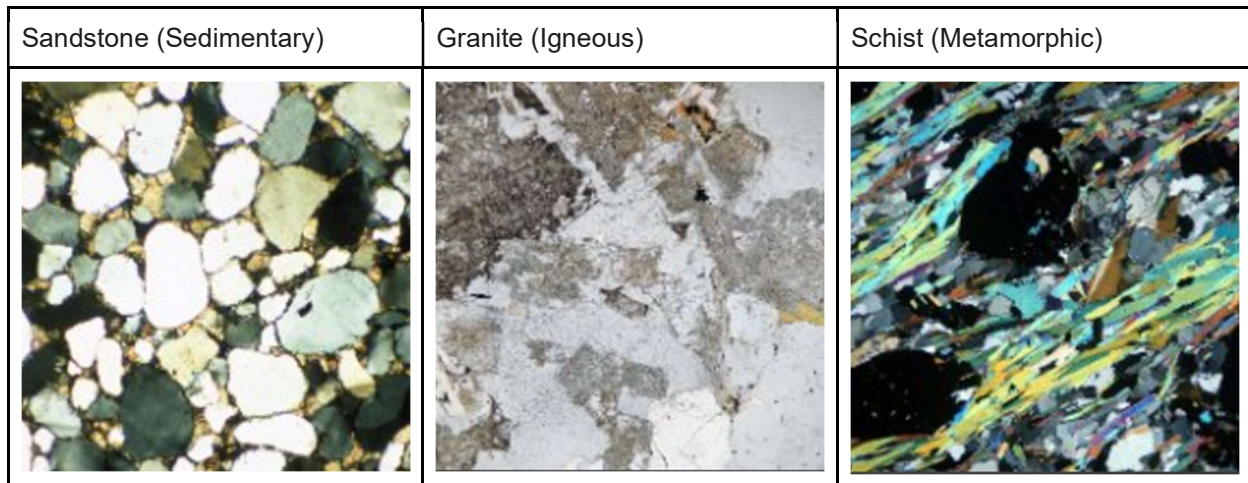


2023 Otilie Schillig Grant: Digital Microscopy Applications in the Geosciences

Project Objectives: The objectives of this project are to: (1) Enhance student learning and engagement in the Geosciences; (2) Increase microscopy & analysis skills relevant in geology (rocks and fossil specimens, sand, and soil); and (3) Promote the Geosciences through community engagement and outreach. These objectives will be accomplished by increasing inquiry-based and experiential learning via the use of a handheld digital microscope across a variety of Geoscience courses and activities.

Project Overview: Many studies have highlighted the benefits of education via microscopy although most of these are in fields related to biology and medicine such as pathology and microbiology. For example, Sivamalai et al. (2011) found that over 50% of pathology students found digital microscopy helpful due to higher quality images. These students also found that they learned more quickly with this more convenient, improved microscope technology. Additionally, Sivamalai et al. (2011) found that classroom use of digital microscopy was helpful because the whole class could view the same image, and this made information more accessible. Lastly, the students in the study noted the advantages for self-paced learning out of class as well as more opportunity for collaborative learning (Sivamalai et al., 2011).

While there is little research on the advantages of microscopy use in the Geosciences, handheld digital microscopes offer an up-close view of many geologic specimens to enhance student learning. Handheld digital microscopes foster inquiry-based and experiential learning as students can view and analyze numerous specimens from our museum collection as well as samples they collect on their own. Digital handheld microscopes will be useful in studying rocks, fossils, sand, sediment, soil, pollen grains, seeds etc. to analyze mineral content and grain characteristics such as particle size, color etc. (See Figures below).



<https://www.earth.ox.ac.uk/~oesis/micro/igneous/index.html>

Justification: The product we've chosen is multi-purpose in that it allows students to view images of specimens on a computer or projected onto a large screen in the classroom. This handheld digital microscope can also capture and save still images or videos for future 'virtual' study and for use in distance learning class lectures and activities. Therefore, handheld digital microscopes have widespread applications in the Department of Geosciences given our diverse geosciences course offerings both on campus and online. They are relatively low-cost, transportable and function with Windows and Mac computer applications. Additionally, these can be used in the field lab during field courses to analyze field samples. Finally, this technology makes Geosciences more accessible and inclusive for students with physical limitations who may have limited exposure to field camps due to the rigorous and demanding conditions. Images and videos captured by the handheld digital microscope bring the field experience to students no matter their location.

The handheld digital microscopes will be incorporated into existing Geosciences courses and labs (see list below) to enhance visual analysis of specimens. Physical, hands-on handling and analysis of specimens is an optimal way for students to learn about rock structure and mineralogy, as well as studying the composition and characteristics of sand and sediment. These handheld digital microscopes allow students to engage in the exploration of earth materials without needing to be in a 'traditional' laboratory setting. The handheld digital microscopes can be linked to a laptop for both student use and instructor use. Instructors of large lectures for introductory Earth Science courses could use the microscope to share enhanced images of different samples to facilitate class discussions. The courses included in this grant are popular with students in Geosciences as well as in other departments across campus (engineering, agriculture, interdisciplinary science, applied science etc.). Thus, the handheld digital microscopes will help expand the Geosciences across curricula for courses that have interdisciplinary appeal and impact. Because there is minimal setup for these handheld digital microscopes, this technology can be deployed immediately. If awarded a Schilling grant, we intend to purchase the handheld digital microscopes during the summer of 2023 so that they are available for use in the Fall 2023 term.

Purpose and Classroom Applications: The handheld digital microscopes can be deployed in our geology and geography courses that include lab and field analysis components, both on-campus and online. The Geomorphology course does not include a lab, but does include a variety of hands-on activities related to course goals. Students collect soil samples from local areas experiencing erosion for analysis to determine the porosity and permeability of the samples. Geomorphology students also determine the composition of the soil (sand, silt, clay, loam) to then classify the soil sample using the official USDA classification system. This information is part of the community engagement project the students complete that includes a report to the City of Starkville. The portable microscopes would allow students to analyze the soil samples in a more in-depth method when determining composition and then predicting porosity/permeability rates, in addition to being used for examining other earth material samples during related lectures.

Geomorphology has an enrollment of 60 students each fall that is a mixture of civil engineers and geology majors, with the majority being civil engineers (70%). This is often the first geology course for the Civil Engineering majors, so including more samples from the landforms and regions they students are learning about could help bridge the knowledge gap between the major and non-majors. Magnification of earth samples can really increase understanding since the microscopic structure connects how that sample played a role in creating the topography of different regions.

Geomorphology and the introductory geology courses are traditionally taught in "large lecture" settings. The portable microscope will allow integration of field and lab based engagement opportunities in a traditional classroom setting. For example, an instructor can use the portable microscope during lecture or lab to project magnified images of the various rock, mineral and fossil samples. The magnification of samples would help meet course goals of identifying the different earth materials from various global locations across large timescales. This is a similar benefit for the portable microscopes to be used for the online courses as a method to provide authentic field and lab experiences through the online environment to supplement lectures and other course activities. Additionally, geology samples across different media (rocks, soils, sediment, sand etc.) can be examined and captured for analysis in the online Forensic Geoscience offering. This course investigates geoscience samples and data for consulting purposes with emphasis on their use in civil and criminal cases.

It is expected that these digital microscopes will be used by approximately 400 undergraduate on-campus students per year. Additionally, this technology will be deployed in our online courses for both undergraduates and graduate students (about 75 students per year). Images and videos captured by the digital microscope can also be used in online virtual field courses for students who are unable to complete an on-site field course. Furthermore, MSU's next Quality Enhancement Plan (Bulldog Experience) will focus on experiential learning. The goal is to engage MSU undergraduate students in experiential learning through curricular and co-curricular activities throughout their education. We believe that the handheld digital microscopes will increase student engagement and interest in the Geosciences.

Lastly, the Department of Geosciences is heavily invested in community engagement and outreach to promote Geosciences careers and studies. Adding visual analysis of geologic specimens to our community outreach events and activities will undoubtedly spur interest in elementary, middle, and high school students who may cultivate an interest in studying Geoscience. Additionally, our department has paired with the MSU-Starkville partnership school. Adding these handheld digital microscopes will allow us to expand our inquiry-based and experiential learning activities with these students.

Courses: This technology will be used for a diversity of on-campus classes including:

- Geomorphology GG 4503/6503 (CEL Certified)
- Forensic Geosciences (Distance Learning) GR 4683/6863
- Earth Science I (and associated) lab GG 1111 and GG 1113

While this technology will be used primarily for our on-campus geology classes and labs, the images can also be saved for use in distance learning courses and labs. Additional uses of the handheld digital microscopes can be deployed during outreach and community engagement events including school visits and departmental functions such as the GEM workshop, Science Night at the Museum and activities associated with the Dunn-Seiler museum.

Budget: Handheld digital microscopes from Flinn Scientific cost \$119.00 each. Cost of ten = \$1190.00

These handheld digital microscopes can be ordered using the Flinn Scientific website:

https://www.flinnsci.com/digital-microscope-handheld/ms1101/?qclid=CjwKCAiA19efBhAkEiwA4TorihZYv22L7ImvSjiLDCPGtmTRRb-twIBBoy_qd1uqzIsFAQHoA2ZEuhoCndwQAvD_BwE#variantDetails

Product Details:

- Handheld microscope is powered by a USB cable that must connect to a computer, laptop or tablet.
- Built-in 2 megapixel digital camera.
- 10X, 40X, 150X magnification.
- LED illumination.
- 4¼" x 1¼", weight 4 oz.
- Includes software CD-ROM.

System requirements: Windows 7, Vista, and XP. Mac 10.4.9 and later.

About the Proposers:

Dr. Christa Haney is an Assistant Clinical Professor in the Dept. of Geosciences. She teaches a variety of undergraduate and graduate courses (forensic geoscience, virtual field methods, environmental geoscience) that collect and use Geosciences data, and which could benefit from handheld microscopes.

Dr. Sarah Lalk is an Assistant Clinical Professor in the Dept. of Geosciences. She teaches a variety of split-level Community-Engaged Learning certified courses in geology and geography which use outdoor environments for observations and data collection, including mobile GIS applications.

References: Sivamalai, S., Murthy, S. V., Gupta, T. S., & Woolley, T. (2011). Teaching pathology via online digital microscopy: positive learning outcomes for rurally based medical students. *Australian Journal of Rural Health*, 19(1), 45-51.