Robogals
Science Challenge

Minor Challenge Set #1
STEM Field: Chemistry / Chemical Engineering
Level: Senior
Challenge Name: Exploring Ceres' Bright Spots
Project cost: 0-20 USD
Materials Required:

- Pen and paper
- 2-3 kinds of salt, for example:
  - Table salt (sodium chloride)
  - Epsom salt (magnesium sulphate)
  - Baking soda (sodium bicarbonate)
- Warm water
- Measuring spoons, or teaspoons
- Items for stirring, for example, spoons
- Small containers to mix salt and water
- Small dishes or containers to apply the solution and allow the solution to dry

Duration:

- This challenge takes approximately 0.5 hour to prepare the solutions and a longer time period for the solutions to dry.

Introduction

Ceres is a dwarf planet in the asteroid belt between the orbits of Mars and Jupiter. It was the first asteroid discovered in 1801. In 2015, as the Dawn spacecraft approached the dwarf planet Ceres, it spotted some mysterious bright spots on the surface of this planet. Even before the Dawn spacecraft, scientists had observed bright regions using

telescopes, however the origin of these regions remained a mystery. The close-up view of the Dawn spacecraft enabled scientists to gain an understanding of how hundreds of these bright regions came to be.

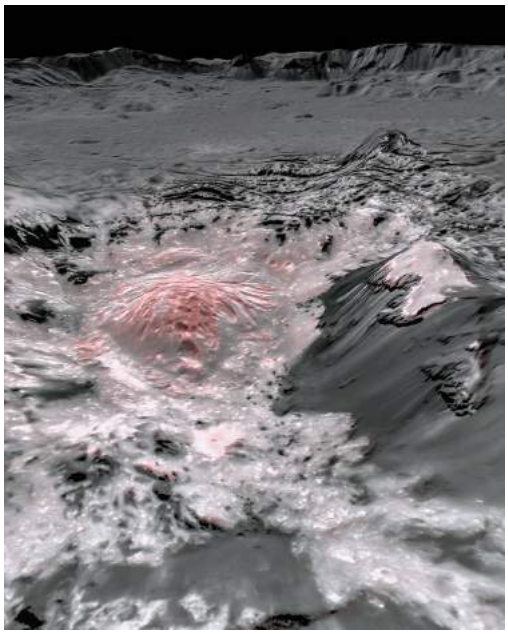

Figure 1. From the spacecraft's captured pictures, a false colour view of a region on the surface of Ceres was created. (Image credit: NASA/JPL-Caltech/UCLA/MPS/DLR/IDA)

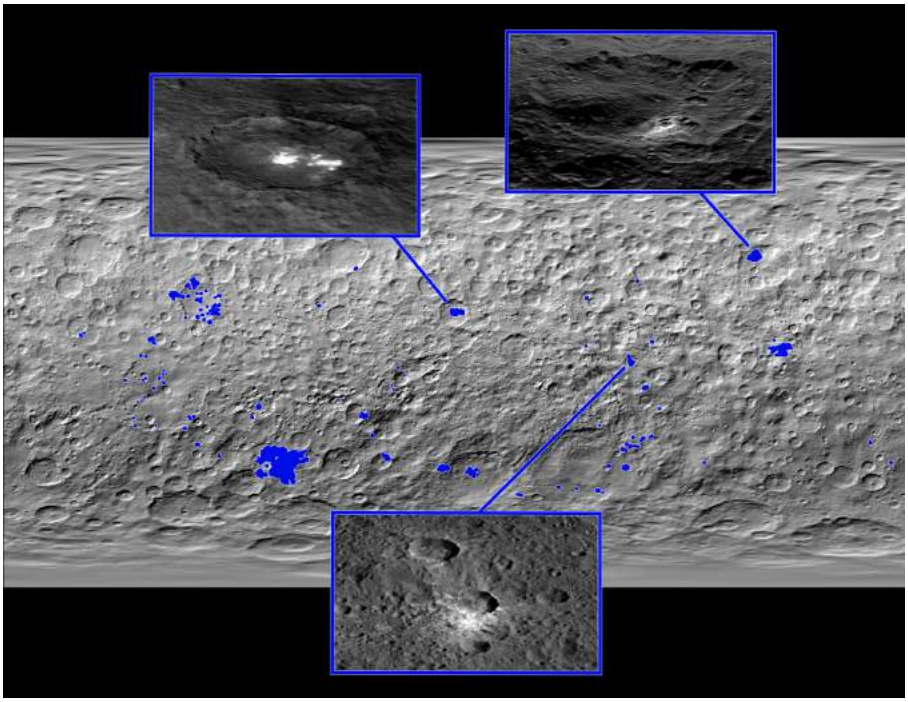

Figure 2. This image taken by NASA's Dawn spacecraft shows the locations of about 130 bright regions across the dwarf planet's surface. Occator Crater, containing the brightest area on Ceres, is shown at top left. (Image credit: NASA/JPL-Caltech/UCLA/MPS/DLR/IDA)

This video shows an animated view of bright areas on Ceres.
https://youtu.be/4t0F6-LuucA

In this project, we will be doing an experiment to find out the structure of these bright regions.

Instruction

1. Fill the same amount of warm water to each container.

2. Dissolve salt into warm water to create saline solutions using one of the following methods:

   Method 1: Use different ratios of the same type of salt

   Method 2: Use the same ratio of different types of salt

   The amount of warm water is the same for all ratios – 0.25 cup (approximately 60mL). The ratios of salt to water are listed in the table below.

Type of salt	Amount of salt	Ratio of salt to water
Table salt OR Epsom salt	1 tablespoon	1:4
	1.5 teaspoon	1:8
	0.75 teaspoon	1:16
Baking soda	1.0 teaspoon	1:12
	0.75 teaspoon	1:16
	0.5 teaspoon	1:24

3. Ensure you record the method of your experiment in a notebook.

4. Apply a small amount of each solution to a separate dish or container and allow the solution to dry. Place approximately 1 teaspoon of each solution to the container.

   Note: You can speed the drying process by placing the dishes or containers in direct sunlight or near another heat source. Be sure to not place the dishes or containers too close to a heat source!

5. When the solutions have dried, take photos of the solution. Write your observations in your notebook.

So, what happened?

Scientists made a key discovery: salt compounds (sodium chloride chemically bound with water and ammonium chloride) concentrated in the bright region. The abundance of salt was detected with Dawn infrared spectroscopy.

On Ceres' surface, salts bearing water quickly dehydrate, within hundreds of years. Scientists found two main pathways that allow liquids to reach the surface of the dwarf planet, allowing ongoing transfer of material from the interior of the planet to the surface. One pathway is: the area beneath the surface that was melted by the heat of the impact that formed the region of Occator Crater about 20 million years ago. The impact created large fractures that could reach the deep brine reservoir. As the brine erupted through these fractures, a highly reflective salt crust was left behind when the water evaporated.

This article describes how scientists have been studying Ceres in laboratories:
https://www.nasa.gov/feature/jpl/do-it-yourself-dwarf-planet-exploring-ceres-in-labs

To learn more about Ceres, you can visit the website here:
https://eyes.nasa.gov/apps/orrery/#/1_ceres

Reflection Questions

- Are there any improvements you would make to this challenge?
- What real world application can you apply the challenge to?
- What are the key concepts of science and engineering that relate to this challenge?

- Can you see any differences between the solutions? If there are, can you explain these differences?
- Where on Earth do you think the process of solids being dissolved in water or water evaporating and leaving behind salts could be occurring? (Hint: dried, drying salty lakes)
- Where else in the solar system do you think these processes can also occur?

Submission Guidelines

- Submit pictures of your solutions, your observations, and answers to the reflection questions.

> Note: Remember, if you want to upload pictures of your Minor Challenge that also include you, please check if it is OK with your mentor first.

- The submission form is on the Minor Challenges page: https://sciencechallenge.org.au/index.php/minor-challenges/
  Fill out the details and make sure you upload your submission.

Learn More! Resources

- You can read more about the results from research on Ceres here: https://www.nasa.gov/feature/jpl/mystery-solved-bright-areas-on-ceres-come-from-salty-water-below/

Bibliography

- NASA/JPL Edu. n.d. *Educator Guide: Mineral Mystery Experiment | NASA/JPL Edu*. [online] Available at: <https://www.jpl.nasa.gov/edu/teach/activity/mineral-mystery-experiment/> [Accessed 27 February 2022].
- NASA. 2020. *Mystery Solved: Bright Areas on Ceres Come From Salty Water Below*. [online] Available at: <https://www.nasa.gov/feature/jpl/mystery-solved-bright-areas-on-ceres-come-from-salty-water-below> [Accessed 27 February 2022].
- Witze, A., 2015. *Mysterious bright spots on Ceres are probably salt - Nature*. [online] Nature. Available at: <https://www.nature.com/articles/nature.2015.18980> [Accessed 27 February 2022].