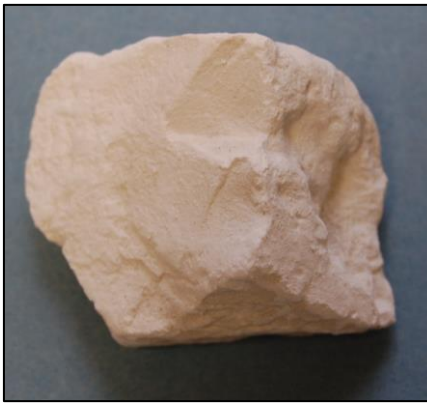
‘I’m pure calcium carbonate’ – the calcium carbonate question
A discussion focussed on common misconceptions about calcium carbonate

Ask your pupils which of these is the purest calcium carbonate? Then guide the discussion to give the best answers (as in the notes below).

Aragonite
(Source below)



Chalk
(Chris King)

I’m pure calcium carbonate

Calcite
(Peter Kennett)

Marble
(Peter Kennett for ESEU)

Limestone
(Chris King)

The back up

Title: ‘I’m pure calcium carbonate’ – the calcium carbonate question

Subtitle: A discussion focussed on common misconceptions about calcium carbonate

Topic: Helping pupils to understand the likely purity of minerals and rocks

Age range of pupils: 11-16 years

Time needed to complete activity: 10 minutes

Pupil learning outcomes: Pupils can:
- distinguish between rocks and minerals;
- explain that minerals are likely to provide purer examples of compounds than rocks.

Context:
Calcite and aragonite are minerals – a mineral is defined as: ‘a naturally occurring inorganic substance with a definite chemical composition and physical properties which vary between known limits’. They are normally pure.

Limestone is a sedimentary rock, whilst chalk is a fine-grained limestone; marble is a metamorphic

rock – a rock is defined as: 'a naturally occurring material composed of minerals or fragments of older rocks or fossils'. Rocks are normally less pure than minerals.

More detailed answers are given below. Minerals are always likely to provide purer versions of compounds than rocks since, as the atomic structure of a mineral builds during crystallisation, any atoms which don't 'fit' the structure are excluded. Meanwhile, many rocks form in sedimentary environments where the environment and the sedimentary processes involved are unlikely to provide 'pure' material – for example fine clay minerals are deposited in nearly all quiet sedimentary environments.

Name	Is it pure?
Limestone	No – limestone is a sedimentary rock made predominantly of calcium carbonate (usually fragments of the mineral calcite – mostly of biological origin) – but also contains other sediment, mainly mud (clay minerals).
Chalk	No – chalk is a fine-grained limestone made predominantly of calcium carbonate (mainly coccoliths, the microscopic calcite platelets found in some forms of planktonic algae) – but, despite being relatively pure, also contains other sediment. It was mostly laid down during the Cretaceous geological period (Latin for "chalk" is *creta*).
Marble	No – marble is a metamorphic rock made predominantly of interlocking calcium carbonate crystals (usually of the mineral calcite) – but also contains other impurities and so can have a range of colours.
Calcite	Almost 'yes' – calcite is the most common of the calcium carbonate minerals, containing the elements calcium, carbon and oxygen in a $CaCO_3$ atomic configuration, different from its polymorph (isomer) aragonite. However, this configuration can accommodate some magnesium atoms, so reducing its purity.
Aragonite	Almost 'yes' – aragonite is also a calcium carbonate mineral in a $CaCO_3$ atomic configuration, different from its polymorph calcite. However, this configuration can accommodate some strontium atoms, so reducing its purity. Most sea shells are made of a combination of aragonite and calcite, often with an iridescent mother of pearl aragonite coating. During rock-forming processes aragonite changes to its more stable polymorph calcite, and so is uncommon in limestones.

Natural calcium carbonate is purified commercially for industrial and food usages.

Following up the activity:

1. These two calcium carbonate rocks could be added to the discussion:

Travertine

Stalagmite

Name	Is it pure?
Travertine	No – travertine is a form of sedimentary rock deposited by hot springs, often as a mixture of calcite and aragonite, but with some impurities. It is also called tufa.
Stalagmite	No – speleothems (including hanging stalactites, upright stalagmites, flowstone, straws, etc.) are formed by dripping/flowing water in caves, from the mineral calcite, but they contain impurities (often iron compounds giving an orange colour).

2. Demonstrate that most limestones contain clay. Crush some limestone and then drop on some dilute hydrochloric acid (0.5M). Most clayey limestones froth grey or brown whilst relatively pure chalk froths white. The more clay in the limestone, the more clay is left as a residue.

Underlying principles:

- Rocks are mixtures, of minerals, fossils and/or other rock fragments and so are unlikely to be 'pure' – even the purest rock is likely contain other material.
- Minerals are natural elements or compounds and may be 'pure' but most natural minerals contain traces of other atoms within their **structures** and so strictly, are not 'pure' either.

Thinking skill development:
Building up a clear picture of what constitutes pure calcium carbonate is a construction activity, with examples that don't fit, causing cognitive conflict.

Resource list:

- the 'I'm pure calcium carbonate' card

For follow up activity:

- dilute hydrochloric acid (0.5M) in a dropper bottle
- pestle and mortar
- safety spectacles

Source: Chris King, Earth Science Education Unit, with contributions from other ESEU members.

- Aragonite image - this file is licensed by Didier Descouens under the Creative Commons Attribution 4.0 International license.
- Travertine image - this work has been released into the public domain by its author, Roll-Stone at the German Wikipedia project.
- Stalagmite image - This file is licensed by Hannes Grobe under the Creative Commons Attribution-Share Alike 3.0 Unported licence.

© Earthlearningidea team. The Earthlearningidea team seeks to produce a teaching idea regularly, at minimal cost, with minimal resources, for teacher educators and teachers of Earth science through school-level geography or science, with an online discussion around every idea in order to develop a global support network.
'Earthlearningidea' has little funding and is produced largely by voluntary effort.
Copyright is waived for original material contained in this activity if it is required for use within the laboratory or classroom. Copyright material contained herein from other publishers rests with them. Any organisation wishing to use this material should contact the Earthlearningidea team.
Every effort has been made to locate and contact copyright holders of materials included in this activity in order to obtain their permission. Please contact us if, however, you believe your copyright is being infringed: we welcome any information that will help us to update our records.
If you have any difficulty with the readability of these documents, please contact the Earthlearningidea team for further help. Contact the Earthlearningidea team at: info@earthlearningidea.com