CHAPTER 6

RECORD OF A LATE JURASSIC DEEP-WATER CANYON AT CHISIK ISLAND, SOUTH-CENTRAL ALASKA: FURTHER DELINEATION OF NAKNEK FORMATION DEPOSITIONAL SYSTEMS IN LOWER COOK INLET

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INTRODUCTION

Sedimentologic, stratigraphic, and geologic mapping-based studies of the Upper Jurassic Naknek Formation are part of a Department of Natural Resources-led project to examine the Mesozoic stratigraphy and structure of lower Cook Inlet (Gillis, 2013, 2014; Wartes, 2015; Herriott, 2016 [this volume]). This ongoing research aims to elucidate geologic relations that are relevant to the petroleum systems in the Cook Inlet forearc basin, a producing yet underexplored hydrocarbon province (LePain and others, 2013). Our recent Naknek Formation work focuses on an ~80 km trend exposed parallel to the basin margin between Iniskin and Tuxedni bays (fig. 6-1), building on the geologic framework established by Detterman and Hartsock (1966).

In this brief paper, we continue to document stratigraphic relations between the Snug Harbor Siltstone and Pomeroy Arkose Members (Naknek Formation), which are interpreted chiefly as marine slope and base-of-slope/basin floor units, respectively (LePain and others, 2013; Wartes and others, 2013). The Snug Harbor–Pomeroy contact is typically sharp and conformable and is mapped at the base of amalgamated, tabular packages of light-gray-weathering arkose (Detterman and Hartsock, 1966; Herriott and Wartes, 2014). However, during field investigations in 2013 and 2014, atypical stacking relations between the Snug Harbor and Pomeroy were recognized in the Mount Pomeroy and Hickerson Lake areas (fig. 6-1), where lithofacies, stratal geometries, and seismic-scale stratigraphic architecture were interpreted to record processes associated with two deep-water canyons (Herriott and others, 2015a, 2015b). Presented below are new field observations from Chisik Island (fig. 6-1) that suggest establishment and filling of a third canyon in the Snug Harbor–Pomeroy interval, further delineating the stratigraphic framework of Cook Inlet during the Late Jurassic.

STRATIGRAPHIC OBSERVATIONS AT CHISIK ISLAND

Aerial reconnaissance of a superb mountainside exposure at the north end of Chisik Island revealed prominent concave-up erosional surfaces in the Snug Harbor–lower Pomeroy that are overlain by channel-form sediment bodies (fig. 6-2). A basal erosional surface is identified as the master channel margin. This surface cuts across ~100 m of stratigraphy, marking the Snug Harbor–Pomeroy contact to the northeast, separating two architecturally distinct packages of Snug Harbor (the lower denoted here as Jns_1 and the upper as Jns_2) in the central area of figure 6-2, and juxtaposing the lower sandstone member (Naknek Formation) and Jns_2 to the southwest, where Jns_1 is entirely truncated. Jns_1 comprises relatively thin, tabular beds of siltstone and very-fine-grained sandstone typical of Snug Harbor (Herriott and Wartes, 2014). Jns_2 is distinguished from Jns_1 in that it lies within the master channel, hosts abundant channel-form stratal geometries, and is sandier. The contact between Snug Harbor and lower Pomeroy (Jnp_1) is mapped at the base of very thick successions of amalgamated arkoses that are tabular to locally channelized, although channel margins are less steep than those observed in Jns_2 (fig. 6-2); siltstone intercalations in Jnp_1 are only a minor constituent. Finally, an upper Pomeroy unit (Jnp_2) contains thicker amalgamated arkosic packages than are observed in Jnp_1, is dominantly tabular-bedded at the scale of exposure, lacks siltstone interbeds, and is lithostratigraphically consistent with Pomeroy successions that typically crop out conformably above Snug Harbor of Jns_1 affinity (Herriott and Wartes, 2014).

INTERPRETATIONS AND DISCUSSION

The lithostratigraphic relations and large-scale stratal architecture described above and in figure 6-2 are interpreted as the record of a deep-water canyon. This Chisik Island canyon association consists of pre-, intra-, and beyond-canyon facies—Jns_1, Jns_2–Jnp_1, and Jnp_2, respectively—permitting insights into trends in Naknek Formation deep-water depositional systems. Deposition of Jns_1 (slope facies) was terminated by canyon incision and establishment of intra-canyon channel belts (Jns_2) with relatively steep channel margins during an early canyon-fill episode that was likely dominated by erosional processes and sediment bypass. Jnp_1 marks a transition to widening channel belts with relatively gentle channel margins, increasing

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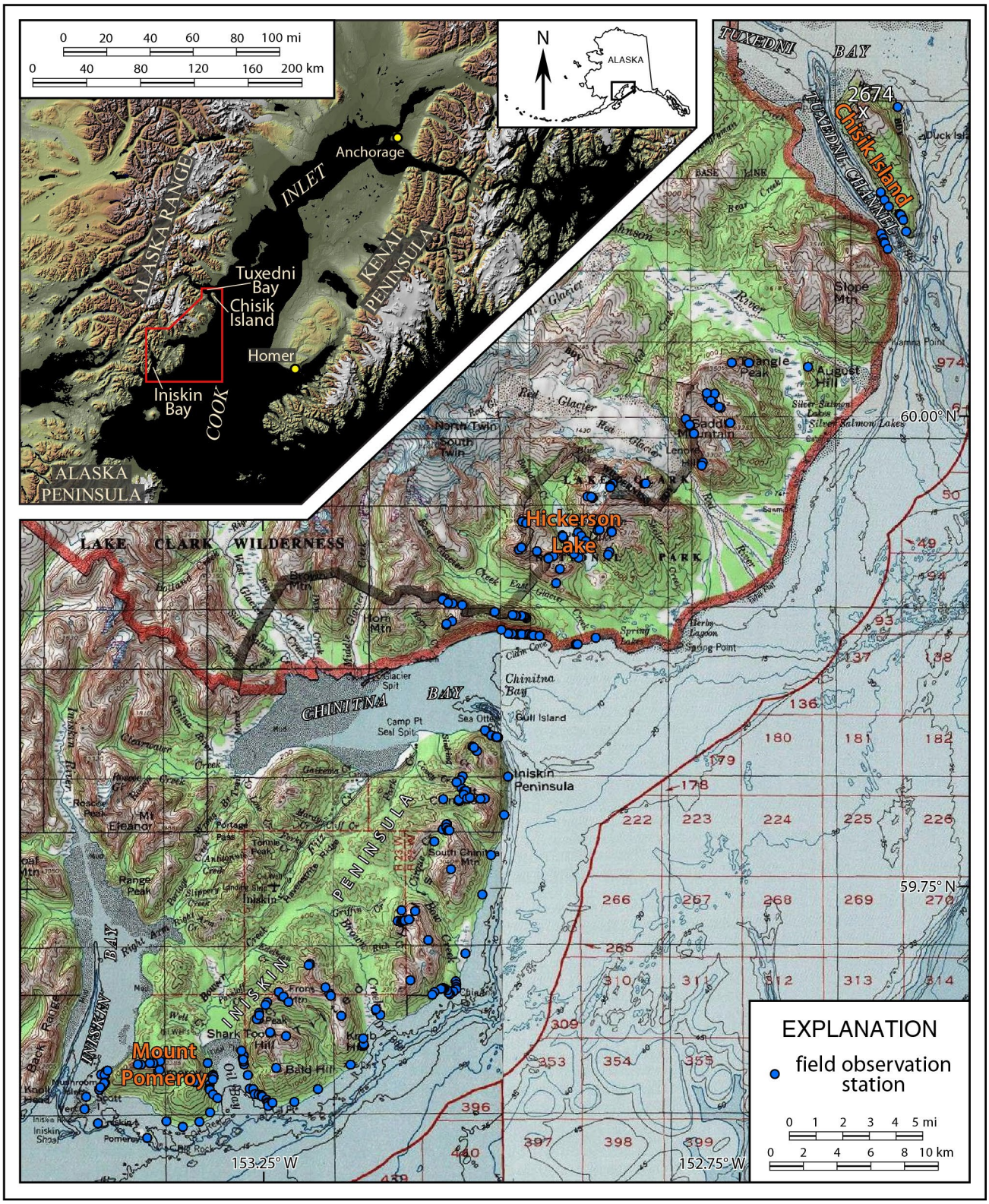

Figure 6-1. Location map of the Iniskin–Tuxedni bays study area. Detailed observations of the Naknek Formation were made by the authors at more than 325 localities during six field seasons. Evidence of deep-water canyon and associated processes in the Snug Harbor Siltstone–lower Pomeroy Arkose Members interval have been documented in three areas (see orange labels with black outlines and text for discussion). 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).

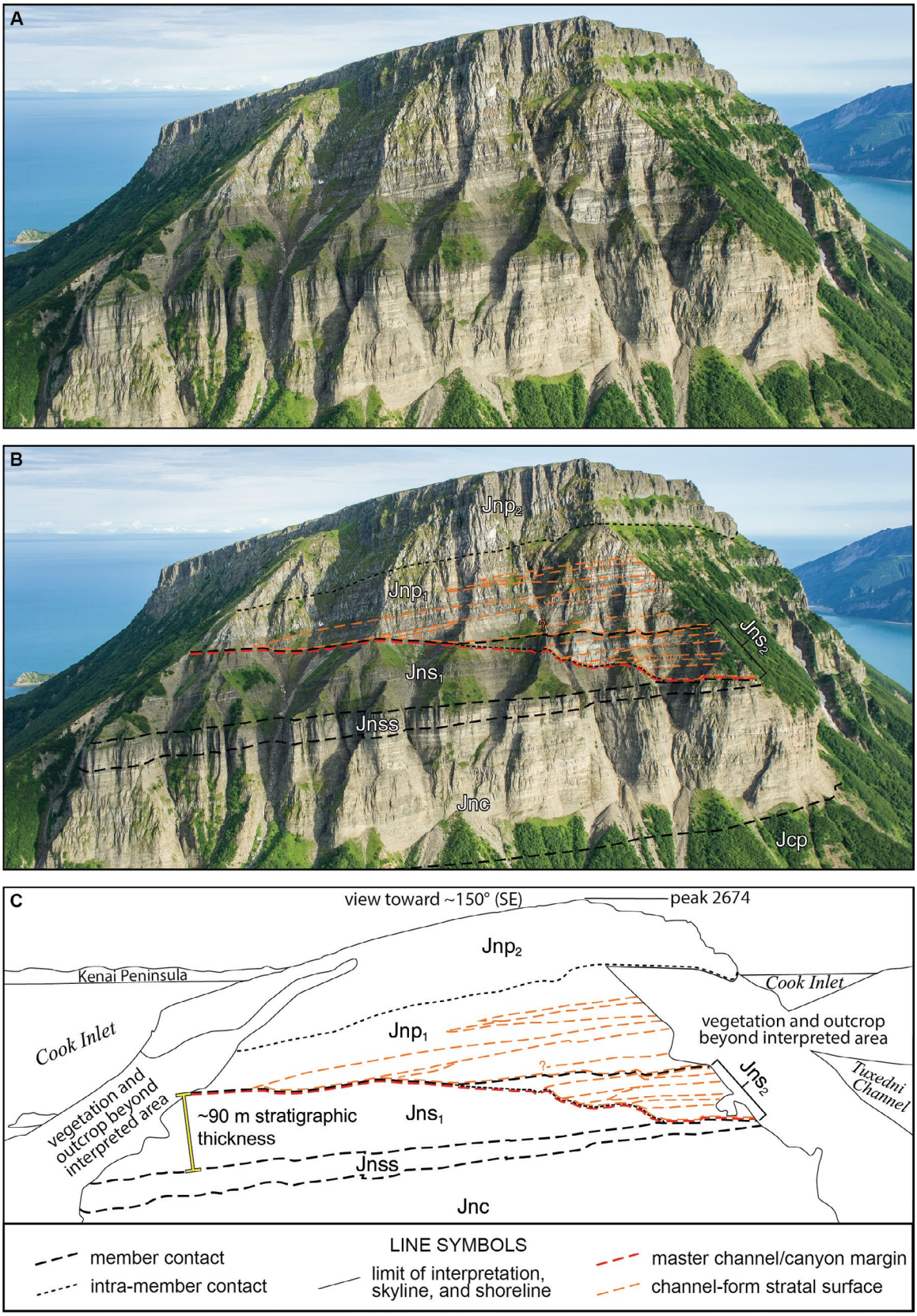

*Figure 6-2. Oblique aerial view southeastward of the northern extent of Chisik Island (fig. 6-1). Key stratigraphic relations in the Snug Harbor Siltstone (*Jns$_1$ *and* Jns$_2$*) and Pomeroy Arkose (*Jnp$_1$ *and* Jnp$_2$*) Members are discussed in the text and include the distribution of lithofacies and stratigraphic architecture.* ***A.*** *Noninterpreted photograph.* ***B.*** *Photogeologic interpretation.* ***C.*** *Line drawing interpretation. Approximately 400 m (~1,300 ft) of topographic relief lie between peak 2674 (fig. 6-1) and the base-of-cliff exposures of Chisik Conglomerate Member (*Jnc*; Naknek Formation), for sense of scale. Additional abbreviations:* Jcp *= Paveloff Siltstone Member, Chinitna Formation;* Jnss *= lower sandstone member, Naknek Formation; SE = southeast. Photograph by T.M. Herriott.*

occurrence of tabular beds, and increasing sandstone-to-siltstone ratios. These Jns_2 to Jnp_1 trends may in part reflect a reduction in gradient along the canyon axis and reduced bypass at this site, potentially as a result of canyon-associated depositional systems trending toward equilibrium grade as the base-of-slope environment accumulated sediment and the basin-floor depositional elements of the Pomeroy onlapped the inherited paleobathymetric profile of the Snug Harbor slope (Herriott and others, 2015a). Jnp_2 is interpreted to record distributary lobe sedimentation beyond the canyon mouth, which retreated farther upslope as arkosic sediment continued to debouch onto the basin floor (compare with Mutti and Normark, 1987).

These observations and interpretations are consistent with: (1) our prior work (see references above), (2) the tendency of deep-water channelized depositional systems to evolve in space and time (for example, Posamentier and Kolla, 2003; Hubbard and others, 2014), with erosional processes and bypass dominant in steeper gradient settings and channelized-aggradational to distributary-aggradational processes dominant in lower gradient settings, and (3) deep-water canyons commonly serving as conduits to route coarse-grained sediment to basin floors (for example, Miall, 1990). The Chisik Island canyon—in conjunction with our observations in the Mount Pomeroy and Hickerson Lake areas—also establishes a maximum canyon spacing of ~30–40 km along the Iniskin–Tuxedni bays outcrop belt (fig. 6-1). This study thus further constrains depositional systems evolution, sediment routing pathways, and location of paleobathymetric elements during Snug Harbor and Pomeroy deposition, yielding insights into the distribution of coarse-grained strata that may host oil and gas in Cook Inlet.

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