

Evolution of the geological model of Renard 3 Kimberley-type pyroclastic kimberlite over 1,000 metres depth, Quebec, Canada

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Introduction

Situated among the Renard kimberlite cluster in northern Québec, Canada, the ~640 Ma Renard 3 pipe has been a part of the main ore feed (along with Renard 2) at the Renard Diamond Mine since its commissioning in 2016. Subsequent to its discovery in 2001, Renard 3 has undergone numerous diamond drilling campaigns, leading to significant changes to its modelled volume, depth and mineral resource.

As of November 2023, the Renard Mine has been put into care and maintenance due to a depressed diamond market, leaving an estimated 9.6 million tonnes of Probable Mineral Reserve (8.9 million carats) in the ground with no further drilling, delineation work or significant mining to be conducted. Renard 3 has been successfully mined to a depth of 470m below surface through both open pit and underground mining, extracting more than 1.14 million tonnes and 1.2 million carats. This abstract showcases the changes of the geological model of Renard 3 over time and the continuity of its internal kimberlite units over a depth of 1030m, similar to that of Renard 2 (Muntener and Gaudet, 2018), highlighting the critical importance of understanding Kimberley-type pyroclastic kimberlites (KPK) as well as their textures and emplacement models for effective exploration campaigns, robust mineral resource estimates and successful mining operations.

Geology

The Renard 3 pipe is infilled with five main contrasting phases of kimberlite: Kimb3b, Kimb3dg, Kimb3f, Kimb3h and Kimb3i (Fig. 1a; Muntener and Scott Smith, 2013), each with a distinct textural classification as either volcanoclastic KPK, coherent kimberlite classified as hypabyssal kimberlite (HK) or intermediate transitional textures (HKt to KPKt). An envelope of cracked country rock (CCR) and country rock breccia (CRB) surround portions of the pipe (Fig. 1a). Renard 3 is interpreted as an eroded, steep-sided deep diatreme to root zone KPK-type kimberlite pipe comparable to the nearby Renard 2 pipe (Fig. 2) as well as Gahcho Kué, Northwest Territories, Canada and the type-area Kimberley, South Africa.

Since the first drillhole in 2002 and for the following 20 plus years, numerous drilling and sampling campaigns have intersected these phases of kimberlite. After detailed petrological, mineralogical and geochemical studies it has been concluded that, like Renard 2 (Muntener and Gaudet, 2018), the kimberlite phases within Renard 3 each remain consistent in texture and mineralogy (including pure diamond content) with depth, currently to 860m below surface, with several drillholes not fully studied intersecting HKt pipe-infill as deep as 1030m below surface (Figs. 1b, 2). As of the end of 2023, the two HK phases of kimberlite, Kimb3i and Kimb3h, were no longer intersected in drillcore or underground drifts below 340m and 440m from surface respectively (Figs. 1a, 2). The transitional phase Kimb3f, distinguished by a higher content of HK autoliths, was originally interpreted as a large remnant of an older intrusion as it was not encountered below a depth of 250m (Muntener and Scott Smith, 2013). Subsequent drilling re-intersected this unit in two additional, separate locations (Fig. 1a), one at a much greater depth of 490-680m below surface. Both

occurrences are interpreted as isolated remnants of one of the earliest phases of kimberlite. The remaining two units, Kimb3b and Kimb3dg, have been encountered over a depth of 860m from surface, with Kimb3b modelled as several separate steep-sided vertical domains and Kimb3dg in a single geologically continuous domain (Figs. 1b, 2). This further confirms the original emplacement model of Kimb3dg being emplaced after the Kimb3b and Kimb3f phases.

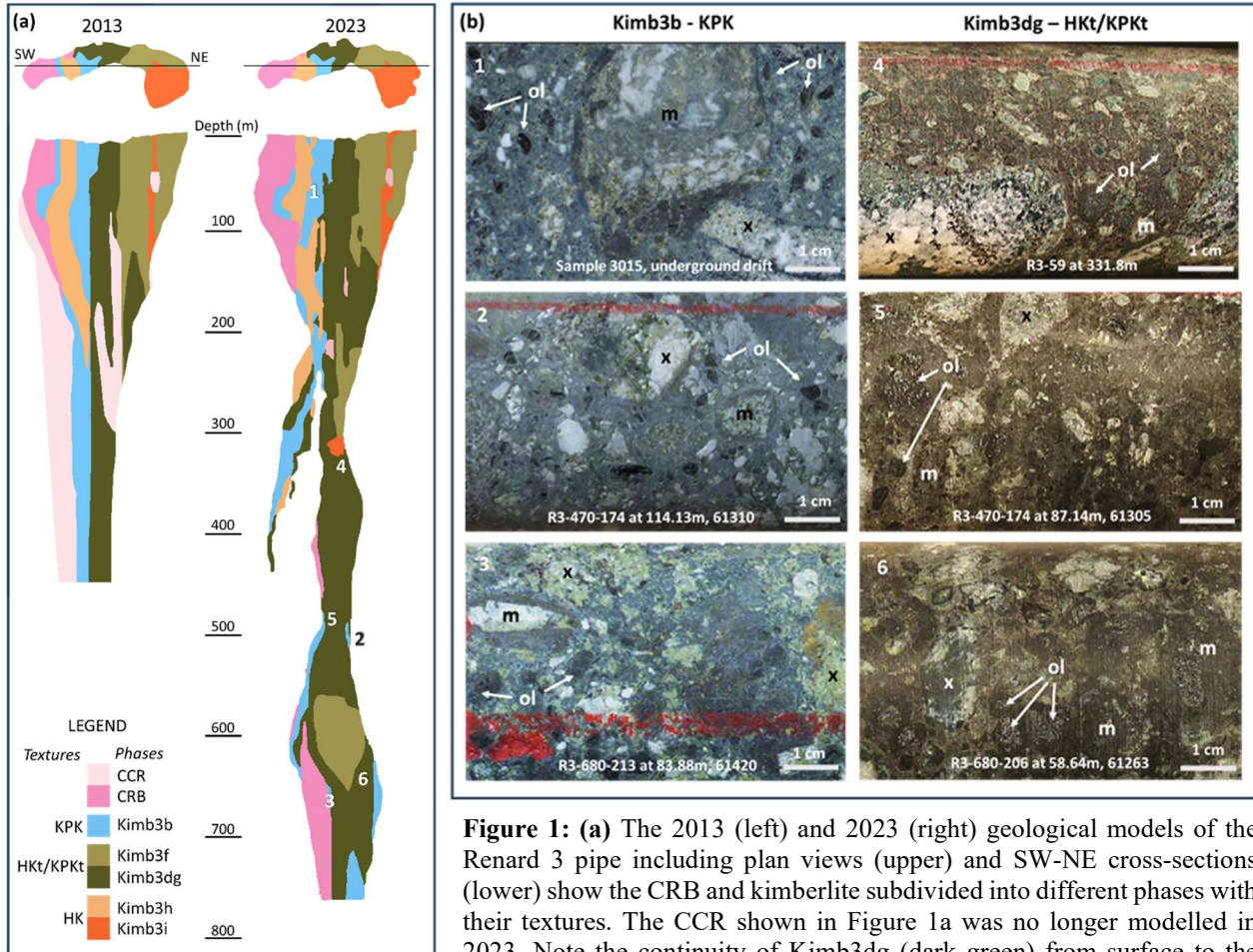


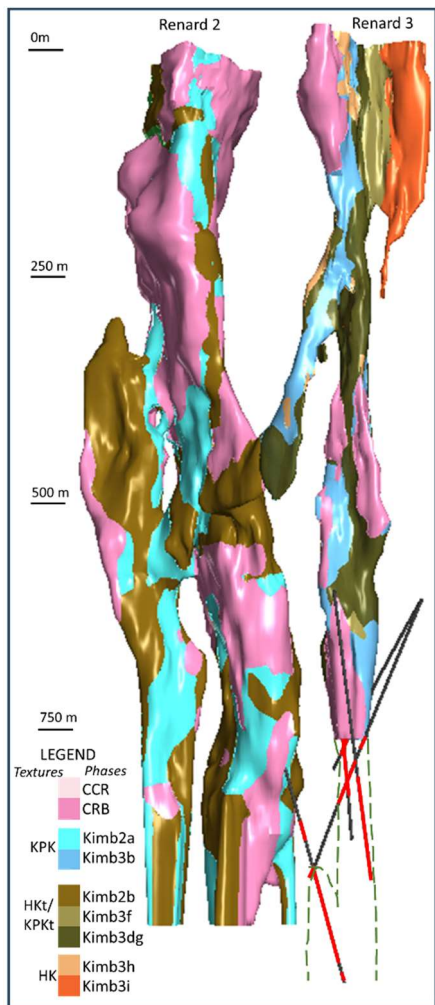
Figure 1: (a) The 2013 (left) and 2023 (right) geological models of the Renard 3 pipe including plan views (upper) and SW-NE cross-sections (lower) show the CRB and kimberlite subdivided into different phases with their textures. The CCR shown in Figure 1a was no longer modelled in 2023. Note the continuity of Kimb3dg (dark green) from surface to the

bottom of the 2023 model. The boundaries between Indicated and Inferred Mineral Resources are shown in Figure 3 to indicate the level of confidence of each model. **(b)** A selection of core photographs illustrates the geological continuity in the 2023 model with depth of Kimb3b (left; sample locations 1-3) and Kimb3dg (right; sample locations 4-6). The olivine macrocryst size ('ol') and abundance, groundmass spinel and perovskite ratios, country rock xenolith and xenocryst ('x') content and kimberlite textures, including magmaclasts (m), (Muntener and Scott Smith, 2013) remain consistent with depth within each phase. Kimb3i, Kimb3h and Kimb3f display a similar continuity in their features with depth (not shown here).

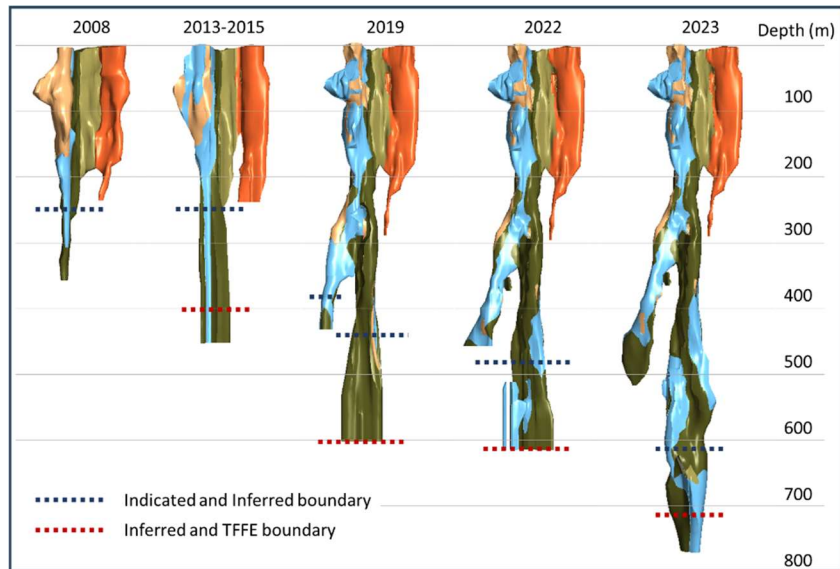
Geological Models

The first three-dimensional geological model in 2008 (Fig. 3) was based on 75 drill holes (11,880m) and underground exploration tunneling (for bulk samples) at 55m below surface, totalling 1.5 million tonnes of kimberlite and producing an average grade of 106 cpht. Following a similar methodology to Lépine and Farrow (2018), the geological model of Renard 3 evolved over time with new information and modelling techniques. Open pit mining and pit mapping began in 2016, while underground drilling and mining began in 2018. The final 2023 geological model included 253 drillholes (43,358m) and seven mapped tunnel extraction levels, totalling approximately 5.3 million tonnes (including material already mined). Not all this

material is considered an Indicated Resource as defined by the CIM definitions. Figure 3 shows the progression of the geological models through the years as well as the boundary between Indicated and Inferred Resources and conceptual volumes classified as targets for further exploration (TFFE).



◀ **Figure 2:** The 2023 three-dimensional geological model of Renard 3 (right) and Renard 2 (left) looking north, showing all modelled kimberlite units. Vertical and horizontal scales are equivalent. Drillholes completed at the end of 2023 but not incorporated into the Renard 3 geological model at depth (black traces) intersected the main pipe-fill kimberlite units (shown as red on the traces). The model could be further extrapolated to extend as deep as 1030m below surface (dashed green lines) based on this information. Note: only drillholes that intersected kimberlite have been displayed.



▲ **Figure 3:** The evolution of the Renard 3 geological model through time based on a progressive increase in geological information from diamond drilling, open pit mapping, underground tunneling and mining. Indicated and Inferred Mineral Resource boundaries are shown to indicate the level of confidence of each model.

While the Renard Mine has ceased active operations, it leaves a legacy of amazing geology and science, offering invaluable insights into the geological dynamics shaping KPK systems. Stornoway's outstanding, well-trained scientific teams have demonstrated the remarkable consistency in internal geological features, particularly texture, of Renard 2 and Renard 3, over depths surpassing 1000 metres. This research enhances our understanding of the Renard cluster and offers invaluable direction for future exploration and mining.

References

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