Recognizing a diamond signature in lherzolitic garnet xenocrysts: approaches to properly evaluate the diamond potential of Alto Paranaíba kimberlites

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The southwestern São Francisco Craton, Brazil, is a geologically complex area obscured by thrust sheets of the Neoproterozoic Brasília belt. In the Cretaceous, intense alkaline volcanism affected the area, giving rise to the Alto Paranaíba Igneous Province (APIP). Throughout the APIP, alluvial diamond occurrences are widespread. Nonetheless, the primary source of the alluvial diamonds is an unresolved question – of considerable economic importance for Brazil. Our previous studies on diamonds and their mineral inclusions from alluvial deposits in this area revealed the presence of an unusual diamond population, dominated by lherzolitic and eclogitic diamonds. Limited chemical depletion recorded in lherzolitic inclusions indicates a likely post-Archean age for the lithospheric mantle beneath this part of the São Francisco Craton. $\delta^{13}C$–$\delta^{15}N$–$\delta^{18}O$ isotope compositions of diamonds and their inclusions indicate a clear link between diamond formation and subduction processes. This enhanced understanding of the characteristics of the diamond substrates tapped by the Alto Paranaíba kimberlites, added to the observation that decades of investigation in the region, since the 1960's, using traditional exploration techniques, has failed to identify the primary sources of these diamonds, motivates the application of improved exploration strategies.

Based on examples of diamond mines from around the world with productions dominated by lherzolitic diamonds, we use classification techniques that consider the Mn, Ca, Cr, Mg and Fe contents of garnet to assess the compositional affinity with garnet inclusions on diamond and the likelihood of derivation from inside the diamond stability field. We apply this method to a database that includes microprobe major-element analysis of 1197 garnet xenocrysts recovered from five kimberlites in the APIP region during exploration by Diamandel Mineração, and compare the results with lherzolitic garnet inclusions in diamonds from the same area and from around the world. Our approach consistently identifies diamond inclusion-like characteristics for some kimberlites, showing the potential of Alto Paranaíba kimberlites to host economical diamond grades. Classifying the kimberlites by the abundance of inclusion-like garnets provides a key constraint that will increase the likelihood of discovery of high-value primary deposits.