

## What Are Minerals – Teacher Notes

Minerals are natural materials which are:

- (1) inorganic (not created by living things);
- (2) have a consistent chemical composition; and
- (3) when solid have constant crystal structures.

### Inorganic

Minerals are inorganic. What is the definition of inorganic? (hint: it doesn't have anything to do with the 'organic' vegetables you can buy at the grocery.)

Inorganic broadly means not created by or consisting of living matter. In chemistry, it also means something doesn't contain the element carbon.

Gallstones form in your gallbladder, which is part of your digestive system. Digestive fluid from the liver containing varying amounts of salt, cholesterol, calcium or bilirubin crystallises and makes rocks! These rocks can be as small as a grain of sand, or as large as a plum. They can block the bile outlet and cause pain. Most people do not know they have them until they start to feel pain.

Are gallstones minerals? Explain your answer.

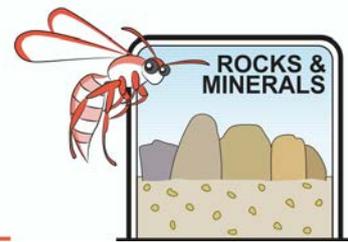
**No. They come from a living thing, and they have varying chemical composition**

### Consistent Chemical Composition

A mineral is made of the same combination of elements no matter when or where in the world it was formed. This combination of elements (or *composition*) is like the ingredients in a cake; every chocolate cake needs flour, water, eggs, and –of course – chocolate. The ratio (the amount of one thing compared to the amount of another thing) of ingredients is also very important; if you had 2kg of chocolate compared to 1 gram of flour, you wouldn't have a cake! Similarly, every piece of quartz in the world contains silicon and oxygen in specific ratios. We write down the chemical composition in what are called mineral formula.

In the table are some common minerals and their formulae. With the help of a periodic table, list the elements present in each mineral.

Minerals	Mineral Formula	List of Elements
Quartz	$\text{SiO}_2$	Silicon and oxygen
Potassium Feldspar	$\text{KAlSi}_3\text{O}_8$	Potassium, aluminium, silicon and oxygen
Calcite	$\text{CaCO}_3$	Calcium, carbon and oxygen
Gypsum	$\text{CaSO}$	Calcium, sulphur and oxygen
Diamond	C	Carbon
Kaolinite (a type of clay)	$\text{Al}_2\text{Si}_2\text{O}_5(\text{OH})_4$	Aluminium, silicon, oxygen and hydrogen
Biotite (a type of mica)	$\text{KMg}_2\text{AlSi}_2\text{O}_{10}(\text{OH})_2$	Potassium, magnesium, aluminium, silicon, oxygen and hydrogen



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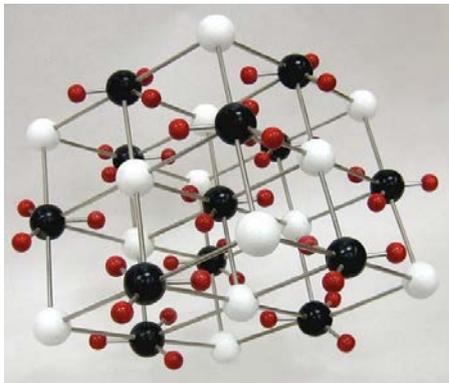
### Constant Crystalline Structures

Minerals form crystals. These crystals are the same shape no matter what size the mineral is – a piece of halite has the same *structure* no matter the size. In the pictures of halite crystals to the right, notice the similarities between the microscopic crystals and the huge crystals.

A mineral's crystalline structure depends on the atoms it contains. Atoms form bonds that link them together, but in specific arrangements due to the different sizes of different atoms. As you move from left to right on the periodic table, the radius of atoms shrink.



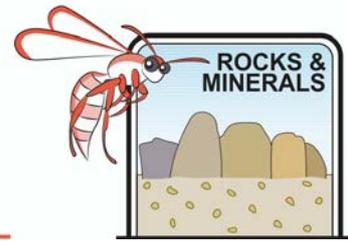
*Halite (NaCl) crystals under a microscope*



*Halite crystals in a cave in Germany. Notice the man wearing a white hardhat in the bottom left corner for scale.*

Above is a model of the atomic crystal structure of calcite ( $\text{CaCO}_3$ ) which uses white, black, and red balls to represent the atoms of different elements, and silver bars to represent the bonds between atoms. **Which colour balls represent which atoms?**

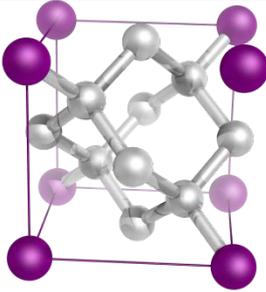
Coloured balls in the model	Elements in calcite
white	Calcium (largest element in calcite)
black	Carbon
red	Oxygen (smallest element in calcite)



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### Same composition, different crystal structure

Diamond is a mineral made of pure carbon, and is one of the hardest, most durable minerals on the planet. Graphite – often used as pencil lead – is one of the softest minerals; it is easily rubbed off onto paper, which is why we use it in pencils. Graphite is also made of pure carbon. The only difference between diamond and graphite is their crystal structures. Which crystal structure belongs to which mineral? Why might that crystal structure make the mineral hard or soft?

<b>Crystal Structure</b>		
<b>Diamond or graphite?</b>	diamond	graphite
<b>Why is the mineral hard or soft?</b>	It is so durable because its atoms are arranged in a cubic structure, with strong bonds between every atom, and bonded in all different directions.	The bonds between layers in graphite are weak, and weaker than the bonds within layers, so the layers can easily be broken and rubbed off onto paper.

### Compare and Contrast

Using the information provided above, *compare and contrast* the minerals quartz and calcite (pictured below). There are many answers possible, so list as many as you can.



Quartz (SiO<sub>2</sub>)



Calcite (CaCO<sub>3</sub>)

<b>Compare</b> - these minerals are similar because:	<b>Contrast</b> - these minerals are different because:
<ul style="list-style-type: none"> <li>• They are inorganic. All minerals are inorganic.</li> <li>• They are colourless.</li> <li>• They have a regular crystalline shape.</li> <li>• They are transparent. Light is transmitted through them.</li> <li>• They are reflective. Light is reflected from their surfaces.</li> </ul>	<ul style="list-style-type: none"> <li>• They have differently shaped crystals. Quartz has six sides along its length and six terminal faces. Calcite is a rhombic prism with 60° and 120° angles.</li> <li>• They are made from different chemicals – silica (or silicon dioxide) and calcium carbonate.</li> <li>• Quartz is harder than calcite – (quartz 7 v calcite 3).</li> <li>• Also, but not available from the information given, an image viewed through calcite is doubled.</li> </ul>