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Geodynamic evolution stages of two orogens: the Carpathians and Ouachita Mts.

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Abstract. The Carpathians and Ouachita Mts., although remote in age display striking similarity in their evolution. In both orogens the similar geodynamic stages could be distinguished: stage I - rifting of terranes off the major continents, forming of oceanic type of basins; stage II - formation of subduction zones, partial closing of oceanic basin, development of flysch basin associate with the reifting on the platform passive margin; stage III - collision, probably terrane
- continent, with the accompanying convergence of two large continents; stage IV - postcollisional rifting system development.

Key words: Orogenese, geodynamic, Carpathian, Ouachita

The Carpathian and Ouachita Mts. are remote geographically. The age of the formation of orogen is also quite different. The Carpathians formed mountain belt during Mesozoic and Cenozoic, while the Ouachitas in Paleozoic. Their tectonostratigraphic history displays however striking similarities. The following geodynamic evolution stages could be distinguish in these two orogens:

Stage I – rifting of terranes off the major continent, forming of oceanic type of basins.

Triassic – Jurassic in the Carpathian region, Cambrian – Devonian in the Ouachita basin.

In the Tethyan region opening of the Meliata-Halstatt Ocean occurred as a result of rifting of the Tisa terrane from Eurasia during the Triassic time. The embayment of this ocean could have reached the Pieniny Klippen Basin. This was followed by the Jurassic opening of the Ligurian – part of Pieniny Klippen Belt/Magura Ocean. This opening was associated with the rifting of Alpine-Inner Carpathian terranes off Eurasia in the Carpathian region. Sedimentation of pelagic limestones, marls, cherts, cherty limestones and some flysch deposits occurred during this period.

There are two models explaining formation of the Ouachita basin. In one model (e.g. Keller and Cebull, 1973) the ocean with the truly oceanic crust was open during the early Paleozoic time. E.g. according to Thomas and Astini (1999) the Argentine Precordillera was rifted from the Ouachita embayment of Laurentia during Cambrian time. In the other model (e.g. Arbenz, 1989) the Ouachita basin was separated from the main (Iapetus-Rheic) ocean by the poorly defined terranes. Present day Sabine uplift perhaps constitutes the remnant of these terranes. The Inner Ouachita Foldbelt in Texas could also be connected with such terranes. Sedimentation of graptolitic shales, pelagic, limestones, flysch deposits, marls, cherts, and cherty limestones occurred during this period.

Stage II – formation of subduction zones along the active margin, partial closing of oceanic basin, development of flysch basin associate with these rifting on the platform (passive margin) with the attenuated crust. Cretaceous-Paleogene in the Carpathian region, Early Carboniferous in the Ouachitas

In the Carpathian region subduction developed at the end of Jurassic/ beginning of the Cretaceous (Fig. 1) along the along the southern margin of the narrowing basin north of the approaching Inner Carpathian or Alcapa terranes and began to consume the Pieniny Klippen Belt Ocean (Birkenmajer, 1986). Cherty limestones turned into marls and flysch deposits. The Outer Carpathian (Silesian) basin had developed on the rifted European with extensional volcanism (Golonka et al., 1999, 2000). Outer Carpathian basin reached its greatest width during the Hauterivian-Aptian time with the development of subbasins, like Sub-Silesian, Dukla, Skole-Tarcău, locally separated by uplifted areas. The flysch sedimentation developed. The material was derived from the northern margin as well as from the inner parts of the basin.

During Lower Carboniferous time the Ouachita basin became a narrowing trough with the flysch sedimentation receiving vast amount of clastics (Arbenz, 1989). The subduction probably developed along the southern margin of this narrowing basin north of the approaching Inner Ouachitas or enigmatic Sabine terrane and began to consume the Ouachita Ocean (Fig. 2). According to Arbenz (1989, the earliest evidence of the constriction of the Ouachita depositional basin and of extension in the northern region is from the Lower Carboniferous (Meramecian). The northern margin supplied the clastic material for flysch deposits.

Stage III – Collision, perhaps terrane – continent, with the accompanying convergence of two large continents

In the circum-Carpathian region Adria-Alcapa (Inner Carpathians) terranes continued their northward move-

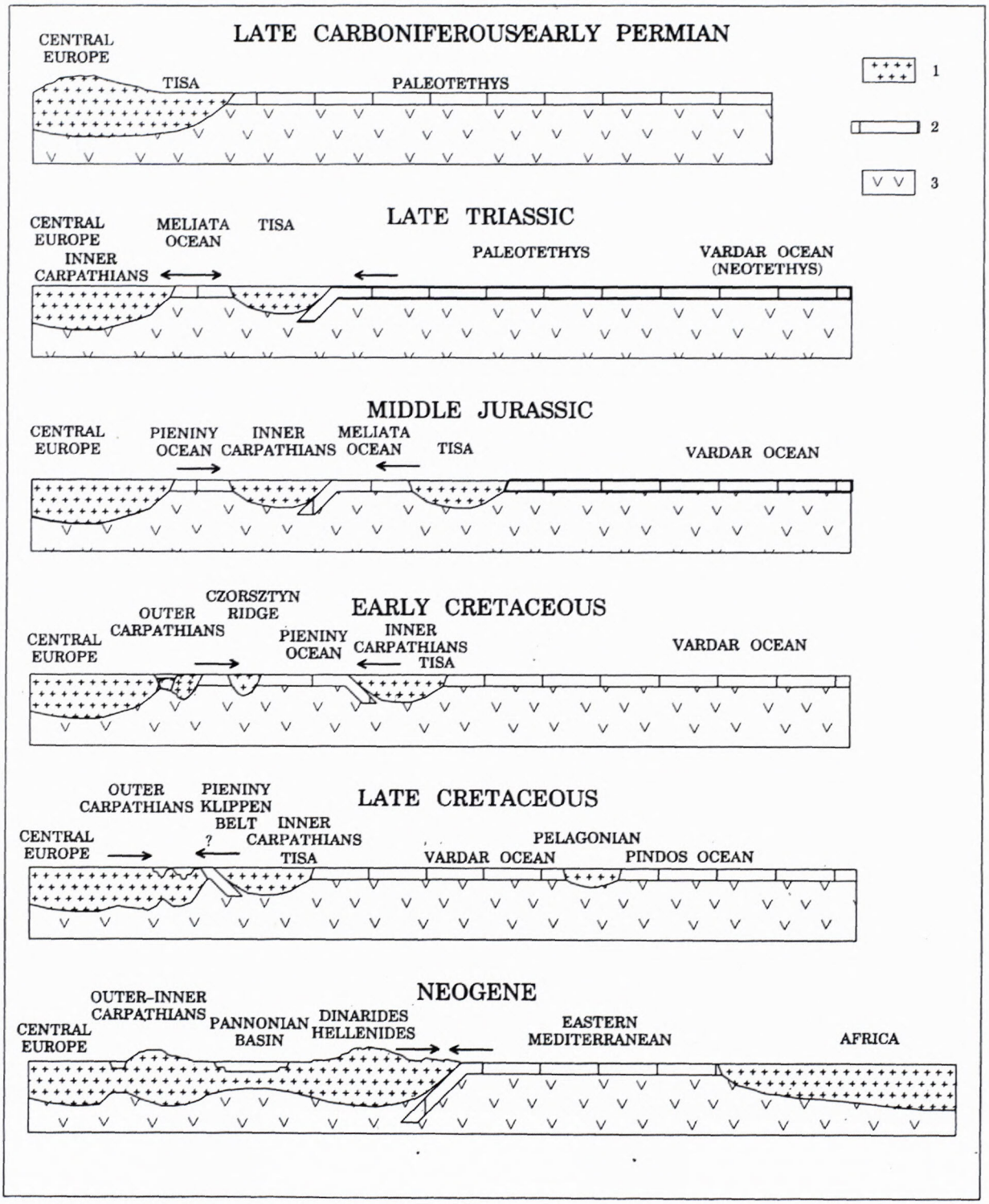

Fig 1. Plate tectonic profiles. Central Europe – Carpathians – Greece. 1- continental crust (including obducted, allochtonous rocks and sedimentary cover, 2 -oceanic crust (including deposits), 3 – upper mantle.

ment during Eocene-Early Miocene time (Golonka et al., 2000). Their oblique collision with the North European plate led to the development of the accretionary wedge of Outer Carpathians. During the compressional stage flysch still continued to be deposited. Numerous olistostromes were formed during this time. At the same time Africa converged with Eurasia. The direct collision of the super-continents never happened, but their convergence did not leave much space, leading to the permanent setting of the Alpine-Carpathian system. The formation of the West

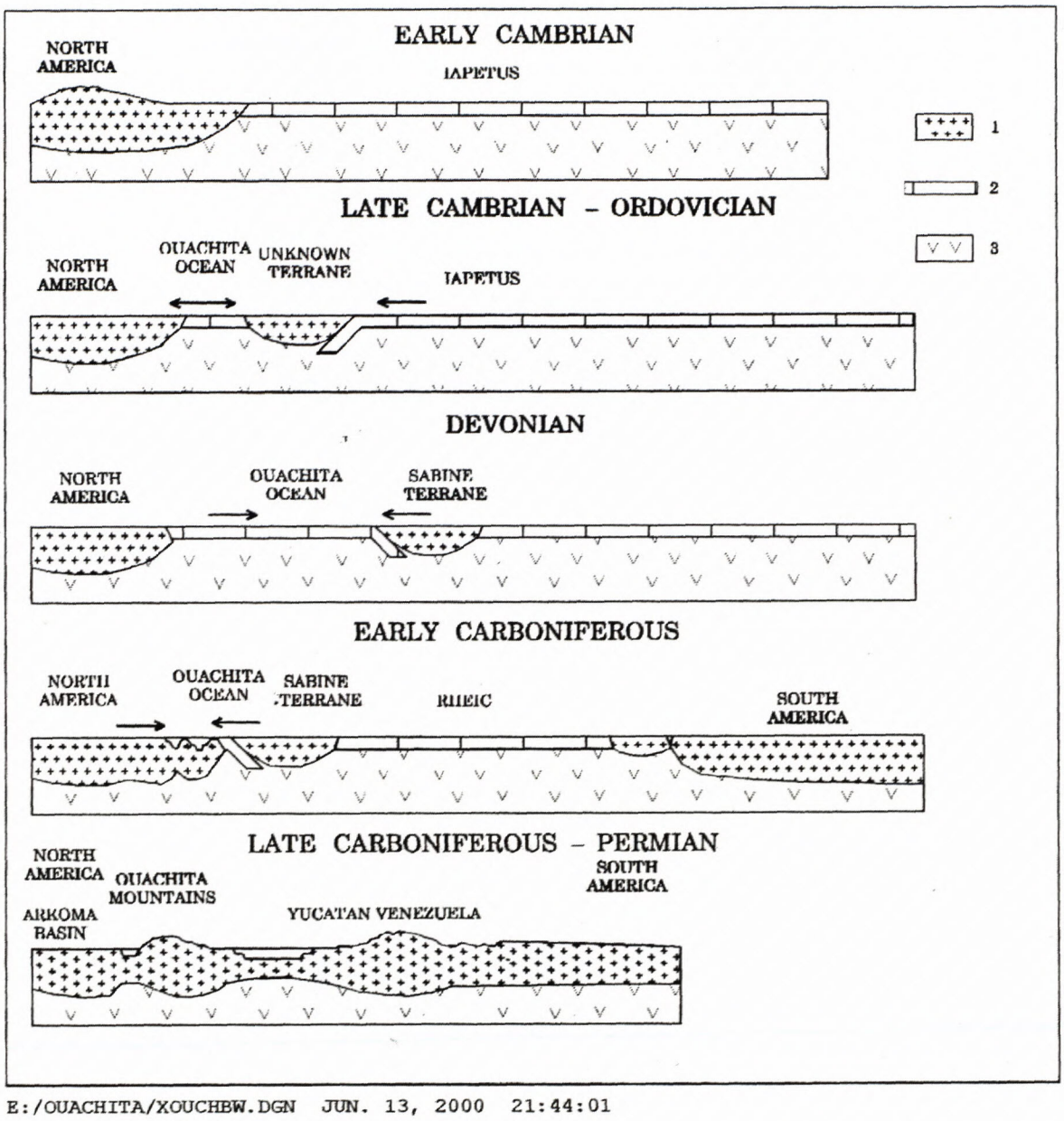

Fig 2. Plate tectonic profiles. North America-Ouachitas-Yucatan- South America. Explanation as on Fig. 1.

Carpathian thrusts was completed by the Miocene time. The flysch deposits passed locally upwards into molasse. The thrust front was still progressing eastwards in the Eastern Carpathians. To the north of the Outer Carpathians and partly beneath them lies the Northern European platform with its Neogene cover. As an results of Miocene tectonic movements, the Outer Carpathians allochtonous rocks have been overthrust onto the platform for the distance of 50 to more than 100 km. As the results of Carpathians overriding the platform the peripheral foreland basin formed along the moving orogenic front (Oszczypko & Ślączka, 1989, Oszczypko, 1998). In the circum-Ouachita region Inner Ouachitas- Sabine terranes continued their northward movement during Carboniferous time. Their collision with the North American plate led to the development of the accretionary wedge of Ouachita Mountains. During the compressional stage flysch still continued to be deposited. Olistostromes of the Maumelle Chaotic Zone formed during this time The main collisional activity occurred during Late Carboniferous – Early Permian in Ouachita Mountains region. The flysch deposits passed upwards into molasse.

This major tectonic activity was caused by the collision of the Inner Ouachitas/Sabine terrane with North America (fig. 2) with the accompanying convergence of Laurasia on the north and Gondwana (composed of Africa and South America with Yucatan promontory) on the south. To the north of the Ouachitas and partly beneath them lies the Northern America platform with its autochthonous cover. As the results of Carboniferous-Permian tectonic movements, the Ouachita allochtonous rocks have been overthrust onto the platform for the distance of 50 to more than 100 km As the results of

Ouachitas overriding the platform the peripheral foreland Arkoma Basin formed along the moving orogenic front.

Stage IV – postcollisional

Miocene-Present- Future? in Carpathians, Permian-Triassic in Ouachitas

During and after the main orogenic phase and the suture of the continents an initial rifting system was initiated in early-Miocene time behind the Carpathian arc in the Pannonian Basin. Extension in the Alpine-Carpathian system continued during the Miocene-Pliocene, forming horst and grabens within the orogen as well as in its foreland. Further development of these processes could be predicted in the future.

During and after the main orogenic phase and the suture of the continents an initial rifting system was initiated in late Pennsylvanian-Permian time in Ouachitas. The basin (equivalent of the Pannonian Basin) developed behind the Ouachitas arc (Arbenz, 199). The system was strongly developed during the Triassic. The rifts contain Triassic sediments. Transgressive Jurassic, Cretaceous and Cenozoic deposits of the Gulf Basin partly covered the Ouachita region. The major part of the Paleozoic hinterland basinal deposits could be hidden below the thick (locally over 10 km) Mesozoic and Cenozoic cover.

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