measuring the hardness of MINERALS

new VOICES

JESSICA BUSHBY shares her newly acquired knowledge of a 200 year-old measurement scale still in use today.

Educational value in primary classrooms

The measurement of a mineral's hardness could be an interesting addition to a late stage 2 or early stage 3 unit integrating mathematics with science or social science topics such as "Earth and its Surroundings" or Environments. The mathematics focus would be on data, in particular, understanding and constructing tables and graphs. The work could also incorporate geometry (position) and measurement (length, volume and capacity, and mass) and number.

Number

- Whole numbers — knowledge of ordering numbers.

Data

- Reading and understanding the table of Moh's hardness scale.
- Constructing a column/line graph to show the hardness of the minerals, e.g. x = names of minerals, y = the number of minerals each one can scratch.

Geometry

- Locating a mineral on a board using co-ordinates, e.g. talc = A4.

Measurement

- Length — measuring and comparing the lengths of minerals.
- Volume and capacity — devising ways of measuring a mineral's volume and capacity.
- Mass — students' predictions of mass and measuring how heavy each mineral is.

A teacher is only limited by their imagination!

How do you measure the hardness of minerals?

In order to measure the hardness of minerals, one must use Moh's hardness scale. This procedure has been in use for centuries, and is still used today (Chard, 2005; Edkins, 2005).

What is Moh's scale?

Moh's hardness scale is a comparative scale for minerals, whereby the softest mineral (talc) is placed at 1 and the hardest mineral (diamond) is placed at 10, with all other minerals ordered in between, according to their hardness.

Table 1. Moh's hardness scale.

1	talc	Used in talcum powder
2	gypsum	Used in plaster of paris
3	calcite	Found in limestone and shells
4	fluorite	Cubic crystals which are normally green, yellow or blue
5	apatite	Mostly made of calcium. Found in teeth
6	orthoclase	The pink/ white part in granite
7	quartz	The main mineral in sand
8	topaz	Emerald and aquamarine also have hardness of 8
9	corundum	Sapphire and ruby are varieties of corundum
10	diamond	Used in jewellery and cutting tools

A mineral can scratch another mineral that is the same hardness or softer. For example, using the table above:

- talc can be scratched by every other mineral — it is the softest mineral on earth, which explains why it is number 1;
- fluorite can scratch gypsum, but it cannot scratch topaz;
- corundum can scratch quartz, but cannot scratch diamond;
- diamond is the hardest mineral on earth, and can scratch every other mineral — that is why it is often used in heavy-duty rock drills and dentist drills (Oliver, 1993).

Some everyday objects can also be placed in Moh's hardness scale:

- fingernail = 2.5 (can scratch talc and gypsum, but not calcite.)
- glass = 5.25 (can scratch talc, gypsum, calcite, fluorite and apatite, but not orthoclase.)
- steel file = 7.5 (can scratch talc, gypsum, calcite, fluorite, apatite, orthoclase and quartz but not topaz.)

Placing these common items in the table is important because not all minerals are easily accessible.

It is important to note that the steps in the table are not of equal value. The difference between diamond and corundum is far greater than the difference between talc and gypsum. It is not a quantitative test because the minerals are only compared with each other and placed in a scale (England, 2005).

The following graph depicts the irregularity in the steps of the scale.

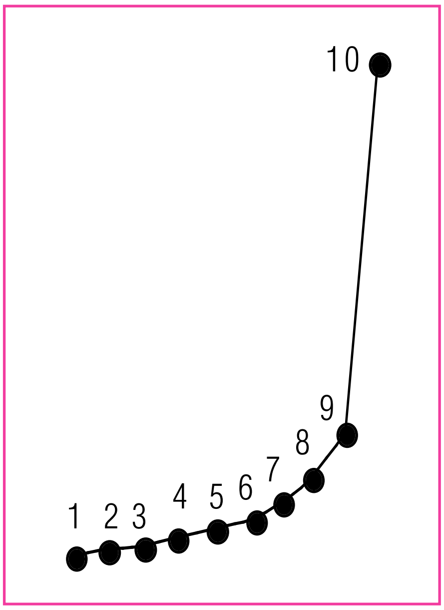

Figure 1. Graph showing relative hardness (IN-VSEE, 2005).

The visible difference on the graph between minerals 9 (corundum) and 10 (diamond) is far greater than that of 1 (talc) and 2 (gypsum). This means the table does not indicate scale, and is really more an ordered list of minerals' hardness.

How does it work?

Steps for testing the hardness of a mineral:

1. Select a fresh surface of the unknown mineral.
2. Hold the mineral and scratch it with an object/mineral of known hardness, e.g. fingernail (H = 2.5) or quartz (H = 7) (or whatever is most convenient — its hardness must be known though).
3. Press the object/mineral lightly but firmly against the unknown surface.
4. If the test object is harder than the unknown mineral it should leave an etched line in its surface.
5. Inspect unknown mineral for an etched line. If there is a line the unknown mineral is softer than the testing object/mineral; e.g., if using your fingernail it will be less than 2.5, if using quartz it will be less than 7. If there is no line this means the unknown mineral is harder than the testing object, and a harder testing object is now required.
6. Repeat process until the unknown object can be identified.

(Challoner & Walshaw, 2000; Maricopa Centre for Learning and Instruction [MCLI], 2003).

Who invented it?

All sources used in compiling this paper agree that Friedrich Moh (1773–1839), a German mineralogist, invented Moh's hardness scale.

Why was it invented?

In the early 19th century, there was no universal way of comparing the hardness of rocks and minerals, and there was a definite need for it by metallurgists, mineralogists and gemmologists. Moh devised a basic comparative scale of 10 minerals that were ordered from least to most scratch resistant, i.e. least hard to most hard mineral. He chose those minerals that were easily accessible by most mineralogists (Chard, 2005).

When was it invented?

Sources vary when it comes to when Moh invented this scale. Some sources (Challoner & Walshaw, 2000; Oliver, 1993. Chard, 2005; England, 2005.) claim it was in 1822, while some other sources (Edkins, 2005; American Federation of Mineralogical Societies [AMFS], 2005) claim it was in 1812. One source (Cacutt, 1992) claims it was in 1820, and some sources do not include a date of invention at all. The variation in dates is only small, and is most probably due to the large amount of time elapsed since Moh invented the scale of hardness (almost 200 years ago!).

Relationship to modern systems

Moh's hardness scale is still being used today by mineralogists and gemmologists, although metallurgists have little use for it now. There are other ways of identifying a mineral, such as:

- streak test
- fizz (carbon) test
- flame test
- borax bead test
- examining a mineral's:
  - lustre
  - cleavage and fracture
  - magnetism
  - density
  - fluorescence
  - radioactivity

Measuring a mineral's hardness using Moh's hardness scale is just one way of identifying a mineral. However, as far as my research went there was no other way of measuring a mineral's hardness without employing Moh's scale of hardness (Oliver, 1993).

References

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Jessica Bushby is a primary teacher education student at the University of Western Sydney.

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