[PS]Diagenetic and Porosity Evolution of Conglomeratic Sandstones in Bayingebi Formation of the Lower Cretaceous, Chagan Sag, China*

Wei Wei[1,2], Xiaomin Zhu[1,2], and Mingxuan Tan[1,2]

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[1]Department of Geosciences, China University of Petroleum, Beijing, China (hunqiu8854@gmail.com)
[2]State Key Laboratory of Petroleum Resource and Prospecting, China University of Petroleum, Beijing, China

Abstract

The fan delta conglomerate sandstones of Bayingebi Formation including conglomerates and pebbly sandstones in the Chagan Sag are reservoir for large accumulations of hydrocarbons. Based on observation of cores, thin sections, SEM and CL, combined with application of fluid inclusion and carbon and oxygen isotopes, it indicates that the conglomerate sandstones are mainly feldspathic litharenites with immature texture. It has considerable heterogeneity with a wide range of porosity from 0.3% to 15.3% and the permeability from 0.004 mD to 1168 mD. This study discusses conglomerate sandstones diagenesis and its controls on reservoir quality. Its eodiagenesis is primary compaction and the minor of calcite cementation. The subsequent mesodiagenesis includes weak compaction, precipitation of quartz overgrowth and feldspar overgrowth, albitization, dissolution of early carbonate cement and metastable framework grains, late carbonate cementation, and illitization. A comparison between porosity-depth data and normal compaction curve of conglomerate sandstones shows two groups. Group “A” is mainly composed of tight conglomerate sandstones with permeability less than 1 mD and porosity less than 10%. Petrology studies show that two types of the tight conglomerate sandstones developed in this group. One type, mainly depositing in the thinly bedded subaqueous channels of fan delta front, is characterized by abundant clay minerals occluding intergranular pores. The other type, mainly depositing in the thinly bedded subaqueous channels or along sandstone/mudstone interface of thickly bedded subaqueous channels, is characterized by abundant carbonate cements occluding intergranular and intragranular pores. Group “B” is mainly composed of conglomerate sandstones with higher permeability more than 1 mD and porosity ranging from 5% to 16% corresponding to the burial depth from 2200 to 3400 m. It mainly deposited within the thickly bedded subaqueous channels of fan delta front. Significant dissolution of carbonate cement, feldspars, and other metastable framework grains by organic acids and CO_2 generated from organic maturation are the major cause of abnormally high porosity.

References Cited

Bjørlykke, K., 2014, Relationship between depositional environments, burial history and rock properties. Some principal aspects of diagenetic process in sedimentary basins: Sediment. Geol., v. 301, p. 1-14.

Bloch, S., R.H. Lander, and L. Bonnell, 2002, Anomalously high porosity and permeability in deeply buried sandstone reservoirs: origin and predictability: AAPG Bulletin, v. 86, p. 301-328.

Giles, M.R., and R.B. De Boer, 1990, Origin and significance of redistributional secondary porosity: Mar. Pet. Geol., v. 7, p. 378-397.

Lander, R.H., and O. Walderhaug, 1999, Predicting porosity through simulating sandstone compaction and quartz cementation: AAPG Bulletin, v. 83, p. 433-449.

Morad, S., K.H. Al-Ramadan, J.M. Ketzer, and L.F. De Ros, 2010, The impact of diagenesis on the heterogeneity of sandstone reservoirs: a review of the role of depositional facies and sequence stratigraphy: AAPG Bulletin, v. 94, p. 1267-1309.

Wei, W., x. Zhu, M. Tan, M. Xue, D. Guo, H. Su, and P. Wang, 2015, Diagenetic and porosity evolution of conglomeratic sandstones in Bayingebi Formation of the Lower Cretaceous, Chagan Sag: Mar. Pet. Geol. v. 66, p. 998–1012.

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Wei Wei[a,b], Xiaomin Zhu[a,b], Mingxuan Tan[a,b]

[a] Department of Geosciences, China University of Petroleum, Beijing, 102249, China

[b] State Key Laboratory of Petroleum Resource and Prospecting, China University of Petroleum, Beijing, 102249, China

Abstract

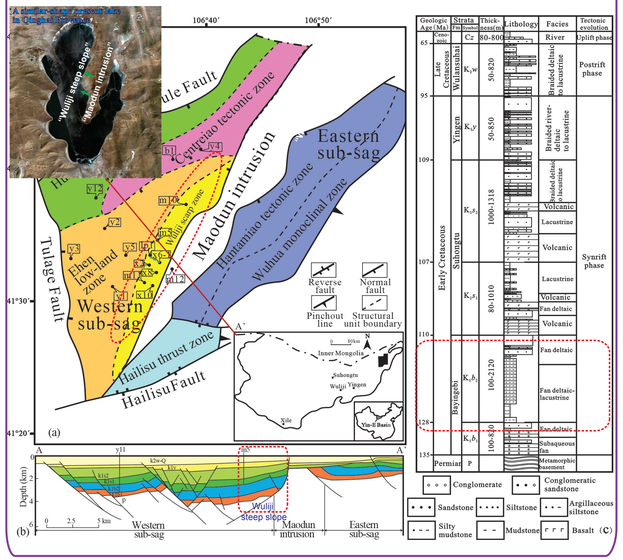
The fan delta conglomeratic sandstones of Bayingebi Formation including conglomerates and pebbly sandstones in the Chagan Sag and reservoirs for large accumulations of hydrocarbons. Based on observation of cores, thin sections, and SEM, combined with application of fluid inclusions and carbon and oxygen isotopes, data indicates that conglomeratic sandstones are mainly feldspathic litharenites with immature texture. They have considerable heterogeneity with a wide range of porosity from 0.3% to 15.3% and the permeability from 0.004 mD to 1168 mD. This study discusses conglomeratic sandstones diagenesis and its controls on reservoir quality. Its eodiagenesis is primary compaction and the minor of calcite cementation. The subsequent mesodiagenesis includes weak compaction, precipitation of quartz overgrowth and feldspar overgrowth, albitization, dissolution of early carbonate cement and metastable framework grains, late carbonate cementation, and illitization. A comparison between porosity-depth data and normal compaction curve of conglomeratic sandstones shows two groups.

Group “A” is mainly composed of tight conglomeratic sandstones with permeability less than 1mD and porosity less than 10%. Petrology studies show that two types of the tight conglomeratic sandstones developed in this group. One type, mainly depositing in the thinly bedded subaqueous channels of fan delta front, is characterized by abundant clay minerals occluding intergranular pores. The other type, mainly depositing in the thinly bedded subaqueous channels or along sandstone/mudstone interface of thickly bedded subaqueous channels, is characterized by abundant carbonate cements occluding intergranular and intragranular pores.

Group “B” is mainly composed of conglomeratic sandstones with higher permeability more than 1mD and porosity ranging from 5% to 16% corresponding to the burial depth from 2200 to 3400 m. It mainly deposited within the thickly bedded subaqueous channels of fan delta front. Significant dissolution of carbonate cement, feldspars, and other metastable framework grains by organic acids and CO_2 generated from organic maturation are the major cause of abnormally high porosity.

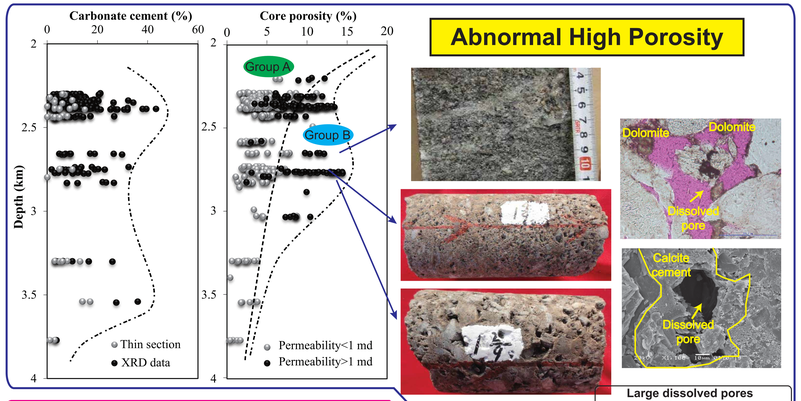
Geological Setting

The Chagan Sag, located in the China-Mongolia frontier area, is a Mesozoic rift basin. It has been discovered 21.9×10⁴ bbl of petroleum reserves, considered to be the most prospective exploration area in Yin-E Basin. It’s a typical small faulted petroliferous lacustrine basin, mainly develops fan delta conglomeratic sandstones, which are favorable reservoirs with the highest yield, especially the Wuliji scarp zone.

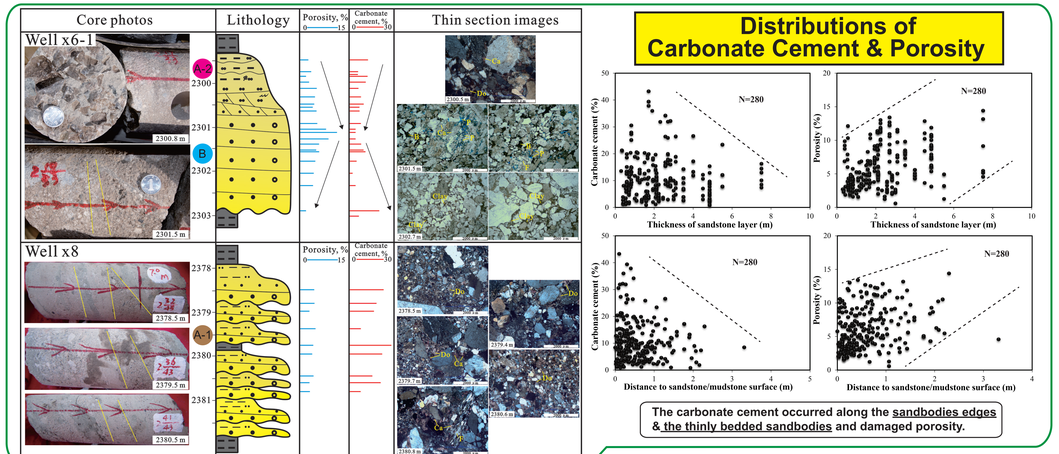


Results

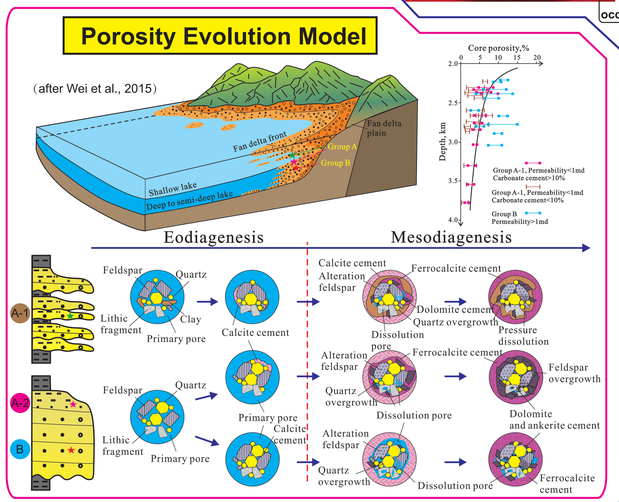
Abnormal High Porosity



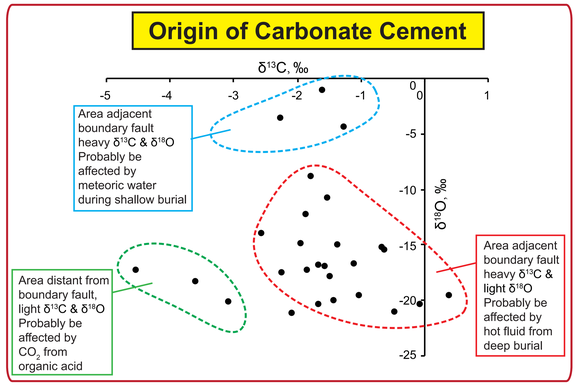
Distributions of Carbonate Cement & Porosity



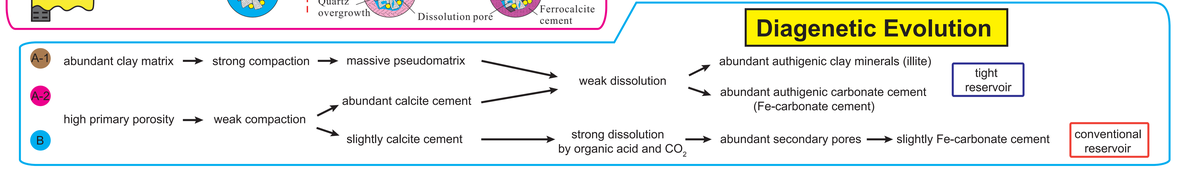
Porosity Evolution Model



Origin of Carbonate Cement



Diagenetic Evolution



Conclusions

Tight conglomeratic sandstone with low permeability of less than 1 mD and low porosity of less than 10%.
It is characterized by poor sorting, sub-angular to sub-rounded, and line to concavo-convex contact.
Its interstitial material includes carbonate cements (2.1%-43.3%, av. 13%) and clay minerals (0%-13%, av. 4.1%).

Group A

- **A-1** Group “A-1” - containing abundant clay minerals:
  It was probably deposited in subaqueous channels of distal fan delta front with abundant mudstone matrix.
  Compaction led to the formation of massive pseudomatrix and reduction of primary porosity.
- **A-2** Group “A-2” - containing abundant carbonate cements:
  It was deposited in high energy deposition environment resulting in low clay contents and medium-poor sorting.
  The carbonate cement along the sandbodies edges and the thinly bedded sandbodies damaged porosity.

Group B

Conventional conglomeratic sandstone with permeability more than 1 mD and porosity ranging from 5% to 16%.
Its interstitial material includes carbonate cements (0.8%-26%, av. 8.1%) and clay minerals (2%-5%, av. 3.25%).

- **B** It was mainly deposited in the thickly bedded subaqueous channels of the fan delta front.
  The single sandstone layer with thickness over 2 m has a higher primary porosity and less mudstone matrix.
  Carbonate cement along the sandbodies edges increased the framework strength to prevent primary pores.
  Organic acids and CO_2 derived from mudstones dissolved early carbonate cement and metastable framework grains (feldspars and lithic grains) to form large amount of secondary pores and to enlarge residual primary pores.

References

Bjørlykke, K., 2014. Relationship between depositional environments, burial history and rock properties. Some principal aspects of diagenetic process in sedimentary basins. Sediment. Geol. 301, 1-14.

Bloch, S., Lander, R.H., Bonnell, L., 2002. Anomalously high porosity and permeability in deeply buried sandstone reservoirs: origin and predictability. AAPG Bull. 86, 301-328.

Giles, M.R., De Boer, R.B., 1990. Origin and significance of redistributional secondary porosity. Mar. Pet. Geol. 7, 378-397.

Lander, R.H., Walderhaug, O., 1999. Predicting porosity through simulating sandstone compaction and quartz cementation. AAPG Bull. 83, 433-449.

Morad, S., Al-Ramadan, K.h., Ketzer, J.M., De Ros, L.F., 2010. The impact of diagenesis on the heterogeneity of sandstone reservoirs: a review of the role of depositional facies and sequence stratigraphy. AAPG Bull. 94, 1267-1309.

Wei, W., Zhu, X.M., et al, 2015. Diagenetic and porosity evolution of conglomeratic sandstones in Bayingebi Formation of the Lower Cretaceous, Chagan Sag. Mar. Pet. Geol. 66, 998–1012.