A New Method for Analysing Ancient Marbles

by: J.J. Forsyth

Marble is one of the more enduring artefacts left by the ancients. Unfortunately, many ancient marbles have been broken and their fragments scattered amongst the fragments of other similarly shattered pieces. Thus the modern archaeologist is sometimes faced with a complex "jigsaw puzzle" in trying to reassemble marble fragments as accurately as possible. One common assumption made is that all the parts of a single carving were made from the same type of marble, so some method of classifying ancient marble would be most useful. In the past, classification systems based on surface appearance were in fact developed, but they were found to lack the necessary precision: you can understand the problem if you think of the word "white" and then look at some white paper beside some white skin.

A more precise method of analysing marble is needed, and one has now been developed which consumes only very minute samples. It is based on the fact that all marble is made of calcium carbonate with a few impurities added. The impurities give different marbles their distinctive appearance, but since impurities exist in such small quantities large pieces of valuable carvings would have to be destroyed in order to collect enough for analysis. Thus, the more plentiful calcium carbonate must be analysed in some way.

Each calcium carbonate molecule contains an atom of calcium, one of carbon, and three of oxygen. Carbon and oxygen naturally contain several isotopes, an isotope being an atom of an element which has a slightly different mass, usually due to the presence of one or two extra neutrons in the nucleus. The ratio of massive to normal atoms can be measured using a machine called a mass spectrometer: a small sample of material, typically about the size of a pin head, is heated and evaporated; the thin stream of vapor is forced between the poles of a strong magnet which pushes sideways with the same force on each atom as it moves by. The lighter atoms will be pushed sideways more than the more massive atoms, so that two streams emerge, one containing normal atoms and the other made of the massive isotopes. The number of atoms in each stream can then be counted, and the ratio of massive to normal isotopes calculated.

This ratio will vary for marbles from different quarries. For example, there is more heavy carbon (carbon-13) in marble from the Cycladic island of Paros than in marble from Italian Carrara. As a result, samples of marble from various ancient quarries are now being analysed to measure the ratios of heavy carbon and heavy oxygen. This will provide an information table which can then be used to identify the source of scattered marble fragments found in an excavation, thus helping the archaeologist sort out the masses of material s/he is faced with.

Moreover, since some historical records provide relatively precise dates for a particular quarry being in operation, it should now be possible to determine the dates of carvings with greater accuracy. Therefore an unknown new statue, for example, could theoretically be dated to the era when its marble was known to be being quarried. This, however, might not be very helpful for quarries that were worked over very long periods of time in antiquity.

Nonetheless, the ability to analyse marble in this fashion will undoubtedly provide archaeologists with a new tool that should enable them to understand their artefacts even better. Indeed, even statues now on display in museums can be studied in this manner to shed new light on old puzzles.

(Those interested further in this subject will find a useful article and bibliography in the September/October 1981 issue of Archaeology magazine.)