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The effects of sedimentation on modern microbial mats in Antarctic lakes

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Photosynthetic microbial mats flourish in ice-covered lakes of Antarctic dry valleys. Where sufficient light penetrates the ice, these mats cover vast swaths of the lake floors, growing under variable illuminance, sediment fluxes, and water chemistry [e.g., 1-5]. In two lakes (Joyce and Fryxell), calcite precipitation partially lithifies the mats, forming stromatolites. Mat and stromatolite morphology varies from lake to lake and within individual lakes, reflecting variations in microbial behaviour [1,4], lithification [4], and sediment influx and grain size.

Microbial pinnacles are common in all lakes, but they have lower abundance where the predicted settling of mud-sized sediment is more abundant. In Lake Untersee, which has a relatively high influx of mud-sized sediment relative to the microbial growth rate, toppled pinnacles are commonly present between mud laminae and many growing pinnacles have tips that are bent over (Figure 1). The bending of tips and toppling of pinnacles is interpreted to be caused by weighting of the pinnacles by deposited suspended sediment. In Lake Joyce, where suspended sediment deposition increases toward the mouths of seasonal streams, pinnacles are rarely toppled, but those interpreted as forming in environments with more abundant mud deposition commonly have bent tips. Many of the Lake Joyce pinnacles are lithified by calcite, which makes them more resistant to toppling. Mud-sized sediment is extremely sparse in Lake Vanda, where almost all pinnacles are sharply peaked and almost no tips were bent, despite little calcification [3]. Lake Vanda pinnacle are also very thin relative to their heights. In contrast, pinnacles that grow with higher mud accumulation rates typically have significantly larger diameter-to-height ratios.

The effects of sand deposition, which occurs through the ice cover, are less well constrained. Where abundant sand is deposited at once, mats are completely buried and growth is temporarily terminated. However, where single grains filter through the ice, they are incorporated into the mat below. Preliminary results from Lake Vanda suggest that these grains disrupt delicate microbial mat features such as thin ridges between pinnacles but do not inhibit pinnacle growth. This observation is consistent with sand grains rolling off pinnacle slopes and accumulating in flat mat between pinnacles, which could compact the surrounding mat.

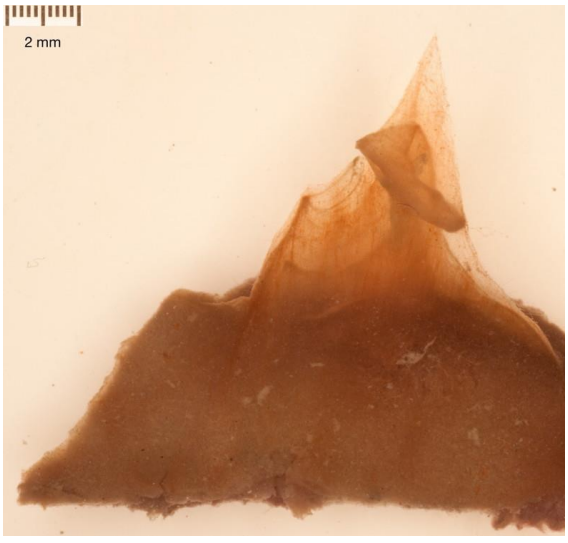

Figure 1: Bent pinnacle tip from Lake Untersee

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