Sedimentary Constraints on Kimberlite Emplacement in the Fort à la Corne Kimberlite Field

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Abstract

Diamond-bearing kimberlite complexes in the Fort à la Corne region of east-central Saskatchewan are among the most complete examples in the world, preserving kimberlite within pipes and maar-shaped craters as well as extensive extra-pipe sheets of both primary and secondary pyroclastic kimberlite. Interstratification of extra-pipe kimberlite with Lower Cretaceous (Albian) marine, marginal marine, and continental sediments reveals a prolonged and complex history of repeated kimberlite volcanism with lengthy temporal hiatuses separating individual eruption events. Radiometric age determination (U-Pb perovskite) and micropaleontologic evidence (from foraminifera and palynomorphs) support the hypothesis that multiple kimberlite eruptive phases occurred.

The oldest kimberlites in the Fort à la Corne region erupted during deposition of the predominantly continental strata of the Cantuar Formation (lower Mannville Group). Primary Cantuar kimberlite is relatively rare in the study area, however, fluvially transported kimberlitic sandstone and conglomerate are common. Rare, thin terrestrial airfall deposits also occur. These deposits provide evidence that kimberlites older than the primary exploration targets occur either within the Fort à la Corne area or in a paleo 'upstream' direction.

One of the main eruptive intervals coincided with deposition of the marginal marine (shoreface-estuarine/deltaic) Pense Formation. Evidence of grain flow and talus slope deposits within the crater support the interpretation of many of these early kimberlite occurrences as asymmetrical maar-shaped volcanoes. Low-relief tuff rings/cones proximal to the volcanic centers grade distally into large, laterally extensive sheets of primary airfall kimberlite. Subsequent volcanic pulses (during the later part of the Pense interval) resulted in partial crater infill. Superimposed on this record of episodic volcanism is a chronicle of periodic fluctuations in local sea level. This is evidenced by interfingering of fine- to medium-grained cross-stratified kimberlitic (olivine dominated) sandstone with primary airfall kimberlite.

Intermittent eruptive activity continued, coeval with deposition of the fully marine black shale and silty, occasionally glauconitic, sandstone beds of the Lower Colorado Group (Joli Fou, Westgate, and Belle Fourche formations). Eruptions during this interval were dominated by subaerial deposits, and resulted in gradational build-up of low, positive-relief, cone-shaped domes over the earlier feeder vents/maars. Distal to the volcanic centers, kimberlite beds (which occur at several horizons) consist of marine airfall deposits that commonly exhibit evidence of wave reworking. Black shale-encased kimberlite beds, deposited as subaqueous debris flows and turbidites are particularly common in the Lower Colorado Group.

Overall, sedimentologic evidence supports the hypothesis that many of the Fort à la Corne kimberlite bodies resulted from a complex eruptive history in a dynamic coastal setting. Physical bedforms and biogenic structures in reworked kimberlite as well as interfingering of primary airfall and reworked kimberlite beds provide strong evidence that multiple eruptions occurred, and appreciable time elapsed between eruptions.

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