CHAPTER 1

OVERVIEW OF 2014 ENERGY-FOCUSED FIELD STUDIES IN SUSITNA BASIN, SOUTH-CENTRAL ALASKA, AND PRELIMINARY RESULTS

R.J. Gillis[1], Editor

INTRODUCTION

The Susitna basin is a poorly-studied Cenozoic terrestrial sedimentary basin expressed as a vast, approximately 13,000 km^2 lowland that is adjoined at its southern edge with the better-studied and petroliferous Cook Inlet basin. Cook Inlet basin is the largest commercially-producing gas basin in the state and the principal supplier of energy to south-central Alaska. Cook Inlet gas is biogenic and likely sourced from abundant interstratified Miocene–Pliocene-age coal seams (Claypool and others, 1980; Magoon, 1994) that, along with the overlying sandbodies, can also serve as a reservoir for the gas. Susitna basin stratigraphy resembles the coal-bearing intervals of Cook Inlet basin, and may also be a potential resource for microbial gas. Although the basin was recently included with Cook Inlet in an assessment of identified, undiscovered conventional and coalbed gas by the U.S. Geological Survey (Stanley and others, 2011), it is structurally distinct from Cook Inlet basin and has been only lightly explored. Therefore, uncertainties persist about whether a Cook Inlet model for biogenic gas is valid for the Susitna basin. However, exploration interest exists in the basin, as a new exploration well near its southern end is currently in the permitting process.

Recent studies leveraging high-density gravity data (Saltus and others, 2012, 2014) and well control, sparse proprietary seismic reflection, and aeromagnetic data (Stanley and others, 2013, 2014; Shah and others, 2014) have improved what is known about the age, stratigraphy, and structural configuration of the basin. However, detailed outcrop studies are still needed and remain important for understanding the stratigraphic architecture, depositional systems, reservoir and seal quality, gas potential of interstratified coal, and structural kinematics of the basin.

To begin filling this gap in data, the Alaska Division of Geological & Geophysical Surveys (DGGS) initiated reconnaissance-level stratigraphic field studies in Susitna basin in summer 2011 (Gillis and others, 2013) to develop a baseline geologic framework and lay the groundwork for future geologic investigations. DGGS continued field studies in 2014 aimed at better defining the stratigraphy, structural geology, and energy potential of the basin (fig. 1-1). Field studies focused mainly on the stratigraphic framework, sediment provenance, and reservoir quality of Cenozoic outcrops discontinuously exposed around the western and northern periphery of the basin, along with selected exposures of underlying Cretaceous bedrock. Samples for coal quality and high-pressure methane adsorption were collected and analyzed from nearly every major accessible coal seam exposed in the basin to quantify their attributes as a primary energy resource in addition to their ability to sequester methane. Additional research included preliminary structural kinematic analyses of fault slip data collected from bedrock outcrops near the western margin of the basin and companion thermochronologic sampling to help link periods of rock uplift with deformation and basin deposition. An overview and preliminary results of these studies are included as individual short interpretive reports in this volume. Main points from each report are summarized below.

CENOZOIC AND MESOZOIC STRATIGRAPHY: LePain and others, 2015

Stratigraphic sections were measured in Cenozoic strata at three locations on the northwest and west sides of the basin at Fairview Mountain and Johnson Creek. Strata mapped as Tyonek(?) Formation (Reed and Nelson, 1980) are coal-bearing and interpreted to have been deposited in mixed-load, low- to moderate-sinuosity streams. Sterling(?) Formation strata at Johnson Creek record deposition in moderate-gradient, low- to moderate-sinuosity gravelly streams. Sandstones at all of the study locations are quartzo-feldspathic, weakly cemented, and likely to have good reservoir potential if not buried too deeply. Common interbedded argillaceous mudrocks likely represent effective seal facies.

Mesozoic Kahiltna assemblage strata were examined at five locations in the Peters Hills, Dutch Hills, and Yenlo Hills. Strata in the Peters and Dutch hills are dominated by argillite with common interstratified fine-grain sandstone beds with rare thick, amalgamated sandstone beds interpreted as low- and high-density turbidites, respectively. Strata in the Yenlo Hills are more sand-prone, mostly massive, and interpreted as reflecting deposition in high-density, non-turbulent flows. Mesozoic strata in all examined locations appear to have poor reservoir potential.

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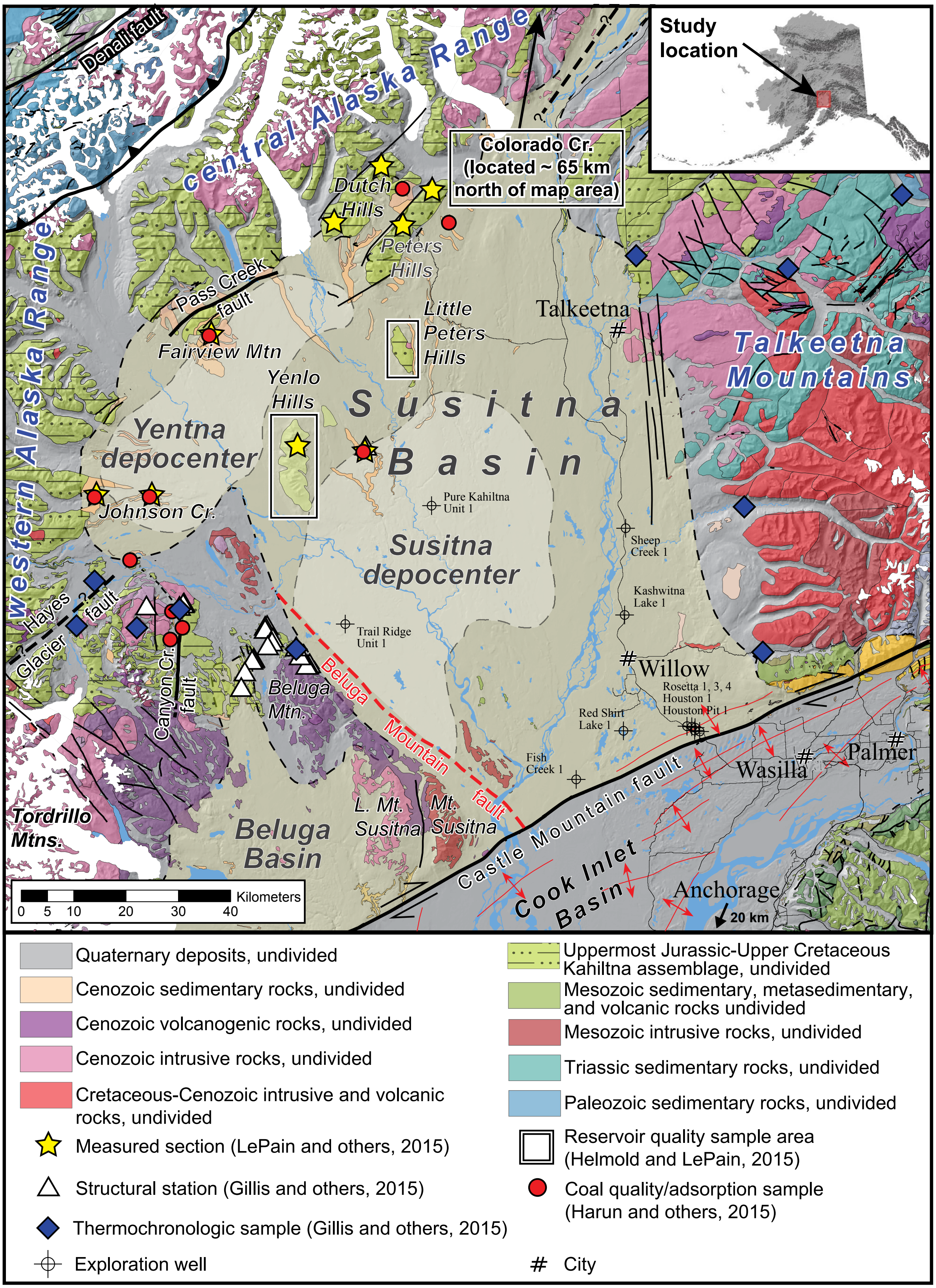

Figure 1. Generalized geologic map of the Susitna basin and its margins, including parts of the western and central Alaska Range, and Talkeetna Mountains. Thick black lines represent mapped surface faults (dashed where approximately located). Thin solid black lines represent lineaments or hypothesized faults (Wilson and others, 2009). Thin dashed lines represent approximate outline of Susitna basin (Meyer, 2005). Figure adapted from Wilson and others, 2009; Solie and Layer, 1993; and Stanley and others, 2014.

RESERVOIR QUALITY OF MESOZOIC STRATIGRAPHY: Helmold, 2015

Seventeen thin-section samples were collected in 2011 for petrographic analysis from Kahiltna assemblage strata at Little Peters Hills and the Colorado Creek area, and the graywacke of Yenlo Hills. Additional field examinations from the same and additional sites were conducted in 2014 and the results will be presented in future reports. Sandstones from Little Peters Hills and the Colorado Creek area strata are mostly quartzo-feldspathic with framework grains consisting mainly of chert with lesser mono- and poly-crystalline quartz. Accessory grains include plutonic and volcanic fragments, feldspar, and mica. Their overall reservoir quality is poor, with porosities less than 12 percent and permeabilities less than 1 millidarcy (md). Sandstones from Yenlo Hills are largely feldspatholithic with framework grains consisting mainly of plagioclase and volcanic lithic fragments that are highly susceptible to alteration. Accessory grains include sedimentary and plutonic rock fragments, mica, and feldspar. Reservoir quality is very poor, with porosities less than 1 percent and permeabilities less than 0.0001 md.

RECONNAISSANCE COAL STUDY: Harun and others, 2015

Twenty-two coal samples were collected from 11 localities and submitted for coal quality, high-pressure methane adsorption (HPMA), Rock-Eval pyrolysis, and vitrinite reflectance analyses to assess their potential as a primary energy source, a potential methane gas source, their organic carbon content and type, and thermal maturity. Coal cleats were also measured at eight locations to lay the groundwork for understanding the coal's fracture porosity and principal orientations. Coal ranks range from lignite A to subbituminous A. Coal cleat orientations varied, but face cleats tend to cluster into two main orientations, northwest-striking and northeast-striking. HPMA, Rock-Eval, and vitrinite reflectance results are pending, and will be presented in future reports.

RECONNAISSANCE STRUCTURAL KINEMATIC ANALYSIS: Gillis and others, 2015

One-hundred-four fault measurements from four areas in the Susitna basin and at its western margin yielded 39 unidirectional slip indicators that were analyzed to assess spatial and temporal patterns of fault slip at the basin margin. Regionally distributed fault orientations formed three sets: northwest striking (set A), east–northeast striking (set B), and north–northwest striking (set C). Set A faults commonly slip sinistrally and in a reverse sense. Set B faults exhibit variable senses of slip, but are commonly sinistral and transtensional. Set C faults also have variable senses of slip, but are commonly dextral and transtensional. Set A and C faults cut all other orientations, and set A faults cut set C faults. Analyzed together, the kinematic data tentatively record two nearly orthogonal directions of principal shortening representing two separate phases of deformation. The first phase was driven by northeast-directed principal shortening resulting in southeast-to-east extension. Phase two was driven by northwest-directed principal shortening resulting in northwest transpression and perhaps reactivation of earlier transtensional faults.

CLOSING REMARKS

The brief reports included in this volume present preliminary results and tentative interpretations from 2014 and earlier Susitna basin field studies by DGGS, which focus on its geologic development and energy potential. These field summaries will be followed by more substantial reports addressing the stratigraphy, reservoir quality, coal quality, hydrocarbon potential, basin structure, and basin uplift history as pending data are returned and interpreted in the coming months.

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