The model shows a kinematic decoupling of Tertiary and Mesozoic units along a detachment horizon in Triassic evaporites. A second decoupling can be observed along the base Tertiary horizon in the south of the study area, probably linked to the thrust front of Subalpine Molasse. East of the city of Fribourg, several N-S-striking, en echelon type normal faults in Mesozoic and Tertiary units can be observed. Faults form a zone of 20 km length from N to S. The zone is called the “Fribourg zone”. Faults root in listric bends within middle Triassic evaporites forming a graben or half-graben structure. Triassic evaporites show an important thickening beneath the Fribourg zone. Mapping of fault structures at surface give evidence for left-lateral reactivation of the Fribourg zone under the NW-SE compressional stress field in Neogene times. Correlation of mapped structures does not indicate the presence of large scale fault surfaces exceeding a length of 1 – 3 km (IBELE, 2011). The location of fault traces between 2D seismic lines is speculative in the central part of the Fribourg zone due to a gap of seismic data. Recent studies on present earthquake activity show an enhanced recurrence of low magnitude earthquakes (ML 0 to 4.3) along the Fribourg zone (VOUILLAMOZ & ABEDNEGO, in prep.; KASTRUP et al., 2007). It is therefore proposed, that the Fribourg zone is formed by an assemblage of multiple small scale fault surfaces rather than a few large scale faults. The Fribourg zone forms the eastern border of a N-S striking, low amplitude syncline, called the “Fribourg structure”. The N-S-alignment of the Fribourg structure deviates from the overall NE-SW trend of fold axis in the region. Triassic evaporites show a thinning beneath the Fribourg structure.

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The Gran Paradiso massif: an upside down lower crust?

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At the structural top of the Gran Paradiso (GP) orthogneiss dome, on its W- and NW-margins, seemingly layered or, at any rate, strongly flattened formations comprise greenstones, quartzites, as well as Al-rich whiteschist seams (BERTRAND, 1968). From their peculiar mineral assemblage, including margarite and magnesiochloritoid, CHOPIN (1977) inferred a premonitory estimation of ~1 GPa peak-pressure for the Alpine metamorphism of a part of the Internal Crystalline Massifs (ICM), i.e. Monte Rosa and GP. Soon after (CHOPIN, 1984), his seminal discovery of >3 GPa coesite in Dora Maira (DM, next ICM massif to the S) was from a chemically similar rock, again associated to metagranites, alike the GP whiteschist layers. In both cases, from the Al,Mg-rich chemistry those authors invoked a sedimentary origin, either as a bauxite or as an evaporite level. However this hypothesis of an upper crustal origin has been questioned. SCHERTL & SCHREYER (2008), based on geochemical investigations, have proposed instead that those whiteschists would have been leucophyllite shear zones inside the granites, secondarily metasomatized at depth.

Underlying DM coesite-units to the E, the conglomeratic Pinerolo unit is analogous by its position and by its rock-types to the conglomeratic Money unit that underlies the GP orthogneiss dome. Both metaconglomerate units were unaffected by eclogitization. Overlying DM as well as GP, eclogitized metamafic units (VZSFO = Mt.Viso and Zermatt-Saas-Fee Ophiolite) comprise subordinate calcschists. VZSFO are in their turn tectonically overlain by Combin-type units composed of dominant calcschists and subordinate ultramafic rocks. All those ultramafic-bearing units were classically supposed to be of oceanic origin, representing the Jurassic Piemont Ocean.

Protolith age data comprise mostly Permian to Late Upper Carboniferous ages (310 to 265 Ma) for the orthogneiss (BERTRAND et al. 2005). This is also the radiometric age range for the Ivrea mafic body, a verticalized, Permian, lower crust wedge. The Gneiss du Charbonnel Formation, consisting of interlayered felsic levels of unknown origin in the VZSFO, nearby GP massif, also yielded zircons of Permian age, as is also the case for the Lanzo peridotites. Gabbros of the latter Lanzo zone yielded Jurassic ages (KACZMAREK et al. 2008), correlated to the radiolarite ages at the base of the calcschists, and representing the age of the oceanization (MOHN et al., 2010).

A suggested vision of the ICM would hence them to be an upside down Permian crust of S-Alpine origin representing a lateral equivalent to the Ivrea body. More speculatively, parts of the presently overlying eclogitized mafic units of the VZSFO might represent parts of their related upper mantle. Thin marble levels previously considered as Triassic deposits, between GP and VZSFO, might instead represent layered lower crust remnants.

Abundant zircon crystals found in the Al,Mg-rich whiteschist of western GP margin are presently being investigated, regarding their age(s) of crystallization as well as their mineral inclusions. Field data might also help better defining the relationships of the GP whiteschist with its host-rocks.

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Evolution and reactivation of basement highs at hyper-extended rifted margins: the example of the Briançonnais domain in the Alps and comparisons with modern analogues

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The development of new reflection and refraction seismic techniques enabled to image the crustal architecture of deep-water rifted margins. The new data show that in addition to the classical tilted blocks rifted margins are formed by a large variety of different types of crustal blocks/structures, including micro-continents, continental ribbons, H-blocks and extensional allochthons. This large variety of structures suggest a complex rheological,