

**AAPG Annual Convention
Salt Lake City, Utah
May 11-14, 2003**

NEW INDICATIONS FOR THE GENESIS AND MIGRATION OF NITROGEN-RICH GASES IN NORTHERN GERMANY - FLUID INCLUSION AND NITROGEN GEOCHEMISTRY STUDIES OF PERMO-CARBONIFEROUS ROCKS.

PEER HOTH, BGR, Berlin, Germany; BIRGIT MINGRAM, GFZ Potsdam, Potsdam, Germany; VOLKER LÜDERS, GFZ Potsdam, Potsdam, Germany

The North German Basin forms part of the Mid European Basin where natural gas sourced from coal-bearing strata and marine shales of Carboniferous age is produced from Carboniferous, Permian, and Triassic reservoirs. The gas composition ranges from predominantly hydrocarbons in the United Kingdom and the Netherlands to predominantly nitrogen in most of the areas of northeastern Germany. Until now the origin of the large nitrogen contents of these gases are a source of controversy.

The study is based on a combination of mainly geochemical methods such as fluid inclusion analyses, vitrinite reflectance measurements, clay mineralogy, determination of organic and inorganic fixed nitrogen and nitrogen isotopic analysis. Rock samples mainly come from deep gas exploration wells of the eastern part of the basin, the stratigraphic age of the samples ranges from Lower Namurian to Lower Permian and sampling depth is between 4400 and 7030 m.

Vitrinite reflectance values of the samples range between 2,3 and 5,5% R_m and illite crystallinity varies from 0,9 to 0,4 $\Delta^{\circ}2\Theta$. Aqueous two-phase fluid inclusions within fissure mineralizations and diagenetic cements of Carboniferous rocks are commonly associated with co-genetically trapped CH_4 - CO_2 or CH_4 inclusions, which only locally show traces of N_2 . A different situation is typical for Rotliegend rocks of the eastern basin part, where gas inclusions have variable N_2 - CH_4 compositions but none or only traces of CO_2 .

The total nitrogen content of the Carboniferous shales ranges between 400 and 3000 ppm with an inorganic fixed nitrogen (in the form of NH_4) portion of more than 60%. Marine Namurian shales are especially enriched in nitrogen. While the $\delta^{15}N$ -values of these shales vary between +1.5 and +5.6 ‰, the whole Permo-Carboniferous sample suite shows values between +1.5 and +9 ‰.

In summary the analyses show, that the inorganic fixed nitrogen content increases with increasing maturation and that the release of this nitrogen occurs at temperature levels above 200 °C or during special fluid-rock interactions. The mobilized nitrogen mainly migrated as NH_3/NH_4 within the Carboniferous and was oxidized to N_2 by Fe^{3+} during upward migration through the red beds of the Rotliegend sections.

P-T information from fluid inclusions combined with subsidence data give evidence of different phases of hydrocarbon migration. Reconstructed low pressure trapping conditions of the common N_2 -rich inclusions within the Rotliegend sections point to a connection of nitrogen migration with tectonic uplift during phases of basin inversion. The different scenarios for hydrocarbon generation and migration compared to the release of inorganic fixed nitrogen and its migration have to be taken into account for future gas exploration in the study area.