FY 2013 Annual Technical Report for NCRDS State Cooperative Program

SUBSURFACE GAS-SHALE SAMPLES OF THE UPPER DEVONIAN AND LOWER MISSISSIPPIAN WOODFORD SHALE, PERMIAN BASIN, WEST TEXAS AND SOUTHEASTERN NEW MEXICO: CORE SAMPLING FOR MEASURED VITRINITE-REFLECTANCE (R_o) DETERMINATION

Prepared by

Tucker F. Hentz, Caroline Breton, and Stephen C. Ruppel

Bureau of Economic Geology
Scott W. Tinker, Director
Jackson School of Geosciences
The University of Texas at Austin
Austin, TX 78713-8924

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Subsurface Gas-Shale Samples of the Upper Devonian and Lower Mississippian Woodford Shale, Permian Basin, West Texas and Southeastern New Mexico: Core Sampling for Measured Vitrinite-Reflectance (R_o) Determination

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Introduction

This report summarizes activities carried out by the Bureau of Economic Geology (BEG) during fiscal year (FY) 2012 for the National Coal Resources Data System State Cooperative Program (NCRDS project). In a continuation of the sampling strategy for measured vitrinite-reflectance (R_o) determination initiated 4 years ago (Hentz and others, 2009) and conducted during the following three years (Hentz and others, 2010, 2011, 2012), this report provides a collection of oil- and gas-shale samples from the oil- and gas-productive Upper Devonian Woodford Shale of the Permian Basin in Texas and New Mexico (Fig. 1).

In FY2009, 2010, and 2011, we provided samples of the Eagle Ford Shale from the San Marcos Arch and Maverick Basin areas, samples of the deeper Pearsall Formation from the Maverick Basin of the eastern part of Texas, and samples of the Smithwick Shale from the Fort Worth Basin of north Texas, respectively. As specified in our work plan for FY2010 through 2014 (Hentz, 2010), this year we have provided samples of the productive Upper Devonian Woodford Shale in the Permian Basin of West Texas and southeastern New Mexico (Fig. 1).

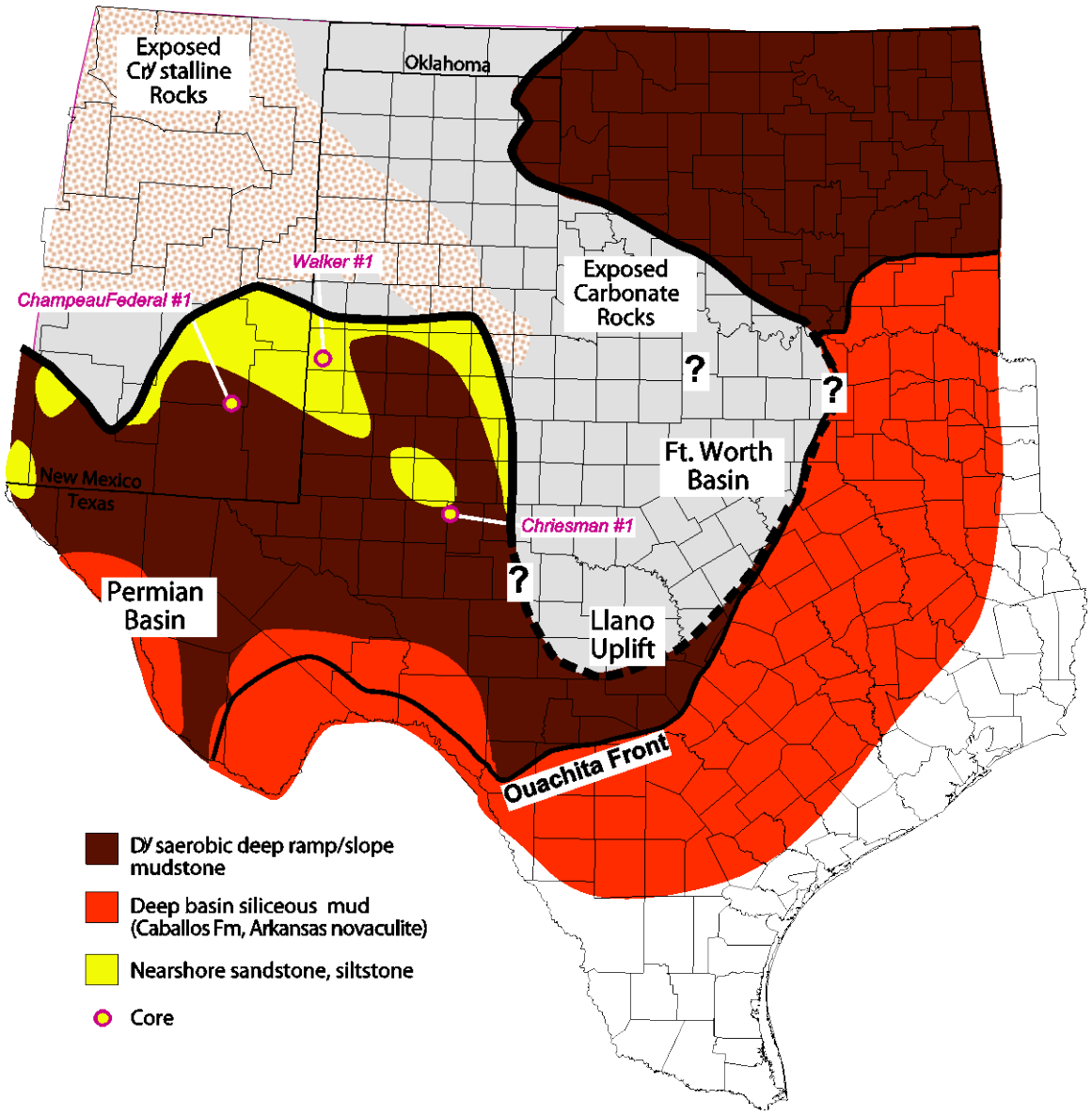

Figure 1. Map of Late Devonian paleogeography of Texas and eastern New Mexico showing the location of three cored wells from which Woodford Shale samples were extracted: Shell Champeau Federal #1, Pan American Walker #1, and Shell Chriesman #1.

We provide gas-shale samples from whole cores of the Woodford Shale from three wells, the Pan American Walker #1, Shell Chriesman #1, and Shell Champeau Federal #1 in Cochran and Glasscock counties, Texas, and Chaves County New Mexico, respectively (Figs. 1–4, Table 1). These samples have been delivered to Dr. James Hower of the University of Kentucky for measured vitrinite-reflectance (Ro). Each of the shale sample's precise geographic location is identified using GIS applications.

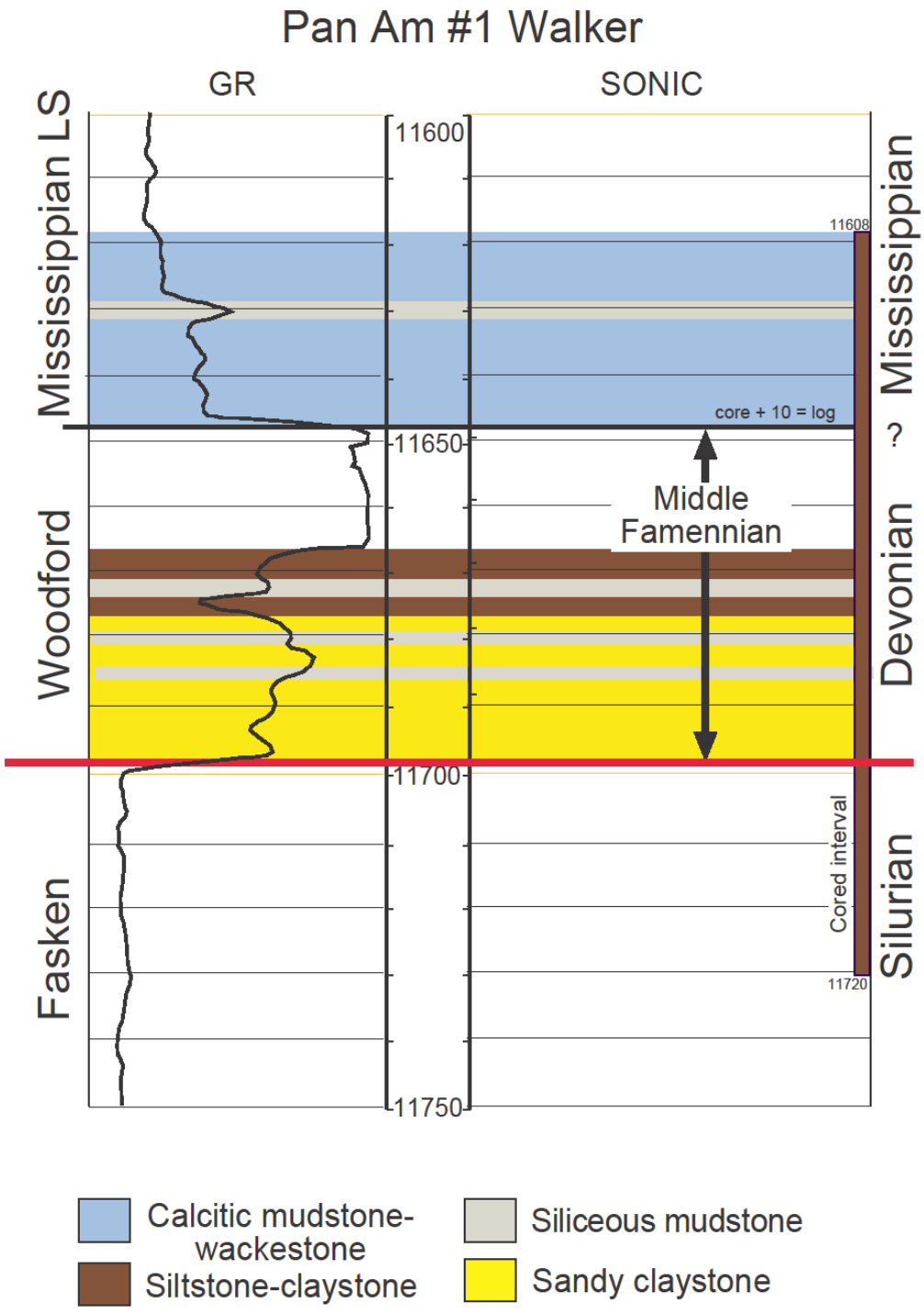

Figure 2. Well log of the Pan American Walker #1 well, Cochran County, Texas. The Woodford Shale occurs from 11,648 to 11,698 ft.

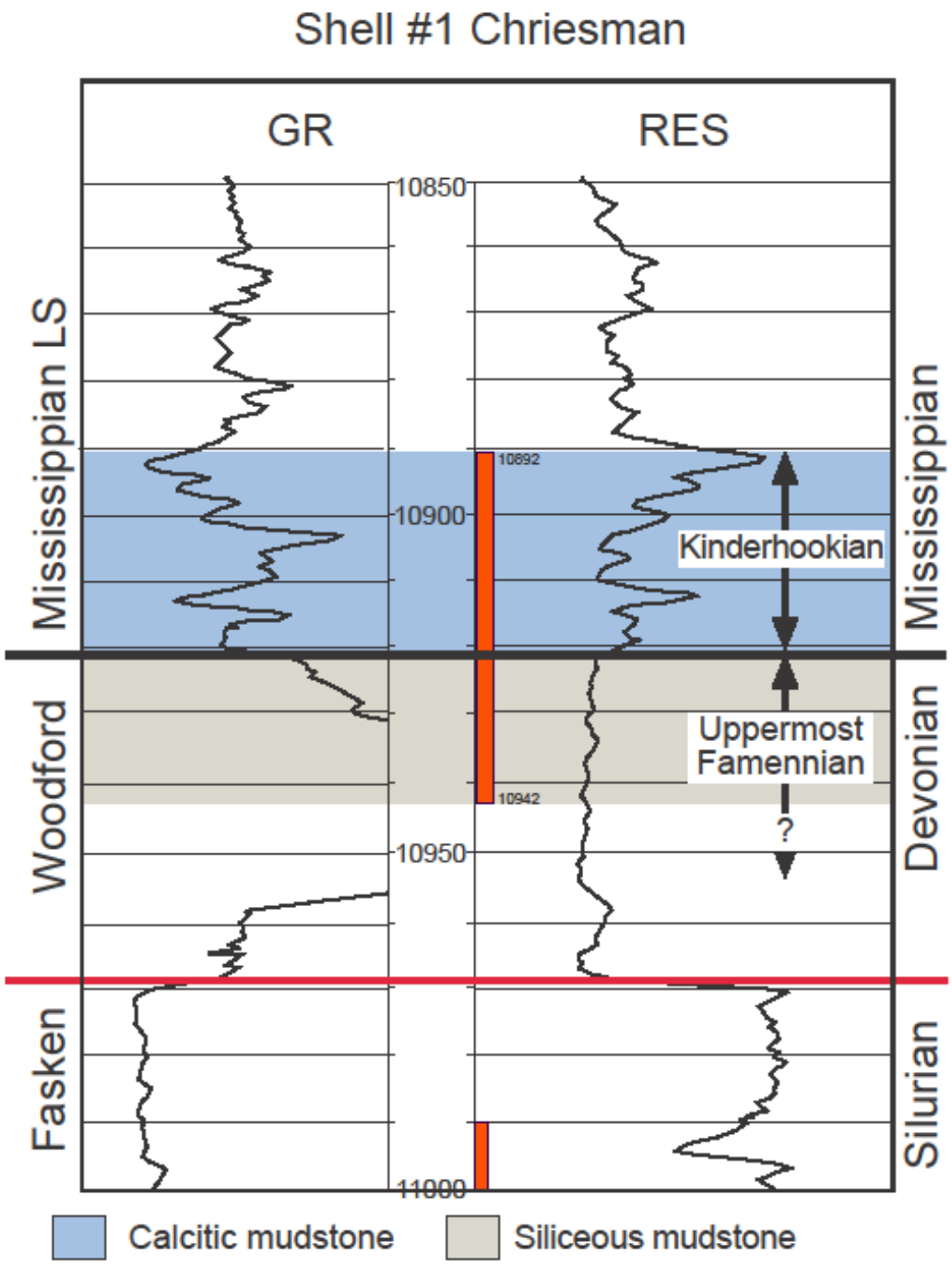

Figure 3. Well log of the Shell Chriesman #1 well, Glasscock County, Texas. The Woodford Shale occurs from 10,922 to 10,968 ft.

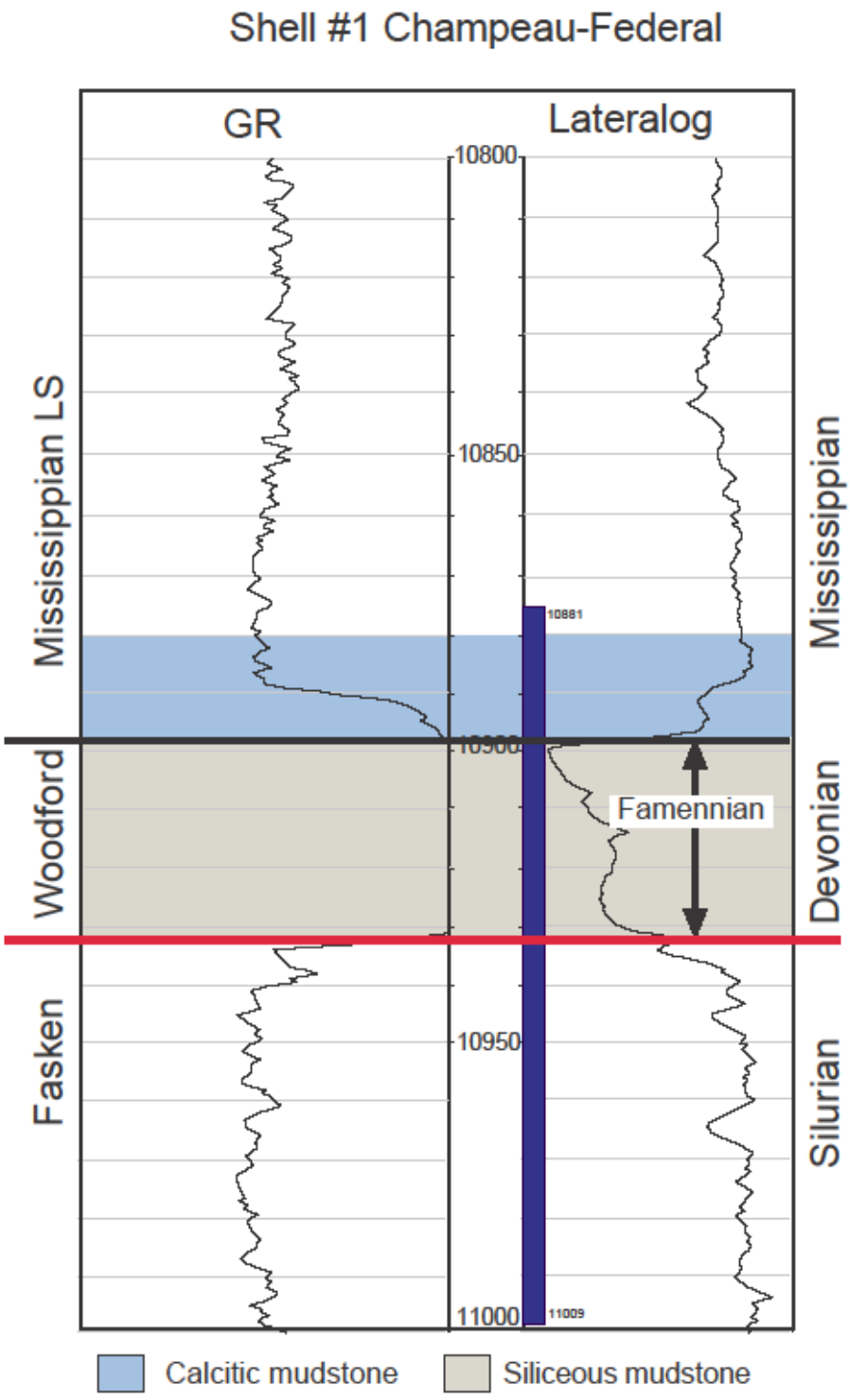

Figure 4. Well log of the Shell Champeau Federal #1 well, Chaves County, New Mexico. The Woodford Shale occurs from 10,899 to 10,932 ft.

Geologic Setting, Lithofacies, and Organic Content

Because the samples provided for this funding year are from a stratigraphic unit new to the project, a short summary of the geologic setting is presented. The Woodford Shale was deposited within the Permian Basin throughout West Texas and southeastern New Mexico mostly during Late Devonian (Frasnian-Famennian) time, with the uppermost part deposited during Early Mississippian (Tournaisian) time (Puckette et al., 2013) (Fig. 1). The unit is an organic-rich petroleum source rock and an oil- and gas-producing reservoir and consists of two primary lithofacies: mostly black shale and minor siltstone. The black shale facies records widespread bottom-water stagnation and anoxia during deposition, as indicated by its high organic content and presence of abundant pyrite and parallel laminae, and a strongly density-stratified water column (Comer, 1991). The abundance of pelagic marine fossils and marine types of organic matter in the shale indicates that surface waters in the stratified water column supported a rich, normal-marine biota. The widespread distribution and nearly uniform lithology of the Woodford Shale indicate that the Permian Basin area was one of low relief during the Late Devonian Period. It was deposited in the arid tropics near 15 degrees south latitude (Comer, 1991). Siltstone facies record bottom-flow deposits under dysaerobic conditions. Regional marine transgression caused flooding of the Late Devonian craton of the present-day West Texas and southeastern New Mexico where strong water-density stratification developed, due partly to accumulation of hypersaline bottom water that

formed locally in an arid climate. Anaerobic conditions resulted from poor vertical water circulation and high oxygen demand caused by decay of abundant organic matter.

The Woodford Shale is now in the oil window in the Midland Basin, Central Basin Platform, and Eastern and Northwestern Shelves, and it is in the gas window in the Delaware and Val Verde Basins (Comer, 1991). It also exists as hydrocarbon plays in the Arkoma, Anadarko, and Ardmore Basins of Oklahoma. In those areas, the bulk organic composition is Type II Kerogen (oil generative organic matter), the organic quantity is as high as 28% total-organic-carbon content (TOC) (highest in black shale facies), and the maximum thermal maturity is meta-anthracite equivalent (5-6.5% Ro vitrinite reflectance) (Cardott, 2013). As a reservoir in Oklahoma, the Woodford Shale is characterized by a brittle, biogenic-silica-rich lithology important for the generation of natural fractures and for fractures induced for hydrocarbon production. In southeastern New Mexico, TOC of the Woodford Shale ranges from 1.7 to 4.9 wt. %, and original pre-maturation TOC ranged from 1.8 to 6.8% (Broadhead, 2010).

Samples

Thirty-four Woodford Shale samples were taken from whole cores of three wells in West Texas and northeast New Mexico: Pan American Walker #1 in Cochran County, Texas; Shell Chriesman #1 in Glasscock County, Texas; and Shell Champeau Federal #1 in Chaves Co., New Mexico (Fig. 1, Table 1). The Woodford Shale is 50 ft thick in the

Pan American Walker #1 well, 46 ft thick in the Shell Chriesman #1 well, and 33 ft thick in the Shell Champeau Federal #1 well.

Table 1. Distribution of gas-shale samples from cores of the Woodford Shale in West Texas and southeast New Mexico.

Pan American Walker #1 (API # 42079200220000)

Sample depth (ft)

11,642
11,645
11,648
11,651
11,654
11,657
11,660
11,663
11,666
11,669
11,672
11,675
11,678
11,681
11,684

Shell Chriesman #1 (API # 42173007160002)

Sample depth (ft)

10,920
10,923
10,925
10,927
10,930
10,933
10,935
10,939
10,941

Shell Champeau Federal #1 (API # 30005005180000)

Sample depth (ft)

10,901
10,903
10,904
10,909
10,915
10,919
10,923
10,926
10,933
10,936

Analysis

Dr. James Hower at the Center for Applied Energy Research, University of Kentucky, is currently conducting measured vitrinite-reflectance analysis on the Woodford Shale samples and will convey his findings to us and the USGS shortly after receipt of this report.

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