

No Soil, No Us, Know Soil, Know Us!

Soil, as we know, is often considered as dirt! We may not know that this dirt is a mixture of different minerals and sometimes liquids, gases, living organisms and organic matter that support life on Earth. It may not be surprising to walk for 1-2 km and see the change in soil type around us. This soil may be formed from the parent rock or brought in by human activities like construction. In this learning unit, we try to get a broader sense of the basic differences in the soils, their unique properties and understanding their roles in our lives.

Task 1: Value of Soil in Your Locality

Soil as known, understood and used by local people is different at different places. Let us try and collect some information on the various types of soils that are present in your localities. Given below are a few questions. Discuss these questions among your friends, teachers and elders in the vicinity. You can do this task in groups of 2-3 students.

Meanwhile, other students from your groups can collect 3 soil samples in the school campus. Soils from garden, roadside, open ground, banks of a pond etc can be collected.

Collect two samples of the same soil.

- One just from the surface.
- Other one by digging a pit of 1-2 ft deep(using a shovel)-Sub surface soil.

Some of you may be familiar with farming/gardening or construction activities. Some of you may not be. Given below are two sets of questions. Depending on your background, you may collect answers for any one of the two sets.

SET A (for students familiar with farming/ gardening/construction)

1) Describe the soil in your locality? (think of properties like color, texture, smell)

2) Is the soil fertile or it needs specific fertilizers to grow plants? Which plants/crops grow well in this soil?

3) Some soils have an ability to let water pass through their pores (porosity) and some soils retain water. Have you seen any canals/ water reservoirs build in the soil in your locality? Does this soil hold water in it for a long time?

4) Certain varieties of soils soften a lot during rainy seasons and get easily washed off. Have you seen any road/building floor in your locality developing cracks or potholes? If yes, do you think the nature of soil will be responsible for it?

5) Often, the nature of soil changes in a span of few years due to various reasons like agriculture, deforestation, industrialisation etc. Do you find any changes in the nature of soil in your locality? Also, is the soil known to be polluted due to any sources of pollution nearby?

6) At many places, coloured soils called geru, khadiya, chuna, or any other coloured soils are used for painting houses or pottery or making rangoli. Is the soil in your locality used for making any kind of colours or pigments?

7) At many places, soils are used to make water filters. Have you seen water filters made out of soil in your locality?

SET B (for students NOT familiar with farming/gardening/construction)

Soil can be understood in terms of following properties : water holding capacity, chemical nature of soil, stickiness, particle size, porosity. Consider these properties for the following questions.

1) If you want to set up a large garden for growing fruits and vegetables, what type of soil will you prefer? What different properties of soil will you consider?

2) You are given 4 different samples of soils viz. red soil, shadu mati (natural clay), black soil and sandy soil. You have to make a *diya*/small pot using any of these soils. Which soil will you use and why?

3) We often hear of structures like tunnels collapsing down, occurrences of landslides due to multiple reasons such as heavy rainfall, deforestation in the nearby places, etc. Do you think soil underneath and around also plays a role in it? In what ways?

4) Sand and clay is mined for construction, bauxite or haematite for metal extraction and silica for electronics. Is any soil in your vicinity used for extracting any metals or materials for industry?

Task 2: Let us observe whatever you have collected.

Colour of the soil depends on the quantity of organic matter present and the kind of minerals it contains.

Soil colour: Look at the soil samples and see if it is red, black, or grey. Is it black even when dry? Do you see particles of same colour or of different colours in it?

Soil Texture: Soil texture is best understood in wet soils. Hence, use wet soil to check its texture.

Take 1-2 pinch of soil on your hand. Pour 2-3 droplets of water on it and feel the soil in between your fingers.

Do you feel hard particles/ slippery but non-sticky/very soft and sticky particles of the soil? Based on size, soil particles are classified as gravels, sand, silt and clay.

Note their colours, texture (fine, coarse, pebbles), containing lot of biological matter (decaying plants, leaves, insects), and fill in characteristics in table below.

Soil	Visual Characteristics (colour, texture, presence of plants/insects matter)			
		Color	Texture	Presence of plants/insects
S1	Surface soil			
	Sub-surface soil			
S2	Surface soil			
	Sub-surface soil			
S3	Surface soil			
	Sub-surface soil			

Note: Use the same soil samples in the same sequence for Task 3- Part B.

Soils that Change Lives and thus Histories

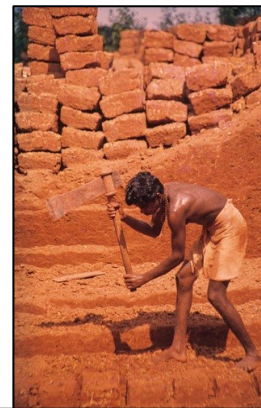
Story 1

Dr. Francis Buchmann, a surgeon in East India Company, when visited Angadipuram in Malappuram district in Kerala in 1807, reported a very unusual observation to the British Government. He saw a red-yellow soil about which he writes:

"What I have called the indurated (Hardened) clay..... is one of the most valuable materials for building. It is diffused in immense masses, without any appearance of stratification and is placed over the granite that forms the basis of Malayala (Kerala). It is full of cavities and pores and contains a large quantity of iron in the form of red and yellow ochres. ... while excluded from air, it is so soft, that any iron instrument readily cuts it, and it is dug up in square masses with a pick-axe, and immediately cut into the shape wanted with a trowel or a large knife."

"It, very soon after, becomes as hard as brick, and resists air and water much better than any bricks that I have seen in India..."

In Kerala, this soil was known as "*chenkallu*". Dr. Buchmann called it Laterite, based on the Latin Word "*letritis*" meaning bricks. Laterite has the peculiar property of being soft when freshly cut from below the ground level and becoming very hard as it dries. On drying, it can be used as construction material (without firing in a furnace like clay bricks) just like stones and bricks. Therefore, mining of Laterite for making construction stones has been a commercial activity in such areas. Many historical building (including parts of Konark Sun temple in Orissa) have been made using laterite blocks which have survived centuries of rains and air. On a given land, therefore, its top layers exposed to air are much harder than the wet layers below the surface.



Cutting of Laterite stones in Angadipuram, Kerala, www.newworldencyclopedia.org/entry/Laterite



Laterite blocks mined in Goa (Source: Directorate of Mines and Geology, Goa, www.dmggoa.goa.gov.in/laterite.php)



Laterite is formed after several years of rainfall on high lands common in Karnataka, Kerala, West Maharashtra, Central Odisha and Assam and in many other parts of the world. When soluble minerals dissolve in rainwater and get washed away, insoluble iron and aluminum compounds remain. The iron compounds give the soil yellow to red colour. This soil cannot hold water due to high porosity. Therefore, it is not highly suitable for agriculture. Iron rich varieties of laterite are also mined as iron ore while aluminum rich varieties are mined as aluminum ore in the name of bauxite.

Now let us try answering a few questions:

Q1. Have you found any soil in your locality having this property of being soft when wet but becoming permanently hard on drying? The soil does not soften even after pouring water over it again.

Q2. Why do you think Dr. Buchmann found the red soil so interesting that he wrote about it to the British Government?

Q3. Do you think the kind of soil in a region can affect the life of people living there? Is laterite soil good for the people living there or bad?

Q4. Is it easy to make canal or a water reservoir in an area with the laterite rich soil? Will you need some other type of soil to make canal/water reservoir?

Soil deposited by the rivers during the 2018 floods in Kerala was acidic in nature and it needed to be treated with laterite or loamy soil before agriculture use.

Task 3: Some chemical properties of soil and soil porosity

Note: Use the same samples collected in Task 2 for this task.

Part A

Soil Acidity/Basicity: (This part can also be done after porosity test)

Take 10 gm (or two spoonful) of soil in a beaker and add about 20 ml (or one test tube) of water. Stir it. Use this slurry for these tasks. Use a litmus paper to check if it is acidic or basic.

Carbonate content: Now take a spoonful of soil and add few drops of lime juice or vinegar. Is there any effervescence (evolution of a gas in form of tiny bubbles)? In most cases, effervescence indicates presence of carbonate minerals in the soil and the gas evolved is Carbon Dioxide

Soil+Vinegar → Carbon dioxide (effervescence)

Part B Porosity Test

- Stir the soil slurry with a spoon or spatula. Pour this slurry into the funnel kept over a beaker/test tube. Is water passing easily through the soil? (surface and sub-surface soil)

- Determine how many ml of water passes through the funnel per minute. Also, calculate relative drainage rate per minute. Does it decrease with time?

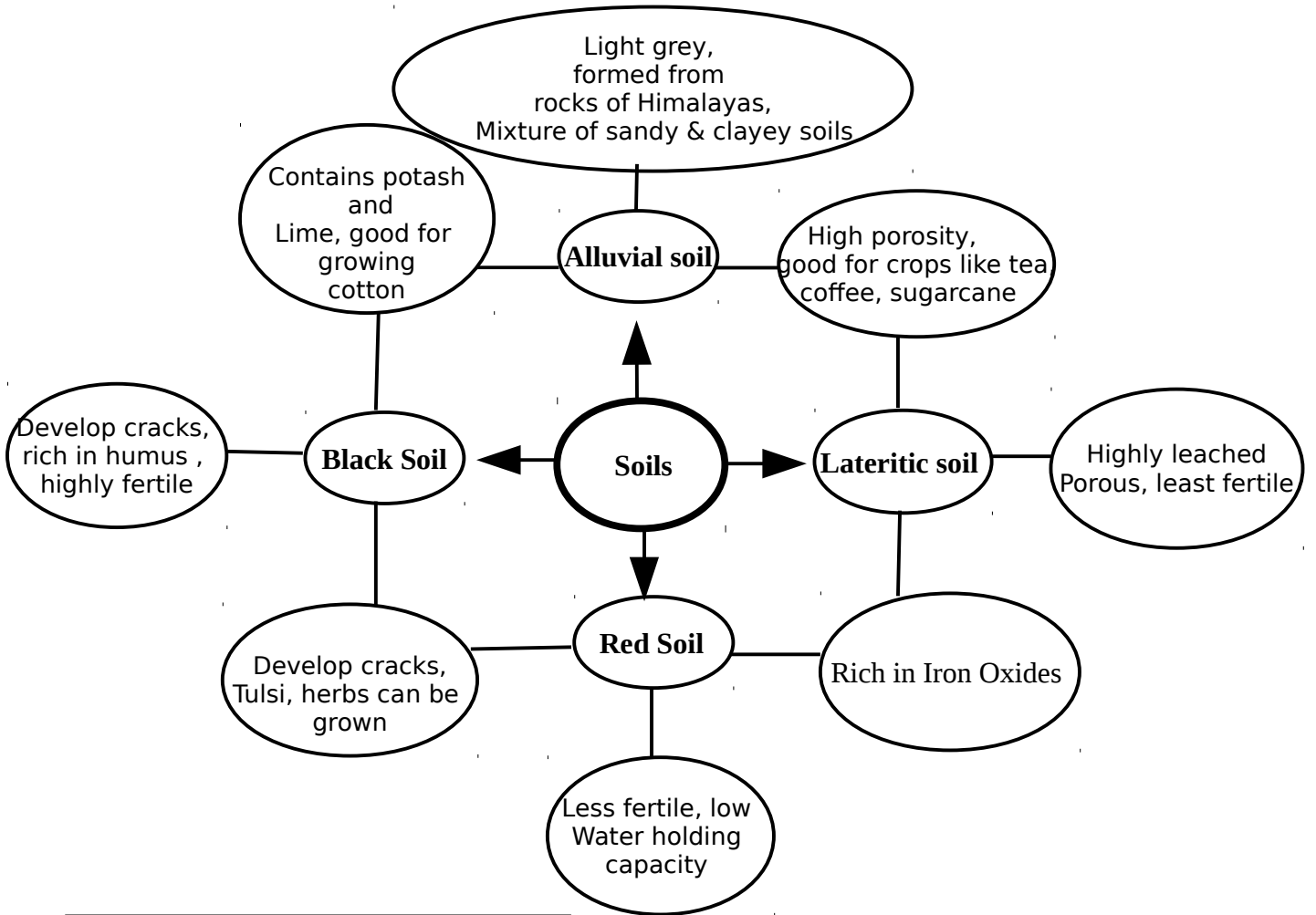
- Add more water over the funnel and measure the rate again. Does it decrease? Is there any difference in the rate with change in soil sample (with depth)?

Record the observations in the table below.

Soil	Physico-chemical Characteristics (stickiness, porosity, acidity/basicity, presence of carbonates)				
		Stickiness	Porosity	Acidic/Basic	Carbonates
S1	Surface soil				
	Sub-surface soil				
S2	Surface soil				
	Sub-surface soil				
S3	Surface soil				
	Sub-surface soil				

Q. What do these above observations of soil in funnel tell you about the porosity of soil in your school area? Will these observations be consistent when you observe the soil during the rainfall?

Study the given concept map of different types of soils.



Q. Have you seen such a soil or pictures of dry land with big cracks in it? Where?

Now a memory game... Try to recollect:

In summers, does the soil in your school area crack? Yes No

In monsoon, do puddles form within few minutes of rain or after a lot of rain? Does it tell anything about porosity of soil?

About your soil samples:

Since now you have observed the colour, texture, porosity, and recollected its behaviour in rains/summers, can you tell if soil in your school is:

- a. Laterite b. Red Soil c. Black Soil d. Alluvial soil e. Any other type _____

Story 2: Diversity in soils over short distances.

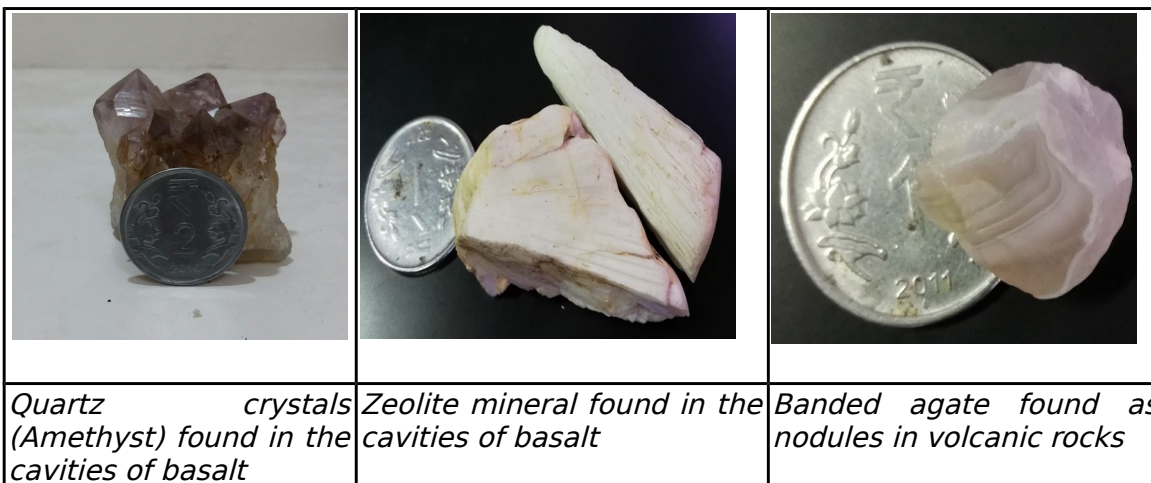
Dr. Pradeep Sarkar, an earth scientist from Pune while walking with his friends in the small hills of *Belhe* and *Alkuti* villages of Ahmednagar district (Maharashtra) noticed huge black boulders of rocks (called Basalt) which had beautiful crystals in them. Some of the large crystals were white to cream colored, and some of the smaller crystals were brownish in color. The brown colouration they thought could be caused by action of water, soil minerals or living organisms on the white crystals. The detailed observation of surrounding rocks gave them a different cluster of varied minerals. There, minerals had shades of green, some of which were opaque and some beautifully crystallized, in the cavities of the main rocks.



Photo showing layer of red bole marking the base of basalt

Their knowledge of earth science indicated that some of these minerals are found in some other parts of the world as well but are not found in all soils of India.

Further, within ~5 km of that area, they also found layers of red and green colored clayey rocks showing angular and blocky structures (common in black basaltic rocks). This was surprising because that region is made of igneous rocks (black basalt), and such layer of red and green soil could not come from physical breaking of the basalt rocks. One of the fellows told *“This red patch (known as Red bole) could be so because of iron and magnesium rich minerals (Fe_2O_3 and MgO) remaining as a result of chemical weathering of the basalt rocks”*. Dr. Sarkar further explained that these layers of red boles have commonly been seen in the Deccan Plateau of southern India, formed due to chemical changes as water flowed through the transition zone between two rocks.



A small kid who was passing by them got fascinated by the rocks these people were holding in their hands. He thought to himself, *“What wonderful structures are shown by these crystals! I could actually collect a lot of them and make a necklace out of them for my sister!”*. Smiling at Sarkar, he went back on his way.

Q5. Do you find such color variations and crystals in the rocks and soils in your surroundings?

Q6. How the colour of crystals affects the colour of the soil in the area?

References:

1. Buchannan F (1807). A journey from Madras through the countries of Mysore, Canara, and Malabar. East India Co., London, 2, 440-441.
2. Sarkar P. et al (2016). Petrography of Megaporphyritic Lava Flow from Belhe-Alkuti area, Ahmednagar district, Maharashtra, India, JGSR vol. 1,no2, pp.105-110.