Goldschmidt 2000
September 3rd–8th, 2000
Oxford, UK.

Journal of Conference Abstracts
Volume 5(2), 950

Kankan Diamonds (Guinea) – Messengers from an Enriched Layer at the Top of the Lower Mantle

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Diamonds from the Kankan district in Guinea have been studied for their syngenetic mineral inclusion content. The Kankan diamonds are mined from alluvial deposits in the eastern part of the country but primary diamond sources are provided by Cretaceous diamondiferous kimberlite intrusions nearby (Haggerty, 1992). The lower mantle appears to be the dominant source for Guinea diamonds. Apart from frequent inclusions of ferropericlase, we observed several associations that may only exist at depths exceeding 660 km. Examples are the paragenesis of ferropericlase with the low pressure polymorphs of $CaSiO_3$- and $MgSiO_3$-perovskite and stishovite. The low aluminium contents of the $MgSiO_3$ inclusions indicate derivation from the uppermost deca-kilometres of the lower mantle (Wood, 2000). The observation of very high Sr (70-1000 times chondritic) and LREE (200-2000 times chondritic) in combination with positive and negative Eu anomalies for $CaSiO_3$ inclusions, may suggest a link between the inclusion chemistry and subducted oceanic crust. Similar Eu anomalies in $CaSiO_3$-perovskites and very high Al contents in some $MgSiO_3$-perovskites from Sao Luiz (Harte et al., 1999) support such an interpretation. In such a scenario, the origin of the Kankan inclusions from the uppermost lower mantle would be consistent with the megalith model of Ringwood (1991). Through subduction, there may also be a direct link between the lower mantle inclusion assemblages and those in the transition zone and asthenosphere, as the majoritic garnet and associated cpx inclusions at Kankan also possess Eu anomalies and high LREE and Sr contents. However, this does not necessarily require diamond formation within a down going slab: another possibility is that the inclusions record a "ghost" signature of recycled oceanic crust with the diamonds and the inclusions forming in a heterogeneous ascending mantle plume (Sobolev et al. 2000). The observation of a K-feldspar inclusion occurring together with $MgSiO_3$ showing the chemical signature of lower mantle perovskite, provides strong evidence that potassic hollandite forms part of the shallow lower mantle parageneses observed at Kankan. In addition, several diamonds contain inclusions which are best explained in terms of re-equilibration of former lower mantle parageneses at decreasing pressure and temperature: (i) $CaSiO_3$-perovskites in part decomposed to Ca_2SiO_4-larnite and $CaSi_2O_5$-titanite, which in turn may recombine to $CaSiO_3$-walstromite, (ii) $CaSiO_3$- and $MgSiO_3$-perovskite may react to form clinopyroxene and (iii) $MgSiO_3$-perovskite and ferropericlase form olivine with excess ferropericlase or enstatite. These observations suggest that exhumation from the lower mantle was slow, probably in a rising plume or convection cell, which allowed adjustment of external pressure on the host diamond and internal pressure on the inclusions via plastic deformation.

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