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Diatoms (Class Bacillariophyceae) and geochemistry from annually laminated mid-Holocene sediments, west coast Canada: insights into abrupt climate change in the past

A. Chang and T.F. Pedersen

School of Earth and Ocean Sciences, University of Victoria, Victoria, British Columbia, Canada (asmchang@uvic.ca)

A 115-year record of annually laminated sediments from Effingham Inlet, a small anoxic fjord on the west coast of Vancouver Island, British Columbia (49˚N, 125˚W), was analyzed for diatoms (species and abundances) and geochemistry (C and N isotopes, organic C and trace elements Ag, Cd, Re and Mo) from a piston core. The sediments were radiocarbon dated at approx. 4200–4400 years before present (yr BP) and show diatom enriched varves in the lower 70 years, with a sudden transition to diatom impoverished varves above. In the lower section, varves are thick (2–5 mm) and consist of well-defined Thalassiosira-Skeletonema-Chaetoceros spring bloom successions. Diatom concentrations average at 787 $\pm$ 733 million valves/g of dry sediment, del 15N at 7.0 $\pm$ 0.5 per mil, and organic C at 5.2 $\pm$ 0.5 wt. %. In the upper section, the varves are thinner (1–2 mm), do not clearly show the seasonal diatom succession, and contain increased terrigenous detritus. Diatom concentrations average at 388 $\pm$ 202 million valves/g with an increased relative abundance of benthic and freshwater taxa, del 15N at 7.3 $\pm$ 0.6 per mil and organic C at 5.7 $\pm$ 0.5 wt. %. Values of del 13C for both sections are similar, averaging at –24.0 $\pm$ 0.5 per mil. The trace element concentrations are quite variable throughout the section. However, several thin (<1 cm) nonlaminated intervals show decreased diatom abundances with concomitant increases in trace element concentrations, suggesting short-lived changes in surface productivity, upwelling and nutrient delivery, and/or anoxic conditions. The abrupt transition from diatom-rich to diatom-poor varves could reflect a shift in dominance of the North Pacific High and Aleutian Low atmospheric pressure systems over the northeast Pacific Ocean, not unlike the well-documented 1976/1977 climate regime shift which showed a change in upwelling and nutrient delivery. A transition between warm and sunny climates to cooler and wetter regimes at around 4000 yr BP has been noted in previous paleoenvironmental studies from British Columbia and the northern hemisphere in general. The Effingham Inlet sediment record data will also be compared with modern sediment trap data from the inlet.