Determination of formation paleo-pressure and evolution process using gaseous hydrocarbon inclusions

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Research on overpressure evolution and its formation mechanisms is of great significance for revealing reservoir formation mechanisms and predicting formation pressures in oil and gas reservoirs before drilling. However, research methods addressing overpressure evolution are not without issues. The fluid inclusion PVT simulation and basin simulation can be used to investigate the paleo-pressure.

The homogenization temperatures of inclusions were tested. The accuracy of the microscopic laser Raman spectroscopy analysis is too limited to fully test the components of gaseous hydrocarbon inclusions so that the organic components of the natural gas in the present-day gas reservoirs represented the gaseous hydrocarbon inclusions. In addition, the vapor-liquid ratio of gaseous hydrocarbon inclusions cannot be measured by CLSM. Firstly, A series of images at different slice depths was obtained by adjusting the focal length of a high-resolution microscope. Secondly, CorelDRAW software was used to calculate the areas of inclusions and bubbles; fitting functions were established between the inclusion areas and slice depths, and between the bubble areas and slice depths. Finally, the inclusion and bubble volumes were integrated to obtain the vapor-liquid ratios of the inclusions. PVTSim software can calculate the trapping pressures of inclusions. Combined with basin simulation, the evolution of paleo-pressure can be determined.

The above methods were used to investigate the paleo-pressure of the Upper Triassic Xujiahe Formation in the northeast portion of the Sichuan Basin. Overpressure began to develop in the Middle Jurassic period. Due to hydrocarbon generation taking place, the formation pressure increased rapidly from the Middle Jurassic period to the early Late Cretaceous period. Since the early Late Cretaceous period, the formation pressure has gradually decreased due to tectonic uplift and erosion. From the Oligocene period to the present, the formation pressure have increased again in local areas due to tectonic compression.