

nees). *Bulletin of Canadian Petroleum Geology*, 44(2): 375-384.

SANS M. and VERGÉS J., 1995. Fold development related to contractional salt tectonics: southeastern Pyrenean thrust front, Spain. In: M.P.A. JACKSON, D.G. ROBERTS and S. SNELSON (Editors), *Salt Tectonics – A Global Perspective*. AAPG Memoir, 65: 369-378.

TOLWIŃSKI K., 1956. Główne elementy tektoniczne Karpat z uwzględnieniem górotworu Salidów. *Acta Geologica Polonica*, 4(2): 75-226.

VERGÉS, J., MUNOZ, J.A. and MARTÍNEZ A. 1992. South Pyrenean fold-and-thrust belt: role of foreland evaporitic levels in thrust geometry. In: K.R. McClay (Editor), *Thrust Tectonics*, pp. 255-264. Chapman and Hall, London.

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

Piotr KRZYWIEC<sup>1</sup> and Rami WEINBERGER<sup>2</sup>

<sup>1</sup> Polish Geological Institute, ul. Rakowiecka 4, 00-975 Warsaw, Poland

<sup>2</sup> Geological Survey of Israel, 30 Malkhi Israel st., Jerusalem 95501, Israel

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 intensely faulted basement resembles 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”.

## References

- AL-ZOUBI A. and TEN BRINK U., 2001. Salt diapirs in the Dead Sea and their relationship to Quaternary extensional tectonics. *Marine and Petroleum Geology*, 18: 779-797.
- AL-ZOUBI A., SHULMAN H. and BEN-AVRAHAM Z., 2002. Seismic reflection profiles across the southern Dead Sea basin. *Tectonophysics*, 346: 61-69.
- KOYI H., JENYON M.K. and PETERSEN K. (1993). The effects of basement faulting on diapirism. *Journal of Petroleum Geology*, 16(3): 285-312.
- KRZYWIEC P., 2004a. Triassic evolution of the Kłodawa salt structure: basement-controlled salt tectonics within the Mid-Polish Trough (central Poland). *Geological Quarterly*. 48(2): 123-134.
- KRZYWIEC P., 2004b. Basement vs. Salt Tectonics and Salt-Sediment Interaction – Case Study of the Mesozoic Evolution of the Intracontinental Mid-Polish Trough. 24<sup>th</sup> Annual GCSSEPM Foundation Bob F. Perkins Research Conference “Salt – Sediment Interactions and Hydrocarbon Prospectivity: Concepts, Applications and Case Studies for the 21<sup>st</sup> Century”, Houston, Texas, 5–8. 12. 2004, 343-370.
- KRZYWIEC P., 2006a. Structural inversion of the Pomeranian and Kuiavian segments of the Mid-Polish Trough – lateral variations in timing and structural style. *Geological Quarterly* (in press).
- KRZYWIEC P., 2006b. Triassic – Jurassic evolution of the Pomeranian segment of the Mid-Polish Trough – basement tectonics and sedimentary patterns. *Geological Quarterly* (in press).
- LARSEN B.D., BEN-AVRAHAM Z., SHULMAN H., (2002). Fault and salt tectonics in the southern Dead Sea basin. *Tectonophysics*, 346: 71-90.
- VENDEVILLE B.C. and JACKSON M.P.A., (1992a). The fall of diapirs during thin-skinned extension: *Marine and Petroleum Geology*, 9: 354-371.
- VENDEVILLE, B.C. and M.P.A. JACKSON, (1992b). The rise of diapirs during thin-skinned extension: *Marine and Petroleum Geology*, 9: 331-353.
- WEINBERGER R., AGNON A. and RON H. (1997). Paleomagnetic Reconstruction of a Diapir Emplacement: a Case Study from Sedom Diapir, the Dead Sea Rift. *Journal of Geophysical Research*, 102: 5173-5192.
- WEINBERGER R., BEGIN Z.B., WALDMANN N., GARDOSH M., BAER G., FRUMKIN A. and WDOWINSKI S., (2006a). Quaternary Rise of Sedom Diapir, Dead Sea Basin. Geological Society of America Special Publication, New Frontiers in Dead Sea Environmental Research. In: Y. ENZEL, A. AGNON and M. STEIN (Editors), New Frontiers in Dead Sea Paleoenvironmental Research, Geological Society of America Special Paper 401, Chapter 3, doi:10.1130/2006.2401(03), (in press).
- WEINBERGER R., LYAKHOVSKY V., BAER G. and BEGIN Z.B., (2006b). Mechanical modeling and InSAR measurements of Mount Sedom uplift, Dead Sea Basin: Implications for rock-salt properties and diapir emplacement mechanism. G-Cubed, (in press).
- ZIEGLER P.A., 1990. Geological Atlas of Western and Central Europe. Shell Internationale Petroleum Maatschappij B.V., distributed by Geological Society Publishing House, Bath, pp. 239

## Internal Flow Fabric Study of Viscous Lava Domes in Central Slovakia by Means of AMS and Quantitative Microstructural Study

Vladimír KUSBACH<sup>1</sup>, Zuzana KRATINOVÁ<sup>1</sup>, Prokop ZÁVADA<sup>2</sup> and František HROUDA<sup>1</sup>

<sup>1</sup> Institute of Petrology and Structural Geology, Charles University, Albertov 6, 128 43, Prague, Czech Republic

<sup>2</sup> Geophysical Institute, Czech Academy of Sciences, Boční II/1401, 14131 Praha 4, Czech Republic

Two examples of acid and intermediate volcanic bodies in the central Slovakia (middle miocene in age, Konečný et al. 1995) were studied in order to understand the mode of magma flow and emplacement mechanism of highly viscous volcanics. We present preliminary results of integrated AMS and microstructural study. The garnet-bearing andezite dome Breziny (Neresnica Formation., Badenian) was investigated in detail. The quarry located cca 1,5 km NE from the Breziny village exposes southern margin

of an extrusive andezite dome. Ten samples were collected from three quarry levels for detailed AMS and textural analysis. It was suggested that the internal magmatic fabric in the quarry forms a fan-like pattern (Konečný et al. 2004), typical for andezite extrusive domes in the region. The strikes of magnetic fabric in the quarry show a sinusoidal trend with one limb subparallel to the dome margin in the map and rather steep dips (80–90°) and do not show any trend of dips incident to fan-like pattern. The mag-