Deciphering the enigmatic origin of Guyana’s diamonds

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ABSTRACT

Diamonds have long been mined from alluvial terrace deposits within the rainforest of Guyana, South America. No primary kimberlite deposits have been discovered in Guyana, nor have there been previous studies on the mineralogy and origin of the diamonds. Paleoproterozoic terranes in Guyana are prospective to diamond occurrences because the most productive deposits are associated spatially with the eastern escarpment of the Paleoproterozoic Roraima Supergroup. Geographic proximity suggests that the diamonds are detrital grains eroding from the ~1.98 Ga conglomerates, metamorphosed to zeolite and greenschist facies. The provenance and paragenesis of the alluvial diamonds are described using a suite of placer diamonds from different locations across the Guiana Shield. Guyanese diamonds are typically small, and those in our collection range from 0.3 to 2.7 mm in diameter; octahedral and dodecahedral, with lesser cubic and minor macle forms. The diamonds are further subdivided into those with abraded and non-abraded surfaces. Abraded diamonds show various colors in cathodoluminescence, whereas most non-abraded diamonds appear blue. In all populations, diamonds are predominantly colorless, with lesser brown to yellow and very rare white. Diamonds are predominantly Type IaAB and preserve moderate nitrogen aggregation and total nitrogen concentrations ranging from trace to ~1971 ppm. The kinetics of nitrogen aggregation indicate mantle-derived residence temperatures of 1124 ± 100 °C, assuming residence times of 1.3 and 2.6 Ga for abraded and non-abraded diamonds, respectively. The diamonds are largely sourced from the peridotitic to eclogitic lithospheric upper mantle based on both δ13C values of −5.82 ± 2.45‰ (VPDB-LSVEC) and inclusion suites predominantly comprised of forsterite, enstatite, Cr-pyrope, chromite, rutile, clinopyroxene, coesite, and almandine garnet. Detrital, accessory minerals are non-kimberlitic. Detrital zircon geochronology indicates diamondiferous deposits are predominantly sourced from Paleoproterozoic rocks of 2079 ± 88 Ma.

Keywords: Diamond, Guyana, Guiana shield, Roraima supergroup

INTRODUCTION

Diamonds have been mined for the past century from alluvial terrace deposits within the rainforest of Guyana’s Amazon rainforest. The diamonds are found as placers in paleo-to-modern channels, terraces, and streambeds. Guyana’s diamonds are found in headless placers, with the most productive gravels associated spatially with the eastern escarpment of the Roraima Supergroup, which suggests that the diamonds originate from this detrital source (Fig. 1). The humid tropical climate and ancient weathering profile of the Guiana Shield makes addressing diamond provenance a difficult task. Exploration has been driven by artisanal miners who prospect using detrital indicator minerals. No primary kimberlites are known in the region, and there is a lack of prior research on the nature and origin of diamonds in Guyana (e.g., Gibbs and Barron 1993; Shields and Letendre 1999; Persaud 2010). Several hypotheses exist on the origin of Guyana’s diamonds. Diamonds may be sourced from yet undiscovered primary kimberlites or igneous intrusions (Shields and Letendre 1999; Persaud 2010). The most likely location would be associated spatially with the highly magnesian ultramafic intrusives of the 1.7 ± 0.2 Ga, Badidku suite (Olszewski et al. 1977). These rocks intruded during a tectonically quiet period of the late Trans-Amazonian orogeny (Gibbs and Barron 1999) and might be associated with other ultramafic intrusions such as kimberlites. The only confirmed examples of primary diamond deposits in the Guiana Shield are in Guaniamo, Venezuela, and Dachine, French Guiana (Fig. 1), where diamonds are found in Neoproterozoic kimberlite sills and metamorphosed Paleoproterozoic ultramafic and pyroclastic shoshonites or lamprophyres, respectively (Capdevila et al. 1999; Magee and Taylor 1999; Kaminsky et al. 2000, 2004; Channer et al. 2001; Wyman et al. 2008; Smith et al. 2016). Kimberlites exist in Roraima, Brazil, but these are not diamondiferous (Svisero et al. 2017; Cabral et al. 2017). Known diamondiferous kimberlites from West Central Africa are an additional potential source for Guyana’s alluvial deposits (Reid 1974; Briceno 1984). These regions were immediately adjacent prior to the Jurassic rifting and opening of the Atlantic Ocean; separated by 200 to 400 km (Fig. 1). If diamonds were derived from Africa then they would be more prevalent in the northeastern Guiana Shield where diamonds are not found. Furthermore, West African diamonds have been traced to the host...