

Mapping of the north flank of the Doonerak Fenster has traced the Amawk thrust, the sole fault of the Endicott Mountains allochthon, from the North Fork of the Koyukuk River–Mount Doonerak area eastward for more than 40 km (25 mi) to the east plunge of the Doonerak anticline at Koyuktuvuk Creek near the Dietrich River. Mapping has concentrated on the structural style of the area and on the autochthonous or parautochthonous Carboniferous Lisburne Group, Kayak Shale, and Kekiktuk Conglomerate—which are present along most of the anticline—and Triassic Karen Creek Sandstone, Triassic Shublik Formation, and Permian–Triassic Sadlerochit Group—which are present only in the west. This Triassic to Mississippian section closely resembles the coeval autochthonous to parautochthonous Ellesmerian section of the subsurface to the north and in the Brooks Range to the northeast.

The north-dipping Amawk thrust is mapped between outcrops of lower Paleozoic metasedimentary rocks and this subjacent Triassic to Mississippian section. On the west, an unbroken stratigraphic sequence underlies the Amawk thrust; a complete section of Karen Creek, Shublik, Sadlerochit, Lisburne, Kayak, and Kekiktuk is exposed in the canyon of Bombardment Creek. The Kekiktuk Conglomerate unconformably overlies weathered Ordovician–Cambrian mafic volcanic rocks. Well-developed slaty cleavage in Sadlerochit and Lisburne rocks is compatible with northward-thrust transport of the overlying Endicott Mountains allochthon. East of Bombardment Creek, structural complexity increases markedly, and multiple slivers of Kekiktuk, Kayak, Lisburne, and Sadlerochit are mapped below the Amawk thrust. At Falsoola Mountain, near the east end of the Fenster, the Lisburne is isoclinally folded. Near Koyuktuvuk Creek, this parautochthonous section can be described as a broken formation. Movement has occurred along incompetent horizons, particularly within the Kayak Shale, resulting in imbrication of the competent beds. This movement can be interpreted as drag resulting from emplacement of the overlying Endicott Mountains allochthon and not from a regionally significant thrust fault.

Along most of the north side of the Fenster, from Mount Doonerak eastward to Falsoola Mountain, east-trending high-angle longitudinal faults uplift the core of the Fenster. These vertical to steeply south-dipping faults have vertical separations of a few meters to over 500 m (1,600 ft), and postdate the Early Cretaceous (probably Neocomian) emplacement of the Endicott Mountains allochthon. This uplift was probably related to the Albian and Late Cretaceous tectonic events interpreted elsewhere in the Brookian orogen. Alternatively, the high-angle faults can be interpreted as part of the floor of a duplex. However, there is no evidence of any large amount of horizontal translation along these faults.

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#### Kemik Sandstones, Arctic National Wildlife Refuge (ANWR), Alaska

In the Sadlerochit Mountains area of ANWR, the Kemik Sandstone of Hauterivian–Barremian age ranges to at least 35 m (120 ft) of very well sorted, fine-grained quartzose sandstone with minor pebble conglomerate. It is an elongate body traceable for over 160 km (100 mi) from the eastern Sadlerochit Mountains into the subsurface near the Sagavanirktok River to the west. In the northeast, it crops out in a belt about 16 km (10 mi) wide; to the southwest in the subsurface, it expands to about 65 km (40 mi) wide. It is a potential petroleum reservoir in the subsurface of ANWR, but its distribution north and east of the Sadlerochit Mountains is unknown.

The Kemik overlies a regional angular unconformity with increasing depth of truncation northward; it is overlain by and intertongues with an unnamed “pebble-shale” unit. Data suggest that the Kemik was derived from erosion of Lisburne Group carbonate rocks and a terrain of mature sedimentary rocks north and east of the outcrop belt. Conglomerate clasts consist dominantly of white leached spicular and foraminiferal chert, silicified carbonate, and quartzite. Although the sand has a nearly uniform grain size from east to west, conglomerate clasts are most abundant to the northeast and become smaller and less abundant westward; few are noted west of the Canning River. This distribution is suggestive of longshore drift from the northeast.

A shoreface depositional environment, possibly a barrier island along a coast with low tidal flux, seems to be represented in the Kemik. Beds up to 2 m (6 ft) thick with sweeping low-angle cross stratification are interbedded with parallel laminated units and scattered, thin, maroon

siltstone–mudstone beds. Vertical burrows up to 0.5 m (20 in.) long and truncated by overlying beds are conspicuous in some areas. A sparse pelecypod fauna is present, usually in the maroon silty horizons.

The Kemik and other coeval sandstone and conglomerate horizons in the subsurface, such as the Put River sands and the Point Thomson sands, are probably separate bodies of sediment derived from uplifted blocks along the rifted Arctic Alaska plate margin.

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#### Goodnews Terrane and Kuskokwim Group, Eek Mountains, Southwest Alaska: Open Marine to Trench-Slope Transition

In the Eek Mountains, southwest Alaska, four depositional settings record Permian to mid-Cretaceous marine sedimentation and post-Valanginian crustal shortening. Sequence 1: pillowed basalt flows ( $\text{SiO}_2 = 44\%$ ) and volcanoclastic sediments intercalated with Permian Atomodesma-bearing sandy limestones grade upward through volcanic debris flow deposits and tuffaceous argillites into sequence 2: thin-bedded chert with argillite partings. Sequence 3 rests conformably(?) on sequence 2 and consists of undated argillite grading upward into Early Cretaceous (Valanginian) thin-bedded T<sub>cd</sub>/T<sub>de</sub> turbidites and thick-bedded conglomeratic grain flow deposits. Sequence 4 consists of late Early Cretaceous (Albian) thick-bedded conglomeratic grain flow deposits and minor T<sub>cd</sub>/T<sub>de</sub> and T<sub>a</sub>/T<sub>ab</sub> turbidites. Sequence 4 (Kuskokwim Group) overlies sequences 1, 2, and 3 (Goodnews terrane) with an angular unconformity preserving submarine canyon cut-and-fill.

Sequence 1 requires an ocean island(?), and sequence 2 an open marine origin. Sequences 3 and 4 are inner-fan turbidite deposits; conglomerate and sandstone compositions indicate recycled orogen, arc orogen, and collision orogen provenances. This suggests preaccretion Valanginian clastic input from the now-adjacent Kilbuck terrane.

All four sequences record southeast over northwest imbrication along southeast-dipping thrusts. Deformation and metamorphic intensity increases with age/depth; a maximum is recorded in pervasively foliated Permian greenstone crosscut by prehnite and pumpellyite veins. Sequences 1 and 2 are highly disrupted, with local blocks-in-matrix fabric. Sequence 3 shows a similar, less pervasive style. Sequence 4 is locally disrupted and overturned along faults but lacks penetrative deformation. Deformation began between Valanginian and Albian times, and either progressively penetrated upsection with time or was multiphased with consistent recurring structural style.

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#### Overview of Gold-Bearing Skarns of Southern Alaska

Although skarn deposits occur throughout Alaska, skarns with appreciable gold production/reserves are largely limited to an arcuate belt that stretches through southeastern and southern Alaska to the Alaska Peninsula. Within this belt are nearly 100 known gold-bearing skarn prospects and deposits. They occur in a variety of tectono-stratigraphic terranes, with no consistent age or character of the host carbonate unit. These skarns are, however, characterized by specific geologic associations, including intrusives, alteration, ore and gangue mineralogy, and trace metals.

Intrusions associated with gold skarns are typically medium-grained, equigranular to slightly porphyritic members of gabbro-diorite-tonalite or diorite-quartz monzodiorite suites. Intrusive alteration, if present, consists predominantly of secondary albite, actinolite, and epidote, with little secondary quartz and sulfide and very rare secondary K-feldspar and muscovite. Typical “identifying” mineralogies include an abundance of epidote, chalcopyrite, and chlorite; the presence of pyrrhotite, “specular magnetite,” idocrase, scapolite, hornblende, and albite; and the general absence of bornite, sphalerite, and galena. Generally, only minor amounts of sulfides and magnetite in gold skarns are present in the skarns per se or the associated plutons; most of the (gold-bearing) sulfide and magnetite is present at the marble front. Trace elements found at anomalous levels in gold skarns include Ni, Co, As, V, Mo, Sb, and Bi. Elements that are inevitably low in gold skarns include Zn, Pb, F, Sn, Be, W, and Ba. These elemental characteristics contrast strongly with those of gold-poor skarns and with metamorphosed volcanogenic massive sulfide deposits.