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Reply to "A comment on 'An evolutionary system of mineralogy: Proposal for a classification of planetary materials based on natural kind clustering'"

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Abstract

I welcome the "Comment" from Hatert et al. (2021) related to the proposal for an "Evolutionary system of mineralogy" (Hazen 2019) and thank them for their historically informed, conceptually nuanced, and consistently constructive contribution. They offer corrections related to two facets of my paper that seemed unfairly to criticize aspects of the International Mineralogical Association's Commission on New Minerals, Nomenclature and Classification (IMA-CNMNC) protocols for classifying minerals.

First, they note an unfortunate inferred ambivalence with respect to the relationship between the IMA system and the new evolutionary system. If I was once ambivalent, that view has changed. Having spent the past two years in an ongoing effort to develop this new historical approach, I am struck every day by the power of the IMA-CNMNC system of species classification and nomenclature, *which is fundamental and indispensable to the science of mineralogy*. As Hatert et al. suggest, any new approach to organizing natural solids, including one focused on planetary evolution, must rest on the foundation provided by the IMA-CNMNC and its many volunteers who selflessly bring order to the mineral kingdom. In the best scenario, the evolutionary system may one day emerge as one of several useful approaches that complement and amplify but in no way replace this core IMA-CNMNC foundation, as clearly stated in the abstract of Hazen (2019).

Second, Hatert et al. (2021) offer corrections regarding the IMA-CNMNC approach to classification, in particular a mischaracterization of the formal process to incorporate amorphous phases, poorly crystalline materials, and loosely defined "mineraloids." I am grateful for the clarifications, as well as the implication that IMA protocols may facilitate the embrace of additional such phases in the future.

Finally, I welcome the chance to explore further the emerging concept of "natural kinds" as applied to the mineral kingdom. Here, our thoughts differ. I suggest that minerals, considered in their information-rich, idiosyncratic, paragenetic contexts (in contrast to IMA-CNMNC species), have the potential to represent quintessential examples of "natural kinds." Furthermore, when viewed in their evolutionary context, minerals offer an intriguing opportunity to expand the concept of "historical natural kinds" beyond its present limited and, at times, controversial use in biology, into the realm of the co-evolving geosphere and biosphere.

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