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Research paper

An integrated chemo-and sequence-stratigraphic framework of the Early Pennsylvanian deepwater outcrops near Kirby, Arkansas, USA, and its implications on remnant basin tectonics

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ABSTRACT

The Jackfork Group in Arkansas, U.S.A. is a major 'training ground' for academics, students, and petroleum industry geoscientists interested in deep water exploration and development. Several superb outcrop sections are exposed and over the years numerous papers have been published on these rocks. The Kirby sections in western Arkansas provide a unique opportunity to build a complete and continuous sequence stratigraphic framework for Early Pennsylvanian time in the ancient Ouachita Basin. There are 25 outcrops, including 12 roadcuts on Highway 27, and 13 measured sections in the Baumgartner Quarry. All the measurements and interpretations on the outcrops were integrated with previous work using modern concepts of deepwater turbidite geology, including (1) regional tectonic and sequence stratigraphic framework of the Stanley Group, Jackfork Group, and Johns Valley Shale in the Ouachita Basin, (2) deepwater outcrop characterization and correlation from the DeGray Lake Section, Dierks Section and Big Rock Quarry which are on the trend of the depositional fairway, (3) chemostrata data from key shale layers which are considered as potential correlative condensed sections.

Twenty-five key shale samples from Kirby, DeGray and Dierks sections have been tested using Inductively Coupled Plasma and Mass Spectrometry (ICP-MS) tests. An additional 525 samples were later collected for Handheld X-Ray Fluorescence (XRF) tests for both major and trace elements. Results of sequence and chemostrata analysis indicate that the entire Kirby sections consist of at least three 3rd order sequences from the bottom of the Jackfork Group to the middle of the Johns Valley Group, and over ten 4th order sequences caused by a combined effect of tectonic uplift, eustatic sea-level change, mixed sediment provenance and shifting of depositional fairways when the Ouachita Basin was transitioning from a passive margin to a remnant marine basin. Rare Earth and Trace Element results are compared with known tectonic data to further pinpoint the tectonic environment of the Ouachita Basin during early Pennsylvanian time, which is dominantly a continental arc setting.

1. Introduction

The ancient Ouachita Basin consists of 15,000 m of Carboniferous deepwater strata which covered an area of 246,592 km^2 from Little Rock, Arkansas to southeastern Oklahoma, U.S.A. The Early Pennsylvanian Jackfork Group in the Ouachita Mountains (Fig. 1) has been studied for over forty years. The outcrops display an excellent example of different types of turbidite deposits from updip slope facies tract to downdip basinal facies tract (Slatt et al., 2000a). The regional tectono-stratigraphic framework of the Jackfork Group in the Ouachita Mountains was described by Walthall (1967); Morris (1971); and Graham et al. (1975). Over the last two decades, various Jackfork outcrops (including roadcuts, rock quarry faces, lake spillways etc.) in the Ouachita Mountains region have been documented in detail. These studies have helped geoscientists to develop analogs for deepwater reservoir characterization and development (Jordan et al., 1991; Pauli, 1994; Al-Siyabi, 2000; Slatt et al., 2000a, 2000b; Omatsola and Slatt, 2003; Goyeneche et al., 2006; Shear, 2006; Duran, 2007; Schlichtemeier, 2011;

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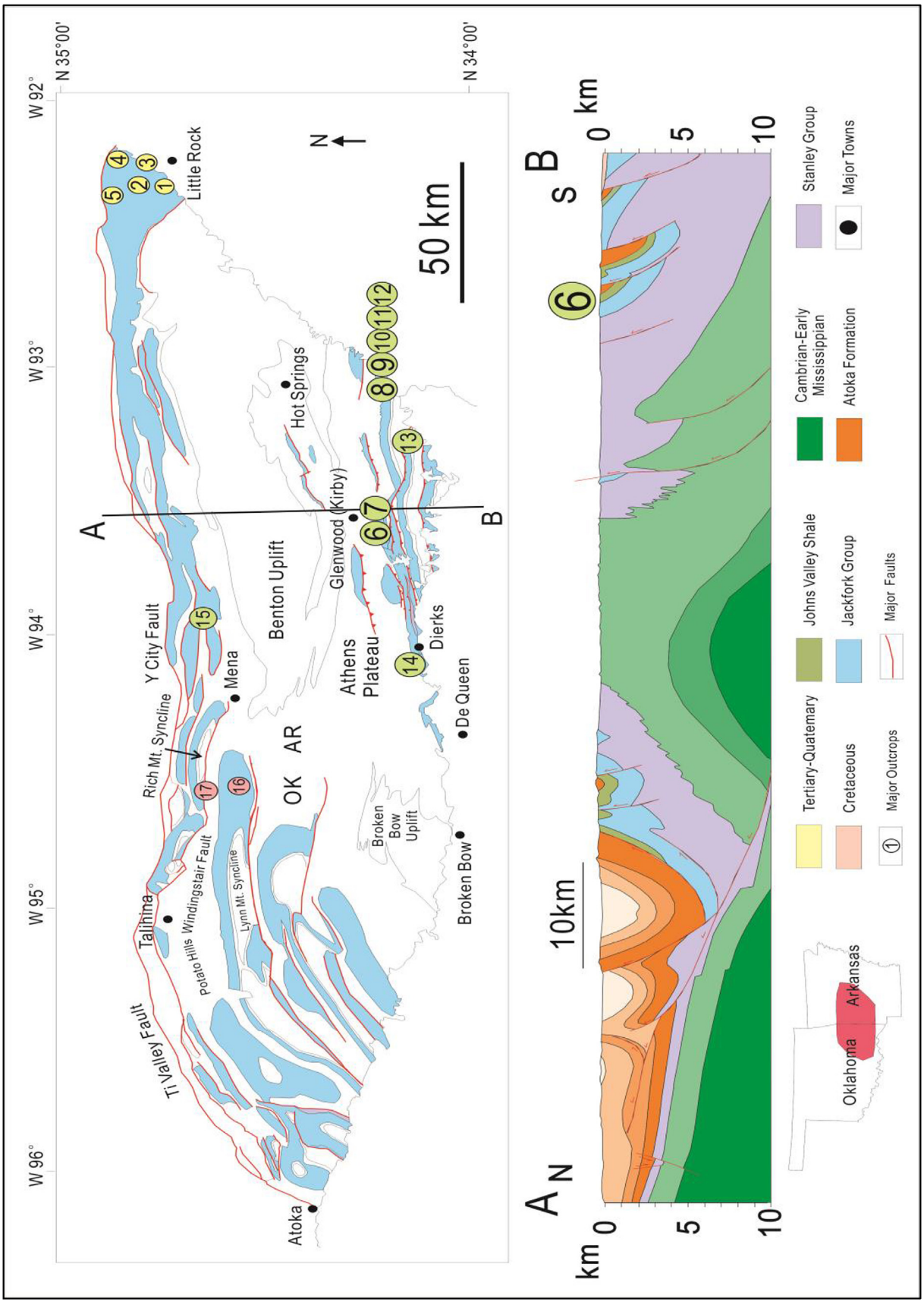

Fig. 1. Overview map of the Jackfork Group and the location of the key outcrops. The details of these outcrops are summarized in Table 1. The Kirby Section and Baumgartner Quarry are located in one of the imbricate thrust sheets of the Ouachita Fold and Thrust belt, west central Arkansas, USA.