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THERMAL STRUCTURE OF ŚWIĄTKOWA AND KLĘCZANY-LIMANOWA TECTONIC WINDOWS (POLISH SEGMENT OF THE OUTER CARPATHIANS) BASING ON CLAY MINERALS

INTRODUCTION

The degree of illite/smectite (I/S) diagenesis have been used to reconstruct the thermal history and structural evolution of two tectonic windows exposed within the Magura nappe. These windows have been chosen as the study object, because results of magnetotelluric studies imply that each of the windows underwent different structural development depending on morphology of the Carpathian basement (Ryłko, Tomasz 2001). Furthermore, studies of illite/smectite (I/S) diagenesis within the Polish segment of the Outer Carpathians are most advanced for the Magura nappe (Świerczewska unpublished).

GEOLOGICAL SETTING

Outer Carpathians are thrust-and-fold belt, north-verging in the Polish segment. Main tectonic features of the belt were formed during Tertiary times due to southward subduction of the southern part of the European Platform (Fig. 1). Outer Carpathians comprise several nappes, the innermost of which within the Polish segment is the Magura nappe. The Magura nappe is underlied by Dukła nappe and its equivalents (Fore-Magura group sensu Cieszkowski & Ślącza 2001). Dukła nappe and its equivalents are exposed within discussed tectonic windows.

Both discussed tectonic windows are located in the outer part of the Magura nappe. Within the windows, crop out largely Paleogene strata (Kozarski, Tokarski 1968, Burtan et al. 1992). Only in the eastern part of the Klęczany-Limanowa window, crop out Cretaceous strata. However, the tectonic position of these strata is not clear (Burtan et al. 1992). On the surface, the windows are surrounded by Late Cretaceous through Oligocene strata of the Magura nappe (Kozarski, Tokarski 1968, Burtan et al. 1992).

MATERIALS AND METHODS

The studies of illite/smectite (I/S) diagenesis were performed on 22 surface samples of claystones. In the windows, the samples were collected mostly from the Oligocene strata whereas in the Magura nappe the sampled strata range in age from

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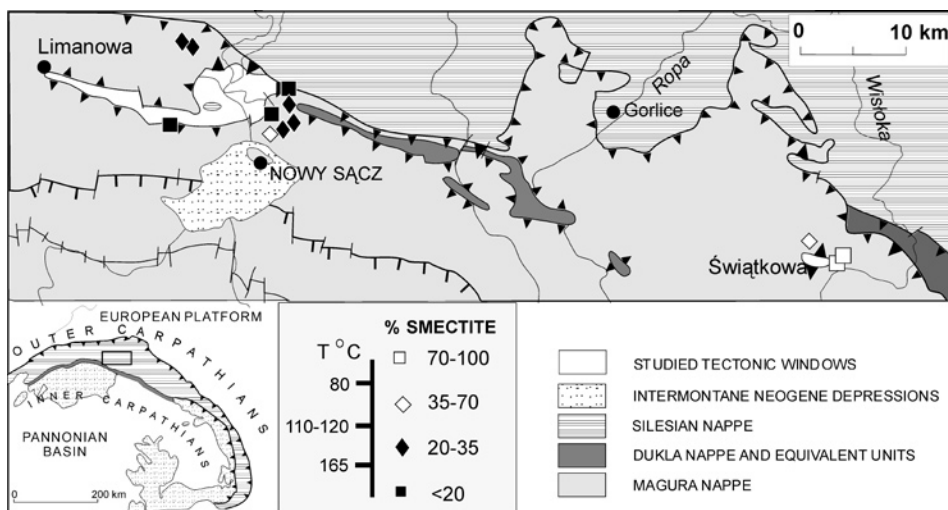


Fig. 1 Geological map of the study areas with the location of the sample sites (after Żytko et al. 1988); inset shows the location of the study areas (boxed) within the Carpathian arc.

Late Cretaceous to Oligocene. Within the Magura nappe, the sampled exposures are situated less than 3 km from the windows. Illitization of smectite has been studied in the clay fraction ($<0.2 \mu\text{m}$) by X-ray diffraction. Air-dried and glycolated preparations were analysed by the Philips diffractometer equipped with Cu tube and graphite monochromator, and scanned from 2 to $37^\circ 2\theta$ with $0.02^\circ 2\theta$ step and counting time $5\text{s}/\text{step}$ at 45mA and 60kV . The degree of diagenesis has been expressed as the percentage of smectite (%S) in mixed-layer illite/smectite minerals and the type of ordering (R) using XRD techniques of Środoń (1984).

RESULTS AND CONCLUSIONS

The Świątkowa window samples contain I/S ($28 \pm 6\% \text{S}$) characterised by $R=1$. This would imply (eg. Jennings, Thompson 1986, Šucha et al. 1993) that sampled rocks were subjected to temperatures of $110\text{--}165^\circ\text{C}$. Samples collected in the Magura nappe, close to the Świątkowa window, are higher in smectite (I/S $60\text{--}75\% \text{S}$) characterised by random interstratification ($R=0$). This suggests that the sampled strata were subjected to temperatures of probably lower than 110°C or even lower than 80°C . In contrast, the degree of I/S diagenesis in the Limanowa-Kłęczany window samples is much more advanced. I/S in the samples contains $10\text{--}18\% \text{S}$ and is characterised by $R>1$ ordering. Samples collected from the Magura nappe, at the rim of the window, show the same degree of diagenesis as the window samples. The high degree of diagenesis suggests that elevated temperatures, exceeding 165°C , affected the sampled rocks. However, in adjoining area, 1 to 3 km from the window boundary, %S in the rocks of the Magura nappe varies from 25 to 45% . The samples show both

random and ordered interstratification ($R=1$). This suggests maximum paleotemperatures of $<165\text{ }^{\circ}\text{C}$ and $80\text{-}120\text{ }^{\circ}\text{C}$.

In both studied regions, the degree of I/S diagenesis increases from the strata of the Magura nappe to those of the underlying Dukla nappe. This implies that the diagenetic maturity results from burial. Assuming that both regions were affected by similar heat flow, we may infer that the amount of post-diagenetic erosion and uplift was larger in the Kłęczany-Limanowa region than that in the Świątkowa region. This conclusion fits well in the tectonic models of Ryłko and Tomáš (1991) in which Kłęczany-Limanowa window is located above prominent escarpment in the Carpathian basement. The sudden change of diagenetic maturity between the strata exposed in the windows and in the surrounding Magura nappe suggests that the uplift of the windows strata was larger than and independent of that of the Magura rocks.

Acknowledgements: The research reported in this paper has been supported in part by the Committee for Scientific Research, grant No 5.91.0021.00.0. to W. Ryłko.

REFERENCES

- BURTAN J., CIESZKOWSKI M., JAWOR E., ŚLĄCZKA A., 1992: Budowa geologiczna okna tektonicznego Kłęczan-Limanowej. Przewodnik 63 Zjazdu Polskiego Towarzystwa Geologicznego, Koninki:171-179. Kraków.
- CIESZKOWSKI M., ŚLĄCZKA A., 2001: The Polish Carpathians – general geology. 12 Meeting of the Association of European Geological Societies. Field trip guide: 99-108. Kraków.
- JENNINGS S., THOMPSON G.R., 1986: Diagenesis of Plio-Pleistocene sediments of the Colorado River Delta, Southern California. *J. Sed. Petrol.* 56: 89-98.
- KOSZARSKI L., TOKARSKI A., 1968: Szczegółowa mapa geologiczna Polski, arkusz Osiek; 1:50 000, Wydawnictwa Geologiczne, Warszawa.
- RYŁKO W., TOMAŚ A., 2001: Neogeńska przebudowa podłoża Polskich Karpat i jej reperkusje. *Biul. PIG*, 395: 1-60.
- ŚRODON J., 1984: X-ray powder diffraction identification of illitic materials. *Clays Clay Miner.* 32: 337-349.
- ŠUCHA V., KRAUS I., GERTHOFFEROVÁ H., PETES J., SEREKOVÁ, M., 1993: Smectite to illite conversion in bentonites and shales of the East Slovak Basin. *Clay Miner.* 28: 243-253.
- ŻYTKO K., ZAJĄC R., GUCIK S., 1988: Map of the tectonic elements of the Western Outer Carpathians and their foreland 1:500,000. Wydawnictwa Geologiczne Warszawa.