

**Dale Pendell:**

**Seeking a Volcano; My Weekend on a Geology Field Trip to Owens Valley--  
A Road Log with Notes**

We meet in the parking lot at Sierra College at 7:30 AM to pack ourselves and our gear into three white vans. With the teacher and the drivers, we're seventeen. The drivers will get a lot of overtime.

We're instructed to keep a road log: cumulative mileage for every turn and stop, along with our notes. It's a geology thing. Mile zero is at Rocklin Road, then we're off, past the serpentine and talc and razor wire of the dam at Folsom Lake. Flagstaff Hill, where I've been before, is across the lake to the east: peridotite and ultramafics from a Mesozoic collision.

I can't look at a dam in the West without thinking of salmon. The greatest single loss of salmon spawning habitat was the construction of Grand Coulee, built too high for fish ladders (and in disregard of Congress)-- the watershed above the dam equal to the rivers of Oregon and California combined.

At Cameron Park Drive, big houses with private runways for their airplanes (the workers live in the trailer park). After 24 miles we're onto Highway 50, old basaltic seafloor turned to greenstone. But we're headed for the east side.

Crossed the Pacific Crest Trail at Echo Summit, head out on 89 to Monitor Pass, and drop down to the Carson River, flat-topped volcanic mud flows. Mountain meadows, ice age lakes, past the deep circulation waters of Grover Hot Springs, where fly fishermen practice their art to a peer review committee of trout. East Fork, Carson River, down to Highway 395.

*A las cinco de la tarde.*

(About when the fascists shot him in a field near Granada.)

*Lo demás era muerte y sólo muerte. (Lorca)*

Hot springs, mist rising:

a touch from the mantle. First fall snow, still on the trees.

And into the Great Basin: old passive margin, "miogeocline"--  
limestones hiding somewhere.

(23,000 continuous feet of Paleozoic sediments in the Inyos, half of it Cambrian.)

A student mentions that one of the geology professors lists himself as a "naturalist." Some discussion follows.

"Aren't naturalists people who think that everything is governed by natural laws?"

"That was what people who studied science were called before there was science."

"You mean, they just accepted things without questioning them?"

Another student adds: "I thought they were people who believed in nudism." John Muir turning in his grave.

Laura asks the students if they've heard of Occupy Wall St, but there seems little interest. They're all just trying to somehow find a versatile position in the shrinking job market, so they can earn less than their parents did and be grateful for it. Our "system."

**Conway Summit**, at 186.1 miles, 8138'

Rabbitbrush in bloom, *Chrysothamnus nauseosus* (got to love them specific epithets). Never seen it in such profusion. Sagebrush country.

Beginning in the late Permian (the story goes), subduction began on the west coast of North America--collisions from the west, island arcs, microcontinents, basalt seafloor squeezing under the continental shelf, scraping off sediments and seafloor, the heavy rock melting as it descended, magma chambers building west to east, the Farallon plate mostly gone by the Oligocene, when the Pacific plate took over, grinding north. San Andreas Fault, Miocene.

The old volcanoes flowed west, all the way to Rocklin and Lincoln. Most of the Sierra granite now exposed is Cretaceous. Crust melted from beneath. Felsic plutons rose, packed like bubbles, thousands of feet of mountains above them, maybe higher than today, and milder. Good hikes for sauropods, with scenic volcanoes, until the mountains wore away, waiting another fifty or sixty million years for the crust to break up.

"Your faults are normal, don't be alarmed."

Grabens sinking, a new Sierra bounding up like a trap door—a couple of million years enough for a major mountain range. (And ten or twenty to wear it down).

Even with the new rain shadow, the Pleistocene lakes held, cold bottoms (tufa at Mono). Mammoth Mountains the youngest. Pumice. Obsidian.

**Mono Lake Visitor Center**, 197.6 miles on the road log.

Most of the west coast's California Gull population nests on the islands in Mono Lake. One, Negit, a basalt island formed around 1200 years ago; the other, Paoha, rhyolite, pushed up by a "sub-aqueous cinder cone" 250 years ago.

The Old People collected Pandora moth caterpillars here, dug trenches around Jeffrey pines to trap them, and collected the pupae of the alkalai flies from the lake. One ton per family per season. *Kazedika*: "fly eaters."  
Lived in little bark-covered A-frames.

A lawsuit concluded in 1994 forced Los Angeles to stop diverting all of the water from the rivers feeding the lake, and the level seems to be rising, many of the tufa towers back in the water, and the big island safely separated from the shore—so the coyotes can't get at the rookery.

Tufa: "a petrified spring." Sort of. The simplified story is that calcium from underwater springs combines with carbonate in the lake water to precipitate calcium carbonate, perhaps with the help of cyanobacteria. And perhaps with the help of the pupae of the alkalai flies, *Ephydra hians*, which secrete the crystals on the tufa towers.

*The First Fly You'll Ever Love*

*You can hold them under water as long as you please--they do not mind it--they are only proud of it. When you let them go, they pop up to the surface as dry as a patent office report, and walk off as unconcernedly as if they had been educated especially with a view to affording instructive entertainment to man in that particular way.*

*--Mark Twain, Roughing It*

On the south shore, "sand tufa": delicate sand castles, vertical sheets of cemented sand grains, rolled and folded like paper, capped by calcium carbonate. Critters, perhaps, and mucous (I thought of stromatolites). The senior student tells me that the tufa is pure calcite, but I'm looking at grains of sand under my hand lens. It's the trap of seniority—having to be the one who knows. (He also maintained that the calcium flowing into the lake didn't necessarily need an anion, and wasn't interested in hearing about physics).

Alkalai flies, linking their legs into big floating rafts, drift with the wind. Brine shrimp below. The lake water 2 ½ times saltier than the ocean, but what I taste is mostly the shrimp.

Salt grass, *Distichlis spicata*, in a mat along the lakeside. Blazing star, *Mentzelia laevicaulis*, ("smooth-stemmed"), along the trail.

Scientists recently claimed to have found arsenic-based life in Mono Lake, but the finding has thus far not been replicated.

We head south, U-shaped valleys to the west fronted by huge mounds of glacial moraine. At 271 miles we get to Brown's Millpond campground, near the Tungsten Hills, about 6 miles north of Bishop, and make camp and eat.

#### #### Day 2 #####

A cold morning at Brown's Mill Pond campground, pink dawn on the fresh snow on the eastern Sierran wall. We stop briefly at Schatt's in Bishop, where they know how to make a bear claw.

Volcanoes are fluid or sticky. The fluid, flowing kind, like the basalt volcanoes of Hawaii, are predictable. Eruption planned for next week. Call up the volcano nuts and walk out to the glowing fresh lava.

The sticky kind of volcano, high in silica and steam, sometimes plug up. The Long Valley caldera explosion, 760,000 years ago, killed everything in a thousand mile radius.

"Incandescent cinders." A rain of half-molten glass. "Welded tuff." Hot foot.

*You wanted a volcano? You got it.*

The problem is the silica tetrahedrons, promiscuously bonding covalently into long polymerized chains. (Why we can blow glass, make those cool flasks, vases, and bottles.)

Some think Yahweh was a volcano god: "pillar of smoke by day, pillar of fire by night." Perhaps in Saudi Arabia.

Tule elk in the meadows, by the Manzanita internment camp.

Union Wash, with its Triassic ammonites, to the east.

#### **Earthquake Cemetery, @335 miles.**

We stop at a cemetery for the victims of the 1872 earthquake—largest known in the west—perhaps 7.8-8.5M, with eighteen feet of slip and at least four feet of vertical rise. (The Alabama Hills said to have risen seven feet all at once.)

Sixteen of the twenty-seven victims of the earthquake buried here in a mass grave on a pressure ridge. A snow-white glistening block of building stone shines in the monument; the professor calls it quartzite, but she hasn't looked closely—it's dolomite (hardness 3.5, highly vitreous crystal faces that fizz a little in acid if scratched).

On the ground a tiny piece of what looks like andesite, pressured a little to create a hint of banding, with a few tiny specks of pyrite. Ants working full time to mix it all up. Winter fat (*Krascheninnikovia lanata*), and two species of *Atriplex* (*A. polycarpa*, and *A. confertifolia*), around the edges.

We talk about the Cambrian, when someone invented "hard parts," and thus: "phanerozoic." Then in the Jurassic the Atlantic opened in one of those 120 degree three-legged splits. One leg usually punks out: "aulacogen," and gets filled in, like the Uinta aulacogen in northeast Utah, where Rodinia broke up around 750 ma..

Extension causes "normal" faults, where the hanging wall drops; compression "reverse faults", with the hanging wall thrust up.

Through Lone Pine, home of Myron Stolaroff, founder of the International Foundation for Advanced Study.

**Fossil Falls** 35° 58 19" 117° 54 39" Mile 382 on our road log.

Good place for basalt: one piece with a cleavage plane. I ask if it might be plagioclase.

"There are no cleavage planes in basalt!" (the senior student again).

Hmm. (At 90° there was another flash: pearly).

And in a vesicular chunk, full of gas holes, a green phenocryst that will scratch steel.

*olivine, olivine,  
prettiest gem I've ever seen.*

Indicative of a deep melt.

These are "alkalai" basalts, and differ in composition from those further south.

Although lava is not generally associated with transform faulting, David Jessey suggests that the difference between the chemistry of the Ricardo and Coso basalts may be due to the change from dip-slip to strike-slip.

Here the Red Hill basalt lies over the Little Lake basalt, and is said to be older than 10K, younger than 130K. The Coso basalt is Pliocene in the east, Pleistocene in the west.

“Pliocene Coso basalt is characterized by small phenocrysts of plagioclase, olivine, and ophitic clinopyroxene, whereas Pleistocene basalt is strongly porphyritic, containing varying proportions of olivine, plagioclase, clinopyroxene, and opaque oxides.” (Duffield et al, 1980, in Bruns, et al, "Basaltic Volcanism in the southern Owens Valley, California")

The falls were cut by Tioga glacial waters. 20k-10k, most recent of the five glaciations—

Sherwin	>760K	
Mono Basin	~136K	(>131)
"Wisconsin" glaciations:		
Tahoe	75-60K	(56-118)
Tenaya	45K	(37)
Tioga	23-12.5K	(10-25)

(there is some variation in dating in different references).

One student finds a three inch obsidian flake in the wash. It looks like a blank, knocked off but rejected for having too much curve.

Much obsidian was traded across the Sierra to the west, shells and other coastal products moved east. Little seems to have been traded north to south. Sometimes blanks were traded, but mostly finished bifaces—why carry the extra weight?

Maybe I just imagined the plag. Maybe it's my old eyes with their cataracts. But to regain some status I manage to shimmy up the smooth basalt chimney by the dry falls that had defeated the kids.

**Alabama Hills** (Our mile 428) 36° 33' 15", 118° 02' 57"

"Triassic/Jurassic metavolcanics intruded by Mesozoic granites."

Crumbly weathering granite: the feldspar chunky, the quartz also, yellow-stained, biotite slabs going every direction. Much of the feldspar is weathered

into white powder, but there are a few large pieces still harder than a 5.5 knife blade.

& another something green—what's that?. This granite is 83Ma. Late Cretaceous. The professor says it's the same granite as at Rocklin, but that rock is older, 140 Ma. (as would be expected by the eastward progress of the subducting plate.)

The granite of the Alabama Hills remains enigmatic. While the monzogranite of the Alabama Hills is the same age as the granodiorite of the Sierra to the west, and evidently exhumed at the same time (determined by apatite-He dating), were the Alabama Hills exposed by transpressional uplift, by down-dropped normal fault blocks, or by a massive landslide? Is the spherical weathering the result of surface exposure, or is it a relict of sub-surface chemical decomposition? Down-dropping seems to be the currently favored theory, but at least one geologist (Aron Meltzner) believes the Alabama Hills monzogranite to be distinct from the orthoclase-rich Sierran boulders on the floor of the valley both to the east and to the west of the hills.

I wanted to see the Jurassic metavolcanics, said to be arc-related, but couldn't find any at our stop. The details of the contact metamorphism in the Jurassic rock, and their relation to the metavolcanics in the Inyos, seems not well sorted out. Perhaps the range was thrust eastward 20-30 km. in the upper Jurassic, before the granitic intrusion, as suggested by Julie M. Brown in her remarkably well-written senior thesis, "Geochemistry and Petrography of the Jurassic Metasedimentary and Metavolcanic Units of the Alabama Hills and the Southern Inyo Mountains near Lone Pine, CA". (It occurred to me that one doesn't see that level of original research from undergraduates in, say, physics. Nor does one see in the other sciences 125 year old papers being regularly cited, as is common in geology.)

Base of graben 4 miles below Sierra crest.

The big attraction seems to be the plaques of all the movies and car commercials shot here--one from a Hopalong Cassidy movie shot the year I was born. Movies and television are our mythology—what the family squabbles on Olympus were to the Greeks. Fremont's cottonwood in the washes, a *Baccharis* I don't know, *Atriplex*. A *Salix sp.* Should have brought a plant press.

The desire to know everything said to be "Faustian" by Oswald Spengler. What's that plant? What's that rock? What was that lizard? Why are these geologists dropping acid?

*I was halfway down to Trona,  
hitching rides on three-ninety-five,  
prospecting for a claim to call my own.  
Got waylaid by a girl  
with amber phenocrysts for eyes. . .*

(The making of a good naturalist.)

The hills named for the CSS Alabama by Confederate sympathizers. That's a story I do happen to know. The Confederacy had agents in England, and though England was officially not aiding the Southern war effort, high-ranking members of the government looked the other way while the ship was constructed under an assumed name. Federal agents knew what was up, and nearly succeeded in stopping the work, but the ship got away and sank 65 Union merchant vessels before being sunk by the USS Kearsarge. The USS Kearsarge was named for a mountain, Mount Kearsarge, in New Hampshire, a name derived from the local indigenous word *Carasarga*, which means something like "notched piney mountain." Kearsarge Pass, due west of the Alabama Hills, was named in turn after the USS Kearsarge in 1864 by Unionist prospectors. After the war the United States of America sued the British government for all of the shipping losses, and won in a British court.

Bishop                      Bishop  
    Bishop                      Bishop  
(rest stop)

(where Barbara and Galen Rowell lived before they died in a plane crash. Galen's son, Tony, is now a fine photographer himself.)

North: pink stuff, Long Valley Caldera, volcanic tableland.

@508: 37° 26.420'; 118° 34.246'

Stopped to look at a petroglyph in the varnish on the rhyolite in a ravine: a zig-zag-- "Great Basin curvilinear"-- perhaps site 268 in Heizer and Baumhoff. I wanted to explore more, but we rushed off to the Owens River Gorge. The junipers were probably *Juniperus osteospermae*, the berries browner and smother and larger than the western juniper, but I didn't get a sample.



@515 Owens Gorge

We hiked down into the gorge, where Laura used to climb.

Two main divisions of the rhyolite tuff, upper and lower. The upper part mostly light and loose, with some spectacular starburst cracking on the far side of the gorge from the cooling of hot spots. The lower rhyolite is a strongly welded tuff, much of it gray "So how would this be distinguished from andesite?"

Not easily, evidently.

Phenocrysts of sanidine, a K-feldspar.

Quartz, plagioclase.

Jupiter was rising in the east when we returned to the campground at Brown's Mill Pond. The kids go off for a hike.

##### Day 3 ###

The Tungsten Hills are to the east: granite intruded into limestone (metamorphosed by the heat into marble). Scheelite. In 1918 world's major source of tungsten.

Moraines at the ends of the valleys.

And we dip again into the caldera:

6000' pinyon pine;

7000' Sherwin Summit,

*Larrya*, *Chrysothamnus*, *Purshia*, *A. tridentata*.

At Horseshoe Lake, to the west, CO<sub>2</sub> tree kills.

@563 the Big Pumice Roadcut

Now greatly covered by erosion; some vegetation on the glacial till beneath the tuff, so the till is older than the tuff, which is 760kya, thus dating the Sherwin glaciation. Clastic "dikes" that filled in from the top.

N. on 395; Crowley Lake, and in the crater, cattle (been quiet around here, the last 760,000 years).

Fred Eaton, born to a prominent and founding family in Pasadena in 1856 ("Eaton Canyon"), taught himself engineering and by 1875 was the superintendent of the Los Angeles City Water Company. As mayor of Los Angeles 1898-1900, Eaton created the Los Angeles Department of Water and Power, and appointed William Mulholland as superintendent and chief engineer. Together, Eaton and Mulholland planned the Los Angeles Aqueduct. Eaton

acted as advance man and bought up water rights all around Owens Valley, as well as the property under what is now Crowley Lake—cattle ranching was his "cover story." Eaton signed over his water rights to the L.A.D.W.P. but kept his ranch. When Mulholland realized that he needed a reservoir, Eaton asked for a million dollars. Mulholland refused, and the two friends became estranged. Instead, Mulholland built St. Francis Dam, which failed in a storm, unleashing a devastating flood in the San Fernando Valley. Eaton finally sold his land to Los Angeles for around \$650,000. By then Eaton was a ruined man—Eaton had invested where he lived and had lost everything when the local bank failed (in part because of the devastation of the Owens Valley and its economy). Shortly before he died in 1934, Eaton and Mulholland, also by that time a ruined man, had a rapprochement. (See *Cadillac Desert*, by Marc Reisner.)

@575 Convict Lake,

dammed by a terminal moraine; Tioga.

Named for a prison escape in 1871, where a posse member was killed at a shootout at the lake. Mt. Morrison named after him. The lake more recently the site of a tragic multiple drowning: three teenagers from a halfway house on a supervised hike and four of their would-be rescuers.

Metamorphic roof pendants in the high mountain to the west. Big time.

(Actually a series of roof pendants, stacked side by side --all Paleozoic)

Rose hips in the brush, *Rosa woodsii*. An alder I don't know. A narrow-leafed willow, probably *Salix exigua*, coyote willow.

Cold ghosts in the steel gray water.

At Hot Creek we walk down the road to the springs. Sinter. Juniper. Carbonate. Under a calcite rind on a boulder there is a bright green arc. Many theories are proposed by the students for the green "mineral": arsenic, tremolite, tourmaline. But it looks like cyanobacteria to me. (And as it dried the green faded, immediately revived by sprinkling with water. The crystals of the acicular rind themselves seem to be pure calcite by the acid test).

N 37° 40.485' W118° 56.277' 7658' elevation

Dry lake: new meadow, pine moving in from the edges.

Dead Man Summit, 8036

@605 At June Lake , an imposing erratic by the road.

@628 short collect, 37° 54.05' 118° 59.754'

Mono cinder cone, just north of Crater Mountain.

Somehow cut my finger: blood on new my gloves (hadn't put them on yet). A bad place to be barefoot.

Under the microscope the pumice is hell on earth—caverns of spun glass, sharp edges at breaks, micro-knives; must have been hot and windy that day, where the winds were hundreds of degrees and the glass glowing orange. I thought of those paired photographs by Andreas Feininger of cross-sections of horseshoe crab shell and the femur of an eagle. Obsidian bands layered throughout: millimeters to inches (to feet in the boulders).

The Maidu toolmaker Smoky Jones said that the obsidian didn't flake as well after exposure to sunlight.

A last look at Mono as we ascend Conway Summit: the dried grass a golden yellow, three bands of blue in the lake, like interlocked fingers, one Prussian blue, one very pale, like the .8 tint of a Rembrandt pastel, and between them the cat's paw, and the brownish shrimp belts beyond that. Caps of something hard on the distant hills, probably basalt, or a strongly welded rhyolite tuff.

We're headed north, and home.