Geology of the Arboretum, Part II

There's Soil Under Them There Plants!

By Paige Embry / Photos by Niall Dunne

In Part I of this article[1], I discussed how glaciers—repeatedly grinding down from Canada during the last two million years—created the parent material for most of the soil in Seattle and the Arboretum. Part II will zoom in a little more closely on some of the specific soils of the Arboretum and examine how they affect the plant collections and the staff's approach to managing them.

As I wrote about in Part I, four basic materials are the source for most of our region's soils: glacial till, a mélange of unsorted material of all sizes; glacial outwash sands from meltwater rivers; silty clays from glacial lakes and riverine flood plains; and organic/peat deposits, where plants have filled in low areas and are not completely decomposed. This doesn't mean that there are only four soil types—oh no: The King County Soil Survey lists around three dozen types, and figuring out which is which on the ground isn't always easy.

Why such diversity? It's because parent material is just one of five key factors in soil formation. The others are climate (primarily temperature and rainfall), living organisms (such as lichens, plants and people), topographical differences (for example, soil on slopes tends to be thinner than low-lying areas, due to erosion), and time (the age of a soil affects its profile). Change one factor, and the soil changes. In the Arboretum, the factors that exhibit the most significant controls are parent material, topography and living organisms—particularly people.

Soil surveys have identified nine soil types in the Arboretum—quite remarkable for such a relatively small area. The two main surveys[2,3] (in 1966 and 1977) agree on the four most-abundant types and don't on the others. Ah, the joys of soil taxonomy!

Arboretum Soils

Soil taxonomy is fraught with arcane language hiding nuggets of useful information. One of the first lines in the official description of the Alderwood Series (abundant in Seattle and the Arboretum) is that its taxonomic class is "Loamy-skeletal, isotic,


A rock-filled streambed channels excess water from the problem soils in the New Zealand Forest.

mesic Aquic Dystroxerepts." Well, that's enough to stop one cold, but keep reading—helpful information is tucked away in the verbiage.

The Alderwood is a soil built from glacial till and is often referred to as the Alderwood gravelly sandy loam. Given that till is all the unsorted material (which can range from infinitesimal clays to car-sized boulders) carried along in a glacier, it might better be called "rocks of random sizes, embedded in a matrix of sand, silt and bits of clay," but "gravelly sandy loam" is shorter. One of the key features of the Alderwood is the presence of a hardpan (a layer of densely compacted soil) 20 to 40 inches down. If the hardpan is on the shallower side, plant growth can be compromised due to waterlogging or inadequate root space. Alderwood soils are found on slopes and hilltops along the length of the Arboretum, including in the new Pacific Connections Garden.

Whether the Alderwood is a "good" or a "bad" garden soil depends not just on the depth of the hardpan but also on variables such as the size and quantity of the drift material (rocks), and how well or badly the soil has been treated. The "crap" under my sidewalk in PART I of this article was Alderwood. It was bad for two reasons: one natural and one machine-made. This particular batch of Alderwood was, by nature, stuffed with rocks. Add man-made compaction from sidewalk construction and the resulting material had my poor husband cursing me under his breath for a week as he dug and loosened. Worse, the all-important soil structure had been destroyed. (See "Soil Texture Versus Structure.")

Another common soil type in the Arboretum is the Indianola. It formed through sandy glacial outwash and is referred to as "somewhat excessively drained"—which means, "Expect to do plenty of watering." However, the addition of organic material helps these sandy soils hold on to both water and nutrients. Like Alderwood, Indianola soils are mostly found on slopes and hilltops in the Arboretum.

The third major Arboretum soil, Bellingham silty clay, is found primarily on Foster Island. Bellingham soils are made from very small mineral pieces—mostly former lake or flood plain deposits—and tend to be soggy things that occupy low-lying ground. One can drain wet soils on uplands, but draining a bottomland is problematic. So these are areas where one should, in general, just succumb and plant things that are happy to grow in wet ground. Other low-lying areas of the Arboretum also tend to the silty and soppy. (It's mostly on these soils that the 1966 and the 1977 surveys can't agree.)

The Arboretum also has a few "organic" soils. There are many different ways to make organic soils, but usually they are wet, squelchy things with significantly more organic matter than normal or "mineral" soils. They can be found in swampy areas marginal to Lake Washington and Arboretum Creek.

One last Arboretum soil worth mentioning is classified as "Anthromorphic," meaning human made. In a sense, most of the soils in the Arboretum have been somewhat modified by human hands—but in the stricter sense, the term applies to a mixture of fill and garbage at the northern tip of the Arboretum and the WSDOT Peninsula, the site of a former landfill, the Miller Street Dump. The quality of this soil varies, depending on the depth and texture of the fill layer on top and the nature of the garbage underneath.

Plant Collections and Soil Management

The story of managing the soils for the plant collections at the Arboretum seems to be largely a story of water—both too much and too little. Before major plantings go in, soils are assessed, and adding drainage and catch basins is, and has long been, part of creating any new planting. Christina Pfeiffer, former horticulturist for the Arboretum, says that the Arboretum is stuffed with Depression-era, clay-tile drainage, installed by Works Progress Administration crews—some mapped and some not[4]. Over the years, changes have taken place above and below ground: Plants have grown, sucking up water and re-shaping the ground; gravity has taken its toll, modifying slopes and low-lying areas; and some drainage tiles have been offset—turning areas that were once well drained into water-logged spots and vice versa.

One example is the *Sorbus* Collection, located along the Broadmoor fence, next to the magnolias and planted on Indianola soil. Back in the early 1980s, the *Sorbus* started showing signs of distress, and the ground was staying water-logged for extended periods, which was odd for the sandy Indianola. Pfeiffer says a percolation test showed that the soil was still draining water quickly. But further investigation revealed that changes in slope gradient at adjacent Broadmoor (due to berm construction)—and within the *Sorbus* area, where buttress roots of some conifers has raised the ground in places—had increased run-off and created a hollow that prevented water from reaching a catch basin. Pfeiffer says she and her colleagues laid under-ground drainage connecting the soggy ground to that catch basin, and it was "like pulling the plug out of a bathtub."

Conversely, when a collection of sumacs along Arboretum Drive next to the Woodland Garden showed distress, Pfeiffer and her crew examined the soil and found it to be dry and cracked—indicating a clayey substrate with a lack of organic matter. (The soil map shows Alderwood in this area, but the high clay content suggests a different soil type.) Amending an already planted area is difficult because of the potential to disturb the roots. The Arboretum staff waited until fall, when the soil was damp enough to work, and gently raked compost into the crusted surface. They then applied about three inches of wood chip mulch. After several years of additional mulching, the sumacs returned to robust health.

Right Plant, Right Place

The "right plant, right place" mantra of sustainable garden design has been practiced in the Arboretum at least since the days of Brian Mulligan. The original plans for the Arboretum, developed by the Olmsted Brothers and James Dawson, sited plants based on their taxonomic groupings and perceived evolutionary relationships rather than their cultural requirements. But during his influential tenure as Arboretum director (1946 to 1972), Mulligan was never afraid to ditch these plans in favor of ensuring that the plants he installed got what they needed in terms of soil, water and sunlight.

Soil Texture Versus Structure

Every soil has a texture that is inherent and a structure that is changeable. The soil texture is just the relative percent of sand- (1/16–2 mm), silt- (1/256–1/16 mm), and clay-sized (<1/256 mm) material in the soil. The holy grail of soil textures is loam because it holds nutrients and water without becoming waterlogged. Loam is about equal parts sand and silt, with a good helping of clay (about a 40%-40%-20% concentration, respectively); if you want one, plan on moving because true loams are scarce around Seattle. You can add compost or manure to your soil until your back gives out, and you won't change the texture. But you can change the structure.

Good structure can make up for a less than ideal texture. Whereas soil texture is about the individual mineral grains, soil structure is about how those grains are clumped together with organic matter into pieces called "peds." If you look at a handful of good soil, it will often consist of balls (granular peds). Large balls of soil crumble easily in the hand to form smaller balls. Clay grains and organic material hold these peds together, so adding organic material to a soil with poor structure is a way to start building peds. Soils with good structure have big holes that empty quickly after a rain, so there is oxygen in the soil (needed by plant roots and beneficial soil critters) and small holes that hold onto water and store it for later use by plants. Compaction of soil—through driving, excessive walking, piling wood, rototilling, applying pesticides that kill off soil life, and more—destroys peds and structure and should be avoided.

Mulligan's legacy lives on today. Sometimes, however, due to space constraints—and the fact that the Arboretum has its fair share of crappy soil—certain plants have to be sited in soils that just don't agree with them. This has happened in recent years with the construction of the New Zealand Forest at Pacific Connections and the re-location of the Holly Collection (to make way for Pacific Connections).

To compensate for poorly draining Alderwood soils—coupled with high rates of runoff from Broadmoor—at the site of the New Zealand Forest, the Arboretum brought in new, high-quality topsoil, planted specimens on mounded beds, and created a network of rock-filled streambeds for drainage. For the relocation of the Holly Collection, the Arboretum commissioned a detailed soil analysis of the proposed new site, just north of the Japanese Garden, along Lake Washington Boulevard. The soil study found heavy, silty-clay-loam—"representative of the Bellingham series"—on the lower, grassy slopes of the site. It also found glacial till and a hardpan layer between 13 to 23 inches (indicative of Alderwood) on the upper, forested slopes. As a result, Arboretum staff brought in new soil and planted the hollies on a series of contoured berms.

The majority of the hollies were transplanted in the fall of 2007, and most have fared well—at least with respect to drainage issues. The New Zealand collection has been in the ground such a short time that it is too soon to tell.

David Zuckerman, the current manager of horticulture at the Arboretum, says areas of the Arboretum have soils that are pleasing to a manager, and some that are not. The camellias, for instance, are located in one of those happy-making areas where drainage is adequate but not excessive. (The 1966 soil map shows the Camellia Collection spread over both Indianola and Alderwood soils.) Then there is Azalea Way, which may be the bane of every caretaker the Arboretum has seen, with its seemingly un-resolvable drainage issues—likely a combination of poorly draining soils (Alderwood on the north end) at the bottom of a hill and heavy usage causing compaction. Zuckerman also notes that, interestingly, the anthropogenic soils at the site of the former dump seem to grow a crop of toxic weeds—such as bittersweet nightshade and poison hemlock—that seldom appear elsewhere in the Arboretum.

Soil is a bit like the weather: Gardeners are always complaining about it! "My soil holds too much water or two little…it's too rocky…too clayey…warms up too late in spring…" The next time you are bemoaning your soil's inadequacy, pity the poor Arboretum gardeners. You likely have only one annoying soil type to cope with; at the Arboretum, they have them all. ~

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References

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2. "Soils of the Arboretum," by Stanley P. Gessel. "Washington Park Arboretum Bulletin," Volume 24, No 3, 1966, pp. 69–83.
3. "Soils of the University of Washington's Arboretum," by Rob Emery. 1977. (Available in the Miller Library.)
4. "The Arboretum Underground," by Rebecca Taylor. "Washington Park Arboretum Bulletin," Volume 59, No. 2, 2001, pp. 14–15.

ABOVE: *Ilex ciliospinosa* planted on a mounded bed in the Holly Collection. The bed provides good drainage for plant roots in a site that is prone to waterlogging.