Geological Interpretive Walk to Grassi Lakes

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

By Ben Gadd, 2018

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 groups.

Bring some **dilute hydrochloric acid** with you for testing for the presence of calcite (lime, $CaCO_3$). You can buy 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, an annotated photo of the view from the parking area, and the latest geological time scale.** These are also on the Downloads page at bengadd.com.

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.

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.**

Distance from Lower Grassi Lake back to the parking lot on the TransAlta access road: 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.

There is a toilet just before you reach the lower lake. However, it is often locked. So 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.

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. It's marked by a small chest-high scar on a pine along the right side (north side) of the trail 98 m past the junction. This is the famous **Rundle Thrust,** found along the base of Mt. Rundle, the Three Sisters, Cascade Mountain and for many kilometres north and south. Permo-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.

The second fault, 370 m farther at N51 04.759 W115 24.113, **is "the mossy boulder's fault,"** marked by a gray limestone boulder 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 on the downhill side.

Stop at the **debris flow** (obvious piles of gray Palliser limestone rocks) 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 cliffs just ahead, and the need to walk single-file. ***No pushing or shoving!***

At the viewpoint—***be very careful here;*** **it's on the edge of the cliff**—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. 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, 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.

Continue up a stretch of trail that is badly eroded and usually has water running down it. Where things dry out you reach the first of many stone steps. Grassi's work from the 1920s, no doubt, with more recent repairs. Along the way there's a sharp right switchback, then a left switchback. The left switchback is up against **orangey-buff rock** of the middle-Cambrian **Waterfowl Formation.** Point out that we have just crossed a soft layer—the Arctomys Formation—and now we have a hard layer forming the cliff the waterfall goes over. 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,** this time on a smaller scale.

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, where he was appointed the first park warden there in 1956 and continued in that job for six summers.

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

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 you walk along a **glacially smoothed Lynx outcrop.**

Upon reaching the junction—view of the **hydro penstock** (big silver pipe) uphill—turn right to arrive at the lower lake, which is close by. If the toilet 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, wait until we reach the big boulder and the modern bench beside the lake, then suggest a pee break 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 by glaciers from farther up the valley. **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 above, which is late-Devonian **Palliser Formation** thick-bedded limestone, some of the slower-eroding stuff mentioned earlier.

Walk to the second lake. 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.

At the trail junction ahead, explain why we are not going over to the obvious cliff of reef rock and the 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, or continue up a few steps to the left to the sport-climbing wall. 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 the 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 the same rock that underlies the prairies 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 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 due to uplift.** Then sea level rose 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 is 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.

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.

Before reaching the roadbed outcrops, you cross the same **debris-flow channel** seen on the way up. At this location it's wider and obviously a water-formed feature.

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

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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