Janesville Grade Field Trip

This is a field trip to experience some local geology and great scenery. It is not required for the Lassen College physical geology class except as a class field trip using college transportation. If you do this on your own, be careful and take precautions. Be safe! To get credit (50 points extra credit) take pictures that include your image. Get a picture of a xenolith. Collect a specimen of the Lovejoy Basalt and one of granodiorite. Bring the pictures, rocks and notes of your trip including exciting things that happened and difficulties encountered. This trip is voluntary and optional. You can get a good grade by attending class, and doing well on labs, homework and tests. These trips are primarily designed for students who missed classes due to illness or personal emergencies. Be careful and safe. Don't drive or ride with someone who is impaired or not careful.

A mantle plume beneath California?
The mid-Miocene Lovejoy flood basalt, northern California

That is the title of a 2008 research paper by Noah J. Garrison, Cathy J. Busby, Phillip B. Gans of the *Department of Geological Sciences, University of California–Santa Barbara, Santa Barbara, California 93106, USA*; Keith Putirka of the *Department of Earth and Environmental Sciences, California State University–Fresno, Fresno, California 93740, USA*; and David L. Wagner of the *California Geological Survey, 801 K Street, Sacramento, California 95814, USA*. What's it all about? What follows are excerpts from their paper:

Mid-Miocene volcanism in the northern Sierra Nevada occurred during a period of widespread and voluminous magmatism in the western United States. To the north of the Sierra Nevada, the 17–14 Ma Columbia River basalt and the Steens basalt erupted in great volumes on the Columbia and Oregon Plateaus behind the ancestral Cascade arc. At 16 Ma, the McDermitt caldera in northern Nevada was active and formed the oldest known of a succession of silicic calderas and basaltic flows that track northeastward along the eastern Snake River Plain toward the Yellowstone caldera. Extending southward from the McDermitt caldera, eruptions occurred in the northern Nevada rift, an extensional basaltic dike complex located in the Basin and Range Province. All of these eruptions occurred inboard of the ancestral Cascades arc. In the northern Sierra Nevada, the Lovejoy basalt erupted, forming California's most widespread basalt flow. In this paper, we present geologic, geochronologic, and geochemical evidence that the Lovejoy basalt is genetically related to the Columbia River Basalt Group, but that the Lovejoy basalt erupted in a forearc, not backarc, tectonic setting. The association of the Lovejoy basalt with mid-Miocene flood basalt activity has considerable implications for North American plume dynamics and strengthens the thermal "point source" explanation, as provided by the mantle-plume hypothesis.

The estimated total volume of the Lovejoy basalt is ~150 km3, roughly one-quarter the volume of the average individual flow in the Columbia River Basalt Group. However, individual flows of the Lovejoy basalt represent a significant volume of erupted material in comparison with major historic lava flows. Based on the distribution of erosional remnants of Lovejoy basalt, individual flows may have erupted with an estimated volume of up to 75 km3. For comparison, the Laki eruption of 1783–1785, the largest basaltic eruption in recorded history, only produced a total volume of 14.7 km3 of basalt from a fissure in central Iceland. Further, new paleomagnetic results indicate "almost 90% of the Lovejoy type section erupted within a few centuries." The rapid eruption of such a significant volume of lava further argues against the Lovejoy being related to Cascade arc-volcanism, and in favor of a relationship to Columbia River Basalt Group flood volcanism.

The Lovejoy basalt is geochemically similar to the Columbia River Basalt Group, but it was *previously considered to be Eocene in age. Recently published age dates and new dating presented here shows that the Lovejoy basalt erupted at ca. 15.4 Ma, and is thus coeval with the 16.1–15 Ma Imnaha and Grande Ronde basalts, which are the volumetrically dominant eruptive units of the Columbia River Basalt Group. These data suggest that the Lovejoy basalt may share a common parentage with the Columbia River Basalt Group, and that the effects of flood basalt volcanism were expressed much further to the southwest than previously recognized.*

The Lovejoy Formation (hereinafter the Lovejoy basalt) was named after Lovejoy Creek, a tributary located adjacent to a principal occurrence of the basalt. It is a distinctive, black, dense, low-MgO basalt with few phenocrysts *that occurs as isolated exposures and remnants in a NE-SW–trending band extending from the Honey Lake fault scarp across the northern end of the Sierra Nevada into the Sacramento Valley, a distance of ~240 km.*

Outcrops of the Lovejoy basalt display a characteristic irregular jointing and are highly fractured, although they may exhibit well-formed columnar jointing. Individual flows in the Diamond Mountains may be up to 45 m thick, and they form an alternating sequence of cliffs and talus slopes, where the upper surfaces of the talus slopes mark the boundary between individual flows. The basalt contains few phenocrysts, except for a few plagioclase phenocrysts *in the upper flow unit in the Diamond Mountains, it is relatively glassy (up to 30%–40%), and is composed of a groundmass of microcrystalline plagioclase, olivine, and glass, with lesser pyroxene and Ti-Fe oxides.*

Agglutinate (pyroclastic igneous rock formed from partly fused volcanic bombs)*, scoria, and bomb fragments are visible along the full extent of the ridge at Thompson Peak. Roberts (1985) previously noted the presence of these deposits at one location in what was, at the time, termed the lower basalt of Thompson Peak and suggested it could be a source vent for the Lovejoy basalt. Coalesced spatter with elongate, plastically deformed, and flattened vesicles are common and were likely produced by the weight from accumulating material. Scoria and highly vesiculated bomb fragments up to 30–40 cm in diameter are also present. Agglutinated clasts are observable on fresh surfaces as mottled, tan, angular to amorphous "blebs" that have been partly reassimilated into the surrounding homogeneous basalt. These deposits appear to represent vent-proximal spatter ramparts. Spatter piles can be diagnostic of the locations of volcanic vents, and the deposits at this location identify Thompson Peak as the source vent of the Lovejoy basalt.*

Thompson Peak, located west of Honey Lake in the Diamond Mountains, during the mid-Miocene period. The vent is identifiable by proximal volcanic deposits, including scoria, agglutinate, and bomb fragments, present along the majority of the ridge of basalt, which forms a relict spatter rampart. Available age data show that the vent was located in a forearc position, in contrast with the flood basalts of Oregon and Washington, which erupted in a backarc setting.

The recognition of the Lovejoy as the southern extension of mid-Miocene flood basalt volcanism has considerable implications for North American plume dynamics. We posit (put forward) *that the Lovejoy basalt represents a rapid migration of material from the Yellowstone mantle plume head in a direction not previously recognized, ~20 cm/yr to the south-southwest.*

What they are saying is, there is good evidence that Thompson Peak was a vent for a fissure eruption of a large basalt lava flow produced by the Yellowstone Hotspot. Wow, great story if it is true! More study is needed. This is a great topic for your master's or Ph.D. dissertation.

In the winter you won't be able to drive to this spot because of snow. Go it the early fall or late spring. As you drive up the Janesville grade you will travel through Cretaceous granodiorite. Granodiorite is an intrusive igneous rock similar to granite, but containing more plagioclase than potassium feldspar. Officially, it is defined as a phaneritic igneous rock with greater than 20% quartz by volume where at least 65% of the feldspar is plagioclase. It usually contains abundant biotite mica and hornblende, giving it a darker appearance than true granite. Mica may be present in well-formed hexagonal crystals, and hornblende may appear as needle-like crystals.

0 miles. Start at the bottom of grade (at gas station and mini market) and set the odometer to zero. Remember mileage is approximate and varies from car to car.

3.7 miles on a blind right hand curve carefully turn left off highway onto dirt road. This is a sandy area with large light colored boulders. This is a good spot to study the granodiorite. Look at the way they weather and look for round xenoliths of darker material. In geology, the term xenolith is almost exclusively used to describe inclusions in igneous rock during magma emplacement and eruption. Xenoliths may be engulfed along the margins of a magma chamber, torn loose from the walls of an erupting lava conduit or explosive diatreme (blocky volcanic pipe) or picked up along the base of flowing lava on Earth's surface. Take a picture of a xenolith and a selfie of yourself at this spot with the big boulders. Don't confuse dark lichen for a xenolith.

Notice that across the road Lovejoy basalt has flown into an old gully in the granodiorite. Take a picture of this. As you drive up the Janesville grade from here, the back will contain more and more basalt. There are still a lot of banks with granodiorite and some have small dikes of harder, finer textured granodiorite.