CORE Kids

Program Overview, Metrics and Evaluations

2017-2018

Report Prepared by Peter Voice

COREKIDS 2017-2018 ANNUAL REPORT TABLE OF CONTENTS

The following report is a summary of the activities of the CoreKids program for the academic year 2017-2018. It provides metrics on the numbers of events and contacts that the CoreKids program worked with, as well as feedback from the teachers that hosted CoreKids events in their schools. Presentations given under the outreach initiatives of the CoreKids program, the Department of Geological and Environmental Sciences at Western Michigan University, the Michigan Geological Repository for Research and Education and the Michigan Geological Survey are also provided.

Report prepared by Dr. Peter Voice

September 12, 2018

CoreKids Overview
And
2017-2018 Events List

CoreKids Program at the Michigan Geological Repository for Research and Education/Michigan Geological Survey

Prepared by Dr. Peter Voice, Director of K-12 Outreach, Michigan Geological Survey

Our Mission: To increase awareness and understanding of Earth, its processes and its natural resources among Michigan's students, teachers and citizenry. We utilize the unique geological resources of Western Michigan University Department of Geological and Environmental Sciences' Michigan Geological Repository for Research and Education (MGRRE). CoreKids educators carry earth science literacy, science literacy and citizenship messages from university faculty, our sponsors and our partners to the K-12 community and to the public. The program utilizes a mixture of presentations and hands-on activities to promote the understanding of earth science as well as to increase interest in the STEM (Science, Technology, Engineering and Math) fields especially the earth sciences among K-12 students. The majority of our contacts with southern Michigan students have been with higher grade level students who are making decisions about their future and we hope that we can influence some of these students into pursuing careers in the earth sciences. A basic tenet of the organization is to provide programming to schools and non-profit organizations without charge.

Our Current Funding: We thank the Michigan Section of the American Institute of Professional Geologists and the Kalamazoo Geological and Mineral Society for their generous funding support for CoreKids.

We are currently seeking additional funding to support the future activities of the CoreKids Program. We are working on a revision of the MGRRE Portal proposal and will be submitting it in the future to various grant-funding organizations and foundations.

Our Partnerships:

The Cranbrook Institute of Science

The Kalamazoo Geological and Mineral Society

The Michigan Department of Environmental Quality

The Michigan Aggregate Association

The Michigan Basin Geological Society

The Kalamazoo Air Zoo

The University of Michigan Museum of Natural History

The Michigan Mineralogical Society

The Branch County District Library

Michigan State University Museum of Science

We also have the support and partnership of several Teachers Associations: The Michigan Earth Science Teachers Association, the Michigan Science Teachers Association, the Michigan Alliance for Environmental and Outdoor Educators and the Metropolitan Detroit Science Teachers Association.

Future Proposals:

1. Develop workshops and continuing education short courses for Michigan teachers. We would use the well cores and samples and production records at MGRRE and allow the teachers to lay their hands on the actual rocks that yield these natural resources such as oil, gas, minerals, metals, and groundwater. This would also allow us to build a stronger collaboration with local teachers associations (Michigan Earth Science Teachers Association, Michigan Science Teachers Association) and promote earth science clubs at their schools.
    a. Progress: (i). Partnership with Steve Kaczmarek (WMU Geological and Environmental Sciences) to put together workshop on Chemistry of Earth Materials with an emphasis on X-ray fluorescence. The workshop ran August 9th, 2017. A second workshop was conducted on August 15, 2018. (ii). Developed over 2017 a variety of teachers' resources focused on Michigan's Natural Resources – presented a brief workshop at the Michigan Earth Science Teachers Association Annual Meeting and at the Fall Science Update at Grand Valley State University in 2016. Materials are hosted at the Michigan Geological Survey webpage and at researchgate. A report will be published by the Geological Survey – likely early 2019.
2. Develop a pilot MGS-MGRRE online education portal focused exclusively on Michigan energy issues. This portal would develop activities using authentic datasets to guide students through the process by which geologists go from exploration to oil and gas production. As part of portal development, we will engage professional Michigan geologists to work with teachers directly, both in the field and in the classroom. These could also lay the foundation for future mentoring relationships between sponsoring companies and participating schools.
3. Develop additional classroom modules. Several teachers that we have worked with in the past are excited to learn that we now present new modules about natural hazards and shale energy. As a result they are inviting us into their classrooms for multiple events. A wider variety of modules will not only interest more teachers, they will invite us back for more events, and more teachers and students will gain a better understanding of our natural resources and the need to responsibly manage them.
4. Develop an Open House Event twice a year at the MGRRE Facility as a resource for local home school associations and youth groups. A series of hands-on activities are planned centered around Michigan Geology, Michigan Natural Resources, Energy and Fossils. We have already done a pilot version of this idea with the Kalamazoo Geological and Mineral Society and their youth group and it was very well received.

Past outreach events July 1st, 2017 to June 30th, 2018

i. July 10th – 14th – Mi Tech Summer Camp
ii. August 9th – XRF Workshop
iii. August 16th – Air Zoo Event
iv. August 30th – Air Zoo Event
v. September 20th – Michigan Basin Geological Society Presentation
vi. Oct. 20th – Central Michigan Lapidary and Mineral Society Annual Show – School Day
vii. Oct. 28th – Spooky Science Saturday, Kingman Museum
viii. Oct. 28th – MSU visit to MGRRE
ix. Nov. 1-2nd MiCareerQuest Southwest Career Exploration Fair
x. Nov. 8th – U of M Museum Joint Event
xi. Nov. 10th – U of M Museum Joint Event
xii. Jan. 8th – MLK Jr Career Cruising Day
xiii. Feb. 15th – MI-AIPG Montly Meeting Presentation
xiv. Feb. 21st – Family Science Night
xv. Feb. 24th – Air Zoo Joint Event
xvi. Feb. 28th – MSU visit to MGRRE
xvii. Feb. 28th – Kalamazoo Air Zoo Joint Event
xviii. Apr. 18th – GVSU Class Visit
xix. Apr. 19th – DEQ Earth Day
xx. May 4th – 6th – KGMS Annual Show

CoreKids Frequently Asked Questions

1. Which regions of the state of Michigan does CoreKids go to?

Due to budget constraints, we are currently only able to provide support to our larger events at Mineral Shows and Earth Day events.

2. What is the MGRRE facility?

MGRRE is the Michigan Geological Repository for Research and Education. It is the premier collection of Lower Peninsula Geologic data and archives half a million feet of core rock data. We are part of the Michigan Geological Survey.

3. How many students can your Educators work with during a school trip or MGRRE tour?

Our modules are designed for groups of 30 students. We bring into the classroom all materials that we use including mineral samples and hands-on activities. We encourage schools with multiple sections of the same grade level at each period to schedule more than 1 day of CoreKids visits – i.e. one day for each 6th grade teacher's sections.

At MGRRE we are limited to groups of 25-30 at a time. We have a classroom at the facility that we use for brief presentations and hands-on activities.

4. How can we book a CoreKids Event?

Contact Dr. Peter Voice (peter.voice@wmich.edu or 269-387-8696 or 269-387-5446) to schedule events. He will try to accommodate your group.

5. What modules do you take into the classroom?

We currently have six modules: Michigan Geologic History; Hydrogeology; Shale Energy and Hydraulic Fracking; Michigan Fossils, Natural Hazards and The Environment and Climate Change. The Natural Hazards module is designed as three submodules: Volcanoes; Earthquakes; and Impact Craters. Each module is designed for a 50 minute session and includes a brief presentation and hands-on activities. Michigan Department of Education Grade Level Content Standards have been described for each module and are available on request.

6. Can I schedule more than one CoreKids event for my school or group with different modules?

If we have room in our schedule, we will gladly visit your school or group multiple times during the year presenting different modules.

7. Is there a charge for CoreKids Events?

Our policy is to provide our content free of charge for school visits and MGRRE tours. For MGRRE tours, we cannot cover the cost of transportation to bring your group to the MGRRE facility. We do accept donations to support CoreKids activities.

8. What if my school has a snow day or other cancellation the day a CoreKids event is scheduled?

We will try our best to reschedule the CoreKids event.

Letters of Support

CRANBROOK INSTITUTE OF SCIENCE

April 21, 2014

39221 Woodward Ave.
Mail Correspondence to:
P.O. Box 801
Bloomfield Hills
Michigan 48303.0801
Ph 248.645.3139
Fx 248.645.3050

To whom it may concern:

I am writing this letter in support of the CoreKids K-12 Earth Science Outreach Program. Cranbrook Institute of Science partners with them to provide outstanding learning experiences that supplement and extend learning beyond the classroom.

Coordinated through the Michigan Geological Repository for Research and Education (MGRRE), Core Kids brings an important collection of rocks to public viewing and understanding. Their collection includes thousands of bedrock samples not found anywhere else, and most unique to Michigan. It is truly a one-of a kind storehouse of valuable geological information.

CoreKids does an outstanding job of relating Earth Science concepts to kids and families with fun, engaging activities and demonstrations that use MGRRE samples. These are impactful and memorable experiences for children to widen their knowledge and perspective on how geology relates to our lives and economy.

I have personally witnessed the excellence in interpretation and materials through numerous events: including water festivals and museum fairs. They inspire thousands of students each year about Earth Science and Natural Resources management. This education plays a significant role in shaping the knowledge and understanding of future citizens to build a sustainable society. I look forward to many years of partnership with the CoreKids K-12 Earth Science Outreach Program. Please feel free to contact me if you have any questions. I can be reached by phone at 248-645-3223 or by email at lappel@cranbrook.edu.

Sincerely,

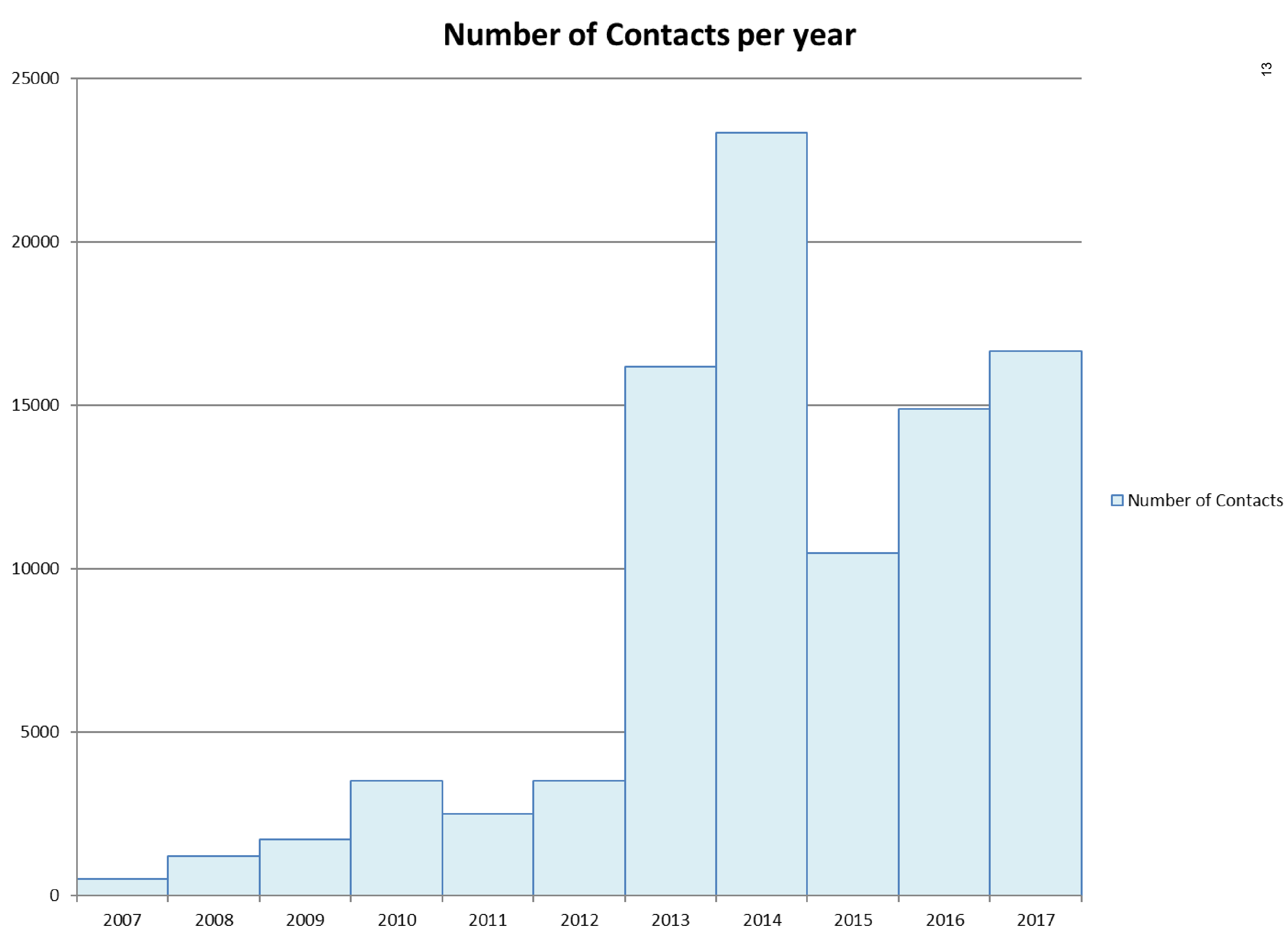
Lisa Appel
Watershed Education Coordinator
Cranbrook Institute of Science

Program Metrics

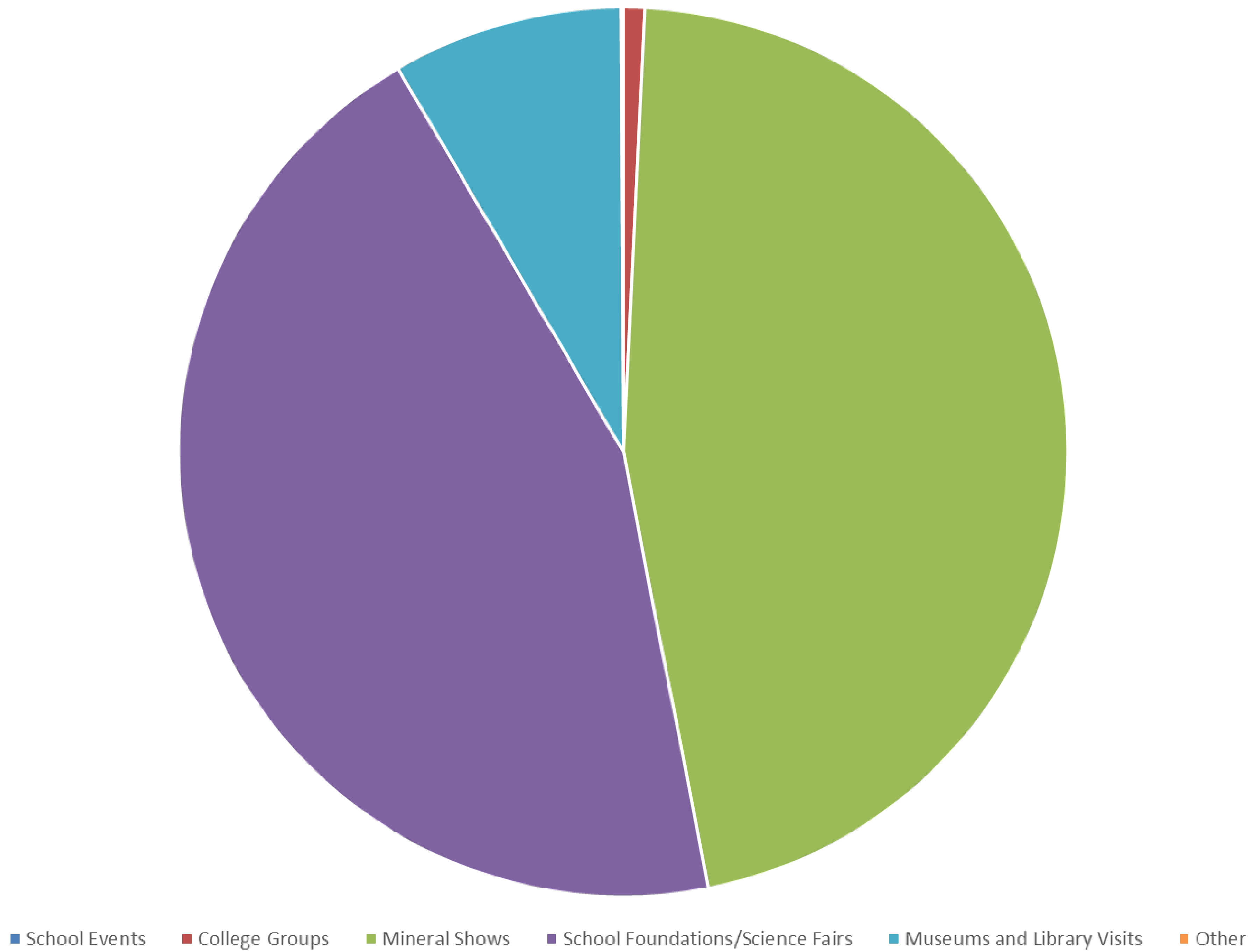
Academic Year	Number of Contacts	Number of Conferences/Teachers Workshops	Number of Events (school visits and allied partner programming)
2013-2014	16,175	7	65
2014-2015	23,329	1	50
2015-2016	10,473	2	45
2016-2017	14,875	3	23
2017-2018	16,590	1	20

Event Totals July 1st, 2017 to June 30th, 2018

MI Tech Summer Camp	15
Kalamazoo Air Zoo Events	110
College Groups	130
Teacher Workshop (XRF)	15
Presentations to MBGS, MI-AIPG, Tulip City Mineral Club	130
Central Michigan Lapidary and Mineral Society Annual Show	1100
Spooky Science Saturday (Kingman Museum)	1000
MICareerQuest Southwest Event	5000
KGMS Nov. Meeting	40
U of M Museum Joint Events	268
MLK Career Cruising Day	70
Family Science Night	270
KGMS Annual Show	6412
DEQ Earth Day	2085
Total:	16,645


Number of Contacts per year
25000
20000
15000
10000
5000
0
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
Number of Contacts

Breakdown of Events conducted between July 1st, 2017 and June 30th, 2016



CORE Kids

Module Overviews

Module	Recommended Grade Level	Michigan Department of Education Standards	Description
Michigan Geologic History	2-12	E.ES.03.41, E.ES.03.32, E.ST.04.31, E.SE.06.12, E.ST.06.42, E4.p3A	Discussion of Michigan's Geologic resources in their historical geology context. Emphasis on resources such as Oil and Gas, and Groundwater
Hydrogeology	7-12	E.ES.07.81, E4.1A, E4.1C	Discussion of infiltration rates, porosity and permeability.
Natural Hazards: Earthquakes	6-12	E.SE.06.51, E.SE.06.52, E.SE.06.53, E3.4A, E3.4C, E3.4f	Emphasis is on vibrational energy of earthquakes and its impact on structures.
Natural Hazards: Volcanoes	4-12	E.SE.06.52, E3.1d, E3.4C, E3.4d, E3.4e, E5.4B	Flow rates and magma chemistry are used to classify different types of volcanic eruptions. Volcanoes as natural hazards are explored.
Natural Hazards: Impacts and Asteroids	2-12	E5.p1A, E5.3C, E5.4B, P3.6A, P3.6B	Describes the influence of asteroids on Earth's geologic history.
Shale Energy and Hydraulic Fracturing	7-12	E.ES.03.41, E.ES.03.32, E2.2B, E2.4A, E2.4B, E3.1c, E4.1C	Discussion of conventional vs. unconventional hydrocarbon reservoirs. Explains the process by which hydraulic fracturing occurs.
Michigan Fossils	2-12	E.ST.04.31, E.ST.06.31, E.ST.04.32, E.St.06.42, Ef.3D, E5.4f	Michigan fossils are used to explore Michigan's changing climate as a function of plate tectonics through geologic time. Fossils are used to explore basic ecological principles (food webs, competition, niches).
The Environment and Climate Change	2-12	E.ES.03.52, E.ES.07.41, E1.2B, E1.2f, E1.2g, E2.3A, E2.3d, E2.4B, E5.4A, E5.4e	Module presents an overview of the nature of carbon dioxide gas and the greenhouse effect. The albedo effect is used illustrate the impact of changes in land cover and land use.

CORE Kids

1. Michigan Geological History Presentation (Michigan Natural Resources)

The Michigan Geological History Presentation provides an overview of the approximately 3 billion years of Earth Processes that the state of Michigan has experienced with an emphasis on two time periods, the Paleozoic and the Holocene. The presentation illustrates that the climate of Michigan has changed through geologic time with much warmer tropical climates during the Paleozoic and colder glacial conditions in the recent past. The concept of uniformitarianism is defined as one of the paradigms of modern Geology – that processes acting on modern environments are the same processes that acted in ancient environments. Examples are used to illustrate uniformitarianism through comparison of Silurian age reefs in the Michigan Basin and modern reefs in the Bahamas. One of the key aspects of this module is the exploration of the rich variety of natural resources present in the subsurface of the state of Michigan. The students are encouraged to discuss everyday objects that they use and the natural resources that had to go into the production of those objects. Natural resources such as groundwater, oil and natural gas, metallic resources, aggregate (sand and gravel), as well as salt are discussed and placed in the framework of the geology of Michigan. A final topic covered in the module is the idea that rocks have pore space which can be used to store materials like oil, natural gas, and water. A hands-on activity designed to supplement this module is the Core permeability test described below. This presentation is appropriate for grades 3-12 and meets the following content standards:

Michigan Department of Education Grade Level Content Standards covered:

K-7 Standards

E.ES.03.41 Identify natural resources (metals, fuels, fresh water, fertile soil, and forests).

E.ES.03.32 Describe how materials taken from the Earth can be used as fuels for heating and transportation.

E.ST.04.31 Explain how fossils provide evidence of the history of the Earth.

E.SE.06.12 Explain how waves, wind, water, and glacier movement, shape and reshape the land surface by eroding rock in some areas and depositing sediments in other areas.

E.ST.06.42 Describe how fossils provide important evidence of how life and environmental conditions have changed.

8-12 Standards

E4.p3A Describe how glaciers have affected the Michigan landscape and how the resulting landforms impact our state economy.

2. Hydrogeology Presentation

The availability of potable water is a significant problem worldwide. This module was developed to increase awareness in students of issues pertaining to the extraction of groundwater as well as to environmental issues that impact groundwater supplies. The module specifically outlines the distribution of water on the Earth's surface and in its interior. Fresh water makes up approximately 2.5% of the total water on the Earth's surface and much of that water is frozen as glacial ice. The module presenter explores with the students the water cycle and how water molecules move from the atmosphere to the surface as precipitation, from the oceans to the atmosphere through evaporation and the connection between surface waters and groundwater stored in subsurface aquifers. The balance of rainwater (and meltwater) runoff and infiltration is discussed in the context of how groundwater aquifers are recharged. As in the Michigan Geological History module, the properties of porosity and permeability are important concepts explored in this module. The storage space in an aquifer is the pore space between sediment particles that make up the rock portion of the aquifer. The importance of permeability to extraction/production of groundwater is discussed with the students. One final concept that is explored is the contamination of aquifers and how hydrogeologists can study or model the movement of contaminants in an aquifer. A brief discussion of remediation techniques is also described. This presentation is appropriate for grades 7-12. The following content standards are met by this module:

Michigan Department of Education Grade Level Content Standards covered:

K-7 Standards

E.ES.07.81 Explain the water cycle and describe how evaporation, transpiration, condensation, cloud formation, precipitation, infiltration, runoff, ground water, and absorption occur within the cycle.

8-12 Standards

E4.1A Compare and contrast surface water systems and groundwater in regard to their relative sizes as Earth's freshwater reservoirs and the dynamics of water movement (inputs, outputs, residence times, sustainability).

E4.1C Explain how water quality in both groundwater and surface systems is impacted by land use decisions.

3. Natural Hazards

The study of how natural hazards occur is an important component of applied geosciences. Students will gain a better appreciation of the types of natural hazards and the destructive nature of these events. Three different sub-modules have been prepared for this module: Earthquakes, Impacts and Asteroids, and Volcanoes. Each sub-module is designed around a series of hands-on activities and rock samples. The individual sub-modules are designed to fill a 50 minute class period and we bring in all of the materials necessary for the activities.

a. Natural Hazards: Earthquakes

The earthquake sub-module develops for the students an understanding of the behavior of earth materials during an earthquake. The students explore the harmful effects of an earthquake through construction of model cities on different substrates. Earthquakes are put into a plate tectonics context and the forces that generate earthquakes are discussed in the short presentation.

Michigan Department of Education Grade Level Content Standards covered:

K-7 Standards

E.SE.06.51 Explain plate tectonic movement and how the lithospheric plates move centimeters per year.

E.SE.06.52 Demonstrate how major geological events (earthquakes, volcanic eruptions, mountain building) result from these plate motions.

E.SE.06.53 Describe layers of the Earth as a lithosphere (crust and upper mantle), convecting mantle, and dense metallic core.

8-12 Standards

E3.4A Use the distribution of earthquakes and volcanoes to locate and determine the types of plate boundaries.

E3.4C Describe the effects of earthquakes and volcanic eruptions on humans.

E3.4f Explain why fences are offset after an earthquake, using the elastic rebound theory.

b. Natural Hazards: Volcanoes

The volcanoes module is a fun, hands-on module that explores the principle of viscosity and its relationship to the fluid flow dynamics of lava. A classification of volcanoes based on shape and size, magma composition, and eruption style is presented to the students and analog versions of the volcanoes are used to exhibit the viscosity of different lava types. Students work in groups to explore crystallization and cooling rate. A discussion of intrusive versus extrusive igneous rocks, highlights the textural differences observed in these igneous rocks which is a function of cooling rate.

Michigan Department of Education Grade Level Content Standards covered:

K-7 Standards

E.SE.06.41 Compare and contrast the formation of rock types (igneous, metamorphic, and sedimentary) and demonstrate the similarities and differences using the rock cycle model.

E.SE.06.52 Demonstrate how major geological events (earthquakes, volcanic eruptions, mountain building) result from these plate motions.

8-12 Standards

E3.1d Explain how the crystal sizes of igneous rocks indicate the rate of cooling and whether the rock is extrusive or intrusive.

E3.4C Describe the effects of earthquakes and volcanic eruptions on humans.

E3.4d Explain how the chemical composition of magmas relates to plate tectonics and affects the geometry, structure, and explosivity of volcanoes.

E3.4e Explain how volcanoes change the atmosphere, hydrosphere, and other earth systems.

E5.4B Describe natural mechanisms that could result in significant changes in climate (e.g. major volcanic eruptions, changes in sunlight received by the earth, meteorite impacts).

c. Natural Hazards: Impacts and Asteroids

This sub-module discusses the impact that a collision by meteorites or asteroids with the Earth would have on humanity. Basic types of meteorites are described and samples are provided for the students to examine. A brief discussion of orbital dynamics and gravitational attraction sets the stage for a hands-on activity where students simulate impacts on the Earth with different types of impactors (size, density, shape) and incident angles. The shapes of craters are described. Example impact craters in the Midwest region, including the Sudbury impact crater (Ontario) and the Calvin 12 structure (Southern Michigan) are used to illustrate how we can identify deposits related to these events in the geologic record.

Michigan Department of Education Grade Level Content Standards covered:

8-12 Standards

E5.p1A Describe the motions of various celestial bodies and some effects of those motions.

E5.3C Relate the major events in the history of the Earth to the geologic time scale, including the formation of the Earth, formation of an oxygen atmosphere, rise of life, Cretaceous-Tertiary (K-T) and Permian extinctions, and Pleistocene ice age.

E5.4B Describe natural mechanisms that could result in significant changes in climate (e.g. major volcanic eruptions, changes in sunlight received by the earth, meteorite impacts).

P3.6A Explain earth-moon interactions (orbital motion) in terms of forces.

P3.6B Predict how the gravitational force between objects changes when the distance between them changes.

4. Shale Energy and Hydraulic Fracturing

This module provides a balanced approach to discussion of hydraulic fracturing and utilizing hydrocarbon resources hosted in shales. Hydrocarbons underpin the world's economy and students need to understand where these natural resources come from that affect their daily lives in so many ways. Permeability and Porosity are used as a starting point for discussion of the differences between conventional hydrocarbon reservoirs and unconventional shale reservoirs. At the end of the session, students will be able to explain the process of hydraulic fracturing and how it is used to extract hydrocarbons from both conventional and unconventional hydrocarbon reservoirs. Students will also be able to list both the positives and negatives of hydraulic fracturing. The module consists of a short presentation and several hands-on activities.

Michigan Department of Education Grade Level Content Standards covered:

K-7 Standards

E.ES.03.41 Identify natural resources (metals, fuels, fresh water, fertile soil, and forests).

E.ES.03.32 Describe how materials taken from the Earth can be used as fuels for heating and transportation.

8-12 Standards

E2.2B Identify differences in the origin and use of renewable (e.g. solar, wind, water, biomass) and nonrenewable (e.g., fossil fuels, nuclear [U-235]) sources of energy.

E2.4A Describe renewable and nonrenewable sources of energy for human consumption (electricity, fuels), compare their effects on the environment, and include overall costs and benefits.

E2.4B Explain how the impact of human activities on the environments (e.g., deforestation, air pollution, coral reef destruction) can be understood through the analysis of interactions between the four Earth systems.

E3.1c Explain how the size and shape of grains in a sedimentary rock indicate the environment of formation (including climate) and deposition.

E4.1C Explain how water quality in both groundwater and surface systems is impacted by land use decisions.

5. Michigan Fossils

The Michigan Fossils module illustrates the diversity of life found in the fossil record of Michigan's sedimentary record. Discussion of how an organism becomes a fossil is presented with hands-on activities that simulate the process of fossilization. At the end of the module, students will be able to define the term index fossil. Specific fossils from Michigan are presented as index fossils that constrain the age of the host sediment. Behavioral and ecological principles are also explored with specific fossils (mastodons and mammoths) as diet and habitat can be inferred from skeletal morphology.

Michigan Department of Education Grade Level Content Standards covered:

K-7 Standards

E.ST.04.31 Explain how fossils provide evidence of the history of the Earth.

E.ST.06.31 Explain how rocks and fossils are used to understand the age and geological history of the Earth (timelines and relative dating, rock layers).

E.ST.04.32 Compare and contrast life forms found in fossils and organisms that exist today.

E.ST.06.42 Describe how fossils provide important evidence of how life and environmental conditions have changed.

8-12 Standards

E5.3D Describe how index fossils can be used to determine time sequence.

E5.4f Describe geologic evidence that implies climates were significantly colder at times in the geologic record (e.g., geomorphology, striations and fossils).

Presentations on the CoreKids program at Meetings

2018: North Central GSA Section Meeting

Bridging the gap: Using geochemical data to integrate geology and chemistry in K-12 Education

Stephen Kaczmarek, Peter Voice, Heather Petcovic, and William B. Harrison III

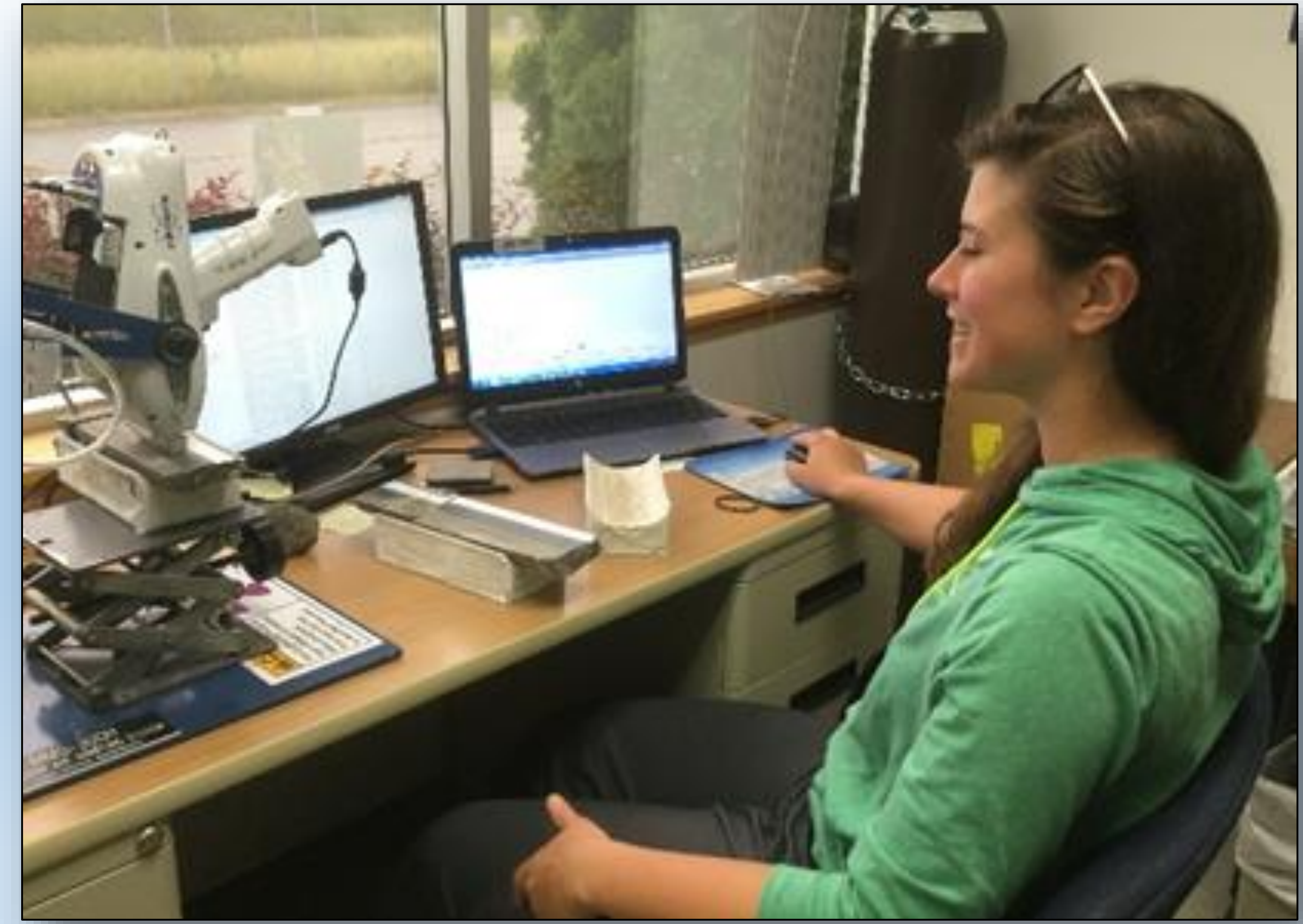
Department of Geological and Environmental Sciences and Michigan Geological Repository for Research and Education

Western Michigan University

MICHIGAN GEOLOGICAL REPOSITORY FOR RESEARCH AND EDUCATION
MGRRE
WESTERN MICHIGAN UNIVERSITY - Department of Geosciences 1903-2003

Bridging the Gap Workshop

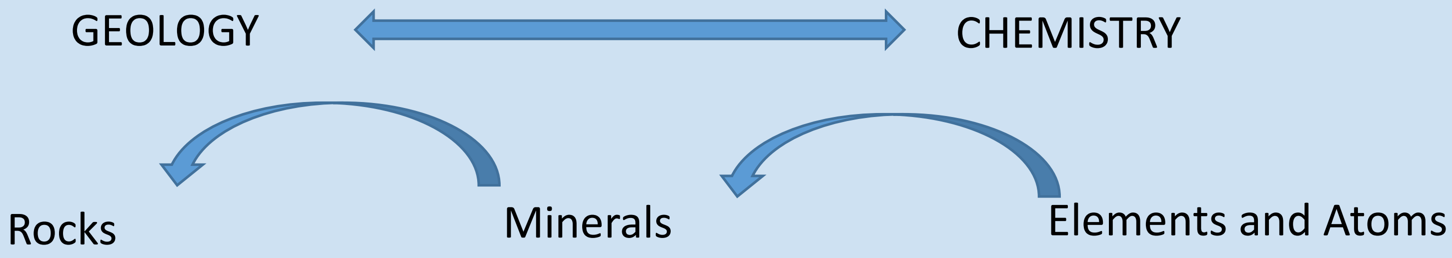
- Funded through a NSF Instrumentation & Facilities Grant
  - Supported purchase of Bruker Handheld X-ray Fluorescence Spectrometer (HHXRF)
  - Training Undergraduate and Graduate students to use the HHXRF to acquire data
  - Develop workshop materials (lesson plans, activities, displays)
  - Travel stipends for teacher participants
- August 2017 Workshop – 15 participants
- August 2018 Workshop – in preparation (37 interested teachers)



One of our students analyzing a core sample with the HHXRF

Workshop Objectives

- Increase familiarity with the concept of using geological materials as sources of quantitative chemical data
- Better appreciate the relationship between common geological materials, their bulk chemical composition, and common societal uses
- Gain a basic understanding of how X-ray fluorescence spectrometry can be used to determine the chemical composition of geological materials



Workshop Agenda

- Short lectures on Earth Materials, Michigan Geology, and X-Ray Fluorescence theory
- Tour of facility
- Hands-on activities – including Pet Rock
- Teacher-led discussion, brainstorming, and lesson plan creation

Teacher Recruitment

- Partnerships with local teachers associations facilitated advertising/recruitment for workshop
- Relationships through existing outreach activities
- 21 teachers interested in 2017 workshop
- 37 for the 2018 workshop

How do we fill the seats????

2017 Workshop Participants

- 15 teachers
- Grade Levels taught – 5 to 12 - mostly at High School level
  - Integrated Science, Earth Science, Biology, Math, Chemistry (Honors, Intro, AP), Physics, Astronomy, STEM, Meteorology, Environmental Science
  - Mix of public, private, and charter schools represented – including a diverse cross section of Urban, Suburban and Rural Schools (primarily Southern Lower Peninsula)
- 53% Female; majority Caucasian/White
- Wide range of experience – 3 to 40 years

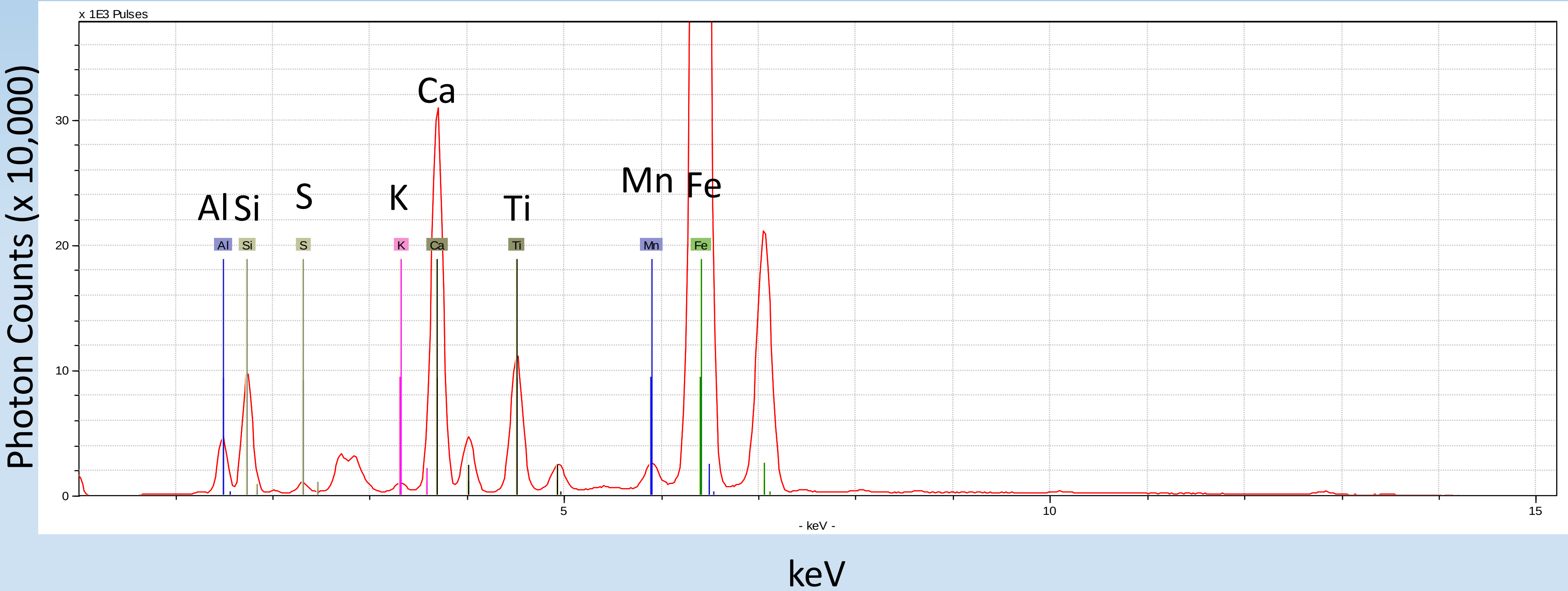
Michigan Geological Repository for Research and Education
Michigan's Rock Archive

560,000 ft. of core, 20 million ft. of cuttings
Well logs, drillers reports for many MI wells
(Hydrocarbons, Water, Mineral)

Hands-on Activities

- Variety of Topics
  - Powder Problem
  - Fossilization
  - Pet Rock
  - Forensic XRF
  - Alien Agua

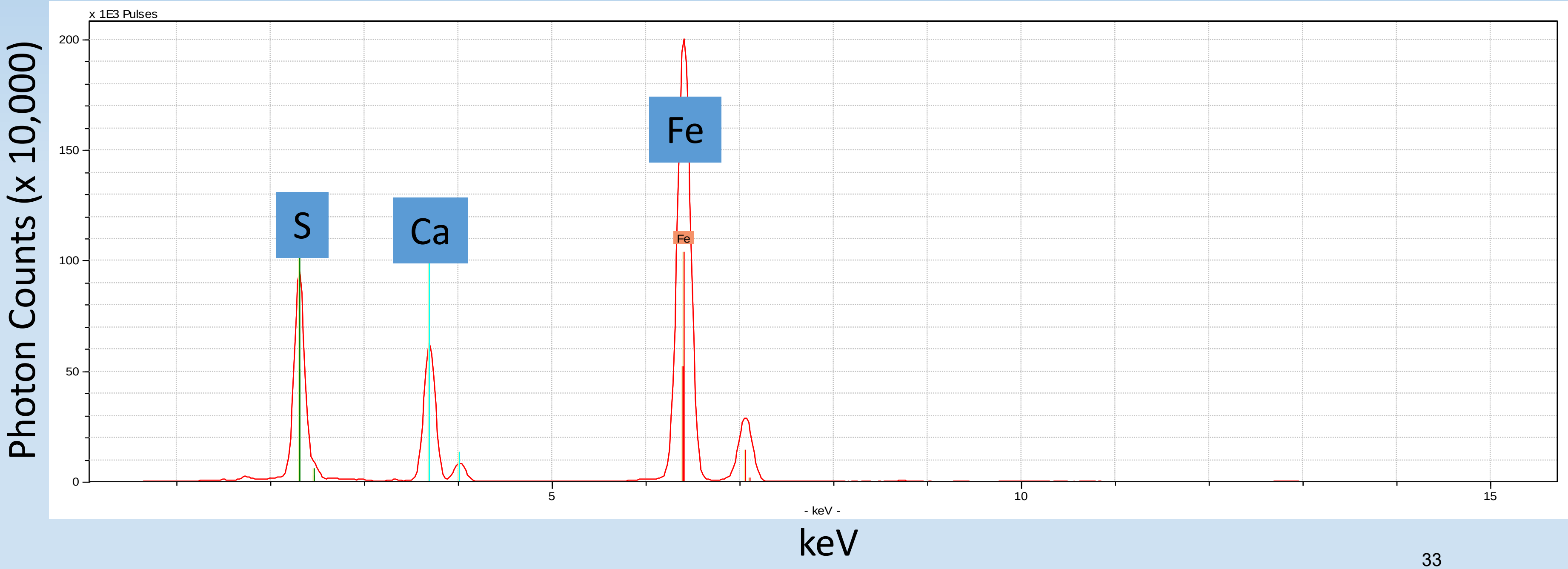
Leslie's Pet Rock – an Icelandic Basalt:



A.

B.

Which Brachiopod is more likely to exhibit the following chemical composition?



Powder Problem

Objectives

The objective of this activity is to identify rock powders based only on their major element compositions as determined by XRF.

Instructions

A set of rocks commonly found in the Michigan Basin has been provided (Table 1). These rocks have been powdered and placed into the vials labeled A-F. The whole rocks are fairly easy to tell apart, but as you can see, it is quite difficult to discriminate between the white powders (except the hematite, of course). Use the raw XRF spectra provided to match the powdered samples to their whole rock counterparts.

XRF – quantitative, quick, analytical technique

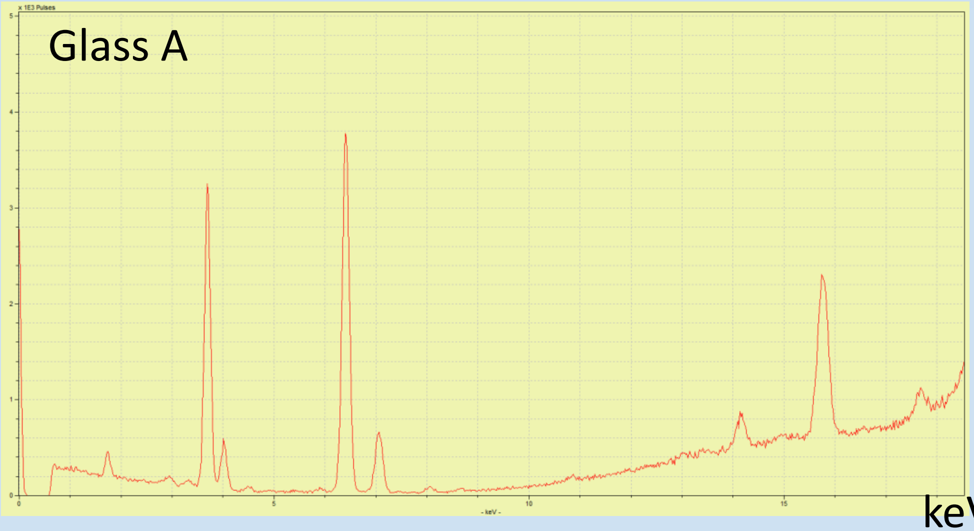
Rock Name	*Mineralogy*	*Chemical Formula*	*Chemical name*
Limestone	calcite, aragonite	$CaCO_3$	calcium carbonate
Dolostone	dolomite	$CaMg(CO_3)_2$	calcium-magnesium carbonate
Rock Salt	halite	$NaCl$	sodium chloride
Rock Gypsum	gypsum	$CaSO_4$	calcium sulfate
Sandstone	quartz	SiO_2	silicon dioxide
Specular Hematite	hematite, mica	Fe_2O_3	iron oxide

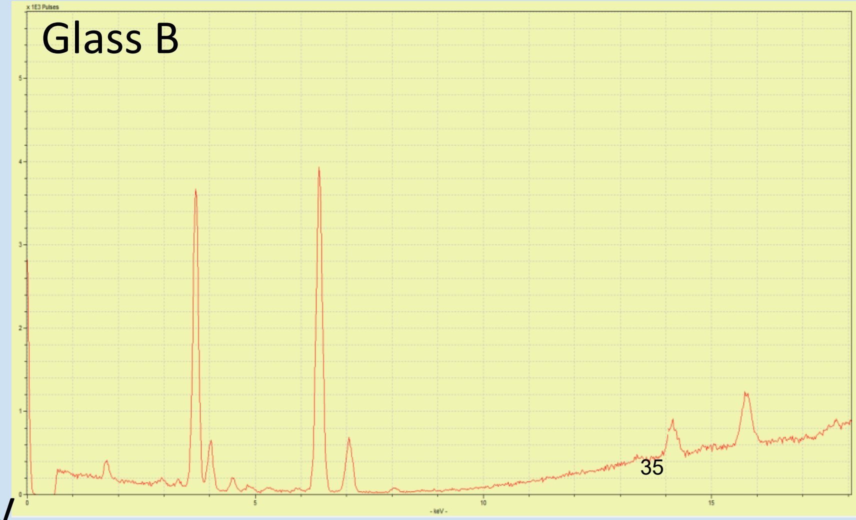
Forensic X-ray Fluorescence: Hit-and-Run

Image that you're a forensic scientist whose task it is to determine what happened in a hit-and-run car accident. At the crime scene, microscopic glass fragments from the car's windshield are found on the victim's body (Glass A). The police locate an abandon car with serious damage that fits a witness's description. The owner of the vehicle (i.e. suspect #1) claims his vehicle was stolen earlier that night and he wasn't involved with the accident. After obtaining a search warrant, your team searches the suspect's home and collects a small glass fragment embedded in the suspect's jacket (Glass B).

Both glass samples have been analyzed with the handheld XRF to determine their trace element compositions. Here are the resulting spectra

Photon Counts (x 10,000)





keV

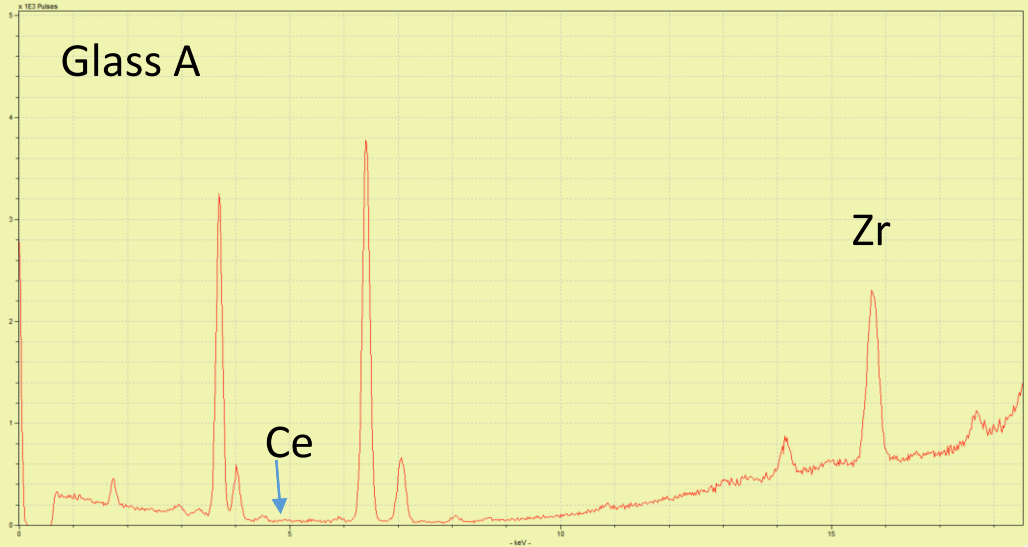
Forensic X-ray Fluorescence: Hit-and-Run

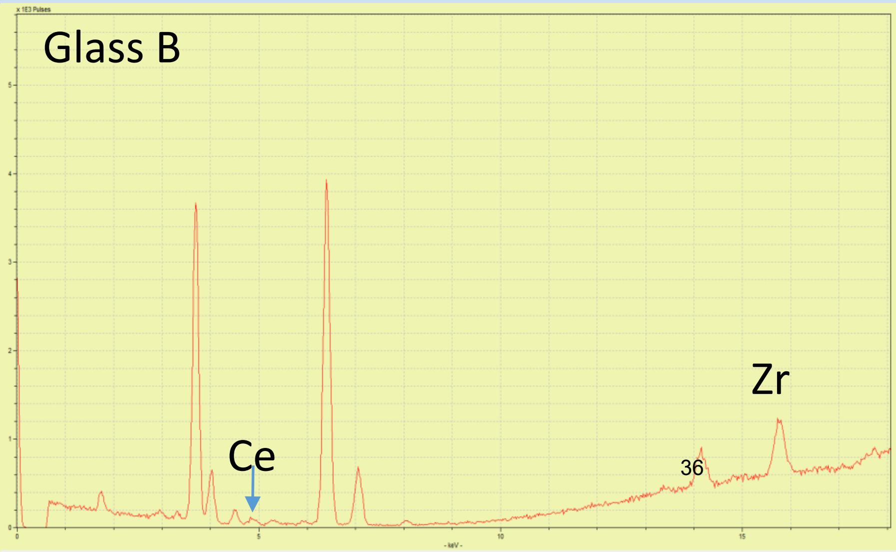
What elements do the glass samples have in common? What elements are unique? Do these samples have the same origin?

These samples likely do not have the same origin due the presence of Ce in Glass B. The samples are also different in their relative amounts of Zr, with Glass A having more Zr than B. Both samples are the same in the amount of all other elements.

Is there enough forensic evidence to say the suspect was or wasn't involved in the crime?

These data do not support the claim that the glass on the suspect's jacket was the same as the glass from the crime scene and on the victim. It doesn't rule out the involvement of the suspect.





Afternoon Hands-on Activities


MQ-153
158A
131
Horse Tooth
Wood
Brachiopod
Brachiopod

Discussion Sessions

- Teacher-mediated discussion in small groups
  - Discussion of how activities/lesson plans fit into NGSS
  - Discussion of multidisciplinary/integrated science – using examples from geosciences to reinforce chemistry and physics concepts

HS-ESS3 Earth and Human Activity

HS-ESS3 Earth and Human Activity

Students who demonstrate understanding can:

HS-ESS3-1. **Construct an explanation based on evidence for how the availability of natural resources, occurrence of natural hazards, and changes in climate have influenced human activity.** [Clarification Statement: Examples of key natural resources include access to fresh water (such as rivers, lakes, and groundwater), regions of fertile soils such as river deltas, and high concentrations of minerals and fossil fuels. Examples of natural hazards can be from interior processes (such as volcanic eruptions and earthquakes), surface processes (such as tsunamis, mass wasting and soil erosion), and severe weather (such as hurricanes, floods, and droughts). Examples of the results of changes in climate that can affect populations or drive mass migrations include changes to sea level, regional patterns of temperature and precipitation, and the types of crops and livestock that can be raised.]

HS-ESS3-2. **Evaluate competing design solutions for developing, managing, and utilizing energy and mineral resources based on cost-benefit ratios.*** [Clarification Statement: Emphasis is on the conservation, recycling, and reuse of resources (such as minerals and metals) where possible, and on minimizing impacts where it is not. Examples include developing best practices for agricultural soil use, mining (for coal, tar sands, and oil shales), and pumping (for petroleum and natural gas). Science knowledge indicates what can happen in natural systems—not what should happen.]

HS-ESS3-3. **Create a computational simulation to illustrate the relationships among the management of natural resources, the sustainability of human populations, and biodiversity.** [Clarification Statement: Examples of factors that affect the management of natural resources include costs of resource extraction and waste management, per-capita consumption, and the development of new technologies. Examples of factors that affect human sustainability include agricultural efficiency, levels of conservation, and urban planning.] [Assessment Boundary: Assessment for computational simulations is limited to using provided multi-parameter programs or constructing simplified spreadsheet calculations.]

HS-ESS3-4. **Evaluate or refine a technological solution that reduces impacts of human activities on natural systems.*** [Clarification Statement: Examples of data on the impacts of human activities could include the quantities and types of pollutants released, changes to biomass and species diversity, or areal changes in land surface use (such as for urban development, agriculture and livestock, or surface mining). Examples for limiting future impacts could range from local efforts (such as reducing, reusing, and recycling resources) to large-scale geoengineering design solutions (such as altering global temperatures by making large changes to the atmosphere or ocean).]

HS-ESS3-5. **Analyze geoscience data and the results from global climate models to make an evidence-based forecast of the current rate of global or regional climate change and associated future impacts to Earth's systems.** [Clarification Statement: Examples of evidence, for both data and climate model outputs, are for climate changes (such as precipitation and temperature) and their associated impacts (such as on sea level, glacial ice volumes, or atmosphere and ocean composition).] [Assessment Boundary: Assessment is limited to one example of a climate change and its associated impacts.]

HS-ESS3-6. **Use a computational representation to illustrate the relationships among Earth systems and how those relationships are being modified due to human activity.** [Clarification Statement: Examples of Earth systems to be considered are the hydrosphere, atmosphere, cryosphere, geosphere, and/or biosphere. An example of the far-reaching impacts from a human activity is how an increase in atmospheric carbon dioxide results in an increase in photosynthetic biomass on land and an increase in ocean acidification, with resulting impacts on sea organism health and marine populations.] [Assessment Boundary: Assessment does not include running computational representations but is limited to using the published results of scientific computational models.]

The performance expectations above were developed using the following elements from the NRC document *A Framework for K-12 Science Education*:

Science and Engineering Practices

Analyzing and Interpreting Data
Analyzing data in 9–12 builds on K–8 experiences and progresses to introducing more detailed statistical analysis, the comparison of data sets for consistency, and the use of models to generate and analyze data.
- Analyze data using computational models in order to make valid and reliable scientific claims. (HS-ESS3-5)

Using Mathematics and Computational Thinking
Mathematical and computational thinking in 9-12 builds on K-8 experiences and progresses to using algebraic thinking and analysis, a range of linear and nonlinear functions including trigonometric functions, exponentials and logarithms, and computational tools for statistical analysis to analyze, represent, and model data. Simple computational simulations are created and used based on mathematical models of basic assumptions.
- Create a computational model or simulation of a phenomenon, designed device, process, or system. (HS-ESS3-3)
- Use a computational representation of phenomena or design solutions to describe and/or support claims and/or explanations. (HS-ESS3-6)

Constructing Explanations and Designing Solutions
Constructing explanations and designing solutions in 9–12 builds on K–8 experiences and progresses to explanations and designs that are supported by multiple and independent student-generated sources of evidence consistent with scientific knowledge, principles, and theories.
- Construct an explanation based on valid and reliable evidence obtained from a variety of sources (including students' own investigations, models, theories, simulations, peer review) and the assumption that theories and laws that describe the natural world operate today as they did in the past and will continue to do so in the future. (HS-ESS3-1)
- Design or refine a solution to a complex real-world problem, based on scientific knowledge, student-generated sources of evidence, prioritized criteria, and tradeoff considerations. (HS-ESS3-4)

Engaging in Argument from Evidence
Engaging in argument from evidence in 9–12 builds on K–8

Disciplinary Core Ideas

ESS2.D: Weather and Climate
- Current models predict that, although future regional climate changes will be complex and varied, average global temperatures will continue to rise. The outcomes predicted by global climate models strongly depend on the amounts of human-generated greenhouse gases added to the atmosphere each year and by the ways in which these gases are absorbed by the ocean and biosphere. *(secondary to HS-ESS3-6)*

ESS3.A: Natural Resources
- Resource availability has guided the development of human society. (HS-ESS3-1)
- All forms of energy production and other resource extraction have associated economic, social, environmental, and geopolitical costs and risks as well as benefits. New technologies and social regulations can change the balance of these factors. (HS-ESS3-2)

ESS3.B: Natural Hazards
- Natural hazards and other geologic events have shaped the course of human history; [they] have significantly altered the sizes of human populations and have driven human migrations. (HS-ESS3-1)

ESS3.C: Human Impacts on Earth Systems
- The sustainability of human societies and the biodiversity that supports them requires responsible management of natural resources. (HS-ESS3-3)
- Scientists and engineers can make major contributions by developing technologies that produce less pollution and waste and that preclude ecosystem degradation. (HS-ESS3-4)

ESS3.D: Global Climate Change
- Though the magnitudes of human impacts are greater than they have ever been, so too are human abilities to model, predict, and manage current and future impacts. (HS-ESS3-5)
- Through computer simulations and other studies, important discoveries are still being made about how the ocean, the atmosphere, and the biosphere interact and are modified in response to human activities. (HS-ESS3-6)

ETS1.B: Developing Possible Solutions
- When evaluating solutions, it is important to take into

Crosscutting Concepts

Cause and Effect
- Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects. (HS-ESS3-1)

Systems and System Models
- When investigating or describing a system, the boundaries and initial conditions of the system need to be defined and their inputs and outputs analyzed and described using models. (HS-ESS3-6)

Stability and Change
- Change and rates of change can be quantified and modeled over very short or very long periods of time. Some system changes are irreversible. (HS-ESS3-3),(HS-ESS3-5)
- Feedback (negative or positive) can stabilize or destabilize a system. (HS-ESS3-4)

Connections to Engineering, Technology, and Applications of Science

Influence of Engineering, Technology, and Science on Society and the Natural World
- Modern civilization depends on major technological systems. (HS-ESS3-1),(HS-ESS3-3)
- Engineers continuously modify these technological systems by applying scientific knowledge and engineering design practices to increase benefits while decreasing costs and risks. (HS-ESS3-2),(HS-ESS3-4)
- New technologies can have deep impacts

*The performance expectations marked with an asterisk integrate traditional science content with engineering through a Practice or Disciplinary Core Idea.

The section entitled "Disciplinary Core Ideas" is reproduced verbatim from A Framework for K-12 Science Education: Practices, Cross-Cutting Concepts, and Core Ideas. Integrated and reprinted with permission from the National Academy of Sciences.

Participant	1. This workshop increased my familiarity with how geoscientists use geological materials as sources of quantitative chemical data.	2. This workshop allowed me to better appreciate the relationship between common geological materials, their chemical composition, and common societal uses.	3. This workshop gave me a basic understanding of how X-ray fluorescence spectrometry can be used to determine the chemical composition of geological materials.
P1	5	5	5
P2	5	5	5
P3	5	5	5
P4	5	5	5
P5	5	5	5
P6	5	5	5
P7	5	5	5
P8	5	5	5
P9	5	5	5
P10	4	4	5
P11	5	5	5
P12	3	4	4
P13	5	5	5
P14	5	4	5
P15	5	4	5

Post-Workshop Surveys – Feedback opportunity

9. How much do you think you now understand about using XRF spectroscopy to study the elemental composition of geologic materials as a result of participating in this workshop?	10. To what extent did the lessons and teaching materials provided in this workshop align with state science standards?	11. I plan to use the lessons and teaching materials provided in this workshop in my classes.
4	5	5
5	5	5
4	5	5
4	5	4
5	5	5
5	5	5
4	4	4
5	5	5
4	5	5
4	5	4
5	5	5
3	3	3
4	4	4
4	4	4
4	4	4

The Workshop was effective:

1. It increased teacher knowledge
2. The materials provided were aligned with MI Science Standards
3. Teachers were willing to use the materials in their classrooms

Post-Workshop Surveys – Feedback opportunity

Conclusions

- Emphasize connections between Geosciences, Chemistry and Physics
  - Better alignment with NGSS
  - Provide examples across disciplines that teachers can use
- Hands-on activities – more engaging to students and teachers
- Data sets authentic and quantitative: math literacy, graph comprehension, statistical analysis of geological data
  - More rigorous approach to outreach and K-12 education – portable tech and "instantaneous testing"

CORE Kids

Michigan Geological Survey
Western Michigan University Geosciences
Established 1837