

Isotopic composition and origin of noble gases, carbon dioxide and nitrogen in the Carboniferous-Permian strata of the Polish Basin

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Introduction

The objective of this study is determining the origin of noble gases, CO₂ and N₂ based on ^{3,4}He, ^{20,21,22}Ne, ^{36,38,40}Ar, ^{78,80,82,83,84,86}Kr, and ^{124,126,128,129,130,131,132,134,136}Xe, ^{12,13}C in CO₂, ^{14,15}N in N₂. Sixteen samples of natural gases were collected from Pennsylvanian and Permian strata of distal part of the Polish Basin in the Lower Silesia and Wielkopolska regions.

Results and discussion

Helium with high concentrations ranging from 0.1 to 0.4 % in the gases is mostly of crustal origin as indicated by the low ³He/⁴He ratios (4–9)×10⁻⁸. The calculation of mixing ratios among the three end members [1] shows that over 99% of ⁴He is of crustal origin. Small amounts of nucleogenic Ne and mantle-derived Ne are added to atmospheric Ne. Isotopic ratios for Kr and Xe are close to those for atmospheric values, although trace amounts of fissiogenic ¹³⁶Xe may exist in the gases. Radiogenic ⁴He/⁴⁰Ar ratios are higher than the average production rate ratio of about 5 for radiogenic ⁴He/⁴⁰Ar in crustal materials, which may have been caused by selective supply of lighter isotope ⁴He than ⁴⁰Ar from crustal rocks surrounding the gas reservoirs, or a (U+Th)/K ratio which is higher than the crustal average in the reservoirs. Carbon dioxide from analysed gases was mainly generated during thermogenic processes of transformation of organic matter, although some gases may contain an endogenic component. Molecular nitrogen concentrations in analysed natural gases vary from 15.1 to 64.0 vol%. Analysed gases, which are very high in N₂/⁴⁰Ar may have been caused by accelerated thermogenic production of N₂ gas under the condition of high heat flux from volcanic activity during late Stephanian-early Rotliegend (Autunian) ages.

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[1] Kotarba & Nagao (2008) *Chem.Geol.*, **255**, 426-438