PS Salt Tectonics and Their Relationships to Hydrocarbons in the Kuqa Foreland Fold-and-Thrust Belt, Northern Tarim Basin, China*

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Search and Discovery Article #10157 (2009)
Posted February 5, 2009

*Adapted from poster presentation AAPG Convention, San Antonio, TX, April 20-23, 2008

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Abstract

The aim of this article is to investigate the styles, evolution, and controlling mechanisms of salt tectonics and their relationships to hydrocarbons in the Kuqa foreland fold-and-thrust belt, northern Tarim basin, northwestern China. The field observations and interpretation of seismic profiles show that the salt tectonics, which can be divided into salt nappes, salt pillows, salt walls, salt welds, mini-basins, and fish-tails of varying scales, are well developed in the Kuqa region. The intense structural distortion of salt tectonics occurred in the later Himalayan period from the Kuqa period to Quaternary.

To comparatively analyze the major factors influencing the development of salt tectonics, the model of elastic-viscous plate showing the relationships between the salt and overburden has been established by virtue of thin film theory. The results indicate that the differential loading induced by the thicker sediments in the Baicheng sag dominated in the early stage of salt flowage. At present, however, the compressional stresses are the most important factor governing the development of salt tectonics. In addition, physical modelling demonstrates that the pre-Paleogene basement tectonics had important influence on the development of salt tectonics.

The salt tectonics exerted important influence on the hydrocarbon accumulations in the Kuqa foreland fold-and-thrust belt. The structural and subtle traps induced by the salt tectonics offered abundant favorable spaces for hydrocarbon accumulations; the faults acted as favorable pathways for hydrocarbon migration, and the thick halite layers served as good regional seals for hydrocarbon preservation. The models of hydrocarbon accumulations are different in the subsalt, salt, and suprasalt in the Kuqa foreland fold-and-thrust belt.

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1 Geological settings

The Kuqa foreland fold-and-thrust belt, covering an area of about 28, 000 square kilometers, is located in the north of Tarim basin and is bounded to the north and south by the South Tianshan Mountains Orogen and Tabei uplift, respectively. The Kuqa fold-and-thrust belt is one of the important structural units where hydrocarbons are rich and salt structures are well developed in the Tarim basin. The evolution of the Kuqa fold-and-thrust belt was closely correlated with the Tianshan Mountains Orogenic belt and Tabei uplift. Five subordinate structural units have been recognized, including the Northern monocline belt, Kelasu-Yiqikelike structural belt, Baicheng-Yangxia sag belt, Qiulitage structural belt, and Forbulge (Fig1).

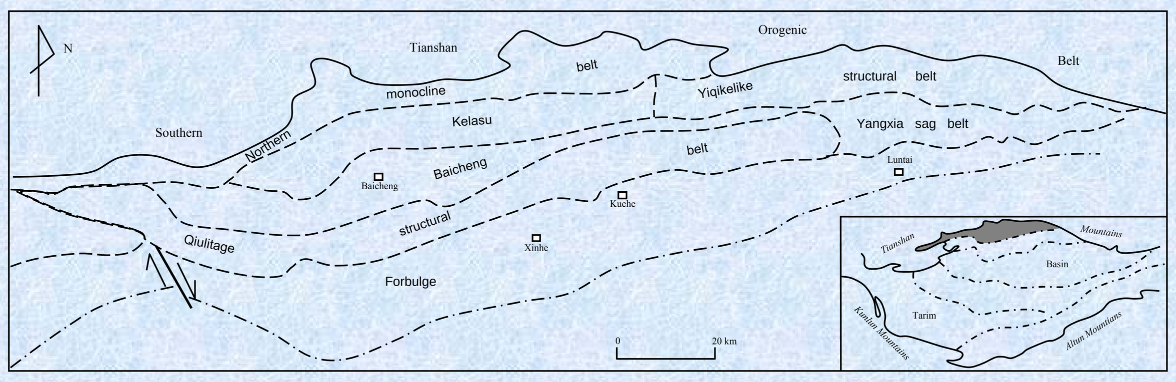

Fig.1 Division of structural units in the Kuqa fold-and-thrust belt, northern Tarim basin

The Paleogene Kumugeliemu Formation and Neogene Jidike Formation contain thick halite layers in the Kuqa foreland fold-and-thrust belt. Approximately bounded by the Kuqa river, the halite in the Kumugeliemu Formation is distributed mainly in the west segment of the Kuqa foreland fold-and-thrust belt, and the halite of the Jidike Formation in the east segment. The maximum thickness of the halite layers is more than 4000 m in the Qiulitage structural belt which is located in the most frontal range of the Kuqa foreland fold-and-thrust belt, where the surface expressions of salt tectonics are various (Fig.2).

Fig.2 Surface expressions of salt tectoncis in the Kuqa fold-and-thrust belt

2 Geometric featrures of salt tectonics

The Kuqa foreland fold-and-thrust belt is dominated by the complicated salt structural systems, including mainly salt pillows, salt nappes, salt welds, fish-tail structures, etc. (Fig.3).

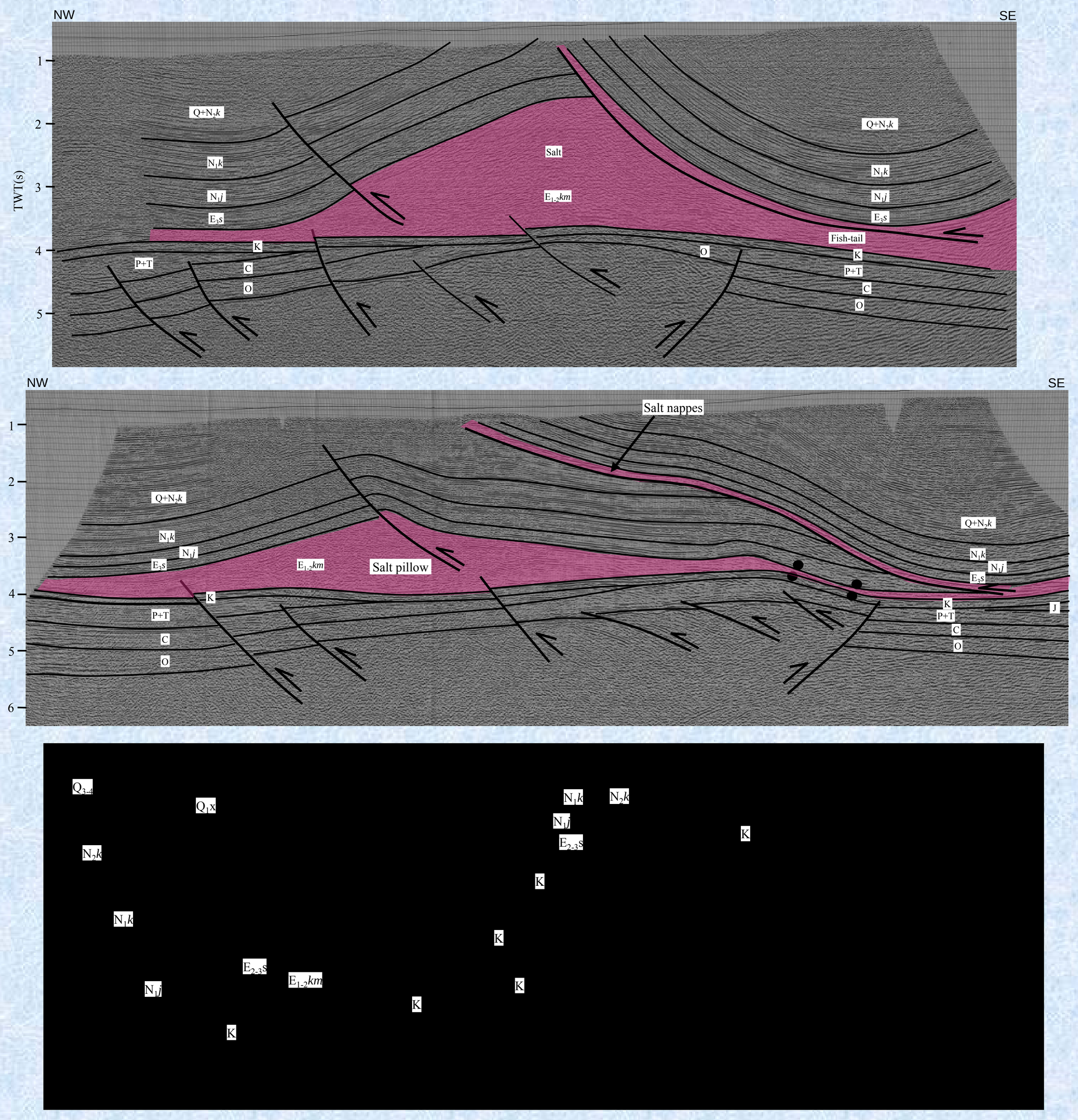

Fig.3 Salt tectonics of varying geometric festures in the Kuqa fold-and-thrust fold

3 Evolution of salt tectonics

The balanced cross-sections show that the intense structural distortion of salt tectonics in the Kuqa foreland fold-and-thrust belt mainly occurred in the late Himalayan period from the Kuqa period to Quaternary (Fig.4). The growth strata and triangles also show the structural evolution of salt tectonics in the Kuqa foreland fold-and-thrust belt (Fig.5).

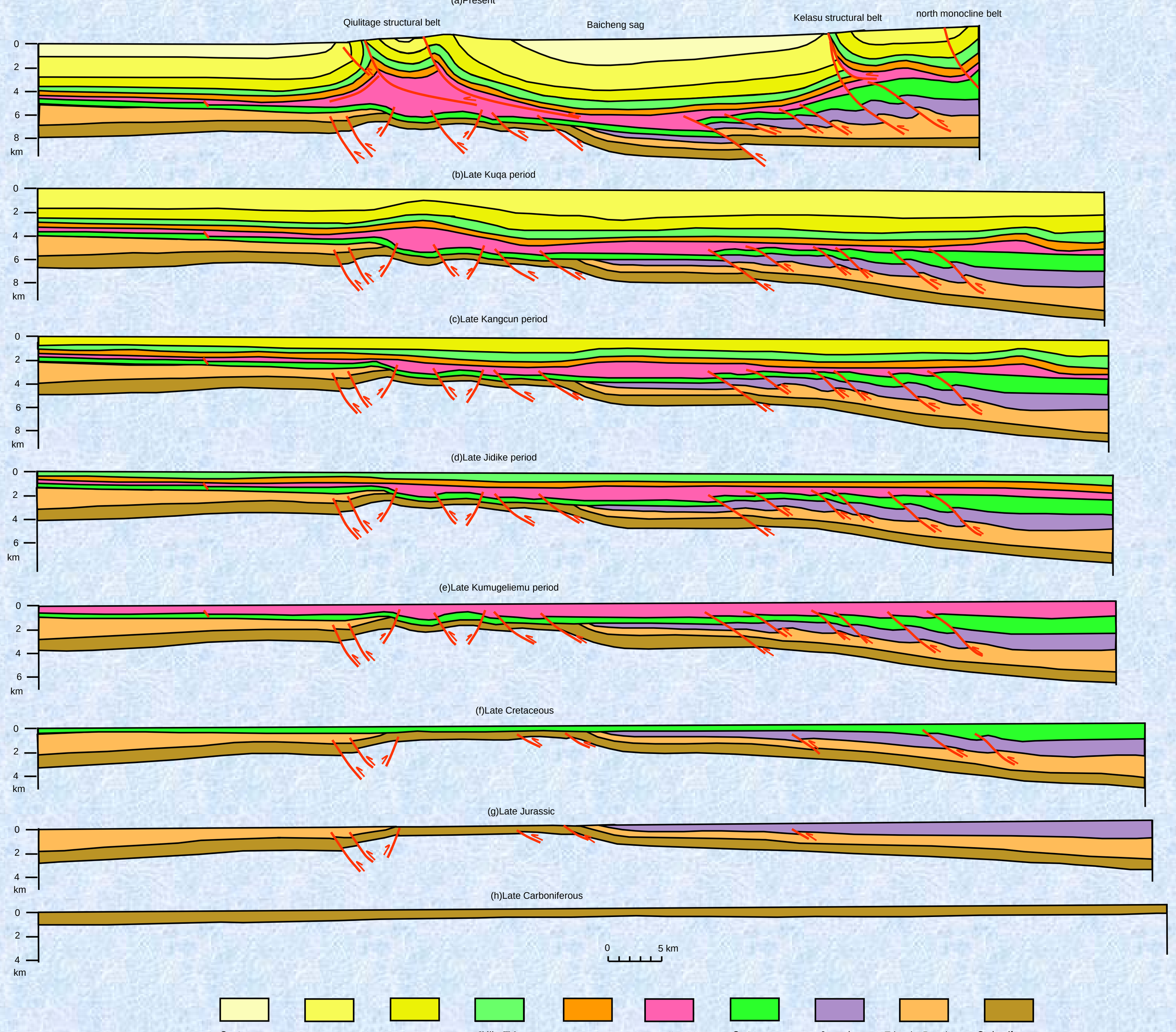

Fig.4 Balanced cross section of salt tectoncis in the Kuqa fold-and-thrust belt

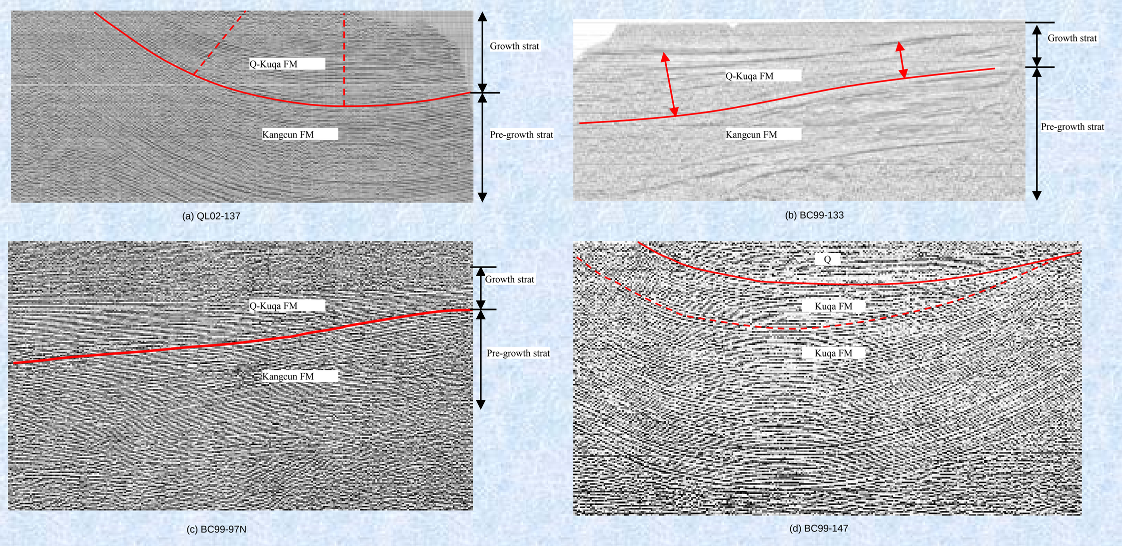

Fig.5 Growth strata and triangles in the Kuqa fold-and-thrust belt

4 Relationships of salt tectonics to hydrocarbons

Some large fields which have close relationships to salt tectoncis have been discovered in the Kuqa foreland fold-and-thrust belt, such as the Kela-2 gas field, Dina-2 gas field, and Dabei gas field (Fig.6).

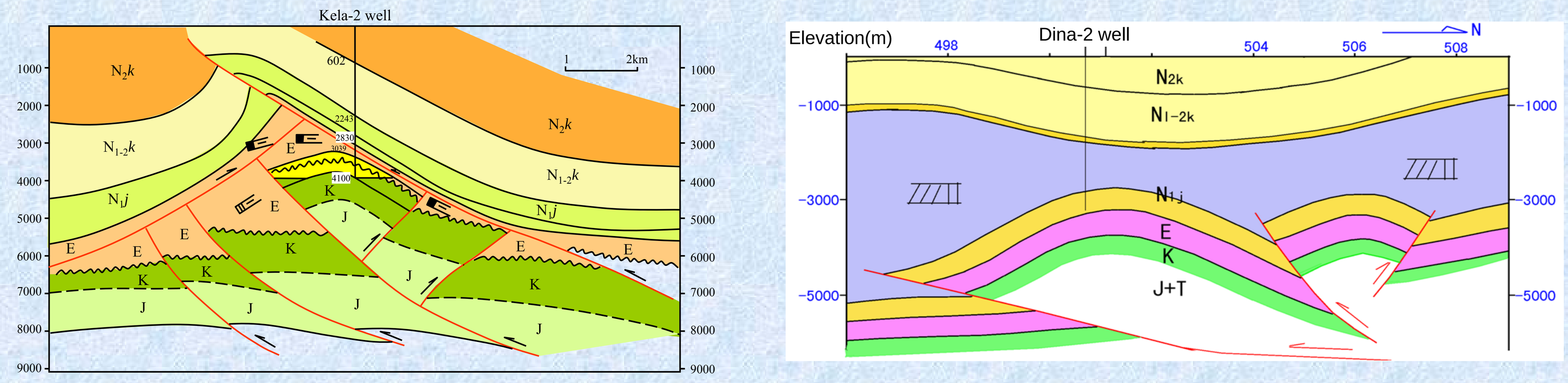

Fig.6 Kela-2 and Dina-2 gas fields in the Kuqa fold-and-thrust belt

The relationships of salt tectonics to hydrocarbons can be simply summarized as follows: ① Salt flowage can change the overburden and then produce various structural and subtle hydrocarbon traps. ②The thermal conductivity of salt is two to three times higher than that of typical sediments. In the vicinity of salt structures it produces thermal anomalies which influence hydrocarbon generation, migration, and maturation. ③The features of compaction and flowage of salt bodies make them very good seal layers. ④ The faults resulting from the salt structural movements can afford good vertical pathways for hydrocarbon migration.