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Lower Miocene structural evolution of the central Vienna Basin (Austria)

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ABSTRACT

The tectonic evolution of the Vienna Basin overlying the Alpine-Carpathian fold and thrust belt includes two stages of distinct basin subsidence and deformation. The earlier phase contemporaneous with thrusting of the Alpine-Carpathian floor thrust is related to the formation of a wedge-top basin ("piggy-back"), which was connected to the evolving foreland basin (Lower Miocene; c. 18.5–16 Ma). This stage is followed by the formation of a pull-apart basin (Middle to Upper Miocene; c. 16–8 Ma). Sediments of the latter unconformably overly wedge-top basin strata and protected them against erosion.

Analyses of subcrop data from the central part of the basin focus on the complex stratal geometries and tectonics of the Lower Miocene wedge-top basin. During that period the overriding allochthon is characterised by syntectonic subsidence and sedimentation, out-of-sequence fold-thrusting, normal faulting and sinistral wrenching. All types of faults are dated as Lower Miocene by the occurrence of growth strata and the age of overlying post-tectonic sediments related to the pull-apart basin stage. Faults mapped in 3D seismic are compared to faults along the SW margin of the Vienna Basin. They prove that complex Lower Miocene deformation occurred in large parts of the Austroalpine overriding nappes concurrent with thrusting at the Alpine floor thrust and in the Molasse unit.

The structural analysis of 3D seismic data shows that Lower Miocene sediments of the Ottnangian and Karpatian stage unconformable overly the Alpine-Carpathian thrust nappes with a thickness of up to 1500 m. Geometries include onlaps to the basin floor, internal unconformities and toplaps to the overlying Middle Miocene sediments. These toplaps are the results of tilting and subsequent erosion of the sediment pile by out-of-sequence thrusting in the central part at the Karpatian–Badenian transition (c. 16.3 Ma) prior to the onset of pull-apart deformation.

1. Introduction

The Vienna Basin is interpreted as a thin-skinned pull-apart structure on top of the thrust sheets of the Eastern Alps and Western Carpathians (Royden, 1985; Wessely, 1988; Brix and Schultz, 1993; Lankreijer et al., 1995; Decker, 1996; Decker and Peresson, 1996), which developed as a result of lateral escape of the Eastern Alps along the Vienna Basin Transfer Fault (Figs. 1 and 2; Ratschbacher et al., 1991; Peresson and Decker, 1997). It covers an area of some 5000 km^2 and includes up to 5.5 km thick Miocene sediments.

Tectonics, subsidence and sedimentation in the basin are characterised by two distinct stages, which are referred to as a Lower Miocene piggy-back stage (Seifert, 1992; Peresson and Decker, 1997) and a subsequent Middle to Upper Miocene stage of pull-apart basin formation at the sinistral Vienna Basin Transfer Fault. Basin subsidence and sedimentation terminated during a compressional phase in the Upper Miocene (Decker and Peresson, 1996).

Lower Miocene sedimentation in the Vienna Basin and the half grabens NW of it (Fig. 3) occurred contemporaneously with both, the development of a foreland basin system in the Molasse unit north of the Alpine-Carpathian orogen (Kapounek et al., 1965) and N- to NW-directed thrusting of the Alpine-Carpathian allochthon over the European foreland (Linzer et al., 2002; Zámolyi et al., 2008). In the Vienna Basin, Lower Miocene sedimentation (Eggenburgian to Lower Badenian, c. 18–16 Ma) post-dates Cretaceous to Palaeogene folding and thrusting of the Penninic and Austroalpine units. Strata overly older rocks with a marked angular unconformity. Fluviatile, deltaic and other shallow-marine sediments reach up to 1.5 km thickness. Facies distribution and paleogeographic reconstructions (Seifert, 1992) indicate that the area of Lower Miocene exceeded the present limits of the Vienna Basin. North-West of the Vienna Basin other remnants of the wedge-top deposition zone, which now are separated from the

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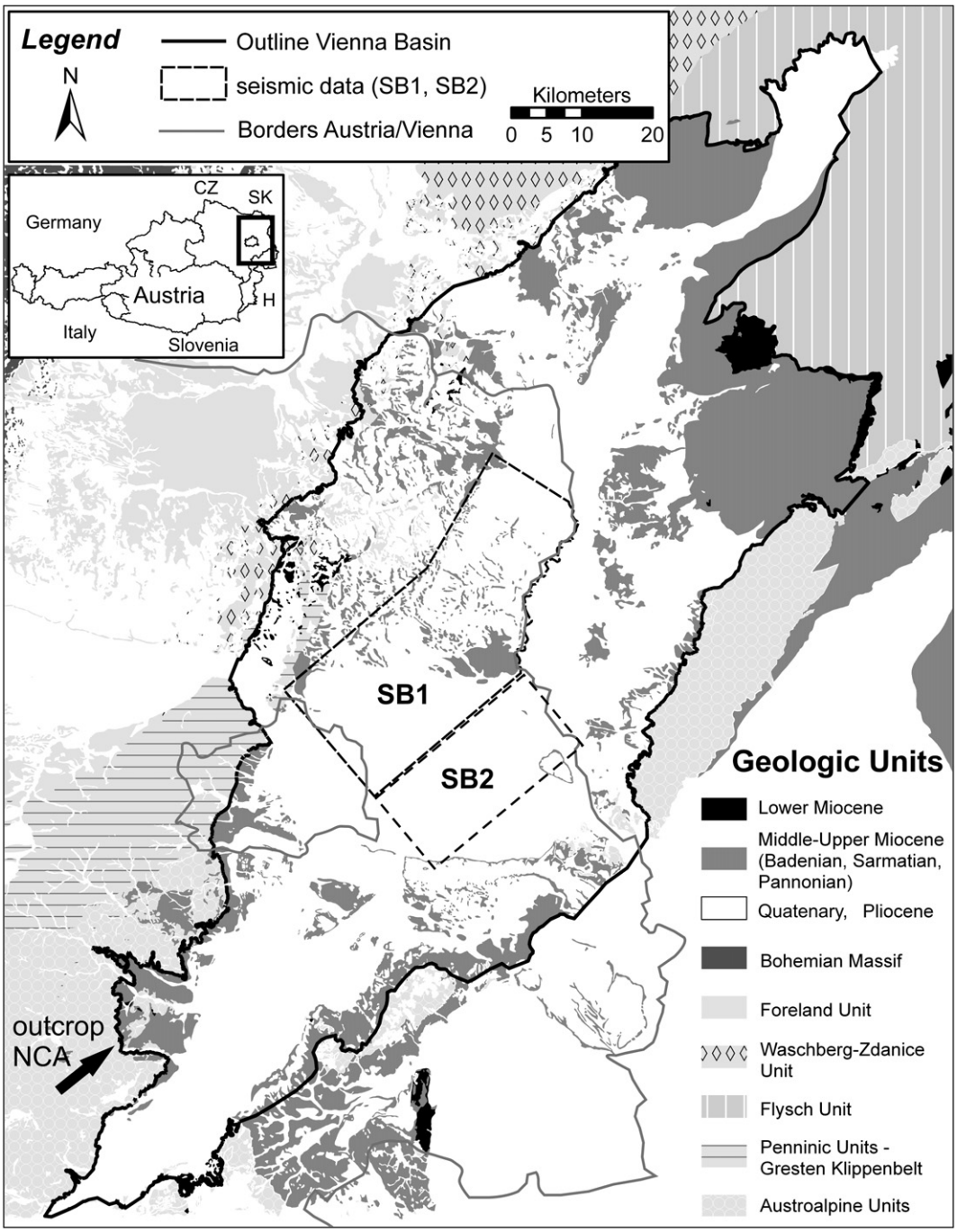

Fig. 1. Position of the Vienna Basin at the transition of the Eastern Alps to the Western Carpathians. The rectangles mark the area covered by 3D seismic (SB1 and SB2). The arrow points to the surface outcrops presented in this paper.

pull-apart, occur in several halfgrabens (e.g. Korneuburg Basin). The oldest sediment infill there has Karpatian age (Harzhauser and Wessely, 2003). The halfgrabens are bordered by Middle to Upper Miocene normal faults in the NW.

Isolated occurrences of Oligocene and Lower Miocene deposits indicate that sediments of that age may have been deposited on large parts of the Austroalpine thrust sheets (Frisch et al., 1998). Due to post-Lower Miocene uplift and erosion, however, remnants are only locally preserved in so-called intramontaneous basins (Sachsenhofer et al., 2000, 2003; Strauss et al., 2001; Gruber et al., 2004; Hölzel and Wagreich, 2004). These basins are all located at releasing segments of major strike-slip faults (Ratschbacher et al., 1991) giving rise to a continuing discussion as whether these basins are small fault-controlled structures, or being remnants of a much larger wedge-top basin, which survived erosion due to Middle Miocene divergent strike-slip faulting.

Preservation of Lower Miocene strata in the Vienna Basin is due to the formation of the Middle to Upper Miocene (Badenian to Pannonian; c. 16–7 Ma) pull-apart basin, which is superimposed on the older basin. Fault patterns in the pull-apart and at the basin margin depict NNE-oriented extensional duplexes (Decker and Peresson, 1996) associated with substantial horizontal extension and normal faulting on NNE-striking faults, which lead to rapid basement subsidence of up to 1500 mm/Ma (Lankreijer et al., 1995; Hölzel et al.,