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Seventeen short papers deal with changes in stratigraphic nomenclature: names adopted, revised, reinstated, or abandoned and ages of rocks changed

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NEW PALEOZOIC FORMATIONS IN THE NORTHERN KUSKOKWIM MOUNTAINS, WEST-CENTRAL ALASKA

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ABSTRACT

Five new formations are proposed for the lower and middle Paleozoic sequence in the northern Kuskokwim Mountains, west-central Alaska. Four of these units, exposed in the Nixon Fork terrane, reflect dominantly shallow-water carbonate depositional environments. The Novi Mountain Formation, of Early Ordovician age, is overlain conformably by the Middle and Upper Ordovician Telsitna Formation. The Paradise Fork Formation, deeper water dark platy limestone and shale, lies disconformably above the Telsitna Formation and is of latest Llandoverian to Wenlockian (Silurian) Age. The Whirlwind Creek Formation, of Late Silurian to Late Devonian (Frasnian) age, lies unconformably on either the Paradise Fork or the Telsitna. The East Fork Hills Formation, a deep-water facies equivalent of the other four formations, crops out southeast of the platform sequence and is separated from it by a northeast-trending fault zone.

INTRODUCTION

Paleozoic rocks in the northern Kuskokwim Mountains occur in two different tectonic terranes that reflect widely separated depositional sites that subsequently have been juxtaposed by strike-slip faulting (fig. 4; Patton and others, 1980). The Nixon Fork terrane, composed of more than 5,500 m of predominantly shallow-water carbonate rocks of early and middle Paleozoic age, is fault-bounded on the southeast by the East Fork terrane composed of slightly metamorphosed, locally sheared and foliated, deep-water shaly carbonate rocks also of early and middle Paleozoic age. The Nixon Fork terrane is well exposed along a northeast-trending belt that underlies the higher parts of the northern Kuskokwim Mountains. The East Fork terrane is poorly exposed and is confined chiefly to low, densely forested hills bordering the Kuskokwim River valley. Both terranes are sliced by pervasive northeast-trending high-angle faults that parallel the nearby Nixon Fork-Iditarod fault zone.

NIXON FORK TERRANE

The platform carbonate sequence of the Nixon Fork terrane is here divided into four new formations, ranging in age from Early Ordovician to Late Devonian (fig. 5). Depositional environments range from mainly supratidal laminated silty limestone in the Lower Ordovician through a complex array of shallow-water carbonate facies that include reefoid bodies in the Upper Ordovician and Middle Devonian. Dark platy limestones and shales containing mid-Silurian graptolites indicate deeper water paleo-environments in that part of the Paleozoic column.

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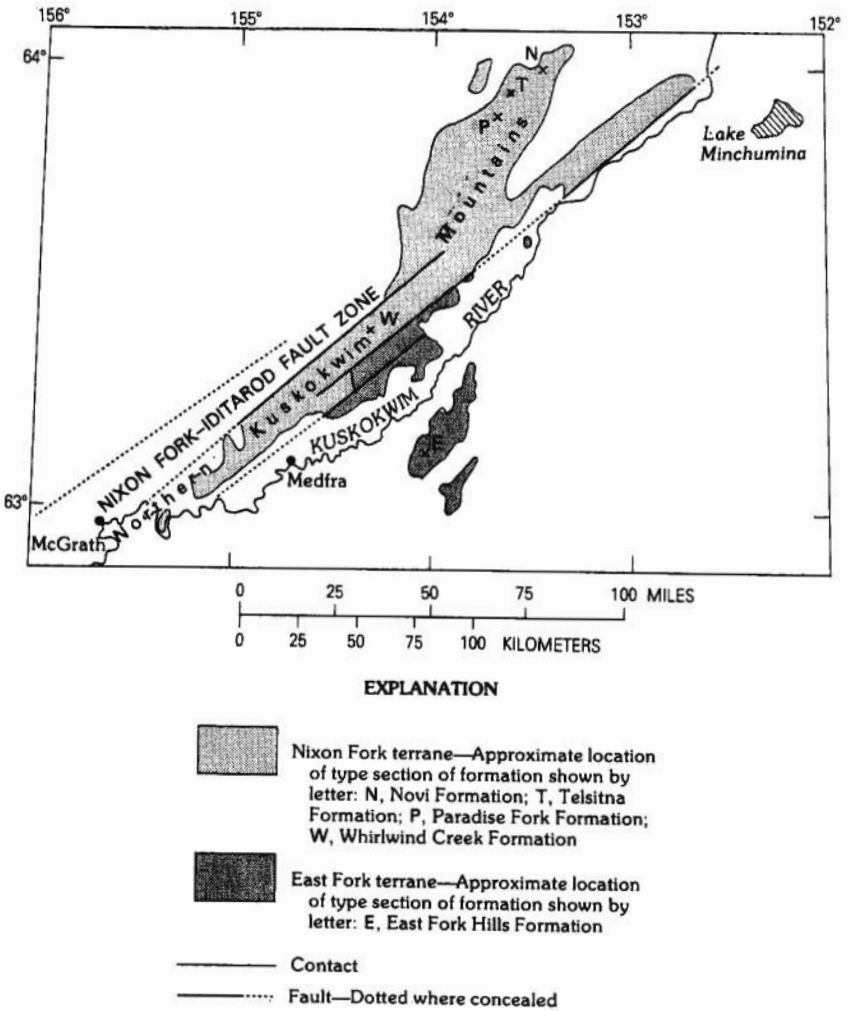

FIGURE 4.—Areas of outcrop of Nixon Fork and East Fork terranes, northern Kuskokwim Mountains, west-central Alaska. From Patton and others, 1980.

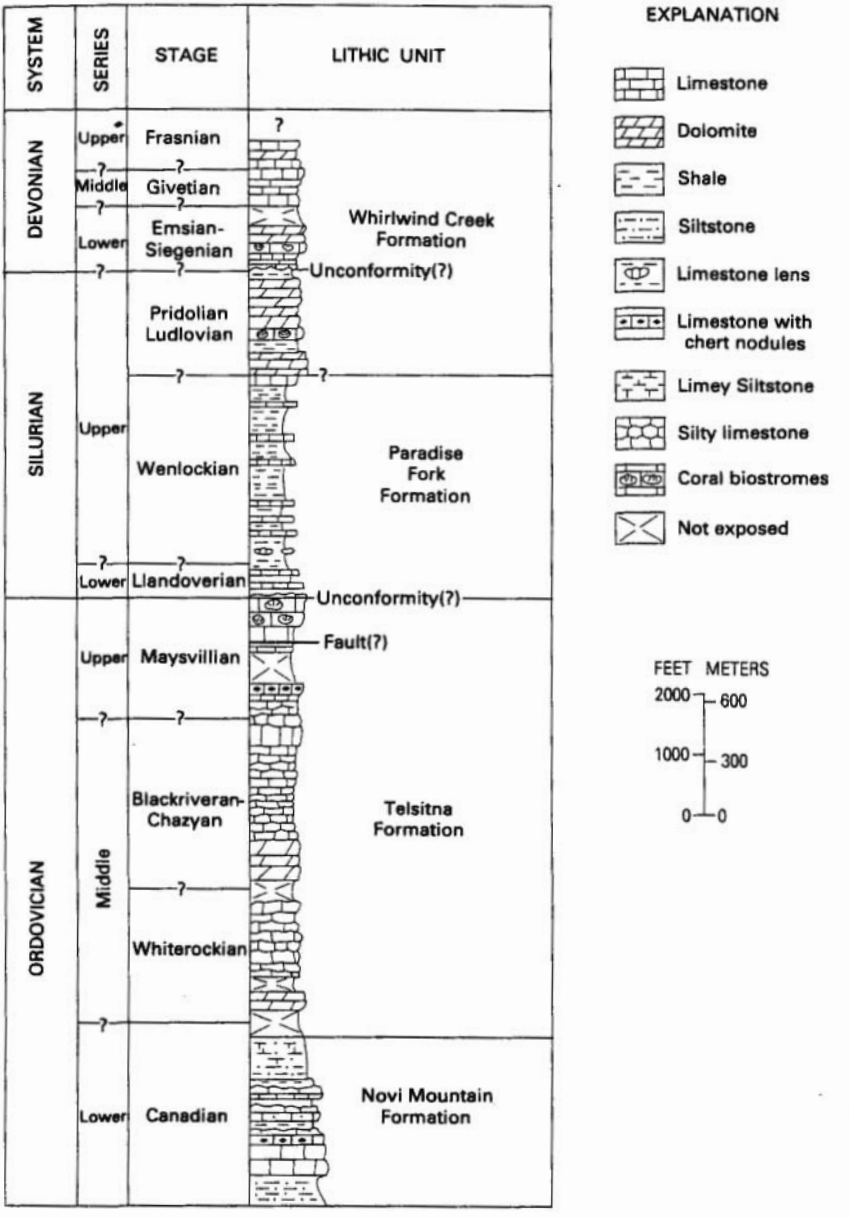

FIGURE 5.—Generalized columnar section of lower and middle Paleozoic rocks, northern Kuskokwim Mountains, west-central Alaska.

NOVI MOUNTAIN FORMATION (HERE NAMED)

Name and distribution

The name Novi Mountain Formation is here applied to a nearly 900-m-thick cyclically interbedded sequence of thin-bedded silty to micritic Lower Ordovician limestone and calcareous siltstone exposed in the vicinity of Novi Mountain. The type section is located on the east and west flanks of Novi Mountain, in sections 29, 30, and 32, T. 17 S., R. 28 E., Medfra (D-1) quadrangle.

The Novi Mountain Formation outcrops are characteristically variegated gray carbonate rocks alternating with yellow-weathering siltier members. The formation is mapped southwestward from its type section for about 25 km along a fault-bounded anticlinal structure (Patton and others, 1980). In addition, it is present in a tightly folded anticline along the same trend, about 50 km southwest of Novi Mountain. The formation also is mapped in the area south of Browns Fork and east of White Mountain Creek.

Stratigraphy

The upper two-thirds of the Novi Mountain Formation is characterized by 5- to 30-m-thick carbonate cycles. Each cycle begins with massive limestone, usually containing flat carbonate pebbles at the base and locally abundant oolites. The thick-bedded limestone grades upward through thin irregularly bedded shaly limestone into calcareous siltstone or shale in the uppermost part of the cycle.

The type section of the Novi Mountain Formation, on Novi Mountain, is a composite of two measured sections with beds dipping generally northwest. The lower section is on the southeast spur of the mountain, measured from a low saddle at about 700 m elevation up to the crest of the ridge at 1,040 m, near triangulation station Higher. The upper part of the formation is exposed on the west side of the mountain where a second section was measured downhill and downdip from the ridgetop to an elevation of 640 m where the stratigraphically highest outcrops occur. The two sections are correlated along the ridge by lateral tracing of cyclic units.

The lower 150 m is predominantly yellow-weathering calcareous siltstone and shale with much evidence of bioturbation. The interval from 150-300 m is characterized by massive limestone beds, 3-5 m thick. At least a dozen cycles, as described above, occur from 300-600 m above the base of the formation. The upper 300 m of the Novi Mountain consists chiefly of thin irregularly bedded silty limestone and shale, in less clearly delineated cycles, with some units of dolomite, interpreted by us to be of supratidal origin. The Novi Mountain appears to grade upward into the Telsitna Formation in the high ridge southeast of the Telsitna River. No clear lower contact is mapped in that area, but the Novi Mountain lies directly on a lower Paleozoic or Precambrian calc-schist unit east of White Mountain Creek.

Fossils and age

The Novi Mountain contains few megafossils, but a sequence of sparse conodont faunas studied by J. E. Repetski (written commun., 1977-80)

indicates that the entire formation is of Early Ordovician age. Conodonts from the middle part of the formation, 300 to 600 m above its base, indicate North American Midcontinent Province Faunas C and D of the Lower Ordovician, according to Repetski. Included in these assemblages are Drepanodus parallelus Branson and Mehl s.f. (= in the form sense), Acontiodus iowensis Furnish s.f., Acontiodus cf. A. staufferi Furnish s.f., Drepanoistodus suberectus (Branson and Mehl), Juanognathus? sp., ?Scolopodus filosus Ethington and Clark s.f., Scolopodus cf. S. gracilis Ethington and Clark, Scolopodus sp., and Oneotodus cf. O. variabilis Lindstrom.

Megafossils include gastropod steinkerns, poorly preserved indeterminate orthoconic cephalopods, and a few fragmental trilobites. E. L. Yochelson (written commun., 1976) identified Sinuites sp. and Liospira sp., both common Ordovician genera. The trilobites include a possible hystricurinid and a pilekiinid, the latter limited to the Lower Ordovician, according to R. J. Ross, Jr. (written commun., 1978).

TELSITNA FORMATION (HERE NAMED)

Name and distribution

The name Telsitna Formation is here applied to an approximately 2,000 m-thick sequence of Middle and Upper Ordovician limestone and dolomite that conformably overlies the Novi Mountain Formation. The type section and type area are located on a high northeast-trending ridge situated along the divide between the head of the Telsitna River and Paradise Fork. The type section is almost completely exposed in southwest-dipping beds along the crest of the ridge in sections 17, 19, and 20, T. 18 S., R. 27 E., Medfra (D-2) quadrangle.

The Telsitna Formation is the most widely distributed Paleozoic map unit in the northern Kuskokwim Mountains. It extends from the type section southwestward to the Kuskokwim River near McGrath, essentially forming the northwest front of the mountains from near Novi Mountain on the north to Halfway Mountain on the south. Most of the prominent hills, including Limestone Mountain and Greens Head, consist of Telsitna Formation carbonate strata (Patton and others, 1980).

Stratigraphy

The lower 300 m of the Telsitna Formation is dominated by variegated light-gray to dark-brown dolomite beds. From 300 to 600 m, the sequence consists mainly of thin-bedded fine-grained medium-gray limestone with silty yellow-weathering interbeds. This part of the formation is highly fossiliferous, including silicified brachiopods and molluscs. Nonfossiliferous dolomite occurs in the interval between 600 and 1,000 m, limestone beds becoming more abundant in the upper 200 m. The upper 600 m of the formation is predominantly limestone that ranges from thick bedded and fine grained to thin bedded, silty, and micritic. Some black chert is present as scattered small nodules and lenses about 200 m below the top of the formation. The overlying Silurian deep-water strata of the Paradise Fork Formation appear to lie disconformably on the Telsitna Formation, but the contact may be faulted.

Fossils and age

Conodonts have been identified from nearly the entire Telsitna Formation (A. G. Harris and J. E. Repetski, written commun., 1979). Samples from about 300 m above the base, in beds that also include the lowest occurence of Maclurites, yielded conodonts of North American Midcontinent Province Middle Ordovician Fauna 3. Fauna 4 conodonts are reported from about 900 m above the base, and a Blackriveran (middle Caradocian) assemblage is identified from about 1,200 m above the base. Late Ordovician (probably Maysvillian) conodonts are present in the upper 50 m of the Telsitna Formation.

The common Ordovician gastropod Maclurites ranges through much of the formation, from 300 m to at least 1,600 m above the base (E. L. Yochelson, written commun., 1978). The upper beds also contain a number of corals, stromatoporoids, and trilobites of Late Ordovician age. W. A. Oliver, Jr. (written commun., 1977-78) reports Catenipora sp., cf. Fletcheria sp., Pycnolithus? sp., Saffordophyllum sp., Tetradium sp., Labyrinthites sp., and Labechia spp., of possible Maysvillian Age. Trilobites from the upper part of the formation, probably within the upper 100 m, are Bumastoides cf. B. milleri (Billings) and Sphaerexochus sp., of late Middle or Late Ordovician age (R. J. Ross, Jr., written commun., 1976). Ostracodes from about 1,300 m above the base are Blackriveran in age, according to J. M. Berdan (written commun., 1980). The assemblage includes: Platybolbina (Platybolbina) sp., Craspedopyxion? aff. C.? tumblingrunensis (Kraft, 1962), Eurychilina aff. E. strasburgensis Kraft, 1962, Leperditella? aff. L.? asymmetrica (Kraft, 1962), "Leperditella" aff. "L." altiforma Harris, 1957, Steusloffina? sp., and Krausella sp.

PARADISE FORK FORMATION (HERE NAMED)

Name and distribution

The name Paradise Fork Formation is here applied to a poorly exposed Silurian sequence, at least 1,000 m thick, of dark-gray thin-bedded platy limestone and black shale. The best exposures and type locality of the formation are located in low hills between upper Paradise Fork and upper Sulukna River drainages in sections 11, 12, 14, and 23, T. 19 S., R. 26 E., Medfra (D-2) quadrangle.

This formation is mapped southwestward from its type area to White Mountain Creek, where it is terminated by a major northwest-trending vertical fault (Patton and others, 1980). The Paradise Fork Formation forms a generally southwest-trending synform that includes younger Devonian beds just north of Stone Mountain. Stone Mountain itself is composed mostly of undifferentiated Cretaceous strata and Upper Cretaceous and lower Tertiary monzonite bodies. No strata assignable to the Paradise Fork are recognized in the southern part of the carbonate outcrop belt.

Stratigraphy

The Paradise Fork Formation overlies, possibly disconformably, the Telsitna Formation and appears to reflect a change to a deeper water depositional environment. The dominant rock types in the lower half of the

formation are dark-gray platy silty limestone and interbedded black silt shale containing nodular concretions at several horizons. Isolated limestone lenses and bodies up to 5 m thick occur in the upper part of the sequence.

The concretions, up to 12 cm in diameter, are composed of dark silty limestone and generally contain fossils or other foreign objects in their cores. Fossils include graptolites, ostracodes, gastropods, and cephalopods. In some instances, pebbles form the cores of the concretions, most of which also contain bits of bituminous material. Silty, yellow-weathering laminae, probably dolomitic, are common at several levels throughout the formation.

Fossils and age

The only diagnostic fossils from the lower part of the Paradise Fork Formation are graptolites that are identified by Claire Carter (written commun., 1978) as Monograptus cf. M. parapriodon Boucek and Paraplectograptus aff. P. eiseli (Manck). Carter suggested a latest Llandoverian to early Wenlockian Age assignment. No beds dated as latest Ordovician or early Llandoverian were found between the uppermost dated Telsitna strata (Maysvillian) and the lowermost graptolite-bearing beds that are no more than 50 m above the base of the Paradise Fork. The absence of these beds suggests that there is a disconformity between the two formations, but field relations also allow for minor faulting along the contact. The age of the upper part of the formation is only roughly estimated, but ostracodes from near the top of the exposed sequence are identified by J. M. Berdan (written commun., 1979) as Herrmannina cf. H. caeca (Jones, 1891). Berdan states, "...Copeland (1976) shows Herrmannina consistently occurring below Leperditia in northern North America, and H. caeca below L. arctica in beds dated as Wenlockian in the south-central Arctic Islands." Consequently, the age of the uppermost part of the Paradise Fork is probably not younger than Wenlockian.

WHIRLWIND CREEK FORMATION (HERE NAMED)

Name and distribution

The name Whirlwind Creek Formation is here applied to an Upper Silurian to Upper Devonian sequence of predominantly shallow-water carbonate rocks, 1,000-1,500 m thick. The type section is a south-dipping sequence exposed on the ridge between Whirlwind and Soda Creeks in section 23, T. 24 S., R. 23 E., Medfra (B-3) quadrangle. The higher beds of the formation are measured in a supplemental section on the north flank of the syncline in sections 29 and 30, T. 23 S., R. 25 E., Medfra (B-3) quadrangle.

The main outcrop belt of the Whirlwind Creek Formation stretches northeastward for about 100 km from the type area to approximately latitude 64° N. (Patton and others, 1980). Exposures are generally poor northeast of Hardscrabble Creek. The southwestern limit of the belt is controlled by two intersecting faults north of Limestone Mountain. Two outlying masses of Whirlwind Creek Formation occur north of Stone Mountain and along a northwest-trending ridge west of White Mountain Creek. These two exposures are regionally significant because they show stratigraphic relations with adjacent formations. North of Stone Mountain, the Whirlwind Creek apparently lies above the Paradise Fork Formation, whereas it lies unconformably on the Telsitna Formation throughout most of

the region. West of White Mountain Creek, the Whirlwind Creek is unconformably overlain by Permian through Lower Cretaceous strata.

Stratigraphy

Although not well exposed, the base of the formation in the type section appears to overlie the Telsitna Formation disconformably. The Whirlwind Creek consists of relatively thick cycles of dolomite and limestone that include some silty intervals and reefoid units with Favosites and other corals and stromatoporoids.

The lowermost cycle in the type section, about 250 m thick, starts with 80 m of algal laminated dolomite that grades upward into pelletoidal limestone and, finally, into silty limestone and siltstone between 80 and 170 m above the base. The upper 80 m of this major cycle is thick-bedded reefy limestone with Favosites that grades into thin-bedded limestone in the uppermost 30 m. A second major cycle, much like the lowermost one, is about 400 m thick. A third cycle, also about 400 m thick, occurs at the top of the type section.

In the supplemental section, cycles do not appear to be as well developed, although the lower 250 m represents a major cycle that correlates with the highest cycle in the type section. The upper 300 m of the supplemental section consists of reefy coral-bearing limestone and dolomite, the latter containing several intervals of dolomite-breccia in the upper 100 m.

Fossils and age

The best age control for the lower part of the Whirlwind Creek is provided by ostracodes present in the upper parts of each major cycle. Ostracodes from two lower horizons, about 170 and 500 m above the base of the formation, are identified by J. M. Berdan (written commun., 1976) as Leperditia aff. L. arctica Salter, 1853, Sulcatiella Polenova, 1968, and Tubulibairdia? sp. Berdan states, "... It seems most probable that both collections are of Late Silurian age, but the possibility of a Devonian age cannot be ruled out."

Ostracodes from about 600-900 m above the base of the formation are probably of Siegenian (Early Devonian) Age, according to Berdan who states (written commun., 1979), "There does not appear to be any distinct change in the character of the ostracode assemblage as one goes up through [this part of the section. The taxa listed are close to forms described by Polenova from the Lower Devonian of Siberia, from localities ranging from Novaya Zemlya on the west to the Sette-Daban Range on the east, and south to the Salair Range on the southwest margin of the Kuznetz Basin. Except for cosmopolitan forms, there are few taxa in common with described North American faunas....There appear to be more Siegenian taxa than either Gedinnian or Emsian but, as ostracode ranges are not yet well known, both Gedinnian and Emsian beds could be present as well as Siegenian."

From the supplemental section, a relatively rich brachiopod assemblage and the coral Rhizophyllum, from about 250 m below the top, suggest an Emsian Age. Corals from elsewhere in the outcrop belt were

identified by W. A. Oliver, Jr. (written commun., 1977). Alaiophyllum, a Middle Devonian genus, occurs in the outcrop north of Stone Mountain. Strata on both limbs of the syncline on upper Soda Creek contain both Middle Devonian and Late Devonian (Frasnian) corals. The Frasnian beds contain Smithiphyllum sp. These corals occur together with abundant Amphipora in beds that are correlated with the dominantly dolomitic unit in the upper 100 m of the supplementary section.

EAST FORK TERRANE

EAST FORK HILLS FORMATION (HERE NAMED)

Name and distribution

The name East Fork Hills Formation is here applied to a poorly exposed sequence of at least several hundred meters of Lower Ordovician to Middle Devonian dark-gray orange-weathering finely laminated limestone and dolomitic limestone. Because of the scattered outcrops, no continuous section is exposed, although several tens of meters can be examined at the designated type locality along the crest of the East Fork Hills in section 14, T. 27 S., R. 25 E., Medfra (A-3) quadrangle.

The East Fork Hills Formation is mapped along both sides of the North Fork of the Kuskokwim River, from just east of Limestone Mountain to Hardscrabble Creek and southeastward to Moose Hill (Patton and others, 1980). None of the outcrops is particularly well exposed, and relations with other mapped units are obscure. Everywhere along the northwest edge of the outcrop belt, the East Fork Hills Formation is in fault contact with the Whirlwind Creek and Telsitna Formations of the Nixon Fork terrane. Paleozoic chert and phyllite in Grayling Hill, east of the East Fork Hills, may be a deeper water facies equivalent, as they are correlated with similar rocks near Lake Minchumina that have yielded probable Ordovician graptolites and radiolaria.

Stratigraphy

Outcrops of the East Fork Hills Formation are characterized by alternating thin bands of limestone and orange-weathering dolomite, locally sheared and foliated. Small-scale crossbedding and penecontemporaneous slump structures are common. Exposures on upper Soda Creek and Beaver Creek contain subordinate amounts of laminated dolomite, dark chert, and siliceous siltstone. Most of the outcrops are shattered by small-scale shearing and faulting, resulting in rubbly colluvial slopes. This formation is interpreted as a deep-water facies, approximately equivalent to the entire shallow-water carbonate sequence of the Nixon Fork terrane represented by the Novi Mountain, Telsitna, Paradise Fork, and Whirlwind Creek Formations.

Fossils and age

Conodonts are reported from several localities in the East Fork Hills Formation (J. E. Repetski, written commun., 1977-79), and ages range from Early Ordovician to Middle Devonian. This nearly complete overlap with the age range of the platform sequence supports the interpretation of the East

Fork Hills sequence as a deep-water equivalent of the Nixon Fork terrane. The original relative positions of the two terranes, before the period of lateral faulting that has juxtaposed them, are unknown.

In addition, we suggest that the East Fork Hills Formation is at least partly correlative with the lime mudstone and shale of the Dillinger River region in the western part of the Talkeetna quadrangle to the east in the southern Alaska Range (Reed and Nelson, 1977).

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