Enhanced Earth System Teaching through Regional and Local (ReaL) Earth Inquiry

Ross, R.M., Duggan-Haas, D., Kissel, R.A., Auer, S.L., Besemer, C., Chapman, E.S.
Paleontological Research Institution, 1259 Trumansburg Road, Ithaca, NY 14850

Grant DRL 0733303

Teaching Earth system science presents unique challenges to inquiry-based methods because the subject matter is often found outside of classroom walls and is unique to each community. Furthermore, student investigations of Earth systems in their community require that educators possess the sufficient content knowledge to engage learners in open inquiry, observations, and analysis.

Through *Enhanced Earth System Teaching through Regional and Local (ReaL) Earth Inquiry*, a professional development (PD) and curriculum materials development project funded by the National Science Foundation (NSF DRL 0733303), **we are developing an approach oriented around place-based observation and analysis that employs**
(1) a "virtual fieldwork experience" (VFE) approach to engaging students,
(2) teacher-friendly content resources that facilitate interpretation of local examples, and
(3) teacher PD programs in each region to foster implementation and prototype our approaches.

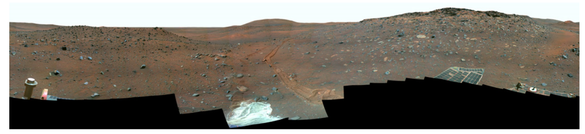
VIRTUAL FIELDWORK EXPERIENCES

Fieldwork is crucial to geology education, yet in 2006, 24% of Earth science teachers were not Earth science certified (CCSSO, 2009). Is it reasonable to expect teachers who have not had field experience themselves to lead meaningful fieldwork for their students? Fieldwork is a core activity for applying inquiry to real-world scenarios. How can we support teachers in using local and regional geology to teach Earth science in an inquiry-based way?

- The PD program begins with a face-to-face workshop involving fieldwork at geologically interesting sites. This provides a brief, mentored introduction to fieldwork.
- **As teachers work in the field and classroom, they also collaboratively create a virtualfieldwork experience of the field sites for use in their classrooms**.
- The program continues post-workshop through virtual study groups in which the teachers complete the VFE they began during the workshop and support each other as they create VFEs of sites near their schools.

1

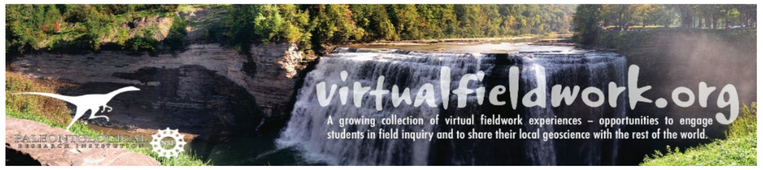
Virtual Field<u>WORK</u> involves the kind of active inquiry experienced during problem solving at actual field sites. A real-life example involving science research is the Mars Rover Expedition.



http://marsrover.nasa.gov/gallery/press/spirit/20090826a/Calypso_L257F_br.jpg

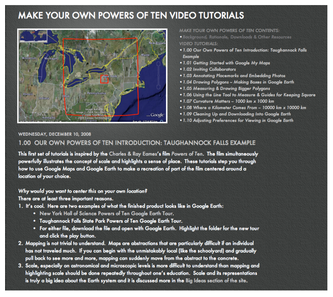
2

The question, "Why does this place look the way it does?" is an overarching question in any given virtual fieldwork context.



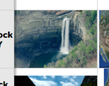
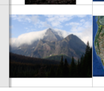
Through the collaborative process of creating a VFE of the workshop field sites, teachers learn the skills needed to create a VFE of their local site and to consider their local environment as a classroom.

VFE creation requires close study of field sites with considerations of what would be relevant to a scientist in the field. This is explicitly intended to be a step towards actual fieldwork with students.



3

Instructions for creating VFEs, including exercises focusing on scale, are available at virtualfieldwork.org.

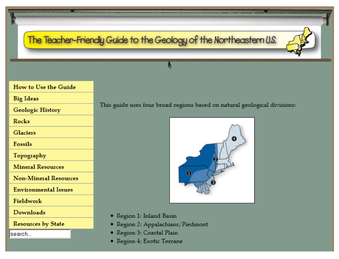
Place name (hyperlinked to teacher page)	Iconic Image	Map (sortable by latitude)	Rock Age (ISC Chart)	Landscape Type	Biome (biome map)	Rock Type (Igneous, metamorphic, sedimentary)	Minimum Elevation (m) (elevation map)	Peak Elevation (m) (elevation map)	Average January Temp (°F) (Jan. temp. map)	Average July Temp (°F) (July temp. map)	Average Annual Precip (in) (precip map)
Arbuckle Mountains, OK			Silurian Devonian Ordovician Cambrian	Folded Mountains	Prairie (wetter, taller grass) and Steppe	Sedimentary Igneous	281	374	37.8	82.2	40.66
Taughannock Falls, NY			Devonian	Plateau	Temperate Deciduous Forest	Sedimentary	116	251	19.8	66.9	36.71
Adirondack High Peaks, NY			Proterozoic	Domed Mountains	Taiga & Tundra	Metamorphic	616	1629	16.3	65.5	39.83
Cascade Mountains, OR			Quaternary Neogene (Tertiary) Paleogene (Tertiary)	Volcanic Mountains	Tundra	Igneous	980	1500	29.6	62.6	14.19
Glacier National Park, MT			Paleogene (Tertiary) Cretaceous Jurassic Proterozoic	Syncline	Tundra	Sedimentary Metamorphic Igneous	900	3000	19.4	58.90	28.26

4

As the project continues, a **database of VFEs at VirtualFieldwork.org** will grow to become a resource not only for teachers in the program but for any teacher or interested learner.

TEACHER-FRIENDLY GUIDES

The content resources being developed include a **nationwide series of "Teacher-Friendly Guides"** for teaching about regional and local Earth science. The series, available online at **TeacherFriendlyGuide.org**, will include seven guides at the end of the project: Northeastern, Southeastern, Midwestern, South Central, Rocky Moutain, Southwestern, and Western.



5

PROFESSIONAL DEVELOPMENT

6

ReaL ESS is designed and implemented with careful attention to research on effective science teacher professional development; to the science of how people learn; and to the nature of scientific inquiry.

Earth System Science: ***The Big Ideas***

Like all scientific disciplines, the Earth sciences continually evolve over time. New discoveries fuel new ideas, providing an ever-increasing understanding of the planet. But of the overwhelming number of observations, theories, and principles that form the foundation of Earth science, what is essential for every American to understand? All too often, curricula are too ambitious and, as a result, may fail to cover topics in any substantial depth. An alternative approach is to build one's curriculum upon a foundation of focused, interconnected *big ideas*. A well-designed set of big ideas can provide an all-encompassing conceptual framework for any discipline, including Earth system science. Developed alongside scientists and Earth science teachers, presented here is a set of big ideas that illuminates what is fundamental to the Earth sciences:

1. **The Earth is a system of systems.**
2. **The flow of energy drives the cycling of matter.**
3. **Life influences and is influenced by the environment.**
4. **Physical and chemical principles are unchanging and drive both gradual and rapid changes in the Earth system.**
5. **To understand (deep) time and the scale of space, models and maps are necessary.**

Critical to developing broad Earth systems science literacy is the synthesis of a concise list of principles that are essential to understanding the Earth. "What is vital for all Americans to understand about Earth?" To provide an **underlying network of literacy principles** that cut across the Earth science content of the project, we are using a set of five big ideas and two overarching questions. The **ultimate goal of the project is for students to apply an inquiry-based understanding of Earth systems to their personal lives**, thinking of and answering questions about processes in the natural world around them.