**High Resolution Characterization of Recent and Ancient Microbial Systems using ToF-SIMS**

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This presentation introduces molecular Time-of-flight secondary ion mass spectrometry (ToF-SIMS) as a tool for biomarker analyses at the microscopic level, with focus on applications in geomicrobiology and organic geochemistry. A combination of optical microscopy and ToF-SIMS imaging enabled a clear-cut assignment of biomarkers to specific microorganisms within cryosections of recent microbial mats. ToF-SIMS spectra and ion images of individual microalgal cells revealed their molecular inventories, including fatty acids, mono-, di-, and triacylglycerols, intact polar lipids, carotenoids, and chlorophyll. In a second example we show how a combination of ToF-SIMS, ‘destructive’ techniques (electron microprobe, laser ablation inductively coupled plasma mass spectrometry (LA-ICP-MS), and isotope analyses (δ13C, δ18O and 87Sr ⁄ 86S)) enabled the detection of microbial remains in fracture minerals, thus identifying an ancient ‘deep biosphere’ in granitic rocks of the continental subsurface (450m below sea level).