Rethinking the traditional mineralogy curriculum

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Like any department, the Lawrence University geology department faces the challenge of presenting a curriculum that meets the needs of our students, reflects the expertise of our faculty, and responds to the evolving geosciences. Our department has seen a complete turnover in faculty over the past decade. We now consist of three faculty members whose primary interests include structure/ petrology, geomorphology, and low-temperature mineralogy/geochemistry. These staffing changes have allowed our department to recreate itself, offering us the opportunity to reevaluate and redesign our curriculum.

Our revised curriculum places primary emphasis on Earth processes, rather than simply Earth materials, and makes explicit the connections with the cognate sciences. One change has been replacing the mineralogy/petrology sequence with two new courses: Geol 240: Chemistry of the Earth: Low-Temperature Environments, and Geol 250: Chemistry of The Earth: High-Temperature Environments.

Our Geol 240 serves as an introduction to geochemical and mineralogical principles, such as crystallography, the silicate minerals, and thermodynamic equilibrium. These topics are all taught in the context of low-temperature processes. For example, the low-temperature formation of biopyriboles offers an opportunity for students to learn both geochemical processes and the structure of the sheet and chain silicates. Also, in an area rich in dolostone, the formation and diagenesis of these rocks offers an opportunity to connect field observations to geochemistry and crystallography. Such connections help to make the study of mineralogy more relevant to the broader interests of students while still presenting the essential material they will need to succeed in geology beyond Lawrence.

Focusing our courses on Earth processes in varying environments, allows our department to consider the geoscience curriculum as a whole, avoiding the synthetic barriers that separate the various subdisciplines. As in any curriculum, we face the challenge of deciding what material to include and exclude. By incorporating mineralogical concepts into courses focused on geochemical processes, we avoid the common trap of teaching mineralogy as simply a precursor to a petrology course. This approach better enables us to focus on the processes that connect these fields, blending the evolving fields of mineralogy, geochemistry and petrology.

Determining structural chemical formulae using the American Mineralogist crystal structure database

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An essential part of the chemical analysis of minerals is the reduction of oxide data into cation numbers and the creation of structural formulae, indicating site occupancies for symmetrically distinct cations. Excellent papers (c.f. Papike 1987, 1988) have served as a guide to data reduction for nearly two decades. These guides were based upon application of crystal chemical principles summarizing known data.

The assembly of crystallographic structures that include site occupancy information from thousands of minerals in the American Mineralogist Crystal Structure Database provides a tool for a new method of determining detailed structural formulae. Using the database, we will examine cation occupancy patterns in several mineral groups. The patterns provide algorithms that distribute the cations into appropriate crystallographic sites, resulting in a structural formula that honors both the chemical data and crystallographic data available for a mineral.

Here we present our cation distribution rules for several mineral groups, and examples of structural formulae obtained using our method. The final goal of this study is to produce an algorithm that accepts oxide values as input and produces structural formulae with no other user input. We intend to make the algorithm available on the web as a component of the existing American Mineralogist Crystal Structure Database.

References

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