Journal of Asian Earth Sciences 88 (2014) 28–40

Contents lists available at ScienceDirect

Journal of Asian Earth Sciences

journal homepage: www.elsevier.com/locate/jseaes

Cenozoic tectonic jumping and implications for hydrocarbon accumulation in basins in the East Asia Continental Margin

Yanhui Suo [a,b], Sanzhong Li [a,b,*], Shan Yu [a,b], Ian D. Somerville [c], Xin Liu [a,b], Shujuan Zhao [a,b], Liming Dai [a,b]

[a] College of Marine Geosciences, Ocean University of China, Qingdao 266100, China
[b] Key Lab of Submarine Geosciences and Exploration Techniques, Ministry of Education, Qingdao 266100, China
[c] UCD School of Geological Sciences, University College Dublin, Belfield, Dublin 4, Ireland

ARTICLE INFO

Article history:
Received 13 November 2013
Received in revised form 14 February 2014
Accepted 16 February 2014
Available online 5 March 2014

Keywords:
East Asia
Tectonic migration
Plate margin
Intraplate
Interplate
Deep-seated tectonic processes
Hydrocarbon accumulation

ABSTRACT

Tectonic migration is a common geological process of basin formation and evolution. However, little is known about tectonic migration in the western Pacific margins. This paper focuses on the representative Cenozoic basins of East China and its surrounding seas in the western Pacific domain to discuss the phenomenon of tectonic jumping in Cenozoic basins, based on structural data from the Bohai Bay Basin, the South Yellow Sea Basin, the East China Sea Shelf Basin, and the South China Sea Continental Shelf Basin. The western Pacific active continental margin is the eastern margin of a global convergent system involving the Eurasian Plate, the Pacific Plate, and the Indian Plate. Under the combined effects of the India-Eurasia collision and retrogressive or roll-back subduction of the Pacific Plate, the western Pacific active continental margin had a wide basin-arc-trench system which migrated or 'jumped' eastward and further oceanward. This migration and jumping is characterized by progressive eastward younging of faulting, sedimentation, and subsidence within the basins. Owing to the tectonic migration, the geological conditions associated with hydrocarbon and gashydrate accumulation in the Cenozoic basins of East China and its adjacent seas also become progressively younger from west to east, showing eastward younging in the generation time of reservoirs, seals, traps, accumulations and preservation of hydrocarbon and gashydrate. Such a spatio-temporal distribution of Cenozoic hydrocarbon and gashydrate is significant for the oil, gas and gashydrate exploration in the East Asian Continental Margin. Finally, this study discusses the mechanism of Cenozoic intrabasinal and interbasinal tectonic migration in terms of interplate, intraplate and underplating processes. The migration or jumping regimes of three separate or interrelated events: (1) tectonism-magmatism, (2) basin formation, and (3) hydrocarbon-gashydrate accumulation are the combined effects of the Late Mesozoic extrusion tectonics, the Cenozoic NW-directed crustal extension, and the regional far-field eastward flow of the western asthenosphere due to the India-Eurasia plate collision, accompanied by eastward jumping and roll-back of subduction zones of the Pacific Plate.

1. Introduction

The continental margin has attracted an increasing amount of attention by geologists internationally. Some international programs such as the Integrated Ocean Drilling Program (IODP), the International Ocean Discovery Program (IODP), the Mid-ocean Ridge Program (Inter-Ridge) and the International Continental Margin Program (Inter-Margins), have made the continental marginal evolution and mechanism an important research topic which has led to some remarkable achievements (Cawood, 2005; Li, 2008; Li et al., 2009a,b). In addition, due to the abundance in natural resources of the basins in or near the continental margins, these basins have attracted many researchers and companies focusing on the economic exploration. In the latter case, many drilling wells and seismic profiles have been recently carried out, further revealing the tectonic evolution of basins on continental margins.

The marginal seas are also an important tectonic unit of active continental margins, particularly those in the western Pacific active continental margin. Notably, tectonic eastward jumping of the marginal basins has been recognized as affecting rocks of Mesozoic and younger age (Maruyama et al., 2009). As an important marginal basin, the East China Sea Basin has provided us with an important opportunity, combined with other related non-marginal basins in its adjacent area such as the Bohai Bay Basin, Yellow Sea basins and South China Sea Basin, for discussing the detailed

* Corresponding author at: College of Marine Geosciences, Ocean University of China, No. 238, Songling Road, Qingdao 266100, Shandong Province, China. Tel.: +86 532 66781971 (O).
E-mail address: sanzhong@ouc.edu.cn (S. Li).

http://dx.doi.org/10.1016/j.jseaes.2014.02.019
1367-9120/

interaction of plates around the western Pacific, their evolution and the geodynamic mechanism of continental marginal seas, utilizing a wealth of new structural data (Li, 2008).

Tectonic migration or tectonic jumping is a widespread geological phenomenon during basin formation and evolution, including migrations of the geodynamic environment. It involves basin faulting, volcanism, sedimentation, depocenters, and accumulation of oil and gas, all of which have the same migration direction as that of the tectonic evolution of the basins (Wang, 1988; Jiang, 2009). Therefore, tectonic migration is a comprehensive phenomenon of various temporal and spatial migrations of geological elements. It can be divided into deformation migration, magmatism migration, depositional migration, metamorphism migration, and mineralization migration, based on the younging in time and jumping in space of the same geological processes, and each of them includes some secondary phenomenon of migration. For example, deformation migration includes faulting migration, folding migration, rifting migration, and subsidence migration in space and time. Jiang and Zhu (1992) defined the tectonic migration theory based on actual geological data from the orogens in China and its adjacent areas. Some basic concepts such as ‘tectonic migration zone’, ‘tectonic migration period’, and ‘tectonic migration direction’ are proposed in this tectonic migration theory, which also provided a detailed quantitative methods for tectonic migration, geodynamics, and thermodynamic research (Jiang and Zhu, 1992), and it is widely used in various aspects of geology (Oleg et al., 1994; Giacomo et al., 2010). Jiang and Zhu (1992) further suggested that China and its adjacent areas can be divided into four tectonic migration zones: (i) Central Asia-Mongolia, (ii) Tarim, (iii) Qinghai-Tibet Plateau, and (iv) the western Pacific coastal zone. However, little is known about the detailed tectonic migration in the western Pacific coastal zone, except for the lateral coastward tectonic migration from west to east.

Because Jiang and Zhu (1992) had few geological data on the western Pacific coastal zone, we have made intensive and systematic work on the Bohai Bay Basin (BBB), the North Yellow Sea Basin (NYSB), the South Yellow Sea Basin (SYSB), the East China Sea Shelf Basin (ECSSB), and the South China Sea Continental Shelf Basin (SCSCSB) in the past decade. Combined with previous results (Wang, 1986, 1990), and based on our long-term study of these basins, this paper focuses on the western Pacific Continental Margin to decipher temporal and spatial characteristics of some representative structural and hydrocarbon-accumulated migration in the basins of East China and its neighboring areas.

2. Tectonic setting and regional geology

East China and its adjacent areas are located in the eastern margin of the Eurasian Plate surrounded by the Indian-Australian Plate to the south, and the Pacific and the Philippine Sea plates to the east. In this region there developed a series of large-scale, active, and NE-trending trench-arc-basin systems since the Late Cretaceous.

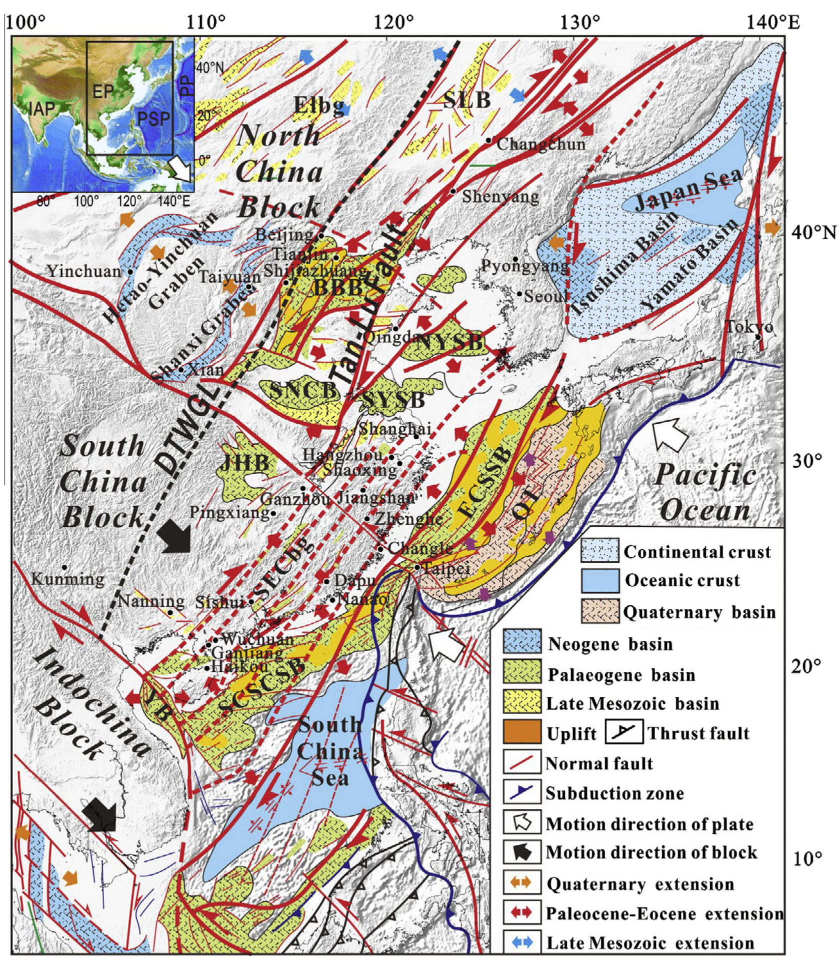

Fig. 1. Present tectonic framework of East China and its adjacent areas. In main map: SLB-Songliao Basin, BBB – Bohai Bay Basin, SNCB – South North China Basin, NYSB – North Yellow Sea Basin, SYSB – South Yellow Sea Basin, JHB – Jianghan Basin, ECSSB – East China Sea Shelf Basin, OT – Okinawa Trough, SCSCSB – South China Sea Continental Shelf Basin; YB –Yinggehai Basin; ELbg – Erlian basin group, SECbg – Southeast China basin group. DTWGL – Daxinganling – Taihangshan – Wulingshan Gravity Anomaly Line. In inset map: EP – Eurasian Plate; IAP – Indian-Australian Plate; PP – Pacific Plate; PSP – Philippine Sea plates.