Ber. Inst. Erdwiss. K.-F.-Univ. Graz	ISSN 1608-8166	Band 16	Graz 2011
IGCP 596 Opening Meeting	Graz, 19-24th September 2011		

Carbon isotope geochemistry and clay mineralogy of lower Famennian deposits in the Timan-northern Ural Region – implications for paleoclimatic changes

ANTOSHKINA, A.I.[1], KANEVA, N.A.[1] & KÖNIGSHOF, P.[2]

(1) Institute of Geology, Komi Science Centre, Ural Branch, RAS, 54 Pervomayskaya St., 167982 Syktyvkar, Russian Federation; *Antoshkina@geo.komisc.ru*; *nakaneva@geo.komisc.ru*
(2) Senckenberg Forschungsinstitut und Naturmuseum Frankfurt, Senckenberganlage 25, 60325 Frankfurt am Main, Germany; *peter.koenigshof@senckenberg.de*

Upper Devonian strata record global events, sea-level fluctuations, and perturbations to the global isotopic record of seawater. There is increasing evidence that climate change and biotic crises in the Late Devonian may also be driven by terrestrial plant radiation. The record of these crises coincides with lithological changes and/or carbon isotope excursions (e.g., BUGGISCH & JOACHIMSKI 2006).

Lower Famennian deposits from different facies settings were investigated in the Timan-northern Ural region in different facies settings: coastal lagoons (sections at the Izhma River, Southern Timan), shallow-water lagoons of carbonate banks (the Pechora Syncline, the East-Kolva square), and microbial mounds of carbonate bank slopes (sections of the Chernyshev Ridge, along the Shar'yu River). Paleogeographic reconstructions place the Timan-northern Ural Region in the northeastern part of the European continent during the Famennian time at an approximate paleolatitude of 30°N (ZONENSHAIN *et al*. 1990). Thicknesses of the lower Famennian deposits varies from 30 m in the South Timan (Izhma River) to 100 m thick sediments preserved in the well 50 East-Kolva. The lower Famennian deposits of the Izhma River sections are represented by an alternation of marly limestones, clays, and massive limestones and dolostones (MAJDL' & BEZNOSOV 2011). In the well 50 East-Kolva marls and fenestral limestone-dominated successions are the characteristic sediments (ANTOSHKINA 2009). In sections along the Shar'yu River microbial mounds of the lower Famennian interval exhibit alternations of massive microbial and mat-like stromatolite boundstones, massively bedded fenestral limestones, microbial and skeletal packstones and grainstones (ANTOSHKINA 2006).
The $\delta^{13}C_{carb}$ and $\delta^{18}O$ data of the sections mentioned above have been used in this study. Compared with coeval sections in the other regions (e.g., JOACHIMSKI *et al*. 2002), the Izhma and Shar'yu rivers sections are characterized by lower $\delta^{13}C_{carb}$ values (from -3.3 to 2.0‰) and the well 50 East-Kolva section by raised $\delta^{13}C_{carb}$ values (from 2.6 to 3.5‰), whereas the maximum value in subequatorial sections is 4‰. The carbon isotope shift amplitude of the South Timan section reaches 5‰, which is 1.5-2 times higher than those in other sites of the region. Absolute $\delta^{18}O$ values in the studied sections are on the average 1-1.5‰ lower than in lower latitudes. The minimum $\delta^{13}C_{carb}$ values in clayish carbonates of the South Timan section (Izhma River) may be a result of fresh water input from the continent with lighter isotopes of soil bicarbonates. The minimum values may also be a result of the lower temperatures of seawater as compared with the subequatorial areas (JOACHIMSKI *et al*. 2004). As shown in the diagram of the carbon and oxygen isotopes locating, the highest $\delta^{13}C_{carb}$ values (2.0-3.5‰) are revealed in the Shar'yu River and the well 50 East-Kolva microbial limestones (Fig. 1). It reflects the increase of organic matter and bioproductivity in sediments during the early Famennian. Anomalous $\delta^{18}O$ low values (21.8-26.1‰) in all sections of the given region may indicate a strong influence of sulphate reduction and formation of bicarbonate-ions in interstitial waters.

Additionally, we have analysed the clay minerals of the Izhma River and well 50 East-Kolva sections. Mineral association the Izhma River sediments is poor – only illite and a hydrated chlorite occur. Some difference is observed in the association of the clay minerals from the well 50 East-Kolva. Here illite is the most common clay mineral whereas sericite and chlorite occur in a subordinate number. In comparison to modern environments in high-altitudes a clay mineral association dominated by chlorite and illite is a common feature. Chlorite acts as the stablest product of severe climatic conditions and processes of a physical weathering. The data indicate that the lower Famennian deposits were most probably formed in cooler climate conditions. On the other hand also warmer periods occurred during the Famennian in the Timan-northern Ural Region. We will describe different facies settings of early Famennian age in the Timan-northern Ural Region, and to determine their relationship to secular changes in the carbon isotope composition of seawater.

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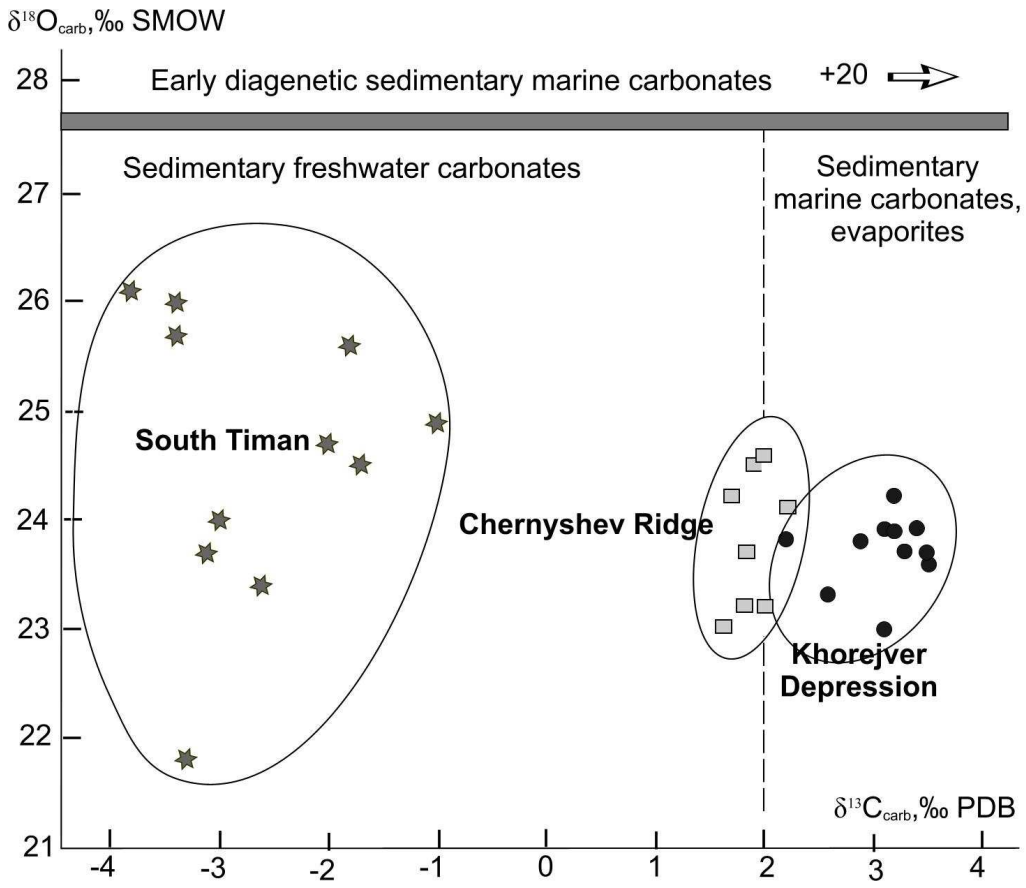

Fig. 1: Distribution of carbon and oxygen isotopes of the lower Famennian deposits in the Timan-northern Ural Region (a diagram modified from KULESHOV 2001).