Our State

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The Foundation of Everything

Perplexed by the useless mound of red clay piled in his backyard, a writer calls in a soil scientist and uncovers the truth about the complex layers lying beneath our feet.

by Our State Staff

In my backyard, a big pile of clay has been sitting for six months. Workers building our screen porch dug foundation holes, and they left about 20 wheelbarrows' worth of Piedmont red clay piled beneath an oak and a maple in February. By July, if there was anything green on that hill of clay, it was a maple leaf shaken loose by a thunderstorm. Through a wet spring and a sunny summer, what grew in that pile of clay was, exactly, nothing.

Naturally, I thought, "That is some no-good soil right there." That was my first misapprehension about soil, though hardly my last. Dirt? Clay? Soil? What's the difference? What is soil, anyway? That clay has been here longer than I have, so instead of just hauling it off, I started asking questions. My trail led to Joseph Kleiss, the go-to expert in soil at North Carolina State University until his recent retirement.

Being retired meant Kleiss had time to come out to my yard and tell me about my pile of clay, and the first thing he told me was that I had to get past that good-soil-bad-soil dichotomy.

"The question I always ask," Kleiss said, "is 'good for what?'" Are you planting a crop? Building a road? Erecting a skyscraper? Soil covers most of the continent, but it's marvelous, complicated stuff, and you need to understand what you're asking before you can get good answers.

"Soil is a fascinating thing," Kleiss said. "Chemistry, biology, and physics, all together. People think, 'Aw, it's just dirt.' Well, it's more than just dirt."

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Soil is the place where rock turns into life. Made up of countless tiny particles, soil is almost pure surface area, and its chemical and biological reactions take place on those tiny surfaces and in the inconceivably tiny pores between them. The International Soil Reference and Information Centre in Wageningen, the Netherlands, calls soil "the world's living skin," which gets to the heart of it. Our own skin, we know, is a complicated boundary. Between bones and organs and other stuff that belong on the inside, and air and cosmic radiation and 100-percent-cotton golf shirts that stay on the outside, we have this weird, semipermeable layer of stuff. Stuff gets in, stuff comes out, it's alive, it's dead, it protects us, it provides habitat for all kinds of things that help and hurt us, it helps maintain the sort of 72-degree atmosphere that our bodies need. It's an almost undefinable miracle without which we would be doomed.

Same thing with soil, only for our planet, not our bodies.

Soil. The stuff of life.

Tomatoes didn't grow this year? Must be the lousy soil. Toss away some mushy watermelon, and two months later, there's a vine? Must be that good soil back there by the compost. Who hasn't spent an hour on a farm Down East, cupping a fistful of rich, loamy humus? On the other hand, every Piedmont Carolinian has despaired of ever getting two blades of grass to share the same square meter of, well, of that stuff I had a pile of in my yard.

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Kleiss took out a sampling tool, a spiral hand digger about the size of the T-bar the city water guys use to turn on and off your main valve. He used a PVC halfpipe to lay the soil in, a way to keep it in order as he pulled plugs out of deeper and deeper ground. Kleiss worked up a sweat corkscrewing a narrow hole a few feet deep in my front yard: a pinch of grass; a little dirty gray; and then, red. Red. Red. Same stuff as that backyard pile. He nodded, pronouncing his soil map in error. The map said my front-yard soil was Appling, but Kleiss

recognized it as Cecil series. The Cecil is slightly redder, but the specifics are not important. The thing to note is that soil comes in series — kind of like breeds of dog, say — and that there are 23,000 series of soil in the United States, probably 500 in North Carolina alone. That Cecil soil in my yard happens to be the North Carolina state soil — we have one, if you can believe it. And Cecil is our most extensive soil series, covering a good 1.6 million acres of the state, plus a third of the Piedmont up and down the coast.

It's "that classic, sticky, red, stain-everything clay," says geologist Kenny Gay. Another geologist described that icky, clay soil to me like it was a troubled teen. "That soil never had a chance. Its parents were worthless."

Which brings up point one about soil. The first thing you need to know about soil is its parent material — which is to say, the rock it came from.

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Soil has parents, and just like you and me, it evidences a lot of the traits it inherits from its parents all its life. There's only so much fixing we can do. The Coastal Plain, for example, is mostly sedimentary rock, laid down by seas whose levels were much higher than ours are now. That sandy, mineral-rich soil drains well and grows cotton and tobacco perfectly. You want an extremely well-drained soil for tobacco, Kleiss told me — a droughty soil, so the water drains and the plant stops getting nutrients and the leaves yellow at the end of the growing season.

Piedmont soils? A different story. The Piedmont has mostly weathered in place — that is, the gentle slope of Piedmont land lets the Piedmont's bedrock break down and just lie there, so the essence of the soil begins as the essence of the rock itself. Some of that isn't bad — granite breaks down into a sandier soil, but metamorphosed volcanic rock breaks down into that clay, and that clay isn't especially good for farming.

We all complain about red clay, but it's not bad soil for living on. The very fact that it's red indicates that air gets in — the red comes from oxidized iron, and iron oxidizes only in the presence of air. It doesn't swell too badly with water, and you can percolate a septic system in it if you use enough space. So settlers could build houses, dig wells, dispose of their waste, plant small fields of crops.

But go a few miles west of my Raleigh neighborhood, by Research Triangle Park, and you enter the Triassic Basin, its yellow clay soils make my parched, red yard look like the Mississippi Delta. Central Cary — the old part — is standard, weathered-in-place Piedmont soil. People settled there. But the new parts of Cary? They're Triassic Basin, created hundreds of millions of years ago when a previous version of our continent was tectonically tearing itself apart.

Rifts like those now seen in Africa developed, and rivers and lakes deposited silt and sand, leaving rock that's almost impermeable. Those areas simply couldn't be settled without centralized water and sewer systems. The clay is so impermeable that septic systems wouldn't percolate, and wells yielded no water. Triassic Basin soil swells and shrinks significantly with water. Kleiss tells stories about Cary developers ignoring his recommendations and building roads that buckled. RTP developers erected buildings using out-of-town, standard methods and then watched parts of them crumble, unprepared for the earth beneath their feet to fret and shift.

But that also answers questions, too. That sprawling acreage between Raleigh and Durham was waiting for developers to build RTP because nothing else would grow there.That soil grows buildings — if you build them right — but not much else. Soil, that is, explains your history and your environment, if you know what you're looking for.

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It's not quite that simple, of course. We all kind of know that soil comes from decomposition — mulch the leaves, put 'em in a pile, you'll have something next spring; throw the vegetable waste in a corner of the yard, toss on some lawn clippings once in a while, and eventually, you get soil. And understanding the parent material helps clarify where that cycle starts. It goes like this: Water seeps into the rock, freezes, cracks the rock, breaks pieces off. Rain and wind weather it into smaller, then even smaller pieces. Eventually organic material joins in, but the substrate of soil is just tiny pieces of the same thing that lies underneath it.

But that's only the beginning. Once you know the parent material, you know only the first thing about your soil. You need to delve into climate and the organisms that live in the area. If the parent rock had, say, magnesium, which plants like to get from soil, and what becomes of them when they drop leaves and die? And what kind of animals like to eat the kind of seeds those plants drop? You have to look at topography — you get different soil at the base of a hill than you do on the top. You have to add in time — thousands and thousands of years of weathering rock and decomposing plants, decomposing animals, occasional floods. (Soil even has an age of its own: If you get a catastrophic flood that leaves a couple of feet of silt on the soil, the clock starts all over.)

You have to consider its drainage, and you have to categorize it according to texture, which you measure on a triangle with sand, silt, and clay at the points: sandy clay; silty loam; loamy, coarse sand. And then you take out a book full of color charts like the ones you see in the paint store, only instead of names like "nuclear sunset" or "duckweed," they have names like "dark gray" or "light yellowish brown."

Even that's hardly the end of it. Where is a particular soil found topographically — on a ridge? On a hillside? Is it well or poorly drained? Deep or shallow?

Up on the mountains, you have a much shorter warm season, so the organic material that dies on top of the weathered rock doesn't have as much time to break down each year. It builds up in a much less-digested form, and you get peaty soils up there. Same thing closer to the coast, where pocosins and other swamps cover dead vegetation with water, preventing breakdown by the kind of microorganisms that create soil. You get peat there, too.

Kleiss says that soil is almost all surface area made up of incredibly tiny pieces. How tiny? Good question. Of course, there are organizing principles. Very coarse sand is from 1 millimeter to 2 millimeters in size; medium sand is a 1/4 millimeter to a 1/2 millimeter; silt particles measure less than 1/16 of a millimeter; and clay comprises particles smaller than 1/256 of a millimeter. You also measure roundness and sphericity and how well the pieces are sorted; Kleiss gave me a little measuring gauge with pictures and sand glued to it.

No, soil is not just dirt — as the engineers who took Carolina soils for granted have learned, and as farmers have learned decade after decade.

What kind of soil you have — where it came from, what makes it up, what lives in it — determines what you can grow, what you need to add to the soil to help it, what will and will not work. What you can build. Where you can dig. What will stick to your boots, and what you can brush off.

I can't say learning this much about the earth beneath my feet has helped me in any tangible way. That pile of red clay still lies in my yard, an inert blob, sending reddish plumes downslope during rainstorms; I still have no idea what to do with it. But now I know its name, and I know the names of its neighbors. And I know why we see those rows of tobacco plants where we do — and why the developers who slap themselves on the back for thinking up RTP might want to give some of the credit to the continental drift that laid down the miserable clays of the Triassic Basin when the earliest dinosaurs wandered around.

Now it's just me wandering around, whether in my neighborhood, in a park, or anywhere else in the state. Noticing the difference in the soil between the ridgetop and the bottom of the slope, seeing what grows where the water pools, what grows out in the sun, what the soil looks like where the crab apple tree cuts through it down by the greenway, what it looks like where the interstate dips out by the airport, where, if I'm driving east, past the fall line, it suddenly turns dark, and the crops begin. Good soil? Bad soil? It depends on what you want to do with it.

Me? I'd like to get something — anything — to grow in a big pile of red clay cluttering up my yard. But if I know nothing else, I know that the best soil for building houses is not necessarily the best soil for growing grass, or gardens, or, well, anything. Living in central North Carolina, though, that's a common complaint. Common as dirt.

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