Iron-eating fungus etches hard mineral using acid and biomechanical force

With the support of the National Natural Science Foundation of China, a research team led by Profs. Chen Jun (陈骏) and Teng Hui (滕辉) at the Key Laboratory of Surficial Geochemistry, Ministry of Education, School of Earth Sciences and Engineering, Nanjing University, revealed a previously unrecognized weathering mechanism driven by the fungal cell-mineral interfacial reactions, which was recently published in *Geology* (2016, 44(4): 319—322). A PhD student, Li Zibo (李子波), was trained under this project and performed the sophisticated experimental work with technical support from faculty at the Schools of Physics, Chemistry, and Environment of Nanjing University.

Microbe-mineral interactions play critical parts in shaping our planet Earth and have been at the forefront of geo-bio-science research for the past three decades. Despite the significant understanding we have achieved to date in microbially mediated weathering/mineralization, significant shortages remain concerning the microbe-mineral interfacial processes due to the difficulties in directly examining the interfaces. The research team discovered the ectomycorrhizal fungus *Talaromyces flavus* in a serpentinite mine in Donghai, China, while searching for native fungal strain good at extracting magnesium from rock. Magnesium could be used in carbon sequestration, and fungi represent promising bioagents to improve the efficacy of magnesium release. They found that Mg^{2+} release rate and efficiency were significantly increased in the presence of the fungus. This finding was published in *Geomicrobiology journal* (2015).

Figure A 125-micrometer-long etch channel produced by fungus *Talaromyces flavus* on the surface of iron-bearing mineral lizardite. Credit: Zibo Li

They then scrutinized the zone where cell meet lizardite mineral using approaches combining a number of the state-of-the-art analytical techniques. When contact the mineral's surface, the cell secretes acids that drop the microenvironmental pH by a factor of 10 to dissolve the mineral and extract iron. The first step implies that the fungal cell uses a sensitive and accurate miniaturized iron-detection mechanism. An extra step requires the cell to manufacture and export unique iron-trapping chemical called siderophore. A gel-like layer that formed as the same acid reacts with silicon and oxygen tends to prevent the hypha to get to more nutrients. With the biomechanical forces, however, the hypha can rip apart this Si-rich coating, leaving behind channels stretching 200—2000 nanometers. More importantly, their measurements showed the interfacial cellular dissolution could contribute 40%—50% to the overall bioweathering, dwarfing the current understanding of ~1%. And different types of cells (hyphae vs. spores) have different cellular dissolution modes, something not even conjectured before. Their findings have a great potential to advance current understanding of bioweathering and have strong implications for terrestrial nutrients and carbon cycling.