Vegetation over hydrologic control of sediment transport over the past 100,000 yr

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Uranium isotopes can be used to determine the residence time of sediments in a catchment, i.e. how long they are stored in weathering profiles and transported through the catchment by rivers. We have measured uranium isotopes in sediments from palaeo-channels of the Murrumbidgee River (Murray-Darling Basin, southeastern Australia) to quantify variations in sediment residence times over the past 100,000 years.

Results indicate that sediments transported through the Murrumbidgee catchment during the Last Glacial Maximum (LGM) resided for 10's of thousands of years in the catchment. This contrasts with modern and 100ka-old channel sediments where the residence time reaches values as high as 400,000-500,000 years. Variations in sediment residence time in the Murrumbidgee basin do not strictly follow changes in bankfull discharge but instead are correlated with shifts in vegetation and atmospheric CO_2. In the absence of significant glacial erosion in this basin during LGM, this is at odds with what is expected from the links between climate and erosion (a decrease in CO_2 and temperature is expected to induce a decrease in weathering and erosion). Vegetation may be the link between climate and sediment transport: sparse vegetation in the upper catchment allows significant hillslope erosion during LGM but dense woodlands in the Holocene and during the last interglacial inhibit sediment delivery to the river from hillslopes and sediments are derived from the re-working of old (a few 100s ka) alluvial deposits. These observations would suggest that (i) changes in hydrology cannot explain alone changes in sediment transport and (ii) the impact of climate change on catchment erosion is operating indirectly, via changes in vegetation type and density.

Geochemical signatures are driven by seasonal flow regimes in the Chena River near Fairbanks, Alaska

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Carbon emission from permafrost degradation is a potential positive feedback to climatic warming. In addition, as permafrost melts mineral surfaces that were previously frozen are exposed to weathering, possibly providing a geochemical signature for enhanced seasonal permafrost melting. The Chena River watershed in central Alaska contains warm (-2ºC) permafrost at risk for degradation. We collected water from the Chena near Fairbanks, Alaska biweekly for a year to measure watershed geochemistry in different seasonal flow regimes. We measured major elements, $\delta^{18}O$, $^{87}Sr/^{86}Sr$ and carbon and nitrogen organic and inorganic species. Major element concentrations were linearly correlated with discharge except during the highest flows. Spring runoff represented flushing of snow melt with the lowest yearly $\delta^{18}O$ values. During a summer rainy period waters became incrementally higher in $^{87}Sr/^{86}Sr$ and $\delta^{18}O$ values as old water was flushed from the system. Winter flows represent the deepest flow paths with the lowest $^{87}Sr/^{86}Sr$ values and yearly average $\delta^{18}O$ values, likely characterizing mineral weathering. Dissolved organic carbon was linearly related to discharge except during spring melt. Our results suggest watershed geochemistry changes markedly during the year and flows can be categorized into six flow regimes. Strong seasonal controls on water chemistry imply long term monitoring campaigns in northern watersheds should apply at least seasonal sampling. Geochemistry of seasonal flow events must be characterized before relationships between melting permafrost and river geochemistry can be assessed.