CHAPTER 9

EVIDENCE OF A SUBMARINE CANYON IN THE SNUG HARBOR SILTSTONE AND POMEROY ARKOSE MEMBERS, NAKNEK FORMATION, SOUTH-CENTRAL ALASKA—IMPLICATIONS FOR THE DISTRIBUTION OF COARSE-GRAINED SEDIMENT IN UPPER JURASSIC STRATA OF COOK INLET

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INTRODUCTION

The Alaska Division of Geological & Geophysical Surveys (DGGS) is continuing research it began in 2009 to study the stratigraphy and sedimentology of lower Cook Inlet's Upper Jurassic Naknek Formation (Wartes and others, 2011, 2013, 2015; Herriott and others, 2013; Stanley and others, 2013; Herriott and Wartes, 2014). This work has been complemented by recent geologic mapping of the Naknek Formation on the Iniskin Peninsula (fig. 9-1), which yielded numerous insights into lithostratigraphic relations among the mappable members of the unit (Herriott and Wartes, 2014; Gillis and others, 2014). During July 2014 we continued field investigations of the Naknek Formation northeastward along the northwest margin of the Cook Inlet forearc basin to the area north of Chinitna Bay (Wartes, ed., 2015). In this brief paper, we present preliminary geologic mapping of the Hickerson Lake area (fig. 9-1) and highlight field observations that indicate establishment and filling of a submarine canyon in the Snug Harbor Siltstone and Pomeroy Arkose Members of the Naknek Formation.

Hickerson Lake lies in a landslide-dammed glacial valley (Detterman and Hartsock, 1966) ~5 km north of Chinitna Bay, with nearby topographic relief locally exceeding 1,000 m. Naknek Formation strata in the area dip gently southeastward and are discontinuously exposed along the lake's northeast and southwest shores as well as in the ridges and peaks surrounding the lake. During this study we mapped the geology near the lake (fig. 9-2), employing the lithostratigraphic mapping criteria of Herriott and Wartes (2014).

LITHOFACIES AND GEOLOGIC MAP RELATIONS

A traverse along the southwest shore of Hickerson Lake revealed a >5-m-thick, boulder-bearing, cobble conglomerate (figs. 9-3A and 9-4) with outsized clasts to ~80 cm. This conglomerate comprises a channel-form sediment body with a sharp, erosional base (fig. 9-3B) that immediately overlies 98 m of thin- to medium-bedded, sandy siltstone and subordinate sandstone of the Snug Harbor; the conglomerate is overlain by thin- to very-thick-bedded sandstone and siltstone. Approximately 200 m above the cobble conglomerate lies a cliff-forming, tens-of-meters-thick, amalgamated, arkosic sandstone succession with prominent, sharp-based, channel-form stratal geometries (fig. 9-4).

Following Detterman and Hartsock (1966) and Herriott and Wartes (2014), we mapped the Snug Harbor–Pomeroy contact at the base of the thick, amalgamated arkose beds described above, thus including the conglomerate and overlying thin- to very-thick-bedded sandstone and siltstone with the Snug Harbor (see fig. 9-4). Extending this contact westward from the lake's shore suggests that this readily mappable lithostratigraphic surface is in a stratigraphically higher position near peak 3140, where an appreciably thicker (~500 m) Snug Harbor section occurs than is observed along the southwest shore of Hickerson Lake, where the unit is ~300 m thick (fig. 9-4C). The difference between these Snug Harbor thicknesses indicates ~200 m of stratigraphic relief along the top of the unit. This relief is in turn occupied by the arkosic, channel-form strata of the lower Pomeroy that onlap the underlying Snug Harbor (fig. 9-4). Aerial reconnaissance suggests the thick Snug Harbor section below peak 3140 is dominantly tabular bodied and finer grained than strata exposed above the conglomerate at the lake shore.

INTERPRETATIONS AND DISCUSSION

Recent sedimentologic and stratigraphic studies suggest that the Snug Harbor–Pomeroy transition records a shift from slope to toe-of-slope or basin-floor sedimentation (Wartes and others, 2013; Herriott and Wartes, 2014). Within this framework, the channel-form stratal geometries, lithofacies, along-strike changes in unit thicknesses, and overall stratigraphic architecture reported above and evident in figure 9-4 strongly suggest a broad (kilometer-scale) "container" with marked negative relief (hectometer scale) that we interpret as a submarine canyon. The boulder-bearing conglomerate locally defines the lowermost

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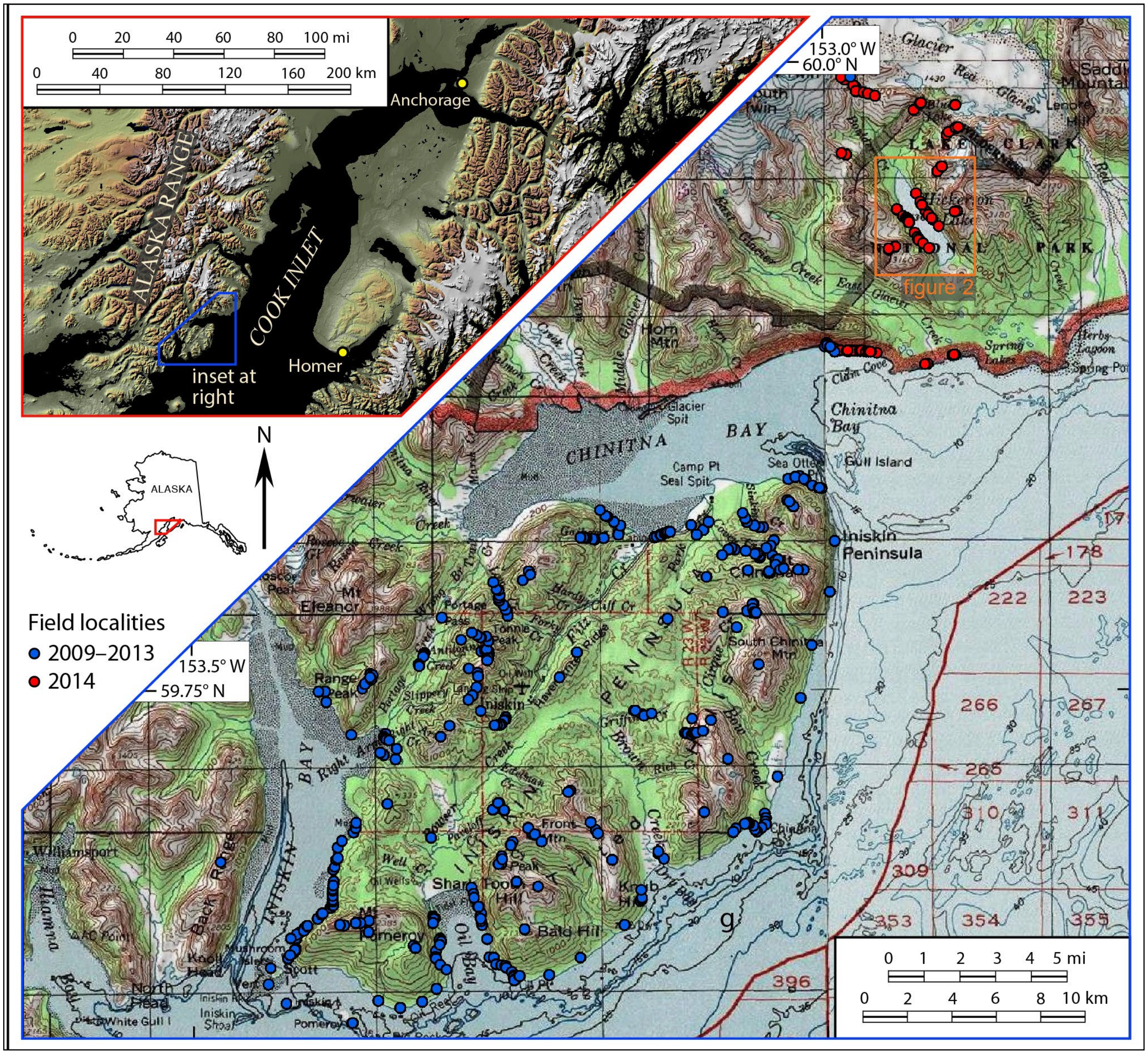


Figure 9-1. Index map of the study area. Detailed observations were made by the authors at more than 400 localities during five field seasons. During 2014, our focus shifted northeastward from the Iniskin Peninsula to the area north of Chinitna Bay. Topographic base map from portions of U.S. Geological Survey Iliamna, Seldovia, Lake Clark, and Kenai 1:250,000-scale quadrangles; shaded-relief image modified after U.S. Geological Survey Elevation Data Set Shaded Relief of Alaska poster. Available for download at http://eros.usgs.gov/alaska-0

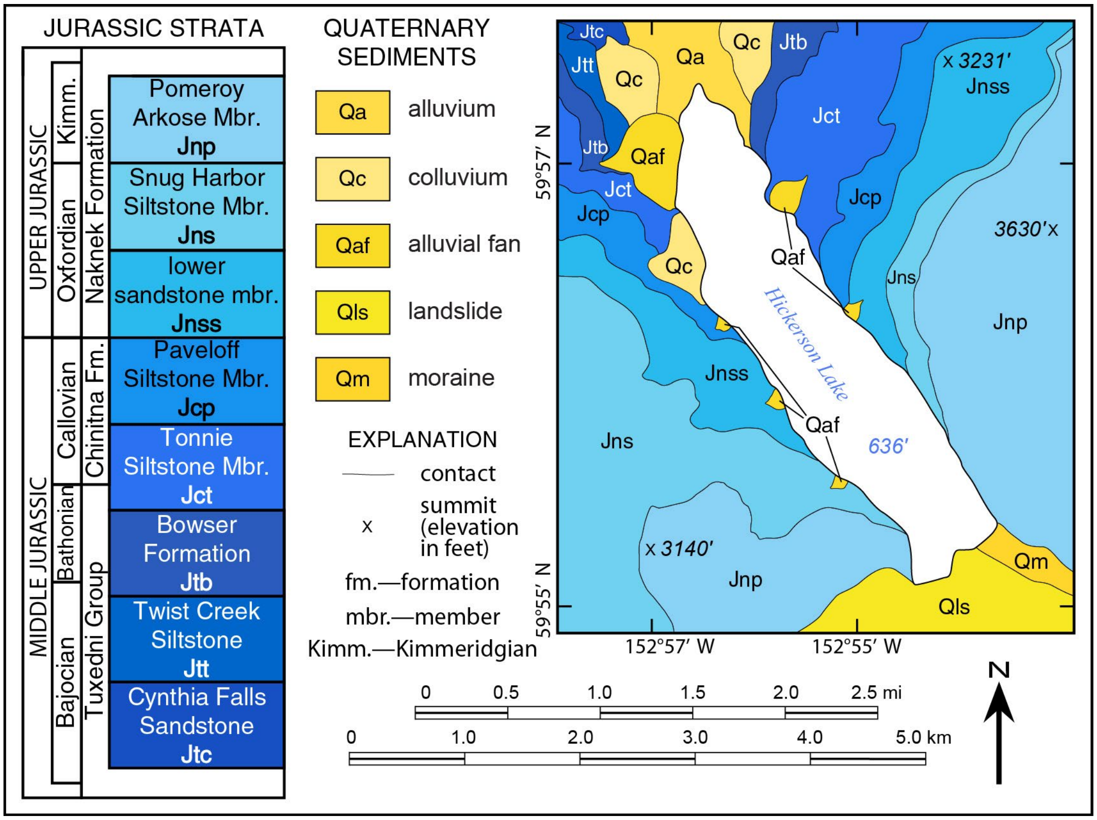
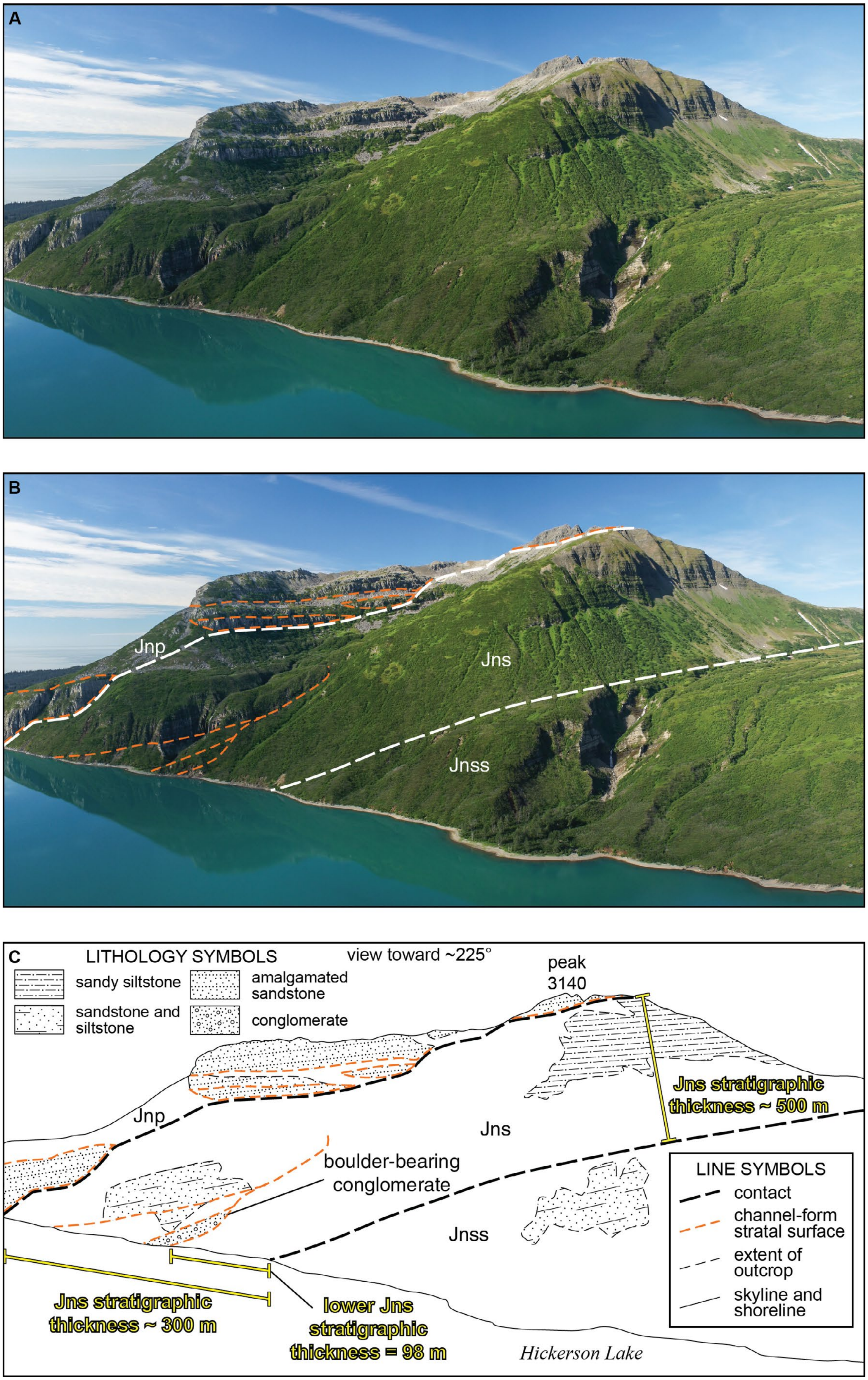


Figure 9-2. Simplified geologic map of the Hickerson Lake area. This preliminary sketch map is based on 1:63,360-scale mapping completed during July 2014 and is part of a larger project focused on mapping the northwest margin of the Cook Inlet forearc basin between Chinitna Bay and Red Glacier (Wartes, ed., this volume). Schematic stratigraphic column (modified after Detterman and Hartsock [1966] and Herriott and Wartes [2014]) is not scaled to time or thickness, nor does it reflect known depositional hiatuses. See figure 9-1 for location index map.

Figure 9-3. Outcrop photographs of the boulder-bearing cobble conglomerate in the Snug Harbor Siltstone Member, southwest shore of Hickerson Lake. **A.** The cobble conglomerate is clast supported and lacks evidence of internal stratification. Rounded cobbles are common and subangular, intra-basinal, siltstone rip-up clasts are also observed. Geologist for scale. Photograph by M.A. Wartes. **B.** Sharp, erosional base (dashed orange line) of channel-form cobble conglomerate bed. Notebook (12 x 19 cm) for scale. Photograph by P.L. Decker.


A
B
Jnp
Jns
Jnss
C
LITHOLOGY SYMBOLS
view toward ~225°
sandy siltstone
amalgamated sandstone
sandstone and siltstone
conglomerate
peak 3140
Jns stratigraphic thickness ~ 500 m
Jnp
Jns
boulder-bearing conglomerate
LINE SYMBOLS
contact
channel-form stratal surface
extent of outcrop
skyline and shoreline
Jnss
Jns stratigraphic thickness ~ 300 m
lower Jns stratigraphic thickness = 98 m
Hickerson Lake

part of the canyon fill succession, with the overlying, upper part of the Snug Harbor at Hickerson Lake comprising a continued early filling history. This proposed canyon is hosted at least in part by the dominantly tabular-bodied Snug Harbor strata below peak 3140. The amalgamated, channel-form arkosic beds of the lower Pomeroy mark a later, continued filling phase of the canyon. The intra-canyon contact between these Naknek Formation members may record back-stepping and onlapping of the Pomeroy depositional system onto the Snug Harbor slope as toe-of-slope accommodation filled with arkosic sand.

Channelized depositional systems on slopes are recognized as pathways for turbidity currents and associated processes to transport coarse-grained sediment (sand and gravel) into deep-marine settings (for example, Hubbard and others, 2014), commonly yielding deposits with high net (sand+gravel) to gross (mud+sand+gravel) ratios (for example, Mayall and others, 2006). In fact, the submarine canyon reported here is consistent with this part of the Naknek depositional system, as sediment supplied to the immensely thick, sand-rich, deep-water Pomeroy must have bypassed the Snug Harbor slope environment, and it has been suggested that most coarse-grained sediment that reaches basin floors is transported through submarine canyons (Miall, 1990). Notably, deep-water canyon fill and basin-floor deposits (commonly comprising fans) constitute significant hydrocarbon reservoirs throughout the world (for example, Richards and others, 1998; Weimer and Slatt, 2006; Macauley and Hubbard, 2013), rendering our observations and interpretations presented here as the basis for a new predictive model for the distribution of potential reservoir facies in the Naknek Formation that includes locally coarse-grained, channelized facies belts hosted in submarine canyons.

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Figure 9-4 (left). Oblique aerial view southwestward of peak 3140, with Hickerson Lake in the foreground. **A.** Noninterpreted photograph. **B.** Photogeologic interpretation of photograph. **C.** Line drawing interpretation. View toward center of photograph is approximately strike parallel. Approximately 760 m (~2,500 ft) of topographic relief is present between Hickerson Lake and peak 3140, for sense of scale.

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