Geophysical Research Abstracts
Vol. 18, EGU2016-1604-1, 2016
EGU General Assembly 2016

Polyphase basin evolution of the Vienna Basin inferred from 3D visualization of sedimentation setting and quantitative subsidence

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This study analyzed and visualized data from 210 wells using a MATLAB-based program (BasinVis 1.0) for 3D visualization of sediment distribution, thickness, and quantitative subsidence of the northern and central Vienna Basin. The sedimentation settings for selected horizons were visualized to 3D sediment distribution maps, isopach maps, and cross-sections. Subsidence of the study area resulted in 3D subsidence depth and rate maps of basement and tectonic subsidences. Due to the special position of the Vienna Basin, the basin evolution was influenced by the regional tectonics of surrounding units. The 2D/3D maps provided insights into the polyphase evolution of the Vienna Basin, which is closely related to changes in the changing regional stress field and the paleoenvironmental setting.

In the Early Miocene, the sedimentation and subsidence were shallow and E-W/NE-SW trending, indicating the development of piggy-back basins. During the late Early Miocene, maps show wider sedimentation and abruptly increasing subsidence by sinistral strike-slip faults, which initiated the Vienna pull-apart basin system. The sediments of the Early Miocene were supplied through a small deltaic system entering from the south. After thin sedimentation and shallow subsidence of the early Middle Miocene, the development of the Vienna Basin was controlled and accelerated mainly by NE-SW trending synsedimentary normal faults, especially the Steinberg fault. From the Middle Miocene, the subsidence was decreasing overall, however the tectonic subsidence show regionally different patterns. This study suggests that a major tensional regime change, from transtension to E-W extension, caused laterally varying subsidence across the Vienna Basin. The Late Miocene was characterized by the slowing down of basement and tectonic subsidence. From the middle Middle to Late Miocene, enormous amount of sediments supplied by a broad paleo-Danube delta complex on the western flank of the basin. The latest Pannonian and Pliocene E-W compressional event resulted in basin inversion and sediment deformation. In the Quaternary the Vienna Basin has been reactivated, and resulted in small basins subsided along the Vienna Basin transfer fault system.

This study arranged the basin evolution of the Vienna Basin to five phases; 1) E-W trending piggy-back subsidence (Early Miocene), 2) NE-SW transtensional subsidence (late Early Miocene), 3) NW-SE to E-W transitioning extensional subsidence (Middle Miocene), 4) E-W extensional subsidence (late Middle - Late Miocene), and 5) NE-SW transtensional subsidence (Quaternary).