CALIFORNIA STATE SCIENCE FAIR
2017 PROJECT SUMMARY

Name(s)

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Project Number

J1203

Project Title

How Will a Change in Mineral Content in Soil Affect the Amount of Water Retained by the Soil?

Abstract

Objectives/Goals

The effect of two clay minerals, montmorillonite and kaolinite, on water retention in soil was investigated, along with how salt and pH changes these properties. Kaolinite is a 1:1 clay whose layers are held together strongly by hydrogen bonds and does not disperse in water, and montmorillonite is a 2:1 clay whose layers are held together loosely by cation interactions and readily disperses in water. The objective was to see how these clay properties affect water drainage, which can influence water retention for plants, soil surfaces for nutrients, and groundwater replenishment.

Methods/Materials

The approach I used was to set up columns where sand was mixed with different amounts of kaolinite or montmorillonite. The columns were made by drilling holes into the bottom of 50 ml plastic conical tubes and sticking tubing into the holes. Powdered kaolinite and montmorillonite were donated by Dr. Robert Graham, a scientist at UCR.

Results

I observed that without clay water runs through sand quickly. For both kaolinite and montmorillonite, as the clay concentration increased, water flow through the column decreased. However, montmorillonite retained water to a greater extent than an equivalent amount of kaolinite. With respect to the effect of salt, I found that adding NaCl made water flow through montmorillonite soil more quickly than water lacking salt. In comparison, adding salt did not have as big of an effect on infiltration through kaolinite soil. Finally, I observed that basic water (pH 10) took longer to move through the column compared to acidic (pH 4) or neutral pH water.

Conclusions/Discussion

The ability of montmorillionite to retain water better than kaolinite is probably due to clay structure. As a 2:1 clay, montomorillionite readily disperses as fine particles that block water movement. In contrast, kaolinite is a 1:1 clay and does not swell as much and so is less effective. Also, because montmorillionite layers are held together by cations, the presence of salt in solution might offset the ability of water to disperse montmorillionite, explaining why more rapid drainage was observed at higher salt concentrations. I do not understand the effect of the pH, but I would like to explore how pH affects soils. With greater amounts of greenhouse gases in our atmosphere, the pH of rain will begin to change, so if we explore this effect now, we will be better prepared to deal with this.

Summary Statement

By examining different concentrations of swelling and non-swelling clays in soil, I was able to show that a swelling clay was more effective at slowing water infiltration in soil, and this effect was altered by salinity and pH fluctuations.

Help Received

Dr. Robert Graham at the Univ. of California, Riverside answered questions I had about clay and soil, and donated the powdered forms of the clay minerals I used. My mom and dad helped me with ideas, running the columns, taught me about preparing graphs in Excel, and helped with putting my poster together.