Geochemistry of rare earth elements in Robat Karim epithermal manganese deposit, South Tehran, Iran

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Robat Karim manganese deposit is located in Tehran province, about 7 km southwest of Robat Karim city. Based on regional geology, the studied area is situated in the northern Saveh Eocene volcanic assemblage, ranging in composition from andesite to basalt. Manganese ores were emplaced along regional faults and is mainly composed of pyrolusite, psilomelane, ramsdelite and holandite, as well as calcite and quartz.

Rare earth elements in manganese ores and volcanic host rocks were analyzed by ICP-MS, using the lithium metaborate fusion preparation method.

Chondrite normalized REE patterns of the volcanic host rocks indicate a strong LREE/HREE fractionation. The Mn ores of the studied area and other hydrothermal Mn ores of the world have a similar REE pattern (strong LREE/HREE fractionation) combined with negative Ce anomalies, which suggest their hydrothermal origin. Similarity of their chondrite normalized REE patterns with volcanic host rocks combined with other geochemical and ore microscopic criteria indicate a probable epithermal origin. Ore forming fluid could be originated from meteoric and/or magmatic waters circulating through Eocene volcanic rocks, dissolve manganese and other components and deposit them along fault planes and major fractures.

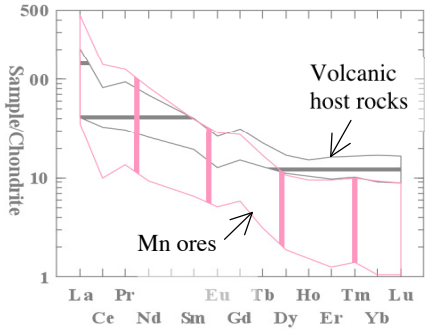

Figure 1: Condorite-normalized REE pattern of Mn ores and volcanic host rocks from Robat Karim manganese deposit.

Teaching mineralogy, petrology and geochemistry: New instructional resources from the *On the Cutting Edge* program

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Extensive collections of on-line instructional resources for teaching mineralogy, petrology and geochemistry (MPG) are available through the *On the Cutting Edge* program. These include searchable collections of class-ready teaching activiites that are characterized by ActivitySheets that describ each activity and provide additional information about learning goals (content and skill mastery, higher order thinking skills), target audiences, context for use in class, supporting references and URLs, asessments, and supporting files (e.g. word documents, spreadsheets, images) required to successfully complete the exercise. In addition, collections of trusted URLs, searchable by topic and resource type, have been built to provide supporting information for instruction in MPG courses. Collections of visualizations and animations that illustrate concepts or processes are now available, as well as collections of articles from the scientific literature that are recommended for student reading. Special collections of resources have been developed for select topics: teaching optical mineralogy and petrography, clay mineralogy, minerals inclusions and volcanic processes, and mineral physics; these topics typically do not have a dedicated course, but are widely applicable across the geoscience curriculum. We have also developed an integrated curriculum on Teaching Phase Equilibria, starting with the Gibbs' Phase Rule and progressing to the most sophisticated modeling programs (e.g. MELTS, ThermoCalc, Perplex). Tutorials are also available that demonstrate the use of online data repositories (EarthChem and American Mineralogist Crystal Structure Database), and Geochemical Instrumentation and Analysis with descriptions of instrumentation and analytical methods. These collections were mostly built as a legacy of *On the Cutting Edge* worksohps for faculty professional development, and continuing community contriubtions have added to these collections. All these resources can be accessed at the following webpages:

Mineralogy: http://serc. carleton. edu/6701
Petrology: http://serc. carleton. edu/1594
Geochemistry: http://serc. carleton. edu/7071