Glossary of Terms

Argillite - blocky, dark colored, metamorphic rock.

Basalt - a dark, fine-grained, volcanic rock.

Batholith - rock structure formed by magma rising within the earth.

Caldera - basin-shaped volcanic depression.

Dacite - locally a pink-purple volcanic rock.

Dredge - used to mine gold from stream bottoms.

Erosion - wearing away of soil and rock by weathering and the action of wind and water.

Facies - characteristics of a rock.

Fluvial - of or pertaining to a stream or river.

Igneous - rock formed from molten material.

Lahar - volcanic mud or debris flow.

Magma - molten rock inside the earth.

Metamorphic - the underground alteration of rock from its original state by heat and pressure.

Moraine - mound or ridge deposited by a glacier.

Obsidian - black or dark colored volcanic glass.

Opal - a silica mineral or gel. It occurs in most colors, and displays a marked play of colors.

Outcrop - geology appearing at earth's surface.

Perlite - a volcanic glass with a higher water content than obsidian.

Placer mine - mining metals using running water.

Porphyry - a fine grained igneous rock that contains conspicuous crystals.

Residual -formed by rocks weathering in place.

Rhyolite - a group of extrusive igneous rocks.

Sedimentary - solid material that has settled down from suspension in a liquid.

Serpentine - green to greyish green rock with greasy or silky luster and slightly soapy feel.

Tuff - term for consolidated ash and pyroclastic rocks.

Vein - mineral filling of a fault or other fracture.

WARNING: The Granite watershed contains many abandoned mines, which are extremely hazardous because of deep unmarked shafts, bad air, and toxic wastes. Never enter mine shafts or tunnels. Never touch orange pond water. Don't allow children or pets to roam unattended.

This field trip is on a paved, two lane by-way. However, it is seasonally inaccessible due to snow. Please inquire locally about snow conditions and drive carefully. If you encounter snow on this field trip, please turn back because the snow will get deeper before you reach the end.

Keep a sharp look-out for wildlife and cattle near the road. These animals may suddenly dash in front of you. Avoid parking in road cuts, as rocks may fall down. Use this guide with the Umatilla National Forest Visitor Map, available at Forest Service offices or www.naturenw.com.

For More Information:

Umatilla National Forest
North Fork John Day Ranger District
401 West Main
Ukiah, OR 97880
541-427-3231

Oregon Department of Geology and Mineral Industries
1510 Campbell Street
Baker City, OR 97814
541-523-3133

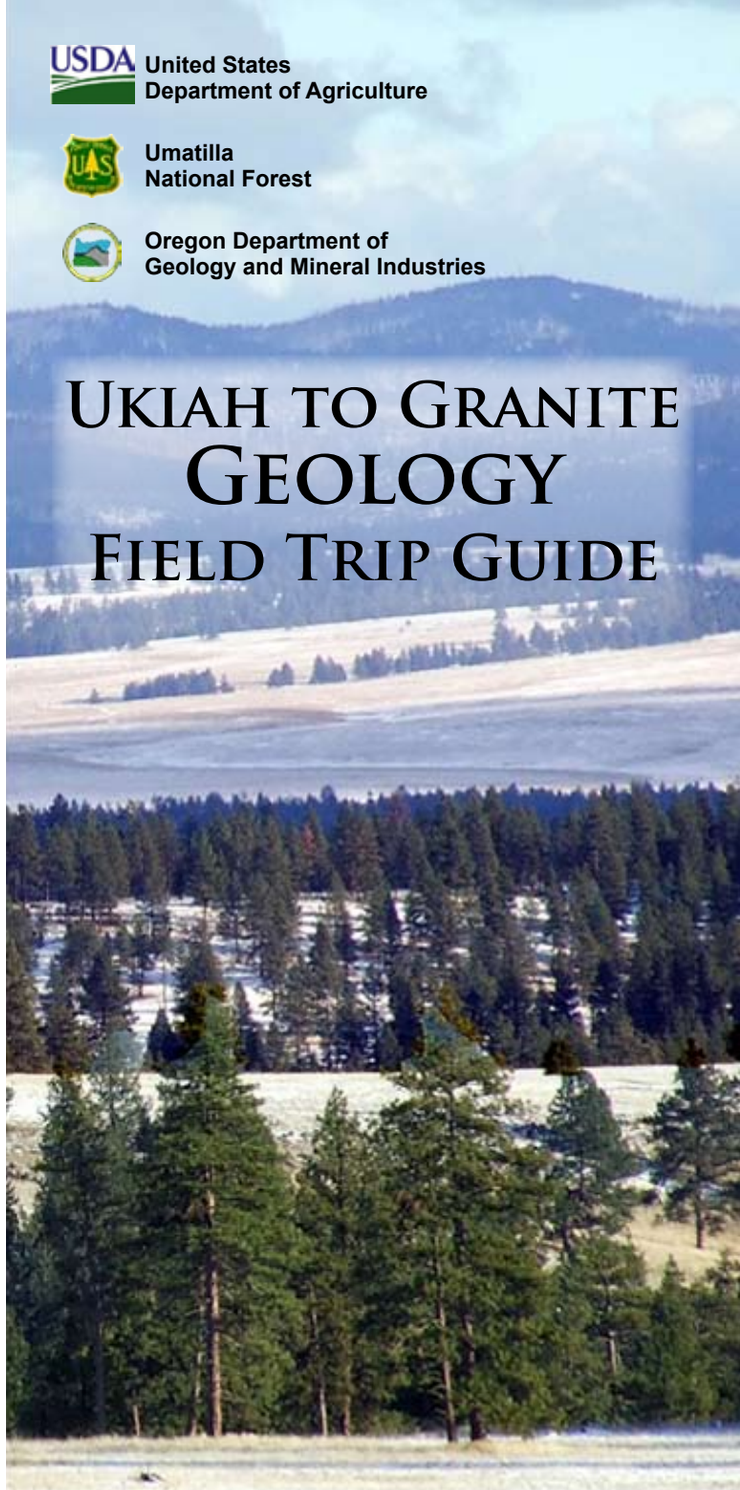
For additional fieldtrip stops and more detailed information on the geology of this area, visit the Oregon DOGAMI website at www.oregongeology.com.

United States Department of Agriculture

Umatilla National Forest

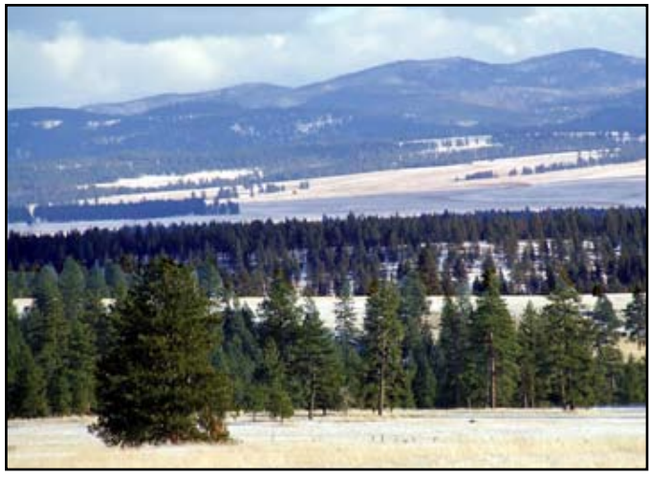
Oregon Department of Geology and Mineral Industries

Ukiah to Granite Geology Field Trip Guide



Developed in cooperation with:

Umatilla County **Ukiah School** **City of Ukiah**
Grant County **City of Granite**



This field trip begins at the historic settlement of Ukiah and ends at the equally historic gold mining camp of Granite. Ukiah owes its existence to the inter-mixed grasslands and stands of Ponderosa pine atop a blanket of relatively recent (7,000 years ago) volcanic ash and older basalt lava flows. Granite owes its existence to the gold washed out of veins in the ancient basement rocks. Between the two, both in distance and in time, lies Tower Mountain; a large, heavily forested rhyolite volcano.

Over the last 100,000 years, volcanoes in the Cascade Mountains have erupted ash which has showered down onto the Blue Mountains. The last notable ash fall came from the formation of Crater Lake 7,000 years ago. Though there have been no earthquakes in recorded time, fluvial geological processes continue to shape the valley's streams and floodplains to this day.

Approximately 15 to 17 million years ago, some of the largest volcanic eruptions in earth's history covered the Columbia Plateau, including what are now Ukiah and the Camas Valley, with basalt lava. After the lava flows were emplaced, the valley was formed by a series of earthquakes which dropped the valley floor several hundred feet. The fault lines from these ancient earthquakes run along the north and south sides of the valley. Erosion from the surrounding mountains partially filled the valley, and formed the present flat benches and valley floor. Above the valley are a series of benches and plateaus which are dissected by steep canyons. A good view of this landscape is Bridge Creek Flats, which is visible to the west from the North Fork John Day Overlook. The landscape changes between field trip stops 3 and 4, from flat benches dissected by steep canyons to eroded volcanic remnants and flows.

The Tower Mountain Volcano can be seen from the Camas Valley. It appears as a wide, low mountain on the eastern horizon. There are two small peaks to the north, and a long ridge to the south. Eruptions of dacite lava and volcanic ash began in the Tower Mountain area about 30 million years ago. Explosive eruptions from the central vent culminated in a large, caldera-forming ash-cloud eruption. The collapsed caldera covers an area of about 40 square miles and the light colored tuff that erupted from it is very visible in the road cuts.

The Tower Mountain eruptions took place during the Paleogene period of geologic time, approximately 24 million to 65 million years ago. There were additional eruptions at other locations during this period, and this field trip moves in and out of Paleogene volcanics from MP (milepost) 16.8 until its end.

At Crane Flats Trailhead, the view is across Paleogene volcanics to the Elkhorn Mountains. Past Crane Flats, the road dips into the gold bearing basement rocks of Granite Creek. These rocks are called the "basement" because they are the oldest rocks, the ones upon which everything else is built. In this part of Northeast Oregon, the basement is made up of fragments of deep ocean floor and volcanic islands formed approximately 250 million years ago. The basement also includes younger granitic rocks, which

formed when hot, liquid magma intruded into the existing geology about 140 million years ago. The interaction of this hot intrusion with the existing basement formed the gold veins which gave Granite its start.

Indians, who first used the area, came to hunt, fish, and gather Camas roots. The Europeans hunted and fished, discovered gold in 1862, began raising livestock in the 1880s, and producing lumber in the early 1900s. Today, people use the area between Camas Valley and Granite for grazing, timber production, hunting, fish habitat, recreation, mining, and wilderness experiences. Geologic processes make these uses possible by creating fertile volcanic ash soils and shallow groundwater aquifers which sub-irrigate the floodplains.

How Soil, Geology and Forests are Related

Soil is the interface between the living and non-living parts of the forest. It is the material in which plants and trees grow. Top soil consists of weathered rock fragments, rotting wood, and leaves, mixed with microscopic plants and animals. The activities of the microbes prepare minerals in the rock and organic matter in the soil for the growth of plants.

Over thousands of years, the Blue Mountains have received wind borne volcanic ash from eruptions in the Cascade Mountains, 200 miles to the west. The addition of the ash allows the soil to hold more moisture. This added moisture has resulted in larger trees, a diversity of trees, and forests which cover a larger area. Generally, larch, true firs, lodgepole, and spruce grow in ash soils, while Ponderosa pine and Douglas fir grow in residual soils. Other factors are involved in determining which trees species grow in which soils, such as lodgepole releasing its seed after forest fires and spruce’s preference for wetter sites.

Generally, all the forest soils will support trees if they can retain enough moisture for tree survival. When soils are too shallow and rocky to retain enough moisture, grasses and shrubs are common. It is an important responsibility of land managers to conserve the soil for future use.

Field Trip Stops

This 51-mile field trip begins in Ukiah at the city park on Main and Camas Streets. Head west 1.3 miles on Hwy 244, pass the Ranger Station (and public rest room), cross Hwy 395, and proceed 0.1 mile on Forest Service Road (FR) 53 -Western Route to Scenic Byway sign. Carefully U-turn into the turn out on the south side of road. Congratulations! You've successfully arrived at Stop 1. Reset your odometer to 0.0.

Stop 1, Milepost (MP) 0.0, Camas Valley Overview: Tower Mountain is visible 20 miles to the east. Open meadows in the valley contrast with the forested benches and mountains. Clay derived from weathered volcanic ash forms soil lenses in the meadows. Run-off water perches on these lenses, which supports vigorous grass and sedge growth. Return to the Ukiah park and turn right on Camas St. (FR 52). Remember, these are the last commercial services for 50 miles.

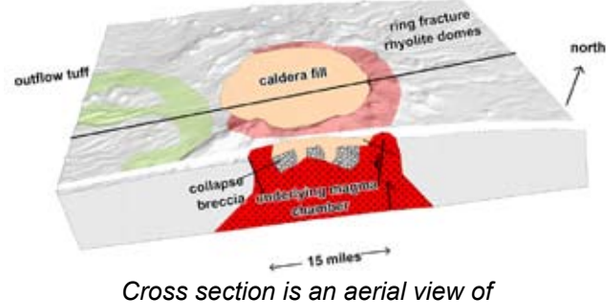
Stop 2, MP 5.7, Bridge Creek Flats: This stop is a gravel road to the right, marked with a binocular sign, where the paved road curves to the left. Park to view Flats and turn around to return to paved road. The topography here is formed upon Miocene age Columbia River Basalt (CRB) lava flows. The grassy meadow lands are used for cattle grazing in summer and winter habitat for approximately 2000 elk. The slopes between the flats support open Ponderosa pine forests.

Stop 3, MP 14.4, North Fork John Day Overlook: This turn out, on the right, is lined with boulders. To the south lies a deep canyon cut into CRB lava flows by the North Fork John Day River. The layer cake appearance of the canyonlands to the west results from the stacking of one lava flow atop another. Much of the foreground topography was formed by large scale landslides, which resulted from slope failures in the volcanic geology that underlies the basalt. At this overlook, the field trip enters timberland which burned in the 1996 Tower Fire. Seven miles to the west you'll see the prominent basalt plateau of Stop 2, Bridge Creek Flats.

En route: As you travel to Stop 4 the tour leaves the benches of the CRB lava flows and enters the volcanic landscapess of the Paleogene period.

Stop 4, MP 17.3, Overlook of Tower Mountain: This turn out, on left, is just past the saddle and OHV (off-highway vehicle) trail. Watch out for OHVs and on-coming traffic! The overlook provides a good view of the west margin of the Tower Mountain caldera. Look east, across 3 miles of ring-fracture rhyolite, at the eroded remnants of the old volcano's caldera (see cross section below). Walk east along the north shoulder of road 0.2 miles to view the outcrops above the road to the south. These outcrops are dacite porphery, a pink-purple rock with pea sized feldspar crystals.

En route: At MP 20.9 the field trip enters the Winom Creek drainage. From this point to MP 26.8 the route passes through the Tower Mountain Caldera. The road cuts contain white ash flow tuff with isolated outcrops of grey perlite and weathered obsidian. The bare cone shaped outcrops along the route are small rhyolite volcanoes.



Cross section is an aerial view of Tower Mountain Volcano with assumed underground cross section.

Stop 5, MP 23.5, Winom Creek Road Cut: Park to the left just past Winom Creek. Grey perlite and black obsidian can be found in the dark vertical band visible in road cut to the left. The ditch along side the outcrop has numerous rounded black beads. If the beads were translucent they would be considered 'Apache Tears.' Narrow seams of opaline quartz occur in the white rhyolite ash. Precious opal has also been found in the area. MP 24.6 is the east edge of the 1996 Tower Fire.

Stop 6, MP 28.5, View lahars near White Creek: Just past creek, enter turnout on left in front of road barricade. Small, orange, weathering-zones are partially petrified logs that were carried along by the debris flows. Carbonized rinds indicate that the debris flows were hot. From MP 36 to MP 46, most of the land to the west of the road is managed as wilderness. At MP 41, FR 52 meets FR 51. Bear right on FR 51 and head south towards Granite. The road cuts through several moraines between MP 41.9 and 44.7. The North Fork John Day campground at MP 42.6 has rest room facilities. FR 51 turns into FR 73 at this campground. Continue south on FR 73 to Granite.

Stop 7, MP 44.8, Crane Flats Trailhead: Turn right into the trailhead parking area. Gold dredged in this area may have eroded from lodes exposed within the Bald Mountain Batholith. The Bald Mountain Batholth forms the core to the Elkhorn Mountains to the east. High alpine vegetation, open meadows and intermixed spruce and lodgepole pine are visible.

En route: As you travel on to Stop 8, you enter the Granite Creek drainage and the gold bearing "basement" rocks.

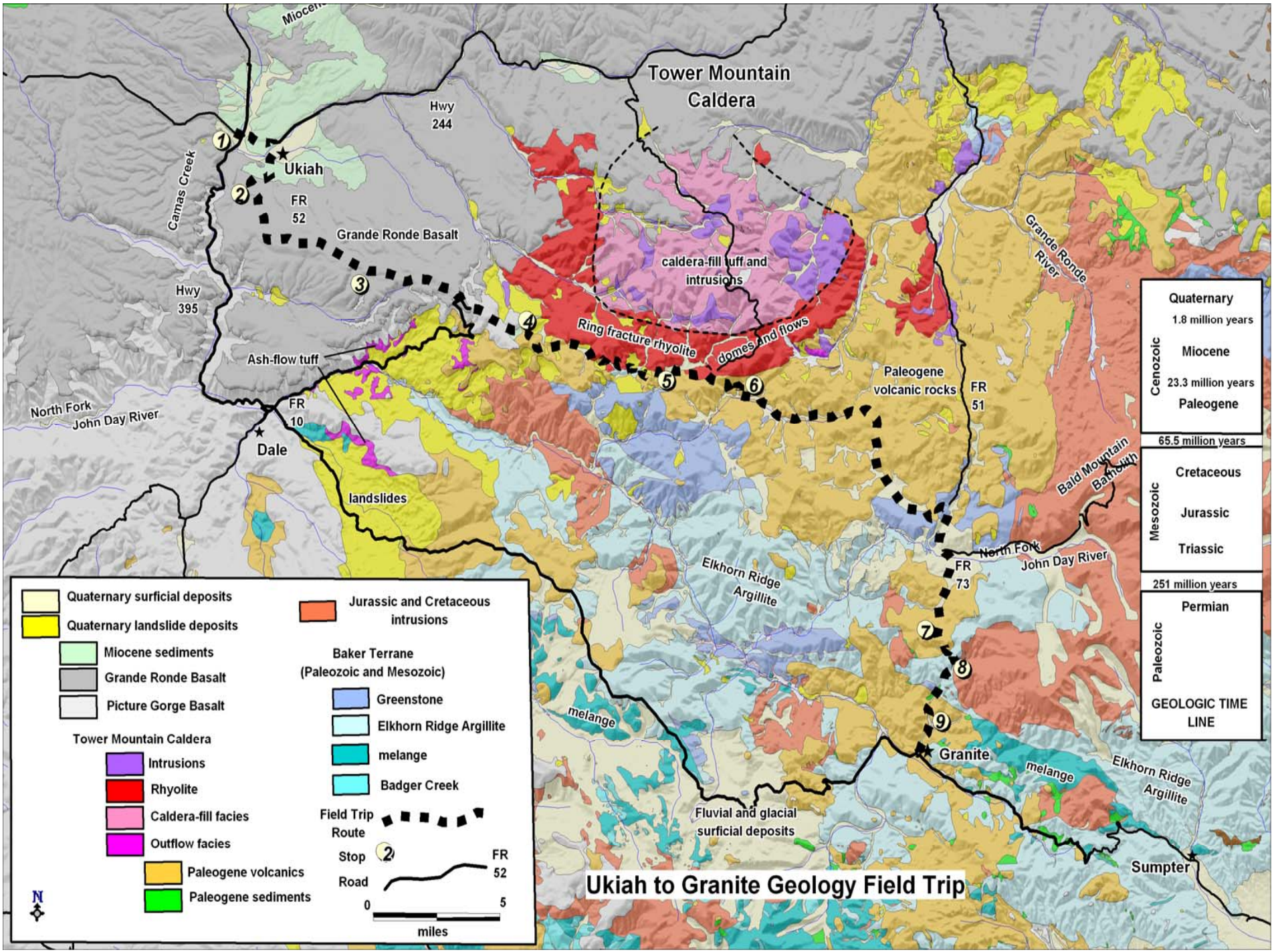
Stop 8, MP 47.6, Contact between Bald Mountain Batholith and Elkhorn Ridge Argillite: Park on the left at MP 47.7, in front of barricade, and walk north on shoulder 0.1 miles to road cut. The granite from the batholith is rounded with a rough surface, while the argillite is smooth and blocky. A fragment of metamorphosed serpentenite is caught up along the contact. A composite quartz vein is exposed in the road cut. The quartz-filled sheer zone also contains pyrite. There are active and inactive mines in this area.

En route: As you travel on to Stop 9, at MP 48.3, visit the interpretive sign for the Independence Mill ruins. There is a turnout on the left for parking.

Stop 9, MP 49.9, Confluence of Granite and Boulder Creeks (Ah Hee Diggings or Chinese Walls): Turnout area is to the left next to the prominent rock. Walk south on east shoulder 0.2 miles to see walls among lodge pole pines. Stream channel has been mined at least three different times:

1st - shortly after gold was discovered in 1862
2nd - by Chinese placer miners around 1870-1900
3rd - by mechanized dredges in the mid 1900's. Remains of the intricately stacked "Chinese Walls" are visible in this area. These rocks were stacked to be out of the way of hand mining between the walls. Please respect this historic site.

This field trip ends at MP 51.5. Commercial services are available in the town of Granite. You can now travel back to Ukiah on this route or chose from several alternative routes home.


Tower Mountain Caldera
Hwy 244
Ukiah
Camas Creek
FR 52
Grande Ronde Basalt
caldera-fill tuff and intrusions
Grande Ronde River
Hwy 395
Ring fracture rhyolite
domes and flows
Ash-flow tuff
Paleogene volcanic rocks
FR 51
North Fork John Day River
FR 10
Dale
landslides
Bald Mountain Batholith
Elkhorn Ridge Argillite
FR 73
North Fork John Day River
melange
Granite
melange
Elkhorn Ridge Argillite
Fluvial and glacial surficial deposits
Sumpter
Ukiah to Granite Geology Field Trip
Quaternary
1.8 million years
Miocene
23.3 million years
Paleogene
Cenozoic
65.5 million years
Cretaceous
Jurassic
Triassic
Mesozoic
251 million years
Permian
Paleozoic
GEOLOGIC TIME LINE
Quaternary surficial deposits
Quaternary landslide deposits
Miocene sediments
Grande Ronde Basalt
Picture Gorge Basalt
Tower Mountain Caldera
Intrusions
Rhyolite
Caldera-fill facies
Outflow facies
Paleogene volcanics
Paleogene sediments
Jurassic and Cretaceous intrusions
Baker Terrane (Paleozoic and Mesozoic)
Greenstone
Elkhorn Ridge Argillite
melange
Badger Creek
Field Trip Route
Stop
Road
FR 52
0
5
miles
N