

Diamond, ruby and sapphire

Which of these gemstones would you like to give or receive as a gift?

People have enjoyed wearing gemstones for centuries. Muslims living a thousand years ago were no exception. Of course, everyone wanted the most beautiful jewels and to pay fair prices for them.

Gemstones are special types of minerals. They are rare, beautiful and hard. The Ancient Egyptians, Greeks and Indians, as well as the Romans, knew a great deal about gemstones. Starting just over a thousand years ago, Muslim scientists continued to build on and extend this knowledge.



Al-Biruni (973 - 1050 CE) observed gemstones carefully. He recorded his observations in detail.

[Rubies] possess different characteristics with respect to brightness of the colour, clarity, glitter, sheen, reflection, and purity from blemishes, and their prices go up according to these characteristics.

If scarlet blood is ...spread over a clean piece of silver, the resultant coloration would be like that of the pomegranate-coloured ruby.

Al-Biruni also classified gems. He grouped them according to the properties below:

- Colour
- Powder colour
- Dispersion (whether white light splits up into the colours of the rainbow when it goes through the gem)
- Hardness
- Crystal shape
- Density

People had studied some of these properties many years earlier. Al-Biruni and other Muslims developed the work of the earlier scientists. Al-Biruni also used combinations of properties to identify gemstones.



Crystal shape

Al-Tifashi studied crystal shape. More than 700 years ago he described diamond crystals:

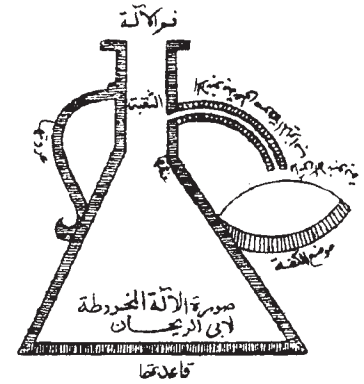
The faces are triangles. If [a diamond] is broken, the faces will be triangular, even at the smallest parts.

Two hundred years earlier, Al-Biruni used crystal shape to help him decide whether a gemstone was quartz or diamond.

Density

Density is the mass of something in a certain size. Al-Biruni invented a piece of apparatus to measure density. It worked like this:

- Fill the apparatus with water to the mark.
- Weigh a piece of the mineral and put it in the water.
- Measure the volume of water that comes out of the pipe end. This is the same as the volume of the mineral.
- Calculate the density of the mineral.
- Use the equation $\text{density} = \text{mass} \div \text{volume}$.



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Al-Biruni's results were very accurate. He used them to help him identify minerals.

Name of mineral	Relative density compared to water (water = 1)	
	Al-Biruni's result	Modern result
Ruby	4.01	4.40
Pearl	2.7	2.7
Quartz	2.58	2.58

Al-Biruni's apparatus was based on the work of the Greek scientist Archimedes, who worked out how to use water displacement to measure volume and so calculate density.

Hardness

Hardness is the ability of a mineral to scratch other minerals. The softer mineral is the one that is scratched. Al-Biruni experimented with hardness. He wrote:

I have started my book describing diamond before all other gems because it is the leader or master. It scratches corundum and corundum scratches what comes below it...However, corundum cannot scratch diamond.

Al-Biruni used hardness to help him identify minerals.

Today, scientists and jewellers still use some of Al-Biruni's techniques to identify gemstones. They also use newer techniques and more sophisticated apparatus to help them learn more about gems.

Image above from al-Khazini's *Kitab mizan al-hikma*, book III, chapter 1, section 2: Hyderabad, al-Uthmaniya University Publications, 1940, p. 59, figure 14.