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Attempting to constrain the source and petrogenesis of Ordovician ashes from Québec, Ontario, and New York using zircon and apatite

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The St. Lawrence Platform (SLP) in southern Québec, southeastern Ontario (Canada) and New York State (USA) consists of a series of Cambrian-Ordovician carbonate and siliciclastic units, as well as several interbedded layers of altered volcanic ash known as K-bentonites. The SLP records the opening of a large ocean basin in response to extensional tectonics following the Grenville orogeny, and its subsequent closure during the Appalachian orogeny. The bentonite horizons are mostly hosted in Upper Ordovician sediments of the Black River and Trenton groups (and equivalents), their origin is almost certainly associated with Appalachian arc volcanism, the exact sources are unknown. Most minerals in the bentonites have been altered to clay; however, pristine apatite and zircon crystals are also present that preserve magmatic signatures. Studying these minerals provides insights into the processes involved in the formation of these extensive volcanic ash deposits and helps refine our understanding of the Late Ordovician tectono-magmatic evolution of the complex accretionary history of the Appalachians in North America.

To trace the evolution or the magmatic source for the bentonites across the platform through time, several bentonite beds have been sampled at various stratigraphic levels and locations. Notably, eight stratigraphically different bentonite beds were sampled in the same quarry on Montréal Island, two beds farther north in Québec, nine beds in southern to south-central Ontario, and ten beds in the Mohawk Valley, New York, in the. Also, the well-known Late Ordovician Deicke and Millbrig bentonite beds, sampled in another platform in both Tennessee and Kentucky, were also analyzed.

Apatite major, volatile, minor, trace elements, and Sr isotopic compositions, together with zircon trace elements and Hf isotopic compositions, were used to investigate the petrogenesis of the bentonites. Apatite and zircon chemical composition combined with Sr and Hf isotopic data suggest a predominantly depleted mantle source with minor addition of an enriched source, which could be represented by crystal contamination, this is typical of arc magmatism. Apatite in the Montréal bentonites show a progressive decrease in $^{87}Sr/^{86}Sri$ over time, which may reflect a reduction in the crustal contaminant or enriched component in the source.