Xenolith-based thermal and compositional lithospheric mantle profile of the central Siberian craton

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EGU22-13175

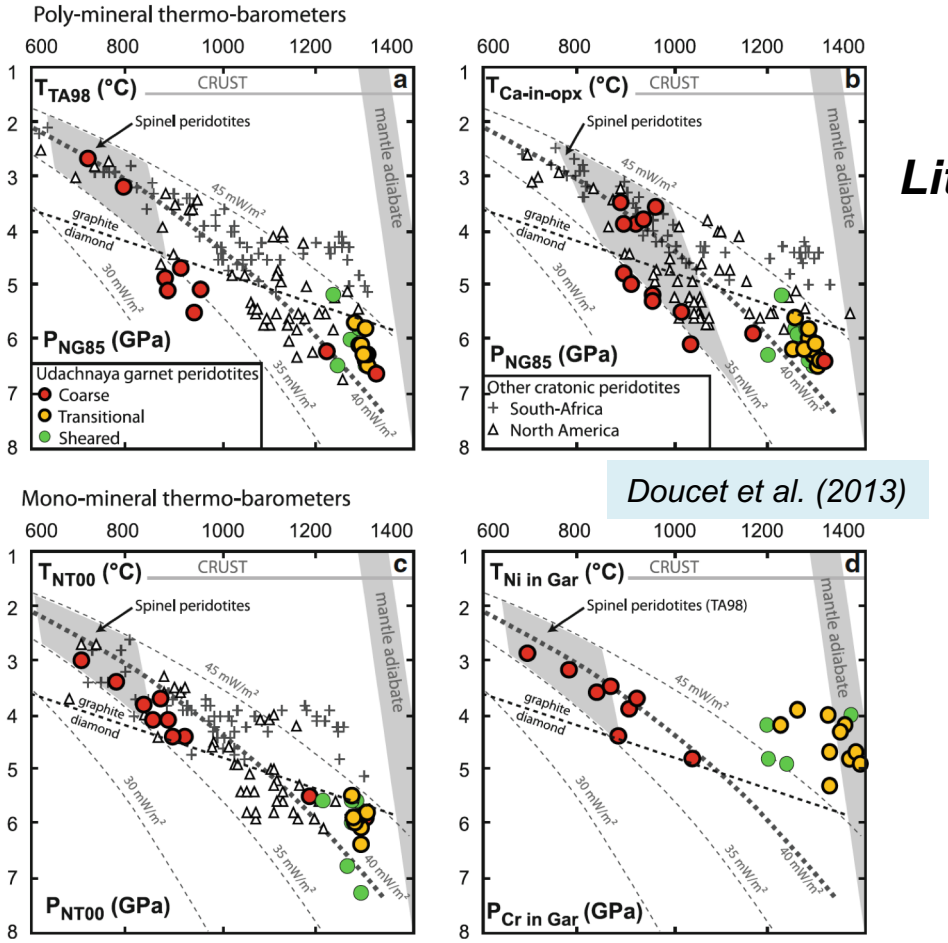
Geology (26 April, 2022): https://doi.org/10.1130/G49947.1

Current knowledge on cratonic lithospheric mantle (CLM)

1. Upper CLM: “cold” coarse harzburgites, lower CLM: “hot” sheared rocks

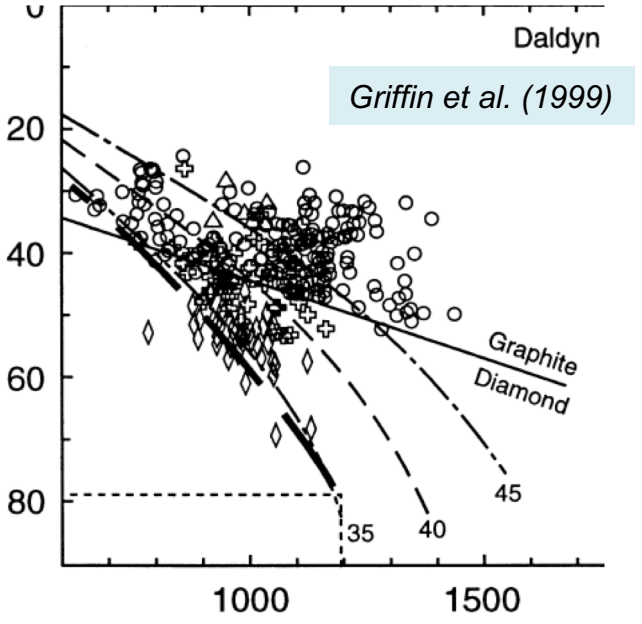
2. Detailed distribution of temperature (T) and rock types in the 150-200 km thick CLM remain uncertain

3. Problems: (a) insufficient sampling; (b) P-T uncertainties *(methods, data quality)*



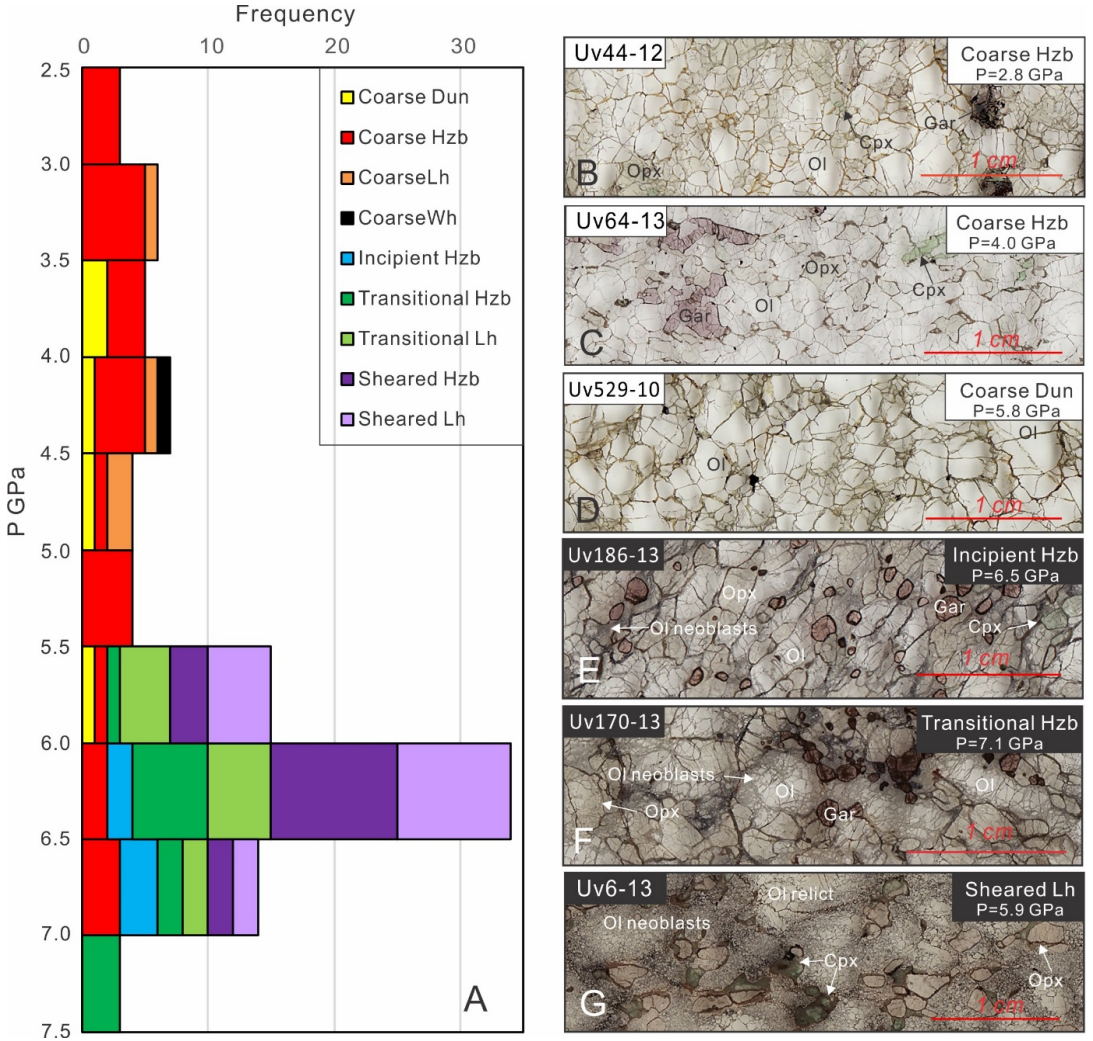
Doucet et al. (2013)

Literature P-T for the Siberian craton



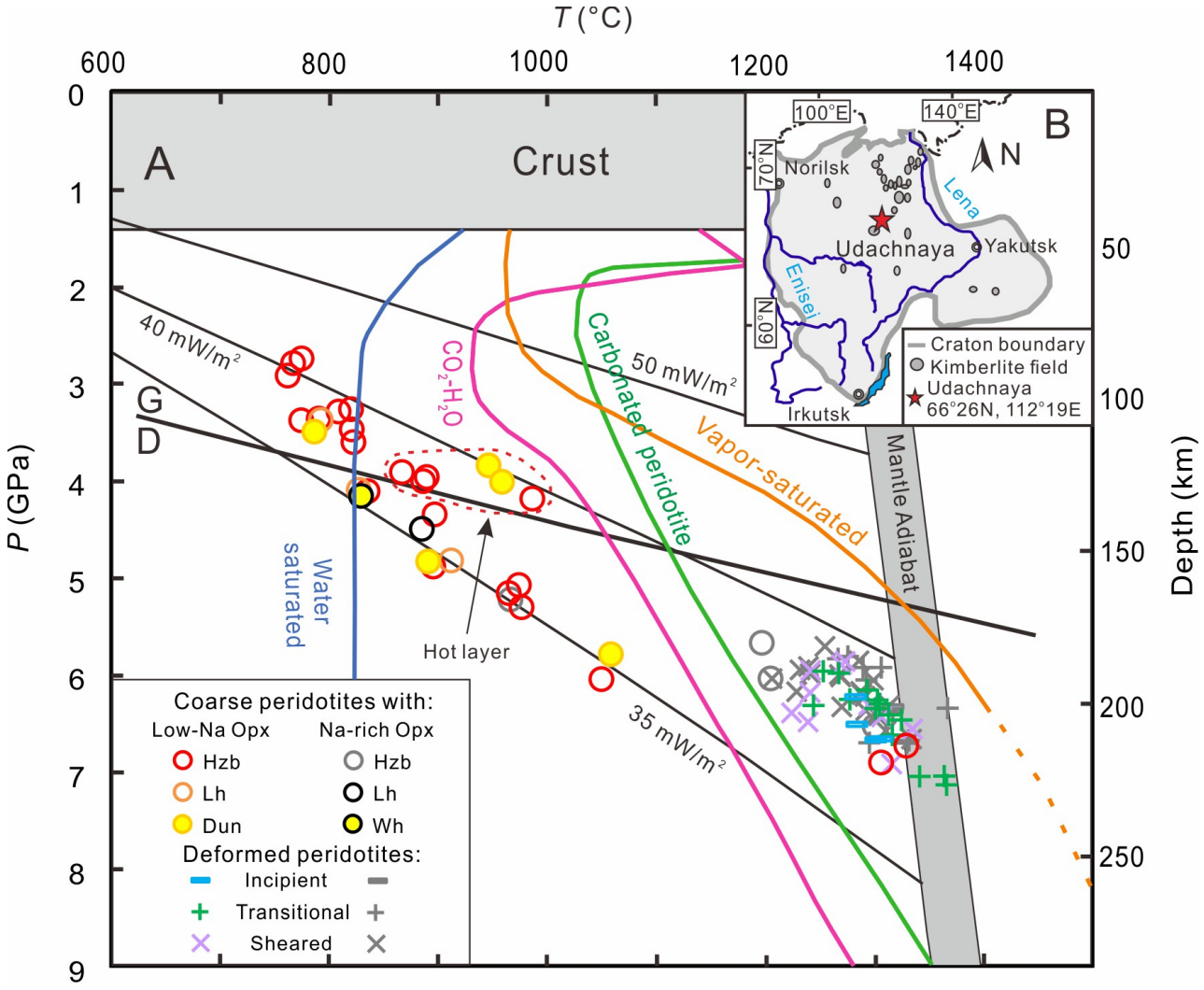
This study - exceptionally detailed

- 200 garnet peridotite xenoliths (Lh, Hzb, Dun, Wh; coarse to sheared)
- Robust P-T data for 92 xenoliths from precise EPMA (Na, Cr, Ca,…)
- Modal estimates, detailed petrography

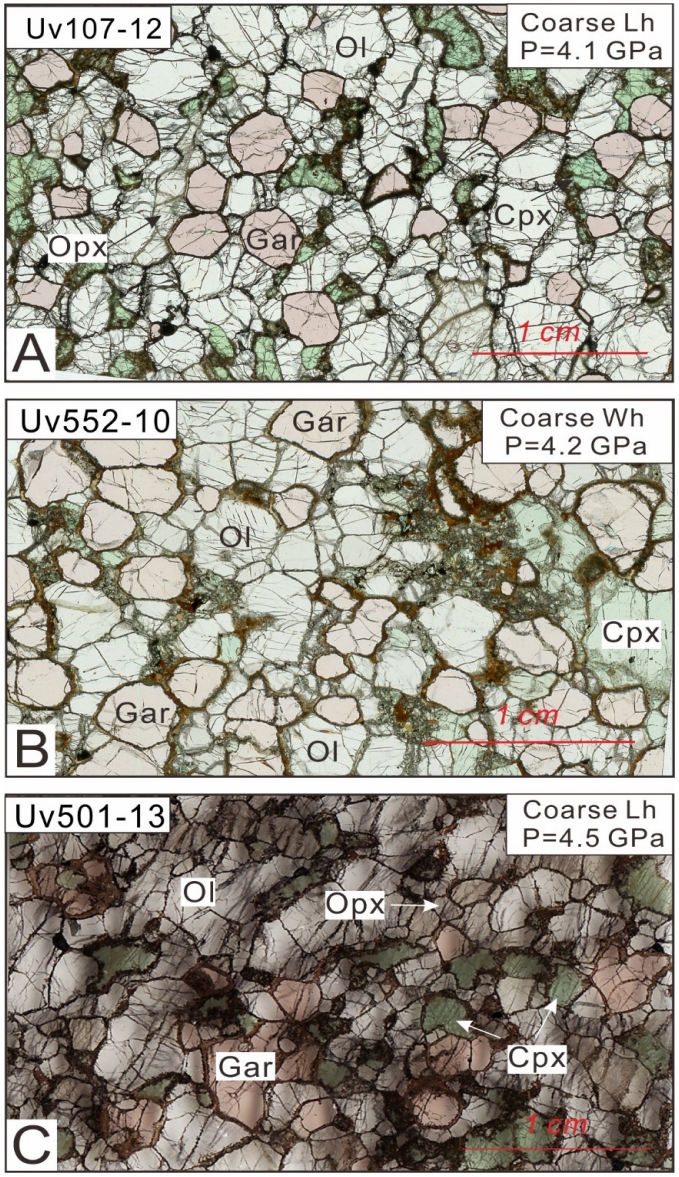


Thermal profile:

- **Complex** with samples between 35 and 40 mW/m^2 model conductive geotherms
- **Hotter layers in the middle** and at the base (190–230 km) of the CLM
- Both deformed and coarse rocks at the bottom

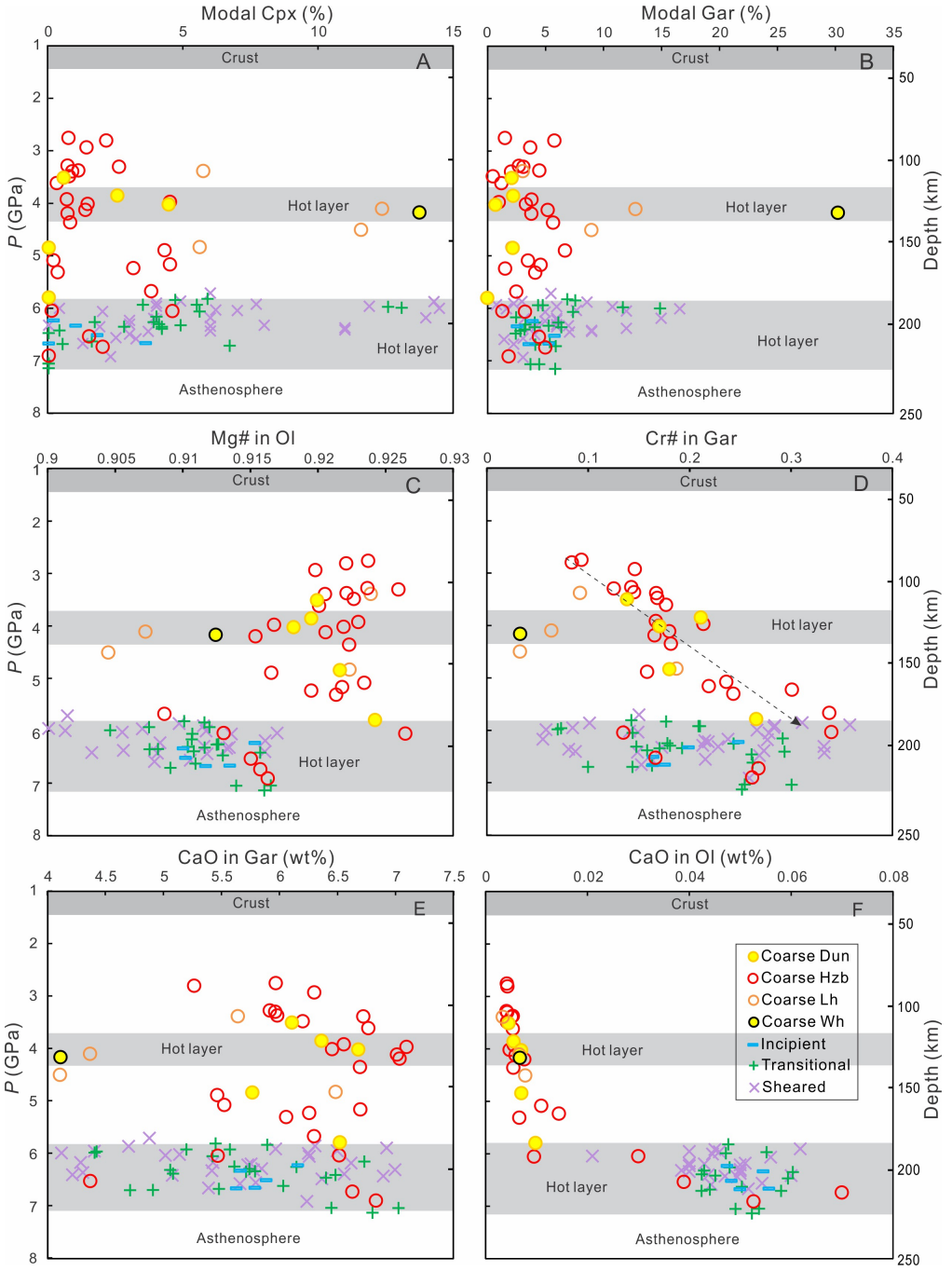


A previously unknown *mid-lithosphere* hot zone (up to 150° hotter than ambient geotherm), with **high modal garnet and cpx**, low-Mg# and melt-equilibrated REE patterns.

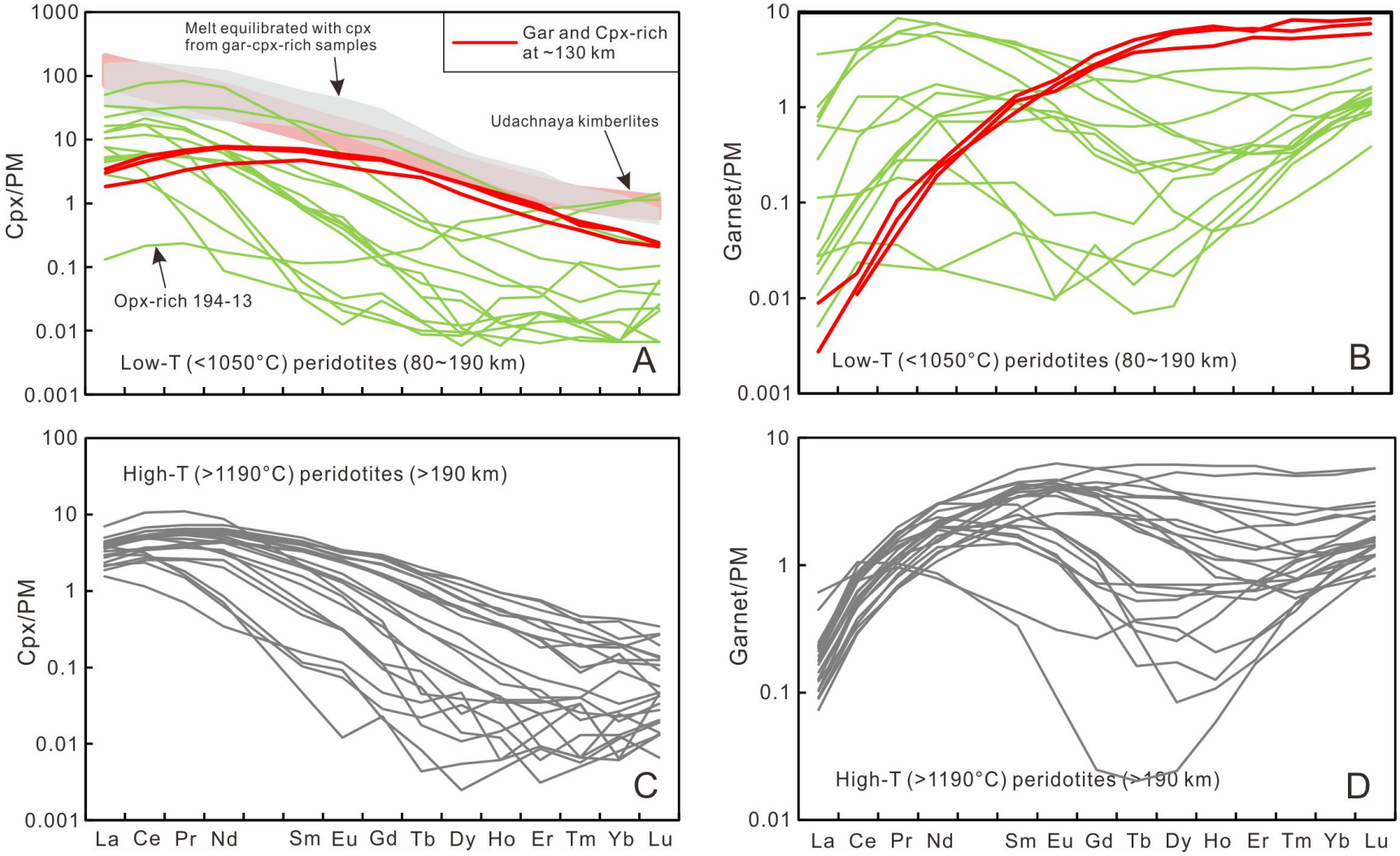


The mid-lithosphere layer, summary:

- high T
- rich in Gar and Cpx
- common low Mg#, Cr#
- high CaO in Gar
- melt-equilibrated REE

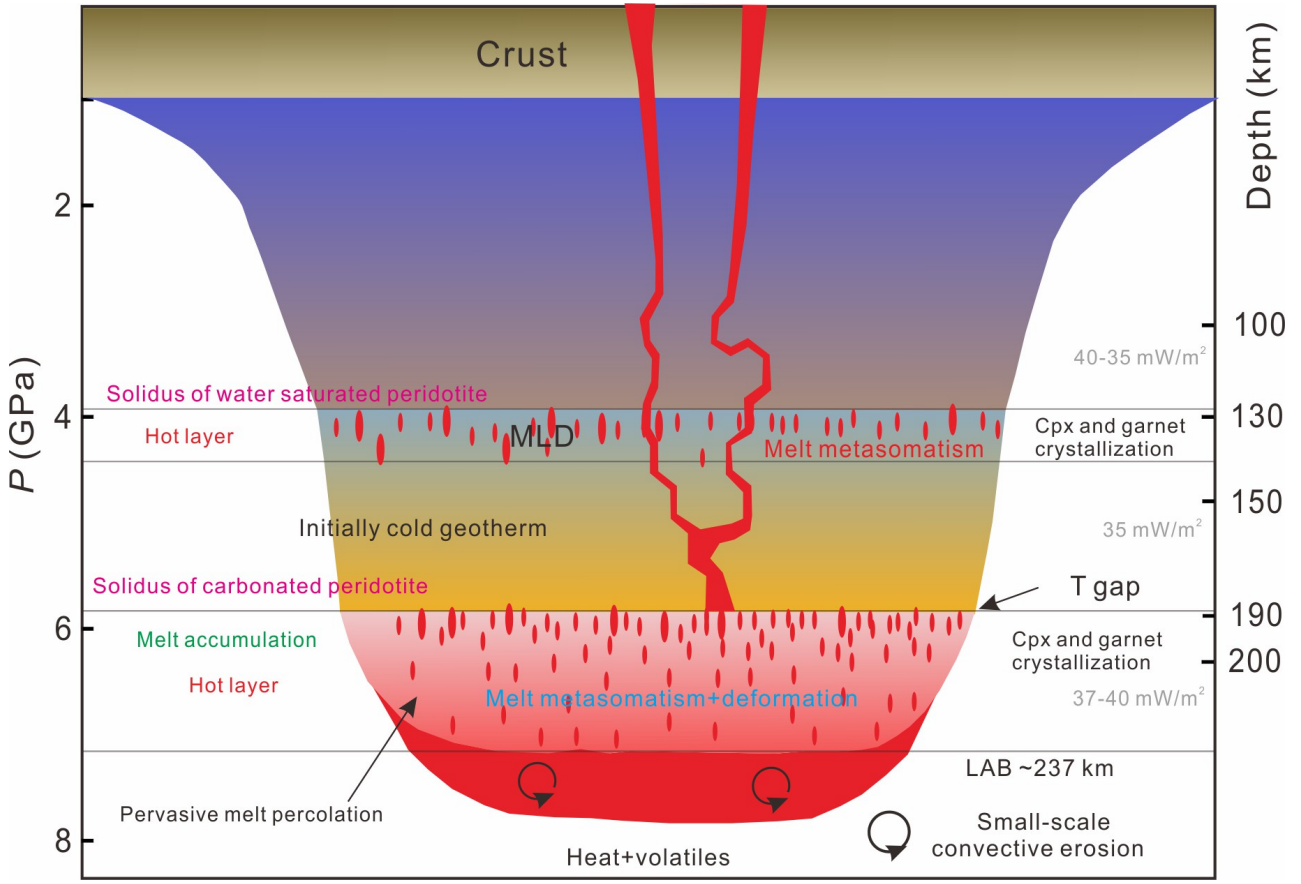


REE patterns in garnet and cpx from the MDL (red) suggest equilibration with silicate melts, unlike LREE-enriched, fluid-metasomatized coarse peridotites (green, gray)



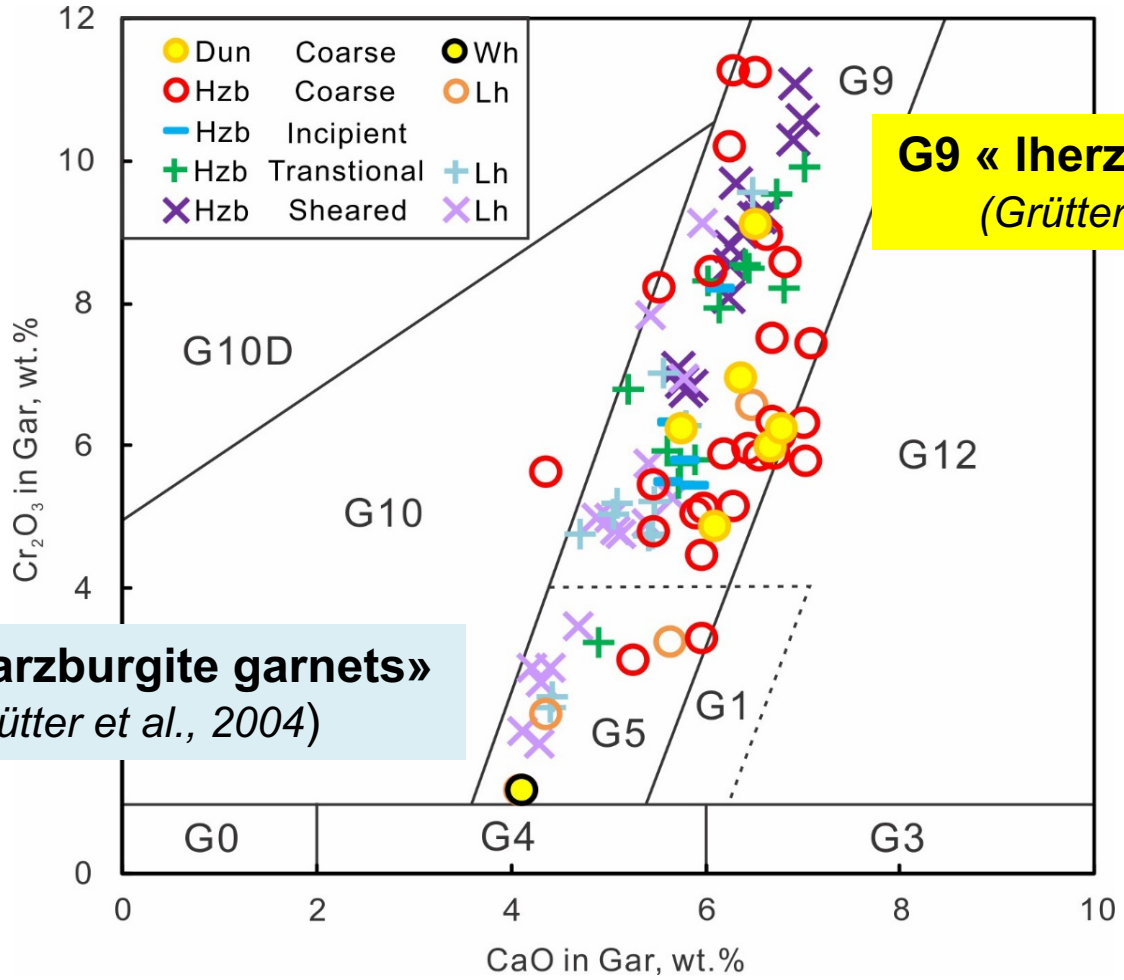
Conclusions:

- Hot, enriched domains form in mid-lithosphere CLM where ascending melts stall (due to loss of volatiles and/or redox change) and react with wall-rocks
- Could explain **seismic Mid-Lithosphere Discontinuities (MLD's) ?**
- No rocks rich in volatile-rich metasomatic amphibole, mica or carbonate
- No layers composed of peridotites with distinct melt-extraction degrees



Distribution of rock types in CLM profile cannot be inferred from data on garnets extracted from kimberlites

- Data on Udachnaya peridotites from this study and literature plotted in the classification plot for mantle-derived garnet based on its CaO vs. Cr2O3 relations (Grütter et al., 2004: G1, megacryst; G3, eclogite; G4 and G5, pyroxenites; G9, lherzolite; G10 and G10D, harzburgites; G12, wehrlite.
- Nearly all garnets fall into G9 (lherzolite) and G5 (pyroxenite) fields whereas the majority of the xenoliths are harzburgites and dunites from modal data. Hence, the classification is not suitable for identification of rock type sources of garnets extracted from kimberlites for the Siberian craton (Griffin et al., 1999), and likely elsewhere.



G9 « lherzolite garnets»
(Grütter et al., 2004)

G10 « harzburgite garnets»
(Grütter et al., 2004)