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Post-eruptive maar lake sediments in kimberlite pipes: progress and prospects for reconstructing “greenhouse” paleoenvironments in subarctic Canada

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Several kimberlite pipes in subarctic Canada host thick accumulations of stratified post-eruptive lacustrine sediment and peat. These fills - though rare - provide a sedimentary archive of paleoenvironments during the sustained Early Cenozoic greenhouse interval, in a high-latitude region otherwise devoid of Phanerozoic sediment cover. Extensive exploration drilling has provided a valuable window into this unique sedimentary record, which would have otherwise remained covered by Quaternary glacial deposits. Post-eruptive chronology is provided by interbedded distal tephra horizons that have been dated by glass fission-track and zircon U-Pb techniques. Our focus to date has been multidisciplinary study of the Giraffe pipe sediment fill: an ∼80 m-thick sequence of post-eruptive lacustrine silt overlain by peat, which paints a remarkable picture of a humid-temperate Middle Eocene forest ecosystem on the Canadian Shield. Paleoclimate proxies derived from pollen, wood cellulose oxygen isotopes, and biomarkers in peat facies converge on reconstructed mean annual temperatures >17 °C warmer than present, with mean winter temperatures above freezing, and mean annual precipitation ∼4x present. Forthcoming analyses of well preserved conifer foliage will provide new independent estimates of atmospheric carbon dioxide concentrations. Biomarkers derived from higher plants are remarkably abundant in the thick lacustrine fill of Giraffe pipe, with evidence for an exceptionally warm and wet interval that coincides with a period of maar lake acidification. More recent investigations of kimberlite maar lake fills have targeted the Wombat kimberlite pipe, tentatively dated to the Late Cretaceous, and its 195 m of well preserved, undisturbed post-eruptive lacustrine fill. Our studies of kimberlite pipes in northern Canada highlight the scientific value of archived exploration drill core, and the potential for new scientific drilling, for providing high-resolution continuous records of high-latitude continental greenhouse paleoenvironments.