CHAPTER 5

PRELIMINARY STRATIGRAPHIC ARCHITECTURE OF THE MIDDLE JURASSIC PAVELOFF SILTSTONE MEMBER, CHINITNA FORMATION, TUXEDNI BAY AREA, COOK INLET, ALASKA

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INTRODUCTION

Field studies of the Chinitna Formation are being conducted by the Alaska Department of Natural Resources to better understand the Middle Jurassic stratigraphy in the hydrocarbon-bearing Cook Inlet forearc basin. The Chinitna Formation crops out in lower Cook Inlet along the northwest basin margin between Iniskin and Tuxedni bays (fig. 5-1), where the formation is ~700 m thick and comprises two members: Tonnie Siltstone and Paveloff Siltstone (Detterman and Hartsock, 1966). Although it remains unclear what role the Chinitna Formation may play in Cook Inlet petroleum systems, Wartes and Herriott (2015) documented an oil-stained locality in the lower Paveloff at Chinitna Bay (fig. 5-1), demonstrating that the formation at least locally hosts migrated oil.

LePain and others (2013) interpreted the Chinitna Formation as a shelfal unit and proposed that sand-rich basal successions reported by Detterman and Hartsock (1966) in each of the members mark onset of regressive–transgressive sedimentation cycles. Detterman and Hartsock (1966) also noted that the Tonnie and Paveloff sand-prone intervals are thicker and locally coarser grained to the northeast, which is consistent with our observations. This short paper presents a preliminary stratigraphic architecture analysis of the Callovian-age Paveloff in the Johnson River area south of Tuxedni Bay (fig. 5-1), where the member's sandy basal unit is well developed and a series of large-scale incisions and their fills are observed. We propose that sand-choked, channelized depositional systems recorded in part by the outcrops described below bypassed coarse detritus to more distal settings that may host hydrocarbons in the subsurface of Cook Inlet.

OBSERVATIONS—STRATIGRAPHIC ARCHITECTURE

The Paveloff is a chiefly fine-grained, dark-gray-brown/green-weathering unit overlying the medium-brown-weathering Tonnie (fig. 5-2; Herriott and Wartes, 2014). However, the lower Paveloff in the Johnson River area is a sharp-based, tan- to gray-weathering, ~95–105-m-thick interval (Jcp_1 of this study) that renders an especially conspicuous Tonnie–Paveloff contact (figs. 5-2 and 5-3). Jcp_1 largely comprises sandstone and subordinate conglomerate that transition up-section from dominantly tabular to dominantly channelized stratal geometries (figs. 5-2 and 5-3); convolute stratification is also common to Jcp_1 (fig. 5-4). Channelized successions in Jcp_1 are very thick bedded and typically amalgamated, with channel fills stacked up to ~75 m thick; an ~15-m-thick, channelized conglomerate is observed near Triangle Peak (figs. 5-1 and 5-4). Jcp_1 is overlain by a thinner- and tabular-bedded, finer-grained succession (Jcp_2) that is ~160 m thick and consistent with the regional lithostratigraphic character of the Paveloff. Large-scale incisions cut Jcp_2, forming concave-up surfaces with up to ~140 m of stratigraphic relief (fig. 5-2). Channel-form sediment bodies of Jcp_3 that fill these containers are locally thicker bedded and more resistant than the host strata of Jcp_2, but are similar in their weathering color. Chaotic stratification and apparent convex-up stratal surfaces are observed within and proximal to the largest Jcp_3 incision-fill succession of figure 5-2. Finally, an uppermost Paveloff subunit, Jcp_4, caps the Chinitna Formation and is overlain by the Naknek Formation (fig. 5-2); the lithostratigraphy of Jcp_4 is generally similar to that of Jcp_2.

INTERPRETATIONS AND DISCUSSION

The stratigraphic architecture of the Paveloff reflects the interplay of numerous factors that influenced forearc basin sedimentation during the Callovian. We concur with LePain and others (2013) that the base of the Paveloff records regression, terminating Tonnie deposition. We infer that high sedimentation rates prevailed during accumulation of thick, sandy beds in the basal Paveloff interval (see also Wartes and Herriott, 2015), likely creating the requisite conditions for rapid dewatering and establishment of convolute stratification in Jcp_1. The channelized Jcp_1 succession is interpreted to record a marine-shoreline-proximal depositional system that prograded over the lowermost Jcp_1 package of chiefly tabular-bedded sandstone. The caliber of sediment and thickness of channel-fill sandstones and the conglomerate of figure 5-4 is suggestive of a high-energy deltaic environment of deposition or possibly nonmarine sedimentation during continued regression. Maximum regression probably corresponds to the end of Jcp_1 deposition; the shoreline is inferred to have stepped landward at onset

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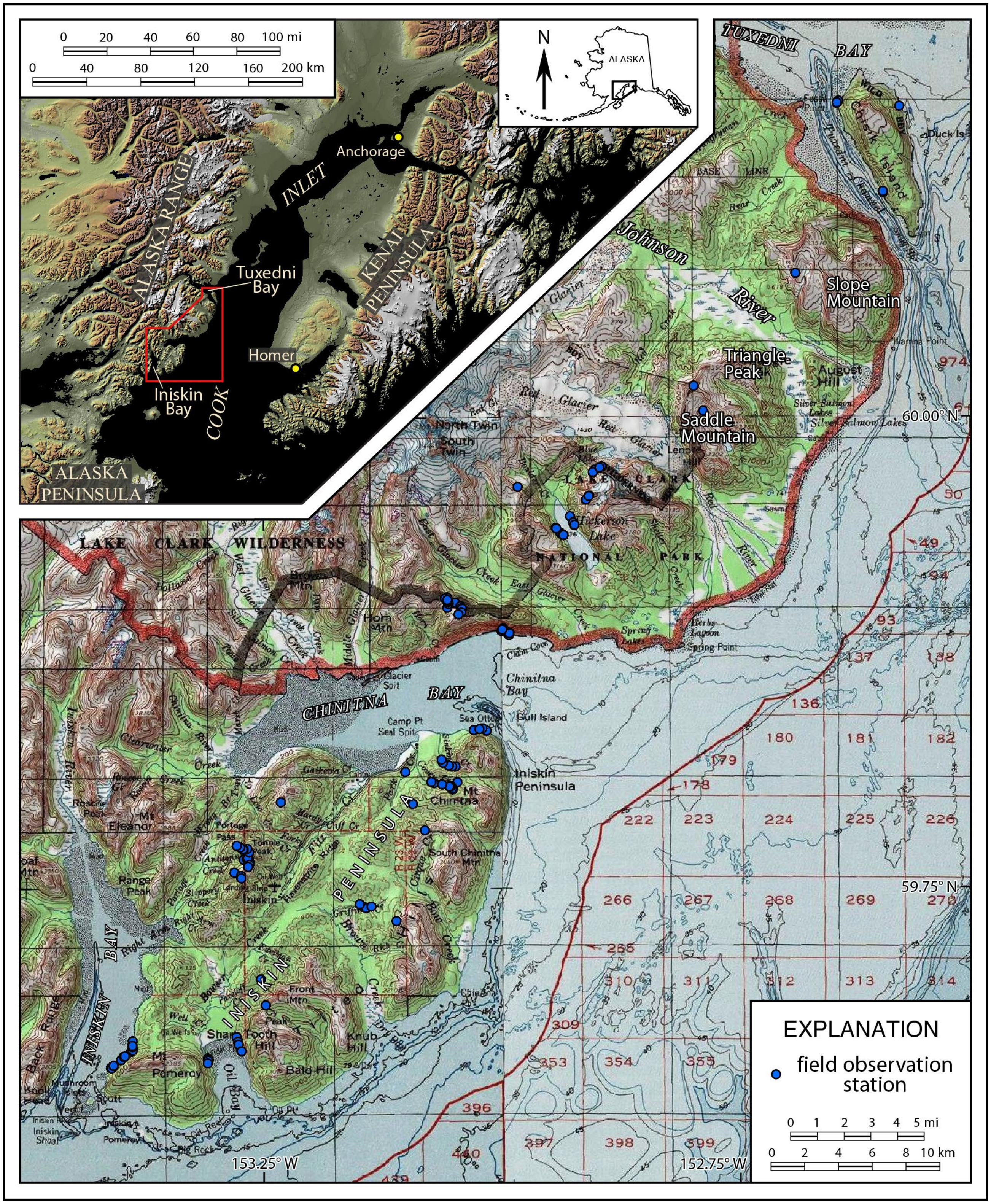

Figure 5-1. Location map of the Iniskin–Tuxedni bays area. Detailed observations of the Chinitna Formation were made by the authors at more than 150 localities during six field seasons and supplemented by geologic mapping of precipitously steep and inaccessible slopes and cliff faces where the unit's two members commonly crop out. This paper focuses on the stratigraphic architecture of the Paveloff Siltstone Member in the Johnson River area south of Tuxedni 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).

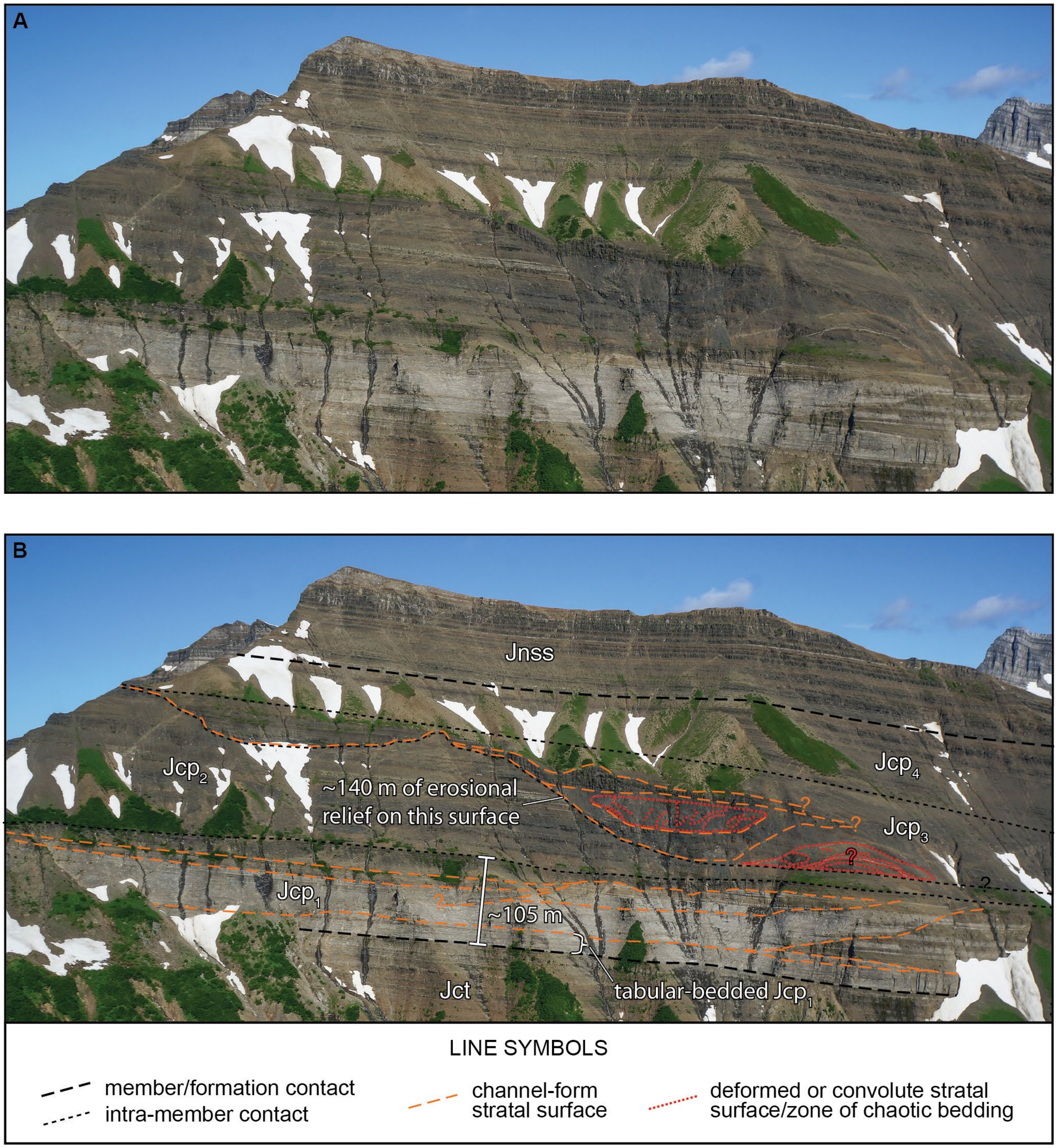

Figure 5-2. Oblique aerial view eastward of mountainside exposure of the Paveloff Siltstone Member and associated stratigraphic units ~3 km northwest of Slope Mountain (fig. 5-1). ***A.*** *Noninterpreted photograph.* ***B.*** *Photogeologic interpretation of photograph. See the text for discussion of the stratigraphic architecture in the Paveloff. Abbreviations:* Jct = *Tonnie Siltstone Member, Chinitna Formation;* Jcp = *Paveloff Siltstone Member, Chinitna Formation (subscripted divisions of this study are discussed in the text);* Jnss = *lower sandstone member, Naknek Formation. Photograph by M.A. Wartes.*

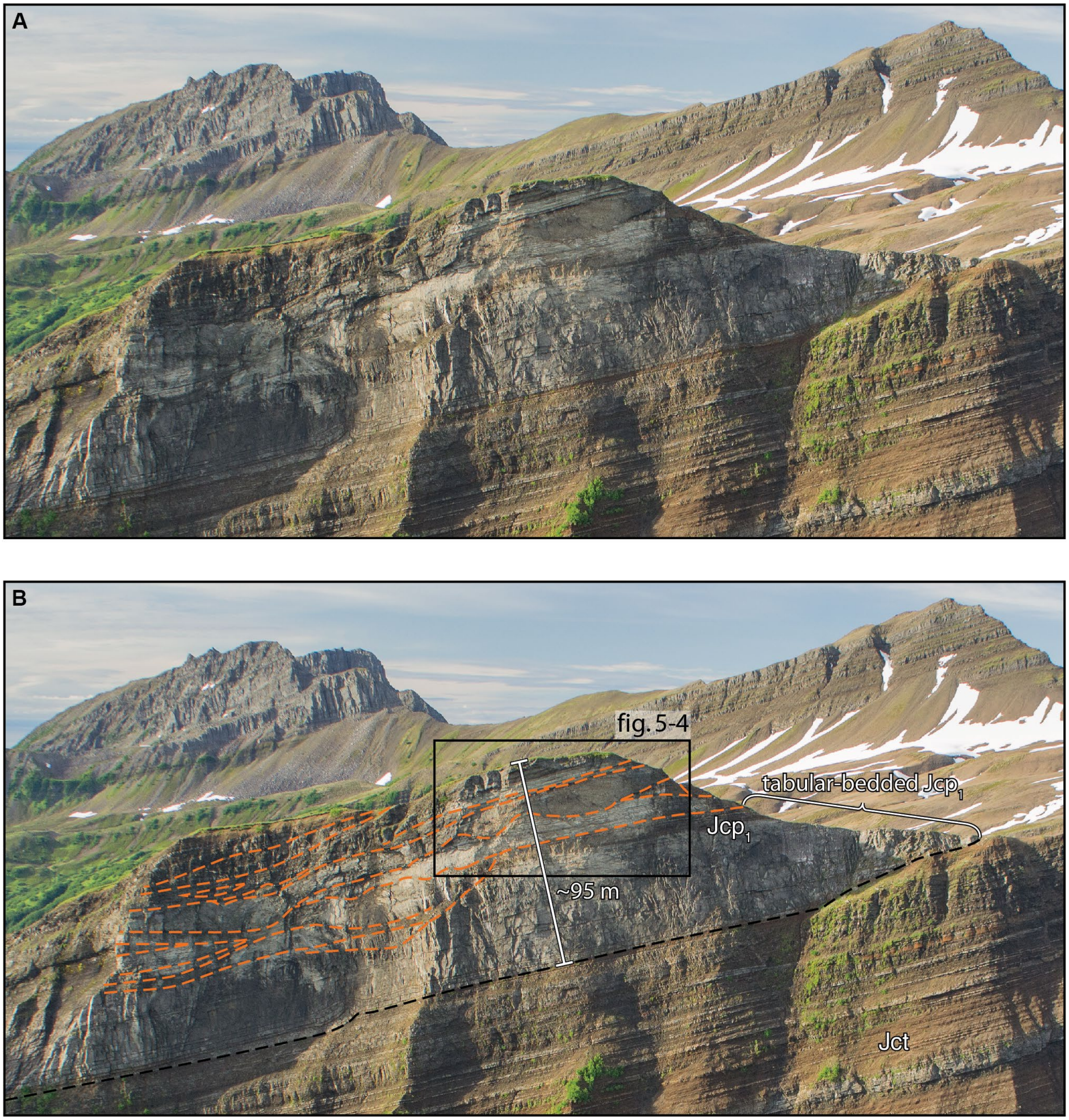

Figure 5-3. Oblique aerial view southward of a cliff-face exposure of upper Tonnie Siltstone and lower Paveloff Siltstone Members ~1.5 km west of Triangle Peak (fig. 5-1). ***A.*** *Noninterpreted photograph.* ***B.*** *Photogeologic interpretation of photograph. Peak at skyline-left is Saddle Mountain (fig. 5-1). See figure 5-2 for line symbol and abbreviation explanations. Photograph by T.M. Herriott.*

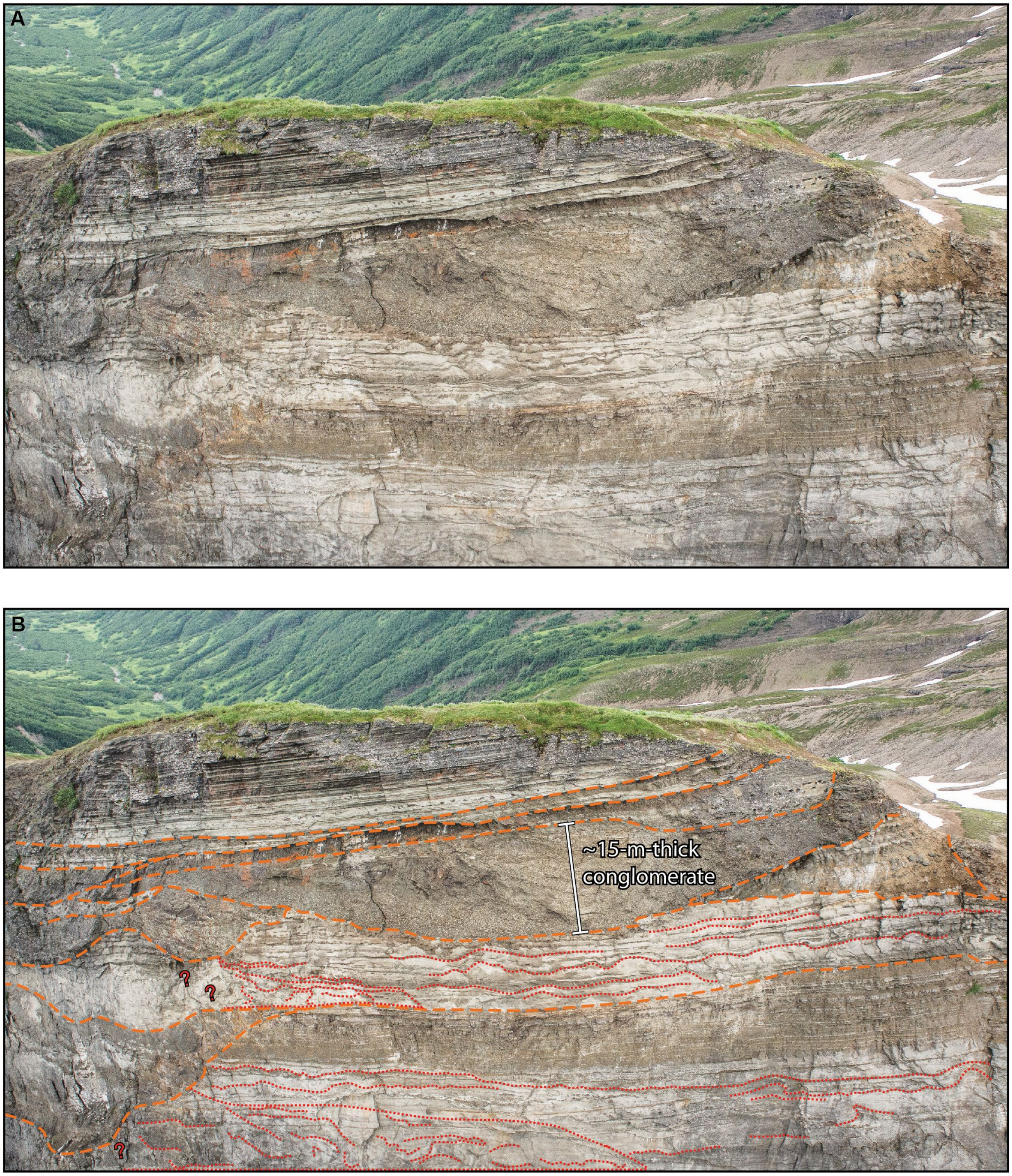

Figure 5-4. Detailed oblique aerial view southward of the cliff-face exposure in figure 5-3. ***A.*** *Noninterpreted photograph.* ***B.*** *Photogeologic interpretation of photograph. Note zones of convolute stratification and ~15-m-thick, channel-form conglomerate discussed in the text. See figure 5-2 for line symbol and abbreviation explanations. Photograph by T.M. Herriott.*

of Jcp_2, which is likely the record of lower-energy shelfal sedimentation. The deep incisions of Jcp_3 may be associated with gravitationally driven submarine mass-wasting processes, as suggested by the deformed strata associated with the largest of these channel forms; a candidate setting for mass-wasting inception of these features is a shelf edge immediately inboard of a steeper gradient slope (compare with Posamentier and Allen, 1999). Although coarser grained and thicker bedded in part, the dark weathering color of the fill in Jcp_3 incisions suggests compositional similarity to the host strata and may in part be recycled sediment from Jcp_2 up-dip. Fine-grained, non-channelized sedimentation (Jcp_4) resumed after the Jcp_3 incisions were healed. Deposition of the Paveloff ceased during establishment of a regional unconformity that Herriott and others (2015) identify as a sequence boundary at the base of the Naknek Formation.

An important aspect of this architectural analysis is the likelihood that significant volumes of coarse detritus associated with Jcp_1 were exported to depositional settings beyond the modern outcrop belt. Furthermore, the incisions of Jcp_3 may indicate proximity to a shelf–slope break, and coarse-grained sediment that reached a shelf edge may have accumulated in slope channels or bypassed to a basin floor (compare with Hubbard and others, 2014). This study thus presents viable scenarios where Paveloff reservoir facies could have been deposited in shallow- to deep-marine environments that today lie in the subsurface of Cook Inlet and may be prospective for oil and/or gas.

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