How biological interactions and physical stresses influence fungal biogeochemical impact

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Atmosphere-rock interfaces are omnipresent and occur at all scales – from planetary to microscopic. Life at the boundary between the atmosphere and the lithosphere is an ancient terrestrial niche, where fungi are dominant and ubiquitous. Micro-organisms in the form of biofilms and microbial mats not unlike modern desert or inter-tidal systems were amongst the first settlers of these inhospitable surfaces. Major groups of micro-organisms that are associated with the colonisation of land (eubacteria including Actinobacteria, Cyanobacteria, and Firmicutes early on and fungi for the last 0,5 Ga) are present in these habitats. Even today, freshly exposed solid surfaces are rapidly colonised by subaerial biofilms (SAB) composed of both heterotrophic and phototrophic partners. Interconnected microbial communities within SAB withstand physical stresses, interact with the underlying substrate as well as the atmosphere and support each other. Here we examine the evidence for: (i) biological interactions between fungal and phototrophic inhabitants of rock biofilms, and: (ii) reciprocity between atmosphere – SAB – rock. Ways of dissecting these interactions at the molecular level, as well as approaching this system as a complex entity, will also be discussed.

U-Pb, O, and Ti zircon depth profiling analyses: Understanding mid-crustal processes

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Secondary ionization mass spectrometry (SIMS) depth profiling of zircon and monazite in high-grade metamorphic rocks provides the ultra-high spatial resolution needed to decipher mid-crustal processes that might otherwise be unrecoverable by conventional methods. To understand the mid-crustal fluid history of a high-grade Cordilleran gneiss dome, we examined zircon and monazite from migmatitic high-grade gneisses of the Valhalla complex, SE British Columbia. Valhalla records a long history of partial melting during crustal thickening and/or orogenic collapse with the gneisses deforming and partially melting from ~60 to 50 Ma, as documented by U-Pb zircon (60 Ma) and Th-Pb monazite (58 to 51 Ma) geochronology. Biotite Ar-Ar ages indicate that the affected rocks had cooled to < 350 °C by 50 to 48 Ma. To better understand the Eocene post-crystallization/fluid history, we measured U-Pb ages, $\delta^{18}O$, and trace element from zircon and $\delta^{18}O$ from monazite from different structural depths. Depth profiling U-Pb measurements of unpolished zircon rims yield ages as young as 51 Ma over 4 µm. Ti in zircon thermometry indicates 650 °C for both rim and interior, confirming that the complex remained at high-temperature until 51 Ma. Oxygen isotopic results clearly resolve a $\delta^{18}O$ contrast between zircon interiors (7.2 ‰) and rims (8.4 ‰). The interior $\delta^{18}O$ values reflect equilibration with melt at 58 Ma. Alternatively, $\delta^{18}O$ values from the 51 Ma rims match the composition predicted (8.4 ‰) from fluid interaction based upon previous work. The results demonstrate that fluid infiltration driven by amphibolite facies metamorphic devolatilization and/or melt crystallization persisted at deep crustal levels until just before the time that the rocks were rapidly exhumed to upper crustal levels. The results further indicate the potential power of coupling ion microprobe U-Pb, $\delta^{18}O$, and Ti depth profiling of natural zircon rims to assess crustal evolution.