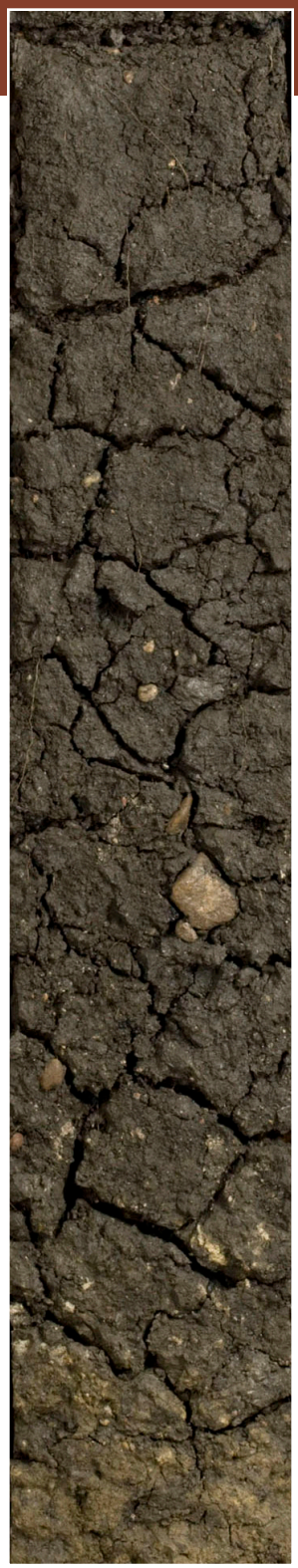
Houston Black

Texas State Soil



Soil Science Society of America

Introduction

Many states have a designated state bird, flower, fish, tree, rock, etc. And, many states also have a state soil – one that has significance or is important to the state. The "Houston Black is the state soil of Texas. Let's explore how the Houston Black is important to Texas.

History

The Houston Black soil series (**Figure 1**) is found only in Texas, and was first described in 1902, the third year of the National Soil Survey program, in Brazoria County. The Professional Soil Scientists Association of Texas chose Houston Black as the state soil of Texas.

What is Houston Black Soil?

The first thing you'll notice about this soil is its dark color and how sticky and moldable it is when wet. Because of these qualities, it's often called "black gumbo."

The Houston Black soil developed from calcareous clays and *marls* that were deposited during the Cretaceous Age (145 to 66 million years ago) from the receding and advancing shorelines of ancient seas. Prairie vegetation contributed to the *organic matter* and dark color in the surface of these soils.

The climate contributed its extreme wetting and drying cycles to the soils shrink-swell nature.

Houston Black soils occur on level to moderately sloping landscapes (0-8% slopes). This soil series is usually more than 200 cm (80 inches) deep. Water will drain through the profile moderately well; however, *permeability* of water is very slow due to the high clay content (46-60%) in this soil. Every soil can be separated into three separate size fractions called sand, silt, and clay, which make up the *soil texture*. They are present in all soils in different proportions and say a lot about the character of the soil. In Houston Black soils, the texture for this series is most commonly clay or silty clay.

The *topsoil* (A horizon) will crack when dry. Cracks can be more than 10 cm (4 inches) wide and 30 cm (12 inches) deep, and remain open for 90 to 150 days in most years. In the top 20 cm (8 inches), these soils typically have a few small shell fragments.

Houston Black is known around the world as a classic example of a *Vertisol*, a soil order which is a soil high in a particular type of clay called *smectite*. These clays swell during wetting cycles and shrink during drying cycles and cause the soil to crack when dry (**Figure 2**). In addition to the cracks, the repeated physical movement of the soil commonly results in formation of surface mounds and depressions that are called gilgai. Gilgai is an Australian aborigine term meaning "little water hole" (**Figure 3**).

A common feature of this soil order is the presence of *slickensides* (**Figure 4**) in the *subsoil* (B horizon) below depths of 30-60 cm (12-24 inches).

Photo: Chip Clark/Smithsonian Institution

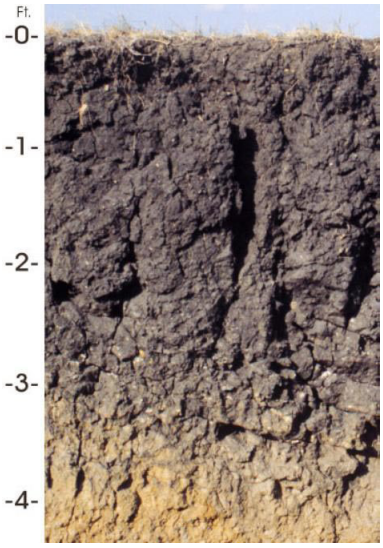


Fig. 1 Soil Profile of Houston Black Soil Series.Credit: USDA NRCS

Fig. 2 Cracks up to 2.5 cm (1 inch) wide in Houston Black soil after several days with no rain. Credit: Julie Howe

Fig. 3 Gilgai features on Texas Vertisol. Depressions that are filled with water after a rain reflect the aboriginal origins of the word meaning "little water hole." Credit: Cristine Morgan

Fig. 4 *Slickensides* are polished, grooved surfaces caused by the surfaces sliding against each other during shrinking and swelling of the soil. Credit: Soil Science Society of America

Fig. 5 Location of the Houston Black soil in Texas. Credit: *Smithsonian Institution's Forces of Change*.

The *smectite* clays are known for their ability to hold on to nutrients tightly enough to prevent them from being lost through water movement, but weakly enough that plants can use them. These nutrients include calcium, magnesium, and potassium.

The soils are generally gray to black due to *organic matter* left from decomposition of the prairie grasses. Because the soil formed from calcareous materials, the soil is slightly alkaline and will fizz when it contacts acid.

Houston Black is a Hall of Fame Series due to its long history of use in the National Cooperative Soil Survey. It is also a Benchmark Soil Series, which indicates that it has a special significance to farming, engineering, urban development and other uses.

Where to dig a Houston Black

Yes, you can dig a soil. It is called a soil pit and it shows you the soil profile. The different horizontal layers are called *soil horizons*. If you want to dig a Houston Black soil pit, you will have to travel to the Blackland Prairie of Texas, which extends from the Texas border north of Dallas to just south of San Antonio, along the route of Interstate 35 (Figure 2). It is here that you'll find the Houston Black. This soil can only be found in Texas, where it covers about 0.6 million hectares (1.5 million acres) of land in 33 counties (**Figure 5**). This does not mean that other types of soil are not found in that portion of the state, just that Houston Black is very common.

There are more than 1300 named soils (series) in Texas.

Fig. 6 Cotton and sorghum are common crops grown on Houston Black soils. Credit: NRCS, istock.

Importance

What makes the Houston Black soil so important is that it is unique to Texas. Before settlers arrived, the region was a tallgrass prairie. Less than 1% of the native prairie exists today. So, this soil reflects the special climate and vegetation conditions of our past. Native vegetation in the Blackland Prairie consists of tall and mid-sized grasses such as little bluestem, big bluestem, indiangrass, switchgrass, and sideoats grama. Now, the land is devoted to producing crops and animals, and to urban, recreational, and industrial uses.

Uses

Generally, soils everywhere can be used for agriculture (growing food for humans and animals); engineering (roads, buildings, tunnels); ecology (wetlands), recreation (ball fields, playground, camp areas), and more. Most Houston Black soil is found on farms, with the majority growing cotton, sorghum, and corn, but hay and pastureland are also common (**Figure 6**). It is one of the highest agricultural producing soils in Texas, generating between $300 to $500 million in annual revenue. Houston Black occurs in the area where millions of people live and work, including three of the largest metropolitan areas in Texas.

Limitations

When a soil cannot be used for one or more of the described functions, it is referred to as a limitation.

Soil experts, called *Soil Scientists*, studied Houston Black soil and determined that it has moderate to severe limitations that affect the choice of plants that can be grown.

While the soil and the landscape make the Blackland prairie very fertile agriculturally; the high clay content causes the soil to be very hard when dry and very sticky when wet, and it tends to shrink when dry and swell when wet. These properties pose limitations to how the land is worked for farming and construction. There are special management issues associated with the soil due to these properties.

Fig. 7 Contour terraces draining into a grassed waterway. Credit: http://passel.unl.edu/Image/siteImages/Terintogrsdwtrwy-LG.jpg

Fig. 8 Cracked foundation on home due to the shrinking and swelling of Houston Black clay it was built upon. Credit: Clay Robinson

Management

Houston Black soil is well known for its management problems. Erosion and water problems are the primary concerns.

Houston Black soil is very clayey, especially in the lower horizons, below 30 to 60 cm (12 to 24 inches). The great amount of clay hinders the movement of water and air. This affects growth of plant roots. Dry soils are cracked, but when it rains, they close and water enters slowly. If rainfall is intense, water may run off before it can infiltrate into the soil. Available water for plants is very high when the soil is wet and erosion hazards are generally moderate. Often *terraces, contour tillage*, and *grassed waterways* are used to keep water from running off the land before it has time to infiltrate (**Figure 7**).

Construction on this soil is often plagued by cracking from the shrinking and swelling movements (**Figure 8**). Hydrated lime often is added to stabilize the clays, and also layers of crushed rock and gravel are added to stabilize roads and large buildings. Foundations of buildings also need to be reinforced with steel rods.

Houston Black Soil Formation

Before there was soil there were rocks and in between, ClORPT. Without ClORPT, there will be no soil. So, what is ClORPT? It is the five major factors that are responsible for forming a soil like the Houston Black series. These are **Cl**imate, **O**rganisms, **R**elief, **P**arent material and **T**ime. ClORPT is responsible for the development of the soil profiles and chemical properties that differentiate soils. So, the characteristics of Houston Black soil (and all other soils) are determined by the influence of ClORPT. Weathering takes place when environmental processes such as rainfall, freezing, and thawing act on rocks causing them to fracture and break into pieces. ClORPT then acts on rock pieces, sediments and vegetative materials to form soils.

Climate – Temperature and precipitation affect the chemical, physical and biological relationships in the soil, and influence the rate at which parent materials weather and dead plants and animals decompose. The Houston Black soil developed in a warm climate with hot summers and cool winters. Rainfall ranges from 700-1000 millimeters (28-40 inches) during an average year. This climate was ideal for prairie grass formation, and the low rainfall prevented high weathering processes that would eventually dissolve and remove much of the calcium carbonate materials.

Organisms – Organisms are the plant and animal life. In the soil, plant roots spread, animals burrow in, and bacteria and fungi break down plant and animal tissue. These and other soil organisms speed up the breakdown of large particles into smaller ones. Plants and animals also influence the formation and differentiation of soil horizons. Plants determine the kinds and amounts of *organic matter* that is added to a soil under normal conditions. Animals break down complex compounds into smaller ones, and in doing so add *organic matter* to soil.

Houston Black soil is strongly influenced by the tall prairie grasses that grew on them **(Figure 9)**. Tall grasses provided plant litter that protected the surface, and as they decomposed they added organic residues to the soil. These residues help provide the characteristic dark color to the soil and provide good growing conditions for the plants. In addition, roots eventually decayed and provided food for earthworms and other soil organisms. Channels formed by roots and soil organisms improved water and air flow through the soil, both of which further improve the soil for plant growth.

Relief – Landform position or relief describes the shape of the land (hills and valleys), and the direction the slopes face which makes a difference in how much sunlight the soil gets and how much water it keeps. Deeper soils form at the bottom of the hill than at the top because gravity and water move soil particles downhill.

The Houston Black soil developed in a relatively flat to gently sloping landscape (0 to 8%) that was formed by ancient shorelines.

Fig. 9 Native tallgrass plant community in the Blackland Prairie of Texas contributed to the dark color of the soils. Dominant grasses include Little Bluestem, Indiangrass, and Big Bluestem. Credit:http://texasprairie.org/images/gallery/nelson_wieting_prairie/Winecup_and_Little_Bluestem.JPG

Parent material – Just like people inherit characteristics from their parents, every soil inherits some traits from the material from which it forms. Some parent materials are transported and deposited by glaciers, wind, water or gravity while others form in place from weathered bedrock. Houston Black soils developed from weathered marine sediments, primarily calcareous clays and *marls*, as well as some shales, sandstones, and chalk.

Marl and chalk are sedimentary rocks that form from the weathering of other rocks and marine deposits, accompanied by erosion and deposition. During deposition, the weathered materials pile up and eventually become compacted and cemented into a new rock. The compaction occurred when they were under water. The parent materials of Houston Black soil developed when the ocean extended into what is now the state of Texas.

Time – All the factors act together over a very long time to produce soils. As a result, soils vary in age. The length of time that soil material has been exposed to the soil-forming processes makes older soils different from younger soils. Generally, older soils have better defined horizons than younger soils. Less time is needed for a soil profile to develop in a humid and warm area with dense vegetative cover than in a cold or dry area with sparse plant cover.

The three main processes involved in the formation of horizons in Blackland soils are (1) accumulation of *organic matter* at the surface, (2) leaching of calcium carbonates and bases, and (3) weathering of parent rock into *smectitic clays*. All these processes influenced the development of Houston Black soil. The shrink-swell nature of the clays in the Houston Black creates mixing that limits the development of well-defined *horizons*, and so the Houston Black appears younger than nearby soils on the same landscape with less clay content.

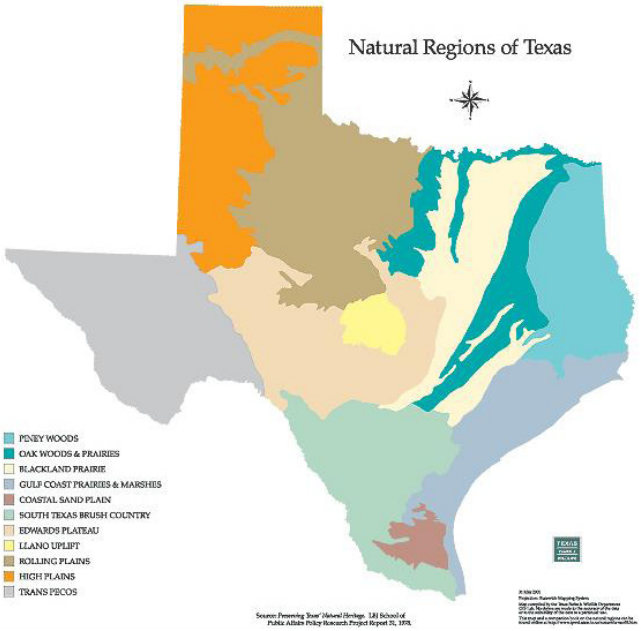


Fig. 10 Ecoregions of Texas include High Plains (orange), Trans Pecos (grey), Rolling Plains (brownish-green), Llano Uplift (yellow), Edwards Plateau (dark beige), Blackland Prairie (light beige), Oakwoods and Prairies (darkest green), Piney Woods (medium green), South Texas Brush Country (light green), Coastal Sand Plain (maroon), and Gulf Coast Prairies and Marshes (blue). Credit: Artwork courtesy Texas Parks and wildlife Department © 2004.

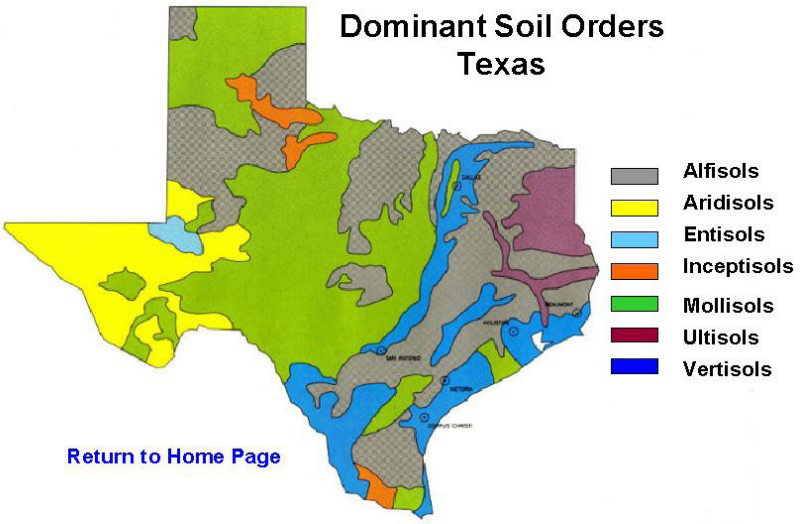


Fig. 11 Dominant soil orders of Texas include Alfisols (grey), Aridisols (yellow), Entisols (light blue), Inceptisols (orange), Mollisols (green), Ultisols (purple), and Vertisols (blue). Credit: USDA-NRCS

Ecoregions and Soils of Texas

Texas is a huge, diverse state that has mountains, valleys, hills, rolling plains, mesas, and coasts. These features occur on landscapes of different ages **(Figure 10)**.

Climate, parent materials, and organisms, combine to create diverse biomes in Texas, with several natural regions, or ecosystems, ranging from deserts to prairies to savannas to forests. Notice how the dominant soil orders of Texas can be related to the natural regions of Texas **(Figures 10 and 11)**.

Remember ClORPT? All these factors contribute to the many different types of soil that can be found in Texas. These individual soils are classified into groups based on similarities in their profiles and other characteristics. Soil, like plants and animals, has a classification system. It's called Soil Taxonomy. It has six levels: Order, Suborder, Great Group, Subgroup, Family, and Series. Nine of the 12 orders can be found in Texas (Figure 13). Houston Black is in the *Vertisol* Order. Notice how the dominant soil orders of Texas resemble the natural regions of Texas (Figures 9 and 10).Most soils around the state are used to support plant or animal agriculture. Cattle, sheep, goats, and wildlife graze on the prairies. Cotton, corn, wheat, sorghum, vegetables, citrus fruit, and pecans are some of the most important crops. Total receipts from all Texas crops totaled $6.9 billion in 2011.

Glossary

Contour: Strips of equal elevation on a landscape that run parallel to the slope. Very often they appear wavy across the farmland.

Contour tillage: Plowing and planting along contour lines (see *Contour* above).

Grassed waterway: Shallow long ditches which catch runoff water and slowly transport it off the field. The ditches have grass to slow water movement and trap sediment.

Marl: A type of sedimentary rock that forms from the weathering of other rocks and a mixture of soft calcium carbonate, clays and marine deposits, accompanied by erosion and deposition.

Organic matter: Material derived from the decay of plants and animals. Always contains compounds of carbon and hydrogen.

Permeability: Ability of air and water to pass through a soil.

Slickensides: A smoothly polished-looking surface on the surface of a soil crack caused by frictional movement.

Smectite: A type of clay that will shrink and swell due to their water content.

Soil Horizon: A layer of soil with properties that differ from the layers above or below it.

Soil Scientist: A soil scientist studies the upper few meters of the Earth's crust in terms of its physical and chemical properties; distribution, genesis and morphology; and biological components.

Subsoil: (B horizon) The soil horizon rich in minerals that eluviated, or leached down, from the horizons above it. Not present in all soils.

Terrace: Earthen structures build along contours on sloping farmlands to catch precipitation and reduce runoff.

Topsoil: (A horizon) – Mostly weathered minerals from parent material with a little organic matter added. The horizon that formed at the land surface.

Vertisol: One of 12 soil orders. They are characterized by *smectites* clays that swell when wet and shrink when dry causing cracks that may be deep and/or wide.

Additional Resources

Lindbo, D. et al. 2008. Soil! Get the Inside Scoop. Soil Science Society of America, Madison, WI.

Lindbo, D. L., D. A. Kozlowski, and C. Robinson (ed.) 2012. Know Soil, Know Life. Soil Science Society of America, Madison, WI.

Web Links for More Information

Soils for Kids, http://www.soils4kids.org/

Resources for Teachers, www.soils4teachers.org

Have Questions? Ask a Soil Scientist,https://www.soils.org/ask

Soil Science Society of America, https://www.soils.org/

Natural Resources Conservation Service, Texas Soils Homepage http://www.nrcs.usda.gov/wps/portal/nrcs/main/tx/soils/

Texas A&M Soil Characterization Laboratory, http://soildata.tamu.edu/

Texas State Soil and Water Conservation Board, https://www.tsswcb.texas.gov/

Web Soil Survey, http://websoilsurvey.sc.egov.usda.gov/App/HomePage.htm

References

Fisher, M., 2012. A Day in the Life: Ted Hartsig. Soil Horizons doi:10.2136/sh2012-53-2-ldl.

Miller, W.L., Sz. Kishne, A., and Morgan, C.L.S. 2010. Vertisol morphology, classification, and seasonal cracking patterns in the Texas Gulf Coast Prairie. Soil Surv. Horiz. 51:10-16.

Natural Resources Conservation Service, USDA. Houston Black – Texas State Soil. ftp://ftp-fc.sc.egov.usda.gov/NSSC/StateSoil_Profiles/tx_soil.pdf

Natural Resources Conservation Service, USDA. What on Earth is Houston Black Soil? Fact Sheet Feb 2003. ftp://ftp-fc.sc.egov.usda.gov/TX/factsheets/fact_houstonsoil.pdf

The Paleontology Portal. http://www.paleoportal.org/index.php?globalnav=time_space&sectionnav=state&state_id=42&period_id=18

Natural Resources Conservation Service, USDA. Official Soil Series Descriptions. http://soils.usda.gov/technical/classification/osd/

Authors:
Julie Howe
Clay Robinson

Soil Science Society of America

5585 Guilford Road
Madison WI 53711-5801
Tel. 608-273-8080 • Fax 608-273-2021
www.soils.org • headquarters@soils.org

This state soil booklet was developed under the auspices of the Soil Science Society of America's K-12 Committee —their dedication to developing outreach materials for the K-12 audience makes this material possible.