

The Evolution of Geological Models for the DO-27 Kimberlite, NWT, Canada: Implications for Evaluation

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4.35 carat DO-27 diamond



4.19 carat DO-27 diamond

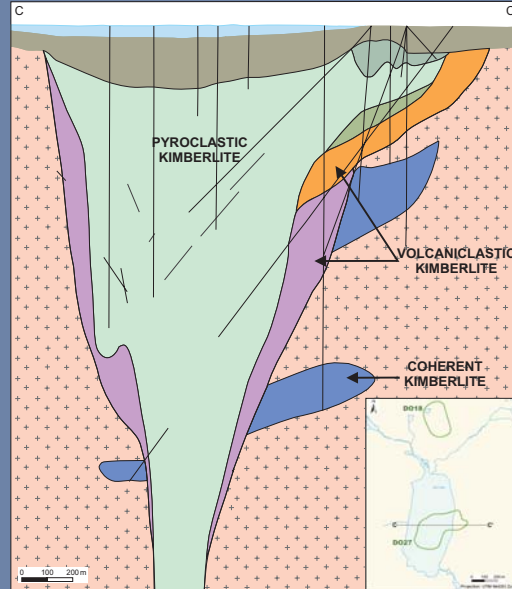
INTRODUCTION

The evolution of geological models (Models 1-5 below) for DO-27 during evaluation by numerous operators over 16 years has impacted the assessed economic viability of the project.

Figure 1: The DO-27 kimberlite, part of the historical Tli Kwi Cho complex, is located in the 45-75 Ma Lac de Gras province. Country-rock at time of emplacement was: Archean granitoids and overlying mainly Cretaceous mudstones.



MODEL 5: 2005-2008



Pyroclastic Kimberlite (PK)

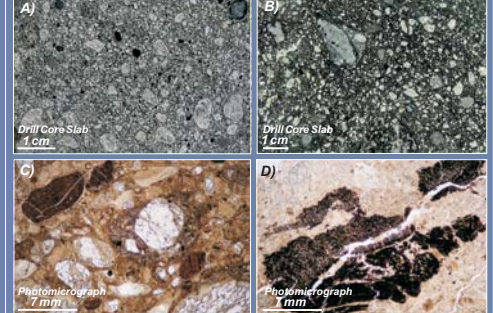


Figure 6: Pyroclastic kimberlite is the dominant pipe infill (85%) in DO-27. A, B) generally massive olivine macrocrystic PK; C) olivine-rich, fines-depleted, fine- to medium-grained kimberlite; D) Charcoal plant fragments are observed indicating a terrestrial environment at the time of eruption.

MODEL 1: 1992



Figure 2: Model 1 represents the two large geophysical anomalies, named DO-27 and DO-18 (see Harder et al., This Volume). The data suggested possible kimberlite beneath the anomalies (Table 1).

MODEL 2: 1993



Figure 3: Model 2 is one large pipe based on ground geophysical surveys and limited core drilling. The apparent irregular pipe shape was suggested to be similar to southern-African kimberlites (Table 1).

Volcaniclastic Kimberlite (VK)

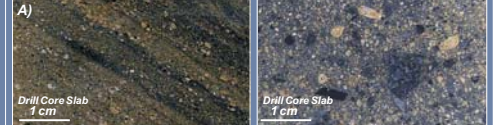


Figure 7: Volcaniclastic kimberlite (VK; likely re-sedimented) is locally preserved and is highly variable with individual units that often cannot be correlated between drill holes. A) Mud-rich bedded VK; B) Mud and granite-rich VK.

MODEL 3: 1993-1994

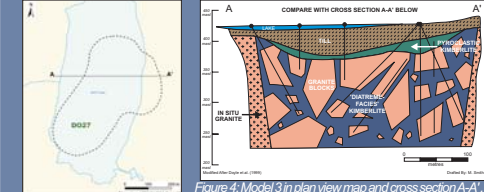
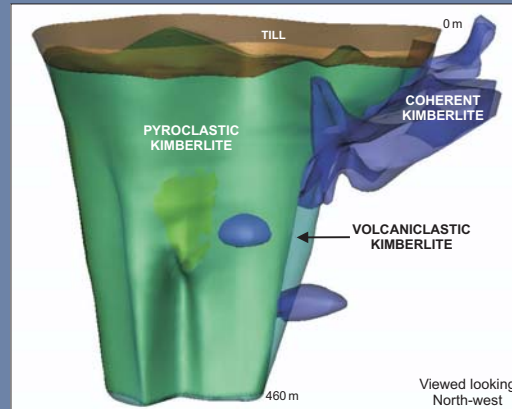


Figure 4: Model 3 in plan view map and cross section A-A'.

57 drill cores (44 at DO-27, 13 at DO18) showed two separate bodies. Model 3, the first drill-core based model, was a large, southern-African style pipe infilled with 'diatreme-facies' kimberlite containing large granite rafts, overlain by lesser 'crater-facies' pyroclastic kimberlite (Table 1). Model 3 predicts considerable amounts of kimberlite in un-drilled areas of the pipe. Further evaluation was terminated because of lower than expected bulk sampling results (Table 2).



Coherent Kimberlite (CK)

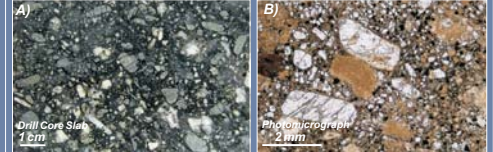


Figure 8: A) Coherent kimberlite was emplaced primarily as pre-pipe intrusive sills, but locally occurs as late-stage intrusions along pipe contacts and within VK. The intrusions are irregular and form a zone comprising kimberlite, granitic xenoliths, and in-situ country rock; B) Olivine macrocrystic moniticellite kimberlite.

MODEL 4: 1995

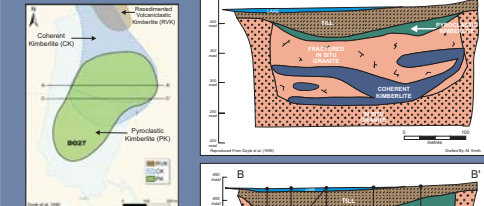


Figure 5: Plan view map shows the distribution of rock types outlined by Doyle et al. (1999). Section A-A': intrusive sheets within in situ, fractured country rock granite (Table 1); same section line as Model 3; Section B-B': the main DO-27 pipe infill, pyroclastic kimberlite (PK).

Some project stakeholders maintained that the original bulk sample was not representative and a re-evaluation of the geological model was required. Model 4, based on the same drill cores as Model 3, proposed a very different kimberlite geology and emplacement history; compare sections A-A' above. The 'diatreme-facies' kimberlite of Model 3 was re-interpreted as volumetrically minor, pre-pipe, shallow-inclined intrusive sills (coherent kimberlite; CK) at depth within in situ, fractured country rock granite (Table 1). The Model 3 'crater-facies' PK was identified as the dominant pipe infill, different to that of typical 'diatreme' kimberlite infilling southern-African bodies. This model predicts little kimberlite in un-drilled areas of the body. DO-27 was interpreted to comprise two separate vents, a smaller north-east vent and a larger, younger vent to the south-west.

Conclusions

Table 1: Summary of DO-27 geological models including kimberlite area (hectares) or volume (tonnes) estimated according to each model (Coopersmith, 2005; Coopersmith et al., 2006)

Model	Summary	Surface Area (hectares)	Year	Tonnes
1	Circular body: geophysics	5	1992-1993	n/a
2	DO27/DO18 complex	24	1993	n/a
3	Two bodies: diatreme model	~12	1993-1994	50 million
4	Two bodies: HK sheet model	9	1995	25 million
5	Current model	7.5	2005-2008	*30 million

*Estimate based on 3D wireframe model to a depth of 460 m, and including all VK in the DO-27 crater; this does not constitute a resource estimate.

Table 2: Summary of reported kimberlite sampled (tonnes), diamonds recovered (carats) and grade (carats per hundred tonnes, CPHT). Summary of geological models for DO-27 (Coopersmith, 2005; www.pdiam.com)

Year	Tonnes	Carats	CPHT	Geological Domain
1994	1157	16	1.3	'Diatreme' (HK)
1994	3003	1079	36	PK (NE lobe)
2005	151	136	90	PK
2006	548	508	88	PK
2007	2520	1724	89*	PK

*Grade reported for the PK domain only, not including other low grade material treated.

This contribution presents the evolution of numerous geological models over 16 years of project development at DO-27. The project history highlights that reliable geological models require sufficient well-placed drill cores, and the number of drill cores depends on the complexity of each pipe. Valid interpretations of observation-based drill logs are necessary for realistic and accurate geological models. A reliable geological model is the basis for representative macrodiamond sampling, which is the foundation for accurate economic assessment of kimberlites.

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