

Micro-CT Imaging of Rock-Inhabiting Fungi: A 3D Approach to Microbe-Mineral Interactions

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Fungi play a critical role in rock weathering and nutrient cycling, yet their spatial interactions with minerals remain poorly understood. This study employs high-resolution micro-computed tomography (micro-CT) to visualize fungal colonization within basaltic rocks, offering a non-destructive 3D perspective on microbe-mineral interactions. Previous SEM analyses indicated that fungal hyphae preferentially colonize specific minerals while avoiding others. To verify and quantify these patterns, we scanned 24 basalt samples from three locations at a voxel size of 3–4 μm using CoreTOM (TESCAN XRE) at Centre for X-ray Tomography at Ghent University, through the EXCITE network. It enabled clear visualization of fungal structures (5–10 μm in diameter) and their association with mineral phases.

In addition to micro-CT, we employed SEM for structural validation, polarized-light microscopy for petrographic analysis, and advanced image processing techniques (Dragonfly, Fiji/ImageJ, and MATLAB) for segmentation and quantitative assessment. These combined approaches allowed us to track hyphal growth pathways, determine fungal selectivity for different minerals, and assess the extent of mineral weathering.

Our findings demonstrate that micro-CT enables unprecedented 3D visualization of fungal hyphae within mineral substrates, providing a deeper understanding of fungal-mediated bioweathering. By integrating multiple imaging techniques with computational analysis, this study advances our ability to quantify fungal-mineral interactions and their role in geochemical processes.