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Lumping and splitting: Toward a classification of mineral natural kinds

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Abstract

How does one best subdivide nature into kinds? All classification systems require rules for lumping similar objects into the same category, while splitting differing objects into separate categories. Mineralogical classification systems are no exception. Our work in placing mineral species within their evolutionary contexts necessitates this lumping and splitting because we classify "mineral natural kinds" based on unique combinations of formational environments and continuous temperature-pressure-composition phase space. Consequently, we lump two minerals into a single natural kind only if they: (1) are part of a continuous solid solution; (2) are isostructural or members of a homologous series; and (3) form by the same process. A systematic survey based on these criteria suggests that 2310 (~41%) of 5659 IMA-approved mineral species can be lumped with one or more other mineral species, corresponding to 667 "root mineral kinds," of which 353 lump pairs of mineral species, while 129 lump three species. Eight mineral groups, including cancrinite, eudialyte, hornblende, jahnsite, labuntsovite, satorite, tetradymite, and tourmaline, are represented by 20 or more lumped IMA-approved mineral species. A list of 5659 IMA-approved mineral species corresponds to 4016 root mineral kinds according to these lumping criteria.

The evolutionary system of mineral classification assigns an IMA-approved mineral species to two or more mineral natural kinds under either of two splitting criteria: (1) if it forms in two or more distinct paragenetic environments, or (2) if cluster analysis of the attributes of numerous specimens reveals more than one discrete combination of chemical and physical attributes. A total of 2310 IMA-approved species are known to form by two or more paragenetic processes and thus correspond to multiple mineral natural kinds; however, adequate data resources are not yet in hand to perform cluster analysis on more than a handful of mineral species.

We find that 1623 IMA-approved species (~29%) correspond exactly to mineral natural kinds; i.e., they are known from only one paragenetic environment and are not lumped with another species in our evolutionary classification. Greater complexity is associated with 587 IMA-approved species that are both lumped with one or more other species and occur in two or more paragenetic environments. In these instances, identification of mineral natural kinds may involve both lumping and splitting of the corresponding IMA-approved species on the basis of multiple criteria.

Based on the numbers of root mineral kinds, their known varied modes of formation, and predictions of minerals that occur on Earth but are as yet undiscovered and described, we estimate that Earth holds more than 10 000 mineral natural kinds.

Keywords: Philosophy of mineralogy, classification, cluster analysis, natural kinds, IMA-CNMNC, mineral species, mineral archetypes