Groundwater Connections

Lesson 4: Groundwater Field Trip & Journal

UNIVERSITY OF CALGARY

WATERFALL VALLEY FIELD TRIP (CALGARY)

Coordinates:

51° 6'6.03"N
114°11'23.20"W

Distance & Elevation Gain:

1.2 km; 50 m

Time Required:

1.5 to 2 hours

Access Point & Parking:

Silver Springs Blvd & 54 Avenue, N.W.

Permission to Access:

The City of Calgary Parks & Recreation currently does not require a permit for site access, as long as classes do not require exclusive use, off-trail activities or collections.

1.0 OVERVIEW

1.1 Description of Site

Waterfall Valley *(Figure 1)* is a part of *Bowmont Park Natural Area* located along the northern banks of the Bow River within northwest Calgary city limits. A pathway and boardwalk provide access to a number of small springs that feed into a small creek flowing into the Bow River. The site also provides access to a small waterfall displaying tufa deposits, Paskapoo Formation sandstone outcrops along the pathway, and a lookout point overlooking the Bow River. There are interpretive signs located along the pathway, describing geological history of the landscape, local plant life and wildlife, and other unique geological features of this small valley.

Figure 1. View from trailhead (Photo Credit: C.R. Farrow).

1.2 Learning Connections

Students will be able to make the following connections with the APL research article:

- Observe and infer impact of glacial erosion and deposition on local topography
- Observe and measure spring discharge contribution to baseflow of a small headwater creek
- Observe groundwater -surface water interaction along creek and within the Bow River
- Observe and measure impact of groundwater on water temperature and dissolved minerals
- Observe interbedded siltstone, mudstone, and sandstone layers of the Paskapoo Formation
- Observe and infer influence of groundwater on plant life within Waterfall Valley

1.3 Curriculum Connections

Alberta Program of Studies for Science 8
Unit E: Freshwater and Saltwater Systems
STS & Knowledge Outcomes 1, 2, 3, & 4

Teaching Notes:

Stop 1:

Glacial deposits and melt -waters have shaped this landscape. For example, the plateau above the Bow River valley was once the bottom of Glacial Lake Calgary.

Stop 2:

In this area, sunlight levels and access to groundwater limit which plants grow where. Aspen stands usually indicate that the water table is close to the surface.

Stop 3:

The groundwater has recharged through the glacial till above this site. It is stored mostly in sandstone layers and then discharges from outcrops along the banks of the valley. These small springs then combine to form what is known as a headwater stream.

2.0 Preparation and Materials

2.1 Logistics

- As part of obtaining field trip approval process, conduct site safety assessment, communication, travel, and evacuation plans prior to your field trip.
- This site does NOT have access to washrooms or shelter; the boardwalk and pathway will be slippery after rain, snowfall, or freezing conditions; and travel is NOT recommended past the lookout at the bottom of the valley. Groups need to remain on pathways and boardwalk, as the site is designated as a *natural environment park*,
- Classes should be divided into small groups of 4-5 students, with half of the groups starting and ending at different points of interest. For example, one half of the class could start at the trailhead interpretive sign, while the other half could start at the second or third point of interest along the boardwalk and finish with an activity at the trailhead. Return to the trailhead using the same boardwalk and pathway.
- Ensure students are prepared for the field trip by discussing safety management plans, being prepared with appropriate clothing and footwear, and any other concerns they may have about a field study.

2.2 Class Materials

- Two-way radios or cell phones (Lead teacher & supervisors)
- Thermometers (1 per group)
- Stopwatch (1 per group)
- Meter stick (1 per group)
- 10 L Plastic pail (1 per group)
- *Optional:* 1 pH meter & 1 EC meter (1 for every 4-5 groups)

2.2 Student Materials

- Small day-pack with water bottle, snacks, extra layers of clothing, hat/toque, gloves
- Student booklet (*see,* Appendix) **and** pencil

3.0 Field Study

Gather as a whole group around the trailhead map to identify location of stops, emergency muster points, hazards and safety precautions, staying on pathway and boardwalk, traveling as a group, and respecting public access. Set an end time to meet as whole group at trailhead. Hand out ***Field Guide & Journal*** and invite groups to record their observations, measurements, and reflections. Send half of the groups with one leader and supervisors to start at Stop 2, while first half starts at trailhead sign.

3.1 Waterfall Valley Topography

- Invite students to read the *Trailhead Sign* to discover how glaciers shaped this landscape surrounding the Waterfall Valley and Bow River Valley.
- Ask each group to look across the landscape to identify and share at least two landscape features that provide evidence of glacial deposits, lakes, or depression-upland topography.

3.2 Ecological Effects of Groundwater

- Invite each group to look for and discuss changes in types of trees, shrubs, and ground vegetation between the start of the boardwalk to the first aspen grove.
- At the first aspen grove, ask each group to develop hypotheses on what might be causing the change in vegetation.

3.3 Headwater Springs & Interpretive Sign 1

- Invite each group to look for and find the first signs of the creek and to identify where the source water might be coming from.
- Ask each group to discuss why the springs might be discharging at these spots. Invite them to read the *Interpretive Sign* to find out why.

Teaching Notes:

Stop 4a:

This activity helps students understand groundwater-surface water interaction and that groundwater will usually have higher EC due to higher levels of dissolved minerals.

Stop 4b:

This activity helps students understand that most of the stream baseflow in this headwater creek comes from spring discharge.

Stop 5:

Calcite precipitation is triggered by an increase in pH. Degassing of dissolved CO_2 in groundwater causes the following reaction to proceed to the right:

$$H^+ + HCO_3^- \rightarrow H_2CO_3 \rightarrow H_2O + CO_2\,(gas)$$

As a result, the solubility of calcite is lowered in the solution, resulting in precipitation of calcite minerals, which then deposit on rock surfaces.

Stop 6:

Most springs discharge at the bottom of the sandstone layer as it has the highest permeability and porosity of all the layers.

Stop 7:

A proportion of the Bow River annual flow comes from shallow groundwater discharge. The exchange of groundwater with surface water typically raises EC and lowers temperature of surface water.

3.4a Cascading Spring

- Invite the students to observe how groundwater becomes surface water, and surface water becomes groundwater in the small cascading spring. This cascade shows a classic example of groundwater-surface water interaction on a small scale. Ask each group to sketch a profile of the cascade showing how the water flows from ground to surface, surface to ground, and ground to surface again.
- Also invite each group to measure the temperature of water discharging from the spring outlet and compare to the temperature in the stream and ask each group to develop reasons as to why they might be different. If EC meters are available, assign groups to also measure and compare electrical conductivity (EC) of the spring and stream water. Why might they be different?

3.4b Spring Discharge & Stream Flow

- Invite half of the groups to measure the spring discharge at the cascading spring and half the groups to measure stream flow volume below the cascading springs by using two methods to estimate how much the spring contributes to stream flow.
- *First method:* Time how fast a 10 L plastic bucket fills to the top (time in seconds) and record as 10 L/__s. Then divide 10 L by time to calculate discharge rate (L/s).
- *Second method:* Measure flow velocity (cm/s) using a set distance along the cascade (50 cm) or stream (100 cm) and time how fast an object (*e.g.,* orange peel) flows set distance. Record as 50 cm/ __ s for cascade or 100 cm/ __ s for stream. Then divide 50 cm or 100 cm by time to calculate velocity (cm/s). To obtain discharge rate, multiply the width (cm) and depth (cm) of flowing water and then multiply by velocity (cm/s) to calculate mL/s. Divide by 1000 mL/L to calculate L/s. Compare to the first method.

3.5 Waterfall & Tufa Deposit

- Invite students to read the *Interpretive Sign* to discover how the tufa deposit was formed in and around the waterfall.
- Ask each group to develop hypotheses as to where the calcium carbonate might have come from and how this might affect pH of spring discharge and stream water.

3.6 Paskapoo Formation Sandstone Outcrop

- Invite students to observe and draw a profile of the layers of mudstone, siltstone, and sandstone on the opposite bank from the waterfall.
- Ask each group to recall and discuss Nathan Green's research on how geology affects recharge and spring discharge, which layer is likely to be most permeable, and most likely to be location of spring discharge.

3.7 Bow River Lookout (Reflection & Discussion)

- Invite groups to review how springs along the way have been feeding into the creek, with groundwater discharging from springs providing baseflow of the small creek, and then merging with the Bow River. Ask groups to estimate how much water in the Bow River might come from springs such the ones found in Waterfall Valley.
- Invite groups to also look across the Bow River to a small island where surface water from the left bank side is flowing under the island, mixing with groundwater, and then emerging again into the river. Ask how this might affect pH, EC, and water temperature just below the island.

4.0 Trailhead Reflection & Assessment

Invite groups to reflect on and discuss how their field observations matched or differed from what was discussed in the adapted primary literature article on groundwater research in the West Nose Creek watershed.

5.0 Student Field Journal

Provide one field journal per group, inviting each group member to contribute to recording and reflections. You might also want to take photos at each stop in your pre-trip visit, in order to replace images with those that match the season or timing of your field experience.

Waterfall Valley Field Guide & Journal

Stop 1: Waterfall Valley Topography

Identify, discuss, and record evidence of how glaciers have shaped this landscape.

Stop 2: Changes in Trees & Ground Plants

Observe how the type of ground plants, trees and shrubs change as you walk down the boardwalk. Create a list of environmental factors that might be causing this change in trees and plants? Which factors do you think are most important for the aspen?

Stop 3: Headwater Springs

Just past the first aspen grove, watch for small headwater springs. As a group, discuss where the water in these springs might be coming from?

Waterfall Valley Field Guide & Journal

Stop 4a: Cascading Spring

Draw a profile of how groundwater and surface water might be interacting at this cascading spring. How might this change temperature or EC of the surface water?

Stop 4b: Spring Discharge & Stream flow

Measure and compare the volume of the spring discharge and the stream just below the cascading spring. How much does the spring contribute to stream flow?

Stop 5: Waterfall & Tufa Deposit

Discuss as a group, as to where the calcium carbonate comes from that forms part of the tufa deposit. How might this affect pH or EC of the surface water?

Waterfall Valley Field Guide & Journal

Stop 6: Paskapoo Formation

Draw a geological profile of the glacial till, mudstone, siltstone, and sandstone layers at this site. Discuss and draw how groundwater might recharge, flow, and discharge in this geological profile.

Stop 7: Bow River Lookout

Draw a profile of how surface water and groundwater might be interacting in and around the island in the Bow River. How might this exchange affect EC, and temperature of the surface water of the Bow River?

Assessing what we learned :

Discuss and record how your field observations in Waterfall Valley were similar or different to what was reported in the adapted primary literature article on groundwater research in the West Nose Creek watershed.

RESOURCES:

BACKGROUND INFORMATION ON BOWMONT PARK

The City of Calgary

Natural and geological history of Bowmont Park

www.calgary.ca/CSPS/Parks/Pages/Locations/NW-parks/Bowmont-Park.aspx

BACKGROUND INFORMATION ON BOW RIVER

Bow River Basin Council

BRBC (2010). Bow River Basin State of the Watershed Summary

http://wsow.brbc.ab.ca/reports/BRBCWSOWBookletV2-Dec28.pdf

Web-based State of the Watershed (WSOW) Tool & Videos

http://wsow.brbc.ab.ca

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