GRAND TETON GUIDE no. 6

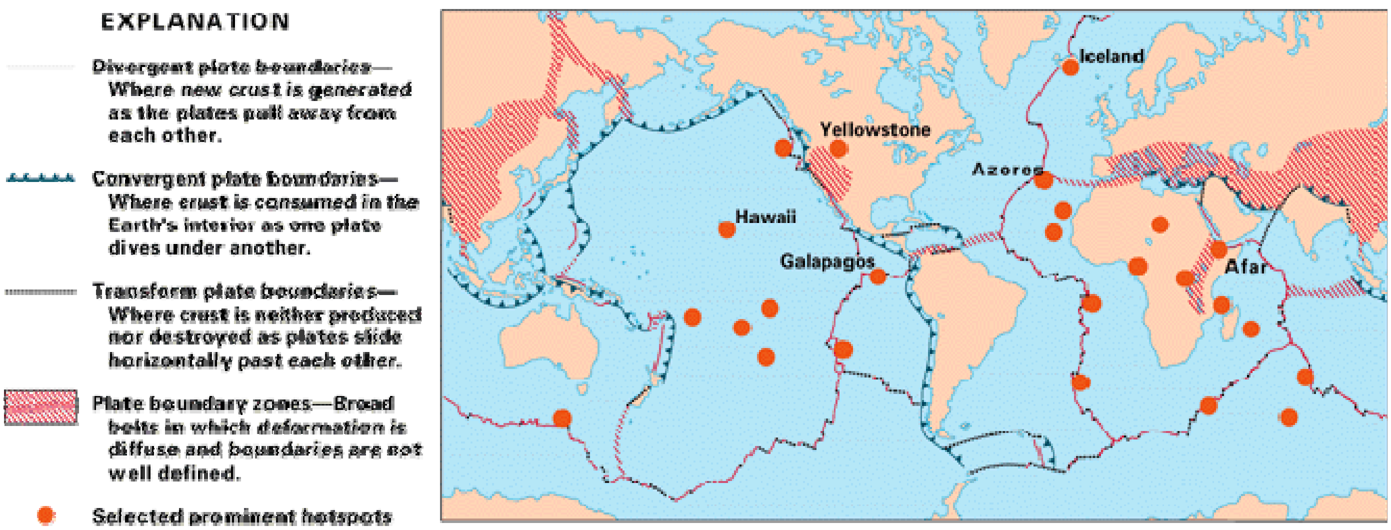
AN AMATEUR'S REVIEW OF BACKPACKING TOPICS

FOR THE

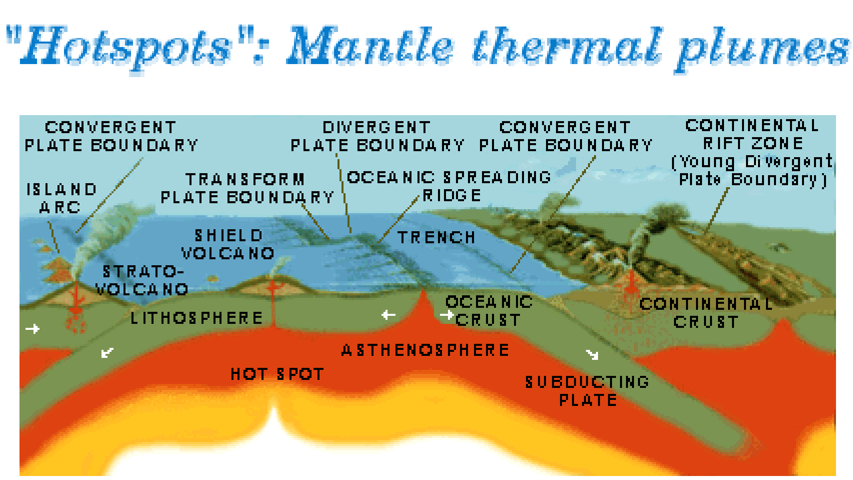
2008

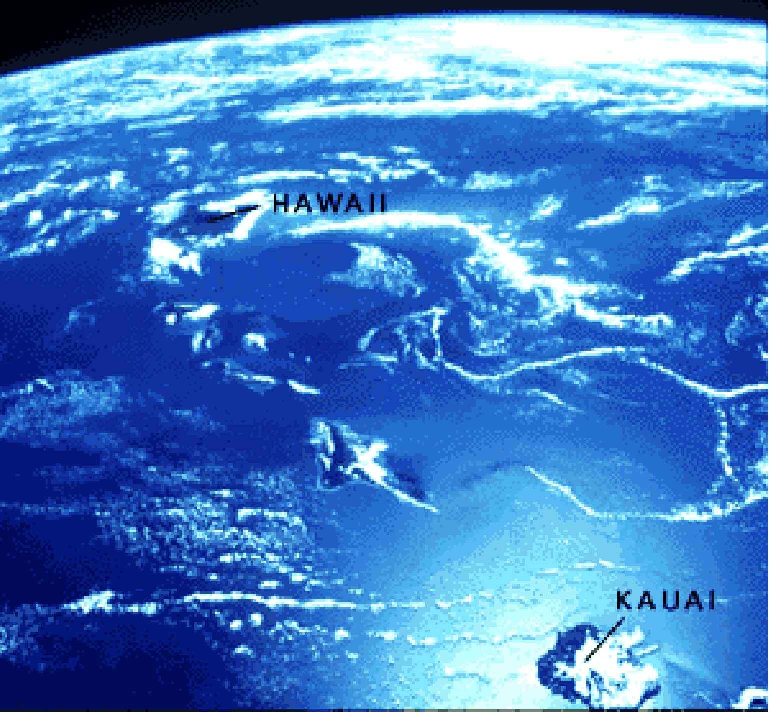
T254 EXPEDITION TO GRAND TETONS / YELLOWSTONE

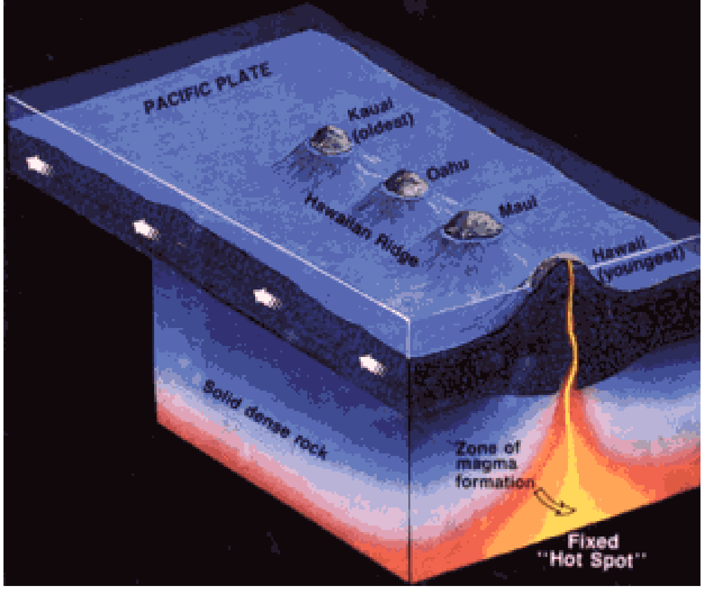
YELLOWSTONE GEOLOGY



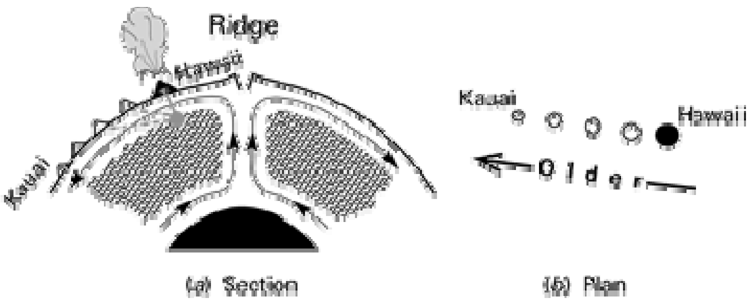
World map showing the locations of selected prominent hotspots. (Modified from the map This Dynamic Planet)



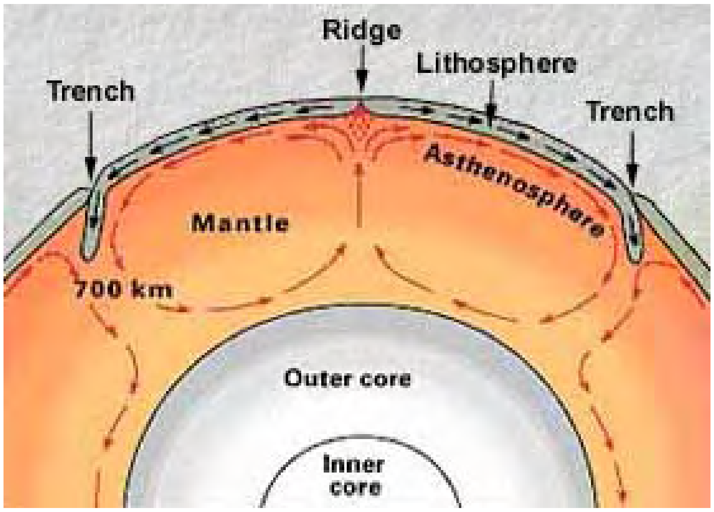




The distinctive linear shape of the Hawaiian Island-Emperor Seamounts chain results from the Pacific Plate moving over a deep, stationary hotspot in the mantle, located beneath the present-day position of the Island of Hawaii. Heat from this hotspot produced a persistent source of magma by partly melting the overriding Pacific Plate. The magma, which is lighter than the surrounding solid rock, then rises through the mantle and crust to erupt onto the seafloor, forming an active seamount.

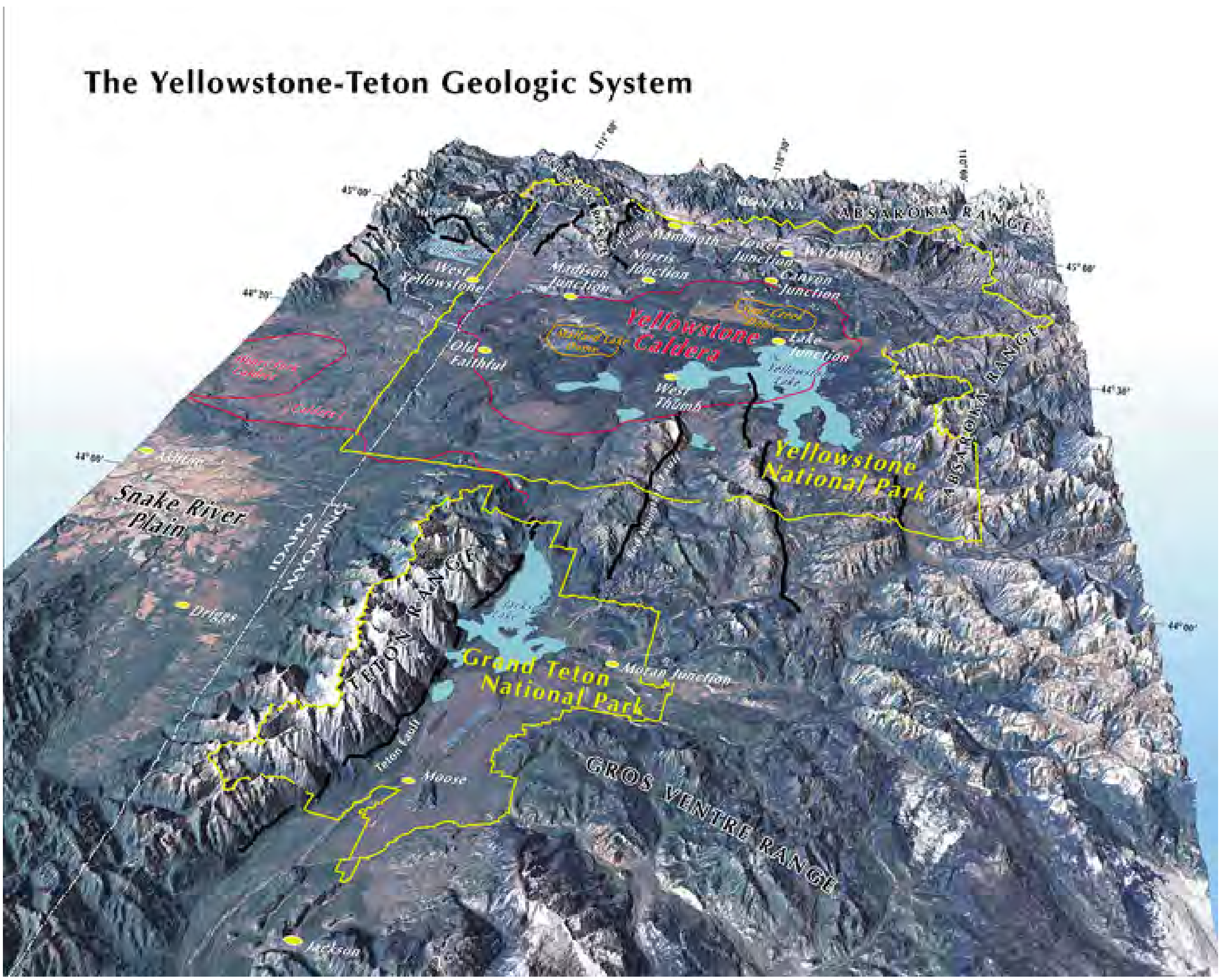


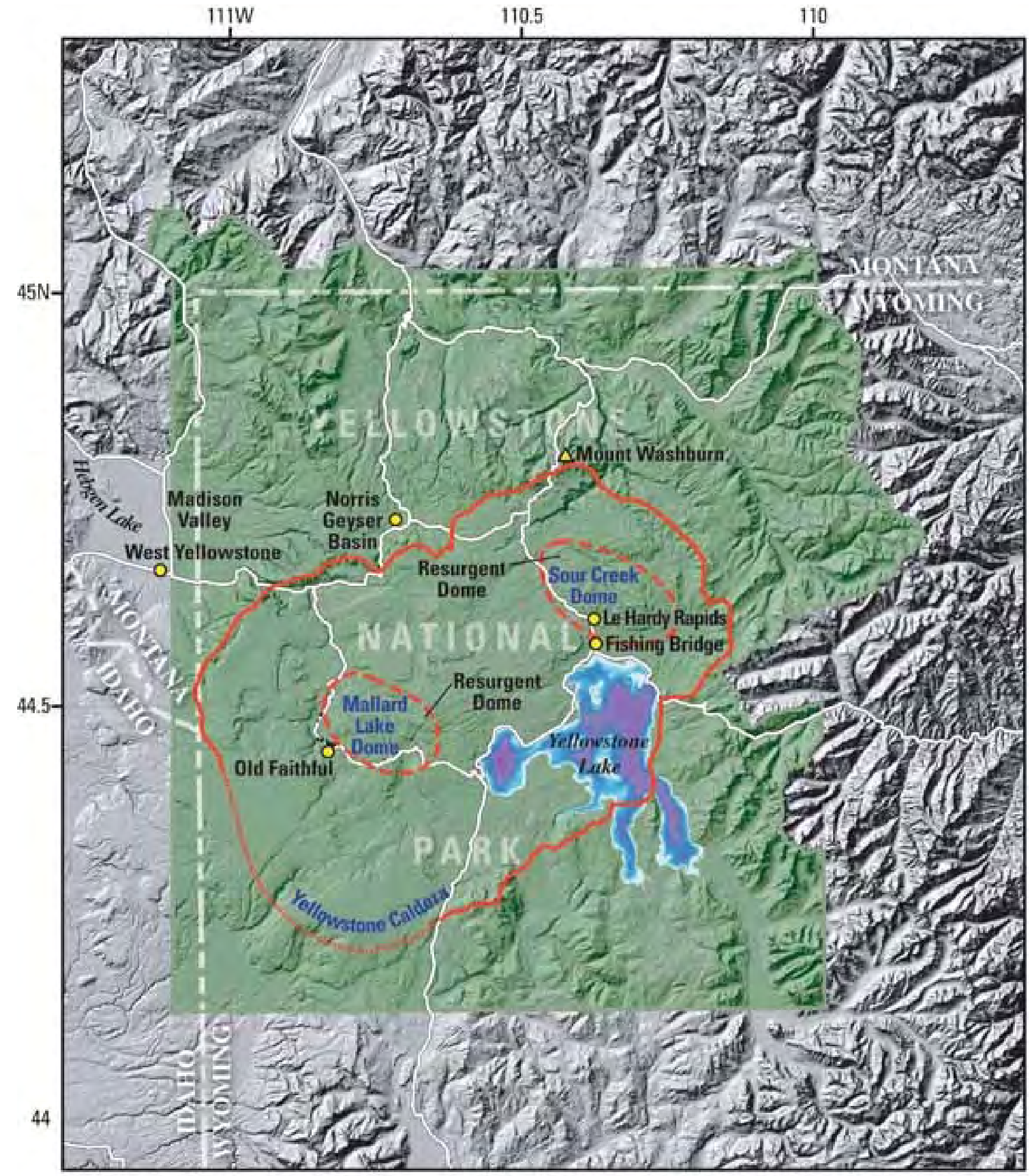
Over time, countless eruptions cause the seamount to grow until it finally emerges above sea level to form an island volcano. Continuing plate movement eventually carries the island beyond the hotspot, cutting it off from the magma source, and volcanism ceases. As one island volcano becomes extinct, another develops over the hotspot, and the cycle is repeated. This process of volcano growth and death, over many millions of years, has left a long trail of volcanic islands and seamounts across the Pacific Ocean floor.

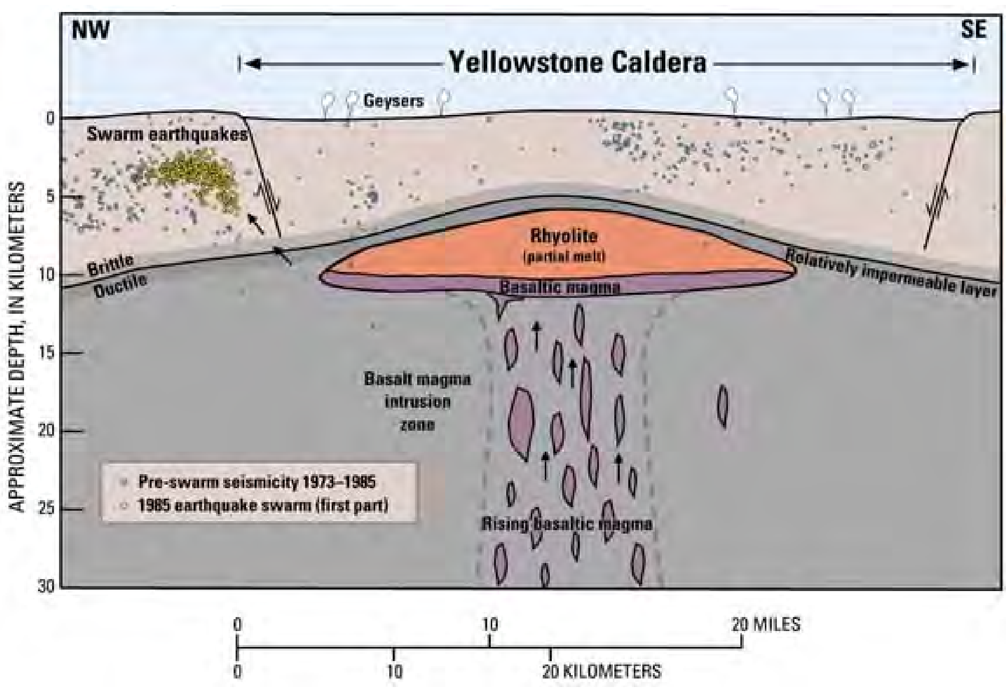


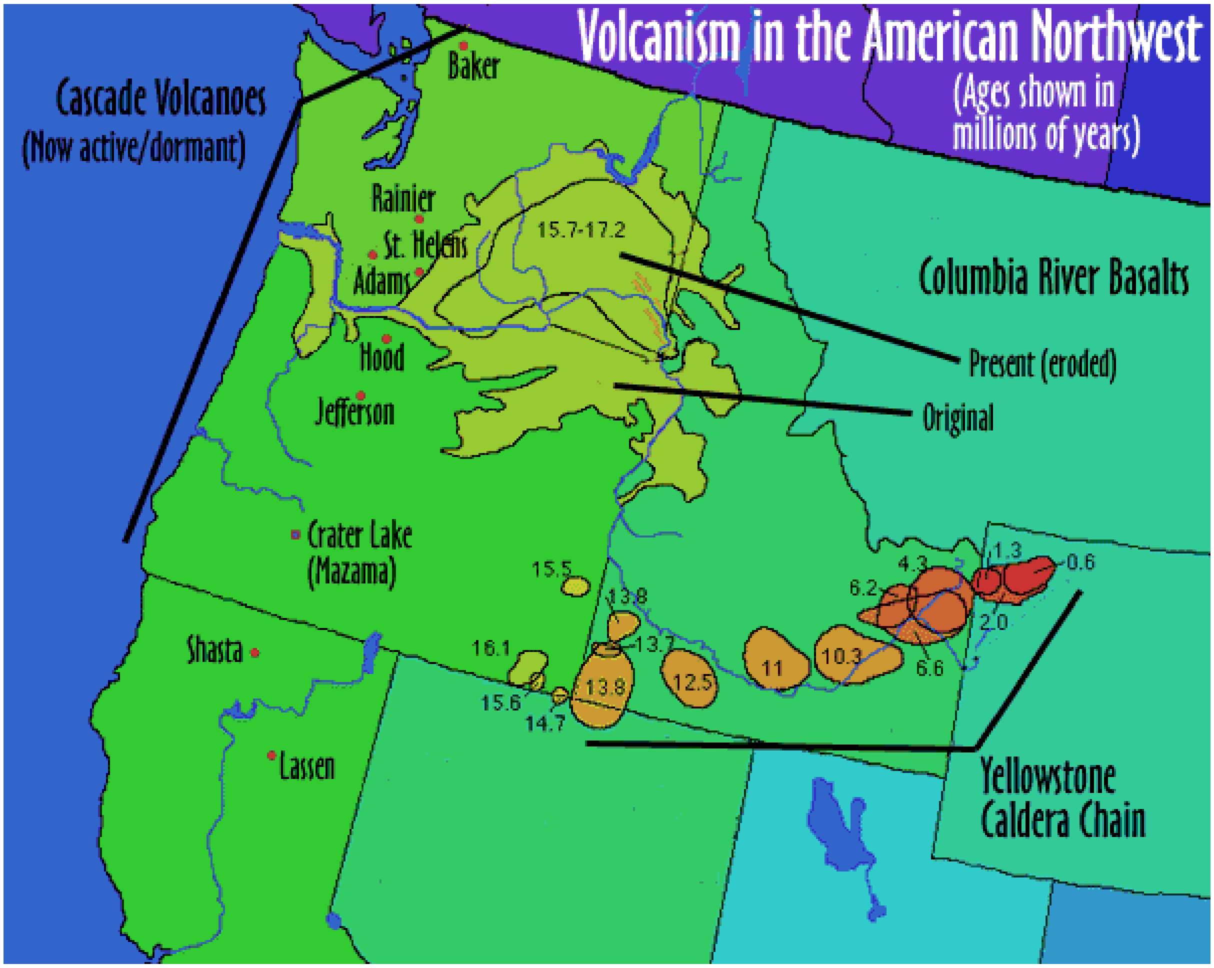
Although Hawaii is perhaps the best known hotspot, others are thought to exist beneath the oceans and continents. More than a hundred hotspots beneath the Earth's crust have been active during the past 10 million years. Most of these are located under plate interiors (for example, the African Plate), but some occur near diverging plate boundaries. Some are concentrated near the mid-oceanic ridge system, such as beneath Iceland, the Azores, and the Galapagos Islands.

A few hotspots are thought to exist below the North American Plate. Perhaps the best known is the hotspot presumed to exist under the continental crust in the region of Yellowstone National Park in northwestern Wyoming. Here are several *calderas* (large craters formed by the ground collapse accompanying explosive volcanism) that were produced by three gigantic eruptions during the past two million years, the most recent of which occurred about 600,000 years ago. Ash deposits from these powerful eruptions have been mapped as far away as Iowa, Missouri, Texas, and even northern Mexico. The thermal energy of the presumed Yellowstone hotspot fuels more than 10,000 hot pools and springs, geysers (like Old Faithful), and bubbling *mudpots* (pools of boiling mud). A large body of magma, capped by a *hydrothermal system* (a zone of pressurized steam and hot water), still exists beneath the caldera. Recent surveys demonstrate that parts of the Yellowstone region rise and fall by as much as 1 cm each year, indicating the area is still geologically restless. However, these measurable ground movements, which most likely reflect hydrothermal pressure changes, do not necessarily signal renewed volcanic activity in the area.




111W
110.5
110
45N
44.5
44
MONTANA
WYOMING
YELLOWSTONE
NATIONAL
PARK
Mount Washburn
Hebgen Lake
Madison Valley
Norris Geyser Basin
West Yellowstone
Resurgent Dome
Sour Creek Dome
Le Hardy Rapids
Fishing Bridge
MONTANA
IDAHO
Mallard Lake Dome
Resurgent Dome
Yellowstone Lake
Old Faithful
Yellowstone Caldera
IDAHO
WYOMING


NW
SE
Yellowstone Caldera
Geysers
Swarm earthquakes
Rhyolite
(partial melt)
Basaltic magma
Brittle
Ductile
Relatively impermeable layer
Basalt magma intrusion zone
Rising basaltic magma
Pre-swarm seismicity 1973–1985
1985 earthquake swarm (first part)
APPROXIMATE DEPTH, IN KILOMETERS
0
5
10
15
20
25
30
0
10
20 MILES
0
10
20 KILOMETERS


Volcanism in the American Northwest
(Ages shown in millions of years)
Cascade Volcanoes
(Now active/dormant)
Baker
Rainier
St. Helens
Adams
Hood
Jefferson
Crater Lake
(Mazama)
Shasta
Lassen
Columbia River Basalts
15.7-17.2
Present (eroded)
Original
15.5
13.8
16.1
13.7
15.6
14.7
13.8
12.5
11
10.3
6.2
4.3
6.6
1.3
0.6
2.0
Yellowstone
Caldera Chain

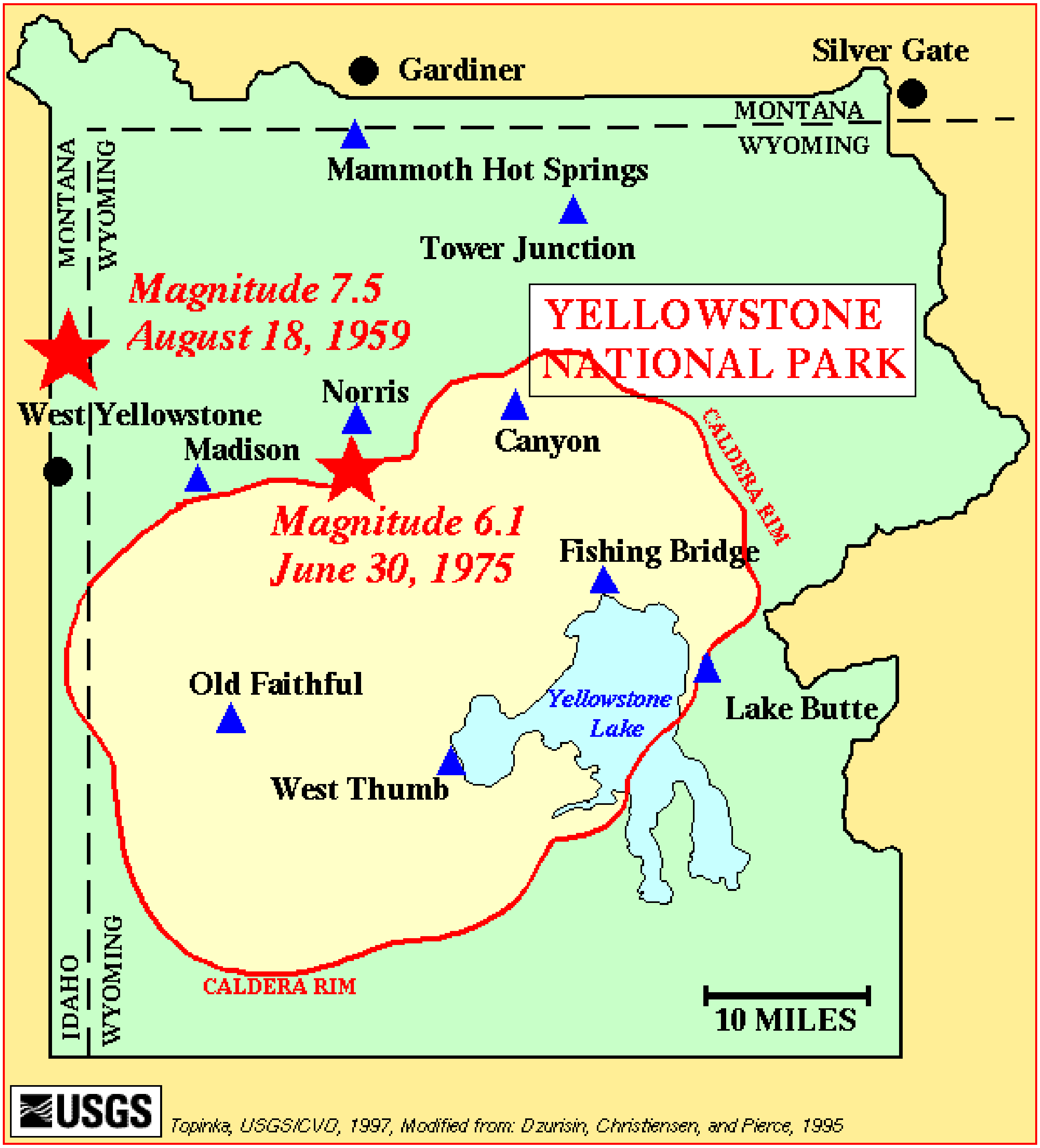


Figure 10n-7: Map of the location of the Yellowstone caldera. Several large earthquakes have occurred in the last century in the vicinity of the caldera indicating that significant volcanic activity is occurring beneath the ground surface. (**Source:** *U.S. Geological Survey* - Yellowstone Volcano Observatory).