Sulfides and sulfates in the "salty" Udachnaya-East kimberlite: their magmatic S-isotopic compositions

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The Udachnaya East pipe (Siberia) hosts a kimberlite of special interest that is dry (<1wt% H_2O) compared to kimberlites worldwide, and anomalously rich in salts (Na_2O and Cl both up to 6wt%) and sulfur. Radiogenic isotopes strongly support a magmatic, uncontaminated origin for this salty kimberlite [1,2], raising the question of the origin of S and its oxidation state (sulfide or sulfate) in alkali magma. An associated less dry kimberlite and a serpentinized kimberlitic breccia are both salt free. We studied samples from these three kimberlitic rock types (dry-salty, n = 8, non-salty, n = 5 and breccia, n = 3) using the complementary approaches of whole-rock and *in situ* techniques.

The salty kimberlite is unprecedentedly S-rich (~0.3wt%) compared to the non-salty kimberlite (~0.08wt%). In the salty kimberlite, S is present mostly as sulfates (up to 94% of S_{total}) disseminated throughout the groundmass and associated with alkali-carbonates. The coexisting groundmass sulfides are djerfisherites ($Na(Fe,Cu,Ni)_{24}S_{26}Cl$), and the $\delta^{34}S$ of sulfides in the salty kimberlite (mean $\delta^{34}S_{bulk}$= -1.3 ± 1.1‰ and $\delta^{34}S_{insitu}$ = -2.1 ± 1 ‰ for djerfisherite) is consistent with that of the depleted upper mantle [3,4]. $\delta^{34}S$ of the associated sulfates (9 to 12‰) are in equilibrium with the sulfides at T of 466 to 565°C, consistent with the magmatic range for kimberlites. Samples that are salt free show evidence that the system has been perturbed, either by the removal of sulfates and the addition of sulfides by sulfidation reactions (non-salty kimberlite) or by hydrothermal contamination (breccia).

The coexistence of magmatic sulfides with sulfates in these deeply sourced magmatic rocks have strong implication for the oxygen fugacity of kimberlite magmatism and more generally for the global S budget of the mantle. Although sulfates are more elusive than sulfides and thus rarely reported so far, our results suggest that sulfate-rich fluids are more important in the mantle than previously thought.

[1] Kamenetsky *et al.* (2014) *Ear. Sci. Rev* **139**, 145–167. [2] Mass *et al.* (2005) *Geology* **33**, 459. [3] Labidi *et al.* (2013) *Nature* **501**, 208–11.[4] Labidi *et al.* (2014) *GCA* **133**, 47–67.