Role of Basement Tectonics in Evolution of Salt Diapirs: the Mid-Polish trough Versus the Dead Sea Basin

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During the extensional basin subsidence, salt layers underlying a thick sedimentary overburden can start to flow, giving rise to the development of a variety of halokinetic structures, such as salt diapirs, salt pillows and salt walls. Salt flow can be triggered by extensional faulting of the sub-salt "basement" (Koyi et al. 1993), as well as by thin-skinned extension of the post-salt sedimentary cover (Vendeville and Jackson 1992a, b). In intracontinental settings salt structures are particularly often related to sub-salt fault zones as in such basins localised extension and subsidence is associated with significant faulting within the pre-salt basement.

The Mid-Polish Trough (MPT) formed the axis of the Polish Basin which belonged to the Permian-Mesozoic system of West- and Central-European epicontinental basins (Ziegler 1990). During the Permian, the MPT formed the easternmost part of the Southern Permian Basin. Prior to its Late Cretaceous – Paleocene inversion, the MPT was filled with several kilometres of Permian and Mesozoic sediments, including thick Zechstein salts. The presence of these Zechstein salts gave rise to the development of a complex system of salt structures in the central and northwest segments of the MPT.

Recently completed regional analysis of seismic reflection data from the entire territory of the Mid-Polish Trough allowed to formulate some rules concerning relative roles of the basement, cover and salt tectonics. Using results of interpretation of seismic data basin-scale sub-Zechstein basement fault pattern responsible for the Mid-Polish Trough subsidence and inversion was proposed together with its role for development of salt structures (Krzywiec 2004a, b, 2006a, b). Basement extension has resulted – since the Triassic – in initiation of salt pillows. In some areas, peripheral (i.e. located outside the zone of maximum subsidence) fault zones formed within the Mesozoic sedimentary cover. Within the central (Kuiavian) segment of the basin very intense extension and faulting led to development in Late Triassic of the salt diapir that extruded onto the basin floor and was covered by uppermost Triassic and Jurassic deposits. During Late Cretaceous inversion salt structures present within the Mid-Polish Trough have been reactivated, both due to basement mobility (uplift of the basement block along reverse faults) as well as compressional stress field acting within the sedimentary cover. Compressional reactivation is best observed for the Drawno – Człopa – Szamotuły salt structure system (Krzywiec 2006b). In this area compression resulted in active diapirism, and growing diapir caused development of numerous unconformities in its vicinity that document consecutive stage of its development. During inversion within peripheral parts of the Mid-Polish Trough salt pillows were formed entirely related to the Mid-Polish Trough inversion and related lateral salt flow. Growth of such salt structures is documented by local thickness variations of the Upper Cretaceous deposits. Analysis of seismic data provided also information on Cenozoic reactivation of selected salt structures. Within the Drawno – Człopa salt structure system extensional reactivation of their topmost parts is observed. Similar activity connected with significant localised subsidence and deposition of brown coal seams has been described above the Damasławek salt diapir (Krzywiec et al. 2000).

A similar interaction between basement faulting, a thick salt layer and its supra-salt sedimentary cover was documented in many other basins, with good example provided by the Dead Sea Basin. This basin is a continental depression located within the rift valley that accompanies the Dead Sea Transform (DST). It is widely agreed that the basin is a rhomb-shaped pull-apart graben that was formed due to the left-lateral displacement along the segmented DST. The basin is bounded on the east and west by a series of oblique-normal (basinwards) faults, which suggest that the basin underwent active transtensional rifting.

Within the Dead Sea basin, the presence of thick Pliocene salt and active Quaternary normal faulting resulted in the development of numerous salt structures (e.g. Sedom and Lisan diapirs) and in different degrees of decoupling between the thick-skinned basement tectonics and the thin-skinned cover tectonics (cf. Al-Zoubi and Ten Brink 2001, Al-Zoubi et al. 2001, Larsen et al. 2002). The location of the Sedom salt diapir was dictated by the existence of oblique-normal faults in the margins of the basin. Presently, salt entirely pierced its overburden and extruded on the surface where it presently forms Mount Sedom with surface expression up to 200 m (Weinberger et al. 1997, Weinberger et al. 2006a). The present uplift rate of Mount Sedom, calculated from precise leveling and Interferometric Synthetic Aperture Radar (InSAR) is 6–9 mm/y, and is similar to the average Holocene rate (Weinberger et al. 2006b). Present-day crustal configuration, including intensly faulted basement resambles the Late Triassic structure of the Kłodawa salt diapir and its basement, located within the central part of the Mid-Polish. Such similarity is also related to possible influence of strike-slip movements on the Triassic evolution of the Mid-Polish Trough.

The comparative study of the Mid-Polish Trough and the Dead Sea Basin is being completed within the International Lithospheric Programme Task Force "Origin of Sedimentary Basins".

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