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Evolution of Kimberlite Exploration - Reasons for Renewed Exploration and One "Classic" Example for a Second Look (Part 2)

Eileen Lyon[1], Gary Vivian[1], Chris Hrkac[1], Darrell Epp[1], Tom McCandless[2], Dave Sacco[3]

[1] *Aurora Geosciences Ltd., Yellowknife, Canada, eileen.lyon@aurorageosciences.com*

[2] *MCC Geoscience Inc., Vancouver, Canada, temccandless@gmail.com*

[3] *Palmer, a part of SLR Consulting., Vancouver, Canada, dave.sacco@pecg.ca*

Introduction

The Kelvin kimberlite was first drilled in 2000 by DeBeers Canada Inc. (DeBeers). Drillhole MPV-00-008C was positioned to test an airborne electromagnetic (EM) anomaly and intersected kimberlite between 31 m and 87 m. Only two more drillholes were completed (another in 2000 and one in 2003) before a decade-long hiatus of activity. Despite lacking knowledge of microdiamond data and a poor, to nonexistent, down-ice dispersion of kimberlite indicator minerals, joint venture partner, Mountain Province Diamonds Inc. (Mountain Province), remained interested in the prospect. Armed with a couple of drillholes and a radical idea of a non-vertical emplacement drawn on a napkin by the late John Knight, exploration restarted in the area with renewed drilling and expansion of geophysics. The work, largely completed between 2012 and 2018, transformed a 40 m true-width kimberlite intercept to an indicated resource of 8.5 million tonnes of kimberlite with a grade of 1.60 carats per tonne (cpt). This result begs the question of whether other opportunities have been overlooked.

Methods

Methods of kimberlite exploration and evaluation have expanded and contracted over time with developments in analytical and laboratory methods that aid in the prediction of economic bodies. Advancements in indicator chemistry like the G9/G10 discrimination plots, the application of self-organizing map (SOM) plots, and even proprietary methods like Mineral Services' Mantle Mapper, have been used as guides for prospectivity, but a kimberlite must first be found to use these methods. While following indicator mineral dispersals has led to many kimberlite discoveries in the Northwest Territories, some kimberlites have little to no glacial entrainment (e.g., Kelvin) or occur in areas poorly suited to the development of detectable anomalies. Recent advances in drift prospecting have improved our ability to identify indicator mineral dispersals. Namely, understanding the influence of deglacial processes on primary dispersion of indicator minerals, in conjunction with the availability of high-resolution topographic data (e.g., LiDAR) and imagery, allows for better mapping of affected areas. Geophysics completed in tandem with till sampling will provide more reliable targets. While it is stating the obvious, differences in survey type and platforms yield different results, and the bottom line relies on increased signal-to-noise resolution, data density, and physical property contrasts. Anomalies generated from airborne surveys and drift prospecting programs can be validated against each other, then ground geophysics can be used to identify reliable drill targets.

Kelvin

A helicopter-supported DIGHEM survey was flown over the Gahcho Kué area in 1997 and identified numerous anomalies. One anomaly, KEN_0037, produced a pronounced EM response with negligible magnetic value and is now known as the Kelvin kimberlite. KEN_0037 was followed up with a ground

horizontal loop EM (HLEM) survey the year it was first drilled. That ground survey, in hindsight, revealed a coincident geophysical expression of the subhorizontal body trending to the west-northwest. The HLEM offshoot shown in the survey results was drilled in 2003 and intersected 36 m of kimberlite in a 117 m drill hole dipping -45°. However, kimberlites were believed to only be (near) vertically emplaced unless they were sills or sheets. Most drilling, therefore, targeted the coincident strongest part of the airborne and ground anomalies, envisioning that response being the top of a vertical pipe.

When Kennady Diamonds Inc. (now a wholly owned subsidiary of Mountain Province) restarted exploration, the existing geophysical coverage and the number of drillholes increased dramatically. The reliance on the ground geophysical toolbox and testing of these geophysical results with drilling ultimately led to the discovery and development of the Kelvin-Faraday Corridor (KFC). Between the years 2012 and 2018, the number of diamond drillholes in the KFC went from (historical) 26 drillholes to 476 drillholes. The geophysical survey coverage was expanded and the types and resolution of surveys increased. Additional methods were added that included Ground Penetrating Radar (GPR), Very Low Frequency (VLF), Ohmmapper^{TM}, and its successor – Aurora Rapid Reactance Tomography (ARRT), each contributing to kimberlite discovery and understanding emplacement geometry.

Big Blue

Few uneconomic kimberlites are as well known as Big Blue. Big Blue, first identified as anomaly PRV-99-8, is aptly named for its strong negative magnetic response (-800 nT) and large anomaly size (3.0 Ha). The target was first drilled by DeBeers in 2000, and then again with a single hole the following year. While all drillholes were collared within the large magnetic anomaly, one of the drillholes (PRV-00-008C) intriguingly did not intersect kimberlite (Figure 1). Despite that result, a schematic interpreting the kimberlite that was included in a 2001 Assessment Report suggested there was one large body (Neto et al. 2001 Assessment Report). Presumedly, the emplacement model for Slave kimberlites (Field and Scott-Smith 1999) recently published at that time had a strong effect on that proposed model.

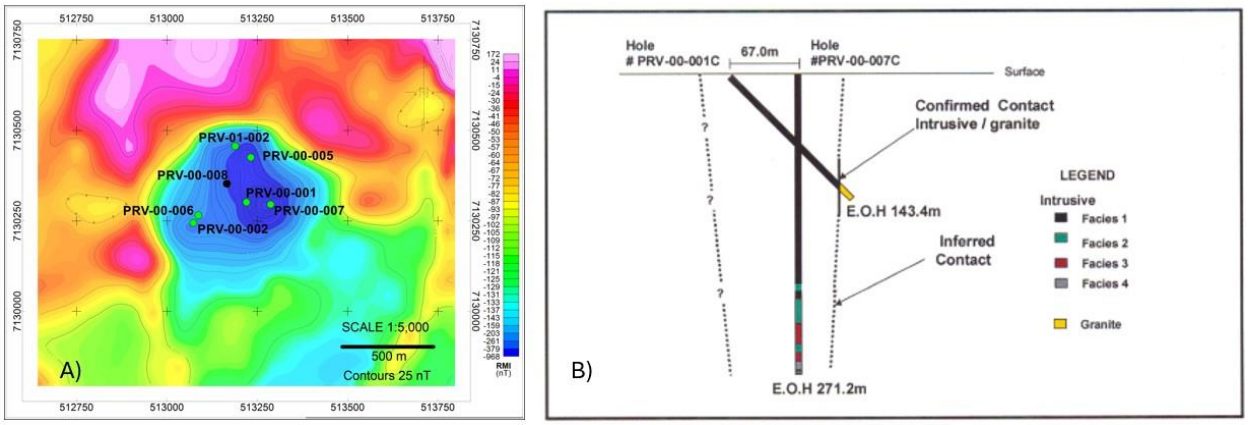

Figure 1: Magnetic response of Big Blue kimberlite with a historical modelled schematic. **A)** Plan view of the residual magnetic intensity of Big Blue from the 2017 DIGHEM survey with drillholes (green symbol intersected kimberlite). **B)** Side view of a model schematic for the drilling at Big Blue completed by DeBeers.

Subsequent exploration did not occur again on Big Blue for another 17 years when (then) Dominion Diamond Mines drilled another ten drillholes. Again, not all drillholes intersected kimberlite (Figure 2). Of those that were successful, a subset amassing 633.4 kg of material was sent for microdiamond analysis and yielded 153 stones (Hetman and Smith 2018 Internal Report). Compared to the early results of the nearby mined kimberlites, this is relatively uneconomic. Nonetheless, an external review of Big Blue was commissioned to evaluate its potential. One aspect of the review involved creating a pipeshell model using

the available geophysics and drilling. Yet again, even with non-kimberlite drill results, the model showed one body suggesting the geophysics used was solely the magnetic data (Hetman and Smith 2018 Internal Report). This approach overlooked the intriguing EM results from the two components (in-phase and quadrature) of the frequency domain data collected in 2017 that strongly suggest variations within the large magnetic low (Figure 2).

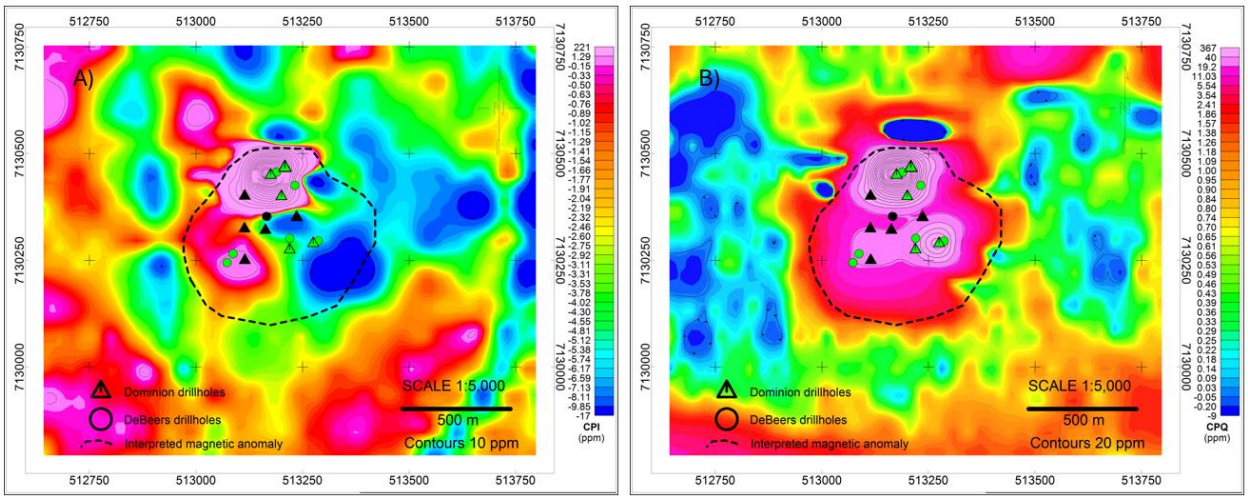

Figure 2: A comparison of the co-planar components for the mid-frequency (7200 Hz) with an outline of the interpreted magnetic anomaly and all drillholes completed (green intersected kimberlite). **A)** Plan map of the in-phase data that shows three distinct responses ranging from strong positive to strong negative intensity. **B)** Plan map of the quadrature response also showing three distinct responses within the magnetic anomaly, with each exhibiting a range in positive intensity.

Conclusions

The Kelvin kimberlite is a prime example of how thinking differently and renewed exploration using evolved methods can change the classification of, in the case of Kelvin, a small kimberlite intercept to a potentially mineable indicated resource. Big Blue is another example of a poorly understood, under-explored, and possibly-missed, opportunity. The question remains: Is Big Blue one large kimberlite or multiple kimberlites? If the answer is the latter, are the existing microdiamond results convincing enough to sterilize all the bodies? All explorers of kimberlites should be awakened to the potential of overlooked kimberlites and, should time, funding and industry outlook allow, ensure that prior results have been fully evaluated and tested using the evolved toolsets now available.

References

Field M, Scott-Smith B (1999) Contrasting Geology and Near Surface Emplacement of Kimberlite Pipes in South Africa and Canada. Proceedings of the VII International Kimberlite Conference 1: 307-313

Neto, P, Wallace, C, Delgaty, J, Ramseder, B (2001) Assessment Report - Report on the Geophysics, Drilling and Sampling on the Lake Providence Property, Northwest Territories. NWT Assessment Report 84434: 41