Diamond geochronology – a record of continental lithosphere evolution

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The development of a technique for the precise determination of Re-Os isotopes in single sulfide inclusions in diamonds has allowed a rapid expansion in the number of ages available for diamond suites around the world. A combination of the capability to analyse individual inclusions to construct isochrons, together with the relatively low blocking temperature of the Re-Os isotope system means that Re-Os isochron ages are a robust way to date sulfide-bearing diamonds. The relatively large database allows us to look in more detail at the linkage between mantle and crustal/lithospheric events for diamond genesis. A detailed analysis of the data available for southern Africa reveals numerous interesting features. Diamonds crystallized in the lithosphere beneath southern Africa over a period of greater than 3 Ga, beginning in the Archean and continuing to the Mesozoic. Diamond formation in the continental lithosphere appears to occur in pulses rather than continuously. Most diamonds formed in the Archean and Proterozoic Eons. There is some correspondence between major events recorded in crustal rocks and some pulses of diamond formation. These events also correspond with events in the lithospheric mantle defined by whole rock and /or peridotite-derived sulfide Re-Os model ages. Other diamond crystallization events, of Mesoproterozoic age, such as those recorded from Jwaneng, do not correlate with recognizable crustal events but coincide with lithospheric mantle disturbances observed within peridotites. All eclogitic diamond forming events are reflected in the sulfide populations of peridotite xenoliths and indicate widespread infiltration of sulfide into the lithospheric mantle accompanying eclogitic diamond formation. This observation could reflect the general mobility of sulfur, as sulfides, during subduction around cratons, or may hint at a possible metasomatic origin, from fluids with a crustal origin, for eclogitic diamonds in general. The chronology of formation of some eclogitic diamonds can be clearly linked to craton assembly events, e.g., Argyle - assembly of cratonic nuclei during the Barramundi Orogeny; Kimberley S. Africa – docking of the Kimberley and Wits blocks. In other regions such as Siberia, it is the silicate peridoditic diamonds that are linked to the strong signature of craton assembly at 2 Ga recorded in the crust and in other mantle assemblages while Siberian sulfide peridotitic diamonds are Mesoarchean. Hence, diamond dating is revealing an intricate pattern of diamond formation that is consistent with other isotope tracers in requiring that eclogitic diamonds result from tectonic processes that were initiated in the Archean.