

USING AN M&M® MAGMA CHAMBER TO ILLUSTRATE MAGMATIC DIFFERENTIATION

Karl R. Wirth

Geology Department
Macalester College
St. Paul, MN 55105
wirth@macalester.edu

BACKGROUND AND NOTES FOR INSTRUCTORS

Purpose:

- improve student understanding of fractional crystallization and magmatic differentiation
- provide students an opportunity to utilize concepts (e.g., stoichiometry) learned in the mineralogy course
- reinforce concepts (e.g., classification and chemical variation diagrams) learned in the petrology course
- provide students with practical experience designing and using spreadsheets
- enhance student knowledge and appreciation of the historical origins of an important concept in geology

Introduction

An understanding of the process of magmatic differentiation is essential to the study of the petrology of igneous rocks. Students at Macalester College typically first encounter this concept in the introductory geology course when they learn about Bowen's reaction series and fractional crystallization. After a brief introduction to phase diagrams in the mineralogy course, students generally receive a thorough treatment of magmatic differentiation in the petrology course. Despite trying several different approaches to "teaching" the concepts of element incompatibility, fractional crystallization, and magmatic differentiation in the petrology course, it was clear that many students still did not have a firm understanding of the details of differentiation. In retrospect, this made sense; the students didn't have any real-world experience with fractional crystallization, they had only heard or read about. Although it would be possible to have students conduct a phase diagram experiment to illustrate the differentiation process, this would likely require specialized equipment and would be time-intensive. The M&M® magma chamber exercise was developed to provide students first-hand experience with the process of magmatic differentiation by fractional crystallization using a simple experiment. This experiment is currently being used in both the petrology and introductory geology courses at Macalester College. Most students indicate that the exercise is both enjoyable and informative. Student knowledge of fractional crystallization and magmatic differentiation, as indicated by exam results and course projects, has increased significantly since incorporating this exercise into the curriculum.

A Brief History of the Theory of Magmatic Differentiation

The origin and evolution of the theory of magmatic differentiation is rich with history. However, the history of this important concept is rarely examined in detail in most textbooks; many currently available petrology textbooks only trace the theory of differentiation back to N.L.