Learning Assessment #7 – Maps & Structures
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This assignment is the seventh of a series of in-class activities known as learning assessments. These assignments were used in an introductory physical geology course that is a requirement for geoscience majors but has no pre-requisites and is open to students in all faculties.

The purpose of the learning assessments is to provide students with frequent feedback on their understanding of the fundamental concepts taught in the course. The learning assessments also provide information to the instructors and teaching assistants on student learning which can be used to help direct instruction in the course.

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Learning Assessment #7: Geologic Structures, Maps & Cross-Sections

Background Information
The diagram on the next page depicts two rock outcrops exposed at the Earth’s surface. In each outcrop there are three distinct geologic units; shale, sandstone and limestone. Limestone is the oldest unit and shale is the youngest. The region between the two outcrops is covered by soil. A distinctive unit of sandstone occurs in both outcrops (the middle unit), between the shale and limestone. The clasts in the sandstone are graded with course sand at the bottom of the bed and fine sand at the top of the bed. The grading of clasts can be used to determine ‘way up’ direction for the rock layers or the top of the bed. This allows you to determine which unit is oldest and which is youngest in the rock outcrop diagram using the principle of superposition. The geologic contacts between the different rock units are striking NORTH-SOUTH so the true dips of the layers is shown in the outcrops (~ 45°).

Part 1: Fault Solution (9 pts): On the cross-section diagram for Part 1, sketch the units below and above the ground surface. Draw in a fault solution that would explain how the layers came to exist in the configuration seen today. Assume your fault has a steep dip of 70° and a N-S strike. **NOTE: there are two possible solutions.**

Be sure to include in your diagram:
- Labels/symbols for all the parts of the geologic structure(s) (i.e. fault plane, hangingwall, footwall, and arrows showing movement of the rocks on either side of the fault)
- Arrows showing the maximum stress direction that would have been acting on the rocks to form the fault structure
- Labels for the rock units – use Lm for limestone, Ss for sandstone and Sh for shale
- Name of the fault (in the bottom right hand corner of your diagram)

Part 2: Map Pattern for Fault Solution (11 pts): Draw all geologic units and structural features on the map for Part 2. Fill in the geology in and around the outcrops and extend the contacts to the edge of the map area, using the strike and dip and outcrop information. The trace of the rock outcrops is shown on the map to help guide your drawing of the geologic contacts. The base of the outcrops and flat ground surface is at 0 m elevation (sea level) and the 1 m contour elevation in the outcrops is shown and labeled. On your map be sure to include the following:

- The geologic contacts for limestone and sandstone & sandstone and shale across the entire map area
- Strike and dip symbols at both outcrop areas for one of the geologic contacts
- Labels/symbols for the geologic structure
- Labels in the map area for the rock units Lm, Ss and Sh
- Complete the map legend (remember the oldest map unit is at the bottom of the legend
  **Note - Be sure your map matches your cross-section**

Part 3 – Fold Solution (9 pts): On the diagram for Part 3, sketch the rock units below and above the ground surface and connect the rock layers using a fold structures. On your sketch include the following:

- Label the geologic structures (anticlines and synclines)
- Arrows showing the maximum stress direction that would have been acting on the rocks to form the structure
- Label all the parts of the geologic structure(s) (i.e. hinge zone, axial planes)
- Labels for the rock units – Lm for limestone, Ss for sandstone and Sh for shale

Reid et al. (2011)
Learning Assessment #7 (FAULT Solution)

Fault type: _________________


Reid et al. (2011)
Learning Assessment #7 – Part 2 (Map Pattern for Fault solution)

Legend
Rock Units

Geologic Map Symbols

Reid et al. (2011)
Learning Assessment #7 – Part 3 (FOLD Solution)


Fold type: _______________________________  
Reid et al. (2011)
LEARNING ASSESSMENT #7 (MAPS & STRUCTURES) STUDENT CHECKLIST

Part 1: Cross-section – Fault Solution (9 pts)
____ units are extended above and below ground to the fault plane drawn
____ steep dipping fault (~ 70°) is drawn between outcrops
____ hangingwall is labelled
____ footwall is labelled
____ arrows show movement of both hangingwall and footwall
____ fault is correctly named
____ layers Lm, Ss and Sh are correctly drawn on hangingwall side
____ layers Lm, Ss and Sh are correctly drawn on footwall side
____ principle stress directions drawn consistent with type of fault

Part 2: Map and Legend (11 pts)
____ at least one strike and dip symbol is drawn for units on footwall side
____ at least one strike and dip symbol for units on hanging wall side
____ contacts are fully extended across the entire map area to the boundaries
____ correct orientations of contacts are drawn (with correct strike direction)
____ v-pattern drawn on outcrops
____ layers Lm, Ss and Sh are correctly labelled on the map
____ fault trace is drawn on map
____ fault trace is given proper map symbol
____ rock units on legend is correctly labelled in order
____ geologic symbols are indicated in legend (strike and dip, geologic contact, fault trace)
____ cross-section and map are consistent

Part 3: Cross-section – Fold Solution (9 pts)
____ units are extended above and below ground
____ fold pair is properly drawn to connect outcrops (2 pts)
____ anticline is labelled
____ syncline is labelled
____ axial plane for anticline is drawn correctly
____ axial plane for syncline is drawn correctly
____ hinge zones are identified / labelled
____ principle stress directions drawn
____ name of fold (describing their geometry) is given