Subducted Carbon in the Earth's lower mantle: The fate of magnesite

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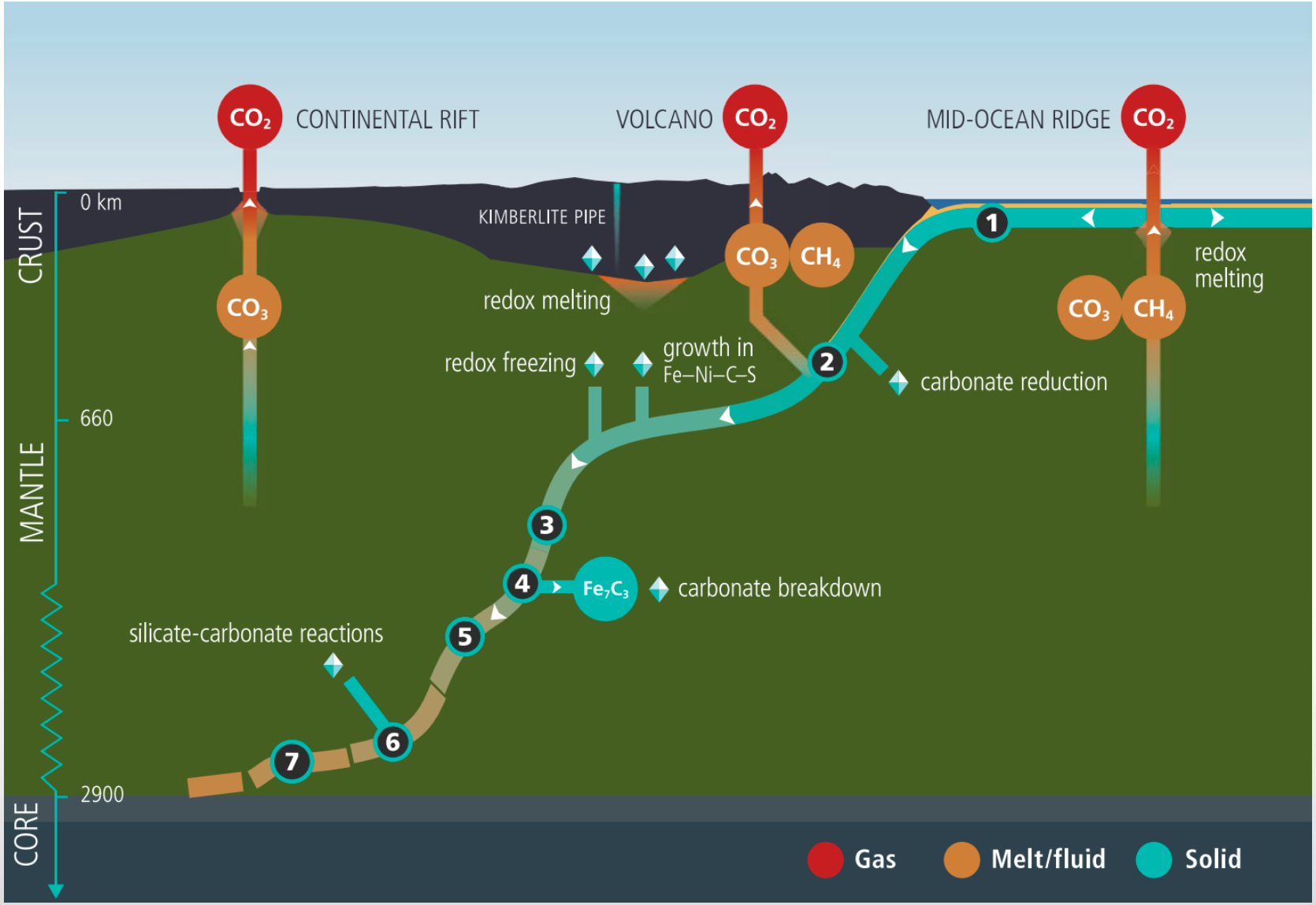
Transport of Carbon in the deep Earth

- **Subducted slabs** could be the source of carbon in the deep mantle.



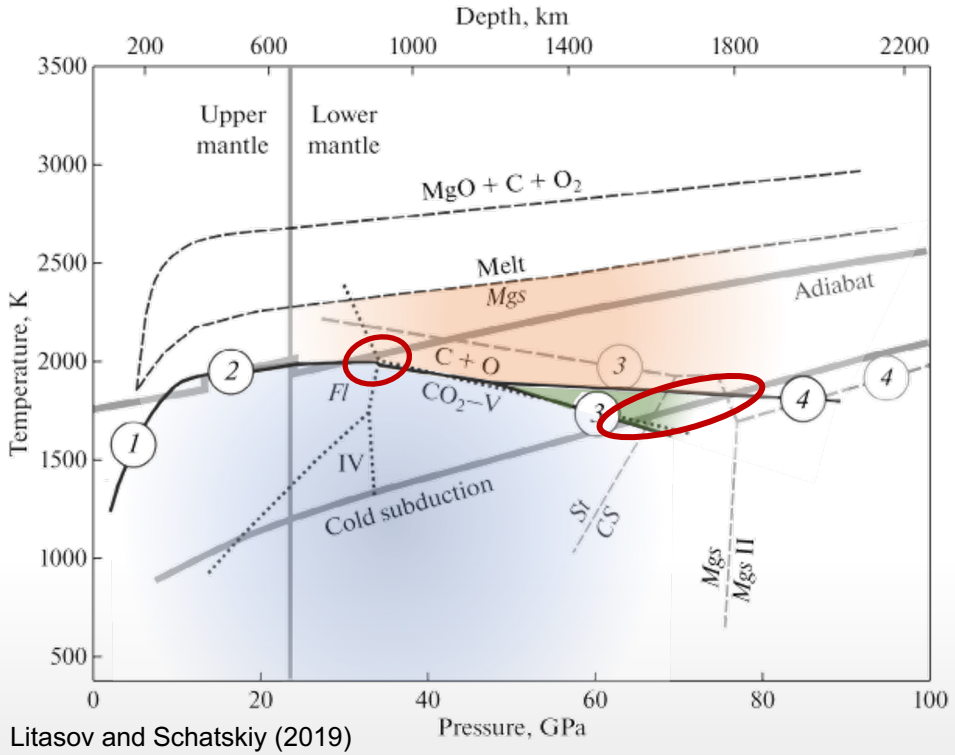
Stagno et al. (2019)

The fate of subducted magnesite in the lower mantle

- **Decomposition**: Carbonate reduction producing diamond.

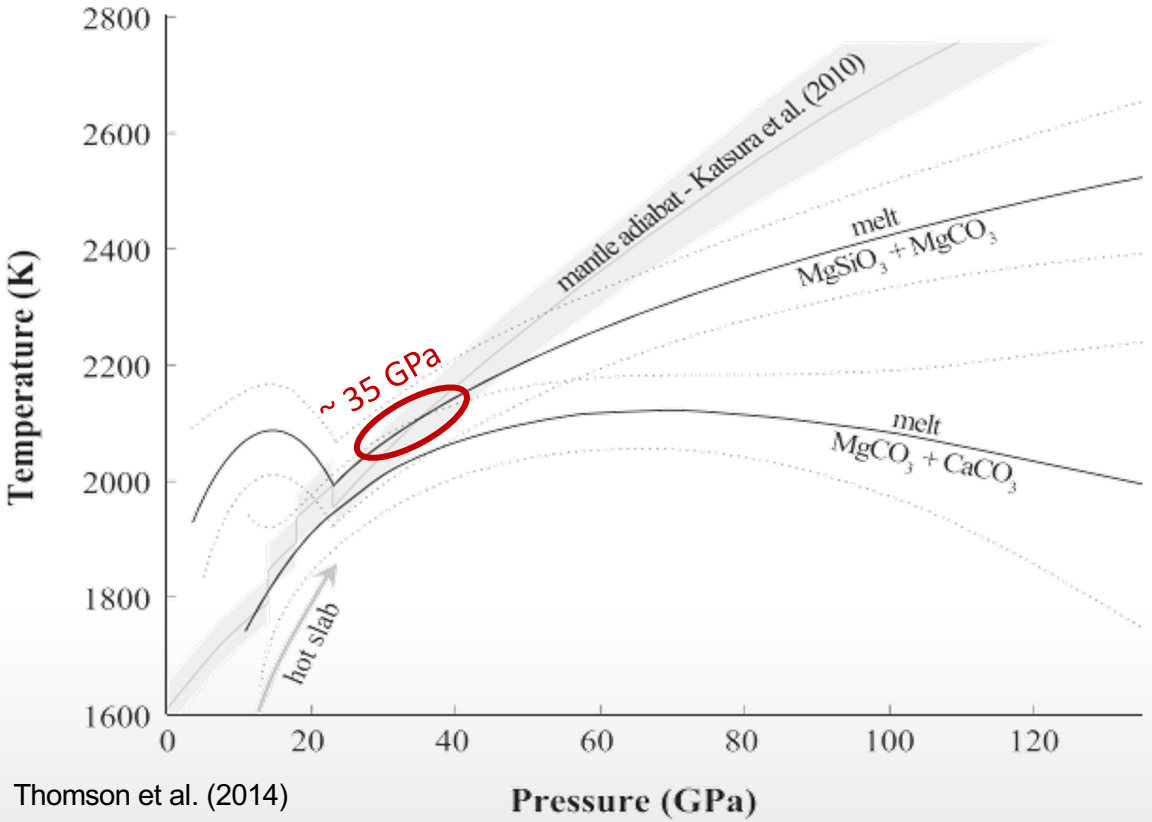
$SiO_2 + MgCO_3 \rightarrow MgSiO_3 + C + O_2$ or $MgSiO_3 + CO_2$

Litasov and Shatskiy (2019) ; Drewitt (2019) ; Maeda (2017) & Seto (2008)



Litasov and Schatskiy (2019)

- **Melting**: The $MgCO_3 + MgSiO_3$ (iron free) system.

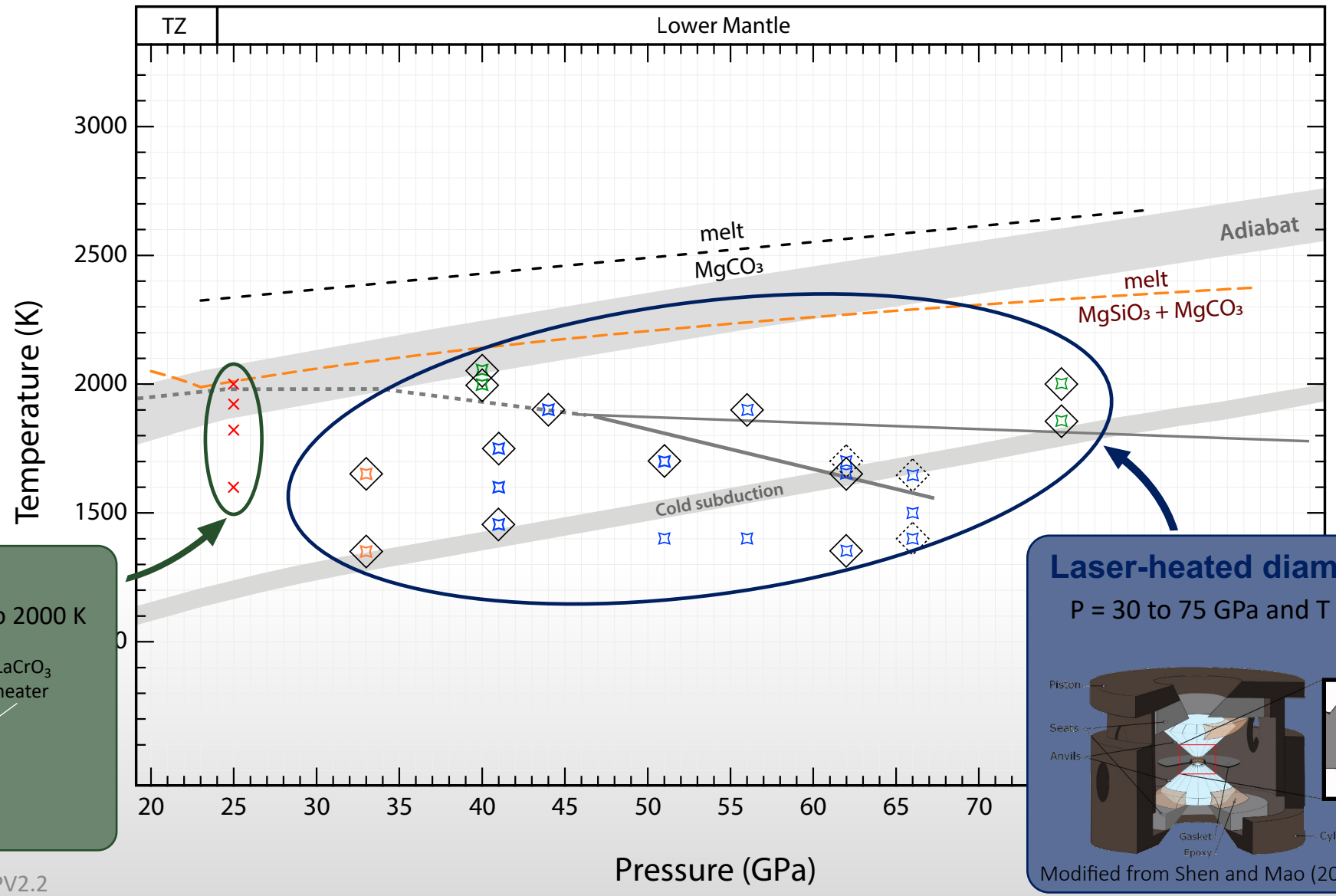


Thomson et al. (2014)

The fate of subducted magnesite depends on its **interaction with the lower mantle major phases: Bridgmanite - $(Mg,Fe)SiO_3$.**

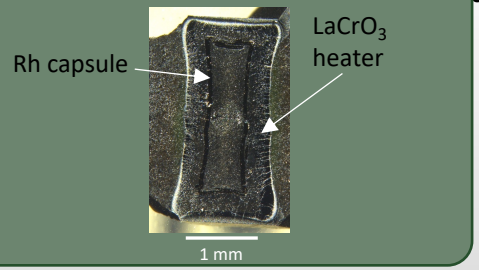
Magnesite's stability in the lower mantle

Starting composition: $MgCO_3$ + (MgFe)SiO_3-glass or $MgCO_3$ + (MgFe)SiO_4



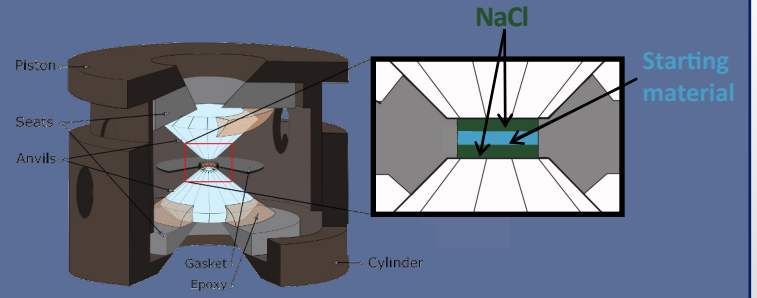
Multi-anvil exp.

P = 25 GPa and T = 1600 to 2000 K



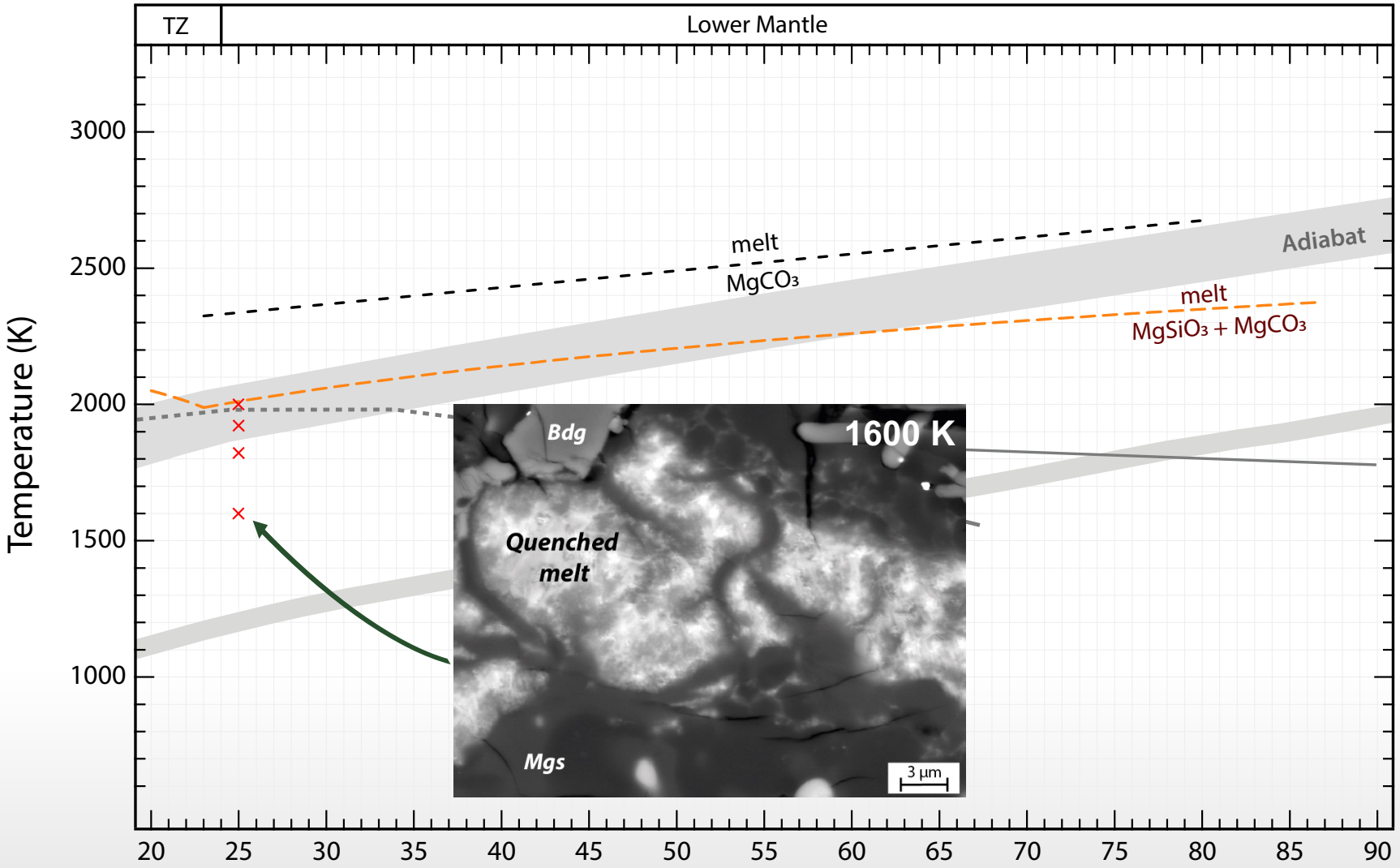
Laser-heated diamond anvil cells

P = 30 to 75 GPa and T = 1300 to 2100 K



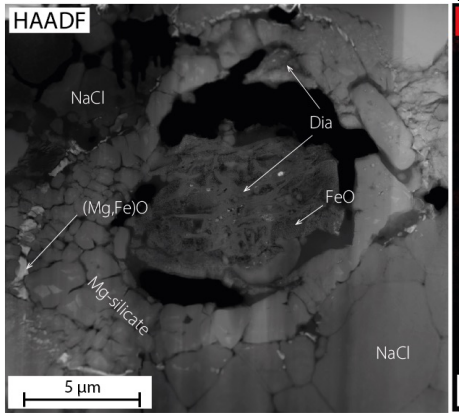
Modified from Shen and Mao (2017)

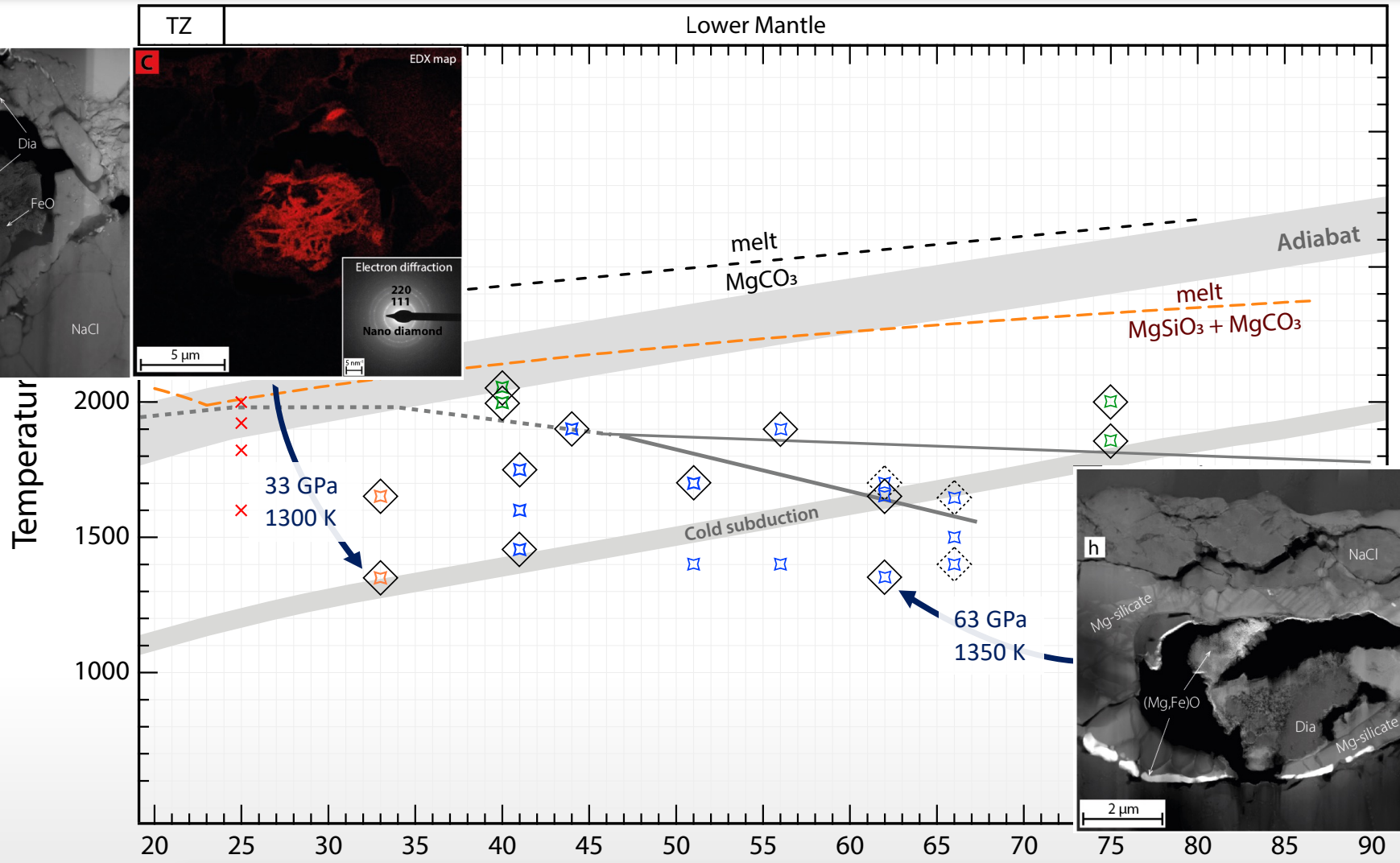
Results – Multi anvil experiments

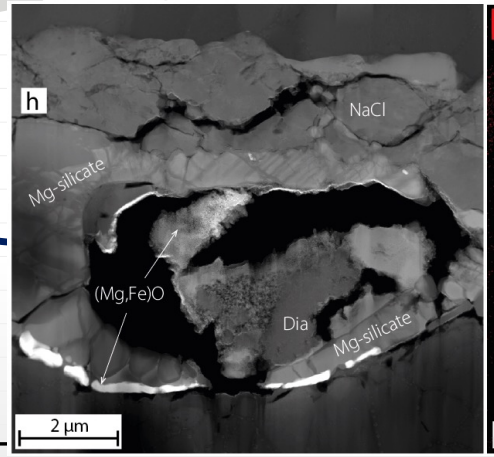


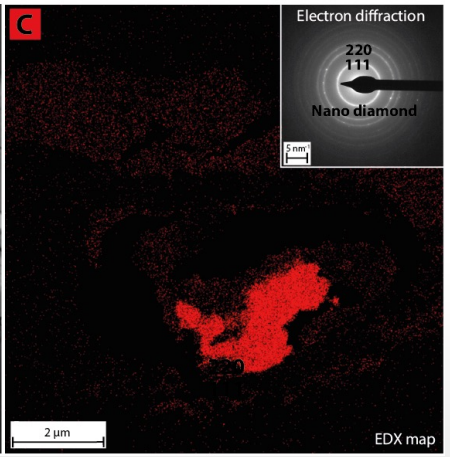
Presence of quenched melt in all experiments and at **temperatures that are below the mantle geotherm.**

Results – Laser heated diamond anvil cells





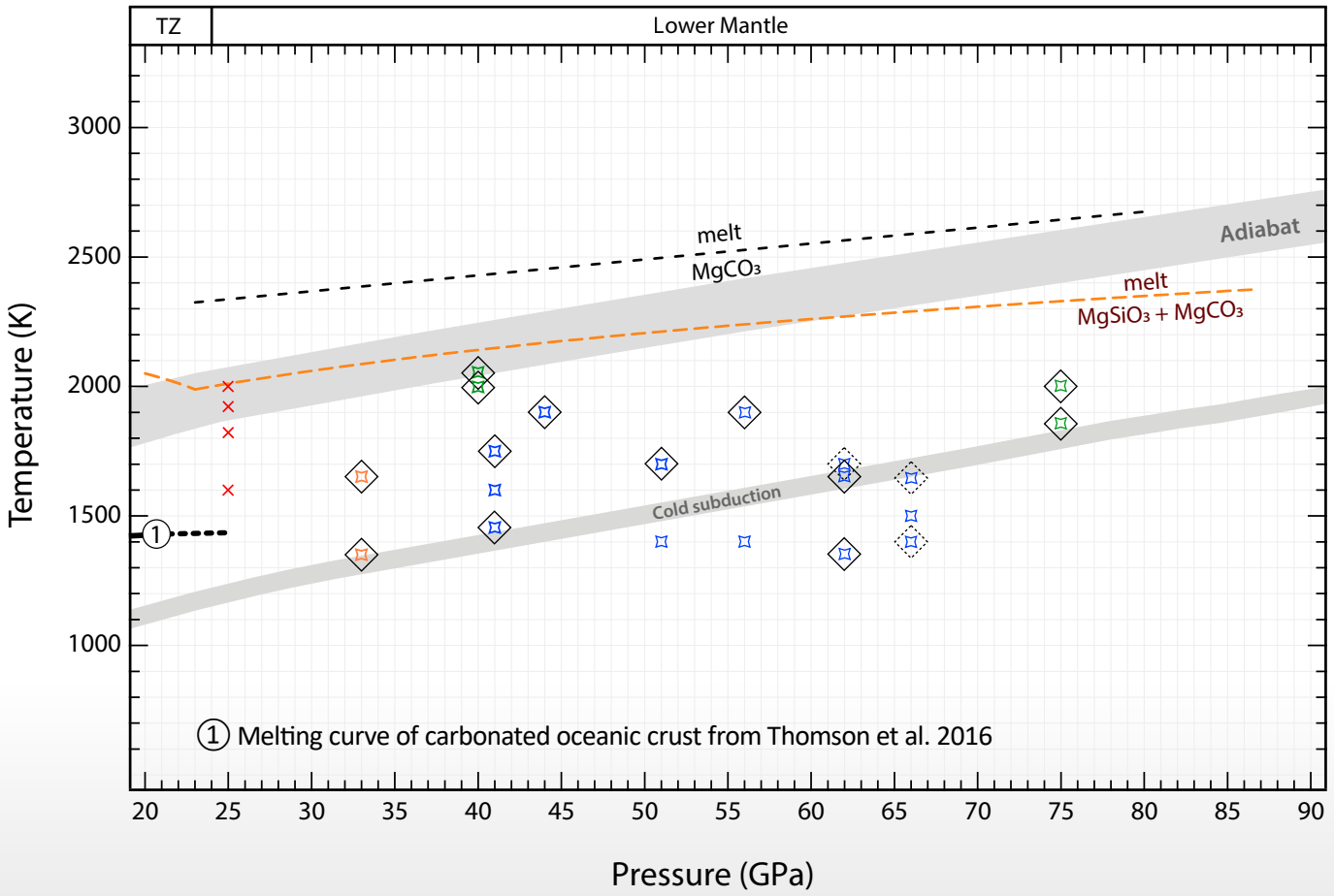




Diamond formation from magnesite decomposition associated or not with melting :

$(Mg,Fe)SiO_3 + MgCO_3 \rightarrow (Mg,Fe)SiO_3 + SiO_2 + \mathbf{C} + (Mg,Fe)O + (\ CO_2$ rich-melt ?)

Take home message



Magnesite **is not stable** in the earth's lower mantle even along cold subduction geotherms:

- it will induce melting under oxidized conditions

or

- foster diamond formation under more reduced conditions.

What does this tell us about the deep carbon cycle ?

Multi-disciplinary studies:

1. Support a barrier to carbon subduction above the lower mantle

2. Show from the isotopic composition of inclusion in ‘superdeep’ diamonds that they crystallized from melting of the carbonated slab.

Regier et al. (2020) ; Thomson et al. (2016) ; Li, X. et al. (2018) ; Kiseeva et al. (2013)

Our study:

Provides experimental evidences that the recycling of magnesite contained in slab:

- can be at the origin of ’superdeep’ diamonds
- will limit carbonate transport deeper into the Earth’s lower mantle, **even if carried in a cold subducting slab**.

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