Vol. 88 Supp. 1 ACTA GEOLOGICA SINICA (English Edition) June 2014
http://www.geojournals.cn/dzxben/ch/index.aspx http://mc.manuscriptcentral.com/ags

MIAO Weiliang, MA Haizhou, ZHANG Xiying, LI Yongshou and SHI Haiyan, 2014. Clay Mineralogical and Geochemical Studies of Detrital Rocks of the Upper Cretaceous Salt-bearing Strata, Simao Basin, SW China: Implication for Provenance and Source Weathering. *Acta Geologica Sinica* (English Edition), 88(supp. 1): 235–237.

Clay Mineralogical and Geochemical Studies of Detrital Rocks of the Upper Cretaceous Salt-bearing Strata, Simao Basin, SW China: Implication for Provenance and Source Weathering

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1 Introduction

Geological studies established on several sections in Lanping-Simao basin have shown that the salt-bearing strata of Mengyejing formation (Yunlong Fm. in Lanping basin) are constituted by an alternation of salt layers and interbedded facies. The latter consists mainly of mudstones, and mudstone-rich conglomerate. The mineralogy and geochemistry of salt-bearing beds and their constituents have been widely studied due to their economic importance. But, the interbedded facies are usually marginalized, although the relatively similarity of thickness between salt layers and interbedded facies of salt-bearing strata. Based on this situation, we choose the interbedded facies of salt-bearing strata as the main object for our research, so that it can provide us with the information of regional tectonic setting, provenances, weathering conditions and sediment recycling.

2 Materials and Methods

Detrital sediments of the Upper Cretaceous salt-bearing stara in the Jiangcheng subbasin, southern Simao basin were deposited in fluvio-lacustrine environment as the India and Eurasia plate collision. Clay mineralogy and element geochemistry of sediment samples (mainly detrital sediments) collected in core sediments (101°38′ 48.77″E, 22°40′58.39″N) of the basin are used to evaluate the source characteristics and its weathering conditions (Fig. 1). The core (SHK4) drilled through the bottom boundary of Mengyejing Fm. (K_2me), and completed in the top of Pashahe Fm. (K_1p). The lithofacies in the core

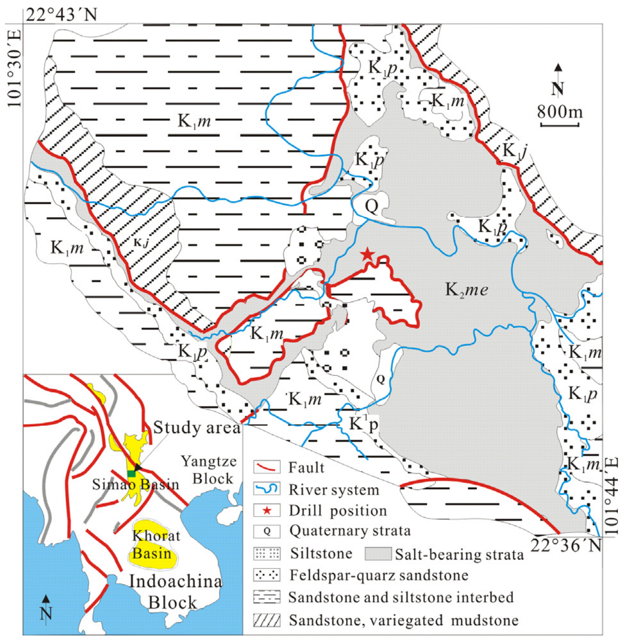

Fig. 1. Geography and distribution of strata within the studied area.

(303m depth) developed a complete salt-forming cycle, general bottom-up presents clastic rock facies - halite facies - sylvine/halite interbedding facies – halite/gypsum facies – clastic rock facies. Clasitc facies is mainly composed of brownish red inequigranular muddy conglomerate with rarely gray black specularite particles. Grey white/black fine crystal halite with horizontal lamination is the main component of halite facies. And in sylvine/halite facies, orange red fine crystal sylvine vein, gray white halite veinlets and brown-red muddy conglomerate uneven developed interactively.

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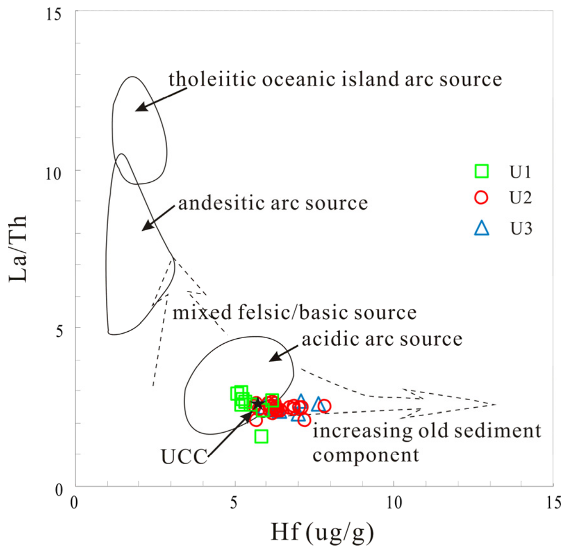

Fig. 2. Plot of La/Th versus Hf for the Mengyejing Fm. sediments (compositional fields are after Floyd and Leveridge, 1987).

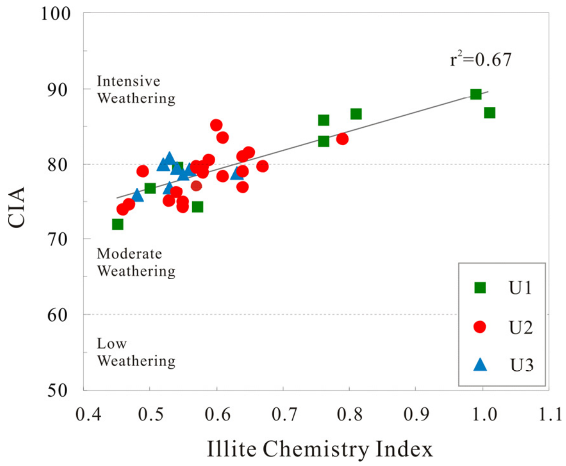

Fig. 3. Chemical index of alteration (CIA) of Mengyejing Fm. sediments and its correlation with illite chemistry index.

3 Results

On the basis of analysis, the clay mineral assemblage consists mainly of illite (average 56%) and chlorite (44%) with minor kaolinite (22%), and has show strong differences in different deposition stage. For example, kaolinite is absent (less than semi-quantitative calculation errors) during the salt-forming stage, and chlorite is very scarce in early stage of detrital sediments deposition. For the purposes of comparison, the distribution of average clay mineral assemblages has been calculated for three units based on the different sedimentary stages of the core. And the results show that the change of source input due to climate fluctuation should be an important reason for the clay mineral assemblage changes.

The major element results of samples indicate that the formation of clay minerals is accompanied by leaching of Ca and Na first and of Fe and Mn thereafter during the chemical weathering process. The chemical composition of weathering products in a sedimentary basin is expected to demonstrate well-established concepts on mobility of various elements during weathering (Nesbitt et al., 1980; Singh et al., 2005), and therefore to assess the state of chemical and physical weathering (Vital et al., 2000; Singh et al., 2005; Liu et al., 2007). The elemental ratios calculated from average major-element concentrations normalized to UCC are used to identify and evaluate the major element mobility. The results show that moderate chemical and strong physical weathering processes. The less mobile Mg are markedly enriched in U1 and U2 sediments, suggesting their common source from Mg-rich minerals, such as dolomite and magnesite. And the mobile element K presents minor enriched in U2 and U3 sediments show that the clay minerals adsorption should be responsible for it.

A plot of La/Th against Hf (Fig. 2) provides a useful tool for sediments discrimination between different arc composition and sources (Asiedu et al., 2000). The composition of the Mengyejing Fm. sediments suggest derivation mainly from acidic arc source and old sediment component, and closely around the UCC.

The degree of chemical weathering can be estimated by the chemical index of alteration (CIA) (Nesbitt and Yong, 1982). Our results show that CIA values are 72–89 for U1 sediments, 74-85 for U2 sediments and 76-81 for U3 sediments (Fig. 3). Among the different units, relatively lower values of CIA and lower illite chemistry index are found in the U2 and U3 sediments, confirming the relatively strong physical weathering processes and the salt-forming environment. A moderate linear correlation of CIA with illite chemistry index exists for all sediments. For some samples of U1, a higher CIA value corresponds to a higher illite chemistry index value indicating stronger hydrolysis and vice versa. The results demonstrate that the degree of chemical weathering is moderate to intensive for all samples. From the linear correlation (Fig. 3), values of illite chemistry index above ~0.6 indicate intensive weathering and below ~0.6 moderate weathering in the core sediments.

Weathering trends in all sediments can be clearly observed on Al_2O_3-(CaO+Na_2O)-K_2O (A-CN-K) and Al_2O_3-(CaO+Na_2O+K_2O)- (FeO+MgO) (A-CNK-FM) ternary diagrams (Nesbitt and Young, 1984, 1989). All samples plot linearly parallel to A-CN or A-CNK line, indicating preferential leaching of CaO and Na_2O and enrichment Al_2O_3, while K_2O contents (less abundant) are almost constant. Loss of CaO and Na_2O in core sediments is very distinguishable, agreeing with the elemental mobility results. The distribution of data plots close to the A-CN line suggests a part of felsic volcanic rock sources.

4 Conclusions

(1) The clay mineral assemblage of core sediments consists mainly of illite (average 56%) and chlorite (44%) with minor kaolinite (22%), and has show strong differences in different deposition stage.

(2) The felsic source and old sediment components is the main source rock for the core sediments. Sub-tropical climate change and the rapid chemical weathering of source rock should be responsible for the clay mineral assembleages.

(3) The CIA results combined with illite chemistry index demonstrate a moderate – intensive chemical weathering degree. And the formation of clay minerals is accompanied by leaching of Ca and Na.

Acknowledgements

We thank Peijun Qiao and Lei Shao for technical help in the laboratories and relevant figures of Taiyu potash fertilizer Co., Ltd. for the help of sample collection. This work was supported by the National Basic Research Program of China (2011CB403004) and the National Natural Science Foundation of China (41303029).

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