MENG Jinluo, JI Youliang, ZHANG Bin, JIN Li and CHE Shiqi, 2014. The Identification of an Alkaline Salt Lake: A Case Study from the Permian Fengcheng Formation in Hashan-Wuxia Area. *Acta Geologica Sinica* (English Edition), 88(supp. 1): 233–234.

The Identification of an Alkaline Salt Lake: A Case Study from the Permian Fengcheng Formation in Hashan-Wuxia Area

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The study area is located in the northwest of Junggar basin which was in the relaxation stage of foreland basin accompanied by momentary extend volcanic activities when the Fengcheng Formation developed in early Permian.

In the center of the basin, the bottom of the lower part of Fengcheng Formation developed volcanic rocks, mainly composed by volcanic ashes, and then, the formation begins the transition from dolomitic shale to shale bearing salt. Up to the middle part of the Fengcheng Formation, dolomitic mudstone, halopelite and salt crust frequently alter. Up to the upper part, the formation begins the transition from salt-bearing mudstone to dolomitic mudstone, and at last , the top deposited the basin-marginal facies.

From the center to the outside, in the littoral or sublittoral of the lake, the lithology of Fengcheng formation mainly consists of calcite bearing or calcareous mudstone and silty mudstone with thin calcareous siltstone interlayers in the Hashan Area.

The main saline minerals include searlesite、shortite and trona. The searlesite often exists in the dolomitic mudstone with thin banded or little lenticular shape. As the main saline mineral for the halopelite, the shortites often float in the mudstone with thin, platy, euhedral crystals. Shortite is believed to result from the ongoing dehydration of the gaylussite which is interpreted to be the result of a reaction of the alkaline brine with early-formed calcite or aragonite. The middle part of the Fengcheng formation bearing thickness trona layers shows obvious periodicity. The depositional succession is from dolomitic mudstone to halopelite（cumulus crystals of shorite）to trona crust with the evaporative concentration going on in one climate cycle.

What's more, there exist a large number of nodular or bedded cherts within the dolomitic mudstone. Given that no cherts are found in the evaporate succession, it can exclude the possibility that silica precipitation from the supersaturated solution while we can attribute it to the oscillation of PH of the alkaline brine water owing to the change of evaporation compared with inflow in one climate cycle.

Based on the hydrologic classification and brine evolution pathways of concentrating nonmarine waters established by Eugster and Hardie, combination with the lithology features, especially in the extensive and voluminous carbonate rocks, it can be identified that the brine type is Na-CO_3-Cl and the ratio of HCO_3/(Ca+Mg) in the inflow of the waters is near unity or a little bit more (path III). With the Ca being progressively removed by calcite, there is a progressive increase in Mg/Ca ratio of the remaining alkaline water until large volumes of high-Mg calcites and dolomites precipitate. After that，the remaining Mg change to Mg-rich smectites. At last, tronas precipitate from the most concentrated alkaline waters. The reason of lacking in sulfate minerals may be the sulfate--reducing bacterias which result more pyrites.

Key words: Alkaline salt lake, Hashan-Wuxia area

Acknowledgements

This study was supported by project《Reservoir features of Fengcheng formation around Hashan area》granted by the western center of Shengli Oilfield , Sinopec Group.

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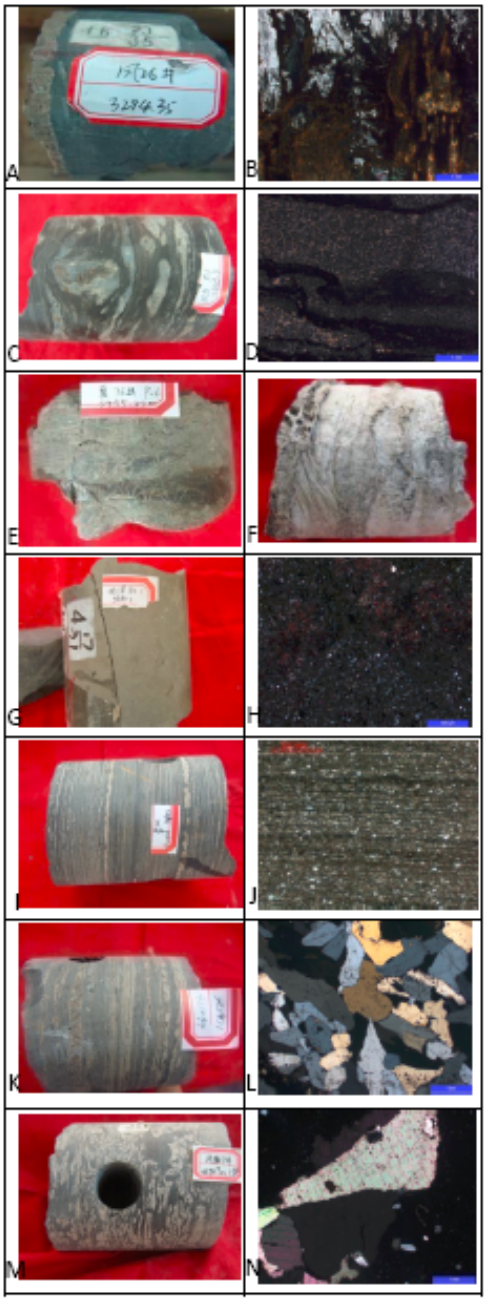


Fig. 1. A: Thin banded smectites，core sample from Well F26,at 3294.35 m in depth. B: Thin section with normal light from sample A. C: Nodular and bedded cherts, core sample from Well F5, at 3439.5 m in depth. D: Thin section with normal light from sample C. E: Grass-like trona, core from Well X76 at 3455.45 m in depth. F: Cross bedding on the trona crust, core sample from Well FN7, at 4591.1m in depth. G: Calcareous siltstone in littoral, core from Well HSX1, at 3684.0 m in depth. H: Thin section with normal light from sample A, stained by Alizarin red. I: Fine lamination comprises white black distal lake dolomitic mudstone with white salt mineral shortites, core from Well FN1, at 4340.3 m in depth. J: The submillimeter lamination comprises thinner, darker organic matter laminae and lighter, coarser laminae that contain mainly powder crystal dolomites and some silt-sized quartz grains. K: Thin banded searlesite within dolomitic mudstone, core sample from Well FN1,at 4210.94 m in depth. L: Searlesite in thin section with normal light, core from Well FN7, at 4589.20 m in depth. M: Thin, platy, euhedral shortites as the main saline mineral for halopelite, core from Well FN7, at 4594.9 m in depth. N: Shortites in thin section with normal light from sample M.

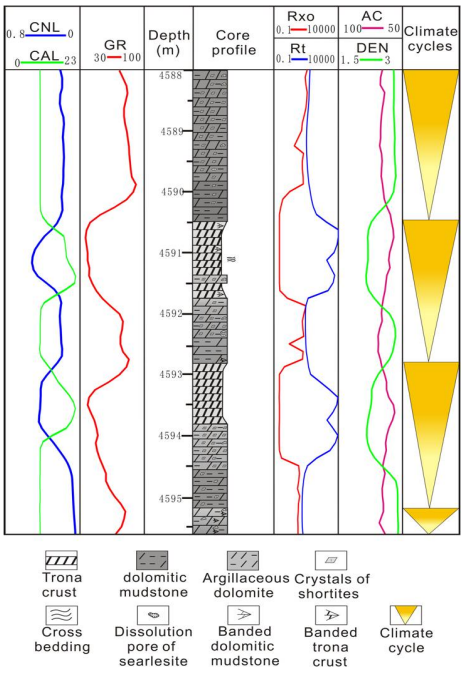
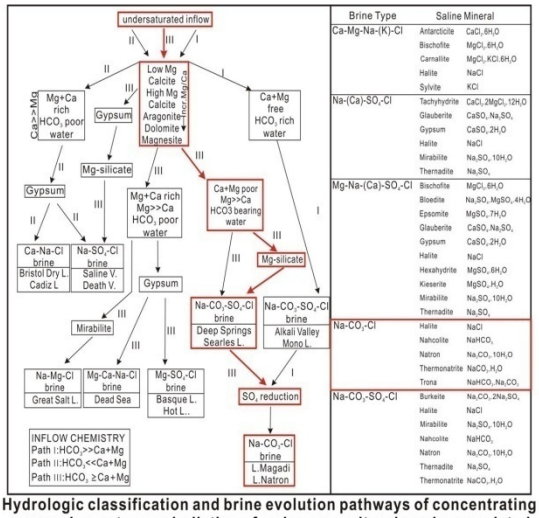


Fig. 2. The periodic sedimentation of alkaline salt lake.



Hydrologic classification and brine evolution pathways of concentrating nonmarine waters and a listing of major evaporite minerals associated with the different brine types (after Eugster and Hardie,1978). L=Lake, V=Valley.

Fig. 3. The evolution pathway III (the left red boxes and red arrows); brine type:Na-CO_3-Cl (the right red box).

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