In the Cambrian of the Polish sector of the Baltic Depression, limestone occurrences are known only from the uppermost portion of the section. The Upper Cambrian deposits are represented by black bituminous claystones with thin limestone interbeds and lenses. They were deposited in a euxinic marine basin probably on a carbonate ramp. The lowermost Ordovician (Tremadocian) section is a continuation of the Late Cambrian sedimentation of the black bituminous shales with graptolites which are overlain by glauconite conglomirates, claystones and limestones. Carbonates are dominant in the Arenig and Llanvirn, whereas upper in the section they are represented by interbeds within a claystone succession (Modliński et al., 1994). The investigations were carried out on limestone samples from wells drilled both offshore and onshore in the Baltic Depression.

The Cambrian limestones are represented mostly by biosparites containing variable amounts of faunal fragments, organic matter, pyrite, phosphates and detrital grains. The rocks are strongly recrystallized and their original structure has been significantly blurred. Microscope images reveal that some parts of the rocks (microlenses) consist of elongated calcite crystals, sometimes of feather-like structure, accompanied by abundant organic matter (Fig. 1a).

Cathodoluminescence studies (CL) revealed the original structure of the limestones (Fig. 1b). CL images clearly show the occurrence of organic fragments, single ooid grains and excellently developed zoned structure of the feather-like calcite crystals.

Central parts of the crystals are automorphic (hexagonal) grains overgrown by a succession of zones showing different luminescence patterns. Their outer parts are commonly less regular, bearing signs of dissolution (see Chafetz et al., 1985; Rossi & Canaveras, 1999). The pore space between the crystals is filled with abundant organic matter. It seems that these uncommon calcite forms resulted from specific conditions in microareas where organic matter accumulated due to the dying of organisms and soft tissue decaying. The calcite crystals had enough space to easily crystallize. This interpretation is especially likely if there was co-occurrence of calcite pseudomorphs after sulphates (Bodziuch, 2005), whose presence was proved by CL images. Sulphate crystallization (barite / celestine) was associated with a process of soft tissue decay, supplying sulphur to the environment (Fig. 2). The Ordovician carbonates are represented mainly by biomicritic and biomicrosparitic limestones. Calcite crystals which are similar to those from the Upper Cambrian deposits, in the Ordovician limestones are less common.

Carbon and oxygen isotope composition analyses of the Upper Cambrian limestones indicate that the average value of $\delta^{13}C_{PDB}$ is -2.30‰ (ranging from 0.43 to -6.89‰), whereas the average value of $\delta^{18}O_{PDB}$ is -8.06‰ (between -6.67 and -8.83‰). The study results suggest that the primary rocks were limestones which,
although Cambrian in age, have not significantly changed their isotopic composition of carbon. That was possible because the limestones occur as isolated bodies within the bituminous claystone facies. The temperatures at which the limestones formed (calculated from the $\delta^{18}O$ values, assuming that $\delta^{18}O$ for sea water ranges from -6 to -7‰ SMOW) varied between 24.8°C and 19.6°C.

Isotopic composition of the Ordovician limestones is similar, although shifted towards higher values of $\delta^{13}C_{\text{PDB}}$ and $\delta^{18}O_{\text{PDB}}$. The average value of $\delta^{13}C_{\text{PDB}}$ is 0.26‰ (from 3.64 to -5.10‰), whereas the average $\delta^{18}O_{\text{PDB}}$ is -6.91‰ (from -3.67 to -12.69‰). Assuming that $\delta^{18}O$ for sea water in the Ordovician was between -5‰ and -6‰ SMOW, the temperatures at which the limestones formed varied from 24.0°C to 19.4°C.

REFERENCES