Tracing the carbon cycle using stable isotopes of carbon in the Pliocene lignite Velenje basin, Slovenia

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Abstract - Stable isotopes of carbon were used to trace processes during and after lignite formation in the Velenje basin. Geochemical studies revealed several genetic types of coalbed gases: microbial methane and CO_2, endogenic CO_2 and CO_2 originating from carbonates. It was found that $\delta^{13}C$ of different lignite lithotypes were mainly influenced by biogeochemical processes (gelification) at the early stage of biomass accumulation. Isotope composition of dissolved inorganic carbon (DIC) in Pliocene and Triassic aquifers indicates mixing of dissolution of carbonates and organic matter decomposition.

Key words: carbon isotopes, coalbed gases, lignite, aquifer, carbonate lens, Velenje basin

Measuring the $\delta^{13}C$ value of either carbonate or organic matter is related to the $\delta^{13}C$ value of its source, which is a function of the overall carbon cycle. The major reservoirs for carbon are organic carbon and carbonate carbon. Although the size of certain carbon reservoirs, such as the atmosphere, are relatively small, the fluxes in and out of these reservoirs can be quite high, so that their abundance can be important, as well as their carrying capacity between other reservoirs (Anderson and Arthur, 1983).

The aim of the study was to trace the carbon cycle in the Velenje basin in different phases by stable isotope techniques to help to determine processes of Pliocene lignite formation.

Sampling of coalbed water was performed in October 2003 at the mining areas of Preloge and Škale from Pliocene and Triassic aquifers. Sampling of different lithotypes of lignite (Markič and Sachsenhofer, 1997) was performed in year 2002 at delivery and exit roadways in the Pesje, Preloge and Škale mining areas. Lenses of diagenetic carbonates were taken from fractured zones of the Šoštanj fault system in the Preloge mining area. Sampling of coalbed gas was performed during the years 2000 – 2003 in the lignite seam in zones with no secondary effects from the coal mining area. "Free" gas (Kotarba, 1990) for geochemical analysis was collected from boreholes in evacuated ampoules using a metal capillary tube and plastic syringe.

The isotope composition of dissolved inorganic carbon (DIC) in water, diagenetic carbonates, methane as well as CO_2 was determined using a Europa 20-20 continuous flow

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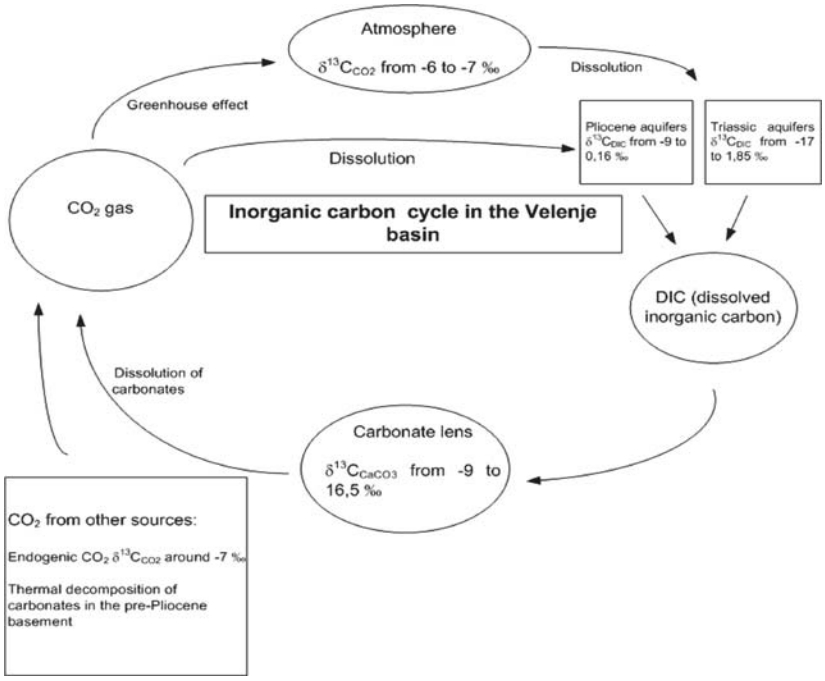

Figure 1. Inorganic carbon cycle in the Velenje basin.

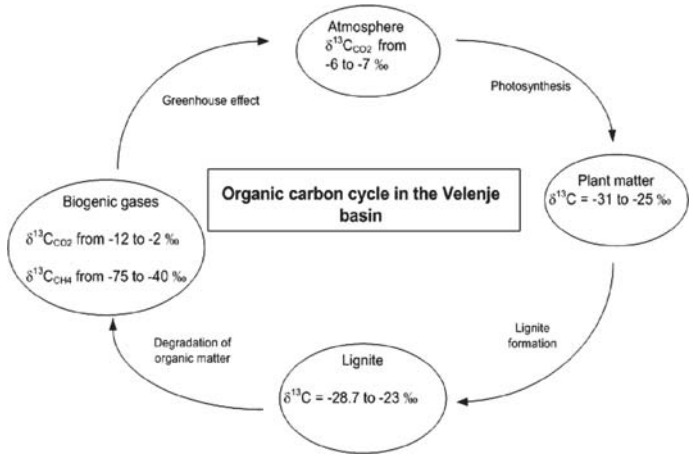

Figure 2. Organic carbon cycle in the Velenje basin.

isotope ratio mass spectrometer (CF – IRMS) with an ANCA – TG preparation module. Stable isotopes of carbon in different lithotypes of lignite were determined using a Europa 20-20 CF – IRMS with ANCA – SL module. The stable carbon isotopes are presented in the δ – notation relative to VPDB standards and expressed in ‰. Analytical precision for carbon isotope composition is estimated to be ± 0.2 ‰.

Stable isotopic inorganic and organic cycles for the Velenje basin are shown on Figures 1 and 2. Stable isotope values of coalbed gases, carbonates and coal are due to isotopic fractionation and reflect all the processes occurring since lignite formation.

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