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Early Cambrian paleoclimate reconstruction in the Tarim Basin, NW China: Implications for hydrocarbon accumulation

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The Ediacaran-Cambrian transition is widely recognized as a pivotal interval in Earth's geological history. During this period, significant changes occurred in continental configuration, biological evolution, global climate, ocean geochemistry and redox conditions [1]. This study investigates the $\delta^{13}C$-$\delta^{18}O$-$^{87}Sr/^{86}Sr$ isotope geochemistry, major and trace elements (including REEs) of the lower Cambrian in the Tarim Basin to better understand the paleoenvironmental conditions and hydrothermal activity of the Tarim Block in early Cambrian (541-509 Ma).

We obtained continuous cutting samples from the Lower Cambrian strata of the Luntan-1 well and Zhonghan-1 well, located in the northern and central regions of the Tarim Basin, respectively. The samples were taken at 5-10 meter intervals with a total of over 100 cutting samples. The sampling was designed to cover the targeted Early Cambrian stratigraphic intervals encompassing the Yurtus Formation, the Xiaoerbrak Formation and the Wusonger Formation from bottom to top.

The $\delta^{13}C$ variations obtained in our study show four notable negative and three positive excursions, consistent with the global $\delta^{13}C$ record. By integrating the newly developed Tarim $\delta^{13}C$ and $^{87}Sr/^{86}Sr$ curves with existing paleontological evidence, we propose a stratigraphic correlation between the Tarim Basin and other paleo-continents [2] from the late Ediacaran to the middle Cambrian. Additionally, our paleoenvironmental reconstruction reveals regional and global sea-level changes, which may have influenced the influx of radiogenic Sr and the influx of nutrients that controlled primary production and the rate of organic carbon burial in the Tarim Basin during the deposition of the Yurtus Formation.

Based on major and trace element analysis, we have determined that the early Cambrian Yurtus Formation in the Tarim Basin underwent a transition from a humid to an arid climate during its deposition. Anoxic-sulfidic conditions characterized the lower portion of the formation, while the development of high-quality source rocks was controlled by a high productivity and excellent preservation conditions. Besides, during the deposition of the Xiaoerbrak and Wusonger Formations, surface seawater of the Tarim Basin appears to be in a state of weak reduction to weak oxidation.

[1] Wei et al. (2018) Geology 46 (7). 587-590.

[2]Zhu et al. (2017) Geological Magazine. 154. 1187-1192.