Dating individual diamond growth zones: A first step towards quantifying the temporal evolution of the mantle carbon cycle

Michael Gress (Free University Amsterdam)

Additional Authors: S. Timmerman, J.M. Koornneef, I.L. Chinn, D.G. Pearson, G.R. Davies

Diamond and encapsulated inclusions are one of few unaltered records from Earth's interior. They provide insight into the evolution of Earth's mantle spanning a period (≥ 3.2 Ga) of major change in Earth's atmosphere, nature of crust formation and presumably plate tectonics. Single diamond mines contain different diamond populations and their formation takes place in several stages over protracted timescales.

Data from the Orapa kimberlite cluster, Botswana, establishes diamond formation from 2.9 Ga until kimberlite eruption at ~90 Ma, spanning the GOE. A representative suite of Botswana diamonds is characterized (CL, FTIR) to image the growth and resorption history. A newly developed Sr-Nd dating technique makes it possible to date distinct diamond growth zones with single silicate inclusions that will be verified by Re-Os dating of sulphides from the same growth zones.

High spatial resolution of stable isotopes (C, N) across dated diamond growth zones will allow to critically assess models proposed for diamond formation (e.g., potential implications for varying redox conditions, pH and elemental speciation). Without such an assessment it is difficult to evaluate how the carbon (and nitrogen) cycle operates within the deep Earth as isotopic variations cannot be unambiguously assigned to recycling or isotopic fractionation processes. Initial data suggests that the nature of carbon recycled from the surface during subduction has undergone a fundamental change over time.