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SUBSURFACE PENNSYLVANIAN COAL SAMPLES, LOWER ATOKA GROUP, FORT WORTH BASIN, WISE AND JACK COUNTIES, NORTH TEXAS: CORE SAMPLING FOR COAL-RANK DETERMINATION

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Subsurface Pennsylvanian Coal Samples, Lower Atoka Group, Fort Worth Basin, Wise and Jack Counties, North Texas: Core Sampling for Coal-Rank Determination

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Abstract

Tasks conducted at the Bureau of Economic Geology (BEG) during Fiscal Year (FY) 2006 for the National Coal Resources Data System State Cooperative Program (NCRDS project) involved sampling of deep (5,400–5,500 ft) subsurface bituminous coal beds from the Fort Worth Basin of North Texas. Identification of their precise stratigraphic position, geographic location, and general depositional setting was a primary objective. This study is one part of a program of sampling and characterization of Texas coals as part of BEG's continuing NCRDS project of coal inventory and investigation of U.S. bituminous coals as a coalbed methane resource.

Seven coal samples were collected from the whole cores of two wells in Boonsville field (Wise and Jack Counties), which produces mostly natural gas from the lower Atoka Group (Lower Pennsylvanian). Chronostratigraphic correlations throughout Wise and eastern Jack Counties show that the coal beds correspond to gamma-ray maxima capping retrogradational intervals above thicker progradational sections and are interpreted to represent maximum flooding surfaces within continental deposits of fourth-order transgressive systems tracts. These flooding surfaces can be correlated throughout Wise and eastern Jack Counties. The sampled coal beds in the Oxy Tarrant #A-4 well are inferred to represent peat-swamp deposits that mark the abandonment of a broad braided-river (braidplain) system. The distribution of mapped primary channel and interchannel areas offers an approximation of the total extent of coal beds within this genetic interval. In contrast, the sampled coals in the EP Operating Tarrant WB #3 well were deposited within a fourth-order transgressive succession deposited above proximal delta-front sandstones.

Introduction

This report summarizes the activities carried out by the Bureau of Economic Geology (BEG) during Fiscal Year (FY) 2006 for the National Coal Resources Data System State Cooperative Program (NCRDS project). Activities were primarily collection of Lower Pennsylvanian coal samples from whole cores of two wells in Wise and Jack Counties, North Texas (fig. 1), for coal-rank (vitrinite-reflectance [R_o]) analysis by the USGS. Other study activities included identification of the sampled coals' precise geographic location and their stratigraphic position and analysis of their general depositional setting. The objective of this report is continuation of BEG's sampling and data compilation of coals from Texas reported by Kim (2003), Guevara and Sakurai (2005), and Guevara and Breton (2006). Our FY 2006 study addresses the ongoing effort to ascertain the geographic and stratigraphic location of coal resources in Texas. In a departure from these previous BEG reports on Texas coals from the shallow subsurface (depths <2,000 ft), we herein discuss coals sampled from the deeper subsurface (depths 5,400–5,500 ft).

Study Area

A total of seven samples of bituminous coal were collected from whole cores of two natural gas wells located in Boonsville field, which encompasses all of Wise County and most of Jack County (fig. 1). Boonsville is a mature field that produces oil and gas from the lower Atoka siliciclastics ("Bend Conglomerate") of the Fort Worth Basin, North Texas. The two cored wells are the EP Operating Tarrant WB #3 and the Oxy Tarrant #A-4, which are located in west-central Wise County and extreme east-central Jack County, respectively (fig. 2). Both cores are stored at BEG's Austin Core Research Center. The precise geographic locations of these wells and specific well data, core data, and coal thicknesses were plotted and annotated on a GIS (ArcView) map of the two counties, which is included with this report on a CD-ROM.

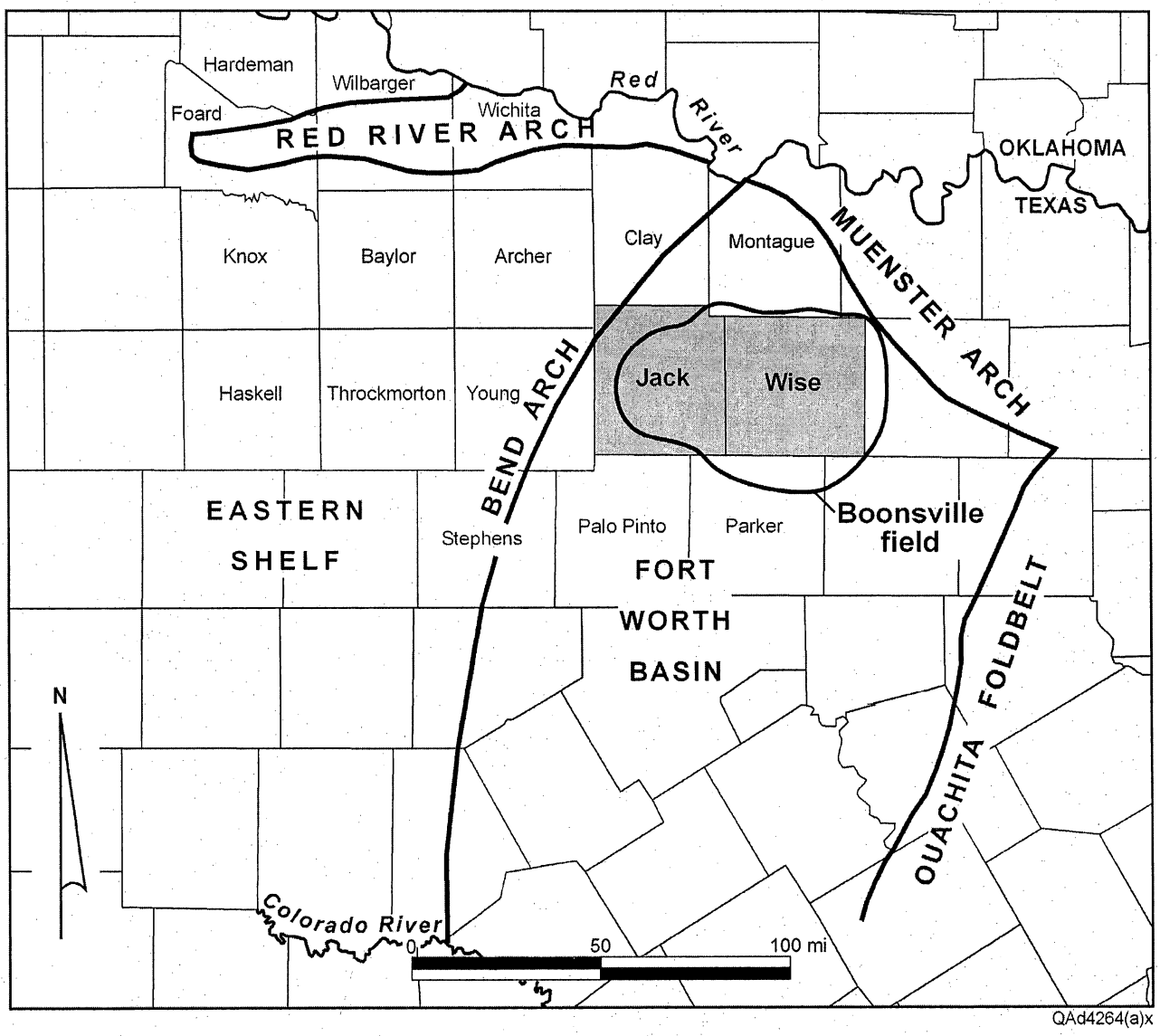

Figure 1. Regional map of the Fort Worth Basin, North Texas.

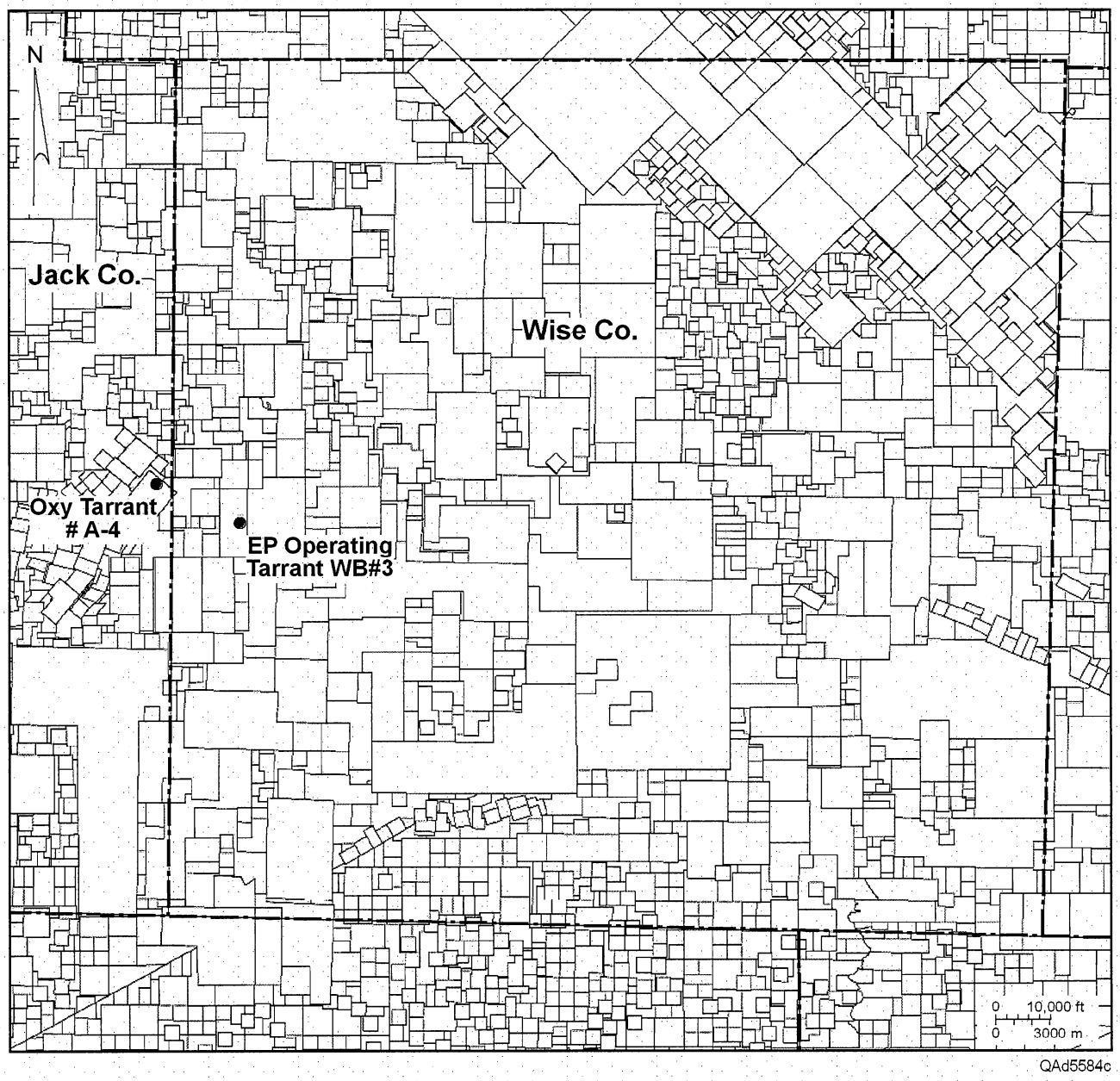

Figure 2. Location map of the two cored wells from which coal samples were taken. Precise geographic locations of these wells and specific well data, core data, and coal thicknesses are annotated in ArcView on a CD-ROM accompanying this report.

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Previous Studies

The presence of coal within the lower Atokan succession is poorly described in the literature, presumably because most existing studies are (1) regional studies in scope and based primarily on broad-scale well log correlation, with little or no core or sample analysis, or (2) field studies that focus on the sandy reservoir facies (e.g., Lahti and Huber, 1982; Thompson, 1982). However, Hardage and others (1995) documented "coaly mudstones" capping the tops of cyclic, progradational/retrogradational successions subregionally within the lower Atoka in Boonsville field. They interpreted these coaly "marsh/swamp" deposits as recording high-order flooding events in nearshore marine and fluvial-deltaic environments.

(3) the thin coals are generally below the vertical resolution capabilities of typical downhole log suites.

Stratigraphy and Depositional Facies

Bituminous coal sampled from the two cores occurs in the lower Atoka Group, which was deposited in the Fort Worth Basin, a late Paleozoic foreland basin that formed during the Early to Middle Pennsylvanian Period in response to tectonic stresses related to formation of the Ouachita Foldbelt (fig. 1). The thick, coal-bearing, continental and shallow-marine facies of the Atoka Group were deposited during the primarily westward progradation of siliciclastic sediments derived from both the Ouachita highlands and locally from the Muenster Arch (Thompson, 1982). Pronounced downwarping and concomitant influx of abundant sediments produced a thick Atokan succession (as much as 2,500 ft) in the basin.

The Lower to Middle Pennsylvanian Atoka Group lies stratigraphically ~~between~~ above the Lower Pennsylvanian Marble Falls Limestone ~~and~~ below the Middle Pennsylvanian Strawn Group (figs. 3 and 4). The Barnett, which comprises organic-rich black ~~shale~~ mudstone and is currently a major gas-producing reservoir, and the lower Atoka successions are the principal reservoir-bearing zones in the Fort Worth Basin.

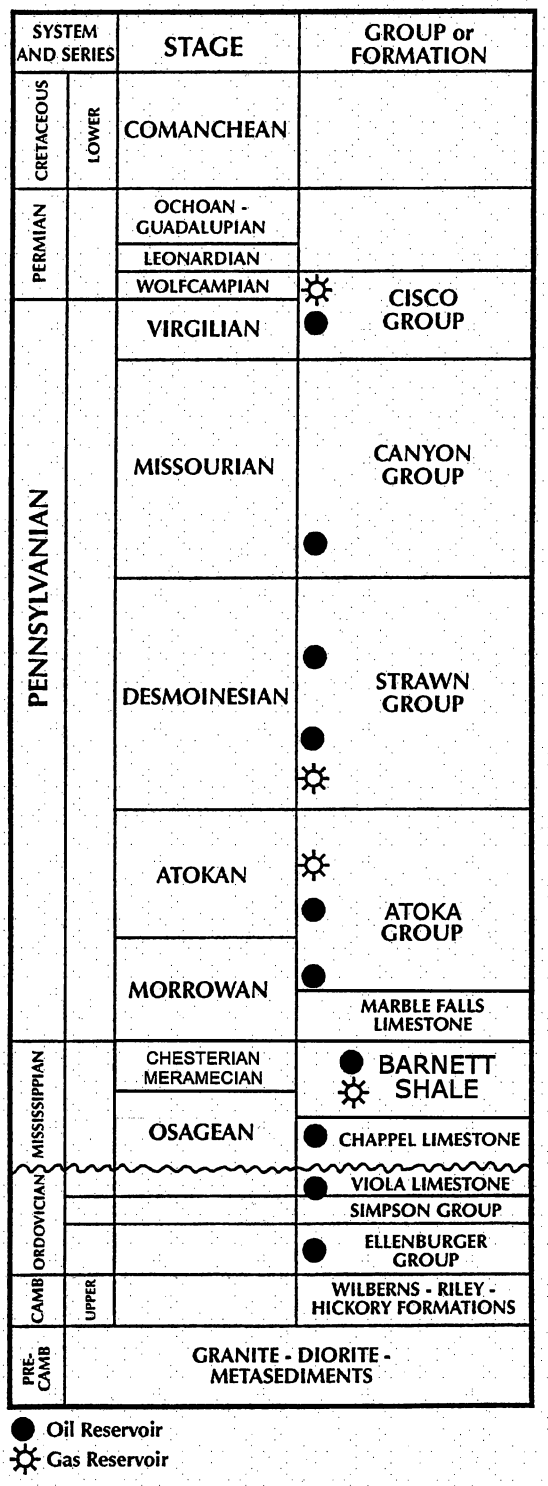

Figure 3. Stratigraphic column of the Fort Worth Basin. Modified from Montgomery (2004).

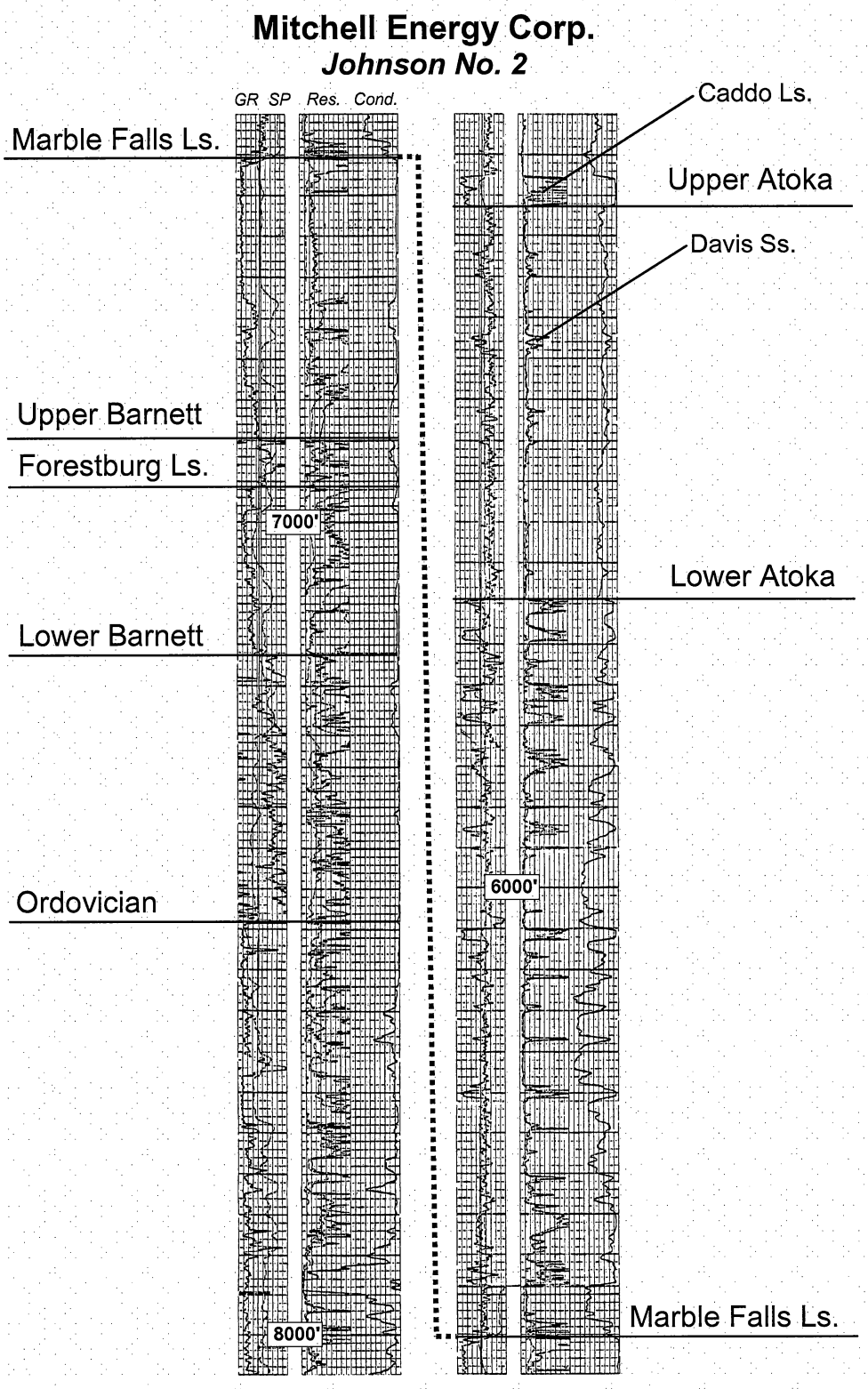

Figure 4. Representative wireline log of the study interval (Mitchell Energy Corp., Johnson No. 2, central Wise County). Correlation lines represent the tops of the identified stratigraphic successions.

Precise chronostratigraphic positions of the sampled coals within the lower Atoka Group can be identified on the basis of the work of Hentz and others (2005). In their study, correlation horizons within the succession correspond to gamma-ray maxima, typically capping upward-fining (retrogradational) intervals above thicker, upward-coarsening progradational sections (fig. 5) and are interpreted to represent maximum flooding surfaces (FS) within continental deposits of fourth-order transgressive systems tracts (TST's). These flooding surfaces can be correlated throughout Wise and eastern Jack Counties. The lower Atoka interval that was studied extends from FS_4 to FS_15, within which 12 flooding surfaces bound 11 mostly fourth-order (reservoir-scale) genetic cycles.

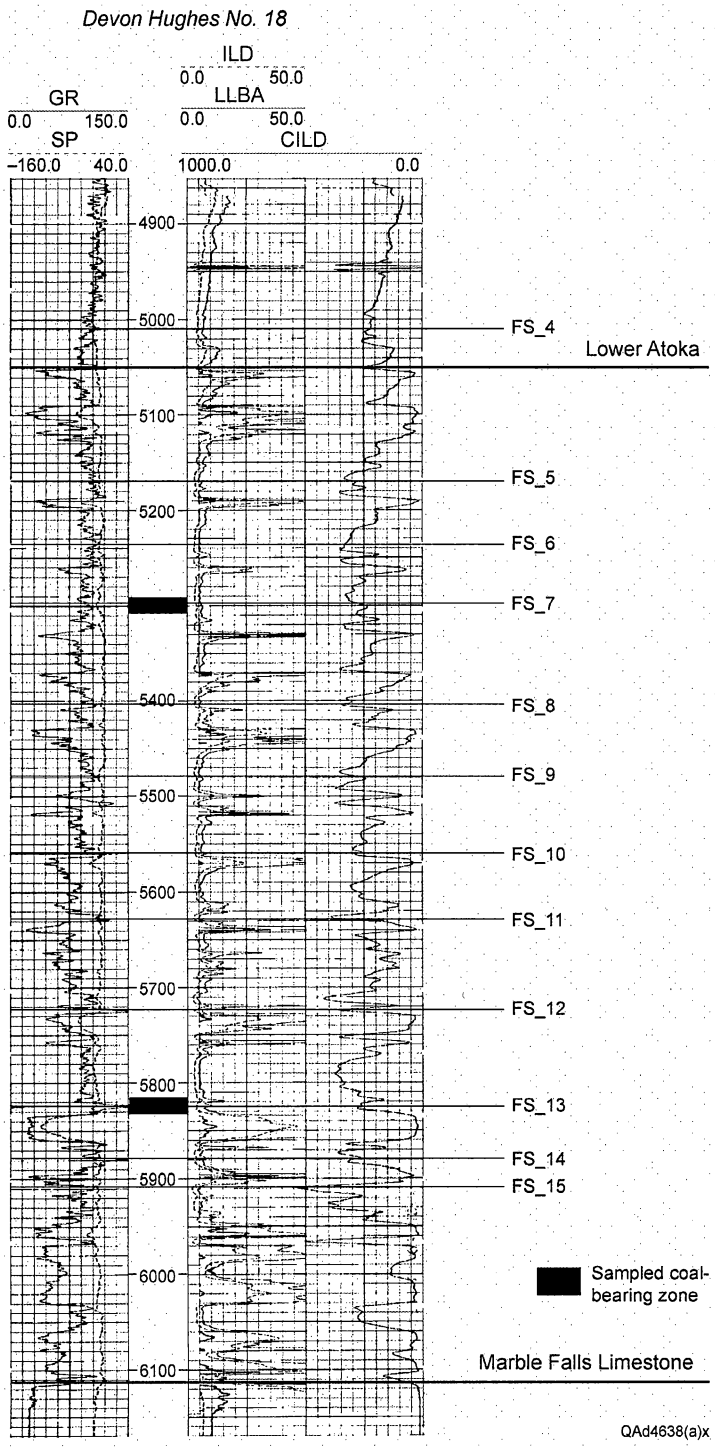

Figure 5. Representative wireline log showing flooding surfaces (FS) correlated throughout Wise and eastern Jack Counties. Stratigraphic positions of the two coal-bearing zones from which samples were collected are shown. Ref: Heitz + others 2005

The sampled coal-bearing intervals coincide with FS_13 and FS_7 within this chronostratigraphic scheme (figs. 5, 6, and 7). The two coal beds in the EP Operating Tarrant WB #3 well are both ~1 ft thick; in the Oxy Tarrant #A-4 well the two beds are 0.5 and 2.0 ft thick. As Hardage and others (1995) surmised, these zones of closely spaced coal beds in the two wells each record episodes of regional relative sea-level (base-level) rise during late Morrowan and early Atokan time (fig. 3). Strata recording some of the other flooding events in the lower Atoka succession (fig. 5) may at least partly also comprise coal and/or carbonaceous shale, although they probably consist of only marine shales.

The coal beds of FS_13 in the Oxy Tarrant #A-4 well (fig. 6) are inferred to represent peat-swamp deposits that mark the abandonment of a broad (2- to ≥4-mi-wide) braided-river (braidplain) system that existed in west-central and southern Wise County and in east-central Jack County (fig. 8). Distal delta-front shales, siltstones, and very fine sandstones above the coal beds mark the inception of deltaic sedimentation at the base of the subsequent progradational cycle. The distribution of primary channel and interchannel areas depicted in figure 8 offers an inferred approximation of the total extent of coal beds within the FS-13 to FS_14 genetic interval. However, stratigraphic relations between coals and the framework facies in braided-river settings (sandstones, conglomerates) are notoriously complex (e.g., Pérez-Arlucea and Smith, 1999), as they are in deltaic and other fluvial settings. More subsurface data are obviously needed to more accurately define the coal-bed distribution in this interval.

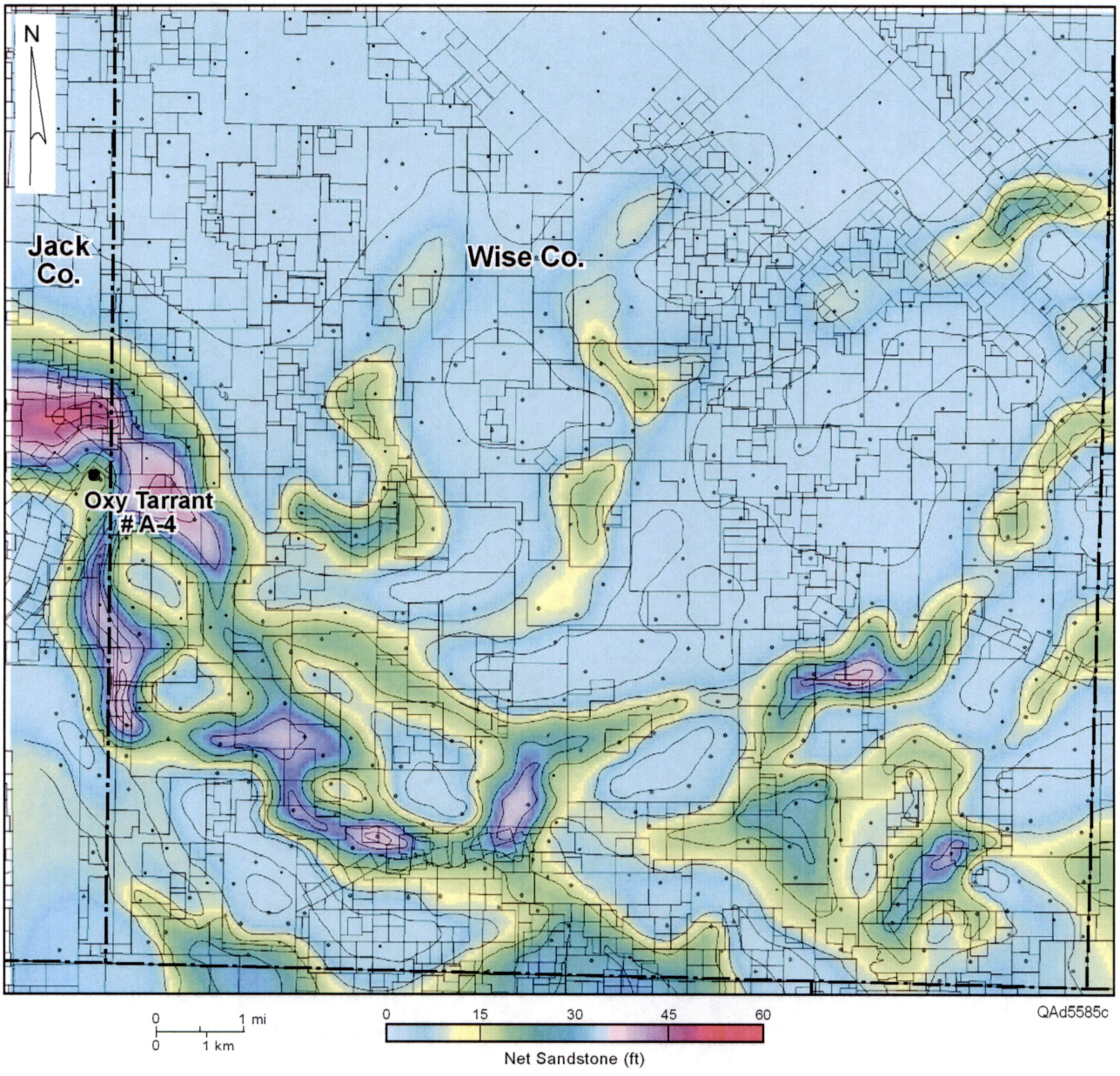

Figure 8. Net-sandstone map of the FS_13 to FS_14 genetic interval, showing anastomosing channels of a braided-river system sourced from the Ouachita Foldbelt and secondarily from the Muenster Arch. Coal beds overlie the channel fill in the Oxy Tarrant #A-4 core (fig. 6). Coal distribution may at least partly coincide with that of the channel and interchannel areas.

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In contrast, the coaly zone of the FS_7 to FS_8 genetic interval in the EP Operating Tarrant WB #3 well (fig. 7) is inferred to have been deposited within a fourth-order transgressive succession deposited above proximal delta-front sandstones. Because FS_7 can be correlated regionally, flooding of the delta was primarily a result of regional base-level rise, not local delta-lobe avulsion. The coal beds are overlain by dark-gray prodelta shales at the base of the subsequent deltaic progradational cycle.

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