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Occurrence and origin of coal-seam gas in the Upper Silesian Basin (Poland): isotopic, hydrous pyrolysis and geological approach

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In Poland, major resources of bituminous coals and coal-bed methane occur in Serpukhovian and Pennsylvanian strata in the Upper Silesian coal basin (USCB), one of the major coal basins in the world [1]. The study area covers about 1000 km² in the southern part of USCB.

Samples and Methods

64 coal-bed gas samples were analyzed. To provide a better characterization of origin of thermogenic gas, hydrous pyrolysis (HP) experiments were performed on five coal samples at 330 and 360°C for 72 h and compared with results of nine HP experiments previously conducted at 360°C for 72 h [2, 3]. Coal-bed and HP gases were analyzed for molecular and carbon [$δ^{13}$C(C₁, C₂, C₃, iC₄, nC₄, iC₅, nC₅)] and hydrogen [$δ^{2}$H(C₁, C₂, C₃)] isotope compositions. Initial and after HP coals were analyzed for vitrinite reflectance, $δ^{13}$C, Rock-Eval, maceral and elemental compositions.

Discussion of Results

Geochemical and geological studies reveal that thermogenic methane and microbial methane are present within the Pennsylvanian coal-bearing strata. Thermogenic methane was generated during the bituminous stage of coalification. This process was completed at the end of the Variscan orogeny. Since that time the uplifted coal-bearing strata had been subjected to erosion, denudation and degassing for about 270 Ma. The degassing process lasted until the deposition of the impermeable, clay-rich, Upper Miocene strata. Meteoric waters infiltrated the Pennsylvanian coal-bearing strata before Paleogene, mainly in eroded slopes, transporting both methanogenic archaeabacteria and nutrients [4]. The depletion of $^{13}$C in thermogenic CH₄ could have resulted also from the diffusion and adsorption-desorption processes during migration through the microporous coal structure [5].

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