# [PS]Paleopressure Evolution Controlled by Activities of Hydrocarbons and Faults, Linnan Sag, Bohai Bay Basin, East China*

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## Abstract

Linnan Sag is located in the southwestern part of the Jiyang Depression, Bohai Bay Basin, East China. It was developed under an extensional and shearing background, and controlled by two boundary fault belts, Linshang Fault Belt and Xiakou Fault Belt, which both trend northeast. Exploration reveals that source rocks developed mainly in the Es3 Formation, which is also one of the key reservoirs. The proved reservoirs are distributed in a band around the hydrocarbon generation center, and this configuration is closely related to formation pressure.

Currently, besides normal pressure, Linnan Sag is characterized by underpressure coexisting with overpressure. Measured formation pressure exhibits three zones in the vertical: the upper zone with normal pressure above 1700 m, the middle zone with coexisting normal pressure and underpressure between 1700 m and 3200 m, and the lower zone with coexisting underpressure, normal pressure and overpressure below 3200 m. In the plane, overpressure is distributed mainly in the center of the sag, while underpressure accompanies mainly faults, especially the northern boundary fault around which are hydrocarbon accumulation areas.

To understand the process of hydrocarbon generation, migration and accumulation in Linnan Sag, it is necessary to unveil the paleopressure evolution. Hence, 73 core samples of the Es3 Formation from the middle and the lower zones were collected from 36 wells to perform fluid inclusion analysis and thermodynamic modeling of oil inclusions with VTFLINC software to reconstruct the paleopressure at different times.

The fluorescence observation of oil inclusion and the thermometry results of fluid inclusion suggest that two episodes of hydrocarbon charging occurred: during 21-13 Ma, and 8-0 Ma. Results of thermodynamic modeling indicate that paleopressure decreased with time. The main decreasing periods correspond to the active stages of faults. Where the fault activity is stronger, the pressure decrease is larger. Although hydrocarbon charging caused pressure increase to a certain extent, it was not enough to compensate for the pressure released through faults. Integrating the results of basin modeling and structural analysis, we conclusion that the activities of hydrocarbons and faults controlled the paleopressure evolution in Linnan Sag.

## Acknowledgements

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# Pressure Evolution Controlled by Hydrocarbon Generation and Faults Activities, Linnan Sag, Bohai Bay Basin, Eastern China


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## INTRODUCTION

The Linnan Sag is located in the southwest of the Huimin depression, the largest sub-depression of the Jiyang depression, Bohai Bay Basin, Eastern China (Fig.1), where the basinal pressure was investigated with respect to hydrocarbon migration and accumulation.

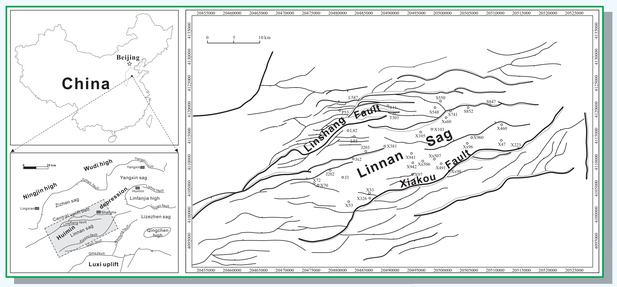


Fig.1 A schematic map showing location of the Linnan Sag, distribution of fault systems, and location of boreholes that were sampled to perform fluid inclusion analysis.

The Linnan Sag was controlled by two fault systems, the Linshang Fault in the north and the Xiakou Fault in the south. The Linnan Sag is characterized by underpressure coexisting with overpressure. Measured formation pressure exhibits three zones in the vertical profile: the upper zone with normal pressure above 1700m, the middle zone with coexisting normal pressure and underpressure between 1700m and 3200m, and the lower zone with coexisting underpressure, normal pressure and overpressure below 3200m (Fig.2).

In order to understand the impact of the complex pressure system on hydrocarbon generation, migration and accumulation in the sag, thermodynamic modeling with petroleum inclusions was employed to reconstruct paleopressure and its evolution with time.

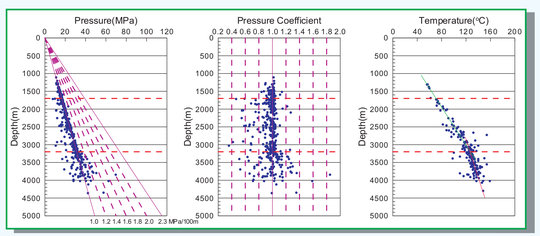


Fig. 2 Vertical profiles of present formation pressures and temperatures in the Linnan Sag.

## THERMODYNAMIC MODELING AND RESULTS

Fluid inclusions can contain abundant geologic information about formation temperature and pressure. The presence of oil inclusions in diagenetic minerals can help us determine the time of hydrocarbon generation, migration and accumulation. Hence, fluid inclusion technique was employed to unveil the hydrocarbon activities and the evolution of palaeopressures in this study. Through reconstructing the phase envelope and isochore of included oil, thermodynamic modeling with oil inclusions gives the pressure when they were trapped (Fig.3).

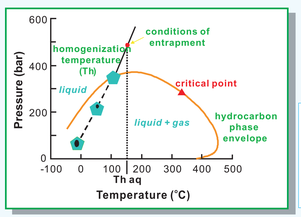


Fig.3 A diagram showing principle of thermodynamic modeling with oil inclusion.

73 core samples from the middle and the lower zones of the Es3 Formation were collected from 36 wells (Fig.1) to perform fluid inclusion analysis and thermodynamic modeling of oil inclusion using VTFLINC software to reconstruct paleopressure at different time.

Based on the characteristics of fluorescence of oil inclusions and microthermometry of both aqueous and oil inclusions, two episodes of hydrocarbon charging event in the Es3 Formation were identified. Fig. 4 shows the evolution of the calculated pressure coefficient (i.e., the ratio of fluid pressure to hydrostatic pressure) with time.

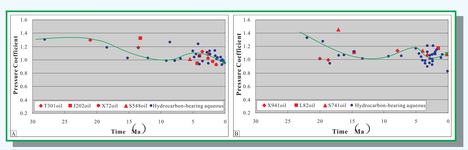


Fig.4 Evolution of palaeopressure coefficient with time. A. Es3z; B.Es3x

## CONCLUSIONS

The following conclusions are based on the results of conventional fluid inclusion analysis and thermodynamic modeling with oil inclusions, and supported by other geologic data, such as basin modeling and evolution history of faults:

(1) There were two episodes of hydrocarbon charging event during 21-13Ma and 8-0Ma in the Es3 Formation in the Linnan sag (Fig.5 & Fig.6).

(2) The palaeopressure in the Linnan Sag showed a general trend of decreasing with time (Fig.4). The current overpressure and underpressure are both evolved from palaeo-overpressure related to hydrocarbon generation.

(3) The major decreasing of pressure corresponds to the activation of the faults. Where the fault activity is stronger, the pressure decrease is larger. Although hydrocarbon charging resulted in a pressure increase to a certain extent, it was not enough to compensate for the pressure released through faulting (Fig.4 & Fig.7).

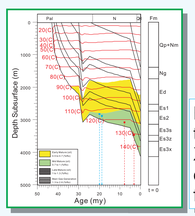


Fig.5 Burial history and thermal evolution of well X941. The charging events were recorded by fluid inclusions.

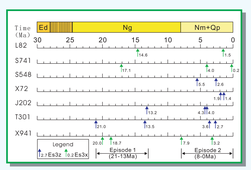


Fig.6 Hydrocarbon charging events in the Es3 Formation, the Linnan Sag.

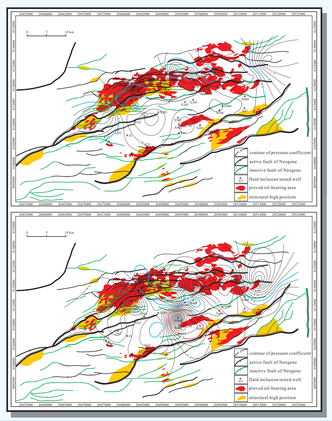


Fig.7 Hydrocarbon accumulation and distribution of the current formation pressure.

## ACKNOWLEDGEMENTS


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