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EARLY PALEOZOIC EVOLUTION OF THE PERI-GONDWANA PLATES

Wczesnopaleozoiczna ewolucja perygondwańskich płyt litosfery

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Treść: Przedstawiono główne etapy wczesnopaleozoicznej ewolucji perygondwańskich płyt litosferycznych w nawiązaniu do historii superkontynentu Rodinia, a zwłaszcza efektu neoproterozoicznego ryftowania, które doprowadziło do izolacji Gondwany, Laurencji, Syberii i Bałtyki. Wskazano z kolei na wczesnopaleozoiczne (późny kambr – wczesny ordowik) ryftowanie terranów awalońskich, które objęło m.in. północno-zachodnią i południową Polskę. Na tym tle zobrazowano również wczesnopaleozoiczne wydarzenia geotektoniczne w dalekowschodniej Azji.

Słowa kluczowe: Perygondwana, Rodinia, Awalonia, wczesny paleozoik

Key words: Peri-Gondwana, Rodinia, Avalonia, Early Paleozoic

PANNOTIA AND PERI-GONDWANA TERRANES

The Proterozoic history of the supercontinent is defined by two major orogenies. The Grenvillian orogeny around 1100 Ma is related to the formation of supercontinent Rodinia (Dalziel 1991, Hoffman 1991). The Cadomian/Pan-African orogeny is related to the assembly of the supercontinent Pannotia (Dalziel *et al.* 1994, Dalziel 1997, Golonka 2000, Golonka *et al.* 2006a, b) around the Precambrian-Cambrian boundary. More than 500 hundred million years between these two events allows assuming two full Wilson orogenic cycles during this time. It allows also many different, speculative paleogeographic approaches, causing lively discussion.

The Cadomian orogeny caused the deformation and magmatic events of terranes from Iberia through Armorica. The Baltica (Eastern Europe) might have collided with the Cadomian part of Gondwana during the Vendian time causing deformation in the Timan area and proto-Uralian area. The Pechora-Timan belt (Roberts & Siedlecka 2002) and fragments of Ural, Novaya Zemlya and Taimyr are related to the Cadomian belt (Golonka 2000, 2002). At the same time rifting occurred along the other Baltica border, related perhaps to the opening of the Iapetus Ocean (Poprawa 2006). Laurentia rifted away from Pannotia along future Iapetus Ocean during Vendian time and along the Ouachita Ocean during Cambrian time (Golonka *et al.* 2006c). Pannotia supercontinent is not so badly constrained, however, it was short lived. Its history resembled somewhat the history of Pangea, which assembled finally during Early Jurassic and broke-up during Middle Jurassic time. One of the possible, speculative reconstructions is linking Central Asian Orogenic Belt terranes (Tuva?) with the Cadomian orogeny in Europe (Golonka *et al.* 2006b).

Both Gondwana and Baltica were included in the Pannotia supercontinent (Golonka *et al.* 2006a, b). The continents forming the core of Gondwana include South America, Africa, Madagascar, India, Antarctica and Australia. The location of numerous smaller continental blocks that bordered Gondwana is less certain. These smaller blocks were assembled during the Early Paleozoic time to Gondwana, forming the so-called Peri-Gondwanian zone. The following were adjacent to Gondwana at some time during the Paleozoic: Yucatan, Florida, Avalonia, central European (Cadomian) terranes between the Armorica and Bohemian Massif, Moesia, Iberia, Apulia and the smaller, southern European terranes, central Asian terranes (Karakum and others), China (several separate blocks), and the Cimmerian terranes of Turkey, Iran, Afghanistan, Tibet and Southeast Asia.

THE RIFTING OF AVALONIAN TERRANES

The south-dipping subduction developed along the central margin of Gondwana in Late Cambrian – Early Ordovician time. It caused the onset of rifting of the Avalonian terranes. Traditionally, the continent of Avalonia consists of northwestern and possibly southern Poland, some accreted terranes in the basement of East Carpathians and their foredeep, terranes in northern Germany, the Ardennes of Belgium and northern France, England, Wales, southeastern Ireland, the Avalon Peninsula of eastern Newfoundland, much of Nova Scotia, southern New Brunswick, and some coastal parts of New England. Brunovistulicum and Małopolska massives, parts of the Scythian platform, Dzurilla massif of Caucasus, terranes in Tian-Shan and adjacent parts of Kazakhstan and Southern Mongolia terrane could have constitute of the eastern extension of the Avalonia (Paul *et al.* 2003, Golonka *et al.* 2006b). The Avalonian plates probably started to rift from Gondwana and move towards Baltica in the Late Tremadocian and were in a drift stage by the Llanvirnian. This subduction caused also the formation of the vast Rheic Ocean. The Turkmen and Solonker oceans in Asia could constitute the eastern parts of this Rheic Ocean. The plates drifted northward toward the nucleus of Asia (Fig. 1).

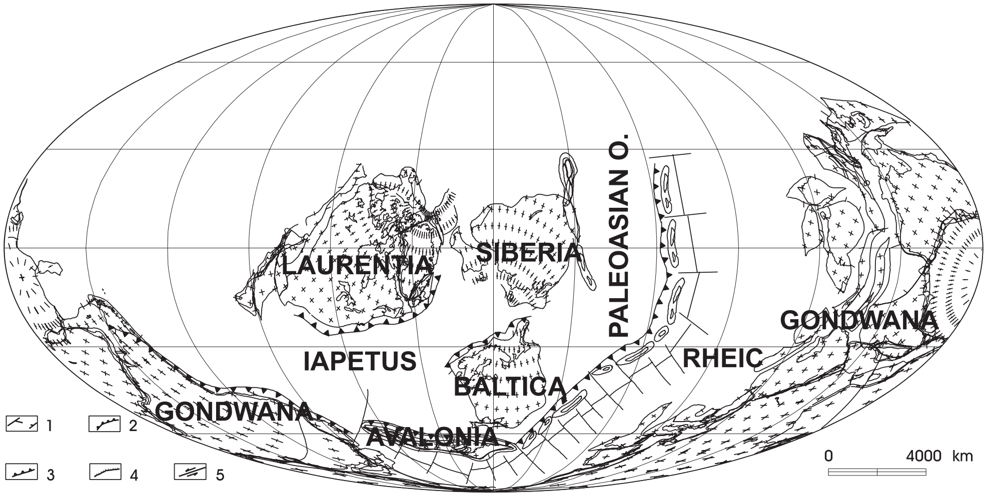

Fig. 1. Plate tectonic map of the Middle Ordovician (plates position as of 472 Ma): 1 – oceanic spreading center and transform faults, 2 – subduction zone, 3 – thrust fault, 4 – normal fault, 5 – transform fault

Fig. 1. Mapa tektoniki płyt środkowego ordowiku (pozycja płyt 472 milionów lat temu): 1 – centrum spredingu oceanicznego i uskok transformujący, 2 – strefa subdukcji, 3 – nasunięcie, 4 – uskok normalny, 5 – uskok przesuwczy

THE PALEOZOIC OROGENIES IN CENTRAL ASIA

The sedimentary sequences in the Gobi desert area in Mongolia as well as in the Chinese Inner Mongolia record the plate tectonic development of Central Asia. Collision between microcontinents (Salairian orogeny) during Late Cambrian – Early Ordovician time in the Mongolia-Tuva area marked the onset of the formation of the Amuria (Mongolia) microcontinent. Relationship of eastern peri-Gondwana terranes and Avalonia plates remain unknown and speculative. It is not impossible that South China and Indochina plates also were rifted from Gondwana in the Ordovician. The uplift and volcanism support such a possibility. According to Shouxin & Yongyi (1991), the Ordovician conformably overlies the Cambrian over most of the South China plate. The northern part of the plate (Yangzi Platform) was covered with carbonates and mixed carbonate/clastic facies. The southern part of the plate is partially uplifted and partially covered by deep water synorogenic clastic deposits – more than 4000 m of weakly metamorphosed flysch, sandstones and graptolitic shales. Similar rocks formed on the margins of Indochina plate. They are known as Pa Ham formation (Ordovician-Silurian).

Late Silurian was the time of the major development of the Caledonian orogeny and final closure of the Iapetus (Fig. 2). The collision between Baltica and Greenland continued, marked by nappes in Norway and Greenland. After the complete closure of the Iapetus Ocean, the continents of Baltic, Avalonia, and Laurentia formed the continent of Laurussia (Ziegler 1989). This Caledonian orogeny and transpressional collision of Gondwana and Laurentia was related to the formation of the enigmatic large supercontinent Oldredia, which existed during Early Devonian times, and included all major plates (Golonka 2000, Golonka *et al.* 2006b).

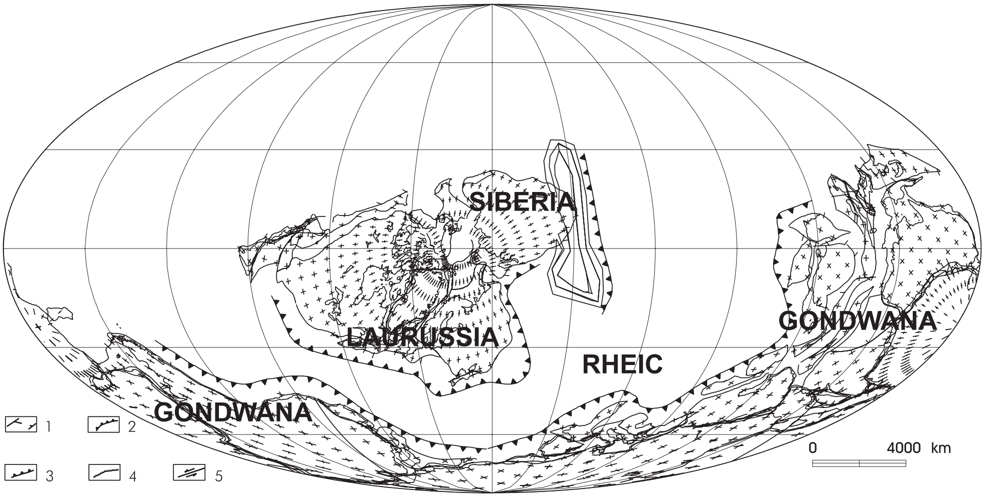

Fig. 2. Plate tectonic map of the Late Silurian (plates position as of 425 Ma): 1 – oceanic spreading center and transform faults, 2 – subduction zone, 3 – thrust fault, 4 – normal fault, 5 – transform fault

Fig. 2. Mapa tektoniki płyt późnego syluru (pozycja płyt 425 milionów lat temu): 1 – centrum spredingu oceanicznego i uskok transformujący, 2 – strefa subdukcji, 3 – nasunięcie, 4 – uskok normalny, 5 – uskok przesuwczy

The above mentioned events indicate possible connection of Asiatic plates with Oldredia. During Middle Devonian times, rifting of continental margins of Oldredia led to disassembly of the supercontinent (Golonka 2000, 2006b). The collision of the North China plate and closure of Solonker ocean (Şengör & Natalin 1996) in Permian time concluded the orogenic process.

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