EGU General Assembly 2020

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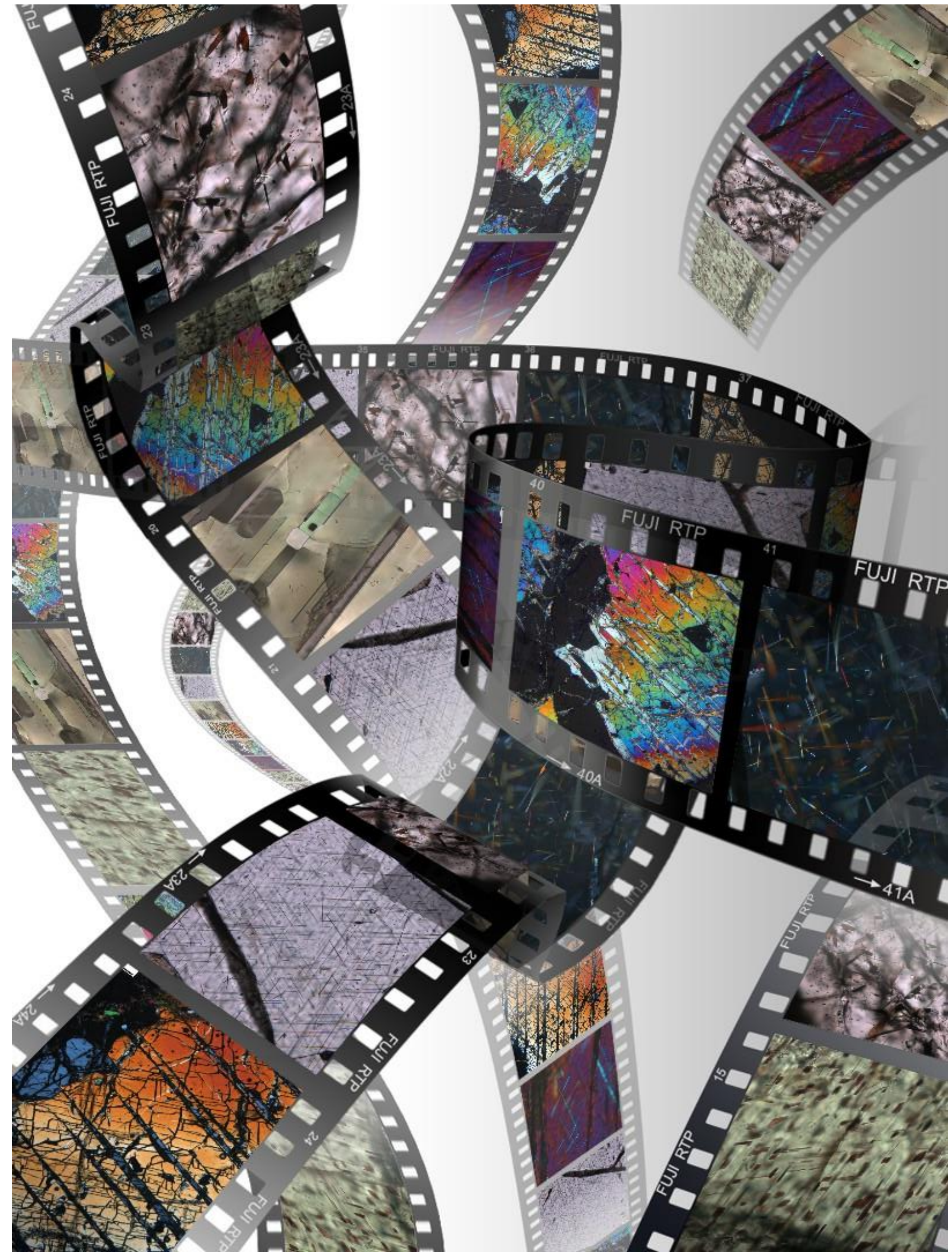
[Session GMPV4.4] Wed, 06 May, 14:00–15:45

Redox events in cratonic mantle underneath Obnazhennaya kimberlite, Yakutia – chemical records in pyroxenites



Taisia A. Alifirova[1,2],
Sonja Aulbach[3],
Nester M. Korolev[4],
Aleksandr V. Golovin[1],
Oleg B. Oleinikov[5]

[1]IGM SB RAS, Novosibirsk, Russia
[2]University of Vienna, Austria
[3]Goethe Universität, Frankfurt am Main, Germany
[4]IPGG RAS, St Petersburg, Russia
[5]IDPMG SB RAS, Yakutsk, Russia

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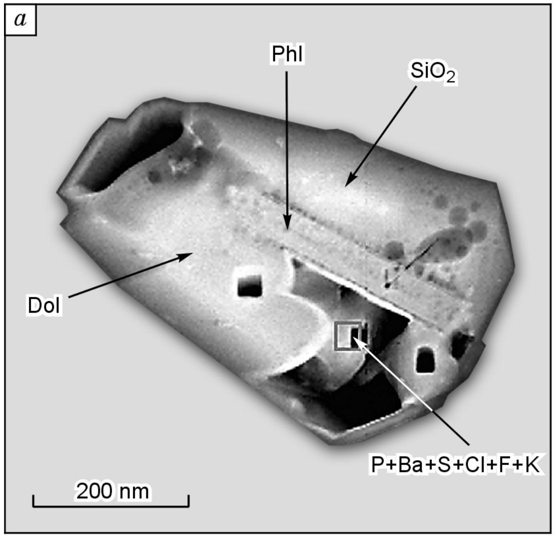
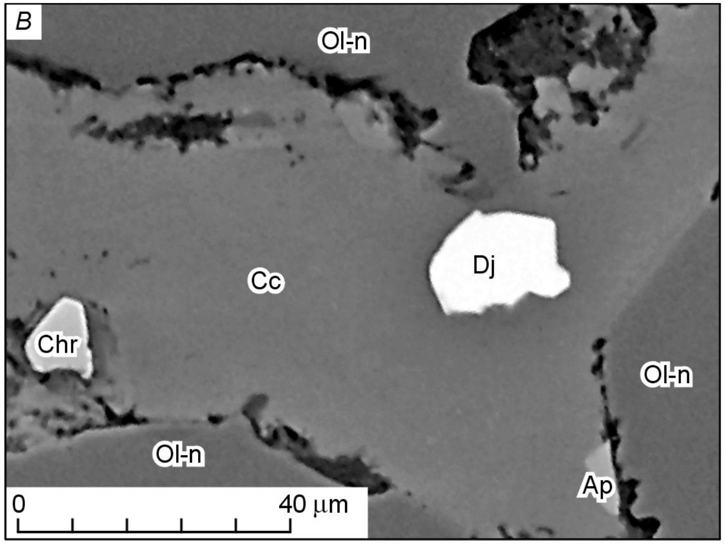
Carbon in mantle rocks

fO_2 controls:
- speciation within C–H–O–S system
- stability of C-bearing phases (Dia, Gr, carbonates, carbides, volatile-bearing fluid and melt)
- C mobility in silicate mantle

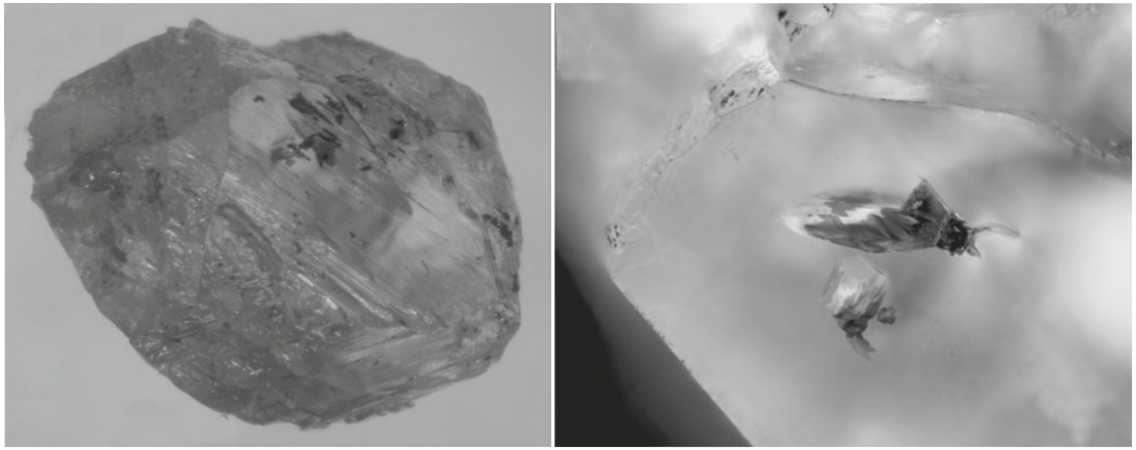
Source of carbon
Subduction of carbonaceous sediments
Deep mantle origin
Kimberlitic and carbonatitic melts



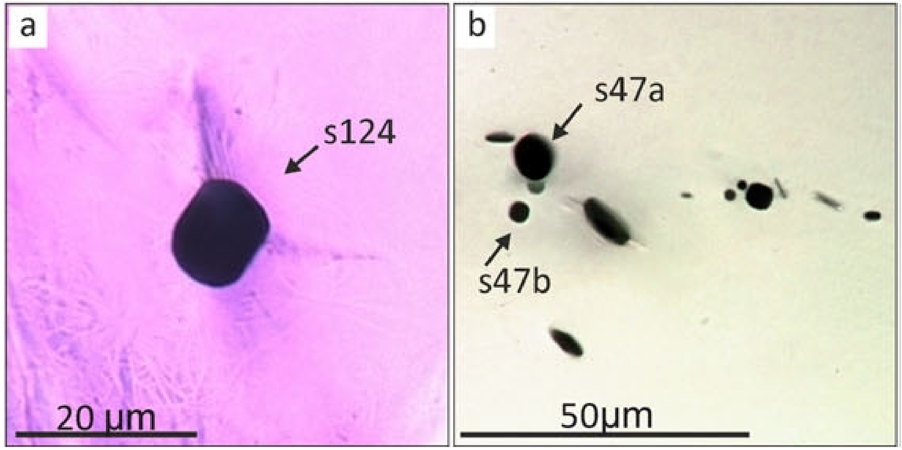
Carbonate inclusions in Dia (Sobolev et al., 2009)



Interstitial carbonates (Sharygin et al., 2018)

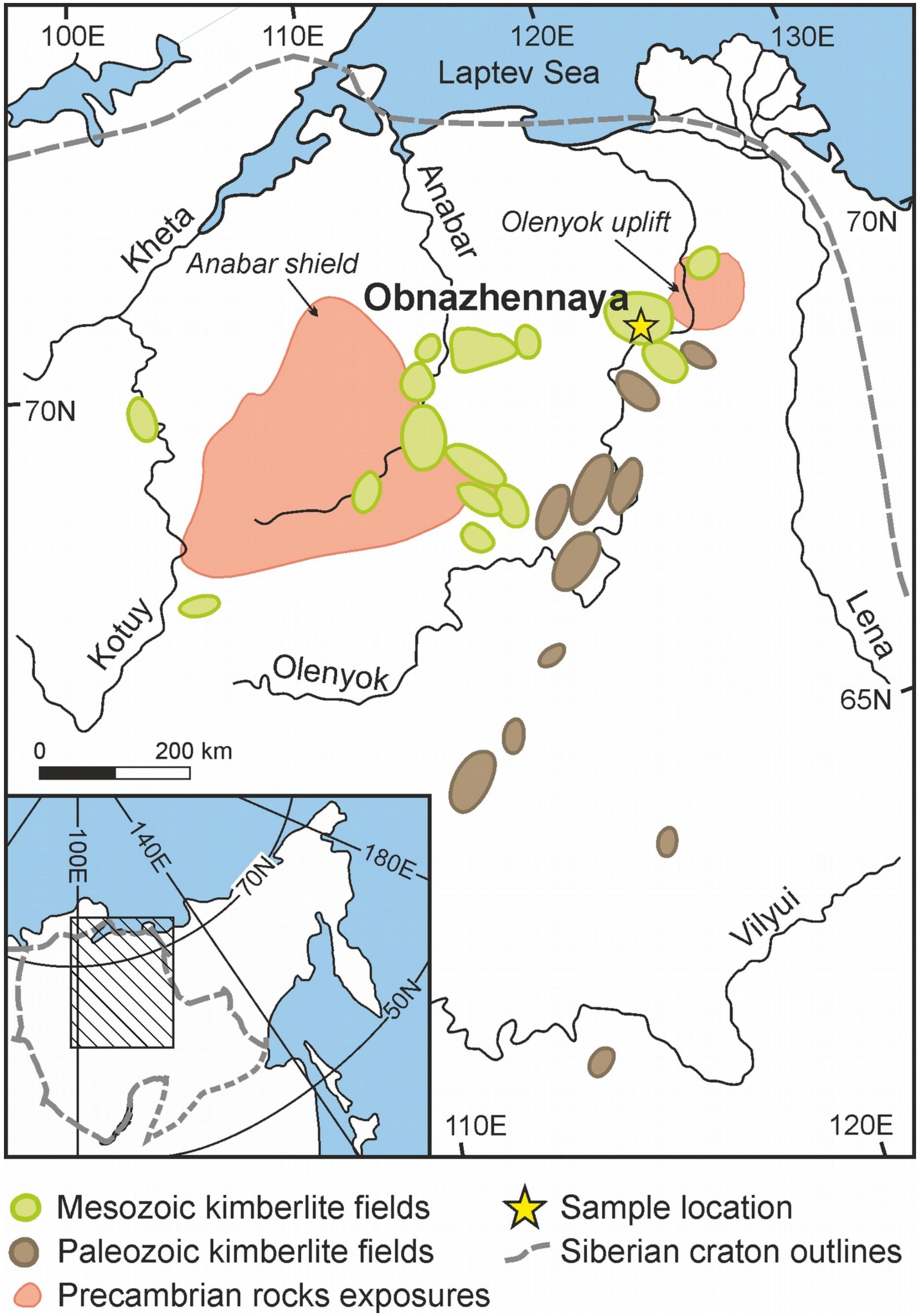


Graphite inclusion in Dia (Mikhailenko et al., 2016)



Graphite inclusions in Grt (Nikolenko et al., 2017)

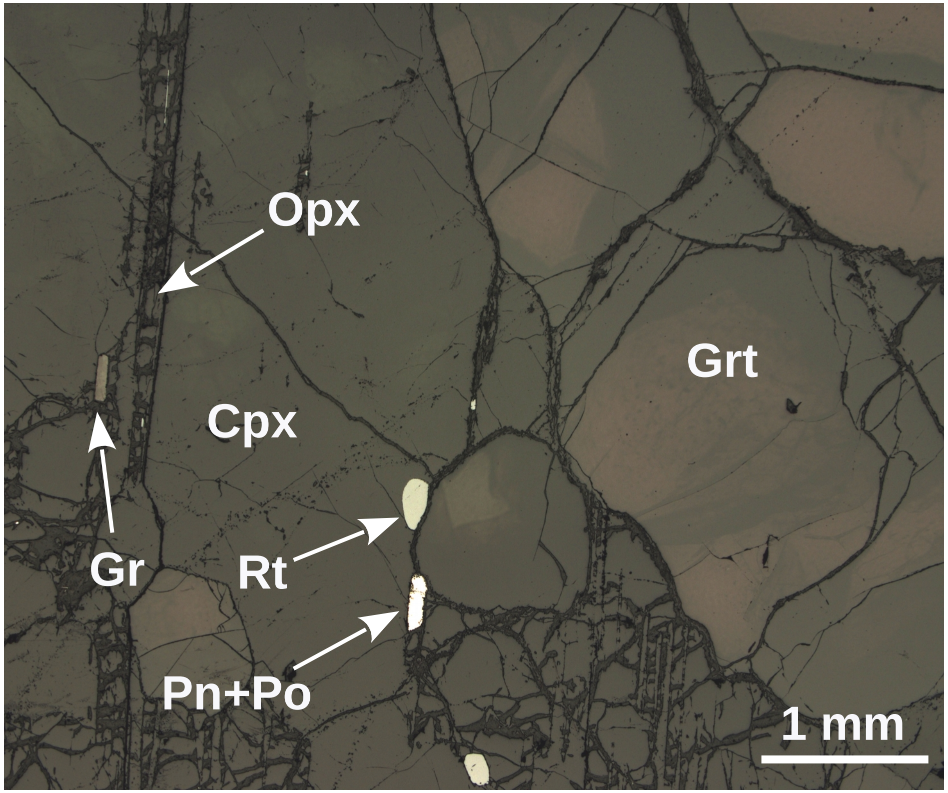
Sample location and petrography



Studied sample Ob90/13:

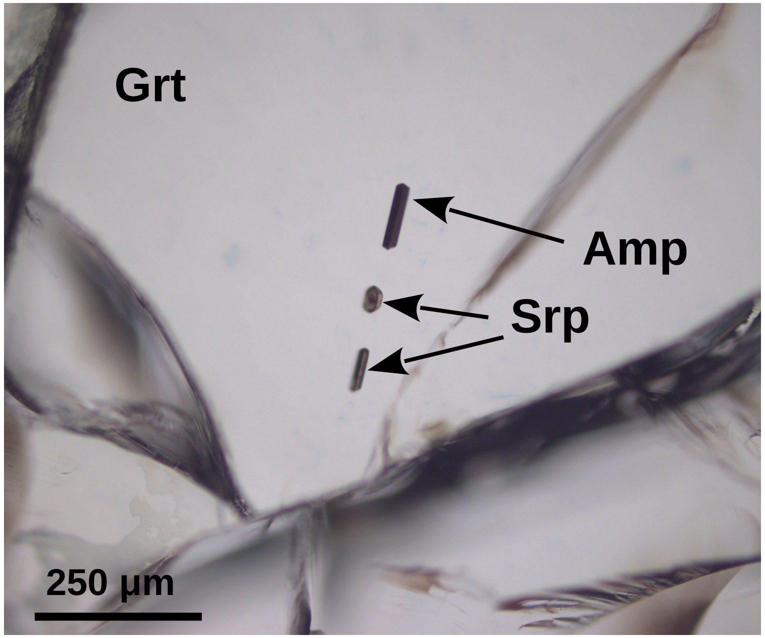
Grt websterite (Cpx+Grt+Opx)

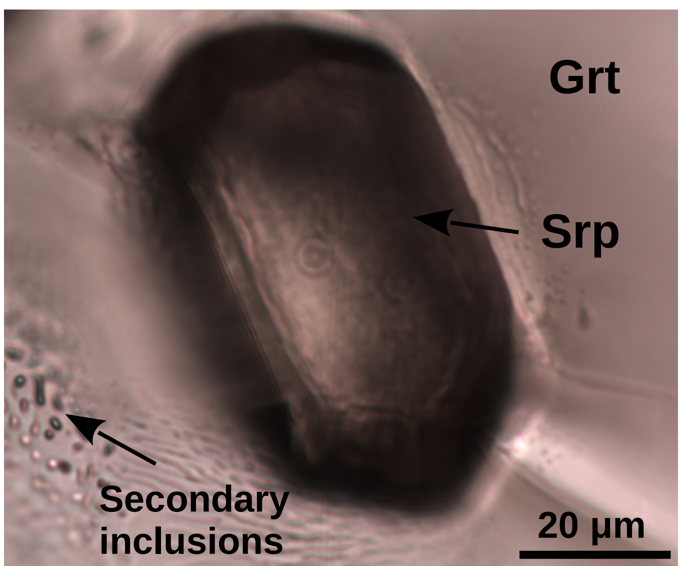
Oxides (Rt, Ilm)
Sulfides (Po, Pn)
Graphite
Secondary — Srp, Phl, carbonates

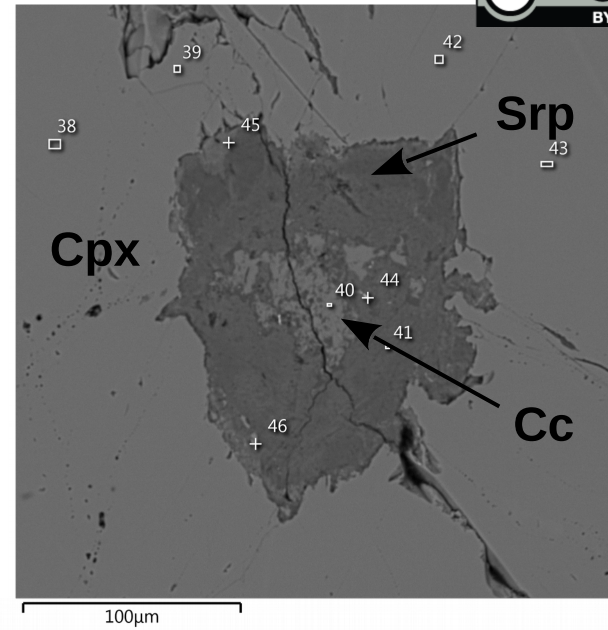


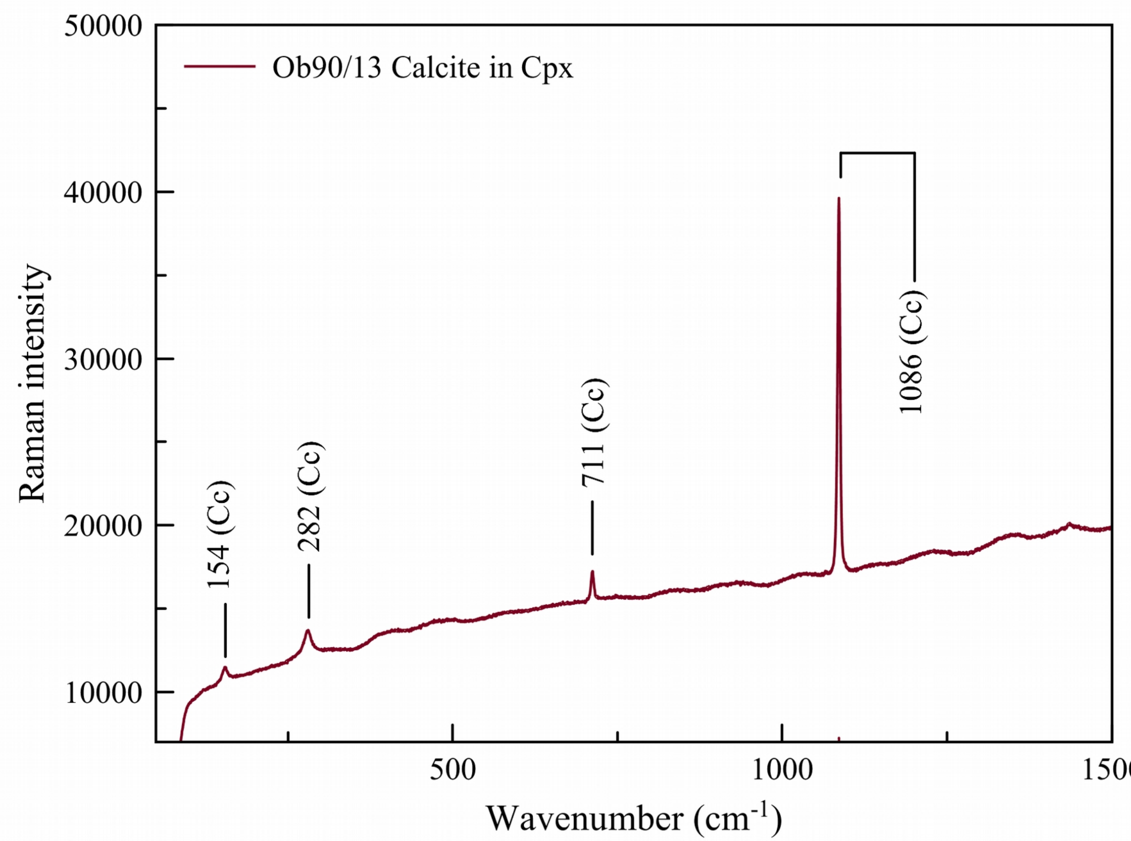
Optical photo made in reflected light

Inclusions in rock-forming minerals



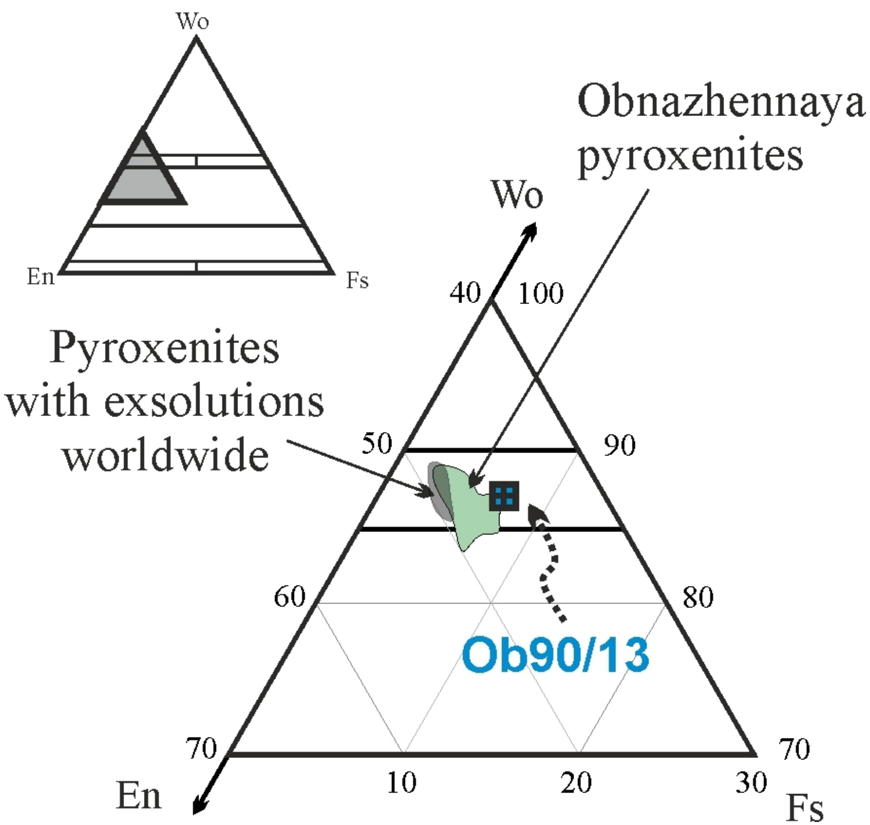




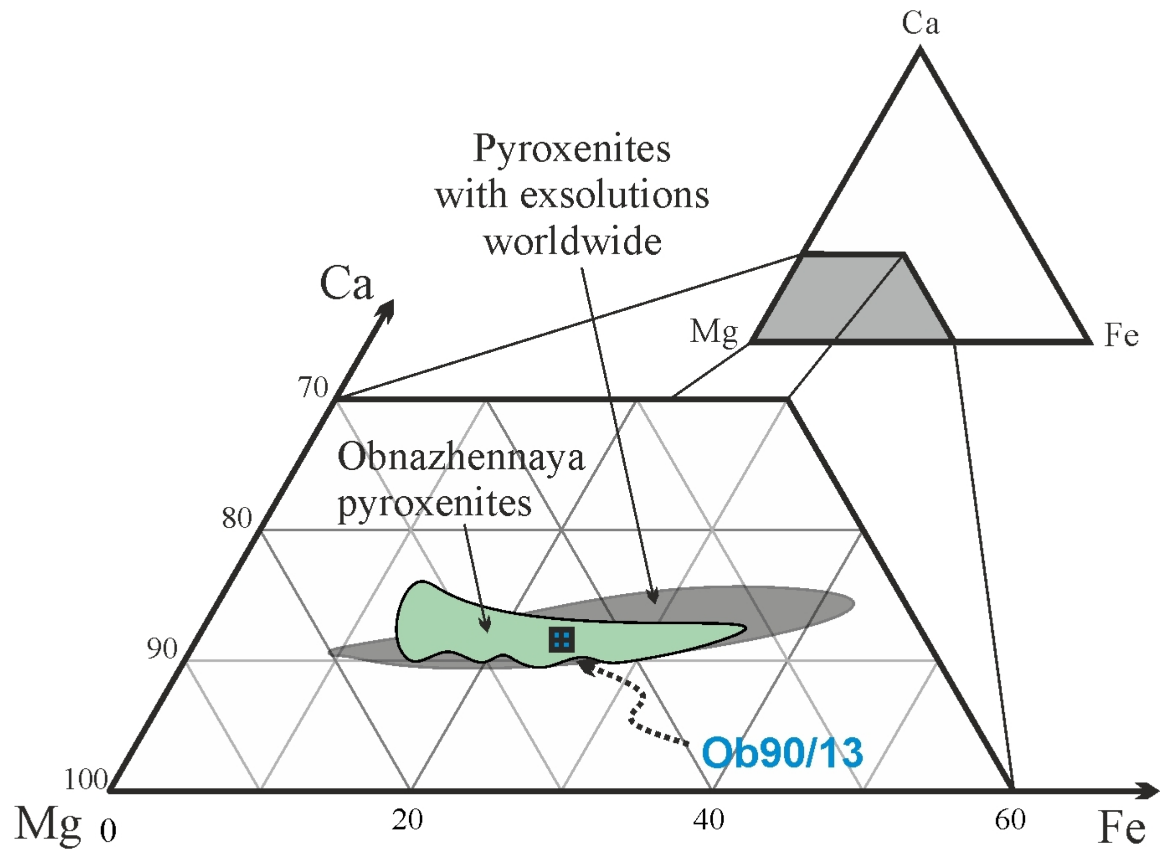


Major elements in rock-forming silicates

Clinopyroxene



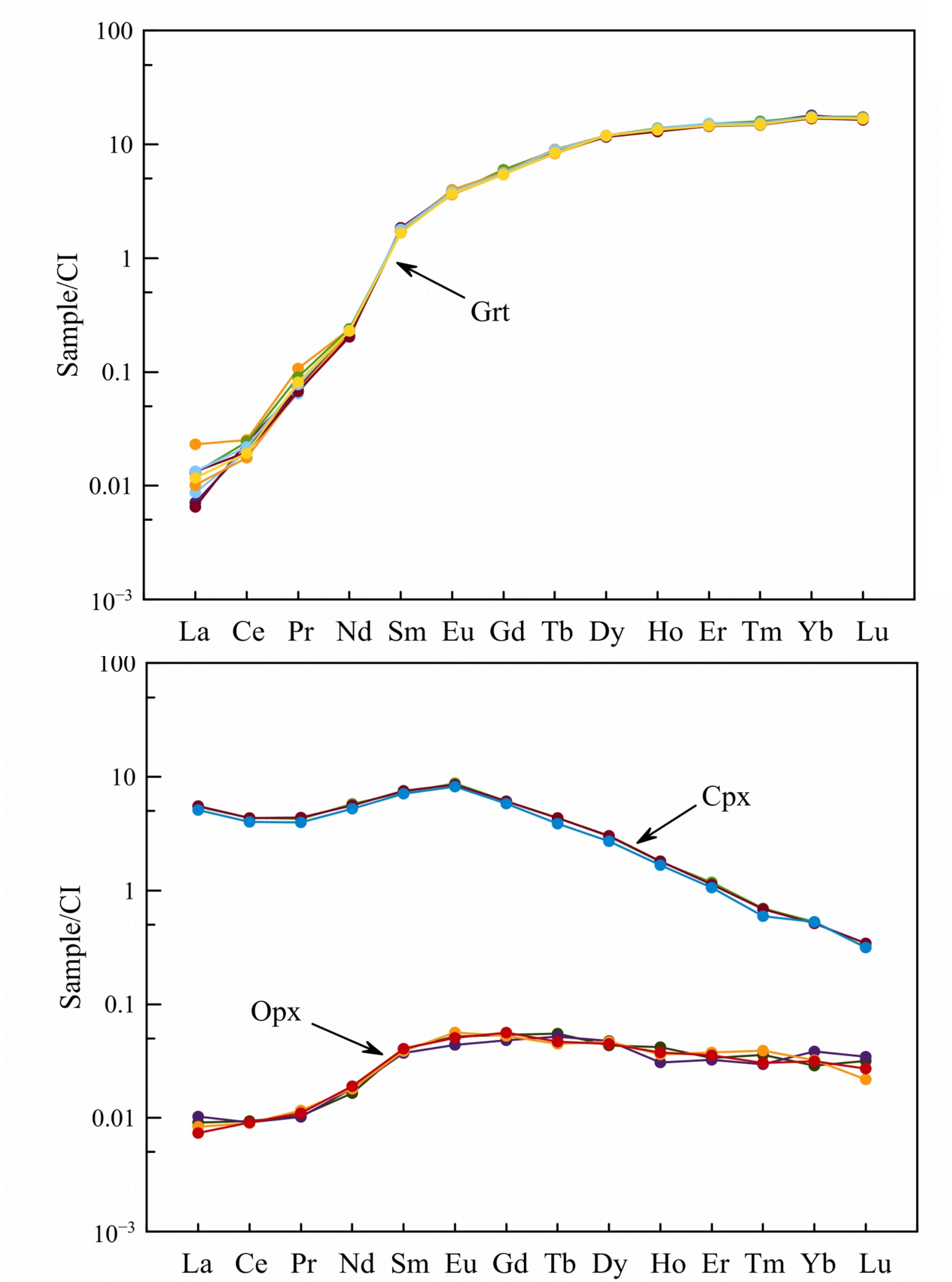
Garnet



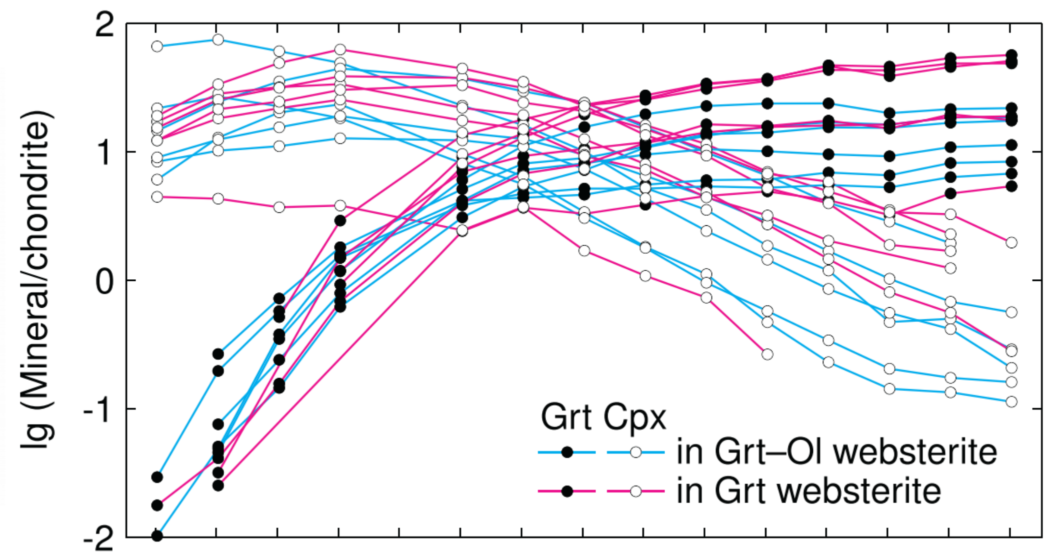
Green field — Obnazhennaya pyroxenite mantle xenoliths with exsolutions in silicates (Solovyeva et al., 1994; Kuligin, 1997; Taylor et al., 2003; Alifirova et al., 2012)

Grey field – peridotite and pyroxenite mantle rocks with exsolutions in Grt and Pyx worldwide (Haggerty & Sautter, 1990; Schmickler et al., 2004; Song et al., 2005; Spengler et al., 2006).

Rare earth elements in rock-forming silicates



REE abundances in Grt, Cpx & Opx normalised to C1 carbonaceous chondrite (Sun and McDonough, 1989).



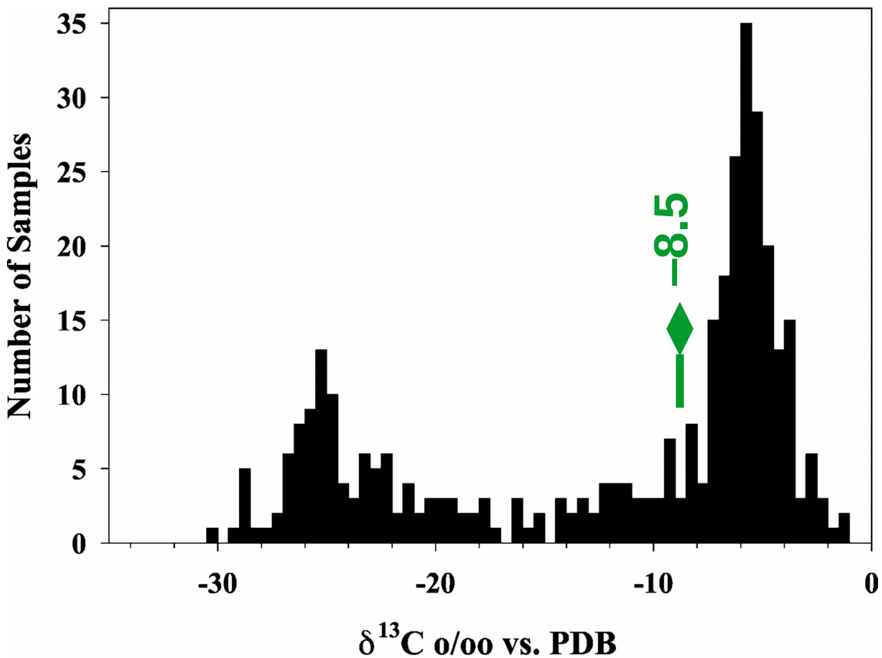
Mineral REE data for Grt-bearing websterites from Siberian craton. Figure is from Spengler & Alifirova (2019)

Graphite mineralogy and carbon isotope composition

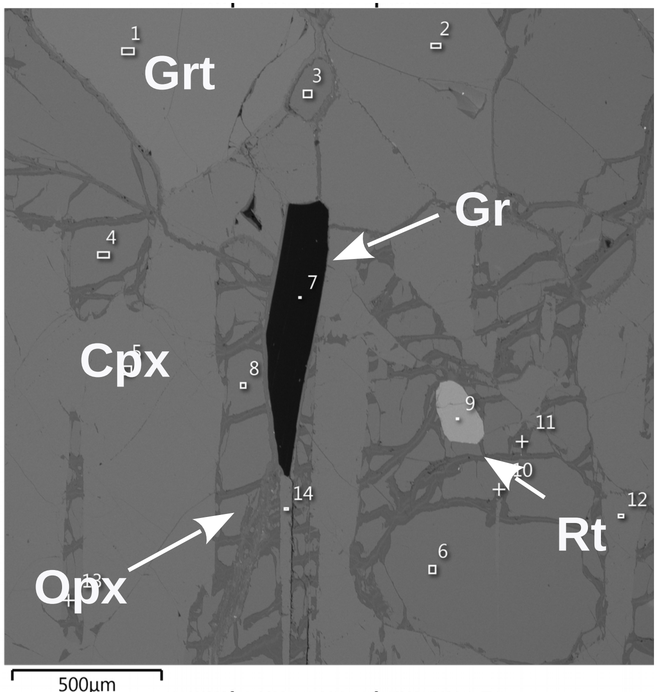
Graphite forms flattened hexagonal crystals
(up to 3 mm in size)
Association with Ti-oxides and Fe-Ni-sulfides

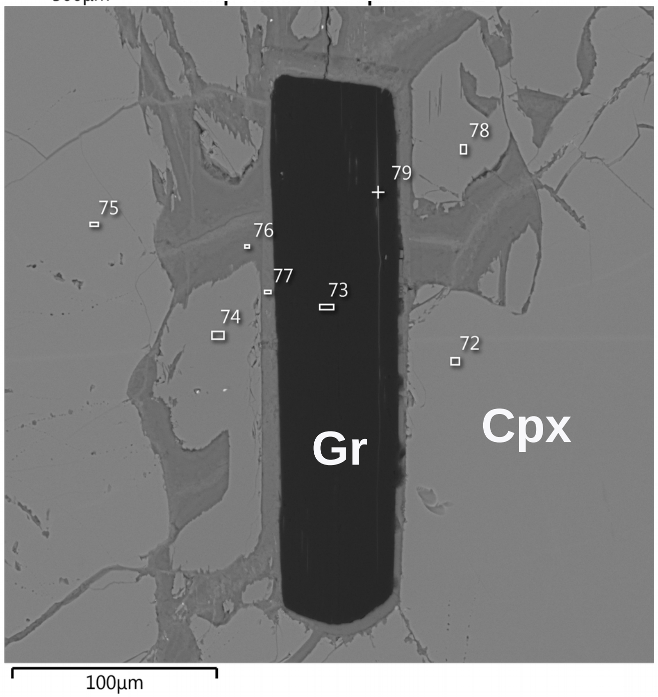
$\delta^{13}C$ –8.5 (‰ PDB)

«Mantle range» C isotopes & mantle source for carbon

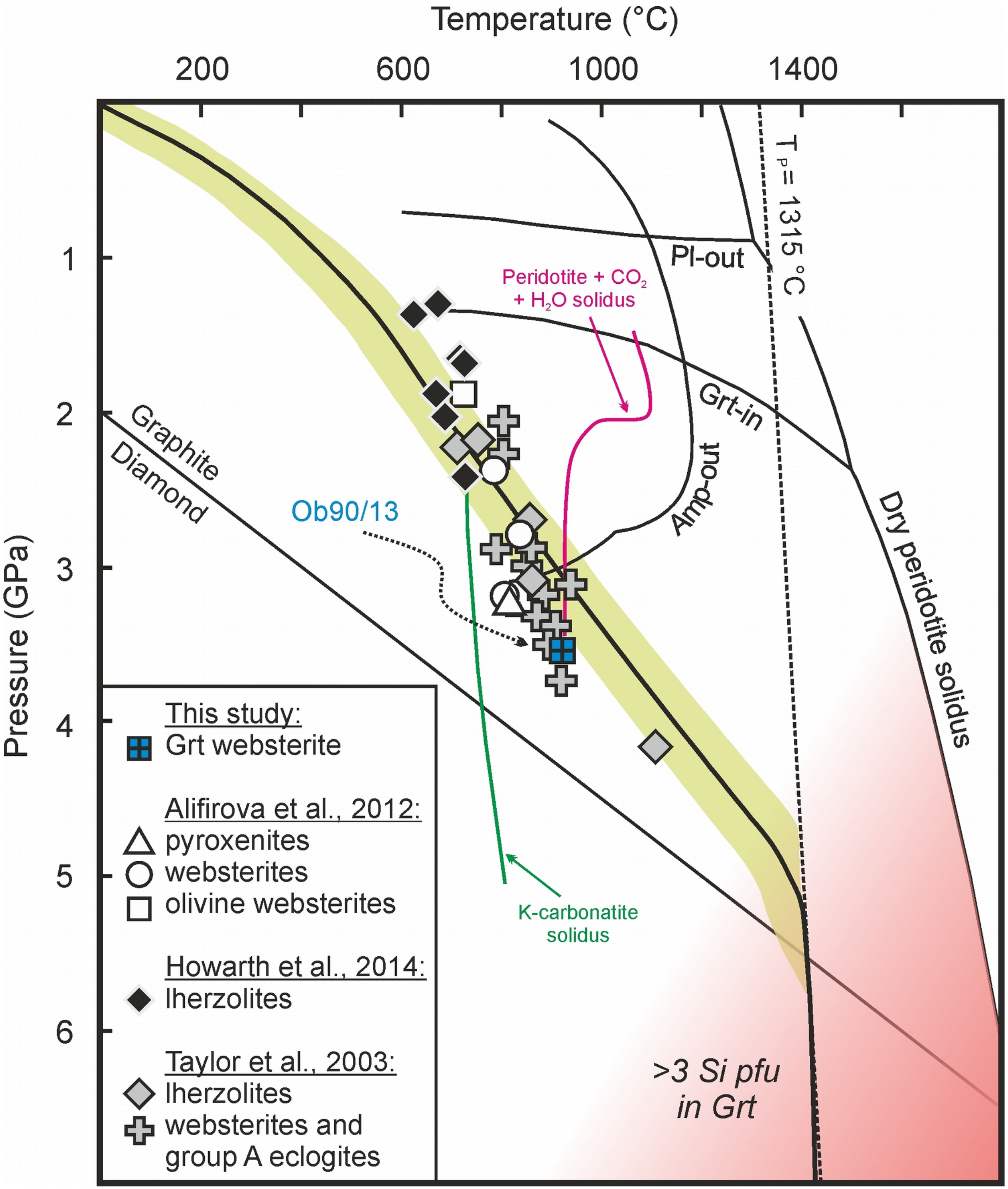


Summary of $\delta^{13}C$ of whole rock mantle xenoliths and separated minerals. Figure is from Deines (2002), the references to data are therein.





P–T estimates for Obnazhennaya mantle xenoliths



T = 910 °C, *P* = 3.5 GPa

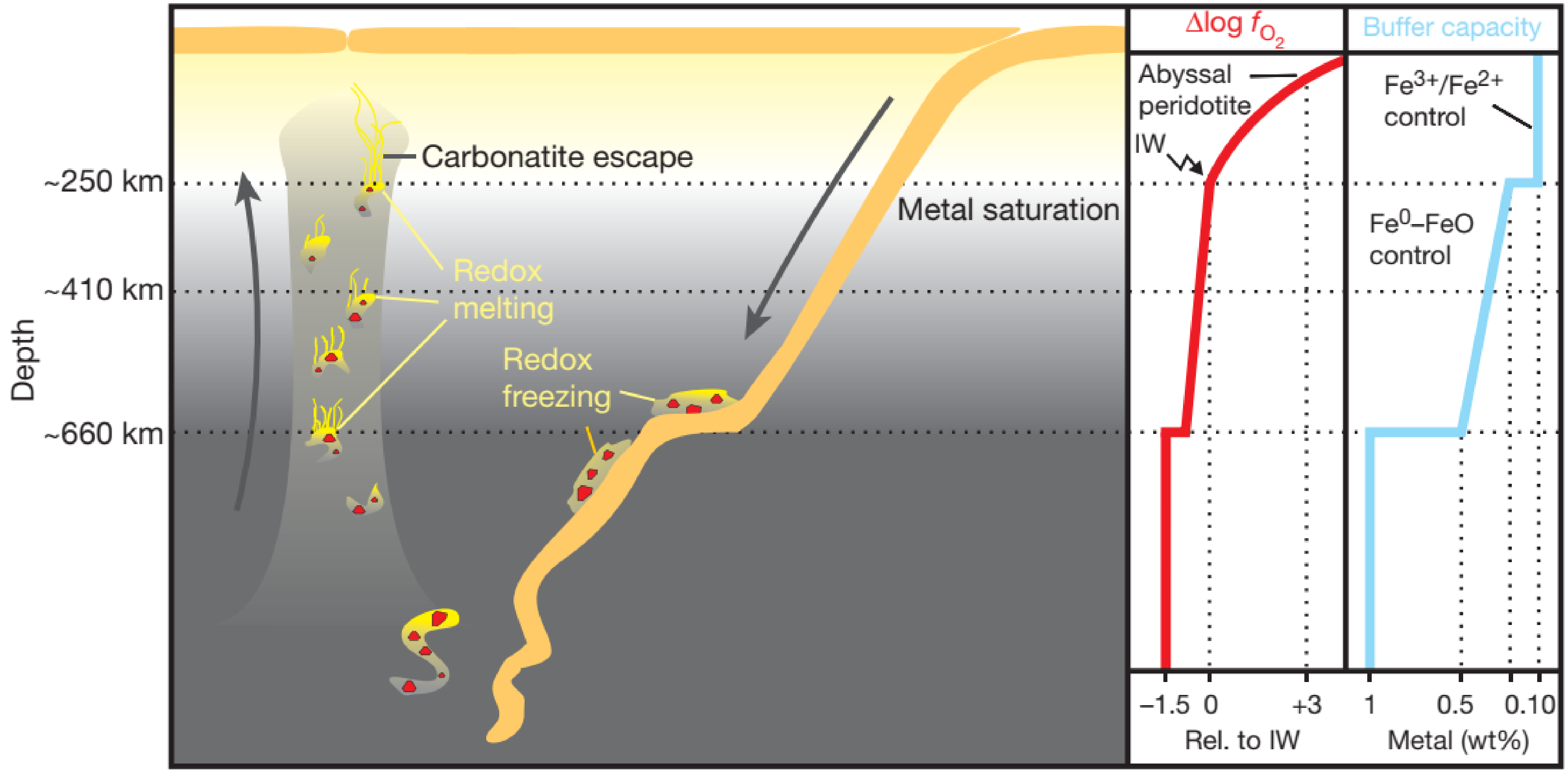
Geothermometer - Taylor (1998)
Geobarometer - Nickel & Green (1985)

Obnazhennaya geotherm, based on equations of McKenzie et al. (2005), is from Howarth et al. (2014).

Graphite-diamond transition line is after Kennedy & Kennedy (1976). Pargasite stability line is according to Niida & Green (1999). CMAS phase relationships are from Gasparik (2014). Isentope for T_P = 1315 °C is from McKenzie et al. (2005).

Solidi are from experiments:
Dry peridotite solidus (Gudfinnsson, Presnall, 1996).
Solidus in alkali-bearing peridotite + CO_2 + H_2O system (Wallace, Green, 1988).
K-carbonatite solidus (Litasov et al. 2013).

A possible sequence of redox freezing and redox melting events driven by oxidation state contrasts



Carbonatitic redox freezing and redox melting caused by redox capacity changes in Earth's mantle. Figure is from Rohrbach & Schmidt (2011)

Concluding remarks

• High-T Mg-rich magmas (similar to AEK komatiites) from which garnet websterite is supposed to crystallize had a deep Grt-bearing depleted mantle source with low oxygen fugacity.

• Subsequent metasomatism of the reduced websterite by oxidising C-O-H fluids caused graphite precipitation through redox freezing.

Thank you for watching display!