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Mineral inclusions in sublithospheric diamonds from Juina, Brazil: Subducted protoliths, carbonated melts and protokimberlite magmatism

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A suite of Type II Diamonds from the Cretaceous Collier 4 kimberlite pipe, Juina Kimberlite Field, Brazil, include syngenetic mineral inclusions comprising a remarkable range of compositions that include calcium- and titanium-rich perovskite, Ca-rich majoritic garnet, olivine, TAPP phase, CAS phase, K-hollandite phase, SiO_2, FeO, native iron, low-Ni sulphides, and Ca-Mg carbonate. The diamonds also exhibit a range in carbon isotopic composition ($\delta^{13}C$) that effectively spans that observed in the global diamond population. Diamonds with heavy, mantle-like $\delta^{13}C$ (-5 to -10‰) contain mineral inclusions indicating a transition zone origin from mafic protoliths. Diamonds with intermediate $\delta^{13}C$ (-12 to -15‰) contain inclusions with chemistry indicating crystallization from near-primary and differentiated carbonated melts derived from oceanic crust in the deep upper mantle or transition zone. Diamonds with extremely light $\delta^{13}C$ ($\sim$ -25‰) host inclusions with chemistry akin to high pressure-temperature phases expected to form in the transition zone from subducted pelagic sediments. Collectively, the Collier 4 diamonds and their inclusions indicate multi-stage growth histories in dynamically changing chemical environments. A $^{206}Pb/^{238}U$ age of 101±7 Ma on a CaTiSi-perovskite inclusion is close to the kimberlite emplacement time (93.1 ±1.5 Ma). This young inclusion age, together with the chemical and isotopic characteristics indicating the role of subducted materials, suggest a model in which the generation of sublithospheric diamonds and their inclusions, and the proto-kimberlite magmas, are related genetically to the interaction of subducted lithosphere and a Cretaceous plume.