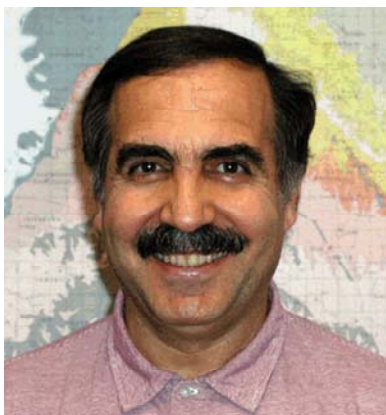


## **Student-Centered Rocks and Minerals Module for Non-Science Majors at Minority Serving Institutions and a Strategy to Establish an Earth System Science Program**

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*To enhance and maintain diversity in Earth system science necessitates the establishment of Earth system science programs at MSIs and HBCUs*



The understanding of rocks and minerals is one of the foundations of Earth System Science Education. Effective teaching of this material has not been easy, however. New strategies are being constantly developed to reach basic concepts. The new module presented here seems extremely effective not only in the transfer of information to students, but also in increasing their interests in Earth Science. The module consists of 6 lab activities and 6 associated assignments. Assignments involve internet-based research and the labs are hands-on activities.

The module achieves several important goals:

- It opens students to a tremendous volume of Earth system science information available on the web.
- It teaches them a basic principle of conducting research: collecting available information before doing the experiment.
- It enables students to make critical observations and to collect detailed records.
- It enforces self reliance and discipline.
- It enhances communication skills.
- It produces an educational habit students can carry into their other courses. In addition, the module brings students into the community of Earth system scientists.

Increasing participation of minorities into Earth system science requires the establishment of degree programs at minority serving institutions. This goal is aided by strengthening of elementary Earth science courses, followed by development of advanced courses, leading to the development of a curriculum.

### **ROCKS ARE FOUNDATIONAL**

The understanding of rocks and minerals is one of the foundations of Earth System Science Education. The basic concept is essential in order to fully comprehend the evolution of the Geosphere, the Hydrosphere, and the Atmosphere. However, effective teaching of rocks and minerals has not been simple. Over the years of teaching elementary Earth



science courses, I have observed a lack of connections between students and rocks and mineral labs. Apparently, the same situation exists at other institutions (Hawley, 2002). As a result, strategies are being constantly devised to convey the information about rocks and minerals to participating students. Some of the most common strategies include the establishment of a rock garden or rock landscape around the campus (Dillon et al., 2000; Calderone et al., 2003), the study of building stones (Wetzels, 2002; Guertin, 2005), using museums as laboratories (Pop et al., 2004), and utilizing urban outcrops (Hoskin, 2000).



The primary goal of this article is to elaborate on the development of a student-centered laboratory in rocks and minerals for our elementary Earth science course at Jackson State University. Although the module proposed here can be applied at any university, it is particularly effective for MSIs in urban areas. The approach is extremely effective not only in the transfer of basic

concepts, but also to increase students' interests in Earth system science. In addition, the participation of African American into Earth system science is very low. We briefly elaborate on a possible mechanism to enhance Diversity in Earth system science.

## **STUDENT-CENTERED ROCKS AND MINERAL LABS**

### **General Procedure**

The module includes 6 labs each consists of one assignment and one lab activity. The assignment is given to students one week in advance and it is due on the day of the related laboratory. Students are instructed to use the internet to collect information and respond to several short questions. They are requested to present the result of their search by the day of the associated lab in order to receive grades for their efforts. The assignment activity achieves the following goals:

- It opens students to a tremendous volume of Earth science information available on the internet.
- It teaches students a basic principle of conducting research: collecting available information before doing the experiment.
- It brings students into a community of Earth system scientists.

In the lab, students are given a lab activity handout describing what they need to do. Five stations are arranged around the classroom, each with 10 identical samples. During a one-hour lab, students (individually, or in groups of 2 or 3) examine mineral or rock samples and record their observations in table format. To conduct their lab, they are expected to use the information they collected in



advance on their internet search. The lab is student-centered, and participants soon realize a valuable lesson: their knowledge depends entirely on their own efforts. At the end of each lab, a discussion is held to evaluate students' responses. Students are encouraged to discuss their findings and exchange ideas. The lab activity also achieves the following important goals:

- It introduces students to two of the most basic principals of conducting research: making critical observations and collecting detailed records.
- It enforces self reliance and discipline for their educational outcome.
- It enhances their communication skills.
- It inculcates an educational habit.

### **Description of the Module**

Lab activities include: (1) physical properties of minerals, (2) silicate mineral identification, (3) non-silicate mineral recognition, (4) igneous rocks, (5) sedimentary rocks, and (6) metamorphic rocks.



The physical properties lab instructs students to collect information about major physical properties of minerals (color, specific gravity, hardness, cleavage, etc). The lab handout for the activity defines and describes each of these physical properties, providing helpful illustrations. Determination of physical properties is organized in such a way as to sharpen students' visual perception of mineral properties, including by asking them to describe the color and crystal shape of unknown minerals. Next, students determine the texture, feel and specific

gravity of samples, which enhances their sense of touch. Finally, students determine hardness, cleavage and streak which strengthens their ability to engage in deductive reasoning.

The silicate mineral lab assignment asks students to collect information about olivine, pyroxene, amphibole, K-feldspar, plagioclase, quartz, biotite, muscovite, and talc. (The non-silicate lab includes hematite, magnetite, bauxite, pyrite, galena, sphalerite, gypsum, barite, calcite, aragonite, dolomite, halite, fluorite, graphite, and diamond.) For each mineral, students are expected to summarize their findings in one page. While in the lab, students use their knowledge of physical properties of minerals and the information they have gathered from the web to determine the name of the unknown mineral.



The assignment for the igneous rock lab asks students to do an internet search

and find textures, mineralogy, and other characteristics of granite, diorite, gabbro, dunite, rhyolite, andesite, basalt, obsidian, scoria, pumice, and tuff. For the sedimentary rock lab, this includes a search for characteristics of terrigenous and biochemical sedimentary rocks, including conglomerate, breccia, sandstone, siltstone, claystone, shale, mudstone, limestone, chert, gypsum, anhydrite, rock salt, peat, lignite, bituminous coal, and anthracite. The metamorphic rock lab involves a search for slate, phyllite, schist, gneiss, hornfels, marble, skarn, and metaquartzite. Again, students are to present their results in one page per rock type. In each respective lab, the lab activity handout describes and illustrates textures and minerals of respective rock types. Students examine rock samples, describe their texture, mineralogy, leading to name for the mineral. They record their findings in a table.

### **The Significance of the Rocks and Minerals Module**

The reason for choosing rocks and minerals are as follows: (1) understanding of rocks and minerals constitutes a foundation for understanding the Geosphere, (2) characteristics and behaviors of rocks and minerals play a large role in events that shape the Earth's system, (3) studying rocks and minerals is truly a hands-on exercise, (4) these labs appear to capture students' interests in Earth science and Earth system science.

However, the methodology we have developed to teach this module achieves much more than just familiarizing students with properties of rocks and minerals. It gives students a chance to conduct literature searches, to make careful observations, to collect data, to formulate a hypothesis, and to discuss their findings. Most importantly, it teaches two of the most important principles for becoming successful in educational achievement: self reliance and discipline. Our ultimate goal is that what we teach in the rocks and mineral module becomes a habit and helps our students to become successful in their education.

In addition, the majority of students who participate in our course are non-science majors, particularly in-service teachers. This by itself is worthy of consideration. Efforts put into the teaching Earth science courses will be transferred to K – 12 students, influencing the future generation of Earth scientists.

### **ENHANCING DIVERSITY IN EARTH SCIENCE**



Only 1.3% of Earth Science Bachelor degrees were granted to African Americans in the year 2000 (Czujko and Henly, 2003). This situation is worse at the Ph.D. level. Over the past 28 years, out of approximately 20,000 people who earned Geoscience Ph.D. degrees in the United States, only 107 were African American, or 0.5% (Czujko and Henly, 2003). Numerous strategies and methods have been proposed to change this demographic, but none has improved the dichotomy (Kasten, 2003).

Most Minority Serving Institutions (MSIs) and Historically Black Colleges and Universities (HBCUs) do not have a degree program in Earth science. Such a situation could be a major contributing factor to the existing diversity in Earth science. Simply, no Earth science program at the institutions where minorities attend will lead to no minority Earth science graduates. On the contrary, Jackson State University (JSU) produced 25% of Bachelor degrees in Atmospheric Sciences and Meteorology during 1995 – 2001. (Dr. Q. L. Williams, personal communication) The reason: the existence of an active program in such disciplines at JSU. Therefore, to enhance and maintain diversity in Earth science necessitates the establishment of Earth science programs at MSIs and HBCUs themselves. Failing to carry through on this task will result in the continuation of the existing trend of low graduation rates for minorities in Earth science..

The first steps to establish an Earth science degree program is to strengthen the elementary Earth science courses. This is continued by development of advance courses, flowed by the establishment of a curriculum in Earth science.

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