Carbon and Oxygen Isotope Stratigraphy of the Oxfordian Carbonate Rocks in Amu Darya Basin

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ABSTRACT: Based on the detailed research on petrologic and geochemical characteristics of deposition and diagenesis of Oxfordian carbonate rocks in Amu Darya Basin, Turkmenistan, carbon and oxygen isotopes were analyzed. The results show that the paleoenvironmental evolution reflected by the samples with well-preserved original carbon isotopes coincides with the carbon-isotope stratigraphic curve and is almost consistent with the global sea-level curve, the Mid-Oxfordian wide transgression, and the positive carbon-isotope excursion event. The Mid-Oxfordian continuing transgression not only laid the foundation for the development of the Oxfordian reef and shoal reservoirs in Amu Darya Basin but also provided an example for the Oxfordian global transgression and the resulting development of reefs and banks and high-speed organic carbon burial events. The response of oxygen isotopes in diagenetic environment showed that micrite limestones and granular limestones underwent weak diagenetic alteration, and the samples largely retained the original seawater features. Dolomitization and the precipitation of hydrothermal calcites filling solution vugs and fractures before hydrocarbon accumulation occurred in a closed diagenetic environment where the main controlling factor is the temperature, and the diagenetic fluids were from the deep hot brine. The chalkification of the limestones after hydrocarbon accumulation occurred in the oilfield water systems.

This study was financially supported by the Important National Science & Technology Specific Projects of China (No. 2008ZX05030-003-02).

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Manuscript received December 23, 2011.
Manuscript accepted March 15, 2012.

KEY WORDS: carbon and oxygen stable isotope, geochemistry, isotope stratigraphic curve, depositional environment, diagenetic information, Oxfordian, Amu Darya Basin.

INTRODUCTION
The carbon and oxygen stable isotope compositions of carbonate minerals are good tracers of sedimentary-diagenetic environments and formation of the basin. Hence, it is one of the most important
topics in the isotope research of sedimentary rocks (Li and Wan, 1999). However, the carbon and oxygen stable isotope compositions of carbonate rocks are often superimposed results of deposition and diagenesis. Therefore, carbon and oxygen isotopes play an important role in geochemical tracers based on the application of deposition and diagenesis. For example, Chen and Chen (1994), Chen et al. (1995), and Zheng and Liu (1997) studied Devonian carbon isotope stratigraphic evolution and their relations to transgression-regression patterns in South China and Longmen Mountains. Using carbon, oxygen, and strontium isotopes, Zheng et al. (2008a, b; 2007) studied the genesis of dolomite reservoirs of Changxing Formation (Upper Permian) and Feixiangguan Formation (Lower Triassic) in the northeastern Sichuan. Li et al. (2007) and Liu et al. (2007) studied the sequence stratigraphy of Triassic carbonate rocks in Southwest Guizhou and Upper Jurassic strata in Qiangtang Basin, respectively. Based on the detailed petrologic results (Zhang et al., 2010) and the application of carbon and oxygen stable isotopes, the carbon and oxygen isotope geochemistry characteristics of Oxfordian carbonate rocks were focused on in the Amu Darya Basin, Turkmenistan. It will provide important geochemical information for the analyses of the sea-level change, isotope stratigraphic correlation, and depositional-diagenetic environment in the Amu Darya Basin.

**GEOLOGICAL CONDITION**

**Regional Tectonic Characters**

Amu Darya Basin is a large Mesozoic superimposed sedimentary basin in southeastern Tulan Platform. The basin is divided into three structural layers, including basement, intermediate layer, and platform cover (Meisel et al., 1995). The basement consists of Paleozoic igneous and metamorphic rocks at varying burial depths. Based on the structural morphology of the cover, the Amu Darya Basin comprises a number of large structural units, including Kopetan piedmont depression, central Karakym uplift, Charjou terrace, and so on (Fig. 1). Two groups of northwest- and northeast-striking faults controlled the structural framework and the distribution of sedimentary cover. The intermediate layer above the basement is composed of Permian–Triassic terrigenous clastic rocks. The Lower to Middle Jurassic coal-bearing clastic rocks of coastal plain and littoral-neritic sea had excellent source rocks and great resource potential. The widespread sedimentary cover is composed of Callovian–Oxfordian (Middle to Upper Jurassic) marine clastic rocks and carbonate rocks, extremely thick Cretaceous to Paleogene evaporites. In Callovian–Oxfordian, good carbonate reservoirs generally developed; the Cretaceous–Paleogene evaporites were high-quality regional cap rocks; and they together with Lower to Middle Jurassic strata formed a very favorable source-reservoir-cap configuration in time and space.

![Regional structural map of the Amu Darya right bank area (Meisel et al., 1995).](image-url)