Petrography of Morrow Sandstones in Southeast Colorado, Southwest Kansas and Northwest Oklahoma

by Kathleen Rader

Consulting Geologist, Denver, Colorado

ABSTRACT

Morrow sandstones in the study area are predominantly quartz arenites with silica and ferroan dolomite as the major cements. Secondary porosity is present in many of the reservoir sandstones and most production is associated with coarse-grained, cross-bedded sandstones.

Compaction of sediments and formation of silica cement took place from Morrowan time through the early Mesozoic. During the Triassic and Jurassic, burial stopped and carbonate cement replaced unstable grains. Subsidence resumed in the Cretaceous and ended with the Laramide Orogeny. The carbonate cement was removed during hydrocarbon maturation and migration leaving secondary pores. Ferroan dolomite and kaolinite formed in conjunction with hydrocarbon migration and emplacement.

Morrow sandstones were probably derived from the Transcontinental Arch and local highs. The Apishapa Uplift contributed sediments in the very southern part of the study area. Volcanic rock fragments are of unknown origin.

INTRODUCTION

This paper is based on the petrographic work completed for the RPI, International, 1988 regional study of the Morrow Series in the Las Animas Arch region. A total of 395 thin sections from 54 wells were examined (Fig. 1). Thin sections, made from core stored by the USGS and proprietary core belonging to Union Pacific Resources Company and Amoco Production Company, were impregnated with blue epoxy and stained for both potassium feldspar and various carbonates. Most of the thin sections borrowed from the Kansas Geologic Survey (KGS) and the USGS also had blue epoxy, but many were not stained. Each sample was examined using a petrographic microscope and estimates of component abundance were tabulated.

COMPOSITION OF SANDSTONES

Most of the sandstones examined are quartz arenites (Fig. 2). The fine-grained samples contain predominantly monocrystalline or "common" quartz as defined by Folk (1974). Coarse-grained samples contain both monocrystalline quartz and composite quartz. Authigenic quartz overgrowths are present on the majority of the quartz grains, recycled or abraded overgrowths were observed on a few grains.

Sodium plagioclase is the dominant feldspar although some potassium feldspar is present. Feldspars show a wide array of alterations including: albitionization; alteration to chlorite, kaolinite, barite and carbonate cement; and partial to complete dissolution. Some feldspars, particularly those from Oklahoma, appear to have undergone appreciable weathering prior to deposition, as noted by the abundance of vacuoles.

Rock fragments tend to be a minor constituent of the sandstones and include plutonic, metamorphic, and sedimentary (siltstone and shale) rock fragments; chert; mica; and accessory minerals (tourmaline, biotite, hornblende). Some samples from Kansas, the southernmost part of Colorado and Oklahoma contain volcanic rock fragments that are composed of plagioclase crystals in a microcrystalline matrix.

Grains that were introduced by the environment of deposition are present in many samples. These components include skeletal debris, phosphatic fossil fragments and pellets in marine-associated sediments; glauconite as discrete pellets in marine- and estuarine-influenced sandstones; and carbonaceous debris associated with fluvial environments.

Clay matrix was observed in some samples. It is the result of: 1) mechanical infiltration and incorporation by burrowing organisms; 2) deformation of soft clay-rich grains; or 3) the early stage of diagenesis. X-ray diffraction data indicates that these are dominantly chloritic clays, but some samples also contain smectite, other mixed-layer clays and illite.

Patches of pore-filling authigenic kaolinite are present in many of the more porous sandstones. Authigenic chlorite occurs as a feldspar alteration product and as clay rims on glauconite and other grains.

Quartz overgrowths and ferroan dolomite are the major cements (Fig. 3A). Other carbonate cements include calcite, dolomite, and siderite. Minor amounts of pyrite are present in many samples, with a few having apprecia-