The crystal morphology of aragonite and its implications in pumping pipe of hot spring, Taiwan

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This study investigates crystal morphology of sinter and discusses what kinds of factors controlling crystal morphology of aragonite to reconstruct the pumping history of hot spring.

The pipe sinter of this study is collected from Ho-Ya SPA hotel, located in Rui-Shui, Hualien County of Taiwan. Precipitated minerals of it are predominantly composed of aragonite (>99.4%) with preferred orientation by Electron Backscatter Diffraction (EBSD). The sinter displays the rings of gray, white and gray from outside to inside. The white ring of sinter is composed of many strips, but the gray one is not by naked-eyes. Under optical microscope, there are two particle morphologies of aragonite in Ho-Ya SPA white sinter. One is small and rounded crystal gathered to strips, while the other is needle. However, the gray ring almost consists of needle shape of aragonite.

Holcomb *et al*. (2009) [1] simulated the coral's growth and concluded that the small and rounded crystal is owing to high pH and saturation state in the solution. In coral, the gathered small and round crystals are called centres of calcification (COC).

In this case, we propose that the higher pumping rate causes the rapid depressurization to over-saturate quickly, and then crystals nucleate and grow. This process may generate higher porosity and rounded shape of aragonite.

In low season with low pumping rate, the aragonite grows the fine and elongate crystal due to slow supply of hot spring. However, in peak season with high pumping rate causes the quick degassing of CO_2 to occur over-saturated in solutions, then precipitate aragonite rapidly and generate rounded crystals with larger porosity. The crystal morphology, therefore, of the colorful rings implies that the sinter of Ho-Ya hot spring grows at the summer-winter-summer during one and a halfyears.

[1] Holcomb *et al*. (2009) *Geochimica et Cosochimica Acta* **73**, 4166–4179.

Reaching part-per-quadrillion: detection of ^{39}Ar in environmental samples using ATTA

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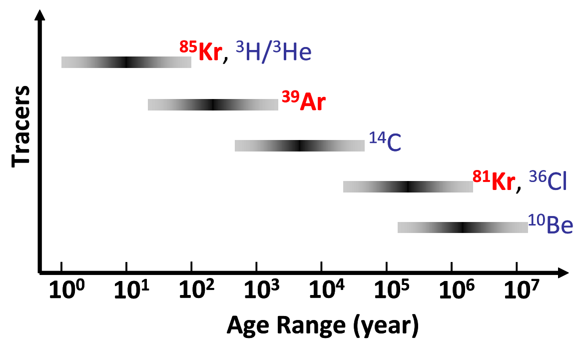
The Atom Trap Trace Analysis (ATTA) method has been used to analyze the cosmogenic isotope ^{39}Ar (half-life = 269 yr, isotopic abundance ~ $8x10^{-16}$) in the atmosphere [1, 2]. With this demonstration, ATTA has reached a new milestone of detecting isotopes at the abundance level of less than one part per quadrillion. Along with the previously demonstrated analyses of ^{81}Kr (229, 000 yr, ~10^{-12}) and ^{85}Kr (10.8 yr, ~10^{-11}), ATTA can now analyze all three long-lived noble gas radioisotopes covering a wide range of ages and applications in the earth sciences. The detection of ^{39}Ar was made possible by a large improvement (x 100) in both the counting rate and counting efficiency of the ATTA method. We have developed a new apparatus (ATTA-3) to perform ^{81}Kr dating with a required sample size of 10-100 liters of water or ice. This work is supported by DOE, Office of Nuclear Physics, and by NSF, Division of Earth Sciences.



[1] Jiang W. *et al*. (2011) *Phys. Rev. Lett*. **106**, 103001.
[2] Chen C. Y. *et al*. (1999) *Science* **286**, 1139.