

CONNECTING TEXTBOOK FACTS TO GEOLOGIC RESEARCH METHODS IN MIDDLE SCHOOL SCIENCE USING ARC9 GIS, PLATE TECTONICS DATA, AND BEACH SANDS



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Abstract

In an effort to introduce middle school students to geologic research methods concerning Earth's history, we developed an inquiry that combines current computer technology, hands-on laboratory experience, and constructivist education concepts. Our inquiry introduces seventh graders to a geographic information system, basic plate tectonics concepts, source rock analyses, and real-world geologic research methods. Students use currently known data regarding topography/bathymetry, earthquake distribution, and volcano distribution, and they record new data regarding sand composition and morphology from several beach sands collected from around the world. Then they use Arc9 GIS to make connections between current plate tectonics processes and nearby beach sand compositions. Finally, they extrapolate their connections regarding current environments to deduce ancient tectonic settings from ancient sandstone compositions. The inquiry introduces concepts pertinent to the rest of the earth science curriculum. We tested this inquiry at Hellgate Elementary School in Missoula, Montana. Hellgate students enjoyed the investigation, made new connections between seemingly unrelated topics (plate tectonics vs beach sands), and gained an appreciation for geologic research and the scientific method.

Introduction

We describe a four-part inquiry that allows middle school students to perform geologic research using observations, analytic equipment, and quantitative data regarding earth processes. This inquiry was tested at Hellgate Middle School in Missoula, Montana. Students answer the question, "How are plate tectonics and sand related?" By relating analyses of beach sands to standard plate tectonics exercises, our inquiry enhanced students' experiences, allowing them to discover connections regarding seemingly unrelated processes (e.g., earthquakes and deposition). Our inquiry focused on simple observations and assumed limited prior geologic knowledge. It introduced multiple disciplines including geography, plate tectonics, sedimentary processes, source rock analysis, and earth history. Students integrated data from earthquakes, volcanoes, and topography/bathymetry to discern types of plate boundaries. Then they used observations and analyses of beach sands to relate types of beach sands to types of current plate boundaries and continental margins. Finally, they discerned ancient tectonic environments through observations and analyses of ancient sandstones.

The Four-Part Inquiry

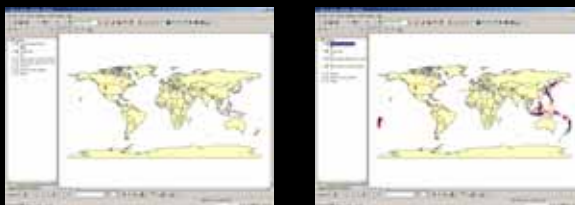
1: Beach Sand Characterization—Students observe sands from worldwide locations through stereographic microscopes, and construct categories of sand grain composition based on color, size, shape, number, and any other observable characteristics.



2: Plate Boundaries Characterization (Arc9 GIS)—The plate boundaries phase of the inquiry is a modified version of *Discovering Plate Boundaries, a Data Rich Classroom Exercise* (Sawyer, 2002) and requires computers with Arc9 GIS software. Software is available through ESRI education grants. Datasets may be downloaded from <http://terra.rice.edu/plateboundary/> (website last accessed 5/2006). Students create their own plate boundary classifications based on volcano, earthquake, and topographic/bathymetric queries.



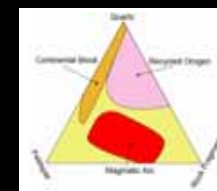
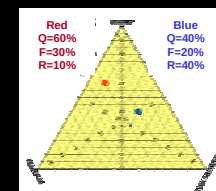
3: Spatial Integration of Beach Sands and Plate Boundary Types (Arc9 GIS)—Students overlay their sand locations onto their new plate boundary map and perform various distance queries using GIS regarding the beach sand location and plate boundary data. Based on their plate boundary classifications and their sand classifications, they infer what type of sand could be expected based on proximity to certain plate boundary types.



4: Extending Source Rock Analyses to Ancient Geologic Environments—As an assessment, students perform another sand classification using stereographic microscopes on an ancient sandstone rock that has been partially crushed into sand. They use the skills gained through the inquiry to infer what type of plate boundary the sandstone was near at the time of deposition.

Geologic Concepts

Sand compositions are influenced by the source rock (the rock that broke down to produce the sand), sedimentary processes, and the paths that link the source rock to the place where the sand is deposited. The primary control on all of these factors, including sand composition, is plate tectonics. Scientists have evaluated the effect of modern tectonic processes on modern sand compositions. They have extrapolated their findings to ancient sandstone compositions in order to determine the ancient tectonic setting necessary to produce those sandstone compositions (Dickinson and Suczek, 1979). We use these basic ideas as the foundation for introducing geologic research methods to middle school students.



• Figure on left illustrates where two different sand compositions would plot on a ternary diagram.
• Figure on right illustrates what tectonic setting certain sand compositions reflect. Students can create their own ternary diagrams and relate their sand classifications to their plate tectonic classifications.

Literature Cited

Dickinson, W.R., and Suczek, C.A., 1979, Plate tectonics and sandstone compositions, AAPG Bulletin, v. 63, no. 12, p. 2164-2182.
Sawyer, D.S., 2002, Discovering Plate Boundaries, a Data Rich Classroom Exercise [abstract], American Geophysical Union Abstracts with Programs.

Acknowledgments

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