were replaced by shallow water carbonates. The mixed character of this carbonates is changing upward leading to the deposition of pure limestone and dolomites.

Acknowledgements

This work was supported by the grants from the Ministry of Foreign Affairs and Ministry of Environment of the Republic of Poland and by AGH University of Science and Technology in Krakow (grant 11.11.140.159).

References

BROOKFIELD M.E., 1996. Paleozoic and Triassic Geology of Sundaland. In: M. MOULLADE and A.E.M. NAIRN (Editors), The Palaeozoic, B The Phanerozoic geology of the world I., Amsterdam, Elsevier, pp. 183-264.

GOLONKA J., 2002. Plate-tectonic maps of the Phanerozoic. In: W. KIESSLING, E. FLÜGEL and J. GOLONKA (Editors), Phanerozoic reef patterns. *SEPM Spec, Publ.*, 72: 21-75.

McKERROW W.S., DEWEY J.F. and SCOTESE C.R., 1991. The Ordovician and Silurian development of the Iapetus Ocean. In: M.G. BASSETT, P.D. LANE and D. EDWARDS (Editors), The Murchison symposium; proceedings of an international conference on the Silurian System. *Spec Papers Palaeont.*, 44: 165-178.

LELOUP P.H., LACASSIN R., TAPPONNIER P., SCHAERER U., DALAI Z.H., XIAOHAN L., LIANGSHAN Zh., SHAOCHENG J. and TRINH P. T., 1995. The Ailao Shan – Red River shear zone (Yunnan, China), Tertiary transform boundary of Indochina. *Tectonophysics*, 251:3-84.

METCALFE I., 1998. Paleozoic and Mesozoic geological evolution of the SE Asian region, multidisciplinary constraints and implications for biogeography.In: R. HALL and J.D. HOLLOWAY (Editors), Biogeography and Geological Evolution of SE Asia. Backhuys Publishers, Amsterdam. pp. 25-41.

PAUL Z., GOLONKA J., WÓJCIK A. and KHUDOLEY A., 2003a. The Iapetus Ocean, Rheic Ocean and Avalonian Terranes in Central Asia. *Geolines*, 16: 79-80.

PAUL Z., KHUDOLEY A., GOLONKA J. and WÓJCIK A., 2003b. Avalonian terranes between Europe and central Asia. In: J. GOLONKA and M. LEWANDOWSKI (Editors), Geology, geophysics, geothermics and deep structure of the West Carpathians and their basement. Publ. Inst. of Geoph.s Polish Acad. Sci.s. Monogr Vol. M-28 (363): 155-156.

PHAN CU TIEN (Editor), 1989. Geology of Kampuchea, Laos and Vietnam. (Explanatory note to the geological map of Kampuchea, Laos and Vietnam at 1/1000000 scale), Institute for Information and Documentation of Mines and Geology, Hanoi. 149 pp.

SHOUXIN Z. and YONGYI Z., 1991. China. In: M. MOULLADE and A.E.M. NAIRN (Editors), The Palaeozoic, A The Phanerozoic geology of the world I. Amsterdam, Elsevier, pp. 219-274.

SENGÖR A.M.C. and NATALIN B.A., 1996. Paleotectonics of Asia: fragment of a synthesis. In: A. YIN and T.M. HARRISON (Editors), The Tectonics of Asia. Cambridge Univ. Press, New York, pp. 486-640.

TORSVIK T.H., SMETHURST M.A., MEERT J.G., VAN DER VOO R., McKERROW W.S., BRASIER M.D., STURT B.A. and WALDERHAUG H.J., 1996. Continental break-up and collision in the Neoproterozoic and Palaeozoic; a tale of Baltica and Laurentia. *Earth-Sci. Rev.*, 40: 229-258.

TRAN DUE LUONG and NGUYEN XUAN BAO (Editors), 1988. Geological Map of Viet Nam on 1:500000. Geological Survey of Vietnam, Hanoi.

TRAN VAN TRI (Editor) et al., 1979 (1977 in Vietnamese). Geology of Vietnam, (the North part). Explanatory note to the geological map on 1:1000000 scale. Hanoi, Sci. and Techn. Publ. House, 354 pp. (in Vietnamese), 78 pp. (in English).

ZIEGLER P.A., 1989. Evolution of Laurussia. Kluwer Academic Publishers, Dordrecht, Netherlands, pp. 102.

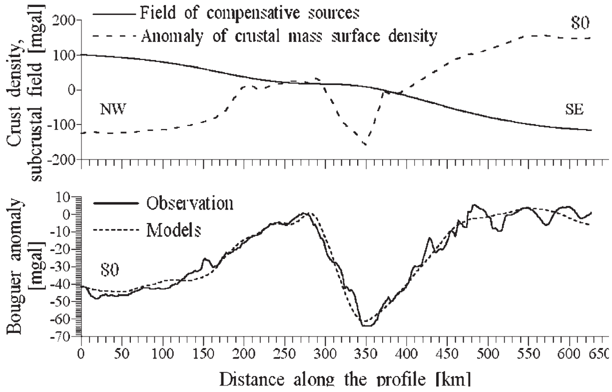
ZONENSHAIN L.P., KUZMIN M.L. and NATAPOV L.N., 1990. Geology of the USSR: A Plate-Tectonic synthesis. In: B.M. PAGE (Editor), *Amer.Geoph.l Union,Geod,s Ser.*, 21: 1-242.

Comparative, Velocity-Dependent Gravity Modeling of the Density Section Along Three Carpathian DSS Profiles

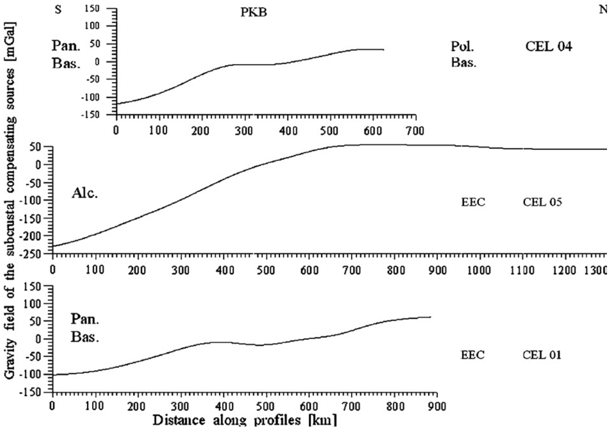
Lech KRYSINSKI

Institute of Geophysics, University of Warsaw, ul. Pasteura 7, 02-093 Warsaw, Poland

Difficulties arisen during gravity modeling along the three Carpathian DSS profiles (CEL 01, CEL 04, CEL 05) crossing boundary of the orogen, were a reason of searching for a modifications of the simplest method of constant layer densities applied at the beginning. The problem was resolved by taking more extensive advantage of the structural information contained in the velocity distribution in the cross section. A stable and convincing results were obtained by using a modified concept of the density field, where density is a function of p-wave velocity in each layer and the density satisfies limitations for



■ **Fig. 1.** Example of successful gravity modeling for profile CEL 04.



■ **Fig. 2.** Comparison of the spatial distribution of the field of compensating sources for the three Carpathian DSS profiles (CEL 01, CEL 04, CEL 05) crossing boundary of the orogen.

its value. Now, the modeling process can be regarded as successful in all three cases (Fig. 1).

The most interesting general results of tectonic character concern the presence of subcrustal isostatic compensation and its characteristic depth. Pronouncing regularity in the spatial distribution of the field of compensating sources (Fig. 2) seems to be a clear documentation of the state of the lower lithosphere showing a large anomaly below Panonian Basin, anomaly being a record of the rift process in the basinal area during formation of Carpathians. Another results concern the significance of the crucial Carpathian tectonic boundary and its present dynamical state.

Timing and Structural Style of Final Thrusting Movements of the Carpathian Orogenic Wedge, S Poland

Piotr KRZYWIEC

Polish Geological Institute, ul. Rakowiecka 4, 00-975 Warsaw, Poland

During progressive evolution of the thrust-and-fold belt deposits of the foredeep basin become progressively incorporated into the orogenic wedge. Such process is often syn-depositional, and consequently syn-kinematic (growth) strata from the foredeep infill could be used to decipher modes and timing of the thrusting movements.

Carpathian foredeep basin developed in front of the advancing Carpathian orogenic wedge (cf. Oszczypko et al. 2006 for further details and references). Its outermost part, presently located in front of the flysch (pre-Miocene) Carpathian units (nappes) is filled by the Badenian – Sarmatian deposits. In this paper two regional seismic lines are presented that illustrate very different gross structure of the orogenic front, foredeep basin and the foreland plate in central and E segments of the Polish Carpathians (fig. 1), and are used to constrain modes of final thrusting movements in this segment of this orogenic belt.

First profile (profile 1 – Fig. 2) is located in the central part of the Polish Carpathians and their foredeep basin, in vicinity of Tarnów. In this area frontal part of the orogenic wedge is built of relatively wide zone of deformed Miocene (Upper Badenian – Sarmatian) foredeep deposits that form the so-called Zgłobice Unit. These unit has been interpreted as a triangle zone cored by passive-roof duplex (Krzywiec et al. 2004). Formation of the triangle zone was controlled by morphology of the Mesozoic basement as well as by distribution of Upper Badenian evaporites. Within this zone numerous evidences of the syn-kinematic deposition have been identified, attesting to the latest Badenian – Sarmatian age of the final thrusting movements. They include progressive unconformities, localized thickness reductions within the crestal parts of the fault-related folds and small-scale fan deltas developed in front

■ **Fig. 1.** Location of regional seismic profiles from the central and eastern segments of the Polish Carpathian foredeep basin. Deformed foredeep deposits (older – Stebnik unit, and younger – Zgłobice unit) are shown by obliquely patterned area.