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The automation of serial grinding, imaging and digital reconstruction of features in samples with weak density contrasts.

Bradley Samuels (1), Robert Beach (1), Sigfus Briedfjord (1), Basar Girit (1), Aleksey Lukyanov (1), Westley Rozen (1), and Adam Maloof (2)

(1) Situ Studio, Brooklyn NY, United States (brad@situstudio.com/718.237.5955), (2) Department of Geosciences, Princeton University, Princeton NJ, United States (maloof@princeton.edu/609-258-1274)

Most 3D fossil reconstructions use CT-scanning technology and rely on X-rays to image strong density contrasts in heterogeneous media. However, in many specimens, the density contrasts between the subject of interest (e.g., fossils, cements, veins, etc.) and matrix are not significant enough to be imaged with traditional X-ray based CT-scanning methods. We have developed a serial grinding, imaging and digital reconstruction routine that streamlines this process into an efficient method of digital reconstruction that employs the coupling of Computer Numerically Controlled machining with digital modeling software. This routine automates what was a previously prohibitively time consuming and human-biased process and provides digital models that are at once useful for morphogenetic analysis and quantification of properties such as porosity, permeability, and other feature-related characteristics. This set of tools, both hardware and software, were developed in research focusing on the reconstruction of putative sponge-grade fossils in pre-Marinoan ($\sim$650 Ma) stromatolitic limestones (these objects are the oldest cm-scale calcified body fossils ever reported by $\sim$90 Myr). In addition to fossil reconstruction, we investigate applications of these tools for the analysis of geological CO2 sequestration, cementation of petroleum reservoir rocks, and salt deposition in pore spaces within building concrete.