

Simultaneous Acquisition of Crystal Fabric Orientation and Chemical Distribution with the Bruker M4 Tornado μ XRF

Tina. R. Hill*¹

Yongli Gao²

Analysis utilizing the Bruker M4 Tornado micro-X-ray Fluorescence tabletop instrument (μ XRF), specifically x-ray chemical mapping, applied to speleothems contributes greatly to our understanding of the combination of crystal fabric with chemical composition. This is a combination typically only seen using multiple techniques with much effort, particularly with large intact samples. Significant advantages of tabletop μ XRF are ease of sample preparation (little to none) for a wide variety of sample shapes and sizes, and quick analysis time while still obtaining elements Na-U in major and trace amounts. Crystal growth mechanisms and their influence on the physicochemical characteristics of each fabric cannot be assessed with optical petrography; isotopic analysis tells us nothing about crystallinity. Understanding crystal growth mechanisms in speleothems is important as changes in geochemistry through successive layers are used to extract paleoclimate information during time of growth. We must, therefore, better understand the relationship between crystal microstructures, fabrics and environment of formation, and geochemical properties. This novel technique allows for interpretation of paleoclimate data in light of new insight into crystal fabrics. A combination of factors such as drip rate, supersaturation, impurity content, discharge, and possibly Mg/Ca ratio of the parent waters control the development of the various calcite fabrics of speleothems. Fabrics, therefore, provide a potential tool for the recognition of the possible effects of environmentally-related factors on isotope fractionation. Here we present a simultaneous collection of x-ray maps of elemental distribution with location in the stalagmite. In addition, we utilize what is typically an artifact of the XRF process, Bragg diffraction, to visualize crystal orientation at the same time as chemical composition. The visible layering observed in hand sample is well-correlated with some elements (Sr, Fig. 1a), but the fabric/crystal appears to have formed somewhat irrespective of composition when compared to crystal orientation maps (Fig. 1b). All three crystal orientations shown (three different colors) in the Bragg maps (Fig. 1b) are seen to cross the layers of the Sr distribution map. It is uncommon to acquire rock texture data, here crystal fabric orientation, simultaneously with chemical layering in one analysis technique. This approach presents a unique opportunity to draw conclusions regarding the interplay of crystal fabric and composition to climate and environmental reconstruction. Now, investigating changes in crystal fabric with respect to composition can be as easy as making an x-ray map with no damage to the sample.

1. Bruker AXS, 5465 E. Cheryl Parkway, Madison, WI 53711 USA
2. The University of Texas at San Antonio, One UTSA Circle, San Antonio, Texas 78249-0663 USA

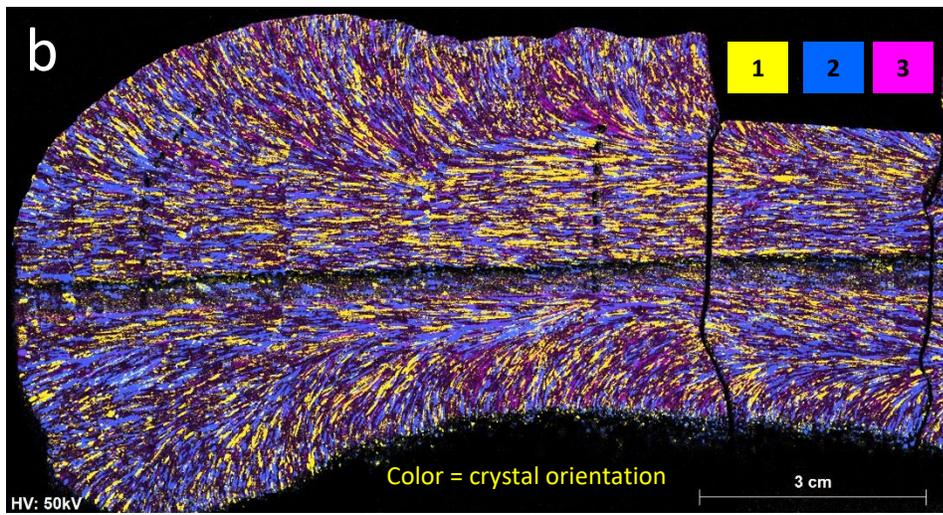
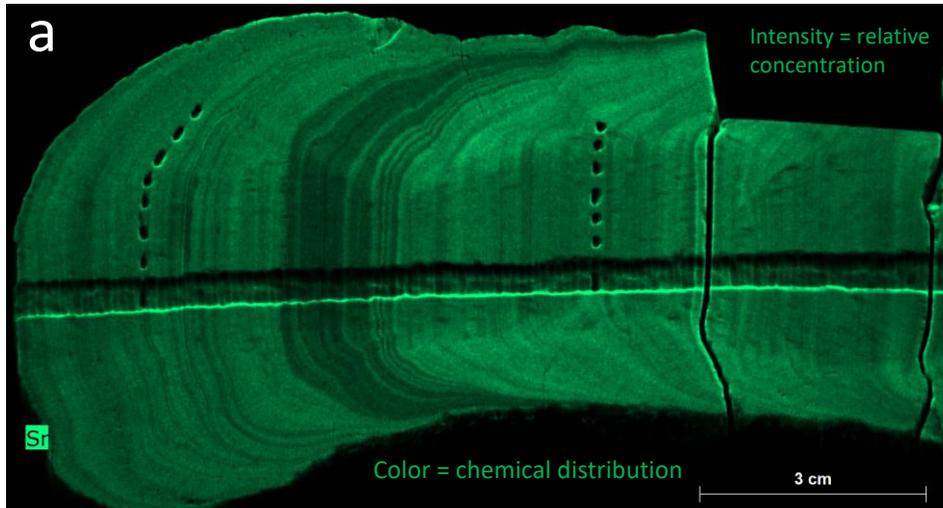


Figure 1. Comparison of elemental distribution of Sr (a) with Bragg diffraction maps (b). In (a), intensity is related to the relative concentration of the element. In (b), each of three colors is one crystal orientation.