PETROLOGY AND DIAGENESIS OF DEEP-WATER SANDSTONES, OUACHITA MOUNTAINS, ARKANSAS AND OKLAHOMA

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ABSTRACT

The Stanley and Jackfork Groups of the Ouachita Mountains consist of 18,000 feet of interbedded sandstones and shales deposited during the Late Mississippian and Early Pennsylvanian. Interest in their hydrocarbon potential has led to study of textures, compositions, and diagenetic alterations of these sandstones. The data and conclusions presented in this study are based on petrographic examination and porosity and permeability measurements of 187 samples collected from outcrop.

The Stanley sandstones are generally poorly sorted, very fine-grained feldspathic and quartz wackes. They average 8% feldspar, 14% matrix, and 5% silica cement. Porosities range from 0.5–26% and permeabilities from 0.05–23 md.

Jackfork sandstones are predominantly moderately to poorly sorted, fine- to very fine-grained quartz arenites. They contain an average of 2% feldspar, 5% matrix, and 9% quartz cement. Porosities range from 0.5–14% and permeabilities from 0.05–9 md.

Pressure solution, silica cementation, and replacement of plagioclase by calcite have acted to reduce reservoir potential in both units, whereas corrosion and dissolution of framework grains have added secondary porosity. The presence of halloysite and kaolinite characterizes sandstones affected by surface leaching. Well sorted quartz arenites have poor reservoir quality as a result of extensive silica cementation. Characteristics associated with the retention or secondary development of reservoir potential include poor sorting, small mean grain sizes, and high matrix content.

INTRODUCTION

The Ouachita Mountains of Oklahoma and Arkansas (Fig. 1) are formed by a thick succession of folded and faulted strata that constitutes one of the thicker Paleozoic depocenters of North America. The rocks of this sinuous 200 mile-long complex are collectively termed the Ouachita Facies (Cline, 1970; Morris, 1974a). These rocks contain all the essentials of an ancient slope/rise/deep-sea fan/abyssal plain system. Studies of approximately 30 partial or complete stratigraphic sections by the senior author have led him to the conclusion that a south-facing muddy slope and rise system dominated by soft-sediment sliding and slumping apparently interfingered with one or more westward-building deep-sea fans. The resulting sedimentary succession of thick shales which can act as both source rocks and reservoir seals, and interbedded sandstones to serve as reservoirs, offers the basic elements for hydrocarbon generation and entrapment.

This study focuses on the textural and compositional character of surface samples of the Carboniferous Stanley-Jackfork sandstones. Our purpose is to describe and compare the pertinent textures, compositions, porosities, permeabilities, and facies of these sandstones, to highlight the principal diagenetic alterations, and to speculate on the controls of diagenesis. Although dry gas has been produced from some Carboniferous reservoirs in the study area, most of the two dozen exploration wells have encountered Stanley-Jackfork sandstones which are too impermeable or "tight" to produce economically. We feel that the degree of diagenetic alteration controls the distribution of the favorable reservoir sandstones. The intensity of diagenesis in turn is controlled by degree of tectonism, original texture and composition, and chemistry of pore waters.

STRATIGRAPHY

The Paleozoic strata in the Ouachita Mountains form a thick, deep-water succession of sedimentary rocks (Briggs, 1973; Cline, 1970; Morris, 1974a, 1974b; Seely, 1963). The Carboniferous portion of the flysch sequence is made up of interbedded sandstones and shales of the Stanley and Jackfork Groups.

The Stanley Group comprises most of the Mississippian section of the Ouachitas (Morris, 1974b). It attains a thickness in excess of 11,000 feet (Cline, 1960). By using a number of telescoping stratigraphic sections taken from outcrops, we have constructed a simplified isopach map (Fig. 2) of the entire Stanley. The most obvious trend is that the unit thins across the overthrust...