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Lessons from Letseng – Evidence in support of the Flamboyant Megacryst

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Introduction

The Super Deep Diamond model for large so-called CLIPPIR Type IIa diamonds is premised on a subducted slab model as the locus for the genesis of these diamonds. But Smith et al., (2016) do not cite a single subduction zone under the Kaapvaal Craton in the vicinity of the Letseng kimberlites to support this model for Letseng. 'Lessons from Letseng' is a review and re-evaluation of published references and data spanning fifty years in search of answers.

The book Lesotho Kimberlites (Nixon, 1973), published for the First Kimberlite Conference, is the starting point for this compilation. My PhD Thesis (Lock, 1980), and subsequent published papers provide added impact and relevance to the CLIPPIR diamonds debate.

Geological Features

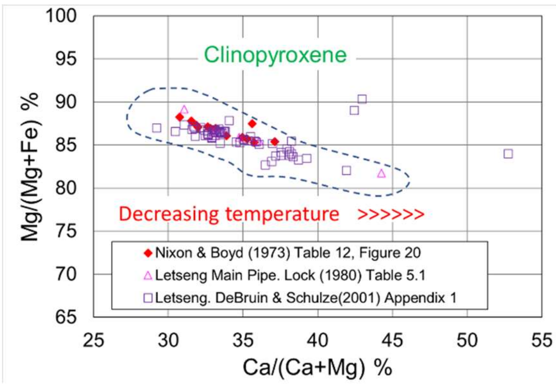
Geological features recognised in the Letseng peridotite xenolith archive (Lock, 1980, Lock & Dawson, 1980) demonstrate specific evidence supporting the dynamics of the Flamboyant Megacryst model of Moore (2009). Pre-eminent are the garnet reaction coronas (Figure 1a) and the subsequent fluidal mosaic porphyroclastic deformation (Figure 1b) displayed by a small number of xenoliths. The reaction results from phase transformation from garnet to aluminous spinel facies consequent on diapiric upwelling. The deformation post-dates the reaction and is the result of attenuation of the peridotite in a plastic state around the thermal aureole to the diapir as it upwells (Figure 1c).

Figure 1a: NL141. Lock (1980) **Figure 1b:** NL 082. Lock (1980). **Figure 1c:** added to Fig 11 of Moore (2009).

Letseng Megacryst Chemistry

The Main and Satellite Pipe kimberlites' xenolith suites, and the respective diamond populations, display distinctive differences demonstrating separate upper mantle origins, or sampling of inhomogeneous mantle during ascent, and/or different thermal input into a mantle aureole around the diapiric ascent of the kimberlite.

The Letseng megacryst suite minerals were first analysed by Nixon and Boyd (1973); they concluded the chemical compositions suggest an igneous fractionation trend with a temperature profile across the range 1400°C to 1000°C. This chemical trend has been independently confirmed by Lock (1980) and by De Bruin & Schulze (2001) (Figure 2a). Moore and Lock (2001) demonstrated chemical continuity between the Letseng sheared peridotite mineral chemistry and the Letseng megacryst chemistry.



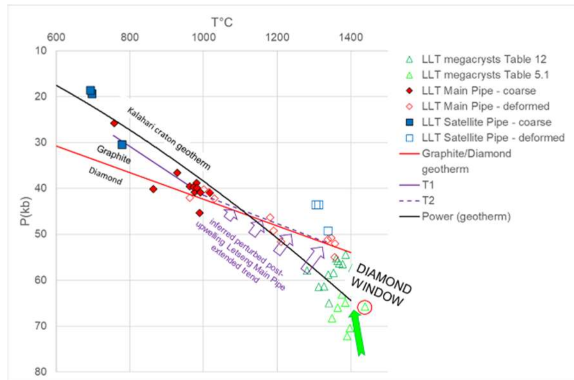
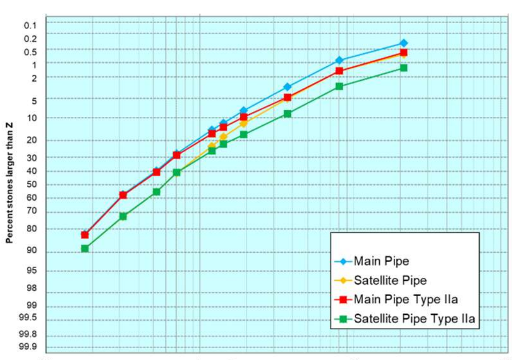


Figure 2a: Data sources as indicated

Figure 2b: Letseng Cpx megacrysts (added to Fig 3 of Lock & Dawson (2013)

The P and T plots of Letseng peridotites demonstrate the distinct difference between the Main and Satellite Pipe suites and illustrate the perturbed geotherm consequent on the thermal impact of the upwelling diapir (Lock & Dawson, 2013). Megacryst clinopyroxene geothermobarometry plotted together with the xenoliths and geotherm display the trajectory of these minerals consistent with an ascending kimberlite and thermal aureole interpretation (Figure 2b).

Letseng Type IIa Diamonds – Size Frequency Distribution



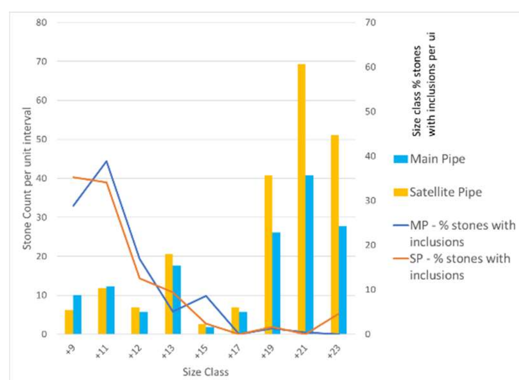


Figure 3a: SFD data - Telfer & McKenna (2011), Bowen et al. (2009). **Figure 3b:** Inclusion data - Harris et al. (1979).

Letseng diamonds comprise several common species (McDade & Harris, 1999), and include the Type IIa variety. The Size Frequency Distribution of Letseng Type IIa diamonds, separate from the other diamond species (Bowen et al., 2009), demonstrates a previously unrecognised bimodal character (figure 3a & 3b). A study of Letseng diamond characteristics (Harris et al., 1979) included the identification of inclusions and their abundance that varies across the size spectrum, with no inclusions in the large Type IIa mode (figure 3b).

Collectively, these observations support the Flamboyant Megacryst model of Moore (2009).

Subduction Models

A critique of the Super Deep Diamond subduction model leads to novel reinterpretation of several published papers (Helmstaedt & Gurney, 1997, Harte & Richardson, 2012, Timmerman et al., 2023). In particular, the peri-Gondwana subduction that is related to the small Type IIa diamonds at Juina, Brazil, and Kankan, Guinea (Timmerman et al., 2023), can be traced under Gondwanaland pre-breakup as far east as Southern Africa (Helmstaedt & Gurney, 1997).

It is reasonable to infer that the small Type IIa mode diamonds at Letseng have the same genetic history as those from Juina and Kankan. However, there is no evidence or link to the large Type IIa mode diamonds at Letseng.

It is therefore concluded that it is also reasonable to infer these large Type IIa diamonds have an entirely different genetic history: the Flamboyant Megacryst is the proposed solution.

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