

4 km sequence (Sibisel Valley) vary systematically from 25 to 23 permil. The data are interpreted to indicate progressive cooling of the continental climate within this interval.

References

- Bojar, A.-V., Neubauer, F., Fritz, H., 1998. Cretaceous to Cenozoic thermal evolution of the southwestern South Carpathians: evidence from fission-track thermochronology. *Tectonophysics* 297, 229-249.
- Grigorescu, D., Avram, E., Pop, G., Lupu, M. & Anastasiu, N., 1990a. Guide to excursions. International Symposium I.G.C.P. Projects 245 and 262.
- Grigorescu D. & Csiki, Z., 2002. Geological introduction to the Uppermost Cretaceous continental formations with dinosaurs and other vertebrates of the Hateg Basin. In: The 7th workshop of vertebrate paleontology, Abstract volume and excursion field guide, (eds: Grigorescu et al.), 86 pp.
- Panaiotu C. & Panaiotu C, 2002. Paleomagnetic studies. In: The 7th workshop of vertebrate paleontology, Abstract volume and excursion field guide, 59.
- Willingshofer, E. 2000. Extension in collisional orogenic belts: the Late Cretaceous evolution of the Alps and Carpathians. PhD Thesis, Vrije Universiteit, 146 pp.

Middle Miocene seasonal temperature changes in the Styrian Basin as recorded by the isotopic composition of Pectinide and Brachiopod shells

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An important interval in the global climatic and cryospheric development of the Cenozoic was the early to middle Miocene from 17 to 12 Ma. The climatic optimum near the early/middle Miocene was followed by global cooling at around 14 Ma. This event was concomitant with the expansion of the east Antarctica ice sheet. Thus the middle Miocene is characterised by climatic changes which resulted in a rapid shift from relative high-latitude warmth to high-latitude refrigeration.

The mechanisms that may have been responsible for global cooling include: 1) changes in ocean circulation and thus heat transport; 2) CO₂ draw down related to topographic uplift; 3) long-term orbital forcing.

In this study molluscs and brachiopod shells have been used to evaluate paleoclimatic parameters for a shelf environment during the Middle Miocene times. The studied outcrop which is stratigraphically well documented (Friebe, 1990, 1991; Fritz and Hiden, 2001) belongs to the Miocene of the Styria basin, which was part of the Paratethys realm, a land-locked remnant sea which formed subsequent to the collision of Europe and Africa-derived microplates.

When molluscs grow, their shells become biogeochemical recorders of climatic and environmental condition during their lifetime. Previous studies have shown that the calcitic

shell of pectinides and of brachiopods are suitable for paleoclimatic reconstruction as they secrete their skeleton in oxygen isotopic equilibrium with seawater. As pectinides are supporting little salinity variation they are particularly suitable in reconstructing water paleo-temperatures.

A geochronological age from a tuff intercalation from the studied outcrop made possible to correlate the evaluated Middle Miocene temperatures and seasonal variations with the interpreted oceanographic changes at that time, which occurred world-wide. The $^{39}\text{Ar}/^{40}\text{Ar}$ age of the fresh volcanic biotites from the tuff intercalations shows a value of 14.2 ± 0.1 Ma

Moreover the $\delta^{18}\text{O}$ profiles measured on molluscs have been used to evaluate growth rates and to determine the relationship between growth interruption and seasonal variation.

References

- Friebe, J., 1990. Lithostratigraphische Neugliederung und Sedimentologie der Ablagerungen des Badenium (Miozän) um die Mittelsteirische Schwelle. *Jahrbuch der Geologischen Bundesanstalt Wien* 133/2, 223-257.
- Friebe, J., 1991. Neotektonik an der Mittelsteirischen Schwelle (Österreich): Die "Steirische Phase". *Zentralblatt für Geologie und Paläontologie I*, 41-54.
- Fritz, I., Hiden, H., 2001. Fossilgrabung im Steinbruch Retznei (Südsteiermark), Projektmappe für Schulen, Graz, 40pp.

Recharge Area of mineral springs in Jezersko area (N Slovenia)

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The geological conditions in the Karavanke mountains are strongly related to Periadriatic lineament. In the geological sense the lineament divides Karavanke into northern and southern part. This tectonic structure of first order has also big influence on hydrogeology of the area. In the central part of Southern Karavanke, along Slovenian and Austrian border, extensive Košuta unit of dachstein carbonate rocks is present. In the Southern Karavanke mountains springs from carbonate rocks prevail, however in the central part of the mountain ridge some other interesting springs can be found, among them mineral springs are very important. Mineral springs are positioned in the area between Jezersko to Solčava in Slovenia and between Vellach and Eisenkappel in Austria. Heterogeneous chemical composition is significant for them and in mainly all springs free CO_2 is present.

In the area of Zgornje and Spodnje Jezersko in Slovenia three springs that are very likely to be from mineral origin were studied. The first spring Ankova slatina is situated in a valley northern from farm Anko (Zgornje Jezersko). The altitude of the spring is 985 m above sea level. In the past the spring was captured by small water capture that is nowadays abandoned. Above the capture site two boreholes were drilled. Usually water flows out from boreholes under the pressure but it sometimes happens that water completely dries up. Due to the presence of CO_2 gas water outflow from the borehole mouth pulsate. Few meters below boreholes the spring occurs. During the research period it was established that the spring is intermittent. The outflow from spring and boreholes varies between 0 to 8 l/s.