Learning Goals

Goals for the camp include:
1. 3-D visualization and how to link surface to subsurface.
2. How to gather and analyze multiscalar data.
3. Relate petroleum engineering to geologic workflows.
4. Integrate engineering, geologic and geophysical technology.

Context

Students in the course:
1. Have completed the junior year in the PE major: average age is 21.
2. Have mastered basic physics, chemistry, and basic petroleum engineering topics such as petroleum fluids, drilling, and rock properties.
3. Have been exposed to basic subsurface and structural geology in lab-based courses the previous two semesters (fall and spring).

The two previous geology courses, in addition to basic geology required of all CSM undergraduates:
1. Are applied courses taught for non-majors: emphasis varies depending on instructor.
2. Are variably field-based, depending on instructor.
3. Retention and transfer of knowledge is an issue.
4. Efforts are being made to link the previous courses to the objectives of field camp by working with instructors.
5. Field camp is likely the last academic exposure to geology for many of the students.

Materials, Data, Tools, and Logistics

Instructor-assigned groups of 3-4, students draw the field area and study 12 "properties" that include oil and gas fields studied during the two-weeks of camp. Each property has a series of geologic data sheets and questions that must be answered, using the geologic tools gathered during field camp. These tools illustrate the "geologic workflows" commonly used in the petroleum industry. Each team selects five fields for building and then selects final tools based on the data and budget available. Geology topics had to be answered using engineering questions. Students then use reservoir models to determine the amount of hydrocarbons recoverable into the field 3D reservoir. Instructors give a mini lecture on stress-strain analysis.

Acquisition Game: Tying the Experience Together

In groups of 3, students measure 100 feet of section through stacked lake shoreface deposits. In instructor-assigned groups of 3-4, students draw the field area and study 12 "properties" that include oil and gas fields studied during the two-weeks of camp. Each property has a series of geologic data sheets and questions that must be answered, using the geologic tools gathered during field camp. These tools illustrate the "geologic workflows" commonly used in the petroleum industry. Each team selects five fields for building and then selects final tools based on the data and budget available. Geology topics had to be answered using engineering questions. Students then use reservoir models to determine the amount of hydrocarbons recoverable into the field 3D reservoir. Instructors give a mini lecture on stress-strain analysis.

Assessment

Assessment during the field camp consists of:
1. Daily journals.
2. Written lab reports.
3. Results from "Acquisition Game," a comprehensive final exam that includes a 1) questionnaire about the field experience: logistical (living) and contextual questions; 2) created exercise that includes building an oil field model; 3) creating linked exercises that builds on each other; 4) retention of material taught.

Stratigraphic Pinchouts & Visualization in 3-D

An excellent outcrop of crevasse channel, splay, and fluvial meanderbelt deposits provides an opportunity for students to physically trace stratigraphic pinchouts in these dimensions. Students are assigned to different buffers beginning at different horizons on the cliff face below. As they walk around the outcrops, they make notes and take sketches to answer various questions about flow continuities. Around the back of the outcrop where everyone finishes, the teams then present their observations and interpretations to the rest of the group. For many students, this is the first time they actually draw in 3-D.

Activities

Activities center on daily outcrop-based labs related to nearby oil and gas fields. Labs are mapping, measuring outcrop oil and gas fields, thought processes, geophysical data link the outcrop to the subsurface. Two types of maps are created, a block model and a sandstone member map. Students in the first time they actually "see" it. Another lab relates student-gathered data from an outcrop facies framework to subsurface stratigraphic patterns. In a day long "Acquisition Game," teams analyze oil and gas properties based on the geology and engineering data analyzed over the two weeks.

Reservoir Continuity in Lacustrine Shoreface Deposits

In a series of exercises along the Weber Sandstone outcrop belt at Dinosaur National Park, students analyze small to large scale heterogeneities in otherwise homogeneous-appearing upper sandstone. Sketching the porous facies students attempt to observe bedding surfaces and small-offset faults. They are required to decide the cliff face exposure into possible flow units.

Fracture Analysis

In groups of three, students analyze fracture length, orientation, and spacing on a well-exposed "filed" sandstone outcrop at the Weber Sandstone. Fracture sizing is an important tool for predicting flow continuity when fracture faulting is present. The exercise is followed by a "Acquisition Game" that includes some fractures that are not discussed by the instructor during the trip. Inquiry is left to curiosity.

Challenges

Teaching non-majors presents several challenges because level of subject matter varies. Challenges related to maintaining an interest in geoscience include:
1. Forming an applied science approach; and
2. Maintaining a positive attitude toward geology and the outdoors.

Presently, we attempt to overcome these challenges by integrating pure engineering into the curriculum on several days and by breaking up the session with a geology field trip that consists of a treading excursion on the Green River through the Flaming Gorge. Geology, however, is NOT discussed by the instructor during the trip. Inquiry is left to students.

In addition, "optional" challenges include:
1. Teaching non-majors: 1) teaching 3-D visualization exercises; 2) creating linked exercises that build and integrate.
2. Assessment: 1) testing students' understanding of the exercises; 2) retention of material taught.