Soils are one of the most essential, and least often considered, natural resources in our environment. Soils are the life-sustaining foundation of forests, grasslands, and farms; they absorb precipitation, moderate stream flows, and prevent floods; they clean and store our drinking water; they store more carbon than the atmosphere and all living plants and animals combined; and are home to billions of creatures from large to microscopic. When you think about soil in central Oregon, what comes to mind? Home gardeners will bemoan its droughtiness and poor nutrient value. Mountain bikers think of summer dust clouds and deep sand traps. We're all familiar with how it turns from mud to dust in a matter of days when the seasons change. Where did our soils come from? And how does our seemingly-poor soil manage to sustain so much life?

About 7,700 years ago, the cataclysmic volcanic eruption of Mt. Mazama (present-day Crater Lake) deposited volcanic ash and pumice over a broad swath of North America. In the Bend area, about three feet of sandy Mazama pumice blanketed our landscape, and our surface soils are formed in this material. 7,700 years is a mere blink of an eye in soil development time frames--as a result, our Mazama pumice soils are very weakly developed. This means that they have thin topsoil layers (the darker surface layer that is enriched in organic matter from decaying plant litter and roots), are very light and porous, infiltrate rain very rapidly, dry out quickly, and don't really stick together. In geology-speak, the pumice is "dacitic" in nature, meaning it has a lot of silica, which weathers slowly and doesn't provide much in the way of plant nutrients. The sandy material hasn't had time to break down into silt- and clay-size particles that would provide cohesion, hold more water, and provide more nutrients to growing plants. The individual pumice particles themselves are complex swiss-cheese-like sponges that suck water up into tiny pore spaces and render it inaccessible for plants.

But the story of central Oregon soils goes a little deeper than that… our soils don't behave the same everywhere, even though they seem very homogenous at the surface. Why is this? Because our soils didn't START with Mt. Mazama. In fact, there was an entire diverse soil-scape out there that was essentially frozen in time 7,700 years ago by eruption of Mt Mazama. The thick blanket of ash and pumice only served to mute or obscure the signatures of millions of years of landscape processes. We're in a unique setting, at a large landscape scale, where the Mazama pumice is thick enough to dominate surface soil properties, but thin enough that the buried soils can still exert a meaningful influence on vegetation communities, water availability, and disturbance response. So what do these hidden soils look like?

Our landscapes west of Bend, where we're accomplishing much of our restoration work, are at a junction point for several big geologic processes. Much of the city of Bend and surrounding area sits on lava flows erupted from the Newberry volcano complex over the last several hundred thousand years. To the west, these flows overlap with flows from numerous vents in the high Cascades that are similar in age and older. The specific layers in this "layer cake" of lava vary from location to location, but in many cases there was plenty of undisturbed time (tens to hundreds of thousands of years) for soils to develop on flow surfaces. These buried soils tend to be finer-textured than the Mazama surface, as basalts and andesites break down fairly rapidly to form silts and clays, and therefore hold more moisture. Finer textures also slow the downward movement of water. The old topsoil was enriched in both organic matter and nutrients from breakdown of the richer rock types. At a mere three feet below the present-day Mazama soil surface, surface vegetation can easily put roots down into these buried soils and capitalize on increased water and nutrient availability. Lower elevations near town are primarily underpinned by these soils. Of course, the story gets more complicated than this. As you move up in

elevation to the west, you enter terrain that was occupied by mountain glaciers during the ice age (most recently about 20,000 years ago). As glaciers advanced, they bulldozed existing soils, ground down into bedrock, and carved deep gouges (the Tumalo creek drainage headed toward Tumalo Falls is a great example of a glacier-carved U-shaped valley). Where these glaciers sat, they left behind cement-like layers of compacted sediment called “glacial till”. When the glaciers receded, meltwater streams transported and deposited large amounts unconsolidated sand, gravel, and stones called “glacial outwash” in lower landscape reaches. Many of our old quarries near town are located in glacial outwash deposits (the pits below Phil’s trailhead are good examples). Glacial deposits usually didn’t have enough time to develop true soil characteristics prior to the Mazama eruption, and are generally gravelly or cobbly and nutrient-poor. Glacial till may restrict the downward movement of water, causing it to be held in the Mazama soil above it, while outwash generally allows water to freely percolate into deeper, inaccessible reservoirs. Lower elevations closer to town tend to be dominated by buried volcanic soils. Higher elevations tend to be dominated by buried glacial till. Mid-elevations will have a mix of buried volcanic and glacial materials, where volcanic buried soils dominate on ridgetops and plateaus and glacial outwash buried soils dominate in valleys and depressions. These broadly-distributed buried soil types are interfingered with smaller pockets of buried soils formed in localized vent eruptions, stream deposits, old lake sediments, and other events.

A simple surface belies a complex soil system that drives diversity and function on our landscape When we appreciate and better understand that complexity, we can manage the land in a way that protects the integrity of the soil for generations to come.

--Submitted by Sarah Hash, Soil Scientist

Resources:

FAO infographics: http://www.fao.org/soils-2015/resources/infographics/en/#c328551