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# Lithofacies and depositional conditions of the Upper Ordovician -Lower Silurian mudstone successions in northwestern Guizhou of the Upper Yangtze area, China

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## Summary

The lack of high-resolution petrographic investigations of fine-grained mudstones makes a great challenge to decipher and predict rock properties for economic resource development. In this study, characterization for vertical lithofacies variability was undertaken on the Upper Ordovician Wufeng (WF) -Lower Silurian Longmaxi (LMX) successions in northwestern Guizhou, China, using mineralogical, inorganic and organic geochemical information, and various high-resolution images. Seven lithofacies were identified within the whole stratigraphic interval, and were further grouped to four facies associations to interpret the changing sedimentary environments. Widespread evidences suggest depositional conditions across the study region were variously influenced by a combination of Hirnantian glacio-eustasy and local tectonic-eustasy during the regional Kwangsian Orogeny. We thus have proposed a comprehensive model to account for depositional controls on facies variability in their mineral grain assemblage and organic matter accumulation. This study can provide a better understanding of sedimentology of the targeted interval for future profitable shale gas exploration.

## Method

Two continuous cores of well XK1 and XK2, covering the whole Upper Ordovician-Lower Silurian WF-LMX successions in northwestern Guizhou, China, were examined at high resolution by using an automated mineralogy tool called RoqSCAN, field emission scanning electron microscopy (FE-SEM), and other analytical tools. Integrated data of mineralogy, petrology, geochemistry and sedimentology was applied to characterize macro- and micro-scale heterogeneity in the composition, structure, and distribution of mudstone lithofacies across the WF-LMX successions, in northwestern Guizhou, south China.

## Results, Observations, Conclusions

Seven types of lithofacies were identified for the whole stratigraphic interval in both two wells, with varying mineral composition, inorganic and organic geochemistry, as well as the multiscale heterogeneity of sedimentary structure. By interpreting changes of facies associations, we argue that depositional conditions across the study region were variously influenced by a combination of Hirnantian glacio-eustasy and local tectonic-eustasy during the regional

Kwangsian Orogeny. We have also provided an important insight to the essential controls of depositional conditions on mineral grain assemblages and on quality and quantity of OM within the whole WF-LMX formations of the study area (Figure 1).

At the basal of WF-LMX Formations, the deep-siliceous shelf (FA-A) contains a high quantity of TOC, pyrite and biogenetic quartz, as well as minor detrital inputs, with the low Roq-GR and Th/U ratios, and are interpreted to deposit out of upwelling or suspension under a strongly anaerobic condition. The enrichment of OM in this FA was predominantly attributed to the high organic productivity, anaerobic watermass and minimum terrestrial dilution during a glacial retreat. The overlying middle-mixed shelf (FA-B) has minerals in a wide range of sizes and origins, and deposited out of bottom-current or storm-waves reworking during a fall of sea level caused by the regional tectonic uplift. The primary productivity was probably promoted by the enhanced volcanic ash because of the increasing convergence of the Yangtze and Cathaysia blocks. However, the moderate terrestrial inputs and relative aerobic conditions made organic matter difficult to accumulate and preserve at this stage. The OM-lean facies 1 partly interbedding with silty laminas, in the lower part of the ULMX Member, was a result of deposition from terrestrial suspension in a shallow muddy shelf (FA-C). A low concentration in OM in this FA was significantly attributed to the low organic productivity. While, the OM-lean faices 2 consists of the highest amounts of silt-size detrital grains, in the top of the ULMX Member, were largely influenced by tidal waves under a shallow silty shelf (FA-D). It is the least favorable facies for OM accumulation because of the strong oxygenated water column, and high detrital dilution caused by sea level fluctuation at this stage.

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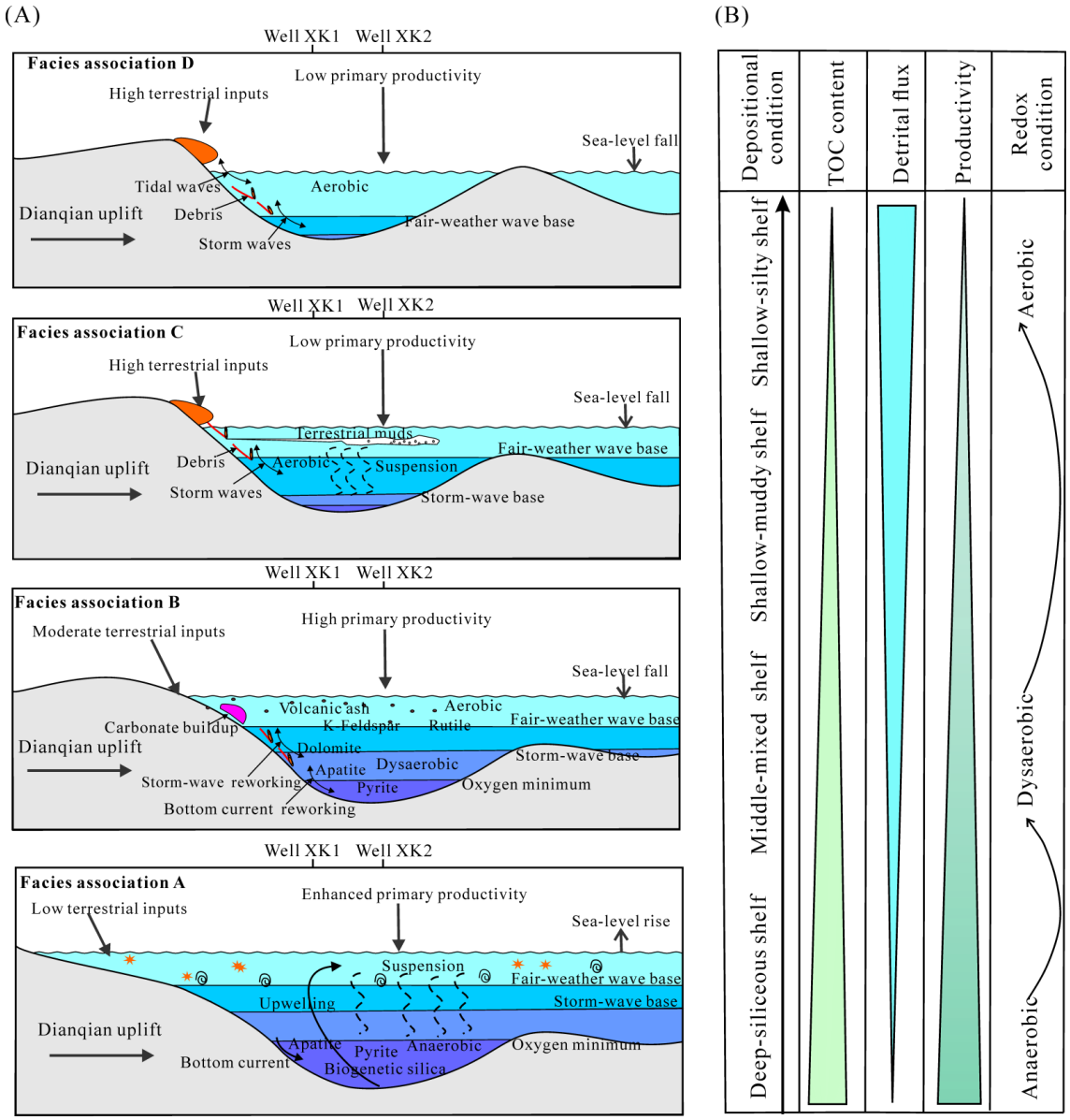


Figure 1 Generalized model for the WF-LMX Formations showing depositional profile and depositional process to account for the variability in terms of grain assemblages and OM accumulations, observed in well XK1 and XK2, in northwestern Guizhou of the Upper Yangtze area, China.