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Cross-stratified Wood: Enigmatic Woody Debris Deposits in Warm-Polar Fluvial Sediments (Pliocene Beaufort Formation, Nunavut)

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Woody debris has been an important sediment component and a significant geomorphic agent in pristine fluvial systems since the Devonian. In recent years a large volume of research has focussed on various aspects of the importance of woody debris within the fluvial realm; from the evolutionary significance of fossil wood accumulations in the rock record to studies of the biogeomorphological and ecological importance of woody debris in modern rivers. In this presentation we describe cross-stratified woody debris deposits comprising organic detritus from a boreal-type treeline forest that included species of pine, birch, poplar, alder, spruce, eastern cedar, and larch, in both shrub and tree form. The cross-stratified wood is an enigmatic subset of fine woody debris which, to our knowledge, has never before been described from either the global stratigraphic record or modern fluvial environments. The deposits we describe are located within the Pliocene Beaufort Formation on Meighen Island, Nunavut, Canada, at a latitude of 80°N, and are compared with other cross-stratified woody debris deposits that have been noted elsewhere in the Pliocene of the Canadian Arctic. We make the robust observation that these deposits appear to be geographically and stratigraphically restricted to polar latitudes from a period of warm climatic conditions during the Pliocene (15-20 °C warmer mean annual temperature than the present day). In this regard it is possible to speculate that the transport of large amounts of woody debris as bedload is potentially a unique feature of forested high latitude rivers. Such bedload deposition requires a large amount of woody debris with a greater density than the fluid transporting it. The softwood composition of the debris suggests that this was most likely attained by saturation and subsequent entrainment of extensive accumulations of deadwood, promoted by unusually high rates of tree mortality and low rates of bacterial decomposition arising from the high latitude and extreme seasonal variations in light and temperature regimes. This observation requires further investigation because, if cross-stratified woody debris is confirmed as a common yet unique feature of warm-polar climates, it may have significant implications for predictive studies of fluvial processes, woody debris accumulation, and carbon burial in a warming Arctic. Recognition of cross-stratified woody debris in pre-Cenozoic records may also provide an independent proxy for this particular environment.