Casa Grande

Arizona 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 Casa Grande is the state soil of Arizona. Let's explore how the Casa Grande is important to Arizona.

History

The Casa Grande series was established in Pinal County in 1936 and named after the city of Casa Grande and the nearby national monument. The Casa Grande National Monument preserves a 1,000 year old Hohokam Indian building. Casa Grande is Spanish for Big House which is an apt name for this earthen structure. Because of the high salt content of Casa Grande soils, the Hohokam employed irrigation to leach out the excess salt to make conditions right for growing cotton, vegetables, and grain. This soil is still very productive.

What is Casa Grande Soil?

Casa Grande soils are very deep, well-drained, saline-sodic soils located on fan terraces and relict basin floors, at elevations ranging from 700 to 2,000 feet above sea level. The slopes of these surfaces range from 0 to 5 percent. These surfaces comprise old alluvium that came from a variety of rocks that include granite, rhyolite, andesite, quartzite, and some limestone and basalt. *Alluvium* is when clay, silt, sand, and gravel are deposited by flowing streams in a variety of settings. These materials get deposited "downstream," which in this case is at the base of well-worn mountains of southern Arizona. These soils are very old and slow in forming since there is very little moisture in the form of precipitation to help with the erosion and deposition of materials needed to create the soils. Casa Grande is known taxonomically as a Natrargid which means it is a soil with a lot of salt and silicate clay from a very dry area. Every soil can be separated into three separate size fractions called *sand, silt,* and *clay,* which makes up the *soil texture*. They are present in all soils in different proportions and say a lot about the character of the soil.

Breaking down the profile of a Casa Grande soil, the uppermost layer, which is the A horizon, has the texture of fine sandy loam. It is only about an inch deep. The A horizon quickly gives way to a thick clay loam B horizon that gets more and more *alkaline* with depth, reaching a pH as high as 9.6. This alkalinity can be attributed to an accumulation of salts and carbonates. If an acid, even a weak one like vinegar, is put on this soil it bubbles violently (known in soil science as effervescence). The clay impedes the progress of the salts and carbonates in the soil, compounded by the fact there is very little moisture in the soil profile to allow for *leaching*. So things like carbonates and salts tend to get stuck in the soil profile. Overall the soil profile has a yellow brown to brown color to it, although there can be seen white carbonate coatings as well as a few dark manganese coatings on the surfaces of the soil's structures.

Photo: Chip Clark/Smithsonian Institution

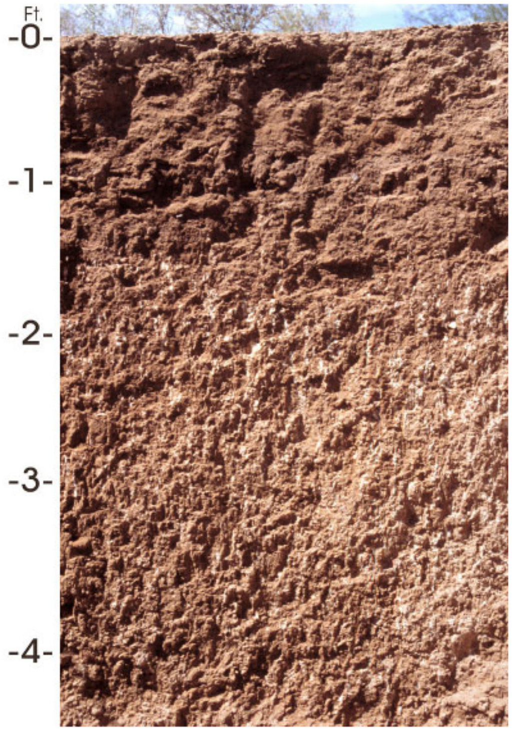

Fig. 1. Casa Grande Soil ProfileSurface layer: light brown, saline-sodic fine sandy loamSubsoil - upper: reddish brown, saline-sodic sandy clay loamSubsoil - lower: light reddish brown, saline-sodic clay loam Credit: WA State NRCS.

Fig. 2. Distribution of Casa Grande soil series. Credit: Smithsonian

Fig. 3. What Casa Grande soil looks like on the surface when not in agricultural use.

Where to dig Casa Grande

Yes, you can dig a soil. It is called a soil pit and it shows you the *soil profile*. The different horizontal layers of the soil are called *soil horizons*. This does not mean that other types of soil cannot be found there but that the Casa Grande is the most common.

Casa Grande soils can be found in southern Arizona, mostly in an area known as the central valley. This area includes the counties of Maricopa, Pinal, and Pima (**Figs 1 and 2**). There are about 275,000 acres determined to be Casa Grande soil and probably several million more acres distributed throughout central and southwestern Arizona. In all, there are over 220 named soils (series) in Arizona.

Importance

What makes the Casa Grande soil important to the state of Arizona is its tie to the past and the lessons it can teach us in the present. As mentioned earlier the soil was named after the town and the national monument located near its type location. The Casa Grande National Monument preserves a very large earthen structure built by Native Americans who had settled in that area centuries earlier. Over 1,000 years ago the Hohokam Indians had a thriving civilization and were very dependent on the soil. The Hohokam realized that with irrigation the salts could be leached out and the soils could be very productive. They built a huge network of canals to bring water out from the Gila and Salt rivers into the desert. However, that practice also caused problems for the soil as climate conditions changed. Temperatures increased, precipitation decreased, and the quality of the irrigation water got worse, which at the time meant there were a lot of minerals in it. Over time salts accumulated again and agriculture suffered. This is one of the theories for why the Hohokam disappeared from that part of Arizona and it is lesson for us in modern times on the importance of proper soil health management. (https://ag.arizona.edu/OALS/ALN/aln58/silvertooth.html)

Fig. 4. Pima cotton growing in a field near Phoenix, AZ. Credit: (http://arizonaexperience.org/remember/pima-cotton-boom)

Uses

In general, soils can be used for agriculture (growing foods, raising animals, stables); engineering (roads, buildings, tunnels); ecology (wildlife habitat, wetlands), recreation (ball fields, playground, camp areas) and more.

Despite the current high salt content in the soil profile, Casa Grande soil can be very productive when provided with a little bit of irrigation which helps wash out salts. Casa Grande soil supports significant Arizona crops such as cotton, small grains, grain sorghum, alfalfa, and pasture grasses **(Fig 4)**. It also serves as pastureland and grazing land for dairy and cattle raising operations.

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 Casa Grande soil and identified that it has several limitations.

Casa Grande soil can only support certain types of plants as well as special conservation practices are required in its management. Because of the high level of salts and some shrink-swell clays there are limitations to building and home construction, such as overexcavating and backfilling with coarse textured material. Construction also brings up salts to the surface and then these salt-affected topsoils are susceptible to blowing. Revegetation of these disturbed areas should be prompt but will be difficult because of the high salt content. Materials like steel pipes and concrete can experience high amounts of corrosion.

Permeability of water into Casa Grande soil is slow making it poorly suited for septic systems. As stated earlier, irrigation can remove much of the salts from the upper profile of the soil allowing for agriculture. However, as soon as the irrigation is discontinued the salts creep back up toward the surface. Plants, especially desert herbaceous plants, shrubs, and trees that provide habitat for wildlife have a hard time getting established without proper leaching, fertilizing, adding amendments, and mulching.

Management

Intensive management is necessary to reduce the impacts of the salts otherwise the soils will not be productive. Because this soil has slow water permeability, the area to come under use should be leveled so as to allow for a deeper, more uniform infiltration. Surface and trickle irrigation systems would work best on this soil. This soil also has very low organic matter content, tends to blow away when uncovered or exposed during tilling. It is recommended that *crop residues* should be maintained on the fields to keep the impacts of wind and evaporation low. Grazing also has an impact on the amount of ground cover and needs to be managed so that enough vegetation is left behind to prevent soil loss by wind.

Casa Grande 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 Casa Grande series. It stands for **Cl**imate, **O**rganisms, **R**elief, **P**arent material and **T**ime. ClORPT is responsible for the development of soil profiles and chemical properties that differentiate soils. So, the characteristics of Casa Grande (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 dissolve or fracture and break into pieces. ClORPT then acts on rock pieces, marine sediments and vegetative materials to form soils.

Climate – Temperature and precipitation influence the rate at which parent materials weather and dead plants and animals decompose. They affect the chemical, physical and biological relationships in the soil. The climate is hot and arid where Casa Grande soils were formed. The annual precipitation is only 6 to 10 inches. The average annual air temperature ranges from 67 to 75 degrees F, which means that more than ¾ of the year there is no threat of frost.

Organisms – This refers to plants and animal life. In the soil, plant roots spread, animals burrow in, and bacteria break down plant and animal tissue. These and other soil organisms speed up the breakdown of large soil 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 are added to a soil under normal conditions. Animals breakdown complex compounds into small ones and in so doing add organic matter to soil. Casa Grande soils actually are very low in organic matter. There are very few plants adapted to the salts that have accumulated in the profile, but there are a few hardy desert dwellers that are able to persist such as desert saltbush, fourwing saltbush, winter and summer annuals, mound cactus, creosote, mesquite, palo verde, and Mediterraneangrass. However, when Mediterraneangrass increase at the expense of native forbs and grasses then this is taken as an indication that the soil is in a decline.

Relief – Landform position or relief describes the shape of the land (hills and valleys), and the direction it faces 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 rather than at the top because gravity and water move soil particles downhill. Casa Grande soil has a slight slope and sits at the bottom of the incline that produced the accumulated alluvium that makes up Casa Grande soil.

Parent material (C horizon) – 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. Casa Grande is a complex mix of granite, rhyolite, andesite, quartzite, and some limestone and basalt. Transported down eroded mountains, this alluvium collected at the base, which is predominantly clay and fine material.

Time – All the factors act together over a very long period of 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 dry area with sparse plant cover. More time is required for the formation of a well-defined soil profile in soils with fine textured material than in soils with coarse-textured soil material. While the region did experience more precipitation during the ice ages, arid and hot conditions have persisted for thousands of years in the area Casa Grande soils can be found. This means it has taken a lot of time to have the kind of formation process Casa Grande soil has had.

Ecoregions, Soils and Land Use in Arizona

Arizona is a very unique place geologically and ecologically speaking. An easy way to discuss this uniqueness is to divvy up the state into different regions and speak about them separately **(Fig 5)**. Arizona can be split up into 3 geologic regions: The Colorado Plateau, The Basin and Range, and the Transition Zone (also known as the Central Highlands). The Colorado Plateau, tucked under the western edge of the Rockies in the northeast corner of the state, is an area dominated by sedimentary rocks that at one time millions of years ago was covered by an inland sea. Due to uplift the Plateau has been raised to an average of 5,000 ft above sea level. The Plateau would be much higher, however, significant erosion, river cutting, and canyon formation (like the Grand Canyon) has been wearing away at the rock there.

At the opposite end of the state in the southwest corner is the Basin and Range region. This is where the Casa Grande soil is located. This area is characterized by mountain chains and sky islands abruptly rising from a valley floor that is several kilometers deep with alluvium deposits from the erosion of those mountains.

In between the Colorado Plateau and the Basin ad Range areas is the Transition Zone. This area also experienced uplift and exceeded the Colorado Plateau in elevation. The erosion that followed exposed some of the oldest rock in the state that go back to the Precambrian era (over 540 million years ago!). There is a lot of evidence of volcanism through the area as well.

Because of the great elevation changes, going from 141 ft above sea level in Yuma to 12633 ft above sea level on Humphreys Peak, this has allowed for the development of many different ecological zones **(Fig 6)**. Starting at the highest elevations above the treeline, there is a Tundra region where plants similar to those that grow in Alaska can be found. Just below is the Coniferous Forest region where pines that can be found in the Rocky Mountain Range dominate. As we continue our descent we find the Temperate Deciduous Forest. Here a mix of aspens, riparian trees, oaks, and some pines thrive. The next two regions, the Grassland and the Chaparral, are nearly the same elevation but occur in different areas in the state. The Grassland Region is unambiguously dominated by grasses, but dried than what can be found in the Great Plains, due to the impact of the nearby desert. The Chaparral Region is semiarid and populated with woody vegetation like low evergreen trees and shrubs. Some tree species of note are oaks, manzanita, low pines, and junipers. The Desert Region, the largest biome in the state comprises 4 deserts: the Great Basin, Mohave, Sonoran, and Chihuahuan deserts. Dominated by cactus and desert adapted plants like the creosote, mesquite, and palo verde, the landscape does maintain a surprising amount of life in spite of very dry conditions.

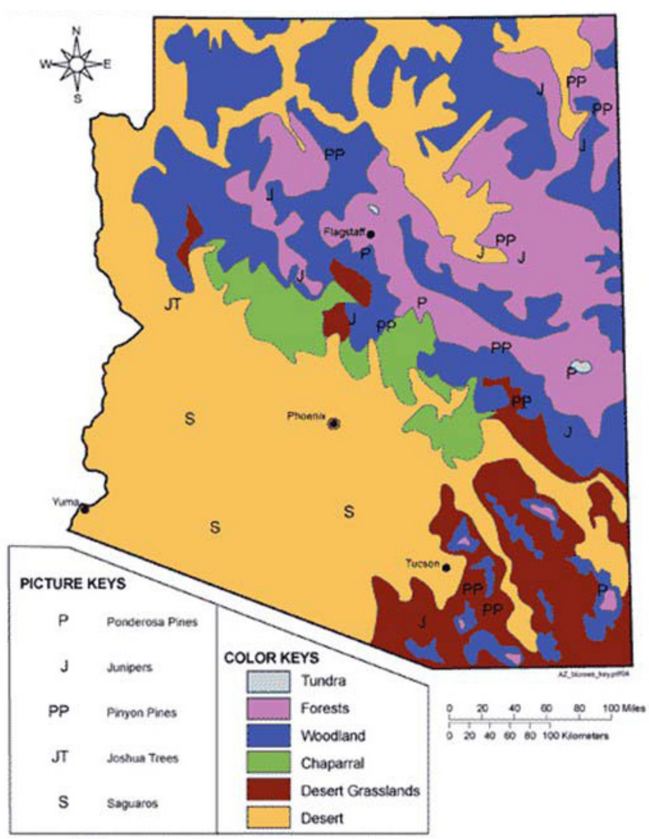

Fig. 5 and 6. Maps displaying the geologic (above) and ecological (right) regions of Arizona. Credit: Arizona Geographic Alliance.

Glossary

Alkaline Soil: Soil with a pH value >7.0.

Alluvium: Sediments deposited by running water of streams and rivers. It may occur on terraces well above present streams, on the present flood plains or deltas, or as a fan at the base of a slope.

Clay: A soil particle that is less than 0.002 mm in diameter. Clay particles are so fine they have more surface area for reaction. They hold a lot of nutrients and water in the soil. A clay soil is a soil that has more than 40% clay, less than 45% sand and less than 40% silt.

Crop Residue: The plant residue (stubble, stalks, etc) on the surface of the soil which is used to prevet wind and water erosion, to conserve water, and to decrease evaporation.

Ecoregion: Represents areas with similar biotic and abiotic characteristics which determine the resource potential and likely responses to natural and man-made disturbances. Characteristics such as climate, topography, geology, soils, and natural vegetation define an ecoregion. They determine the type of land cover that can exist and influence the range of land use practices that are possible.

Horizon: see Soil horizons

Leaching: The removal of soluble material from soil or other material by percolating water.

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

Sand: A soil particle between 0.05 and 2.0 mm in diameter. Sand is also used to describe soil texture according to the soil textural triangle, for example, loamy sand.

Silt: A soil particle between 0.002 and 0.05 mm diameter. It is also used to describe a soil textural class.

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

Soil Profile: The sequence of natural layers, or horizons, in a soil. It extends from the surface downward to unconsolidated material. Most soils have three major horizons, called the surface horizon, the subsoil, and the substratum.

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. A soil scientist needs a strong background in the physical and biological sciences and mathematics.

Soil Texture: The relative proportion of sand, slit, and clay particles that make up a soil. Sand particles are the largest and clay particles the smallest. Learn more about soil texture at www.soils4teachers.org/physical-properties

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

Water table: The top layer of ground water where the soil is filled with standing water. It can move up or down during different seasons.

Additional Resources

Soil! Get the Inside Scoop. David Lindbo and others. Soil Science Society of America, Madison, WI.
Know Soil, Know Life. David L. Lindbo, Deb A. Kozlowski, and Clay Robinson, editors. Soil Science Society of America, Madison, WI.

Web Resources

SOIL SCIENCE LINKS:

Soils for Teachers—www.soils4teachers.org

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

Have Questions? Ask a Soil Scientist—https://www.soils4teachers.org/ask

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

References

Arizona Biomes Map. Biomes. Class Brain, n.d. Web. 13 Sept. 2016. <http://www.statereports.us/wp-content/uploads/2010/04/az_biomes.gif>.

Central Highlands Planning Area Geography. Arizona Water Atlas Volume 5. Arizona Department of Water Resources. 27 Mar. 2014. Web. 10 Sept. 2016. <http://www.azwater.gov/AzDWR/StatewidePlanning/WaterAtlas/CentralHighlands/PlanningAreaOverview/Geography.htm>

Hall, Jon F. *Soil survey of Pinal County, Arizona*, western part. (1991).

Hendricks, David M. *Arizona soils*. (1985).

Schoeneberger, P. J., D. A. Wysocki, and C. G. Olson. Glossary of landform and geologic terms. (1998).

<https://www.google.com/url?sa=t&rct=j&q=&esrc=s&source=web&cd=1&cad=rja&uact=8&ved=0ahUKEwikg4mO7o3PAhXBOj4KHUgJANcQFggcMAA&url=http%3A%2F%2Fwww.nrcs.usda.gov%2FInternet%2FFSE_DOCUMENTS%2Fnrcs142p2_052234.doc&usg=AFQjCNGfGdIfJH64o9wljAo0C1KESUjXFg&sig2=_A5rVdziTg6FdrGLugc-nA&bvm=bv.132479545,d.eWE>

Silvertooth, Jeffrey C. Saline and sodic soil management in irrigated crop production systems. Arid Lands Newsletter. University of Arizona. 2005. Web. 10 Sept. 2016. <https://ag.arizona.edu/OALS/ALN/aln58/silvertooth.html>

The Pima Cotton Boom. The Arizona Experience. Arizona Centennial Commission, n.d. Web. 10 Sept. 2016. <http://arizonaexperience.org/remember/pima-cotton-boom>

Author: Luke Cerise, Soil Scientist, Okanogan-Wenatchee National Forest, Vytas Pabedinskas, and Wilson, Robert, NRCS-AZ

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.