Earth System Science I

Earth Science Content Teaching team

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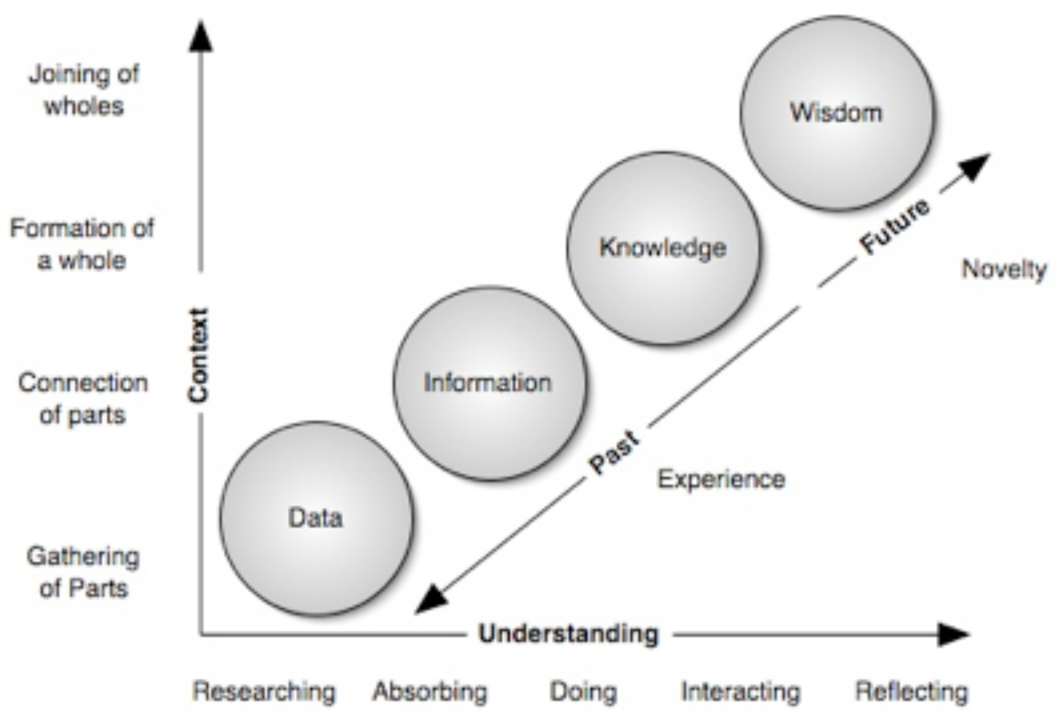
Course Philosophy

This class is to introduce Earth Science content to science teachers, with help at presenting this material in inquiry form to students. It is aimed to emphasize the development of the participants' problem-solving skills and will employ inquiry based techniques. An important part of the class will use tools that research scientists use and to teach participants to do scientific research. The style of the class is observational, geographical, descriptive, analytical and interpretive. It is aimed to repeatedly apply a sequence of logical questions that can be tested, so that hypotheses can be rejected or refined.

Overall the subject matter is **how the earth works.** We aim to engage participants in understanding, interpreting, applying, analyzing, synthesizing and evaluating their own observations in the same way as scientists do. Since all of us live on the earth, the topics are fundamentally linked to a sustainable world, and education of earth people about earth processes is an essential scientific obligation.



Understanding Continuum and how we gain knowledge. (Bloom). http://www.nwlink.com/~Donclark/

Course Format

At the day's beginning we will introduce a problem to consider. There will be a brief lecture about it. This lecture will be accompanied by background material, which is intended mainly to help a teacher to recall and synthesize details and to prepare to teach parts of the same material. There is also a text book for the class for which there are short helpful readings related to each field day:

Michigan Geography and Geology 2009 ed by **R Schaetzl** Custom Publishing, New York

It is not expected that participant should absorb this material before the day's class, but they are welcome to scan it the night before. This material includes linkages to **Michigan Merit Curriculum in Earth Science** and **District Learning Outcomes**.

Each field day will be linked to location through GPS and Google Earth. This will be done pretty effortlessly and will become habitual. This will enable participants to know exactly where they went all day, a template for all the observations. Each participant will have a laptop and a GPS for use during the class. The use of these outside is limited, but participants will be expected to be able to access simple spreadsheets in Excel, to access Google Earth, and to plot their location records. There will be plenty of help to ensure that frustration about computers or technology will be minimal. The point is to know **context**, including where you are all the time, and how those places relate to each other in geographic space.

Following the brief lecture, we will go to the field site(s), and the group will be broken into groups of several participants each. The composition of groups will change every day. Each group will have an instructor and a different investigation sequence. When new skills or concepts are needed to formulate or evaluate hypotheses, we will work through intensive instruction modules. Most of the day will be spent in groups gathering information and instructors will be available throughout.

At the end of each day, each participant will compose a brief written summary of the day's activities (including a problem statement, methods, observations, and interpretations sections). The summary will explain the ways in which all available data are used to develop a hypothesis in response to the problem posed at the beginning of the day. The written summary will conclude with a discussion of the methods and data that could be used to test the proposed hypothesis. The instructors will review the written summaries each evening.

Participants will also create an ongoing daily diagnostic learning log that will be kept separate from their written technical summary. The "log" will be used by participants to assess their own grasp of the material presented during the day. Instructors will review the logs each evening. Whenever participants express doubt that they have mastered the concepts or techniques presented during the day, the course's itinerary will be modified to allow time for additional practice. The instructors will not comment on or assign grades to the logs.

Grading

Performance will be judged mainly on the basis of the written summaries. The instructors recognize that the course includes participants from diverse backgrounds. Grades will therefore be assigned on the basis of how well each participant uses their own observations to develop their own hypotheses. Answers are not wrong simply because they do not conform to prevailing geologic opinions. The research-oriented nature of the problems posed to the participants facilitates this approach because the questions focus on problems for which solutions are debated among professional geologists. The least geologically experienced participants often produce some of the best summaries. Perhaps the fact that they are unencumbered by dogma and jargon allows them to see what really exists more clearly.

To ensure participants do not continue their careers as geologists and educators with a basic misunderstanding of some feature or process, the instructors will summarize their own data and hypotheses (typically divergent) for the previous day's problem at the start of the each day. Group discussion will be encouraged at all stages of the process of developing hypotheses. There are many possible answers to the problems, so it is pointless to search for the "correct" answer in the field library.

Day 1: Great Sand Bay and Selwyn Dunes, Keweenaw Peninsula

Problem: What evidence is there to support or refute the hypothesis that coastal dunes of the Great Lakes could only have developed long ago, when conditions were different?

Necessary Background Information: (Schaetzl Chapters 17 and 18)

- Course introduction: course (geologic) goals; how do the next two weeks fit together; why are we starting here?
- What causes wind? What is a sea breeze?
- Weather and climate
- Aeolian processes, dunes, sand, dust and haze.
- Formation of sedimentary rocks: clastic versus chemical
- Basic mineralogy: quartz, feldspar, "other"
- Grain size and flow rate
- Geologic timescale and unconformities
- What is the relationship of wind and waves?
- What is the Pleistocene?
- Solar heating of the earth.
- Basic tools: topographic maps, geologic maps, compass, hand lens, acid, hammer

Roots and links:
It is linked to the following parts of Michigan Earth Science Content: E1.1A-D E1.2C, E2.1B, E2.2A, C, D, E3.p1A, E3.p1B, E3.p1C, E4.p1A, E4.p2B, E4.p3A, E4.p3C, E4.1A, E5.4f. This day relates to Units 1, 2, 4, 9 and 10 in District learning outcomes for Science 8.

The sources for web-based linkages are on your laptop under **Day 1**.

Required Materials: Topographic map of Great Sand Bay, field notebook, ruler, compass, hand lens, grain-size charts, shovel, trenching tool, hoe, weather station, leaf blower, sieves, weighing balance, pencils and erasers, lunch, sunscreen, hat, lots of water.

Activities in the Field:
- Potholes and scaling a river
- Mapping and describing a dune, using GPS.
- Simulating Aeolian processes and dunes.
- Determining a grain size distribution of the local sands.
- Field sketching and note-taking.
- Plotting a topographic cross section.
- Investigating wave processes at a shoreline.
- Tracking sediment displacement and experimenting with artificial barriers.
- Measuring weather changes and land and water surface temperatures.
- Collect data in the field that either supports or refutes the hypothesis that current conditions at the lakeshore ...

Group activities:
Each group will do a series of activities from the list below (in different order):

- Making dunes with a wind machine. Observing ripple marks in a stream.
- Doing a grain size distribution determination for a sand sample.
- Measuring winds, temperatures of the air and land and water surfaces.
- Observing waves and their relationship to wind.
- Mapping and measuring dunes.
- Describing dune and beach cross sections and changes along the shore.
- Observing waves and their relationship to wind.
- Longshore sediment movement experiment
- Mapping and measuring dunes using GPS.

Spreadsheets:

Weather conditions at Great Sand Bay
Grain size distributions
Terminal velocities and grain size
Longshore experiment results

Hints and Other Things to Consider - *You don't have to answer any of these questions specifically, but thinking about them will help you to formulate a response to the problem*:

- How is the Keweenaw different from areas of active dunes?
- What is the likely source of sand for the area?
- What explains the winds in this place?
- What controls the land and water temperature? How does it differ during winter and summer, day and night?
- What explains the near shore topographic profile?
- Could changing lake levels influence dune formation?
- How would conditions be different 10,000 years ago in this place?
- Would you expect the size of dunes to be related to the strength of the wind?
- How would the shoreline be affected by stronger winds?
- What does observations of artificial dune formation teach you about real dunes?
- Where would you go, and what would you study, to gather additional information?
- What does the size of sedimentary particles reflect the origin of the sediment?
- Is the geologic map of the area helpful?

Anticipated Outcomes - *As a result of the day's activities you may be able to do the following*:

- Learn how to make sketches of geologic features.
- Learn how to locate yourself and identify features on a topographic map.
- Learn how to use a Brunton-type compass and hand lens.

- Learn how to take field notes.
- How to collect weather data.
- Identify quartz, feldspar and other minerals in sands.
- How to simulate sand dunes with an artificial wind.
- Interpret when dust storms and sand storms and even haze and smoke conditions are favorable.
- Relate sedimentary rocks to a source region.
- Understand how this shoreline might relate to others in Michigan.

What to Turn In - *Turn in all materials to the instructors before the after-dinner meeting (8pm)*:

Field Notebook

Topographic Map - *labeled and with cross-section*

Written Summary - Use your written summary to describe the data collected and how it either supports or refutes the hypothesis you develop in response to the problem for the day. Make sure your written summary includes the following components.

- *Problem statement* - State the problem for the day.
- *Methods* - Describe the activities you performed during the day to develop a hypothetical response to the problem.
- *Observations* - Describe the data you collected in the field and the information you gathered from the field library or course instructors. Reference all sources of published or verbal information.
- *Interpretations* - Describe the interpretations that you formulated based on the data or information you collected.
- *Hypothesis* - State your hypothesis developed in response to the problem. It should be clear to the reader that your hypothesis is a natural outgrowth of your observations and interpretations so make sure that the preceding sections of the summary build to the concluding hypothesis.
- *Tests* - In this section describe the types of data or other information that could be collected (given sufficient time) to test the hypothesis you propose.

Data - turn in completed spreadsheets and any plotted data

Learning Log - Review the "Anticipated Outcomes" listed above. For each outcome that is associated with a skill, please rate your competence at performing tasks requiring that skill. For each outcome that is associated with a concept, please rate your understanding of the concept and its potential implications.

Please use a 1-5 numerical scale to rate your proficiency, with 1 being low (don't understand, low confidence in learned skill) and 5 being high (concept is well understood, confident that you can accurately use the skill)

Day 2: Black and Red rocks: Calumet, Eagle River and (mainly) Horseshoe Harbor

Problems: What role do microbes play in forming geologic deposits? How can biological and sedimentological features in rocks tell us about earth's ancient environments? How do we know how old rocks are? How does this very different, very ancient environment inform our current understanding of living on earth?

Necessary Background Information: Schaetzl Ch 12

- Earth history timeline; Deep time, unconformities.
- Basic divisions of rocks (igneous, metamorphic, sedimentary)
- Rift geology, red and black rocks
- Derivation and transport of sediments
- Formation of sedimentary rocks: clastic versus chemical
- Basic mineralogy: quartz, feldspar, "other"
- Rodinia and the Keweenaw rift
- Oxygen, snowball earth, paleomagnetism
- "Reading" rocks, sedimentary environments, alluvial fans, debris flows
- Sedimentary features
- Stromatolites—an index fossil?
- Radiometric dates
- Fossils and the fossil record
- Energy and grain size in sediments
- Basic tools: topographic maps, geologic maps, compass, hand lens, acid, hammer

Roots and links:
It is linked to the following parts of Michigan Earth Science Content: E2.1B, E2.2F, E2.4C, E3.p1B, E3.p3B, E 3.3A, E3.4A, E4,p3C, E4.1A, E5.3B, C, D, E5.3e,g, E5.4f. This day relates to Units 1, 5, 6, and 7 in District learning outcomes for Science 8.

The sources for web based linkages are on your laptop under **Day 2**.

Required Materials: Topographic map and airphotos of Copper Harbor area, field notebook, ruler, compass, hand lens, jacob's staff, acid bottle, grain-size charts, pencils and erasers, lunch, sunscreen, hat, lots of water.

Activities in the Field:

- Beach profile description, compare with Great Sand Bay
- Geologic mapping, strike and dip.
- Compiling a stratigraphic section. Paleoenvironment identification.
- Cyanobacteria in fossil and living form
- Mineral and rock identification.
- Visualizing geologic time; Radioactivity discussion (lunch event)

Web based linkages:

http://serc.carleton.edu/quantskills/activities/popcorn.html

http://serc.carleton.edu/quantskills/activities/MandMModel.html

Spreadsheets:

- Geological time
- Stratigraphic section
- Pebble, Cobble size, types
- Weather data
- Climate Spread Houghton

Hints and Other Things to Consider - *You don't have to answer any of these questions specifically, but thinking about them will help you to formulate a response to the problem*:

- How do we know that stromatolites were once alive?
- What does the presence of cyanobacteria mean in this context?
- When were these clastic sedimentary rocks deposited (i.e., how old are the rocks), in millions of years?
- What kinds of rock are included in the conglomerate?
- What is the significance of the red color of the Copper Harbor formation (and Freda and Jacobsville Sandstones)?
- Where are older rocks exposed in Michigan that might have supplied sediments to these deposits?
- Is it possible to determine what happened here between the Precambrian and the Pleistocene?
- What process(es) formed the Precambrian/Pleistocene contact we see today?
- What does the contact at Eagle River represent, with respect to rifting?
- Are any places on earth devoid of life now?
- Does the Keweenaw Rift basin have anything to do with Lake Superior?
- Where would you go, and what would you study, to gather additional information about these questions?
- Was the climate colder or warmer at the time the Copper Harbor Conglomerate was deposited?
- Is the geologic map or the airphotos of the area helpful?

Anticipated Outcomes - *As a result of the day's activities you may be able to do the following*:

- Learn how to make sketches of geologic features.
- Learn how to “read” rocks, especially sedimentary environments.
- Learn how to use a Brunton-type compass and hand lens.

- Learn how to take field notes.
- Identify transitions, or contacts between different rock units.
- Identify quartz, feldspar and other minerals in rocks.
- Identify sedimentary structures and trace fossils in sedimentary rocks.
- Interpret depositional environments from sedimentary rocks.
- Relate sedimentary rocks to a source region.
- Understand links in geologic and biologic systems.
- Understand geological time, radioactive decay and geological age dates

What to Turn In - *Turn in all materials to the instructors before the after-dinner meeting (8pm)*:

Field Notebook
Topographic Map - *labeled beach profile w/ comparison to Great Sand Bay*
Stratigraphic Section
Written Summary - Use your written summary to describe the data collected and how it either supports or refutes the hypothesis you develop in response to the problem for the day. Make sure your written summary includes the following components.

- *Problem statement* - State the problem for the day.
- *Methods* - Describe the activities you performed during the day to develop a hypothetical response to the problem.
- *Observations* - Describe the data you collected in the field and the information you gathered from the field library or course instructors. Reference all sources of published or verbal information.
- *Interpretations* - Describe the interpretations that you formulated based on the data or information you collected.
- *Hypothesis* - State your hypothesis developed in response to the problem. It should be clear to the reader that your hypothesis is a natural outgrowth of your observations and interpretations so make sure that the preceding sections of the summary build to the concluding hypothesis.
- *Tests* - In this section describe the types of data or other information that could be collected (given sufficient time) to test the hypothesis you propose.

Learning Log - Review the "Anticipated Outcomes" listed above. For each outcome that is associated with a skill, please rate your competence at performing tasks requiring that skill. For each outcome that is associated with a concept, please rate your understanding of the concept and its potential implications.

Please use a 1-5 numerical scale to rate your proficiency, with 1 being low (don't understand, low confidence in learned skill) and 5 being high (concept is well understood, confident that you can accurately use the skill)

Day 3 Quincy Mine, Huron Creek: Human impact on Earth's surface

Problems: What controls the temperature in a mine? What role does a river play in nature?

Necessary Background Information: Schaetzl Ch 12, 15 and 16

- Earth's internal Heat- a classic geopuzzle
- Earth's hydrological and tectonic systems, where do they meet?
- Heat and copper deposits—models of ore formation
- Heat, time, plate boundaries
- Earth's geothermal gradient, continents and oceans
- Mining techniques—nature of ore and "poor rock"
- Geometry of the mines
- Mineral properties
- Geothermal energy: where are when?
- The water table and water in mines, connate water
- Water chemistry, water quality
- River systems and linkages to groundwater
- Residence time
- Landfills and garbage—what are they and how do they work (or <u>not</u> work) ?
- Paving paradise—so what?

Roots and links:
It is linked to the following parts of Michigan Earth Science Content: E1.1C, E1.2A, E1.2i,j,k, E2.1B, E2.2A,B,C, E3.2c, E2.4A,B, E3.p2A, E3.2C, E4.p1B,C,D, E4.1B,C. It relates to units 5, 9 and 10 in District learning outcomes for Science 8.

The sources for web based linkages are on your laptop under **Day 3**.

Required Materials: Topographic map of Quincy Mine area and Huron Creek, field notebook, ruler, compass, hand lens, water quality tests, shovel, trenching tool, hoe, pencils and erasers, lunch, sunscreen, hat, lots of water.

Activities in the Field:

- Mine trip observations—visualization in 3D
- Temperature and vertical depth
- Stopes and the geometry of mining
- Mineral identification
- River traverse map
- Water quality tests
- Field observations in the river and along its banks
- Steam flow rates and velocities

Spreadsheets

- Temperature and depth
- Timing of mining at Quincy
- Population of Houghton County Michigan
- Chemistry, temperature of Huron Creek water with distance
- Comparison of river systems

Hints and Other Things to Consider - *You don't have to answer any of these questions specifically, but thinking about them will help you to formulate a response to the problem*:

- How can the Quincy mine have a permanent sign which tells the temperature in the mine that applies all year?
- Can geothermal principles be used for both heating and cooling?
- How is the Quincy Mine linked to the environment around it? How does it impact life in Hancock and Houghton?
- What controls the water table?
- How does Huron Creek compare with other river systems?
- What percentage of the stream's length is unaffected by man's activity?
- What is a natural system?
- How is Huron Creek linked to the environment around it? How does it impact life in Hancock and Houghton?

Anticipated Outcomes - *As a result of the day's activities you may be able to do the following*:

- Visualize the subsurface
- Understand water tables and how they relate to rivers and lakes
- Consider the economics of geothermal heat sources anywhere
- Identify some common minerals
- Understand river systems
- Understand landfills and what makes them "work"
- Think about water chemistry and citizen science

What to Turn In - *Turn in all materials to the instructors before the after-dinner meeting (8pm)*:

Field Notebook
Topographic Map - *with labels*
Written Summary - Use your written summary to describe the data collected and how it either supports or refutes the hypothesis you develop in response to the problem for the day. Make sure your written summary includes the following components.

- *Problem statement* - State the problem for the day.
- *Methods* - Describe the activities you performed during the day to develop

a hypothetical response to the problem.

- *Observations* - Describe the data you collected in the field and the information you gathered from the field library or course instructors. Reference all sources of published or verbal information.
- *Interpretations* - Describe the interpretations that you formulated based on the data or information you collected.
- *Hypothesis* - State your hypothesis developed in response to the problem. It should be clear to the reader that your hypothesis is a natural outgrowth of your observations and interpretations so make sure that the preceding sections of the summary build to the concluding hypothesis.
- *Tests* - In this section describe the types of data or other information that could be collected (given sufficient time) to test the hypothesis you propose.

Data - turn in your graphs showing: temperature vs depth (include your value for calculated geothermal gradient) and river characteristics over distance

Learning Log - Review the "Anticipated Outcomes" listed above. For each outcome that is associated with a skill, please rate your competence at performing tasks requiring that skill. For each outcome that is associated with a concept, please rate your understanding of the concept and its potential implications.

Please use a 1-5 numerical scale to rate your proficiency, with 1 being low (don’t understand, low confidence in learned skill) and 5 being high (concept is well understood, confident that you can accurately use the skill)

Day 4 Gay, Torch Lake and Owl Creek stamp sand locations: Mining Wastes and the environment

Problems: How does longshore drift influence the distribution of sediment (and Pollutants) along the shore? Why can a point source of contamination not affect all nearby points equally? Why is this of importance?

Necessary Background Information: Schaetzl Ch 12, 14 and 19

- Mining processing sequence: find ore, blast scoop, move it to mill, crush, separate, carry waste rock away in moving water and dump it into tailings pond.
- Alluvial fans
- Tailings and stamp sands
- Native Copper, sulfide and arsenate ores and why that matters
- Chemistry and weathering—sulfide to acid
- Fluvial sediments and their deposition
- Sluicing processes, dump it in the lake
- The Ekman Spiral and Coriolis
- Lake currents in a round lake and in Lake Superior
- Erosion patterns and rates
- Superfund sites
- Remediation of stamp sands
- Known environmental effects of stamp sands
- Unresolved issues

Roots and links:
It is linked to the following parts of Michigan Earth Science Content: E1.1D, E2.4B, E2.4d, E3.p1C, E4.p1B,C, E4.1B,C, E4.2A, E4.2f. It relates to unit 1, 9 and 10 in District learning outcomes for Science 8.

The sources for web based linkages are on your laptop under **Day 4**.

Required Materials: Topographic map of Gay Sands, Torch Lake Sands and Owl Creek Sands, field notebook, ruler, compass, hand lens, grain-size charts, shovel, trenching tool, hoe, weather station, water pump and hoses, sieves, weighing balance, pencils and erasers, lunch, sunscreen, hat, lots of water.

Activities in the Field:

- Map shoreline topographic profiles and locations, compare with airphotos at various dates
- Simulate sluicing process with water pump system
- Describe cross sectional sediment sections and discuss interpretive ideas
- Measure currents with floating devices and measure sand movement rates
- Collect weather measurement set and temperatures over surface and water

- Observe coastal barriers, discuss future effects
- Test local water and groundwater
- Do water table investigations and sample pore water of stamp sands for tests

Spreadsheets

Fan width with time
Weather observations
Current movement data

Hints and Other Things to Consider - *You don't have to answer any of these questions specifically, but thinking about them will help you to formulate a response to the problem*:

- We can see the changes in stamp sand distributions along the shoreline, but what are the likely changes at depth?
- How does erosion of the sands proceed? How do rates relate to seasons and weather events?
- How do stamp sands compare to the sands at Great Sand Bay? What explains the difference?
- Why are the stamp sands barren and unvegetated even after decades?
- What are some ways of determining ecological health?
- Compare stamp sand sites in Lake Superior, Torch Lake and at Owl Creek. Which are more hazardous to the environment?

Anticipated Outcomes - *As a result of the day's activities you may be able to do the following*:

- Understand mining practices and their links to environmental issues
- Understand the differences between toxic and non toxic pollutants
- Understand mobility of sediments and fluvial erosion
- Learn how to make sketches of geologic features.
- Learn how to "read" rocks, especially sedimentary environments.
- Learn how to use a Brunton-type compass and hand lens.
- Learn how to take field notes.
- Identify transitions, or contacts between different rock units.

What to Turn In - *Turn in all materials to the instructors before the after-dinner meeting (8pm)*:

Field Notebook
Topographic Map *- with labels*
Written Summary - Use your written summary to describe the data collected and how it either supports or refutes the hypothesis you develop in response to the problem for the day. Make sure your written summary includes the following components.

  - *Problem statement* - State the problem for the day.

- *Methods* - Describe the activities you performed during the day to develop a hypothetical response to the problem.
- *Observations* - Describe the data you collected in the field and the information you gathered from the field library or course instructors. Reference all sources of published or verbal information.
- *Interpretations* - Describe the interpretations that you formulated based on the data or information you collected.
- *Hypothesis* - State your hypothesis developed in response to the problem. It should be clear to the reader that your hypothesis is a natural outgrowth of your observations and interpretations so make sure that the preceding sections of the summary build to the concluding hypothesis.
- *Tests* - In this section describe the types of data or other information that could be collected (given sufficient time) to test the hypothesis you propose.

Data - turn in completed spreadsheets and any plotted data

Learning Log - Review the "Anticipated Outcomes" listed above. For each outcome that is associated with a skill, please rate your competence at performing tasks requiring that skill. For each outcome that is associated with a concept, please rate your understanding of the concept and its potential implications.

Please use a 1-5 numerical scale to rate your proficiency, with 1 being low (don't understand, low confidence in learned skill) and 5 being high (concept is well understood, confident that you can accurately use the skill)

Day 5 Pedagogy Day to be held in room 610 of Dow Building

Coordinated by Bill Smith, GRPS

Day 6 Sleeping Bear Point, Sleeping Bear National Lakeshore

Problems: What special teaching value does a site with a deep sense of place offer? Can you teach better in this context?

Necessary Background Information: (Schaetzl Chapters 18, 26 and 35)

- Oral Histories of Indigeous people
  - Hiawatha
  - Sleeping Giant, Face in the Rock, Sleeping Bear
  - Do the stories inform us as scientists?
  - Overlap of glacial retreat and Indigenous people
  - Fire history—wild fires and man
- Active dune conditions—how to define them

Roots and links:
It is linked to the following parts of Michigan Earth Science Content: E1.2A, B, K, E2.4B, E3.p1A,C. It relates to unit 1, 9 and 10 in District learning outcomes for Science 8.

The sources for web-based linkages are on your laptop under **Day 6**.

Required Materials: Topographic map of Sleeping Bear Point, field notebook, ruler, compass, hand lens, grain-size charts, pencils and erasers, lunch, sunscreen, hat, lots of water.

Activities in the Field:

- Map shoreline topographic profiles and locations.
- Describe cross sectional sediment sections and discuss interpretive ideas
- Measure scale of dunes

Hints and Other Things to Consider - *You don't have to answer any of these questions specifically, but thinking about them will help you to formulate a response to the problem*:

- What does the analogy of a sleeping bear add to understanding of dunes and dune formation?
- How does erosion of the sanddunes procede? How do rates relate to seasons and weather events?

- Can you see effects of human impact on the pristine eenvironment of the SBD? What should be management policy about this?
- Are these dunes too large for the wind conditions that occur along the Michigan shore today? How would one establish the age of these dunes?
- What are some ways of determining ecological health?
- What makes a national park?

Anticipated Outcomes - *As a result of the day's activities you may be able to do the following*:

- Understand the power of place
- Think about bridging between science and culture

Week 2 Day 1: Michigan Natural Storage Company, Grand Rapids

Problem: What evidence is there to support or refute the hypothesis that the rocks exposed in the gypsum mine formed in an ocean environment?

Necessary Background Information: (Schaetzl Chapters 4 and Appendix)

- Earth history timeline; Deep time, unconformities.
- Basic divisions of rocks (igneous, metamorphic, sedimentary)
- Derivation and transport of sediments
- Formation of sedimentary rocks: clastic versus chemical
- Basic mineralogy: dolomite, gypsum, "other"
- “Reading” rocks, sedimentary environments, continental vs marine
- Sedimentary features
- Fossils and the fossil record
- Energy and grain size in sediments
- Basic tools: Jacob staff, hand lens, acid, hammer

Roots and links:
It is linked to the following parts of Michigan Earth Science Content: E1.1A-DE1.2C, E2.1B, E2.2A, C, D, E3.p1A, E3.p1B, E3.p1C, E4.p1A, E4.p2B, E4.p3A, E4.p3C, E4.1A, E5.4f.

It is linked to the following parts of the GRPS 8th grade syllabus: : E1.1A-D, E.1h, E1.2B, E1.2k, E5.3C.
This day is linked to *Earthcomm’s* Understanding Your Environment - Bedrock Geology, Chapter 1, Activity 1 (Sedimentary Rocks) and Earth’s Natural Resources – Mineral Resources, Chapter 2 (all acivities).

The sources for web-based linkages are on your laptop under **Week 2 Day 1**

Web based linkages:

U.S. Geological Survey Gypsum Statistics and Information http://minerals.usgs.gov/minerals/pubs/commodity/gypsum/index.html#myb

Gypsum
http://www.geo.msu.edu/geogmich/gypsummining.html

Required Materials: Jacket, hat, second pair of shoes, plastic bag, flash light or head lamp, field notebook, ruler, compass, hand lens, Jacob staffs or meter sticks, graph paper, pencils and erasers, lunch.

Activities in the Field:

- Compiling a rock section
- Visualizing geologic time
- Mineral and contact identification
- Paleoenvironment identification
- Field sketching and note-taking
- Reading the rocks
- Plant and animal fossils

Group activities:
Teachers will work in groups of three and be accompanied by one of the faculty. Each teachers should record their own observations and collaborate within their group to construct a more comprehensive interpretation.
Each group will do a series of activities from the list below:

- Describing layered rocks in cross sections.
- Identification of sedimentary minerals and rocks.
- Speculating on the environment where rocks form.

Spreadsheets

Geologic time
Michigan stratigraphic section

Hints and Other Things to Consider - *You don't have to answer any of these questions specifically, but thinking about them will help you to formulate a response to the problem:*

- How do we know that the layers formed in a marine environment?
- What does the presence (or absence) of fossils mean in this context?
- When were these sedimentary rocks deposited (i.e., how old are the rocks), in millions of years?
- How much water is needed to precipitate this much chemical sediment?
- Compare the age of these rocks/fossils to what you observed the UP. What does this suggest about the biological complexity of earth over time.
- Where are older rocks exposed in Michigan that might have supplied sediments to these deposits?
- Where would you go, and what would you study, to gather additional information about these questions?
- Where (what latitude) was "Michigan" when these rocks formed and how might that be significant?
- How was "North America" different when these rocks formed and how might that be significant?

- How can gypsum of the same age be mined north of Detroit?
- Why doesn’t the Grand River flood the mine?
- How much gypsum do you need for your lifetime and how is it used? How many feet of the mine are needed to meet your lifetime need?
- How does the temperature of the mine differ from what you measured in the UP? Why?
- How could the mine be used to lower the energy needs of nearby citizens?

Anticipated Outcomes - *As a result of the day's activities you may be able to do the following:*

- Learn how to record data contained in layered rocks.
- Learn how to locate yourself in a mine.
- Learn how to take field notes.
- Identify shale, dolostone, gypsum. And classify these rocks as clastic or chemical.
- Relate rock type, sedimentary structures, and fossils to potential environments in which rocks form.
- Understand how tectonics and climate might influence the rocks that form (and that we now see in Michigan).

What to Turn In - *Turn in all materials to the instructors before the after-dinner meeting (8pm)*:

Field Notebook
Topographic Map *- with labels*
Written Summary - Use your written summary to describe the data collected and how it either supports or refutes the hypothesis you develop in response to the problem for the day. Make sure your written summary includes the following components.

- *Problem statement* - State the problem for the day.
- *Methods* - Describe the activities you performed during the day to develop a hypothetical response to the problem.
- *Observations* - Describe the data you collected in the field and the information you gathered from the field library or course instructors. Reference all sources of published or verbal information.
- *Interpretations* - Describe the interpretations that you formulated based on the data or information you collected.
- *Hypothesis* - State your hypothesis developed in response to the problem. It should be clear to the reader that your hypothesis is a natural outgrowth of your observations and interpretations so make sure that the preceding sections of the summary build to the concluding hypothesis.
- *Tests* - In this section describe the types of data or other information that could be collected (given sufficient time) to test the hypothesis you propose.

Data - turn in completed spreadsheets and any plotted data

Learning Log - Review the "Anticipated Outcomes" listed above. For each outcome that is associated with a skill, please rate your competence at performing tasks requiring that skill. For each outcome that is associated with a concept, please rate your understanding of the concept and its potential implications.

Please use a 1-5 numerical scale to rate your proficiency, with 1 being low (don’t understand, low confidence in learned skill) and 5 being high (concept is well understood, confident that you can accurately use the skill)

Week 2 Day 2: Flood History of the Grand River, Grand Rapids (downtown Grand Rapids and National Weather Service)

Problem: What evidence is there to support or refute the hypothesis that people should be concerned about flooding on the Grand River?

Necessary Background Information: (Schaetzl Chapters 15 and 19)

- What factors influence the amount of water in a river ?
- What factors cause a river to flood?
- Basic tools: velocity meter, graphing paper, topographic maps, levels, measuring tapes.

Roots and links:
It is linked to the following parts of Michigan Earth Science Content:E1.1A-DE1.2C, E2.1B, E2.2A, C, D, E3.p1A, E3.p1B, E3.p1C, E4.p1A, E4.p2B, E4.p3A, E4.p3C, E4.1A, E5.4f.

This day is linked to *Earthcomm's* Earth's Natural Resources - Water Resources Chapter 3, Activities 1-4 and Understanding Your Environment Chapter 3, Activity 3.

The sources for web-based linkages are on your laptop under **Week 2 Day 2**.

USGS Real-Time Water Data http://waterdata.usgs.gov/nwis/rt

US EPA Surf Your watershed http://cfpub.epa.gov/surf/locate/index.cfm
New Perspectives on the 1904 Flood in Grand Rapids, Michigan
http://www.gvsu.edu/geology/index.cfm?id=72561D13-A242-1336-A866971D1F58EA6D

Teaching Floods And Flooding Quantitatively
http://serc.carleton.edu/quantskills/methods/quantlit/floods.html

Snowmelts and Floods
https://pumas.gsfc.nasa.gov/examples/index.php?id=76

National Weather Service Climate - Past Weather (F6 data)
http://www.crh.noaa.gov/grr/climate/

USGS Flood hazard http://www.usgs.gov/hazards/floods/

Required Materials: Grand Rapids West 7.5' topographic map of, field notebook, ruler, compass, clinometers, pencils and erasers, sunscreen, hat, lots of water, lunch.

Activities in the Field:

- Measure stream velocity.
- Calculate discharge and compare with other estimates.
- Observing natural river landforms and contrast with human modifications.
- Using a model to evaluate which factors have the greatest influence on the runoff footprint of a watershed.
- Identify human modifications to rivers to mitigate floods.
- Using a topographic map build a flood-safe community.
- Interpreting hydrographs.

Activities at the National Weather Service Office:

- Construct a profile of the Grand River in an urban environment.
- Estimate the discharge of the Grand River.
- Identify human modifications of the Grand River channel and speculate on how these changes influence flood frequency and/or severity.
- Construct a flood-frequency curve to estimate the frequency of major floods.

Group activities:
Each group will do a series of activities:

- Construct a profile of the Grand River in an urban setting.
- Measure stream velocity.
- Calculate discharge and compare with other estimates.
- Observing natural river landforms and contrast with human modifications.

Spreadsheets:

Hydrographs
Flood frequency

Hints and Other Things to Consider - *You don't have to answer any of these questions specifically, but thinking about them will help you to formulate a response to the problem:*

- How is the Grand River different from the rivers studied in Week 1?
- Should the federal government force the city of Grand Rapids to extend the existing floods walls vertically? How much?
- What is the government's role in assisting home owners that get flooded each spring?
- How can you use today's activities in your classroom?

- Do hurricanes influence the flood hazard in Michigan?
- Describe a worse-case scenario that results in a 100-year (or larger) flood in Grand Rapids.
- How can the Grand River continue to flow in “dry” months like August?
- Does potential flood hazard influence home values?
- How has changes in land use influenced the severity of flooding on the Grand?

Anticipated Outcomes - *As a result of the day's activities you may be able to do the following:*

- Learn how to make profiles of natural or man-made features.
- Learn how to locate yourself and identify features on a topographic map.
- Learn how to use a flow meter.
- Learn how to take field notes.
- How to collect discharge data.
- How to model river and flood data graphically.
- Interpret flood data to estimate severity and frequency of major floods.
- Relate weather events to river behavior.
- Discuss how humans introduce imbalance to natural systems.

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