A REVIEW ON BASALT SOIL AND ITS USES

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ABSTRACT
On Earth, most basalt magmas have formed by decompression melting of the mantle. Basalt commonly erupts on Io (the third largest moon of Jupiter), and has also formed on the Moon, Mars, Venus, and the asteroid Vesta. The crustal portions of oceanic tectonic plates are composed predominantly of basalt, produced from up welling mantle below, the ocean ridges.

Keywords: Basalt soil, Mining, volcanoes, magma

I. INTRODUCTION

Landowners and managers use soil map units in local Natural Resources Conservation Service (NRCS) soil surveys to understand the land use limitations of an area. Each type of soil map unit in the survey includes a description, in terms of percent of composition, of any feature with the potential to adversely affect land management practices (e.g., rock outcrop). Presently, the most accurate way to determine the percentage of rock outcrop in any soil map unit involves field transect data collection. While transect data collection is an adequate estimation method for a small FYI, it is a time-intensive and an impractical mapping technique for large areas, such as Idaho's Eastern Snake River Plain (ESRP). A common member of the soil map unit descriptions in this survey area is exposed basalt bedrock. The amount of rock outcrop present is highly variable, because of the relief and eruption time of the lava flows and the amount of soil that has been deposited on them. The quantity of forage available for domestic animals and wildlife, as well as the placement of routes for energy infrastructure, such as water pipelines and roads, are highly dependent on the amount and location of rock outcrops. As a result, new remote mapping methods are needed to accurately determine the spatial extent of rock outcrops in soil map units across this and similar landscapes. The purpose of this research is to investigate remote sensing methods for effectively determining the presence of basalt rock outcrops for soil mapping in regions, such as the Clark Area Soil Survey area, Idaho, USA.Remote sensing techniques that have recently been investigated for mapping soil and rock outcrops from moderate resolution imagery (i.e., Landsat 30-m pixels) include using band ratios, coupled with.Synthetic Aperture Radar (SAR) data, vegetation masking and linear spectral unmixing. For example, several studies have leveraged the multiple broad bands available from Landsat 5 TM and Landsat 7 ETM sensors by testing the usefulness of band combinations and band ratios (e.g., red band/NIR bad) in detecting organic carbon-based soils, gypsic and natric soils, limestone outcrops and

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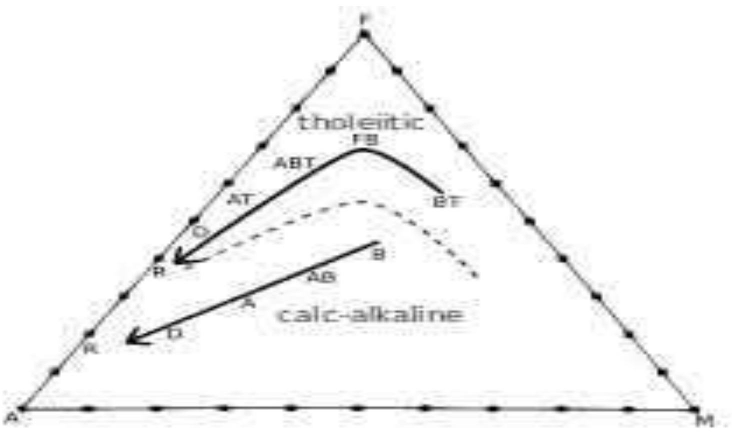
lithologic units and to separate dry soil from other components. Landsat has also been coupled with Synthetic Aperture Radar (SAR) data, because the optical data from Landsat is complimentary to microwave data, which can provide estimates of during.

Single and Multi-Date Landsat Classifications of Basalt to Support Soil Survey Efforts



II. GEOCHEMICAL CHARACTERIZATION

This is an AFM diagram, a ternary diagram showing the relative proportions of the oxides of Na_2O + K_2O (A), FeO + Fe_2O_3 (F), and MgO (M). The arrows show the path of the magmas in the tholeiitic and the calc-alkaline magma series.

III. DEFINITION OF BASALT

With a name derived from the Latin for 'very hard stone', basalt is indeed a very hard, black igneous rock found all over Earth and our solar system. It can be found not only on Earth, but also on Earth's moon and Mars. It is an extrusive igneous rock, which forms from volcanic lava that cools rapidly at Earth's surface. It is generally black in color due to the high amounts of magnesium oxide and calcium oxide, and very low amounts of lighter colored silicate minerals. It has several industrial applications, including building materials and thermal insulators. Basalt is a dark-colored, fine-grained, igneous rockcomposed mainly of plagioclase and pyroxene minerals. It most commonly forms as an extrusive rock, such as a lava flow, but can also form in small intrusive bodies, such as an igneous dike or a thin sill. It has a composition similar to gabbro. The difference between basalt and gabbro is that basalt is a fine-grained rock while gabbro is a coarse-grained rock.

IV. CHEMISTRY OF BASALT

Basalts are composed primarily of magnesium oxide (MgO) and calcium oxide (CaO). They are very low in silicon (SiO2), usually less than 50 percent. They also contain some iron oxide (FeO) and aluminum oxide (Al2O3). As a result, they are very dark in color, and usually appear as shades of black and black-green. Occasionally, some red or orange colors can appear in basalts and are due to that particular basalt containing rusting iron compounds. Basalt is an igneous rock that forms from the cooling and crystallization of magma. And usually, magma is formed from the melting of dark colored peridotite and pyroxene-rich rocks. There are some lighter colored basalts found, which form when a basalt magma contains a higher than normal amount of calcium or sodium minerals.

V. FORMATION OF BASALT

Basalt is an extrusive igneous rock. All igneous rocks form as the result of the cooling and crystallization of magmas, either at Earth's surface or below the surface. If the rock hardens below the surface, it forms large crystals and is referred to as intrusive. If it hardens at the surface, it forms small crystals (because it doesn't have sufficient time for crystals to grow in size) and is called an extrusive rock. Basalt forms at the surface and has small crystal grains, and is, therefore, an extrusive rock. When basalts form at the surface, it does not have to be on a dry surface, as many basalts form in the water. Pillow basalts form when basalt lavas erupt into ocean waters, and basalt is also formed at the earth's mid-ocean ridges (where new ocean crust is formed).

VI. BASALT-FORMING ENVIRONMENTS

Most of the basalt found on Earth was produced in just three rock-forming environments: 1) oceanic divergent boundaries, 2) oceanic hotspots, and 3) mantle plumes and hotspots beneath continents. The images on this page feature some of these basalt-forming environments.

VII. EARTH'S MOST ABUNDANT BEDROCK

Basalt underlies more of Earth's surface than any other rock type. Most areas within Earth's ocean basins are underlain by basalt. Although basalt is much less common on continents, lava flows and flood basalts underlie several percent of Earth's land surface. Basalt is a very important rock.

VIII. BASALT ON MOON AND MARS

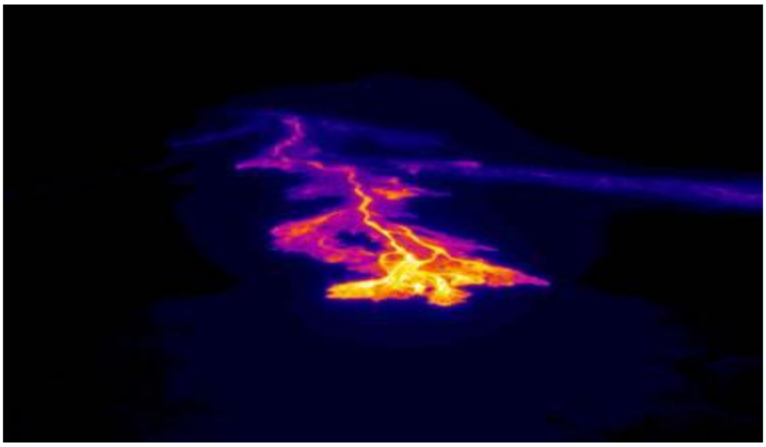
Basalt is also an abundant rock on the Moon. Much of the Moon's surface is underlain by basaltic lava flows and flood basalts. These areas of the Moon are known as "lunar maria." Large areas of the Moon have been resurfaced by extensive basalt flows which may have been triggered by major impact events. The ages of lunar maria can be estimated by observing the density of impact craters on their surface. Younger basalt flows will have fewer craters.

Olympus Mons is a shield volcano on Mars. It, like most other volcanic features on Mars, was formed from basaltic lava flows. It is the highest mountain on Mars and is the largest known volcano in our solar system.

IX. BASALTS AT OCEANIC DIVERGENT BOUNDARIES

Most of Earth's basalt is produced at divergent plate boundaries on the mid-ocean ridge system (see map). Here convection currents deliver hot rock from deep in the mantle. This hot rock melts as the divergent boundary pulls apart, and the molten rock erupts onto the sea floor. These submarine fissure eruptions often produce pillow basalts as shown in the image on this page.

The active mid-ocean ridges host repeated fissure eruptions. Most of this activity is unnoticed because these boundaries are under great depths of water. At these deep locations, any steam, ash, or gas produced is absorbed by the water column and does not reach the surface. Earthquake activity is the only signal to humans that many of these deep ocean ridge eruptions provide. However, Iceland is a location where a mid-ocean ridge has been lifted above sea level. There, people can directly observe this volcanic activity.



Thermal image of a hot basalt flow on the flank of Hawaii's Kilauea volcano. Hot lava at he front of the flow is revealed in yellow, orange and red colors. The channel that if flowed through on the previous day appears as a purple and blue track. United States Geological Survey image.

X. OCEANIC HOTSPOTS

Another location where significant amounts of basalt are produced is above oceanic hotspots. These are locations where a small plume of hot rock rises up through the mantle from a hotspot on Earth's core. The Hawaiian Islands are an example of where basaltic volcanoes have been built above an oceanic hotspot.

Basalt production at these locations begins with an eruption on the ocean floor. If the hotspot is sustained, repeated eruptions can build the volcanic cone larger and larger until it becomes high enough to become an island. All of the islands in the Hawaiian Island chain were built up from basalt eruptions on the sea floor.

The island that we know today as "Hawaii" is thought to be between 300,000 and 600,000 years old. It began as an eruption on the floor of the Pacific Ocean. The volcanic cone grew as recurrent eruptions built up layer after layer of basalt flows. About 100,000 years ago it is thought to have grown tall enough to emerge from the ocean as an island.

Today it consists of five overlapping volcanoes. Kilauea is the most active of these volcanoes. It has been in amost continuous eruption since January, 1983. Basalt flows from Kilauea have extruded over one cubic mile of lava, which currently covers about 48 square miles of land. These flows have travelled over seven miles to reach the ocean, covering highways, homes and entire subdivisions that were in their path.

XI. PLUMES & HOTSPOTS BELOW CONTINENTS

The third basalt-forming environment is a continental environment where a mantle plume or hotspot delivers enormous amounts of basaltic lava through the continental crust and up to Earth's surface. These eruptions can be from either vents or fissures. They have produced the largest basalt flows on the continents. The eruptions can occur repeatedly over millions of years, producing layer after layer of basalt stacked in a vertical sequence (see outcrop photo).

The Columbia River Flood Basalts in Washington, Oregon, and Idaho are an example of extensive flood basalts on land (see map below). Other examples include the Emeishan Traps of China, the Deccan Traps of India, the Keweenawan Lavas of the Lake Superior region, the Etendeka Basalts of Namibia, the Karroo Basalts of South Africa, and the Siberian Traps of Russia. (The word "traps" is derived from the Swedish word for "stairs," which describes the outcrop profile of these layered basalt deposits.

XII. USES OF BASALT SOIL

Basalt is used in construction (e.g. as building blocks or in the groundwork), making cobblestones (from columnar basalt) and in making statues. Heating and extruding basalt yields stone wool, said to be an excellent thermal insulator. Carbon sequestration in basalt has been studied as a means of removing carbon dioxide, produced by human industrialization, from the atmosphere. Underwater basalt deposits, scattered in seas around the globe, have the added benefit of the water serving as a barrier to the re-release of CO_2 into the atmosphere.
Basalt is used for a wide variety of purposes. It is most commonly crushed for use as an aggregate in construction projects. Crushed basalt is used for road base, concrete aggregate, asphalt pavement aggregate, railroad ballast, filter stone in drain fields, and may other purposes. Basalt is also cut into dimension stone. Thin slabs of basalt are cut and sometimes polished for use as floor tiles, building veneer, monuments, and other stone objects.

XIII. BUILDING SOIL HEALTH WITH VOLCANIC BASALT

Organic and sustainable farmers have long relied on rock dust as an all-natural way to improve roots systems, increase yields and promote general plant health in a wide variety of crops and conditions. Yet, it has taken the rapid depletion of our global soils to bring rock dust to the attention of modern agricultural science. The good news is that there is undeniable evidence that rock minerals can help restore soil health, minimize crop deficiencies and boost resistance to pests and disease.

XIV. BOOSTING RESISTANCE

The latest research focuses on rock dust's ability to enhance the innate resistance of plants to a multitude of physical and biological stressors. Silicon (Si), which occurs naturally in volcanic basalt and is a key component of cell walls, strengthens stems and helps plants stand tall to capture more light and maximize photosynthesis. Silicon has also been identified as playing a particularly significant role in helping plants stay healthy and boosting their resistance to pests and disease. Plants that don't have access to adequate silicon in the soil are stressed out, weak and unable to resist injuries caused by insects and pests.

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