



### Overview

**Age Range:**

10-14

**Lesson Time:**

45 Minutes (including 1 video)

**Equipment Needed:**

Computer

Projector

**Topics Covered:**

- Chemistry (states of matter)
- Biology (life in extremes)
- Astronomy (Mars surface conditions).

### Activity Outline

Understand the formation of salt pans via the mechanism of evaporation.

### Learning Outcomes

After completing this activity, pupils will be able to:

- Critically examine evaporation
- Understand states of matter
- Describe how salinity and desiccation affect the habitability of an environment.

## Background Material:

**Slide 1 -  
Introduction**

In this lesson we will be looking at the development of salt beds and the potential for their habitability.

**Slide 2 - Objectives**

Can be seen above in Learning Outcomes.

**Slide 3 –  
Evaporation**

Firstly, we must look at evaporation. Can anyone explain what is meant by evaporation?

(Take answers)

Evaporation is the process by which a liquid moves from a liquid state to a gaseous state. This can take many forms – the most common example is a process often referred to as air-drying. This occurs due to

liquid molecules towards the surface escaping into a vapour. Another example is boiling, which occurs as the temperature of a liquid exceeds its boiling point (in the instance of water, this is 100 °C). Water, when exceeding 100 °C, becomes steam. Contrary to common belief, steam is invisible and the clouds that can be seen above boiling water are actually steam, or water vapour, condensing back into droplets of liquid water.

#### Slide 4 – States of Matter

We have already touched upon the idea of states of matter, but can anyone explain what the states of matter are?

(Take answers)

A **solid state** will maintain its shape. Its molecules are far more structured and do not have the available energy to move around freely. For most compounds, their solid form is their densest form. However, there are exceptions to this rule, for example ice, which is less dense than liquid water. This is due to its molecular structure as a solid.

As a compound receives more energy and melts, we have the **liquid form** of a compound. A liquid is a fluid, which means that it can flow, taking the shape of its container. Some liquids can be quite unstable, readily evaporating or even requiring great pressure to form in this first place in the case of carbon dioxide. When a solid such as carbon dioxide moves from a solid to a **gas** under normal Earth pressure, it is called sublimation. The final state of matter contained in the scope of this lesson is, as just mentioned, gas. Gases, like liquids, are fluids and will fill all available space depending on their density.

#### Slide 5 – Makgadikgadi Salt pans and formation

In this photo we have the [Makgadikgadi Salt Pans](#) in Botswana. This a huge expanse of salt which has become very valuable in the study of microbiology in areas of high salinity.

#### Slide 6 – Discuss How This Environment Formed

Discuss in groups how this environment may have formed.

(Allow time for group discussion)

(Take answers)

#### Slide 7 – How does this happen?

Here we have a video that demonstrates how an environment such as the Makgadikgadi Salt Pans may have formed:

<https://youtu.be/Cr7SRbOFQN8>

Video background information: In this video we have a saturated solution of sodium chloride (NaCl). As the water is boiled away, the solution becomes supersaturated. With further evaporation, it will

become over-saturated and the sodium chloride will precipitate out of solution. The sodium chloride is far more dense than the water vapour and is significantly below its melting point, let alone its boiling point. Therefore, as the water is evaporated away, the denser solid compounds such as the sodium chloride are left behind.

**Slide 8 – Do you think life could survive there?**

Please discuss in groups if you believe life could survive in such a high salinity environment.

(Allow time for group discussion)

(Take answers)

**Slide 9 – Salt and desiccation tolerant bacteria**

Desiccation (a state of extreme dryness) is a common stress that bacteria face in the natural environment. Therefore, they have developed a variety of protective mechanisms to mitigate the damage caused by water loss. Some species have developed mechanisms that either help protect susceptible cellular components from damage, or that sequester water in an attempt to avoid dehydration. These mechanisms include the alteration of membrane composition or Lipopolysaccharide modification to help stabilise membranes during drying, and the accumulation of compatible solutes, such as trehalose, which can protect cytoplasmic and membrane constituents. This has led some to believe that life could survive the extreme environments such as high salinity found on Mars.

**Slide 10 - Review**

From this lesson, students should be able to answer these questions:

- What are the different states of matter?
- Can you explain the concept of evaporation?
- How could salt and desiccation affect the habitability of Mars?