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Paleoenvironment and Origin of the Sedimentary Phosphorite of the Yurtus Formation (Early Cambrian, Sugetbrak Phosphorite Deposit, Tarim Basin)

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1 Introduce

Early Cambrian phosphorites, with more than 177.7 million tons are mainly distributed in the Akesu-Wushi area (Sugetbrak phosphorite deposit) and Jinghe county (Kegurqin phosphorite deposit), Xinjiang (Huang et al., 2007). The phosphorus was occurred among the black shale and chert units of the early Cambrian Yurtus Formation in Akesu-Wushi area. This article showed the paleoenvironment and origin of the sedimentary phosphorite of the Sugetbrak phosphorite deposit in Akesu-Wushi area.

2 Geological Setting and Sampling

Thick Cambrian sedimentary successions well outcrop in the Aksu-Wushi area of the northern margin of the Tarim Basin, China (Fig. 1b). The strata of the lower Cambrian in

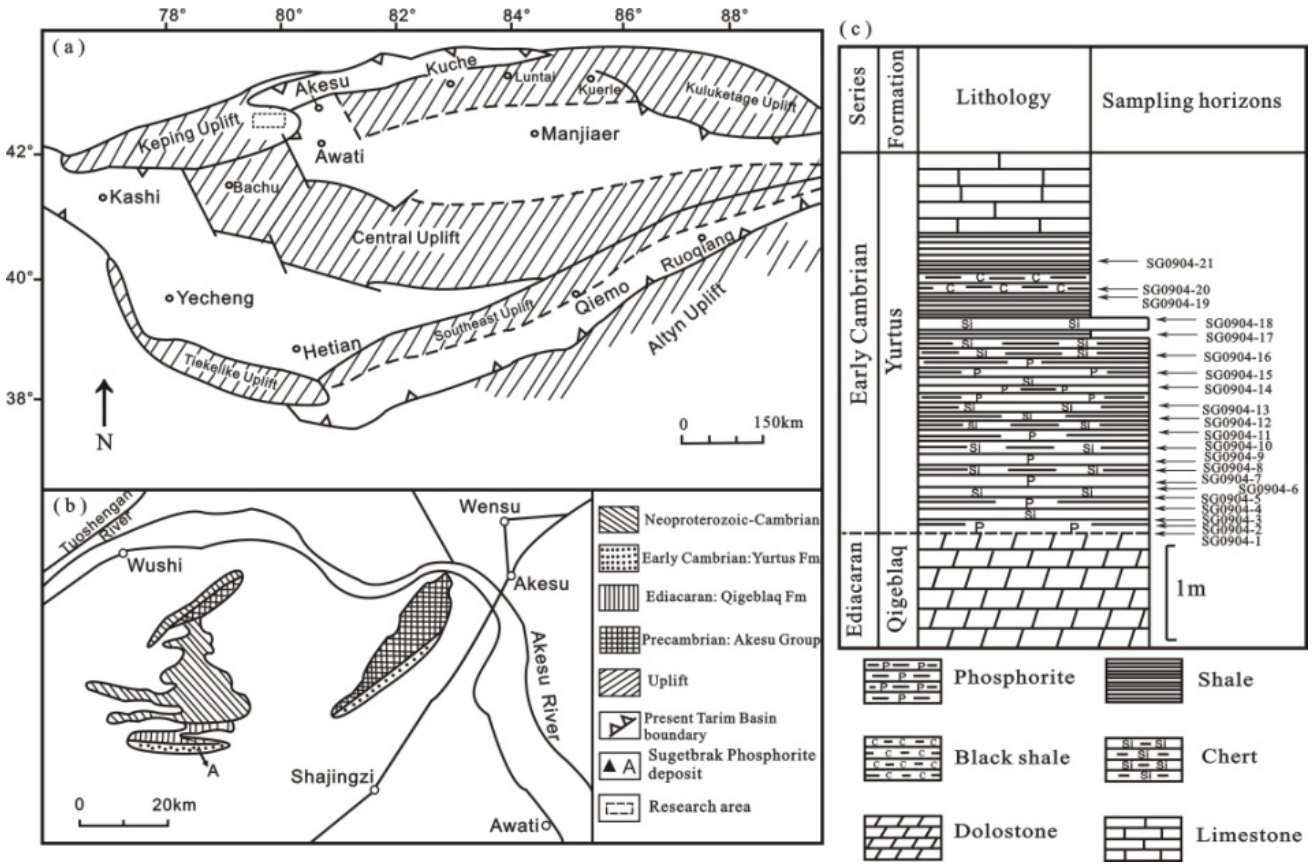

Fig.1. (a) Position of the study area. (modified after Yu et al., 2009); (b) Geological setting of the studied section and the tectonic setting. (modified after Qian et al., 2000); (c) Lithostratigraphy and the sampling horizons of the Sugetbrak phosphorite mine.

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the Tarim Basin consist of the Yurtus, Xiaoerblaq and Wusonger Formations in ascending order. The Yurtus Formation unconformably overlies the dolostone of the Ediacaran Qigeblaq Formation and conformably underlies the trilobite-bearing limestone of the Xiaoerblaq Formation (Wang et al., 1985). The Sugetbrak phosphorite mine is located at the Wushi area, northwest of the Tarim Basin (Fig. 1a). There is no volcanic record in the study area (Wang et al., 1985).

The measured thickness of the Sugetbrak section is about 4.4m. This section consists of phosphatic chert (1.6 m), black shale (2.8 m) of the Early Cambrian Yurtus Formation in ascending order (Fig.1c). Twenty-one samples were collected from the Yurtus Formation at the Sugetbrak phosphorite deposit (Fig.1c).

3 Paleoenvironment and Origin of the Sedimentary Phosphorite

3.1 Paleoenvironment

In the studied section, Th/U ratios (from 0 to 0.42) are correlated with the $\delta^{13}C_{carb}$ and $\delta^{13}C_{org}$ negative anomalies, V/Cr ratios ranged from 2 to 4.25 in the chert－phosphorite assemblages and as high as 4.25 in black shale unit, Ni/Co ratios were approximately 7 in the chert－phosphorite layers, and relatively high Ni/Co ratios were found in the black shale units of the studied section. The geochemical evidences of the trace elements especially the redox－sensitive trace elements (such as V, Mo, etc.) and the elemental ratios (such as Th/U, V/Cr, V/Sc, Ba/Sr, δEu, δCe, etc.)provide valuable information, regarding the depositional environment of the chert－phosphorite－black shale unit ranged from suboxic to anoxic (Jones et al., 1994;Kimura et al., 2001; Rimmer, 2004; Brookfield et al., 2009; Yu et al., 2005). Negative Ce and positive Eu anomalies in the chert－phosphorite assemblages of the studied Yurtus Formation indicated the existence of a redox－stratified ocean, similar to that of South China (Shields et al., 1997). Overturn or upward expansion of the deep water-mass probably reached the shallow marine zone after the formation of the Yurtus phosphorites (Mazumdar et al., 1999). The characteristics of the negative Ce anomaly may be due to phosphoritic inheritance from the Ce-depleted signature of the overlying water column. Subsequent hydrothermal inputs and reduced detrital supplies of the deep water caused by the upwelling affected certain redox sensitive elements in the sedimentary basin. $\delta^{13}C_{carb}$ and $\delta^{13}C_{org}$ negative excursions in the Yurtus chert－phosphorite unit may be related to a transgression phase when episodic basinal upwelling moved ^{12}C－and P－rich waters from the pelagic basin floor to the continental shelf (Yu et al.,2005). Multi－proxy geochemical studies indicated that the $\delta^{13}C_{carb}$ values of the Yurtus chert－phosphorite assemblages might be considered reflections of a predominantly suboxic environment that was subsequently affected by hydrothermal inputs due to the upwelling.

3.2 The origin of the sedimentary phosphorite

The Sugetbrak phosphorites have high Ba, Zn, As, Sb, Ni, and V contents, and high Ba/Sr, U/Th ratios, suggesting hydrothermal origin (Rona, 1987; Peter and Scott, 1988).The Suitable tectonic setting, sedimentary environment and rich phosphorite sources etc., were favorable for phosphorus deposition forming in the Yurtus Formation of the Akesu－Wushi area in the early Cambrian. The metallogenic materials of the phosphorus－bearing sequence in the Sugetbrak were mainly from seafloor hydrothermal, the upwelling oceanic current, and the biological occurrence (Liu et al.,2009; Brasier, 1992; Genn et al.,1994). To sum up, the phosphorite deposits in the Sugetbrak were formed under the alternation between the transgression and the regression, Akesu paleo－uplift margin tectonic setting, near shelf paleogeographic environment, rich phosphorite sources, and anoxic－suboxic sedimentary environment.

Acknowledgments

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