
Editorial

It has been fourteen years since Hill and Forti's *Cave Minerals of the World*, second edition (CMW2), was published by the National Speleological Society. This *International Journal of Speleology* Special Issue on Cave Minerals marks the most important publication in the field of Cave Mineralogy since that time.

The Review by Onac and Forti is an especially important contribution because of its discussion of the main processes leading to the deposition of minerals in caves. While these processes were covered in a number of sections in CMW2, this condensed overview allows the reader to compare and differentiate between the different mechanisms causing specific mineral deposition. If there ever is a CMW3, then this overview by Onac and Forti should definitely be included.

Also of interest in the Onac and Forti article is their figure showing the exponential growth of the science of Cave Mineralogy since 1800. The articles in this issue fit into this figure between CMW2 (1997) and the number of cave minerals and printed papers projected for 2015. Their placement within this figure also fits with these articles being more sophisticated than the papers referenced in CMW2. In other words, since CMW2 the field of Cave Mineralogy has blossomed into a scientific discipline of professional quality rather than being a conglomerate of observations made mostly by amateurs. These symposium papers reflect this increase in sophistication, both from the viewpoint of their technological base and in their more-advanced style of presentation.

All of the remaining eleven articles in this symposium have something new to contribute instead of being a rehash of old material. In fact, an overall title for this group of papers could be "unusual cave minerals/speleothems in unusual environmental settings". Under this general title, I have broken down these eleven articles into four subcategories:

- (1) Articles that describe new places/caves where speleothem types and subtypes of common minerals have not been reported previously.
- (2) Articles that describe new cave minerals.
- (3) Articles that describe minerals/speleothems formed in new or unique cave settings.
- (4) Articles that describe microbial processes related to the deposition of cave minerals – a new field of Cave Mineralogy that is just emerging.

In the first subcategory (1) are the articles by Filippi et al. and Leél-Óssy et al. In both cases the minerals involved were in CMW2, but the speleothem types and subtypes recognized within these caves go beyond those described in CMW2. The Filippi et al. article involves the Iranian salt karst – a country and cave area that has not been well represented in the karst literature. The mineral is halite, a relatively common cave mineral. However, the Iranian salt karst hosts a wealth of halite speleothem types and subtypes that probably represents the most varied display in the world – even surpassing the halite displays in Israeli, Atacama and Western Australian caves.

The second article in subcategory (1) describes the minerals and speleothems of the József-hegy thermal cave, Budapest, Hungary. What is especially interesting about this article is that various types of speleothems from different thermal episodes have been dated so as to trace the descent of the paleo-water table over time. Surprisingly, some of the dated speleothem types (e.g., water-table-type cave rafts) are older than 350 ka – or the upper limit of the U/Th dating

method. Dating of water-table-type speleothems has been used by Victor Polyak and Carol Hill in the caves of the Grand Canyon, Arizona, USA to determine paleo-water table lowering and incision of the canyon (see *Science*, 391), but this method applied in József-hegy Cave should be used more extensively in other cave systems. Concepts of hypogene karst are also employed in this article, which shows a more advanced, up-to-date knowledge of karst processes that relate to the mineralogy of this cave.

Articles that describe new cave minerals (2) are those of Onac et al. in Cioclovina Cave, Romania and Lazarides et al. in the hypogene caves of the Kassandra Peninsula, Greece. The new mineral found in Cioclovina Cave is kröhnkite, a sodium-copper sulfate where the copper is derived from nearby ore bodies. The first occurrence of orpiment as a cave mineral on the Kassandra Peninsula is due to the oxidation of fumarolic H₂S in a near-seawater environment. The orpiment accumulated from vapors under subaerial conditions at low temperatures through an evaporation-condensation process.

The most common subcategory of papers in this Special Issue is (3), or those that describe minerals and speleothems formed in new or unique cave environments. This is a deviation from pre-CMW2 papers that mostly describe mineral occurrences without trying to test and decipher the environmental conditions under which these minerals formed. This represents a leap forward in the field of Cave Mineralogy because it shows that cave mineralogy investigations can impact entire karst regions and past environments.

Probably the most unique cave environment represented by subcategory (3) is the paper by Badino et al. on the Ojo de la Reina Cave, which was intersected by the workings of the Naica Mine, Mexico. In this cave are the largest gypsum crystals in the world, precipitated from sulfate-rich fluids having temperatures in the range of 48-56°C. After the caves became dewatered due to mining activity, a decrease in cave temperature has led to condensation and drip-type speleothems, with the most unusual sulfate minerals actually being sourced by fluid inclusions within the giant gypsum crystals as the crystals have partially dissolved.

Another very unusual cave environment is represented by a cave in quartz sandstone in the Sydney region of Southeastern Australia. This paper by Wray involves sulfuric acid and the sulfuric-acid mineral alunite, which occurs within silica stalactites. In this case the quartz sandstone bedrock supplies the silica and the alunite is created by the sulfuric acid conversion of kaolinite or illite group minerals to alunite under low pH conditions.

The article by Tămaș et al. on Iza Cave, Rodnei Mountains, Romania, shows the importance of rock-water interactions in the underground environment. In this cave it is not only the sedimentary bedrock that is the source of its mineralogy, but it is also the weathering deposits derived from non-karstic metamorphic rock. Minerals deriving from mica schists consist of illite, kaolinite, jarosite, goethite, gypsum and alunite.

The importance of the next two papers – those by Bieniok et al. and Caddeo et al. – is that they both employ stable isotopes in their attempt to understand the cave environment under which cave minerals form. Bieniok et al., in Gamslöcher-Kolowat Cave near Salzburg, Austria, report an unusual suite of sulfate minerals/speleothems in the dry part of the cave which, from their different sulfur isotope signatures, seem to have derived from different sources – the mirabilite cotton and gypsum needles from an organic source and the gypsum balls from a bedrock source. More stable isotope studies like this one need to be done in order to understand the origin and genesis of cave minerals.

The Caddeo et al. paper discusses aragonite precipitation in a flowstone deposit in a natural cave within the mining district of SW Sardinia, Italy. From carbon and oxygen stable isotope

analysis on alternating calcite and aragonite layers in the flowstone it appears that aragonite precipitation was not driven by Mg^{2+} inhibition of calcite or by more arid conditions, but by the effect of dissolved Zn^{2+} and/or Pb^{2+} under humid conditions where more infiltration dissolved the overlying Pb-Zn ore deposits before entering the cave.

The final subcategory of papers (4) involves the effect of microorganisms on speleothem deposition. The first of these papers by Gázquez et al. investigates the role of manganese bacteria in El Soplao Cave, Cantabria, Spain. The black Mn-Fe crusts apparently formed in the phreatic zone where metals released under reducing conditions were oxidized and fixed by manganese bacteria, causing the Mn-Fe deposits to precipitate. Then as vadose conditions were re-established, aragonite was deposited on the surface of the Mn-Fe crusts, becoming markers of abrupt paleoenvironmental changes.

The final paper of the symposium by Florea et al. also involves microorganisms; i.e., the iron bacteria *Leptothrix* sp., which forms biofilms in Thorton's Cave, Florida, USA. The regular input of iron and organic matter into the cave from the surface causes the Fe-oxidizer *Leptothrix* sp. to thrive in this environment and to precipitate the widespread biofilms. CO_2 degassing from cave waters likely contributed to the precipitation of calcite on these Fe-biofilms and together they formed "cornflake"-like speleothems on the cave walls.

This Special Issue on Cave Minerals is sure to be another landmark in the advancement of the science of mineralogy and is highly recommended reading for anyone who is interested in what cave minerals can reveal about past environments in karst regions.

Carol A. Hill