Controls of Ice Cover on Arctic Delta Morphodynamics and Depositional Processes

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Deltas are dynamic systems that can provide important information on past environmental conditions. Arctic deltas in particular have the potential to preserve critical information about climate change in one of the most temperature-sensitive regions of the Earth. Despite the fact that the responses to climate change in the Arctic can significantly affect deltaic morphology, Arctic deltas have largely been neglected as records of climate conditions, and the mechanism(s) by which ice cover alone produces the resultant delta morphology unique to Arctic deltas remains unexplained. We have performed laboratory experiments to directly evaluate the key controls of ice cover on delta morphodynamics and associated depositional processes to identify signatures of ice cover presence during deposition. Our results show that ice cover drives spatially varying sediment transport on the subaqueous delta clinoform through sub-ice channels, which leads to the development of (1) extended delta lobes built by elongated, subaqueous sediment wedges and (2) highly variable bathymetry with increasing topographic roughness up to a water depth above which bottom-fast ice cover exists. The results of our laboratory experiments provide evidence for the effects of ice cover on delta sediment transport and depositional processes, and predictions for changes to delta morphology in the presence of ice cover during deposition. Notably, the unique seascape features of ice-covered deltas may serve as diagnostic geomorphic markers of cold climate conditions where ice cover exists, and hence, as indicators of climate change captured on Arctic coasts. Therefore, Arctic deltas can potentially be a valuable tool for developing geomorphic models to understand and predict coastal landscape changes in the sensitive Arctic where more rapid and much larger changes (e.g., ice cover, temperature, and sea level) are projected in response to climate change.

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