

**The Earth Shook, The Sky Burned, And
All The Bunny Rabbits Ran Away**

Central Valley Guide from the Sacramento & Delta area to Lava Beds

Ver. 4.3

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about everyone else in the world

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THE GREAT CENTRAL VALLEY'S GEOLOGIC HISTORY

Welcome to the Great Central Valley of California! The day actually began nearly 20 hours earlier in the U.S. at Wake Island, a speck of land in the mid-Pacific Ocean now inhabited by squadrons of Gooney birds and formerly by some slightly sun-crazed sailors and Marines. That fact notwithstanding, a smattering of geology, geography, and history will be presented here to assist in alleviating the intrinsic boredom of endless hours endured while heading north along Interstate 5. It is written in English as opposed to Geologise so that those among us not in possession of a PhD in the earth sciences may derive some useful and, perhaps, even interesting information about the part of California toward which we are about to embark.

This road log/guide starts just northwest of Sacramento, capital of the Golden State. We are smack in the middle of one of the largest valleys in North America. To the west lies the northern Coast Ranges, a series of roughly parallel mountain ranges pushed up like folds in a rug by continental drift as the rest of North American Plate launched itself over the Pacific (Ocean) Plate. Additionally, a large slug of Jurassic and Cretaceous Period rocks form the Coast Ranges at the western edge of the Great Valley. The rocks were formed in the middle to this late "Age of Reptiles" and following "Age of Dinosaurs" and are a mixture of old proto-Pacific sea floor (a large plate of rocks called the Farallon Plate that is now sitting under the Great Basin and extending east to nearly the Mississippi River Valley).

The adjacent, ocean bottom, continent edge and "seashore" sedimentary rocks, called the Franciscan Assemblage and Great Valley Sequence, respectively, compose the Coast Ranges here. These pillow basalts (underwater erupted lavas), deep ocean basin chert and shale, and graywacke (feldspar-spiked sandstones) of the Franciscan Assemblage were scraped off the disappearing ocean floor as it was over-ridden by North America starting about 100 million years ago. After being quickly stuffed down into the subduction trench along North America's West Coast, these rocks were crumpled, bent, partially metamorphosed, and, in some cases, melted before being once again pushed back up to form part of the Coast Ranges. Somewhat later these rocks, along with the adjacent sedimentary rocks of the Great Valley sequence (a pile of sedimentary rocks eroded from the then western edge of North America), were welded onto the western edge of the continent. And with these few words, we gloss over nearly 4 billion years of the Earth's formative history.

At about the same time, some 140 million years ago, the Klamath Mountains had somehow become detached from the northern Sierra Nevada and skated west about a hundred miles, leaving the narrow oceanic Klamath Seaway. The older rocks bottoming this seaway are now deeply buried under the southern end of the Cascade Range with its multitude of volcanoes including Mt. Shasta, Mt. Lassen, and, possibly, Sutter Buttes.

Pressing onward in time, we find that a series of younger rocks, predominantly sandstone and shale, of the Great Valley sequence were still being deposited east of the Franciscan rocks. All this took place in the shallower basin located at the edge of the North American continent. At about the same time the Great Valley gradually became an isolated arm of the sea where 2-foot diameter ammonites (similar to today's Pearly Nautilus) lived and leathery-winged pterosaurs glided over the waves. Just why the Great Valley did this cannot at present be fathomed. However a simplistic answer can be postulated here using the Mother of All Answers: It likes To.

The geology of the Great Central Valley is relatively straightforward compared with some portions of the state. The Valley has been slightly below, at, or slightly above sea level since the Cretaceous "Age of Dinosaurs" and following early Tertiary Period a total of about 144 million years of time, all the while accumulating sediment. It is over this truly colossal pile of silt and sand that we now travel. In any case, all this changed by the start of the Tertiary.

About 65 million years ago a 3.5-mile diameter asteroid, or whatever it was, skimmed in over what's now the north coast of the Yukatan Peninsula and formed Chixulub Crater, exterminating nearly 80% of all life on Earth. Ignoring the slight problem of the demise of life forms, the Great Valley continued to fill with debris from the emerging Sierra Nevada, then a series of low rolling hills. Indeed, even as we speak, sediments washed from the Sierra and the Coast Ranges is trying their mightiest to fill in the valley. Jumping ahead slightly, it was on this fertile and sparsely watered plain that the Vaca family was granted ownership of the area in 1845 and, by 1852 the small town named for them was a going concern. To the east is Davis, home to University of California Davis campus better known as UC Aggies as well as an unexplained traffic jam of immense extent; also to the northeast is lovely, historic downtown Woodland.

NATIVE AMERICANS

Before the settlement of the area by Europeans, the area east of I-505 was inhabited by the Poo-e-win, a dialect group of the Hill Patwin American Indians. Like most of the Patwins, the Poo-e-win settled along the major rivers and tributary creeks such as the Sacramento River, Cache and Putah Creeks as well as a few large springs. Only places high enough to keep them above the rising waters of seasonal floods were selected for permanent villages, or tribelets; no fools they, unlike the current inhabitants of the Sacramento-San Joaquin Delta. The Yodoi tribelet of the Poo-e-win at one time occupied the present site of Knight's Landing. The Poo-e-win probably occupied the Woodland area in seasonal camps for hunting and seed gathering. Of special importance to the Poo-e-win and their neighbors was a main trading trail that followed the course of Cache Creek. This trade route served as an important means of cultural and social interchange in addition to a vital economic supply line for the Patwin and their neighbors, the Nomlaki to the north, the Nisenan to the east, and the Pomo to the west. And you thought you'd never learn anything about California anthropology from a geologic guide?

Information about the Poo-e-win is limited compared to what is known about neighboring Indians. The “religious enlightenment” and enslavement of the Poo-e-win by the Spanish missionaries rapidly and dramatically reduced their numbers through hardship, missionary over-work, and disease. That and a malarial epidemic in 1830-33 and following smallpox epidemic in 1837, took care of most of the survivors... such a lovely thing was the European “civilization.”

The lower Sacramento Valley’s modern historical development was the result of several factors: its rich soil and climatic conditions; good transportation systems; and its function as the county seat. This combination of natural and man-made influences is still the critical influences in area's growth and development.

DAVIS & WOODLAND

The origins of the Woodland-Davis area just to the east of our route as an agricultural hot spot can be traced to the early 1850's. In the winter of 1853, one Henry Wyckoff settled down in a dense grove of Valley and Blue Oaks and opened a small store. Soon other businesses located in the area, including a store owned by Major F.S. Freeman. Major Freeman offered free home lots to those who would clear the land and build homes. Before long the settlement of Yolo City was established around what is now the central part of Main Street. Yolo City soon became an important agricultural center. Irrigation was a major contributor to the agricultural success of the region. In 1856, James Moore, who owned the water rights to Cache Creek, dug the first irrigation canal through the underlying Red Bluff soils. By 1870, the population of Woodland was an estimated roaring 1,600 souls and most of the sturdy and scenic oaks for which the town was named had disappeared under the axe. Woodland finally incorporated in 1871.

Money earned in the California Gold Rush financed the purchase and cultivation of much of the farmland surrounding Woodland and Davis. A variety of crops were grown, including tobacco (not a real success), peanuts (of better, but not spectacular, success), grapes, rice, sugar beets, assorted grains, and row crops. Wineries and livestock were also important agricultural operations. From the 1840's to the 1860's, the abundant wheat output of California managed to feed not only the growing California and US population, but, as ship-loads of grain arrived across The Pond (as some wags called the Atlantic Ocean), fed the starving population of Eastern Europe after a series of devastating wars (among them the Crimean War-the first of many involving just who “owned” the Crimean Peninsula) and the resulting famines lasting nearly 40 years.

The State was enjoying the bountiful rainfall of the “Neoglacial” period. This encompassed the last 5,000 to 6,000 years when alpine glaciers reformed and advanced. The "Little Ice Age" (named by Frank Matthes in 1939) is generally regarded as the culmination of the Neoglacial period. The term used by

climatologists, geologists, and glaciologists to describe a period of worldwide lower temperatures, greater rainfall, and advanced glacier positions from the 16th century through the late 19th century. In the 1880's, the Woodland Creamery was built to provide dairy products for local residents. The Contented California Cows happily munched in the luxuriant grasses still covering parts of the Great Valley. One historical document notes that the first laborers used by the earliest farmers of Woodland in the 1850's were the native Patwin people...lucky folks.

As with most communities in the Central Valley, railroads played an important role in the development of Woodland and Davis since they made it so much easier to transport crops to market and bring in goods needed and desired by local residents. The 1869 California Pacific Railroad Company began laying track just east of I-5 and was eventually acquired by Southern Pacific Railroad.

Over time, modern highways replaced the railroads as the critical transportation corridors. Rebuilding State Route 113 and Interstate 5 began in 1959. Interstate 5 opened in 1973, and construction of SR 113 (initially connecting Antioch to Marysville) connecting I-80 with I-5 was completed in 1990. Eventually the City of Woodland and Cal Trans will complete the connection between SR 113 and I-5, hopefully (to Woodland residents anyway) making Woodland a central watering stop for weary Great Valley travelers. And speaking further of watering places, for those concerned about processing all that coffee they have ingested to jump start the day, a eucalyptus bedecked Cal Trans rest stop is located 38 miles north of Vacaville on Interstate 505 just past Dunnigan.

Driving north on I-5, one continues over that pile of sediments nearly 8 miles thick, flatter than a pancake, and oozing natural gas and some petroleum. To the southeast lies the Stockton Arch, a geologic relic of bygone days. This up-warp in the crust is a great natural trap for much natural gas along with some liquid petroleum. Making good time, we pass such hot beds of intellectual stimulation as D.Q.U. (Deganawidah Quetzalcoatl University) and Winters, prosaically named for Ted Winters. Good ol' Ted donated half the land the town was built on in 1875, midway along the Elmira to Madison section of the Southern Pacific Railway.

DUNNIGAN HILLS

Twenty three miles north of Winters one passes the low Dunnigan Hills, composed of Tertiary sedimentary rocks bent into a doubly plunging fold (both ends droop) that have been faulted upwards for more than 750 feet between a million and 400,000 years ago. The dry climate and fertile soils would be ideal for growing more grapes if there were any water near the place. However, the local "Dunnigan Hills" vintage, actually grown and bottled by R. H. Phillips in nearby Esparto and "Harvested by the Light of the Moon," is well worth sampling. Old A. W. Dunnigan probably didn't know that when he settled here in 1853, as that was some years before the first vines were put

out, but he probably did see Esparto (Spanish for "feather grass") settled in 1875.

ZAMORRA

Celebrated in sound and song (or at least in the sound by shotgun blasts), little Zamora is now little but a freeway exit. In its heyday, however, Zamora was . . . well, it never really had a heyday, sad to say . . . hey, hey ... do-do-ditty-oh, day. Founded in 1877 as Black's Station, the town grew by leaps and bounds to its present population of 61. The current name goes back to a medium-sized city on northwest central Spain near the Portuguese border. Home to a specialized soil, the USDA sez that these underpinnings are Mollic Haploxeralfs. "Typically, Zamora soils have grayish brown, slightly acid loam A horizons; brown silty clay loam, neutral Bt horizons; and yellowish brown C horizons." Both the native & inadvertently imported pest grasses and widely spaced forbs thrive here . . . so do wine grapes if irrigated. And sheep if irrigated. And paint ball enthusiasts—if irrigated. The hamlet is also the site for the annual Yolo County Antique Machinery Association Tractor Ride that runs 9 miles to the Phillips Winery for a picnic lunch, then back to downtown via a 9 mile-long route . . . fascinating. Zamora, Spain, on the other hand is famous for its large collection of Romanesque churches and as a relic of the Moorish invasion of the Iberian Peninsula. Even more fascinating to know is that this was the site of the siege of Zamora wherein none other than Bellido Dolfos treacherously murdered King Sancho II, which, of course as we all know, caused Alfonso to take possession of the Spanish throne. Brilliant.

MORE CENTRAL VALLEY DIRT

Returning to the Central Valley's geology (What? Again?), we find that by about 50 million years ago the sediments being dumped into the Great Valley trough are beginning to change in character, probably in response to renewed uplift of the ancestral Sierra Nevada and Klamath Mountains. Coarse sand, pebbles, and conglomerates replaced the earlier mud and silt. These rocks thin to the east and south, indicating that most of the debris came from the north and west borders of the Great Valley. For the next several tens of millions of years the Sierra Nevada and Klamath Mountains, plus some of the Coast Ranges, eroded and dumped vast quantities of sediments into the shallow seaway that was to become the Central Valley. All the while the proto-Coast Ranges bobbed up and down, alternately shedding material that became marine rocks and continental (river and lake) sediments. On the east side of the rapidly filling Great Valley some of the last of these heavily weathered continental rocks to roll down the sluggish streams of the Sierra Nevada were the white clay and white quartz of the Ione Formation. These rocks are now extensively mined east of Sacramento near, would you believe, Ione home to raw materials to make high-end ceramics. A Southern California Grotto caver-geologist by the name of Bill Besse once worked for one of these companies, providing an ample supply of 1975 NSS Convention staff beer mugs made of prime, white clay.

FAILED VOLCANOES

One more event of interest took place some 24 miles further north in the vicinity of Williams about 1.5 million years ago. A thin finger of silica-rich andesitic magma slowly pushed its way towards the surface through the muddy sedimentary rocks of the Great Valley. Despite heroic efforts, it failed to make its appearance in the middle of the valley during the Ice Ages. Stymied, it rested while the surrounding domed sedimentary rocks were somewhat eroded away. After a short time it again tried erupting, this time in the guise of an even more silica-rich rhyolite (similar to the rocks at Pinnacles National Park located south of the San Francisco Bay area), but again failed to break the surface as any self-respecting volcano is supposed to do. Its nearness to the surface, however, led to ground water percolating down newly formed cracks to the superheated rock and, after sufficient steam pressure built up, a series of catastrophic explosions shattered the nascent volcano and surrounding rocks. Several plugs of rhyolite finally breached the surface and a nearly half mile high cone of shattered rock grew on the site.

Erosion over the last million years or so has reduced the volcano to a few concentric rings of rhyolite and andesite. The result of all this rigmarole was the formation of Sutter Buttes. Just why this volcano burst forth in the middle of the rather placid Sacramento Valley is unclear. It has been suggested, however, that it, and not Mount Lassen, marks the true southern end of the Cascade Range of volcanoes. One rather serendipitous result of this blister in the mid-Sacramento Valley's planar topography is that accumulations of gas followed the arcuate fractures upwards and formed the extensive fields on the south and west flanks of the buttes; this appears to presage the founding of the legislative capital of the State with its copious amounts of political gas and hot air. For other tired buttes, another Cal Trans rest stop is located approximately 4 miles further, halfway between Williams and Maxwell.

MORE SMALL SACRAMENTO VALLEY TOWNS WILLOWS

We speed 64 miles further north, past Willows, named in 1876 for the "... one watering place in the plains south of Stony Creek. That was a willow pond, from which the present town took its name." Next is the settlement of Orland, a railroad town named after the birthplace of Chauncey Orland, an early, displaced Brit settler and whose name was selected as the winner in a three-way contest.

CORNING

Finally Corning (originally named Riceville in 1872) rolls into view, a rail town that was named in 1882 for Southern Pacific general manager John Corning. Corning, New York, was named in honor of John's uncle, Erastus, and Corning, California, was named in honor of John himself. The first railroad train arrived in Corning on October 1, 1882. Mission olives, used in oil production, were planted in the Corning area in the 1890s, but in 1897, Nevadillo Blanco and Manzanillo olives became *the* oil-producing olives of choice, since they were less expensive to grow. The inhabitants of the

Maywood Colony, as Corning was then known, were shareholders in the Maywood Colony Canning and Olive Pickling Association, all came out to see the first airplane land on August 1, 1919. Initially, and for many years to follow, Corning, California, was known as "Corning--The Clean Town." On December 28, 1923, Warren N. Woodson finally changed the slogan to "Corning--The Olive Town." John Corning, unfortunately, died 4 years short of seeing his name applied to the town. As appropriate for a town named after a bureaucrat, a large natural gas field is located just northeast of town.

To the east is the little town of Gerber. Founded in 1910, it originally had astounding rules. When Edward Gerber laid out the unincorporated community in 1910, he gave nine of its 30 blocks to the county for a park, its first. The park is still there, but a lot of other things have changed. Originally were to be no Africans, Mongolians, Hindus, or Japanese permitted to own, lease, or occupy land in Gerber. There was to be no tannery, slaughterhouse, or pigs. Every building must cost at least \$500. There were to be no signs larger than 1 by 2 feet and no alcohol was to be sold or given away.

But some time before Ol' Ed came up with this rather restrictive set of rules, William George Chard, a native of New York, had come to California in 1832. He married a sloe-eyed daughter of the Robles family and the Mexican government granted him 13,300 acres on the north bank of Elder Creek. He named it Rancho de las Flores--Ranch of the Flowers. After a few years, a bit of the Chard rancho was acquired by a black man named Logan and named Logan's Field since the piece of pasture land was crisscrossed by sheep and mule trails. Shortly there after, one Jonathan Tyler bought more of the Chard land and some of the Robert Hasty Thomes Rancho de los Saucos, Ranch of the Elder Trees, south of Elder Creek. By the late 1860's, the Central Pacific Railroad was preparing to cross the river there and push on to the north. Tyler struck a deal, donating a right-of-way in exchange for an arrangement for stopping trains on his land. The place, just north of Elder Creek, was named Tyler's Switch.

A building from the 1915 San Francisco Panama Pacific International Exposition was moved to Gerber from the future site of Chrissy Field. It was slated for a big rectangular railroad engine house to replace the roundhouse at Red Bluff, inadequate for servicing the huge Mallet railroad steam-driven engines being built to pull the trains over the steep Siskiyou Mountain grades. The railroad stop in Gerber enabled local folks to see and hear many famous persons who came to the rear platform of the trains to speak. It is reported that 7,000 loyal Democrats (and a few Republicans as well...) stood to hear Franklin Delano Roosevelt campaign in 1932. Others seen and heard on trains passing through Gerber include Charlie Chaplin, Herbert Hoover, Will Rogers, and good ol' Harry Truman. Enough of Gerber, already . . .

RED BLUFF

At last we arrive in the neighborhood of Red Bluff. In 1843, Peter Lassen (of Mt. Lassen fame) obtained a land grant of 25,000 acres from the Mexican

government and laid out the town site of "Benton City" just south of modern-day Red Bluff. This town was named in honor of Senator Thomas H. Benton of Missouri, a staunch supporter of Western Expansionism; believer in the gold standard; and father-in-law of Capt. John C. Fremont. However, the discovery of gold drew all of the first settlers into the hills, and the town folded. Lassen's original town site eventually did attract other settlers who later built Red Bluffs (named after the reddish-colored soil), which became a distribution point for the Shasta and Trinity mines.

Mr. Sashel Woods (of the Jamestown in the Sierra Nevada Mother Lode, "Woods Crossing" fame) and one Charlie Wilson made landfall at the ghost town in May of 1850. The re-established town was christened The Bluffs by Sashel and Chuck, then renamed Covertsburg in 1853 by ~~the CIA~~ parties unknown, and finally back to Red Bluffs in 1854. By 1856 the "s" was dropped from the name; apparently the good folks just couldn't get their "S" in gear. Now the only dirt we could dig up on Red Bluff was that in 1904 John Diller, an early USGS geologist, defined the Red Bluff Formation from the area. The Red Bluff Formation is a thick alluvial unit laid down by the Sacramento River on top of the 1.08 million year old Deer Creek basalt and itself capped by the 400,000-year old Rockland ash.

Red Bluff(s) was incorporated in 1876 and served an important role in the early history of the northern part of the State. Originally the "head of navigation" on the Sacramento River, steamship freight was off-loaded here for delivery by wagon or packhorse to the Trinity Mountains mining camps to the northwest. Lumber and agricultural products were the primary exports of the area (which tells one of just how much mineral wealth was actually exported from the nearby mines). Steamship transportation connected early Red Bluff with both Sacramento and San Francisco. The Victorian architecture popular in the 1870's soon spread up-river to prospering Red Bluff, where lumber was abundant, thanks to the surrounding forests and the completion of Pierson B. Reading's Sierra Lumber Company Flume. The Central Pacific Railroad arrived like a mixed blessing and blight in late 1876 and soon replaced the steamships as the primary transportation and commerce link.

Today both wood products and agriculture continue to be important economically. The fertile Sacramento Valley soils produce bountiful orchard and field harvests of walnuts, almonds, prune plums, corn and alfalfa, and rice. In the more upland outlying areas, livestock (cattle and sheep) production continues to dominate the landscape. A modern airport with a 6,000-foot long runway is owned and operated by the City, comforting in case you should have cause to fly into town for some unknown reason.

INSKIP HILL CAVE

To the east along CA-36 is the little town of Paynes Creek. Towering above it are the twin summits of Inskip Hills, a pair of Pleistocene Ice Age volcanoes that blew lots of cinders and ash skyward and debouched basalt flows along

their slopes that contain a nearly half-mile long Inskip lava tube. First mentioned in 1885 by John Hittell, a travel writer, they were known to locals as Cottonwood Cave(s), then “lost,” then re-discovered in the late 1920’s. The two Inskip Hill Caves are parts of the same tube, separated by a comfortably large collapse. These caves are not large, being “only” a half-mile long, but are famous in mineralogical circles for a paper the venerable Charlie Anderson (Dean of early Cascade Range volcanic geology) wrote in 1930. He described opal stalactites (actually mostly cave coralloids) from the cave. Unfortunately, mineral collectors then stripped most of the coralloids, but missed the several dozen “opal” (cristobalite) stalactites on the 12 foot-high ceiling, where they remain to this day. It has been suspected that the cave might have been a maternity colony location for Townsend’s big-eared bats (*Corynorhinus townsendii townsendii*), but until a chance visit in summer of 2016, no one really knew. Inspection and photographs confirmed it and now cavers are asked to please refrain for visiting between May and September of each year to allow the colony to sustain itself. Despite being “Graffiti Central” for the local, spray paint can-wielding bozos, this little cave is worth a visit should one be in the area during the off bat maternity season.

Some 30 or so miles further east at Hat Creek and Old Station is the long Hat Creek Flow holding many dozens of lava tubes and the HCRO’s (Hat Creek Radio Observatory) ATA (Allen Telescope Array) run by SETI and the Radio Astronomy Lab of UC Berkeley. Hat Creek itself rises on the northeast slopes of Mount Lassen, flows down Hat Creek Valley, is joined by both the Rising and Lost Rivers, and eventually joins the Pit River near Hidden Valley Ranch, the secret home of bucolic salad dressing ads. The creek owes its name to either a corruption of the Wintu Indian name "Hat'-te-we'-we" or possibly after a fellow on the 1852 Noble Trail blazing party who lost his hat hereabouts. Then again it might be a corruption of the Wintu interpretation of a gringo cussing about a lost hat in the...well, we'll never know, will we?

BILL IDE & THE CALIFORNIA REPUBLIC

The hallowed ground of Tehama Country was also the home of the first and only president of the California Republic, William B. Ide. His original adobe home has been fully restored on its 5-acre site and is now a part of the California State Park System. Ide organized the Bear Flag Party and issued the proclamation, which declared California an independent republic. It was the Bear Flag Party’s Guard that defeated a Mexican garrison at Sonoma, Sonoma County, paving the way for the occupation of California by armed forces of the United States. The famous Bear Flag of California flew for several weeks before the outbreak of the Mexican-American War and was replaced by the Stars and Stripes on July 9, 1846.

BLACK BUTTE, BATTLE CREEK FAULT, AND THE INKS CREEK FOLDS

What, more rock stuff? Yes, friends, here we are on the threshold of more geology stuff. To the east sits the abrupt rise of the very north end of the Sierra Nevada. Here not only is the full escarpment of the Battle Creek Fault and the bulk of Black Butte sitting upon it justly displayed, but also Tuscan

Buttes, (the type area for the volcanic rocks of the Tuscan Formation) and the Chico Monocline (a huge down warp in the Sierra Foothills). The now USGS-retired, Not Quite World Famous Metamorphic Petrologist, Dr. Dave Harwood along with Also Not Quite World Famous Dr. Ed Helley, of Lakeside Winery fame (“Oh, the ’85 Cabernet, a fine little hamburger wine...”), spent years studying these rocks. To abstract their work just a little, the Battle Creek Fault not only marks the western edge of the Sierra Nevada uplands, but also drops the Great Valley's floor down to the south. These earthly actions also riffled the mighty Sacramento River's bed, but, in concert with the adjacent Inks Creek Folds, also probably accounts for the sudden widening of the Sacramento Valley as well. Wow, heady stuff from rock knockers! Whew!

MT. LASSEN

To the east towers the nearly two-mile high Mt. Lassen. The peak is named after Peter Lassen, a decidedly not melancholy Dane who settled in the area in 1840, working as a blacksmith. His outstanding exploits as a pioneer in the area resulted in many geographic features being named in his memory. Mount Lassen “may” be the southernmost high (almost 10,500 feet high) Cascade volcano identified as we saw in the above Sutter buttes blurb. Nearly 5 million years ago the earth split here and basaltic lavas oozed out and chased all the bunny rabbits away.

Shortly thereafter, a series of very fluid andesite flows speckled with "Dr. Pepper" green pyroxene crystals rapidly covered these oldest flows. These andesite flows evidently uncorked the underlying pocket of molten rock in the magma chamber as floods of lava poured forth to cover 30 square miles of the countryside. A large composite volcano, Brokeoff Cone, grew at the southwest corner of the future park and reached a height of over 11,000 feet and a diameter of 15 miles. At about the start of the Ice Ages, some 2 million years ago, the underlying magma chamber was tapped by a lateral conduit, the molten rock drained off, and the entire volcano collapsed under its own weight leaving a huge, irregular caldera.

Almost immediately to the west a series of fissures opened up and another great dollop of dark dacite lava commenced building Mount Lassen itself. As the Ice Ages waned, the lavas ceased flowing and plugs of stiffer, gas-poor dacite built the bulk of the mountain including the capping domes. Things were then pretty quiet save a few dacite burps from nearby cinder cones 1,500 and 200 years ago.

All this changed just before the opening guns of the First World War in 1914. To celebrate May Day, a series of small violent eruptions blew debris out of the summit crater and a quarter-mile-long lava flow ran down the northern slopes, scattering the bunnies again. Finally, in late May of 1915, the entire northeast flank of the mountain blew off in a several megaton force explosion. A mushroom-shaped debris cloud rose 7 miles into the atmosphere and combination landslides and debris flows roared along the ground at speeds over 100 miles per hour. Somewhat lesser activity continued for nearly 2

years, then stopped. The volcano is still considered active, however, and in addition to solfataras and boiling and bubbling hot springs, is capable of equally devastating eruptions in the future, something that still greatly worries the bunnies.

COTTONWOOD

For the next 34 miles we traverse the rolling uplands of Red Bluff Formation and Holocene Sacramento River alluvium. Shortly thereafter we come to Cottonwood, named in 1842 for the prolific cottonwood grove along the banks of the meandering Sacramento River. Cottonwood was important since it was about midway between Red Bulff(s) and (Old) Shasta (City), the next town of any size north. Many private bridges were built surrounding Cottonwood starting in 1854 . . . and just as fast as they were built, yearly winter storms and spring floods washed them away. Eventually a permanent toll bridge was built and little Cottonwood prospered. This bridge was part of the original US 99, a highway so initially under-utilized that local kids played marbles on the tarmac, knowing they would have plenty of warning should a vehicle interrupt them.

As part of the local African American heritage, the Logan's of Cottonwood (and Logan's Fields) were early-day "pillars" in Cottonwood's diverse boomtown days of cattle and other livestock. Just as the Indians formerly migrated up the Cottonwood Creek in the late spring, following the migratory patterns of deer and other game, then back down the creek again in the fall, the white settlers did a similar thing with their cattle. The ranchers took the cattle and sheep up the drover's trail into Hayfork Valley range land for summer pasturage, then down to the "greasewoods" and the Cottonwood area for winter (and we remember, of course, that the Hayfork area to the west is also home to several important limestone caves with their threatened Townsends Big-eared bat colonies . . . and the 9- to 12-foot high poison oak thickets successful standing guard over the caves).

Cottonwood is home to the largest fish hatchery in the US and Cottonwood Creek itself is also the longest undammed tributary to the Sacramento River, hence the location of the salmon hatchery. Since Cottonwood had its C&O railroad (later incorporated into the Southern Pacific), it became a natural site for stockyards to locate. This cattle industry has been a principal economic mainstay over the years and is commemorated by the (not quite World) Famous yearly Cottonwood Rodeo Parade. The still flourishing stockyards north of town, called the largest auction yard in the United States west of the Rockies, have been in continuous operation for nearly 50 years. The volume of transactions ranges to 5,000 odd head of cattle every Friday, plus auctions of horses, pigs, sheep and goats on the last Tuesday of the month. What a shame we'll miss just this sale of odd-head cattle...

BALLS FERRY . . . OR WAS IT FAIRY?

Just to the east is Balls Ferry (first named Parkville), of which little is known save an unverified story of an early settler named Joshua Ball who is reported

to have set up a bowling alley on the site in early 1852. After three strikes in a row one night, it is reported that he saw a vision of Tinkerbelle, thus prompting the name Balls Fairy. This was later corrupted into Balls Ferry, giving rise to the legend of a gilded barge filled with pixies and pulled by six white horses plying the waters of the Sacramento River during full moons. (Sorry, just wanted to see if anyone really reads any of this stuff.)

In real life, Balls Ferry and the Balls Ferry town site are both designated as a California Historic site. In addition to the ferry crossing on the Sacramento River, a small town grew up here. In 1868, William Ball purchased a ferry, quite possibly from William Wilcox who had recently purchased the ferry from the estate of the dearly departed Major Pierson B. Reading (see the following entry). Bill Ball gave the ferry his name, of course, and began operations across the Sacramento River approximately 100 feet downriver from the present concrete bridge. The ferry carried everything imaginable across the river including wagons loaded with supplies and freight, buggies, stagecoaches, and many herds of cows, horses, pigs, and sheep. The settlement of Balls Ferry began growing around the ferry site on the east side of the Sacramento River. The settlement included the Balls Ferry Hotel at the rivers edge, plus miscellaneous businesses (apparently selling miscellaneous) and residences on the hill to the east behind the hotel.

Balls Ferry was an important place because it was strategically located on the main road from Cottonwood to Millville, Shingletown, Burney Valley, Hat Creek Valley, Adin, Alturas, and all points in southeast Oregon. For a time, stagecoaches stopped daily at the Balls Ferry Hotel. Mr. Ball operated the ferry until 1897 when Shasta County built a steel bridge (not the existing bridge) next to his ferry and put him and most of those stores selling miscellaneous stuff out of business.

ANDERSON

Shortly there after, as we begin to again drift off into unconsciousness, we pass Anderson, named for Elias Anderson, owner of the American Ranch, who sold right of way to the California and Oregon RR (now the Southern Pacific) in 1872. Its founder Elias Anderson initially named Anderson American Ranch; later the town was renamed for its founder.

Shortly thereafter, as we enter the southern reaches of Redding, we reflect and say ... so what? Indeed, so what? But wait! If you call right now, we'll double the amount of trivia vaguely related to caves that you'll get by email! We approach State Highway 299 that heads east and itself is the gateway to the back door route to Lava Beds via Burney, Bieber, Tionesta, and other, less famous towns.

INGOT

Just shy of 20 miles out east of Anderson for those heading east, the hamlet of Ingot would loom into view. This near ghost town was founded in about 1919 at the site of a copper smelter. The unimaginative townsfolk named it

after the primary product of the smelter...copper ingots, which were shipped out to a metal-hungry world. The town flourished until 1940 when the ore supply from the surrounding mines (the ruins of which are still visible along the highway) ran out and all operations ceased. Now the site is a festering morass of highly polluted seasonal stream replete with a dearth of vegetation along the stream.

Its second great claim to fame was that on one bright and sunny spring afternoon in 1932, the bulldozer gouging out that section of CA-299 suddenly disappeared from sight. Seems it had broken through the roof of an unsuspected cave that was described as modestly lengthy and well decorated. The offending cavern was quickly filled with debris and the roadwork continued, albeit with a slightly more cautious cat skinner. Sadly the cave is long gone . . . but a geology Masters thesis of the 1970's shows a bold limestone bluff with disappearing streams, sinkholes, suspected subterranean caverns, and all that stuff that's so far never been exploited . . .

REDDING

Soon Fabulous Redding, hub of the northern Sacramento Valley, is approached. The town was first known as Latona; however there were several local objections to the name:

"While upon this matter we have to record an objection to the name 'Latona.' It is not a proper name for a town or anything else that we know of. As well as we can remember, Latona was the name of one of the high goddesses of Grecian mythology, who conducted herself in a very improper manner. We would take the liberty of suggesting the name of 'Redding' as by far the more appropriate." – *Editor, Shasta Courier, Nov. 1861.*

Also known as Leto to the Greeks, apparently Ms. Latona was the daughter of Jupiter, supreme god of the Romans (and equivalent to Zeus of the Greeks) and his queen Hera (the Greek Juno). Eventually Latona had an affair with Jupiter and bore an out of wedlock twins, Apollo and Diana, and had to skip town.

Major Pierson Barton Reading, paymaster to Brevet Capt. John C. Fremont (Mexican War hero & pioneer Western explorer) was the best known of Col. John Sutter's employees, having been the first real pioneer in the northern Sacramento Valley. Pierson was also one of the founders of the lumber industry in Shasta County, beginning lumbering in 1843. He and his partner received a Spanish land grant from Gobernador Micheltoresa for 26,000 acres (19 x 3 miles in extent) along the east bank of the Sacramento River and including Goat Island (later renamed to the more "cultured" name of Reading Island). He built a home and settled in, also planting the state's first cotton and Northern California's first grapevines. Ever busy, he is also locally well known for discovering gold in the Trinity Mts. in 1848. By 1862 he mapped

out the site for the town near the mouth of Clear Creek and the Sacramento River.

In 1872 the Central Pacific Railroad arrived and a 19-year-long battle then erupted between the townsfolk and the railroad about the town's name. Seems the Central Pacific Railroad wanted to name the town after their land agent and former California Secretary of State, B. B. Redding, while the local populace were rabid Maj. Reading supporters. Redding's live constituents finally mustered more pull than the dead pioneer's champions and the name was officially changed in 1880, aided, it is rumored, by a large donations of cash to important local politicians. An appreciative B. B. Redding, however, did give a fine 245-pound bell to the town's Presbyterian church in 1881... and there you have it.

WEST SHASTA/IRON MTN. MINES AND HYDROCHLORIC ACID STALACTITES

As Interstate 5 crosses the main Lake Shasta Bridge at Goat Creek, those keen of eye will recognize the mine dumps and other remnants of the Devonian age Balaklala Rhyolite lavas high in the mountains to the west of the lake. Further afield to the west on Iron Mountain are the abandoned workings of the West Shasta Copper-zinc Mining District. In 1885 the somewhat-less-than-well-known George Graves first found copper-gold ore in the Balaklala Rhyolite and claimed the Mammoth Mine. By 1900, the Uncle Sam, Shasta King, Spread Eagle, and 10 other mines located along Squaw Creek were working full tilt. These mines became prolific producers of copper and zinc from about 1905 to 1925, when they were abandoned. Not only the copper, gold, lead, and zinc in the rhyolite, but also gold and a bit of silver were placered and hard rock mined from the streams and quartz veins in the Devonian Copley Greenstone bedrock. Nearly \$600,000,000 in copper, gold and silver and \$51,600,000 in zinc was recovered from the mines.

Today, however, ground water seeping into the mines has produced a less-than-salubrious climate. Inside the mines, the pH of the water is -1 . . . yes, folks, it's more reactive than "normal" hydrochloric acid. Glassy stalagmites of clear, hydrochloric acid crystals compete for attention with azure blue-colored azurite-doped and moss green-colored malachite-doped hydrochloric acid stalagmites and flowstone – it's a strange and extremely deadly place. The acid drainage pouring forth from the mines has been detected as far away as the upper reaches of San Pablo Bay. Thanks to a cofferdam constructed in the mid-1990's, the Sacramento River no longer has an unusually high copper, lead, and arsenic content. In the holding reservoir, however, a several meter thick "blanket" of heavy metals gunk lives – like the proverbial Colorado River water, it's too thin to plow and too thick to drink. Short of simply pumping it into a drying reservoir to desiccate and be later buried, a long-term method of dealing with this deadly, iron- and base metal-rich Jell-O has yet to be satisfactorily formulated. The deadliness of this witches brew was demonstrated in 2014 when part of the remediation process collapsed one of the ponds and a slug of deadly water flowed down the

Sacramento River to San Francisco Bay and out into the Pacific Ocean. After the river-borne toxic brew and the adjacent drinking water wells cleared, the remediation process continued, albeit with a bit more caution.

Just over the skyline is the Igo District, home to nearly 115,022 ounces of gold worth some \$101 million dollars at today's price. The nearby Harrison Gulch District's Midas Mine produced about \$78.4 billion dollars worth of gold at today's prices while the Deadwood-French Gulch district produced about 128,900 ounces of gold worth today about \$113.69 billion bucks.

LAKE SHASTA AND SCREAMING MAIDENS

North of Redding I-5 for approximately 7 miles we trundle over the reddish-brown gravel of the Sacramento River gravels and the underlying late Pleistocene Red Bluff Formation. I-5 then abruptly starts up the slopes of the Klamath Mountains. The Klamath Mountains are actually the north end of the Sierra Nevada that were faulted west, following the moniker "Go west, young man, go west..." At Mountain Gate look to the east and you will see a large, gray-colored peak adjacent to the freeway. Named the Gray Rocks, this massive limestone outcrop is occasionally referred as Whale Rock, as named by some inebriated pioneer who thought it looked like a large gray whale illogically stranded along the Sacramento River . . . and it must have been awfully good [or bad] whiskey to see that). This, and the adjacent, more northerly mountains are masses of Permian age limestone of the McCloud Limestone. The Calaveras Cement Company blasts and grinds the limestone in the hidden quarry, transfers it under the Interstate via a conveyor belt, and roasts it into Portland and other specialty cements at the main plant to the west of the highway. The cement plant was built in the 1930's for the construction of Shasta Dam just to the west.

Nearby to the west, Project City marks not only the site of the 1880's "Old Diggin's" gold placer mining district, but also the WPA (Works Progress Administration of Franklin Roosevelt's first term in office) construction camp built during the 1930's construction of Shasta Dam. Here more placering for gold was undertaken as well as some quartz vein mining in Copley Greenstone, part of that old metamorphosed Devonian Period ocean bottom (about 408- to 387-million years old); the gold-bearing quartz veins were added somewhat later in the early Age of Dinosaurs (Late Jurassic Period) at about 163- to 144-million years ago. Soon we will cross the Pit River Bridge spanning the now drown Pit River arm of Lake Shasta.

Just before the O'Brian exit, large, gray Horse Mtn. is visible across the Pit River arm. This is also a massive pile of Permian McCloud limestone and accompanying shale beds and is the largest exposure of this limestone in the Klamath Mountains. Across the lake is Lake Shasta Caverns, a commercial cave well worth a stop. Lake Shasta Caverns, formerly known as Baird Cave, as well as several other nearby, large, heavily decorated solution caves were worked in the first 15 years after 1900 by University of California Berkeley for their Pleistocene Ice Age fossils of such colorful (and deadly) denizens as

timber wolves, coyotes, short-faced bears, raccoons, musk ox, Shasta ground sloths, and a host of birds and smaller mammals. The near-mythic NSS Stanford Grotto also worked these deposits between the late 1940's and early 1950's. In the past year or two, researchers from University of California's Davis campus have reopened the cave to excavations and are continuing finding a Golgotha of past local animals.

Nearby Cave of the Lost Maiden or Samwel Cave has long been known for both its fossil contents and colorful Native American legend. The Wintu American Indian name Sam wel translates as "Magic Pool" and the cave has long figured in their legends. Many years ago, so the story is told, three maidens overcame their fear of the magic held in the cave's depths. They timidly journeyed into the cave's twisting passages to drink from two magic pools to make them irresistible to the tribe's eligible males. Near the second pool the older woman lost her footing and slipped screaming into a deep pit. There was a sickeningly hollow thud followed by another thud, then silence. After calling for some time, the remaining women rushed from the cave. Even using their latest vertical gear consisting of deer hide-bound cedar saplings, the tribe's best men were unable to reach the maiden. Since that time the cave has been avoided by the Wintu.

In 1905, E. L. Furlong and J. C. Merriam of UC Berkeley explored the upper maze of large rooms and passages of this cave and reaped a rich harvest of Pleistocene to Holocene fossils. Furlong eventually found a deep pit in the back of the cave, constructed a tree branch and fence barbed wire ladder(!), and rolled it down into the depths of the pit. In the name of science, he descended the rickety contraption with candle firmly clamped in his teeth, carefully avoiding setting fire to his facial shrubbery. Once on the bottom he called that he had found a "mountain lion." With some consternation his topside companions looked for something to toss down to him for use as a weapon, failing to consider what anything of such weight might do to Furlong's cranial profile should the two connect. Moments after, however, Furlong called that it was a partially fossilized lion . . . and added: "The Lost Maiden . . ." indicating that he had found the skeleton of a young Indian woman.

The following day the entire party descended the pit on a somewhat better ladder made of rope scraps and poles. Furlong then found a fragment of human tooth within the lion's cavity and got very excited. Here, he initially thought, was proof of Wo/man's antiquity in North America. However, ever the cautious man of science, he lifted the fragment and neatly fitted it into the young woman's jaw. Sighing, he remembered the story of "...a sickeningly hollow thud followed by another thud, then silence." He looked up at the projecting spine of limestone that had made his ladder descent so troublesome and realized that the projecting spine was what the Wintun Lost Maiden had hit, mercifully breaking her neck and jaw, and depositing the tooth fragment within the much older lion skeleton. No matter, it did confirm the Wintun legend. The remains of the unlucky maiden were respectively

removed and given a long-delayed, but tender burial by the Wintun tribe members.

PALEOZOIC ROADCUTS

For the next 20 or so miles one will hurtle along the deep road cuts of I-5 past Winton (sic) Cove and the Lake Shasta Caverns-O'Brian Road overpass. Here the limestone and shale of the McCloud Formation disappear, swallowed up and melted by a Late Jurassic plug of quartz diorite (the same host rocks for those pesky gold-bearing veins mentioned earlier).

Further along Interstate 5 more, older marine rocks are exposed. Five miles along the road, Tater Hill and Tombstone Mtn. rise to the east and the highway passes the "town" of Sims. Settled in 1859 by Simeon Fisher Southern, the town's only claim to fame was "Sims" himself. His claim to fame was his ability to modestly regale the pioneer California exploration Joseph Brewer Party of 1862 with marvelous tales of his life among the wilderness such that truth, truly, was stranger than fiction.

Further along the highway are gray and black mudstone, slate, sandstone, chert, and volcanic rocks of the Bragdon Formation laid down in deep basins in the Mississippian Period ocean. These rocks have weathered for tens of millions of years into thick, reddish iron oxide-stained, simple clay soils which have had most of the soluble compounds long leached away. These soils are passably good for trees, but poor to grow crops on without heavy doses of fertilizer. Black shale and mudstone of Devonian to Mississippian age, some 400 to 300 million years old, have been folded and contorted by under-thrusting of the rest of the Klamath Mountains. Construction of new high bridges near Dog Creek has exposed older andesite lava flows at the edges of the highway. Columnar jointing in low outcrops, caused by stress set up during the lava's uneven cooling, and large, white, lath-shaped crystals of plagioclase feldspar are easily visible in these rocks.

NANCY AND THE LEMURIAN GOLD

Cretaceous and Eocene rocks partially cover these older rocks. Several miles further the spires of Castle Crags State Park loom on the western horizon. This 225-million year old plug of granodiorite is composed of inch-long, light gray plagioclase feldspar crystals with lesser amounts of glassy quartz and black biotite mica. The plug has punched its way up through the surrounding serpentinite of an old sea floor. The serpentinite itself was altered from the underlying, deep crust peridotite that formed the very base of the old sea floor. Heavy rainfall over the last several tens of millions of years has stripped away the crumbly soils and exposed this fantastic ruined boss resembling a medieval fortress. Local rumor tells of an elderly Native American woman named Nancy who lived to a ripe old age in a hidden cave at the base of the cliffs. She was well cared for, paying for her groceries in gold coin. It is unlikely that such a cave with its gold coin hoard exists, but no one has looked for it either. It is probably more believable to assume Nancy had an improper affair with the Lemurian Adjunct Prime Minister Zoltan and

exacted a few gold sovereigns for her silence (Just checking to see if you're still with us).

The pine-and oak-clad rocks exposed for the next several miles belong to the eastern edge of the Klamath Mountains province. These rocks are more or less identical to those exposed in the northern Sierra Nevada. These rocks were laid down in the deep proto-Pacific Ocean around a third of a billion years ago. Approximately 200 to 150 million years ago the rocks were faulted into slabs and slivers then stuffed to the east under similar and younger rocks. Initially the highway passes through blackish basic and ultrabasic intrusive rocks, greenstone (metamorphosed ocean floor basalt "pillows"), and greenish serpentinite that are more of the aforementioned old sea floor remnants.

DUNSMUIR, MILLION DOLLAR CAVE, AND THE WORLD'S BEST WATER
 We swish up and down on the freeway, ending at Dunsmuir, home of the "best drinking water in the United States." This little railroad town, originally consisting of a single railroad boxcar, was initially known as Cedar Flat. When "Big Al" Dunsmuir, a San Francisco and British Columbia coal baron, stopped by he promised to build a fountain for the town if the local populace renamed it after him. The town was moved slightly to the site of Pusher and renamed in January of 1887. The fountain remains downtown near the railroad depot, but is missing its bronze maiden statues that somehow disappeared since about 1900.

Within Dunsmuir's Hedge Creek Falls City Park lurks one of the most elusive and fabled caves in northern California. The little cave is located under pretty Hedge Creek Falls where the creek has scoured out a wide grotto with unusual carbonate mineral flowstone. As Caltrans planned to widen I-5, it planned to dump the waste rock into the creek, spoiling the short canyon and nearly burying the cave. The Sierra Club and local activists got into the show and Caltrans was forced to revise their plans. Some one with far too much time on their hands figured out it cost Caltrans about a million bucks to alter their plans, thus the little grotto became Million Dollar Cave. Nearby Cave Springs Cave is another local point of interest, having its own series of little grottos of some minor renown for their thick calcite decorations and an adjacent motel for weary travelers. This area is also near ground zero for the headwaters of the Sacramento River.

THE CASCADE RANGE

Interstate 5 then passes over Ice Age and more recent lava flows over at the summit of the resort town of Mt. Shasta, while climbing out of the headwaters of the Sacramento River Canyon. For the next 11 miles one treads softly across the southern reaches of the Cascade Range. Interstate 5 slowly climbs approximately 5 miles to Black Butte Summit. The road passes along the west base of Black Butte, a half-mile high, andesite plug dome that was slowly extruded out of the earth during several months in the far distance past. As the dome's outer layers cooled they cracked and slid down its

slopes, mantling the butte in rubble. Indeed, only a few small in-place outcrops of dark reddish andesite can be found at the summit of the dome. Several more domes of similar origin are visible on the south flanks of Mt. Shasta; all are favored refuges for Western rattlesnakes.

WEED . . . WHAT A NAME

Shortly we leave Interstate 5 and traverse downtown Weed, named for Abner Weed, and then head northeast on old US 97. After witnessing Lee's surrender at Appomattox, Abner came west from Maine in 1869 and started the Weed Lumber Company. The salubrious climate must have agreed with him for he lived to a ripe old age, serving as a State Senator from 1907 to 1909. There are several important points in Weed. One of these is the last (relatively) cheap gas before entering the wilds of Northern California. Another other is the Hi and Lo Restaurant and motel, a good place for vittles, as is the "Now You See It-Now You Don't" Dave's BBQ place across the street.

MOUNT SHASTA

Dead ahead is the imposing bulk of Mt. Shasta. The mountain's 80 cubic miles of volcanic rock is mostly andesite and dacite, both stiff and pasty lava. Long known for their nasty dispositions by blowing volcanoes apart, these flows and intrusions have been erupted to a height of nearly 14,200 feet during the last million or so years. The lava flows and, later, ash falls are largely composed of brown andesite, a common volcanic rock named after the Andes Mountains of South America. Shasta is a stratovolcano or composite volcano built of lava flows, breccia, and "glowing avalanche" ash deposits and shows the steep sided graceful symmetry of such volcanoes. Other similar volcanoes include Fujiyama in Old Nippon (that's Japan to you gringos), Mount Banyan in the Philippine Islands, and Mt. Etna in Italy.

On the northwest side of Shasta is the somewhat smaller, newer parasite cone of Mt. Shastina. This large, smooth lava cone has formed in the past approximately 2 million years since the waning of the Ice Ages, thus it lacks the deep glacier-cut furrows of Shasta itself. There used to be several very long glacier caves (caves cut into the bottoms of active glaciers by sub-glacier streams), but in the 1920's most of them collapsed, sending gushes of volcanic mudflows-lahars-down Mt. Shasta's slopes. Fortunately only a few plants took it in the shorts, the bunnies and squirrels already having headed for a bed and breakfast at the nearby lumber town of McCloud. On Mt. Shasta itself are 5 active glaciers. Both Shasta and Shastina are mantled in a thin brown-colored pumice layer that Shasta apparently blew out in 1786. These may have been laid down as the star-crossed Pacific Ocean French explorer Laperouse sailed by observing a "lofty, burning mountain" . . . (apparently Mt. Shasta was showing its grumpy side and erupting) only to disappear somewhere near the Solomon Islands... never to be heard from again (sound of baying hounds in distance).

As one drives northwest along the base of Mt. Shasta, you may look further northwest up Shasta Valley towards Yreka and see an irregular, hummocky

terrain. The topography of Shasta Valley just looks strange. The valley's relatively flat floor is studded with scores of small hills composed of coherent volcanic rocks and arranged in a puzzling random pattern. Strange closed depressions with flattened floors are scattered throughout the area, reminding one of the pothole and kettle terrain in the glaciated areas of the US Midwest.

Various mappers have proposed everything from a buried flattened sill of volcanic rocks spurting up to the surface at a multitude of points of light to eroded glacial debris. This carpet of debris has fooled geologists since 1915, but now the truth according to Dave Crandall is known...and it has little to do with Harmonic Convergences or Lemurians (allegedly a small, advanced race of extra-terrestrials who live inside Mt. Shasta).

SLUMGULLIONS

Nearly 330,000 years ago nearly the entire northwest half of the ancestral Mt. Shasta coughed, excused itself, and then headed for the Klamath River for a drink. To put that in more scientific verbiage, the northwest portion of the old Mt. Shasta cone under discussion is now scattered along the floor of Shasta Valley as a result of a catastrophic debris avalanche. Nearly 10 cubic miles(!!) of paleo-Mt. Shasta was sent galloping 28 miles down Shasta Valley, effectively erasing Mt. Shasta from the face of the earth! This giant slug of geologic slumgullion roared off at relatively high speed in a cushion of trapped air, spilling over into both the Shasta and Klamath Rivers to the north. Yreka itself was spared from becoming Klamath riverside property by a low ridge of bedrock, thus assuring one a place to consume a sumptuous lunch. So...it appears that this little sucker of a slide is a top contender for one of the largest Quaternary debris avalanches known on this little green Earth.

Those in a position to know estimate that 50% of the slide was fine-grained matrix stuff consisting of crushed volcanic rocks from Mt. Shasta, alluvial debris (including gravel from the Klamath Mountains, scraped off the valley floor as the avalanche passed). To this was added a few stray lake and marsh deposits from the valley floor. About 23% of this flow was water and/or steam from the volcano's insides, the postulated glaciers, snowfields, etc., on the slopes, and any summit crater lake water. The rest of the avalanche, about 27% of the total, was relatively large blocks of volcanic rock from Shasta's cone that now make up the strange little hills scattered willy-nilly across the floor of Shasta Valley.

The exact cause of this more-than-exciting event is not known. No volcanic blast debris or effects were found along the edge of the avalanche path so that triggering mechanism probably could be ruled out. However, the 1980 catastrophic failure of Mt. St. Helens to the north was triggered by a M 5.2 quake. Recent studies along the nearby Mount Lassen to Medicine Lake Volcano-Mayfield-Hat Creek-McArthur Fault Zone suggests that the faults are part of a lengthy earth rupture called Walker Lane that starts just south of Death Valley and extends far north under the southern Cascade Range.

Further studies suggest a 6.8 magnitude quake is within the realm of possibility along this segment of Walker Lane. Such a magnitude quake could have triggered the slide. Glacial undercutting of the volcano's slopes is a possibility; however, since the volcano dismembered itself and probably destroyed any clues in the process, this possibility remains an unknown. Ah, the realm of hard, irrefutable science falls short at times. The age of the avalanche, however, can be bracketed with a little better precision. The 300,000-year-old Pluto Cave Basalt overlies part of the avalanche debris and the 400,000-year-old Rockland ash is found within the coherent blocks of volcanic rock. Thus an age approximating a third to half a million years is very reasonable.

The little Shasta River itself piddles its way along the valley, a mere remnant of a larger Ice Age river that originally cut the valley itself. These rivers are called under fit rivers because they are a mere wisp of their former selves that discharged clear, cold water during the Ice Ages.

LAVA FLOWS, HORNITOS, AND DANCING CRANES

One may note the steep lava flow fronts along the east side of the highway about 5 miles out of Weed. These aa-surfaced basalt flows of the Lava Park flow were once thought to be only a few hundred years old until some one dated burnt trees under them and found they were 9,700 years old. Shortly after the road swings north past these flows is the Historical Marker on the east shoulder of Highway 97 for the old 1870's Military Road that wound its way around Mt. Shasta's eastern side. The formerly lightly forested (a huge forest fire in the early 2000's took care of those pesky trees), pumice-covered flats to the northwest of the highway for the next several miles are part of a grand subdivision scheme that only lacked one tiny little thing: a suitable water supply.

PLUTO'S CAVE

The Ice Age basalt lavas mantling the ground hereabouts are riddled with lava tubes. However, some time would be required to stop to inspect them. The Pluto Cave Basalt, which one is even now traversing, contains, astoundingly, Pluto's Cave. This lava tube was one of the earliest caves to have been explored in northern California when one George Tyler braved its depths just after income tax time in April of 1863.

Just past these flows one may also note the freshly scoured, light-colored bed of Whitney Creek crossing under the highway, a stream debouching from the Whitney Glacier on Shasta itself. In response to a very heavy rainstorm the late 1990's, a large slug of water came cascading down the creek, inundating the highway and piling nearly 4 feet of loose ash and cinders along its pathway.

GRENADA

Next, about 12 miles out of Weed, is the 99-97 cutoff (Road A-12) that heads west through Grenada and Montague. The little community of Grenada was

originally known as Starve-Out for its poor soil. Later irrigation schemes improved the lot of the Grenadians and some person unknown optimistically named the town for the rich farmland near Grenada, Mississippi; the fool.

This road passes over two lava tubes that one can simply open the car door and fall into, a practice that is not recommended since often people dispose of dead animals in these handy pits. The cave is also the location of a thriving colony of Townsend's big-eared bats, probably the most common bat most cavers will see in the California underground. Thirteen miles outside of Weed on the left (west) side of US 97 is the Living Memorial Sculpture Gardens War Memorial & Maze, a memorial with bronze statues and mazes remembering those who fought and fell since WWII; it is well worth stopping to see.

SHEEP BUTTE AND GRASS LAKE

The looming bulk of Sheep Butte, with its phantom caves that few know about and fewer have ever visited, is passed to the west as the road starts climbing up in earnest. The Whaleback on the east and the bulky angularity of Sheep Rock to the west are composed largely of Miocene to Pliocene andesitic breccia, typical of the older Western Cascades volcanoes. Shortly there after is a large viewing spot on the west side of the highway - a good place to get a marvelous shot of Mt. Shasta. The road climbs, passing many Pliocene, Pleistocene, and Holocene basaltic and andesitic volcanic edifices to Grass Lake Summit at just about a mile high (el. 5101 ft.). On the northeast side of the pass is the large Grass Lake, a shallow Ice Age lake remnant formed atop more High Cascades basalt. Normally flooded in spring and summer, it nearly dries out in fall and winter. The Caltrans potty stop is a good place to make a stop and look across the lake in fall and spring for 5-foot tall, dancing Sandhill Cranes. As we pass the level, grassy expanse of Grass Lake a mile further, notice the small mounds to the right (south) of the highway. They are man-made nesting mounds for the ducks and geese that regularly nest in the area. The highest peak to the west is Goosenest Mountain, an Ice Age basaltic andesite shield volcano.

The road passes through Ponderosa pine-forested lava flows with many near railroad freight car-sized spatter cones and hornitos. No caves are known along this stretch of road, but don't let that stop you from looking. The road passes over more andesite, then again climbs over 5202 foot high Mt. Hebron Summit made of more gas bubble-filled basalt (named after the old Palestine town), then drops. This part of the old US 97 rolls on over yet another old Ice Age lake down into Butte Valley, home of the Butte Valley National Grasslands . . . and site of mid-winter chariot races. Barley, onions, potatoes, alfalfa, and, more recently, budding strawberry plants to be shipped south to the Monterey area and on to your breakfast table are King here... and somewhere out there in the sage are the actual grasslands.

BUTTE VALLEY

Passing the ill-fated Cedar Lodge on the right, one drive along miles of strawberry fields and grazing cattle. At the north end of Butte Valley, past

the airport and seasonal Meiss Lake (most times a barely muddy sump) are the small towns of Mount Hebron and Macdoel, the latter a place to get remarkably expensive gas. Still further we pass the State Agricultural Inspection Station, the abandoned lumber mill site that has become the Butte Valley Museum, and enter Pleasant Valley, the northern extension of Butte Valley.

DORRIS

Shortly thereafter we enter the community of Dorris (named for Presley and Carlos Dorris, 1860's settlers in the valley) with its main street laid out smack dab on top of the Mount Diablo Meridian. Dorris also has the largest community US flag flown in CA if not the US, several good restaurants, and a motel we've never stayed in; all in all it's a nice little community to spend, oh, a half hour looking through. One then speeds across Butte Valley, Barley Capital of the West. Butte Valley is a closed hydrologic basin (for all of you non-hydrologists this means it lacks an outlet to the sea). The basin is over 900 feet deep and has layer after layer of fresh-water, carbonate fossil shells packed in between the lake sediment and volcanic ashes. Thus it differs from the Tule Lake basin in that the Tule Lake sediments have been extremely altered and leached of most of their fossil content which went on their way south to the Pit River.

MODOC PLATEAU

We are now about to enter the Modoc Plateau. This large area is bounded on the west by the High Cascade Range and on the south by the rag-tag margin of the Sierra Nevada; to the east it slowly fades away into the Great Basin. Something happened about 15 million years ago. Some hold an asteroid hit SE Oregon; others think it was something to do with the drift of the North American Plate and the proto-Pacific Plate; others champion alternative theories. All this melting and flooding took place at about the same time the San Andreas Fault started ripping California apart and thus this mysterious event may have some relation to plate movements along the western edge of North America.

Essentially we just don't know what did happen. What we do know is that this enormous flood of basalt covers most of this corner of California and adjoining Oregon and Nevada. The Modoc Plateau is more or less the same age as the Columbia River basalt to the north and is just as extensive. Other, smaller lava fields occupy intervening areas between these two giants. These flood basalts cover the huge pile of sediments that most probably filled in that pesky Modoc Seaway of the Age of Dinosaurs time and have obscured any clues we might use to figure out what happened.

In any case, the ocean-bottom molten rock floods that burped out basalt for nearly 2 million years, finally shutting down about 15 million years ago. Almost immediately at that time the edge of the former Pacific Ocean bottom, now called the Farallon Plate, was over-ridden by the ever-active North American Plate pushing westward. The Farallon Plate started on its merry

way pushing east under the Western States. This independently minded plate didn't sink as it was supposed to do, but simply pushed eastward to about eastern Oklahoma, then dismembered and sank. On its way, the overlying crust was bowed up and started stretching apart resulting in the Great Basin forming. Oregon and southern Washington State started rotating about 41 degrees clockwise as the older ocean plates forming the Pacific Ocean bottom slid northwest and dragged the continental block's west edge along with it. This entire mess then slowly cracked open the Great Basin's bottom and allowed a great deal of volcanic activity to start. So here you are, at the margin of one of the most colossal scenarios in North America's geologic history . . . and aren't you lucky it all happened much earlier than today.

KLAMATH BASIN . . . AT LAST

About 3 miles north of Dorris and over the low lava pass, we turn hard right onto CA-161, Stateline Road. We continue east along the northern margin of Lower Klamath National Wildlife Refuge, passing the road to Indian Tom Lake, and tiny, semi-ephemeral White/Sheepy (pick one) "Lake", a pond named for its exotic carbonate mineral surface. The occasional prankster will still put fake shark fins in the 6-inch deep water just for fun. If one looks closely, one will observe panhandling egrets splashing through the lake's calcium and unusual mineral sodium carbonate-rich waters that are fed from the northwest slopes of Medicine Lake volcano via Hot Creek. To our right is the imposing Dome Mountain, an about 40,000 year-old volcano shaped like ... well, you know.

Further along State Line Road, look to your right (south) and see several sharply defined fault scarps across the marshes to the east of the Marsh Ranch, itself built on a maar volcano. Maar volcanoes are erupted under water and usually result in a pile of broken cinders and fragments of basalt. Continue past most of the wetlands and pop over the 5-million-year-old Sheepy Ridge basalt. This linear ridge of many names formed as the northern, surface manifestation of the Gillem Fault and shelters a Store-It-yourself stopping place and adjacent Duck Blasters Park. About 16 miles further east we pass the Cox home Ranch. The Cox brothers were early sheep ranchers and also explorers of "The Modoc Lava Beds." Charlie and his brother named Cox Ice Cave and Well and used melted cave ice to water their sheep with a wire bail and bucket operated from the entrance. About a mile further east we come to the Westside Store in the lovely hamlet of Ainsworth Corner and turn right (south) into Hill Road; there are signs to Lava Beds and the Wildlife Reserve HQ.

KLAMATH FALLS

To the north (left) is the western half of the Klamath Basin. Klamath Falls, a growing community, is just over the low ridge along the north skyline. Klamath, by-the-by, is the gringo corruption of an old Chinook name, Tlamatl, for a sister tribe of Modoc Native Americans and means "People." To illustrate the nature of such ephemeral corruption of such perfectly good

names, we look at a small settlement on the Klamath River slightly to the northwest of here. Initially named Honolulu in 1851, probably after the “nearest” westerly islands; the town then was renamed Gottville, after local good fellow Bill Gott; then Pokagama, after a Wisconsin lumber town; and finally in 1892, Klamathton, by combining Klamath and -ton meaning town. And you think you have trouble remembering your cousin's name!

Hill Road runs south and follows the Gillem’s Bluff-Sheepy Ridge scarp of the Gillem’s Fault. This and the three smaller scarps to the west are the western edge of the Great Basin. The Great Basin, the Sierra-Klamath Province, and the Cascade Range all come together here, thus producing a wealth of biological, botanical, and geological features. We continue south past the Indian Hills Golf Course, several potato farms, and the paved turn-off for the microlopolis of Tulelake along the East-West Road. If you require a trip to Tulelake, the acknowledged Horseradish Capitol of the U.S. for other reasons best left unsaid, this is your last non-amphibious opportunity to do so. In approximately 1.3 miles one passes the headquarters of the Lower Klamath Wildlife Refuge, a fine place to make a short stop for their museum and gift store.

As we drive south, we pass several farms on the right with collections of obsolete farm machinery. One, however, stands out. At the front gate of a new (in 2007) large house is the decaying bulk of a turn-of-the-century, wooden-bodied, steam-driven grain thresher, now retired from the barley fields of Tule Lake. A small bulletin board has a vintage photograph of the thresher and a short history of its life. While this is hardly an earth-shaking site, it is worth a stop to read the sign and take a look at this behemoth that used to feed the Western US.

A few more miles down the road past the doglegs and a short spur road formerly called “Easy Street,” we pass a set of heavily weathered buildings on the right (west) side of the road. A large “Government Property - No Trespassing” sign alerts us to yet another remote part of Lava Beds National Monument. These buildings were in an arrested state of decay and were slated for demolition. They are the remnants of a WWII POW camp. German and Italian officers were brought here to sit out the war. Most of these folks were farmers and were allowed to go to Tulelake and work the fields under supervision (= armed guards), a better fate than sitting around a POW camp. After the war, a fair number decided not to return to ravaged Europe and applied for citizenship, thus the goodly number of Italian and German family names in the region. Saner heads prevailed and with some stabilization, the Park Service now conducts tours of the complex of buildings slowly being restored as a unit of the War in the Pacific National Monument.

Speaking of the War in the Pacific National Monument (administered from Lava Beds National Monument itself), to the south past Tulelake itself a few dozen miles is the site of the Tulelake Internment Camp, now surrounded by the community of Newell. In the Second World War, Americans of Japanese

decent on the West Coast were hustled away to "internment" camps to protect the U. S. from possible (read as "imaginary") sabotage. The Tulelake camp was the largest of these camps and grew most of the produce for the other camps scattered throughout California and Nevada. The Tulelake airport is located in Newell and the runway is built on the central street of the old internment camp. In 2007, a land transfer was signed between the BLM and NPS that transferred about a quarter of the internment camp to Lava Beds. While little remains, and aerial flight above the area will reveal the outlines of barracks, wash houses, and many more elements of the former camp. Other pieces of the camp remains, but few of the present population generation have any idea of what they are or what they represent. Now part of War in the Pacific National Monument, you are encouraged to make time to visit these dark reminders of our xenophobic past.

Returning to Hill Road, the winding strip of macadam traverses south between the west edge of Tule Lake and the trace of the Gillem Fault. We are traveling on the former beachfront property of the Modoc Native Americans. The tenuous, intermittent line of willow trees marks the former high water line of the historic lake. The large puddle to the east marks the current Tule Lake, which is approximately a tenth of its former extent. If one peeks through the grasses and brush one may be able to pick out cavorting white shore birds among the lines of beach-rounded boulders and bare bedrock beaches.

GILLEM'S BLUFF

Gillem's Bluff itself is topped by 2 million year old lava; those lavas exposed beneath may range to approximately 2.5 million years old. The oldest lava blanketing the Monument's scenery is that of the Basalt of Hovey Point, exposed beneath Gillem's Bluff near the 1872-73 US Army camp and extending east to near Captain Jack's Stronghold. These lavas are the oldest units making up Medicine Lake volcano proper and weight in at about 450,000 years old. The volcano is considered active and may yet produce new lava tubes for exploration.

Several winding miles further south is the Winema Hunting Lodge (the Headquarters for the ISV Conference and actually quite a nice place to stay).

Approximately 5 miles along the road one may also see on the right a several small gravel pits that show rough stratification of talus deposits, age unknown, but probably Quaternary or earliest Holocene (less than 2 million years ago). Approximately 2 miles further is a large block of up faulted Gillem's Bluff/Sheepy Ridge basalt, andesite, and beach deposits(?) about a million years old. All along the escarpment of the Gillem Fault are weathering grottos and pockets (tafoni) that are utilized by many barn owls and other hunting birds. Approximately 3 miles further a thick vertical dike of volcanic rock stands out in relief on the slopes of Sheepy Ridge to our right (west).

As we near the 8-mile mark from Ainsworth Corner, we approach the northern boundary of Lava Beds National Monument. The old road used to continue straight ahead and into the site of both the 1872-73 US Army Modoc War encampment and the 1930's Works Progress Administration (WPA) and Civilian Conservation Corps (CCC) Camp. The CCC buildings were also used as an NPS entrance station that was, unfortunately, torn down in the late 1960's. The WPA and CCC are responsible for much of the infrastructure in the Monument. They cleared some of the first roads in the Monument, made trails inside of many of the more well-known caves, and built the first substantial building - the rock and timber Superintendent's House, now the Chief Ranger's residence.

Along the foot of Gillem's Bluff are scores of tafoni shelters. One is supposedly the home of Winema herself before she become "civilized." This Modoc woman was instrumental in ending the 1872-73 Modoc Indian War—the last of the western Indian Wars. Only a few of them have been searched or scientifically excavated for Modoc or earlier cultures artifacts...and perhaps that's just as well since these things tend to just disappear into thin air when located. When Tule Lake itself was drained in the late 1920's, literally hundreds of artifacts were revealed. Most of these were simply taken as items of curiosity by local folks and were lost to the world. What a pity.

Once inside the monument, the road swings east, then back south to a stop sign. To the east is Canby's Cross where Gen. Canby was killed by some of the more volatile Modoc Indians during peace talks in 1872. We, however, will turn right and head for the Monument HQ. You pass an entrance kiosk, then adjacent Gillem's Camp, HQ for the Army in the Modoc War. There are several interesting sites here including the site of the graveyard, circular corrals and such from that unfortunate episode of US history.

DEVILS HOMESTEAD, OSTRACODS, AND MAUI POTATO CHIPS

We continue up to the Desolation Point, now renamed Devils Homestead Overlook, a good place to take a stop to look over the northern half of the Monument. Sticky basaltic lava pouring out of Fleeners Chimneys to the south slowly flowed down the eastern edge of the Gillem's Fault, cooling into a morass of jagged aa lava. Don't miss the bronze plaque about the CCC work in Lava Beds at the southern end of the overlook.

There is a series of north-trending, east-facing, west-tilted fault blocks between the west Monument boundary and Gold Digger Pass. These faults, which we glimpsed on the way in just before popping over Sheepy Ridge at the Duck Blasters camp, are some 3 miles to the west and, as you now know, mark the western edge of the Great Basin. Gillem's Bluff runs south from the flat lake basin floor some 14 miles to the north to just beyond Fleener's Chimneys. Just behind Gillem's Camp the lake basin floor has been down dropped more than 525 feet while at Fleener's Chimneys 2.5 miles further south, the displacement is approximately 110 feet. These 120-foot deep

chimneys were named after Sam Fleener (1822-1911), a waggoner for the US Army during the Modoc War.

Further south the fault either gradually dies out or is buried under the blocky basaltic andesite of the Callahan flow. Some of the andesitic and basaltic volcanic rocks exposed by the faulting are magnetically reversed; potassium argon dating has them erupting just over a million years old. Strands of the fault provided a ready route for the eruption of the Devil's Homestead basalt. This flow originated at Fleener's Chimneys as a platy basalt and changed texture to blocky aa as it rolled its way nearly 4 miles down the slopes to within a cap and ball pistol shot of the historic lakeshore. The exact age of the flow has not been determined but appears to be about 10,500 years old based on the amount of vegetation present in the Devil's Homestead.

TULE LAKE BASIN

The extent of Tule Lake Basin is evident from this overlook. The basin apparently formed some 3 million years ago when the area was pulled apart by Great Basin rifting. Nearly a half-mile-thick pile of sediments slowly settled into the basin, leaving an unparalleled record of the past. Studies of pollen, diatoms (tiny, silica-"shelled" plants or phytoplankton), ostracods (tiny, clam-like critters), tephra (volcanic ash), and just plain mud reveal that the basin underwent a great number of changes during its lifetime. It appears that Upper and Lower Klamath lakes drained into the Tule Lake Basin. This water then exited via both a large lava tube system and gravel-filled stream channels to the southeast under Tionesta to the region of Mud Lakes near Damon's Butte and then far south to the headwaters of the Pit River near Egg Lake (named for egg-laying fowl) and Splawn Lake (apparently named as the home of the nesting splawns). The formation of Medicine Lake Volcano in the Pliocene, the down cutting of the Klamath River, and monkeying around by the Bureau of Reclamation in 1915 complicated this pattern; the result is that now the lake drains north into the Klamath River Canyon, a total reverse of its original direction. The actual history of Tule Lake includes a major shift in the basin's and lake's plant life at the start of the Ice Ages about 2 million years ago. From about 2.3 to 2 million years ago the lake partially dried out and the bunny rabbits adopted Beau Geste outfits. At approximately 2 million years ago the lake returned and was healthy until approximately 1.6 million years ago when it again partially dried up. Tule Lake has been cyclically drying and expanding in response to the climate ever since.

Formerly the basin was open water with extensive marshes, with attendant rude white wading birds, along its margins. Into this pastoral scene came the first settlers in 1846 when a band of "slightly off-route" settlers bound for Portland arrived. By 1860, bands of southern Klamath Native Americans and their neighbors, the Modocs, were "safely settled on reservations" and small scale draining of the lake proceeded. Potatoes, onions, barley, and horseradish (Tulelake is the acknowledged Horseradish Capitol of the World) were favored crops as was as dairy farming and horse grazing. Except during

the slight disruption of 1872-73, the lake quickly disappeared under the onslaught of the gringo drain pumps and plows. In 1903 the local farmers decided to stop playing around and get serious about draining the lake. They lobbied the Bureau of Reclamation and by 1915 a series of drains were installed in the southern part of the lake. Over the next 17 years approximately 90% of the lake was converted to farmland with only the twin small sumps of the lake and the marshy "Frog Pond" left for the egrets and other wild life to angrily stamp their feet in. The town of Tulelake was incorporated in 1937 and the potato farmers haven't looked back since. In addition to at least 9 types of prepared horseradish formerly made in town (and now made in the mid-Great Valley near Modesto); most of the excellent quality potatoes are shipped south where they are converted into Maui-style, extra thick and crispy potato chips.

MEDICINE LAKE VOLCANO

The large, low mountain crowding the skyline to the south is Medicine Lake Volcano. Nearly 20 miles in diameter and a scoshi under 8,000 feet high, the volcano is a classic shield volcano, being built up of innumerable, very fluid basalt and andesite lava flows. Well over 100 smaller cones are scattered over its flanks, many in a ringing zone at about 5,000 feet in elevation. Apparently the main volcano began as a series of platy andesite fissure flows rich in olivine crystals just over 1.8 million years ago. There apparently never was any "classic" magma chamber under the volcano, just scores of fissures tapping pockets of the upper melted crust. Throughout time the lava flows erupted onto the flanks of Medicine Lake volcano changed in composition, becoming more basaltic. Indeed, the bulk of the volcano was built up out of these very fluid basalt lavas along with some basaltic andesite. Late in the volcano's history, magma was withdrawn and the summit collapsed in on itself, creating an elliptical summit caldera 6 miles long and 4 miles wide. Medicine Lake now occupies the lowest part of the caldera. The lake is mostly less than 20 feet deep, but does reach 146 feet at its deepest.

Following the collapse of the volcano's summit, andesite lavas were squeezed up along the caldera rim, forming a "crown" of small volcanoes. Andesite and some dacite from these vents eventually over-flowed and, indeed, nearly filled the caldera. Smaller eruptions outside the caldera and near the summit have been much more silica-rich. Glass Mountain and Little Glass Mountain are rhyolitic obsidian (volcanic glass) flows. The northeast flank of Glass Mountain is quarried for pumice and perlite that is shipped to Japan to stone wash Levis for sale to eager young youths in the U.S. (is there no justice here?). The timing of this andesite and rhyolite filling can be approximately dated. The uppermost of these flows have been polished by Ice Age glaciers, thus dating them to at least the latest Pleistocene Epoch. After the rhyolite and andesite flows, many, many basaltic vents opened on all but the western flanks of the volcano, spewing out cinders and blanketing the slopes with enough basalt to scare the few remaining bunnies out of their collective wits. A final episode of small magnitude, very recent faulting has since fractured the whole furschlugginer mess.

The Basalt of Mammoth Crater carpets most (more or less 70%) of Lava Beds National Monument that we will crawl around inside of, and scuff our little knees on; it dates to between 36,000 and 30,000 years ago. Among the more interesting facts to come out of the studies done by Julie Donnelly-Nolan and others made during the last 15 years is that the eruptions have been relatively episodic over the last 11,000 years or so. We have also found that the basalts erupted from Mammoth Crater are of relatively "primitive" (ocean island types) lava that is uncontaminated by rocks they've been erupted through. We also now know that the Great Basin stretching and faulting has apparently allowed these magmas to squirt right up to the surface without passing go and becoming contaminated. Finally we note that the higher the eruption is located on the volcano, the more silica-rich (rhyolite or andesite) it probably will be.

As we have previously discussed, there is a belt of secondary craters ringing the main volcano at an elevation between 5,000 and 6,000 feet in elevation. Mammoth Crater erupted between 38,000 and 36,000 years ago. The volcano has produced a series of eruptions during its history, many of which lasted perhaps 100 to 200 years in duration. When this particular piece of real estate formed, about a quarter cubic mile of lava was blown out of the mountain, conveyed downhill through channels and lava tube caves, and then spread over about 90 square miles of the Monument. The real estate market for the bunnies of Medicine Lake Volcano was never to recover.

The studies of Drs. Julie Donnelly-Nolan, Duane Champion, and others have resulted in several key points:

1. The volcano's fits of bad temper have been strongly episodic over at least the last 11,000 years (The 11,000 year cut-off allows one to work in well-dated, exposed flows as opposed to the largely covered, cruddy stuff underlying these flows). The oldest siege of bunny torture events is a group of eight eruptions of basaltic lava that cluster within about a 400-year interval centered at approximately 10,500 years ago. This was followed by a small andesite eruption at approximately 4,300 years ago. Some 3,000 years ago another small basaltic outpouring took place on the north flank of the volcano. At least four basaltic to rhyolitic venting took place clustered about 1,100 to 900 years ago.
2. The older flows on the volcano tend to be more basaltic in flavor, high in aluminum oxides, and closely approximating "primitive" (ocean floor versus those "other continental types," you know) basalts. The younger, more silica-rich andesite and rhyolite apparently were derived from mixing, fractionalization, and contamination of these older basalts of Madam Pele's kitchen.
3. The structural setting at the edge of the Great Basin with its "pull apart" style of mountain and basin building allowed these "primitive basalts" to be

whisked up the cracks with little contamination. The Gillem Fault along the western edge of Lava Beds and the Mayfield Fault along the eastern edge of the Giant Crater and Timbered Crater flows on the south side of the volcano are two examples.

4. The 1,100 to 900 year old volcanic rocks (the Glass Mtn., Little Glass Mtn., and other dacite flows) are largely silica-rich and have been restricted to the caldera areas of the volcano.

5. Predicting future events on Medicine Lake volcano is not very reliable based on the last 11,000-year record. The type of eruption, however, can be guesstimated with much more confidence. Eruptions high on the volcano will probably be silica-rich pasty lava, tephra (volcanic ash), and other explosive type activity guaranteed to scorch your tail feathers. Burps lower on the volcano are most likely to be very fluid basalt or andesite lava flows that even a slow moving bunny with a hangover probably could avoid.

SCENIC VIEWS

Along the northeast skyline are the ponderosa-forested slopes of Warner Mountains that are made of . . . the Warner Basalt. To the southeast are more volcanic cones bear such picturesque names as Egg Lake Butte (named for the multitudes of waterfowl that nest in adjacent Egg Lake) and Splawn Lake. We would be remiss if we didn't also mention Crank Mountain (probably named after the obstreperous waterfowl that nest there) and Damon's Butte (reputedly named for the south end of a north-bound Damon); there are small lava tubes adjacent to the butte (Ulysses Major Damon himself was a Vermont-born telegraph operator in the late 1800's in Oroville, CA).

SUGGESTIONS FOR CAVE TRIPS

For those interested in furthering their geologic knowledge of the volcano and its plumbing it is suggested that you make stops at Devil's Homestead, Gillem's Bluff and Fault; Skull Ice Cave; Valentine Cave; and Mushpot Cave.

For those interested in a slower paced, but geologically interesting trip into the plumbing of Medicine Lake volcano, a more leisurely self-paced trip to Mushpot Cave at Monument Headquarters and a stop at Catacombs Cave on Cave Loop is suggested.

For those interested in the avian biota, a trip along the northern edge of the Monument east of the Stronghold to Tule Lake National Wildlife Refuge to observe the varied residents and visitors of this southern margin of the Klamath Basin is suggested.

For those interested in the early human occupancy of the Monument area, we suggest a trip further east past the Stronghold for approximately 6 miles to Prisoner's Rock and the Petroglyphs Section of the Monument. This could be

followed by a trip out to Symbol Bridge off the Skull Cave road; both spots are highly recommended.

Those interested in recovering from this fast paced trip, enhancing their tans, and looking at the panoramic scenery of the basin, will find the mile-high slopes of Schonchin Butte attractive.

Those botanically inclined will find in the volcanic trenches and schollendomes in both the Garden Bridges part of Cave Loop and at the western base of Caldwell Butte a great variety of trees, shrubs, and wild flowers to delight the eye. It is suggested that you make notes on the flowers you find unfamiliar, as some seasonal evening Ranger talks may be on the wild flowers of the Monument.

For those of you who want to do all of the above, just do your favorite activity now, then plan to return to the Monument later to do all those other things!

DIRECTIONS TO THE LAVE RESEARCH CENTER

Some events may be held at the newish Research Center near the Visitor Center and campgrounds in Lava Beds itself. To access this facility, continue on past the roads/turnouts to Fleeners Chimneys, Black Crater, Merrill Ice Cave, Schonchin Butte, Skull Cave, and the road up to Medicine Lake, and on past the Monument Head Quarters. Just past this point and at the parking lot for Indian Well, a road angles down north towards the campgrounds. Turn left (north) on this road and proceed down it for about a quarter mile to an unimposing paved road to the right; this is marked Service Road or some such nonsense. Follow it for several hundred feet and you will be at the new Research Center.

This concludes your road log to Lava Beds from the Sacramento and Delta areas; we now return some semblance of control of you.

Q.E.D.