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Mechanisms of terrestrial organic matter burial in fjords

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Fjords are hotspots of organic matter (OM) burial, burying OM at rates approximately 100 times higher than the global ocean average and accounting for ~11% of annual marine carbon burial [1]. These high burial rates are often linked to high sedimentation rates and inputs of recalcitrant, terrestrially derived OM, but a complete understanding of the mechanisms that drive enhanced OM burial remain unclear. Here, we investigate the controls on OM burial in fjord sediments from three sites in the fjords of Tofino Inlet, Vancouver Island, Canada that span a range of local redox and geochemical conditions and vary in dominant OM source.

We evaluate two processes hypothesized to enhance OM burial: sulfurization and mineral protection. We find that sulfurization reactions are ubiquitous at all sites despite differences in OM type and reactivity. The highest degree of sulfurization was observed at the most sulfidic site, where proto-kerogen OM (insoluble OM) is primarily terrestrial, with a wood-like C:N ratio of 89 ± 10. The organic sulfur that accumulates in proto-kerogen with depth has a sulfur-isotope composition that resembles porewater sulfide and is primarily reduced (thiols, alkyl sulfides, and disulfides). Therefore, we conclude that a major constituent of wood-derived OM is rapidly sulfurizing in Tofino Inlet sediments, potentially hemicellulose.

Mineral protection is a primary mechanism for OM burial globally [2], but the interactions between sulfurization and mineral sorption of organic matter (MOM) has not been evaluated. We isolated MOM and organic debris and found that both pools of OM sulfurize to a similar degree over the length of the sediment core, which suggests that organics can sulfurize while bound to mineral surfaces, and/or that they can sorb after sulfurization. Together, these results advance our understanding of the mechanisms behind global marine carbon burial in fjords and other hotspots of OM burial globally.

[1] Smith, Bianchi, Allison, Savage & Galy (2015), *Nature Geoscience* 8, 450-453.

[2] Hemingway et al. (2019), *Nature* 570, 228-231.