Tectonics of the Western Internal Jura Fold-and-Thrust Belt: From the Geneva Basin (Switzerland) to La Bienne Valley (France). Mapping and forward modelling

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[Master thesis in Geology]

This Master thesis focuses on the structural geology of the Internal part of the Western Jura Fold-and-Thrust Belt (FTB), between the Crêt de la Neige anticline, the Crêt au Merle summit and La Bienne valley. A forward model along a valid and balanced cross-section of the study area provides new insight on the kinematic evolution. In a first step, a cross-section has been constructed using seismic interpretations, field measurements and a harmonized geological map based on a stratigraphic compilation from the literature. Based on these seismic depth-converted lines and the elevation model of the Pre-Mesozoic basement of Schori (2021), the depth of the near base Mesozoic horizon has been well constrained. The resulting top basement line under the Jura domain is dipping 1.7° to the SE, whereas under the Geneva Basin it is dipping between 2.7°-3.3° to the SE. The change in angle located under the SE flank of the Crêt de la Neige anticline is considered to be linked to a preexisting normal fault. Based on this initial cross-section and the refined depth of the near base Mesozoic horizon, a new kinematic model of the Western Internal Jura has been developed by using the forward modelling technique implemented in the software Move 2020.1 from Petroleum Experts. The kinematic forward modelling applies fault-bend folds, trishear and fault-parallel flow algorithms. The results yield a total shortening of 23.6 km for the Western Internal Jura. This forward model shows a thin-skinned style and forward stepping deformation accompanied by minor back-stepping thrust sequences. Imbricate fault-bend folding can explain the high southern slope of the Crêt de la Neige and the Crêt au Merle anticlines. The first deformation is attributed to the thrusting of the Crêt de la Neige anticline (shortening of 4.8 km) followed by the Crêt Chalam thrust and its imbrications (shortening of 6,4 km), then, the Tacon thrust (shortening of 8.4 km) and the Bienne thrust (shortening of 3.4 km). Based on seismic interpretations, duplexes have been constructed in the Keuper evaporites (shortening 600 meters). In addition to the primary décollement level situated at the base of the Keuper evaporites, three other detachments levels have been used to explain the topographically elevated position of the Valserine syncline, the Crêt au Merle anticline, the Pesse syncline, and the valley south of the Tacon river. These detachment levels are found in the marly layers of the Aalenian “faciès de transition” units, the Oxfordian “Couches d’Effingen-Geissberg” members and the Berriasian Goldberg formation. Using such a multiple thrust horizon approach avoids having to introduce thick evaporitic duplexes in the Keuper units, high basement horst or inverted Permo-Carboniferous graben structures. The final result is a kinematically viable cross-section of the Western Internal Jura, from the Geneva Basin to La Bienne valley, with deep structures validated by forward modelling.

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