Earth Revealed VIDEO #14: Intrusive Igneous Rocks

This assignment can be found at: http://www.learner.org/resources/series78.html

0:00-1:18 Remarks by series host

Volcanic activity is very common, but lava makes up only a tiny portion of the magma found in Earth. Explanation is presented concerning where and why rocks melt. Most magma does not extrude onto Earth's surface but cools slowly deep inside Earth. This magma either seeps into voids and fractures in Earth's crust or is forced upward and intrudes into cooler rocks above as huge globs where it slowly cools forming **(01)** ________ rocks.

1:19-2:28 Images

Background information is given on the debate between **(02)** ________ and Abraham Wemer about rock formation. Images of an intrusion cutting strata support James Hutton's idea. Hutton believed the granite must have been injected into the strata as a molten liquid. Hutton made a link between granites formed at depth and the quickly cooling deposits of erupting volcanoes. This connection is explained with images superimposed on a lava pool. Hutton helped geologists to recognize a new class of "fire-formed" or **(03)** ________ .

2:29-3:14 Interview with David Sigurdson, California State University, Dominguez Hills

Some of the heat that results in the formation of magma came from Earth's original formation. As the materials that formed Earth came together; they produced an enormous amount of compression. This occurred some 4.5 billion years ago. Also, heat has been generated from the decay of **(04)** ________ contained in Earth's interior. Animation is used to show .how **(05)** ________ of the sun and moon could work together to generate heat inside Earth.

A. igneous rocks	**B. intrusive igneous**	**C. James Hutton**
D. radioactive isotopes	**E. tidal effects**	

Earth Revealed VIDEO #14: Intrusive Igneous Rocks

3:15-6:05 Animation • Images • Remarks by series host

Magma that cools underground forms into **(06)**______, sometimes called plutonic, rocks. Magma that reaches Earth's surface and cools forms **(07)**______ or volcanic rocks. Igneous rocks that contain abundant iron and magnesium are called **(08)**______ rocks by geologists. If igneous rocks contain abundant silica and aluminum, geologists call them **(09)**______ rocks. An example of an intrusive mafic rock is gabbro and an example of an intrusive felsic rock is granite. Igneous rocks can also be mixtures of felsic and mafic compositions. These are known as the **(10)**______ or andesitic igneous rocks. An intrusive example is diorite.

A. Extrusive	**B. Felsic**	**C. Intermediate**	**D. Intrusive**	**E. Mafic**

(11)______ (intrusive) and **(12)**______ (extrusive) samples are compared by images and explanation. Rocks compared are granite-rhyolite, gabbro-basalt, and diorite-andesite. Images of obsidian and then granite are used in close-up to illustrate the concepts of **(13)**______ or cooling and crystal size. Images are used to explain the cooling process of igneous rocks. The manner in which speed of cooling affects **(14)**______ size in igneous rocks is explained. An outcrop of intrusive igneous rock is used to show how the cooling rate of different parts of the intrusion can be studied. Footage of crystals growing with insets of granite and rhyolite are used to help explain how each of these **(15)**______ form.

A. Crystal	**B. Plutonic**	**C. Quenching**	**D. Rocks**	**E. Volcanic**

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6:06-8:03 Interview with J. Lawford Anderson, University of Southern California (with images)

Whenever igneous rocks form at depth, they cool very slowly forming large crystals. Rocks that form in this way are said to display **(16)** ____ texture. Other igneous rocks cool at Earth's surface, undergoing rapid crystallization, forming small crystals or an **(17)** ____ texture. Even faster cooling allows no crystals to form at all producing **(18)** ____ or obsidian. Reading the texture of a rock tells what conditions under which the rock formed. Images of thin sections are used to show that a study of crystals can lead to an understanding that not all crystals in a magma form at the same time. Early-forming crystals of plagioclase or olivine preserve symmetrical shapes as if they formed in a liquid. Later-forming crystals such as potassium feldspar and quartz have irregular shapes, indicating they formed last in small compartments of liquid confined in spaces between earlier-formed crystals.

8:04-10:44 Interview with David Sigurdson (with animation and images)

The manner in which magma **(19)** ____ is called **(20)** ____. As magma cools, early-forming minerals react with the magma to form new minerals. Some minerals react continuously, constantly undergoing change, whereas other minerals react discontinuously, reacting only at certain specific temperatures. Animation is used to show the types of minerals, the reasons for their formation, and the temperatures at which they form in the continuous and discontinuous portions of the reaction series, as well as the low-temperature minerals that form last. The effect of water content on the melting point of magma is also explained. By showing that lava crystallizes in a piecemeal fashion, Bowen provided an explanation as to why plutonic rocks contained so many different types of crystals and volcanic rocks so few.

A. Aphanitic	**B. Bowen's Reaction Series**	**C. Crystallizes**
D. Phaneritic	**E. Volcanic glass**	

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10:45-12:26 Interview with David Sigurdson • Animation • Remarks by series host
In addition to explaining how minerals form as a magma crystallizes, Bowen's Reaction Series also explains the processes of **(21)** ______ and magma separation. Bowen's work explains how many different types of igneous rocks can be formed from the same magma. He felt that all magmas originated as basaltic and then changed by differentiation. Early-forming minerals became separated in some way from the magma thus allowing for a different composition to evolve for the magma. This shows the evolution of magma from basaltic to felsic in composition. Animation is used to show differentiation processes that caused layering in some intrusions. Mafic minerals formed first and settled out leaving only felsic minerals to crystallize in the upper part of the intrusion. Processes that cause a magma to form are usually tied to the movement of tectonic plates.

12:27-17:05 Interviews with J. Lawford Anderson; Dee Trent, Citrus College; David Sigurdson (with animation and images)
Animation shows a model of a spreading center with moving plates. The relationship of igneous activity to **(22)** ______ is explained. The reasons for ocean crust being basaltic in composition are explained. Also, the manner in which **(23)** ______ and partial melting of subducted ocean crust affect the compositions of lava forming **(24)** ______ along the rim of fire surrounding the Pacific Ocean is presented. Particular types of magma are associated with specific types of plate boundaries. The reasons for ocean floor volcanoes being basaltic and volcanoes at subduction zones being more andesitic are given. Animation shows an Earth model, then zooms in on a convergent boundary showing a cross-sectional view of the subduction of oceanic lithosphere. As ocean crust subducts, partial melting of the basalt causes a magma to form. Animation is used to show the less-dense magma being forced upward toward the surface. The manner in which the composition of the rising magma is changed is also shown by the animation. Further animation shows how many different compositions of magma can form along a subduction zone. Sometimes the silica-rich felsic magma of higher **(25)** ______ cannot easily move up to the surface to erupt.

A. Differentiation B. Plate tectonics C. Subduction zones D. Viscosity E. Volcanoes

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17:06-21:44 Images • Animation • Remarks by series host

When felsic magma cannot reach the surface, it may lodge in the crust, cool, and solidify forming a pluton. __**(26)**__, huge masses of igneous rock, form when continental crust and sediment partially melt because of the heat of rising mafic magmas. The molten continental crust cools to form granite, one of the most characteristic rocks of convergent plate boundaries. Magma is forced upward from Earth's interior because it is buoyant, less dense than rock material surrounding it. Animation is used to show how this process occurs at divergent plate and convergent plate boundaries. Magma may also fracture overlying __**(27)**__ through a process called __**(28)**__ The formation of xenoliths is explained. Animation is used to show and classify intrusive igneous rock bodies. Various types of igneous intrusions—dikes, sills, laccoliths, and plutons, which are also called stocks, and batholiths—are identified and explained. A batholith can be composed of many plutons that have risen together A lava lamp is used to help show movement of plutons inside Earth. When rocks inside Earth melt, the magma is forced upward because it is less dense than surrounding rock. As magma bodies rise through Earth, they expand and join together producing very large intrusive igneous rock bodies. When erosion uncovers these igneous masses, they can produce very large mountain ranges. Batholiths, such as Sierra Nevada Batholith, help geologists understand the tectonic history of Earth. Explanation of how the Sierra Nevada Batholith formed and what it tells geologists is presented.

21:45-25:03 Interview with David Sigurdson (with images)

Images are used to show how certain types of minerals tell a great deal about Earth's interior, early history, and process of __**(29)**__ . Samples of komatiite indicate Earth's interior was once much warmer than it is today. Samples of anorthosite, rare on Earth's surface, have been found to be rather common on the moon. This may indicate that Earth and the moon may once have been much closer to each other in composition. Earth's interior heat, however, allowed the planet to continue to evolve.

A. Country rock	**B. Differentiation**	**C. Metallic ores**	**D. Plutons**	**E. Sloping**

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25:03-end Remarks by series host

Most of Earth is composed of intrusive igneous rocks. Continents are mostly granitic rocks beneath a coating of soil and sediment. The ocean crust is mostly gabbro beneath a coating of basalt and mud. Research into intrusive igneous processes helps in the location of **(30)**________, precious metals, and gems, and in understanding the complexities of plate tectonics.

A. Country rock	**B. Differentiation**	**C. Metallic ores**	**D. Plutons**	**E. Sloping**