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## Volcanogenic Manganese Deposits in Western Cordillera

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Our preliminary investigations suggest that numerous stratiform manganese deposits in the western United States were formed by hydrothermal-volcanogenic processes. These deposits can be grouped into five categories on the basis of the manganese mineral assemblage, lithologic association, and tectonic setting: (1) deposits in chert-graywacke sequences (e.g., in melange of the Franciscan complex of California—lenses and beds of manganese carbonate and manganiferous opal associated with bedded chert within thick sequences of graywacke and conglomerate; (2) deposits in chert-greenstone (ophiolite) sequences (e.g., the late Paleozoic Havallah Formation, Nevada)—occurrences of manganese-jasper,

manganese-oxides, and the manganese-silicates braunite, bementite, and rhodonite in lenses within bedded chert, at the interface between basalt and chert, and within basalt; (3) deposits in metachert-metavolcanic sequences (e.g., late Paleozoic to Jurassic strata of the Sierra Nevada and Klamath Mountains)—deposits that are similar in occurrence and general lithology to those in the Franciscan and Havallah sequences but that have undergone a higher grade of metamorphism, so that the manganese mineral assemblage includes rhodochrosite, rhodonite, spessartine, piemontite, and manganese-rich pyroxene and amphibole; (4) deposits in pelagic-limestone/oceanic-basalt sequences (e.g., the Eocene Crescent Formation on the Olympic Peninsula, Washington)—marine carbonate and spilitized volcanic rocks hosting a diverse manganese mineralogy dominated by silicate (e.g., bementite) and oxide (e.g., hausmannite) phases; and (5) deposits in Miocene and Pliocene sequences of conglomerate-sandstone-tuff-gypsum of the Colorado River-Lake Mead area, Nevada and Arizona—high-tonnage low-grade stratiform and largely strata bound deposits consisting mainly of amorphous manganese oxide cement in clastic sedimentary rock.

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