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Carbon isotope "stratigraphy" in a single graphite crystal: Implications for the crystal growth mechanism of fluid-deposited graphite

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ABSTRACT

A 2 cm long and 0.8 cm thick, single graphite crystal embedded in quartz, feldspar, and orthopyroxene of a granulite-facies metamorphic rock from southern India exhibits unique homogeneity in $\delta^{13}C$ values along layers parallel to the (0001) surface and smooth unidirectional variation of about 1‰ along the **c**-crystallographic axis. The fluid-precipitated graphite shows isotope homogeneity indicative of crystal growth along the (0001) plane. The C-isotope data along with the textural features suggest that the formation of graphite initiates in a layer perpendicular to the **c**-axis, possibly by a spiral growth mechanism. The initial layer is followed layer after layer, until the final stages of graphite growth. A second stage of graphite growth unrestricted by surrounding minerals is inferred from the un-deformed idiomorphic hexagonal form of the overgrown crystals. The C-isotope values in the overgrown rim of the crystal are lowered by about 2‰, suggesting a multistage precipitation. Morphologic and stable isotope studies thus confirm uniform crystal growth of graphite recording an isotope evolution pattern relating to fractionation from a fluid in an infinite reservoir during the main crystal formation. Spiral growth parallel to the (0001) face can explain the perfect uniformity of stable isotope composition in a single layer, whereas the variation across the (0001) surface gives insights into the time-integrated fluid evolution attending the crystal growth.