YIN Hongwei, ZHENG Mianping，ZHANG Zhen, WU Zhenyun and WANG Xingyuan, 2014. Mechanism of Salt Migration Driven by Tectonic Processes: Insights from Physical and Numerical Modeling. *Acta Geologica Sinica* (English Edition), 88(supp. 1): 273–274.

Mechanism of Salt Migration Driven by Tectonic Processes: Insights from Physical and Numerical Modeling

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1 Introduction

Physical and numerical models are constructed to investigate the evolution and mechanism of salt migration driven by tectonic processes. In recent years, we have designed and ran series of models to simulate salt structures driven by regional compression (Figure 1A, Wu et al., 2014) and regional extension (Fig. 1B). In this research, we apply the modeling results to study the controlling factors which influence the distribution, migration, and accumulation of salt, with the purpose to prove insights into the favorable potash deposit exploration targets. The modeling results are used to interpret the salt structures in Mengyejing potash deposit, Yunnan, and Kuqa, Xingjiang.

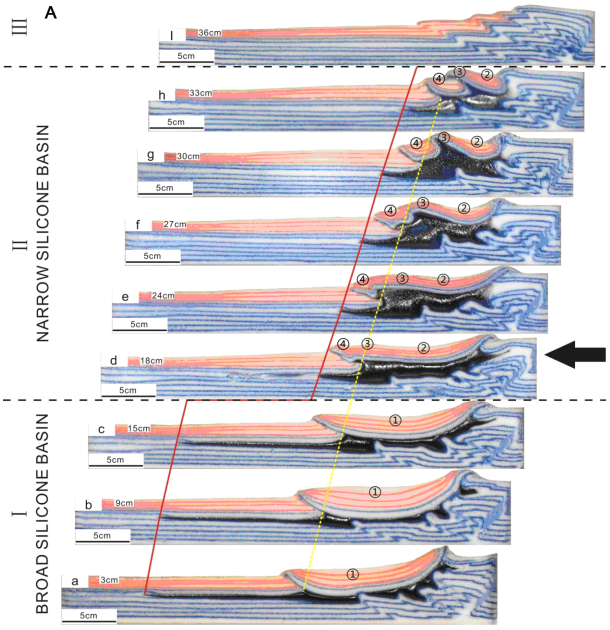

Fig. 1. Physical analog modeling results of compressive (A) and extensional (B) salt structures.

2 Modelling Results

For the compressive salt structures, model results show that the initial width of the salt basin is the major controlling influence on the salt migration and accumulation. For a wide salt basin, a broad salt withdrawal minibasin with very thick overburden strata is developed, while a narrow salt-upwelling minibasin with thin overburden strata is developed in a narrow salt basin. Model results also demonstrate that the early salt structure (passive salt diapir) has an important controlling role on the subsequent compressional structural deformation. Model results also demonstrate that the early salt structure (passive salt diapir) has an important controlling role on the subsequent deformation. The preexisting diapir acts as a stress concentration zone during the subsequent shortening, and become a salt nappe. Salt may flow out of the minibasin and accumulate near the preexisting salt diair, and may even flow to the surface during the subsequent shortening. For the extensive structures, salt distribution and migration are controlled by the normal faults and synkinematic deposition. Driven by the differential loading and normal faulting in the overburden strata, salt in the deep may migrate along the normal faults, extrudes from deep to the shallow and accumulate near the surface.

3 Insights into Natural Salt Structures

Based on modeling results and geophysical and geological data, we interpret that the Cenozoic salt-related structures in Kuqa fold-and-thrust belt experienced two

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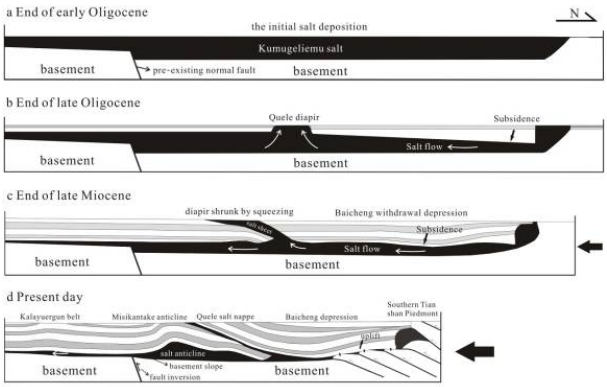

Fig. 2. Schematic model showing the salt migration in Kuqa fold-thrust-belt, Tarimu basin.

major phases: firstly regional passive diapirism phase caused by differential loading and then the following regional compression phase, which remolded the early salt structures (Fig. 2).

Generally, for the Kuqa salt-bearing fold-and-thrust belt, salt migrated from north to south, and from the mini-basin (Baicheng sag) to the salt nappe or salt anticline. Based on the salt accumulation and thickness of overburden strata, we suggest that for the salt and potash deposit exploration in Kuqa area, Tarimu basin, southern is better than the northern, and western is better than the eastern.

Mengyejing potash deposit in Jiangchen County, Yunnan Province is the only ancient chloride solid potash deposit in china. Since 1960's, scholars and geologists have conducted extensive research on Mengyejing potassium salt deposit. Although there are controversies about the origin of the brine, it has been widely accepted that the age of the potash deposit in Mengyejing belongs to Palaeocene, and the salt deposit is the evaporate sequence in the the upper part of Mengyejing Formation (E_1m^3) (Fig. 3). Using this concept as guidance, in the past decades, the potash deposit investigation and exploration in Yunnan have focused on the shallow Cenozoic strata, and unfortunately no big discovery so far.

Recently, a new Metallogenic model is proposed for the Mengyejing potash deposit (Fig. 4). Zheng et al. (2014) proposed that the age of salt in the Mengyejing is Jurassic. The salt deposit discovered in the shallow is the result of migration of salt from deep source salt layer to the shallow Mengyejing Formation.

Our modeling results have provided insights into the

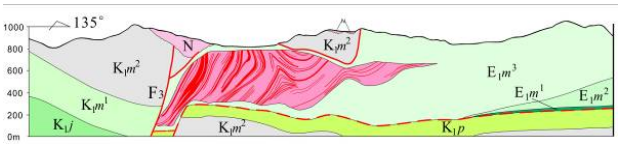

Fig. 3. Geological section of the Mengyejing potash deposit in Jiangcheng County, Yunnan Province data from NO. 16 Geological Party of Yunnan Province (1980).

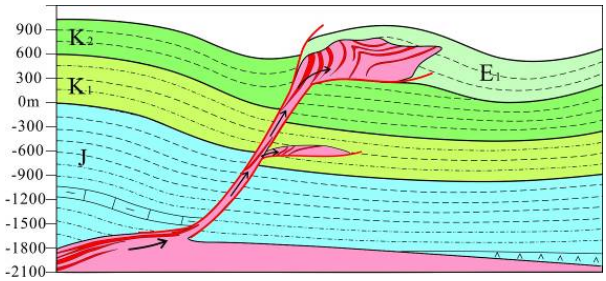

Fig. 4. Metallogenic model of the Mengyejing potash deposit, Yunnan Province (from Zheng et al., 2014).

mechanism of salt migration from deep to the shallow. Normal faults during the regional or local extension is the favorite migration path for the salt. Salt might flow along the fault and extrude to the surface, and meanwhile covered by the synkinematic sediments. Due to the following regional compression, the normal fault reacted and reversed. The hanging-wall moved up, and hence the salt-extrusion and the surrounding rock of upper part of Mengyejing Formation in the northern part of fault were eroded. The preserved salt body in the footwall formed current Mengyejing potash deposit.

Acknowledgements

This research is supported by China Geological Survey Bureau potash resources investigation and evaluation project (1212011085524) and NSFC projects (40872134, 41272227).

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