

SDG 15 Seeding Sustainability

MM5: Secrets of Soil



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Experimentation and Exploration

Lesson 12: Soil Chromatography Experiment

Subjects: CSPE, English, Geography, Horticulture, Science

Lesson Title and Summary: Soil Chromatography Experiment

In this lesson, we look at the intriguing world of chromas, captivating and intricate images that unveil the hidden beauty and complexity of soil composition. This method allows us to capture a soil sample's essence on paper, creating unique pieces of art that reflect the soil's composition and the bustling microcosm within it.

NB: Learners should have completed Lesson 11, in advance as preparation for this class.

Vocabulary: Biodynamic, Chroma, Solution, Supernatant

In this lesson, the learner will:

- obtain and interpret results (chromas) of a chromatography experiment using soil.
- consider the differences in soil health visually and defend its view critically.

Materials:

- Worksheet: Chromatography
- All the materials produced in lesson 11
- Petri dishes
- Pipettes
- Coffee filters or chromatography paper
- Scissors

3 GOOD HEALTH AND WELL-BEING



11 SUSTAINABLE CITIES AND COMMUNITIES



12 RESPONSIBLE CONSUMPTION AND PRODUCTION



13 CLIMATE ACTION



MM5: Secrets of Soil

L12: Soil Chromatography Experiment



ACTIVITY INSTRUCTIONS

NB: This lesson is linked to Lesson 11 and should be delivered sequentially

Activity 1: Experiment and Analysis (50 minutes)

1. Learners should get into their groups from Lesson 1.
2. Hand out Worksheet: chromatography and have learners complete the pre-experiment questions.
3. Discuss as a class.
4. Have learners retrieve their circles and soil samples from Lesson 11.
5. Have learners follow the instructions to complete the experiment and record their information on the worksheet: chromatography.
6. Have learners complete the post-experiment questions on the worksheet: chromatography.
7. Discuss as a class.
8. Allow learners to take home their soil chromas or display them in the classroom.

Additional Lessons: Learners could also create a public display, using the soil chromas to share their knowledge with other classes or their communities. This could be done using Microsoft Sway if you are using this in your school or using Media Communication 2 or 3, from one of the other programmes e.g. Future of the Ocean, MM7, to create a presentation or a poster

REFLECTIVE EXERCISE: 3-2-1 (10 mins)

- Three things they feel they have learnt from the tasks.
- Two things they found most interesting and would like to explore more.
- One – their opinion they have about the tasks.

Use Post-its or a mentimeter survey - www.mentimeter.com - to gather reflections

MM5: Secrets of Soil

L12: Soil Chromatography Experiment



EXTENSION / REDUCTION ACTIVITIES

Reduction: For a shorter class, have learners complete the pre-experiment and post-experiment questions at home.

Extension: For a longer class, have learners write a blurb for their chroma describing where the soil is from and what the chroma means. They may also point out their favourite features of the chroma. Have learners share with the class, and display the chroma like an art gallery.

Option B: Let the chromas sit for about 10 days and have the learners answer the post-experiment questions after they have dried for 10 days.

MEDIA BOX (materials, online video links, extra resources, case studies etc)

Soil Chromatography, CSUC/CEDECO

[4:54min] https://www.youtube.com/watch?v=VLqD9CEewx8&list=PLSfsUDrR_Mt17V-grdyRWYpZhoQk3t_Cn&index=3&ab_channel=QuintinTroester

Paper & Thin Layer Chromatography | Chemical Tests | Chemistry | FuseSchool (4:01)
<https://www.youtube.com/watch?v=ByJ6lzD2Vbg>

Eugenio Gras on biofertility & chromatography [3:55min] https://www.youtube.com/watch?v=QU7gH3ZeGnY&list=PLSfsUDrR_Mt17V-grdyRWYpZhoQk3t_Cn&index=3&ab_channel=LearnPermaculture

Portraying Soils and Compost: Color, Form, and Pattern
<https://www.natureinstitute.org/article/bruno-follador/portraying-soils-and-compost>

Using paper chromatography for assessing soil health <https://torbaycatchment.org.au/wp-content/uploads/2019/07/Using-paper-chromatography-for-assessing-soil-health-compressed-1.pdf>

Soil chromatography <https://kitondaatjerolls.com/SOIL-CHROMATOGRAPHY>

[Day 4] Soil Chromatography Workshop <https://forum.openhardware.science/t/day-4-soil-chromatography-workshop/1512>

LOCAL TRIP / EXPERTISE / ADDITIONAL WORK AND ASSESSMENTS

Contact a farmer or grower in your area and see if they will allow you to conduct this experiment with soil from their land. Discuss the results with the farmer.

MM5 L12 WS: CHROMATOGRAPHY



You are going to create a chroma using chromatography for your soil samples. Before you do the experiment, answer the following questions.

Using this website, how can you tell if your soil is healthy or unhealthy?

<https://www.natureinstitute.org/article/bruno-follador/portraying-soils-and-compost>

What are the differences in the chroma between healthy and unhealthy soil?

What do you think your chroma is going to look like for both soil samples? Why do you think this?

Now, follow the instructions below to create your chromas.

NOTE: Steps 1-8 should be done in a dark environment so close the blinds on the windows, ensuring you can still see what you are doing.

Equipment needed

Soil samples from last class

Two petri dishes

Circles from last class

Coffee filters or chromatography paper

Scissors

1. Take your soil samples from the last class and give them one last good shake.
2. Take two petri dishes and pipette each soil sample into a separate petri dish to fill the dish half-way.
3. Make sure to know which petri dish is sample 1 and which petri dish is sample 2.

MM5 L12 WS: CHROMATOGRAPHY

15 LIFE ON LAND



4. Take your circles that have soaked in the AgNO_3 and label one sample 1 and label the other sample 2.
5. Take the old wicks out and replace them with new wicks.
6. Place the circles with the new wicks in the petri dishes with your soil solutions in them ensuring that only the wick is touching the solution. Make sure you put the circle labelled sample 1 into the petri dish with the sample 1 solution, and the circle labelled sample 2 into the petri dish with the sample 2 solution.
7. Let the solutions soak into the circles for about 15 minutes until the solution reaches about 1 cm from the edge of the circle or when the image does not change anymore.
8. Remove the circle from the solution and take out the wicks.

Now, open the window blinds and let the light come into the classroom. Let your chromas dry for about 15 minutes.

NOTE: Typically we want to leave the chromas to dry for about 10 days, however, we will shorten this time for the purpose of this lesson.

Look at your chromas for each soil sample and answer the following questions:

Draw each of your chroma and label the four zones:

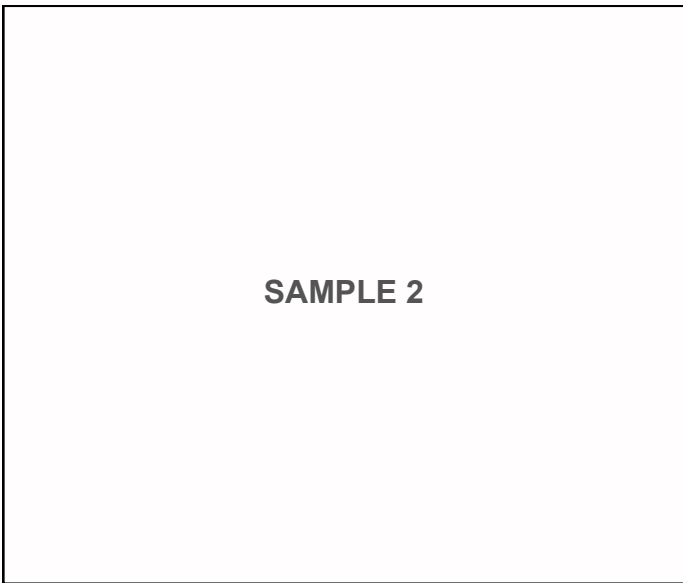
The centre

The inner ring

The outer ring

The edge

SAMPLE 1



SAMPLE 2

Look at each zone and decide if there is a lot of interaction between the zones (lots of peaks and bleeding between the zones) or very little interaction between the zones (e.g. distinct zones). Keep in mind that the chromas vary in their characteristics depending on soil quality. Separate zones with little interactions signal poorer quality soils, while complex and interacting patterns usually link with soils of a higher quality.

Sample 1:

Sample 2:

How many zones do you see in your two chromas? Do the two soil samples have a similar number of zones?



Each zone represents a different characteristic. The first zone, the centre, shows the humus (dead material) content and microbial activity of the soil.

The inner ring shows the mineral balance and availability of the soil. The outer ring shows the oxidation-reduction potential and pH of the soil. The edge shows the water-holding capacity and structure of the soil.

Using the photo and analysis below, analyse your chromas in a similar manner.

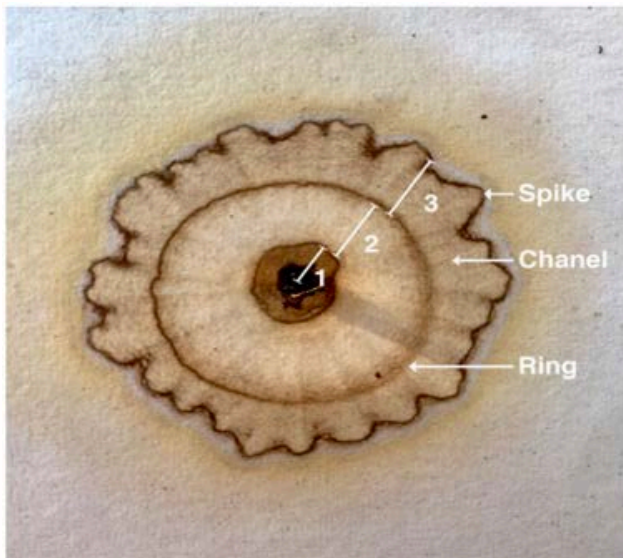


Image 16. A chromatogram that indicates fertile soil.

1. Inner zone with heavy material such as minerals.
2. Middle zone with lighter material such as organic humus.
3. Outer zone with the lightest material such as enzymes and proteins, indicating microbial life.



Image 17. A chromatogram that indicates less fertile soil.

The urban farmers discussed if the purple line was toxic lead, concluding that it was more likely traces from bacteria, since it was in the outer circle and heavy lead would likely develop in the inner circle (the outer yellow zone is pure silver nitrate without soil solution).

From: [Relating to Soil: Chromatography as a Tool for Environmental Engagement \(acm\)](https://dl.acm.org/doi/pdf/10.1145/3532106.3533503)
<https://dl.acm.org/doi/pdf/10.1145/3532106.3533503>

Two possible chromas examples:

Chromatogram 1 (image 16): Excellent Humified Compost

- Outer Circle: This chromatogram resembles an iris, with a light-beige outer circle radiating outwards.
- Spike-Like Formations: Spike-like formations penetrate this outer layer, each ending with brown spots, akin to the brown ring in the other figure.
- Main Disc: The inner main disc features brownish hues instead of violet and is filled with feather-like radiations.
- Interaction: Unlike image 17, here, every region harmoniously relates to and interpenetrates the others, creating a sense of movement, development, and harmony.

MM5 L12 WS: CHROMATOGRAPHY



Chromatogram 2 (image17): Anaerobic and Stagnated Soil

- Outer Ring: A striking dark, greyish ring encompasses everything, suggesting a sense of enclosure.
- Brown Ring: Inside this boundary, there's a thick, irregular, brown ring, almost an inch thick, appearing somewhat discordant.
- Large Violet Disc: Dominating the figure is a large violet disc, with a smaller violet disc at the very centre. These zones seem rather isolated.
- Interaction: There's minimal interaction between these regions, except for some protrusions extending from the brown ring into the greyish outer belt. Overall, it gives a feeling of stagnation.

These chromatograms illustrate the strong differences in soil quality and soil health. Chromatogram 1 represents healthy, well-aerated, and humus-rich soil with vigorous interactions among soil components, while chromatogram 2 shows a soil with poor aeration, limited organic matter, and stationary processes, indicative of soil degradation. These interpretations can help you understand how chromatography can be used to assess soil quality qualitatively.

Now your turn!

Sample 1 analysis:

Sample 2 analysis:

MM5 L12 WS: CHROMATOGRAPHY

15 LIFE ON LAND



Which soil sample do you think is healthier? Why? Does this match your prediction from before the experiment?

What suggestions would you give a farmer or grower for each of your soil samples (e.g. conduct a further test of nitrogen, phosphorus and potassium, increase humus matter with compost, etc.)?
