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Ordovician Geology of Alaska

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Abstract

Ordovician rocks, found in northern, east-central, interior, and southern Alaska, formed in a variety of depositional and paleogeographic settings. Shallow- and deep-water strata deposited along the northwestern Laurentian margin occur in east-central Alaska (Yukon River area) and probably correlative rocks crop out to the north in the Porcupine River area. Ordovician strata elsewhere in Alaska are parts of continental or island arc fragments that, as indicated by faunal and detrital zircon data, have been variously displaced. In northern Alaska, Ordovician rocks are included in the Arctic Alaska–Chukotka Microplate (AACM), a composite tectonic entity with a complex history. Some Ordovician strata in the AACM (parts of the North Slope subterrane) represent displaced fragments of the northern Laurentian margin. Coeval strata in southwestern parts of the AACM (York and Seward terranes, Hammond subterrane) share distinctive lithologic and biotic features with Ordovician rocks in interior Alaska (Farewell and related terranes). Ordovician strata in southeastern Alaska (Alexander terrane) also likely compose a composite crustal fragment that accumulated in a complex arc system. Shared features between many of these units suggest similar origins as part of one or more crustal fragments situated in the paleo-Arctic between Laurentia, Baltica, and Siberia during early Paleozoic time.

Ordovician rocks are widely distributed throughout Alaska, represent a range of lithofacies deposited in shallow- to deep-water marine environments, and occur in several tectonic terranes with distinct geologic histories (fig. 1). In this chapter we summarize the lithologies, biostratigraphy, depositional settings, and paleogeographic affinities of these strata, updating previous overviews (Harris et al. 1995; Blodgett et al. 2002; Dumoulin et al. 2002, 2014; Dumoulin and Harris 2012).

Much of Alaska is roadless and the geology of many areas is not yet known in detail. Lower Paleozoic rocks in Alaska have mostly been studied as part of regional mapping efforts, so the ages of all or parts of these successions are generally not well constrained. In addition, many Paleozoic successions in Alaska have been deformed during Paleozoic or younger tectonic events, and they are commonly metamorphosed. We focus here on strata of definite Ordovician age in east-central, northern, interior, and southeastern Alaska (fig. 1). Many Ordovician rock units in Alaska have no formal stratigraphic names and are referred to below using map unit designations. Fossil ages are given using modern global stage terminology (Goldman et al. 2020) as well as the series/stage and/or zone terminology of the paleontologists who described the fossils where appropriate.

Faunal affinities (Dumoulin and Harris 1994, 2012; Blodgett et al. 2002; Dumoulin et al. 2002, 2014; Strauss et al. 2013) and more recently detrital zircon U-Pb data (Strauss et al. 2013, 2019a; Till et al. 2014a, b; Dumoulin et al. 2018) indicate diverse origins for the Ordovician rocks that occur across Alaska. Ordovician carbonate rocks that likely formed as part of the Laurentian continental margin crop out in east-central Alaska, in the Yukon River area; possibly correlative strata occur to the north in the Porcupine River area (fig. 1). Some Ordovician rocks in northern Alaska (North Slope subterrane of the Arctic Alaska–Chukotka Microplate, AACM; fig. 1) are also of probable peri-Laurentian origin. Other Ordovician strata within Alaska contain Laurentian, Siberian, and locally Baltic endemic faunal elements and most likely were not attached to the Laurentian craton during their deposition. To avoid a long review of terrane and map unit nomenclature in Alaska, below we identify what terrane and/or subterrane these various Ordovician rocks belong to and then differentiate internal exposures based on the regional geography.

East-Central Alaska: Laurentian Margin

Ordovician strata of the Laurentian continental margin are exposed in several Cordilleran thrust sheets along the Yukon-Alaska border region between the Tintina fault and the Porcupine shear zone (figs. 1, 2; Churkin and Brabb 1965; Dover 1994). Silberling et al. (1994) separated this region into two distinct tectonic domains: 1) autochthonous rocks of the North American margin exposed immediately north of the Tintina fault and south of the Mesozoic Kandik basin (also referred to as the Nation Arch area, e.g. Payne and Allison 1981, or the Yukon River area herein); and 2) para-autochthonous or allochthonous rocks of the Porcupine terrane exposed between the Kandik basin and Porcupine shear zone (fig. 1). The Porcupine terrane nomenclature should most likely be abandoned, as many of the early Paleozoic rocks in this region are correlative with autochthonous age-equivalent strata south of the Kandik basin (e.g., Jin and Blodgett 2020); here, we refer to these exposures as the Porcupine River area. Collectively, lower Paleozoic strata of east-central Alaska mark the westernmost edge of what has been referred to as the Yukon block in adjacent Canada (also called the “Yukon Stable Block” or the “Ogilvie Platform”; Morrow 1999), which represents a distinct paleogeographic high that accommodated platformal carbonate sedimentation along the northwestern edge of Laurentia (in present coordinates).

Yukon River Area

Unmetamorphosed, predominantly shallow-water carbonate strata of the lower Cambrian–Upper Ordovician Jones Ridge Limestone (Brabb 1967; Taylor et al. 2015) are best exposed in mountainous regions of the Yukon-Charley Rivers National Preserve along the international border. These rocks were originally subdivided into an ~900 m thick lower member of lower Cambrian–Lower Ordovician fine-grained limestone and dolostone and a thinner (~15 m thick) upper member of coarse-grained Upper Ordovician bioclastic limestone (Churkin and Brabb 1965; Brabb 1967; Rigby et al. 1988, 2008; Rohr and Blodgett 1994). Recent work by Taylor et al. (2015) tentatively reassigned the lower half of the Jones Ridge Limestone to the lower-middle Cambrian Funnel Creek Formation and subdivided the remaining Jones Ridge strata into the informal Squaw Mountain, Harrington Creek, Hi-Yu, and Nimrod members, in stratigraphically ascending order. Lower Ordovician (Tremadocian) faunas were recovered in the Hi-Yu member of the Jones Ridge Limestone; these strata are separated by a significant unconformity from Upper Ordovician (Katian) strata of the Nimrod member. Silurian (mid-Wenlock) chert and shale of the middle Cambrian–Middle Devonian Road River Group (recently elevated to Group status by Strauss et al. 2020 in adjacent Yukon, Canada, and adopted herein) locally onlap the Nimrod member of the Jones Ridge Limestone (Churkin and Brabb 1965; Brabb 1967; Blodgett et al. 1984).

Ordovician deeper-water equivalents of the Jones Ridge Limestone are exposed west of the mountainous Jones Ridge area but still within the Yukon-Charley Rivers National Preserve and surrounding regions of the Charley River quadrangle (Churkin and Brabb 1965; Brabb 1967). These strata consist of fine-grained limestone of the Lower Ordovician (Tremadocian) Hillard Limestone (Brabb 1967), which is locally unconformably overlain by Middle Ordovician (Darriwilian)–Silurian chert and shale of the Road River Group (Churkin and Brabb 1965). Age-equivalent shallow-water carbonate strata of the Bouvette Formation are exposed further north and east in Yukon, Canada (e.g., Morrow 1999; Pyle 2012).

Porcupine River Area

Ordovician rocks of the Porcupine River area have been examined at only a reconnaissance level and have no formal stratigraphic names. These poorly understood rocks lack detailed lithologic descriptions and precise age control and have been reported as an ~600 m thick succession of mottled to laminated limestone and dolostone (e.g., Brosgé and Reiser 1969; Brabb 1970). Rare fossil collections from the Porcupine River area document Lower Ordovician conodonts and brachiopods (Brabb, 1970; Dumoulin and Harris 2012), as well as Middle and Upper Ordovician brachiopods, corals, and conodonts (Brabb 1970; Oliver et al. 1975; Rohr and Blodgett 1994; Dumoulin and Harris 2012; Jin and Blodgett 2020). The fossil assemblages from this region are almost exclusively Laurentian, and it is likely that these strata correlate with age-equivalent strata in adjacent Yukon, Canada, and the Yukon River area of east-central Alaska.

Northern Alaska: Arctic Alaska–Chukotka Microplate

Ordovician rocks crop out discontinuously across northern Alaska, from the Seward Peninsula through the Brooks Range, and have also been penetrated by exploration wells beneath the North Slope (figs. 1, 2). These strata are all included in the AACM, a composite tectonic entity with a complex geologic history (Hubbard et al. 1987; Natal'in et al., 1999; Miller et al., 2006). A variety of different subdivisions have been proposed for this composite microplate; here we mainly follow the terminology of Till and Dumoulin (1994), Strauss et al. (2013, 2019a, b), and Dumoulin et al. (2014). Ordovician strata in the northeastern Brooks Range, on the Lisburne Peninsula in northwestern Alaska, and in the subsurface beneath the North Slope are part of the North Slope subterrane. Ordovician rocks are also found in the southwestern part of Arctic Alaska, on Seward Peninsula and in the western and central Brooks Range, all parts of the "southwestern subterranes" of Strauss et al. (2019a, b). Diverse data sources, including faunal affinities, stratigraphic correlations, and detrital zircon U-Pb analyses, indicate distinct histories for lower Paleozoic strata in these two regions within the AACM. The Doonerak arc complex in the central Brooks Range also includes Ordovician rocks (Repetski et al., 1987); this complex marks a tectonic boundary between the North Slope subterrane and rocks of the southwestern subterranes of the AACM (Strauss et al. 2017).

North Slope Subterrane

Northeast Brooks Range: Platformal Succession. Peri-Laurentian and largely unmetamorphosed Ordovician carbonate strata of the Sunset Pass Formation (Nanook Group) are exposed in the Shublik and Sadlerochit Mountains of the northeastern Brooks Range (fig. 1; Dutro 1970; Blodgett et al. 1986; Strauss et al. 2013, 2019a). These Lower Ordovician (Tremadocian) and Middle(?)/Upper Ordovician (Katian) strata consist predominantly of peloidal mudstone, wackestone, and grainstone with rare intervals of biohermal boundstone (Blodgett et al. 1986, 1988; Strauss et al. 2013, 2019a). Age constraints from this succession are relatively sparse, but Blodgett et al. (1986, 1988) and Strauss et al. (2013) reported definitively Laurentian Tremadocian (Stairsian) conodonts and trilobites, as well as non-diagnostic Middle-Late Ordovician gastropods and cephalopods. The Sunset Pass Formation is overlain by a profound Early Devonian angular unconformity (Blodgett et al. 1988; Strauss et al. 2019a).

Northeast Brooks Range: Basinal Succession/Whale Mountain Allochthon. Polydeformed peri-Laurentian Ordovician siliciclastic rocks are exposed in two distinct lower Paleozoic outcrop belts within the Franklin, Romanzof, British, and Barn Mountains of the northeastern Brooks Range of Alaska and Yukon. The first belt is the northeast Brooks Range basinal succession of Strauss et al. (2019b). Lower–Middle Ordovician (Floian–Dapingian) graptolites were reported from an interbedded black to dark grey chert and slate/phyllite unit in the Firth River area, Yukon (Lane and Cecile 1989), which is likely correlative with Reiser et al.'s (1980) lithologically similar chert and phyllite map unit Ccp in the Demarcation Point quadrangle and Strauss et al.'s (2019a) Leffingwell formation. These strata were previously considered part of the Road River Group (Lane et al. 2015), but given they are exposed within the peri-Laurentian North Slope subterrane of the AACM, Strauss et al. (2019b) recommended avoiding nomenclatural ties to autochthonous rocks of the adjacent Yukon block. The second Ordovician–bearing outcrop belt is from the structurally overlying Whale Mountain allochthon (Johnson et al. 2019; Strauss et al. 2019a). Middle Ordovician (Darriwilian) graptolites (Moore and Churkin 1984) have been recovered from grey and black chert, slate, and mudstone of the Romanzof formation (Johnson et al. 2019), which is correlative with map unit OCcp of Reiser et al. (1980) or the Romanzof chert of Mull and Anderson (1991). A lithic wacke ~100+ m above the graptolite collection, in the upper part of the Romanzof formation (Johnson et al., 2019) has yielded detrital zircons with Middle Ordovician (ca. 460 Ma) maximum depositional ages (Strauss et al. 2019b). The depositional relationship between Ordovician strata in the basinal succession and the Whale Mountain allochthon is poorly understood, although Johnson et al. (2019) hypothesized they are part of the same tectonically shortened peri-Laurentian passive margin succession. The peri-Laurentian affinities of these strata are based on Cambrian trilobite assemblages described in Dutro et al. (1972) and Johnson et al. (2019).

Cape Lisburne. The Iviagik Group (Martin 1970; Moore et al. 2002) crops out south of Cape Lisburne; it consists of Middle and Upper Ordovician (Darriwilian through Katian) graptolitic argillite and shale overlain by mixed siliciclastic-carbonate turbidites that contain early Silurian (Llandovery) conodonts and graptolites (Dumoulin et al. 2014 and references therein). Bentonitic(?) layers occur in the lower part of the succession, which formed in a slope and/or basinal setting (Dumoulin and Harris 2012; Dumoulin et al. 2014). Silurian turbidites from the upper part of the Iviagik Group produced abundant ca. 700-400 Ma detrital zircon U-Pb ages, in addition to a range of older, mainly Mesoproterozoic grains (Dumoulin et al. 2018). This signature has similarities to those of both Ordovician and Silurian strata in the Farewell terrane, which is discussed below.

North Slope subsurface. Lower Paleozoic strata beneath the North Slope of Alaska that were penetrated by exploratory petroleum wells are part of a Devonian and older basement complex (Dumoulin 2001; Dumoulin and Harris 2012). Ordovician and Silurian fossils have been recovered from dark, organic-rich, siliceous argillite interbedded with radiolarian chert. One core sample yielded chitinozoans of Late Ordovician (Caradoc to Ashgill) age with strong Baltic paleogeographic affinities (Carter and Laufeld 1975).

Doonerak Arc Complex

The early Paleozoic Apoon assemblage (Julian 1989; Julian and Oldow 1998) of the Doonerak arc complex is exposed in a structural window within the central Brooks Range (fig. 1; Mull et al. 1987; Julian and Oldow 1998; Strauss et al. 2017). The Apoon assemblage was subdivided into four fault-bounded and informal map units (Pza, Pzc, Pzp, and Pzv) whose primary depositional and/or intrusive relationships are ambiguous (Julian 1989; Julian and Oldow 1998). Early–Middle Ordovician (~478–462 Ma) mafic volcanic and intrusive rocks of map unit Pzv (Dutro et al. 1976; Strauss et al. 2017) yielded calc-alkaline, island arc, and mid-ocean-ridge geochemical signatures (Moore 1987; Julian and Oldow 1998; Moore et al. 1997). Repetski et al. (1987) also reported poorly preserved Middle(?) Ordovician conodonts from siliceous volcaniclastic rocks of map unit Pza of the Apoon assemblage. Strauss et al. (2017) reported Early Ordovician (Tremadocian-Floian) and Middle–Late Ordovician (Darriwilian–Hirnantian) detrital zircon U/Pb maximum depositional ages from volcaniclastic units in map units Pzp and Pzc, respectively. Together, these data suggest the Doonerak arc complex records multiple phases of juvenile volcanism and sedimentation in a long-lived island arc system. Although there are no paleobiogeographic data from the sparse Ordovician fossils in the Doonerak arc complex, middle Cambrian trilobite fossils from map unit Pzp have affinities with Siberian forms (Dutro et al. 1984).

York and Seward Terranes

Ordovician rocks make up the bulk of a thick, unmetamorphosed carbonate succession (York succession of Dumoulin et al. 2014) in the York terrane (Till and Dumoulin 1994) on western Seward Peninsula (fig. 1). Variously deformed and metamorphosed carbonate and siliciclastic strata of Ordovician age also exposed in this area may have formed as parts of the York succession and its offshore equivalents. Ordovician carbonate rocks also make up parts of several units within the blueschist- and greenschist- facies Nome Complex on central and eastern Seward Peninsula (Till et al. 2014b), part of the Seward terrane of various authors (e.g., Till and Dumoulin 1994).

Megafossils and general lithologies of carbonate rocks in the York terrane are found in Sainsbury (1969, 1972); more detailed lithofacies and conodont biostratigraphy of Ordovician strata across Seward Peninsula are described in Dumoulin et al. (2014). Conodont color alteration indices (CAIs) from Seward Peninsula define distinct thermal provinces that likely reflect structural burial during the Jurassic-Cretaceous Brooks Range orogeny (Dumoulin et al. 2014). CAIs of 2 to 5 characterize unmetamorphosed to weakly metamorphosed strata of the York terrane. Penetratively deformed, high-pressure rocks of the Nome Complex have CAIs of 5 to 8; highest values (>6) reflect hydrothermal alteration related to dolomitization and/or faulting. We focus here on the unmetamorphosed rocks of the York succession (fig. 2) and then briefly describe partly coeval, more deformed and metamorphosed rocks found elsewhere on Seward Peninsula.

York Terrane. The York succession is at least 2000 m thick and consists chiefly of shallow water carbonate strata of Early Ordovician through at least late Silurian (Ludlow) age that have no formal stratigraphic names (fig. 2); most precise ages throughout the succession come from conodonts (Dumoulin et al. 2014 and references therein). Lower Ordovician rocks are the most widely distributed part of the succession and comprise map units Oal (argillaceous limestone) and Ol (limestone) of Sainsbury (1969). These units are in part coeval and intergradational, but Oal is as old as early Tremadocian (*Rossodus manitouensis* Zone) and Ol is as young as latest Floian or slightly younger (*Reutterodus andinus-Tripodus laevis* zones). Both units consist mainly of lime mudstone and peloid-intraclast grainstone deposited in a deepening upward shelfal regime. Floian (lower Arenig) graptolitic shale locally interfingers with the carbonate strata. Middle Ordovician rocks are graptolitic shale interbedded with carbonate turbidites that shallow upward into cephalopod-bearing limestone; these strata likely accumulated in an intraplatform basin. Youngest Ordovician rocks are diversely fossiliferous limestones containing rugose corals of probable Katian (Richmondian) age deposited in locally restricted, shallow-water platform settings.

Biotic and detrital zircon data imply a non-Laurentian origin for the York succession. Conodont and megafossil faunas from these strata include a distinctive mix of Laurentian and Siberian endemic forms, particularly well-developed in Early and Late Ordovician (Tremadocian-Floian and Katian) assemblages (Dumoulin et al. 2014). Trilobites from the Ol unit (Ross 1965) have closest affinities with coeval faunas from the eastern margin of Baltica (Ormiston and Ross 1979; Dumoulin et al. 2014). A detrital zircon sample from sandy beds in Oal yielded major peaks at ca. 480 Ma and smaller peaks at ca. 1800, 780, and 600 Ma (Dumoulin et al. 2014, 2018); the youngest peak is close to the absolute age of the sampled strata based on conodont zonation. This spectrum is similar to those obtained from Ordovician strata elsewhere in Alaska thought to have a non-Laurentian origin, further discussed below.

Nome Complex. The Nome Complex (Till et al. 2011, 2014b) encompasses varied lithologies that have all experienced penetrative deformation and blueschist- and greenschist-facies metamorphism. Fossils (mainly conodonts) and detrital zircons constrain the protolith ages of these rocks (Till et al. 2011, 2014a, b). The complex has been divided into several informal subunits, all of which exhibit a common set of structural and/or metamorphic features likely formed in the same deformational event (Till et al. 2014b). Ordovician rocks are found in three of these subunits: the "Layered sequence", "scattered metacarbonate rocks", and "metaturbidites".

The Layered sequence includes five map units that occur in a consistent structural order (Till et al. 2011, 2014b). Two units produced Ordovician conodonts: Oim, impure marble, and DOx, a lithologically mixed unit that includes marble and quartz-graphite schist. Ordovician dolostone (map unit Od of Till et al. 1986, 2011) is part of the scattered metacarbonate rocks subunit and forms small, widely dispersed outcrops (Dumoulin et al. 2014). Conodonts indicate mainly Early and a few probable Middle Ordovician ages; relict sedimentary structures and conodont biofacies imply mostly shallow- and warm-water depositional settings. Conodonts are mainly cosmopolitan forms but include some Siberian and Laurentian endemics.

Lower Paleozoic carbonate metaturbidites crop out on northeastern and southeastern Seward Peninsula (Dumoulin et al. 2014). Both successions have yielded mainly Silurian conodonts but include some older rocks; conodont CAIs are 5-7.5, consistent with the metamorphic grade found elsewhere in the Nome Complex. The northeastern succession begins with ~50 m of argillite that contains abundant Late Ordovician graptolites and sparse Ordovician conodonts; graptolites represent four zones within the Sandbian and Katian (Ryherd et al. 1995). The southeastern succession yielded one collection of middle Early through Late Ordovician conodonts, including forms typical of outer shelf or deeper depositional environments (Dumoulin et al. 2014).

Hammond Subterrane

A succession of lower Paleozoic (locally Cambrian through Devonian), mainly carbonate rocks is discontinuously exposed in the western and central parts of the southern Brooks Range and makes up a prominent part of the Hammond subterrane (fig. 1; Moore et al. 1994; Strauss et al. 2013, 2019a, b). Like the Nome Complex, these strata are deformed and have experienced blueschist- and greenschist-facies metamorphism, but original sedimentary features are locally well preserved, and many sections are tightly dated, largely by conodonts. Ordovician rocks in this succession have been best studied in the western and eastern Baird Mountains in the western Brooks Range and in the Snowden Mountain area to the east (fig. 2; Dumoulin and Harris 1987, 1994; Dumoulin et al. 2002, 2014). Ordovician strata are also known from a handful of other localities in the Hammond subterrane, including sites in the Ambler River, Survey Pass, and Arctic quadrangles (Toro 1998; Brosgé et al. 2001; Till et al. 2008). Lithologic and biotic features of Hammond strata are much like those in coeval successions on Seward Peninsula, suggesting a common provenance (Dumoulin and Harris 1994; Dumoulin et al. 2002, 2014).

Western Baird Mountains: The lower Paleozoic carbonate succession in the western Baird Mountains (Dumoulin and Harris 1987, 1994; Karl et al. 1989) is part of the Baird Group (as restricted by Dumoulin and Harris 1994) and is like the York succession on Seward Peninsula (Dumoulin et al. 2014). No pre-Ordovician strata are known in the western Baird Mountains, and the carbonate succession begins with ≥400 m of Lower and Middle Ordovician strata deposited in very shallow to deeper water platformal settings with restricted to normal marine circulation (fig. 2). Two partly coeval facies are recognized. The older, Lithofacies II, is similar to unit Oal in the York succession; it includes strata of *R. manitouensis* Zone through *Macerodus dianae* Zone age with locally abundant non-carbonate detritus. Lithofacies I extends from the middle Tremadocian into the Floian or slightly higher and resembles unit Ol in the York succession. Several intervals of dark, fine-grained metacarbonate rock that produced cool-water conodonts of Early and Middle Ordovician age represent slightly deeper water incursions within the predominantly shallow-water section. Areally restricted Upper Ordovician strata yielded conodonts typical of mid- to outer-platform settings.

Eastern Baird Mountains and Snowden Mountain area: Carbonate platform successions in these areas correlate well and include Neoproterozoic(?), Cambrian, and Ordovician strata. Ordovician rocks in the eastern Baird Mountains have no formal stratigraphic names and form a shallowing upward succession overlying Cambrian strata that is capped by Upper Ordovician and Silurian shallow-water dolostone and metalimestone (fig. 2). Lower to lower Upper Ordovician rocks (unit Opc of Till and Snee 1995; subunits 3 and 4 of unit OCc of Karl et al. 1989) are carbonaceous phyllite, metachert with radiolarians, and calcareous interbeds that increase upward in abundance and thickness and pass from basinal carbonate turbidites to platformal bioclastic grainstone. The age of this interval is well constrained by Floian through Darriwilian (Arenig-Llanvirn) graptolites (Carter and Tailleur 1984) and Darriwilian (Llanvirn–Caradoc?), chiefly cool-water conodonts.

The metacarbonate succession in the Snowden Mountain area is much like that in the eastern Baird Mountains. Ordovician strata at Snowden Mountain are included in two informal units (Dumoulin and Harris 1994). The Snowden Creek unit consists of carbonaceous phyllite, metachert, and metalimestone. Conodonts indicate an age of Middle to early Late Ordovician (late Arenig to early Caradoc?); lithofacies and biofacies indicate deposition in settings that shallowed upward from basin and slope to platform. This unit is overlain by the Mathews River unit, which consists of Upper Ordovician and Silurian shallow-water carbonate rocks.

Summary and Discussion

As highlighted above, the AACM is a composite microplate that hosts diverse Ordovician-bearing carbonate and siliciclastic sedimentary successions with Laurentian, Siberian, and Baltic paleogeographic affinities. In the North Slope subterrane, Ordovician strata are exposed in four different localities: 1) the northeast Brooks Range platformal succession; 2) the northeast Brooks Range basinal succession; 3) Cape Lisburne; and 4) the North Slope subsurface. The northeast Brooks Range platformal and basinal successions most likely represent displaced fragments of the northern Laurentian margin (fig. 3), with potential affinities to the Franklinian basin of Ellesmere Island, Canada, and Greenland (Strauss et al. 2019a, b). In contrast, the affinities of the lower Paleozoic strata at Cape Lisburne and in the North Slope subsurface remain ambiguous. The Cambrian-Silurian Doonerak arc complex marks a prominent tectonic boundary between the North Slope subterrane and rocks of the southwestern subterranes of the AACM (Strauss et al. 2017).

The southwestern subterranes include strata on the Seward Peninsula (York and Seward terranes) and in the western and central Brooks Range (Hammond subterrane). Ordovician rocks in the southwestern subterranes are part of a discontinuously exposed succession of early Paleozoic (locally, Cambrian to Devonian) age; these strata share lithologic and biotic features that suggest a similar origin. Most are carbonate rocks that may once have been part of a single continental margin succession, the North Alaska carbonate platform of Dumoulin et al. (2002). Subordinate siliciclastic strata likely accumulated in more distal settings along this margin. Paleozoic, Mesozoic, and Tertiary tectonic events disrupted the original distribution of this succession, and much of it has been metamorphosed to greenschist and blueschist facies. Unmetamorphosed Ordovician rocks in this region occur only on northwestern Seward Peninsula. Ordovician strata in the southwestern terranes contain a highly distinctive early Paleozoic biota that includes Laurentian, Siberian, and some Baltic endemic forms (Blodgett et al. 2002; Dumoulin et al. 2002, 2012, 2014). This biota, along with detrital zircon data (Till et al. 2014a), suggest that the southwestern subterranes were situated in the paleo-Arctic realm between Laurentia, Siberia, and Baltica during Ordovician time (fig. 3; Dumoulin et al. 2002, 2012, 2014, 2018).

Interior Alaska: Ruby Terrane

The Ruby terrane (Jones et al. 1987; Silberling et al. 1994) is a Proterozoic(?)–Paleozoic assemblage that extends southwest from the southeastern margin of the AACM (fig. 1). It consists of blueschist and greenschist facies metamorphic rocks, chiefly schist and quartzite and lesser carbonate and metabasite (Patton et al. 1994; Patton and Moll-Stalcup 2000; Till et al. 2008). Few precise ages are known from these strata and the paleogeographic affinities of the terrane are uncertain; a shared Devonian-Jurassic tectonic history with the AACM has been proposed (e.g., Roeske et al. 2017).

Dolostone in the southwestern part of the Ruby terrane (Nulato quadrangle) produced Ordovician conodonts from several samples (fossil locality 33 in Patton and Moll-Stalcup 2000). The most tightly dated fauna is diagnostic of the *Pygodus serra* Zone of the Middle Ordovician (upper Darriwilian) and indicates a mid-shelf to basinal depositional environment (Dumoulin and Harris 2012). Conodonts of this same age and biofacies are found in parts of the Hammond subterrane (eastern Baird Mountains, Snowden Mountain area) discussed above (Karl et al. 1989; Dumoulin and Harris 1994).

Interior Alaska: Farewell and Related Terranes

South of the Ruby terrane, Ordovician rocks occur in several other terranes in interior Alaska. Definitively Ordovician strata that are mostly unmetamorphosed are widespread in the Farewell terrane, and partly coeval and possibly correlative strata are found in the White Mountains and Livengood terranes (fig. 1).

Farewell Terrane

The Farewell terrane (Decker et al. 1994; Bradley et al. 2014; Dumoulin et al. 2018) is a large continental fragment made up of a Proterozoic basement complex overlain by mainly unmetamorphosed younger Proterozoic through Mesozoic strata; these younger rocks are divided into several subterranes. Ordovician strata occur in the Nixon Fork subterrane, a Neoproterozoic to Devonian carbonate platform succession, and its deep-water equivalent, the Dillinger subterrane. These rocks have lithologic, biotic and other similarities to coeval successions in northern and southeastern Alaska.

*Nixon Fork Subterrane***.** Rocks of the Nixon Fork subterrane have been studied in some detail in the Medfra quadrangle and to the south in the Lone Mountain area (central McGrath quadrangle; figs. 1, 2). A thick succession of Ordovician through Devonian, chiefly shallow-water strata is exposed in the eastern Medfra quadrangle (Dutro and Patton 1982; Dumoulin and Harris 2012 and references therein). The oldest unit, the Novi Mountain Formation, is 900 m thick and consists of limestone, silty limestone, and calcareous shale of Early Ordovician (Tremadocian) age. It is succeeded by the

Telsitna Formation, 2000 m of micritic to peloidal limestone of Floian through Hirnantian age. Both units accumulated mainly in inner to middle platform environments, although the uppermost part of the Telsitna includes Katian to Hirnantian calcareous turbidites and radiolarite deposited in deeper water settings.

Strata in the Lone Mountain area represent an outlier of the Nixon Fork carbonate platform. Unnamed Cambrian and Ordovician dolostones overlie a late(?) Neoproterozoic sedimentary succession (Babcock et al. 1994; Dumoulin and Harris 2012; Dumoulin et al. 2018). Definitively Ordovician strata here yielded Tremadocian-Floian conodonts and Late Ordovician conodonts and diverse megafossils; lithofacies and biofacies indicate shallow- to very shallow-water platformal settings (Dumoulin and Harris 2012 and references therein).

Ordovician biotas of the Farewell terrane, like those of the southwestern subterranes of the AACM, contain a distinctive mixture of Siberian, Laurentian, and lesser Baltic endemic species (Blodgett et al. 2002; Dumoulin et al. 2002, 2012, 2018; Rasmussen et al. 2012). Identical endemic Ordovician conodont species, some with Laurentian and some with Siberian biogeographic affinities, occur in the carbonate successions of the Farewell terrane and in coeval strata on Seward Peninsula and in the western and central Brooks Range; megafossil assemblages in these areas also show similarities (Dumoulin et al. 2014).

Dillinger Subterrane. The Dillinger subterrane is exposed mainly east and southeast of Lone Mountain and consists of Cambrian through Devonian turbidites and related strata deposited in slope to basinal settings (figs. 1, 2). The succession has been best studied in the McGrath quadrangle, where it begins with the upper Cambrian to Lower Ordovician Lyman Hills Formation (Bundtzen et al. 1994, 1997). This unit is mainly parallel- and cross-laminated silty limestone with Furongian conodonts and Early Ordovician (Tremadocian; *Adelograptus tenellus* Zone) graptolites (Churkin and Carter 1996; Bundtzen et al. 1997). These strata are overlain by the Ordovician to lower Silurian Post River Formation, which is largely dark graptolitic shale and argillite; graptolite zones diagnostic of Floian through Katian age are recognized in the Ordovician part of this unit (Churkin and Carter 1996). Very fine-grained sandstone interbedded with shale bearing late Darriwilian–early Sandbian graptolites produced a detrital zircon sample with a youngest U/Pb age population of ca. 491 Ma (latest Cambrian), as well as abundant Neoproterozoic and rare Mesoproterozoic grains (Dumoulin et al. 2018).

White Mountains and Livengood Terranes

The White Mountains and Livengood terranes (Silberling et al. 1994) are exposed northeast of the Farewell terrane (fig. 1); biotic, lithologic, and detrital zircon data suggest ties between lower Paleozoic strata in all three areas (Blodgett et al. 2002; Dumoulin et al. 2014, 2018). White Mountains and Livengood strata are structurally complex and have undergone low-grade metamorphism.

The lower Paleozoic succession in the White Mountains terrane begins with the Fossil Creek Volcanics, a succession of alkali basalt, agglomerate, and volcaniclastic conglomerate, with lesser limestone and feldspathic sandstone (Mertie 1937; Weber et al. 1992; Reifenstuhl et al. 1998). The base of this unit is generally covered or faulted, and it is thought to have formed in an extensional setting along a continental margin (Wheeler et al. 1987; Weber et al. 1992). Abundant fossils have been interpreted to indicate an age of early Early Ordovician (early Tremadocian) for the lower part of the Fossil Creek and a late Late Ordovician (late Katian; Ashgill) age for the upper beds (Blodgett et al. 1987; Weber et al. 1994); the age of magmatism is uncertain. The Fossil Creek Volcanics are overlain by the Silurian-Devonian Tolovana Limestone (Blodgett et al. 1987; Weber et al. 1994), which contains conodonts of early Silurian (early to middle Llandovery) age a few meters above the base.

Recent detrital zircon data indicate that at least part of the Fossil Creek Volcanics is no older than Silurian (Dumoulin et al. 2018). Two samples of volcaniclastic sandstone and conglomerate from the uppermost 8 m of the unit, interbedded with limestone that produced late Katian (Ashgill) brachiopods and corals (Blodgett et al. 1987), yielded peak (and maximum depositional) ages of ca. 438 and 436 Ma (early Silurian; Llandovery; Dumoulin et al. 2018). One possible resolution of the conflict between fossil and detrital zircon ages is that Late Ordovician fossils were eroded and redeposited into younger (early Silurian?) strata. Further work at additional localities is needed to clarify the age of the Fossil Creek Volcanics, but the prominent detrital zircon peaks in this unit match well with those in Silurian and Devonian units in the Dillinger subterrane discussed above (Dumoulin et al. 2014).

The Ordovician Livengood Dome Chert is widespread within the Livengood terrane; it consists of varicolored chert and mudrock, with rare coarser clastic strata, limestone, and mafic volcanic rocks (Chapman et al. 1980; Weber et al. 1992; Athey and Craw, 2004). The unit has produced conodonts and ostracod steinkerns of Early to earliest Middle Ordovician age and late Katian (Ashgill) graptolites, as well as sponge spicules and poorly preserved radiolarians (Chapman et al. 1980; Weber et al. 1994) and likely accumulated in outer shelf to basinal settings (Harris et al. 1995; Athey and Craw 2004). Fine- to medium-grained volcaniclastic sandstone at the reference section of this unit produced a unimodal detrital zircon peak (and maximum depositional age) of ca. 486 Ma (latest Cambrian); no older zircons were found in this sample (Dumoulin et al. 2014). This peak is close in age to the younger of the two predominant age populations in the Post River Formation (ca. 490 Ma) in the Dillinger subterrane, discussed above.

Southwest Alaska: Goodnews/Kilbuck Terranes

The Goodnews terrane in southwestern Alaska is a Mesozoic subduction assemblage that includes Paleozoic strata with oceanic and continental affinities (Decker et al. 1994; Dumoulin and Harris 2012); it lies directly south of the Kilbuck terrane, an assemblage of Proterozoic metamorphic rocks (Bradley et al. 2014; fig. 1). Coherent limestone blocks of Ordovician age (parts of map unit DOl of Hoare and Coonrad 1978) occur sparingly in mélange of the Nukluk subterrane of the Goodnews terrane (Decker et al. 1994). These blocks consist of thin bedded to massive limestone and metalimestone that produced tropical cosmopolitan conodonts of probable early Early Ordovician (Tremadocian) age and normal marine, shallow water biofacies, with CAIs of 4.5 to 6 (Dumoulin and Harris 2012 and references therein). Carbonate strata of unit DOl are spatially associated with Proterozoic amphibolite facies rocks of the Kilbuck terrane but also with mafic volcanic rocks (Hoare and Coonrad 1978; Decker et al. 1994). Map relations thus suggest that DOl was deposited on continental basement (Kilbuck terrane) and/or on oceanic seamounts adjacent to the continental margin. Lower Paleozoic carbonates of the Goodnews terrane may have ties to coeval strata in the Farewell terrane (S.E. Box pers. comm. in Dumoulin and Harris 2012); U-Pb igneous and detrital zircon ages indicate links between the Kilbuck and Farewell terranes and the AACM (Bradley et al. 2014).

Southeast Alaska: Alexander Terrane

The Alexander terrane in southeastern Alaska and western Canada (fig. 1) is a Neoproterozoic-Jurassic crustal fragment that encompasses several subterranes (e.g., Berg et al. 1978; Gehrels and Saleeby 1987; Beranek et al 2012). Distinct lower Paleozoic sedimentary and volcanic successions that include Ordovician rocks are recognized in northern and southern parts of the Craig subterrane and in the Admiralty subterrane (Beranek et al. 2012, 2013). Lower Paleozoic strata in both subterranes overlie Neoproterozoic metamorphic rocks; those in the Craig subterrane formed as part of an early Paleozoic volcanic arc system (e.g., Beranek 2012, 2013; Tochilin 2014; White et al. 2016).

Craig Subterrane

Northern Craig Subterrane. Lower Paleozoic strata in the Saint Elias Mountains (Yukon Territory and British Columbia, Canada) include two informally named units that are in part Ordovician; both units have been deformed and metamorphosed (Beranek et al. 2012, 2013). The Cambrian-Middle Ordovician Donjek assemblage encompasses quartzose to calcareous sandstone, lesser volcaniclastic sandstone, mafic sills, and basalt. It contains late Cambrian-Early Ordovician conodonts, bivalves, and brachiopods and is overlain by limestone that has produced Early to Middle Ordovician conodonts, ellesmeroceroid cephalopods, and gastropods (Beranek et al. 2012 and references therein). The Donjek assemblage is thought to record rifting of the so-called “Descon arc” and deposition in a shallow-marine, back-arc basin (Beranek et al. 2012).

The Donjek assemblage includes strata with two distinct detrital zircon signatures (Beranek et al. 2013). Quartz-rich sandstone yielded mainly Neoproterozoic (ca. 760 to 565 Ma) and subordinate older grains, whereas volcaniclastic sandstone recorded a unimodal detrital zircon U/Pb age population with a peak at ca. 477 Ma (Early Ordovician; Beranek et al. 2013). The latter signature has similarities to those of Ordovician strata in northern and interior Alaska (unit Oal in the York terrane, parts of the Doonerak arc complex, and the Livengood Dome Chert in the Livengood terrane; Strauss et al. 2017; Dumoulin et al. 2018).

The Upper Ordovician-Silurian Goatherd assemblage consists of limestone, argillite and calcareous sandstone that formed in shallow- to deep-marine settings; argillite units contain Middle and Late Ordovician (Darriwilian and Sandbian) graptolites (Norford and Mihalynuk 1994; Beranek et al. 2012). This Ordovician carbonate platform unit does not occur throughout other regions of the Alexander terrane.

Southern Craig Subterrane. Two lower Paleozoic successions on Prince of Wales Island include Ordovician rocks that formed within a juvenile island arc system potentially correlative with the Descon arc of the northern Craig subterrane (Gehrels and Saleeby 1987; Beranek et al., 2012; Dumoulin and Harris 2012; Tochilin et al. 2014; White et al., 2016) and the Doonerak arc complex of the AACM (Strauss et al., 2017)). The Descon Formation (fig. 2) is a thick succession of graywacke turbidites, mafic to felsic volcanic rocks, and lesser limestone, shale, and chert that is locally penetratively deformed and metamorphosed to greenschist facies; it contains Early Ordovician to

Silurian graptolites (Churkin and Carter 1970; Eberlein and Churkin 1970; Eberlein et al. 1983). The oldest graptolites are mid-Tremadocian (*Adelograptus antiquus* Zone; Eberlein et al. 1983); faunas diagnostic of several Middle and Late Ordovician graptolite zones are also recognized (Churkin and Carter 1970; Eberlein et al. 1983; Fig. 17, col. 14 in Dumoulin et al. 2014). Sedimentary and volcanic rocks that resemble the Descon Formation and are informally called the Moira Sound unit (Ayuso et al. 2007) have produced late Cambrian-Early Ordovician conodonts and Middle and/or Late Ordovician graptolites (Dumoulin and Harris 2012 and references therein; Tochilin et al. 2014). Detrital zircon spectra from the Descon Formation and the Moira Sound unit have peak ages of ca. 460 Ma (late Middle Ordovician); the Moira Sound sample also contains abundant late Neoproterozoic (Ediacaran) grains (ca. 580 to 542 Ma; Tochilin et al. 2014; Dumoulin et al. 2018).

Admiralty Subterrane

The Hood Bay Formation (Loney 1964) of the Admiralty subterrane consists of radiolarian chert, argillite, graywacke, limestone, and pillow basalt deposited in a basinal setting (Beranek et al. 2012). Argillite in this unit contains Late Ordovician (late Sandbian) graptolites (*Climacograptus bicornis* Zone; Carter 1977).

Summary and Discussion

White et al. (2016) synthesized available faunal, lithologic, U-Pb geochronologic, and Hf isotopic information to illuminate the history of the composite Alexander terrane. These authors proposed that Alexander terrane was a single tectonic entity and that the southern part of the terrane (e.g., rocks on Prince of Wales Island) formed in a juvenile Neoproterozoic-early Paleozoic arc system with little continental influence, whereas rocks to the north (e.g., Saint Elias Mountains) were deposited adjacent to a Neoproterozoic-early Paleozoic magmatic system with continental affinities. Building upon previous work, these same authors posited that during the early Paleozoic, the Alexander terrane was in the paleo-Arctic realm, with the northern part of the terrane adjacent to Baltica (White et aal., 2016). Contrasts in the geology and provenance of the northern and southern Craig subterrane regions (i.e., Saint Elias Mountains and Prince of Wales Island) led Strauss et al. (2017) and McClelland et al. (*in press*) to suggest the Alexander terrane may have comprised independent arc and/or crustal fragments in the early Paleozoic (fig. 3) with assembly of the composite Alexander terrane during the late Silurian–Early Devonian Klakas orogeny. Faunal and detrital zircon data suggest proximity between the Alexander and Farewell terranes and the southwestern subterranes of the AACM in the Ordovician (Dumoulin et al. 2018).

Conclusions

Ordovician strata occur in diverse carbonate and siliciclastic successions found across Alaska; faunal, lithologic, and detrital zircon U-Pb data indicate that few of these successions formed as part of Laurentia. Ordovician rocks in the Yukon River area of east-central Alaska are one exception. Here, the Jones Ridge Limestone and equivalent deeper water strata of the Hillard Limestone and Road River Group were deposited on the western edge of the Yukon block, a paleotopographic high on the northwestern margin (in present-day coordinates) of Laurentia. Less studied Ordovician rocks in the Porcupine River area to the north likely correlate with the Yukon River area strata. Laurentian fossil assemblages characterize Ordovician rocks in both areas.

Ordovician successions are widely distributed throughout northern Alaska; all are included in the AACM, a composite tectonic entity made up of crustal and arc fragments (subterranes and terranes) with varied histories. The North Slope subterrane includes exposures in the northeastern Brooks Range and at Cape Lisburne in northwest Alaska, as well as subsurface strata beneath the North Slope. Ordovician rocks are part of both carbonate platformal and basinal successions in the northeastern Brooks Range. Laurentian fossils characterize these successions, which likely represent displaced fragments of the northern Laurentian margin. Paleogeographic affinities of Ordovician rocks elsewhere in this subterrane—deep-water strata found at Cape Lisburne and in the North Slope subsurface—remain uncertain.

Southwestern parts of the AACM also include Ordovician rocks. These strata, mainly platform carbonates, occur in the York and Seward terranes on Seward Peninsula and in the Hammond subterrane in the western and central Brooks Range. Lithologic correlations and a distinctive fauna that includes Siberian, Laurentian, and lesser Baltican endemic forms link the lower Paleozoic rocks in these areas and suggest a common origin on a crustal fragment (North Alaska carbonate platform) sited within the paleo-Arctic realm. Detrital zircon data support a non-Laurentian origin for these strata.

Non-Laurentian origins are also likely for Ordovician rocks elsewhere in Alaska described above. The Farewell, White Mountain, and Livengood terranes of interior Alaska include diverse Ordovician strata deposited in shallow- and deep-water environments. Biotic and detrital zircon analyses provide numerous ties between these terranes, the North Alaska carbonate platform, and volcanic arc-related rocks of the Alexander terrane (southeast Alaska) and indicate similar depositional settings within the paleo-Arctic during Ordovician time. Lesser-known Ordovician strata in the Ruby terrane (interior Alaska) and the Goodnews terrane (southwest Alaska) have affinities with coeval parts of the North Alaskan carbonate platform and the Farewell terrane, respectively, and may have a comparable provenance.

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References

Athey, J. E., and P. A. Craw, 2004. Geologic maps of the Livengood SW C-3 and SE C-4 quadrangles, Tolovana Mining District, Alaska: Alaska Division of Geological and Geophysical Surveys Preliminary Interpretive Report 2004-3, 24 p.

Ayuso, R.A., Karl, S.M., Slack, J.F., Haeussler, P.J., Bittenbender, P.E., Wandless, G.A., and Colvin, A.S., 2007. Oceanic Pb-isotopic sources of Proterozoic and Paleozoic volcanogenic massive sulfide deposits on Prince of Wales Island and vicinity, southeastern Alaska: U.S. Geological Survey Professional Paper 1732-E, 20 p., https://doi.org/10.3133/pp1732E

Babcock, L. E., R. B. Blodgett, and J. St. John, 1994. New late(?) Proterozoic-age formations in the vicinity of Lone Mountain, McGrath quadrangle, west-central Alaska. *In* A. B. Till and T. E. Moore, eds., Geologic studies in Alaska by the U.S. Geological Survey, 1993: U.S. Geological Survey Bulletin 2107, p. 143–155.

Beranek, L.P., van Staal, C.R., Gordee, S.M., McClelland, W.C., Israel, S., and Mihalynuk, M.G., 2012. Tectonic significance of Upper Cambrian–Middle Ordovician mafic volcanic rocks on the Alexander terrane, Saint Elias Mountains, northwestern Canada: The Journal of Geology, v. 120, p. 293–314, doi: 10 .1086 /664788.

Beranek, L.P., van Staal, C.R., McClelland, W.C., Israel, S., and Mihalynuk, M.G., 2013. Baltican crustal provenance for Cambrian–Ordovician sandstones of the Alexander terrane, North American Cordillera: Evidence from detrital zircon U-Pb geochronology and Hf isotope geochemistry: Journal of the Geological Society of London, v. 170, p. 7–18, doi: 10 .1144 /jgs2012 -028.

Berg, H. C.; Jones, D. L.; and Coney, P. J. 1978. Map showing pre-Cenozoic tectonostratigraphic terranes of southeastern Alaska and adjacent areas. U.S. Geol. Surv. Open File Rep. 78-1085.

Blodgett, R.B., Potter, A.W. and Clough, J.G., 1984. Upper Ordovician-Lower Devonian biostratigraphy and paleoecology of the Jones Ridge-Squaw Mountain area, east-central Alaska. Geological Society of America, Abstracts with Programs. 16, p. 270.

Blodgett, R.B., Clough, J.G., Dutro, J.T., Jr., Ormiston, A.R., Palmer, A.R., and Taylor, M.E., 1986. Age revisions for the Nanook Limestone and Katakturuk Dolomite, northeastern Brooks Range. *In*: Bartsch-Winkler, S. and Reed, K.M., eds., Geologic Studies in Alaska by the U.S. Geological Sur-vey during 1985: U.S. Geological Survey Circular 978, p. 5–10.

Blodgett, R.B., Wheeler, K.L., Rohr, D.M., Harris, A.G., and Weber, F.R., 1987. A Late Ordovician age reappraisal for the upper Fossil Creek Volcanics, and possible significance for glacio-eustacy. *In*: Hamilton, T.D., and Galloway, J.P., eds., Geologic Studies in Alaska by the U.S. Geological Survey during 1986: U.S. Geological Survey Circular 998, p. 54–58.

Blodgett, R.B., Rohr, D.M., Harris, A.G., and Rong, J., 1988. A major unconformity between Upper Ordovician and Lower Devonian strata in the Nanook Limestone, Shublik Mountains, northeastern Brooks Range. *In*: Hamilton, T.D., and Galloway, J.P., eds., Geologic studies in Alaska by the U.S. Geological Survey during 1987: U.S. Geological Survey Circular 1016, p. 54–56.

Blodgett, R.B., Rohr, D.M., and Boucot, A.J., 2002. Paleozoic linkages between some Alaskan accreted terranes and Siberia based on megafossils. *In* Miller, E.L., Grantz, A., and Klemperer, S.L., eds., Tectonic Evolution of the Bering Shelf–Chukchi Sea–Arctic Margin and Adjacent Landmasses: Geologic Society of America Special Paper 360, p. 273–290.

Brabb, E.E., 1967. Stratigraphy of the Cambrian and Ordovician rocks of East Central Alaska: U.S. Geological Survey Professional Paper 559-A, 29 p.

Brabb, E. E., 1970. Preliminary geologic map of the Black River quadrangle, east-central Alaska: U.S. Geological Survey Miscellaneous Investigations Map I-601, scale 1:250,000, 1 sheet.

Bradley, D.C., McClelland, W.C., Friedman, R.M., O'Sullivan, P., Layer, P.W., Miller, M.L., Dumoulin, J.A., Till, A.B., Wooden, J.L., and Abbott, J.G., 2014. Proterozoic geochronological links between the Farewell, Kilbuck and Arctic Alaska terranes: The Journal of Geology, v. 122, p. 237–258, https:// doi .org /10 .1086 /675663.

Brosgé, W. P., and H. N. Reiser, 1969. Preliminary geologic map of the Coleen quadrangle, Alaska: U.S. Geological Survey Open-File Map 69-25, scale 1:250,000, 1 sheet.

Brosgé, W. P., H. N. Reiser, J. T. Dutro Jr., R. L. Detterman, and I. L. Tailleur, 2001. Geological map of the Arctic quadrangle, Alaska: U.S. Geological Survey Geologic Investigations Series I-2673, scale 1:250,000, 2 sheets, 38 p.

Bundtzen, T. K., G. M. Laird, R. B. Blodgett, K. H. Clautice, and E. E. Harris, 1994. Geology of the Gagaryah River area, Lime Hills C-5 and C-6 quadrangles, southwest Alaska: Alaska Division of Geological and Geophysical Surveys Public Data File 94-40, scale 1:63,360, 1 sheet, 17 p.

Bundtzen, T. K., E. E. Harris, and W. G. Gilbert, 1997. Geology of the eastern half of the McGrath quadrangle, Alaska: Alaska Division of Geological and Geophysical Surveys Report of Investigations 97-14a, scale 1:125,000, 1 sheet, 34 p.

Carter, C. 1977. Age of the Hood Bay Formation, Alaska. *In* Sohl, N. F., and Wright, W. B., eds., Changes in stratigraphic nomenclature by the U.S. Geological Survey, 1976. U.S. Geol. Surv. Bull. 1435-A, p. A117–A118.

Carter, C., and Laufeld, S., 1975. Ordovician and Silurian fossils in well cores from the North Slope of Alaska. American Association of Petroleum Geologists Bulletin, v. 59, p. 457–464.

Carter, C., and Tailleur, I.L., 1984. Ordovician graptolites from the Baird Mountains, western Brooks Range, Alaska. Journal of Paleontology, v. 58, p. 40–57.

Chapman, R.M., and Weber, F.R., Churkin, M., Jr., and Carter, C., 1980. The Livengood Dome Chert, a new Ordovician Formation in central Alaska, and its relevance to displacement on the Tintina fault. U.S. Geological Survey Professional Paper 1126 A–J, p. F1–F13.

Churkin, M., Jr., and Brabb, E.E., 1965. Ordovician, Silurian, and Devonian biostratigraphy of east-central Alaska. *AAPG Bulletin*, *49*(2), pp.172-185.

Churkin, M., Jr., and Carter, C., 1970. Early Silurian graptolites from southeastern Alaska and their correlation with graptolitic sequences in North America and the Arctic: U.S. Geological Survey Professional Paper 653, 41 p.

Churkin Jr., M., and C. Carter, 1996. Stratigraphy, structure, and graptolites of an Ordovician and Silurian sequence in the Terra Cotta Mountains, Alaska Range, Alaska: U.S. Geological Survey Professional Paper 1555, 84 p.

Colpron, M. and Nelson, J., 2020. A digital atlas of terranes for the northern Cordillera: Yukon Geological Survey, https://data.geology.gov.yk.ca/Compilation/2 [accessed Jan. 2022].

Decker, J., et al., 1994. Geology of southwestern Alaska. *In*: G. Plafker and H. C. Berg, eds., The geology of Alaska: Geological Society of America, The Geology of North America, v. G-1, p. 285–310.

Dover, J. H., 1994. Geology of part of east-central Alaska. *In*: G. Plafker and H. C. Berg, eds., The geology of Alaska: Geological Society of America, The Geology of North America, v. G-1, p. 153–204.

Dumoulin, J. A., 2001. Lithologies of the basement complex (Devonian and older) in the National Petroleum Reserve- Alaska. *In*: D. W. Houseknecht, ed., National Petroleum Reserve-Alaska core workshop, petroleum plays and systems in the National Petroleum Reserve-Alaska: SEPM Core Workshop 21, p. 201–214.

Dumoulin, J. A., and A. G. Harris, 1987. Lower Paleozoic carbonate rocks of the Baird Mountains quadrangle, western Brooks Range, Alaska. *In*: I. L. Tailleur and P. Weimer, eds., Alaskan North Slope geology: SEPM-Pacific Section and Alaska Geological Society, v. 1, p. 311–336.

Dumoulin, J. A., and A. G. Harris, 1994. Depositional framework and regional correlation of pre-Carboniferous metacarbonate rocks of the Snowden Mountain area, central Brooks Range, northern Alaska: U.S. Geological Survey Professional Paper 1545, 74 p.

Dumoulin, J.A., and Harris, A.G., 2012. Cambrian–Ordovician sedimentary rocks of Alaska. *In*: Derby, J.R., Fritz, R.D., Longacre, S.A., Morgan, W.A., and Sternbach, C.A., eds., The Great American Carbonate Bank: The Geology and Economic Resources of the Cambrian–Ordovician Sauk Megasequence of Laurentia: American Association of Petroleum Geologists Memoir 98, p. 649–673.

Dumoulin, J.A., Harris, A.G., Gagiev, M., Bradley, D.C., and Repetski, J.E., 2002. Lithostratigraphic, conodont, and other faunal links between lower Paleozoic strata in northern and central Alaska and northeastern Russia. *In*: Miller, E.L., Grantz, A., and Klemperer, S.L., eds., Tectonic Evolution of the Bering Shelf–Chukchi Sea–Arctic Margin and Adjacent Landmasses: Boulder, Colorado, Geological Society of America Special Paper **360**, 291–312.

Dumoulin, J.A., Harris, A.G., and Repetski, J.E., 2014. Carbonate rocks of the Seward Peninsula, Alaska: Their correlation and paleogeographic significance. *In*: Dumoulin, J.A., and Till, A.B., eds., Reconstruction of a Late Proterozoic to Devonian Continental Margin Sequence, Northern Alaska, Its Paleogeographic Significance, and Contained Base-Metal Sulfide Deposits: Geological Society of America Special Paper **506**, 59–110, doi: 10 .1130 /2014 .2506 (03)

Dumoulin, J.A., Jones, J.V., III, Box, S.E., Bradley, D.C., Ayuso, R.A., and O'Sullivan, P., 2018. Geochronologic, geochemical, and isotopic data for selected rocks from the western Alaska Range, Medfra quadrangle, Livengood area, and White Mountains, Alaska: U.S. Geological Survey Data Release, https://doi.org/10.5066/F7765DN7.

Dutro, J.T., Jr., 1970. Pre-Carboniferous carbonate rocks, northeastern Alaska. *In*: Adkison, W.L., and Brosge, W.P., eds., Proceedings of the Geological Seminar on North Slope of Alaska: Los Angeles, American As-sociation of Petroleum Geologists, Pacific Section, p. M1–M7.

Dutro Jr., J. T., and W. W. Patton Jr., 1982. New Paleozoic formations in the northern Kuskokwim Mountains, west central Alaska. *In*: Stratigraphic notes, 1980–1982: U.S. Geological Survey Bulletin 1529-H, p. H13–H22.

Dutro, J.T., Jr., Brosgé, W.P., and Reiser, H.N., 1972. Significance of recently discovered Cambrian fossils and reinterpretation of Neruokpuk Formation, northeastern Alaska: The American Association of Petroleum Geologists Bulletin, v. 56, p. 808–815.

Dutro, J.T., Jr., Brosgé, W.P., Lanphere, M.A., and Reiser, H.N., 1976. Geologic significance of Doonerak structural high, central Brooks Range, Alaska: American Association of Petroleum Geologists Bulletin, v. 60, p. 952–961.

Dutro, J.T., Jr., Palmer, A.R., Repetski, J.E., and Brosgé, W.P., 1984. Middle Cambrian fossils from the Doonerak anticlinorium, central Brooks Range, Alaska: Journal of Paleontology, v. 58, p. 1364–1371.

Eberlein, G. D., and M. Churkin Jr., 1970. Paleozoic stratigraphy in the northwest coastal area of Prince of Wales Island, southeastern Alaska: U.S. Geological Survey Bulletin 1284, 67 p.

Eberlein, G. D., M. Churkin Jr., C. Carter, H. C. Berg, and A. T. Ovenshine, 1983. Geology of the Craig quadrangle, Alaska: U.S. Geological Survey Open-File Report 83-91, scale 1:250,000, 4 sheets, 53 p.

Gehrels, G.E., and Saleeby, J.B., 1987. Geologic framework, tectonic evolution, and displacement history of the Alexander terrane: Tectonics, v. 6, p. 151–173, doi: 10.1029 /TC006i002p00151.

Goldman, D., Sadler, P.M., and Leslie, S.A., 2020. The Ordovician period. *In*: Geologic Time Scale 2020. DOI: https://doi.org/10.1016/B978-0-12-824360-2.00020-6

Harris, A.G., Dumoulin, J.A., Repetski, J.E., and Carter, Claire, 1995. Correlation of Ordovician rocks of northern Alaska, p. 21-26, *in*: J.D. Cooper, M.L. Droser, and S.C. Finney (eds.), Ordovician Odyssey: Short Papers for the Seventh International Symposium on the Ordovician System, Las Vegas, Nevada, USA, Pacific Section Society for Sedimentary Geology (SEPM), Fullerton, California, U.S.A.

Hoare, J. M., and W. L. Coonrad, 1978. Geologic map of the Goodnews and Hagemeister Island quadrangles region, southwestern Alaska: U.S. Geological Survey Open-File Report 78-9-B, scale 1:250,000, 2 sheets.

Hubbard, R.J., Edrich, S.P. and Rattey, R.P., 1987. Geologic evolution and hydrocarbon habitat of the 'Arctic Alaska microplate'. *Marine and Petroleum Geology*, *4*(1), pp.2-34.

Jin, J. and Blodgett, R.B., 2020. Late Ordovician brachiopods from east-central Alaska, northwestern margin of Laurentia. *Journal of Paleontology*, *94*(4), pp.637-652.

Johnson, B.G., Strauss, J.V., Taylor, J.F., Ward, W.P., Colpron, M., McClelland, W.C., and Toro, J., 2019. The Whale Mountain allochthon: A relic of the Iapetus Ocean preserved in the northeastern Brooks Range of Alaska and Yukon. *In*: Piepjohn, K., Strauss, J.V., Reinhardt, L., and McClelland, W.C., eds., Circum-Arctic Structural Events: Tectonic Evolution of the Arctic Margins and Trans-Arctic Links with Adjacent Orogens: Geological Society of America Special Paper 541, Chapter 20, https://doi.org/10.1130/2018.2541(20).

Jones, D. L., N. J. Silberling, P. J. Coney, and G. Plafker, 1987. Lithotectonic terrane map of Alaska (west of the 141st Meridian): U.S. Geological Survey Miscellaneous Field Studies Map MF-1874A, scale 1:2,500,000, 1 sheet.

Julian, F.E., 1989. Structure and Stratigraphy of Lower Paleozoic Rocks, Doonerak Window, Central Brooks Range, Alaska [Ph.D. thesis]: Houston, Texas, Rice University, 127 p.

Julian, F.E., and Oldow, J.S., 1998. Structure and lithology of the lower Paleozoic Apoon assemblage, eastern Doonerak window, central Brooks Range, Alaska. *In*: Oldow, J.S., and Avé Lallemant, H.G., eds., Architecture of the Central Brooks Range Fold and Thrust Belt, Arctic Alaska: Geological Society of America Special Paper 324, p. 65–80.

Karl, S. M., J. A. Dumoulin, I. Ellersieck, A. G. Harris, and J. M. Schmidt, 1989. Preliminary geologic map of the Baird Mountains and part of the Selawik quadrangles, Alaska: U.S. Geological Survey Open-File Report 89-551, scale 1:250,000, 1 sheet, 65 p.

Lane, L.S., and Cecile, M.P., 1989. Stratigraphy and structure of the Neruokpuk Formation, northern Yukon: Geological Survey of Canada, Current Research, Part G, Paper 89-1G, p. 57–62.

Lane, L.S., Gehrels, G.E., and Layer, P.W., 2015. Provenance and paleogeography of the Neruokpuk Formation, northwest Laurentia: An integrated synthesis: Geological Society of America Bulletin, v. 128, no. 1–2, p. 239–257, doi:10.1130/B31234.1.

Loney, R.A., 1964. Stratigraphy and petrography of the Pybus-Gambier area Admiralty Island, Alaska: U.S. Geological Survey Bulletin, 1178, 103 p., (incl. geologic map, scale 1:63,360)

Martin, A. J., 1970. Structure and tectonic history of the western Brooks Range, De Long Mountains and Lisburne Hills, northern Alaska: Geological Society of America Bulletin, v. 81, p. 3605–3622, doi:10.1130/0016-7606(1970) 81[3605:SATHOT]2.0.CO;2.

McClelland, W.C., Strauss, J.V., Gilotti, J.A., and Colpron, M., *in press*. Paleozoic evolution of the northern Laurentian margin: Evaluating links between Caledonian, Ellesmerian, and Cordilleran orogenesis *in* Whitmeyer, S.J., Williams, M.L., Kellet, D.A., and Tikoff, B., eds., Laurentia: Turning Points in the Evolution of a Continent, *Geological Society of America Special Paper*.

Mertie, J.B., 1937. The Yukon-Tanana region, Alaska: U.S. Geological Survey Bulletin 872, 276 p.

Miller, E.L., Toro, J., Gehrels, G.E., Amato, J.M., Prokopiev, A., Tuchkova, M.I., Akinin, V.V., Dumitru, T.A., Moore, T.E., and Cecile, M.P., 2006. New insights into Arctic paleogeography and tectonics from U-Pb detrital zircon geochronology: Tectonics, v. 25, doi: 10.1029 /2005TC001830.

Moore, T.E., 1987. Geochemical and tectonic setting of some volcanic rocks of the Franklinian assemblage, central and eastern Brooks Range. *In*: Tailleur, I.L., and Weimer, P., eds., Alaskan North

Slope Geology: Bakersfield, California, Society of Economic Paleontolo-gists and Mineralogists, Pacific Section, and Alaska Geological Society, Publication 50, p. 691–710

Moore, T.E. and Churkin, M., Jr., 1984. Ordovician and Silurian graptolite discoveries from the Neruokpuk Formation (sensu lato), northeastern and central Brooks Range, Alaska: Paleozoic Geology of Alaska and North-western Canada Newsletter, no. 1, p. 21–23.

Moore, T. E., W. K. Wallace, K. J. Bird, S. M. Karl, C. G. Mull, and J. T. Dillon, 1994. Geology of northern Alaska. *In*: G. Plafker and H. C. Berg, eds., The geology of Alaska: Geological Society of America, The Geology of North America, v. G1, p. 49–140.

Moore, T.E., Wallace, W.K., Mull, C.G., Adams, K.E., Plafker, G., and Nokleberg, W.J., 1997. Crustal implications of bedrock geology along the Trans-Alaska Crustal Transect (TACT) in the Brooks Range, north-ern Alaska: Journal of Geophysical Research, v. 102, no. B9, p. 20,645–20,684, doi:10.1029/96JB03733.

Moore, T.E., Dumitru, T.A., Adams, K.E., Witebsky, S.N., and Harris, A.G., 2002. Origin of the Lisburne Hills–Herald Arch structural belt: Stratigraphic, structural, and fission-track evidence from the Cape Lisburne area, northwestern Alaska. *In*: Miller, E.L., Grantz, A., and Klemperer, S.L., eds., Tectonic Evolution of the Bering Shelf–Chukchi Sea–Arctic Margin and Adjacent Landmasses: Geological Society of America Special Paper 360, p. 77–109.

Morrow, D.W., 1999. *Lower Paleozoic stratigraphy of northern Yukon Territory and northwestern District of Mackenzie* (No. 538). Geological Survey of Canada.

Mull, C.G., and Anderson, A.V., 1991. Franklinian lithotectonic domains, northeastern Brooks Range, Alaska: Alaska Division of Geological and Geophysical Surveys, Public-data File 91-5, 41 p., 1 sheet.

Mull, C.G., Adams, K.E., and Dillon, J.T., 1987. Stratigraphy and structure of the Doonerak fenster and Endicott Mountains allochthon, central Brooks Range, Alaska. *In*: Tailleur, I., and Weimer, P., eds., Alaskan North Slope Geology: Bakersfield, California, Society of Economic Paleontologists and Mineralogists (SEPM), Pacific Section, and Alaska Geological Society, Publication 50, p. 663–679.

Natal'in, B.A., Amato, J.M., Toro, J., and Wright, J.E., 1999. Paleozoic rocks of northern Chukotka Peninsula, Russian Far East: Implications for the tectonics of the Arctic region: Tectonics, v. 18, no. 6, p. 977–1003, doi: 10.1029 /1999TC900044.

Norford, B. S., and Mihalynuk, M. G. 1994. Evidence of the Pacific Faunal Province in the northern Alexander Terrane, recognition of two Middle Ordovician graptolite zones in northwestern British Columbia. Can. J. Earth Sci. 31:1389–1396.

Oliver Jr., W. A., C. W. Merriam, and M. Churkin Jr., 1975. Ordovician, Silurian, and Devonian corals of Alaska: U.S. Geological Survey Professional Paper 823-B, p. 13–44.

Ormiston, A.R., and Ross, R.J., Jr., 1979. *Monorakos* in the Ordovician of Alaska and its zoogeographic significance. *In*: Gray, J., and Boucot, A.J., eds., Historical Biogeography, Plate Tectonics, and the Changing Environment: Corvallis, Oregon State University Press, p. 53–59.

Patton Jr., W. W., and E. J. Moll-Stalcup, 2000. Geologic map of the Nulato quadrangle, west-central Alaska: U.S. Geological Survey Geologic Investigations Series I-2677, scale 1:250,000, 41 p.

Patton Jr., W. W., S. E. Box, E. J. Moll-Stalcup, and T. P. Miller, 1994. Geology of west-central Alaska. *In*: G. Plafker and H. C. Berg, eds., The geology of Alaska: Geological Society of America, The Geology of North America, v. G-1, p. 241–269.

Payne, M.W. and Allison, C.W., 1981. Paleozoic continental-margin sedimentation in east-central Alaska. *Geology*, *9*(6), pp.274-279.

Pyle, L.J., 2012. Cambrian and Lower Ordovician Sauk megasequence of northwestern Canada, northern Rocky Mountains to the Beaufort Sea. *In*: Derby, J.R., Fritz, R.D., Longacre, S.A., Morgan, W.A., and Sternbach, C.A., eds., The Great American Carbonate Bank: The Geology and Economic Resources of the Cambrian–Ordovician Sauk Megasequence of Laurentia: American Association of Petroleum Geologists Memoir 98, p. p. 675–723.

Rasmussen, C.M.Ø., Harper, D.A.T., and Blodgett, R.B., 2012. Late Ordovician Brachiopods from West-Central Alaska: Systematics, Ecology and Palaeobiogeography: Fossils and Strata 58: New York, Wiley, 103 p.

Reifenstuhl, R. R., J. H. Dover, R. J. Newberry, K. H. Clautice, D. S. Pinney, S. A. Liss, R. B. Blodgett, and F. R. Weber, 1998. Geologic map of the Tanana A-1 and A-2 quadrangles, central Alaska: Alaska Division of Geological and Geophysical Surveys Public-Data File 98-37A, 19 p.

Reiser, H.N., Brosgé, W.P., Dutro, J.T., Jr., and Detterman, R.L., 1980. Geologic map of the Demarcation Point quadrangle, Alaska: U.S. Geological Survey Miscellaneous Investigations Series Map I-1133, scale 1:250,000.

Repetski, J.E., Carter, C., Harris, A.G., and Dutro, J.T., Jr., 1987. Ordovician and Silurian fossils from the Doonerak anticlinorium, central Brooks Range, Alaska. *In*: Hamilton, T.D., and Galloway, J.P., eds., Geologic Studies in Alaska by the U.S. Geological Survey during 1986: U.S. Geological Survey Circular 998, p. 40–42.

Rohr, D.M. and Blodgett, R.B., 1994. *Palliseria* (Middle Ordovician Gastropoda) from east-central Alaska and its stratigraphic and biogeographic significance. *Journal of Paleontology*, *68*(3), pp.674-675.

Rigby, J.K., Potter, A.W. and Blodgett, R.B., 1988. Ordovician sphinctozoan sponges of Alaska and Yukon Territory. *Journal of Paleontology*, p.731-746.

Rigby, J.K., Blodgett, R.B. and Britt, B.B., 2008. Ordovician sponges from west-central and east-central Alaska and western Yukon Territory, Canada. *Bull. Geosci*, *83*, pp.153-168.

Roeske, S., Till, A.B., Miller, M.S., Saltus, R.W., and McClelland, W.C., 2017. Large vertical offsets of Moho coincide with major Mesozoic transform faults in Northern Alaska, Geological Society of America Abstracts with Programs. Vol. 49, No. 6, ISSN 0016-7592, doi: 10.1130/abs/2017AM-305345

Ross, R.J., Jr., 1965. Early Ordovician trilobites from the Seward Peninsula, Alaska: Journal of Paleontology, v. 39, no. 1, p. 17–20.

Ryherd, T.J., Carter, C., and Churkin, M., Jr., 1995. Middle through Upper Ordovician graptolite biostratigraphy of the Deceit Formation, northern Seward Peninsula, Alaska: Geological Society of America Abstracts with Programs, v. 27, no. 5, p. 75.

Sainsbury, C.L., 1969. Geology and ore deposits of the central York Mountains, Seward Peninsula, Alaska: U.S. Geological Survey Bulletin 1287, 101 p., 6 sheets.

Sainsbury, C.L., 1972. Geologic map of the Teller quadrangle, western Seward Peninsula, Alaska: U.S. Geological Survey Miscellaneous Investigations Map I-685, 4 p., scale 1:250,000.

Silberling, N.J., Jones, D.L., Monger, J.W.H. and Coney, P.J., 1992. Lithotectonic terrane map of the North American Cordillera: United States Geological Survey, Miscellaneous Investigation Series, Map I-2176. 2 sheets.

Silberling, N. J., D. L. Jones, J. W. H. Monger, P. J. Coney, H. C. Berg, and G. Plafker, 1994. Lithotectonic terrane map of Alaska and adjacent parts of Canada, in G. Plafker and H. C. Berg, eds., The geology of Alaska: Geological Society of America, The geology of North America, v. G-1, scale 1:2,500,000, 1 sheet.

Strauss, J.V., Macdonald, F.A., Taylor, J.F., Repetski, J.E., and McClelland, W.C., 2013. Laurentian origin for the North Slope of Alaska: Implications for the tectonic evolution of the Arctic: Lithosphere, v. 5, no. 5, p. 477-482. Doi: 10.1130/L284.1.

Strauss, J.V., Hoiland, C.W., Ward, W., Johnson, B.G., Nelson, L., and McClelland, W.C., 2017. Orogen transplant: Taconic–Caledonian magmatism in the Brooks Range of Alaska: Geological Society of America Bulletin, v. 129, p. 649–676, https://doi.org/10.1130/B31593.1

Strauss, J.V**.**, Johnson, B.G., Colpron, M., Nelson, L.L., Perez, J**.**, Benowitz, J.A., Ward, W., and McClelland, W.C., 2019a. Pre-Mississippian stratigraphy and provenance of the North Slope subterrane of Arctic Alaska II: Basinal rocks of the northeastern Brooks Range and their significance in circum-Arctic evolution. *In* Piepjohn, K., Strauss, J.V**.**, Reinhardt, L. and McClelland, W.C., eds., Circum-Arctic Structural Events: Tectonic Evolution of the Arctic Margins and Trans-Arctic Links with Adjacent Orogens: *Geological Society of America Special Paper 541,* p. 525–572.

Strauss, J.V**.**, Macdonald, F.A., and McClelland, W.C., 2019b. Pre-Mississippian stratigraphy and provenance of the North Slope subterrane of Arctic Alaska I: Platformal rocks of the northeastern Brooks Range and their significance in circum-Arctic evolution. *In*: Piepjohn, K., Strauss, J.V**.**, Reinhardt, L. and McClelland, W.C., eds., Circum-Arctic Structural Events: Tectonic Evolution of the Arctic Margins and Trans-Arctic Links with Adjacent Orogens: *Geological Society of America Special Paper 541,* p. 493–524.

Strauss, J.V., Fraser, T., Melchin, M.J., Allen, T.J., Malinowski, J., Feng, X., Taylor, J.F., Day, J., Gill, B.C., and Sperling, E.A., 2020. The Road River Group of northern Yukon, Canada: early Paleozoic deep-water sedimentation within the Great American Carbonate Bank: Canadian Journal of Earth Sciences, v. 57, p. 1193–1219.

Taylor, J.F., Allen, T.J., Repetski, J.E., Strauss, J.V., and Irwin, S.J., 2015. Life on the edge in eastern Alaska: basal Ordovician (Tremadocian), platform-margin faunas of the Jones Ridge Formation. *In*:

S.A. Leslie, D. Goldman, and R.C. Orndorff (eds.), The Ordovician exposed: Short papers and abstracts for the 12th International Symposium on the Ordovician System, Stratigraphy, online supplement to v. 12, no. 2, p. 71-77.

Till, A.B., and Dumoulin, J.A., 1994. Seward Peninsula: The Seward and York terranes. I*n*: Plafker, G. and Berg, H.C., eds., The Geology of Alaska: Boulder, Colorado, Geological Society of America, The Geology of North America, v. G-1, p. 141–152.

Till, A. B., and L. W. Snee, 1995. 40Ar/39Ar evidence that formation of blueschists in continental crust was synchronous with foreland fold and thrust deformation, western Brooks Range, Alaska: Journal of Metamorphic Geology, v. 13, p. 41–60, doi:10.1111/j.1525-1314.1995.tb00204.x.

Till, A. B., J. A. Dumoulin, B. M. Gamble, D. S. Kaufman, and P. I. Carroll, 1986. Preliminary geologic map and fossil data, Solomon, Bendeleben, and southern Kotzebue quadrangles, Seward Peninsula, Alaska: U.S. Geological Survey Open-File Report 86-276, scale 1:250,000, 3 sheets, 74 p.

Till, A. B., J. A. Dumoulin, A. G. Harris, T. E. Moore, H. Bleick, and B. Siwiec, 2008. Bedrock geologic map of the southern Brooks Range, Alaska, and accompanying conodont data: U.S. Geological Survey Open-File Report 2008-1149, scale 1:500,000, sheet 1; scale 1:600,000, sheet 2, 88 p.: http://pubs.usgs.gov/of/2008/1149/.

Till, A.B., Dumoulin, J.A., Werdon, M.B., and Bleick, H.A., 2011. Bedrock Map of the Seward Peninsula, Alaska, and accompanying conodont data: U.S. Geological Survey Scientific Investigations Map 3131, 79 p. + 2 map sheets.

Till, A.B., Amato, J.M., Aleinikoff, J.N., and Bleick, H.A., 2014a. U-Pb detrital zircon geochronology as evidence for the origin of the Nome Complex, northern Alaska, and implications for regional and trans-Arctic correlations. *In*: Dumoulin, J.A., and Till, A.B., eds., Reconstruction of a Late Proterozoic to Devonian Continental Margin Sequence, Northern Alaska, its Paleogeographic Significance, and Contained Base-Metal Sulfide Deposits: Geological Society of America Special Paper 506, p. 111–131, https:// doi .org /10 .1130 /2014 .2506 (04).

Till, A.B., Dumoulin, J.A., Ayuso, R.A., Aleinikoff, J.N., Amato, J.M., Slack, J.F., and Shanks, W.C.P., III, 2014b. Chapter 1, Reconstruction of an early Paleozoic continental margin based on the nature of protoliths in the Nome Complex, Seward Peninsula, Alaska *In*: Dumoulin, J.A., and Till, A.B., eds., Reconstruction of a Late Proterozoic to Devonian Continental Margin Sequence, Northern Alaska, Its Paleogeographic Significance, and Contained Base-Metal Sulfide Deposits: Geological Society of America Special Paper 506, doi: 10 .1130 /2014 .2506 (01)

Tochilin, C.J., Gehrels, G.E., Nelson, J., and Mahoney, J.B., 2014. U-Pb and Hf isotope analysis of detrital zircons from the Banks Island assemblage (coastal British Columbia) and southern Alexander terrane (southeast Alaska): Lithosphere, v. 6, p. 200–215, https:// doi .org /10 .1130/L338 .1.

Toro, J., 1998. Structure and thermochronology of the metamorphic core of the central Brooks Range, Alaska: Ph.D. thesis, Stanford University, Palo Alto, California, 200 p

Weber, F.R., Wheeler, K.L., Rinehart, C.D., Chapman, R.M., and Blodgett, R.B., 1992. Geologic map of the Livengood quadrangle, Alaska: U.S. Geological Survey Open-File Report 92-562, 20 p., 1 sheet, scale 1:250,000.

Weber, F.R., Blodgett, R.B., Harris, A.G., and Dutro, J.T., Jr., 1994. Paleontology of the Livengood quadrangle, Alaska: U.S. Geological Survey Open File Report 94-215, 24 p., 1 sheet, scale 1:250,000.

Wheeler, K.L., Forbes, R.B., Weber, F.R., and Rinehart, C.D., 1987. Lithostratigraphy, petrology, and geochemistry of the Ordovician Fossil Creek Volcanics, White Mountains, east-central Alaska. *In*: Hamilton, T.D., and Galloway, J.P., eds., Geologic Studies in Alaska by the U.S. Geological Survey during 1986: U.S. Geological Circular 998, p. 70–73.

White, C., Gehrels, G.E., Pecha, M., Giesler, D., Yokelson, I., McClelland, W.C., and Butler, R.F., 2016. U-Pb and Hf isotope analysis of detrital zircons from Paleozoic strata of the southern Alexander terrane (southeast Alaska): Lithosphere, v. 8, p. 83–96. doi:10.1130/L475.1

Figure Captions

Fig. 1: Simplified terrane map of Alaska modified after Silberling et al. (1992, 1994) and Colpron and Nelson (2020). Note lack of terrane classification in the Yukon Flats region is a function of unclear regional geological relationships. PSZ, Porcupine Shear Zone. Numbers refer to locations shown in Figure 2 (columns 1-16), as well as described in the main text. Laurentian margin: 1–Yukon River area of east-central Alaska; 2–Porcupine River area. Arctic Alaska–Chukotka microplate: 3–northeast Brooks Range platformal succession, North Slope subterrane; 4–northeast Brooks Range basinal succession/Whale Mountain allochthon, North Slope subterrane; 5–Doonerak arc complex; 6–York Mountains, York terrane; 7–western Baird Mountains, Hammond subterrane; 8–eastern Baird Mountains, Hammond subterrane; 9–Snowden Mountain area, Hammond subterrane. 10–Ruby terrane. Farewell terrane: 11–Medfra quadrangle, Nixon Fork subterrane; 12–Lone Mountain area, Nixon Fork subterrane; 13–McGrath quadrangle, Dillinger subterrane. 14–White Mountains/Livengood terranes. 15–Goodnews/Kilbuck terranes; Goodnews terrane here included in the Koyukuk terrane. Alexander terrane: 16–Prince of Wales Island, Craig subterrane; 17–Admiralty Island, Admiralty subterrane.

Fig. 2: Correlation of Ordovician rocks in selected areas of east-central, northern, interior, and southeastern Alaska. See Figure 1 for locations of columns; adapted from Dumoulin and Harris (2012) and Dumoulin et al. (2014). Only fossil groups that most narrowly restrict age of collection or unit are shown. British series Tremadoc through Ashgill were used in many original conodont age assignments; modern global stages Tremadocian through Hirnantian are shown in right-hand column. D., Dapingian; Dar., Darriwilian; H., Hirnantian; Trem., Tremadocian. Correlations between British series and global stages, and between conodont and graptolite zones and global stages, from Goldman et al. (2020). Ordovician rock units in columns 6, 8, and 12 have no formal or informal stratigraphic names. L., Lyman Hills Formation; MR, Mathews River unit; NMF, Novi Mountain Formation. BR, Brooks Range; NE, northeastern; POW, Prince of Wales Island.

Fig. 3: Schematic Late Ordovician (Katian) paleogeographic reconstruction of the circum-Arctic after Strauss et al. (2017) and McClelland et al. (in press) with key Alaskan terranes discussed in the text highlighted in blue text. Arctic Alaska–Chukotka microplate (AACM): AAns–North Slope subterrane; AAsw–southwestern subterranes (including York/Seward terranes); Ch–Chukotka Peninsula (Russia) and Chukchi shelf region of the southwestern subterranes; D–Doonerak arc complex. Alexander terrane: ATsc–Southern Craig subterrane (Prince of Wales Island); ATnc–Northern Craig subterrane (Saint Elias region); ATa–Admiralty subterrane. F–Farewell terrane. P–Pearya terrane of Ellesmere Island, Canada. S-K–Sierra-Klamath terranes of California and Oregon. Svalbard: Sve–eastern basement province; Svw–northwestern-southwestern basement provinces.

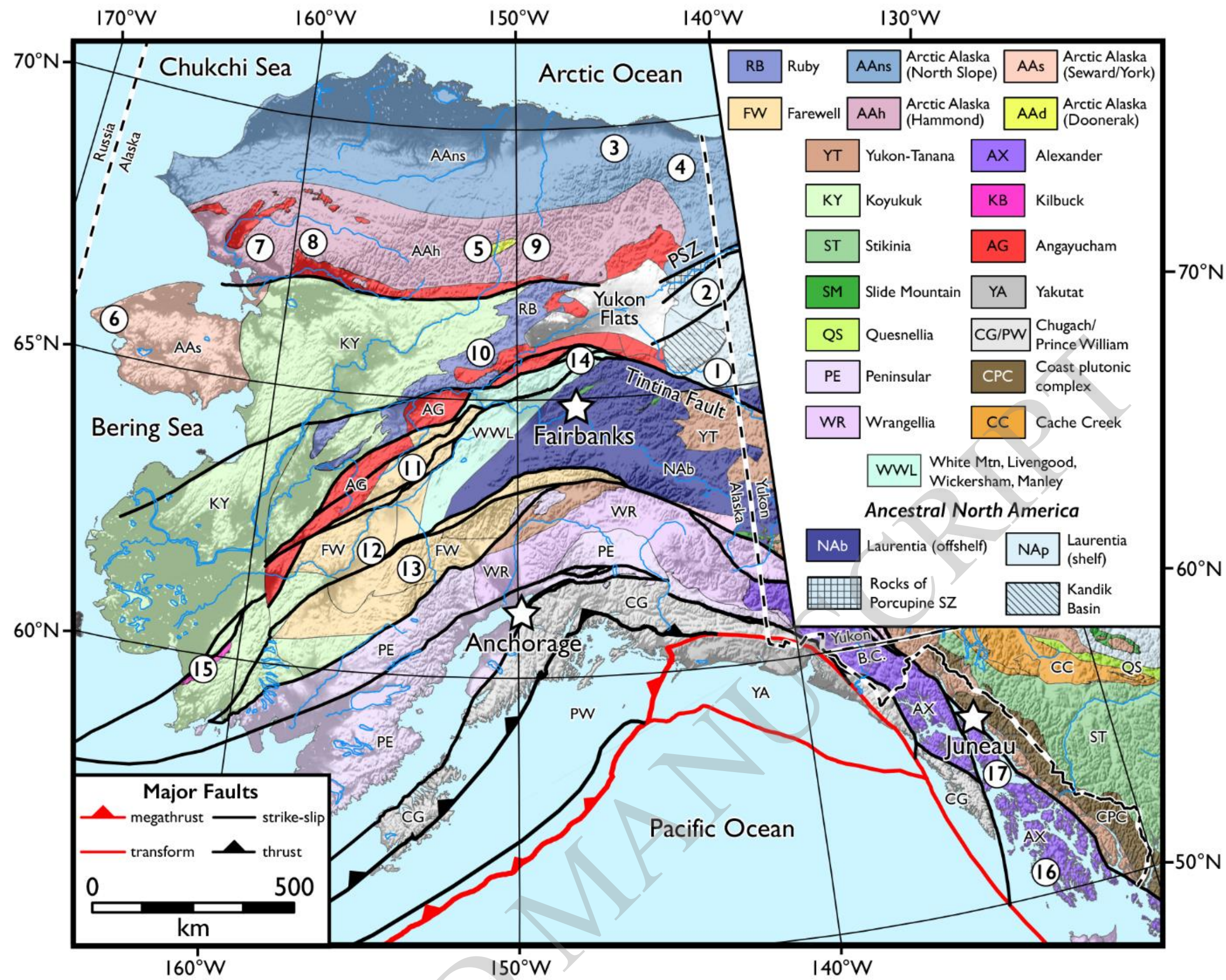
Chukchi Sea
Arctic Ocean
Bering Sea
Pacific Ocean
Russia
Alaska
Yukon Flats
Fairbanks
Anchorage
Juneau
Tintina Fault
PSZ
Alaska
Yukon
B.C.
RB Ruby
AAns Arctic Alaska (North Slope)
AAs Arctic Alaska (Seward/York)
FW Farewell
AAh Arctic Alaska (Hammond)
AAd Arctic Alaska (Doonerak)
YT Yukon-Tanana
AX Alexander
KY Koyukuk
KB Kilbuck
ST Stikinia
AG Angayucham
SM Slide Mountain
YA Yakutat
QS Quesnellia
CG/PW Chugach/ Prince William
PE Peninsular
CPC Coast plutonic complex
WR Wrangellia
CC Cache Creek
WWL White Mtn, Livengood, Wickersham, Manley
Ancestral North America
NAb Laurentia (offshelf)
NAp Laurentia (shelf)
Rocks of Porcupine SZ
Kandik Basin
Major Faults
megathrust
strike-slip
transform
thrust
0
500
km
170°W
160°W
150°W
140°W
130°W
70°N
65°N
60°N
50°N

Figure 1

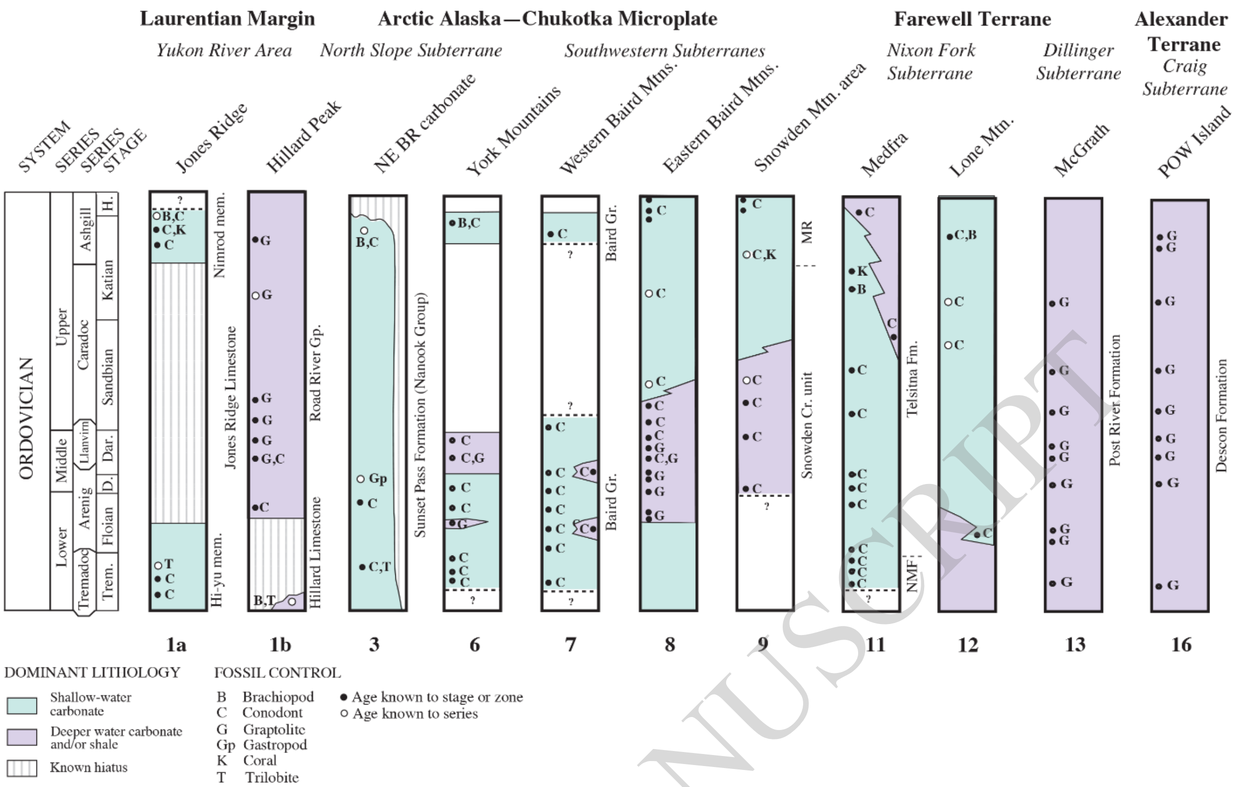
Laurentian Margin
Yukon River Area
Arctic Alaska—Chukotka Microplate
North Slope Subterrane
Southwestern Subterranes
Farewell Terrane
Nixon Fork Subterrane
Dillinger Subterrane
Alexander Terrane
Craig Subterrane
SYSTEM
SERIES
SERIES
STAGE
Jones Ridge
Hillard Peak
NE BR carbonate
York Mountains
Western Baird Mtns.
Eastern Baird Mtns.
Snowden Mtn. area
Medfra
Lone Mtn.
McGrath
POW Island
ORDOVICIAN
Lower
Middle
Upper
Tremadoc
Arenig
Llanvirn
Caradoc
Ashgill
Trem.
Floian
D.
Dar.
Sandbian
Katian
H.
Nimrod mem.
Jones Ridge Limestone
Hi-yu mem.
Road River Gp.
Hillard Limestone
Sunset Pass Formation (Nanook Group)
Baird Gr.
Snowden Cr. unit
MR
Telsitna Fm.
NMF
Post River Formation
Descon Formation
1a
1b
3
6
7
8
9
11
12
13
16
DOMINANT LITHOLOGY
Shallow-water carbonate
Deeper water carbonate and/or shale
Known hiatus
FOSSIL CONTROL
B Brachiopod
C Conodont
G Graptolite
Gp Gastropod
K Coral
T Trilobite
• Age known to stage or zone
○ Age known to series

Figure 2

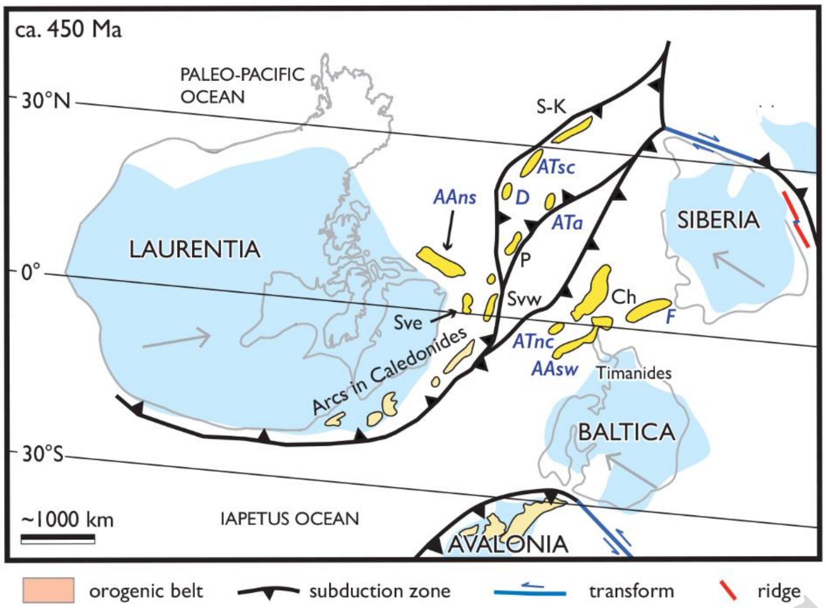
ca. 450 Ma
PALEO-PACIFIC OCEAN
30°N
0°
30°S
LAURENTIA
SIBERIA
BALTICA
AVALONIA
IAPETUS OCEAN
S-K
ATsc
AAns
D
ATa
P
Svw
Sve
Ch
F
ATnc
AAsw
Timanides
Arcs in Caledonides
~1000 km
orogenic belt
subduction zone
transform
ridge

Figure 3