Stratigraphic and Provenance Data from the Upper Jurassic to Upper Cretaceous Kahiltna Assemblage of South-Central Alaska

By Kevin R. Eastham[1] *and* Kenneth D. Ridgway[1]

Abstract

Upper Jurassic to Upper Cretaceous marine sedimentary strata of the Kahiltna assemblage occur on the suture between the allochthonous Wrangellia composite terrane and the former Mesozoic continental margin of North America. The Kahiltna assemblage crops out in a northeast-southwest-trending belt that is about 800 km long and about 200 km wide in southern Alaska. Most previous studies described these strata as a monotonous, highly deformed "flysch" succession. We have measured a series of stratigraphic sections in the Kahiltna assemblage along a traverse from the south contact in the Clearwater and Talkeetna Mountains to the north contact in the Alaska Range. Our data suggest that the thousands of meters of Upper Jurassic to Upper Cretaceous strata which has been grouped together as the Kahiltna assemblage in south-central Alaska may actually represent several different sedimentary basins.

Proximal-distal lithofacies trends along the southern part of our traverse in the Clearwater and Talkeetna Mountains indicate deposition by predominately mud rich submarine-fan systems that transported sediment northwestward. Locally, adjacent to the Wrangellia composite terrane, the Kahiltna assemblage consists of proximal submarine-fan conglomerate and sandstone. Compositional data from proximal conglomerates in this area show a dominance of volcanic (greenstone) and sedimentary clasts that probably reflect unroofing of the Wrangellia composite terrane carried in the hanging wall of the nearby Talkeetna thrust fault.

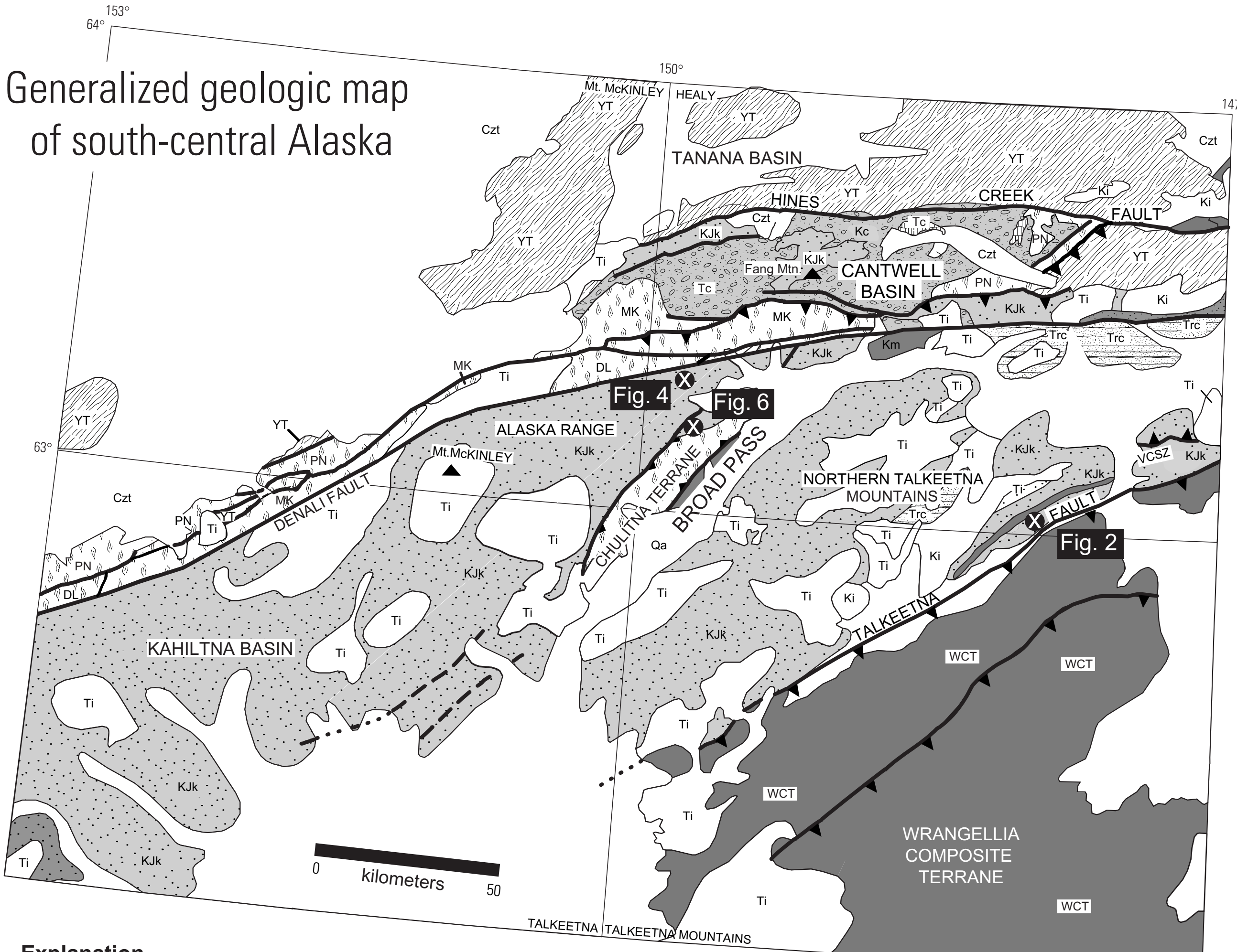
Proximal-distal lithofacies trends in the Kahiltna assemblage along the northern part of our traverse suggest deposition by gravel- and sand-rich submarine-fan systems that transported sediment southwestward. Pebble-boulder conglomerates of the Alaska Range are dominated by sandstone, chert, and granitic clasts indicative of a source terrane rich in sedimentary and plutonic rocks. Possible source terranes for the Kahiltna assemblage of the Alaska Range are Paleozoic continental-margin strata north of the Denali Fault system.

The Kahiltna assemblage of the Alaska Range is separated from the Kahiltna assemblage of the Clearwater and Talkeetna Mountains by a large thrust block of Paleozoic and Mesozoic strata known as the Chulitna terrane. Upper Jurassic to Upper Cretaceous sedimentary strata, also mapped in previous studies as the Kahiltna assemblage, crop out in the Chulitna terrane. These strata are characterized by massive black shale, chert, and inplace fossiliferous limestone that are distinct from lithofacies of the Kahiltna assemblage of the Talkeetna Mountains and Alaska Range. We interpret the lithofacies of the Chulitna terrane as representing deposition on a bathymetric high relative to submarine-fan lithofacies of the Kahiltna assemblage in the Talkeetna Mountains and Alaska Range.

Introduction

Mesozoic strata of the Kahiltna assemblage in the Alaska Range and Talkeetna Mountains of southern Alaska provide a record of sedimentary-basin formation along an accretionary convergent margin. The Kahiltna assemblage consists of Upper Jurassic to Upper Cretaceous strata that occur between the allochthonous Wrangellia composite terrane and the former Mesozoic continental margin of North America—in other words, the Yukon-Tanana terrane (YT, fig. 1; Csejtey and others, 1982; Jones and others, 1982, 1986). The Wrangellia composite terrane consists of three tectonostratigraphic terranes: the Wrangellia, Peninsular, and Alexander terranes (Plafker and Berg, 1994). The thickness of the Kahiltna assemblage is unknown but is estimated to range from 4 to 10 km. The only detailed study of the Kahiltna assemblage is from southwestern Alaska, where Wallace and others (1989) showed that the Kahiltna assemblage was derived from the Wrangellia composite terrane and that the basin formed on the suture zone between the Wrangellia composite terrane and North America. Previous studies of the Kahiltna assemblage in south-central Alaska have been in the context of regional-mapping projects (Csejtey and others, 1978; Reed and Nelson, 1980; Jones and others, 1982; Smith and others, 1988; Csejtey and

[1]Purdue University.



Explanation

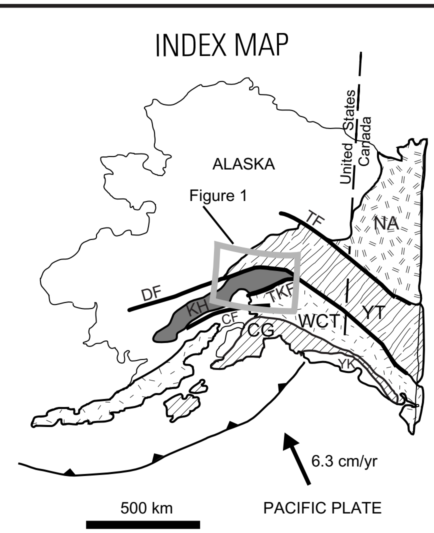
Contact, dotted where concealed

Fault, dashed where inferred, dotted where concealed

Thrust fault, dashed where inferred dotted where concealed, teeth on upper plate

WCT = Wrangellia composite terrane
YT = Yukon-Tanana terrane
DL = Dillinger terrane
MK = McKinley terrane
PN = Pingston terrane
VCSZ = Valdez Creek Shear Zone

Qa = Alluvium (Quaternary)
Czt = Tanana basin deposits (Cenozoic)
Ti = Igneous rocks (Tertiary)
Tc = Cantwell basin volcanic strata (Tertiary)
Kc = Cantwell basin sedimentary strata (Cretaceous)
Ki = Igneous rocks (Cretaceous)
Km = Melange (Cretaceous)
Kjk = Kahiltna assemblage (Late Jurassic to Late Cretaceous)
Trc = Calcareous sedimentary rocks (Late Triassic)



Index Map explanation

KH = Kahiltna assemblage
WCT = Wrangellia composite terrane
YT = Yukon-Tanana terrane
NA = North American craton
CG = Chugach terrane

YK = Yakutat terrane
TKF = Talkeetna thrust fault
DF = Denali fault
TF = Tintina fault
CF = Castle Mountain fault

Figure 1. Generalized geologic map of south-central Alaska, showing locations of measured stratigraphic sections discussed in text. Note location of the Kahiltna assemblage (KJk) between late Mesozoic continental margin of North America (YT) and the Wrangellia composite terrane (WCT). Modified from K.D. Ridgway and others (unpub. data).

others, 1992; Bundtzen and others, 1997; Wilson and others, 1998; Clautice and others, 1999). Csejtey and others (1992) described the Kahiltna assemblage in south-central Alaska as “a monotonous, intensely deformed and locally highly metamorphosed, probably several thousand meters thick, flyschlike turbidite sequence…dark-gray to black argillite, fine- to coarse-grained, generally dark gray lithic greywacke; dark-gray polymict pebble conglomerate; subordinate black chert-pebble conglomerate…” Our preliminary fieldwork, as part of the Talkeetna Mountains mapping project, found that the Kahiltna assemblage contains thick sections of conglomerate and coarse-grained sandstone, as well as “monotonous” fine-grained turbidite facies. We also found that the deformation varies widely in intensity, with much of it concentrated near igneous intrusions. Our study focused mainly on the Kahiltna assemblage exposed in the area between the Denali Fault and the Talkeetna thrust fault (fig. 1). Before our study, few measured stratigraphic sections and compositional data had been collected from the Kahiltna assemblage in south-central Alaska. In this chapter, we present data to characterize the lithofacies, sedimentary structures, and provenance of the Kahiltna assemblage in three different areas of the outcrop belt: the northern Talkeetna Mountains, the southern Alaska Range, and the Chulitna terrane (fig. 1).

Data

Talkeetna Mountains

Stratigraphy

We measured a stratigraphic section of the Kahiltna assemblage from the Butte Creek area in the northern Talkeetna Mountains (fig. 2). The section is adjacent to the Talkeetna thrust fault and represents some of the southernmost Kahiltna assemblage deposits in the study area (fig. 1). In the Butte Creek area, the Kahiltna assemblage consists of three dominant lithofacies: pebble to boulder conglomerate, horizontally stratified sandstone, and laminated siltstone (fig. 2).

The conglomerate lithofacies occurs in discontinuous lenticular beds that are 20 to 50 m long and as much as 25 m thick. The conglomerate is clast supported, containing subrounded pebble- and cobble-size clasts. Internally, this lithofacies consists of normally graded, moderately sorted conglomerate in 0.5- to 1.5-m-thick packages that fine upward into siltstone (for example, 200–216 m, fig. 2). The conglomerate facies is commonly interbedded with laminated siltstone and shale that are tens of meters thick (230–297 m, fig. 2). The normal grading, overall grain size, and moderate sorting of the conglomerate lithofacies all suggests deposition by sandy to gravelly turbidity currents. Clast grading probably occurred as a result of a decrease in current velocity that allowed progressively smaller clasts to settle (for example, Hein, 1982). Imbrication of clasts is rare in these conglomerates. Also present in the Butte Creek section are ungraded, laterally discontinuous boulder conglomerates (308–334 m, fig. 2) that contain poorly sorted, subangular clasts ranging in size from 0.1 to more than 7 m across. We interpret the wide variation in clast sizes (especially the exceedingly large clasts), the angularity of the clasts, and the absence of grading as representing submarine-rockfall/avalanche and debris-flow deposits that occurred in the proximal part of submarine-fan systems adjacent to submarine canyons (for example, Lowe, 1982; Stow and others, 1996).

The sandstone lithofacies is fine to coarse grained and commonly part of the upward-fining packages. Beds range from 10 to 50 cm in thickness, and the bases of the sandstone beds are generally sharp. Horizontal stratification is the most common sedimentary structure observed in the sandstones (360–429 m, fig. 2). Using the Bouma (1962) classification for turbidite deposits, the sandstone beds can be described as Ta (massive, graded sandstone), Tab (Ta unit overlain by horizontally laminated sandstone), and Tabd (Tab unit overlain by laminated siltstone and mudstone). Well-preserved pelecypods (*Buchia*) and ammonites were sampled 525 m from the base of the section in the sandstone facies (fig. 2).

We interpret the siltstone lithofacies (0–54, 230–297, and 476–522 m, fig. 2) as representing pelagic sedimentation and (or) very fine grained, low-density-turbidity-current deposition (Bouma, 1962).

Provenance

Clast composition changes upsection in conglomerates of the Butte Creek section. Low in the section, clasts are mainly of black argillite (53 volume percent), gray limestone (22 volume percent), and siltstone (11 volume percent) (fig. 3*A*). In the middle of the section, the clasts are dominantly of gray limestone (86 volume percent), and black argillite is much less abundant (9 volume percent) (fig. 3*B*). In the uppermost part of the section, clasts are mainly of volcanic rocks (greenstone, 60 volume percent) and chert (17 volume percent) (fig. 3*C*). We interpret the upsection compositional trend in the conglomerates from argillite-dominated, through limestone-dominated, to volcanic-rock (greenstone)-dominated clasts as representing the progressive unroofing of the nearby Wrangellia composite terrane. In this area of Alaska (fig. 1), the Wrangellia composite terrane is exposed in the hanging wall of the Talkeetna thrust fault and consists of more than 3,000 m of Triassic volcanic rocks (Nikolai Greenstone), overlain by 1,100 m of Triassic carbonate strata (Chitistone and Nizina Limestones) and capped by 600 m of Triassic and Jurassic argillite (McCarthy Formation) (Csejtey and others, 1978).

Alaska Range

Stratigraphy

In the southern Alaska Range, we measured a stratigraphic section of the Kahiltna assemblage in the Bull

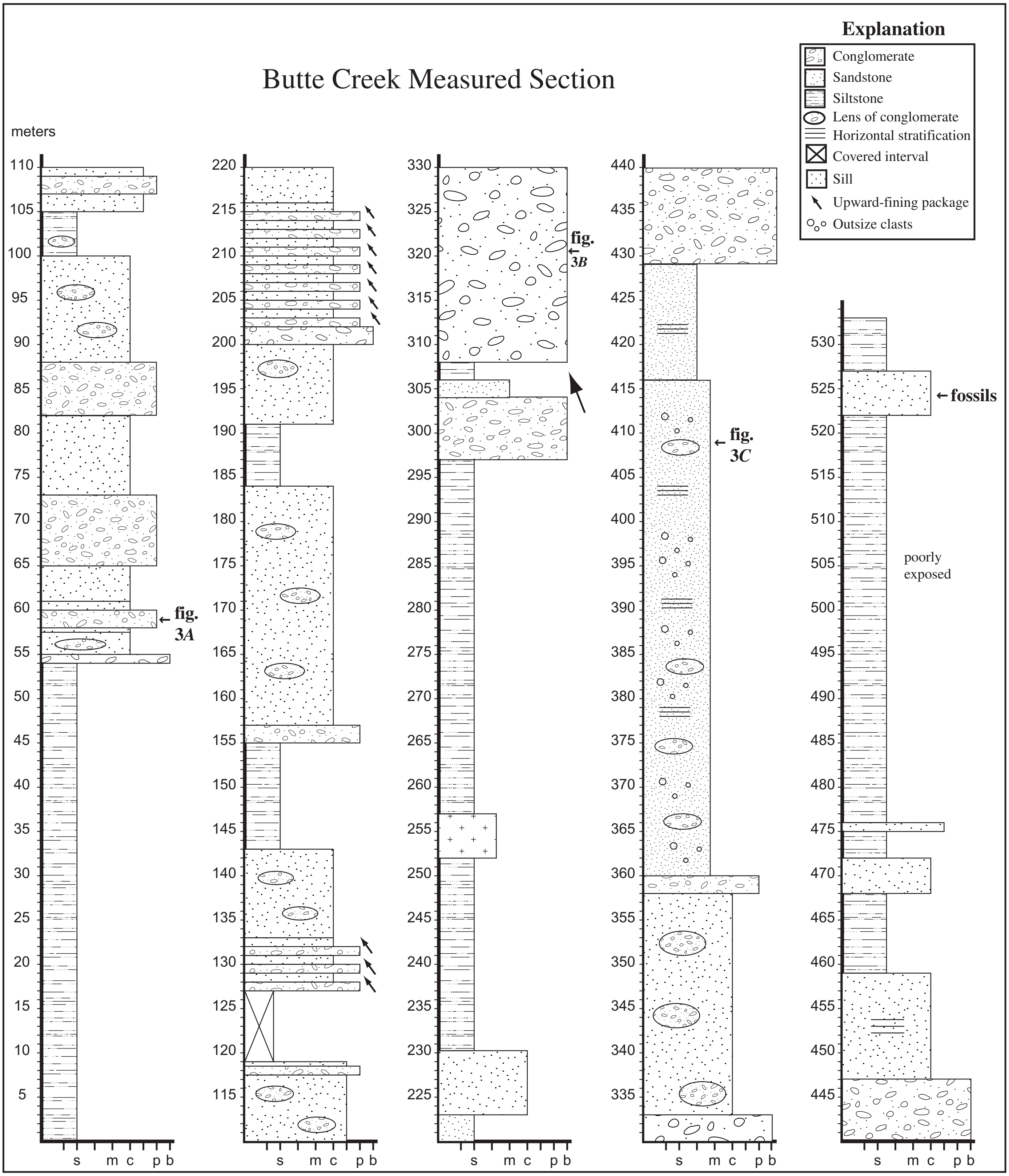


Figure 2. Log of measured stratigraphic section in the Butte Creek area of the northern Talkeetna Mountains, south-central Alaska (fig. 1). Grain sizes are listed on horizontal scales: b, boulder conglomerate; c, coarse-grained sandstone; m, medium-grained sandstone; p, pebble conglomerate; s, siltstone.

River area (fig. 4). The section is immediately south of the Denali Fault and describes some of the northernmost deposits of the Kahiltna assemblage in the study area (fig. 1). Common lithofacies in this section include pebble to boulder conglomerate and upward-fining packages of sandstone, siltstone, and shale.

Massive, ungraded conglomerate beds, as much as 25 m thick (103–128 m, fig. 4), dominate the lower half of the stratigraphic section (0–145 m, fig. 4). The conglomerates are generally poorly sorted, clast supported, and contain subrounded pebble to boulder clasts; imbrication is rare. We interpret these conglomerates as the deposits of subaqueous gravelly debris flows and gravelly turbidity flows (for example, Lowe, 1976a, 1982).

The upper half of the stratigraphic section consists mainly of tabular, upward-fining packages of sandstone, siltstone, and laminated mudstone. The upward-fining packages range in thickness from 0.5 m (204–216 m, fig. 4) to 2 m (154–190 m, fig. 4). Groove casts occur along the sharp, erosive basal contacts of these packages. The upward-fining packages are best described in terms of Bouma's (1962) classification of turbidite deposits. Most of the sandstones are normally graded, from very coarse sandstone at the base (Ta) upward into ripple-laminated, fine- to medium-grained sandstone (Tc) and laminated siltstone (Td). The grain size, normal grading, erosive bases, average bed thickness, and sedimentary structures indicate deposition by sandy, low-density turbidity currents (for example, Bouma, 1962; Middleton, 1967; Lowe, 1976b). Some of the units contain disarticulated pelecypods (190–216 m, fig. 4), but macrofossils are uncommon.

Provenance

The conglomerates in the Bull River section of the Alaska Range (fig. 1) contain clasts of argillite, tuff, granite, and minor chert, limestone, sandstone, and quartz (fig. 5). Upsection trends in clast composition are not apparent (fig. 5), suggesting a mixed igneous and sedimentary source terrane for these conglomerates. Csejtey and others (1992) reported Devonian conodonts from a limestone clast in conglomerate of the Bull River section. Our limited compositional data and Csejtey and others' (1992) Devonian age for this limestone clast suggest that one possible source terrane for the Kahiltna assemblage in the Alaska Range may be Paleozoic continental-margin strata inboard of the suture zone. For example, the Dillinger terrane on the north side of the Denali Fault (DL, fig. 1) contains Devonian limestones lithologically similar to limestone clasts in the Kahiltna assemblage (Csejtey and others, 1992). The Dillinger terrane, however, does not contain a source for the granitic clasts common in the Bull River section. To help identify possible source terrane(s) for clasts, we plan to obtain ages by radiometric dating of granitic clasts and radiolarian identification in chert clasts.

Chulitna Terrane

Stratigraphy

We also measured a stratigraphic section of the Kahiltna assemblage in the West Fork area of the Chulitna terrane (figs. 1, 6). The Chulitna terrane is a large thrust block of

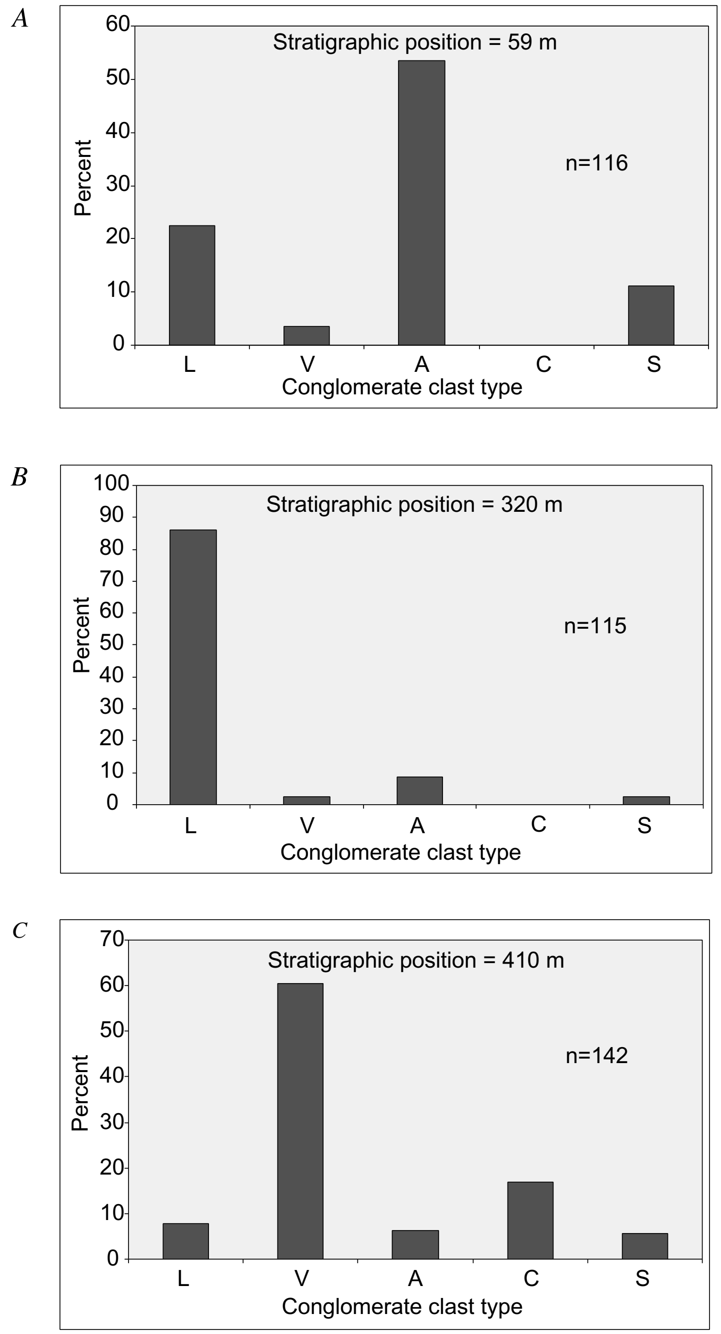


Figure 3. Clast-count data for conglomerates in Butte Creek measured section of the northern Talkeetna Mountains, south-central Alaska (fig. 1). Note upsection change in dominant clast composition from argillite through limestone to volcanic rocks. Stratigraphic position of clast count in measured section is shown in figure 2. Conglomerate clast types: A, argillite; C, chert; L, limestone; S, siltstone; V, volcanic rocks. n, number of clasts counted.

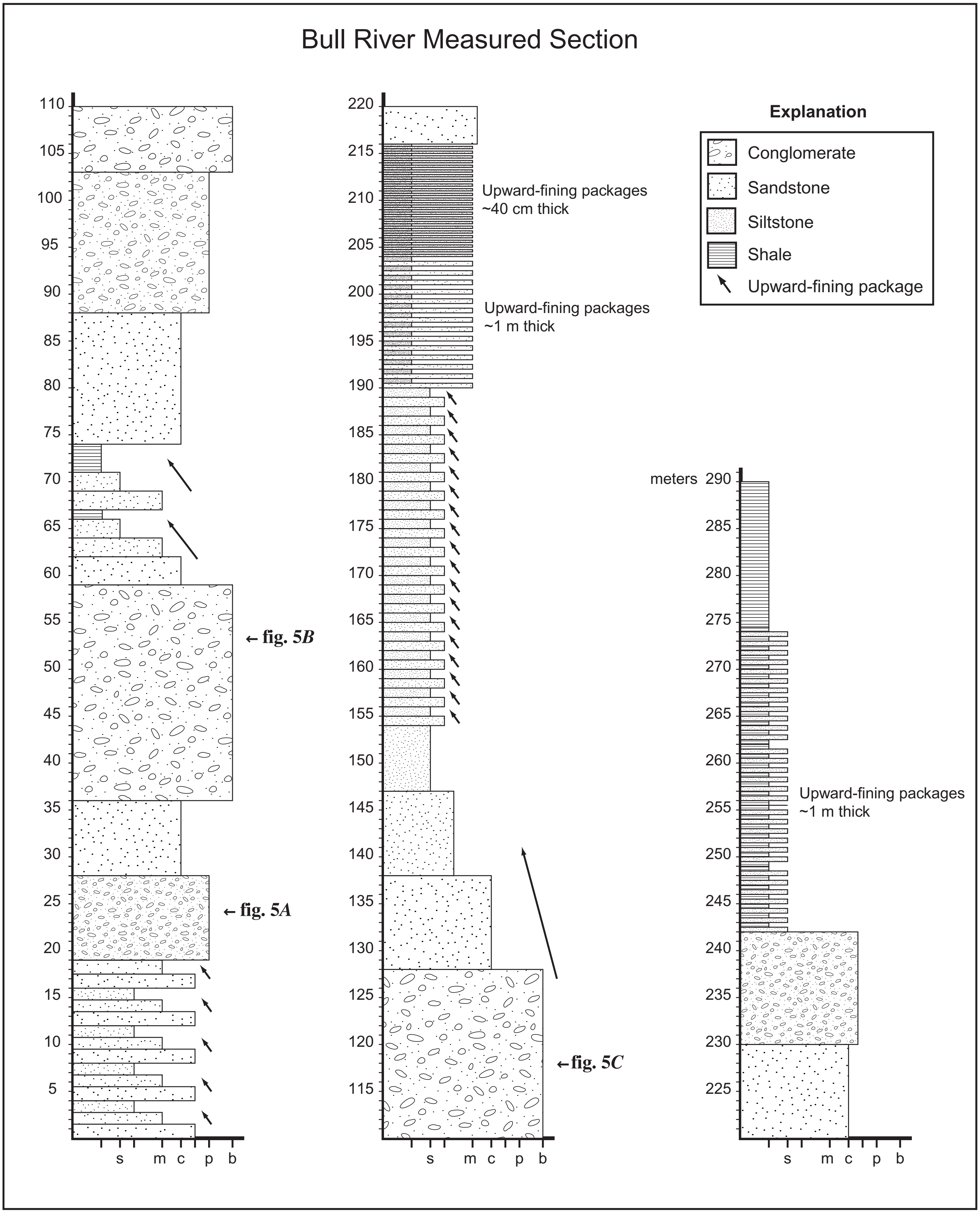


Figure 4. Log of measured stratigraphic section in the Bull River area of the southern Alaska Range, south-central Alaska (fig. 1). Coarse-grained deposits characterize lower part of section (0–150 m), whereas upward-fining packages dominate upper part (150–290 m). Grain sizes are listed on horizontal scales: b, boulder conglomerate; c, coarse-grained sandstone; m, medium-grained sandstone; p, pebble conglomerate; s, siltstone.

upper Paleozoic to lower Mesozoic strata between the northern Talkeetna Mountains and the southern Alaska Range (fig. 1; Jones and others, 1980). Locally, the Kahiltna assemblage disconformably overlies older strata of the Chulitna terrane (Clautice and others, 1999). Our measured section is in the northern part of the Chulitna terrane (fig. 1).

Our measured stratigraphic section consists of three main lithofacies: black shale, chert and cherty siltstone, and fossiliferous limestone (fig. 6). The shale lithofacies, which is the most common in the section (0–121 m, fig. 6), is massive, ungraded, and contains little sand- or gravel-size detritus. We interpret this lithofacies as the product of suspension fallout deposition. The siltstone lithofacies, which is the next most common, consists of gray to brown, laterally continuous, thin-bedded (5–15 cm thick) chert and cherty siltstone (154–168 m, fig. 6). We interpret this lithofacies as the product of biogenic sedimentation in a sediment-starved marine environment. The limestone lithofacies, which is characterized by the pelecypod *Buchia*, consists primarily of well-articulated *Buchia* shells and contains little clastic detritus. As in the other lithofacies of this section, the limestone lacks grading and any distinct current-generated structures. These observations suggest that the limestones formed in place and are not transported storm deposits. Similar *Buchia*-rich limestones in east-central Alaska and the Yukon Territory have been interpreted to form in less than 125 m of water (Clautice and others, 1999).

The presence of black shale, chert, and inplace fossiliferous limestone suggests to us that the Kahiltna assemblage on the Chulitna terrane was deposited in a shallow (<125 m deep) marine environment in which pelecypod communities could flourish with little detrital sedimentation. We interpret the lithofacies of the Chulitna terrane to represent a bathymetric high relative to submarine-fan lithofacies of the Kahiltna assemblage in the Alaska Range and Talkeetna Mountains (fig. 1). Detrital sedimentation on this bathymetric high was mainly limited to pelagic suspension fallout of clay particles.

Conclusions

Our preliminary data suggest that the thousands of meters of Upper Jurassic to Upper Cretaceous strata that have been grouped together as the Kahiltna assemblage in south-central Alaska may actually represent several different sedimentary basins. The Kahiltna assemblage in the northern Talkeetna Mountains was deposited by mud-rich submarine-fan depositional systems that were sourced by a volcanic and sedimentary terrane. The most likely source terrane for these deposits is the Wrangellia composite terrane to the southeast in the hanging wall of the Talkeetna thrust fault (fig. 1). The Kahiltna assemblage in the southern Alaska Range was deposited by gravel- and sand-rich submarine-fan depositional systems that were sourced by a sedimentary and igneous terrane. Although we have not yet identified a specific source terrane for these deposits, we suspect that they may have been derived from Paleozoic continental-margin strata inboard of the suture zone. The Kahiltna assemblage of the Chulitna terrane was deposited in a sediment-starved, shallow (<125 m deep)-marine environment relative to the deeper-marine, submarine-fan systems represented by the Kahiltna assemblage of the northern Talkeetna Mountains and southern Alaska Range. More measured stratigraphic sections and compositional data will be collected during the

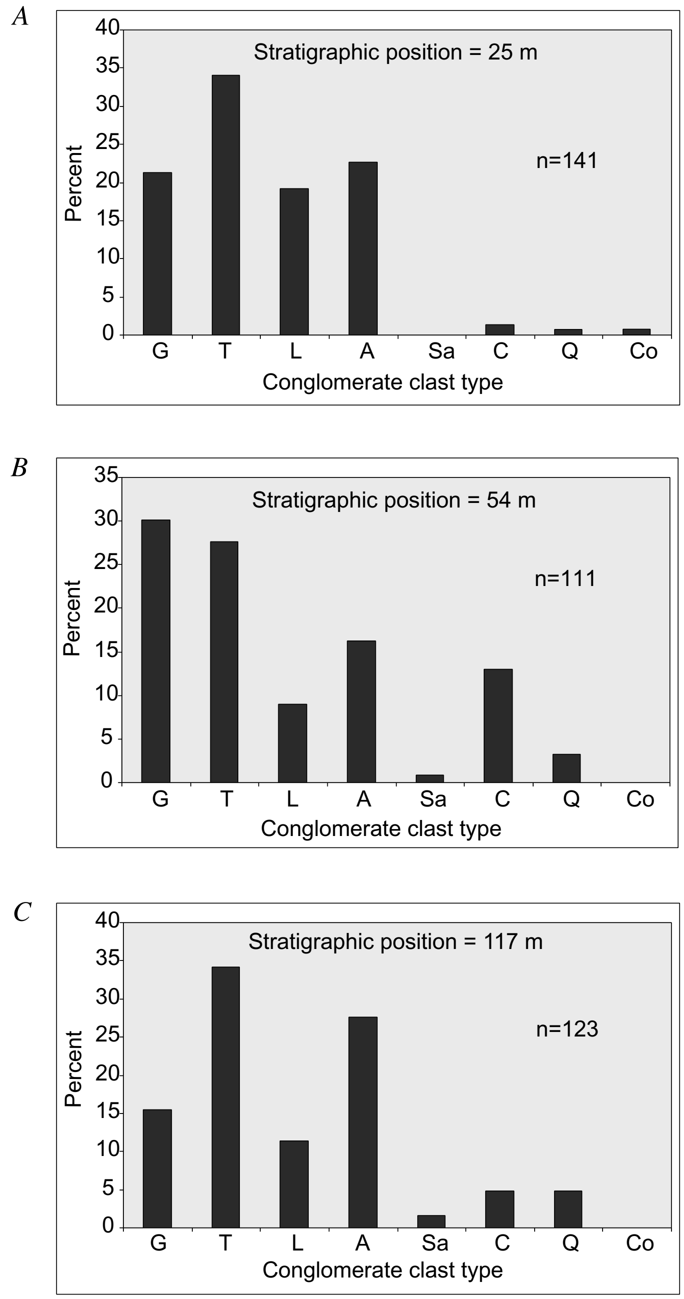


Figure 5. Clast-count data for conglomerates in Bull River measured section of the southern Alaska Range, south-central Alaska (fig. 1). Note that no apparent upsection trends occur in clast composition. Stratigraphic locations of clast counts are shown in figure 4. Conglomerate clast types: A, argillite; C, chert; Co, conglomerate; G, granite; L, limestone; Q, quartz; Sa, sandstone; T, tuff. n, number of clasts counted.

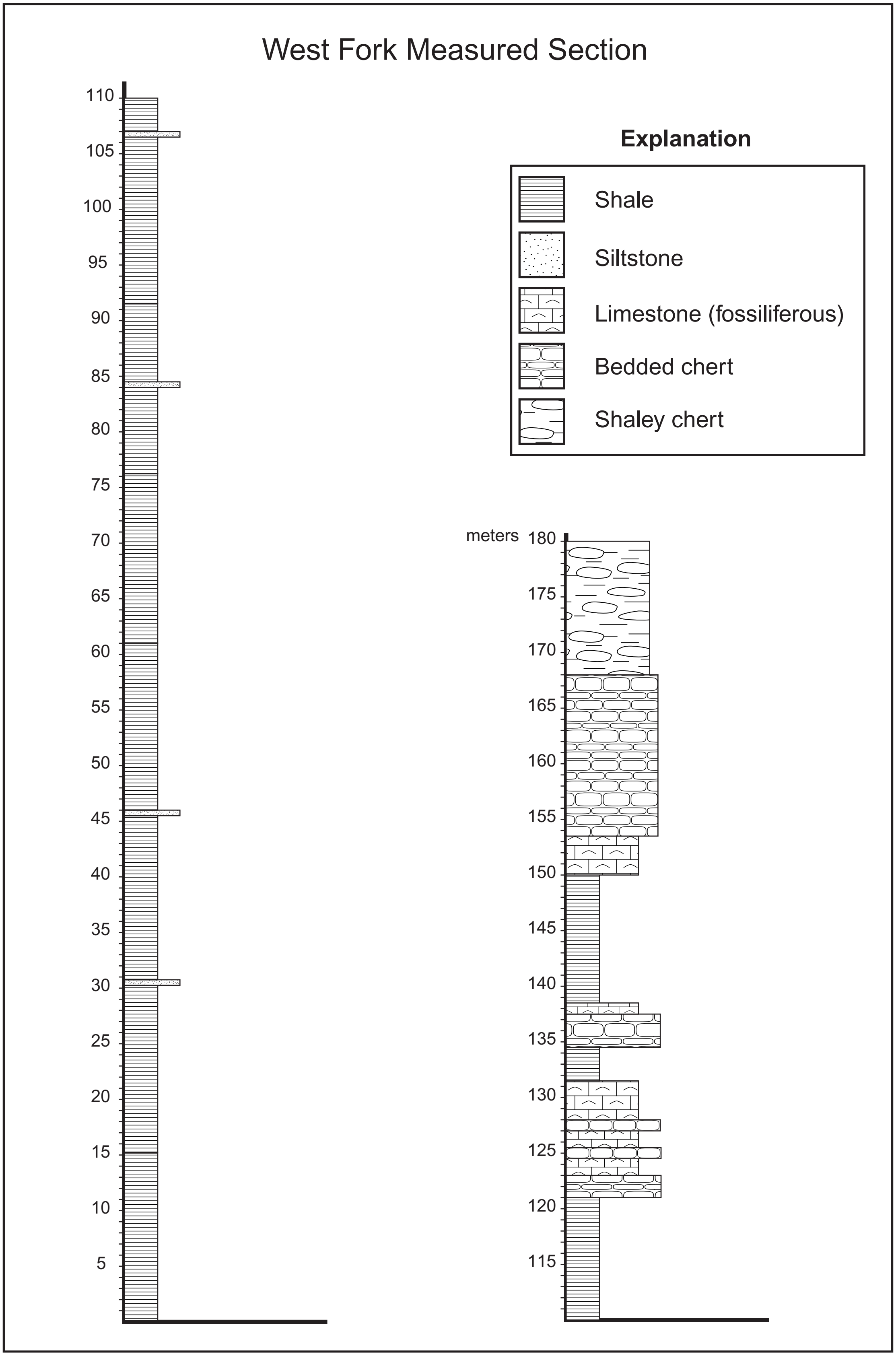


Figure 6. Log of measured stratigraphic section in the West Fork area of the Chulitna terrane, south-central Alaska (fig. 1). Section is characterized by shale, bedded chert, and fossiliferous limestone.

2001 field season to better determine the configuration of the basin(s) represented by the Kahiltna assemblage in south-central Alaska.

Acknowledgments

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