Zeitschrift: Eclogae Geologicae Helvetiae

Herausgeber: Schweizerische Geologische Gesellschaft

Band: 85 (1992)

Heft: 3: Symposium on Swiss Molasse Basin

Artikel: Deformation of the subalpine Molasse4

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DOI: https://doi.org/10.5169/seals-167043

when crossing the Molasse from the footwall of the Alps (Subalpine Molasse) to the external foreland (Jura Mountains). The asymmetric cross section of the Molasse – that is rather a wedge than a basin – corresponds to the typical facies development in synorogenic foreland basins: thick coarse grained alluvial sediments in the proximal part change laterally into much thinner fine grained and sometimes evaporitic units.

Molasse geologists created a huge number of lithostratigraphically defined formations and members in the course of time, often mixed up with bio- and/or chronostratigraphic names. Significant biostratigraphic markers were and still are quite rare. For regional or even global correlations this descriptive stratigraphy puts up many problems. Exploration wells of the oil industry helped to solve correlation problems from east to west. Detailed heavy mineral analyses made paleogeographic reconstructions possible but the geological concepts were still quite static.

Today we try to understand foreland subsidence by testing different geodynamic models. What we need is a reliable correlation of international chronostratigraphy with the lithoformations of the Molasse Basin to quantify the subsidence history on an absolute time scale. Besides the direct stratigraphic informations from boreholes, quarries and natural outcrops we have a wide range of indirect implications for the understanding of the geodynamic history of the Molasse Basin. Some examples shall be presented to point out these possibilities. Above all reflection seismics and borehole geophysics are very powerful tools that have to be integrated today into a geodynamic concept.

Deformation of the Subalpine Molasse

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The Subalpine Molasse encompasses the strongly deformed southern part of the Molasse Basin which is overthrust by Helvetic and Penninic Alpine nappes.

In a general way the Subalpine Molasse forms an imbricate fan: thrust faults that dip steeply southwards at the surface level out at depth. In many instances the shaly UMM served as detachment horizon. Some of the thrust faults, as well as bedding within the thrust sheets form a marked structural discordance with the overlying basal thrust of the Alpine nappes (interpreted as disconformity due to erosional relief by some authors). In map view the thrust sheets are arranged en échelon with individual thrust sheets disappearing beneath the Alpine nappes going westward. The structural discordance, as well as some prominent folds oblique to the regional trend might be related to the geometry of the fluviatile fans which are characterized by very rapid lateral facies changes (e.g. from thick, competent conglomerate units to incompetent marly units).

The transition between Subalpine and Plateau Molasse is often developed as a classic triangle zone; it can be interpreted as a type of fault-propagation fold, in which a thrust fault terminates in the core of an anticline-syncline pair.

Deformation of the Subalpine Molasse seemingly progressed from the internal to the external part. It was coeval with deformation in the hinterland and sedimentation in the Plateau Molasse. An area balance suggests that in eastern Switzerland shortening within the Subalpine Molasse is compensated in the pre-Triassic basement by bulging of the Aar massif. In western Switzerland, where the basement uplift is more important, additional shortening might be related to the folding of the Jura.

3-D constraints for tectonic models of Molasse Basin and Jura arc deformation in Central and Western Switzerland

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Balancing sections across frontal parts of the Central Swiss Alps between the crest line of the external crystalline Aarmassif and the most external Jura yields invariably some 25 km or more of net cover shortening. This amount of shortening seems to be constant across the major cross-strike discontinuity represented by the disappearance of the Jura fold belt in the east. The decreasing net shortening of the Jura seems to be compensated by an increased shortening within the more internal subalpine Molasse belt. The two most external latest alpine deformation zones: Jura and Subalpine Molasse are proposed to be formed in an en échelon array in front of a large indenter, the main body of the Central Alps. According to this model (Fig. 2; Burkhard 1990, Fig. 7) the seemingly undeformed Plateau Molasse of Central Switzerland, particularly in an area between Zürich and Bern, had to undergo a dextral shearing deformation (corresponding to Laubscher's (1961)) 7°-clockwise rotation of the Jura indenter. Given the summary knowledge about structures and internal deformation within the Plateau Molasse this model seems at least a viable alternative to the currently proposed models of Jura arc formation. Many of the still largely accepted ideas about Jura and Molasse tectonics clearly violate simple 3-D mass balance considerations. As an example, it is extremely difficult to accomodate the Jura arc by a "radiating" push (balanced cross sections are drawn WNW-SSE in the western and N-S in the eastern part of the Jura!) without extensively deforming the Hinterland (Molasse) by considerable SW-NE strike parallel extension. Jura and Molasse tectonics are intimately linked with each other and an increased knowledge in either area will have consequences for a better understanding of the entire Alpinefront (Fig. 2).

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