

‘What good are your results if you can’t explain them clearly?’

Teaching petrology as a writing-intensive course

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Petrology is often taught using an intimidating array of jargon. At the undergraduate level, the use of highly technical terminology to explain igneous and metamorphic behavior is more likely to alienate promising students than attract them, and allows students to hide behind big words without fully understanding their significance. In a region of the United States where simply mentioning that you are a geologist often results in a tirade against evolution, environmental issues, or climate change, it is of vital importance that our students can effectively communicate with a public that often distrusts geoscientists for political or religious reasons.

At Appalachian State University, Petrology is taught as a writing-intensive capstone course that incorporates calculus, physics, transport theory, linear algebra, and quantitative and qualitative analyses of igneous and metamorphic rocks. The central theme of the course is *what good are your results if you can’t explain them clearly?* If students cannot explain a complex, quantitative topic in everyday language, then they clearly do not understand it. Since taking this approach, student interest in petrology and geochemistry has significantly increased at Appalachian, and many are now hoping to pursue graduate studies in the geochemistry field.

Several teaching activities have proven to be particularly successful in conveying the importance of being understood by people besides the professor. The first is an in-class debate on the origins of hand samples of volcanic rocks. The debate audience is encouraged to challenge the students, as members of a conference audience would. Another successful teaching activity is a comprehensive project on regional rocks, which involves detailed optical petrography and quantitative SEM data collection, and involves writing for both a scientific and a non-scientific audience. The non-scientific report is graded by freshmen in other courses who have no geology background, in the equivalent of a double-blind peer review process.

Student evaluations indicate that exercises like these have been successful, not only at revealing their weaknesses in communicating with a variety of audiences, but at increasing their own understanding of geologic processes.

A ^{40}K - ^{40}Ca perspective on the oceanic Calcium cycle

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This study uses the decay of ^{40}K to ^{40}Ca to investigate the contributions of weathering and hydrothermal fluxes in the oceanic Ca budget. Because of its high K/Ca ratio, the silicate upper crust delivers radiogenic Ca to the oceans, while hydrothermal reactions deliver unradiogenic Ca from the mantle. The abundance of ^{40}Ca in the carbonate reservoir should thus reflect the relative importance of these different sources in the Ca budget of seawater. The main difficulty with this approach is the requirement that $^{40}\text{Ca}/^{44}\text{Ca}$ must be determined with a precision higher than 50 ppm, which is made difficult by the high abundance of the ^{40}Ca isotope (96.94%). Using Finnigan Triton, we show that a reproducibility of 35 ppm (2σ) can be obtained for the $^{40}\text{Ca}/^{44}\text{Ca}$ ratio when strict measurement procedures are applied [1]. Our results indicate that seawater and marine carbonates ranging from Archean to recent have no discernable effects of ^{40}K decay to within the limit of $\pm 0.3 \epsilon$ -units. This indicates that the Ca isotopic composition of seawater has remained constant and indistinguishable from that of the mantle for the past 3.5 Ga, despite the radiogenic flux delivered by weathering of the continental crust. We estimate that unless the contribution of silicate weathering is much less than the current estimate of 10-20% of the river flux [2], the total hydrothermal input of calcium must exceed the input from high-Temperature vents at ridge axes by at least one order of magnitude [3]. Thus, for Ca and many other elements, low-T hydrothermal fluxes appear as the predominant factor in defining the chemical composition of seawater.

[1] Caro, Papanastassiou & Wasserburg (submitted) *EPSL*.

[2] Gaillardet *et al.* (1999) *Chem. Geol.* **159**, 3–30.

[3] Elderfield & Schultz (1996) *Ann. Rev. Earth Planet. Sci.* **24**, 191.