



High pressure-Ultrahigh pressure metamorphism and geochemical cycles in subduction zones

俯冲带高压超高压变质作用与地球化学循环

张立飞

北京大学地球与空间科学学院



Outline

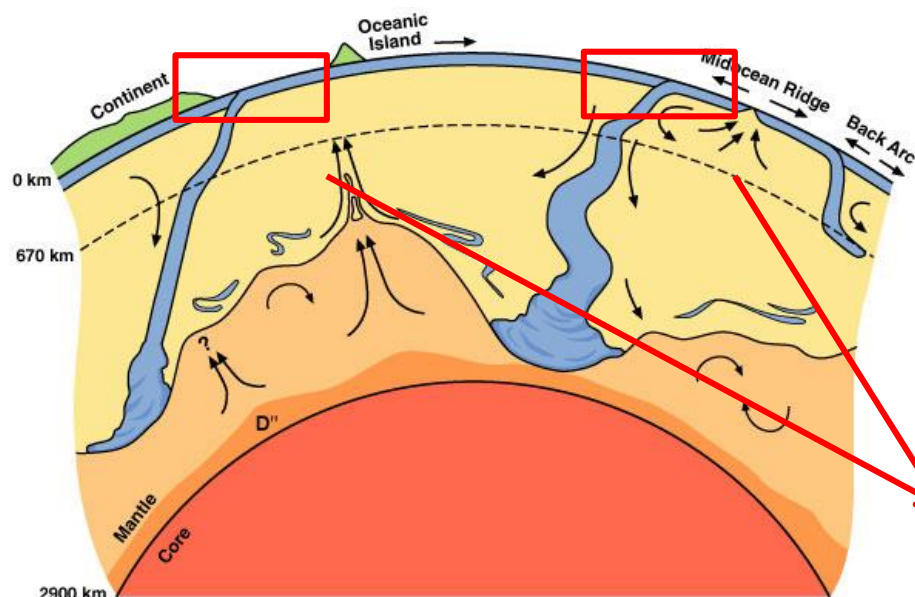
- Background
- Aims
- Project leaders
- Workplan



Outline

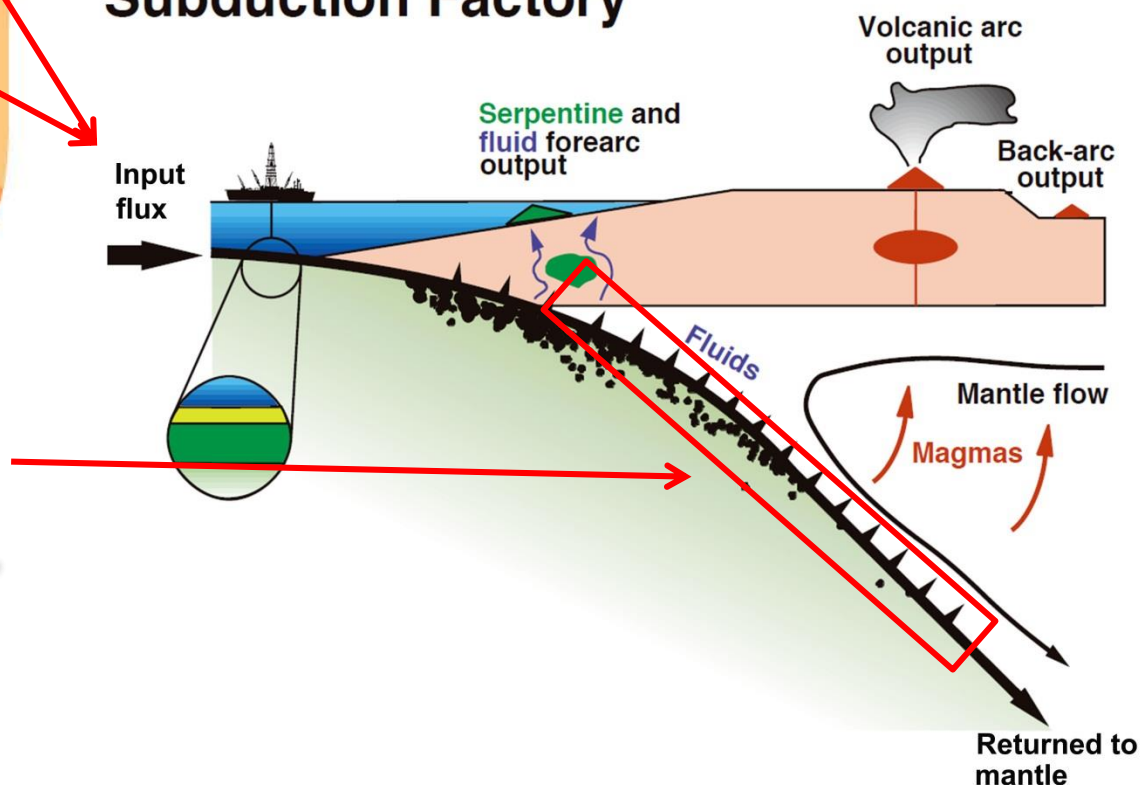
- *Background*
- Aims
- Project leaders
- Workplan

高压-超高压变质作用与地球化学循环



板块俯冲是地球上最重要的化学分异过程，对于大陆地壳的形成、地幔的演化、地幔柱的形成等都起着极其重要的作用。

Subduction Factory

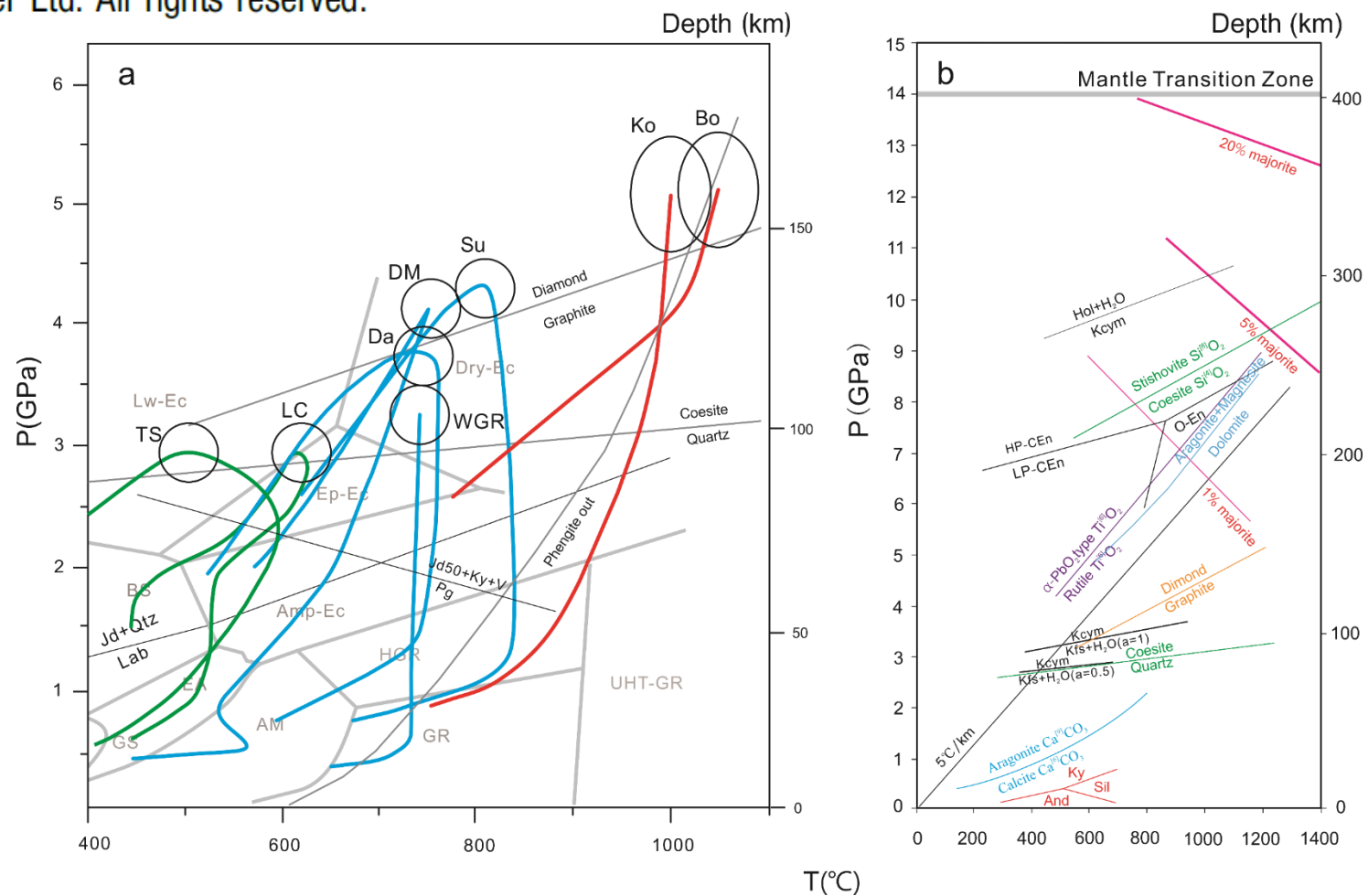


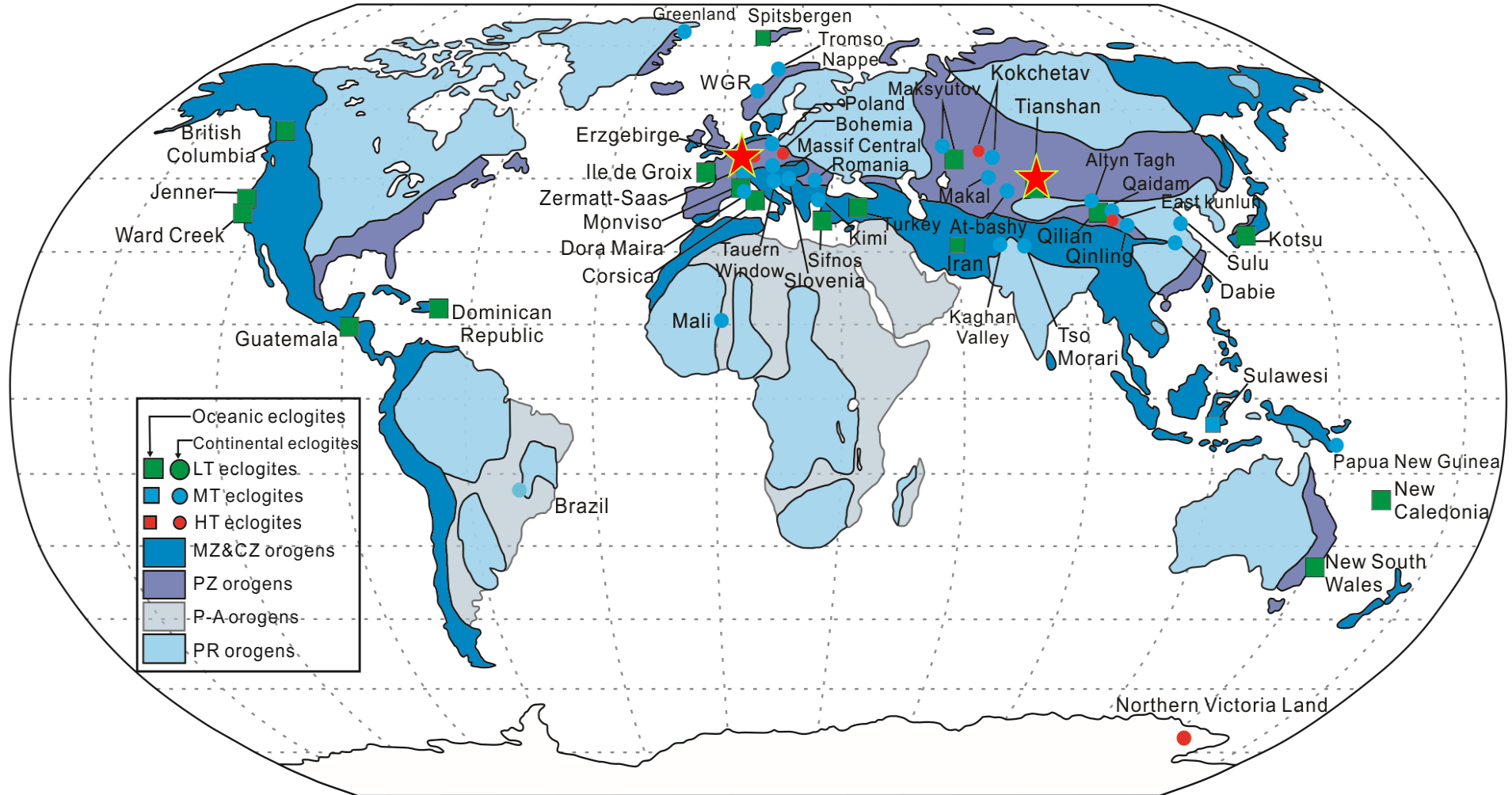
深俯冲超高压变质作用是近30年来固体地球科学研究取得的突破性的研究成果。包括了矿物相变， P - T 轨迹重建，微量元素变化及变质年代学等。

Ultrahigh Pressure Metamorphism

Lifei Zhang and Guibin Zhang, School of Earth and Space Sciences, Peking University, Beijing, China

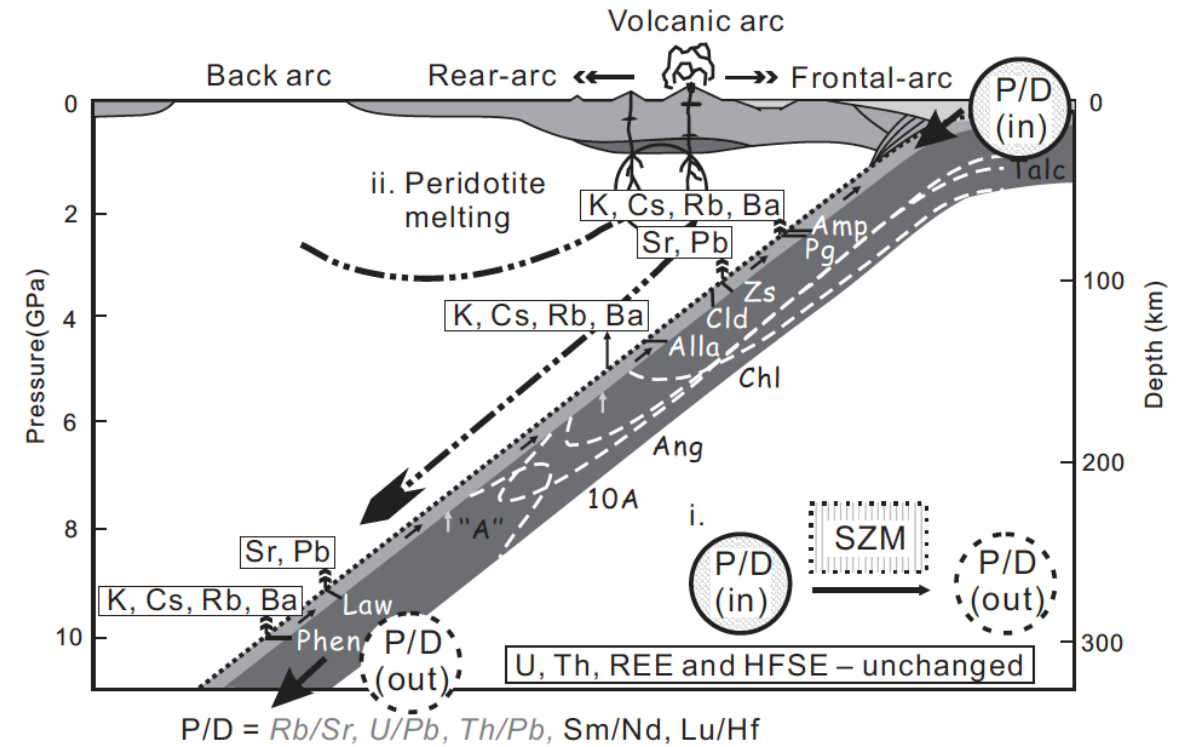
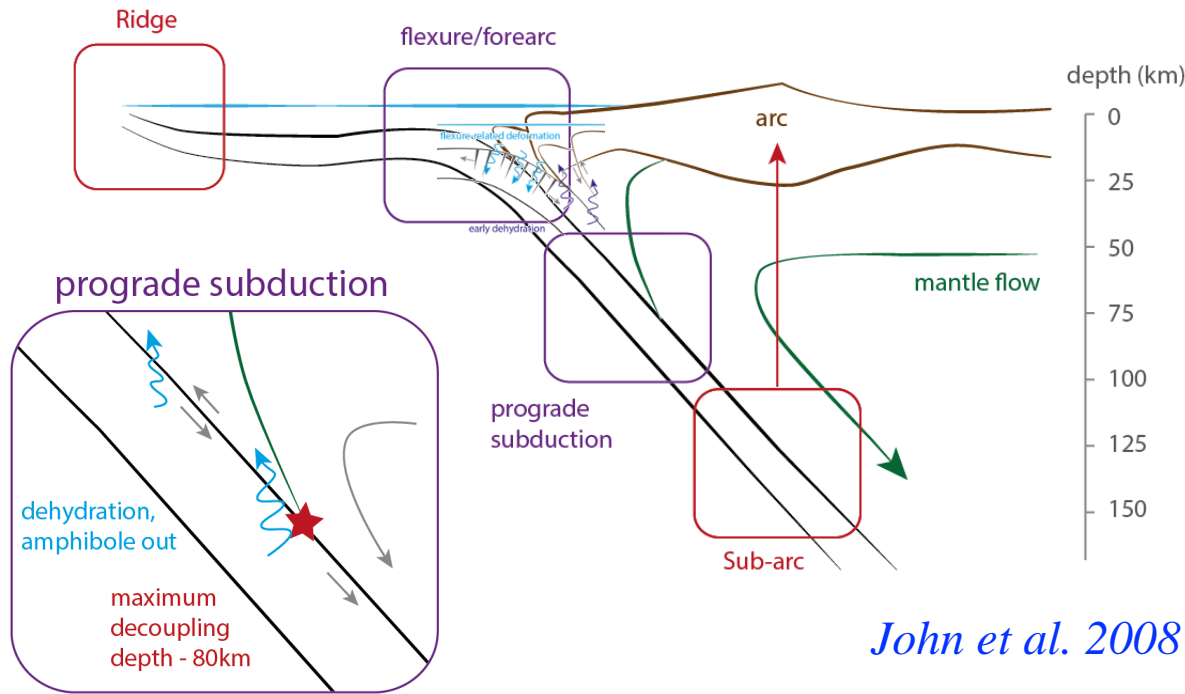
© 2021 Elsevier Ltd. All rights reserved.





The distribution of UHP metamorphic belt in the world (Zhang and Zhang, 2021)

Geochemical cycles in subduction zone



Fluids from devolatilization reactions, metasomatize the mantle wedge, trigger the island volcanism.

Some fluids will be subducted below 200 km, and contribute to various intra-plate volcanic activities

The subducted slab, after its devolatilization, is transported into deeper lower mantle regions or even towards the core-mantle boundary mantle heterogeneities

Outline

- Background
- *Aims*
- Project leaders
- Workplan

Aims

- Provide a platform for international experts to conduct a **comparative study of HP-UHP metamorphic belts across the globe**.
- Organize field trips including workshops and on-the-spot discussions of HP-UHP metamorphic belts of different ages, from the **oldest Precambrian lithologies from Russia to the Cenozoic UHP eclogite from Western Alps, and the even younger eclogite-facies rocks from Himalaya**.
- Improve our **current understanding** of HP-UHP metamorphism, related **geotectonic processes** and **deep cycling of carbon and water** ect. in subduction zones.
- Provide the basis for the development of a **coherent model of evolution for convergent plate margins**.

Outline

- Background
- Aims
- *Project leaders*
- Workplan

Project leaders:

Prof. Lifei Zhang (张立飞), (Peking University, China)

Dr. Hans-Peter Schertl (Ruhr-University Bochum, Germany)

Prof. Bishal N. Upreti (Nepal Academy of Science and Technology, Nepal)

Dr. Alexander I. Slabunov (Russian Academy of Sciences, Russia)

Dr. Alberto Vitale Brovarone (Università degli Studi di Torino, Italy)

Prof. Haissen Faouziya (Université Hassan II de Casablanca, Maroc)

Prof. Yilin Xiao(肖益林) (Chinese University of Science and Technology, China)

Prof. Chunjing Wei (魏春景) (Peking University, China)

Project Secretary:

Dr. Guibin Zhang (张贵宾), (Peking University, China)

Project leader: Prof. Lifei Zhang (张立飞)

Dean of School of Earth and Space Sciences, Peking University,
Director of The Key Laboratory of Crustal Evolution and Orogenic belt, MOE

Born in 1963, PhD in 1990

Fellow of Geological Society of America in 2011,
Fellow of Mineralogical Society of America in 2010.
Chair of Chinese Metamorphic Petrology Committee since 2009.



More than 200 papers in international peer review journals, cited more than 6500 times.
“Most Cited Chinese Researchers in the field of Earth and Planetary Science” by Elsevier for 2015, 2016 and 2017.

“HP-UHP metamorphism and tectonic evolution of orogenic belts”, 35th International Geology Conference in Cape Town, 2016;
“Subduction zone metamorphism, magmatism and geodynamics” in GSA meeting in Vancouver 2014;
8th International Eclogite Conference field excursion in North Qaidam UHP belt, Xining, China, 2009, etc.

Dr. Hans-Peter Schertl (Ruhr-University Bochum, Germany)

Senior Researcher

Born in 1958, PhD in 1992

82 scientific papers and 7 books/chapters, covering localities of Dora Maira Massif/ Italy; Kokchetav- Massif/ Kazakhstan; Dabie Shan/China; Rio San Juan Complex / Dominican Republic; etc



Fellow of “Mineralogical Society of America” in 2014;

Secretary for “International Mineralogical Association” (IMA) since 2014;

National Representative for Germany on the “International Eclogite Conference Co-ordinating Committee” (IECCC) and served as the president of IECCC between 2015-2017.

Member of IGCP546 (Subduction zones in the Caribbean) between 2007-2011,

Member of IGCP 649 (Diamonds and Recycled Mantle) for 2015-2020.

Prof. Bishal N. Upreti (Nepal Academy of Science and Technology)

Born in 1951

Fellow (Academician) of the Nepal Academy of Science and Technology;

Fellow of The World Academy of Sciences (TWAS);

Fellow of Geological Society of America;



President of Nepal Geologic Society between 1996-1998;

Dean of the Institute of Science and Technology in Tribhuvan University between 2006-2008 ;

Head of the Department of Geology in the University of Zambia;

Structural geology & tectonics and Himalayan geology, with over 80 research papers and 7 books published.

Member of the National Committee on IGCP between 2004-2008,

Member of ongoing IGCP project 675.

Dr. Alexander I. Slabunov

Karelian Research Centre, Russian Academy of Sciences, Russia

Born in 1957, PhD in 2005



Head of the Laboratory of Precambrian Geology and Geodynamics, Institute of Geology,
Karelian Research Centre (IG KarRC RAS) ;

Chief Academic Secretary of the Karelian Research Centre, RAS (1997-2002).

Early Precambrian geology and geodynamics, has author/co-authored over 300 papers

He has initiated scientific conferences and led field trips on Precambrian geology in Russia:

33rd International Geological Congresses (IGC) in 2008

13th International Eclogite Conference (IEC-13) in 2019.

Dr. Alberto Vitale Brovarone
Università degli Studi di Torino, Italy

Born in 1983, Italy
University of Turin (Italy) with a BSc (2005), a MSc (2007) and a PhD (2011).

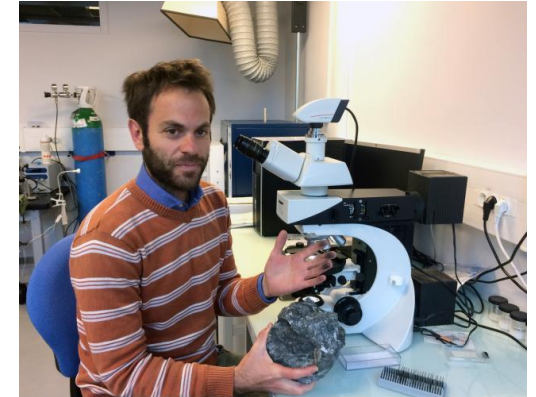
Alpine geology

“Deep Carbon Observatory (DCO) Emerging Leader Award” for his distinguished performance and unique potential as leaders of the deep carbon science community.

EAG council member for 2019-2022.

French candidature committee for the 2022 International Eclogite Conference.

Co-conveners for Goldschmidt 2018, 2017; and AGU fall meetings 2014, 2013.



Prof. Haissen Faouziya

Université Hassan II de Casablanca, Maroc

Born in 1967, PhD in 2001

Professor at the University Hassan 2 of Casablanca (Morocco) since 2011
and at the University of Chouaib Doukkali (Morocco) between 2001-2011.
PhD from the University of Granada (Spain) in 2001



The 2nd Colloquium of International Geoscience Program IGCP638 hosted in Casablanca, Morocco in 2017;
The First West African Craton and margins international Workshop hosted in Dakhla, Morocco in 2017;
The First ASRO Geological Congress in El Jadida, Morocco;
The 2th Conference of the African Association of Women Geosciences in 2006, etc.

Prof. Yilin Xiao

Chinese University of Science and Technology

Born in 1962, PhD in 2000



Lecturer of Geochemistry between 1991 and 1996;

Guest scientist, PhD, Research Fellow, University of Göttingen (1997-2007)

Full professorship of Geochemistry and Petrology at the University of Science and Technology of China

Extensive research experience in the UHP metamorphic rocks in Dabie orogenic belt, China,

A pioneer in the field of isotopic tracing of fluid/mineral interactions during high- and ultrahigh-pressure metamorphism.

National Awards for Natural Sciences of the People's Republic of China (Second-class, 2010-Z-104-2-04).

Prof. Chunjing Wei (Peking University, China)

Born in 1962; PhD in 1992



Over 180 academic papers, covering following subjects:

phase equilibria modeling of metamorphic rocks,

HP/UHP metamorphic evolution from the orogenic belts of Dabieshan, Qinling, Qilian, Altyn and Tianshan,

metamorphic evolution of the North China Craton, and the metamorphism in the Central Asian Orogenic belts.

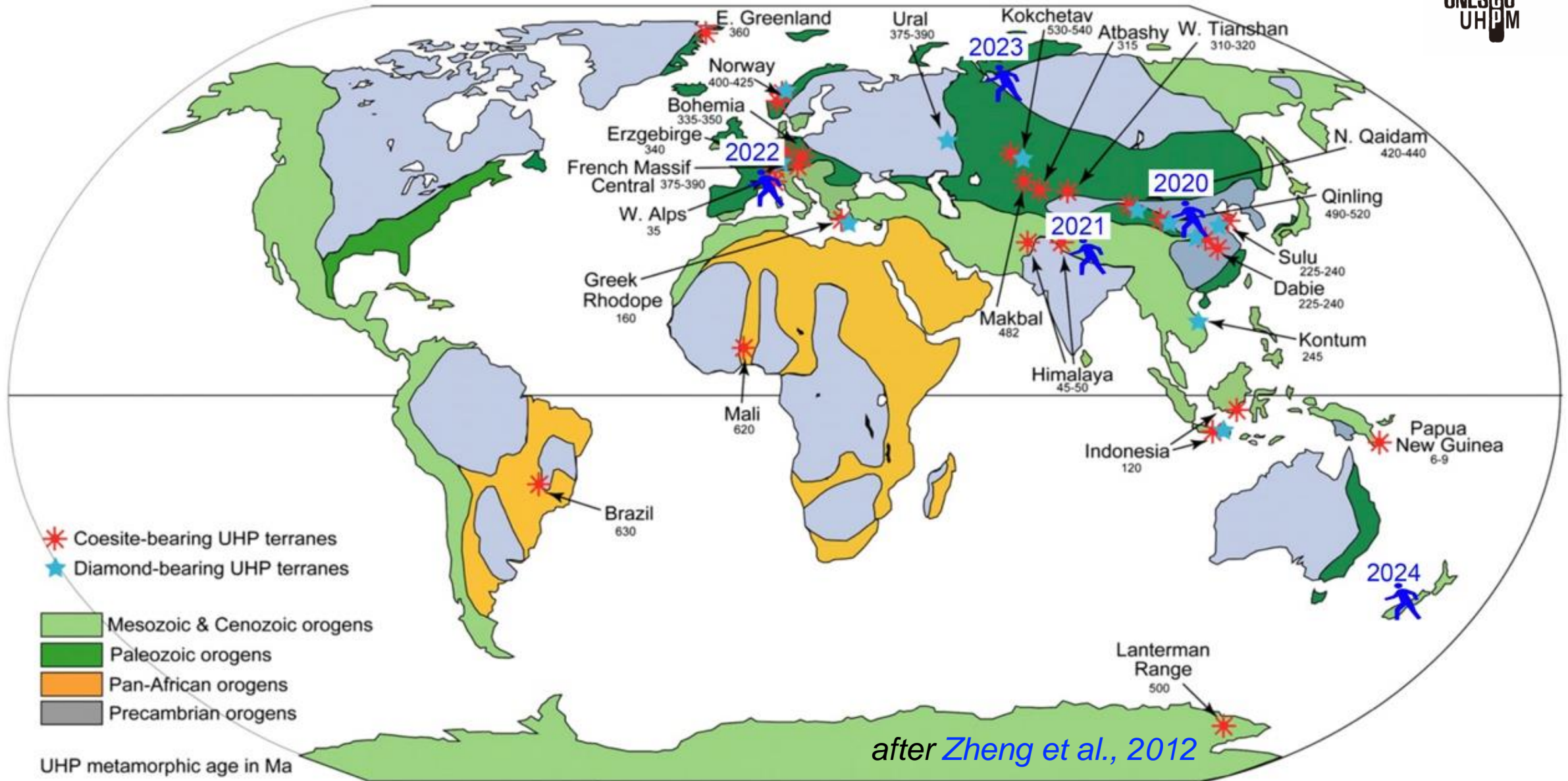
Editorial committee of several journals including “Journal of Metamorphic Geology”, “Journal of Earth Science”, “Acta Petrologica Sinica”, and “Science in China–D”.

Outline

- Background
- Aims
- Project leaders
- *Workplan*



Workplan





2020年12月12日召开项目启动会

www.igcp709.com

IGCP-709

HP-UHP metamorphism and geochemical cycles in subduction zones





www.igcp709.com



HP-UHP metamorphism and geochemical cycles in subduction zones

International Geoscience Programme (IGCP-709) Project

[Home](#) [About](#) [Workshops](#) [News](#) [Leaders](#) [Participants](#) [Download](#)

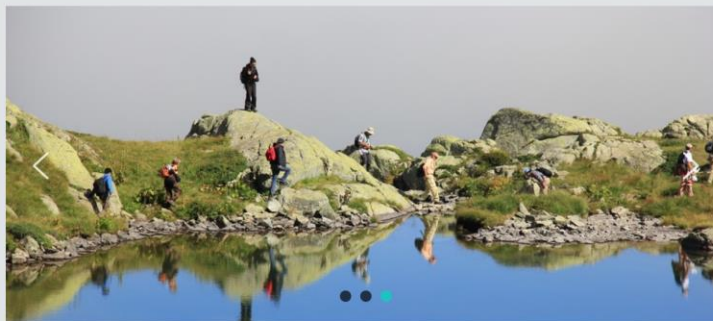
Search



Welcome to the IGCP-709 website

Recent Post Pages

- [IGCP-709 Project Logo](#)



News and activities

[Conference on Chinese Metamorphic Geology and Precambrian Research](#)

[Conferences in 2020](#)

[Dr. Cong Zhang was elected as IGCP scientific board member](#)

[Project 2020 annual meeting was hold online in 12th December](#)

[18 new projects to join the International Geoscience Program in 2020](#)

[Project 709 – High pressure-Ultrahigh pressure metamorphism and geochemical cycles in subduction zones”](#)

Contact Information

[Dr. Guibin Zhang](#), School of Earth and Space Sciences, Peking University, China

[Dr. Cong Zhang](#), Institute of Geology, Chinese Academy of Geological Sciences, China

Categories

[Download](#)
[News](#)
[participants](#)

Meta

[Log in](#)
[Entries feed](#)
[Comments feed](#)
[WordPress.org](#)

Online Users: 1
Total Visits: 27,401

2021年4月16-21日， 西北大学举行“全国变质岩学术研讨会”

中国矿物岩石地球化学学会第九届变质岩专业委员会2021年学术研讨会



IGCP709参与举办2021年变质岩学术年会，会后秦岭野外考察



IGCP709参与举办2021年变质岩学术年会，会后秦岭野外考察

2021年发表论文30多篇，包括NC、GCA、JP、JMG等



Trace Elements and Li Isotope Compositions Across the Kamchatka Arc: Constraints on Slab-Derived Fluid Sources

Haiyang Liu^{1,2,3,4} , Yilin Xiao^{1,5} , He Sun^{1,6}, Fengtai Tong¹, Alexander Heuser^{7,8} , Tatiana Churikova⁹ , and Gerhard Wörner⁸ 



JGR Solid Earth

Abiotic metamorphism
serpentinite-hosted

Issues More Content

DOI: 10.1111/jmg.12577

ORIGINAL ARTICLE

Article Contents

Weigang Peng^{a,b,c}, Lifeng He

Abstract

High-*P* metamorphism of garnet–epidote–amphibole schists from the Yuli Belt, Eastern Taiwan: Evidence related to warm subduction

Po-Hung Huang¹  | Chunjing Wei¹  | Jinrui Zhang² 

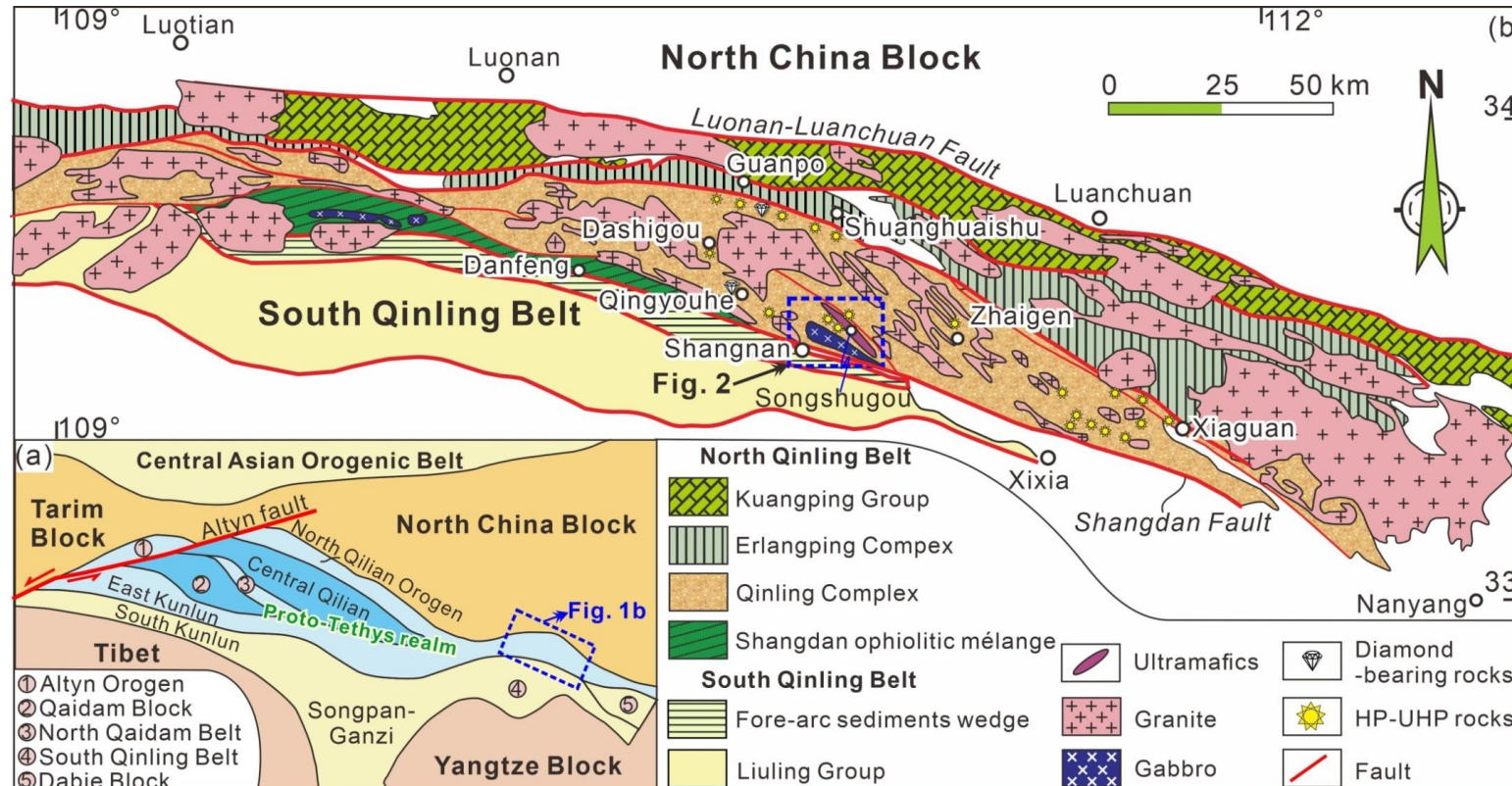
Journal of METAMORPHIC GEOLOGY WILEY

1.1 北秦岭-阿尔金 HP-UHP变质作用

Deep subduction and exhumation of micro-continents in the Proto-Tethys realm: Evidence from metamorphism of HP-UHT rocks in the North Qinling Orogen, central China

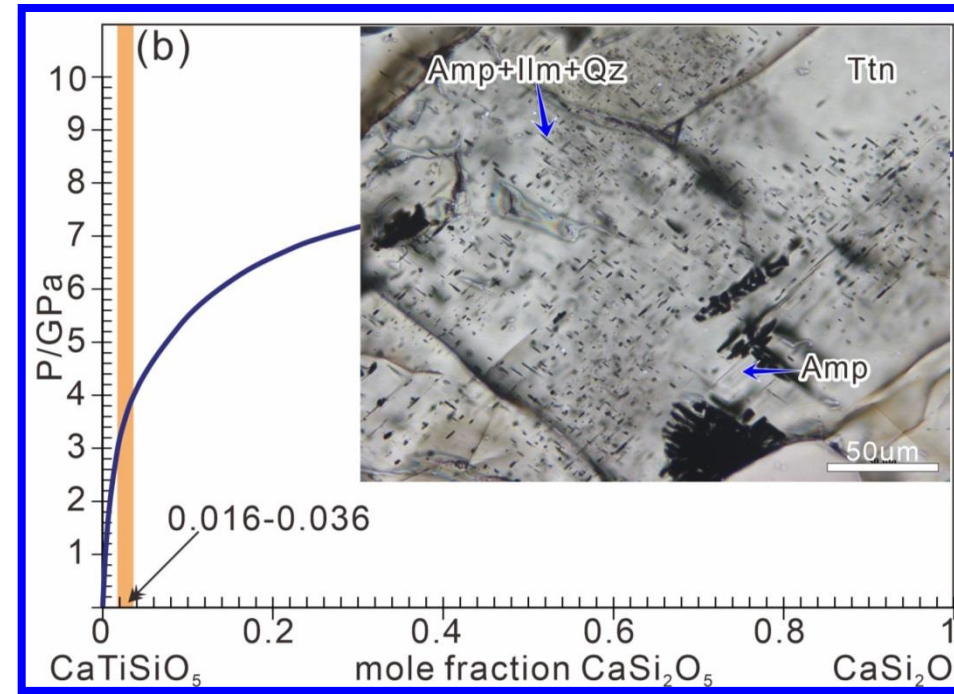
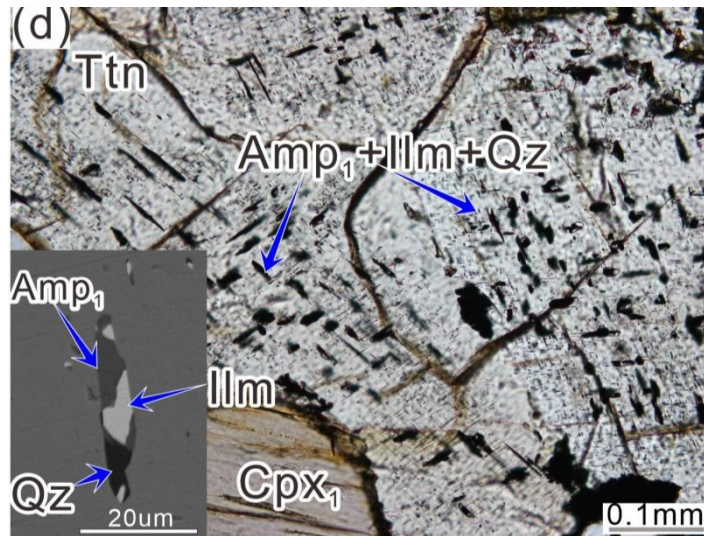
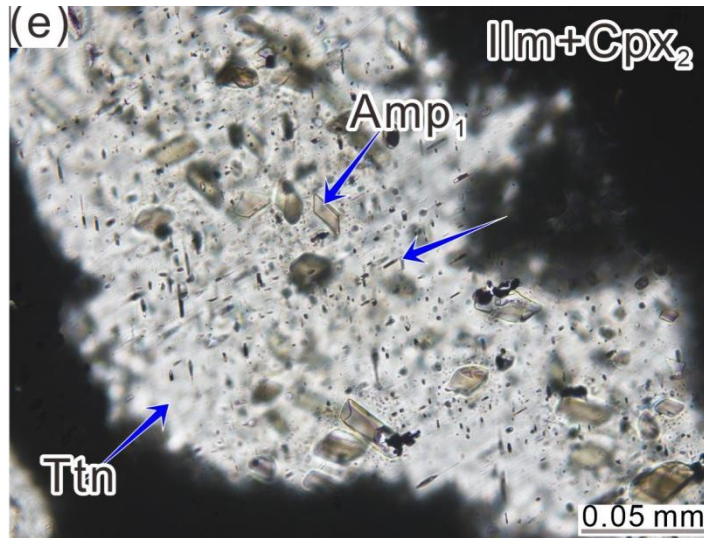
Jie Dong*, Chunjing Wei, Shuguang Song

MOE Key Laboratory of Orogenic Belts and Crustal Evolution, School of Earth and Space Sciences, Peking University, Beijing 100871, China

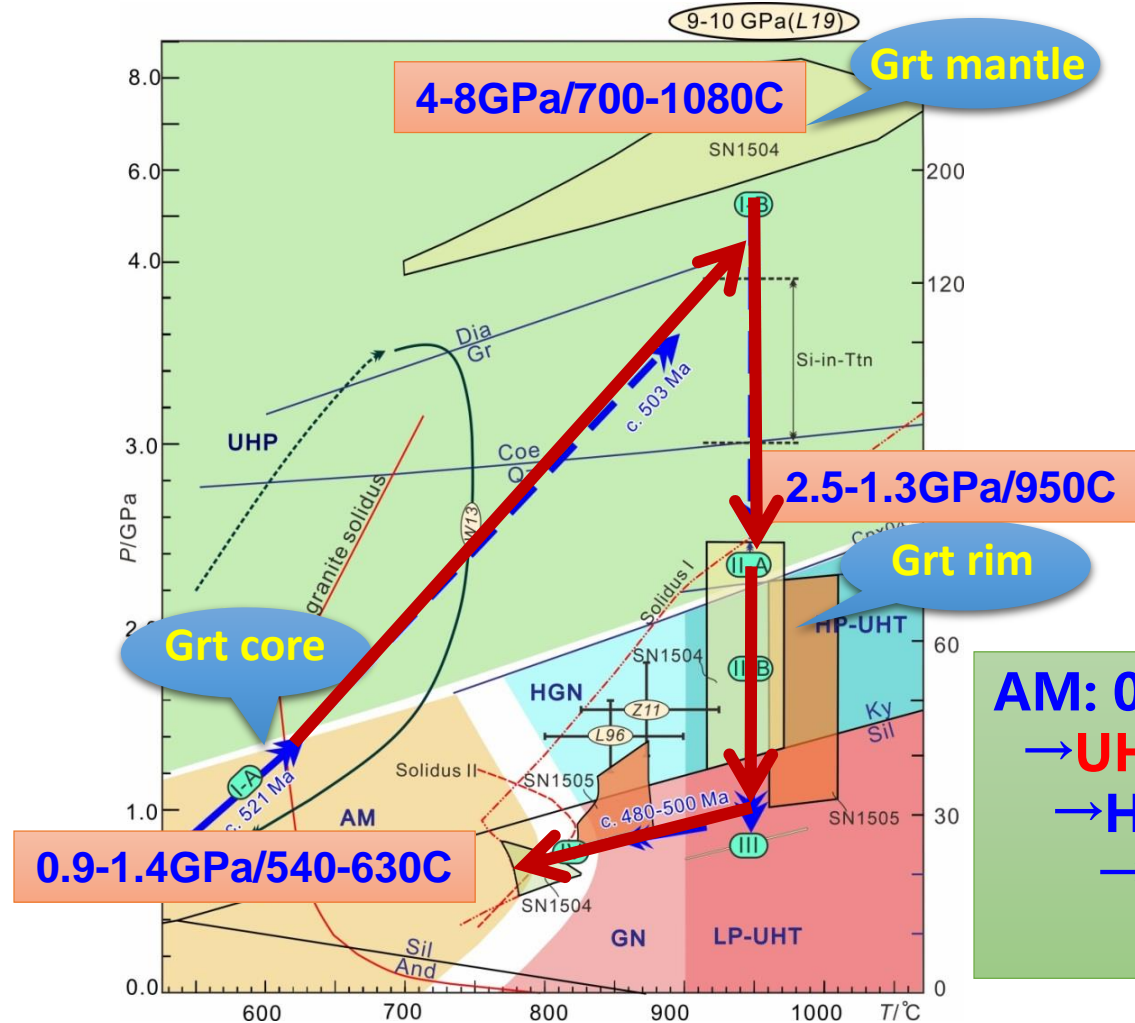


HP-UHP rocks have been reported from the Qinling Complex of North Qinling HP-UHP belt

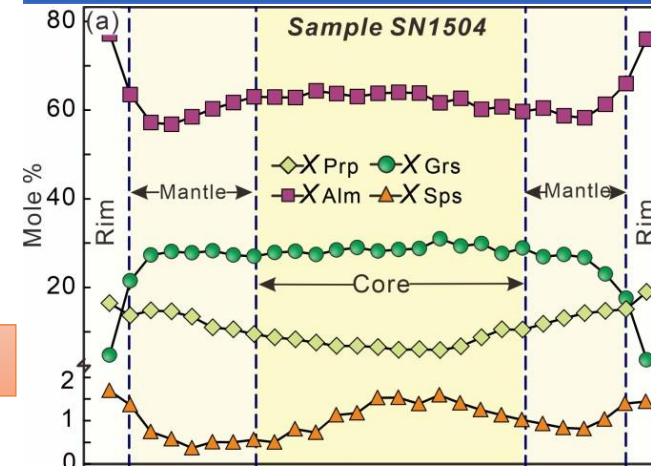
The metamorphic evolution of Gt pyroxenite and HP has not been well addressed



- Exsolutions of
Amp、Amp+Ilm+Qz in Titanite
- Supersilicic titanite
Si = 1.016-1.036
P = 3.0-3.9 GPa



Notable zoning: C-M-R



AM: 0.9-1.4 GPa/540-630°C
 → **UHP: 4-8 GPa/700-1080°C**
 → **HP-UHT: 2.5-1.3 GPa/950°C**
 → **LP-UHT: 0.9 GPa/950°C**
 → **Solidus: 830-770°C/0.5 GPa**

Grt composition and related mineral assemblages have recorded the entire continental ultradeep subduction-exhumation evolution

Article Contents

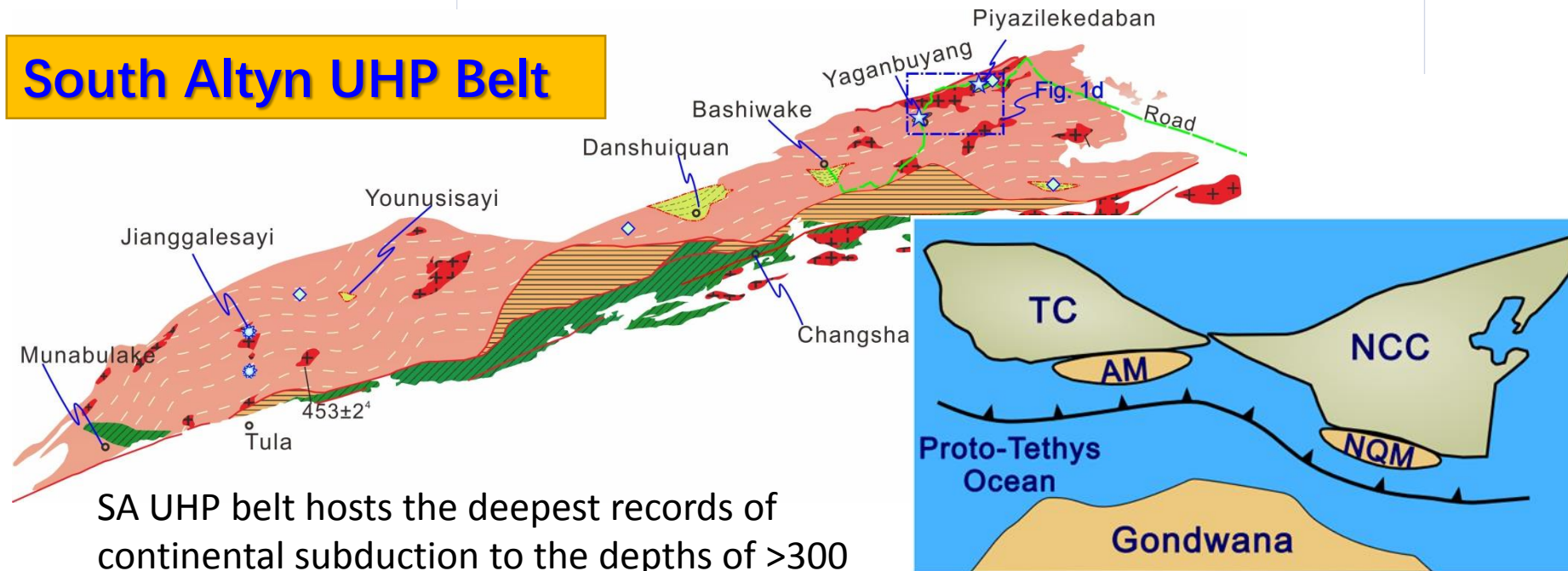
Abstract

ACCEPTED MANUSCRIPT

Multi-stage metamorphism of the South Altyn ultrahigh-pressure metamorphic belt, West China: insights into tectonic evolution from continental subduction to arc-backarc extension

Jie Dong, Chunjing Wei

South Altyn UHP Belt

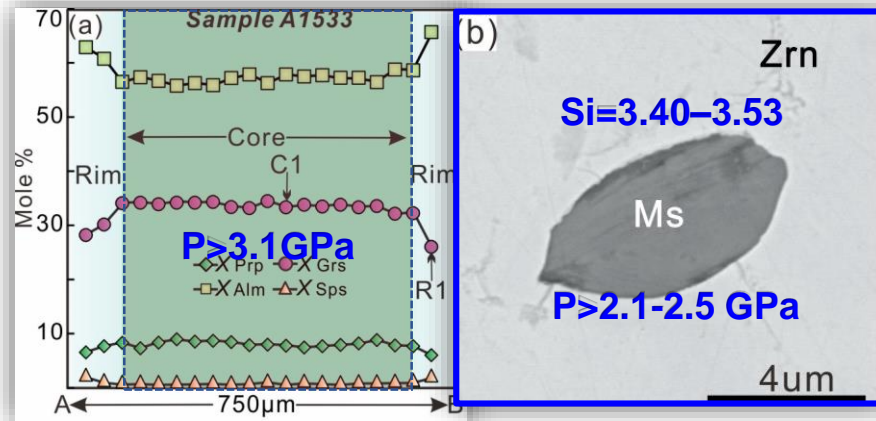


SA UHP belt hosts the deepest records of continental subduction to the depths of >300 km from the former presence of

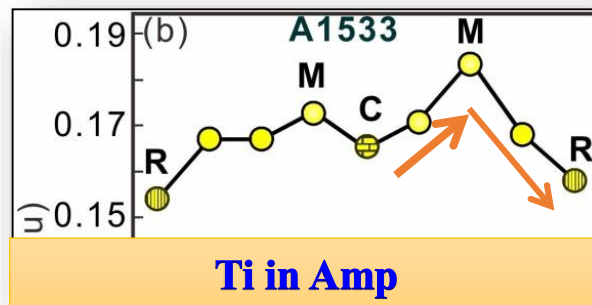
**Subduction of micro-continents
in Proto-Tethys ocean**

Garnet amphibolite

South Altyn UHP Belt

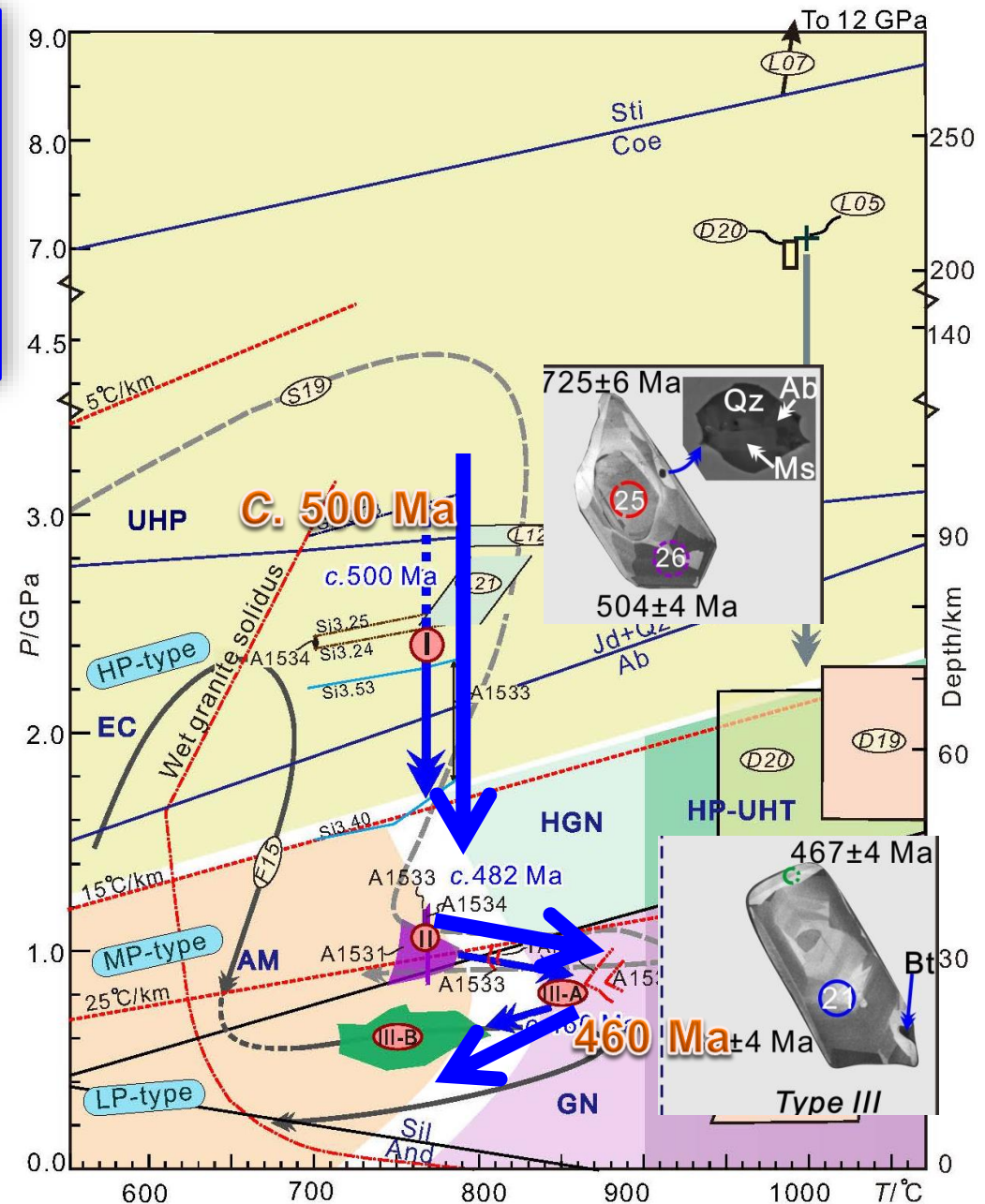


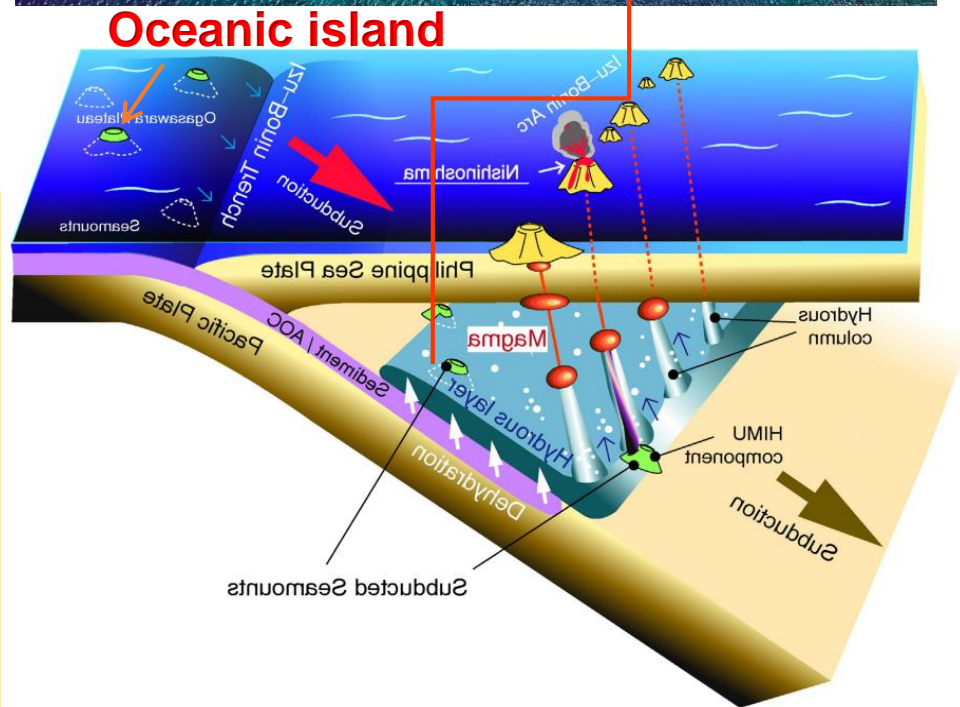
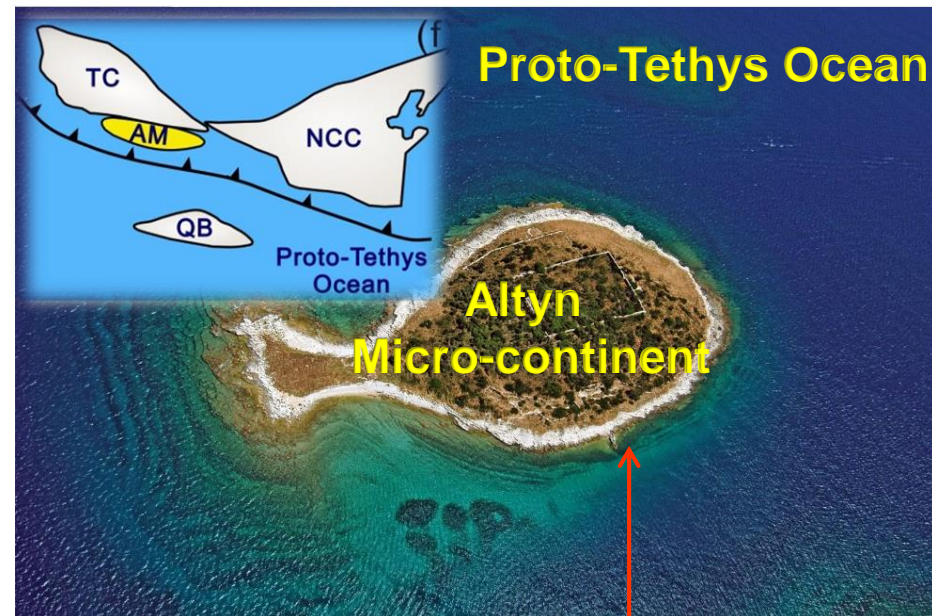
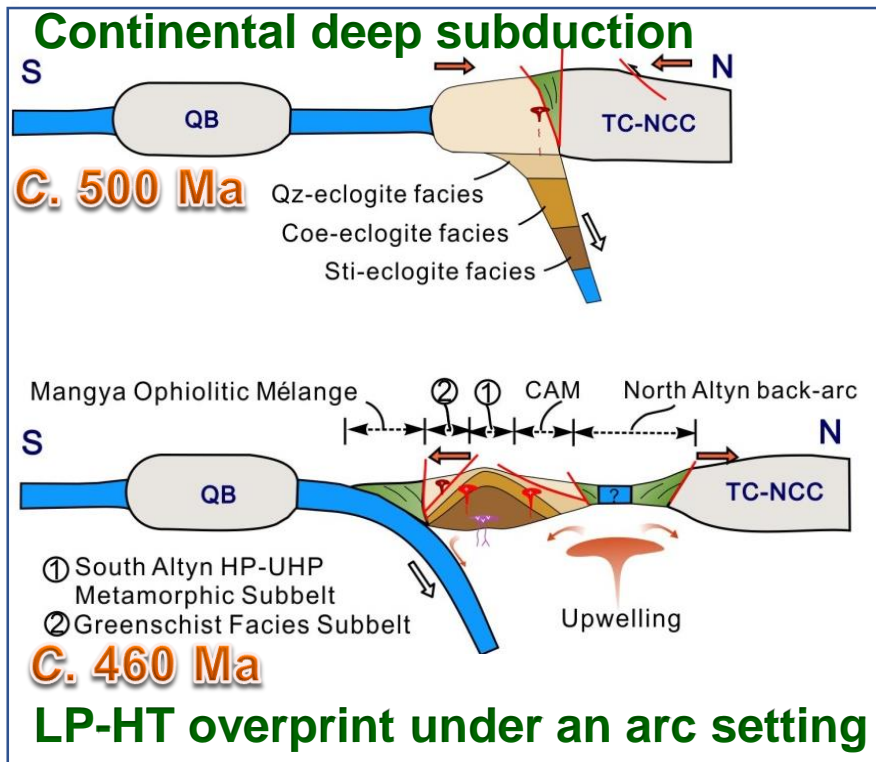
Ec facies $>2.1-4.5 \text{ GPa}/760\text{C}$
Age = $\sim 500 \text{ Ma}$



LP-HT Overprinting
 $\leq 0.9 \text{ GPa}/860-870\text{C}$
Age = $\sim 460 \text{ Ma}$

Dong and Wei, 2021, JP





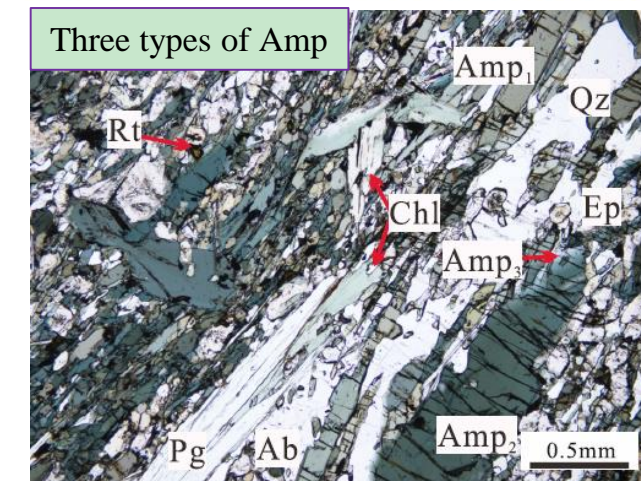
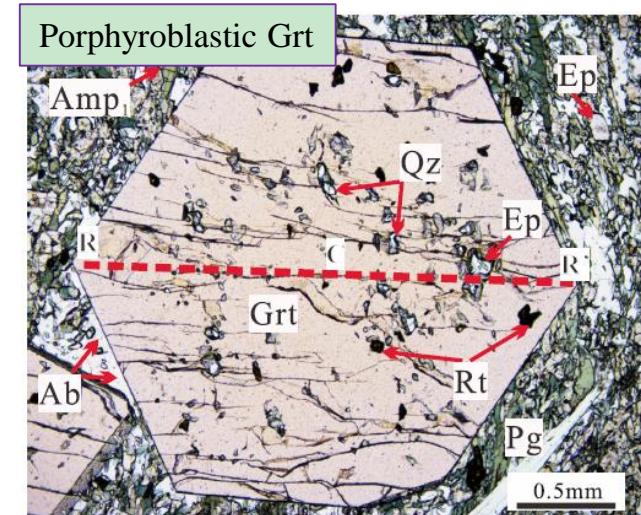
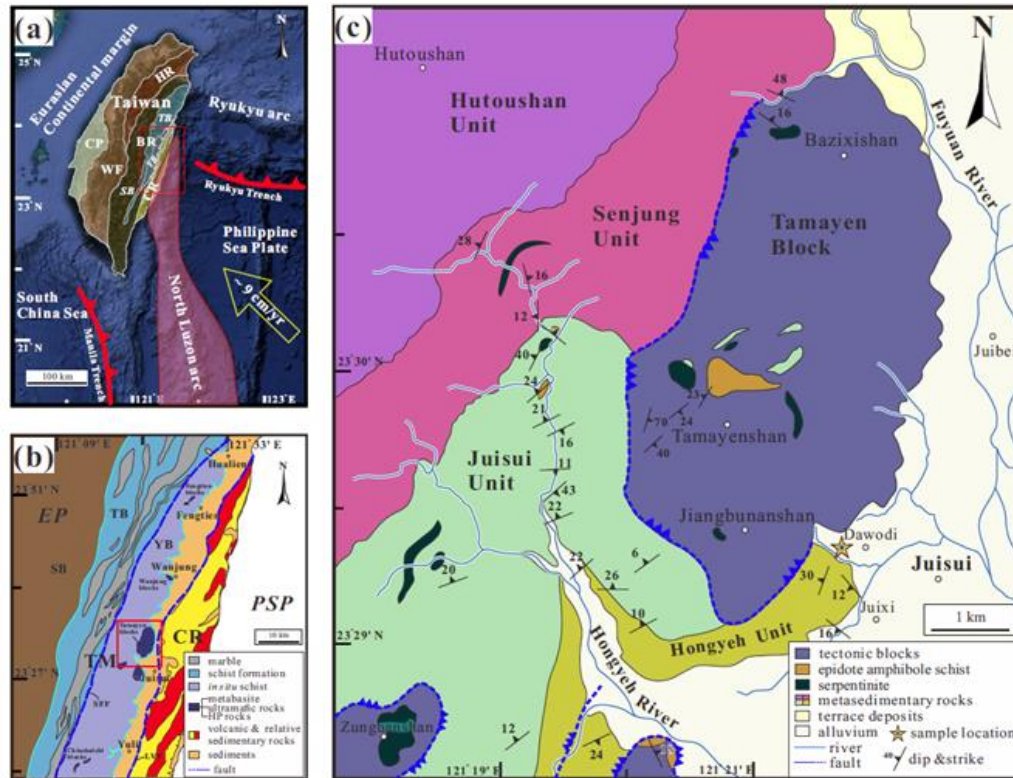
Altyn Micro-continent subduction

1. occurs during early closure of an ocean
2. act like the subduction of an oceanic island, with the aid of the oceanic crust ahead and around
3. exhumed rocks were subjected to an arc environment to experience LP-HT overprinting

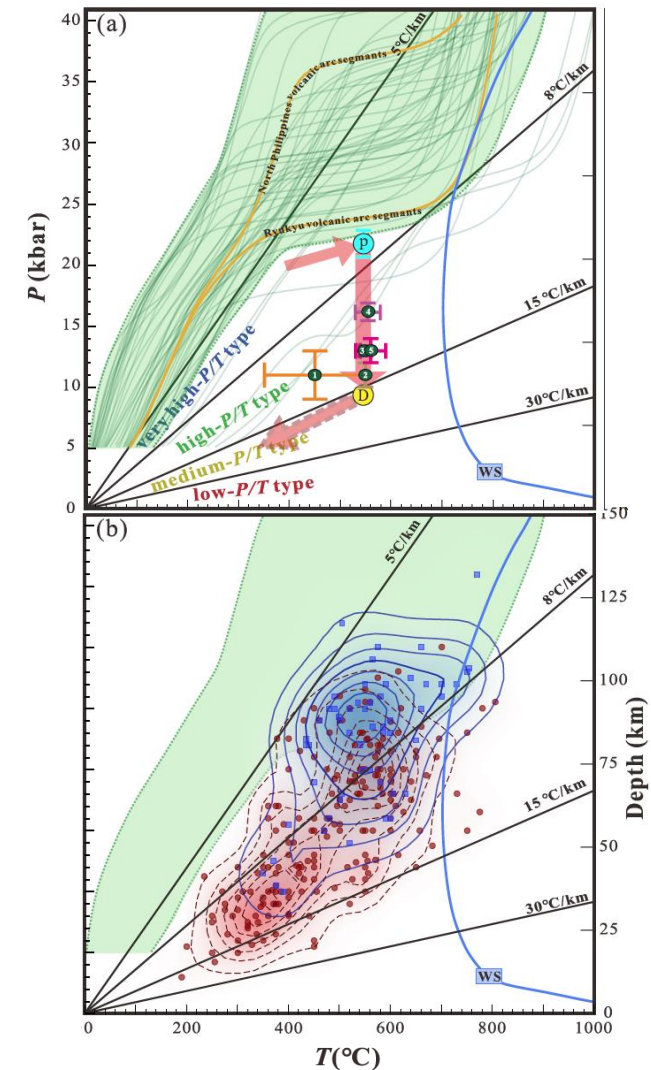
1.2 台湾玉里HP变质带

High-*P* metamorphism of garnet–epidote–amphibole schists from the Yuli Belt, Eastern Taiwan: Evidence related to warm subduction

Po-Hung Huang¹  | Chunjing Wei¹  | Jinrui Zhang² 

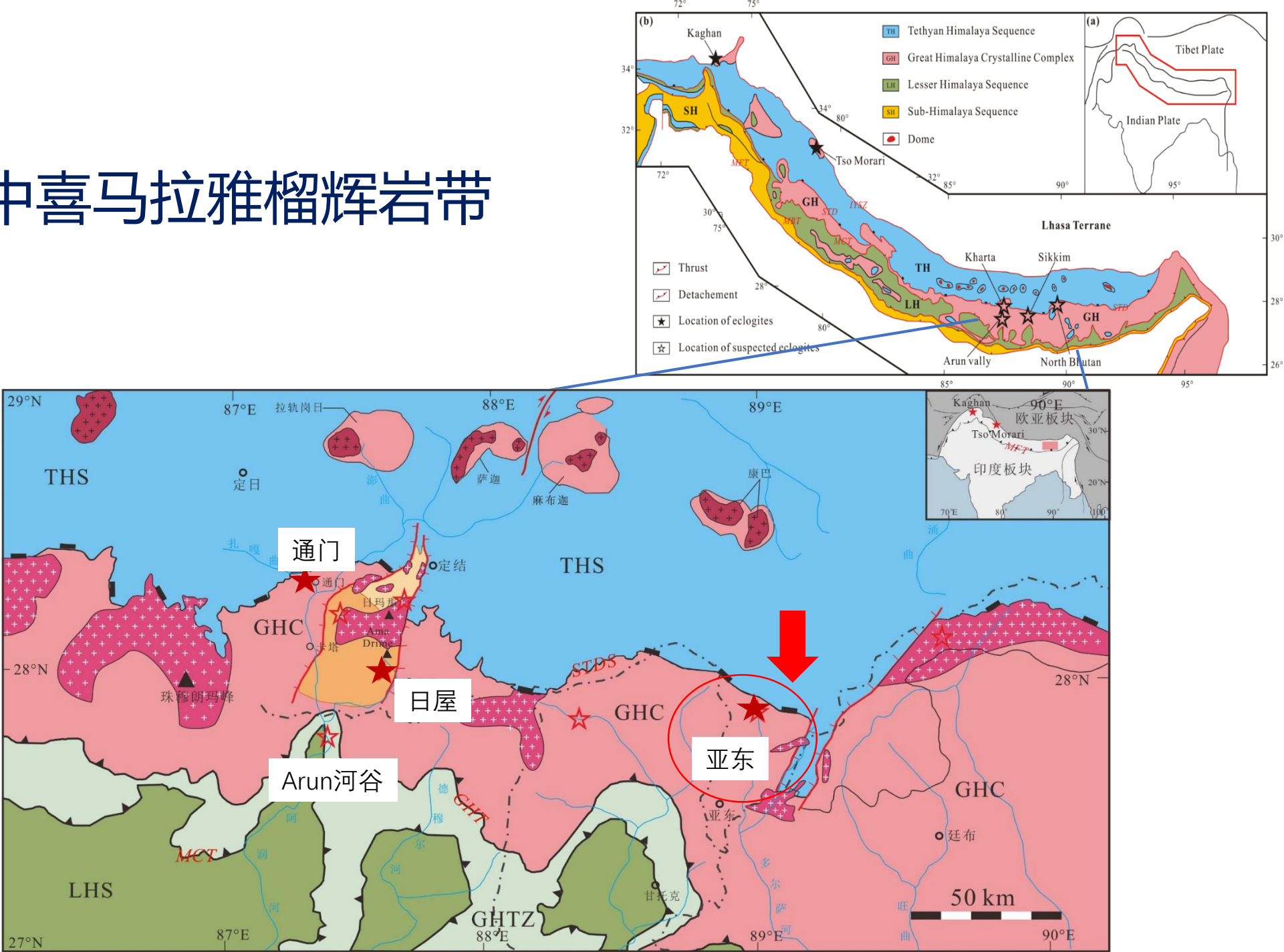


- 2. Peak condition of ~22 kbar/545 °C in the Lws and Gln-bearing assemblage



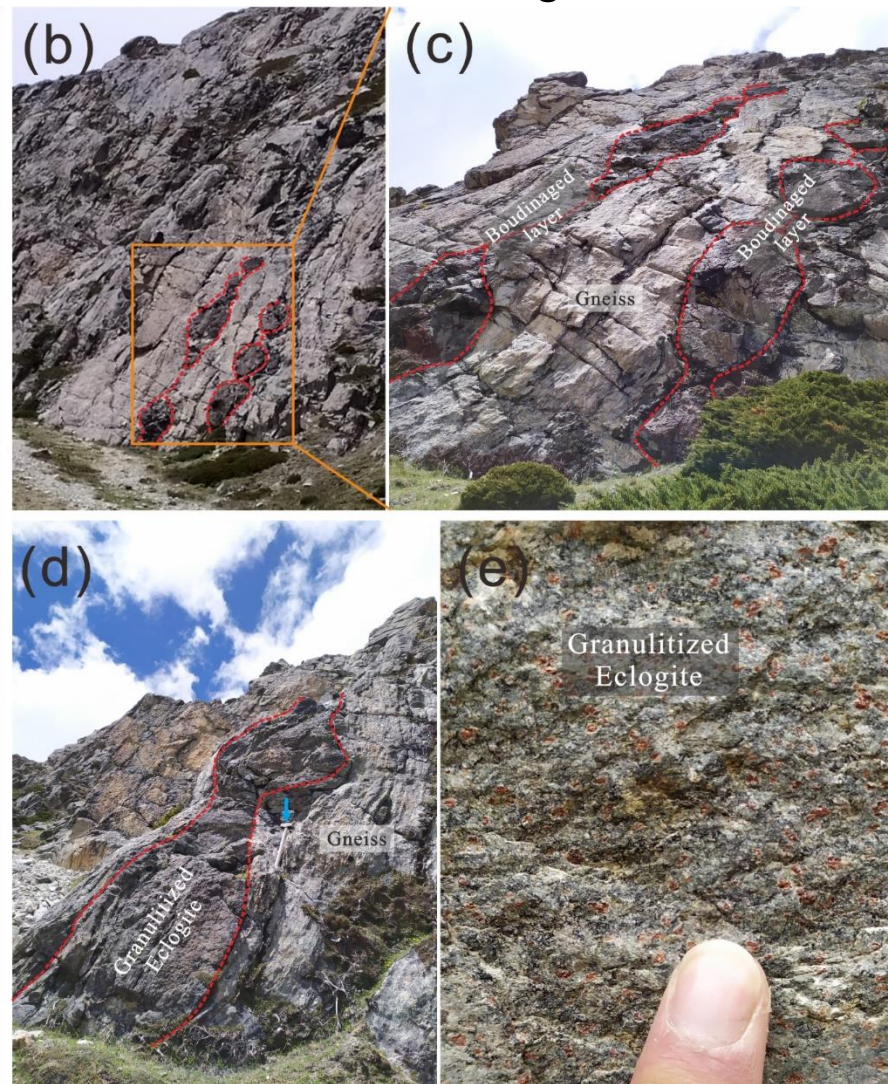
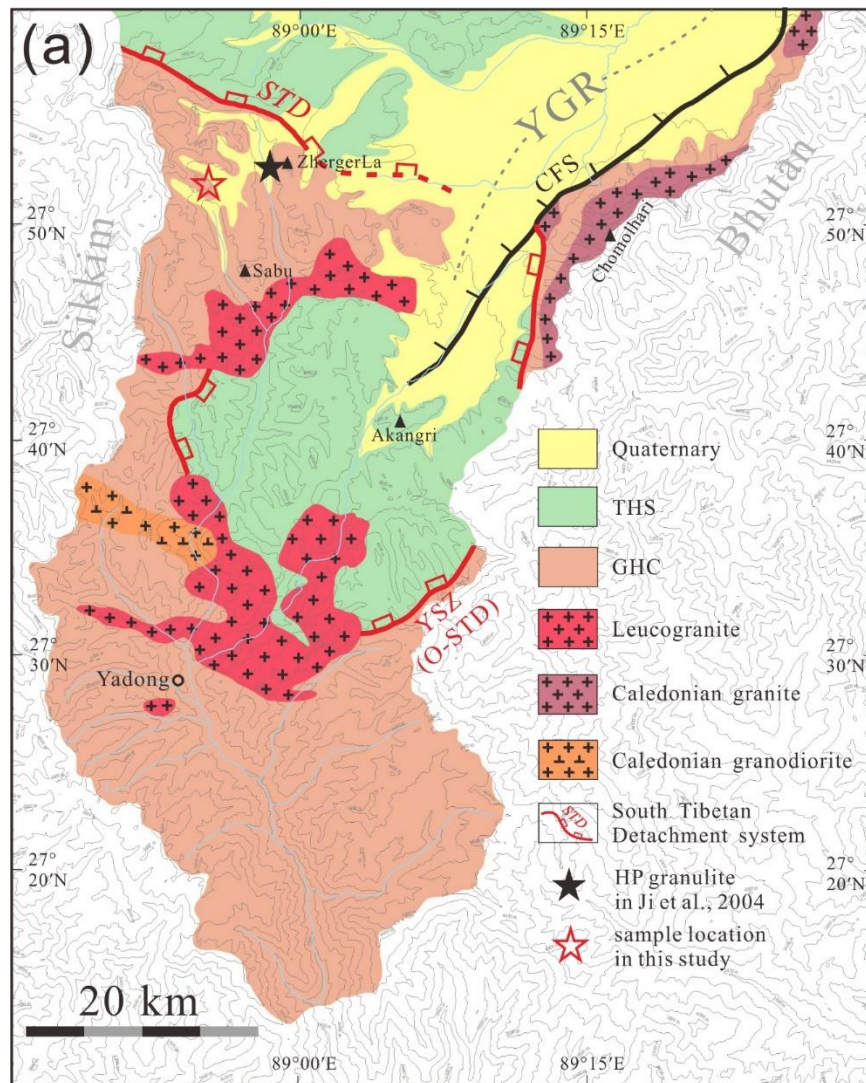
- The HP metamorphism with a thermal gradient of $\sim 7^{\circ}\text{C}/\text{km}$ reflects warm subduction from numerical modelling.
- HP rocks from ancient orogenic belts can firmly constrain the thermal structure of subduction zones if their P–T evolution is well recovered.

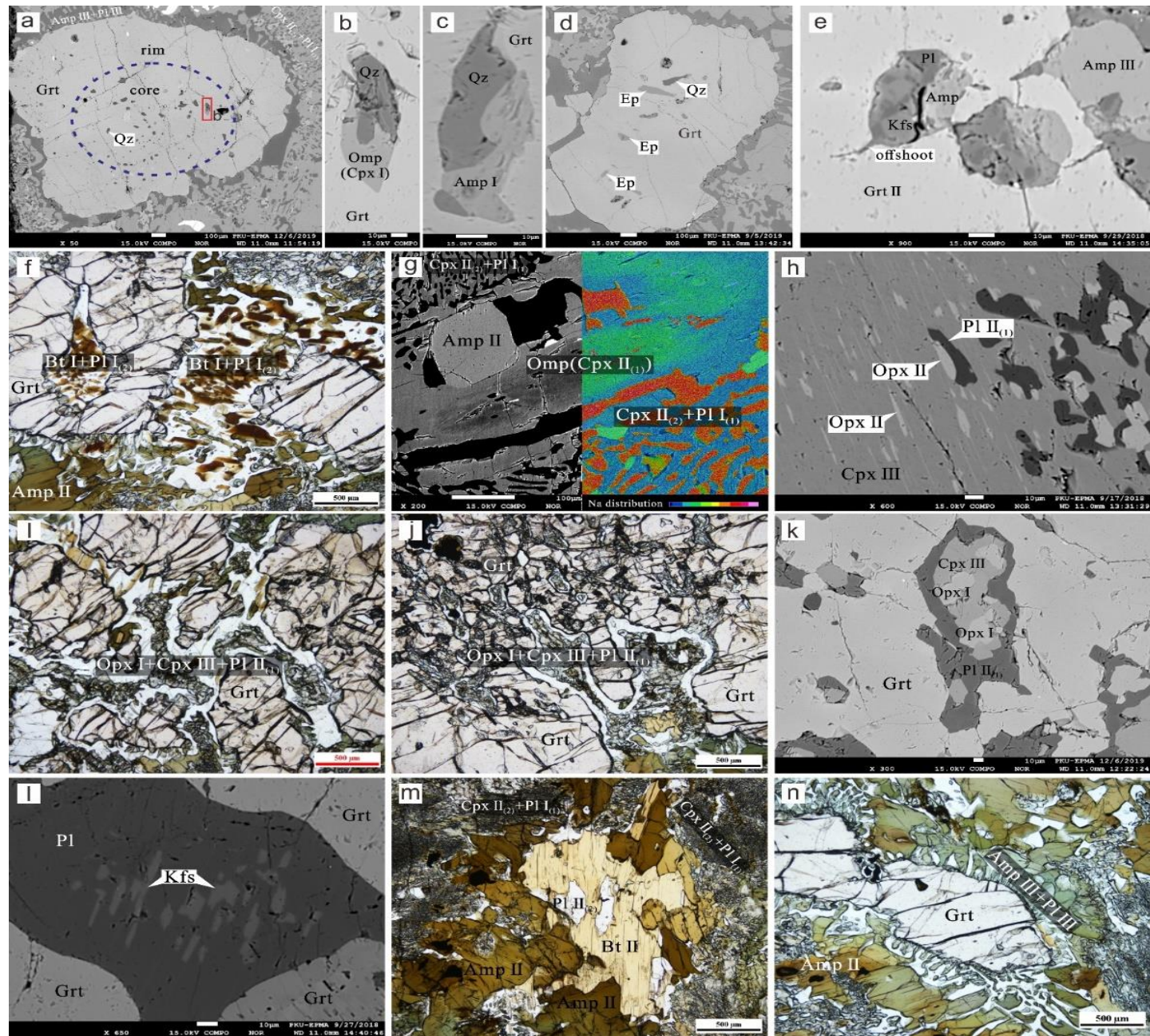
1.3 中喜马拉雅榴辉岩带



中喜马拉雅造山带亚东一带发现榴辉岩

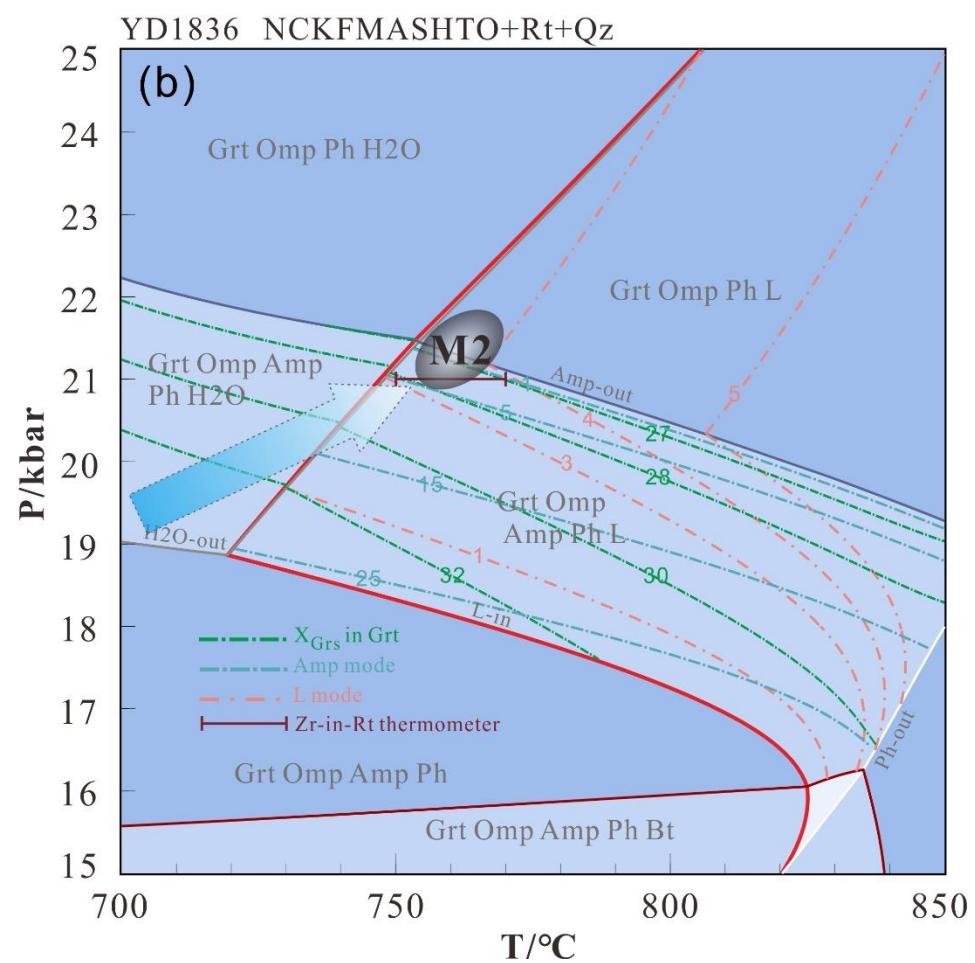
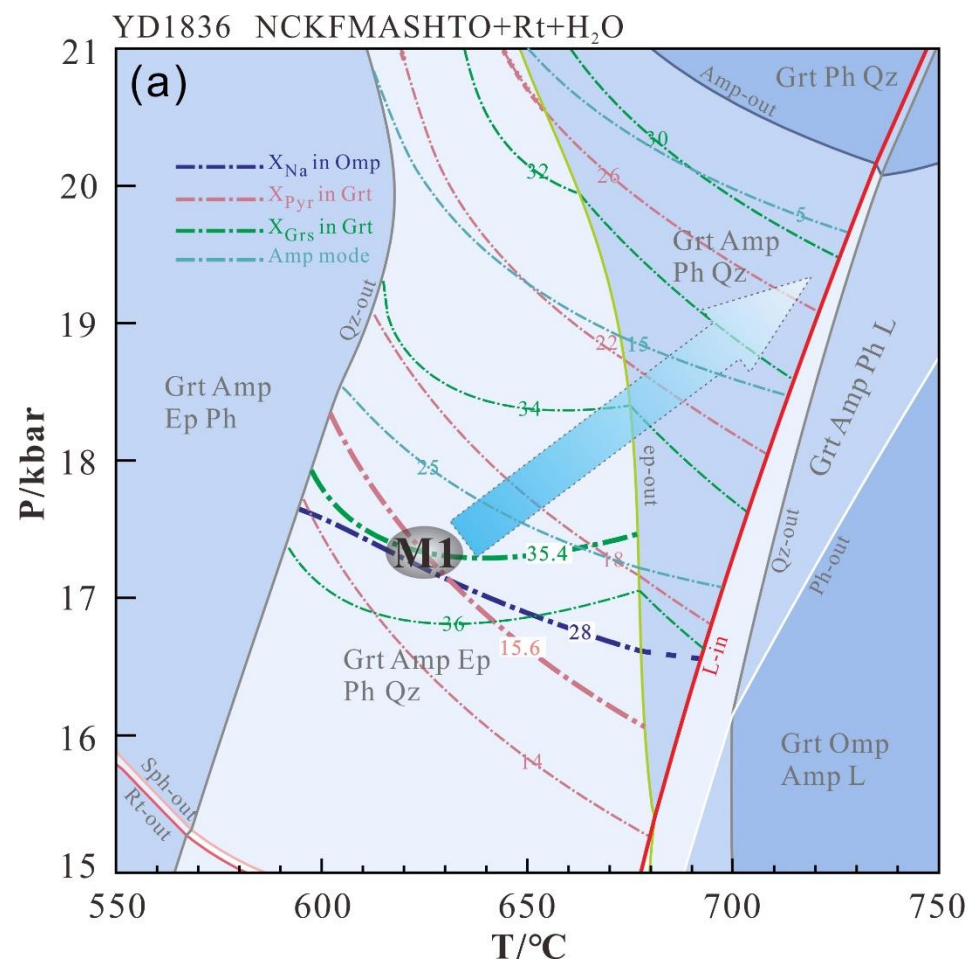
Wu & Zhang et al., 2021, JMG



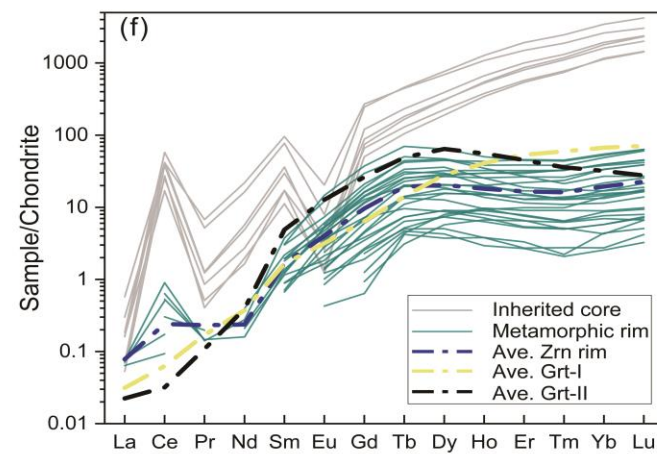
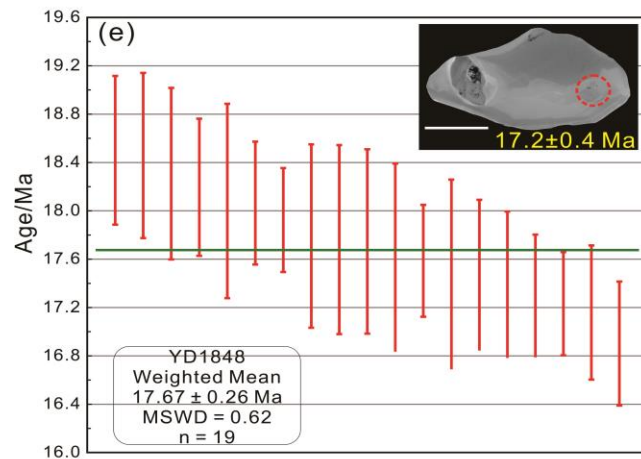
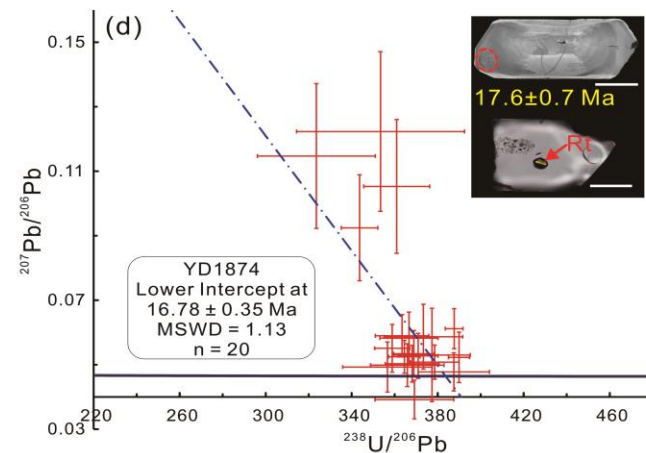
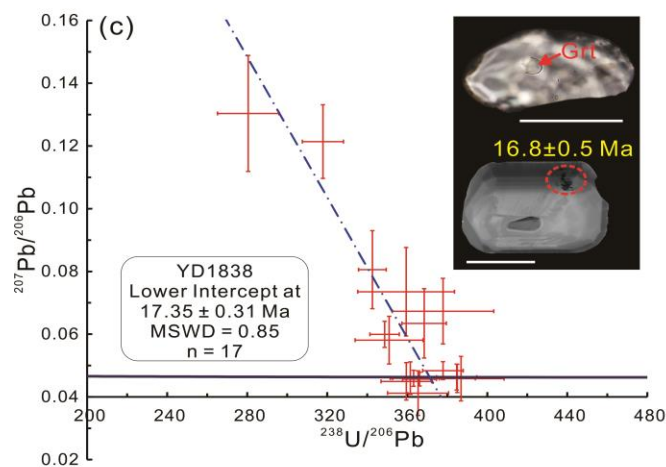
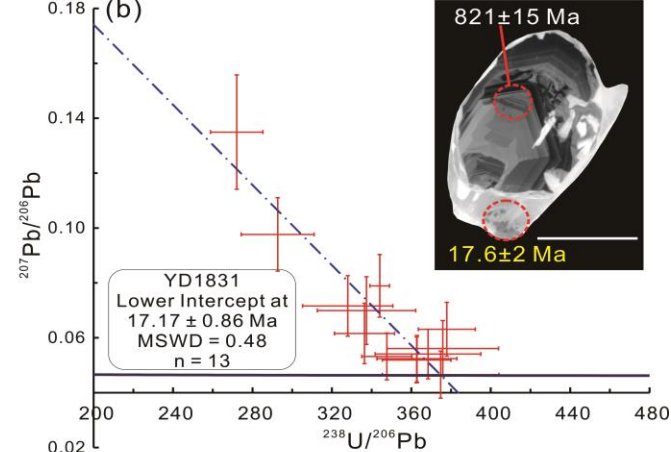
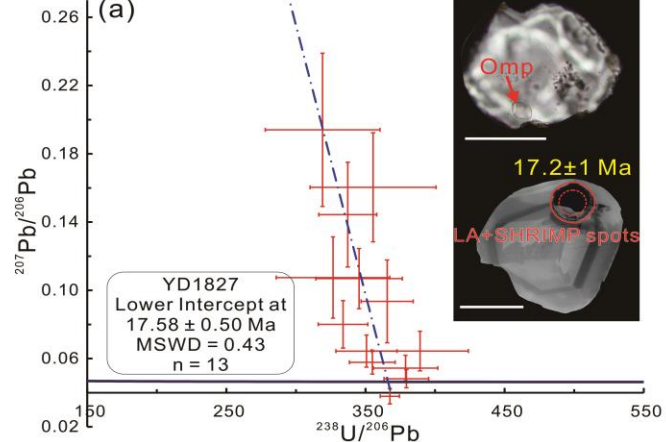


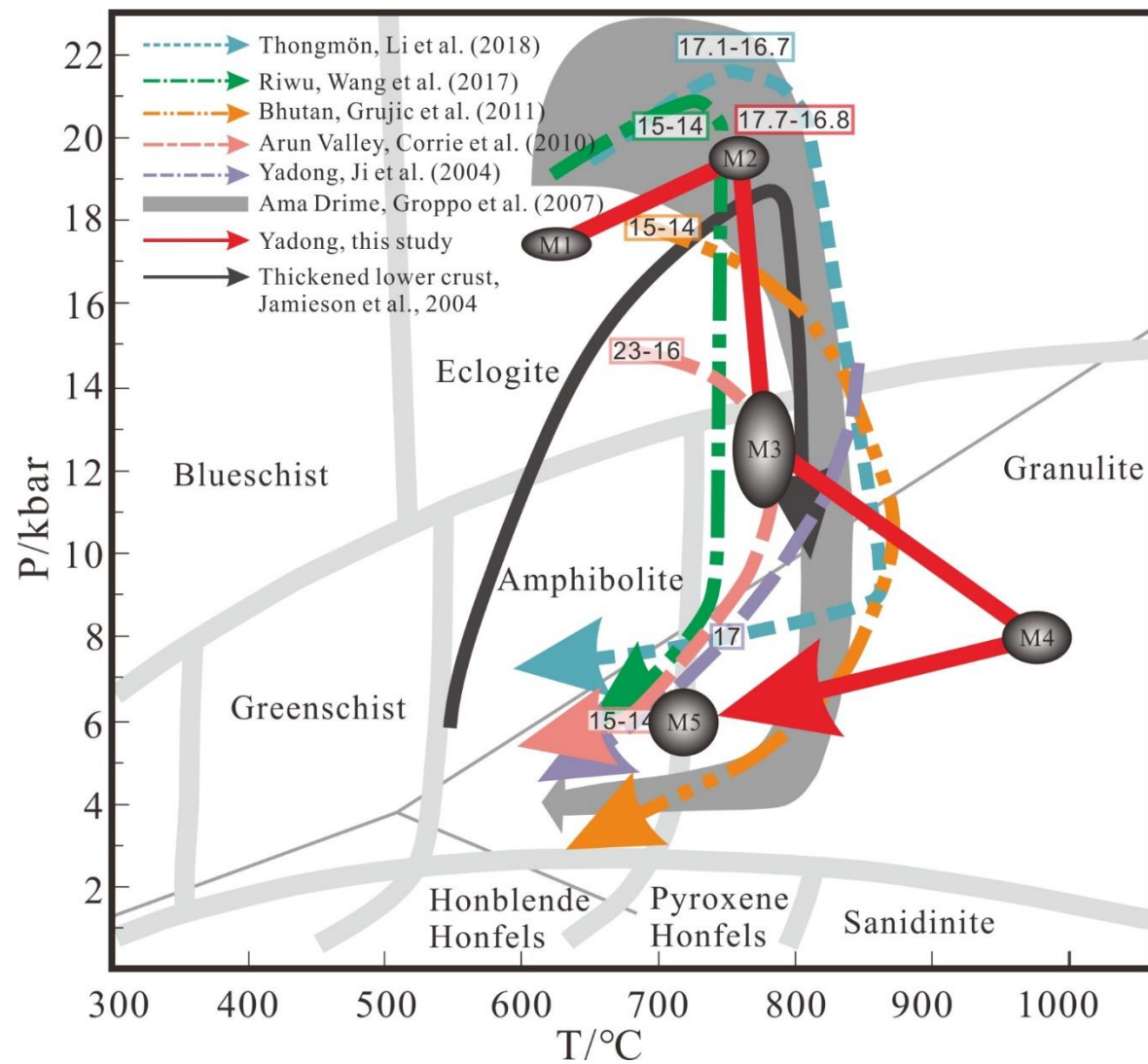
stages mineras	M1 Ep-Amp eclogite facies	M2 Peak eclogite facies	M3 High-Pressure granulite facies	M4 Two-Pyroxene granulite facies	M5 Amphibolite facies
Grt I	—————				
Grt II		—————			
Cpx I (Omp)	—————	—————			
Cpx II			—————		
Cpx III				—————	
Opx I				—————	
Opx II				—————	
Amp I	—————				
Amp II				—————	
Amp III					—————
Ep	—————				
Bt I			—————		
Bt II				—————	
Pl I			—————		
Pl II				—————	
Pl III					—————
Qz	—————			—————	—————
antiperthite				—————	
Melt I		—————			
Melt II			—————	—————	
Rt	—————	—————	—————		
Ilm				—————	—————
Ph*	—————	—————			

*Ph is represented by the symplektite of Bt I + Pl.

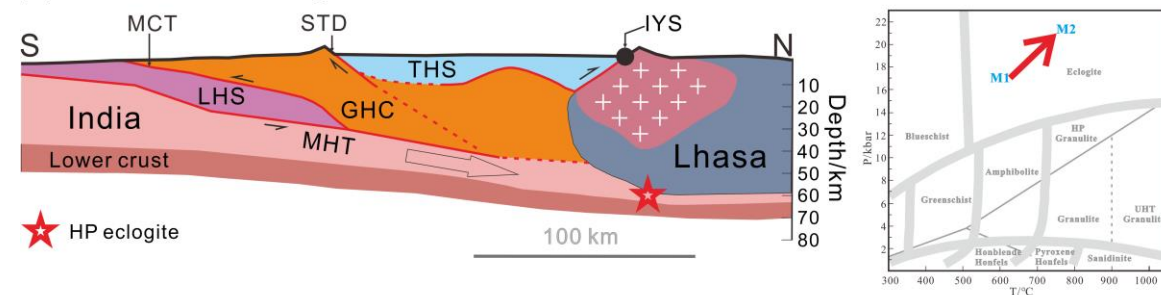


变质锆石时代： 16.8-17.6Ma

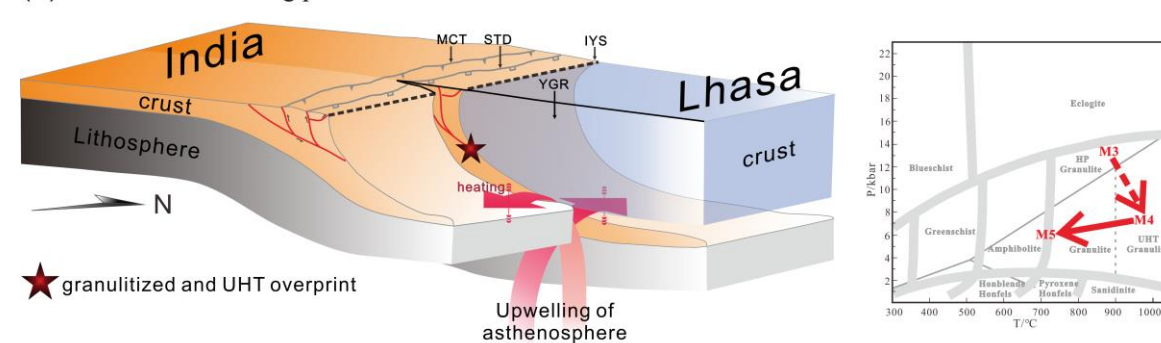




(a) M2: subduction during collision at ca. 17 Ma



(b) M4: slab tear during post-collisional exhumation



Wu, Zhang et al., 2021, JMG (in press)



Contents lists available at [ScienceDirect](https://www.sciencedirect.com)

Ore Geology Reviews

journal homepage: www.elsevier.com/locate/oregeorev



The chromitites of the Neoproterozoic Bou Azzer ophiolite (central Anti-Atlas, Morocco) revisited

Núria Pujol-Solà^{a,*}, Diego Domínguez-Carretero^a, Joaquín A. Proenza^a, Faouziya Haissen^b,
Moha Ikenne^c, José María González-Jiménez^{d,e}, Vanessa Colás^f, Lhou Maacha^g,
Antonio García-Casco^{d,e}

^a Departament de Mineralogia, Petrologia i Geologia Aplicada, Facultat de Ciències de la Terra, Universitat de Barcelona, Carrer Martí i Franquès, s/n, 08028 Barcelona, Spain

^b LGAGE, Département de Géologie, Faculté des Sciences Ben M'sik, Université Hassan II, Casablanca, Morocco

^c LAGAGE, Faculty of Sciences, Ibn Zohr University, Agadir, Morocco

^d Departamento de Mineralogía y Petrología, Facultad de Ciencias, Universidad de Granada, Avda. Fuentenueva, s/n, 18071 Granada, Spain

^e Instituto Andaluz de Ciencias de la Tierra (CSIC-UGR), Avda. de las Palmeras 4, E-18100 Armilla, Granada, Spain

^f Instituto de Geología, Universidad Nacional Autónoma de México, Ciudad Universitaria, 04510 Ciudad de México, Mexico

^g MANAGEM Group, 191, bd Mohamed Zerkouni, angle bd., Massira Alkhadra, Twin Center Tour, A-20100 Casablanca, Morocco

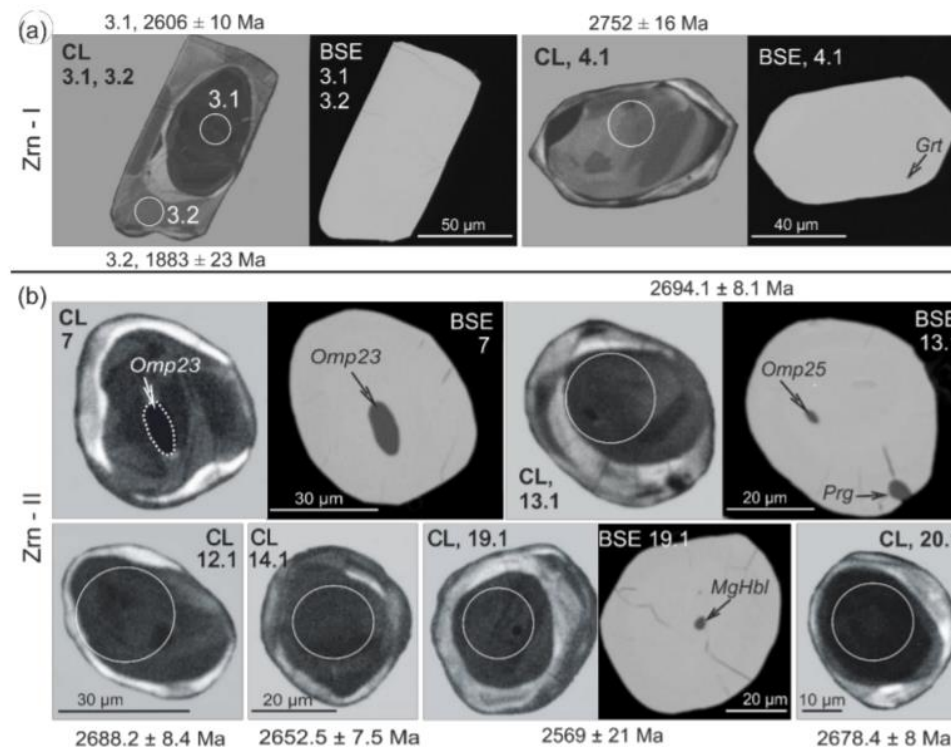
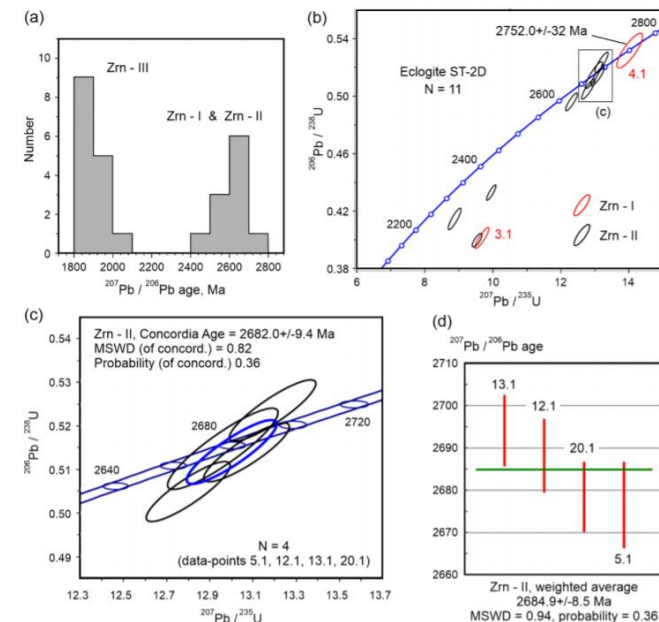
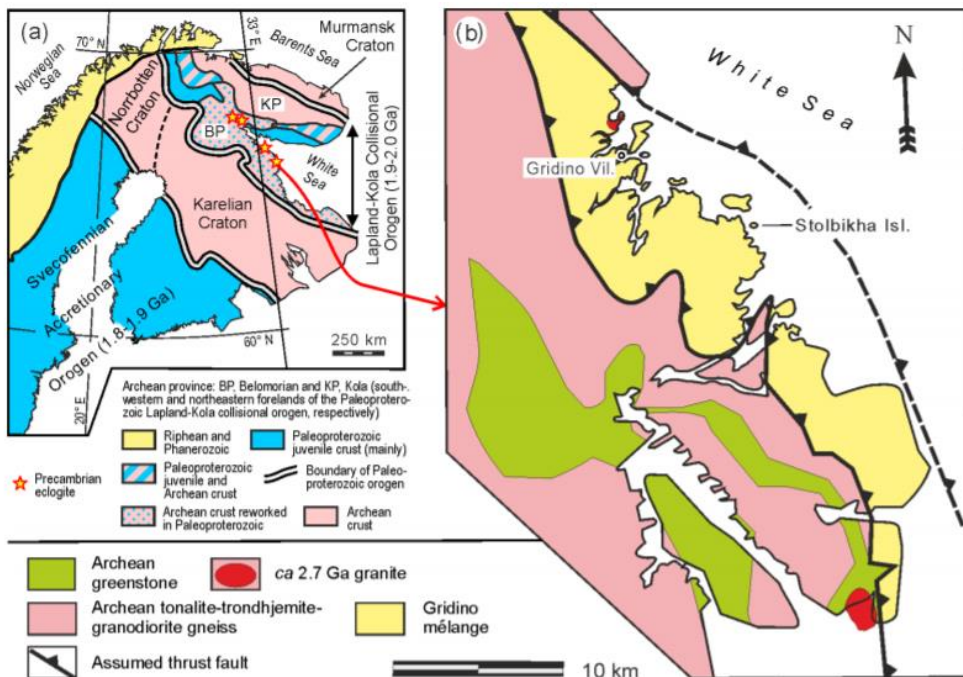
将 Bou Azzer 铬铁矿与世界上其他前寒武纪蛇绿岩铬铁矿进行比较，认为Bou Azzer铬铁矿形成于俯冲-初始地球动力学环境，具有两个演化阶段，早期形成FAB-derived intermediate-Cr 铬铁矿，晚期形成 boninite-derived high-Cr 铬铁矿。

Article

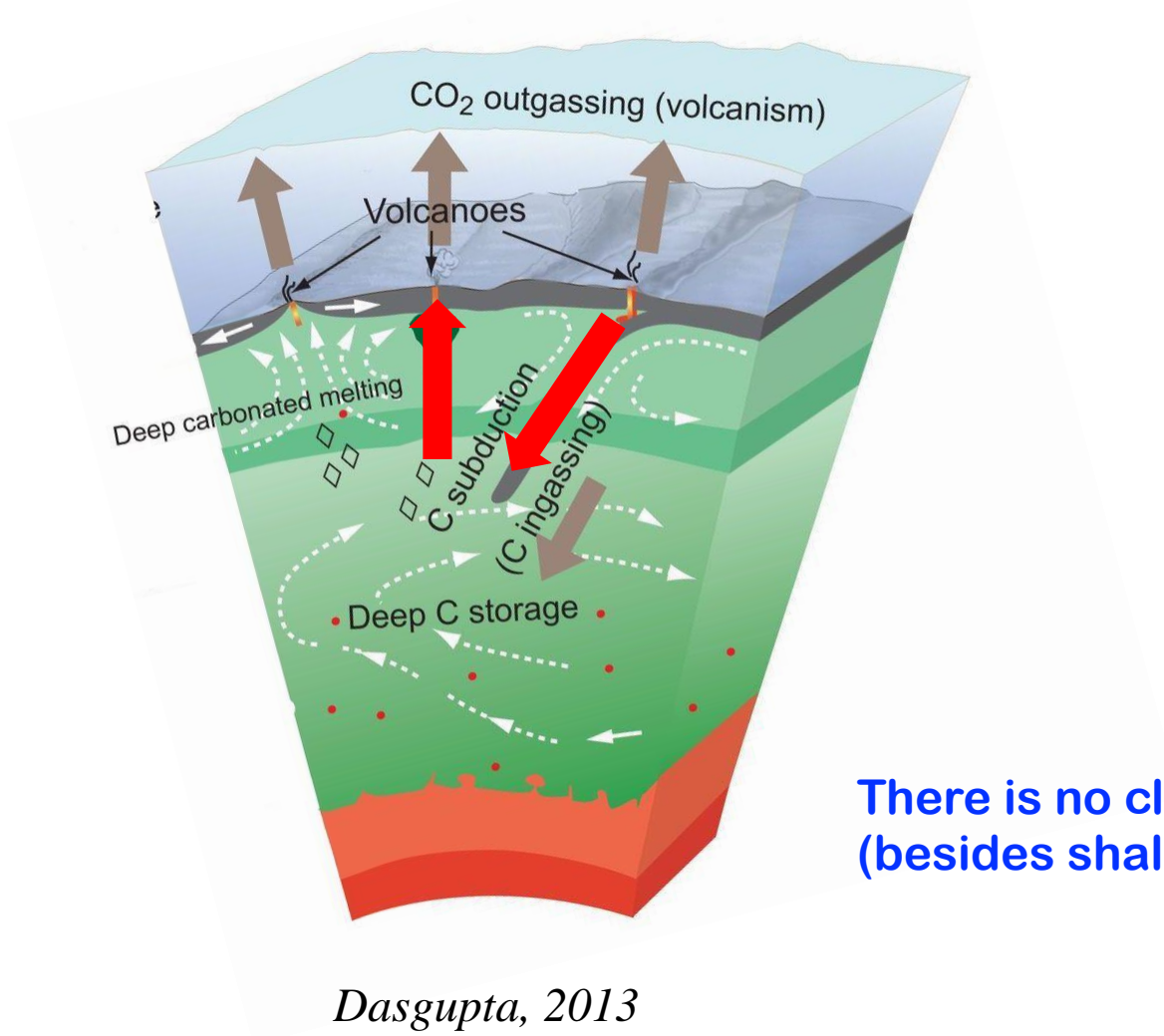
Archean Zircons with Omphacite Inclusions from Eclogites of the Belomorian Province, Fennoscandian Shield: The First Finding

Oleg I. Volodichev, Oleg A. Maksimov *, Tatiana I. Kuzenko, Alexander I. Slabunov

锆石U-Pb年龄：
26.8-27.5亿年



2. 俯冲带深部无机碳水化合物与碳循环 Abiotic hydrocarbons and the deep C cycle



Deep carbon cycle

Regulates habitability

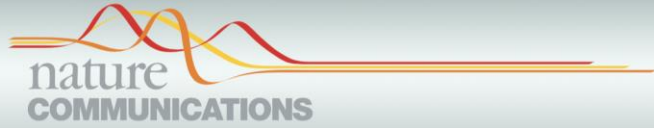
Provides C for life



Our “frame” of the deep C cycle
is based in CO₂

There is no clear picture of a CH₄-H₂ cycle in subduction zones
(besides shallow thermogenic gases < 300 °C)

2.1 西阿尔卑斯高压变质蛇纹岩中的CH4

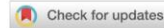


Alberto Vitale Brovarone (2020)

ARTICLE

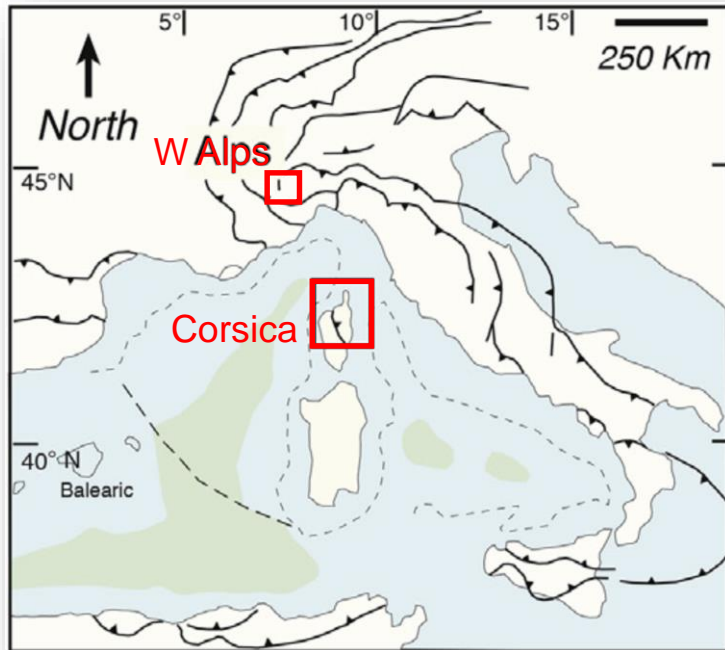
<https://doi.org/10.1038/s41467-020-17342-x>

OPEN



Subduction hides high-pressure sources of energy that may feed the deep subsurface biosphere

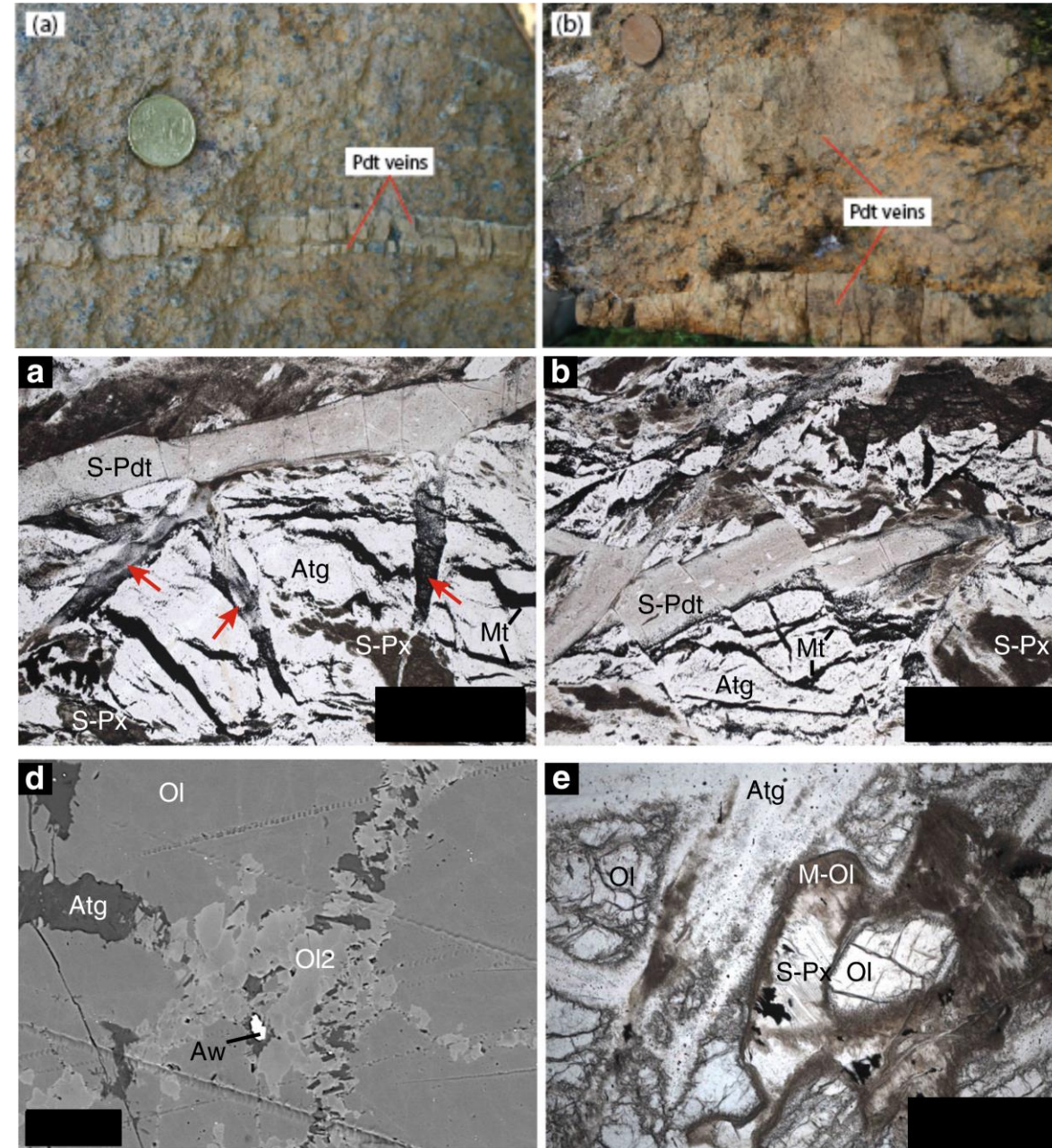
A. Vitale Brovarone^{1,2}, D. A. Sverjensky³, F. Piccoli⁴, F. Ressico¹, D. Giovannelli^{5,6,7,8} & I. Daniel⁹



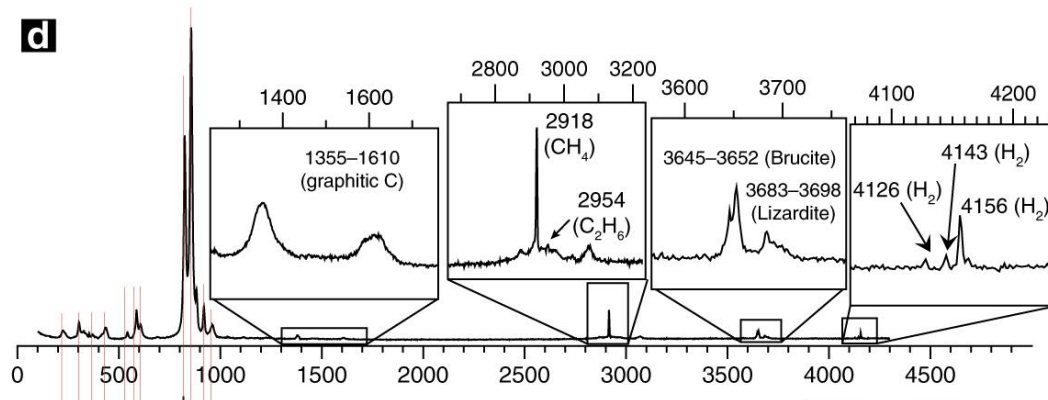
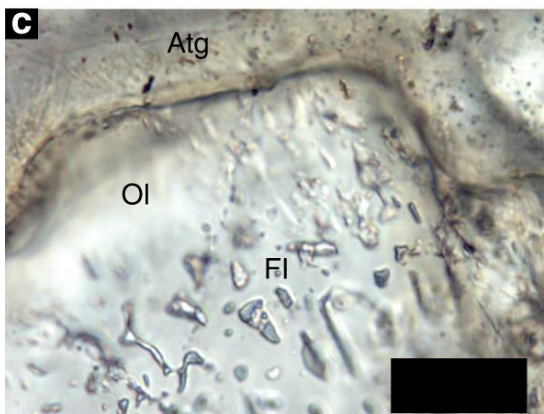
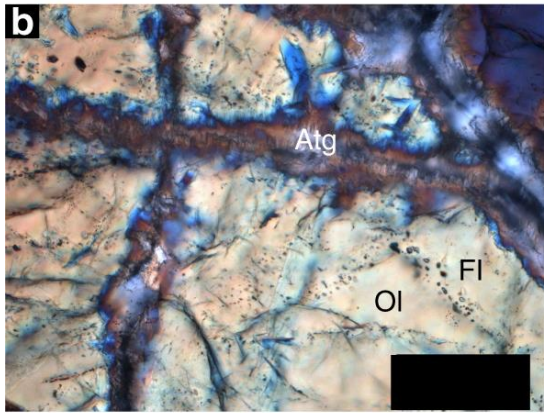
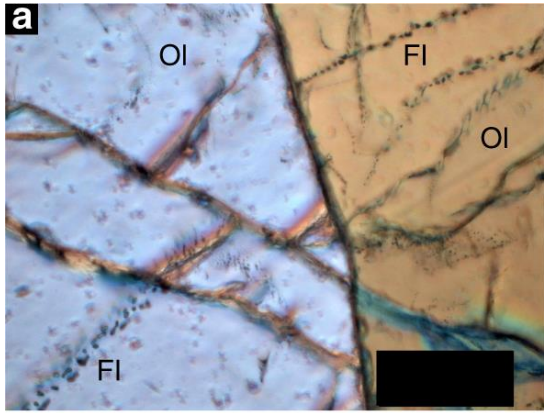
Study areas:

- ① Lanzo massif, Western Alps (Eclogite facies, 80km)
- ② Cima di Gratera, Corsica (Blueschist facies, 45km)
- ③ Monte San Petrone, Corsica (Eclogite facies, 70km)

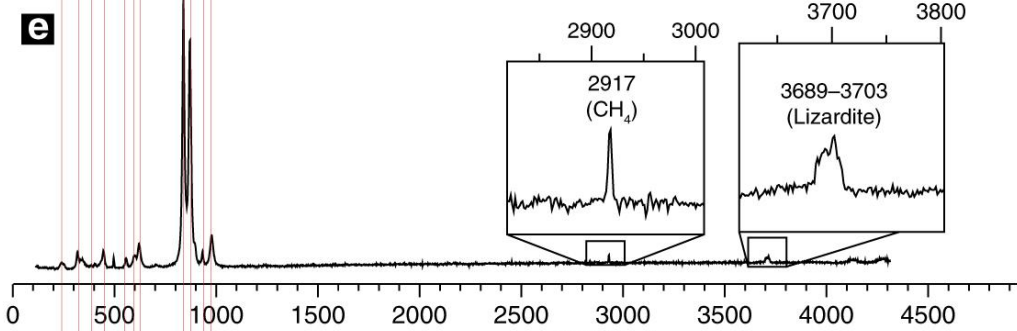
☐ Pseudotachylyte-bearing peridotites



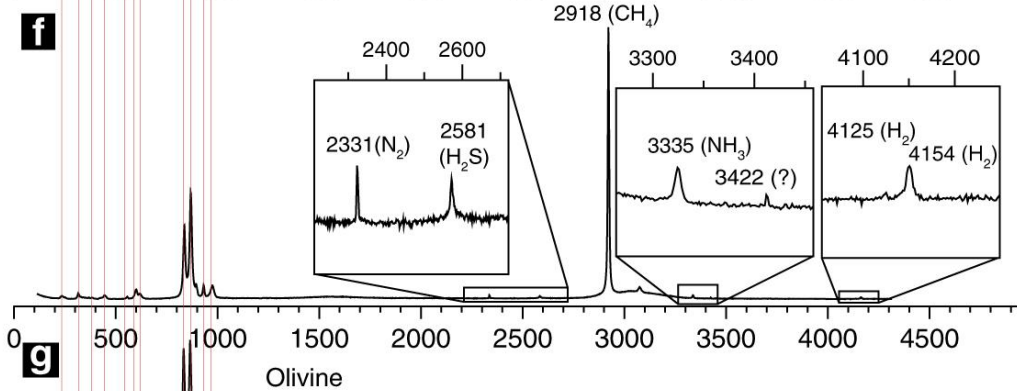
Olivine-hosted fluid inclusions in partially serpentinized pseudotachylyte-bearing peridotite



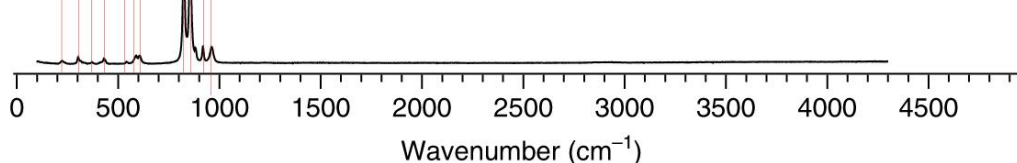
← 1 GPa
(Blueschist facies)



← 2 GPa
(Eclogite facies)



← 2 GPa
(Eclogite facies)



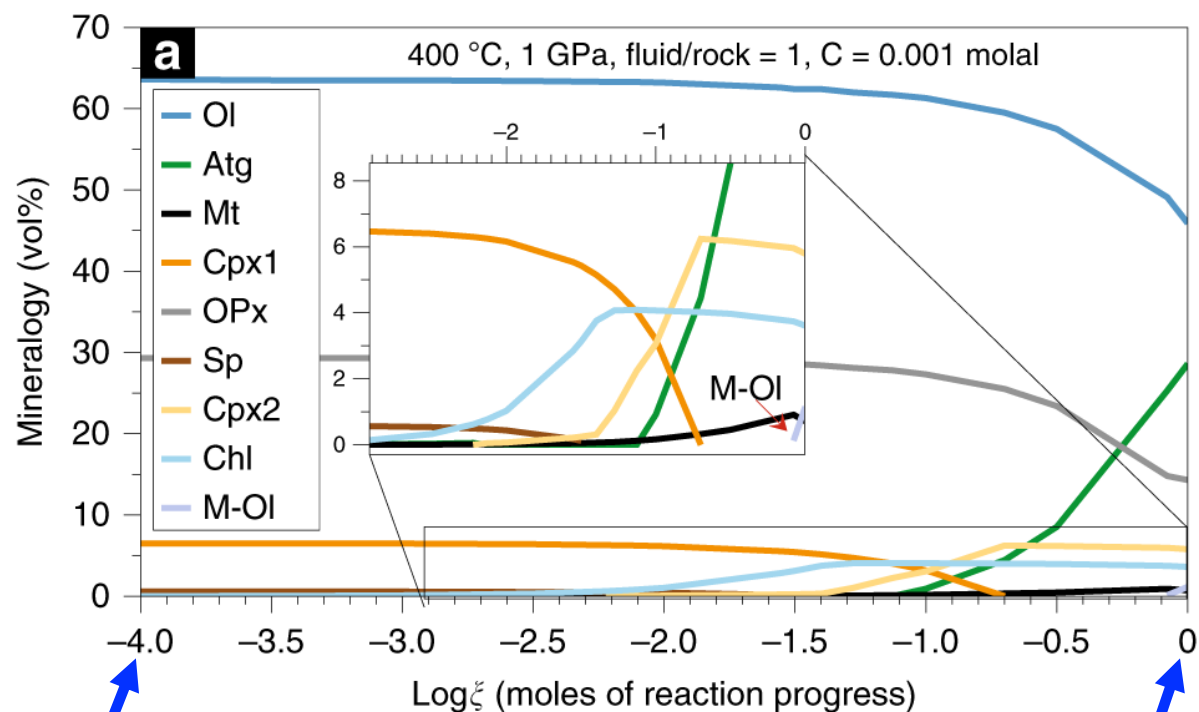
← Host olivine

Fluid composition

- CH₄
- H₂
- H₂S
- NH₃

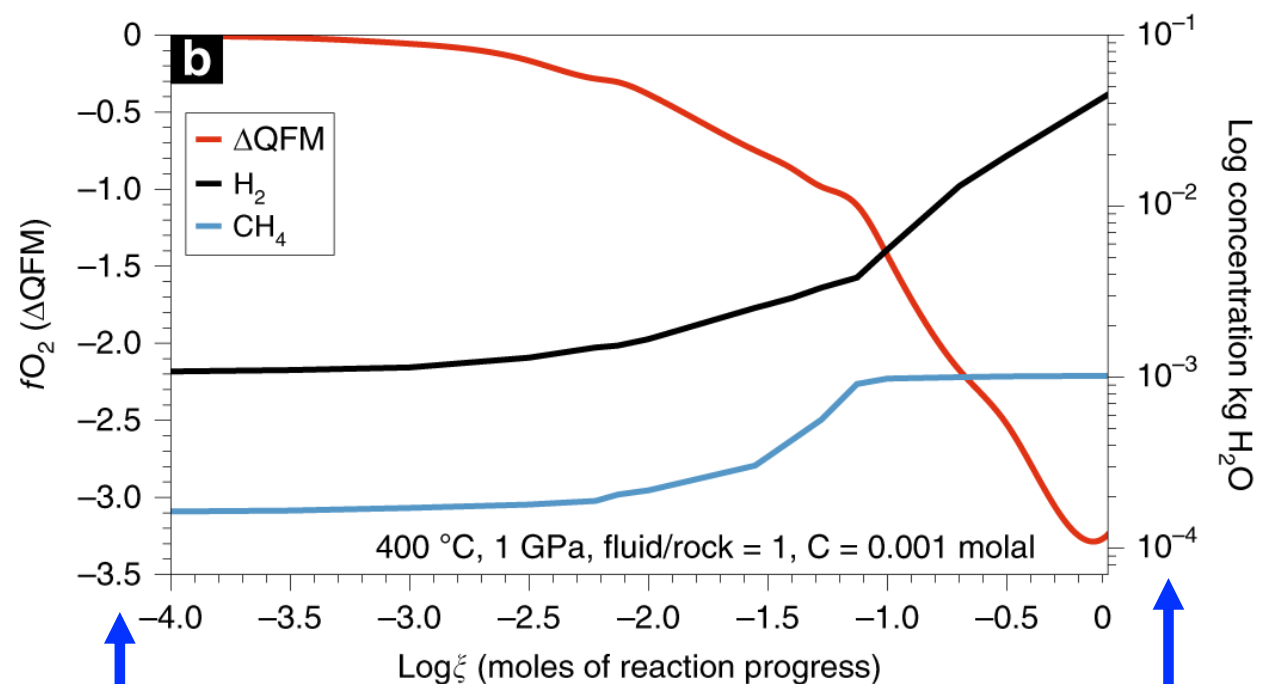
Intense HP
serpentinization
releasing CH₄-
H₂-rich fluids at
40-80 km depth.

Thermodynamic modeling with Deep Earth Water Model (DEW model)



Aqueous fluid start reacting with a peridotite

Fluid and (serpentinized) peridotite reach equilibrium

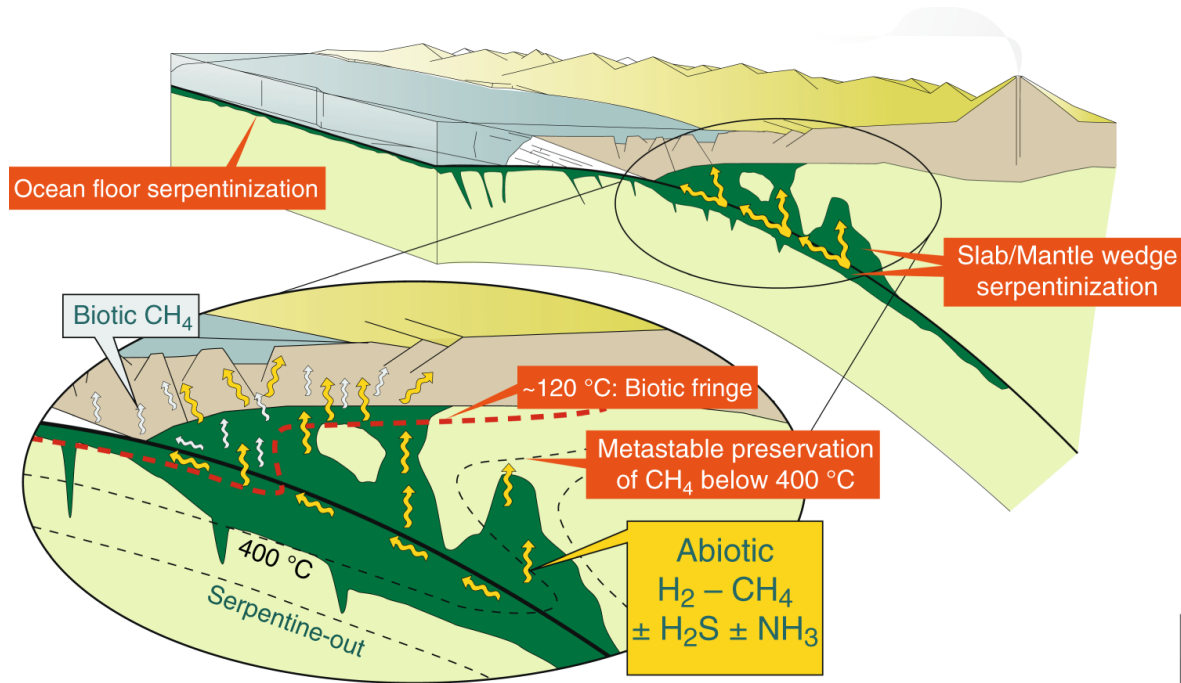


ΔQFM

H_2 , CH_4

Global implications

Serpentinization may affect slab and mantle wedge ultramafic rocks over 1000s of km of convergent margins



Conservative* H_2 and CH_4 flux estimates from deep subduction serpentinization (35-70 km only)

- 9×10^{-3} to $0.3 \text{ Mt/y } \text{H}_2$ (MOR: 2×10^{-2} to 1.4 Mt/y)
- 2.3×10^{-3} to $1 \text{ Mt/y } \text{CH}_4$ (MOR: 1.1 to 1.9 Mt/y)

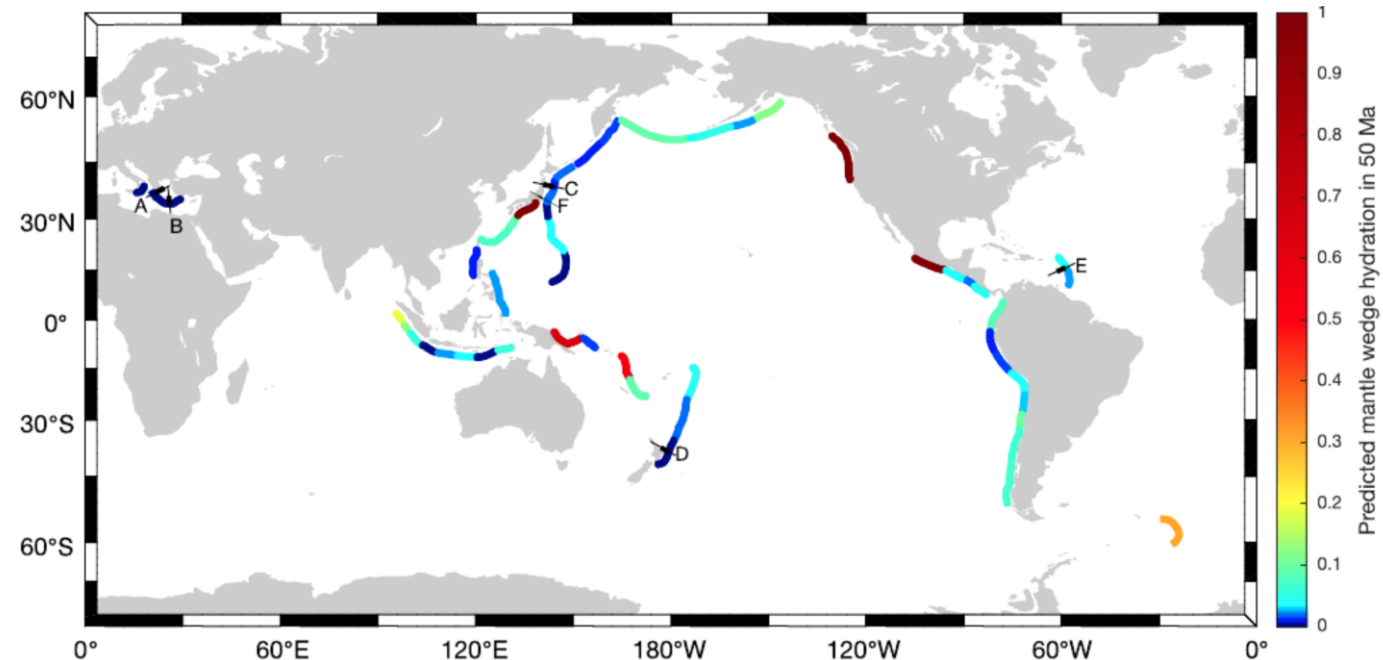
* Low C concentrations; instantaneous H_2 - CH_4 concentrations (not cumulative)

SCIENCE ADVANCES | RESEARCH ARTICLE

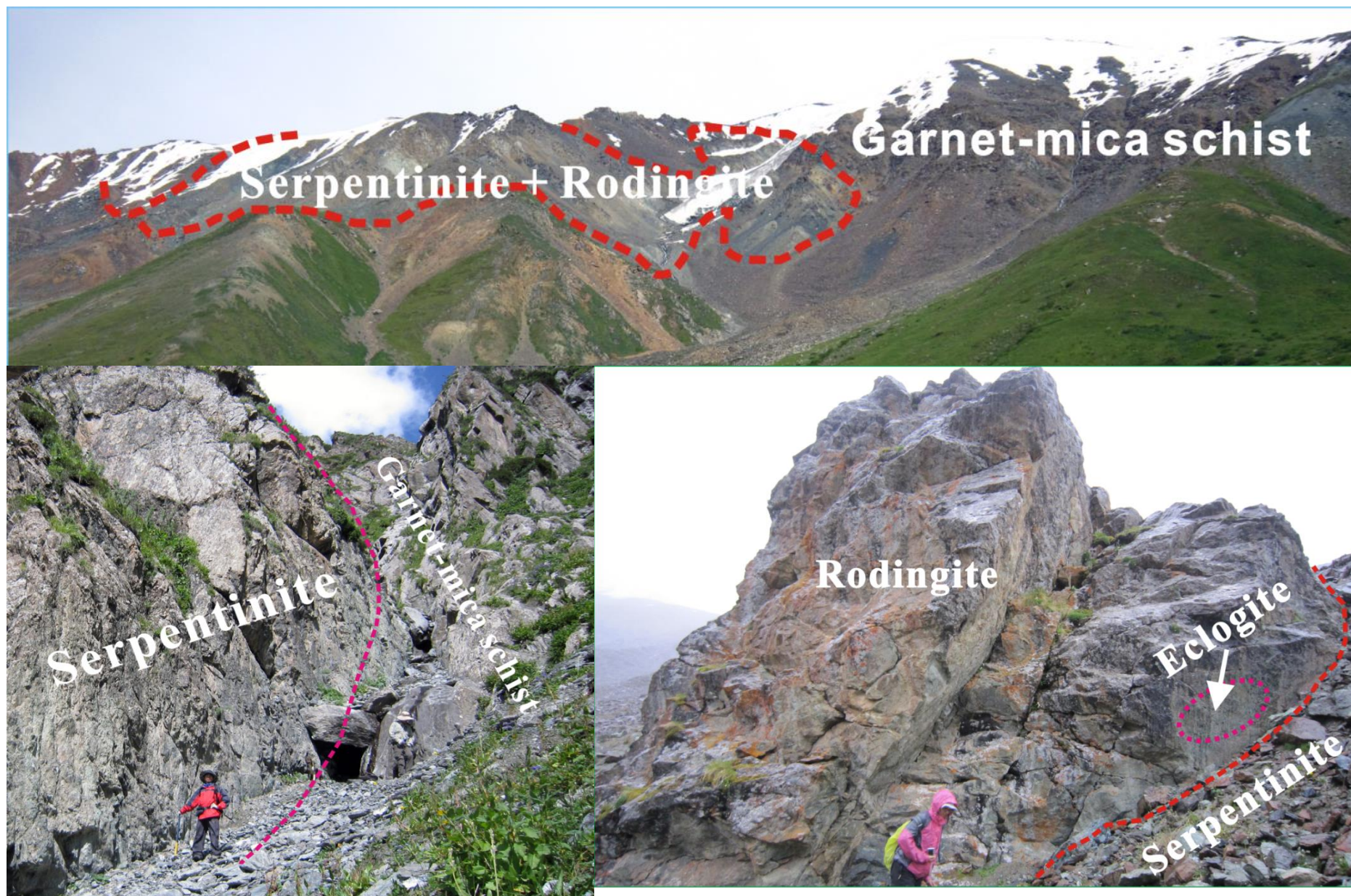
GEOPHYSICS

Earthquakes track subduction fluids from slab source to mantle wedge sink

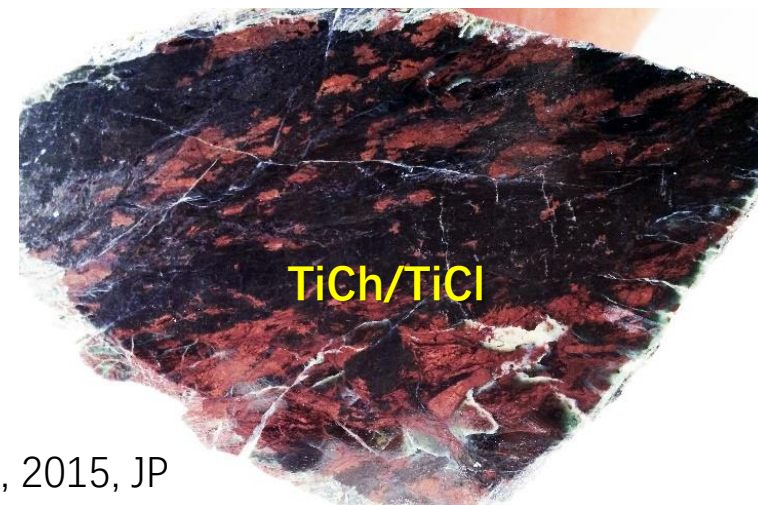
Felix Halpaap^{1*}, Stéphane Rondenay¹, Alexander Perrin², Saskia Goes², Lars Ottemöller¹, Håkon Austrheim³, Robert Shaw², Thomas Eeken²



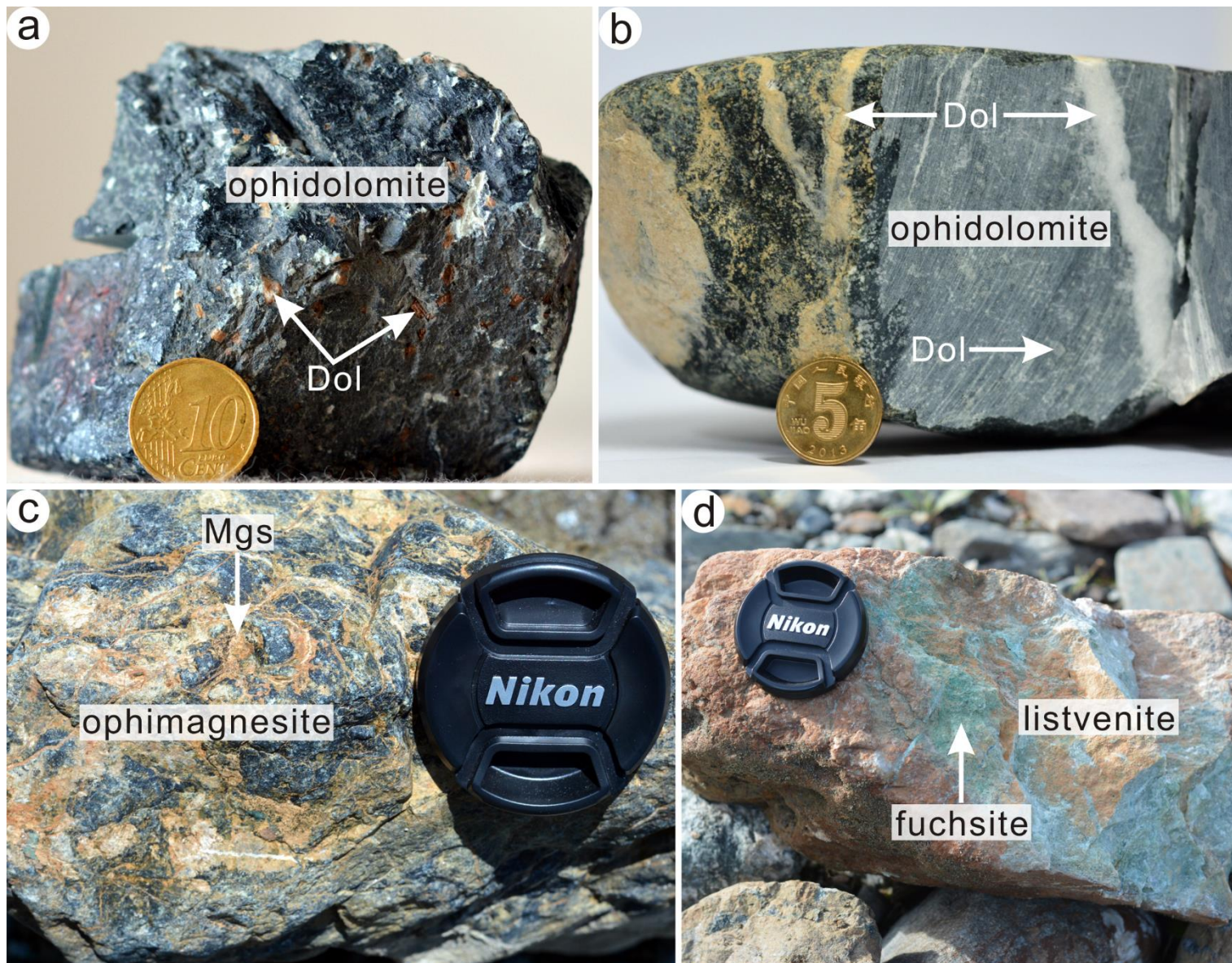
2.2 西南天山超高压变质蛇纹岩中的CH₄



区域地质背景及野外地质产状

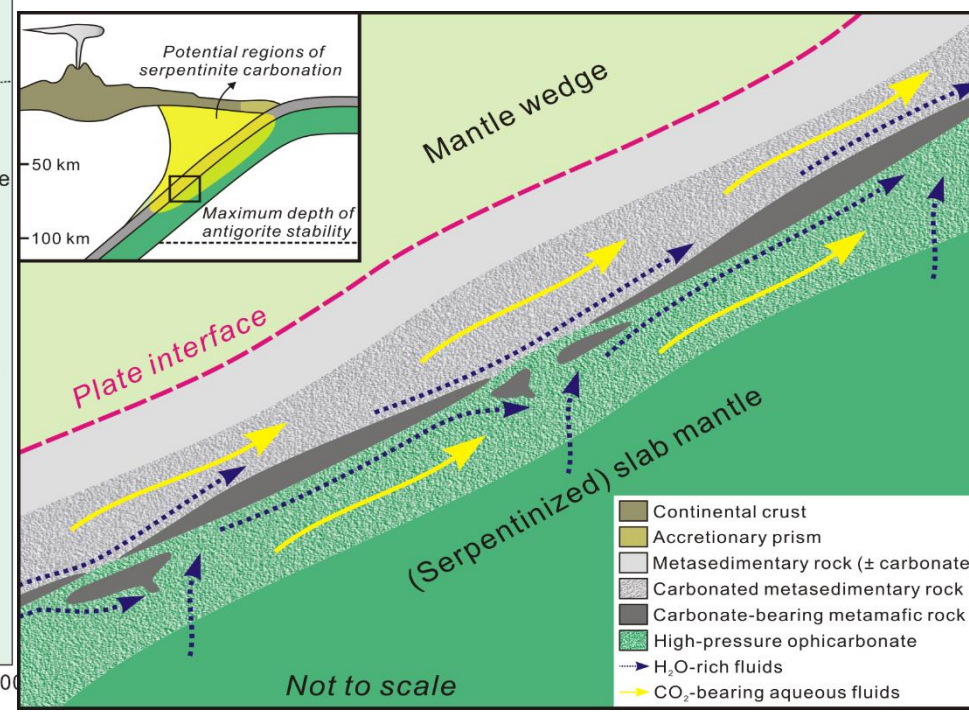
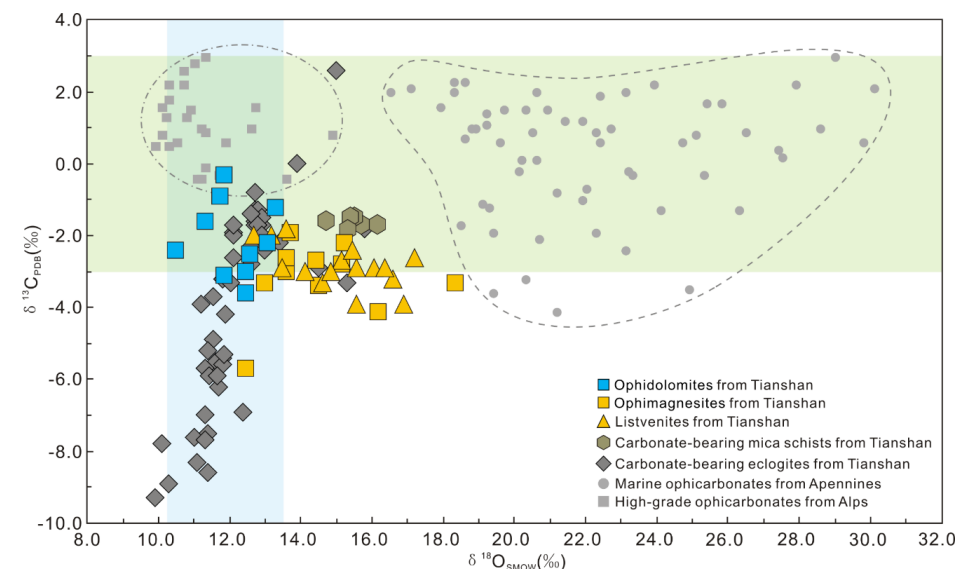
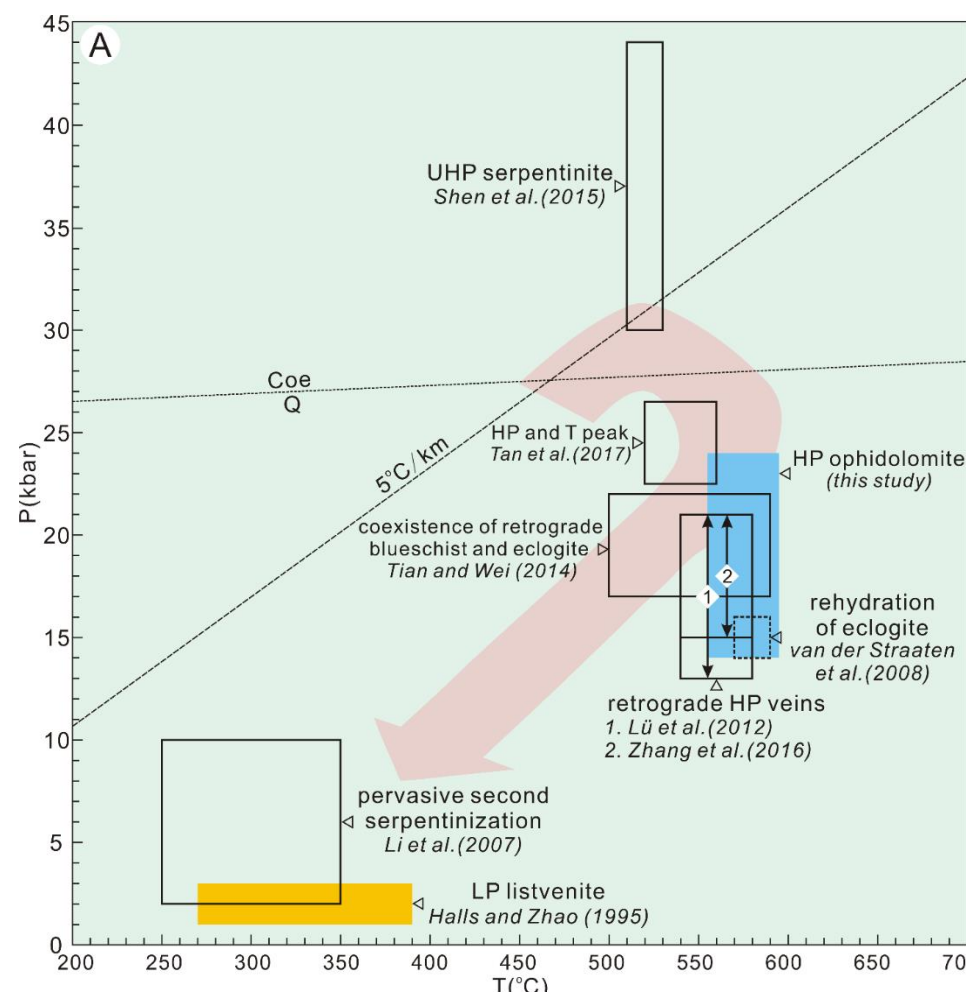


Shen and Zhang et al., 2015, JP

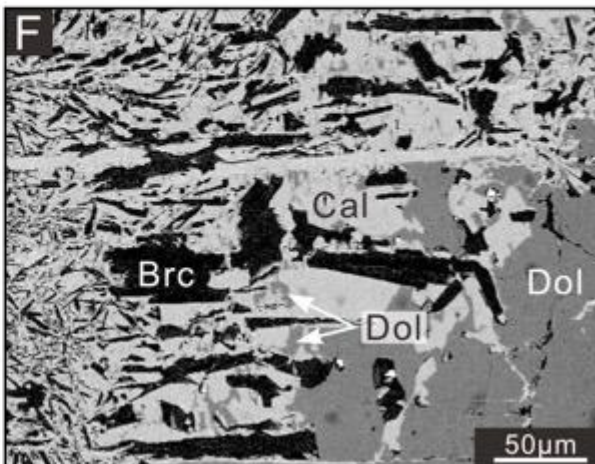
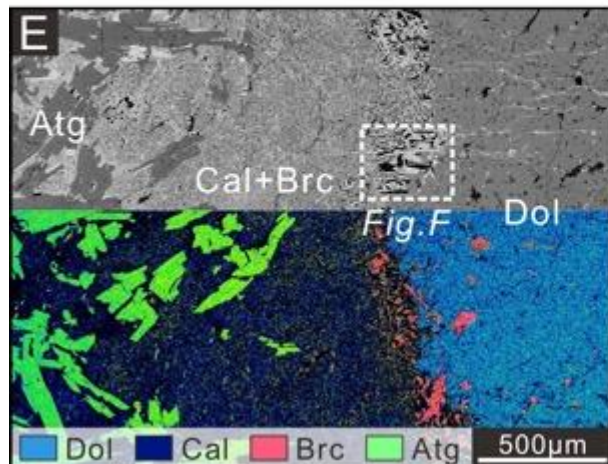
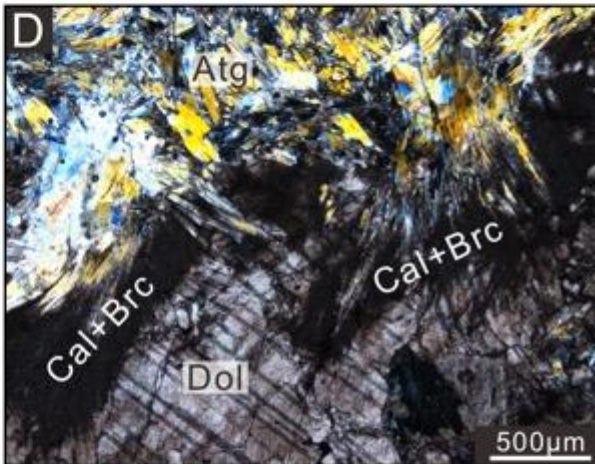
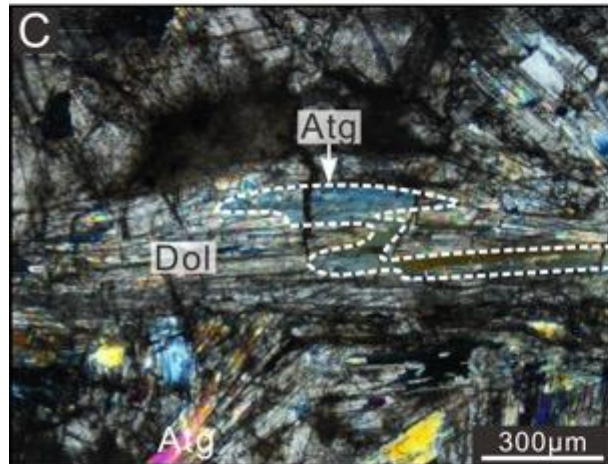
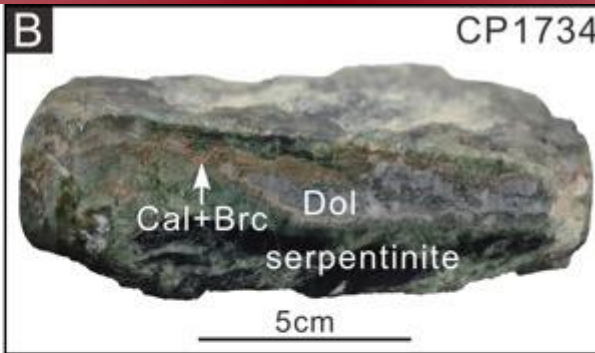
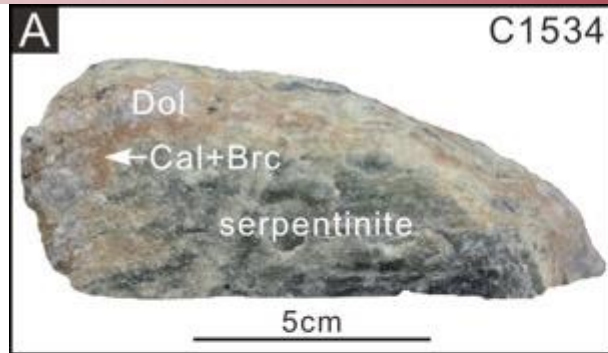


Multistage CO₂ sequestration in the subduction zone: Insights from exhumed carbonated serpentinites, SW Tianshan UHP belt, China

Weigang Peng^{a,b}, Lifei Zhang^{a,*}, Manuel D. Menzel^c, Alberto Vitale Brovarone^{d,e},
Simone Tumati^b, Tingting Shen^f, Han Hu^a

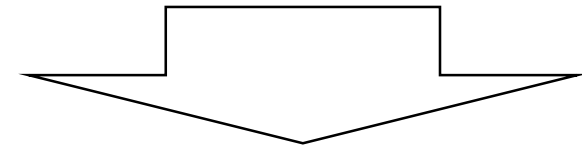


寄主ophidolomite岩相学特征



Dol的形成

含CO₂流体-蛇纹岩作用
(HP ophidolomite?)

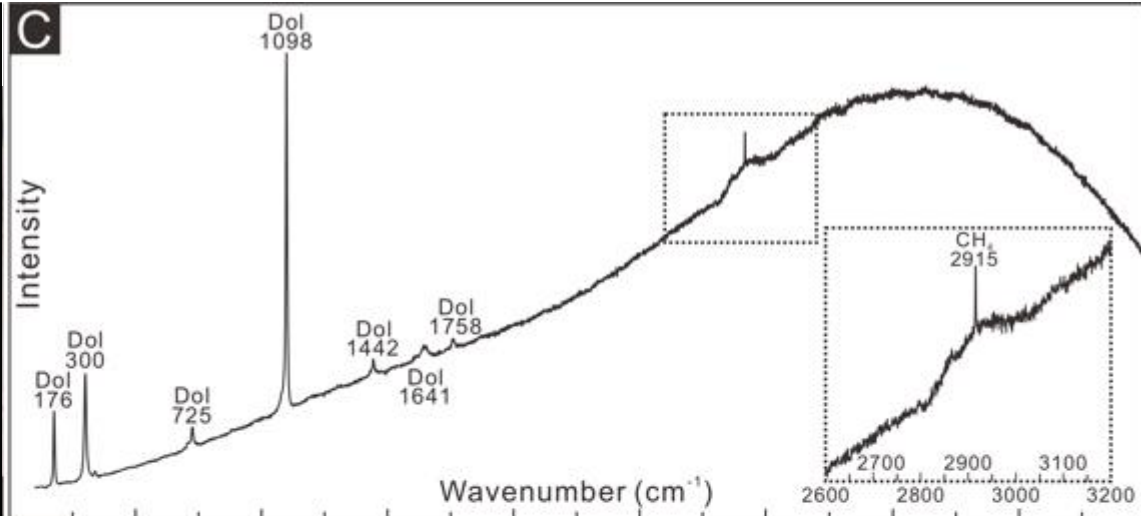
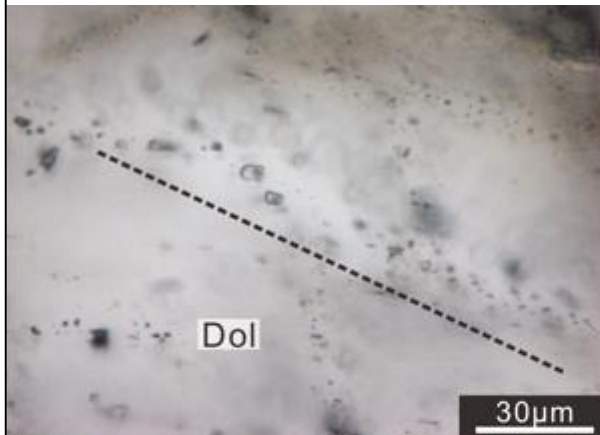


Dol的分解

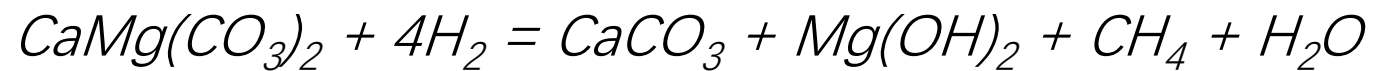
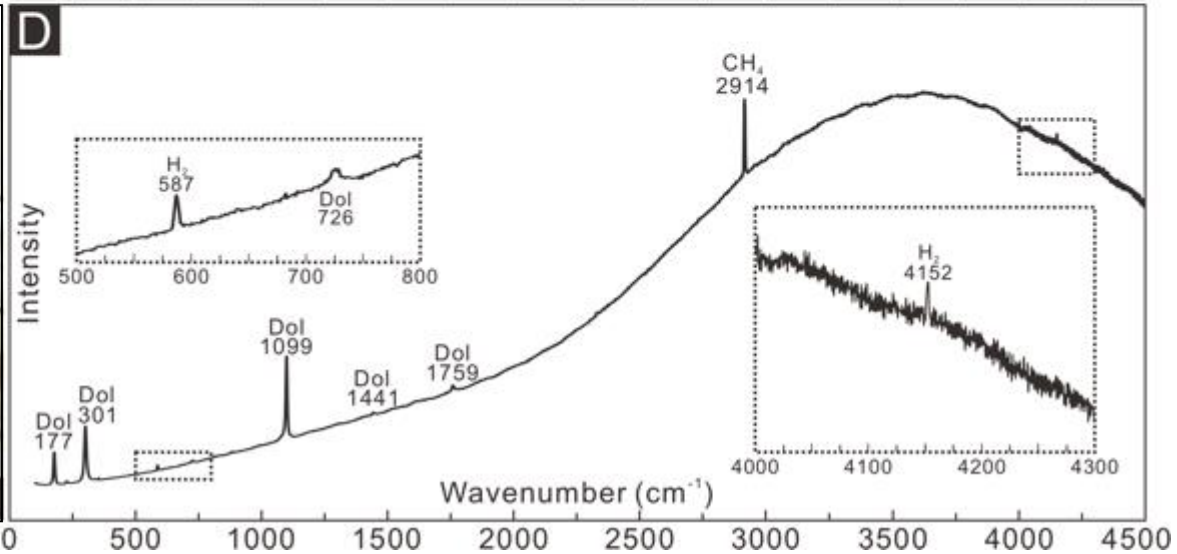
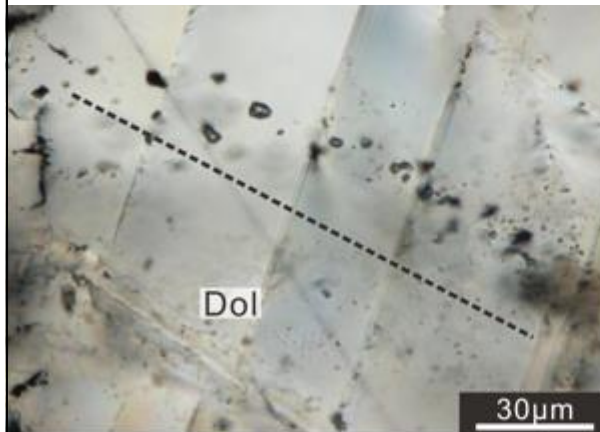


蛇纹岩中H₂,CH₄包裹体特征

CH₄ + H₂O (Type 1)



CH₄ + H₂ (Type 2)



Available online at www.sciencedirect.com

ScienceDirect

Geochimica et Cosmochimica Acta 311 (2021) 119–140

**Geochimica et
Cosmochimica
Acta**

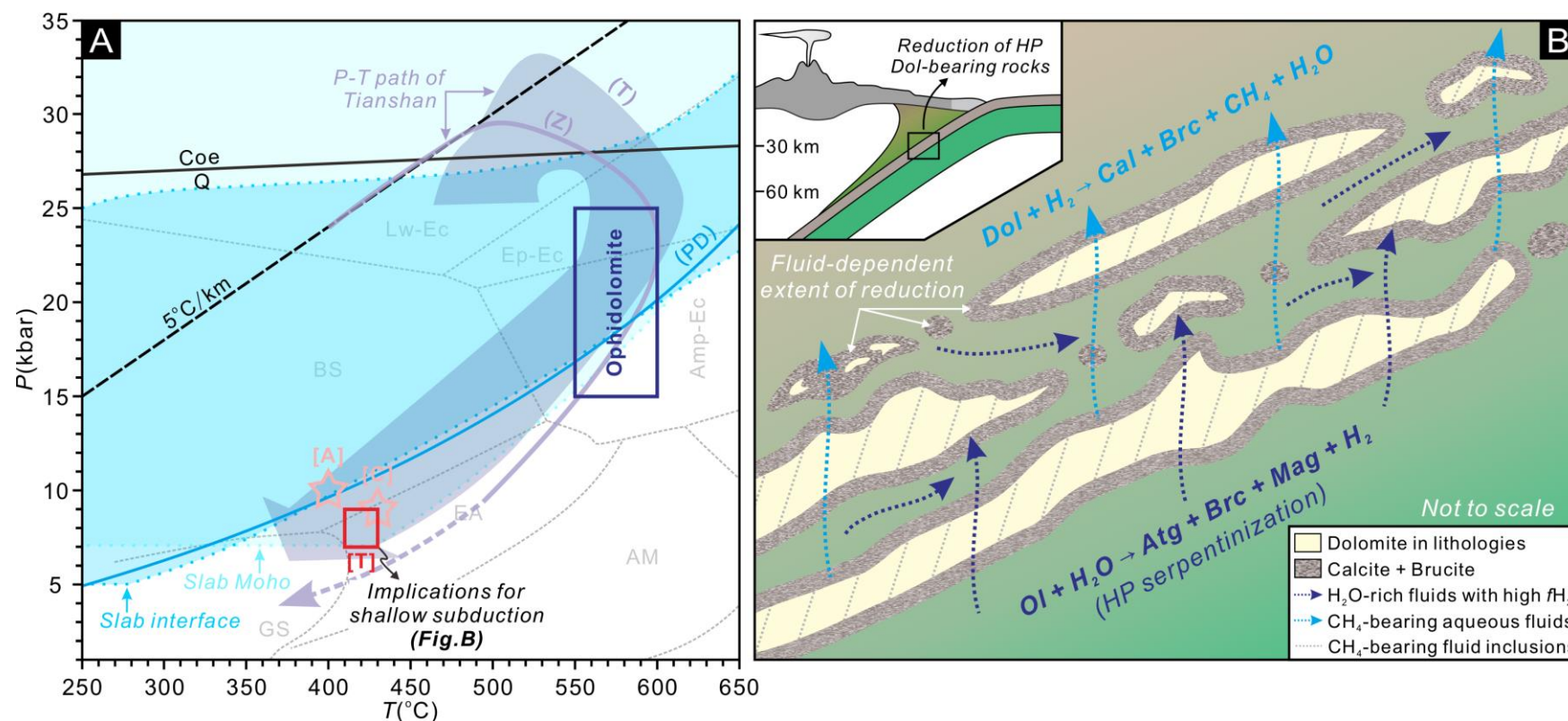
www.elsevier.com/locate/gca

西南天山经历超高压变质的蛇纹岩在其抬升折返过程中，碳酸岩矿物被还原形成甲烷气

Abiotic methane generation through reduction of
serpentinite-hosted dolomite: Implications for carbon mobility
in subduction zones

Weigang Peng^{a,b,c}, Lifei Zhang^{a,*}, Simone Tumati^c, Alberto Vitale Brovarone^{d,e},
Han Hu^a, Yachun Cai^b, Tingting Shen^f

Peng and Zhang et al., 2021, GCA





Workplan

2020: Paleo-proterozoic eclogite, granulite and igneous carbonate, from the central orogenic belt of North China Craton; Beijing, Sept.

2021: The youngest eclogite in the Himalaya orogenic belt, Kathmandu, Nepal, Oct.

2022: LT/HP law-eclogite, Alpine Corsica belt, France,

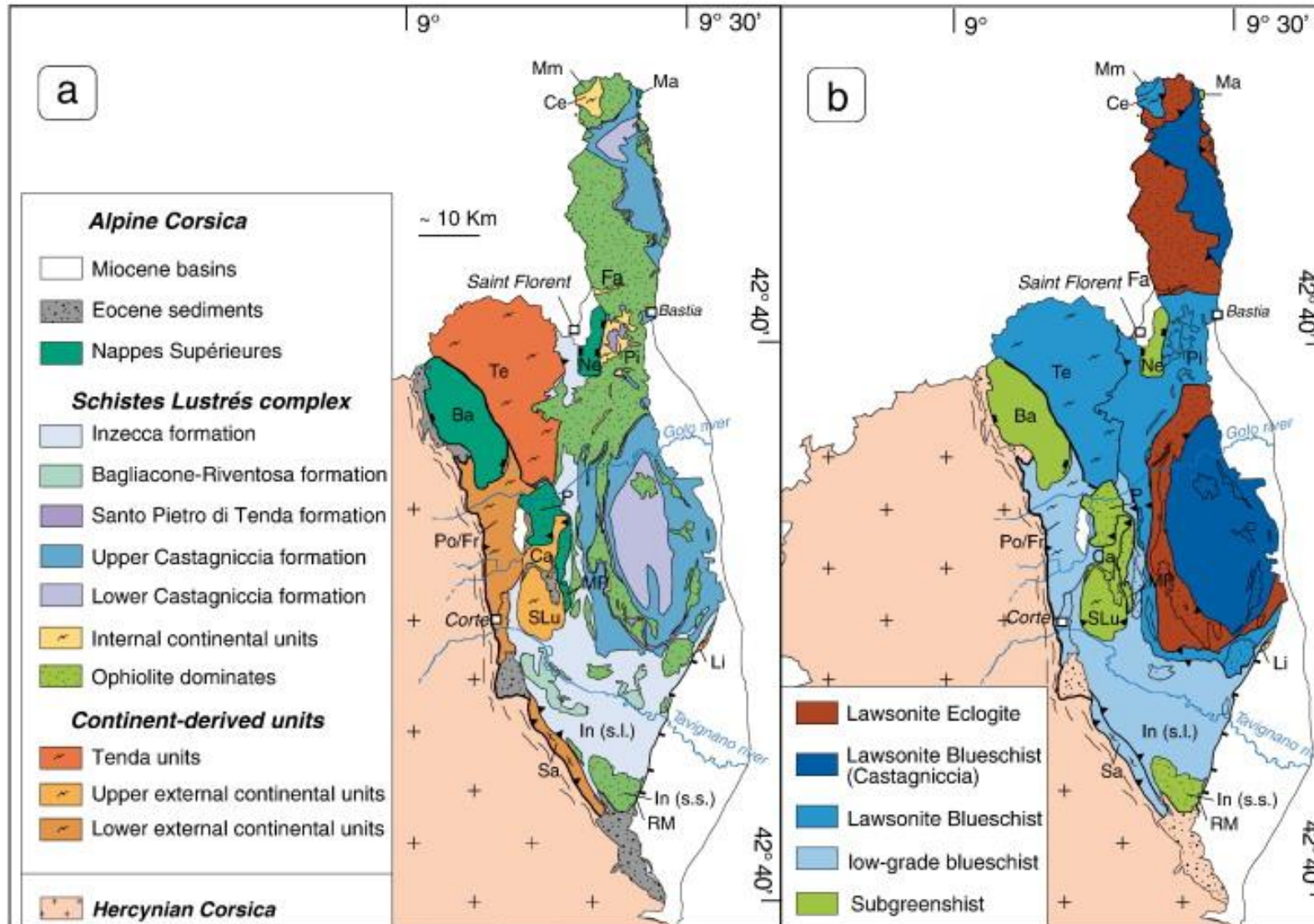
2023: The oldest eclogite outcrops with Archean age, Petrozavodsk, Russia

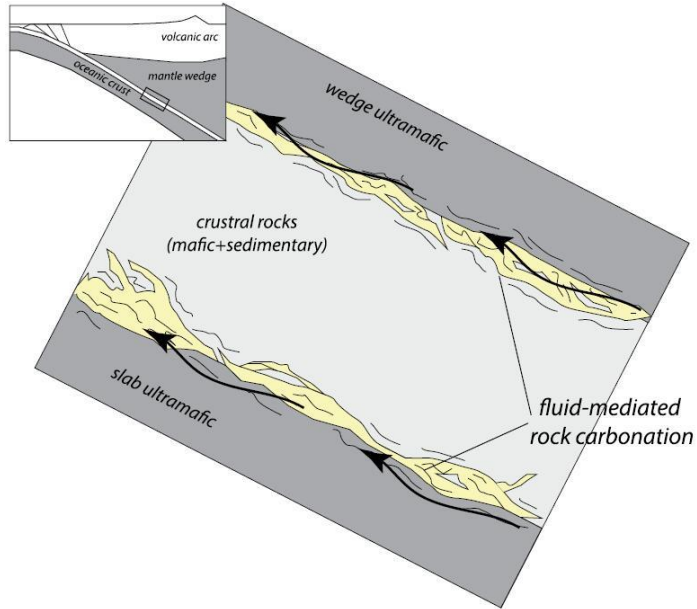
2024: The origin of high-pressure metamorphic rocks in arc, Fiordland, New Zealand

谢谢！

请各位专家批评指正！

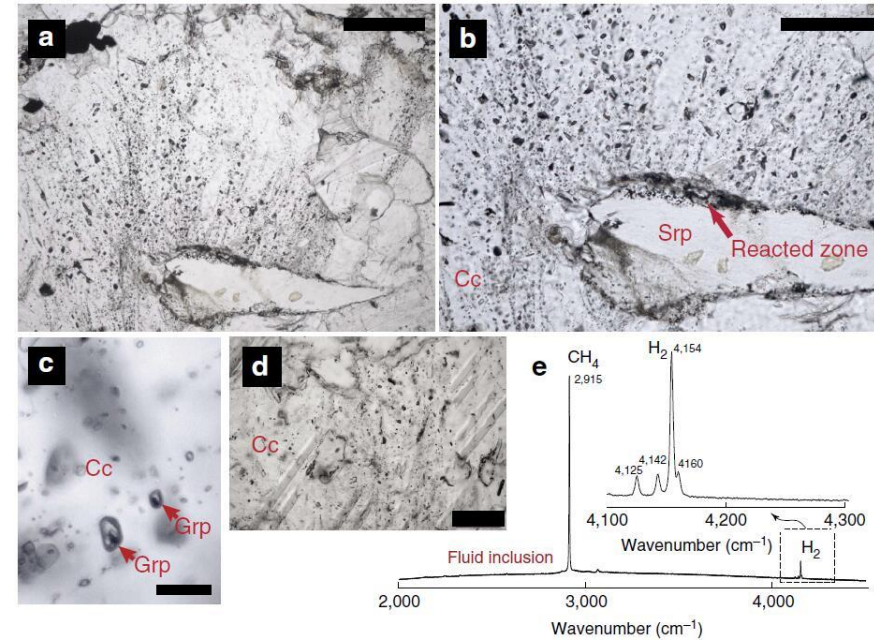
2022: Alpine Corsica (France)





Piccoli and Vitale Brovarone et al., 2016, EPSL

HP fluid–rock interactions



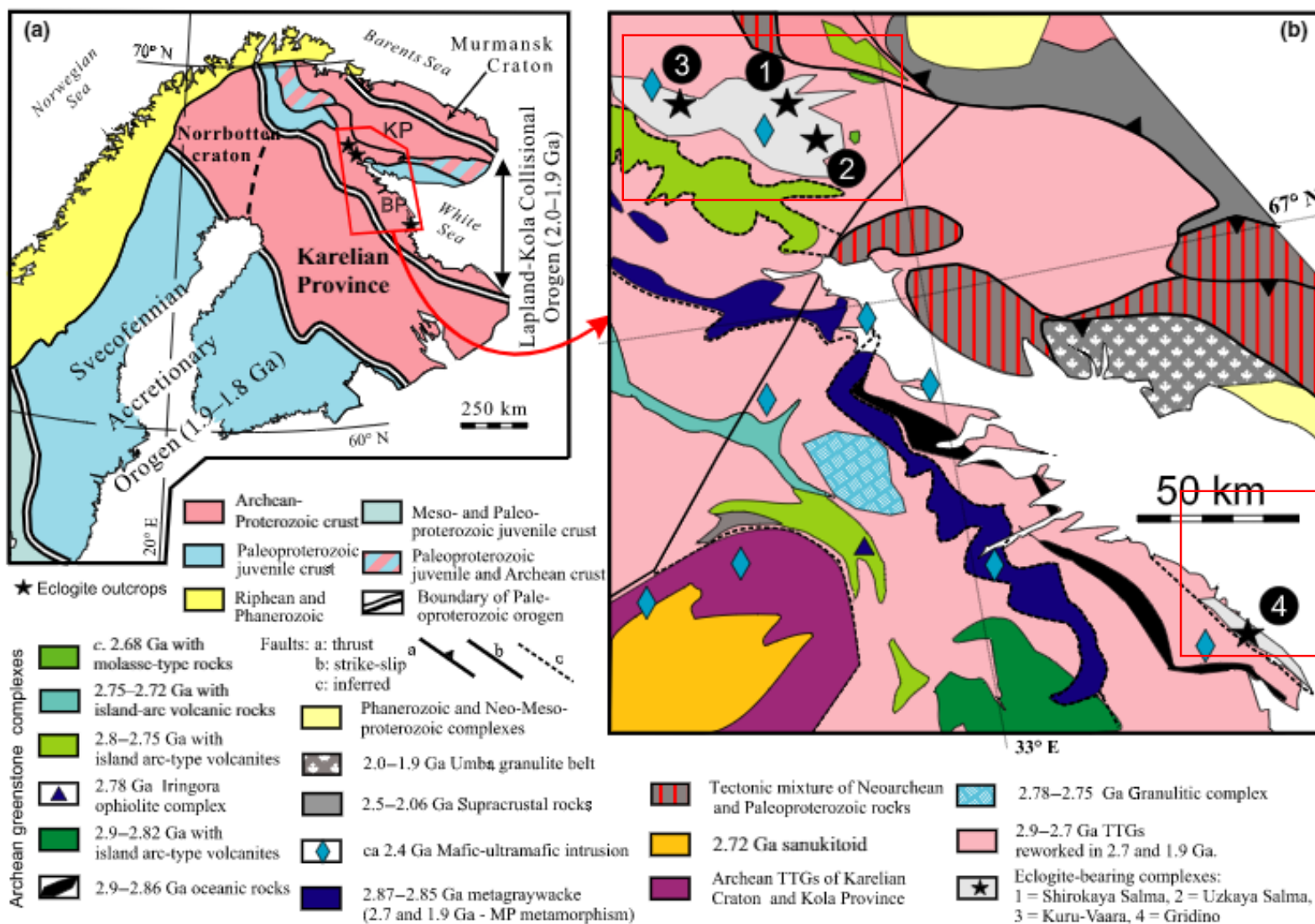
Vitale Brovarone et al., 2017, Nat. Commun.

HP abiotic methanogenesis

1. Petrology and geochemistry of high-pressure fluid–rock interactions
2. Volatile recycling in the Solid Earth
3. Deep carbon cycle (e.g., high-pressure abiotic methanogenesis)

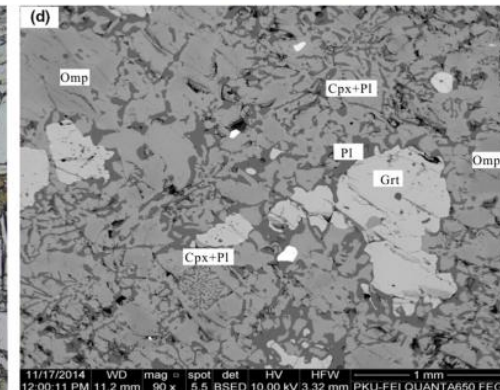
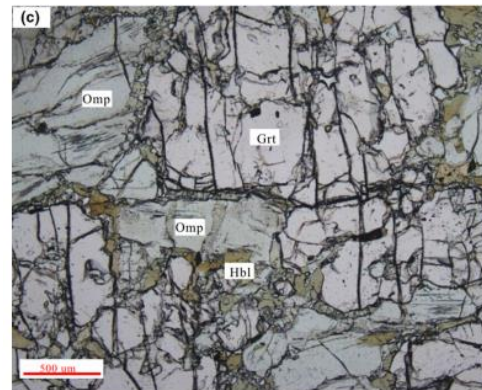
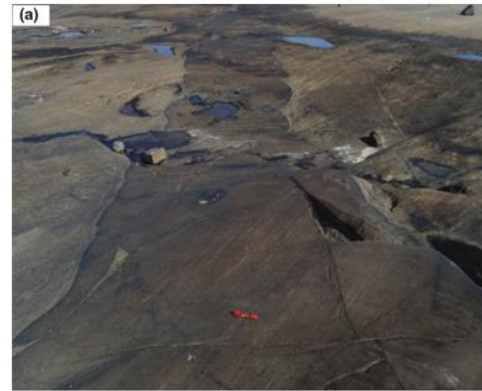
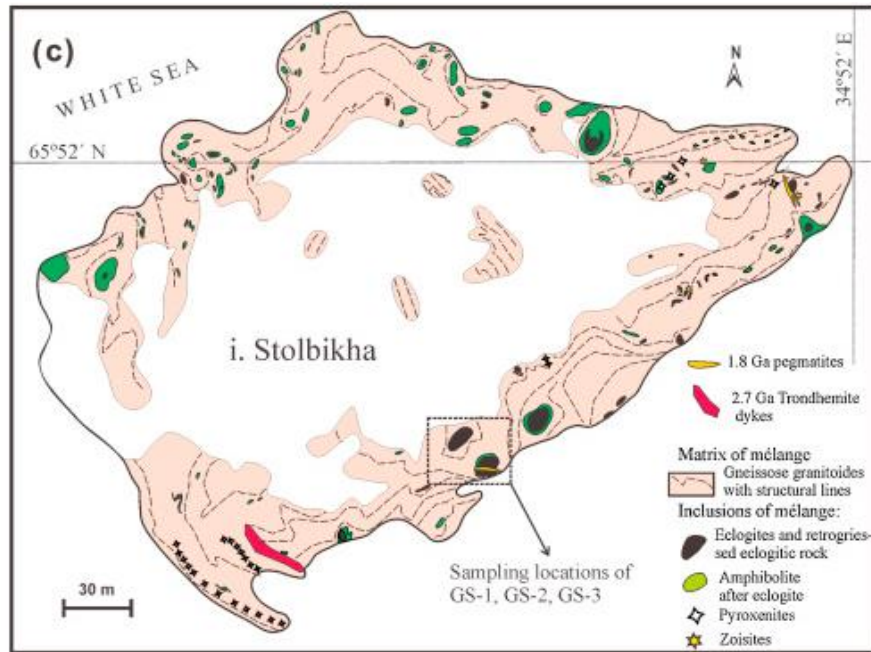
2023:

俄罗斯Belomorian Province: 2.72-2.87GPa中温榴辉岩



(以俯冲-碰撞为特征) 的板块构造运动是何时启动的?

Gridino



2.7 Ga

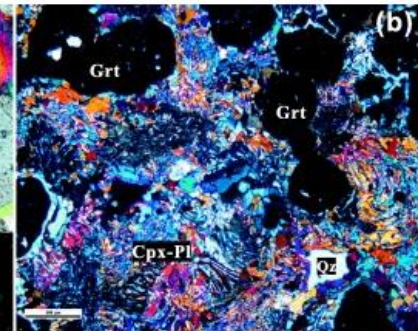
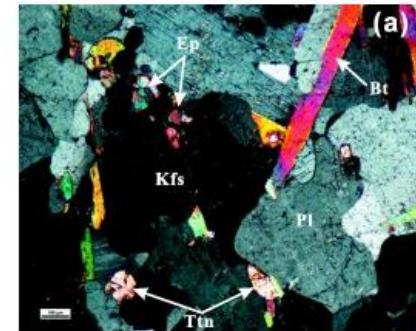
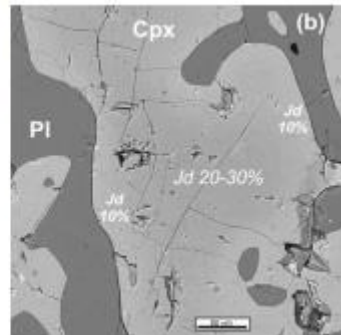
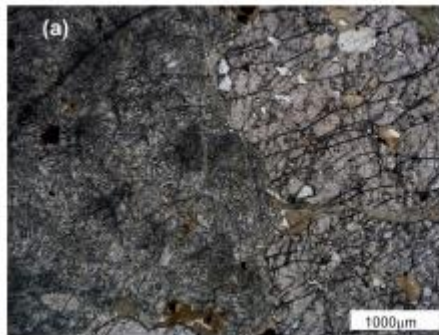
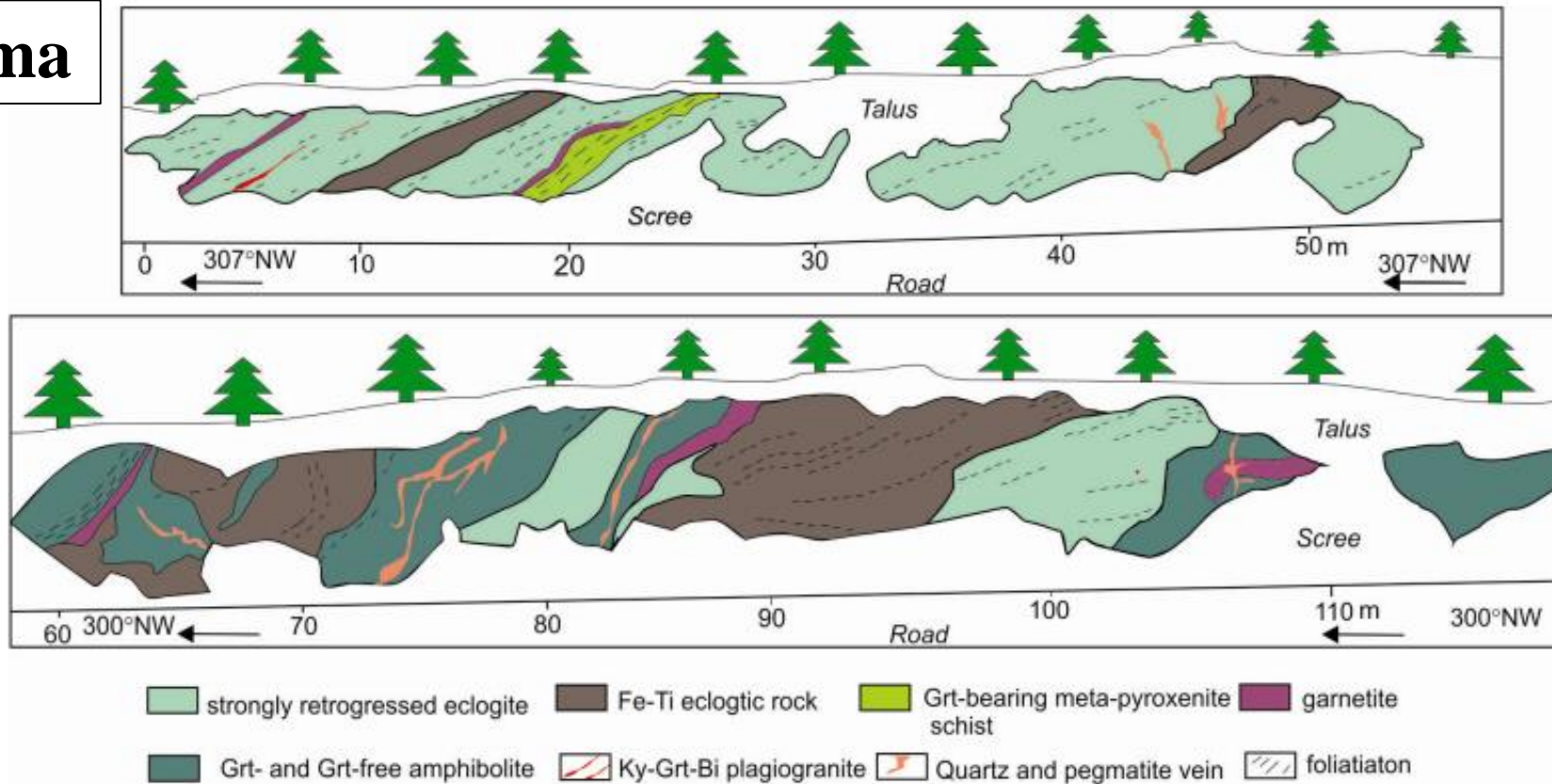
(Volodichev et al., 2004, Petrology; Li et al., 2015, PR)

VS.

1.9 Ga

(Yu et al., 2017, JMG)

Uzkaya, Salma



2.87-2.7 Ga Eclogite + 1.9 Ga Amphibolite

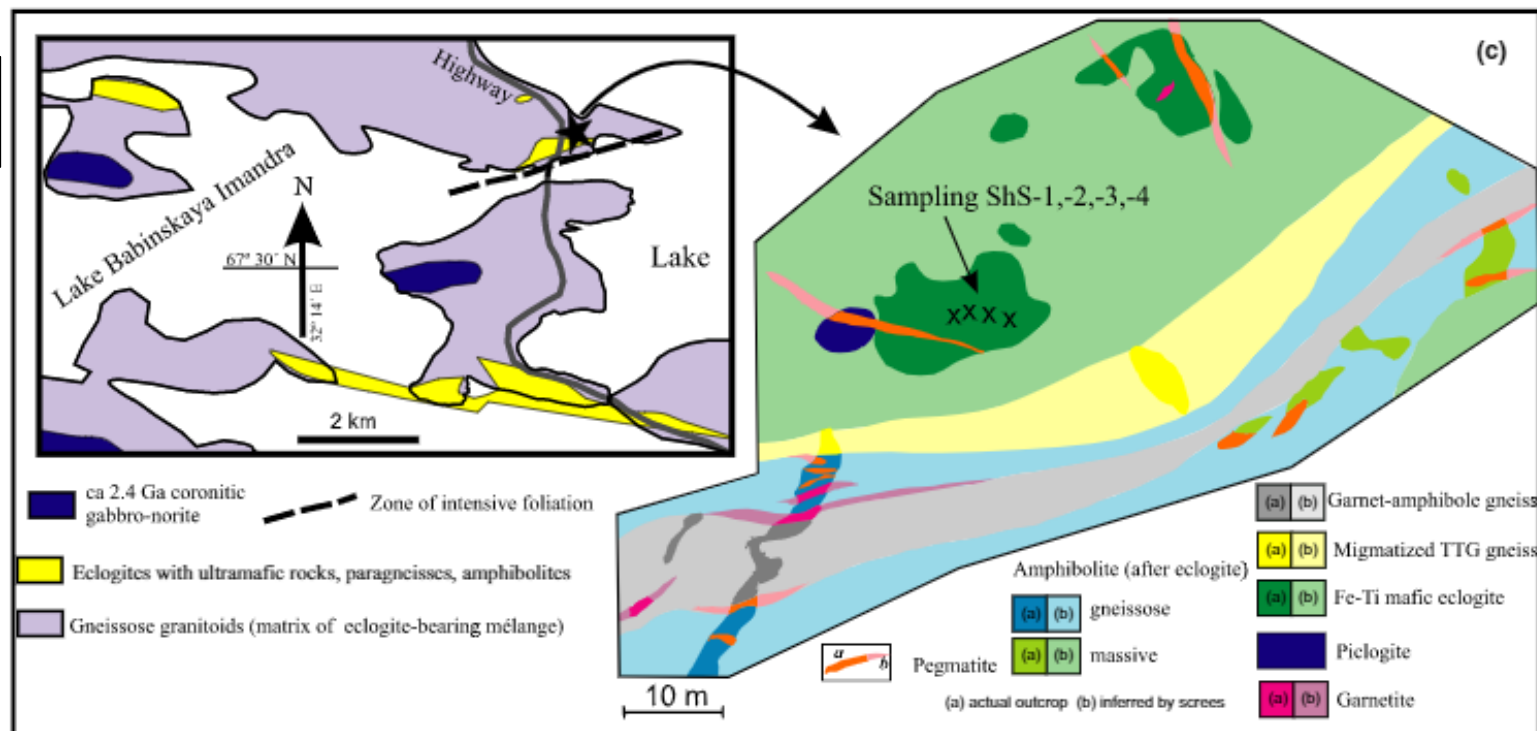
Mints et al., 2010, Geology

VS.

2.7 Ga Retrogressed eclogite

Li et al., 2017, PR

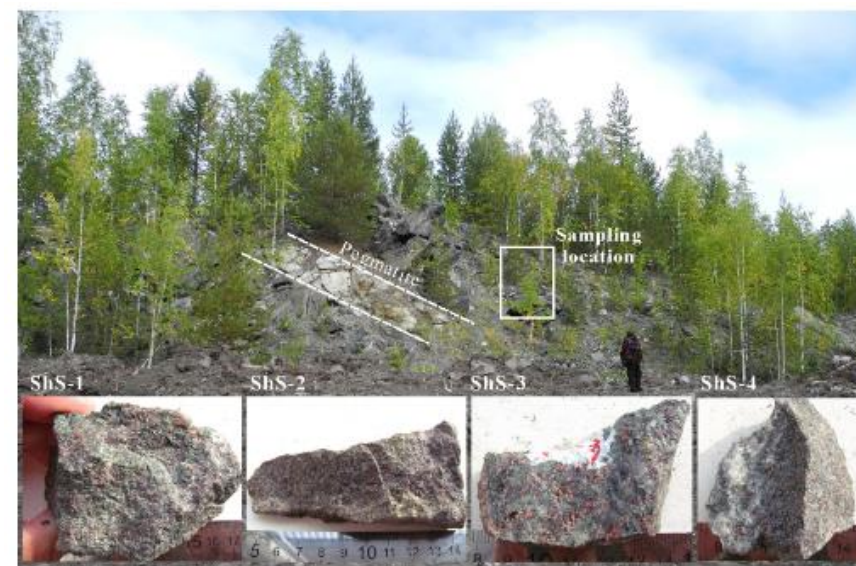
Shirokaya, Salma



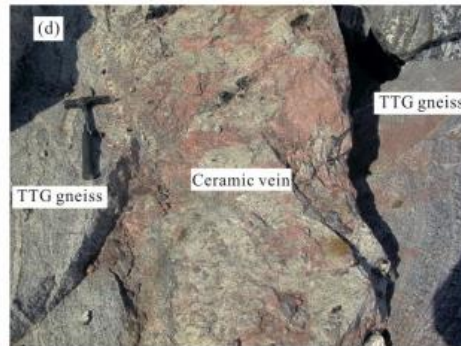
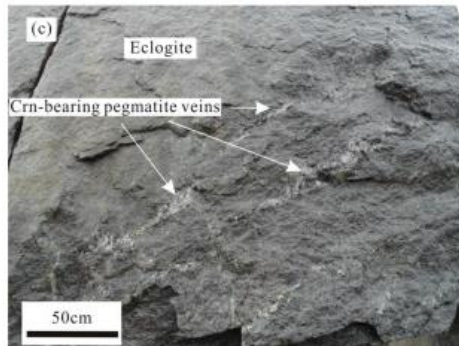
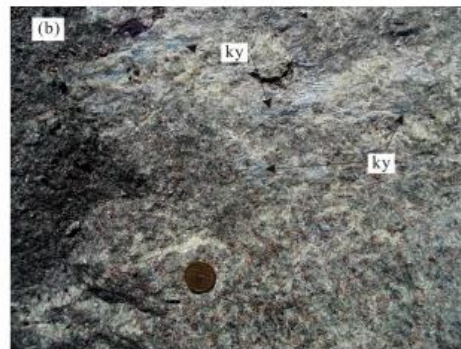
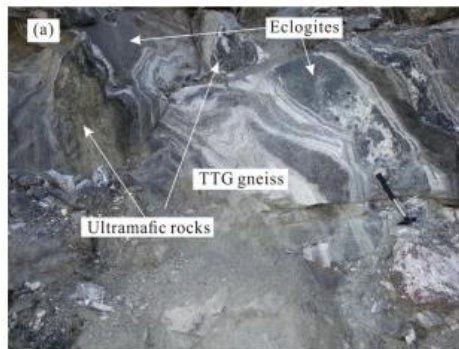
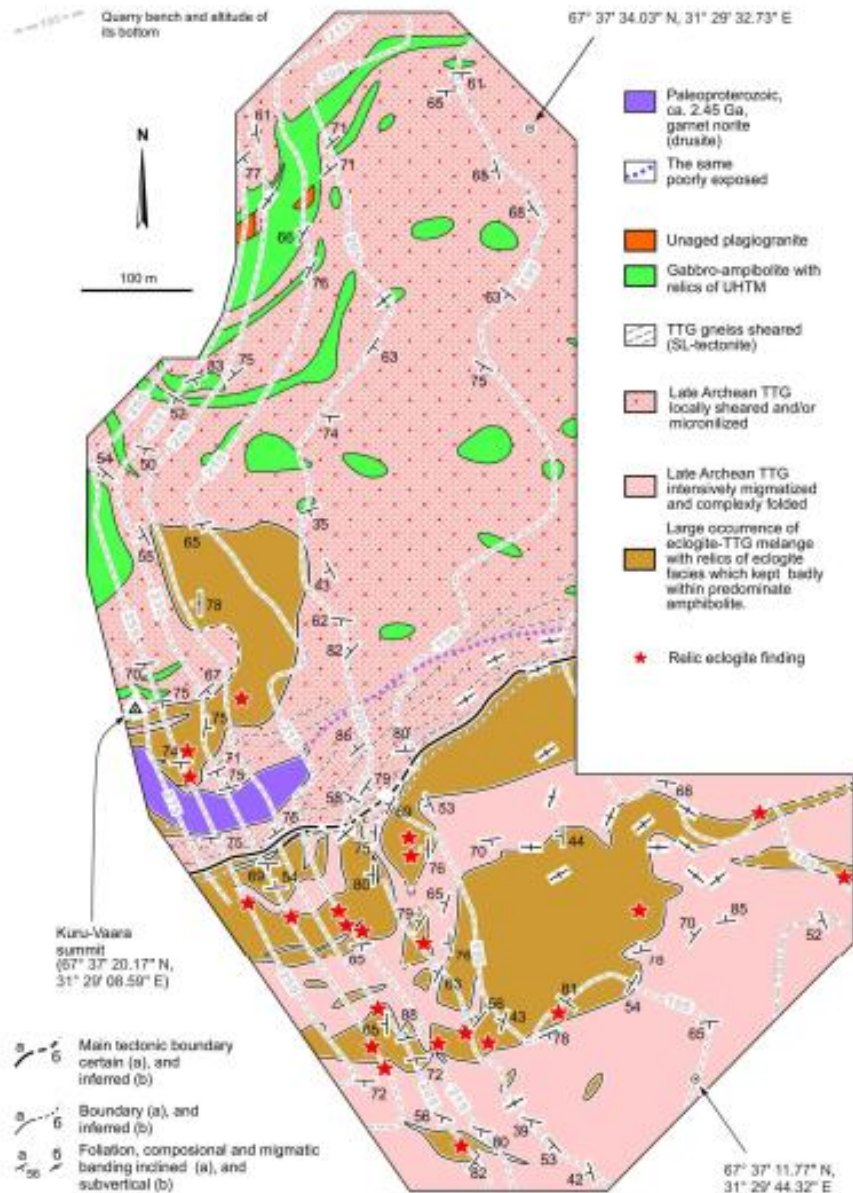
> **2.7 Ga**, Eclogite-facies (?)
 1.89 Ga, Amphibolite-facies
Kaulina et al., 2010, Geochem.

VS.

2.7 Ga, HP-Granulite-facies
1.9 Ga, Eclogite-facies
Li et al., 2017, JMG



Kuru-Vaara



Balagansky et al., 2015

South Eclogite:

2.82 Ga, Protolith

2.0-1.9 Ga, Eclogite-facies

North Eclogite:

2.82-2.80 Ga, Protolith

2.72-2.70 Ga, Eclogite-facies

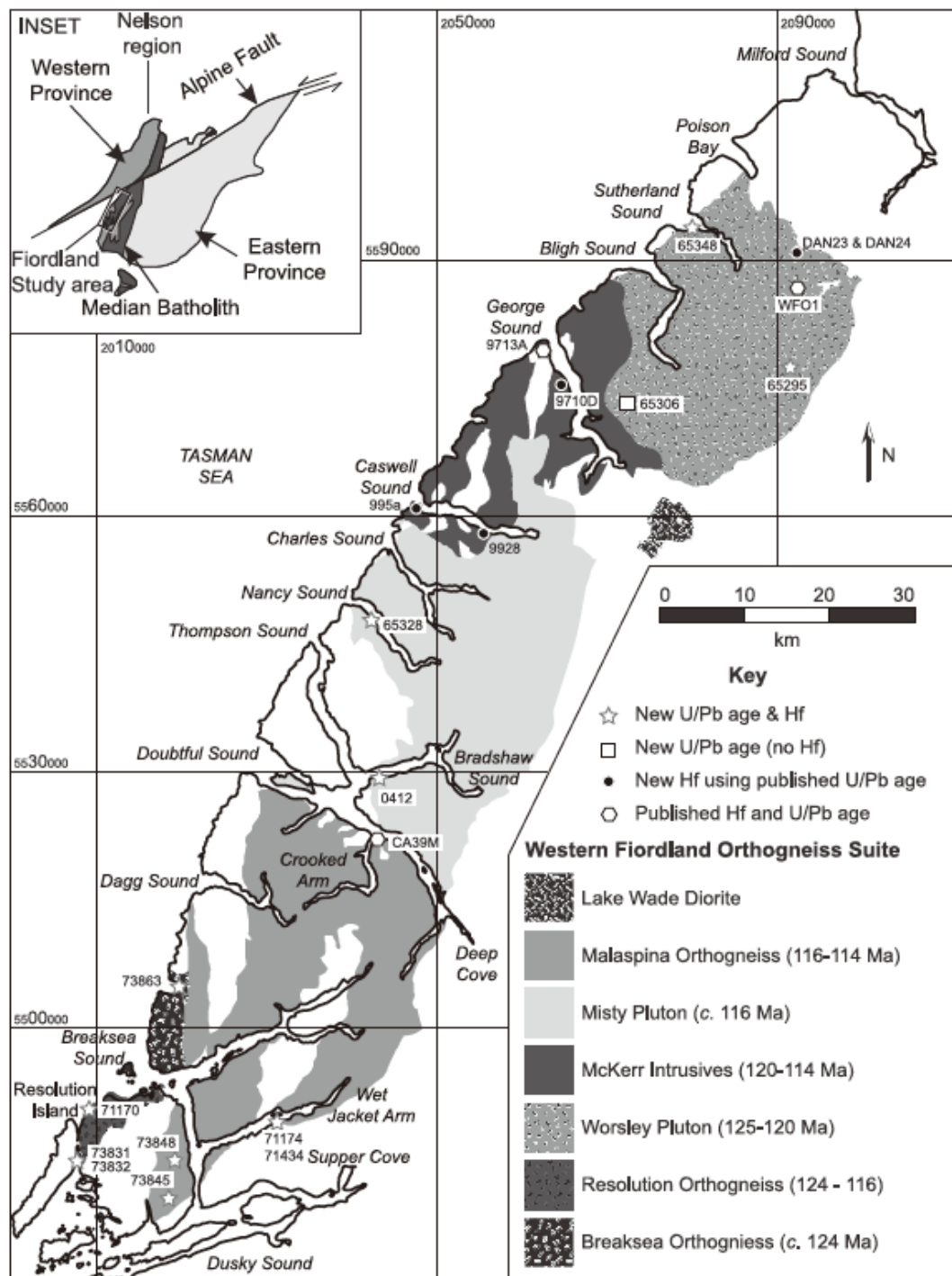
VS.

Liu et al., 2017, PR

2.92-2.82 Ga, Protolith

1.9 Ga, Eclogite-facies

2024:



Fiordland, New Zealand.

Chunjing Wei (Peking University, China)

Geoffery Clark (University of Sydney, Australia).

The origin of high-pressure metamorphic rocks
in arc, slab subduction or arc crustal thickening?