Mineral ecology and evolution of first-row transition elements

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More than half of all known mineral species (2715 of 5106 species as of 15 February 2016; rruff.info/ima) incorporate one or more of the first-row transition elements (Sc through Zn). Mineral ecology studies examine the diversity and geographic distribution of these minerals collectively, as well as for mineral species that incorporate these individual elements. We find that most of these minerals are rare, and their frequency distributions conform to Large Number of Rare Event models that facilitate predictions of the numbers of minerals that exist on Earth but have not yet been discovered and described [*1-6*]. We find that >20%, or at least 550 species of minerals incorporating first-row transition metals, have yet to be found.

Mineral evolution studies of the minerals of Cr, Mn, Co, Ni, and Cu document the distribution of primary transition metal mineral species through deep time. These minerals display patterns of episodicity associated with supercontinent assembly—patterns that have been demonstrated for other mineral groups, as well as [*7-9*]. We also find significant gaps when few minerals form, as well as a sharp increase associated with ephemeral minerals of the past few millions of years. Of special note are systematic changes in the transition metal oxidation states through time: more reduced forms dominate minerals formed at >2.2 Ga, whereas the most oxidized forms dominate <0.5 Ga.

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