Figure 1. Field and petrographic features of MTS, Helena Formation, Mesoproterozoic Belt Supergroup, Montana. (a) Sketch and two thin section images showing compactional draping of laminae around MTS (pink coloring in the image on the right is a stain specific to calcite). MTS is stained, but the dolomite host is not. (b) Sketch and photos of lag deposits related to erosion of MTS-bearing sediments showing incorporation of reworked clasts of host dolomite and MTS ribbons in lag. Field photo from the Helena Formation, Logan Pass, Glacier National Park, Montana. (c) Sketch, field, and thin section images of calcitic 'halos' around MTS ribbons from an outcrop at Logan Pass. *This a-c sequence captures the steps of formation and evidence for very early origins (shallow burial) of MTS*: (i) cracks form by gas expansion in partially cemented stiff mud; (ii) cracks fill rapidly by microspar (calcitic) cement, with invasion of cement into surrounding host sediment along margins of cracks; (iii) penetrating fluids subsequently dolomitize the original $CaCO_3$ host muds without replacing the more strongly calcite-cemented crack fills and halos; (iv) currents erode early formed ribbons and replacive dolomite, leaving behind lags; and (v) continued compaction of partially lithified muds results in draping around stiffer, early cemented ribbons.

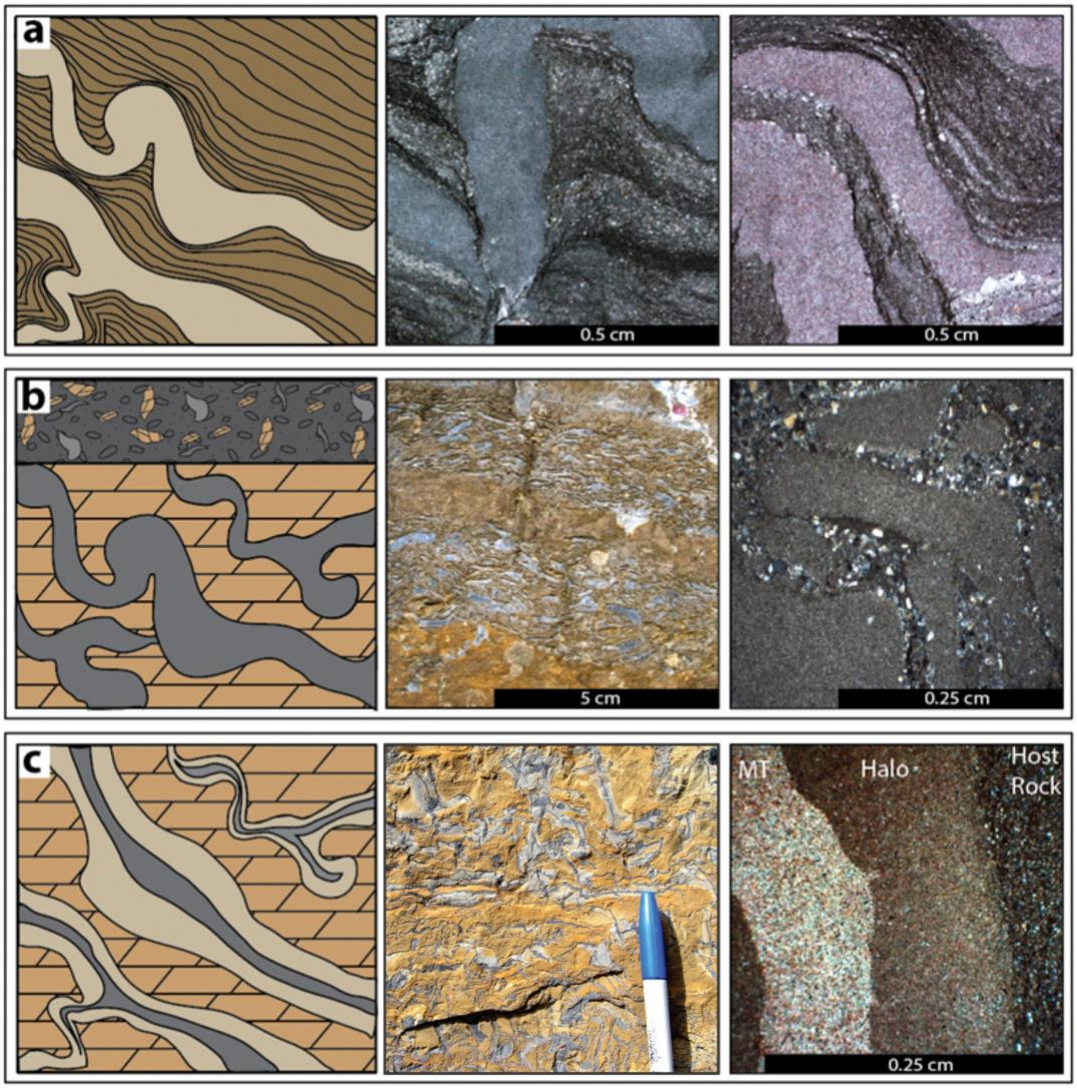

Figure 2. Temporal distribution of MTS (modified from Kriscautzky et al., 2022) and estimates for evolving marine sulfate concentrations (modified from Fakhraee et al., 2019, additional sulfate constraints from Crowe et al., 2014, and Blättler et al., 2018). Note that stratigraphic successions are binned into 200 My intervals, and vertical dashed lines mark the approximate timing of the Great Oxidation Event and the Neoproterozoic Oxidation Event.