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COMPOSITIONAL VARIATION OF MANTLE-FLUIDS TRAPPED IN FIBROUS DIAMONDS FROM BOTSWANA.

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Fibrous diamonds of cubic morphology from Zaire, Botswana and many other localities contain myriads of submicron inclusions enclosed in the diamond matrix. These micro-inclusions are rich in H₂O, CO₃²⁻, SiO₂, K₂O, CaO, FeO and incompatible elements, and are believed to represent a fluid (or a melt) that was trapped during the growth of the diamonds (NAVON et al., 1988). High internal pressures observed within the micro-inclusions suggest that these fluids were trapped at depths >130 km (NAVON, 1991).

Intra- and inter-diamond variation in the concentration of the major oxides in the trapped fluid were examined in thirteen diamonds from Jwaneng (Botswana) by analyzing individual inclusions along radial profiles with an electron-microprobe (EMP). Variations in the H₂O/CO₃²⁻ ratio (representing the H₂O/CO₂ ratio of the original fluid) were investigated by infrared-spectroscopy (IR). Both IR- and EMP-analyses were carried out using polished central sections cut parallel to (100). A (15 keV, 50 nA) focused beam of a JEOL JXA 8600 Superprobe was rastered over an area of 0,5 x 0,5 μm (vol. of resulting X-ray emission covers an individual shallow inclusion). Data were collected for 100 seconds using an EDS system and four WDS spectrometers and reduced using a full ZAF correction. The total oxide content varied between 1-35 wt% and was finally normalized to 95 wt%. Infrared absorption spectra were collected using a Nicolet 740 FTIR Spectrometer. The spectra were recorded with 4cm⁻¹ resolution in the range 400-4500 cm⁻¹ using a Glowbar source, KBr Beam-splitter, MCT-B detector and an aperture of 620μm.

Due to the small size of the inclusions (<0,5μm), all of the 650 analyzed inclusions yielded a very low oxide content (average 7%). The majority of the inclusions within a single diamond fall within a tight compositional range and their average compositions

are similar to those reported previously for fibrous diamonds from Zaire (NAVON et al., 1988). However, a significant compositional variation of the trapped fluid was found between different diamonds. Taken together, the analyses of individual micro-inclusions in all thirteen diamonds span a wide, continuous range of compositions. The volatile free fraction of the trapped material varies in the following ranges: SiO₂, 12-58 wt%; K₂O, 10-25%; CaO, 0-25%; FeO (total Fe as FeO), 8-20%; MgO, 3-14%; Al₂O₃, 0-7%; TiO₂, 4-6%; Na₂O, 1,5-3%; Cl, 0,5-2,5%; P₂O₅, 0,5-3%. This range is much wider than the range recorded by any single diamond and exceeds the compositional variation reported for diamonds from Zaire (NAVON et al., 1988). The oxide constituents show strong inter-element correlations: The concentration of SiO₂ correlates positively with Al₂O₃ and negatively with CaO, FeO, MgO and P₂O₅. K₂O concentration also shows a slightly negative correlation with SiO₂. Na₂O, TiO₂ and Cl concentrations are not correlated with the other elements. The H₂O/CO₃²⁻ ratio within individual diamonds is reasonably uniform but varies between different diamonds. Values for the molar ratio H₂O/(H₂O+CO₃²⁻) fall in the wide range between 0,3-0,9 and show a strong correlation with the chemical composition (e.g., SiO₂ content) of the fluid. SiO₂+Al₂O₃-rich inclusions contain more water and are less peralkaline than CaO+MgO+FeO-rich ones. The observed correlations between all constituents define rather linear trends limited by a hydrous Si+Al-rich- and a Ca+Fe+Mg+K+CO₃²⁻-rich endmember. Beside absorption bands due to H₂O and CO₂ the IR spectra of all diamonds also exhibit the characteristic absorption bands of mineral phases (carbonate, phosphate, silicates and quartz) that are believed to have formed from the fluid during its cooling. The absorption bands of quartz within the micro-inclusions are shifted due to high internal pressures of about 15 GPa (at room temperature) within the micro-inclusions. This value falls in the lower range of pressures detected in Zairian diamonds (15-21 GPa; NAVON, 1991).

The clear compositional distinction between the micro-inclusions and their host kimberlites led NAVON et al. (1988) to propose that the fluid was formed by fractionation of a proto-kimberlitic melt at depth. This process may explain the low Mg/Fe ratio and the strong enrichment in potassium and other incompatible elements in the fluid. However, the covariation of the H₂O/CO₂ ratio with the major oxides is difficult to explain in such a scenario, unless the major fractionating phase is rich in carbonate. Incipient melting of a mantle peridotite was also proposed. It seems less likely in view of the wide compositional range, the low Mg/Fe ratio of the fluid and the extreme enrichment in SiO₂ in the hydrous endmember.

In view of the new data, we would like to propose two additional scenarios. (1) The primary fluid is CO₂ rich. Reduction of CO₂ leads to diamond formation and to an increase in the H₂O/CO₂ ratio of the residual fluid. The solubility of oxides such as SiO₂ and Al₂O₃ increases, while the solubility of CaO, FeO, MgO and K₂O, oxides that are more associated with carbonate, decreases. SCHNEIDER & EGGLEER (1986) observed similar trends in their experiments at pressures up to 20 kbar. Future quantitative determination of the solute/solvent ratio in the fluids will enable us to better evaluate this scenario. (2) The observed compositional range may be the result of a mixing process between a carbonate-rich endmember and a hydrous endmember. The mixing may take place by flushing a hydrous mantle source with a carbonatitic melt, penetration of a hydrous fluid into a carbonate-rich source rock, direct mixing

of a carbonatitic melt and a hydrous fluid or the separation of a hydrous fluid from a H₂O+CO₂-rich melt.

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BASALTKLÄRSCHLAMMKOMPOST-ROTTE UND ROTTEPRODUKTE (CHEMIE, MINERALOGIE, MIKROGEFÜGE)

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Stoffumsetzungen und Stoffumwandlungen, namentlich auch Stoffseparierungen und -aggregationen sind wesentliche Erscheinungsformen terrestrischer Ökosysteme. Die Intensität solcher Prozesse nimmt mit der Intensität der Zustands- und Rahmenbedingungen zu und die Grundzüge von Umsetzung und Umwandlung werden besonders kontrastreich, sodaß die Formen intensiver Umsetzungen häufig ergiebige Forschungsobjekte darstellen. Andere Formen, vor allem solche mit modernen Problembezügen stehen diesen in nichts nach und können sie sogar noch übertreffen. Ein Beispiel dafür sind Rotteprozesse und Rotteprodukte, da die Zustandsbedingungen in der Rotte besonders extrem sind. (z.B. Zusammensetzung, Temperatur, Redox etc.)

Ein wesentliches Charakteristikum von Stoffen, die aus intensiver Umsetzung hervorgegangen sind, ist der morphologische, speziell auch der mikromorphologische Zustand. Dabei ist die klassische Methode der Mikromorphologie (Dünnschliff) um die modernen Analysemöglichkeiten zu erweitern (REM, chemische Mikroanalytik). Diese Analytik baut selbstverständlich auf der Kenntnis der chemischen und mineralogischen Zusammensetzung des Stoffes auf und bindet die Daten der Stoffgenese ein.

Die vorliegende Arbeit hat die Charakteristik eines Basalt/Klärschlamm-Kompostes nach den o.zit. Kriterien zum Gegenstand. Die Klärschlämme stammen aus dem ländlichen Raum des Unteren Raabtales, der Basalt in Form von Basaltmehl aus Klösch. Die Kompostmiete war im April 1990 in Feldbach gesetzt und die Rotte ein halbes Jahr intensiv geführt worden. Die Rotte wurde aus Gründen der Verlust- und Geruchs-