UNIVERSITY OF MANITOBA

Clayton H. Riddell Faculty of Environment, Earth and Resources
Department of Geological Sciences

Petrography and geochemistry of the Mud Lake kimberlite, Northwest Territories, Canada

Ankar Sheng
Department of Geological Sciences
University of Manitoba

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The Mud Lake kimberlite dyke is located at the southernmost edge of the of the Slave Geological Province in the Northwest Territories, and approximately 4 km southeast of the Ordovician Drybones Bay kimberlite pipe. The Mud Lake and Drybones Bay kimberlites are diamondiferous, but these and other Silurian-Ordovician kimberlites in the Slave lack economically viable grades, and have received little attention beyond preliminary exploration work. Due to the close proximity to Drybones Bay, it is possible that these structures are related, but this hypothesis is untested, and the Mud Lake rocks have yet to be conclusively classified as kimberlite.

Kimberlites share many textural, mineralogical and chemical characteristics with other silica-undersaturated, volatile-rich, mantle-derived rocks, which complicate their geological interpretation and economic assessment. The hypabyssal rocks at Mud Lake are characterized by chloritized phlogopite macrocrysts set in a fine-grained groundmass containing abundant primary dolomite, and bare a strong petrographic resemblance to the kimberlite-indicator-mineral-bearing carbonatite from Wekusko Lake, Manitoba. The initial misclassification of the Wekusko carbonatite as a kimberlite raises the specter of grave misinterpretation of similar rocks.

This study examines the petrography, mineralogy and chemistry of the Mud Lake kimberlite, using optical microscopy, scanning electron microscopy and cathodoluminescence microscopy, wavelength dispersive spectroscopy and laser ablation inductively coupled plasma mass spectrometry. The kimberlitic provenance of the Mud Lake rocks is confirmed by the trace-element signature of petrogenetic indicator minerals used to differentiate kimberlites and carbonatites. The temporal relationship with the nearby Drybones Bay pipe is established with U-Pb dating or zircon. Efforts to determine the crystallization conditions revealed the pitfalls of the popular Zr-in-rutile thermometer method.