Snow and ice algae rock - Cryo-Life habitability in an extreme environment

STEFANIE LUTZ[1], ALEXANDRE M. ANESIO[2] AND LIANE G. BENNING[1]

[1]School of Earth & Environment, University of Leeds, LS2 9JT, UK (*correspondance: s.lutz@leeds.ac.uk)
[2]Bristol Glaciology Centre, School of Geographical Sciences, University of Bristol, BS8 1TH, UK

Snow and glacial ice surfaces cover about 10% of Earth's surface and despite being extreme environments they are colonised by a plethora of organisms [1]. On an ecosystem scale, snow and ice algae are the crucial primary colonisers and producers [2]. They evolved a suite of protective biomolecules (e.g., pigments), are well adapted to cold, UV and nutrient stress [2] and dominate the organic and inorganic carbon flux on glaciers. This may also imparts them a central role in controlling the diversity and structure of other communities in glacial ecosystems, yet so far little is known about this. Microbial cryo-adaptation and preservation of life and geochemical signals also have clear implications for the life detection on other icy planets (e.g., Mars, Europa).

Here we show how assessing a variety of physico-chemical (T, melting and transition from snow to bare ice habitats, UV/PAR radiation) and biogeochemical (nutrient and trace metal scarcity, pigment and lipid compositions, and structure) parameters in varied cryogenic glacial habitats (e.g., snow, ice and cryoconites) can be used to define cryo-life habitability at a whole ecosystem scale of a glacier (~ 1 km^2 of Mittivakkat glacier, SE-Greenland). We found that by far the snow and ice algae dominate the glacial C cycle and the primary production on a glacial scale. The low nutrient (< 1 ppm) and trace metal (< 100 ppb) contents combined with slowly weathering and nutrient-scarce minerals provide an extreme setting for algae growth. Nevertheless, spectroscopic and chromatographic analyses of cells revealed a broad and, rapidly changing cryo-organic inventory during the melting season. The spatial and temporal heterogeneity in pigment composition and abundance between samples correlated well with the functional group distributions showing a clear trend among microbial communities and their adaptation strategies. These findings together with metagenomic diversity and functional gene analyses provide a first comprehensive insight into the ecology of an entire glacial surface ecosystem.

[1] Anesio & Laybourn-Parry (2011) *Trends in ecology & evolution* **27(4)**, 219-225. [2] Remias *et al*.. (2005) *European Journal of Phycology* **40(3)**, 259-268.

The MUSIC model over the years from a personal point of view

J. LÜTZENKIRCHEN[1]

[1]Institut für Nukleare Entsorgung, Karlsruher Institut für Technologie (KIT), Hermann-von-Helmholtz-Platz 1, 76344 Eggenstein-Leopoldshafen, Germany; johannes.luetzenkirchen@kit.edu

The first MUSIC papers were revolutionary: explicit consideration of distinctly different sites on a single face of a mineral based on structural considerations vs. previously used generic sites; fractional (Pauling) charges in surface chemical reactions vs. text-book integer charges; prediction of proton affinity constants vs. numerical fitting. The failure of MUSIC to describe goethite surface charge for updated particle morphology required inclusion of further details of the mineral water interface, such as the effects of H-bonds on predicted affinity constants. Fractional charges were now based on Brown-Altermatt. Up to this point basic charging was the major issue treated by MUSIC. Completion of the framework by introducing charge distribution (CD) allows modeling the adsorption of dissolved pollutants to minerals by combining macroscopic with atomistic level data. CD-MUSIC (to my mind still the most advanced model for this purpose) is heavily cited, but comparably few CD-MUSIC applications from outside Wageningen appeared, maybe related to its incompatibility with common speciation codes or due to other shortcomings of the few codes permitting fractional charges. Fortunately, popular tools like Phreeqc now include CD-MUSIC. Model calculations will exemplify recent developments and associated problems. Experimental model systems will be discussed that strongly support the MUSIC approach, but at the same time hint to limitations arising from effects that CD-MUSIC was never supposed to handle. Grateful for having met Willem van Riemsdijk early on I will surely miss discussions with him and his continued encouragement over the years.

www.minersoc.org
DOI:10.1180/minmag.2013.077.5.12