SPECIFIC-GRAVITY IDENTIFICATION OF ARAGONITE

-- Rane L. Curl (NSS 2247)

One of the most intriguing mineralogical puzzles from caves is the presence of aragonite. Calcite, of course, makes up most speleothems. Its polymorph (same chemical, but different crystal structure) aragonite is much less common because of its relative instability, but it is much more common, even if in small quantities, than generally supposed.

In its finest development - as displays of clusters of fine needles - it is unmistakable. In stalactitic and stalagmitic forms, it is usually overlooked. Aragonite often occurs as compact masses of fine "fibrous" crystals, sometimes alternating with calcite in the structure of a speleothem.

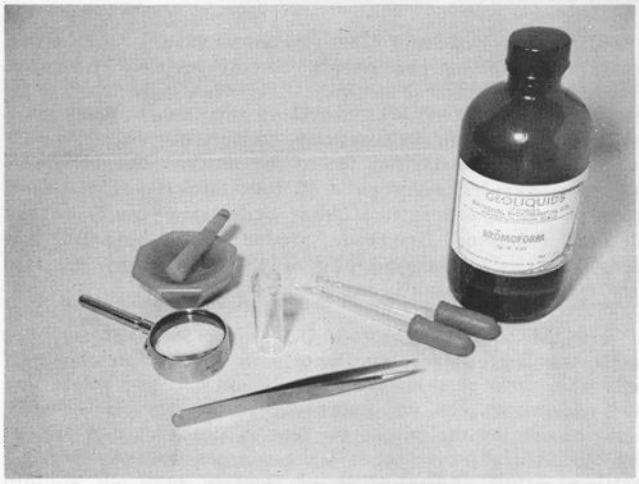
The professional mineralogist can distinguish calcite and aragonite - absolutely - by X-ray diffraction, but the apparatus is beyond the reach of the amateur speleologist (although some professionals will offer limited identification services). A simple and inexpensive technique for identifying aragonite has long been needed by the amateur.

While a variety of "staining" methods have been proposed, it does not take much reading into the subject to conclude that they are all unreliable. These respond to surface chemical properties, which are highly variable. A fundamental structural difference between calcite and aragonite is that the atoms in the latter are more closely packed. This is evidenced by aragonite having a higher specific gravity (2.95) than calcite (2.72). The difference may appear small, but it is easily detected with a pure heavy liquid, bromoform ($CHBr_3$), with a specific gravity of 2.85, in which calcite floats and aragonite sinks.

Heavy liquids have been used for a long time in mineral identification and separation, and bromoform is well known in these applications. Nevertheless, I have been unable to find the suggestion that it be used in distinguishing aragonite from calcite, at least in the speleological literature. Therefore I made a few experiments.

Twenty-two specimens identified as aragonite (including massive, fibrous, flos-ferri, and other forms), and eight identified as calcite were obtained from the mineral collection at the University of Michigan, and fragments of each were tested in bromoform. All the "calcite" fragments floated, but so did twelve of the "aragonites" (the others sank, as good aragonite should). In the face of this conflict, the light "aragonites" were identified with X-ray diffraction and it was found that only one was aragonite, one contained a small fraction of aragonite, eight were calcite (pseudomorphs after aragonite), one was some other carbonate, and one wasn't a carbonate at all! Several other specimens of calcite and aragonite which I have, produced correct responses.

The procedure is simple and requires only a minute sample. The picture shows the equipment used. A one-dram vial is filled about half full with bromoform and a tiny specimen is introduced below the surface with fine-tipped forceps. When the fragment is released one observes whether it sinks or floats. Many tests may be made in the same filling of bromoform - this was true of *all* the above tests. How small the mineral sample may be is only limited by the steadiness of one's fingers and the ability to observe the fragment. A hand-lens may be helpful.



Calcite-aragonite identification kit.

An aragonite specimen might float in bromoform if its average density were reduced by its being porous, or being a mixture with a lighter mineral - such as calcite. The one pure aragonite which floated in the above tests was a white, porous, fibrous specimen. When it was established as aragonite, a small fragment of it was finely ground, with a few drops of bromoform, in a mortar, and the suspension was then introduced into clean bromoform in the vial. After about an hour all the powder had sunk. This was also done with the sample that X-ray diffraction indicated to be a mixture. When ground and tested, about 15% sank and the rest floated, thus giving a rough estimate of the composition of the mixture. It appears that, with care, neither porosity nor mixtures restrict this technique.

Dividing all minerals into two categories - heavier or lighter than fromoform - is obviously useful only when the possibilities are very limited. This is the case in most caves, especially if the specimen is first identified as a carbonate using an acid. There then are only various magnesium minerals, such as hydromagnesite and huntite, all lighter than bromoform, and a few rare (in caves) carbonates of strontium, zinc, or lead. A fragment of the lightest of these, strontianite, was observed to fall considerably more rapidly than aragonite - a little experience would prevent one from being misled.

The used bromoform can be recovered. I use a medicine dropper with a tiny cotton plug as a filtering funnel. Bromoform is somewhat unstable and should be stored in a well-stoppered, brown glass bottle. If it darkens, it may be treated by shaking with a dilute sodium carbonate solution, washing with clear water, separating, and filtering. Remember also that it is *TOXIC* and should only be used in a well ventilated area.

The emphasis given here to *small* samples is important. It is a necessity that collecting in caves be, in the words of the NSS Cave Conservation Policy, "professional, selective and minimal." It would be pointless and destructive to indiscriminately "identify" the minerals in a cave

if such information is not to be of permanent value. Therefore I recommend that any program of aragonite identification in a cave be closely related to an existing speleological study of the cave and its environment. This would ensure selective collection; the specific-gravity method ensures minimal collection; planning and publication are needed for it to be of professional character.

The following are references for those wishing to look into this subject further:

Aragonite and Calcite: R. L. Curl, *Bull. Nat. Speleo. Soc.*, **24**, 57-73, 1962; J. R. Fisher, *Speleo Digest*, 2-(85-97), 1962.

Specific Gravity methods: *Dana's Manual of Mineralogy (Wiley)*; G. T. Warwick, in *British Caving* calls specific gravity determinations "useful.....in the laboratory", but the bromoform test is easily portable.

REVIEWS

Manual of Caving Techniques by the Cave Research Group of Great Britain. Cecil Cullingford, Editor. Routledge & Regan Paul, London, 416 pp.

This book is a supplement to the classic *British Caving*, also by Cullingford and the CRG. The style and binding of the two books are identical. Chapters on different topics are by different authors; and as might be expected, the quality of the chapters varies. Some of the topic selections might be questioned. There is a chapter on conservation and access, but none on mapping or photography. However, the faults are minor and the book is destined to become the major reference on most of its topics.

The British origin of the book is very evident in some of the chapters. Rappelling and prusiking, U. S. standard vertical techniques, are barely mentioned. Instead, the *Manual* illustrates 38 methods for attaching rungs to ladders. After reading the chapters on water in caves and digging in caves, this reviewer has admiration and sympathy for British cavers. The chapter on communications covers mainly telephones and inductive systems as radio regulations are strictly enforced in Britain. British cave rescue groups seem to be much better organized than in this country. The description of rescue techniques and equipment are written with authority. Among the more interesting equipment are a neoprene exposure bag and an apparatus for getting an unconscious person through a submerged passage.

Many other topics are covered, including: expedition planning, ropes, scaling poles, leadership, personal equipment, and climbing.

-- Robert Thrun
NSS 8979

National Speleological Society

POLICY FOR CONSERVATION

The National Speleological Society believes; That caves have unique scientific, recreational, and scenic values; That these values are endangered by both carelessness and intentional vandalism; That these values once gone, cannot be recovered; and that the responsibility for protecting caves must be assumed by those who study and enjoy them.

Accordingly, the intention of the Society is to work for the preservation of caves with a realistic policy supported by effective programs for; the encouragement of self-discipline among cavers; education and research concerning the causes and prevention of cave damage; and special projects, including cooperation with other groups similarly dedicated to the conservation of natural areas. Specifically:

All contents of a cave -- formations, life, and loose deposits -- are significant for its enjoyment and interpretation. Therefore, caving parties should leave a cave as they find it. They should provide means for the removal of waste; limit marking to as few, small and removable signs as are needed for surveys; and, especially, excerise extreme care not to accidentally break or soil formations, disturb life forms or unnecessarily increase the number of disfiguring paths through an area.

Scientific collection is professional, selective and minimal. The collecting of mineral or biological material for display purposes, including previously broken or dead specimens, is never justified, as it encourages others to collect and destroys the interest of the cave.

The Society encourages projects such as: establishing cave preserves; placing entrance gates where appropriate; opposing the sale of speleothems; supporting effective protective measures; cleaning and restoring over-used caves; cooperating with private cave owners by providing knowledge about their cave and assisting them in protecting their cave and property from damage during cave visits; and encouraging commercial cave owners to make use of their opportunity to aid the public in understanding caves and the importance of their conservation.

Where there is reason to believe that publication of cave locations will lead to vandalism before adequate protection can be established, the Society will oppose such publication.

It is the duty of every Society member to take personal responsibility for speading a consciousness of the cave conservation problem to each potential user of caves. Without this, the beauty and value of our caves will not long remain with us.