SUBSIDENCE VERSUS DEPOSITION – QUANTITATIVE ANALYSIS FOR THE POLISH OUTER CARPATHIAN BASINS

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Abstract: Origin of the Outer Carpathian basins is related here to the late Jurassic (? –Hauterivian) rifting. Post-rift thermal sag mechanism controlled the early Cretaceous (?Barremian)-Cenomanian subsidence of the basins. Two phases of tectonic uplift were recognised: the Turonian-Maastrichtian one and, more prominent, the late Eocene-early Oligocene one. The onset of syn-orogenic, extremely rapid deposition migrated in time from the inner (Early Eocene) to the outer zone (Late Oligocene) of the system of basins.

Key words: Outer Carpathians, sedimentary basin, backstripping, palaeobathymetry

The Outer Carpathians in Poland are divided into Magura, Dukla, Silesian, Subsilesian and Skole thrust units, derived from separate basins/sub-basins (fig. 1). The basins were divided by elevated zones, which were source area for sediments. The Tithonian to Lower Miocene basin-fill was detached from a basement, folded and thrust over the European Platform.

In the present contribution tectonic process governing development of the Outer Carpathian basins were examined by means of subsidence analysis (backstripping) of reconstructed, synthetic sections. The present results are in agreement with previously obtained by Poprawa & Malata (1996, 2000) and Oszczypko (1998), although differs from subsidence histories reconstructed by other authors (Kuśmierek, 1995; Nemčok et al., 2001). This is solely due to differences in paleobathymetric corrections.

The Outer Carpathian sedimentary basins are regarded as a deep marine ones (e.g. Książkiewicz, 1975). This leads to uncertainties in paleobathymetric

estimation, and thus widens error bars of subsidence analysis. Correction for eustatic sea level changes has very limited influence on backstripping results. Relatively low precision of stratigraphy of the Outer Carpathian flysch sediments (e.g. Olszewska, 1984) has limited effect on subsidence curves, however it influences error bars of calculated deposition rates.

The results of backstripping for the Outer Carpathian basins show similarities in a general pattern of their subsidence history. In the Silesian and Skole sub-basins tectonic subsidence and deposition rates systematically decreased during the Early Cretaceous and Cenomanian (Figs. 2, 3). This is suggestive for post-rift thermal sag stage of the basin development (Poprawa & Malata, 1996; Oszczypko, 1998). Also general facies development of sediments deposited at this time, i.e. predominance of fine-grained siliciclastics and relative facial unification, particularly for the late Early Cretaceous, confirms post-rift mechanism. However, for the late-most Jurassic-Hauterivian control on subsidence history is very limited.

According to here presented interpretation possible syn-rift basin-fill is not recognised in all units of the Outer Carpathian orogen. This is due to preferential emplacement of detachment surfaces at a level of the shaly post-rift (Early Cretaceous) sediments. By comparison with tectonic evolution of surrounding basins, i.e. the Southern peri-Tethyan realm (Polish Basin) and the Northern Inner Carpathians, it is possible to assume that the main phase of rifting in the Silesian and Sokle sub-basins took pace, or at least begun, during the Late Jurassic (Oxfordian-Kimmeridgian). Magura Unit could have a different history, possibly being linked with Pieniny Klippen Belt.

Alternatively, Nemčok et al. (2001) suggested the Early Cretaceous to Cenomanian age of the main rifting phase. That was based on reconstruction of syn-sedimentary activity of horsts and grabens during this period of time. Additionally, dating of teschenites volcanism indicates that extensional regime prolonged in the Silesian sub-basin until the end of Barremian (Lucińska-Anczkiewicz et al., 2000) or even Albian (Grabowski et al., 2001). However here the Early Cretaceous extension is regarded as a supplementary mechanism of subsidence to thermal sag.

During the Upper Cretaceous (Turonian-Maastrichtian) the Silesian and Skole sub-basins were subject to a minor uplift (several hundreds meters at most; Fig. 2) (Poprawa & Malata, 1996; Oszczypko, 1998; Nemčok et al., 2001). Contemporaneous increase in deposition rates (Pescatore & Ślączka, 1984; Poprawa

& Malata, 2000; Nemčok et al., 2001) indicates that source areas were uplifted as well (Fig. 3). Reconstruction of Nemčok et al. (2001) indicates presence of inversion tectonics of this age. The uplift and inversion was coeval with orogenic phase in the Inner Carpathians and directly predated tectonic inversion/uplift of the peri-Tethyan basins. This might indicate genetic relations between above-mentioned processes. According to Golonka & Bocharova (2000) the widespread inversion in Europe could be a result of the stress induced by movement of Europe and ridge pushing from the Bay of Biscay spreading. During the latest Cretaceous and Paleogene subsidence was re-established in the Outer Carpathian basins, accompanied by decrease in deposition rates (Figs. 2, 3) (Poprawa & Malata, 2000).

Since the late Eocene a rapid uplift of a big magnitude (several hundreds metres at last) begun, which prolonged until early Oligocene (Fig. 2) (Poprawa & Malata, 1996; Oszczypko, 1998). This was contemporaneous with one of the main collision phases in the Alpine belt (e.g. Sandulescu, 1988). The Eocene/Oligocene uplift was followed by the last, minor subsidence event (Oligocene-Early Miocene) in the Outer Carpathians basins, which partially could be related to loading of the plate by accretionary wedge.

Generally for the Eocene-Miocene stage of the Outer Carpathians basins evolution the prominent increase in deposition rates is characteristic (Fig. 3) (Pescatore & Ślączka, 1984; Oszczypko, 1992, 1998; Poprawa & Malata, 2000; Nemčok et al., 2001). The onset of rapid, syn-orogenic deposition migrated systematically in time from the inner zone (southern part of Magura sub-basin – Early Eocene) towards the outer zone of the belt (northern part of Skole and Silesian sub-basins – Late Oligocene) (Fig. 3).

Supposed presence of extensional structures controlling syn-rift subsidence at the early stage of the basins evolution favours their inversion during first stages of the collision. This might lead to speculation on possible evolution from basement-involved thick-skinned style into thin-skinned style of collision.

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Figure 1
A – Location of the studied area. B – Simplified map of the main tectonic elements of the Outer Carpathians in Poland with location of the analysed synthetic profiles.

Figure 2
Tectonic subsidence curves calculated for chosen synthetic profiles (see Fig. 1 for location) compiled for the Polish Outer Carpathians. Strings shaded with grey colour indicate two separate tectonic uplift events: the late Cretaceous one and the end Eocene-beginning Oligocene one.

Figure 3
Changes of deposition rate in time calculated for chosen synthetic profiles (see Fig. 1 for location) representing sedimentary basins of the Polish Outer Carpathians. The deposition rate is interpreted here as indicative for general tectonic activity of the source area (so called ‘cryptic ridges’), with additional influence of sea level changes. String shaded with grey colour indicates diachronous syn-orogenic deposition.

Figure 1
(Poprawa et al.)

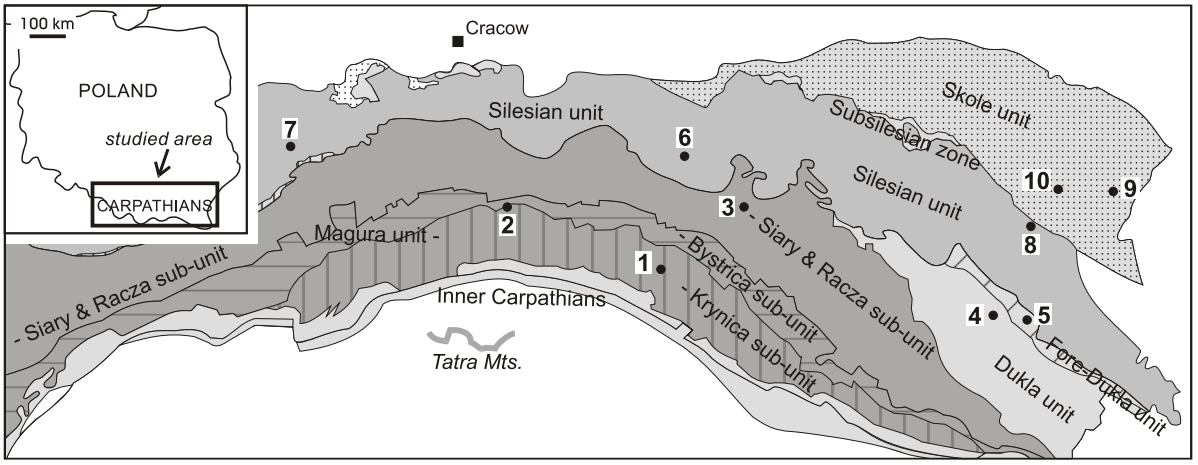

Figure 2
(Poprawa et al.)

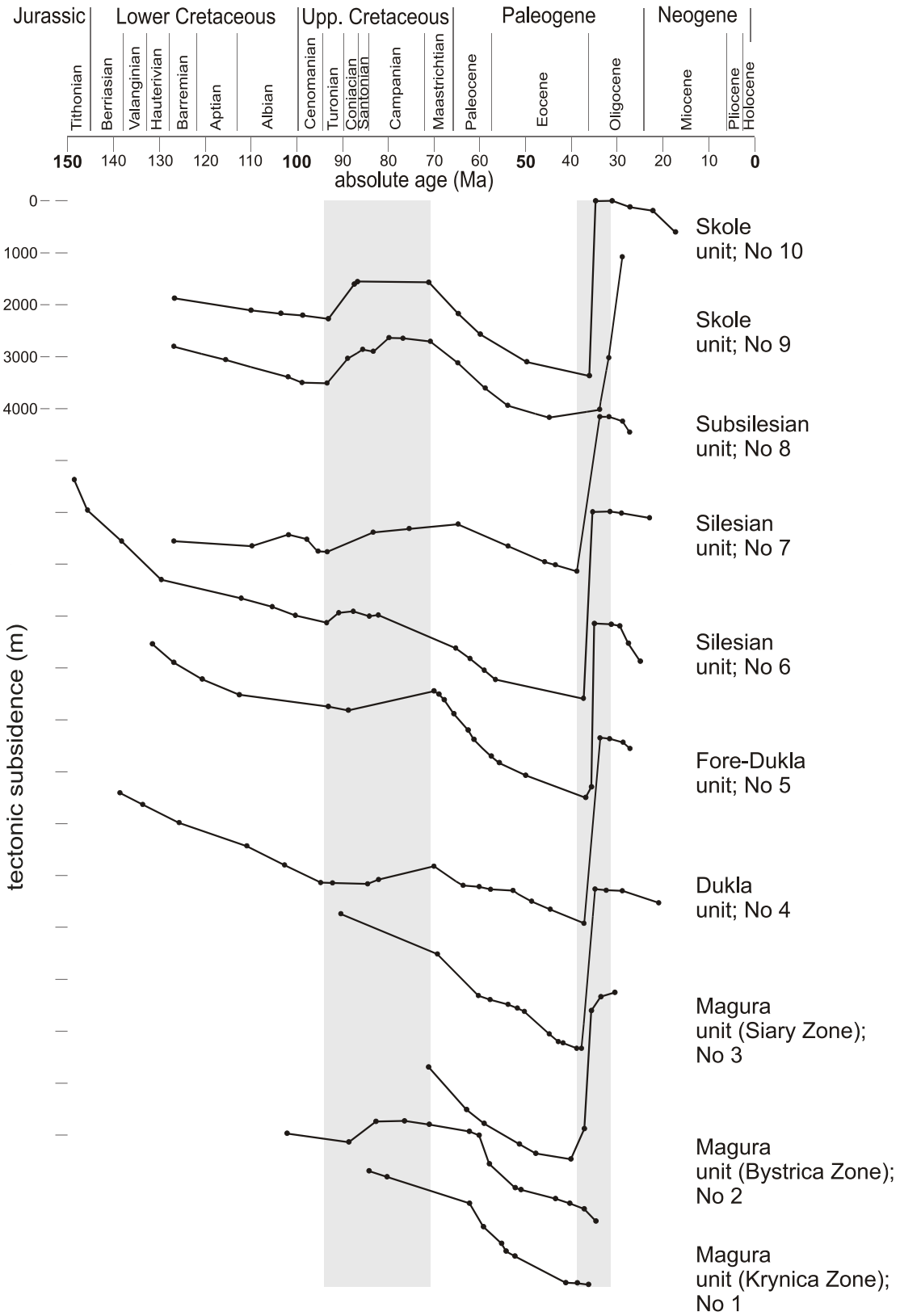

Figure 3
(Poprawa et al.)