Volcanic Domes

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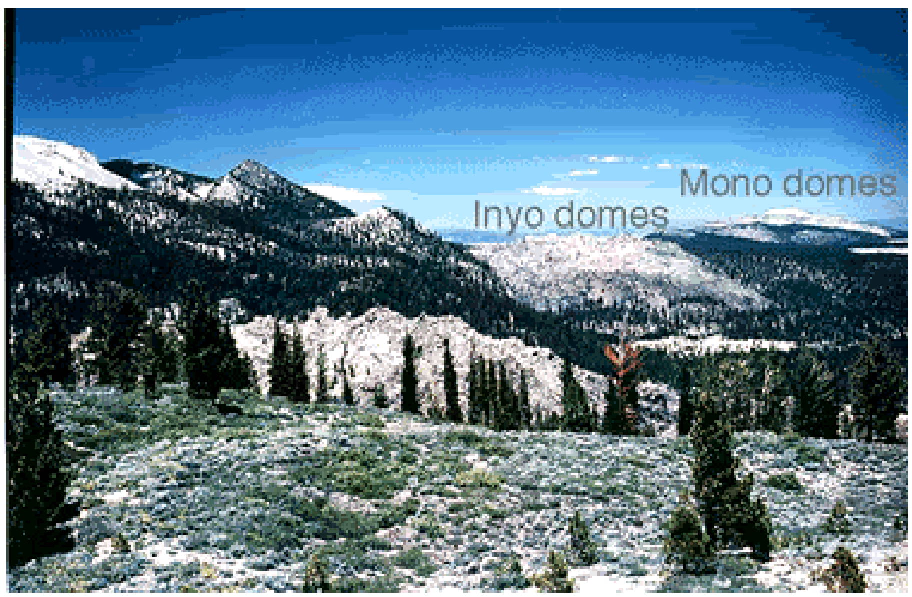
Volcanic activity has been affecting the California area and others for millions of years. However, the main activity that has shaped the landforms that can be seen today began anywhere from 650,000 to 750,000 years ago. Affected initially by plate tectonics, the volcanic activity eventually lead to the formation of domes, among many other features.



View (facing north) of South Glass Creek and North Glass Creek domes and Mono Craters ("Long... California").

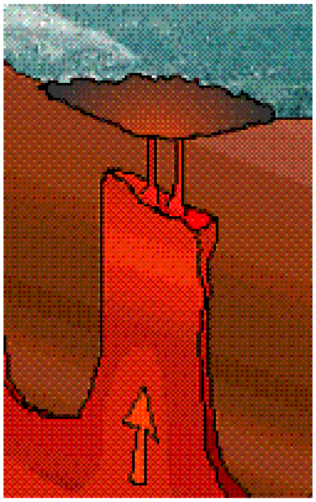
Basics of Volcanic Processes Relevant to the Domes

Volcanoes usually occur at the boundary between two plates. While the volcanism that occurs in Eastern California is not directly at the boundary between two plates, it is still greatly affected by plate tectonics. The subduction of plates under the North American Plate induced volcanic activity. The high proportion of water and carbon dioxide in the magma in addition to slightly lower eruption temperatures leads to explosive eruptions in subduction volcanoes (Decker 89). The need for gas to escape combined with the cooler, more viscous magma results in volcanic ash being released in an explosive eruption (Decker 89). The eruption generally begins with explosive ash and lumps of pumice and ends with lava flows which are usually thick and viscous (Decker 90). This trend, however, can vary for individual volcanoes in different areas.

There are many different shapes and types of volcanoes that are determined in part by the viscosity of the magma. The molten rock that occurs beneath the earth's surface, magma is produced as the spreading and sinking plates interact with other materials in the earth's layers (Keller 206). Magma that has emerged above the earth's surface is called lava. Shield volcanoes typically have magma with a relatively low silica content (about 50 %) which leads to a generally non-explosive eruption (Keller 206). Composite volcanoes have magma with an intermediate silica content (around 60%) which results in a combination of both explosive activity and lava flows (Keller 208). A third type of volcanic landform is the volcanic dome.

Formation of Volcanic Lava Domes

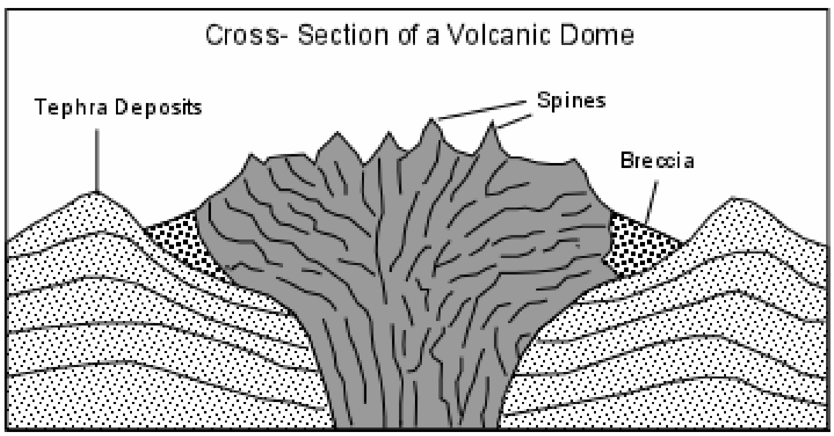
Of the landforms produced by lava emissions, domes are the smallest and rarest and are also the most easily recognizable (Scarth 154). Domes are fairly young and form quickly, geologically speaking, compared to volcanoes of similar size (Williams 193). Volcanic domes are characterized by magma with high a silica content (70%) and that is extremely viscous (Keller 209). The eruptions are usually explosive, making them dangerous (Keller 209). Formed in the open air, domes develop when the lava is too viscous to flow and accumulates and solidifies as a bulbous mass as it emerges from the vent (Scarth 159). In addition to the viscous lava, the temperature also affects the formation of the dome and is usually relatively low, for a volcanic eruption, at around 900°C to 750°C (Scarth 154). The flow rate of the lava erupted is also affected by the steepness of the ground from which is being exuded ("Lava… Effects"). Typically the dimensions of a volcanic dome do not exceed 250 meters high and one kilometer broad (Scarth 154).



Lava eruption forming a volcanic dome ("Eruptions… Area").

As with volcanoes in general, domes can form in a variety of different shapes. Dome shape can vary from rounded and well formed to narrow and barely larger than the vent from which the lava was exuded (Scarth 154). The viscosity of the magma affects the steepness of the sides of the dome and the ratio between diameter and height

(Williams 190). One type of dome is the upheaved plug, which is formed as a steep-sided column from extremely viscous lava and is present in the Panum Plug of the Mono Craters in California (Williams 189). Another type of dome is peléan dome which has a much larger diameter and is characterized by a fractured top with blocks of rocks on top and around the dome (Williams 190). Spines are slender columns that can occur at the top of domes (Williams 190). The obsidian dome is very common in the Mono-Inyo area of California.



Cross-section showing the different parts of a volcanic dome (Nelson).

The structure of the obsidian dome consists of a few parts that were formed at different times in the development and formation. There is often an outer rim to the dome that consists of fine ash and lapilli, small volcanic fragments (Hill 118). The core is made of black, glass obsidian while the top my be a brownish color (Hill 118). As the dome grows, the top becomes covered in blocks of sharp-edged glass (Fisher 45). If the lava is extremely viscous, it is not able to spread out and forms a narrow, nearly vertical piston (Scarth 155). These rugged surfaces with blocks and pinnacles are actually more common than the relatively smooth surface of some domes (Scarth 156). Piles of rubble are formed as pieces break off as the dome rises and when weathering occurs (Hill 118). If the dome is on a steep surface, the pieces will fall due to gravity and can possibly form pyroclastic flows or volcanic materials (Fisher 46). Gravity also affects the shape of domes consisting of less viscous lava by flattening them out or elongating them down slope (Scarth 158).

Volcanic Rocks in Domes

Different types of volcanoes not only have different shapes, but also have different chemical compositions. Depending on the silica content, the igneous rocks formed can be anywhere from basaltic to rhyolitic (Scarth 154). Because the domes develop from very viscous lava, they are usually composed of rhyolite, dacite, andesite, or trachyte (Williams 197). The domes in the Mono-Inyo area typically contain rhyolitic rocks. Rhyolite, which has a 70-78% silica content, contains more sodium and potassium than some of the other rock types (Decker 145). Rhyolite also contains less iron, calcium, and magnesium; because these minerals generally lead to a darker color, their absence helps explain the light color of rhyolite (Decker 145). The major exception to this is obsidian, a form of rhyolite that is generally a black to brown glass that can sometimes contain streaks or bands (Decker 145).

Having the same chemical composition as rhyolite, the appearance of obsidian is determined by other factors. The black color comes from the iron in the rock being finely dispersed and then reflected by the glass of the obsidian (Decker 146). In addition, because it has an fast cooling time, the magma that makes up obsidian has no time for crystals to form (Lye 108). The high viscosity of the magma slows the crystallization process and causes the rocks formed to be more glassy in appearance (Decker 146). Because obsidian has this make-up, when broken it will have a conchoidal fracture (Lye 108). A conchoidal fracture is curved and somewhat resembles a sea-shell (Lye 25).

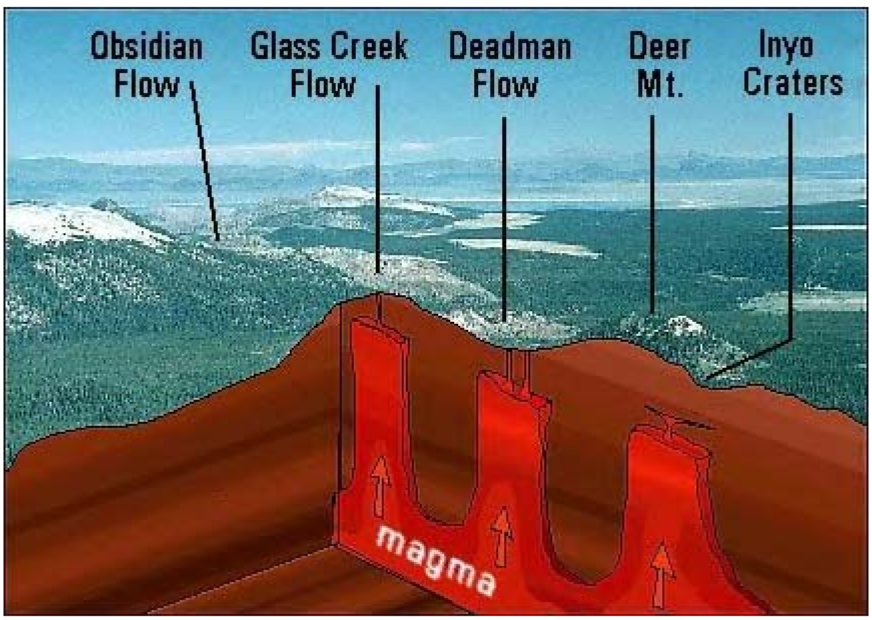
Obsidian (VolcanoWorld).

Obsidian can only be found in areas where volcanic activity has occurred fairly recently in geologic time (Pough 15). Over time, obsidian will gradually start to crystallize or will decompose from the intake of moisture (Pough 15). Therefore, in the geologic sense, obsidian cannot be very old.

Pumice is another rhyolitic volcanic rock that is similar in composition to obsidian and is also found in domes. Because pumice is formed from frothy lava, the high gas content causes the rock to be extremely porous (Lye 108). While pumice is also glassy like obsidian, it usually maintains the typical gray color of rhyolites (Lye 108).

Domes in the Mono-Inyo Area of California

While volcanic activity in the Mono-Inyo area of California has occurred for hundreds of thousands of years, the volcanic domes have formed in the more recent geologic history. Rhyolitic volcanism began in the Mono Crater area around 35,000 years ago ("Long… California"). The domes in the Mono and Inyo areas, however, were formed as recently at 600 years ago (Camp). The flows that formed the domes in this area occurred after an explosive eruption of pumice and ash ("Eruptions… Area").



The molten rock beneath the earth's surface in the form of a dike. This magma fed the eruptions that formed the flows and domes in the Inyo area ("Eruptions… Area").

The domes in the Mono-Inyo area are formed out of obsidian, much like many other domes. The eruptions in the area were very silica rich, thus forming types of rhyolite (Scarth 160). Because the lava cooled quickly, it took the form of obsidian. When the lava was contained more gas, pumice was also formed.

Glass Creek Flow

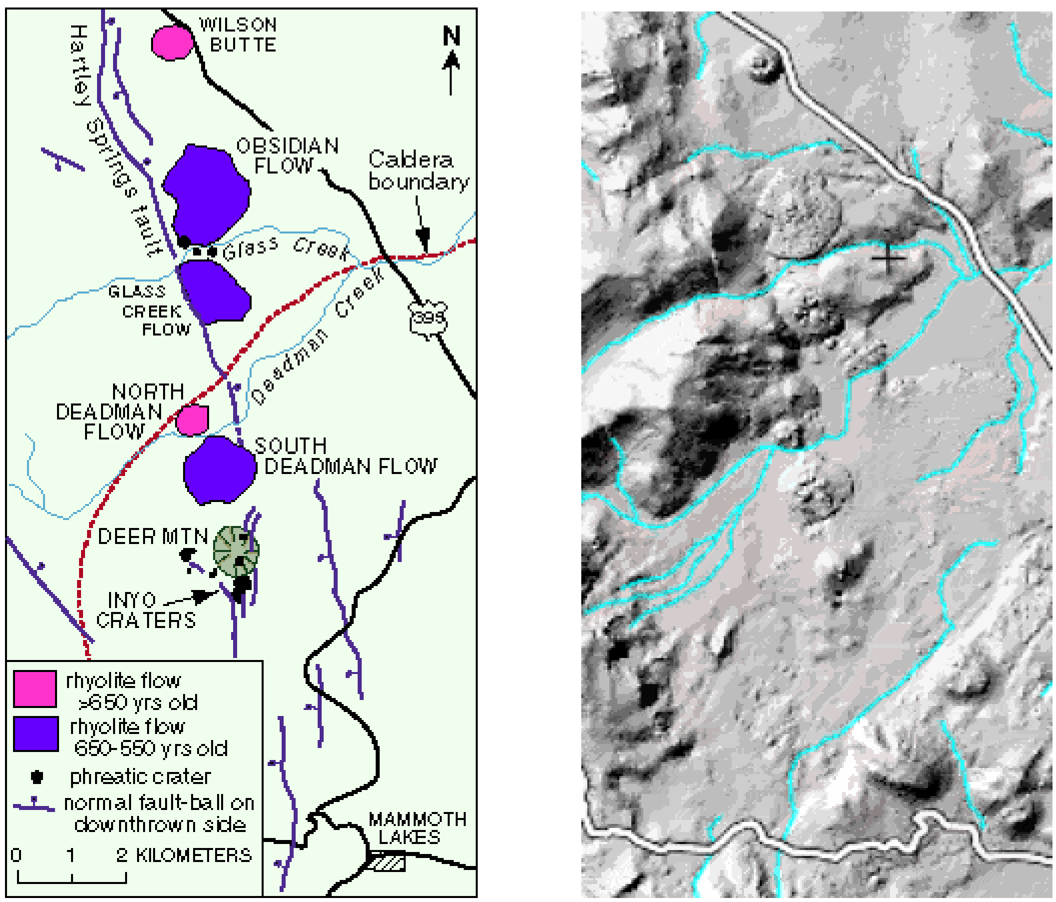
South Deadman Flow

("Eruptions… Area")

The most easily recognizable domes in the area are the three large circular shaped domes of Glass Creek Flow, Obsidian Flow, and South Deadman Flow ("Eruptions… Area"). These flows and the domes that they formed were part of the eruptions that occurred 600 years ago in the Inyo area.

Obsidian Flow ("Eruptions… Area").

While the domes are beautiful to look at and are presently dormant and not erupting, they are still part of a chain of volcanic activity and remain under observation. The USGS keeps a record of observations made about the domes and other volcanic landforms in the area in order to predict further activity.



Map and relief of the Inyo domes, chains, and faults that were formed 600 years ago. ("Eruptions… Area").

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