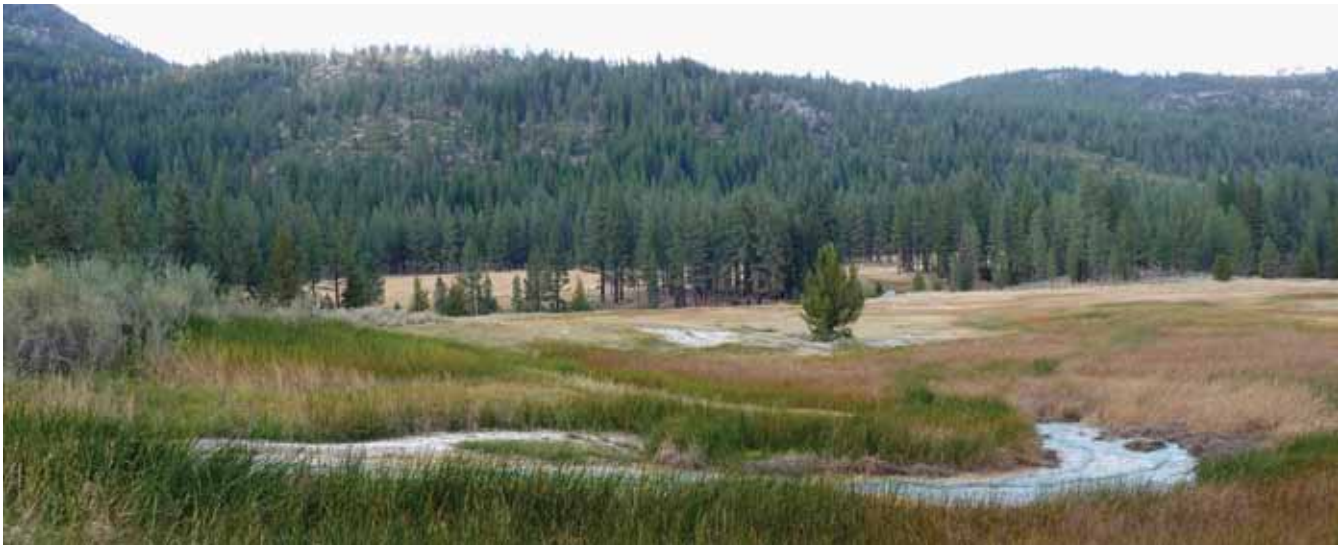
Grover Hot Springs State Park



Hot Springs and Geothermal Systems

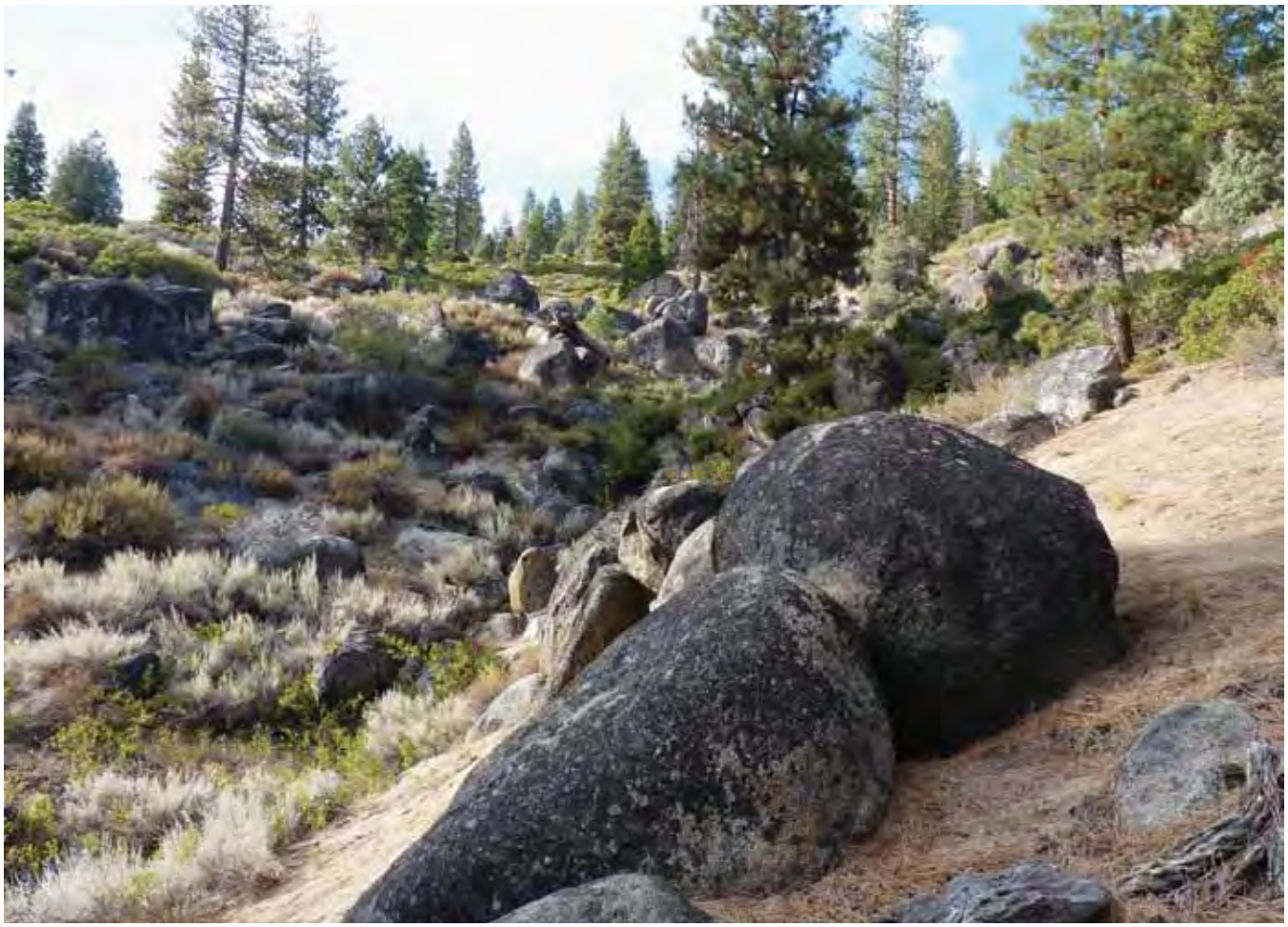
Process/Feature:
Hydrogeology along a nascent plate boundary, hot springs

Hot springs can be associated with fault activity and with volcanic processes. The thermal springs at Grover Hot Springs State Park are thought to be related primarily to circulation of groundwater in connection with faulting, as water below the ground is heated by contact with abnormally hot rocks. The water carries dissolved minerals, depositing the minerals around hot springs and along the fractures that channel the waters to the surface. The contents of the heated water contain chemical clues to processes operative deep beneath the ground surface. The mineral deposits built up at Grover are carbonate, which precipitate at near-surface conditions as the lime-rich waters cool and reach normal surface pressures.

Boundary Between Two Geomorphic Provinces

Sweeping vistas from high alpine zones to the desert below are the result of uplift of the Sierra Nevada along a major system of faults.

On a gross scale, the Sierra Nevada is a nearly intact block of igneous and metamorphic rocks that has been uplifted and tilted to the west. The boundary between the Sierra Nevada and the Basin and Range geomorphic province to the east is marked by a major zone of faults known as the Sierra Frontal fault system. The faults allow the Sierra crest to rise, while the blocks to the east drop and stretch. The Basin and Range is actually growing as the North American continent stretches and rifts due to plate tectonics.



Why it's important: Grover Hot Springs is treasured for its beautiful alpine setting and alleged restorative and refreshing natural hot springs. For more than 100 years nature lovers have been drawn to the springs to bask in the warm mineral waters and absorb the pleasant views of the tranquil peaks surrounding the hot springs meadow.

Grover Hot Springs shares its origin with numerous other hot springs that occur along the east side of the Sierra Nevada along the boundary with the Basin and Range geomorphic province to the east.

Faults and Hot Springs

One strand of the Sierra Frontal fault zone, the Genoa Fault, follows the base of the mountain front south from Genoa, Nevada then extends into the mountains near the Grover Hot Springs. This fault is active, clearly offsetting young geologic deposits (younger than the last ice age). Studies near Genoa show the fault was active as recently as 300 years ago. A splay of the Genoa Fault helped form the valley in which the park resides and is probably the conduit for the rising hot water that emanates at the hot springs. The valley was also sculpted by glaciers that occupied it perhaps as recently as 11,000 years ago, and remnants of glacial moraines dot the landscape.

In general, rain and snowmelt seep down along faults to reach relatively shallow hot rocks; the water is heated and propelled upward to the surface before cooling.

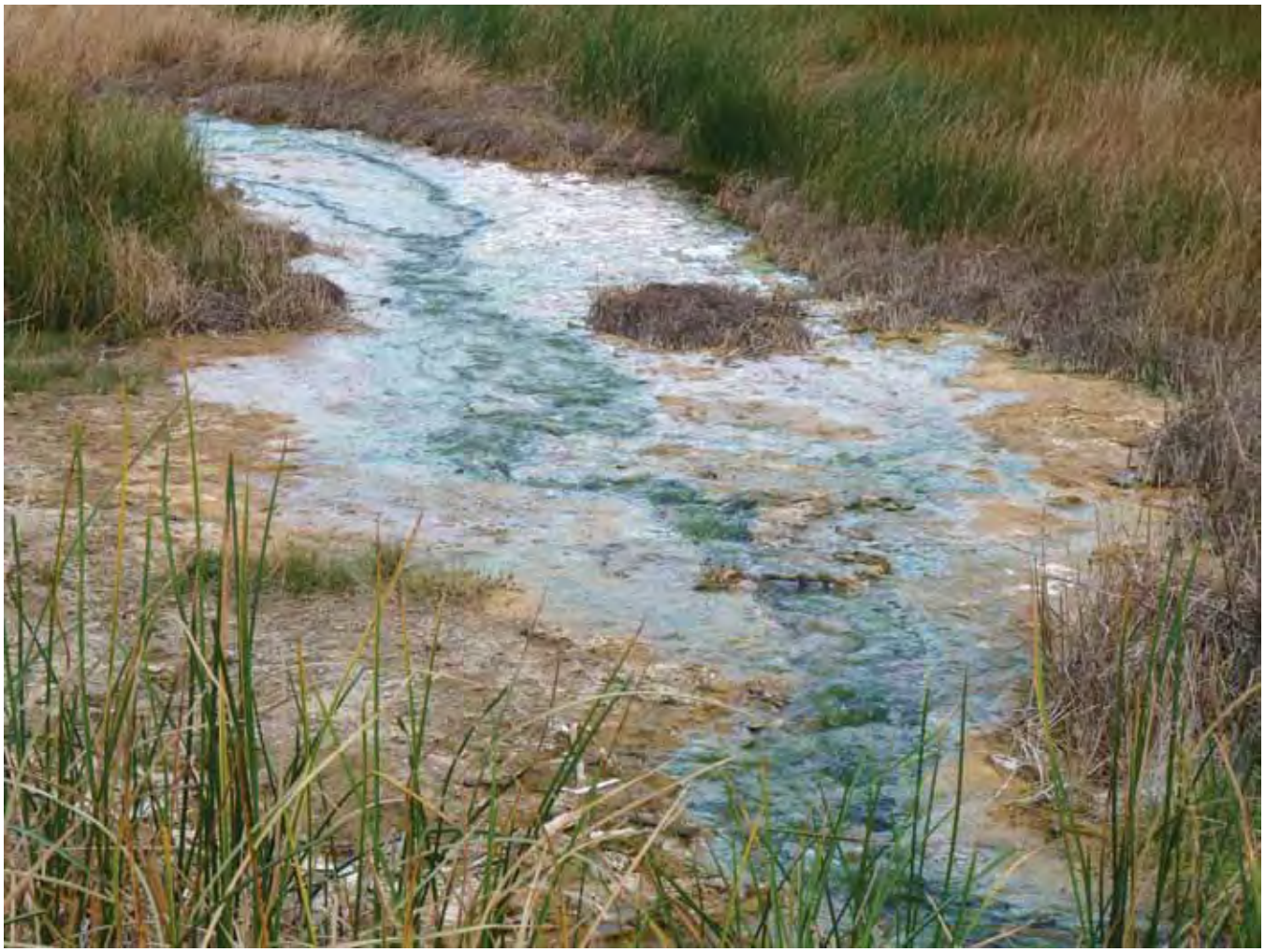
Chemistry of the Water

Prior to early commercial development, there were a dozen springs and seeps in two marshy areas about 100 yards apart, at the edge of the meadow on the southern side of Hot Springs Creek. The spring water is slightly acidic, gas-charged, and rich in sodium bicarbonate. Upon evaporation, it leaves a whitish crust at the surface which in areas has built up mounds and terraces of travertine (limestone). In the early 1900s, the hot and cold springs were developed to provide temperatures favorable to bathing by mixing hot and cooler water. The hottest spring varies from 128 to 146° F, depending on the contributions from rain and snowmelt.

The content of the heated water holds chemical clues to processes operative deep beneath the ground surface.

Chemical analysis of water from a hot spring at Grover Hot Springs State Park

Elemental Analysis (milligrams per liter)			
Sodium (Na)	440.0	Iron (Fe)	<0.02
Potassium (K)	13.0	Manganese (Mn)	0.08
Lithium (Li)	0.82	Ammonia (as N)	<0.1
Rubidium (Rb)	0.06	Bicarbonate (HCO_3)	775.0
Cesium (Cs)	0.10	Carbonate (CO_3)	<1.0
Calcium (Ca)	31.0	Sulfate (SO_4)	160.0
Magnesium (Mg)	1.9	Chloride (Cl)	190.0
Aluminum (Al)	0.002	Fluoride (F)	4.2
Silica (SiO_2)	100.0	Boron (B)	3.1
		Sulfide (as H_2S)	<0.5
(micrograms per liter)			
Cobalt (Co)	<50.0	Copper (Cu)	<10.0
Cadmium (Cd)	<10.0	Mercury (Hg)	<0.1
Nickel (Ni)	<20.0	Lead (Pb)	<100.0
		Zinc (Zn)	110.0
Analysis of gas escaping (in volume percent)			
Oxygen + Argon	1.4	Methane	0.34
Nitrogen	52.0	Carbon dioxide	36.4



What you can see: Hot springs emerging from a frontal scarp of the Sierra Nevada, fault bounded valley, granitic basement rocks with volcanic cap rocks and glacially-influenced landscape.

Final Thoughts

The geologic history surrounding the park exemplifies the geologic development of the eastern Sierra Nevada geomorphic province.

Written by Mike Fuller, California Geological Survey
Photos: Mike Fuller

Prepared by California Geological Survey, Department of Conservation | www.conservation.ca.gov/cgs
for California State Parks | www.parks.ca.gov

Geological Gems of California State Parks, Special Report 230 – Fuller, M., Brown, S., Wills, C. and Short, W., editors, 2015 Geological Gems of California, California Geological Survey under Interagency Agreement C01718011 with California State Parks.