commonly present as a constituent of silicate and other minerals, as an adsorbed component on clays and humates, as colloidal organic complexes, and (or) as a constituent of most soil, in which it is present as oxide or hydroxide minerals (Crerar and others, 1980). No data specific to the geochemistry of soil near epithermal manganese deposits are available.

Potential environmental concerns associated with mineral processing

Because low grade ore is usually concentrated by hand or jig to high grades, stockpiles and waste piles of low grade material, potential sources of materials with elevated quantities of manganese or other environmentally deleterious elements, may be present at mine sites or at storage facilities. Manganese-enriched dust, which may pose health risks, may also be produced by these stockpiles and waste piles.

Smelter signatures

No data available.

Climate effects on environmental signatures

Because most epithermal manganese deposits contain low sulfide mineral abundances and because manganese oxide minerals are relatively insoluble, climatic variation probably does not significantly affect geoenvironmental signatures associated with these deposits.

Geoenvironmental geophysics

Metal-bearing ground water plumes may be traceable using geoelectric methods, including the ground slingram. Plumes containing 1,000 mg/L (or more) total dissolved metals can be detected using this method. Heavy-metal contaminated plumes are usually more conducting than ordinary ground water, particularly in the eastern and northern United States, where most ground water contains <1,000 mg/L dissolved metals. Slingrams such as the Geonics EM-31 or EM-34 give readings of greater than about 25 mS/m within 5 m of metal-charged plumes. In ideal circumstances, contaminant plumes can be rapidly outlined by sequential traverses across their edges. Silicic zones near manganese veins are characterized by very low conductivity because conductivity values decrease with increasing silica content.

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