

# Learning Assessment #7 – Maps & Structures

Reid, L.F.<sup>1</sup>, Cowie, B.R.<sup>1</sup>, Cubley, J.F.<sup>2</sup>, Speta, M.<sup>3</sup> (2011)

<sup>1</sup>*Department of Geoscience, University of Calgary*

<sup>2</sup>*School of Mining & Technology, Yukon College*

<sup>3</sup>*Department of Earth & Atmospheric Sciences, University of Alberta*

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.

*Corresponding author:*

Dr. Leslie Reid  
Associate Dean (Teaching and Learning)  
University of Calgary Faculty of Science  
lfreid@ucalgary.ca

## 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 coarse 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:

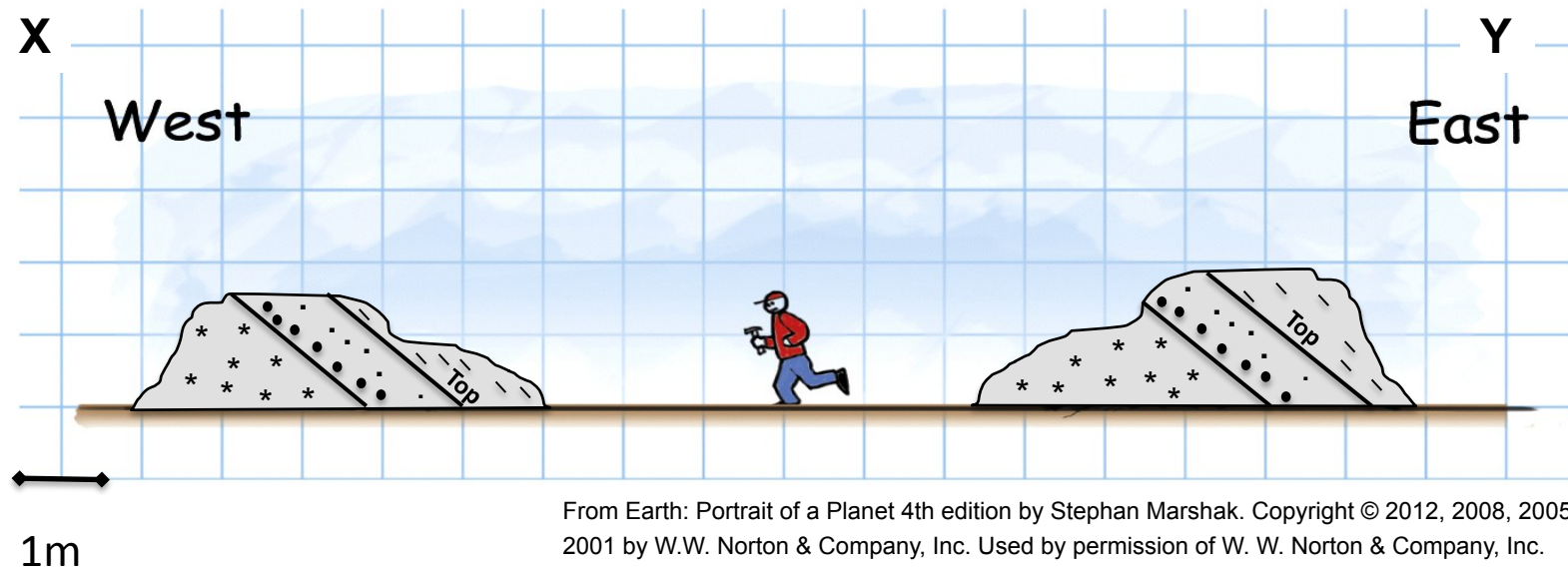
- Label the geologic structures (anticlines and synclines)
- Arrows showing the maximum stress direction that would have been acting on the rocks to form the structure
- Label all the parts of the geologic structure(s) (i.e. hinge zone, axial planes)
- Labels for the rock units – Lm for limestone, Ss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

Last Name: \_\_\_\_\_

First Name: \_\_\_\_\_

ID: \_\_\_\_\_

## Learning Assessment #7 (FAULT Solution)



Fault type: \_\_\_\_\_

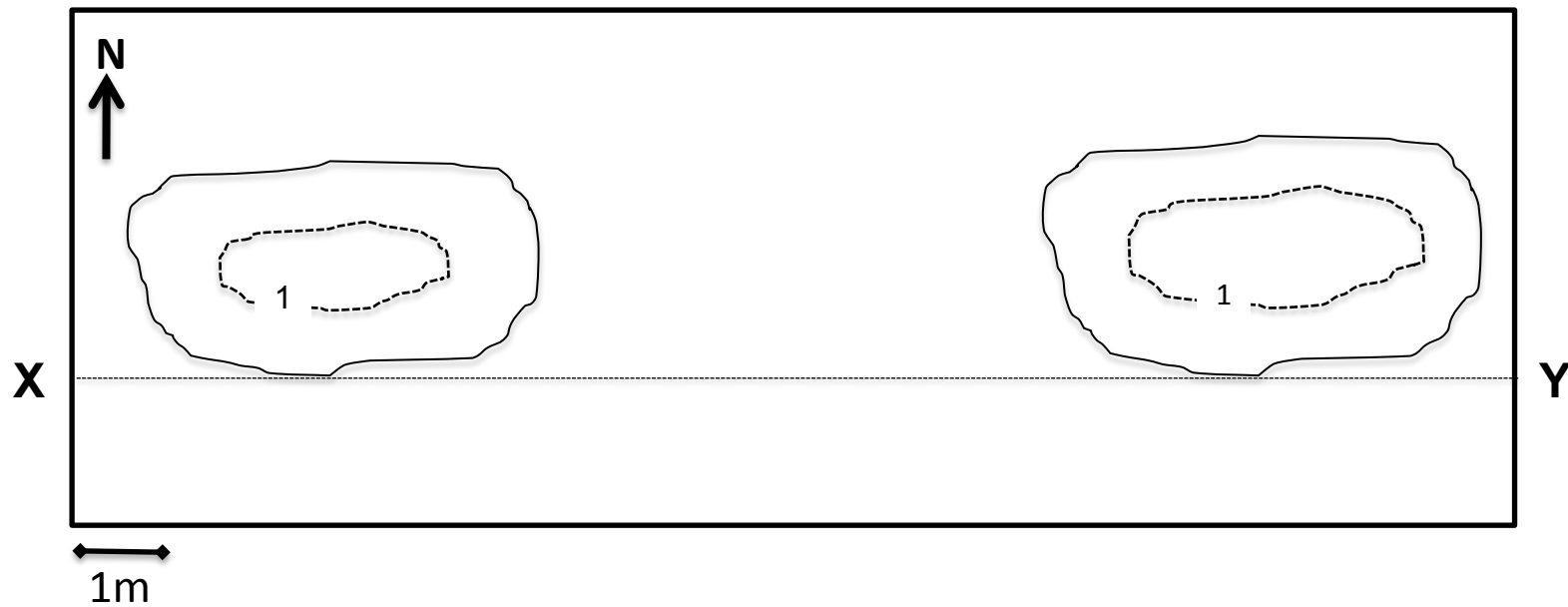
Reid et al. (2011)

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## Learning Assessment #7 – Part 2 (Map Pattern for Fault solution)



### Legend

Rock Units



### Geologic Map Symbols

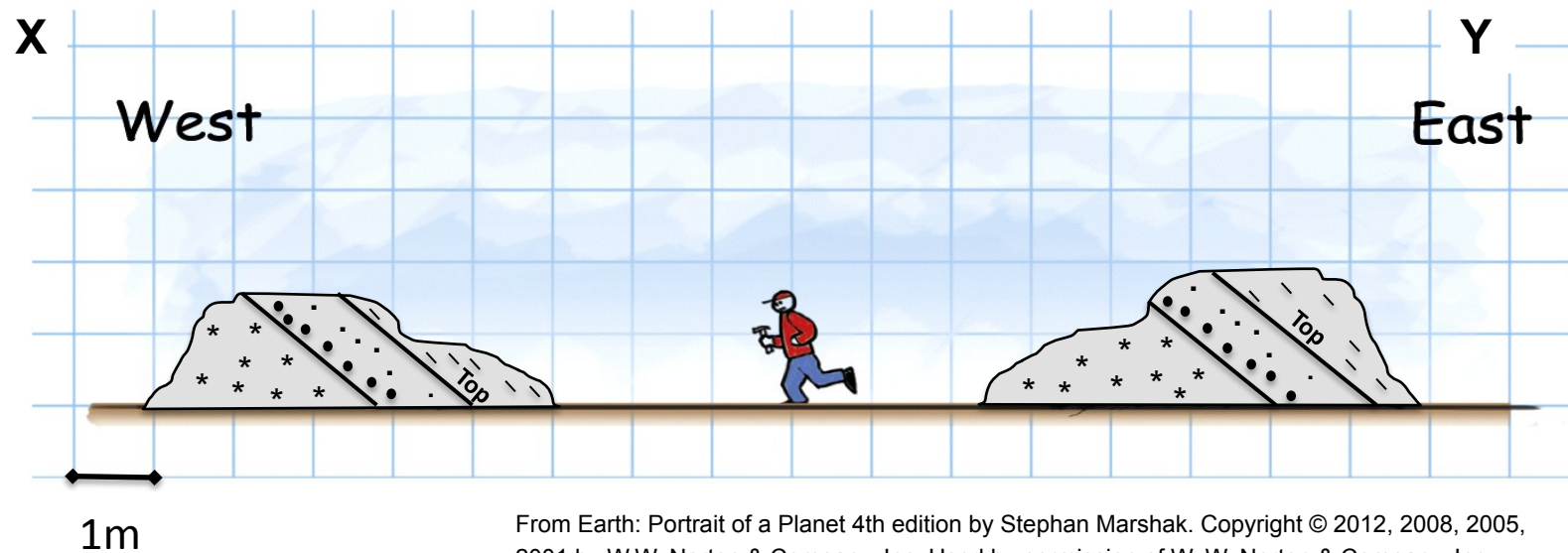
Reid et al. (2011)

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## Learning Assessment #7 – Part 3 (FOLD Solution)



From Earth: Portrait of a Planet 4th edition by Stephan Marshak. Copyright © 2012, 2008, 2005, 2001 by W.W. Norton & Company, Inc. Used by permission of W. W. Norton & Company, Inc.

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 ( $\sim 70^\circ$ ) 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