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Extension in a compressional regime: Structural analysis of normal faulting at the basal part of the Molasse foreland basin, Austria

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Normal faulting in foreland basins may reveal high-amplitude flexure of the lower plate due to the advancing orogenic belt which generates extension in the forebulge and the distal parts of the foredeep ("flexural extension"). The resulting normal faults usually strike parallel to and dip towards the orogen. The Upper Austrian Molasse Basin (UAMB) is part of the North Alpine foreland basin formed during the latest Eocene to early Oligocene due to flexural downbending of the lower European plate under the tectonic load of the Alps. The present-day stress regime in the Oligo-/Miocene foreland basin is compressional with a stress orientation roughly perpendicular to the orogenic front throughout the basin. However, in a 3D seismic-reflection volume provided by the Rohöl-Aufsuchungs AG Austria, we recognize extensive normal faulting offsetting strata from the Eocene to the lower Miocene Upper Puchkirchen Formation in the subsurface of the UAMB. This study focuses on constraining the style, timing and mechanisms of Tertiary extensional faulting within marine sediments of the UAMB supplied by a deep-marine channel belt that ran parallel to the Alpine thrust belt. We test the flexural extension hypothesis as being the main process generating Tertiary normal faults in the UAMB. Moreover, we aim to determine if those faults are newly formed or if they reactivate pre-existing, rift-related structures. Furthermore, we investigate if fault location and timing of activity reflect the advance of the orogenic belt and the migration of the forebulge. The study area is located 60 km NE of Salzburg and extends for 25 by 25 km. Fault interpretation is conducted by analysing key seismic horizons and their offsets in 3D seismic-reflection data. Normal fault planes extend vertically for several hundreds of meters with an approximate offset of more than 60 m and are preferably located in the northern, distal part of the basin. Here, the sediments consist of fine-grained overbank deposits created by overtopping turbidity currents and debris flows that flowed along the axial submarine channel. The mean dip azimuth of the Tertiary normal faults is approximately 180°, showing a southward dip towards the Alpine front and an orogen-parallel strike. In contrast, the orientation of Mesozoic rift-related faults alternates between north and south-directed dips. Tertiary normal faults are connected only with southward-dipping Mesozoic rift-related faults possibly indicating reactivation of previous normal faults. Moreover, a major erosional surface extending along the northern slope of the basin – the Northern Slope Unconformity (NSU) – overlays and is not affected by the Tertiary faulting. Hence, the extensional phase is followed by a basin-wide erosional event and post-NSU sedimentation was unaffected by extensional processes in our study area.