The Trace Element Characteristics of Shales from Upper Ordovician-Lower Silurian in Wuling Depression: Implication for Block Amalgamation Time and Tectonic Setting

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***Abstract*—The collision time of the Yangtze Block and the Cathaysia Block has been controversial for decades. This paper discusses the sedimentary provenance and tectonic setting through the analysis of the trace element characteristics. The study results suggests that the Yangtze Block and Cathaysia Block were still in collision between the Ordovician and Silurian.**

Keywords-Wuling depression; block; tectonic; trace element; shale

I. INTRODUCTION

The South China Block is composed of the Yangtze Block in the northwest and the Cathaysia Block in the southeast. However, the collision time of the Yangtze Block and the Cathaysia Block has been controversial for decades. A main view suggested that there was an ocean existed between the Yangtze Block and the Cathaysia Block for at least the latest Neoproterozoic to Cambrian period or even until the Jurassic before the two blocks get impacted. Another alternative view suggested that the amalgamation of the two blocks had been completed by the Neoproterozoic period [7].

Previous studies showed that the geochemical characteristics of shale could indicate of sedimentary provenance and tectonic setting [1-6,8]. In this paper, block amalgamation time and tectonic setting has been investigated through trace element and rare earth element of shale samples from Upper Ordovician Wufeng Formation and Lower Silurian Longmaxi Formation in Wuling depression.

II. DISCUSSION

A. *Sedimentary Provenance*

The Rare earth element (REE) distribution patterns of shale is commonly an indicator of provenance. The distribution pattern of REE in the Upper Crust was rich in Light rare earth element (LREE), diluted in Heavy rare earth element (HREE) and negative anomaly Eu [5-6].

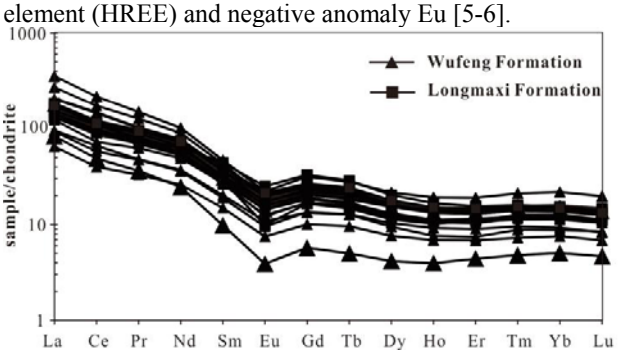

Figure 1. The REE distribution patterns of shale in study area (The chondrite-normalized data from Taylor and McLennan[6])

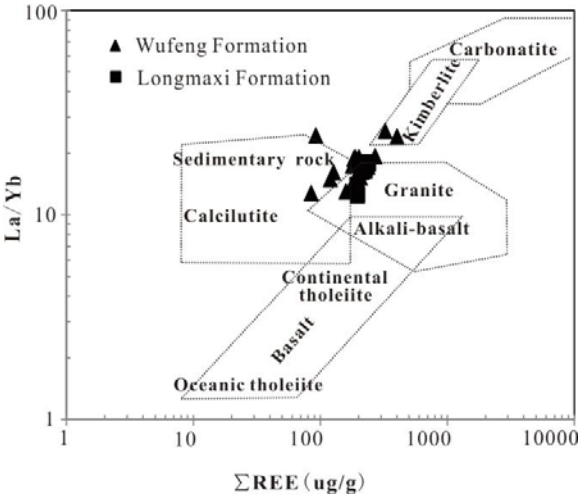

Figure 2. Discrimination diagram of ∑REE-La/Yb for provenance attribute of shale in study area (Modified according to Allegre[1])

As shown in Fig.1, the distribution pattern of the REE normalized to chondrite in Shale samples was akin to the Upper Crust, suggesting that the provenance was stable during the sedimentary process and the provenance was from the Upper Crust.

As shown in the Fig.2, the plots of rare earth elements (ΣREE) and La/Yb indicated the source rock was felsic provenance, mixed with more granite and a small amount of kimberlite. The discrimination diagram of Hf-La/Th and La/Sc-Co/Th could also analyze the provenance property. The diagram of Hf-La/Th also indicated of the felsic provenance (Fig.3a), as well as the Upper Crust. In addition, we could know that the felsic provenance might be accompanied with the intrusion of andesite and granite using the diagram of La/Sc-Co/Th (Fig.3b).

B. Tectonic Setting

The trace elements (such as Th, Sc, Zr etc.) could be frequently used to discriminate the tectonic setting of the sedimentary basin [2-3]. The plots of La-Th-Sc, Th-Sc-Zr/10, Th-Co-Zr/10 substantiated that the tectonic setting was the active continental margin area (Fig.4). The provenance is different from previous studies, besides, tectonic setting revealed that the Yangtze Block and the Cathaysia Block could still be in the colliding status during the Ordovician-Silurian period.

III. CONCLUSIONS

1. The source rock of Ordovician-Silurian shale was from the upper earth crust and mixed with more granite and few andesite, kimberlite, suggested shales were not derived from the clastic sediment from Ordovician Wufeng formation to Silurian Longmaxi formation.

2. The La-Th-Sc, Th-Sc-Zr and Th-Co-Zr discrimination diagram of shale indicated that the tectonic setting was mainly the active continental margin.

3. Through the analysis of the sedimentary provenance and tectonic setting, the Yangtze Block and Cathaysia Block were still in collision between the Ordovician and Silurian..

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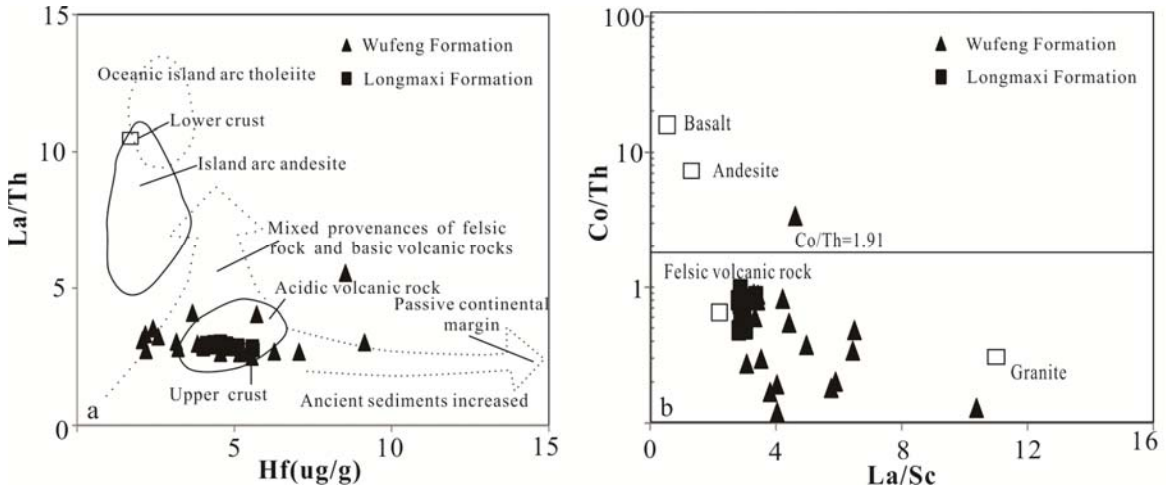

Figure 3. Discrimination diagram of Hf-La/Th and La/Sc-Co/Th for provenance attribute of shale in study area(a-Modified according to Floyd and Leveridge[4], b-Modified according to Wronliewicz and Condie[8])

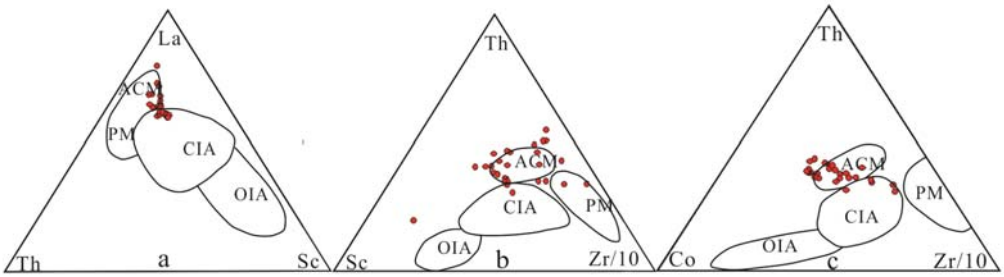

Figure 4. Discrimination diagram for tectonic setting of shale in study area(Modified according to Bhatia and Crook[2-3]).Tectonic setting: CIA continental island arc: OIA oceanic island arc: ACM active continental margin; PM passive continental margin