

Virtual Landscapes

Geoscience Education in Digital Environments

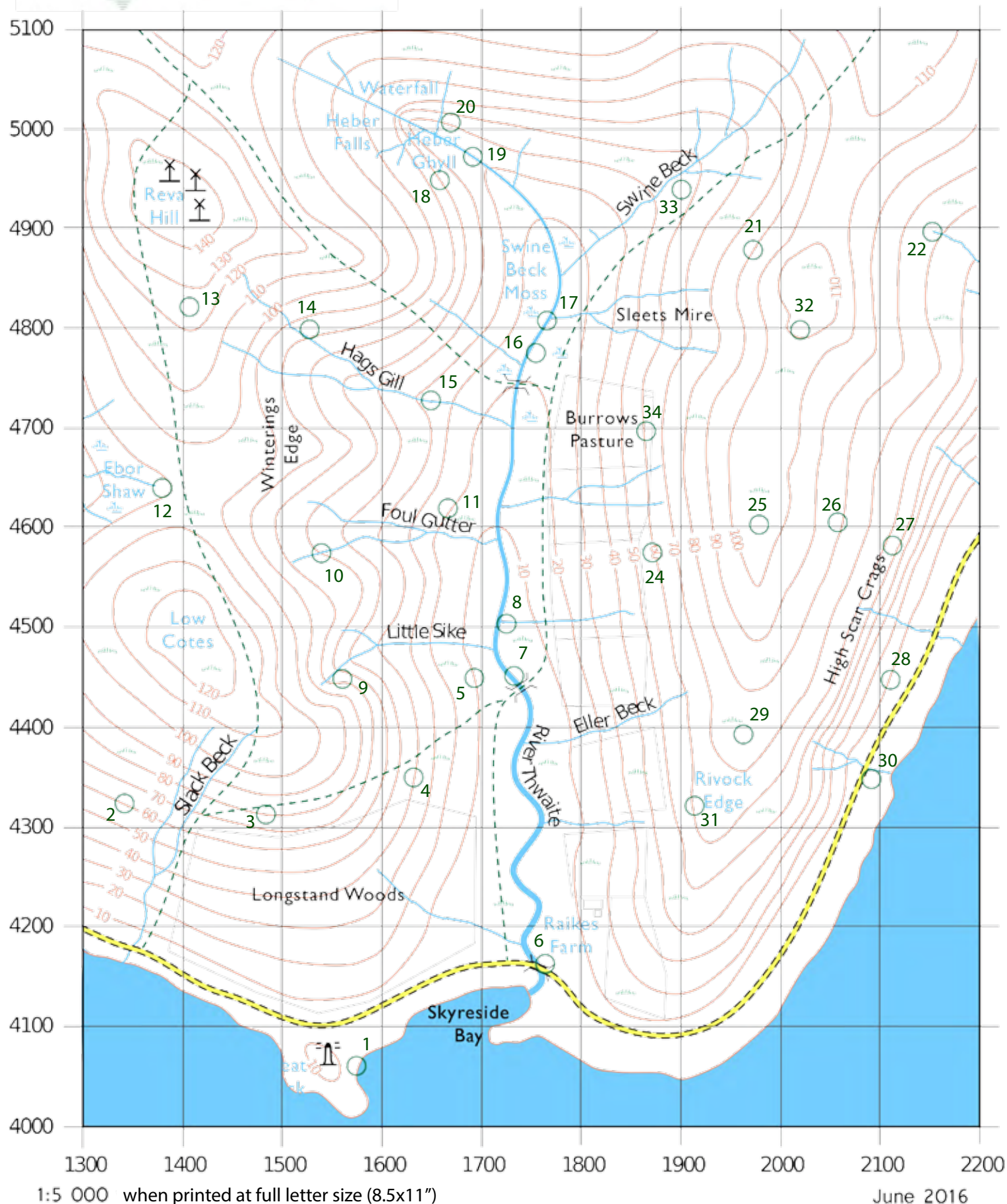
Lighthouse Bay basemap
resized to 8.5 x 11" (Letter)
1:5000

Geo420k Trip 4 Exercise

UNIVERSITY OF LEEDS

Fieldslip for geological mapping exercise.

<http://www.see.leeds.ac.uk/virtual-landscapes/schools>



Geo420k Virtual Field Trip 4: Lighthouse Bay Exercise

(with special thanks to the [Virtual Landscapes](#) team at University of Leeds)

Equipment from your 420k supply kit:

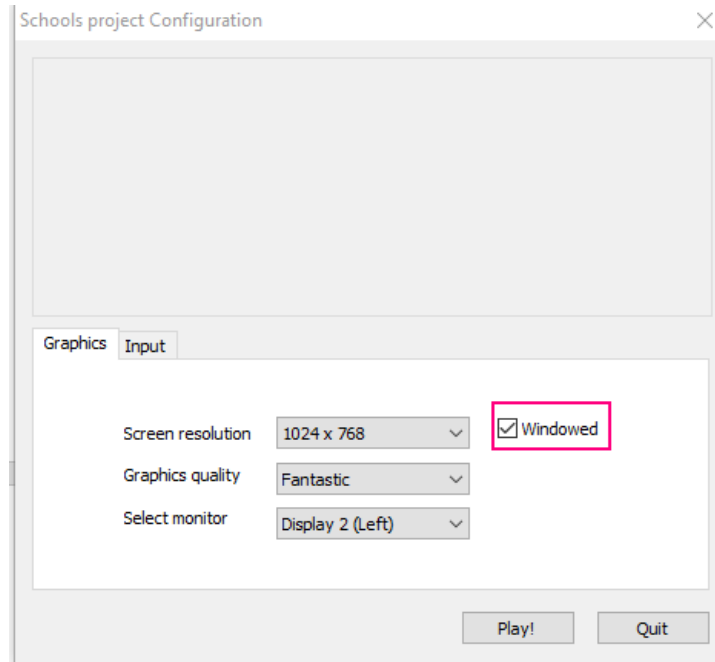
- Colored Pencils
- 0.5 mm Pentel pencil and eraser
- Drafting pens
- Field book (*n.b.*, those not picked up during Dr. Horton's last class are in my office; get them from me when UT reopens)
- Protractor

You will also need:

- Metric ruler
- Calculator
- Two or more **printed copies** of the *Lighthouse Bay* base map at the front of this document or downloaded from Canvas. Print in portrait mode on standard letter size (8.5x11 in.) paper. Do not "shrink to fit" or use any other printer sizing option. Print it at full size. **A printed version of the base map is essential for the exercise.** If you don't have a printer, use a local printing service (e.g FedEx, UPS, Staples, Office Depot, Walgreens, etc.) **before the weekend.** Most cities have deemed these essential businesses so they remain open. Most have websites that permit file uploads so that your copies are waiting for you when you arrive.
- **Important:** Use only the base map provided through Canvas, which has been resized to print on standard letter size paper. The one that can be downloaded from the Virtual Landscapes web site is for A4 paper (8.3 × 11.7 in) and when shrunk to letter size is no longer 1:5,000 scale.

Software/Hardware:

- **For Windows:** a downloaded version of the program "*Lighthouse Bay v4b.exe*". This runs only under Windows and is available on Canvas within a software zip file for this Trip. The zip file can also be downloaded from: <https://www.see.leeds.ac.uk/virtual-landscapes/schools/index.html>. Open the program by a double-clicking on the file name or selecting File "Open". On startup, the initial window allows a choice of how to display the game. I recommend the settings below:



Running it “Windowed” (red box above) will allow you room for a second window to run Zoom. You can restart and adjust the “Screen resolution” if it runs slowly. You can also change the navigation keys in the “Input” tab.

- **For iOS Mac:** there is no downloadable, stand-alone program. Instead the program runs directly in a web browser (no download required). **It runs best in the Google Chrome browser** (free); Safari and other browsers are painfully slow in this instance. Open the program by browsing in Chrome to <https://www.see.leeds.ac.uk/virtual-landscapes/schools/index.html>. Be patient, wait for it to slowly load (~5-15 mins.).
- **The program will not operate in a browser on a mobile device (iPad, phone, etc).**
- A mouse or joy stick is helpful. Otherwise, landscape navigation requires use of both your keyboard and touch pad, a slower experience for all but the most dexterous.
- Optional: graphics software that allows writing, drawing and coloring on top of PDF files, such as Adobe Illustrator, Photoshop, etc. This exercise is designed to be completed on paper – **this is not an exercise in learning to use graphics software**. If you don’t already have (and know how to use) graphics software, please do this exercise on paper, carefully scan or photograph your results, and submit it as you would a lab exercise.

Deliverables (two components):

1. A completed geologic map that includes:
 - a. The trace of unit contacts, shown with dashed lines where inferred and solid where exposed, in ink.
 - b. Properly plotted symbols of strikes and dip values for all outcrops, in ink.

- c. Lightly colored units with inked unit abbreviations. You can create your own abbreviations (e.g. J_{ss1} for Jurassic sandstone 1, J_{Lm2} for Jurassic limestone 2, etc.)
- d. An accompanying map key that shows:
 - i. a labeled & colored box for each unit, *stacked in proper order from oldest at the bottom to youngest at the top*
 - ii. a symbol key for contacts (“dashed where inferred”) and for bedding strike and dip

Study carefully the example field map below. Your work should emulate these. Neatness and clarity count.

2. On a separate piece of paper, provide a stratigraphic column, like that in your map key (but with larger colored boxes; *see the example below*). To the right of each box include a short, written description of each unit taken from the outcrop field notes. These can be word-for-word from the field notes. You should compile these in your own field book as you walk the landscape and discover the outcrops.

Directions

This is a mapping video game. You navigate a virtual landscape to “collect” outcrops and their field notes, recording your observations and progress on a paper base map and field book as you go. A pop-up compass and GPS instrument help you navigate and decide which outcrops on the base map you’ve discovered. Having recorded everything on the base map and compiled the field notes, you will have all you need to complete a paper geologic map and a stratigraphic column. Making a geometrically sound map from the sparse data is challenging (and realistic). To do it correctly you’ll also need to incorporate Rule of V’s concepts and strike lines, as explained below, discussed in lab, and further described during this weekend’s online session.

A. Gathering field data

1. Get the software running on your Windows computer or in your iOS Mac browser and become familiar with the navigation keys, on page 2 above. Be patient, it can take a while to load.
2. Study your base map and decide where to go. Outcrops are indicated by 30+ numbered open circles, and there are trails, stone walls, bridges, a road, river, a coastline and other features to navigate. You need to visit every outcrop – finding a parsimonious strategy to do so is part of the challenge (both here and in reality).
3. Open the field book at each outcrop. You’ll find a sketch of the outcrop, rock descriptions, and a strike and dip of bedding. While at the outcrop, plot the strike and dip on the base map at the outcrop, then choose the appropriate color for that rock unit and shade the open circle with colored pencil. If an outcrop contains a contact between two units, then use the appropriate colors to shade two halves of the open circle.

4. You will find it useful to place the rock unit, and notes about them, in a properly ordered (oldest at the bottom, youngest at the top) stratigraphic column as you map.
5. Use the GPS and compass when needed to navigate. **Do not blithely go from outcrop to outcrop collecting data.** Instead, try gradually building a mental image of the geometric and stratigraphic relationships as you record new data on the base map. This is what accomplished field geologists do.
 - a. As you place data on the map ask: What is the stratigraphic sequence so far, from oldest to youngest, based on the notes and dip direction? What do I predict I'll find at the next outcrops to the north, south, east or west?
 - b. With some data already plotted, what do the Rule of V's and strike lines predict about what should be found at each outcrop?
 - c. If your predictions aren't confirmed by your new observations, you need to ask why. Can you discover your error(s) in logic or, if your logic is sound, can you come up with another testable hypothesis that explains the new data? The game is far more interesting once it becomes an intellectual exercise of this sort. For many, the joy and pleasure of geologic mapping comes from solving just these sorts of puzzles.

B. Finishing the map

At this point you'll have visited all the outcrops and have spots of color and strikes and dips plotted on the base map. Your next job is to predict where rock unit contacts belong in areas where no rock are exposed, and to draw them in with dashed lines. Examine the data carefully:

- Where are the oldest rocks? Where are the youngest rocks?
- Can you see a pattern to the distribution of rocks types perpendicular to strike? Parallel to strike?
- Are all strikes and dips the same?
- What does the rule of V's predict for these north dipping contacts? For 22° dips, how pronounced will the V's be?

Draw and erase, draw and erase until you get a map pattern that makes sense for the distribution of rocks types, the topography, AND the strike and dip data. This is your first educated "guess". It can then be refined by constructing strike lines on contacts where contacts are exposed. For guidance for how to do so, see the *Bugalo Butte* video example on the Trip 4 Canvas assignment.

Once finished in pencil, go over your lines and symbols with a drafting pen, then lightly erase the pencil underneath. Label the rock units with unit abbreviations (in ink). Shade, very lightly using colored pencils, the rock units to complete the map. Create a rock unit and symbols key. See the maps below for examples of what a finished map might look like.

C. Compiling a stratigraphic column

See the example below; emulate the layout and appearance, but place the written descriptions to the right of the colored boxes. It should be neatly inked and colored, with hand-**printed** or typed text (or, if you're graphic software-proficient, you can finish it that way).

Kdr

Del Rio Clay

Blue-gray to tan gypsiferous, ferruginous, marly shale, 40-60 ft thick (DeCook, 1963); about 45 ft thick in map area. Clays are dominantly illite and kaolinite in unweathered state, but the illite is converted in the weathered zone into plastic montmorillonite. Characterized by gypsum veinlets, pyrite or marcasite, and abundant specimens of Ilmatogyra arietina. Subject to slope failures during construction in the weather zone. Distinguished in the field by predominance of mesquite trees in a clayey soil. Lower and upper contacts readily mappable on air photos. Occurs with Georgetown, Buda and Eagle Ford Formations in a band extending from the northeast to the southwest corner of the map area.

Kgt

Georgetown Formation

Light-gray and white argillaceous nodular limestone and tan calcareous shale, 25 to 35 feet thick (DeCook, 1956; 1963). Sharp contact with underlying Person Formation is visible on air photos. Supports oak-juniper assemblage. Occurs with Del Rio Clay, Buda, and Eagle Ford Formations in a band extending from the northeast to the southwest corner of the map area.

Ked

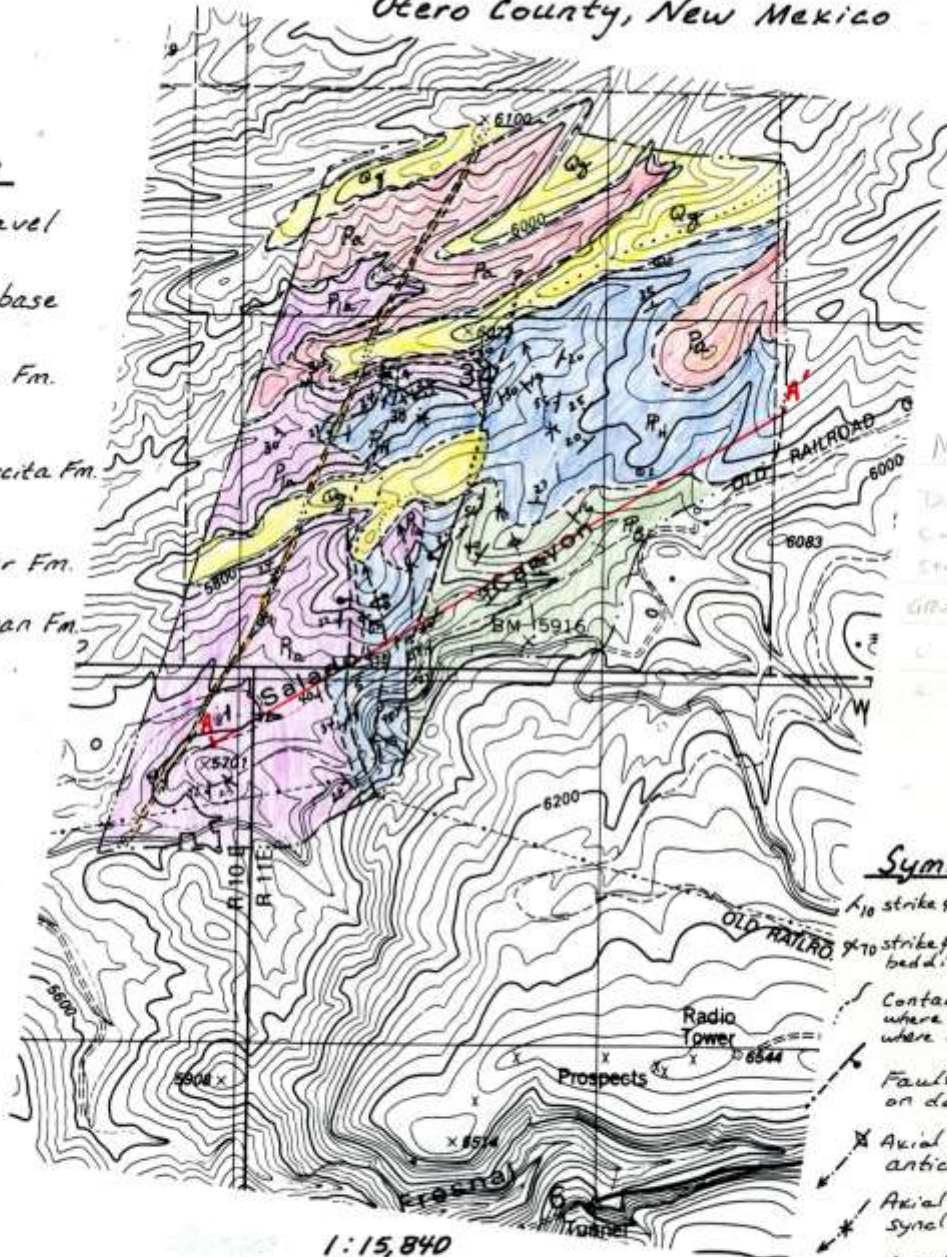
Edwards Group, undivided

In Hays County, upper gray dolomitic, siliceous, massive, honeycombed limestone overlies lower light-gray argillaceous, nodular limestone (DeCook, 1963). Thickness is 430-450 ft in the San Marcos area (Rose, 1972). Divided by Rose (1972) into a lower Kainer and an upper Person Formation, separated by the "Regional Dense Member". Comprises the principal aquifer in the map area and throughout central and southwest Texas. Underlies typical hill country landscape, occurring in a broad band in the west and northwest part of the map area. Supports dense growth of oak and juniper. Dolines and karstic solution features are common.

Example Unit Descriptions. Your descriptions should appear to the right of each color coded rock unit box. Note the unit abbreviation in the boxes, which have a capital letter for the age (Period) and lower case for the formation name. *Importantly, the boxes are arranged from oldest at the bottom to youngest at the top*, as they would ideally appear in outcrop.

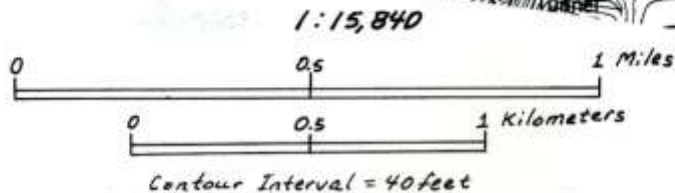
Geologic Map of the Pennsylvanian and Permian strata
in Section 34, T. 15S., R. 11E., Sacramento Mountains,
Otero County, New Mexico

- Units
- Q_g Gravel
 - T_i Diabase
 - P_a Abo Fm.
 - P_{la} Laborcita Fm.
 - P_H Holder Fm.
 - P_B Beeman Fm.



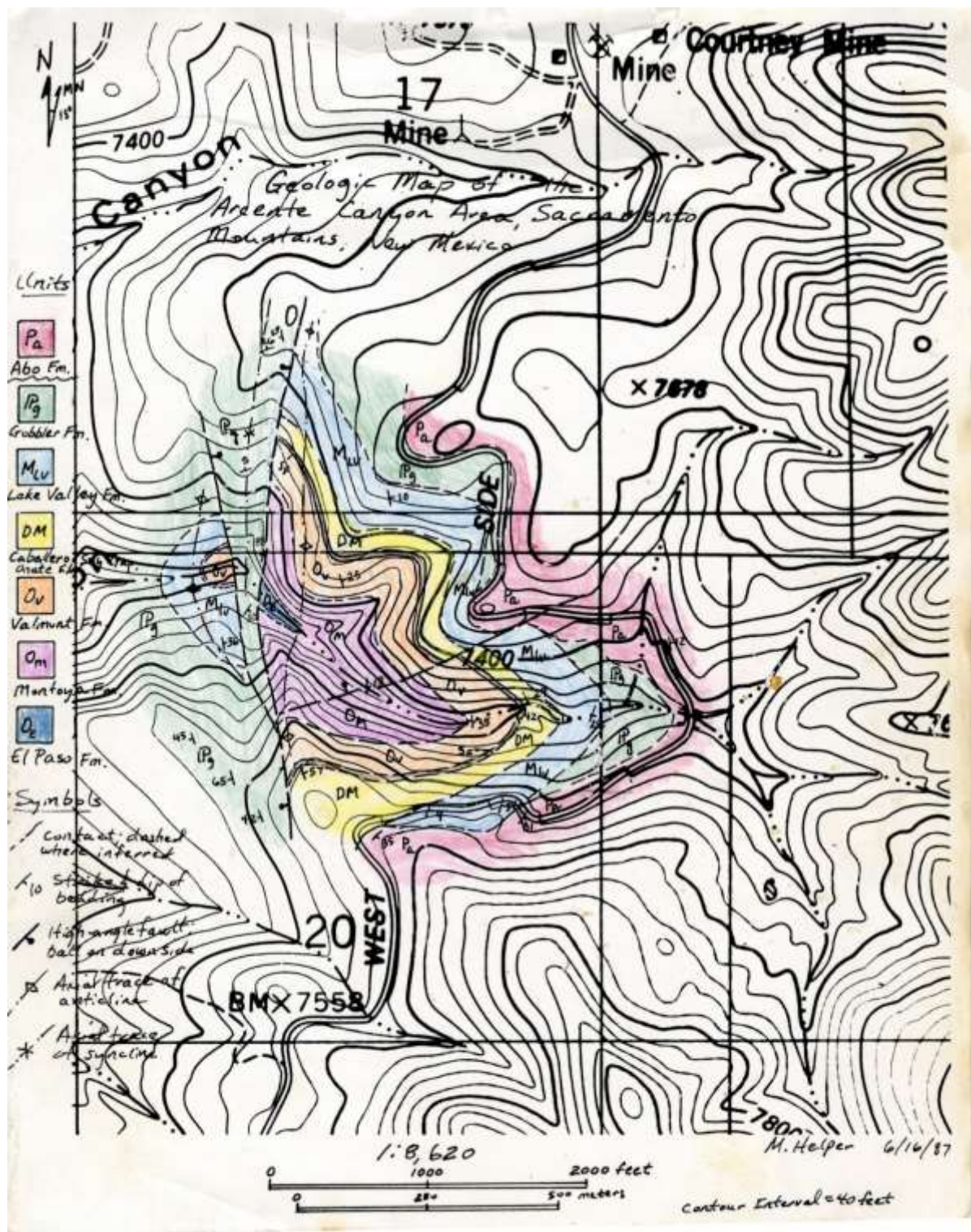
Symbols

- \angle strike & dip of bedding
- \angle strike & dip of overturned bedding
- Contact; dashed where inferred, dotted where covered
- - - Fault; ball & bar on down side
- * Axial trace of anticline
- * Axial trace of syncline
- * Axial trace of overturned anticline
- o⁺ petrified wood locality



M. Helper 6/10/87

A completed field map, with a rock unit and symbol key. Line work is a little thick; my penmanship has improved with time.



A completed field map, with a key that is poorly placed and squeezed in, and a map that is colored a little too darkly, but with results still clearly legible.