Carbonate conundrum

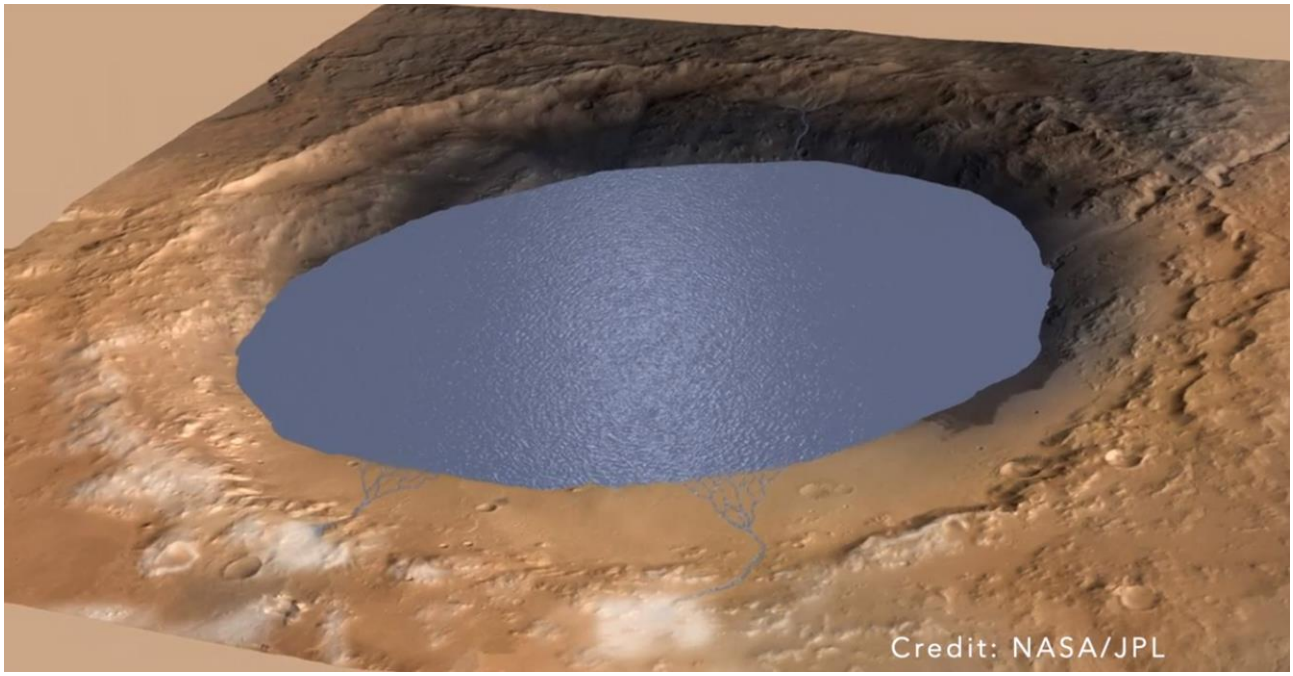
Suitable for UK KS3 students or ages 11-14

Notes for teachers

At a glance

Evidence collected from Mars rovers tell us that the surface of Mars was once covered in rivers and lakes – and possibly even early life. However, scientists are puzzled as to how Mars was once warm enough to permit liquid water. One idea is that its atmosphere was once much thicker and rich in carbon dioxide. If this is true, then rocks on Mars should be high in carbonate minerals.

In this activity students are asked to design a chemical test that could be used to see if a rock from Mars contains carbonates. In doing so they learn about the acid-carbonate reaction and how to carry out gas tests.



Learning Outcomes

- Students learn the reaction between acids and carbonates
- Students learn how to carry out gas tests
- Students design a results table

Each student will need

- Copy of student worksheet page 1
- Copy of student worksheet page 2

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The class will need access to

- Eye protection
- Samples of at least 5 different carbonates, one of which should be copper carbonate (IRRITANT) e.g. calcium carbonate, zinc carbonate, sodium carbonate, iron carbonate with spatulas
- Hydrochloric acid, sulfuric acid, sodium hydroxide (IRRITANT) (all low concentration – around 0.25 mol/dm^3)
- Water
- Disposable pipettes
- Spotting tiles
- Test tubes
- Bunsen burners
- Heatproof mats
- Wooden splints
- Limewater - calcium hydroxide solution (IRRITANT)
- Delivery tubes with bungs

Possible Lesson Activities

1. Starter activity

- Ask the class: 'do you think aliens exist?'. Initiate a discussion on where they think aliens might come from. Ask them if they think there might be life on Mars and their reasons. They may talk about the fact that we have no evidence that life exists there, and it is too cold and has no liquid water. Ask them if they think life might have existed there in the past.
- Discuss the fact that scientists around the world are collaborating to piece together what early Mars might have been like. Introduce the research of Lucy Kissick, a PhD student at The University of Oxford by showing the class the Oxford Sparks clip 'Using your science to explore the climate history of Mars' (see web links).

2. Main activity: Testing carbonates

- Give each student a copy of page 1 of the student worksheet and ask them to read through it. This outlines the background behind the reasons for Lucy's research.
- Make sure the class understand their task – to design a test that can be used to show that a rock from Mars contains carbonate compounds.
- Ask the class to work in pairs. Ask them to look at the carbonates and see if they can tell by looking that they are carbonates. The answer is no – most are white powders but copper carbonate is green so they have nothing in common. But, there could be a chemical property they all share.
- Ask the students to test each carbonate with each liquid (hydrochloric acid, sulfuric acid, water and sodium hydroxide) and write down their observations in a results table. The simplest way to do this is to add a small amount of one carbonate to 4 dimples in the spotting tile and then add a few drops of each liquid to each dimple. This task will give students practice at being methodical, organised and observant.

- When students have tested all the carbonates and liquids ask them if they spotted any patterns. They should have observed that the carbonates all bubbled when acid was added to them. Remind them that this is a sign of a chemical reaction and ask what type of substance must be produced if there is fizzing (a gas).

3. **Main activity: Testing gases**
   - Demonstrate to the class how to carry out gas tests for oxygen, hydrogen and carbon dioxide. After each demonstration, they should complete the relevant part of page 2 of the student worksheet to describe a positive test.
   - Assign each pair one of the carbonate-acid reactions they did previously and ask them to use gas tests to find out the name of the gas produced. They should discover that it is carbon dioxide.
   - Explain to the class the general equation for the carbonate-acid reaction:
     Carbonate + acid → salt + water + carbon dioxide
     And an example (not from a reaction they carried out) e.g.:
     Barium carbonate + hydrochloric acid → barium chloride + water + carbon dioxide
   - Guide them on how to work out the name of the salt formed. They then write the word equation for the reaction they carried out.

4. **Plenary**
   - Ask the class to write down what they would do to see if a rock from Mars contains carbonates. They should include the tests they would do, what the results would be and why.

Web links

Oxford Sparks clip 'Using your science to explore the climate history of Mars':

https://www.oxfordsparks.ox.ac.uk/content/using-your-science-explore-climate-history-mars

Safety disclaimer: The practical work suggestions given here have not been tested by us for safety. While the suggested practical work is based on existing laboratory experiments, you should always carry out your own risk assessment, especially before using or making a hazardous procedure, chemical or material. All practical work should be supervised by a qualified science teacher with suitable knowledge of the equipment used and carried out in a properly equipped and maintained laboratory. For more information, refer to www.cleapss.org.uk/.