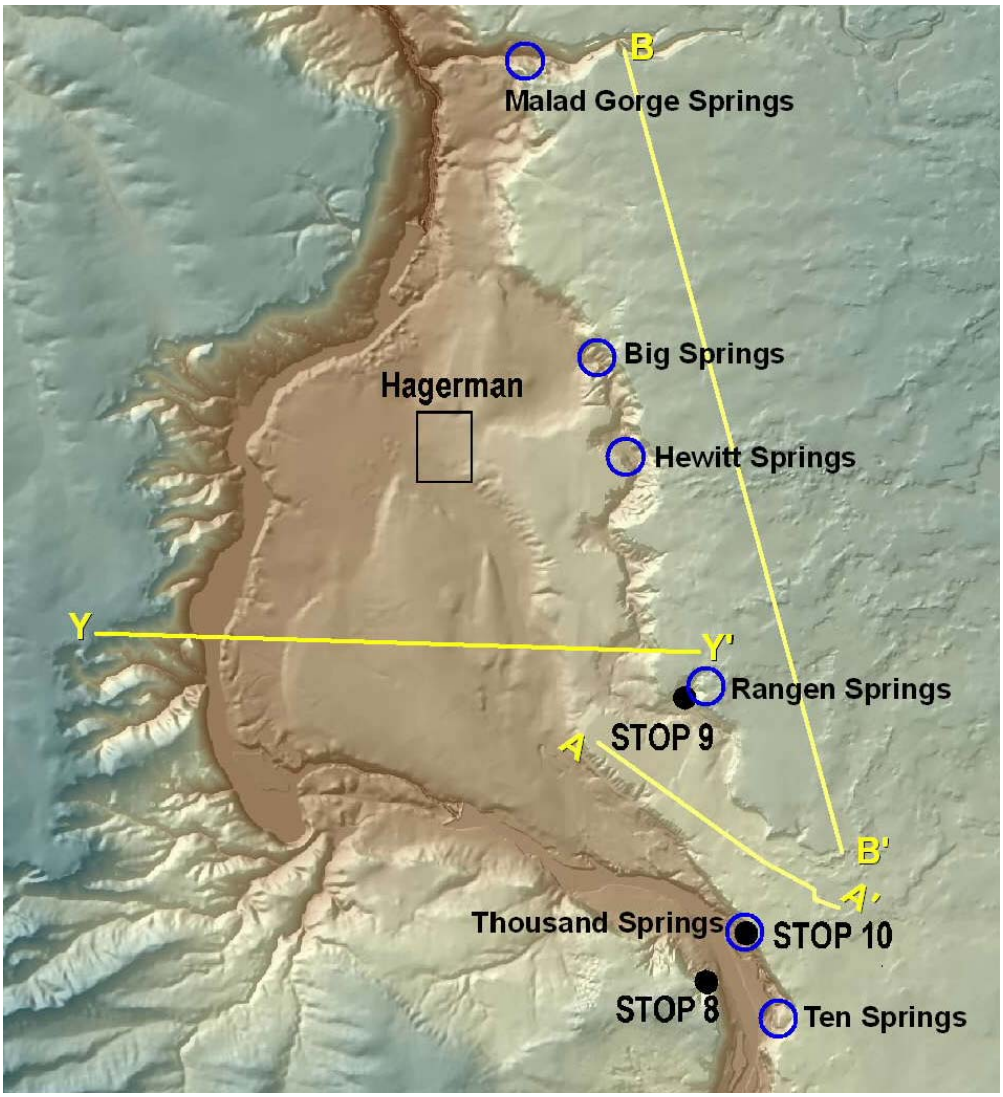
Stop 8: Sligar Hot Springs Rest Area Across the Snake River from Thousand Springs

Background:

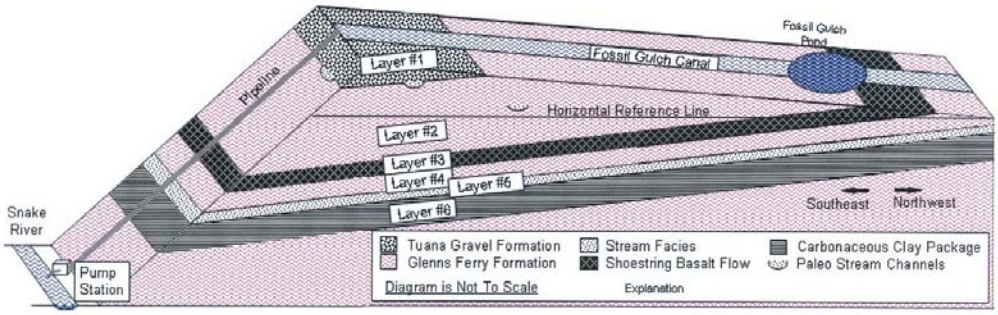
The Hagerman valley is an approximately six square mile expanse of Snake River flood plain bounded by steep canyon walls on the west and basalt cliffs on the east.

Shaded relief map of the Hagerman valley showing some of the spring locations



The valley is bounded by very different geology on the east and west sides of the Snake River. The fine-grained sediments of the Glenn's Ferry Formation dominate the stratigraphy on the west side of the valley, acting as impediments to ground water flow, with intercalated basalt lavas and buried fluvial channel facies acting as hosts for preferential ground water flow within the low-permeability sediments of the Glenn's Ferry Formation.

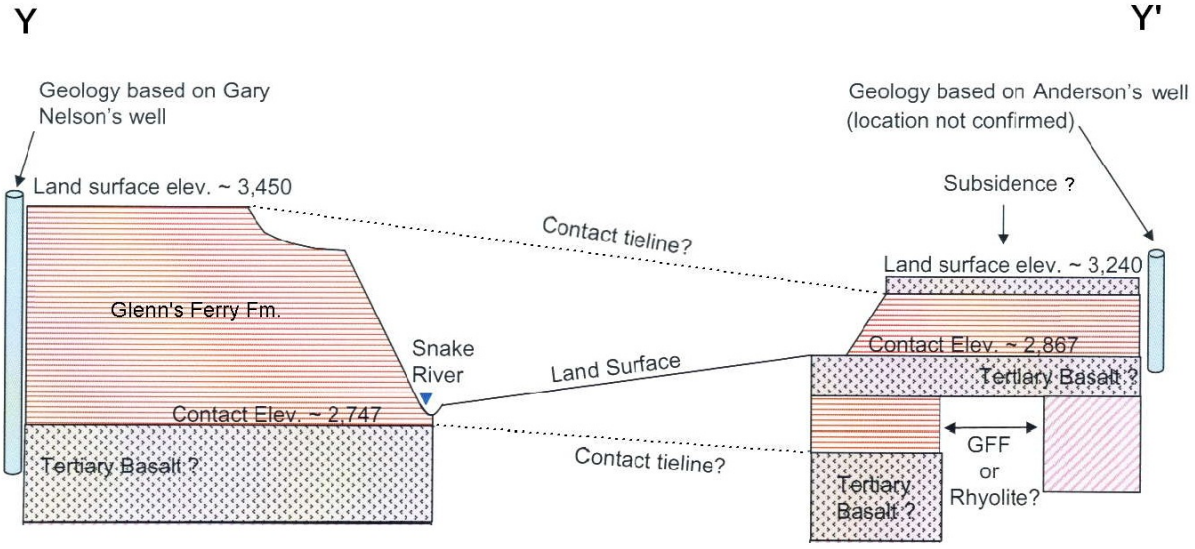
Conceptual hydrogeologic model, south side of Snake River (view looking south).



(after Neal Farmer, 1998, Univ. Idaho M.S. thesis)

In addition to the impacts of outcrop- and larger-scale heterogeneity seen in the basalt-dominated ESRP aquifer, ground water flow is controlled by even larger-scale heterogeneity, such as where the fine-grained, low permeability Glenn's Ferry sediments interfinger with the highly permeable basalts on the east side of the Hagerman valley (see cross-section Y-Y', below).

Conceptual geologic cross-section Y-Y' through the Hagerman valley.

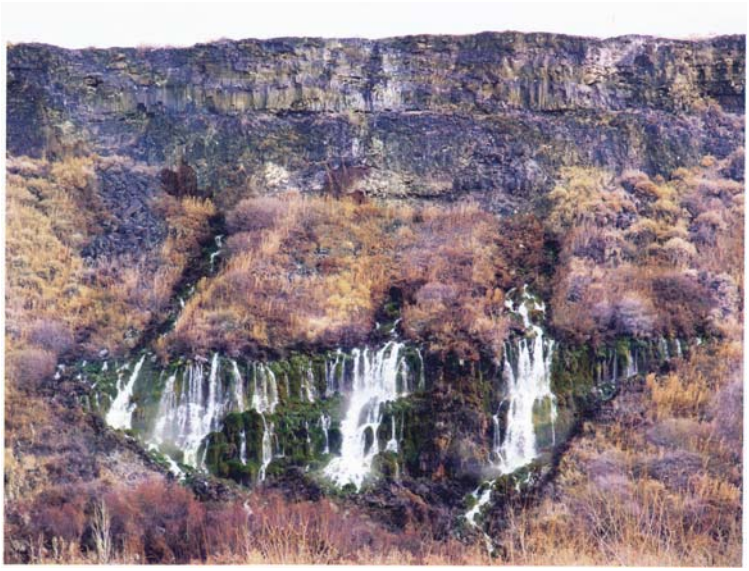


(courtesy of Neal Farmer, IDWR)

Objectives:

- obtain an overview of the Thousand Springs ground-water discharge system in the context of the Hagerman valley's geology and structure
- formulate hypotheses about the mechanisms controlling spring discharge in this and other spring complexes in the Hagerman valley

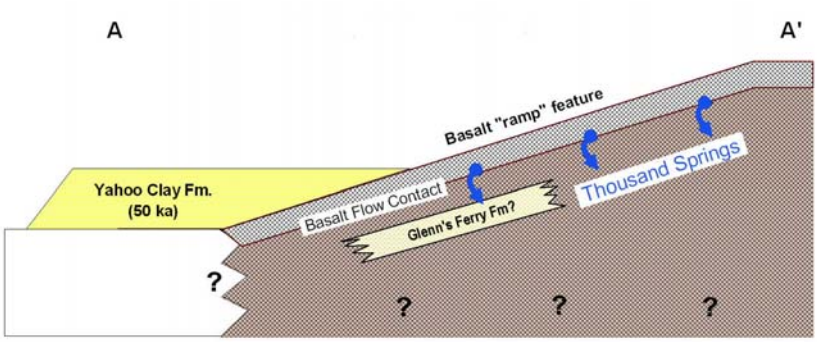
Snake River canyon rim looking east, showing some of Thousand Springs discharge from the upper contact of a northwest-dipping basalt lava flow group.



(courtesy of Neal Farmer, IDWR)

As well as being a zone of lithologic and stratigraphic change, the Snake River has downcut and exposed the ESRP ground-water flow system in the Hagerman valley, creating some of the largest natural springs in the U.S. (collectively known as the Thousand Springs area, but comprising many individual spring complexes such as Ten Springs, Thousand Springs, Malad Gorge Springs, etc.). The valley is a topographic depression displaying tantalizing clues that suggest the valley may be structurally controlled or possibly the geomorphic expression of the interplay between weathering, fluvial erosion and volcanism.

Conceptual cross-section A-A', through the northwest-dipping basalt "ramp"



(courtesy of Neal Farmer, IDWR)

Notes

Stop 9: Glenn's Ferry Outcrop at Vader Grade Pull Out

Objectives:

- compare and contrast the nature of geologic heterogeneity here with what you have observed in the basalt-dominated eastern Snake Plain aquifer
- consider scale-dependent features of basalt and sedimentary heterogeneity that control ground water motion through the aquifer where it interfingers with sediments of the Glenn's Ferry Formation.

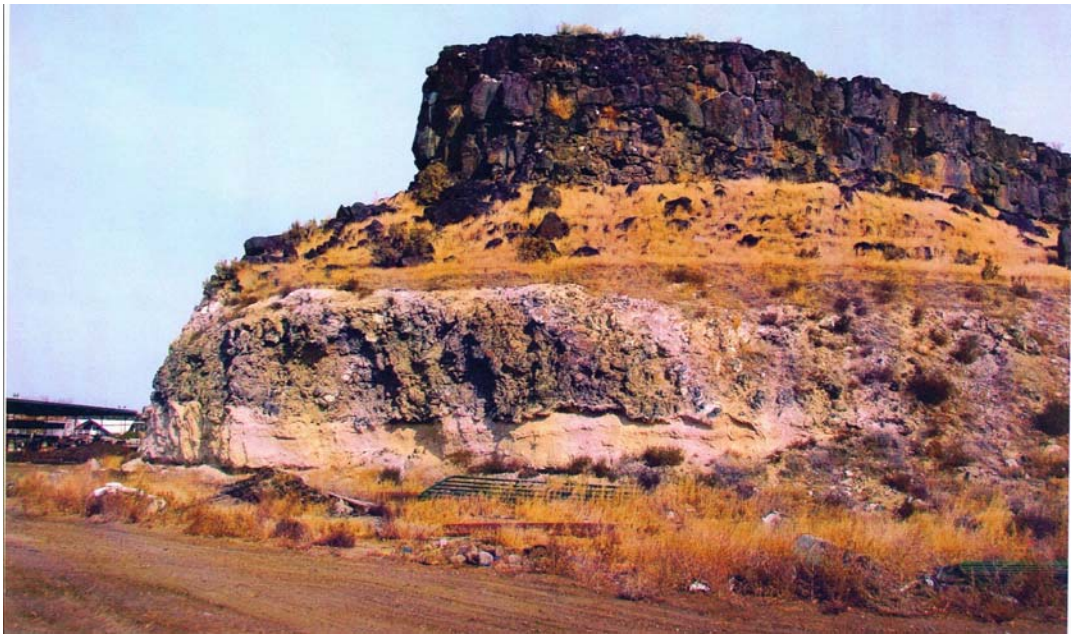
View of Glenn's Ferry Fm. at two spatial scales: Basalt overlying fine-grained sediments at Vader Grade (foreground), and steep cliffs across the Hagerman valley (background).

(courtesy of Neal Farmer, IDWR)

The Glenn's Ferry sediments impart a striking hydraulic contrast to the basalts' high permeability and, like almost all sedimentary interbeds intercalated within the aquifer's basaltic stratigraphy, have a marked effect on ground-water flow rate, direction and, when water levels are low, spring discharge.

Because Glann's Ferry sediments were deposited in a lake environment, they tend to be fine-grained, low permeability, and have high reactive surface area compared to the basalts. In areas where basalt erupted onto these wet lakeshore sediments, "water-affected basalts" were formed at the base of lava flows (e.g., as at Perrine Bridge).

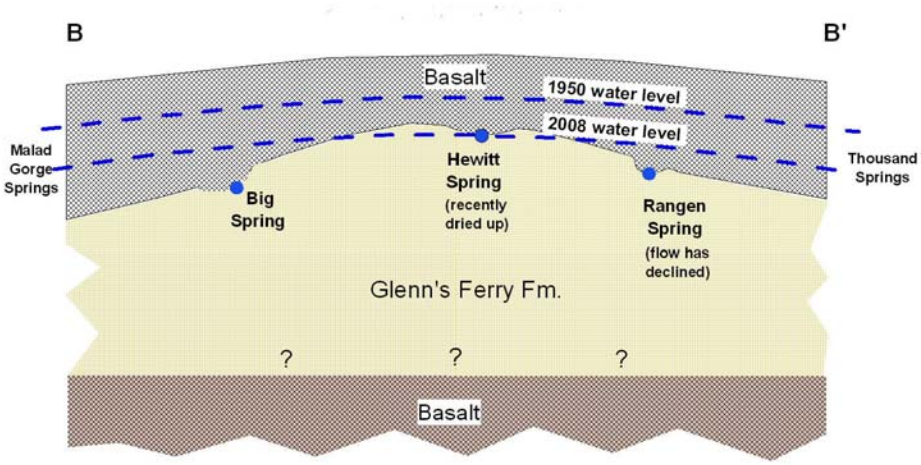
Basalt lava flow overlying "WAB" pillows and Glenn's Ferry sediments at Veenstra Dairy



(courtesy of Neal Farmer, IDWR)

Of particular interest to ground-water users and managers is the decreasing flow that has characterized the springs in Hagerman valley, where ground-water discharge has decreased by more than 40% since 1950 as aquifer water levels have dropped. Glenn's Ferry sediment within the basalt aquifer may have much to do with this (N. Farmer, pers. comm., 2008). Well logs in and around the Hagerman valley reveal that the Glenn's Ferry Formation on the east side of the valley has a bowed upper surface, either a paleo-topographic or a structural (anticlinal) feature, that may affect the local water table and may also explain why the highest elevation springs have experienced the greatest decline in discharge.

Conceptual cross-section B-B', showing how some springs are more susceptible to drought.



(courtesy of Neal Farmer, IDWR)

Notes

Stop 10: Thousand Springs

Objectives:

- observe outcrop-scale hydrogeologic features that characterize the ESRP aquifer
- relate mesoscale hydrogeology to the larger stratigraphic context of regional flow
- wrap up field observations and discuss implications

View of basalt outcrop, showing locus of ground water discharge relative to lava flow lobes.

Exercise 10.1

a) describe the rock textures and structures that you observe at this outcrop
b) sketch geologic features of the outcrop, particularly
    - lava flow lobes' shape and lateral continuity, and the contacts between flows
    - fractures, vesicle-rich zones, and rubble zones
    - locations of ground-water discharge relative to these features

Notes

Wrap-Up Discussion Points:

a) Compare your observations of micro- and mesoscale features that control gound-water flow, as seen at Stops 3 and 7-10.

b) How would you conceptualize and describe the nature of ground water flow in the ESRP aquifer?

c) How would you conceptualize and describe the nature of ground water flow in the west (sediment-dominated) side of the canyon.

c) How would the migration of dissolved contaminants differ during transport on the east and west sides of the Hagerman Valley?

c) How similar or different would your instrumentation have to be in these two different aquifers, in order to:
   - accurately determine hydraulic properties of the aquifer
   - determine ground-water flow rate and direction among wells 20 m apart
   - characterize water quality and rate of contaminant movement
   - monitor, model, and predict transport?