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Review Article

APPLICATION OF VOLCANIC SOILS

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Volcanoes can clearly cause much damage and destruction, but in the long term they also have benefited people. Over thousands to millions of years, the physical breakdown and chemical weathering of volcanic rocks have formed some of the most fertile soils on Earth. In tropical, rainy regions, such as the windward (northeastern) side of the Island of Hawaii, the formation of fertile soil and growth of lush vegetation following an eruption can be as fast as a few hundred years. Some of the earliest civilizations (for example, Greek, Etruscan, and Roman) settled on the rich, fertile volcanic soils in the Mediterranean-Aegean region. Some of the best rice-growing regions of Indonesia are in the shadow of active volcanoes. Similarly, many prime agricultural regions in the western United States have fertile soils wholly or largely of volcanic origin. The verdant splendor and fertility of many farmlands of the North Island of New Zealand are on volcanic soils of different ages. Volcanic loams have developed on older (4,000 and 40,000 years old) volcanic ash deposits of the Waikato and Bay of Plenty regions. Combined with ample rainfall, warm summers, and mild winters, these regions produce abundant crops, including the kiwifruit found around the world in modern recipes. The altered volcanic ashes are well-drained, yet hold water for plants, and are easily tilled. Deep volcanic loams are particularly good for pasture growth, horticulture, and maize.

Rodrigo Navia reported as The main physicochemical characteristics of the volcanic soil of Southern Chile, with allophane as the main pedogenic mineral phase were analysed and compared with common zeolites (clinoptilolite) of the European market. The ultimate goal of this study was to test volcanic soil for the use as mineral landfill liner. The main results indicated that the clay and silt fractions together of the volcanic soil were between 38 and 54%. The buffering capacity of the volcanic soil was higher compared with the studied zeolites, whereas the cationic exchange capacity of the volcanic soil (between 5.2 and 6.5 cmol+ kg^{-1}) is of the same order of magnitude of the studied zeolites (between 9.7 and 11.4 cmol+ kg^{-1}). Moreover, the anionic exchange capacity of the volcanic soil was higher compared to the zeolites analysed. The hydraulic conductivity of the volcanic soil, measured in the laboratory at maximum proctor density, ranges between 5.16×10^{-9} and 6.48×10^{-9} ms^{-1}, a range that is comparable to the value of 4.51×10^{-9} ms^{-1} of the studied zeolite. The Proctor densities of the volcanic soil are in a lower range (between 1.11 and 1.15 g ml^{-1}) compared with zeolites (between 1.19 and 1.34 g ml^{-1}). The volcanic soil physicochemical characteristics are comparable to all the requirements established in the Austrian landfill directive (DVO, 2000). Therefore, the use as mineral landfill basal sealing of the analysed volcanic soil appears reasonable, having a pollutant adsorption capacity comparable to zeolites. It is of special interest for Southern Chile, because there are no alternative mineral raw materials for basal liners of landfills

Although volcanoes have the reputation of being very dangerous, (Volcanoes can kill people and animals. They can be very destructive.) there nevertheless are advantages of living near a volcano. Volcanoes provide resources for energy extraction, also called geothermal resources. Heat from the earth's crust is being converted to energy. The big advantages to this type of energy are that it is very clean and the resources are nearly inexhaustible. When a volcano erupts it throws out a lot of ash. At short notice this ash can be very harmful to the environment, but on the long term the ash layer, which contains many useful minerals, will be converted to a very fertile soil. Nearly everywhere volcanoes are located people use the rich soil for farming. Even after an eruption people still return because of the fertile soil around the volcano Volcanoes can produce very spectacular scenery like the beautiful sunsets caused by explosive eruptions. Other features include plant-rich environments, stunning eruptions, beautiful lava fountains etc.

Volcanic soils cover 1% of the Earth's surface yet support 10% of the world's population, including some of the highest human population densities. This is usually attributed to their high natural fertility. However this is true only in part. Clearly such soils represent the surface areas of our planet that are being replenished with new minerals escaping from the interior of the Earth. However, some deep magmatic processes do lead to an imbalance of elements in volcanic soil parent materials which can impact on the health of plants and animals growing in or on them. In contrast, all other soils express various stages of the degradation (weathering) of these minerals. This account addresses the specific features and genesis of volcanic soils, how they are classified, the problems when they are farmed or cropped, and how they are used and abused in various global environmental settings. Physical Limitations to Plant Growth in Volcanic Soils Limitations to plant growth in volcanic soils may be climatic, physical or chemical. Climatic extremes include aridity, recognized in volcanic soils having aridic or xeric moisture regimes. These soils occur in such diverse countries as Syria, Greece, Peru, and Chile. Other climatic limitations include severe cold (Cryands in Soil Taxonomy, 1999), these being mainly limited to the Northern Hemisphere north of 49o N, such as the volcanic soils in Alaska, Iceland, and the Kamchatka Peninsula of eastern Russia. Many volcanic soils have excellent soil physical properties that make them highly desirable for a wide range of land uses. However, in some areas certain soil physical properties can limit productivity. The first is a high water table (Aquands in Soil Taxonomy, 1999). In some volcanic environments, such as on debris avalanche fields with numerous closed depressions or on low terraces in basins such as the niadi of Chile, there may be poor or imperfect drainage that leads to waterlogged volcanic soils. Whilst these may be advantageous for paddy rice, the presence of a high water table for longer periods of the year than their well drained counterparts leads to lower soil oxygen levels, severely limiting deep rooting plants. An obvious remedy is to install drainage. The types of drainage vary according to the economics of the land use enterprise. They may vary from open cut drains, installed either by hand or trenching equipment, to installation of clay tiles (hollow pipes), or plastic perforated piping, as seen on numerous dairy farms in Taranaki, New Zealand. A distinct feature of poor drainage in volcanic soils is the lack of distinct graying (gleying) of the subsoil as seen in other soils. This is due to the high iron contents of many volcanic parent materials that retard the visual graying (removal of iron) in the gleying process. To overcome this situation, specific criteria were devised in Soil Taxonomy (1999), such as determination of ferrous iron using an α, α'-dipyridyl field test. A second limiting soil physical property is the high proportion of pumice or scoria (also called cinders) encountered in some soil profiles. Not only does this convey a coarse texture but it also implies the dominance of largely unweathered volcanic glass (vitric soil properties) in the sand and silt fractions. The coarse texture reduces the soil water storage capacity under dry conditions (lowering the field capacity and wilting point). It has, however, been recognized that pumice does not behave like sand and that there is often a film of water stored in the micro-- vesicles of pumice that may be accessible to trees or deep rooting crops.One aspect that accentuates the vitric property in a soil is the common occurrence of glass selvedges around minerals in the sand and silt fractions that then dominate the surface weathering processes in the soil, rather than the mafic or felsic mineral grain beneath. Sharp, angular grains of volcanic glass inhibit the passage of soft bodied soil invertebrates (e.g. earthworms), reducing the quantity and biodiversity of soil organisms, particularly in subsoils. A third limiting soil physical property is the presence of impenetrable horizons within a soil profile. Despite having excellent soil physical properties both above and beneath, the presence of either a placic, duric or petrocalcic horizon, or a paralithic or lithic contact prevents further plant root penetration, thus limiting the ability of plants to reach their full capability. Placic horizons are generally found in higher rainfall environments (above 1800 mm mean annual rainfall) where they form a thin, iron cemented and highly irregular feature in well drained soils. They thicken in progressively higher rainfall environments. Duric and petrocalcic horizons are usually found in drier environments, where in the latter case calcium carbonate has not been leached from the soil-forming environment. Petrocalcic horizons, called cangagua in Ecuador or caliche in the western United States, can be a major limiting factor for plant growth. In many countries, such as New Zealand, cemented lahar or debris avalanche deposits form paralithic or lithic contacts beneath an upper soil possessing andic soil properties. There are a very wide range of chemical (soil fertility) limitations in volcanic soils, most of which are nutrient deficiencies. These are discussed below under each land use