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Short Communication

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Remarks on the use of inclusions in the minerals in the rocks of hydrocarbon fields

Abstract

Based on the assumption of the wide presence of inclusions in minerals in the rocks, some details and general statements are presented as well as references for detailed studies. Examples presented come from two oil and gas basins in Poland. In the minerals as dolomite, calcite and/or quartz hydrocarbon (oil) and brine inclusions are present in the microscale being studied aiming at their characterization and differentiation.

Keywords: hydrocarbons, fluid inclusions, oil and gas fields, permeable rocks

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Introduction

Oil fields are usually built of rocks which display high permeability and porosity and are sealed with not permeable rocks. That is why petrological studies are very important in the search for hydrocarbon accumulations. In those studies - analyses of inclusions in the rock-forming minerals are significant.

Theoretical background

Different minerals contain one or more types of inclusion – solid inclusions and/or fluid ones.[1] The solid inclusions may be variable – they may be other minerals included in those main ones. They may be also of bitumen composition. Those last ones are really interesting from the hydrocarbon point of view. When studying them in an exact position (i.e., in reference to the mineral in detail, and to the rock in general) it is possible to obtain their characteristics and to draw conclusions on geological processes involved. In case of fluid inclusions observed in minerals, these tiny portions of fluids may be representative for palaeofluids which were present in the basin in time of its formation, or for the later processes that occur in the geological past.[1,2]

The aim of the present communicate is to show some use of the inclusions trapped in sedimentary minerals in hydrocarbon basins on two examples from two oil and gas fields in Poland. This presentation should result in a wider understanding of the necessity of conducting basic studies (in that: inclusion analyses). The author's suggestion is to introduce them as the standard in all types of the search on hydrocarbon occurrences.

Geological

Fluid inclusions were widely studied in Poland in rocks from different wells, both onshore and offshore in the Polish Lowlands[3,4] in the surface outcrops in the Carpathian Mts. as well.[5–7] The oil- and gas-bearing deposits occur almost in the whole country, while fields under present remarks are located in central western part of Poland and in the north of the country Figure 1. Sampling was performed at the relatively high depth e.g., around 3100 m in the Main Dolomite formation and around 2000 m in the Middle Cambrian basin, respectively.[8–10]

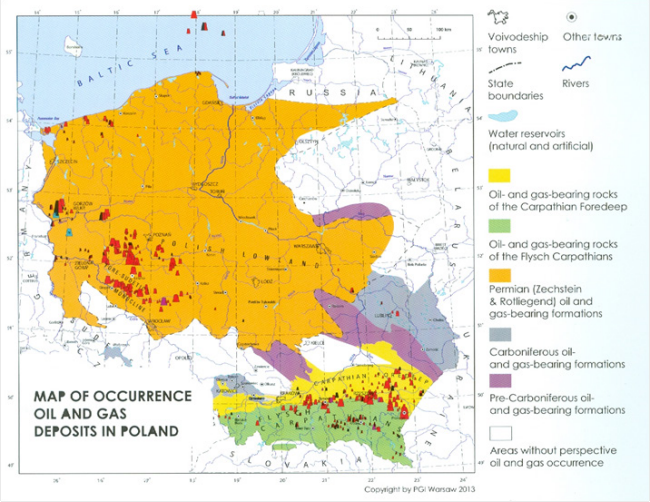

Figure 1 Geological background for fluid inclusion studies. Oil and gas fields under discussion are in the central western and northernmost parts of the Poland. Quotation from: Materials of PGI, Warsaw, 2013.

Methodology

Studies of inclusions were performed by microscopic means on special rock wafers using a polarization microscope, fluorescence device (UV and blue lights) and Nikon freezing-heating Linkam stage. Rock fragments were glued on the glass slides and polished from both sides. The samples were first observed under the polarization microscope (Nikon Optiphot) aiming at selection of the areas for detailed fluid inclusion studies. Later on, UV observations were conducted prior to the microthermometric analyses. Microthermometry was performed in heating and freezing modes.[11] The Linkan stage was calibrated against melting temperatures of pure chemicals and phase transitions in synthetic fluid inclusions.

Results

Similarly to the facts described in general by Roedder[1] in his world-wide known Fluid Inclusion handbook, different minerals studied in the rocks in the present case have revealed a presence of

inclusions. These fluid inclusions are either aqueous (AQFI) and/or hydrocarbon (HCFI) in the content. The differentiation of these two types was relatively easy to be checked by means of fluorescence in the ultraviolet range Figure 2. The hydrocarbon inclusions display fluorescence in UV, in contrary to the aqueous inclusions which do not fluoresce. The fluorescence of inclusions is mostly in white-blue colors.

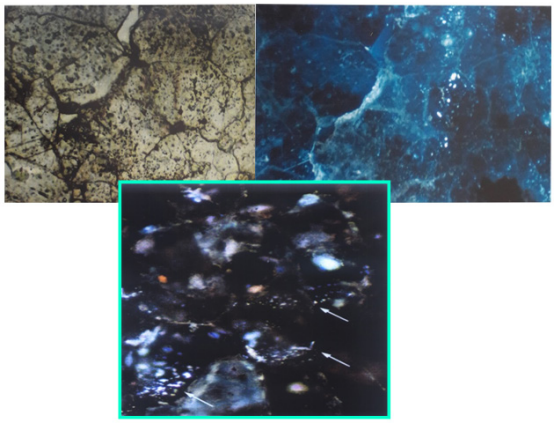

Figure 2 Aqueous and hydrocarbon (oil) inclusions in calcite and quartz. Polarizing microscope. Upper photos - left: fan-like calcite, B 11 well, transparent light, one polarizer; right: same object in UV light, reflected light; hydrocarbon inclusions show white fluorescence. Lower photo: trails and accumulations of HCFI in the quartz (B 8-1 well); UV light, reflected mode; hydrocarbon inclusions show white fluorescence. Longer dimension of the photomicrographs is 350 μm.

As it is seen in the photomicrographs, the position of the inclusions is different. They occur in evident associations and are either wide-spread in the whole crystal (AQFI, HCFI), or form groups, sometimes in evident lines (HCFI). Their distribution is either random, or they are connected with the primary zones of the crystal growth. The inclusions have either primary or pseudo-secondary character. They are between 1 and 5μm in size, occasionally larger.

Results of micro-thermometric measurements performed comprise the values of eutectic, ice melting and homogenization temperatures, i.e., those pieces of information, that further give data on characterization of fluids trapped in the mineral as well as the possible sequence of the mineral formation and/or fluid trapping.[9,10] The dolomite from the rocks from the field in central-western part of Poland, which displays rather low homogenization temperatures between 92 - 97°C, may have crystallized from the solutions of a moderate salinity (about 11-15 weight % NaCl eq.). The quartz there reveals moderate homogenization temperatures (103-107°C) and is formed from the high saline solutions (21weight % NaCl eq.) and the fluid density of about 1.06 g/cm^3.

The eutectic temperatures below -21°C point to the presence of calcium and/or magnesium together with NaCl in the fluid. In their turn, the eutectic around-56°C and cotectic of about-40°C point to more complicated fluid systems as e.g., NaCl-$CaCl_2$-$MgCl_2$-H_2O.

Based on the results obtained, the character of basic two types of inclusions may be described in detail and discussed in the context of diagenesis, hydrocarbon migration and accumulation in both the selected fields in Poland.[4,10,12]

Although the minerals as dolomite and calcite studied come from the high depth and are easily susceptible to the influence of outer pressure and temperature, they may have crystallized from hot, salted waters.[13]

Further conclusions that may be drawn from the fluid inclusion studies conducted are as follows: aqueous inclusions (AQFI) are often co-present with the hydrocarbon inclusions (HCFI) in the minerals; primary HCFI are abundant in the dolomite and the calcite, less frequent in anhydrite and fluorite in the Main Dolomite sequences; primary HCFI are present in quartz cements in the offshore Cambrian rocks; the presence of abundant HCFI points to hydrocarbon migration in the certain area and the connection with the diagenetic processes.

Acknowledgements

None.

Conflict of interest

The author declares no conflict of interest.

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