Characterizing the mineralogy of X-ray amorphous biogenic silica and geological opal analogs

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X-ray amorphous silica mineraloids are essential to life on Earth as they provide architectural structure to dominant primary producers, such as plants and phytoplankton, as well as to protists and sponges. Silicifying marine diatoms alone make up approximately 45% of the ocean's primary productivity. Due to the difficulty in characterizing and quantifying crystallinity in X-ray amorphous silica, relatively little has been done to understand the mineralogy of biogenic silica and how this may impact the material properties of biogenic silica, such as solubility and strength. Typically, geologically-formed opal-A is regarded as an analogue to biogenic silica, however, some spectroscopic and imaging studies suggest that this might not be a reasonable assumption. In this study, we use a variety of quantitative and qualitative techniques (X-ray diffraction, Raman spectroscopy, Scanning electron microscopy) to compare differences in structural disorder and bonding environments of geologically-formed X-ray amorphous silicas (Opal-A, hyalite, glass) versus biogenic silicas from an array of organisms. Our results indicate higher disorder in biogenic silica compared to geologically-formed silica, which aligns with qualitative observations and corroborates previous studies that suggest differences between biogenic and geologically-formed silica.