

Plate tectonic phenomena in the Southern Poland and adjacent areas – a geotouristic point of view

The aim of the study was to underline the importance of the plate tectonic theory and show how it might be used for education and touristic purpose on the basis of geological sites from Sudetes and Western Carpathians.

In the first part of the dissertation theoretical assumptions of plate tectonic theory and geotourism were described with special attention given to the educational function. After analysis of the school's education programs on different levels the high school students were chosen as a target group.

The plate tectonic theory is a mobilistic (neomobilistic) theory which corresponds to the Wegener's continental drift theory. Plate tectonic theory assumes that outermost part of the Earth, so called the lithosphere, is built of two different types of plates which are in constant motion. The continental type plates are 30 to 80 km thick and are built of light, acidic rocks. On the other hand, the oceanic type plates are much thinner, c.a 8 km, and are composed of more dense mafic rocks with high content of minerals such as olivines. Plate's velocities usually do not exceed 10 cm/year, however in the past even the large cratons like Baltica or Laurentia might reached velocities up to 20 cm/year.

The plate tectonic theory assumes three different types of plate's boundaries. The convergent boundary is a place where thin and dense oceanic plate sinks in the mantle creating so called subduction zone. Subduction zones are marked by oceanic trenches. Volcanic activity and strong seismicity are typical for this kind of boundary. The rift zone is another type of plate's boundary. Along rift zones, due to the volcanic activity a new oceanic plates are created . The full profile of the oceanic crust is represented by ophiolites. The third kind of plate's boundary are transform faults, which are also known as a conservative boundaries.

The constant movement of tectonic plates leads to the amalgamation of new continents and also to desintegration of those which already exist. The simplified scheme showing the continent's evolution is described by the Wilson Cycle. The Wilson Cycle consists of 6 stages. During the first, so called embryonic stage, the continental rift is initiated within an old craton. During the juvenile stage a new oceanic crust is being created as a result of submarine volcanism. The mature stage covers a wide oceanic domain with fully developed passive margins. The onset of subduction along ocean's edge marks the beginning of the declining stage. During the terminal stage an accretionary prism is created. The final stage is marked by suturing and orogen formation.

In the next part of the dissertation the geology of the Sudetes and Polish Outer Carpathians is presented. The Sudetes Mountains are part of the Bohemian Massif. The Sudetes are composed of

Cadomian fragments, which were dismembered and reconsolidated during the Variscan orogeny.

The Polish Western Carpathians, which were also in the scope of interest, can be divided into the Outer Carpathians, which are sometimes also called the Flysch Carpathians, and the Inner Carpathians. The Outer Carpathians are built of Upper Jurassic to Lower Miocene sediments deposited in several basins in the eastern part of the Tethys Ocean (Parathetys). The Inner Carpathians are part of the Alcapa terrane – the microplate which was consolidated during the Variscan Orogeny.

As a result of field work most interesting parts of the Sudetes and Carpathians were chosen. The Kaczawa Foothills, Rychlebskie Mountains and Łądek Zdrój were chosen as a most representative for the Sudetes, and most significant geological sites from Pieniny Klippen Belt, Silesian Nappe and Magura Nappe from the Western Carpathians were described. Several sites which were recognized as a valuable geotouristic localities were described more detailed. Based on others the Wilson Cycle in the Sudetes and Carpathians were presented.

As a most valuable, the following geotouristic sites were chosen:

- the “Gruszka” Quarry – olistoliths formed by shallow water limestones on a passive margin of the Rheic Ocean deposited within the deep water sediments,
- the Nýznerovské Vodopády – fragments of the ophiolites, representing oceanic crust of the Rheic ocean,
- the Wapienica Hill – probably represents the closure stage of the back arc basin,
- na Pomezí and na Špičáku caves – Devonian carbonates representing synrift sequence of the back arc basin,
- the Ślęża ophiolite – fragments of the oceanic plate of the back arc basin,
- the Szlary Mine – part of the ophiolitic complex. Because of the high geotouristic potential the development of this place was presented,
- the Srebrna Góra Pass – classical outcrop of synorogenic flysch deposits,
- the Vycpálek Quarry – postorogenic granites representing the final step of the Wilson Cycle
- the Wieprzówka falls – deepwater shales, siltstones and locally sandstones deposited within the widening Protosilesian Basin,
- the Basaltic Klippe, Biała Woda Valley and olistoliths of the Pieniny Klippen Belt – remnants of the Czorsztyn Ridge,
- the Mosorny Stream – contact of thickbedded sandstones with deepwater, mainly shaly sediments.

In the Sudetes the Wilson Cycle covers the Early Cambrian to Late Carboniferous timespan.

The Sudetes were created as a result of fragmentation of the Pannotia supercontinent during Cambrian and consolidation of the Pangea in Carboniferous. During this time two wide oceans were present (i. e

Iapetus Ocean and Rheic Ocean) and numerous continents were created (i.e. Laurentia, Siberia, Baltica, Gondwana, Laurussia and Oldredia). As a result of the closure of the Rheic Ocean the Variscan Orogen was created with Sudetes in its eastern part.

The first stage of the Wilson Cycle in the Sudetes is represented by large bodies of Lusatian granitoids identified in the Western Sudetes which are interpreted as postorogenic intrusions marking the cessation of the Cadomian orogeny in the Neoproterozoic – Early Cambrian times. The early opening of the Rheic Ocean is clearly visible in the Kaczawa Unit, where Early Paleozoic rocks exhibit typical succession of deepening ocean. The Rheic Ocean reached its greatest extent in the Silurian. It is estimated that its width was about 4000 kilometers. This stage is probably represented by Lower Paleozoic fine grained deposits which can be found as olistoliths within synorogenic deposits of the Bardo Unit. The onset of the opening of the back arc basin took place as a result of ongoing subduction of the Rheic Ocean oceanic plate along Laurussian continent. It resulted in formation of the volcanic island arc, which divided the back arc basin (the Rhenohercynian Ocean) from the Rheic Ocean.

The back arc basin was filled by both clastic and carbonate sediments which are represented by deposits of Branna Unit, Bardo Unit or Świebodzice Unit. The back arc basin was closed in lowermost Upper Carboniferous. As a result of Gondwana – Laurussia collision a large accretionary prism was created as well as ophiolites were obducted. The best examples of the ophiolite of the back arc basin is the Intrasudetic Ophiolite. During the final stage numerous syn- and postorogenic granitic intrusions were emplaced within the Sudetes Mountains. Most impressive ones are the Karkonosze Massif, Strzegom Massif or Żulowa Massif. During the Upper Carboniferous and Permian times a thick postorogenic molasses was deposited. It can be found for example in the Kaczawa Unit.

In the Carpathians, the first stage of the Wilson Cycle is univocal with opening of the Alpine Thetys in Middle Jurassic with the Mega Pieniny Basin as a part of this domain. In the next stage the Protosilesian Basin was created in Cretaceous times. This stage is marked by emplacement of so called teschenites. During the Late Cretaceous – Paleogene times, as a result of the onset of the subduction zone, the Thetys Ocean started to shrink. In the same time the basin was filled by deep water sediments with abundant olistostromes. The accretionary prism was formed from Eocene to Early Miocene. Because of ongoing subduction the basin was filled by reworked clastic material. The final stage of the Wilson Cycle in Carpathians is marked by the collision of terranes with East European Craton in Miocene. During the last stage, the exhumation took place and postcollisional volcanic arc was formed.

It is stated that because numerous, highly differentiated and easily accessible geological sites, the whole study area, but especially the Sudetes, exhibits high geotouristic potential. Most of described

sites do not need and complicated or expensive preparation to make them available for touristic purpose. It is stipulated that the Wilson Cycle is a key to understanding the geological framework of described areas, and the presented approach is helpful to elucidate the geology to non-professionals. It is also stated that geotouristic field trips might help to diversify school programs and ecological awareness of the teenagers.