Geological Interpretive Walk to Grassi Lakes

Near Canmore, about 90 km west of Calgary in southern Alberta

By Ben Gadd, 2019

Not only is the short walk to Grassi Lakes the most popular hike in the Canmore area, it also makes a first-rate geological field trip.

These notes are especially applicable to groups of students in high school and junior high, but there is enough material here for university and professional groups, too.

Bring some **dilute hydrochloric acid** with you for testing for the presence of the mineral **calcite,** the main component of limestone. Buy some muriatic acid at a paint store (muriatic acid is HCl) and dilute it approximately eight-to-one water to acid. See my instructions for doing this, and suggestions for a safe container you can carry in your pocket, on my website **bengadd.com.** Go to the Downloads page and click on “Identifying rocks and preparing testing acid.”

Also worth bringing: copies of the **geological map of the Grassi Lakes area and an annotated photo of the view from the parking area.** These items are available on the Downloads page at bengadd.com. The **latest geological time scale** is included in the document you are reading. See page 6.

Here is a further suggestion. Bring **some inexpensive prizes** to award at the end of the trip, when you are asking review questions and wish to make them more interesting. I am retired from leading student hikes, but when I did I would award copies of my books.

There is a toilet at the lakes but it is usually locked. There is no garbage bin. Bring some garbage bags, plus toilet paper and plastic pickup-bags for dog poop. These also work for picking up human poop if need be. This can be transported back to the trailhead in a container with an odor-sealing screw-on lid.

Starting point: park at N51° 04.887' W115° 23.653' off the Smith Dorrien Spray Trail, also called “Spray Lakes Road,” Highway 742. To get there, head for the Canmore Nordic Centre and drive 1.1 km past it to the turnoff on the left. The TransAlta power plant access road leads downhill a short distance to the parking area.

As described, this walk makes a loop. You go up **Lawrence Grassi’s original 1920s trail** to the lakes, and you come down the gated hydro-power access road built in the 1940s.

Distance to Lower Grassi Lake on the Grassi Lakes Trail (the path with steep sections and steps), including the first 0.2 km on the TransAlta access road (wide, evenly graded cart track) is only 1.6 km. Elevation gain 140 m (460 feet). Distance and elevation gain to the upper lake are negligible.

Add another hundred metres and a further 40 m elevation gain above Upper Grassi Lake to the **best and safest Cairn Formation reef-rock exposures.**

Double that if you wish to reach the **pictographs** described on page 4.

Distance along the TransAlta access road from Lower Grassi Lake back to the parking lot is also 1.6 km.

If anyone asks, there is an upper trailhead farther along the Smith Dorrien Spray Trail. The distance from Upper Grassi Lake to this trailhead is 0.6 km, for a total of 2.2 km. The additional elevation gain is 105 m, and the trail is quite steep at the top. Not recommended.

Time required: as much of the day as you can get. I liked to start at about nine a.m., have lunch at the lakes and get back to the trailhead at two or three.

Since the toilet near the lower lake is often locked, it’s a good idea to suggest that **everyone try to use the toilets at the parking lot** before starting the hike.

The rules

There are places along this route that are close to the edges of cliffs. Safety is important. Before you start walking, collect everyone and tell them the following, as I did for any student hike I led.

1. Stick with the group. "If you heard and understand, please say yes."

2. Pay attention to the guide. "If you heard and understand, please say yes."

3. Don't walk ahead of the guide. "If you heard and understand, please say yes."

If you are going to award prizes for correctly answering questions at the end of the event, this might be a good time to announce it. Participants may pay more attention along the way.

Trail guide

At the junction reached soon after the start, take the **Lawrence Grassi Trail,** which is the left branch, the one labelled "More difficult."

Stop at the three **thrust faults** found along the way. None of them has any bedrock showing. I have located them based on the geological map of the area.

First is "the tree's fault," located at N51 04.860 W115 23.862. By chance, a tree is growing approximately along the fault line, unseen below the forest floor. Look for a small pine along the right side (north side) of the trail 98 m past the junction. The tree has a chest-high scar on the bark. This fault is the famous **Rundle Thrust,** found along the base of Mt. Rundle, the Three Sisters, Cascade Mountain and for many kilometres north and south. Upper Carboniferous (Pennsylvanian) **Rocky Mountain Group** dolostone and chert on the uphill side have been thrust over Jurassic-Cretaceous **Kootenay Group** siltstone and coal on the downhill side.

Dolostone: sedimentary (layered) rock rich in the mineral dolomite, which is calcium-magnesium carbonate, $CaMg(CO_3)_2$.

Chert, also known as flint and chalcedony: a mineral made up of microscopic crystals of quartz, SiO_2. Agate is a colorful type of chert.

The second fault, 370 m farther at N51 04.759 W115 24.113, **is "the mossy boulder's fault."** A gray limestone boulder marks the location, again by coincidence. The bolder is about 50 cm across on the left side of the trail, lying at the foot of a small pine. This unnamed thrust has late-Devonian Southesk Formation reef dolostone on the uphill side thrust over Rocky Mountain Group layers on the downhill side.

Reef dolostone: in our area, dolostone that makes up extensive mounds built in shallow seawater by marine organisms hundreds of millions of years ago. More on these reefs later in the tour.

On the way to the third fault, stop at the **debris flow** (obvious piles of gray **Palliser Formation** limestone chunks) between the second and third faults. Introduce the **three great questions of geology.**

1. What is it? (Identification)

2. How did it get to be that way? (Process)

3. When? (Age)

Best guess: it's a debris flow (identification) caused by storm water (process). We use what we see here to support or attack the idea. **This is how science works.** We ask a question about something, we think of a possible answer (the hypothesis), and we test the hypothesis with evidence.

Small trees growing over the rocks must be younger than the debris-flow event, so they give an idea of when the event occurred (age). Stop at the large gully beyond, with its **natural levees** (low ridges of rocks emplaced on either side of the gully during the maximum flow) to further support the hypothesis that this is a water-formed feature.

Remember to stop at the **upper crossing of this debris flow** along the upper trail on the way back. I have walked between these two points to confirm the connection. The identification of this feature is quite obvious there, which shows that the hypothesis (it's a debris flow) is correct.

The third and last fault is “the logs’ fault,” 372 m farther at N51 04.603 W115 24.300, where several cut logs have been piled in the gully. The trail makes an obvious left turn here and starts to climb more steeply. At this unnamed thrust, middle-Cambrian Pika Formation dolostone has been thrust over Southesk rock. **Note the steepening of the slope, a sign of harder bedrock beneath.** The slope steepens further as we move along it, becoming a cliff of Pika rock.

Also at the third fault, point out the boulder sitting next to two trees on the uphill side of the trail. These trees are curved, as if they were bent over by the boulder but are now growing straight. Consider the curved tree in the middle of the trail just beyond. Same sort of thing? Probably.

Past the old bench, stop at the water flowing over the trail. Discuss groundwater, and **how it keeps rivers flowing in the winter,** when surface water is frozen. Warn of the cliffy terrain just ahead, and the need to walk single-file. ***No pushing or shoving!***

The viewpoint is at the top of the Pika Formation. ***Be very careful here. It’s on the edge of a cliff.***

Point out the **Spray hydroelectric plant** at the base of the slope. It began operating in 1951 and produces 210,000 megawatt-hours of power per year. The **penstock** (big silver pipe) that feeds the plant is plain to see, as is the **surge tower** at the upper end of the penstock, which helps to even out the flow. But few trail users know that the original route of the water from the small reservoir above Grassi Lakes to the plant was **blasted through the bedrock.** It’s a concrete-lined tunnel, still in use. The drop in elevation is 279 m. The pipe was added in 1960 to feed an additional turbine. For more about the power plant, see my annotated photo of the view from the parking lot. (My information about the plant came from employees currently working there and from interviewing Art Harris, plant supervisor from 1951 to 1974.)

Talk about the development of the valley through **differential erosion.** The valley floor is underlain by thin-bedded, fairly soft siltstone and shale, which are easily erodible. The ridges on either side are made of thick-bedded, harder limestone, more difficult to erode. So the valley erodes downward more quickly than the ridges do. Over time the **topographic relief** (difference in elevation between the valley floor and the ridgelines) increases. This is a classic example of differential erosion on a grand scale.

A thickness of about 4 km of rock has gone down the river here, the result of 0.06 mm of erosion per year averaged over 70 million years. **In geology, the passage of time explains a lot.** We multiply by millions.

Above the viewpoint, there is a low outcrop of middle-Cambrian **Arctomys Formation siltstone,** which has weathered banded buff and brown but is pinker inside. To reach this spot, you walk up to the first switchback (goes right) and continue past the guardrail off the end. ***It’s not a very safe stop.*** It’s close to an edge.

Siltstone: sedimentary rock made of particles smaller than grains of sand but larger than the microscopic particles making up shale.

Continue up a stretch of trail that is eroded and usually has water running down it. Where things dry out you reach the first of many stone steps. These are Grassi’s work from the 1920s, no doubt, with more recent repairs. Along the way there’s a sharp right turn, then a sharp left turn beside orangey-buff dolostone of the middle-Cambrian **Waterfowl Formation.** Point out that we have just crossed a soft layer—the Arctomys Formation—and now we are crossing the hard layer—the Waterfowl Formation—that the waterfall spills down. That’s the pattern in the Rockies. Harder layers form cliffs and softer layers from gentler slopes, often covered with rock debris and overgrown with vegetation. It’s another example of **differential erosion.**

Now up the stairs and through the Waterfowl. Top of the stairs is also the top of the unit, where some wavy-layered **algal laminate** (rock produced by microbes) is nicely exposed in a low, glacially smoothed outcrop.

Stop at the long bench just beyond, with an interpretive sign about **Lawrence Grassi,** who built this trail while the Canmore coal miners were on strike in 1924 and 1925. Back then the lakes were known as the **Twin Lakes.** Grassi built and/or maintained many other trails in the Canadian Rockies, especially in the Lake O’Hara area of Yoho National Park, where he was appointed the first park warden there in 1956 and continued in that job for six summers.

On to the lakes. You could mention that above the Waterfowl we are crossing a thin, unseen, recessive (easily erodible) unit of soft green shale, the **Sullivan Formation,** which is lowermost late Cambrian, before reaching numerous outcrops of **Lynx Group** interbedded limestone and dolostone.

Limestone: sedimentary rock rich in the mineral calcite, $CaCO_3$ (calcium carbonate, lime).

At the bridge over the creek, ***ask everyone to use the handrail.*** If you fall into the water here, you might be swept over the waterfall below. This would spoil your whole day.

Just beyond the creek you walk along a **glacially smoothed Lynx outcrop.**

Upon reaching the junction—view of the **hydro penstock** (big pipe) uphill—turn right to arrive at the lower lake, which is close by. If the toilet there is open, suggest that anyone who needs to use it may do so now. The whole group will be stopping at the lake for some time. If the toilet is locked shut, which is often the case, it's okay to pee behind the even bigger boulders in the woods. Girls first—they hardly ever go—and boys second, many of whom go.

As soon as you reach the lake, note the bench here, close to a very large gray boulder. Time for lunch.

Afterward, gather around the boulder to show **how to identify rocks** in the Canadian Rockies. **Sandstone:** you see the sand grains. Any sandstone here? No. **Shale:** soft, splitty rock, often dark-colored. Any shale here? No. **Quartzite:** very hard rock; can't scratch it with my knife. Any quartzite here? Yes. Look for quartzite pebbles carried here from farther up the valley by glaciers and streams. **Limestone:** softer, easy to scratch. Any limestone here? Yes, the big boulder. Examine it. Show that it's not sandstone, not shale, not quartzite. But it's soft enough to be limestone. Clinch the identification by **using mild hydrochloric acid** and noting the bubbly reaction. This boulder fell from the huge cliff directly above, which is the full thickness of the late-Devonian **Palliser Formation** thick-bedded limestone, some of the slower-eroding stuff mentioned earlier.

Walk to the second lake. At the first view of it, kids can sit among the boulders on the uphill side of the trail while you stand on the other side, right by the water. People can pass between the students and the lecturer. Discuss the **source of the water** (no surface inlet stream; it's groundwater, perhaps from a cave system, entrance unknown), the **absence of glacial rock flour,** and the natural **bluegreen color of pure water,** as seen here.

Do the lakes freeze? Yes, during cold snaps, when the overnight temperature falls below -20° Celsius for several nights in a row. The upper lake always has an open spot at the far end, where much of the groundwater flows in. In the lower lake there is always a strip of open water along the shore on the east side. It runs from the inlet stream to the outlet stream.

At the trail junction ahead, explain why we are not going over to the cliff of gray pock-marked reef rock and the obvious cave there. As a sign here clearly warns, ***there is rockfall hazard by that cliff.*** We're going to a safe place on this side of the valley, the left side (southeast) from our direction of travel, where there is a better exposure of the reef rock anyway.

Continue up the steps to the reef rock. Gather there. Talk about the reef rock (late-Devonian **Cairn Formation** limy dolostone), the **stromatoporoids** that produced it, and how they got wiped out in the **late-Devonian extinction event.** Scrape stones together to release smelly hydrogen sulphide gas. This rock holds a lot of **oil and gas** under the prairies. It can easily be studied here in the mountains, where it has been thrust up.

Continue up the steep main trail to the **pictographs,** protected by a low fence. They may be genuine, but persons who have seen them twenty or thirty years ago have told me that the red color was noticeably brighter then. Genuine pictographs in the Rockies typically do not fade that quickly, even when touched often.

Last thing here: you may wish to let the participants climb up into the **shelter cave** just past the pictographs. It's fairly big and fun for kids, although it's dusty and smelly from wood-rat poop. In 2012 I knocked down the loose blocks and made it safe at that time, but more rocks may have loosened up since then, so it's wise to go in first yourself and check. In fact, it's wise to **pre-hike this whole trip,** which is a basic rule for doing good interpretation, and check on the safety of the shelter cave at that time. There is probably no hantavirus hazard in the cave. Wood rats do not carry the disease, and I have seen no deer-mouse droppings there.

This is the turn-around point for the hike. Before starting back down the trail, explain that hiking and mountaineering accidents are more common on the descent than on the ascent. ***Watch where you put your feet!***

Between the lakes, take the left branch past the **Lawrence Grassi commemorative plaque.**

When you reach the hydro access road, have 'em line up on the east side (the far side, away from the lakes), then take four steps west to the other side. They have just crossed a gap in the geological record of 130 million years—an **unconformity.** This is Alberta's famous **sub-Devonian unconformity.** The rock on the eastern (lower) side is the late-Cambrian Lynx Group. The rock on the western (upper) side is the late-Devonian Cairn Formation. All Ordovician, Silurian and early and middle Devonian rock is missing, having been eroded away when the region was uplifted above sea level late in the Silurian, about 420 million years ago. Then sea level rose in the mid-Devonian, about 390 million years ago, and sedimentation began again. The Cairn reef rock was deposited.

Now walk down the wide, easy hydro access road for 1.6 km to the trailhead area. ***No running. Stay behind the guide.*** Returning to the parking lot typically takes much less time than we spent on the way up to the lakes.

Low road cuts along the way expose debris-flow material and **colluvium:** rock fragments weathered from the cliffs above. Colluvium works its way slowly downhill under the pull of gravity, aided by soil moisture that freezes and thaws, causing movement through expansion and contraction.

There is no bedrock exposed along the access road, *except* for two tiny patches seen not in the cuts but in the road surface itself. These are located close to each other at N51° 04.652' W115° 24.383', at the lower end of a long straight stretch beside a clump of white birch (peeling bark) on the uphill side of the road. This clump is easy to spot. Two of the trees are twisted together. The smaller rock patch is also easy to recognize. Only a metre or so in size, it is pink **Arctomys siltstone.** The color makes it stand out. The other patch, a few metres *up* the road from the pink patch, is larger and gray. It may also be Arctomys rock, but I'm not sure.

Might these tiny outcrops actually be nothing more than the surfaces of large boulders? That's unlikely. Layering is visible in the rock, and in both cases it is oriented exactly like that of the bedrock we have been seeing.

After going past the roadbed outcrops, you cross the same **debris-flow channel** seen on the lower trail. At this location (N51° 4.841' W115° 24.196'), it's wider and obviously a water-formed feature. If you look up the slope you can see where the channel originates at the base of the big Palliser limestone cliff. Water flowing down the rock from rain and snowmelt collects naturally there and follows the channel down the slope.

At N51° 04.843' W115° 24.199', just past a trailside bench, you go by the site of what was once a **small shed for storing dynamite.** Look for the flat spot on the downslope side of the access road, where a few logs remain from the simple structure. It was built in the 1940s by Calgary Power for storing explosives a safe distance away from workers during the construction of the Spray hydroelectric power plant at the base of the hill. The dynamite was used mainly for blasting a tunnel from the small reservoir above Grassi Lakes down to the plant. This was the original route the water took. The penstock was added later to increase the flow.

No, the shed did not explode.

When you arrive back at the trailhead, you may wish to gather up the group and **award prizes for answering review questions.** Here are some good ones to ask.

1. What are the three great questions of geology? *What is it, how did it get to be that way, and when?*

2. In science, we ask questions such as these and come up with reasonable answers. **What do we call a possible answer to a particular question?** *A hypothesis.* **And what do we use to support or detract from the hypothesis?** *Evidence.*

You might explain that in science, **a theory is not the same as a hypothesis.** A theory is a major idea that has been shown to be correct. Einstein's famous theory of relativity is a good example, as is geology's theory of plate tectonics or biology's theory of evolution. People who say, "That's just a theory" are actually misusing the word.

3. What is the name of the common geological process that formed the Bow Valley? Hint: the rock in the ridges on either side is harder than the rock underlying the valley. *Differential erosion.*

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On the next page I have included the current geological time scale.

Geological time scale 2013, in millions of years

This scale is by the **International Commission on Stratigraphy** (ICS). Still current as of 2020, it is based on the ICS *International Chronostratigraphic Chart*, which is the standard time scale used by the Geological Survey of Canada, the Geological Society of America and most other geological organizations worldwide.

PHANEROZOIC EON 541–Present

Cenozoic Era 66.0–Present
- **Quaternary Period** 2.59–Present
  - Holocene Epoch 13,500*– Present
  - Pleistocene Epoch 2.59–13,500*
- **Neogene Period** 23.0–2.59
  - Pliocene Epoch 5.33–2.59
  - Miocene Epoch 23.0–5.33
- **Paleogene Period** 66.0–23.0
  - Oligocene Epoch 33.9–23.0
  - Eocene Epoch 56.0–33.9
  - Paleocene Epoch 66.0–56.0

Mesozoic Era 252–66.0

- **Cretaceous Period** 145–66.0
  - Late 101–66.0
  - Early (no middle) 145–101
- **Jurassic Period** 201–145
  - Late 164–145
  - Middle 174–164
  - Early 201–174
- **Triassic Period** 252–201
  - Late 237–201
  - Middle 247–237
  - Early 252–247

Paleozoic Era 541–252

- **Permian Period** 299–252
  - Late 260–252
  - Middle 272–260
  - Early 299–272
- **Carboniferous Period** 359–299
  - Pennsylvanian Epoch 323–299
  - Mississippian Epoch 359–323
- **Devonian Period** 419–359
  - Late 383–359
    - *Famennian Age 372–359*
    - *Frasnian Age 383–372*
  - Middle 393–383
  - Early 419–393
- **Silurian Period** 443–419
  - Late 423–419
  - Middle 433–423
  - Early 443–433
- **Ordovician Period** 485–443
  - Late 458–443
  - Mid 470–458
  - Early 485–470
- **Cambrian Period** 541–485
  - Late 497–485
  - Middle 509–497
  - Early 541–509

PROTEROZOIC EON 2500–541

Neoproterozoic Era 1000–541
- **Ediacaran Period** 635–541
- **Cryogenian Period** 850–635
- **Tonian Period** 1000–850

Mesoproterozoic Era 1600–1000
- **Stenian Period** 1200–1000
- **Ectasian Period** 1400–1200
- **Calymmian Period** 1600–1400

Paleoproterozoic Era 2500–1600
- **Statherian Period** 1800–1600
- **Orosirian Period** 2050–1800
- **Rhyacian Period** 2300–2050
- **Siderian Period** 2500–2300

ARCHEAN EON 4000–2500

Neoarchean Era 2800–2500
Mesoarchean Era 3200–2800
Paleoarchean 3600–3200
Eoarchean Era 4000–3600

HADEAN EON 4000–4567

No eras or periods are defined in the Hadean eon. Scale begins when Earth and the other planets are fully formed from the pre-solar nebula left by the supernova explosion of a previous star. Planets took only about ten million years to form.

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*In calendar years. Same as 11,800 BP, where “BP” stands for “Before the present,” meaning radiocarbon years.