Hammes, Ursula and Gale, Julia, 2013, Introduction, *in* U. Hammes and J.F.W. Gale, eds., Geology of the Haynesville Gas Shale in East Texas and West Louisiana, U.S.A.: AAPG Memoir 105, p. 1–4.

1

Introduction

Ursula Hammes and Julia Gale

Bureau of Economic Geology, The University of Texas, 10100 Burnet Rd., Bldg. 130, Austin, Texas 78758, U.S.A. (e-mails: ursula.hammes@beg.utexas.edu; julia.gale@beg.utexas.edu).

INTRODUCTION

We present a wide-ranging AAPG Memoir on the geology, geochemistry, petrophysics, and engineering of the Upper Jurassic Haynesville Shale. Eleven papers were solicited from experts in government, industry, and academe to contribute a variety of topics that describe the Haynesville Shale from basin- to nanoscale, reflecting the dimensions affecting shale-gas assessment and demonstrating the variety of techniques applicable to shale-gas evaluation. This memoir is therefore not only an analysis of the East Texas Shale Basin, but also an example of approaches to evaluating shale basins worldwide. We provide a short overview of the Haynesville Formation and East Texas Basin, followed by a synopsis of papers included in the memoir.

OVERVIEW OF GEOLOGY AND PRODUCTION

The Kimmeridgian Haynesville Shale spans more than 16 counties along the boundary of eastern Texas and western Louisiana (Fig. 1). Basement structures and salt movement influenced carbonate and siliciclastic sedimentation associated with the opening of the Gulf of Mexico. The Haynesville Shale is an organic- and carbonate-rich mudrock that was deposited in a deep, partly euxinic and anoxic basin during Kimmeridgian to early Tithonian time, related to a second-order transgression that deposited organic-rich black shales worldwide. The Haynesville Basin was surrounded by carbonate shelves of the Smackover and Haynesville lime Louark sequence in the north and west. Several rivers supplied sand and mud from the northwest, north, and northeast into the basin. Haynesville mudrocks contain a spectrum of facies, ranging from bioturbated, calcareous mudstone; laminated, calcareous mudstone; and silty, peloidal, siliceous mudstone to unlaminated, siliceous, organic-rich mudstone (Hammes and Frébourg, 2012). Framboidal to colloidal pyrite is variably present in the form of concretions, laminae, and individual framboids and replaces calcite cement and mollusk shells (Hammes et al., 2011). Haynesville reservoirs are characterized by overpressuring, porosity averaging 8 to 12%, S_w of 20 to 30%, nanodarcy permeabilities, reservoir thickness of 200 to 300 ft (70–100 m), and initial production ranging from 3 to 30 MMcfe/day. Reservoir depth ranges from 9000 to 14,000 ft (3000–4700 m), and lateral drilling distances are 3000 to 5000 ft (1000–1700 m) (Wang and Hammes, 2010).

In the beginning of 2013, the Haynesville Shale gas field surpassed 7 Tcf of gas in production, making it one of the most prolific shale-gas fields in the world (Fig. 2). The most prolific wells had a peak month daily average of 13.3 MMcf of gas per day (RRC, 2012). The reservoir pressure is about 10,000 psi, with geopressured gradients ranging from 0.7 to 0.95 psi/ft, resulting in steeper decline curves (~80% in the first year) than other shale-gas plays. The high pressure gradient

DOI:10.1306/13441841M1053596

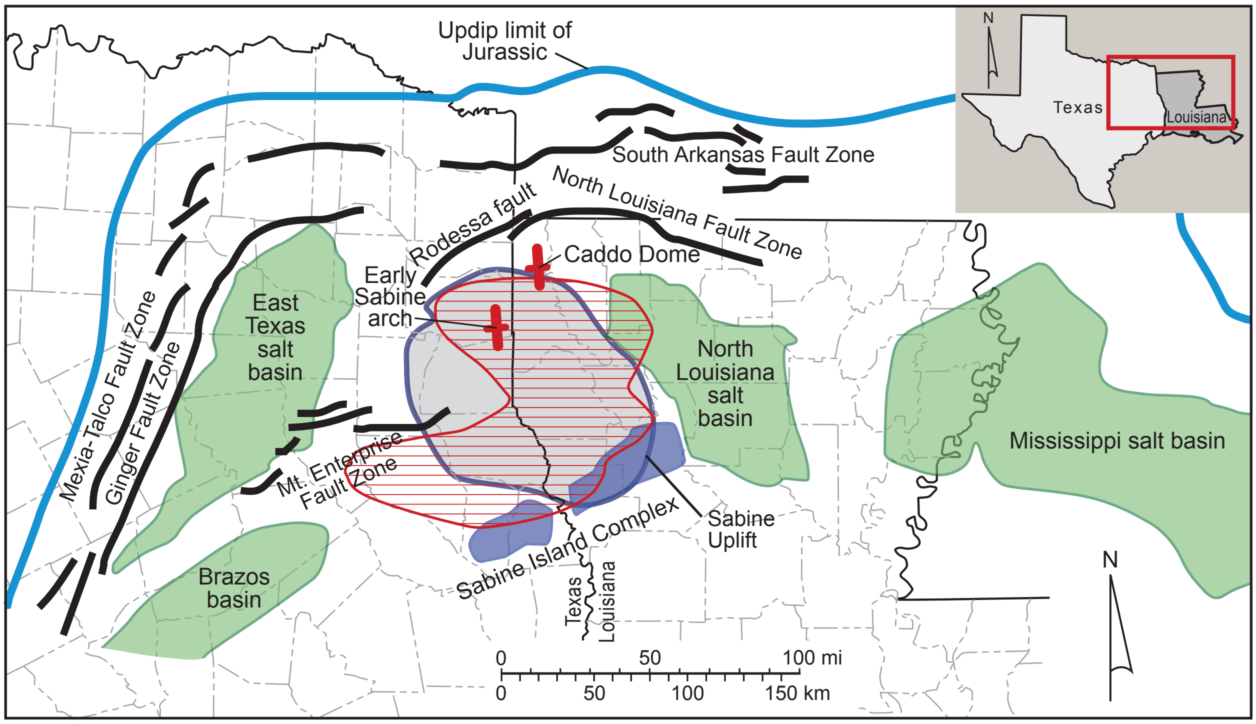

Figure 1. Map of study area in East Texas and West Louisiana showing Late Jurassic structural elements and the Haynesville Shale productive area (red striped area). Structures were controlled by the opening of the early Gulf of Mexico basin that controlled Haynesville deposition. Areas in green are basins, and areas in blue and red crosses are highs. Reprinted by permission of AAPG. From Hammes et al. (2011).

increases porosity, permeability, and free-gas content while reducing effective stress. As a result of high reservoir pressure, free-gas content is doubly increased through increases in porosity and gas density (Wang and Hammes, 2010). Several companies operating in the Haynesville have been choking back new wells in an attempt to preserve fracture conductivity and reservoir permeability. This activity results in lower initial gas rates but could translate into significantly higher ultimate recoveries per well if the technique proves successful over the long term. The optimal range of choke size is from 14/64 to 22/64 of an inch, and the optimal range of fracture stages is from 12 to 16 (Wang and Hammes, 2010). Drilling and completion costs range from $6 to $9 million per well; completion typically includes 12 to 15 fracture stages stimulated using slickwater and either ceramic or resin-coated proppant.

STRUCTURE OF THE PUBLICATION

The intent of this volume is to integrate multiple aspects of the Haynesville shale-gas play, including geology, geophysics, reservoir engineering, drilling and completion, and geochemistry. As such, this volume provides an integrated view of a prolific shale-gas system.

Chapter 2 by Eoff provides a general overview of controls on self-sourced shales using paleotectonics, paleogeography, and eustasy, titled "Shale Hydrocarbon Reservoirs: Tectonics and Paleogeography." This paper establishes the general setting of the Haynesville Formation in contrast to that of other shale basins, as well as the fundamental controls on preservation of organic matter and organic productivity.

Chapter 3 by Cicero and Steinhoff, titled "Sequence Stratigraphy and Depositional Environments of the Haynesville and Bossier Shales, East Texas and West Louisiana," provides the necessary detailed sequence stratigraphic framework and depositional environments of the Haynesville Basin.

Frébourg and Ruppel's analysis of mass-wasting processes along the Gilmer Platform describes the sedimentology along the slope of the Haynesville Basin. Their paper is titled "Sedimentology of the Haynesville (Upper Kimmeridgian) and Bossier (Tithonian) Formations, in the Western Haynesville Basin, Texas, USA."

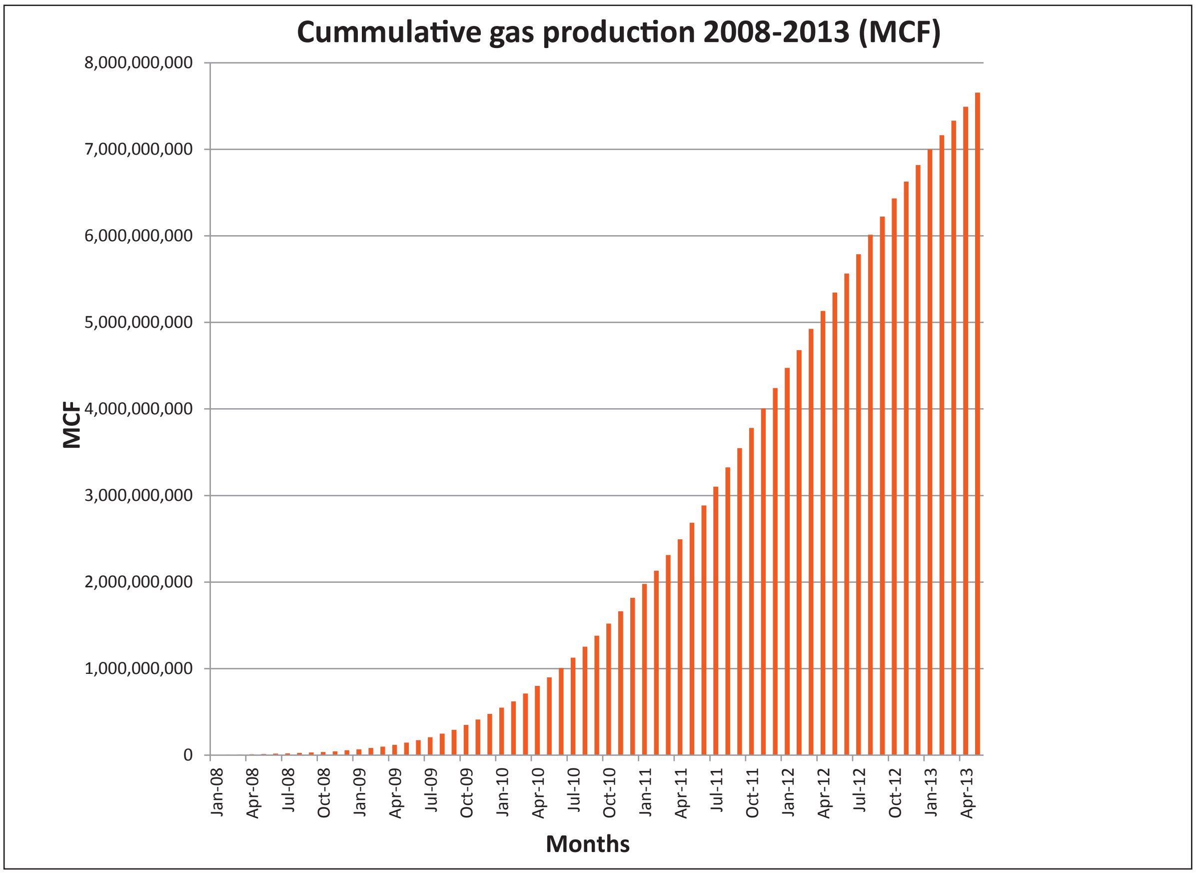

Figure 2. Cumulative production chart (Mcf) for Haynesville Shale. Data generated from IHS Enerdeq.

The Upper Jurassic biostratigraphy, using nannofossils from research on D.S.D.P. Site 534, has been applied to the East Texas Basin. The paper by Bergen, Boesiger, and Pospichal, titled "Low-Latitude Oxfordian to Early Berriasian Nannofossil Biostratigraphy and Its Application to the Subsurface of eastern Texas," includes the discovery of two new Kimmeridgian species.

The combined stratigraphic record of nannofossils, foraminifera, ammonites, and radiolarians in the Upper Jurassic and Lower Cretaceous in the East Texas Basin are described by Staerker, Thompson, Cantu-Chapa, and Pujana in "Biostratigraphic Correlation and Biofacies of the Haynesville Shale and Bossier Shale in east Texas and western Louisiana."

The chemostratigraphy, stratigraphic variations in inorganic chemistry, and defining zones of anoxia in the Haynesville Shale Basin are addressed by Sano, Spain, and Ratcliffe in "Chemostratigraphy of the Haynesville Shale."

Wang, Hammes, and Li investigated the effects of petrophysical, geochemical, geologic, mechanical, and engineering properties, as well as completion practices on production of the Haynesville Shale in "Overview of Haynesville Shale Properties and Production."

Sondergeld, Rai, and Curtis describe nanopores in shale intervals of Haynesville and other shales relative to kerogen maturity, lithology, microstructure, and pressure dependency of anisotropy in their paper titled "Microstructure and Anisotropy in Gas Shales."

Spikes and Jiang modeled elastic properties of the Haynesville Shale by relating reservoir properties such as porosity, pore shape, and composition to elastic properties in "Rock Physics Relationships between Elastic and Reservoir Properties in the Haynesville Shale." Results of this rock physics model could be used in conjunction with seismic data to identify sweet spots that have higher organic content or more fractures.

Microseismicity is an important and widely used tool in monitoring the extent of hydraulic-fracture stimulations in gas shales. Duncan, Smith, Smith, Barker, Williams-Stroud, and Eisner elaborated on this topic in "Microseismic Monitoring in Early Haynesville Development." They discuss problems associated with applying the technique in the Haynesville and describe how they surmounted these difficulties. They summarize the key findings of the monitoring work and explain how these were used to enhance development of the play.

ACKNOWLEDGMENTS

We are grateful for Terri Olson, EOG, for soliciting the memoir on the Haynesville Shale geology, and to Colin North, the current AAPG Book Editor, for continuing encouragement. We would like to thank the reviewers of the different manuscripts for their hard and diligent work, and all the contributing authors for making this volume come to fruition. We also thank the AAPG publication staff, Beverly Molyneux and Kelsy Taylor. Many thanks for the support for editing this volume from the STARR and MSRL projects at the Bureau of Economic Geology to Ursula Hammes, the FRAC project to Julia Gale, and to the Director of the Bureau of Economic Geology.

REFERENCES CITED

Hammes, U., and G. Frébourg, 2012, Haynesville and Bossier mudrocks: A facies and sequence stratigraphic investigation, East Texas and Louisiana, USA: Marine and Petroleum Geology (2011), doi: 10.1016/j.marpetgeo.2011.10.001.

Hammes, U., H.S. Hamlin, and T.E. Ewing, 2011, Geologic analysis of the Upper Jurassic Haynesville Shale in east Texas and west Louisiana: AAPG Bulletin, v. 95, p. 1643–1666.

RRC 2012, Railroad Commission of Texas Production Query: www.rrc.state.tx.us/PDQ: accessed April 2013.

Wang, F.P., and U. Hammes, 2010, Effects of petrophysical factors on Haynesville fluid flow and production: World Oil, v. 231, D79–D82.