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Trace elements of fibrous diamonds

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Twenty-seven fibrous diamonds from Kankan, Udachnaya, Diavik, DeBeers Pool and Koingnaas were analyzed for their trace element contents using the cellulose calibration LA-ICP-MS method; their major and volatile content were previously determined by EPMA and FTIR. This set of diamonds carries high-Mg carbonatitic, saline and low-Mg carbonatitic to silicic high-density fluid (HDFs) which represent the four end-members found in microinclusion-bearing diamonds.

The trapped HDFs in all diamonds are highly enriched in incompatible elements typically reaching levels of a few thousand times the primitive mantle values. The majority of diamonds show similar patterns from Pr towards the more compatible elements, with moderate to high negative anomalies of Sr, Zr, Hf, Ti and Y. These anomalies are found in kimberlitic melts as well as in other metasomatic fluids in the lithospheric mantle. In the low-Mg carbonatitic to silicic HDFs and in the saline ones, two patterns are distinguished in the most incompatible elements (Cs-Ce). The first (designated "Table") has significantly higher Ba, U, Th and LREE compared to Nb, Ta and, in most cases, K, Rb and Cs. The second pattern ("Bench") is flatter with no significant anomalies in this range. The high-Mg carbonatitic HDFs do not show such defined patterns. Still, high-Mg carbonatitic HDFs from Kankan show higher depletion of the alkalis, and to a lesser extent Nb and Ta, compared with Udachnaya high-Mg HDFs.

The present database is still limited, but "Table" patterns were found in the coat of a Kankan diamond that carries eclogitic inclusions in its core and in a Diavik diamond with peridotitic micro-mineral inclusions in its coat. Thus, the two patterns are probably not related to the peridotitic or eclogitic rocks that host the diamonds. "Table" and "Bench" patterns of the incompatible elements are found in HDFs of diverse major-element compositions (carbonatitic, silicic and saline). This suggests that the two patterns reflect the nature of the sources that contributed to the very high abundance of the most incompatible elements.

There is a strong similarity between the high-Mg carbonatitic HDFs and kimberlites for the complete set of incompatible elements. The huge variation in Th/Nb and La/Nb in carbonatitic-silicic and carbonatitic-saline HDFs, suggests scavenging of Nb by rutile or a similar phase. This can be achieved either by rutile addition (e.g., by dissolution during early melting) or removal (during fractionation). Similar arguments, based on major and trace element patterns, may be made for the involvement of other phases, such as zircon, apatite, mica and carbonates. Rocks rich in the above phases are known from xenoliths in kimberlites (e.g., MARID, PIC and glimmerites) and in many cases show the inverse Cs-Ce anomalies to the “Table” pattern. These features may indicate a close relation between HDFs, kimberlites and formation or dissolution of the above mica-rich rocks.