Polycrystalline and Intracrystalline Growth of Akimotoite in a Clinoenstatite in the L-6 Tenham Chondrite

T. Ferroir, P. Beck, Ph. Gillet, A. Simionovici, L. Dubrovinsky, M. Bohn, A. El Goresy

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École normale supérieure de Lyon
46, Allée d'Italie, 69364 Lyon cedex 07 - Tél.: +33 (0)4 72 72 80 00 - Fax: +33 (0)4 72 72 80 80
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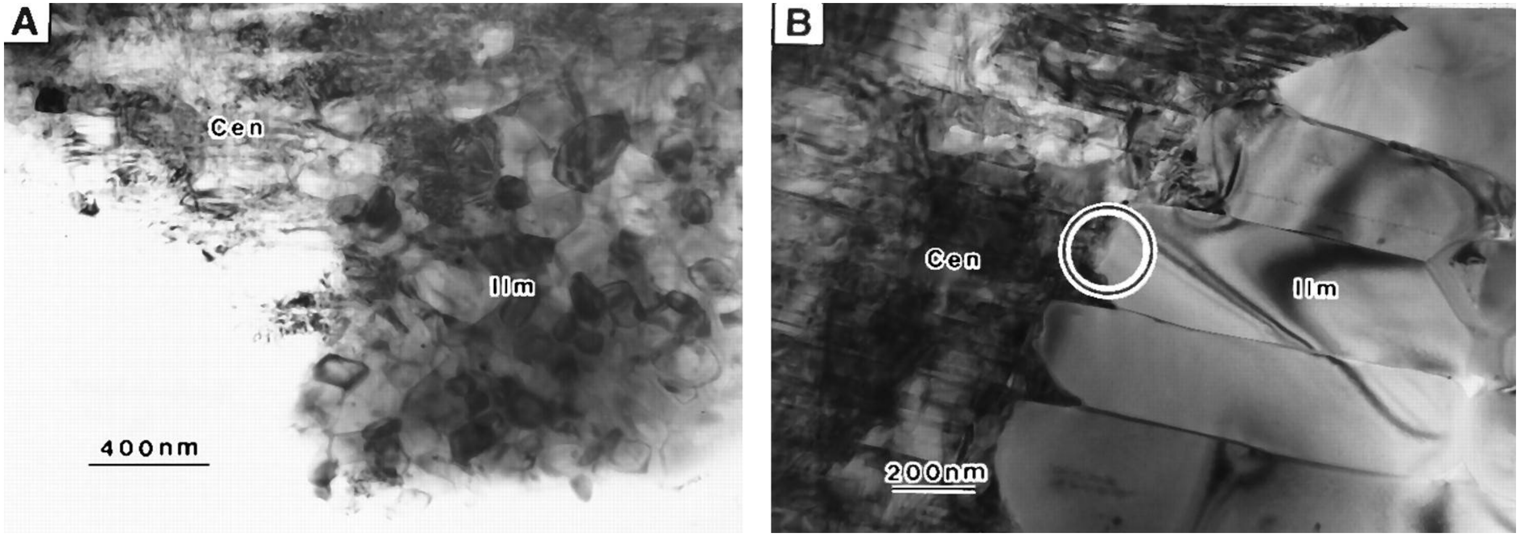
Introduction

- Akimotoite is a major constituant of the transition zone of the mantle
- Akimotoite has been reported by Sharp et al. and Tomioka et al. in shocked meteorite



Tomioka et al., *Science*, 1997

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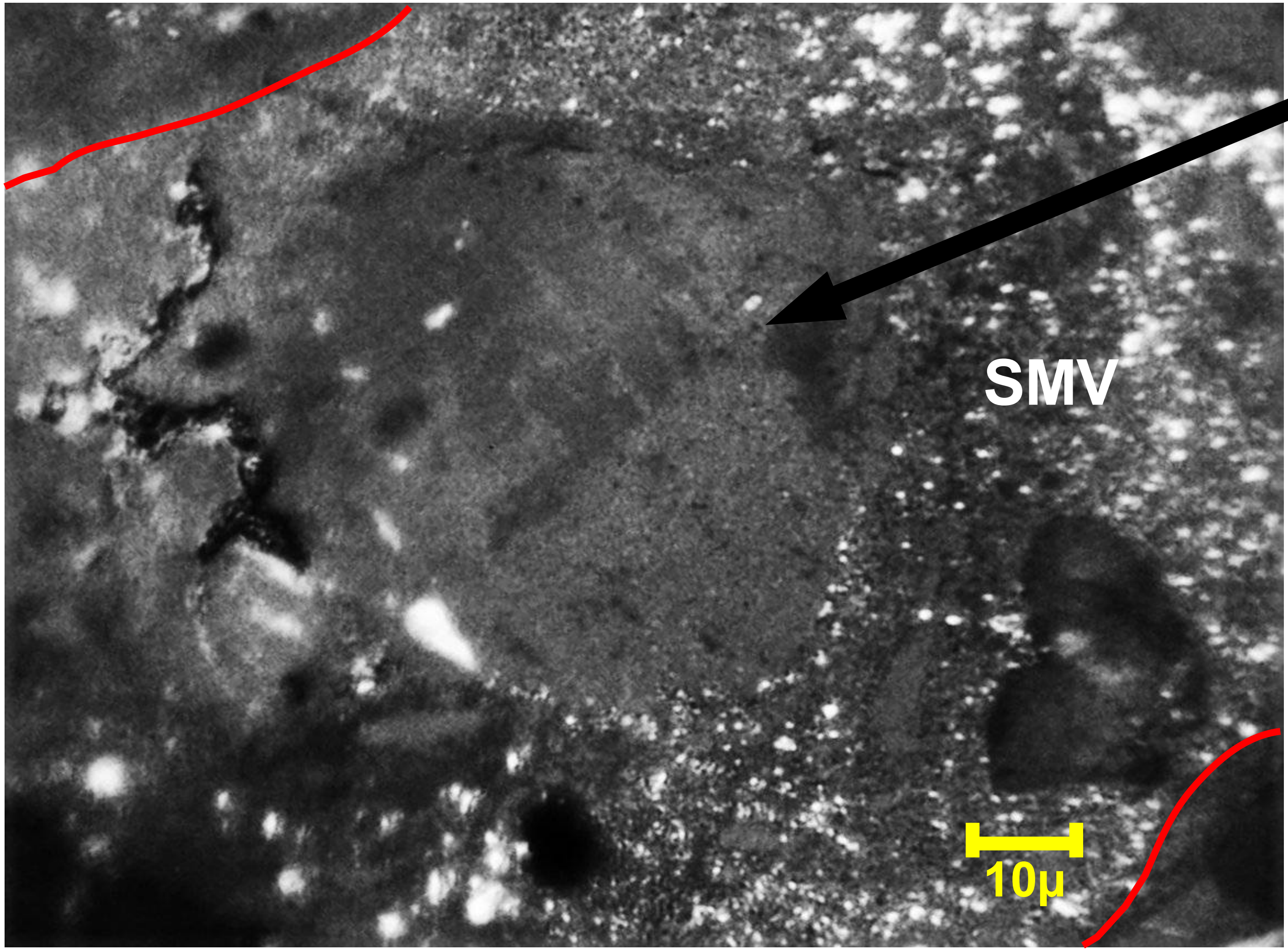
Introduction

- Stability of the subducting lithosphere is mainly calculated based on olivine polymorphs
- Hogrefe et al. (*Nature*, 1994) reported that enstatite-ilmenite transformation is slower than olivine-wadsleyite-ringwoodite

- Kinetics and mechanism of enstatite-ilmenite transformation is of great interest to discuss subduction dynamics

Reflected light observation



- Clinoenstatite grain entrained in a shock melt vein (SMV)
- Grain close to a vein wall

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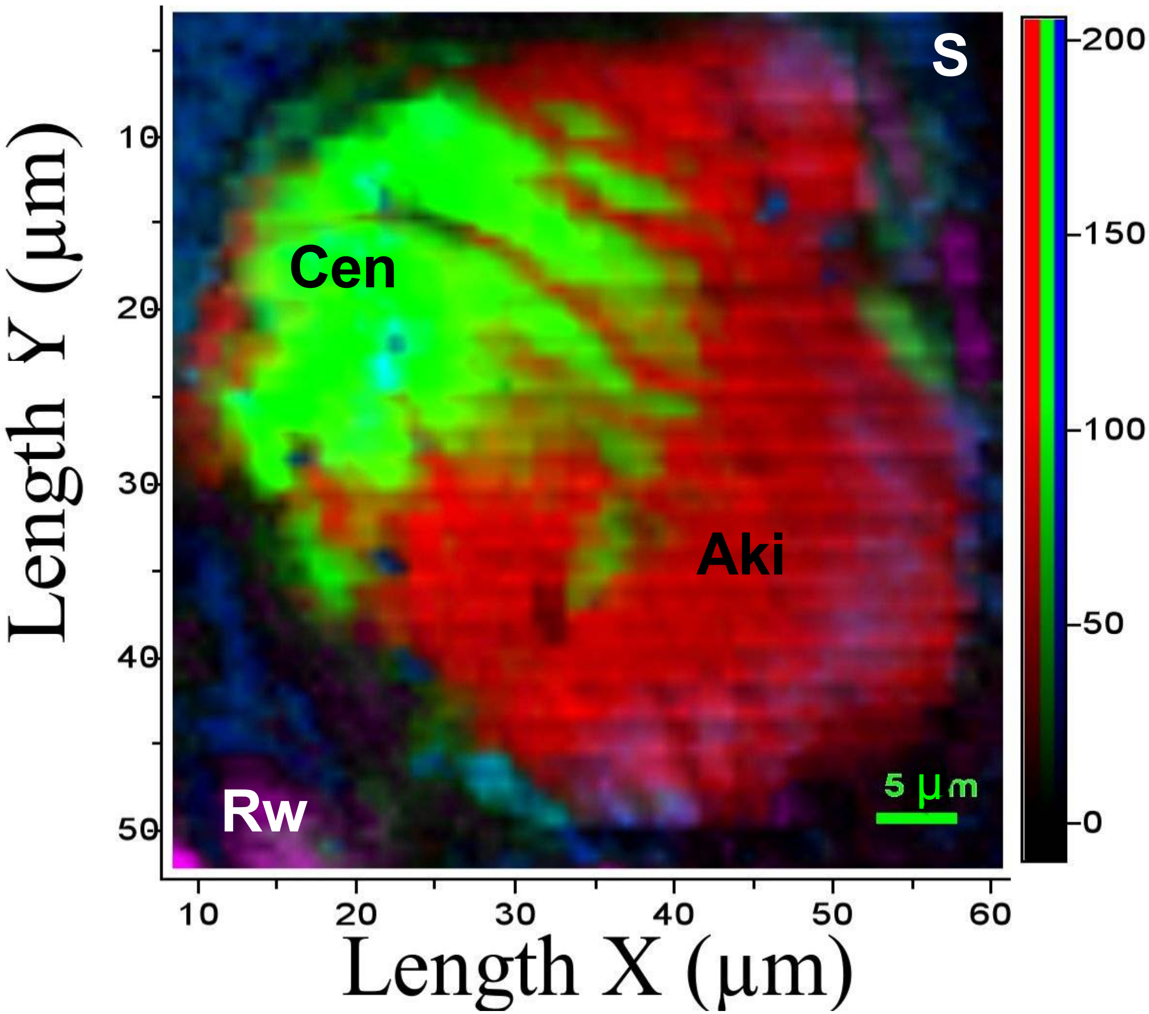
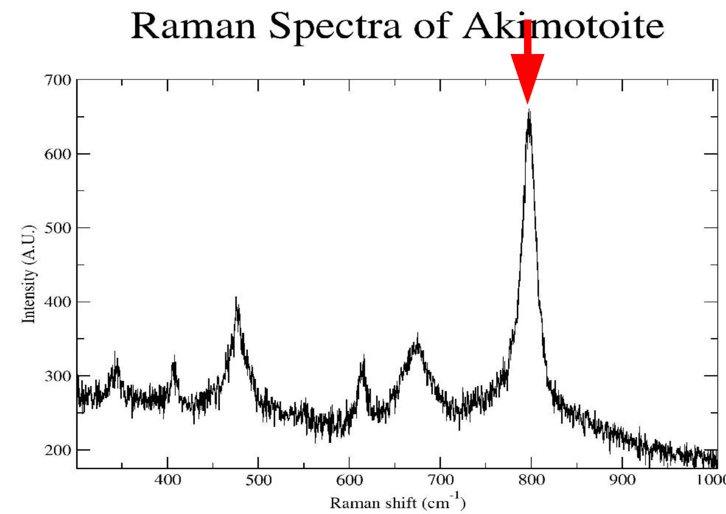
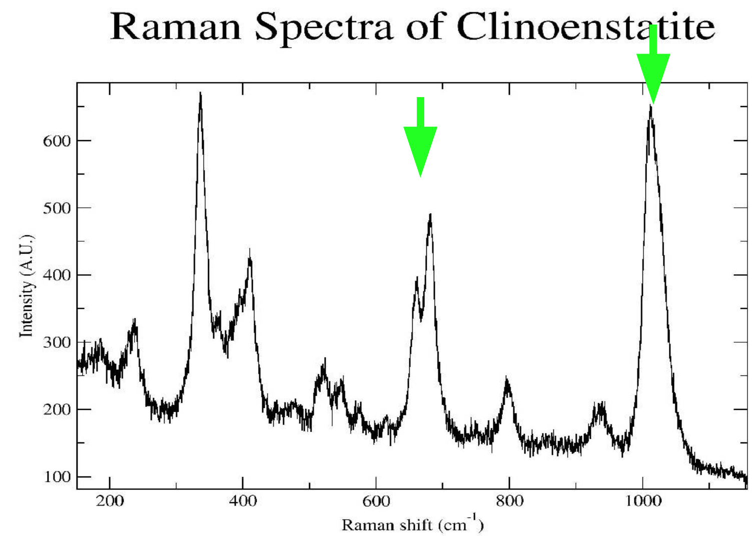
MicroRaman spectroscopy

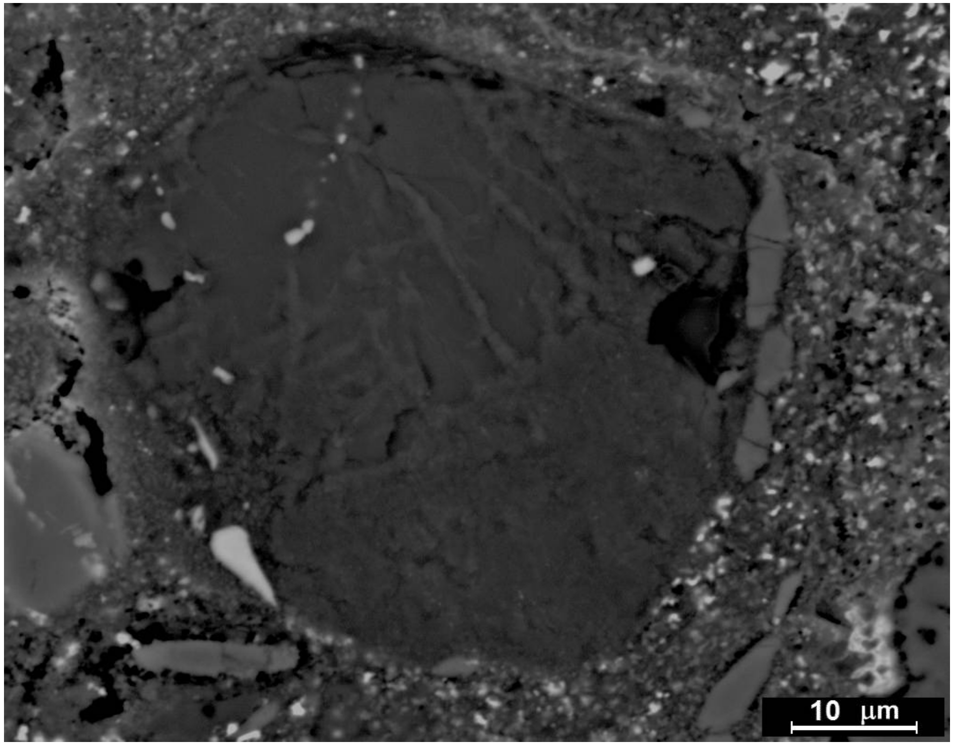


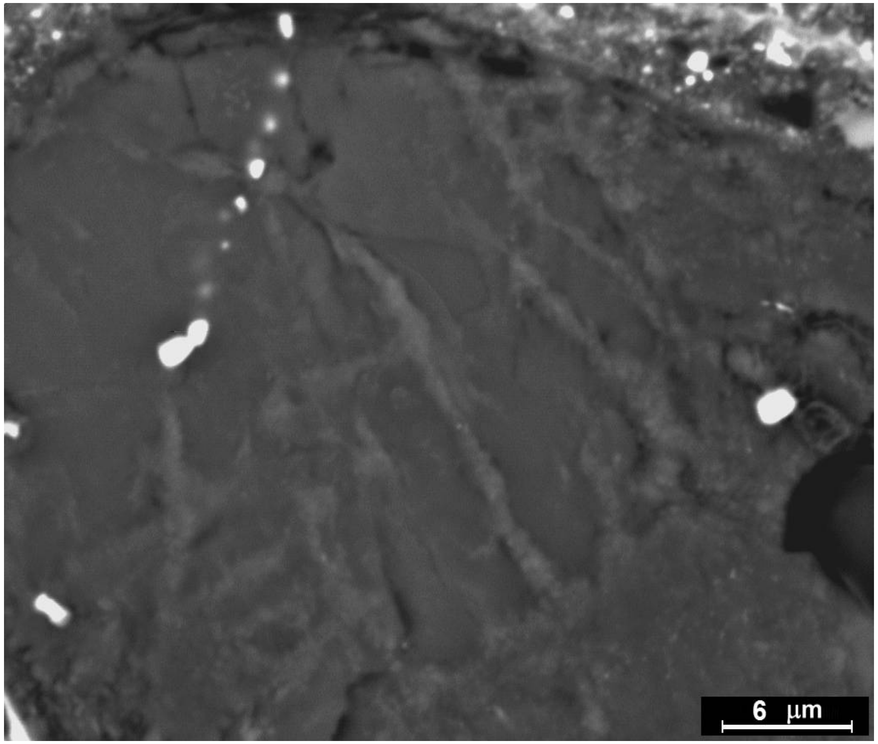




- Refering to reflected light picture, light gray part is akimotoite with extending lamellae into dark gray which is clinoenstatite

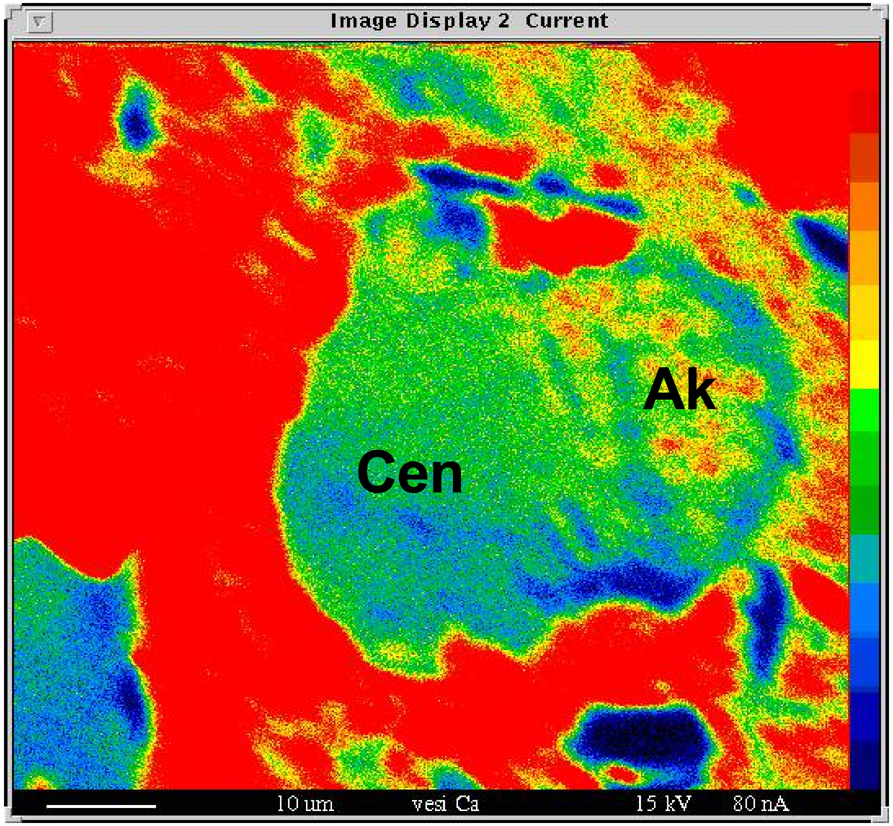
SEM investigation





- Polycrystalline part involving a solid state transformation starting at grain boundary
- Intracrystalline growth starting at akimotoite-clinoenstatite boundary and extending as thin lamellae to the interior

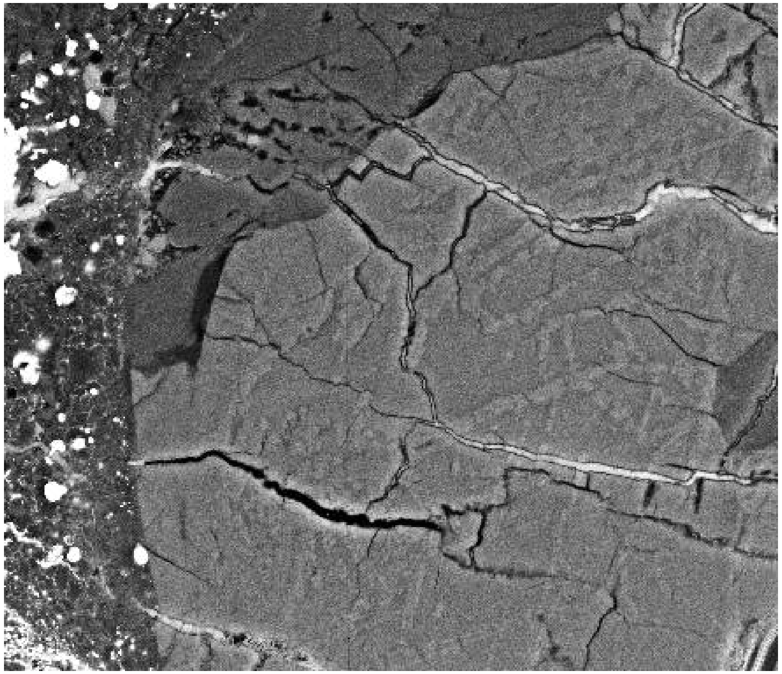
Chemical Composition



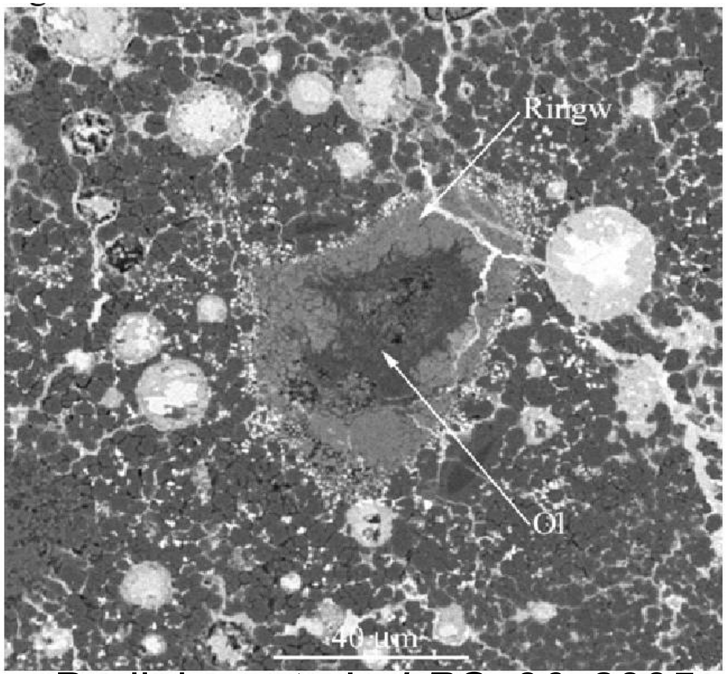
Oxide (wt%)	Akimotoite (polycrystalline)	Clinoenstatite and intracrystalline akimotoite
Na2O	1,73	0,18
K2O	0,11	0,02
FeO	13,4	14,38
SiO2	54,2	55,27
MgO	22,95	28,91
CaO	1,74	0,71
MnO	0,4	0,45
Al2O3	4,18	0,25
Cr2O3	0,23	0,06
P2O5	0,01	0
TiO2	0,13	0,14
TOTAL	99,09	100,39

- Polycrystalline akimotoite has a higher concentration in Ca, Al and Na than clinoenstatite
- Akimotoite lamellae have the same composition as clinoenstatite

- **Solid-state** transformation of clinoenstatite into akimotoite
- Similar mechanism as in olivine-ringwoodite transformation : both **polycrystalline and intracrystalline** mechanism



Beck et al., *Nature*, 2005

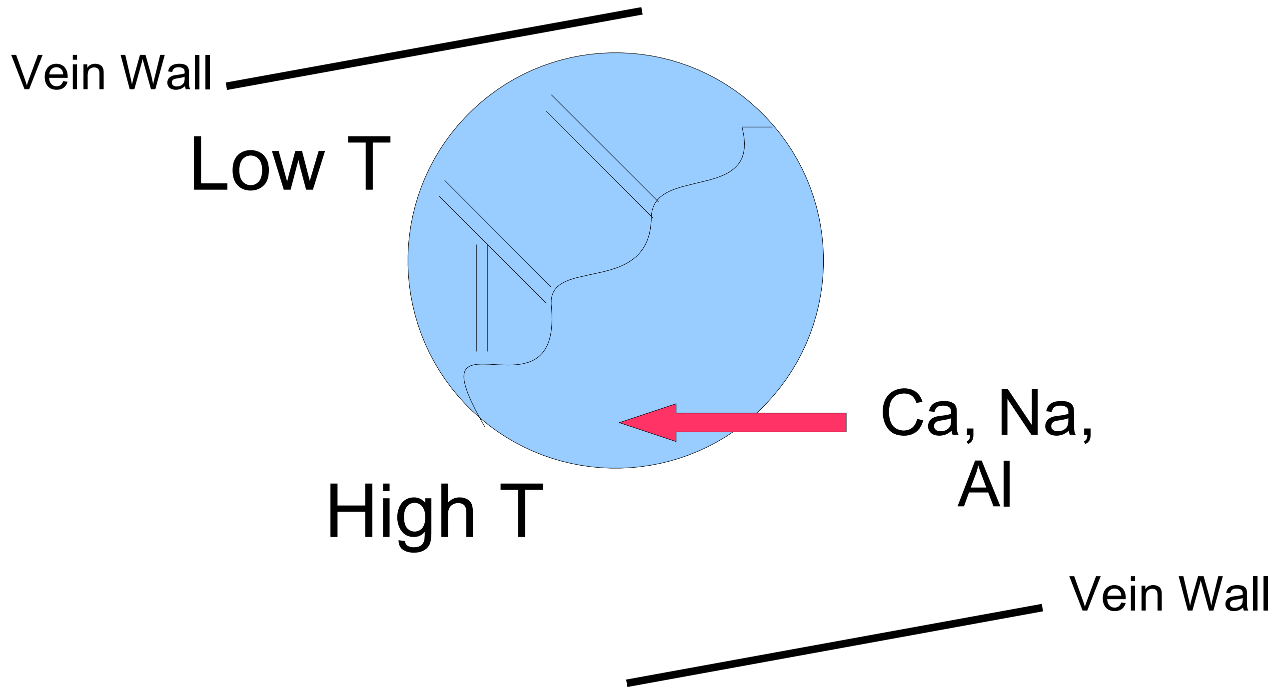


Badjukov et al., *LPSc36*, 2005

- Higher concentration of Ca, Na and Al in akimotoite compared to clinoenstatite support a **diffusion** from the SMV into akimotoite

Model 1 : Temperature gradient

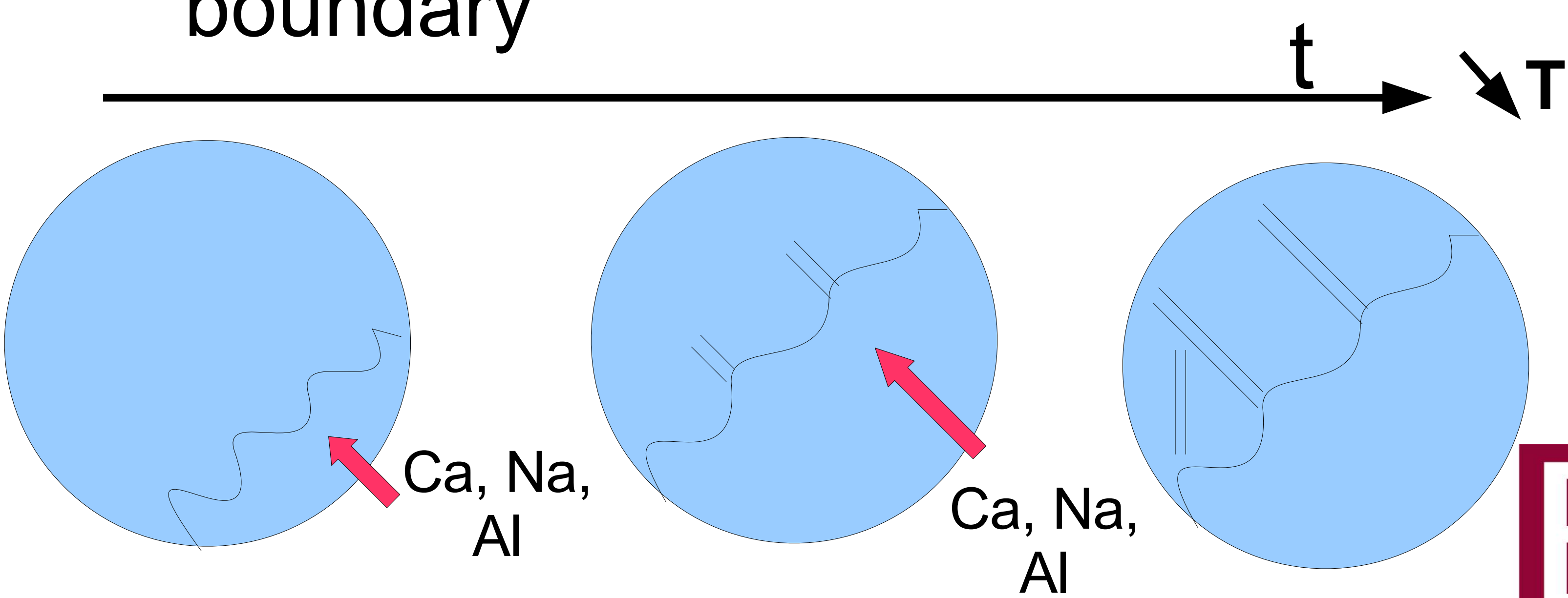
- Simultaneous growth of polycrystalline and intracrystalline transformation triggered by a temperature gradient



- High temperature ⟶ polycrystalline transformation
- Low temperature ⟶ intracrystalline transformation

Model 2 : Two stage model

- First stage: polycrystalline transformation starting at grain boundary and Ca, Na, Al diffusion
- Second stage : intracrystalline transformation starting from the akimotoite-clinoenstatite grain boundary



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Clinoenstatite-akimotoite growth kinetics

- Akimotoite lamellae ~ 0.75μ thick – Polycrystalline ~ 25μ
- Polycrystalline transformation faster than intracrystalline transformation
- Rw lamellae in Tenham are 1-1.5μ (Beck et al., 2005, *Nature*)
- Enstatite-akimotoite intracrystalline transformation slower than olivine-ringwoodite

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Conclusions

- Large clinoenstatite grain partially transformed
- Solid-state transformation and Ca, Al and Na diffusion
- T — High → Polycrystalline; Low → Intracrystalline
- Intracrystalline transformation is slower compared to olivine ringwoodite

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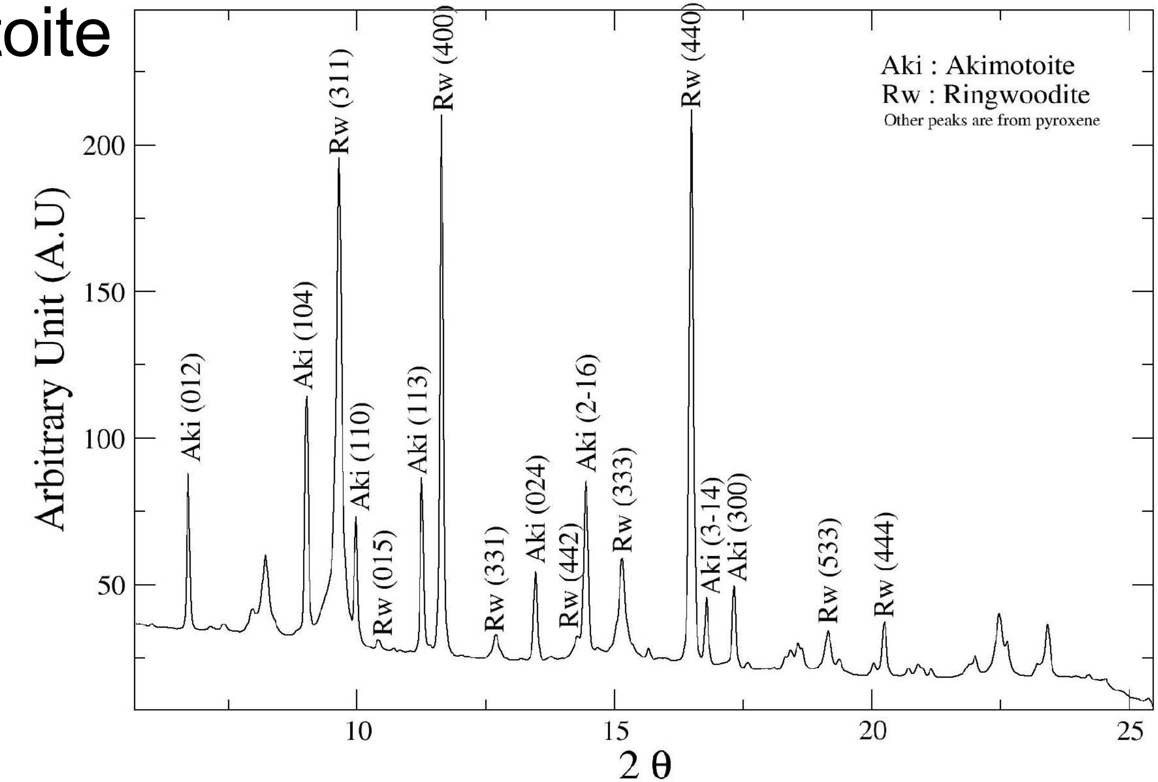
Conclusions

- Higher metastability of the subucting lithosphere
- TEM investigation
- Processing data of synchrotron XRD : structure of **natural** akimotoite



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