RESEARCH FIELDS:
Structural Geology - Geodynamics – Tectonics

RESEARCH TOPIC:
Pangea assembly, dispersal and re-assembly: the plate margin record of super-continent cycles

PARTiCIPANTS AND COLLABORATIONS:
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RESEARCH DESCRIPTION:
Plate margins host large mineral ore and hydrocarbon deposits, whose formation and preservation are intimately related to the tectonic and thermal evolution during rifting and orogeny. This complex history may be recorded in metamorphic rocks cropping out at the Earth's surface. Our group is currently developing a methodology combining detailed field structural analyses conducted at local and mountain belt scales with state-of-the-art structural, petrological and geochronological techniques to provide firm quantitative constraints on crustal flow and evolving thermal structure along divergent and convergent plate margins.

Our main efforts are currently devoted to tracing the tectonic evolution leading to the Paleozoic assembly of Pangea, followed by its Mesozoic dispersal and subsequent partial re-assembly along the Alpine-Himalayan belt. The main focus of our research consists in:

(1) constraining the multi-stage deformation history leading to progressive thinning of continental plates culminating into plate break-up along magma-poor rifted margins (Figure 1);
(2) understanding material flux along subduction zones, by reconstructing flow paths of different sections of rifted margins preserved in Alpine-type mountain belts (Figures 2 and 3);
(3) understanding crustal flow and exhumation processes active during continent-continent collision

These different evolutionary stages of the Wilson's cycle are being investigated in areas hosting ancient and more recent collisional belts, including the Western Alps, Himalayas (Figure 4), Apennines, Corsica-Sardinia and Antarctica. Our multi-scale and multi-disciplinary approach is bringing fresh insights into widely studied regions, showing that the exhumation of the deeply seated metamorphic rocks in the Himalayas is largely unrelated to frontal extrusion accommodated along the Main Central Thrust and South Tibetan Detachment (Carosi et al., 2010) and that much of the apparent complexity of the Western Alps is inherited from Jurassic rifting, rather than being related to complex subduction dynamics (e.g. Beltrando et al., 2010).

LABORATORIES OF THE DST IN USE:
- Thin section lab
- Optical microscopy
- SEM-EDS

RESEARCH PRODUCTS:

- BALESTRIERI M.L., PANDELI E., BIGAZZI G., CAROSI R., MONTOMOLI C. (2011), Age and temperature constraints on metamorphism and exhumation of the syn-orogenic metamorphic complexes of Northern Apennines, Italy. Tectonophysics 509, 254–271.
- BELTRANDO, M., ZIBRA, I., MONTANINI, A., TRIBUZIO, R. (2013), Crustal thinning and exhumation along a fossil magma-poor distal margin preserved in Corsica: A hot rift to drift transition? Lithos, doi: 10.1016/j.lithos.2013.01.017
- BELTRANDO, M., FRASCA, G., COMPAGNONI, R., VITALE BROVARONE, A. (2012), The Valaisan controversy revisited: multi-stage folding of a Mesozoic hyper-extended margin in the Petit St. Bernard pass area (Western Alps). Tectonophysics, doi:10.1016/j.tecto.2012.02.010
- BELTRANDO, M., LISTER, G., ROSENBAUM, G., RICHARDS, S., FORSTER, M. (2010), Recognizing episodic lithospheric thinning along a convergent plate margin: the example of the Early Oligocene Alps. Earth Science Reviews 103, 81-98, doi: 10.1016/j.earscirev.2010.09.001
- BELTRANDO, M., RUBATTO, D., MANATSCHAL, G. (2010), From passive margins to orogens: The link between Ocean-Continent Transition zones and (Ultra-)High-Pressure metamorphism. Geology 38, 559-562, doi:10.1130/G30768.1
- CAROSI R., MONTOMOLI C., RUBATTO C., VISONA' D. (2010), Late Oligocene high-temperature shear zones in the core of the Higher Himalayan Crystallines (Lower Dolpo, Western Nepal). Tectonics 29, TC4029, doi:10.1029/2008TC002400.
- CAROSI R., MONTOMOLI C., TIEPOLO M., FRASSI C. (2012), Geochronological constraints on post-collisional shear belt in the Variscides of Sardinia, Italy. Terra Nova 24, 42-51.
- CROUZET C, APPEL E., EL BAY R., DING L., DUNKL I., MONTOMOLI C., CAROSI R., ZHANG Q.H., WAUSCHKUHN B. (2012), Kinematics of the crust around the Ama Drime massif (southern Tibet) - constraints from paleomagnetic results. J. Asian Earth Sciences, 58, 119-131.
- RUBATTO, D., REGIS, D., HERMANN, J., BOSTON, K., ENGI, M., BELTRANDO, M., MCALPINE, S.R.B. (2011), Yo-yo subduction recorded by accessory minerals in the Italian Western Alps. Nature Geoscience 4, 338-342, doi: 10.1038/ngeo1124
- VISONA' D., CAROSI R., MONTOMOLI C., PERUZZO L., TIEPOLO M. (2012), Miocene andalusite leucogranite in central-east Himalaya (Everest-Masang-Kang area): low-pressure melting during heating. Lithos 144-145, 194-208.

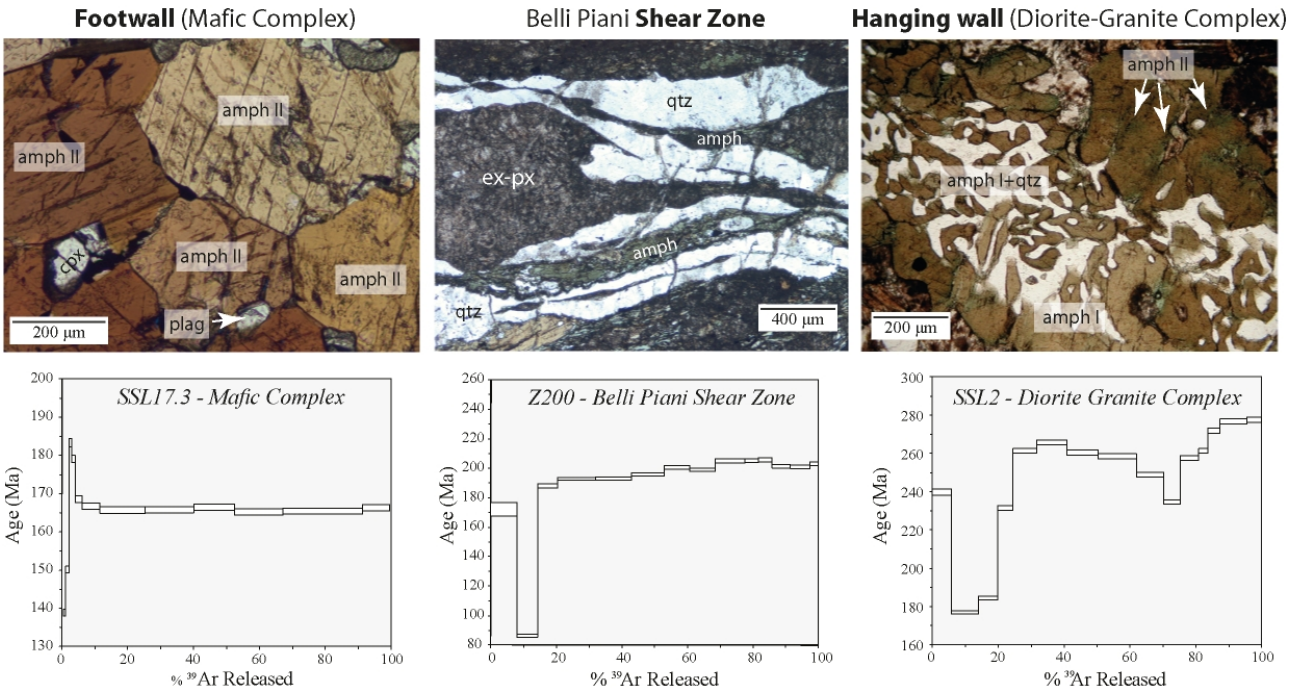

Figure 1: The Santa Lucia unit, in Corsica, samples the Jurassic distal margin of the European plate. A combined microstructural and geochronological study in this unit has recently shown that a Late Triassic-Middle Jurassic extensional shear zone was responsible for exhumation/cooling of the Mafic Complex underneath the Diorite-Granite Complex (see Beltrando et al., 2013 for details)

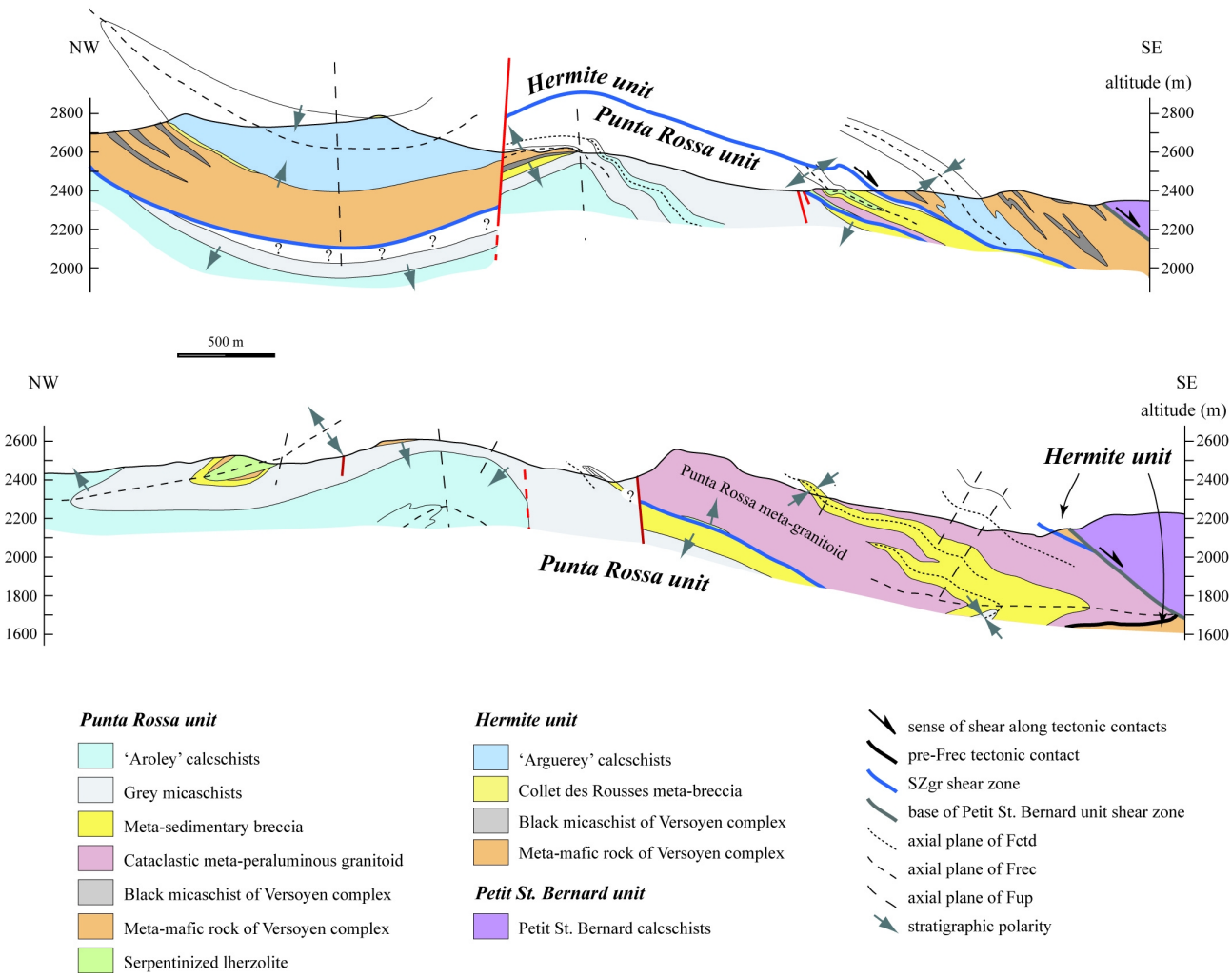

Figure 2: Cross sections of the Valaisan units at the Petit St. Bernard Pass (from Beltrando et al., 2012). The pre-Alpine lithostratigraphy, which is characteristic of a hyper-extended continental margin, can still be recognized despite pervasive Alpine folding

Figure 4: Folded Cretaceous sediments in southern Tibet

Figure 5: Shear zones in the Carboniferous Roses granodiorite (Spain)