

Meya Kimberlite Dyke: Classification and Diamond Potential

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Correct classification of diamondiferous ultrapotassic rocks and differentiation between kimberlite units are crucial for assessing diamond potential and understanding mantle processes. The Meya dyke, an on-strike extension of the Koidu kimberlite cluster on the Man Craton (Sierra Leone), has been debated due to its high phlogopite and low carbonate contents. This study integrates petrography, SEM–AMICS modal mineralogy, mineral chemistry, whole-rock geochemistry, and garnet thermobarometry to clarify the classification, petrogenesis, mantle sampling, and diamond potential of three Meya rock units (KIMB 1, KIMB 2, KIMB 3). Modal mineralogy, diagnostic mineral assemblages, and compositional trends confirm that these units are kimberlites, distinct from carbonate-rich olivine lamproites. All three units share similar bulk-rock compositions and REE patterns, indicating derivation from a common magmatic system, whereas associated carbonatitic rocks likely represent late-stage or exsolved volatile-rich melts. Systematic mineralogical variations exist among the units, including olivine, phlogopite, perovskite, spinel, xenolith abundance, and alteration styles. Garnet chemistry records progressive lithospheric mantle refertilization from ~110 to 170 km depth, evolving from depleted G10 to Ca- and Ti-enriched G9 and G11 garnets. High-temperature metasomatism near the lithosphere–asthenosphere boundary is indicated by Ti-rich G11 garnets, Fe-rich olivine, and Ti-bearing phlogopite, particularly in KIMB 2. Thermobarometry confirms that all units sampled the diamond stability field, with KIMB 3 favoring lithospheric diamonds and KIMB 2 showing potential for sublithospheric CLIPPIR-type diamonds. Sierra Leone has yielded several CLIPPIR diamond discoveries, very large megacrystals (>100 ct) with high economic value due to their rarity. Overall, this study identifies Meya dyke as a new kimberlite occurrence, advances understanding of the Man Craton mantle, and provides practical implications for local diamond exploration.