Crystallographic and chemical characteristics of a rutile megacryst from the Mbuji-Mayi kimberlite, Central Africa

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A centimeter-size polycrystalline rutile [Rt] grain extracted together with diamonds, zircon, and baddeleyite from the Cretaceous kimberlite, was analyzed for its crystallographic and chemical characteristics (EPMA, TEM). Individual crystal domains of rutile are surrounded by submicron phases, containing Ti, Al, and Si to various degrees but no distinct mineral could be identified by EPMA. On the other hand, the rutile domains contain so far unexplained twin-like lamellae parallel (110) as well as exsolutions made up of spinel and ilmenite [Ilm]. Both exsolutions are in epitaxial relationship with the host rutile. Spinel [Sp] shows additionally the typical spinel law twinning on (111). Crystallographic relationships between the host rutile and exsolutions are the following:
[100]Rt // [001]Ilm
[001]Rt // [1-10]Ilm
[100]Rt // [111]Sp
[001]Rt // [110]Sp
The multi-stage evolution of rutile recorded by the microstructure strongly resembles the complex history of the Mbuji-Mayi baddeleyites carrying a primary Archean age component [1], also showing intense twinning and transformation of the originally cubic to the actual monoclinic phase [2]. A lower mantle origin was inferred, which could also be the case for our rutile; however, to directly correlate the newly discovered characteristics with P-T conditions, experimental data are lacking. Constraining these conditions will be the next step of our investigations.
[1] Schärer U., Corfu F:, Demaiffe D. (1997). U-Pb and Lu-Hf isotopes in baddeleyite and zircon megacrysts from the Mbuji Mayi kimberlite: constraints on the subcontinental mantle. Chem. Geol. 143, 1-16.
[2] Kerschhofer L., Schärer U:, Deutsch A. (2000). Evidence for crystals derived from the lower mantle: Baddeleyite megacrysts in the Mbuji Mayi kimberlite. Earth. Planet. Sci. Lett. 179, 219-225.

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