Visitor Center to Painted Hills Geology Road Log

John Day Fossil Beds National Monument

Instructions: The route is about 75 miles total. Please pull over at each stop rather than try to drive, read, and look (which is very dangerous). At each stop set your trip odometer to zero. About two-tenths of a mile from the next stop start looking for the pull-off spot (odometers vary in accuracy). Pull-offs will be at least big enough for a medium sized RV, and graveled. If a pull-off is not available you may have to stop in the roadway (so noted below). If so, then please turn on your flashers to warn other approaching drivers.

When you stop, keep your vehicle parallel to the road and in the direction you're traveling. The direction for you to look is given as clock time. The front of your car is pointing to 12 o'clock, the rear to 6 o'clock, directly right to 3 o'clock, and directly left to 9 o'clock. **Have fun and please drive carefully!**

odometer distance between stops	pull-off area on left or right, or on the roadway	
0.0		From the Thomas Condon Paleontology Center, turn left onto Oregon State Rt. 19, traveling along the John Day River. In a couple hundred yards you will pass by the James Cant Ranch historic district, on the right. The house features a museum on the human history of the region.
1.5	right	(all around) Goose Rock Conglomerate ... These well-cemented (cliff) gravels are exposures of goose rock conglomerate, named for the nesting Canada Goose. These rocks are about 110 million years old (cretaceous) and include leaf imprints, pollen grains, and other dateable materials in the fine-grained units. Few fossils, however, are found in the coarse pebbles and cobbles, which are unsuited for preservation. Flow analysis suggests these were deposited in an undersea channel/fan complex, from the mouth of a nearby river along an ancient coastline.
0.6	right & left	(4 o'clock) Deer Creek drainage. Formed as a result of the middle mountain fault, a 30 mile, east to west trending fault with the south side risen upward. You are on the north side of the fault, the side that lowered, having just passed over the fault. It folded the cretaceous deposits to the south into direct unconformable contact with the Miocene John Day Group, now well below you. The drainage you can see from here follows a portion of the fault line.
1.0	right	Blue Basin ... Blue Basin contains the "type area" of the Turtle Cove Formation of the John Day Group (see chart on last page). The short "Island-in-Time" trail affords an intimate view of one of the major erosional, fossil basins in this member (noted for its blue-green layers). Interpretive exhibits and fossil replicas are on display along the trail.
0.5	right	(3 o'clock) Dick Creek Road points to distant red hills the "type area" for the Big Basin Formation of the John Day Group, similar to the Painted Hills near Mitchell, the end of this tour.
0.4	right & left	(1 o'clock) Note the eroded and unusually shaped rocks. Around them are Eocene hardpan soils that once buried these much older (200 my) schists, marbles, and other metamorphosed rocks. The soils essentially buried the eroded rock topography of the ancient landscape, long before the John Day Group was deposited. This is a nice view of an ancient landscape, eroded, buried, and resurfaced, a landscape that dinosaurs may have seen!
1.6	left- be- fore the crve	(12 o'clock) Cathedral Rock ... Cathedral Rock is a part of the John Day Group which probably slumped from a much higher elevation to the west. Remaining upright, it came to rest here and forced the river to arc around it. The prominent red and buff bands on top are Picture Gorge Ignimbrite which was deposited as a fiery tidal wave of incandescent gas and volcanic debris from an enormous volcano explosion (28.7 mya) somewhere to the southwest near Newberry Crater. If the sun is right, you may see some of the ignimbrite shining, as it is a glass-like rock. Two cooling units can be seen in this ignimbrite exposure. The cooling duration between flows remains problematical despite evidence of liesegang rings and other gelling peculiarities. A K/Ar date for this ignimbrite is 28.7 million years (my).
2.0	right	Entrance to the "Foree" area of the national monument. This round-trip 1.1 mile drive is very scenic, providing great views of the valley layers. Picnic tables, restrooms, water (except in winter), and very short self-guiding trails with exhibits are available. Outstanding fossils are being

		collected from this area by paleontologists (with special authorization) for research. Visitors are reminded that all other collecting from monument lands is illegal. We recommend hiking the short Story in Stone Trail, which would take about 20 minutes.
0.6	Left	(3 o'clock) 1/4 mile away is an exposure of the Turtle Cove Formation of the John Day Group. The blue-green color banding is due to fossilized soil horizons, consisting primarily of claystone with a high density of both yellow and blue crystal minerals. This is the northern end of the Monument's Sheep Rock Unit.
0.6	left	Park at mile-post 113 ... (4 o'clock) Note the river channel deposits. They are the rounded rocks in former water sediments, as opposed to edged rocks in the debris of slope-fall depositions.
2.0	right	(2 o'clock) "Round Up Flat" - Exposures of the upper Turtle Cove Formation are about 1/4 mile away. As you proceed north, these exposures will be getting progressively younger in age (the green will seem to fade in the younger layers).
2.6	right & left	(9 o'clock) Massive lava flows of the Dayville Basalt Formation of the Picture Gorge Basalt Subgroup (part of the extensive Columbia Plateau Flood Basalts) are on top of the buff-colored ash of the Kimberly Formation of the John Day Group. If you look carefully at the lowest lava flow you may see where the flow thickened and thinned as it pooled or flowed over what were then shallow valleys and hills some 16 million years ago. The top is flat while the bottom waves.
1.3	left	(11 o'clock) Kimberly Dike ... The vertical wall of dark rock on the west side of the river is a basalt dike, named for the town of Kimberly. This dike is one of many remnants of lava which surged upward through massive cracks and covered incredibly large areas of the northwest about 16 million years ago. Later, the material in the crack cooled and slowly solidified leaving dikes such as this one, while the material they passed through has long ago eroded away. Dozens of these dikes are around this region, part of the "Monument Dike Swarm" of the Picture Gorge Basalt Subgroup. Behind the dike is a small exposure of the Kimberly Formation of the John Day Group. Note how the dike has cut through the older, lower sediments of the formation.
1.6	road way	Kimberly Store and Hamlet. Pass junction with road to the town of Monument. Continue northward on Rt.19. As you travel along the next few miles you will note road-cuts of almost pure white ash. This is Mazama Ash from the former Mt. Mazama volcanic explosion about 7,700 years ago, which formed Oregon's Crater Lake.
1.4	left	(11 o'clock) On the other side of the river note the landslide block of Twickenham Basalt under an exposure of the (older, buff-colored) Kimberly Formation, of the John Day Group.
0.7	left	(1 o'clock) Here, a prominent basalt dike forms a vertical spine. Behind, at 6 o'clock, see if you can spot the same linear dike exposed in the hillside across the river.
3.1	right & left	(11 o'clock) Here a small exposure of columnar (column-like) joints is surrounded by a confused-looking mass of "braided" basalt. How were these columns formed? (hint: lava forming thicker ponds and thus a slower cooling rate allows more structure).
1.0	left	(all around the clock) Shady Grove Recreation Site – BLM ... The landscape around you might best be called the "land of the basalts." These massive Picture Gorge flood (lava) basalts are a subgroup of the extensive Columbia Plateau Flood Basalts, which cover over 100,000 square miles of eastern Washington, Oregon, and northern Idaho. You are on the southern edge of this huge area. The Columbia Plateau Flood Basalts were formed primarily about 17 to 12 million years ago, some as recent as 6 mya. The thickest point of all these basalt layers is near Yakima, Washington, the total thickness there reaching over 13,000 feet. The basalt layers cooled from molten lava, generally into two forms, which you can see in the layers along the river. The six-sided, straight columns are primarily due to a very slow cooling rate. The braided, twisted, small columns are a result of swifter cooling, taking on the appearance of shattered glass. Both forms are possible in the same lava flow layer, slow cooling below meeting quicker cooling above. If you head north you eventually rise above these basalts to the fertile wheat fields of OR & WA.
2.8	left	(3 o'clock) Haystack Valley Formation ... Along the road for the next mile are exposures of the buff-colored Haystack Valley Formation of the John Day Group. Excellent fossils of camels and pronghorn, among the first known in North America, have been found in these rocks. Zeolites (note the pastel green layers) are represented in these claystone strata, although never attaining

		the thickness of the similar tuffs in the Turtle Cove Formation. In this valley you have left a syncline and entered an anticline which has exposed the older rocks under the basalt layers.
0.8	road way	(3 o'clock) Junction with Oregon 207. Hardman and Heppner are to the north, on Rt 207. Continue on Rt. 19. You will soon enter the town of Spray.
3.8	left	(9 o'clock) John Day River interpretive wayside exhibit pull-off.
11.6	left turn	Turn left onto Oregon 207 and park after you cross the creek bridge. You are at the confluence of Service Creek with the John Day River. Across the river are scenic exposures of the Twickenham Basalt Formation flow unit of the Picture Gorge Basalt Subgroup. This particular flow is a porous, distinctive volcanic layer with small vesicles that contain crystals of exotic zeolites and other authigenic minerals.
0.4	right be-fore brdg	(11 o'clock) Look for the picturesque wall of basalts with mosses growing all over it. The wayside area you just passed on the left is a popular put-in spot for rafters and boaters of the John Day River. Nearby outfitters provide river recreation services.
2.1	right	(9 to 12 o'clock) Excellent views of slightly folded and faulted terrain toward the north and east as the road nears the top of these basalts.
1.2	left-after grd-rail	(10 o'clock) Across the canyon was the Steele energy well, drilled in 1984-85 to a depth of 6,400 feet, into the Clamo Group. The bottom of the well is in metamorphic greenschist and blueschist such as exposed just up the road at Meyer's Canyon (coming up ahead). Basalts exposed here near the drill site, in the center of the Donelly Dome (a huge rise in this entire area), are Clarno Group basalts. At 3 o'clock in the roadcut, notice the bright, brick red layer that separates two basalt lava flows. It was a soil layer formed from the lower flow over several thousand years, then was covered and baked by the newer, upper lava flow.
1.8	road way	(9 o'clock) Road to the old townsite of Richmond. Continue on route 207.
1.9	left	(3 o'clock) View of a structural downwarp known as Donelly Basin, with John Day Group (green) exposures noticeable below the basalt layers of the ridgeline. The agricultural land is primarily situated where Cretaceous marine shales surface.
1.6	left	(10 o'clock) View of Toney Butte to the south. It is a forty-million year old Oligocene volcano composed of upper Clarno Group flows and breccias.
2.4	drive way	(3 o'clock) Jumbled Beds ... Notice the obvious, jumbled, steeply inclined Turtle Cove fossil bed layers (greenish) across the valley. Angled Picture Gorge Ignimbrite (orange layers) top the beds. These "blue beds" form the northwest flank of a deeply eroded anticline. Clamo Group basalts make up the low hills to the east (4 o'clock).
2.7	rdwy	(3 o'clock) Junction with Gird's Creek Road to Twickenham. Stay on Rt. 207.
1.2	left	(9 o'clock) "Hoo-doo" outcrops of Gable Creek conglomerates. These conglomerates are similar in texture and content to some outcrops seen earlier (Goose Rock).
0.6	right &left	(8 o'clock) More channel conglomerates of the Gable Creek Formation. How old are these? (about the same age as the Goose Rock conglomerates)
2.8	right	(1 to 3 o'clock) These conglomerate-filled outcrops are remnants of ancient coastlines.
1.9	right	(4 o'clock) Meyer's Canyon. Permian metamorphics may be seen from here, but only with difficulty. Permian fuselinids occur in the marble, and are the oldest fossils in this part of the state, about 240 million years in age!
0.6	right &left	(12 and 1 o'clock) Ancient Volcanoes ... On the hill directly ahead (12 o'clock) is Bailey Butte, a prominent cap of the Clamo intrusive sill. There are also good views of White Butte (behind Bailey Butte) and Black Butte (1 o'clock, to the right), both remnants of Eocene volcanoes which surged through the conglomerates, shales, and other strata, severely deforming and, in places, metamorphosing those previously deposited rocks.

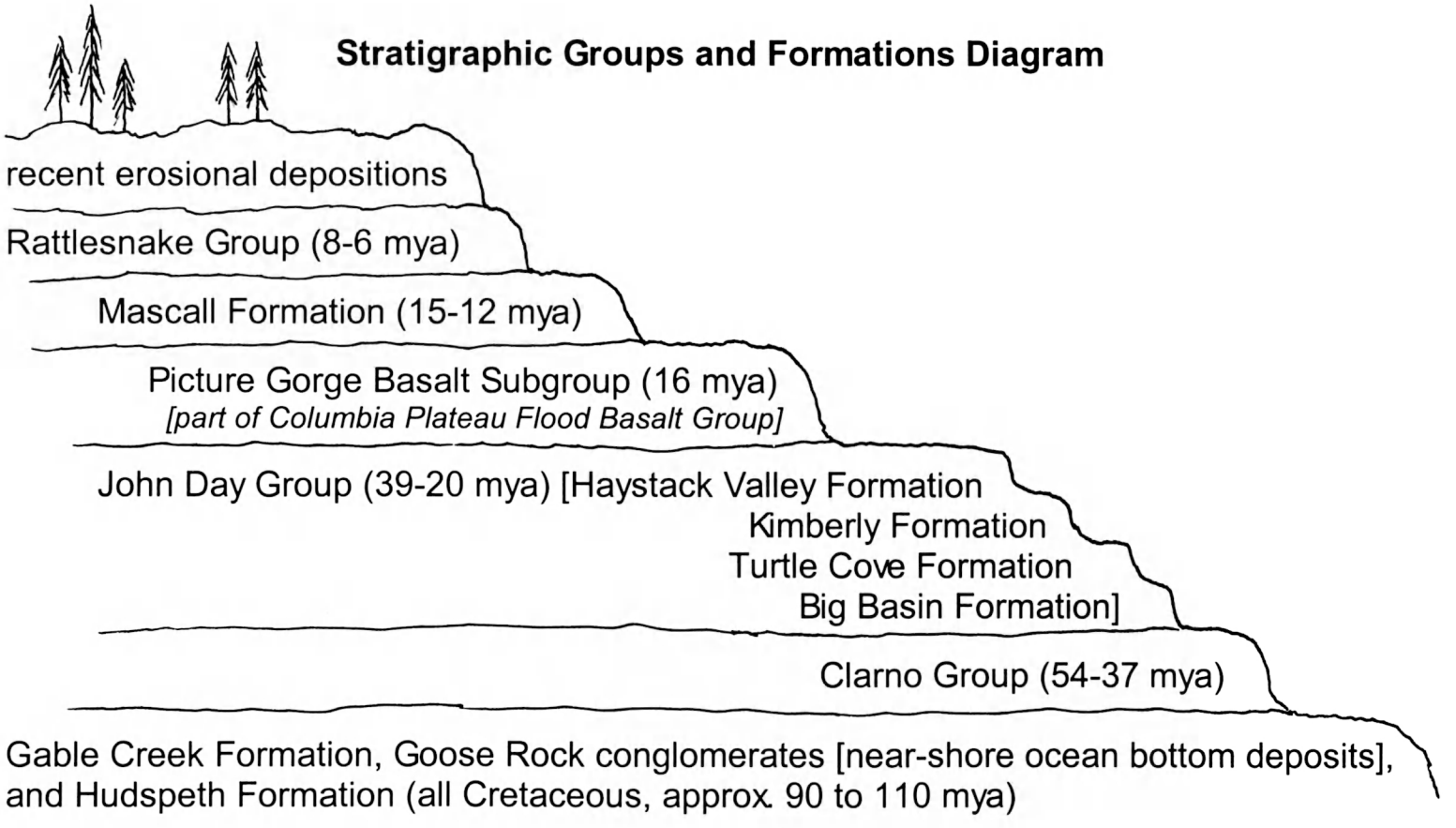
2.3	right	(9 o'clock) Note the evenly, rhythmically-bedded Hudspeth mudstones. Calcium-rich siltstones are interbedded with silica-laden silts in this roadcut. What would cause such periodicity?
.25	stop	Junction with Highway 26. Turn right to go to Painted Hills.
0.6	right	(1 o'clock) "Mitchell Rock," an intrusion of Clarno Group andesite, on this side of the highway. Mitchell Rock is the plug of a volcanic cone.
2.2	right	(all around the clock) Gable Creek exposure is throughout this roadcut.
0.5	turn	(3 o'clock) Turn right onto the road to the Painted Hills.
0.5	road way	(10 o'clock) To the west is a mottled hillside comprised of rhyolites and baked soils of the Clarno age (54-37 mya).
0.4	road way	(3 o'clock) In the roadcut on the right are (light colored) Clarno tuffs and ancient weathered lava. Many of these lavas must have been subjected to long periods of humid and hot conditions to develop such prominent laterites. Black Butte is directly behind you at 6 o'clock.
0.3	left	(9 o'clock) A Mammoth Site ... in 1988 a mammoth tusk (about five feet long and now on display in the Bureau of Land Management office in Prineville) was discovered and excavated from the contemporary gravel of an undercut stream bank to the left. This medium-sized "elephant" was here when the landforms looked much as they do today, but with much cooler temperatures. The vegetation, however, was much different than today.
0.4	road way	(3 o'clock) Exposures of Clarno basalts on your right, and ahead along the right side of the road.
1.2	road way	(3 o'clock) A John Day Basalt ... On your right is an exposure of the olivine basalt at the base of red hillside of the Big Basin Formation of the John Day Group. These basalts are about 31.5 million years old and were extruded through cracks about five miles south of here. This lava is chemically different from the Clarno basalts, with which it can be confused. Its magma source was completely different. Its composition shows a major change in the collision geometry of the Pacific and North American tectonic plates. Small outcrops like this one offer data about events on a far greater scale than one might suppose.
1.4	road way	(9 & 10 o'clock) To the left across the valley, faults displace the neatly bedded and colorful Big Basin Formation layers. Fault lines can be seen (look for a break and shift of layers).
1.4	left	(9 o'clock) Turn left into the Painted Hills Unit.
0.2	road way	(3 o'clock) The thick, reddish layer on the ridgeline is Picture Gorge Ignimbrite (28.7 mya), the same layer and event as the ignimbrite atop Cathedral Rock. It is not to be confused with the Picture Gorge Basalt Sub-group (16 mya - part of the Columbia Plateau Flood Basalts) which make up the series of layers atop the Sutton Mountain ridgeline (8 o'clock).
0.1	left	(3 o'clock) Intersection with road to picnic area, restrooms, and exhibits. Welcome to the Painted Hills!!! Be sure and drive to the viewpoint/overlook. This unit of the Monument has several short trails, with exhibits, you may wish to hike. The most popular is the Painted Cove Trail.

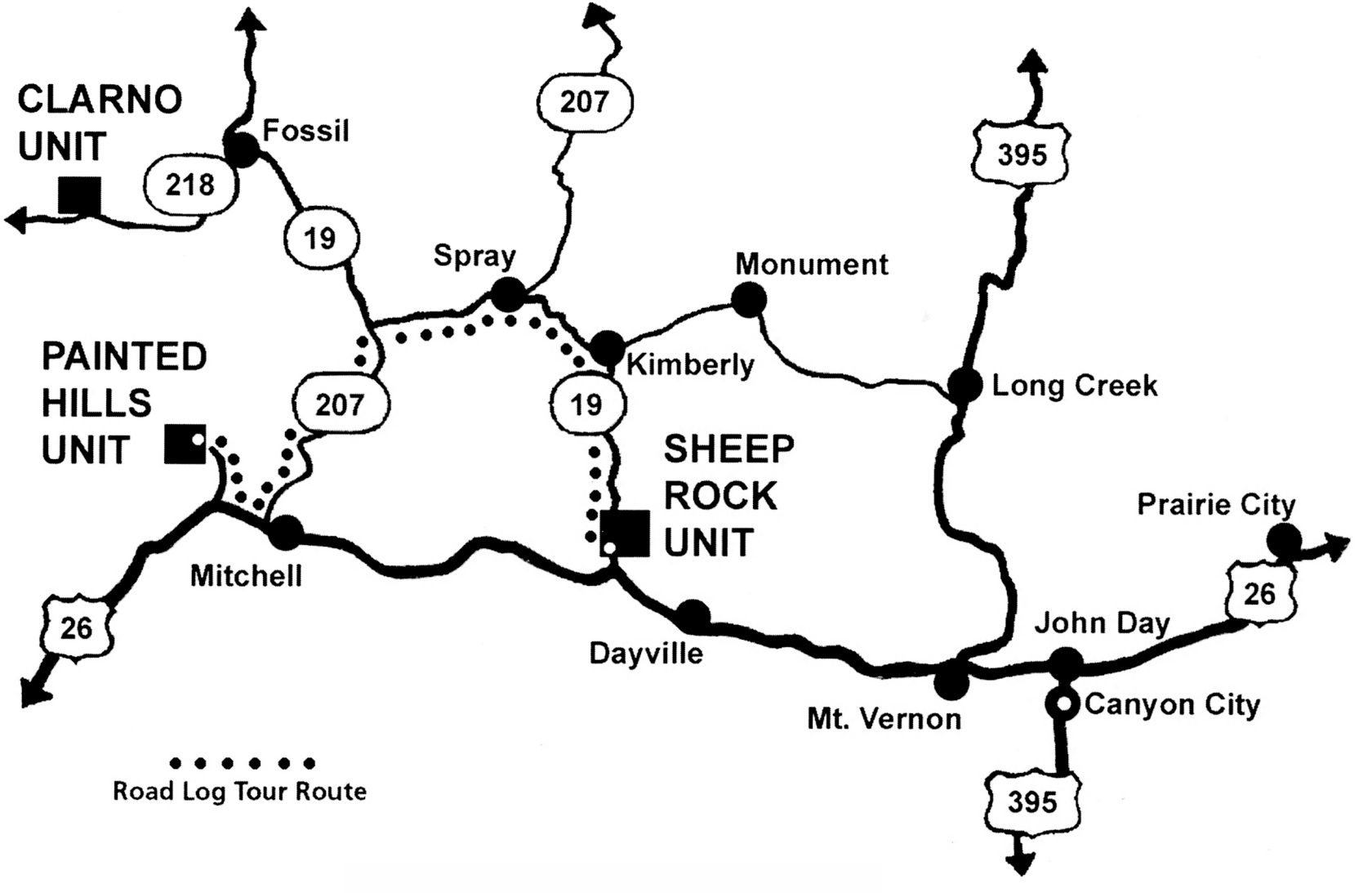
Glossary

anticline: An upward "n" fold in strata.
andesite: Volcanic rock containing mostly plagioclase (composition na al si o to ca al si o)
authigenic: Generated on the spot. Term applied to growth in place of occurrence.
breccia: Sedimentary rock of sharp angular fragments.
conglomerate: A sedimentary rock with pebbles cemented together by finer material.
Cretaceous: Time period from about 140 to 65 million years ago, end of the age of dinosaurs.

dike: Tabular body of igneous rock that cuts across the layers of adjacent rock, or cuts massive rocks.

formation: Formations possess certain distinctive or combination of distinctive lithic (rock fragments, not feldspar grains, are determining factor) features. Boundaries are not based on time criteria.
fusilinids: A fossilized single-celled marine animal.
group: A combination of formations (q.v.)
ignimbrite: Rock unit which developed from a pyroclastic cloud of super-heated volcanic material (much like a fiery tidal wave) which, after settling, welded together by its own heat.
K/Ar: Radiometric, potassium-to-argon gas, decay isotope age determination.
laterite: Soil profile leached of its aluminum, silica, and soluble materials but retaining oxides and hydroxides of iron.
liesegang: Rings or bands visible in the rock resulting from rhythmic precipitation in a gel.
member: Subdivision of a formation (q.v.)
metamorphic: Deformation in solid rock; by heat, pressure, or pronounced chemical action.
rhyolitic: Volcanic rock containing mostly feldspar (composition MAl(AlSi)O were M can be K, Na, Ca, Ba, Rb, Sr, and Fe; makes up about 60% of the earth's crust) and quartz (a mineral of SiO).
syncline: A downward "u" shaped fold in the strata.
type area: Stratagraphic section recognized as the standard, generally the one from which a stratigraphic unit received its name.
unconformity: Pertaining to an erosional contact where strata join discontinuously. Generally an obvious line between strata is visible, indicating the point of missing strata due to erosion.
vesicle: Small cavity in a mineral or rock.
zeolites: A group of hydrous aluminosilicate minerals, noted for their ease of ion exchange.

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