

## Salts from Udachnaya-East kimberlite pipe (Yakutia, Russia): occurrences and mineral composition

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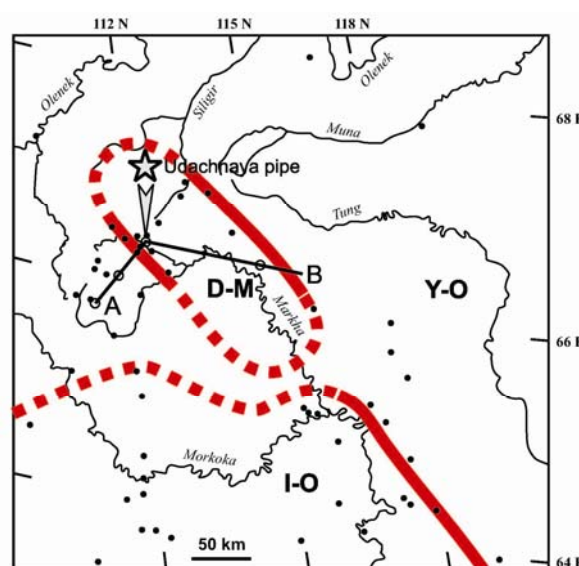
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### Introduction

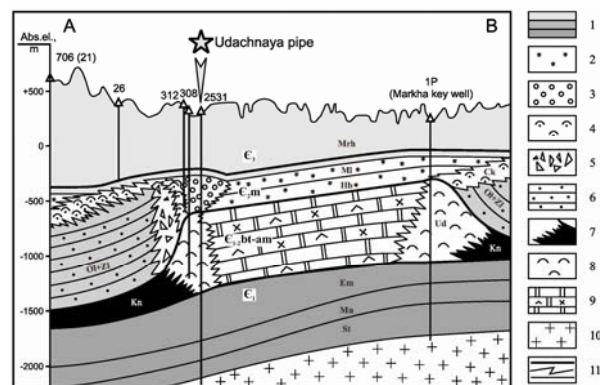
Last years mining activity on Udachnaya-East kimberlite pipe gave us a chance to study kimberlite breccias with abundant of halides and carbonates (Sharygin et al., 2007a, b). This water-soluble assemblage occurs as breccia cement and forms chloride xenoliths of various size and composition. Olivine phenocrysts in the breccias unaffected by serpentinization include complex (carbonates + sulfates + chlorides + gas) secondary inclusions trapped at  $P < 1$  kbar and  $T \leq 800^\circ\text{C}$  (Golovin et al., 2007). Inclusions of saline melts in halite xenoliths show its high temperature water-free origin (Grishina et al., 2007). Similar Sr–Nd–Pb isotope data of salt xenoliths, groundmass silicates and groundmass water leachate imply a comagmatic origin of the chlorides with parental kimberlite magma (Kamenetsky et al., 2004, 2006; 2007a, b; Maas et al., 2005). Salts from this pipe have the same  $\delta^{37}\text{Cl}$  value as mantle, crust and carbonaceous chondrites (Sharp et al., 2007). By Sharygin's opinion, carbonate-chloride and chloride xenoliths could be fragments of evaporites that underwent thermometamorphism from kimberlitic melt (Sharygin et al., 2007b). Salt xenoliths occurrences and mineral composition are described insufficiently, however, and that is the target of this contribution.

### Geological setting

Cambrian rocks adjacent to the Udachnaya pipe lack salts, whereas black shale and carbonate rocks are abundant. Furthermore, Devonian salts are also absent in this area (Matukhin, 1991). The Udachnaya pipe is located on the SW flank of the Cambrian Daldyn-Markha carbonate bank (Sukhov, 2001). Evaporite rocks accumulated in at sabkha environment from ca. 520 Ma. Unfortunately, there is no deep drilling into inner part of bank, thus we have no direct evidence of the presence of sedimentary salts. Nevertheless, because of our reconstruction we suppose that Cambrian salts from Daldyn-Markha bank could be a potential supplier to Udachnaya pipe.



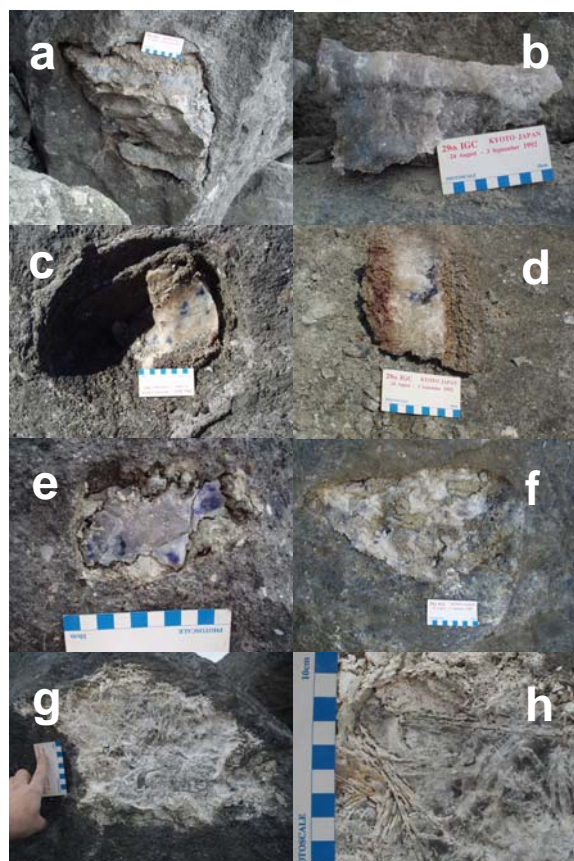
Irkutsk – Olenka (I-O) carbonate platform and Daldyn – Markha (D-M) carbonate bank conjugated with Yudom-Olenek (Y-O) basin at Late Amga (Middle Cambrian) Time. Reef margins established (solid line) and proposed (dotted line) compiled from Sukhov (2001) and Kononov et al. (2007). Dots are prospecting boreholes and A-B line is the cross-section, shown on the next figure.



Cross-section of Daldyn-Markha bank along A-B line. Note inclined position of carbonate bank, composed by various rocks: 1 – Cambrian and Ediacarian carbonates; 2 – sabkha; 3 – carbonate bar deposits; 4 – terrigenous-carbonate rocks (marls); 5 – dolomite breccias; 6 – carbonate-terrigenous rocks; 7 – black shales; 8 – reef rocks; 9 – lagoon sulfate-salt-carbonates rocks and 10 – granite-gneiss basement; 11 – time (thick), facial (zigzag) and geological (thin) lines. Time interval of sedimentary rocks span Ediacarian and Cambrian.

### Occurrence of salts in Udachnaya-East pipe

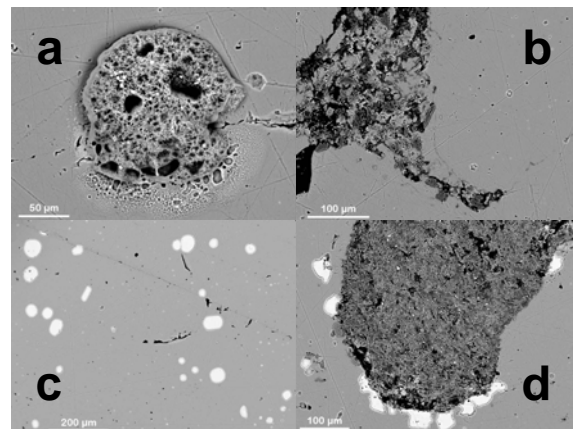
Salts in pipe occur as groundmass cement, phenocrysts vugs, veins, cutting mantle xenoliths, and as xenoliths (a-h). Xenoliths size varies from cm (e,f) to 0.5m (a). They have various angularity and surfaces (a,c), corroded by both surface water (c) and kimberlite melt (e). Big xenoliths have clear rims that contain pale to deep blue halite crystals (b,d). Smaller xenoliths compose of predominantly blue halite. Carbonate-halides xenoliths compose of tabular carbonates, interstitial halides, and some minor minerals (g,h).



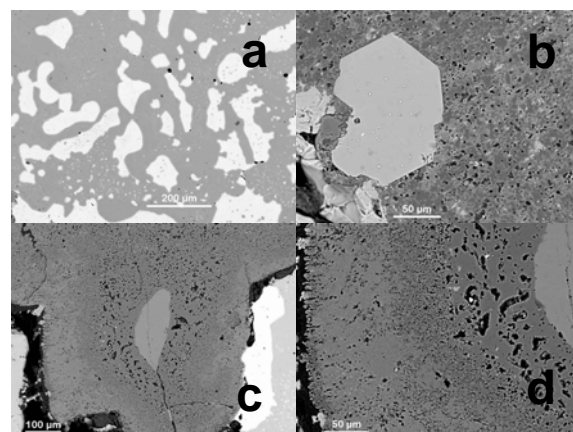
**Samples List (SL).** Salts xenoliths with various size, angularity (a,c,e,f), mineral composition (a,c,e,f,g,h) and presence of pale to deep blue halite (b,c,d,e) originated from thermal metamorphism of salt xenoliths.

### Salt xenoliths composition

We studied minerals with electron microprobe, SEM-EDS, and XRD. Mineral associations of cores include silicates, carbonates and sulfates of both sedimentary and metamorphic origins. Host halite in cores retains rare chevron-like pattern of fluid inclusions. Mineral associations of rims include silicates, carbonates and sulfates with evidence for metamorphic overprint and possibly melting. Xenolith rim halite contains abundant elongated sylvite inclusions. Carbonate-halides xenolith contains halite-sylvite mixtures, silicates (e.g. monticellite) and rare carbonates (e.g. shortite).



**Salt xenoliths.** Inclusions of  $\text{CaCl}_2$  (a) and pelitic sedimentary clasts (b) from central part of salt xenolith (c,d of SL). Later comprise of small crystals of anhydrite and hydrosilicates(?). Round sylvite inclusions (c) and metamorphised pelitic clasts (d) from redish rim zone of xenolith (c,d of SL). Later comprise of rare zircon, magnetite, ilmenite, feldspar and hayuine.



**Carbonate-halide xenoliths.** Complex intergrowing of white sylvite and grey halite (a) from intergranular infilling of carbonate minerals from (g,h of SL) and monticellite (b) from silicate-carbonate aggregates. Complex history of calcite transformation (c,d) from the same type of xenoliths (g,h of SL).

## Conclusion

Metamorphosed and melted salts impregnate kimberlite groundmass, resulting in an apparent magmatic origin. Our results demonstrate of sedimentary origin of salt xenoliths from Udachnaya-East pipe.

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