



HAL
open science

Various-scale controls of complex subduction dynamics on magmatic-hydrothermal processes in eastern Mediterranean

Armel Menant, Laurent Jolivet, Pietro Sternai, Maxime Ducoux, Romain Augier, Aurélien Rabillard, Taras Gerya, Laurent Guillou-Frottier

► To cite this version:

Armel Menant, Laurent Jolivet, Pietro Sternai, Maxime Ducoux, Romain Augier, et al.. Various-scale controls of complex subduction dynamics on magmatic-hydrothermal processes in eastern Mediterranean. EGU General Assembly 2014, Apr 2014, Vienne, Austria. hal-00933496

HAL Id: hal-00933496

<https://brgm.hal.science/hal-00933496v1>

Submitted on 2 Apr 2015

HAL is a multi-disciplinary open access archive for the deposit and dissemination of scientific research documents, whether they are published or not. The documents may come from teaching and research institutions in France or abroad, or from public or private research centers.

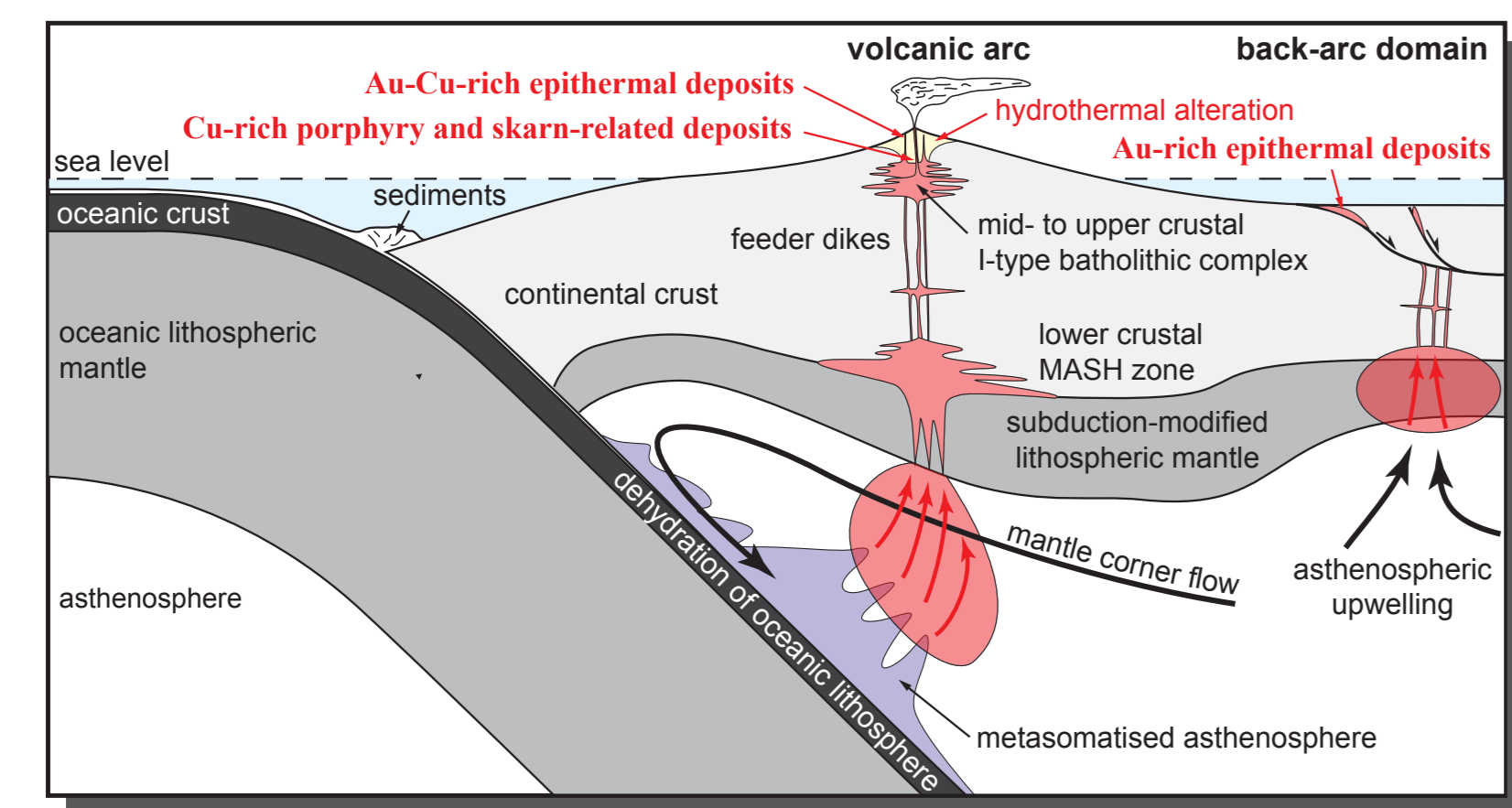
L'archive ouverte pluridisciplinaire **HAL**, est destinée au dépôt et à la diffusion de documents scientifiques de niveau recherche, publiés ou non, émanant des établissements d'enseignement et de recherche français ou étrangers, des laboratoires publics ou privés.



Distributed under a Creative Commons Attribution - NonCommercial - NoDerivatives 4.0
International License

Introduction

Ore deposits and related magmatism in subduction and post-subduction environments are controlled by the thermal structure and hydrous and magmatic fluid dynamics from the underlying mantle to the upper crust.

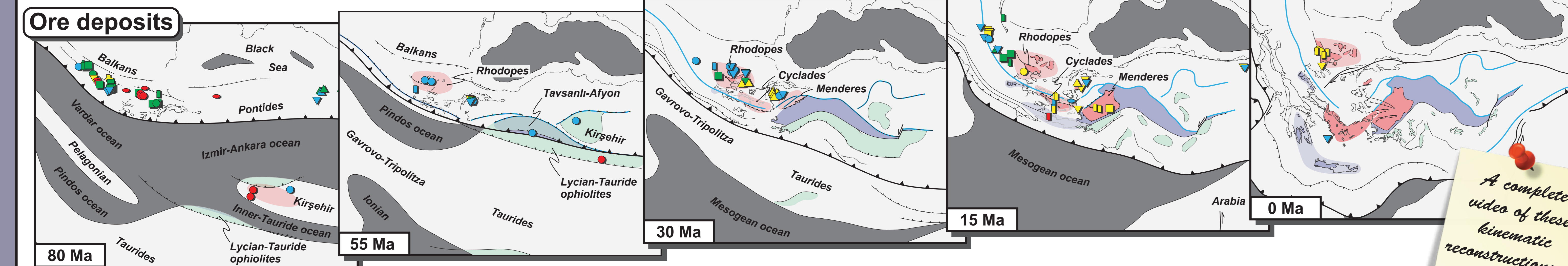
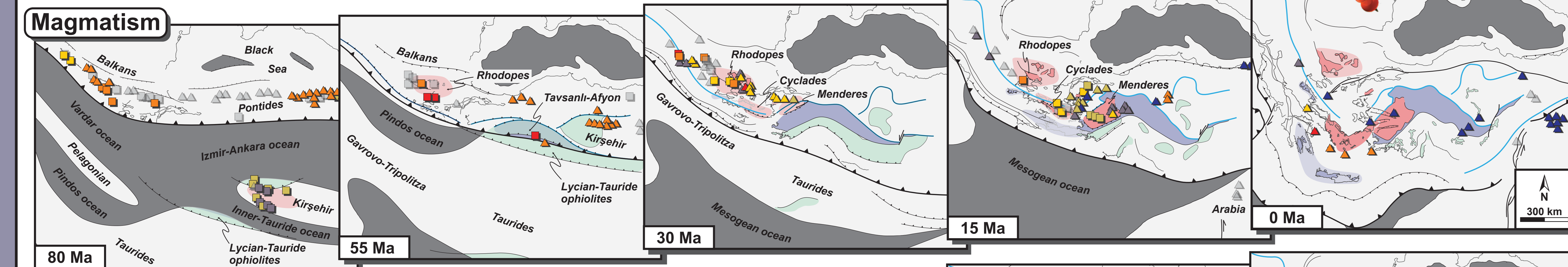


In regions where the 3D subduction dynamics is complex such as in eastern Mediterranean,

- Which processes affect the distribution of mineralization and magmatism?
- Considering this evolution at different scales, can we better constrain the dynamics of subduction in eastern Mediterranean?

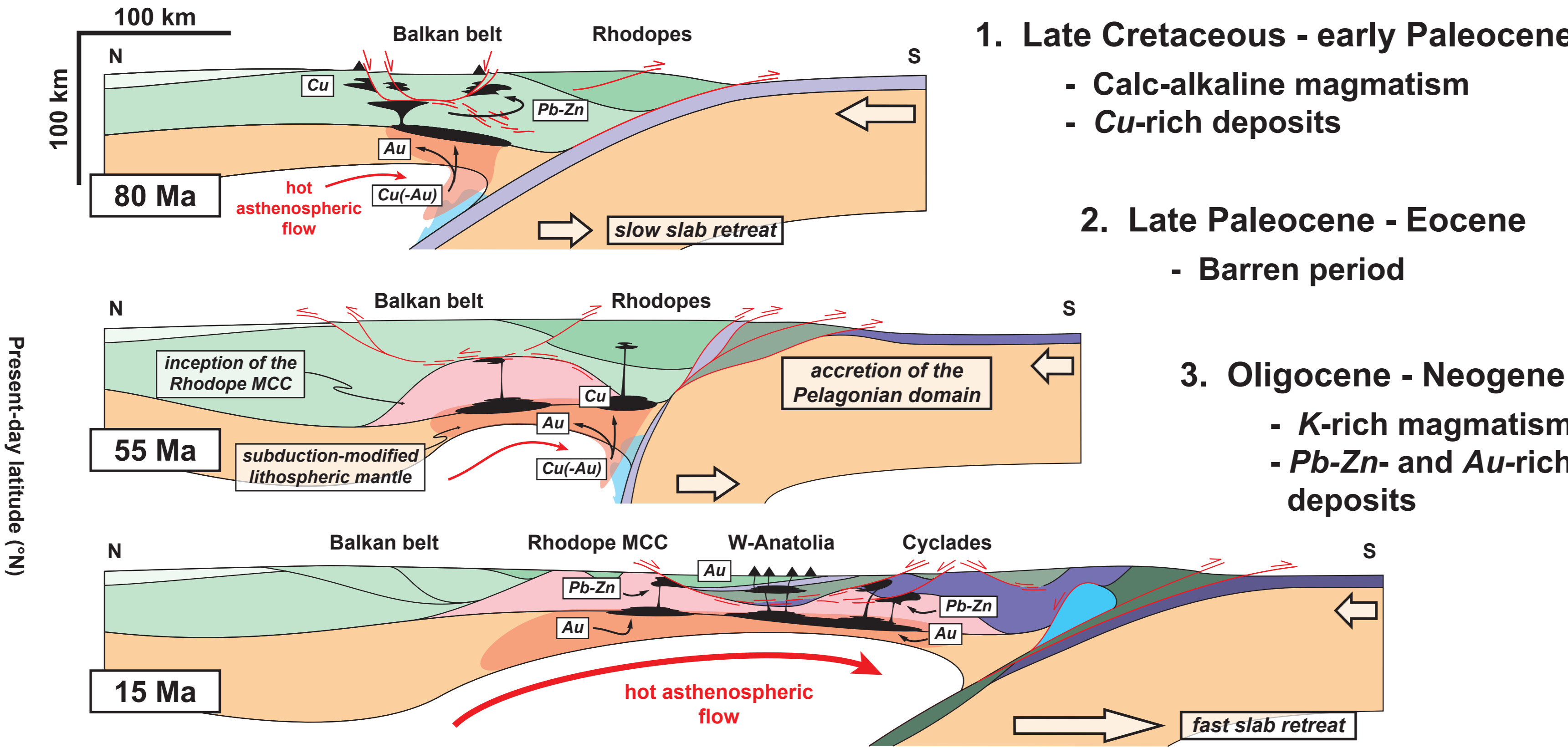
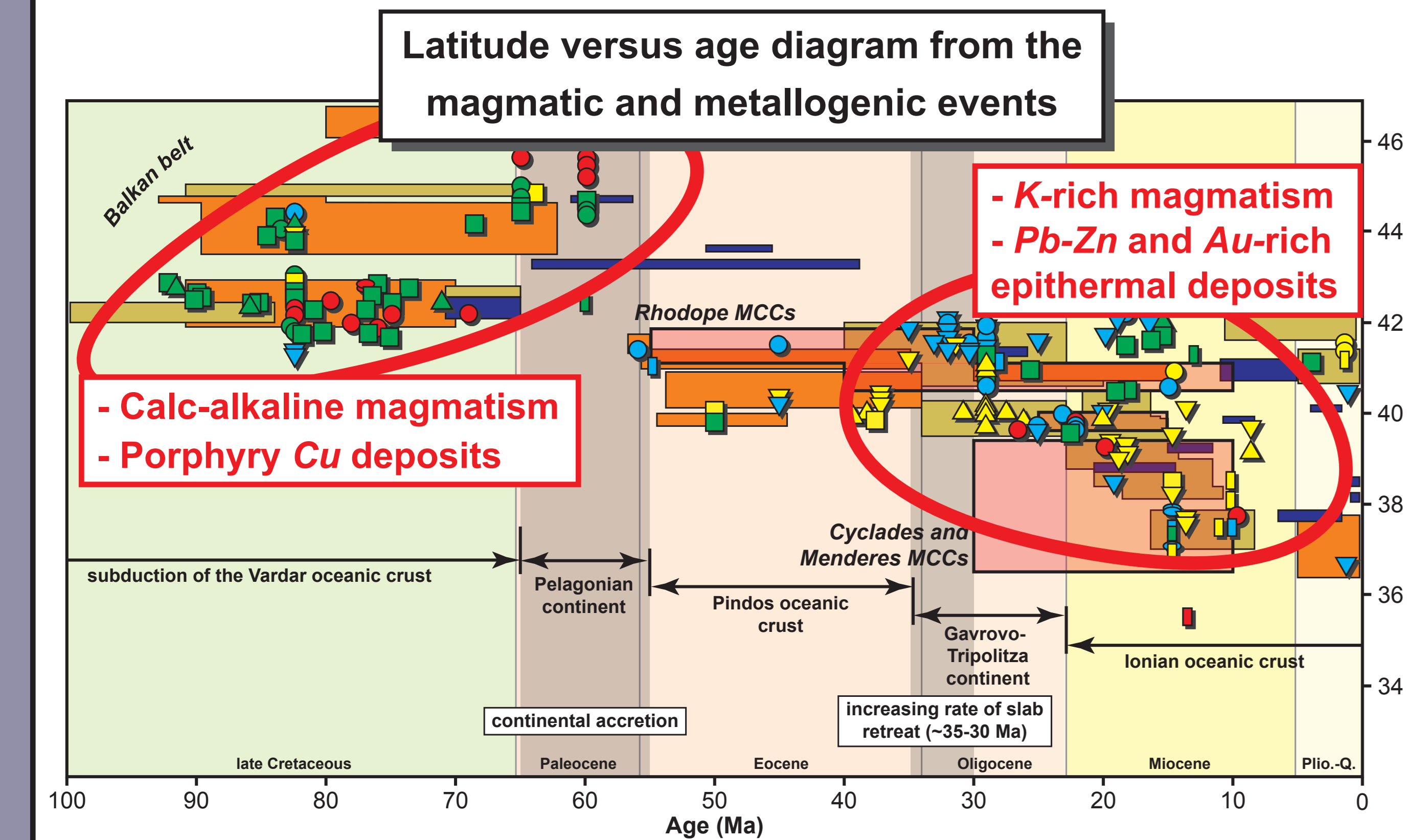
One deposits in subduction environment - 55% of the world production in Cu - 16% of the world production in Au Major economic interest!

Large-scale evolution: input from kinematic reconstructions



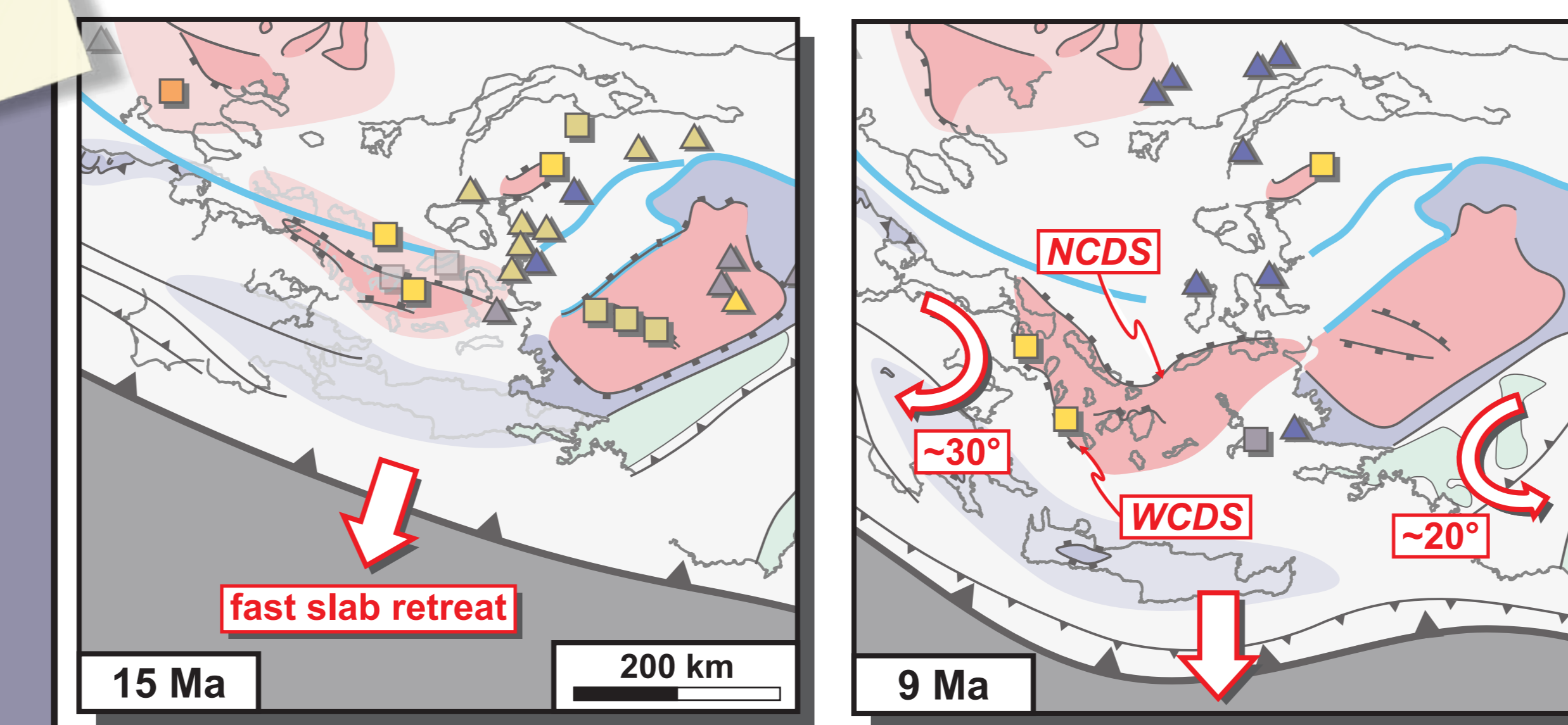
Petrological affinity	Tectonic structures	Magmatism	Ore deposits
continental crust	active major thrust fault	volcanism/plutonism (v./p.)	porphyry
oceanic crust	active major high-angle normal fault	alkaline v./p.	skarn
obducted oceanic crust	active major low-angle normal fault	shoshonitic v./p.	high-K calc-alkaline to shoshonitic v./p.
	active major strike-slip fault	high-K calc-alkaline v./p.	high-K calc-alkaline v./p.
	inactive major fault	medium- to high-K calc-alkaline v./p.	medium- to high-K calc-alkaline v./p.
	major oceanic suture	medium-K calc-alkaline v./p.	medium-K calc-alkaline v./p.
Metamorphic Core Complex (MCC)			high-sulphidation epithermal
buried/exhumed high pressure MCC			low-sulphidation epithermal
buried/exhumed high temperature MCC			fault-related
			volcano-sedimentary

3 main periods in eastern Mediterranean with a general southward migration of the magmatic-hydrothermal systems



Small-scale evolution: the Miocene geodynamics of the Aegean and western Anatolia

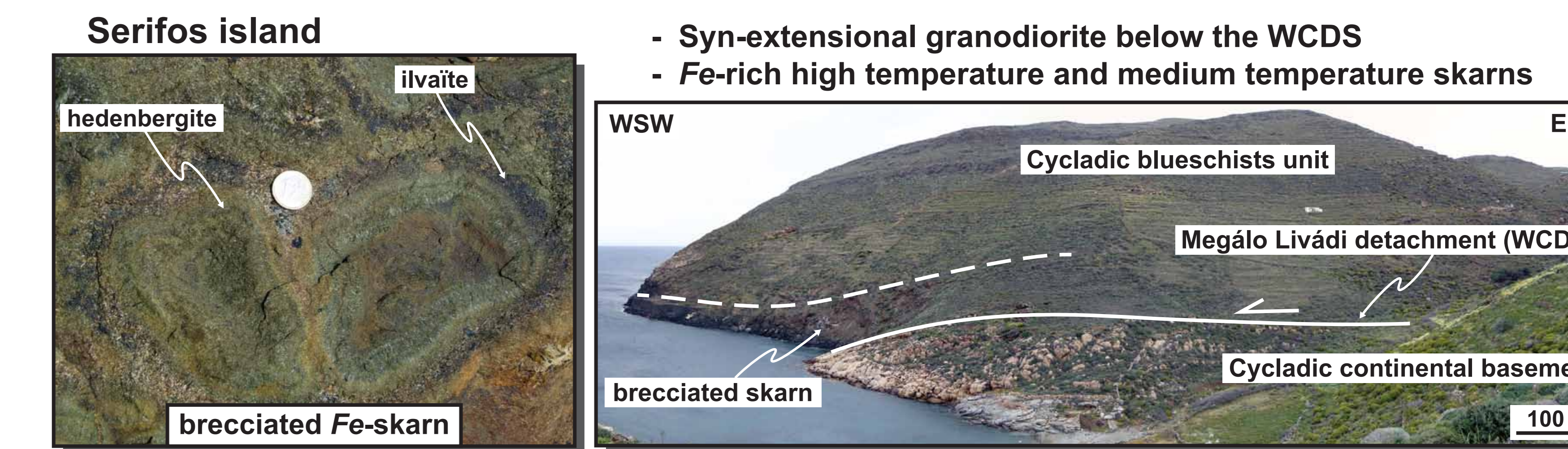
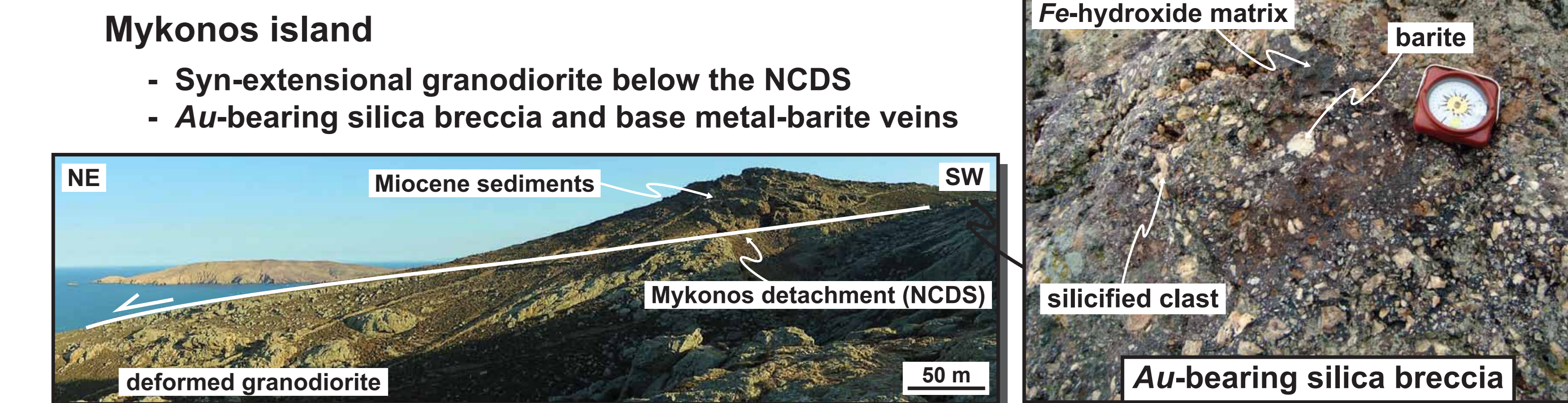
Since 35-30 Ma, fast slab retreat resulted in the opening of the Aegean back-arc domain. However, 15 Ma ago, a major change occurred in the dynamics of this back-arc opening.



Field evidences

- Block rotations [van Hinsbergen et al., 2005]
- Appearance and westward migration of alkaline volcanism [Dilek & Altunkaynak, 2009]
- Westward migration of plutonism from the Menderes to Cyclades with an increase of the mantle component [Altherr & Siebel, 2002]

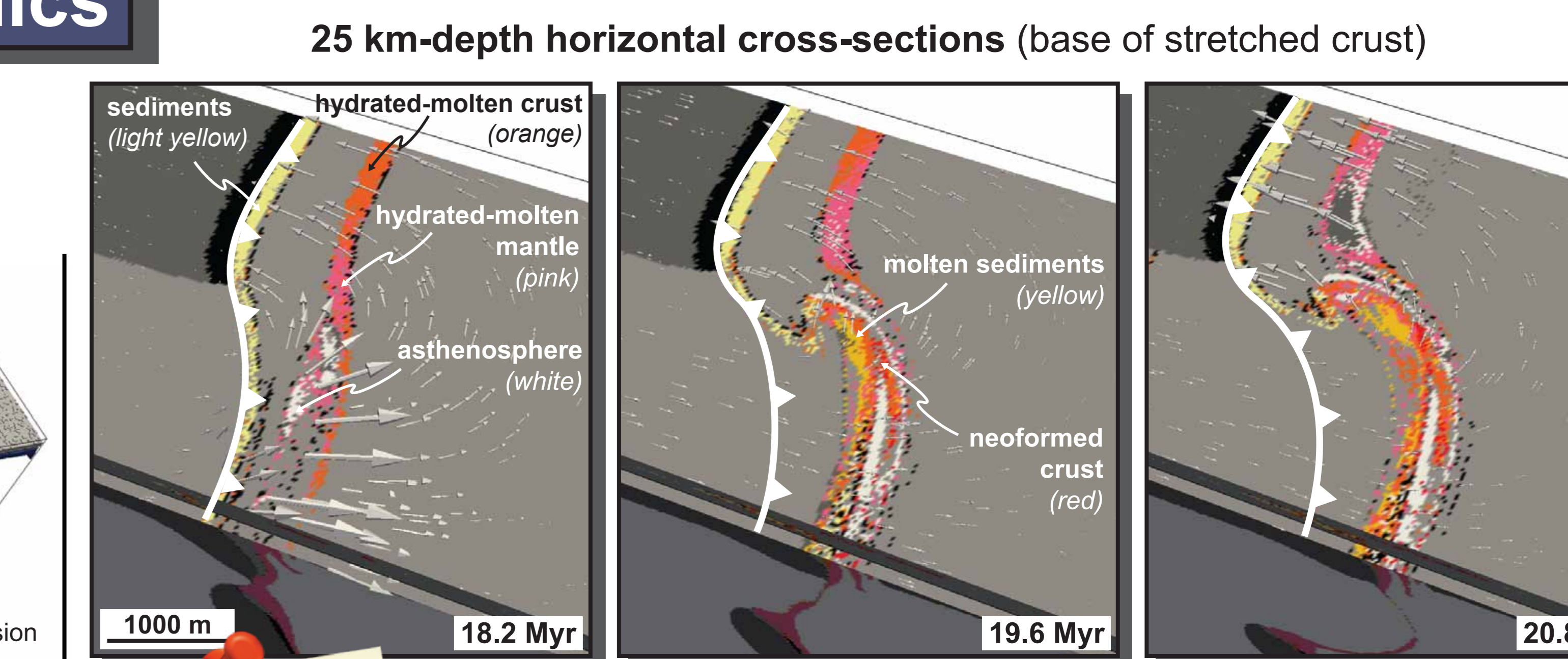
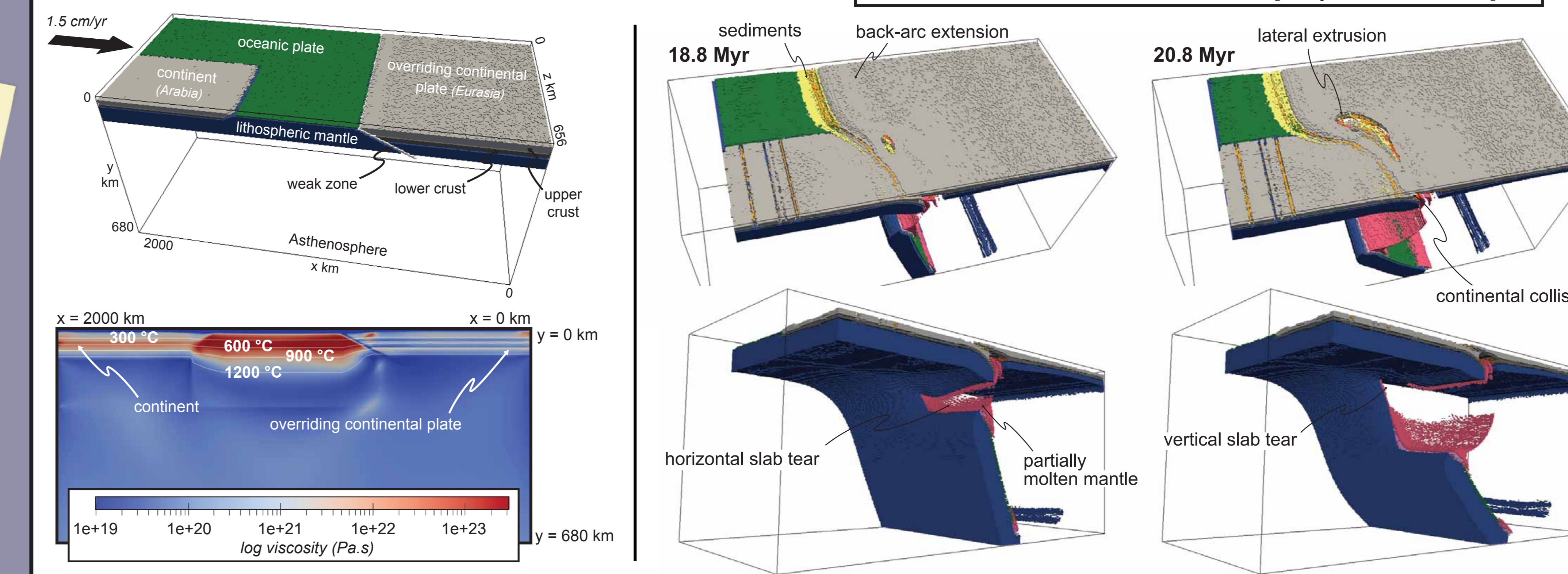
In the Cyclades, the activity of large-scale detachment systems such as the North Cycladic Detachment System (NCDS) and the West Cycladic Detachment System (WCDS) is contemporaneous with the emplacement of magmatic intrusions and ore deposits



Combined scales: numerical modeling of subduction dynamics

Using a simple large-scale model of subduction, can we reproduce these geological observations and relate them to the subduction dynamics and associated mantle flow?

3D thermo-mechanical numerical modeling with complex rheologies, integrating fluid/melt transport, partial melting and melt extraction mechanisms [Gerya & Yuen, 2003]



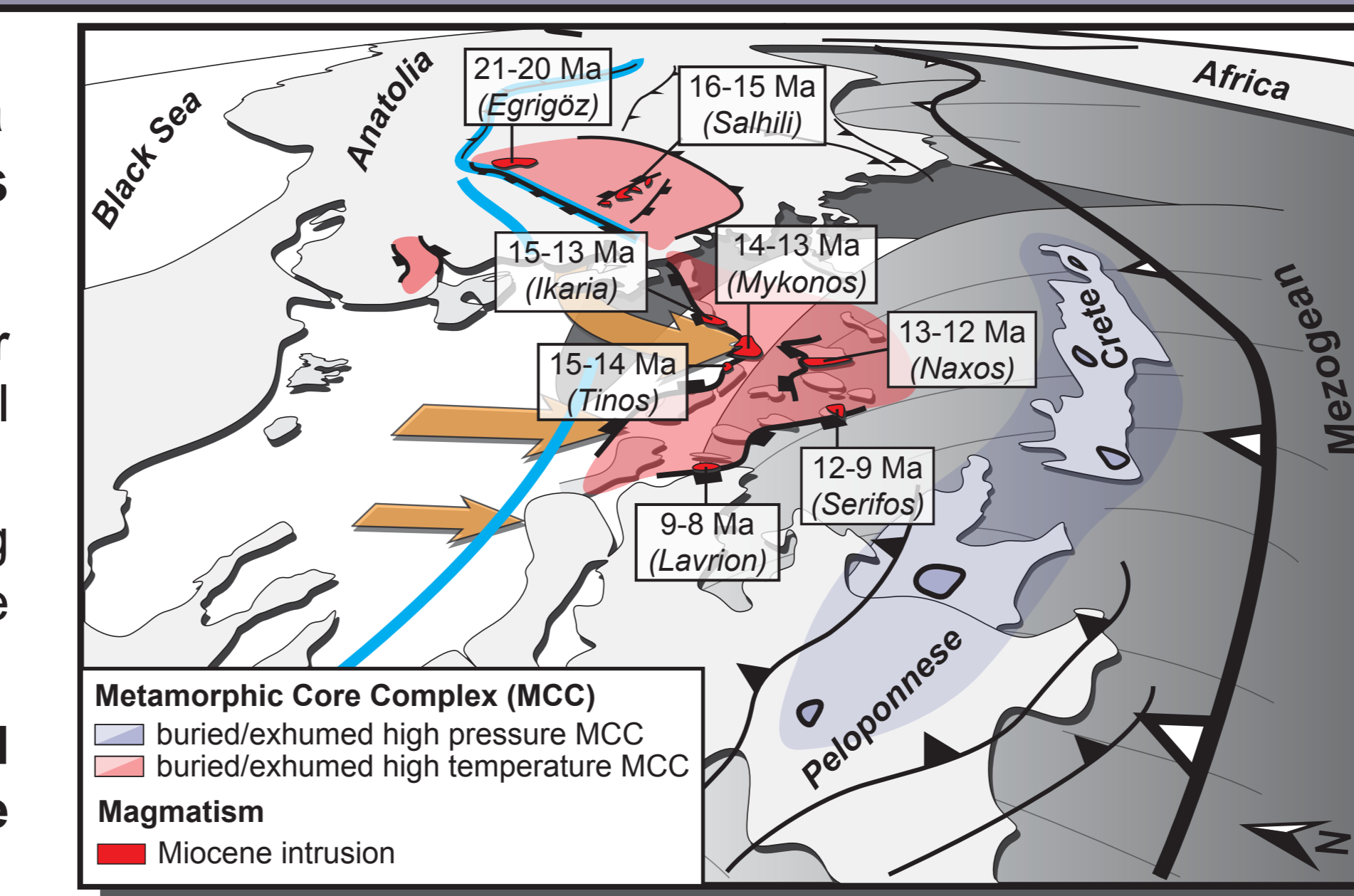
Videos of this model are also available!

Lateral migration of magmatism and asthenospheric upwelling related to toroidal flow. In back-arc region, increase of mantle-derived material relative to crustal-derived material

Conclusion

In eastern Mediterranean region, a southward migration of magmatic-hydrothermal systems is observed from the late Cretaceous to nowadays

- Barren periods are associated to dominant compressional or transpressional tectonics within the upper plate (e.g. continental accretion)
- Cu-rich periods are related to stagnant magmatic arc resulting from the dehydration of the subducted oceanic crust and the partial melting of the mantle wedge
- Au-rich periods are related to fast slab retreat and associated mantle flow inducing the partial melting of the lithospheric mantle or the base of the crust where Au was previously stored



During the Miocene, a secondary westward migration of the magmatic-hydrothermal activity is observed from the Menderes massif to the Cyclades

- Possible consequence of a slab tearing event below western Anatolia and related hot asthenospheric flow

References

Altherr R. & W. Siebel (2002). I-type plutonism in a continental back-arc setting: Miocene granitoids and monzonites from the central Aegean Sea, Greece. *Contrib. Mineral. Petrol.*, 143, 397-415.

Dilek Y. & S. Altunkaynak (2009). Geochemical and temporal evolution of Cenozoic magmatism in western Turkey: mantle response to collision, slab break-off, and lithospheric tearing in an orogenic belt. *Spe. Pub. - Geol. Soc. London*, 311, 213-233.

Gerya T. V. & D. A. Yuen (2003). Characteristics-based marker-in-cell method with conservative finite-differences schemes for modeling geological flows with strongly variable transport properties. *Phys. Earth Planet. Int.*, 140, 293-318.

Richards J. P. (2011). Magmatic to hydrothermal metal fluxes in convergent and collided margins. *Ore Geol. Rev.*, 40, 1-26.

van Hinsbergen D. J. J., et al. (2005). Revision of the timing, magnitude and distribution of Neogene rotations in the western Aegean region. *Tectonophysics*, 396, 1-34.