Mineral or not?

Discussion about what is a mineral and what is not

The term “mineral” is used in several different senses. This activity aims to help students understand what a geologist usually considers to be a “mineral”.

To an Earth scientist, a mineral is defined as “a naturally occurring inorganic substance with a definite chemical composition, a definite atomic structure and physical properties which vary within known limits.”

Unfortunately, the term “mineral” is also widely used in other contexts, e.g. industrial minerals, such as sand and gravel; mineral sources of energy, e.g. coal, oil and natural gas; minerals in food which are essential for healthy living including iron, phosphates etc; and mineral water, containing dissolved salts derived from rocks through which the water has passed.

The most common source of confusion among young Earth scientists is between minerals as strictly defined above, and rocks, especially when the rock is made of just one mineral, e.g. marble, which is predominately composed of the mineral calcite ($CaCO_3$). It may help pupils who have usually studied different materials in science lessons, to be told that minerals in the Earth science context are either elements, or compounds, whereas rocks are mixtures.

Use whatever materials you have to hand to help pupils to grasp the above differences, or use the photographs below.

First show photos 1 to 4 (or samples) of minerals as defined above. The two upper pictures show minerals with well-defined crystal faces which present few problems in fulfilling the definition. However, in the two lower photos, good crystal faces are absent, yet both are “naturally occurring inorganic substances with a definite chemical composition, a definite atomic structure and physical properties which vary within known limits.” They are therefore minerals to a geologist.

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Two minerals with well-defined crystal faces- 1) calcite, $CaCO_3$ 2) quartz SiO_2

Two minerals with poorly-defined crystal faces- 3) haematite Fe_2O_3 4) bauxite Al_2O_3

Then ask pupils to study the pictures below (or examples in your classroom) and state whether each is a mineral in the strict sense or not. The pictures may be printed onto card, cut out and used as a sorting exercise if required.

5) Found on a mine dump. (6cm across)

6) Alabaster tomb (2.5m long)

7) Underground in a cavern. (About 30cm across)

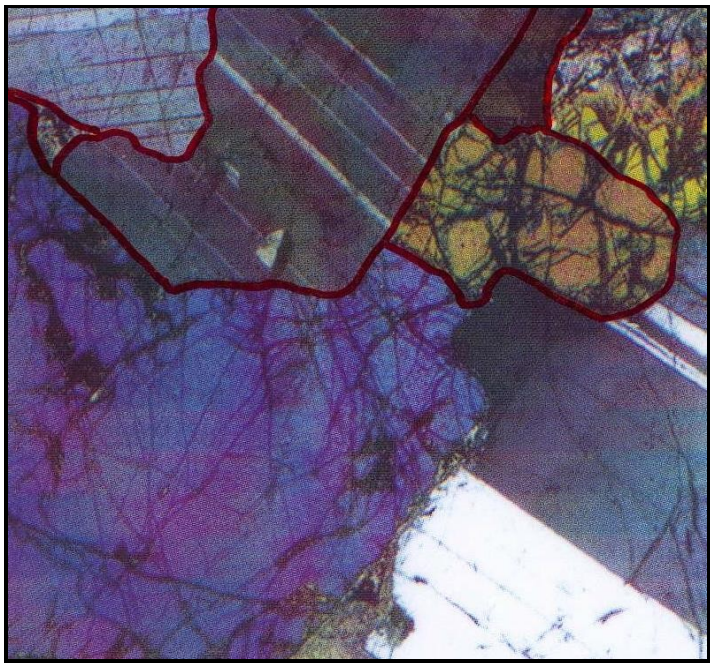
8) Coal. (10cm across)

9) Quarry for road-making material

10) Viewed from above. (Case is 10cm long)

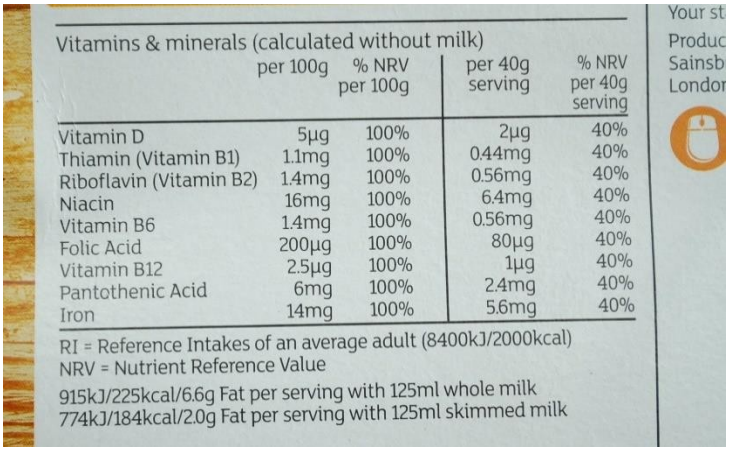
11) Rounded pebbles in a very hard “cement”

12) Essential for life!



13) View down a microscope.(Field of view 8mm)

14) An important resource



Vitamins & minerals (calculated without milk)

	per 100g	% NRV per 100g	per 40g serving	% NRV per 40g serving
Vitamin D	5µg	100%	2µg	40%
Thiamin (Vitamin B1)	1.1mg	100%	0.44mg	40%
Riboflavin (Vitamin B2)	1.4mg	100%	0.56mg	40%
Niacin	16mg	100%	6.4mg	40%
Vitamin B6	1.4mg	100%	0.56mg	40%
Folic Acid	200µg	100%	80µg	40%
Vitamin B12	2.5µg	100%	1µg	40%
Pantothenic Acid	6mg	100%	2.4mg	40%
Iron	14mg	100%	5.6mg	40%

RI = Reference Intakes of an average adult (8400kJ/2000kcal)
NRV = Nutrient Reference Value
915kJ/225kcal/6.6g Fat per serving with 125ml whole milk
774kJ/184kcal/2.0g Fat per serving with 125ml skimmed milk

15) A breakfast cereal – with an enlarged view of the label (*All photos: P. Kennett*)

The back up

Title: Mineral or not?
Sub-title: Discussion about what is a mineral and what is not

Topic: An activity centred around pictures or samples to enable pupils to distinguish between a mineral in the Earth science sense and other ways in which the term is commonly used.

Age range of pupils: 11 years upwards

Time needed to complete activity: 15 minutes

Pupil learning outcomes: Pupils can:

distinguish between minerals as defined by an Earth scientist and other materials which are commonly referred to as "minerals" in everyday use;
understand that rocks are composed of mixtures of minerals – to refer to a rock as a mineral is therefore incorrect;
appreciate that the term "mineral" is commonly utilised in biology and in economics and geography. In those contexts, users usually understand what it means, but it can be confusing.

Context: The term "mineral" is widely used in society and in several different subjects in the school curriculum. It can mean a mineral in the strict Earth science context defined above. It is also applied to the mineral resources of a country, which may include other materials such as "energy minerals", i.e. coal, oil, natural gas, "constructional minerals", e.g. hard rock aggregates, sand and gravel, components of cement etc. Suggested responses to the "mineral or not" photographs above are:

Card 1 – etc? – a cluster of fluorite crystals (CaF_2) showing cubic crystal faces – a mineral;
Photo 6 – Alabaster is composed of the mineral gypsum ($CaSO_4.2H_2O$), plus impurities and is usually regarded as a rock.
Photo 7 – crystals of purple fluorite and white calcite in a host rock of limestone. Although they may be regarded as a mixture of minerals, and therefore a rock, such occurrences are usually referred to as mineral veins.
Photo 8 – coal: part of the "mineral wealth" of a country, but not a mineral. Coal is of organic origin and was deposited in layers and is best thought of as a rock.
Photo 9 – bulk constructional "minerals" are being extracted here, but they are actually rocks (comprising a mixture of several different minerals, which, in this igneous rock, cooled from the molten state).
Photo 10 – the top surface of a mud deposit, showing shrinkage cracks. Although the regular shapes of the surface may suggest columnar crystals of minerals, we are seeing mud that may eventually become rock.
Photo 11 – a rock composed of fragments of even older rocks, rounded in the sea and now cemented together by natural compounds;
Photo 12 – "mineral" water. The water has picked up dissolved elements from the rocks through which it has passed. Any chemicals in it will be in ionic form and are not minerals in the strict sense.
Photo 13 – a microscope section of an igneous rock, cut very thinly and seen in polarised light. The constituent minerals may be seen very clearly interlocked together (some are outlined in red).
Photo 14 – North Sea oil is of organic origin, has a variable chemical composition and no defined atomic structure. It is not a mineral in the strict sense, but only in common usage e.g. as an "energy mineral".
Photo 15 – The "minerals" in processed food, may have been derived from true minerals, but are not naturally occurring and so are only "minerals" by common usage, most are elements.

Following up the activity: Ask pupils to spot the differences between minerals in the strict sense and other materials at home, or on their journey to school.

Underlying principles: To an Earth scientist, a mineral is defined as "a naturally occurring inorganic substance with a definite chemical composition, a definite atomic structure and physical properties which vary within known limits." The term "mineral" is also applied in other contexts in society at large and in other school subjects, which can cause confusion.

Thinking skill development: Pupils need to construct their own conceptual model of the meaning of the term "mineral" in its strict sense. Widespread use of the term in very different contexts causes cognitive conflict.

Resource list: Copies of the photographs (cards?) on these sheets. These could be cut up and pupils asked to sort them into true minerals and others. If resources are available, equivalent materials might be displayed on the desk.

Useful links: Earthlearningidea activities:
https://www.earthlearningidea.com/PDF/131_Identifying_minerals.pdf
https://www.earthlearningidea.com/PDF/165_Minerals_1.pdf
https://www.earthlearningidea.com/PDF/166_Minerals_2.pdf
https://www.earthlearningidea.com/PDF/170_Minerals_3.pdf

Source: Based on *Mineral misconceptions - or not?* King, C. 2010. School Science Review 92.339

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.