# Plutons – Tutorial Script

**Magma** is molten rock below the surface. **Lava** is molten rock above the surface. **Igneous rocks** are rocks that form from the solidification of this molten rock.

**Magma chambers** are areas in the crust where magmas can accumulate and potentially reside for long periods of time. Magmas in these chambers can erupt at any time – usually when new magma rises under them and pushes them out. Occasionally when magmas move through the crust, they can break up pieces of the surrounding rock. If these pieces fall into the magma and don't melt, we can see them later as preserved foreign rocks inside a lava or cooled magma underground. We call these foreign rocks **xenoliths**.

Igneous rocks formed through eruption are referred to as **extrusive or volcanic**. Igneous rocks formed through cooling underground are referred to as **intrusive or plutonic**. How can you recognize the difference just by looking at the rock today? When rocks form underground, they have a longer time to cool, so they will form larger interlocking crystals. When you pick up a rock that has 100% visible interlocking crystals (the texture known as phaneritic), you know that you're looking at an intrusive igneous rock. The opposite – most of the crystals are too small to see (aphanitic) or no crystals (glassy) – means the rock must have erupted and cooled quickly. What are some other features associated with eruption? Pyroclastic rocks are made from pieces of material thrown from a volcano – so by definition these would be extrusive. And whenever you have vesicles, holes in the rock left by escaping gases, you know you were at Earth's surface as only here is the pressure low enough for the gases to escape while the rock is cooling and solidifying around the escaping gas.

Let's go back to intrusive igneous rocks and dive deep into the crust below a volcano. We can further classify igneous intrusions by the shape of the bodies they form as they solidify. We call these bodies collectively **plutons**. If the cracks that form and along which the magmas move are between existing horizontal rock layers, we call the solidified magma pluton a **sill**. Sills are tabular in shape and 5-30 meters thick. They can look very similar to the rock layers above and below and are identified in the field by their chilled margins on both their tops and bottoms and their age being younger than the layers into which they intruded. If the cracks that form and along which the magmas migrate cut across existing rock layers, we call the solidified magma pluton a **dike**. Dikes are also tabular in shape, but they appear more as a very thick vertical or near-vertical wall of rock, 0.5 to 30 meters thick. When the magma at depth pools and cools in a large magma chamber that is massive and bulbous in its shape and many hundreds of meters thick, cutting through and across many rock layers, the solidified magma pluton is called a **batholith**. Where these magma chambers intersect across a chain of active volcanoes, like at subduction zone volcanic arcs, we can be left with a batholith that can be hundreds of kilometers long. Such a batholith exists in the Sierra Nevada mountains of California, which used to be an active subduction zone volcanic arc that ended its active volcanism about 80 million years ago. Since then, the mountains have been uplifted and eroded exposing the rocks that lay underneath – the plutons – the largest of which is referred to as the Sierra Nevada batholith and connects the old magma chambers that would have been strung along the volcanic arc. So when we hike today in the Sierra Nevada, we are hiking on the exposed underbelly of ancient volcanoes – the old magma chambers, now solidified and exposed through erosion.

For more information and more detail, continue on to the next video in this series.

**<u>Igneous Rocks Series:</u>**
Part I: Igneous Rocks
Part II: Plutons
Part III: Magma Viscosity

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