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Factors controlling the colors of aragonite in pumping pipe of hot spring, Taiwan

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Hot spring of Ho-Ya SPA hotel, located in Rui-Shui, Hualien County of east Taiwan, is the sodium bicarbonate with iron in composition, It is reputed as "Kingly Golden Amber Spring", because the spring is always amber red in color due to the Fe^{2+} be oxidized to Fe^{3+} as soon as the spring water meeting with air,. This study investigates controlling factors of the sinter's colors in the pumping pipe of Ho-Ye hot spring, which displays gray, white and gray from outside to inside.

Precipitated minerals of pipe sinter from Ho-Ya hot spring are predominantly composed of aragonite ($>99\%$) with preferred orientation by Electron Backscatter Diffraction (EBSD). We also used acid to dissolve the sample and took the concentrations of Ca, Cd, Co, Cu, Fe, Mg, Mn, Ni, Pb, Sr, and Zn by Inductively Coupled Plasma Emission Spectroscopy-Atomic Emission Spectrometry (ICP-AES). The results show that there are little or no relationships between strip colors with these ions and crystal's orientation.

The images were photoed by SEM (mag. X150) with EBSD to count the porosity, average size of pores and crystal size distributions in every colorful strip of pumping pipe from the Ho-Ye hot spring by software named Image J. It shows that the higher the porosity is the larger the average size of pores. It also displays that the whitest strip has the highest porosity (26%), and the largest average size of pores., In addition, it also has the biggest crystal size with few calcite. Oppositely, the darkest gray has the lowest porosity ($< 1\%$) and smallest crystal size. Those results can be explained by optics theory. The bigger the crystal and pore are, the more light could be passed through them to display the whiter in color. In contrast, the smaller and less pores are, the crystals generate more contact with each other to block or reflect the light through them. The more light are blocked or reflected, the darker color can be observed in the strip aragonite.