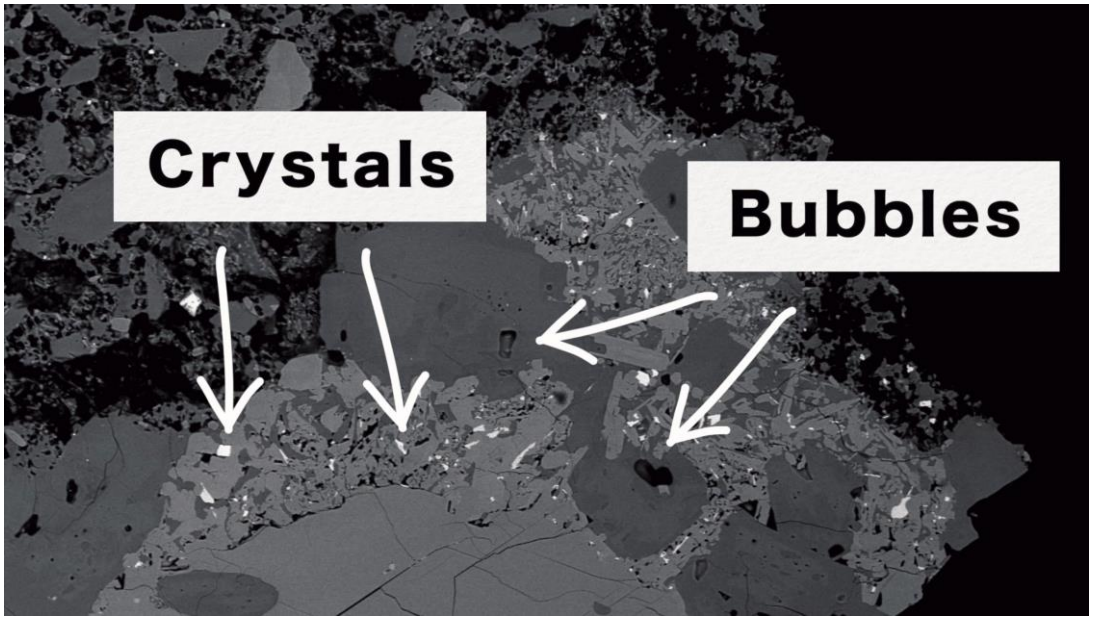
Investigating the Effect of Temperature on Crystal Size

Suitable for UK KS3 students or ages 11-15

Notes for teachers

At a glance

The following resource is most suited to students studying the rock cycle (e.g., UK KS3). Through a simple experimental investigation, the resource encourages students to explore how formation temperature effects crystal size. Students are then directed to use their findings to explain the difference in crystal size between intrusive and extrusive igneous rocks.



Learning Outcomes

- Develop experimental skills and the ability to use lab equipment safely
- Use experimental data to draw a conclusion
- Explain the difference in crystal size between intrusive and extrusive igneous rock

Each student will need

- A student worksheet

Each group will need (pairs recommended)

- 1 x Bunsen burner
- 1 x heatproof mat
- 1 x gauze
- 1 x 25cm^3 measuring cylinder

- scrap paper to place under and label their own groups evaporating dish
- 1 x filter paper
- 1 x filter funnel
- 1 x weighing boat
- 3 x petri dish or evaporating dish
- 1 x spatula
- 1 x heatproof (Pyrex) conical flask (100cm^3)
- 1 x 250ml beaker
- 1 x large boiling tube (able to hold 45cm^3 fluid)
- 1 x thermometer
- Access to individual or class supply of copper oxide powder
- Access to individual or class supply of 1.4M sulfuric acid
- Access to electronic scales

Possible Lesson Activities

1. **Starter activity**
    - Show the Oxford Sparks video outlining a PhD student's research into volcanoes, 'Using your science to understand volcanic eruptions' (see web links). You might want to introduce the students to the concept of pressure if they have not done this before.
    - Highlight that understanding crystal structure can be useful in helping to predict volcanic activity as well as the properties of igneous rock.
2. **Main activity: Practical investigation**
    - Hand out student worksheets and encourage students to read through introduction and experimental procedure.
    - Sort students into practical working groups. It is recommended that students work in pairs but larger groups will also work.
    - Following reading, ask students to identify the hazards and the safety precautions that will be required. Depending on the practical capabilities/experience of the class, you may wish to demonstrate how to set up a water bath, how to operate a Bunsen burner, how to use electronic scales or how to set up a filter funnel. Although written on the sheet, students should be reminded not to vigorously boil their copper sulfate solution or let it boil dry.
    - Given the volume of equipment, it is recommended that students be given equipment in prearranged trays.
    - The last step of the practical involves leaving crystals to form at different temperatures. Temperatures have not been specified it is dependent on the facilities available in the lab. Possible locations with different temperatures include;
        - Fridge
        - Windowsill
        - On top of radiator
        - Standard room temperature
        - Under a heat lamp

- **Safety**
  - **Copper oxide residue can be disposed of in standard waste although you may wish to collect in in line with school policy.**
  - **Copper sulfate is an irritant and can cause serious damage to eyes and is harmful if swallowed. Goggles must be worn at all times. Copper sulfate solution should not be poured down the sink.**
  - **Copper sulfate crystals should be collected and students should not be allowed to remove them from the lab**
  - **At the concentration given, sulfuric acid is an irritant.**

3. Main activity: Practical follow up

- Once practical is complete and copper sulfate is left to crystallise, students should ensure they have a tidy working area and complete the practical follow up section. Students should complete up to the questions about their conclusions.
- At the start of the next lesson, students can observe and measure their crystals and complete the final conclusion questions.

4. Answers

- Q - What crystallises to form igneous rock?
  - A – Minerals
- Q - In your experiment, what crystallises?
  - A - Copper Sulfate
- Q - What does the copper sulfate solution you produced represent in the volcano?
  - A - Magma
- Q - Suggest why you think it was important to heat the sulfuric acid before dissolving in the copper oxide?
  - A - Heating the acid makes it easier to dissolve the copper oxide
- Q - Suggest why you heated the acid in a water bath, rather than using a direct heat source such as a Bunsen burner.
  - A – It can be dangerous to boil an acid
- Q - What safety precautions did you take during the experiment and why?
  - A – Goggles were worn at all times to protect eyes. A water bath was used to heat the acid instead of Bunsen burner so there was less risk of boiling the acid. The Bunsen burner was lit on a safety flame to reduce risk of burn and to make flame more visible. Hot conical flasks were only handled at the neck where coolest. Copper sulfate solution was not boiled dry to prevent spitting.
- Q - Which condition of cooling most closely replicates the formation of intrusive (rocks that cool underground) igneous rock?
  - A – The warmest condition of cooling as intrusive rocks cool slowly beneath the surface where conditions are hotter and heat is lost more slowly.
- Q - Which condition of cooling most closely replicates the formation of extrusive (rocks that cool on the surface) igneous rock?
  - A – The coolest condition of cooling as extrusive rocks cool rapidly when exposed to the cold atmosphere.

- Q - Write down your prediction for how the temperature of cooling will affect this size of crystals formed.
    - A - Students make prediction linking crystallisation temperature and crystal size.
- Q - Write a conclusion for your experiment. Was your prediction above correct?
    - A - Students write conclusions based on data collected. Students should find that larger crystals are found at higher temperatures.
- Q - Use your conclusion to explain why the largest crystals are found in intrusive igneous rock.
    - A – Crystallisation in intrusive igneous rocks occurs during slower cooling of the magma so larger crystals have more time to form as the elements that make up the crystals have time to move through the magma and keep the crystals growing.

5. Plenary

- Show picture of intrusive and extrusive igneous rock as ask students to guess which is which based on the size of their crystals. A useful website for this is https://geology.com/rocks/igneous-rocks.shtml

6. Homework

- Describe the lifecycle of an igneous rock exposed on the surface.
    - From a rock's perspective, students describe the processes of the rock cycle starting from the moment an igneous rock becomes exposed on the surface. They should describe the process of weathering, deposition, compression etc.

Web links

Oxford Sparks video 'Using your science to understand volcanic eruptions':

https://www.oxfordsparks.ox.ac.uk/content/using-your-science-understand-volcanic-eruptions

Additional information:

- https://geology.com/rocks/igneous-rocks.shtml
- https://www.bbc.co.uk/bitesize/guides/zgb9kqt/revision/2
- **https://www.tcd.ie/news_events/articles/trinity-scientists-persuade-volcanoes-to-tell-their-stories/**
- **https://www.sciencemag.org/news/2016/11/smudged-volcanic-crystals-offer-clues-past-eruptions**

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/.