Characteristics and accumulation period of Cambrian-Ordovician hydrocarbon inclusions in Yingmai 7 area, Tabei Uplift

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Abstract: According to the fluorescence characteristics of hydrocarbon inclusions under the microscope, the interpenetration relationship with the occurrence veins, and the homogenization temperature, the hydrocarbon inclusions developed in the Cambrian-Ordovician reservoir in Yingmian 7 area can be divided into four periods, which correspond to four hydrocarbon accumulation events respectively. The periods of accumulation determined by the analysis of homogenization temperature and burial history are as follows: late Caledonian to early Hercyian low mature heavy oil filling, late Hercyian medium mature normal oil filling, early Himalayan high mature light oil filling and late Himalayan over mature natural gas filling. Among them, periods of I, II hydrocarbon inclusions distribution range is limited, only visible in part of the wells in Yingmai 7 area; periods of III, IV hydrocarbon inclusions in Yingmai 7 area are widely distributed, which reveals the Himalayan period of the two-stage oil and gas filling on the reservoir formation.

Key words: Hydrocarbon inclusions; homogenization temperature; Hydrocarbon accumulation period, Yingmai 7 area

1. Introduction

Due to the characteristics of bidirectional oil and gas sources, multi-stage accumulation, and complex distribution of oil and gas in Yingmai 7 area, the analysis of hydrocarbon accumulation is the difficulty in the study of this area. A series of studies have been carried out on the accumulation of Cambrian-Ordovician oil and gas reservoirs in Yingmaili area [1-3]. Most scholars analyze from sedimentary evolution, burial history, hydrocarbon source rocks, etc. There are disputes on the classification of the accumulation period, and different scholars have different views. Fluid inclusion, as a carrier of ancient fluid information in underground rocks and a relatively closed geochemical system, is the code for identifying oil and gas generation, classifying the period of oil and gas filling, and analyzing the process of oil and gas accumulation [4]. In this paper, fluid inclusion testing equipment, testing technology and analysis method are used to systematically study the Cambrian-Ordovician hydrocarbon inclusion in this area, and the geothermal history and sedimentary and burial history are combined to divide the filling period of oil and gas and determine the accumulation period, so as to provide a basis for further research on the accumulation law of oil and gas reservoirs in this area.
2. Study Area and Sample Collection
Tabei Uplift is one of the most oil-enriched areas in Tarim Basin. It is adjacent to kuqa Depression in the north and adjacent to Manjia’er depression in the south, so it is the direction and accumulation area of hydrocarbon migration of the two sets of sources in the north and the south, and the accumulation conditions are excellent. At present, industrial oil and gas reservoirs have been found in the Cambrian - Neogene series, so it is one of the most important prospective oil and gas exploration and development blocks in Tarim Basin. The study samples were taken from Yingmai 7 area in the north of Tabei Uplift (Fig. 1). They were all Cambrian - Ordovician core samples and were ground into double-sided polished sections according to the standard method. Considering the heterogeneity of core samples, at least 2 thin sections were ground for each sample.

![Fig. 1 Tectonic location and well location distribution of Yingmai 7 area](image)

3. Results and Discussion
3.1 Fluorescence characteristics and periods of hydrocarbon inclusions
Based on a systematic observation of hydrocarbon inclusions of 8 Wells 106 thin sections, the hydrocarbon inclusions developed in Cambrian-Ordovician reservoirs in Yingmai 7 area can be divided into four periods according to the growth relationship of calcite cement, interpenetration relationship between calcite vein and healing seam, the fluorescence characteristics and the associated saline water inclusions homogenization temperature characteristics with hydrocarbon inclusions.

Period I hydrocarbon inclusions were dark brown fluorescence under ultraviolet fluorescence (Fig. 2a), mainly distributed along the early healing seam. Their content was small, their distribution was limited, their formation time was early, and their preservation was incomplete. As a result of component leakage, they became dry asphalt inclusions, which represented a period of low mature heavy oil filling.

Period II hydrocarbon inclusions were shiny yellow fluorescence under ultraviolet fluorescence (Fig. 2b), mainly occurred in the early healing seam and calcite vein. Their content was small, only occasionally seen in Yingmai 32 well area, and they represented a period of medium mature normal oil filling.
Period III hydrocarbon inclusions were blue-white fluorescence under ultraviolet fluorescence (Fig. 2c), often associated with a small amount of gaseous hydrocarbon inclusions at the same time. They mainly occurred in early generation fillings in late calcite veins and middle-late dolomite fillings in the dissolution holes. Their content was medium and widely distributed, which can be seen in each well in Yingmai 7 area, representing a period of high mature light oil and gas filling.

Period IV black gaseous hydrocarbon inclusions were no fluorescence or weak blue fluorescence at the edges under ultraviolet fluorescence (Fig. 2d). They mainly occurred in late generation fillings in late calcite veins and fractured semi-filled calcite veins, forming late. They were abundant and widely distributed, which is a significant feature in Yingmai 7 area, indicating that there was a large number of over mature condensate oil and gas filling in the late period and became important reservoir forming characteristics in this area.

3.2 Hydrocarbon accumulation period determination

The homogenization temperature of saline water inclusions formed at the same time with hydrocarbon inclusions in a reservoir represents the temperature at which oil and gas enter the reservoir. Combined with the geothermal history and burial history of the study area, the hydrocarbon accumulation period can be estimated. This is the basic principle for determining the hydrocarbon accumulation period by applying the homogenization temperature of fluid inclusions [5, 6].

The homogenization temperature of the saline water inclusions associated with the 4-period hydrocarbon inclusions was determined by using the above principle, combined with previous studies, the surface temperature in Yingmai7 area was set as 20°C, the paleoburial depth was calculated through the homogenization temperature and paleogeothermal gradient, and the paleoburial depth was put into the burial history map of Yingmai 7 area (Fig. 3), and the formation period of Cambrian-Ordovician oil and gas reservoirs in Yingmai 7 area could be determined: the homogenization temperature values of period I oil and gas filling of the fluid inclusions associated saline water inclusions were concentrated in 70-90°C, their paleoburial depth ranged from 1814m to 1891m, and they were formed in Devonian, the late Caledonian to early Hercynian; the homogenization temperature values of period II fluid inclusions were concentrated in 90-100°C, their paleoburial depth ranged from 2274m to 2485m, and they were formed in Permian, the late Hercynian; the homogenization temperature values of period III fluid inclusions were concentrated in 110-130°C, their paleoburial depth ranged from 3762.9m to 3787m, and they were formed in Miocene, the early Himalayan; the homogenization temperature values of period IV fluid inclusions were concentrated in 130-150°C, their paleoburial depth ranged from 4341m to 4838m, and they were formed in late Himalayan.
4. Conclusions

(1) Four hydrocarbon inclusions developed in Cambrian-Ordovician reservoirs in Yingmai 7 area, representing four hydrocarbon filling events. Period I hydrocarbon inclusions were brown dry asphalt, representing low mature heavy oil filling; Period II hydrocarbon inclusions were shiny yellow fluorescent hydrocarbon inclusions, representing medium maturity normal oil filling; Period III hydrocarbon inclusions were blue-white fluorescent hydrocarbon inclusions, accompanying a small amount of gaseous hydrocarbon inclusions, representing high mature light oil and gas filling; Period IV hydrocarbon inclusions were black gaseous hydrocarbon inclusions, representing over mature gas filling. Among them, periods III and IV hydrocarbon inclusions were widely distributed in Yingmai 7 area, and were the important accumulation period in the area.

(2) According to the histogram of homogenization temperature of hydrocarbon inclusions associated with saline water inclusions, there are 4 main oil and gas filling periods in this area: the homogenization temperature values of period I fluid inclusions were concentrated in 70-90°C; the homogenization temperature values of period II fluid inclusions were concentrated in 90-100°C; the homogenization temperature values of period III fluid inclusions were concentrated in 110-130°C; the homogenization temperature values of period IV fluid inclusions were concentrated in 130-150°C.

(3) The homogenization temperature and the data of burial history-thermal evolution were combined to determine the hydrocarbon accumulation period: period I hydrocarbon inclusions formed in Devonian, belonging to the late Caledonian to early Hercynian; period II hydrocarbon inclusions were formed in Permian, belonging to the late Hercynian; period III hydrocarbon inclusions were formed in Jidike period, Miocene, belonging to the early Himalayan; period IV hydrocarbon inclusions were formed in Kangcun period, Neogene, belonging to the late Himalayan.

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