SHORT READINGS FROM THE AMERICAN MINERALOGIST: SNEAKY TOOLS FOR TEACHING SCIENTIFIC READING COMPREHENSION AND MINERALOGICAL CONCEPTS

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Overview

Writing across the curriculum has become an important concept, and even practice, in many schools. Reading across the curriculum is also important, but students already read a lot, don't they? Maybe, but what do they read? In mineralogy courses students usually read a textbook. Most textbooks are written to pass on information determined by generations past to generations present. This is fine for conveying general principles and information, and even some aspects of mineral science, but most mineralogy texts are really reference books that convey little about what mineralogists do, why they do it, or what minerals can tell us about the geologic environments in which they formed.

In 1988 I looked through recent issues of the American Mineralogist to find well-written, short articles that were clear, concise, that covered a narrowly focused topic, and that contained analytical data of some sort. For each article I wrote a 1-page sheet of questions and tasks for the students to answer for homework as they read the paper. The object of the questions and tasks was to help guide the students through the information and concepts in the paper.

The questions included simple things like the geographic location and the geologic environment of the samples. More sophisticated questions included such things as which curves on a graph corresponded to absorption by which atomic or molecular species in a mineral, or what experimental conditions favor dendritic vs. euhedral crystal growth. The answers to these questions were in part in the articles, in part in their textbook or class notes, and in part had to be determined by careful thought.

The tasks included plotting analytical data on graphs or doing simple algebraic calculations using data in the paper. The object was to look at the data in a slightly different way than was presented in the paper, to make certain points more clear and in some cases to allow interpretation beyond that in the paper.

When the homework is due I usually try to have some kind of discussion. The following method works well. Two students are told, days before the homework is due, that they will give a 10 minute presentation on the paper. I offer help preparing overheads and I help them plan the presentation. The other students are required to write two questions and to ask one of them during the discussion, to be answered by the class as a whole. These questions must be submitted to me in writing immediately prior to the discussion. I pay close attention to the submitted questions to see that they involved some thought. For example, "What color is the andalusite?" is not a question that required much thought if the abstract and the 2nd paragraph in the article gives the answer. "What color does andalusite usually have?" is a more interesting question that is not answered in the article but can be answered readily. Submission of written questions forces all students to participate in the discussion, to think a bit more about the article, and sometimes forces students to think about mineral science in general.

Although I have chosen these articles to be relatively short and simple, most students do not find them easy. They are shocked by how carefully they have to read the papers in order to understand the important points. This is quite different from reading a textbook, in which the information density is so low that a reader can often daydream through several paragraphs and not miss much. On the whole, however, students are rightly pleased with themselves after they have read and understood a real scientific paper. They have reported to me that they are glad to see what mineralogists and others are actually doing, and that the work is being done to answer fundamental questions about mineral chemistry and physics, physical properties, and the environments of mineral formation. By the end of the course, after having read four or five of these papers, I have noticed that students are more animated during discussions of mineral properties or chemistry than previous classes that never read such papers. I think students gain a deeper understanding of the nature and use of mineralogical research, and themselves become more confident in their understanding of mineralogy.

Using short, well-written articles to enhance teaching is easily adapted to other courses. I also use such articles in my Petrology course, although the articles happen to be from the journal Geology rather than from the American Mineralogist.

Special Reading: Instructions to Students (an Example)

Hazen and Sharp (1988): Compressibility of sodalite and scapolite. People generally think of solids as being incompressible, in contrast to gasses which are easily compressible. In reality, all materials are compressible to some extent. This paper describes compressibility measurements that were made on the two minerals sodalite and scapolite. As you read the paper, answer the following questions. For the graphs you may use graph paper or a spreadsheet.

1) What are the ideal chemical formulae of Ca-scapolite (meionite), Na-scapolite (marialite), and sodalite?

2) In what geologic environments is sodalite commonly found?

3) In what geologic environments is Ca-scapolite commonly found?

4) Plot on three graphs the following data from Tables 1 and 2 in the paper. Expand the scales on the graphs to clearly show the changes.

    A) The sodalite a cell parameter a(Å) vs. pressure P.
    B) The scapolite a cell parameter a(Å) vs. pressure P.
    C) The scapolite c cell parameter c(Å) vs. pressure P.

    Put a straight line through the data points in each graph. These lines show how the minerals are compressed continuously along each crystallographic axis as the pressure is increased.

5) The changes in unit cell volumes of sodalite and scapolite with pressure are given in Tables 1 and 2 under the headings V(Å^3). Next to the cell volumes are columns labeled V/V_0, which is the ratio of the cell volume at each pressure to the cell volume at 1 bar (0.001 kbar). This is a relative measure of how the volumes of the minerals change with pressure. On another graph plot the V/V_0 values for scapolite and sodalite. Put straight lines through the data.

6) Which mineral is more compressible, sodalite or scapolite? What is your evidence?

7) At 1 bar pressure the densities of sodalite and Ca-scapolite are 2.30 and 2.69 g/cm^3, respectively. What are the densities of these two minerals at 26 kbar?

Annotated List of Articles Used

Carlson, W.D., and Rossman, G.R. (1988) Vanadium and chromium-bearing andalusite: occurrence and optical-absorption spectroscopy. American Mineralogist, 73, 1366-1369. This is useful for teaching some principles of optical absorption, color, and pleochroism in minerals, and it is a good example of the utility of the crystal chemical rules of ionic solids for deciding which site or sites different ions might occupy.

Hazen, R.M., and Sharp, Z.D. (1988) Compressibility of sodalite and scapolite. American Mineralogist, 73, 1120-1122. An excellent, short paper showing that solids are compressible, and that mineral volumes and densities must change as the pressure varies.

Jambor, J.L., Bladh, K.W., Ercit, T.S., Grice, J.D., and Grew, E.S. (1988) New Mineral Names: Atlasovite. American Mineralogist, 73, 927. This is a brief abstract presenting a new mineral, including its chemical composition, ideal formula, and various physical, chemical, and structural properties. I have found it useful to give this to students to look at on the first day of class (they are usually horrified), and then again in the last week of class as an exercise to explain different parts of the abstract. By that time they are usually quite familiar with most of the concepts in the abstract. It helps show them how much they have learned.

Murowchick, J.B., and Barnes, H.L. (1987) Effects of temperature and degree of supersaturation on pyrite morphology. American Mineralogist, 72, 1241-1250. This paper helps show students that one mineral may look different depending on the conditions of growth. The experimental apparatus is described in words, and I have the students make a sketch of the apparatus based on the description. This is a long article, but about 1/3 of it is SEM photos.

Norimoto, N. (1989) Nomenclature of pyroxenes. American Mineralogist, 73, 1123-1133. This is a long, advanced, but excellent paper that dwells on the crystal chemistry of pyroxenes. It is useful toward the end of the course after students have become reasonably comfortable with crystal chemical concepts.

Parnell, John (1988) Native platinum in pyrobitumen from Fonda, New York. American Mineralogist, 73, 1170-1171. This odd occurrence of platinum is near Union College, so it interests the students in that respect. It also ties the mineral occurrence to regional geology and tectonics, since we can discuss the tectonic history of eastern New York State and speculate on the timing of migration and trapping of the hydrocarbons and platinum.

Rosenberg, P.E. (1987) Synthesis of metastable Ca-Mg carbonates. American Mineralogist, 72, 1239-1240. This paper describes the experimental synthesis of a variety of Ca-Mg carbonate materials intermediate in composition between end member calcite and dolomite. The data are somewhat 'fuzzy', and require some interpretation to conclude that there are indeed four synthesized phases rather than just a continuum. The students have to plot the analytical data to see if the author's conclusions are reasonable.

Solomon, G.C., and Rossman, G.R. (1988) NH_4^+ in pegmatitic feldspars from the southern Black Hills, South Dakota. American Mineralogist, 73, 818-821. This paper illustrates the use of non-visible light spectroscopy for understanding the crystal chemistry of minerals. Students have to match absorption peaks on a graph with proposed absorbing species, and they have to explain why this pegmatite contains ammonium-bearing feldspar whereas mineralogically similar pegmatites nearby do not.