Water content of silicate mineral inclusions in superdeep diamonds from Juina, Brazil

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The water content of the convecting mantle is an open, but important, question for solid Earth Scientists. It is widely believed that ppm concentrations of water in the mantle can induce partial melting, alter chemical partitioning and profoundly affect the creep behaviour and viscosity of mantle rocks, all effects that influence Earth's habitability. The mantle's water content is almost certainly highly heterogeneous, but the transition zone (TZ) has the potenital to be Earth's most significant water storage reservoir. However, indirect estimates of the TZ's water concentration vary between essentially dry[1] and saturated[2] values. Diamonds, and the mineral inclusions they contain, are the deepest direct samples that we have – and will ever have – for geological study. However, diamond-hosted inclusions have received relatively scant attention in terms of investigating Earth's deep water cycle.

Low nitrogen diamonds from Cretaceous kimberlites in Juina (Brazil) show complex growth structures[3], a recycled crustal origin[4], and contain abundant sub-lithospheric inclusions, including many from TZ depths[3-5]. Using the NanoSIMS 50L at DTM, we measured the water and fluorine content of 56 individual inclusions from within 26 superdeep diamonds. The studied inclusions have polyphase assemblages that are believed to have formerly been stishovite, majorite, calcium perovskite, bridgmanite, NAL and CF-phase minerals. H_2O concentrations vary between samples, but all inclusions have water contents above detection limits (0.05 ppm). Individual measurements range from ~ 10 to 2100 ppm H_2O, clearly demonstrating the role of water in superdeep diamond formation. Results will be discussed in consideration for potential grain boundary and retrogressive water loss during exhumation.

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