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TERRANE ACCRETION AND DEVELOPMENT OF A FOLD-AND-THRUST BELT IN THE KANDIK REGION, EAST-CENTRAL ALASKA: EVIDENCE FROM FORELAND BASIN SANDSTONES

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The Kandik region straddles the Yukon River just west of the border between Alaska and the Yukon Territory. The region, a fold-and-thrust belt (Howell and Wiley, 1987; Dover and Miyaoka, 1988), lies geographically and structurally at the junction of the Brooks Range and Canadian Cordillera fold-and-thrust belts. Thus, an understanding of the tectonic evolution of the Kandik region is critical to interpreting the geologic development of much of northern Alaska and the Yukon.

The Kandik region can be conveniently viewed in terms of three tectonostratigraphic terranes—the Tatonduk, Kandik River, and Tozitna terranes (Jones and others, 1987; Patton and others, 1989)—that have been juxtaposed during the formation of the fold-and-thrust belt. Middle Triassic through Tertiary rocks preserved in the region record the transition from passive margin to orogenic sedimentation resulting from thrusting and juxtaposition of the three terranes. These deposits include the Middle Triassic to Lower Cretaceous Glenn Shale, the Valanginian Keenan Quartzite, the Lower Cretaceous Biederman Argillite, the Aptian(?) Kathul Graywacke, and Upper Cretaceous to Pliocene(?) nonmarine clastic rocks (the sandstone, mudstone, and conglomerate unit (TKs) of Brabb and Churkin (1969).

The Glenn Shale represents pre-orogenic conditions in the Kandik region. This unit consists predominantly of shale with a rare thin sandstone beds, and records very low rates of sedimentation in a tectonically stable setting. The conformably overlying Keenan Quartzite, a quartz arenite (fig. 1), marks the onset of coarse clastic deposition that began in the Valanginian. The lack of polycyclic quartz overgrowths or sedimentary lithic fragments in this unit suggests a first-cycle origin. The Keenan Quartzite is conformably and gradationally overlain by the Biederman Argillite. This unit, 1,500 to

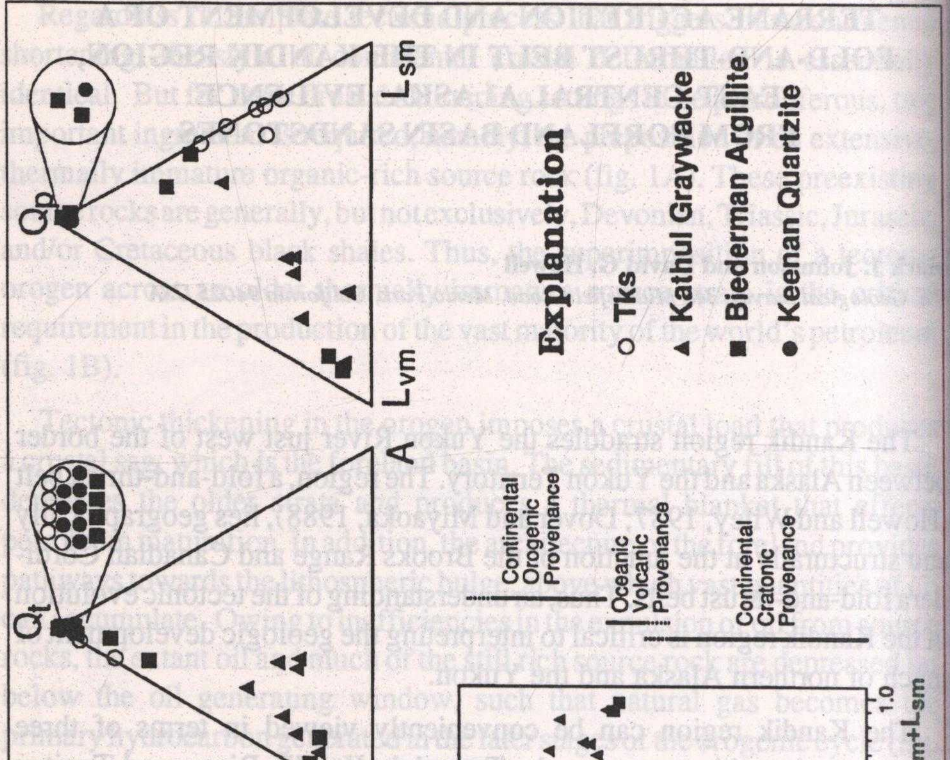

Fig. 1: Compositions of Early Cretaceous through Tertiary sandstones from the Kandik region, determined by preliminary point-counting data. a) Ternary diagrams; Q_t, mono and polycrystalline quartz; Q_p, polycrystalline quartz; F, feldspar; A, monomineralic accessory minerals; L, polymineralic (lithic) fragments; Lv_m, volcanic and metavolcanic lithic fragments; L_{sm}, sedimentary and metasedimentary lithic fragments. b) Stratigraphic variation in ratios of feldspar (F) to quartz+feldspar (Q+F) and of volcanic and metavolcanic lithic fragments (L_{vm}) to sedimentary and metasedimentary lithic fragments (Lsm) in Early Cretaceous through Tertiary sandstones from the Kandik region. Data collected under Gazzi-Dickinson conventions.

at least 2,500 m in thickness, consists almost entirely of fine-grained turbidites (mostly Bouma divisions T_{ce} and T_{ace}) of Mutti/Ricci-Lucchi facies C and D. We interpret the Biederman to represent submarine-fan or related mass-flow deposition in a deep-marine setting. Fine-grained sandstones are quartz wackes near the base of the section but become more feldspathic higher in the section (fig. 1). The uppermost part of the Biederman (<100 m below the contact with the Kathul Graywacke) is a volcanic litharenite that consists primarily of basaltic material of probable oceanic affinity, indicating a major change in provenance. The sedimentary lithic fragments that are important constituents of some samples from the Biederman Argillite (fig. 1) appear to be of intraformational origin. The Kathul Graywacke gradationally overlies the Biederman Argillite and is composed primarily of very coarse grained sandstone and fine-grained conglomerate. The basal part of the Kathul Graywacke contains volcanic litharenites consisting of basaltic detritus similar to that of the upper Biederman. Higher in the section, low-grade metasedimentary lithic fragments become abundant and the proportions of quartz and chert increase (fig. 1). Polycrystalline quartz with metamorphic textures also increases higher in the section. Unit TKs unconformably overlies all of the units in the Kandik River and Tatonduk terranes. This nonmarine unit appears to record late-stage erosion of the the same fold-and-thrust belt as is recorded in the Lower Cretaceous units, but it may contain detritus from terranes outside of the Kandik region as well. Low-grade metasedimentary lithic fragments are much more abundant in this unit than in the underlying Lower Cretaceous units (fig. 1), and volcanic lithic fragments are present only in the stratigraphically lowest portion of the unit (fig. 1).

The compositional variations in the Lower Cretaceous through Tertiary clastic rocks of the Kandik region largely reflect changes in the composition of the source rocks; modification by chemical weathering is probably slight, given the rapid uplift and sedimentation rates inferred for the source regions and the sedimentary basin, respectively. These compositional variations can be conveniently summarized by the ratios of feldspar to feldspar+quartz and of volcanic lithic fragment to volcanic+sedimentary lithic fragments (fig. 1b). The sands of the Keenan Quartzite and the lower part of the Biederman Argillite clearly were derived from a cratonic continental source. The compositional maturity and apparent first-cycle origin of these sandstones are consistent with their derivation from a tectonically quiescent continental setting in which pronounced chemical weathering and a high-energy mechanical breakdown destroyed most unstable components. The upper part of the Biederman records a shift to a basaltic volcanic source, which remained important throughout the deposition of the Kathul Graywacke. A continental orogenic source became important during the deposition of the upper parts of the Kathul Graywacke, and was the dominant source throughout the deposition of unit TKs (fig. 1b).

We interpret believe that these compositional trends reflect the change from passive margin sedimentation to orogenic sedimentation resulting from the obduction of oceanic basaltic rocks onto a continental margin followed by intracontinental shortening, analogous to the Brooks Range orogeny. The Glenn Shale represents preorogenic, shallow-marine passive-margin sedimentation. A sudden influx of quartzose sandstone in the Valanginian, recorded by the Keenan Quartzite and turbidites of the lower part of the Biederman Argillite, probably reflect the regional uplift of a deeply weathered continental source (fig. 2a), perhaps on the rift-shoulder of the opening Canada Basin. The upper part of the Biederman Argillite and the lower part of the Kathul Graywacke record a major shift in provenance to a basaltic volcanic source. The most likely source for such mafic volcanic detritus is the Tozitna terrane, a Devonian ophiolite. Accordingly, this shift in provenance probably records the timing of accretion of the Tozitna terrane (fig. 2b). Continued thrusting and erosion through the uppermost thrust panels of the accreting orogen could have uplifted and exposed Paleozoic strata of the Kandik River terrane, providing sedimentary and metasedimentary sources for the upper part of the Kathul Graywacke and unit TKs (fig. 2 c).

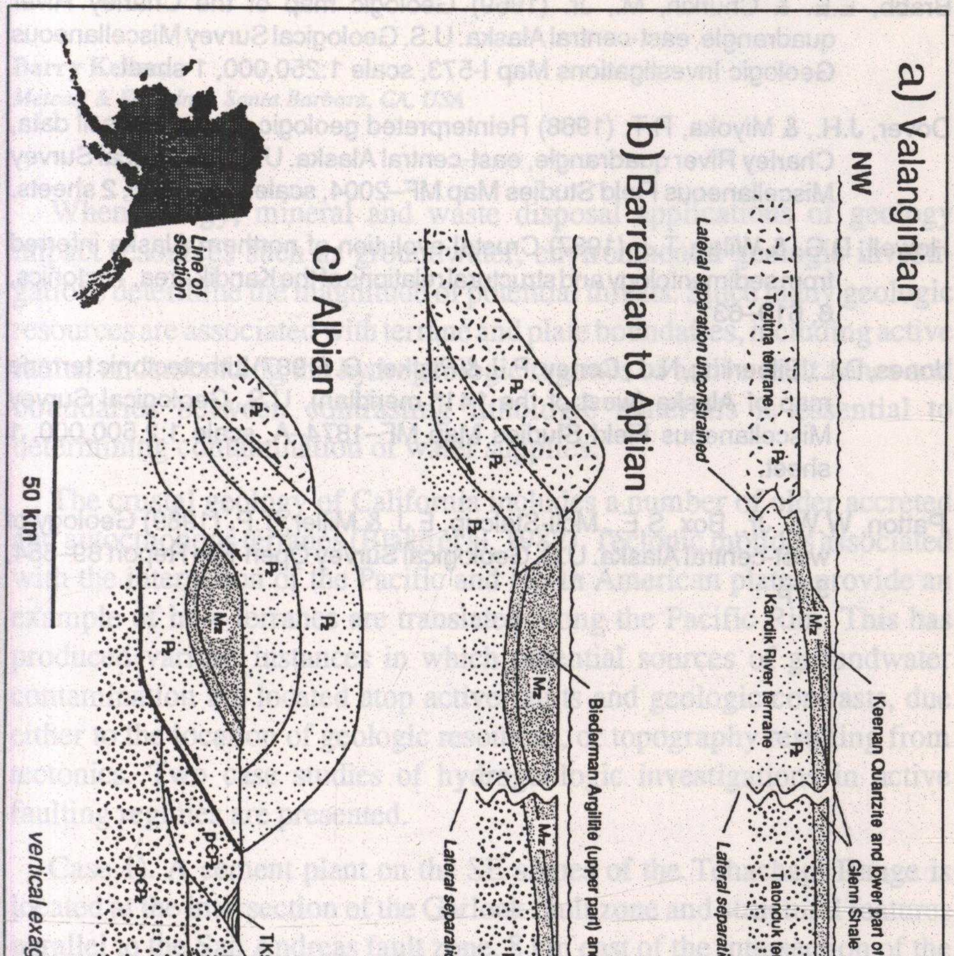

Fig. 2: Schematic structure sections for Kandik region showing development of fold-and-thrust belt. /3: Precambrian to Paleozoic rocks; 3: Paleozoic rocks; 4: Mesozoic rocks; TKs: Cretaceous and Tertiary sandstone, mudstone, and conglomerate unit of Brabb and Churkin (1969).

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