Interference of thin- and thick-skinned tectonics at the northwestern Jura front during Neogene to recent transpressive reactivation of the Rhine-Bresse transfer zone

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At its northwestern front the Late Miocene to Early Pliocene Jura fold-and-thrust belt intersects with the Rhine-Bresse Transfer zone. The latter is part of the European Cenozoic Rift System and formed during the Eo- to Oligocene, reactivating Paleozoic basement structures, and linking the opening of the Rhine and Bresse graben in a sinistral transtensive manner (Lacombe et al. 1993). Current results of detailed field and subsurface investigations show that parts of this intracontinental transfer zone have been reactivated by dextral transpression during Neogene to recent times.
The formation of normal faults during Paleogene rifting in the Rhine Bresse Transfer zone, as observable in the Mesozoic cover, was widely controlled by the structural inheritance of Paleozoic basement structures. The most distinctive of those is the La Serre horst that features the confined outcrops of crystalline basement of the La Serre massif. The two main normal fault sets observed in the Mesozoic cover strike NNE-SSW and ENE-WSW, directly reassembling the boundary faults of the Paleozoic horst. The intersection of these two normal fault sets resulted in a patchwork of basement blocks throughout the transfer zone.
From Late Miocene to Early Pliocene this block geometry was partially overridden by the thin-skinned Jura fold and thrust belt. However, the dissection of the decollement horizon (evaporites within the Keuper formation) at the various basement block boundaries led to a variable propagation of the thrust belt at its northwestern most part (“Avant-Monts zone” Sommeruga 1999). Typical field structures associated with the thin-skinned tectonics of the thrust belt are gently dipping thrust faults and folds showing steeply inclined limbs. Paleostress analysis yields divergent directions of sigma 1 depending on the direction of thrusting. The overall distribution is fan-like with sigma1 striking N-S in the east and almost E-W in the western part of the study area.
The examination of industry-type seismic reflection data has shown that in contrast to the eastern Avant-Monts zone, where thrust related folds are found, no thrust belt propagation took place in the western Avant-Monts zone bordering the La Serre massif. Here the observed gentle folding is caused by a thick-skinned positive flower structure inverting Paleozoic and Paleogene structures. Subvertical strike-slip faults that reactivated pre-existing Paleogene normal faults are the predominant structures found in the field. Paleostresses from that area yield sigma 1 striking consistently WNW-ESE. These observations are interpreted as a partial dextral transpressive reactivation of the Rhine Bresse transfer zone.
Within the city of Besancon, large scale structures formed by thin- and thick-skinned tectonics, respectively, interfere with each other. This enabled us to establish a relative

chronology. The main frontal Jura thrust fault, gently dipping south, is dissected by steep northward dipping reverse faults that reactivated former Paleogene normal faults. Therefore thick-skinned deformation post-dates the thin-skinned Jura formation and was active until at least Late Pliocene times. Indeed, as deformation of Quaternary geomorphic marker horizons is observed in the Avant-Monts as well as in the Besancon area thick-skinned tectonics appear to be active until recent times. This hypothesis is strengthened by observations from neighboring areas (Giamboni et al. 2004) and latest seismological data (earthquake of Rigney, Baer et al. 2005).

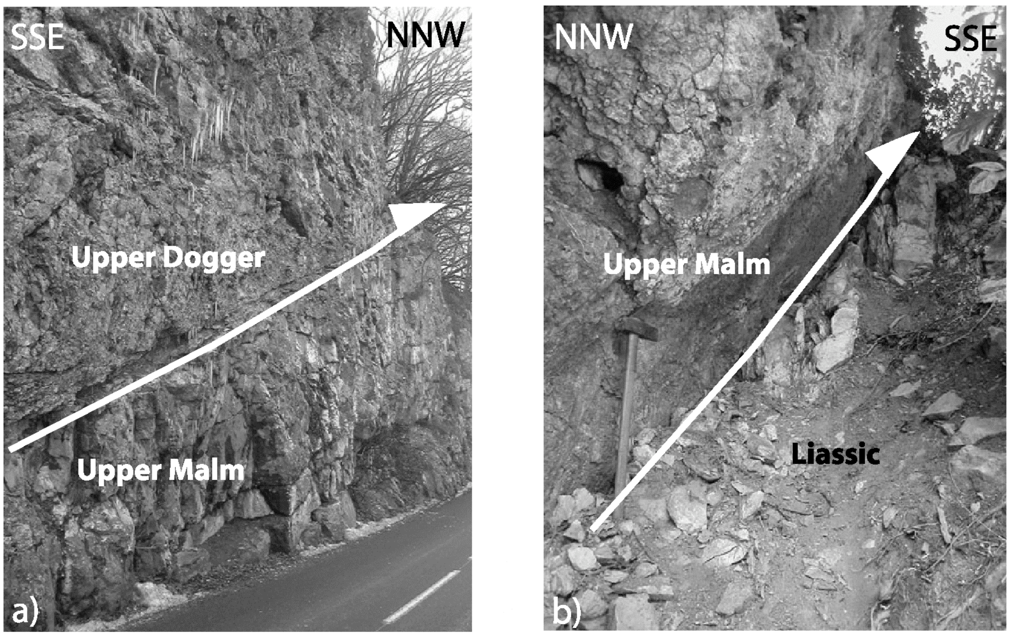

Figure 1. Interference of thin- and thick-skinned structures:
a) gently to the south dipping NNW vergent thrust faults thrusting Upper Dogger above Upper Malm b) steeply northward deeping reverse faults that offset the gently dipping thrust fault and move the footwall of the original thrust (Upper Malm) next/above its hanging wall (Liasssic).

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