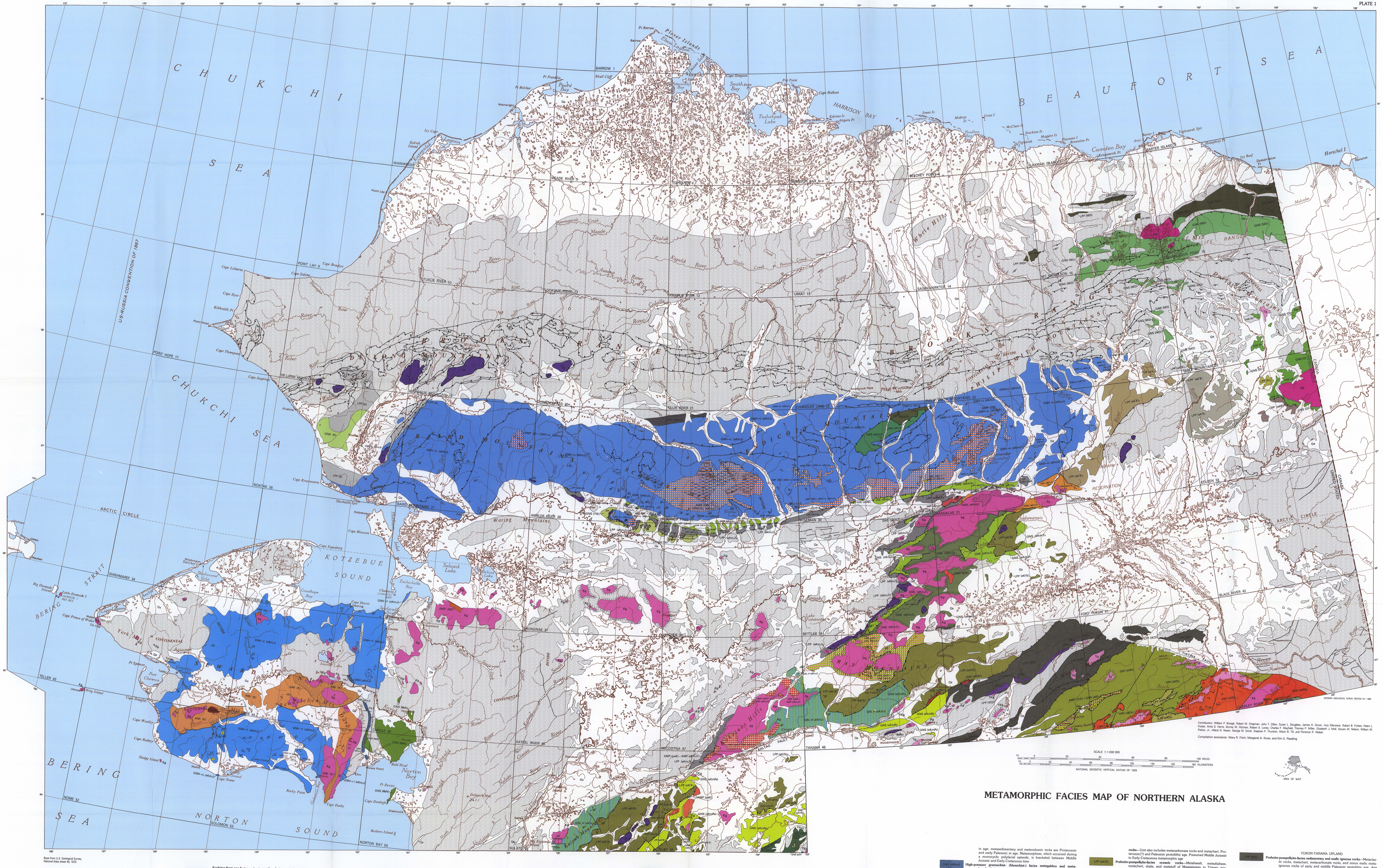
DEPARTMENT OF THE INTERIOR
U.S. GEOLOGICAL SURVEY

PREPARED IN COOPERATION WITH
STATE OF ALASKA DEPARTMENT OF NATURAL RESOURCES,
DIVISION OF GEOLOGICAL AND GEOPHYSICAL SURVEYS

PROFESSIONAL PAPER 1497-A
PLATE 1

METAMORPHIC FACIES MAP OF NORTHERN ALASKA



INTERIOR—GEOLOGICAL SURVEY, RESTON, VA—1989

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Base from U.S. Geological Survey,
National Atlas sheet 40, 1970

The metamorphic scheme used to compile this map (Zwart and others, 1967; figure 3; table 1) is based on pressure- and temperature-sensitive metamorphic minerals. Metamorphosed rocks are divided into four facies groups based on increasing temperature: (1) laumontite and prehnite-pumpellyite facies (LPP), shown in shades of gray and tan; (2) greenschist facies (GNS), shown in shades of green; (3) epidote-amphibolite and amphibolite facies (AMP), shown in shades of red and orange; and (4) two-pyroxene facies (2PX), shown in reddish brown. Where possible, the greenschist-facies and the epidote-amphibolite- and amphibolite-facies groups are divided into three facies series on the basis of pressure. H, I, or L in place of the final letter in the symbol for the facies group indicates a high, intermediate, or low pressure series, respectively. High-pressure greenschist- (blueschist-) facies rocks and rocks metamorphosed under blueschist-facies conditions that evolved to intermediate- or low-pressure greenschist-facies conditions during a single episode are shown in shades of blue.

USE OF METAMORPHIC COLOR PATTERNS AND SYMBOLS

GNS (eKmPz)

Metamorphic-facies designation—Age or bracketing ages[1] of metamorphism given in parentheses. Letters preceding age: l, late; m, middle; e, early; p, pre-. (For example, GNS (eKmPz) indicates greenschist-facies metamorphism bracketed between Early Cretaceous and middle Paleozoic)

GNI,H

Undifferentiated facies series

Undifferentiated intermediate- and high-pressure greenschist facies

LPP/GNS

Transitional between two facies groups

Transitional between laumontite and prehnite-pumpellyite facies and greenschist facies

GNH→L (eKmJ)

Evolving from one facies series to another during a single continuing episode

High-pressure greenschist (blueschist) facies evolving to low-pressure greenschist facies

AMP (peK) +GNS (eKmJ)

Polymetamorphism

Two phases—Older given first

Vertical stripes—Older phase (AMP (peK))

Horizontal stripes—Younger phase (GNS (eKmJ))

Area of migmatite

Strongly metamorphosed pluton—Metamorphic-facies designation of pluton considered to be that of surrounding metamorphic unit; protolithic age of metaplutonic rocks given in detailed description of metamorphic unit

.gl

Location of metamorphic-mineral occurrence—a, andalusite; c, cordierite; cs, crossite; gl, glaucophane; jd, jadeite; k, kyanite; l, lawsonite; (l), pseudomorphs after lawsonite

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Metamorphic-mineral locality and number—Shown on plate 2 and referred to in table 2

GRANITIC AND OTHER ROCK SYMBOLS

(Areas shown as granitic rocks may include some intrusive rocks of intermediate or mafic composition and some related volcanic and hypabyssal rocks)

Qs

Quaternary surficial deposits

Tg TKg Kg Dg

Tertiary, Tertiary or Cretaceous, Cretaceous, or Devonian granitic rocks—Not associated with metamorphism

Ju MzPzu ePzu

Jurassic, Mesozoic and (or) Paleozoic, or early Paleozoic ultramafic rocks—Unit may also include associated layered gabbroic rocks and minor pillow basalt

Area of unmetamorphosed volcanic or sedimentary rocks—Pervasive low-grade alteration and propylitization is characteristic of both Neocomian and Albian-Cenomanian rocks of the Yukon-Koyukuk basin (Stephen Box, oral commun., 1985), but they are shown as unmetamorphosed because diagnostic minerals of laumontite and prehnite-pumpellyite facies have not been reported

xxxxxxxxxxxxxx

Narrow, low-pressure facies-series aureole—Approximately 1 km or more in width

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Eclogite locality—Metamorphic-facies scheme considers this to be a rock type and not a separate facies Description of metamorphic history of eclogite given under metamorphic unit in which locality occurs

LINE SYMBOLS

Contact or boundary between metamorphic-facies units—Dashed where approximately located. May cut across premetamorphic faults

High-angle fault—Dashed where approximately located; dotted where concealed; queried where uncertain. Arrows show relative horizontal movement

Thrust fault—Dashed where approximately located; dotted where concealed; queried where uncertain. Sawteeth on upper plate

Low-angle normal fault on which most recent movement is known to be or may have been extensional (down-to-the-south)—Dashed where approximately located; dotted where concealed; queried where uncertain. Sawteeth on upper plate

Sillimanite isograd—Ticks on high-grade side

Kyanite isograd—Ticks on high-grade side

1:250,000-scale quadrangle—Boundary, name, and map reference number

ABBREVIATED DESCRIPTION OF METAMORPHIC UNITS

(See text for more detailed information)

WESTERN AND CENTRAL BROOKS RANGE

LPP/GNS (TIK)

Prehnite-pumpellyite- or greenschist-facies metaconglomerate, slate, and phyllite—Unit also includes a minor amount of metabasalt and meta-andesite. Protoliths are Late Cretaceous in age. Metamorphism was probably Late Cretaceous or Tertiary in age

LPP (K)

Prehnite-pumpellyite-facies metacarbonate and metasedimentary rocks—Unit also includes metachert and minor metadiabase. Protoliths are Devonian through Early Cretaceous in age. Metamorphism occurred sometime during Early and mid-Cretaceous time

GNS (K)

Greenschist-facies phyllite and quartzite—Unit also includes a minor amount of metalimestone and calcareous metasandstone. Protoliths are Devonian and Mississippian in age. Metamorphism occurred sometime during Early and mid-Cretaceous time

GNH→L (eKmJ)

High-pressure greenschist- (blueschist-) facies rocks partly to totally recrystallized to low(?)-pressure greenschist-facies assemblages—Polydeformed Devonian and older metasedimentary rocks and volumetrically minor metacarbonate rocks, metarhyolite, metabasite, and granitoid orthogneiss; northern part of unit also includes a subordinate amount of upper Paleozoic and Triassic metapelite and metacarbonate rocks. Metamorphism, which occurred during a monocyclic polyfacial episode, is bracketed between Middle Jurassic and Early Cretaceous time

LPP (eKmJ)

Prehnite-pumpellyite-facies metasedimentary rocks and metalimestone—Protoliths are Devonian and Mississippian in age. Metamorphism bracketed between Middle Jurassic and Early Cretaceous time

LPP (eKmJ)$_1$

Prehnite-pumpellyite-facies metavolcanic and metasedimentary clastic rocks—Protoliths are early and middle Paleozoic in age. Metamorphism bracketed between Middle Jurassic and Early Cretaceous time

GNS (eKmJ)

Greenschist-facies metasedimentary rocks, metabasite, and minor metacarbonate and metaclastic rocks—Protoliths are early and middle Paleozoic, Devonian, and Carboniferous through Triassic, respectively, in age. Metamorphism bracketed between Middle Jurassic and Early Cretaceous time

LPP (eKmJ)$_2$

Prehnite-pumpellyite-facies oceanic metabasaltic and metasedimentary rocks—Unit also includes metatuff, metachert, and metalimestone. Basaltic protoliths appear to be Devonian, late Carboniferous, and Triassic in age, and sedimentary protoliths are Devonian to Jurassic in age. Metamorphism bracketed between Middle Jurassic and Early Cretaceous time

GNS (eKmJ)$_1$

Greenschist-facies metagraywacke, phyllite, metasiltstone, metalimestone, and chert—Protoliths are Middle Devonian to Triassic in age. Metamorphism bracketed between Middle Jurassic and Early Cretaceous time

AMP (eKmJ)

Amphibolite-facies pelitic schist, amphibolite, and foliated granite—Unit includes some lower grade phyllite, metagraywacke, and metachert of unknown protolithic age. Metamorphic age tentatively bracketed between Middle Jurassic and Early Cretaceous time

AML (eKmJ)

Low-pressure amphibolite-facies pelitic schist and minor interbedded metachert—Protolithic ages unknown. Metamorphic age bracketed between Middle Jurassic and Early Cretaceous time based on tentative correlation with greenschist-facies rocks to the southwest

AMP (DP)+ GNH→L (eKmJ)

Epidote-amphibolite-facies rocks recrystallized to greenschist-facies assemblages—Schist, quartzite, grit, marble, greenschist, metabasite, and granitoid gneiss, presumably initially metamorphosed during pre-Devonian time and subsequently retrograded between Middle Jurassic and Early Cretaceous time. Sedimentary and volcanic protoliths are pre-Devonian in age; orthogneiss protoliths are Devonian and Proterozoic or middle Paleozoic in age

AMP (Z)+ GNH→L (eKmJ)

Amphibolite-facies schist, quartzite, marble, metabasite, and mafic metaplutonic rocks recrystallized to blueschist- and greenschist-facies assemblages—Rocks initially metamorphosed during Late Proterozoic time and subsequently retrograded between Middle Jurassic and Early Cretaceous time

EASTERN BROOKS RANGE

LPP (K)$_1$

Prehnite-pumpellyite-facies phyllite and orthoquartzite—Late Jurassic or Early Cretaceous protolithic ages; probable Cretaceous metamorphic age

LPP (eKTR)

Prehnite-pumpellyite-facies metasedimentary and metavolcanic rocks, metalimestone, metachert, and minor metaconglomerate—Protoliths are middle Paleozoic to Triassic in age. Metamorphism bracketed between Triassic and Early Cretaceous time

LPP (eKTR)$_1$

Prehnite-pumpellyite-facies metasedimentary rocks, metachert, and minor metalimestone and metavolcaniclastic rocks—Protoliths are Devonian to Triassic in age. Metamorphism bracketed between Triassic and Early Cretaceous time

LPP (eKP)

Prehnite-pumpellyite-facies phyllite, slate, and quartzite—Metamorphism bracketed between probable Proterozoic protolithic age and Early Cretaceous time

LPP (MD)

Prehnite-pumpellyite-facies metasedimentary, metacarbonate, and metavolcanic rocks—Protoliths are of Proterozoic and Paleozoic age. Metamorphism bracketed between Middle Devonian and Mississippian time

GNS (MD)

Greenschist-facies metasedimentary and metavolcanic rocks—Protoliths are Proterozoic and Paleozoic in age. Metamorphism bracketed between Middle Devonian and Mississippian time

GNS (D)

Greenschist-facies metasedimentary and meta-igneous rocks—Protoliths are Proterozoic(?) to Devonian in age. Rocks probably metamorphosed during a Devonian plutonometamorphic event

SEWARD PENINSULA

GNH→I (eKmJ)

High-pressure greenschist- (blueschist-) facies metasedimentary, metavolcanic, and metaplutonic rocks partly recrystallized to intermediate-pressure greenschist-facies assemblages—Orthogneiss is Devonian in age; metasedimentary and metavolcanic rocks are Proterozoic and early Paleozoic in age. Metamorphism, which occurred during a monocyclic polyfacial episode, is bracketed between Middle Jurassic and Early Cretaceous time

GNH (eKmJ)

High-pressure greenschist- (blueschist-) facies metagabbro and metabasalt—Low-temperature subfacies of unit shown by stipple pattern. Protoliths interpreted to range in age from middle Paleozoic to Jurassic. Metamorphism probably occurred between Middle Jurassic and Early Cretaceous time

AMI (K)

Intermediate-pressure amphibolite-facies schist, marble, quartzite, and amphibolite—Protoliths are thought to be Proterozoic and early Paleozoic in age. Metamorphism probably occurred in Cretaceous time

GNS (MzPz)

Greenschist-facies schist, quartzite, and metacarbonate rocks—Marble protolith is tentatively regarded as middle Paleozoic in age. Metamorphism occurred sometime during Paleozoic or Mesozoic time

AMP (KP)

Amphibolite-facies hornblende gneiss, calc-silicate gneiss, marble, and metapelite—Protolithic age unknown. Exact metamorphic age unknown but is within age range of Proterozoic to Cretaceous

2PX (IK)

Granulite- and minor upper amphibolite-facies gneiss, marble, and migmatite—Unit also includes minor amount of garnet lherzolite, partly recrystallized to spinel lherzolite. Protolithic ages are unknown but are thought to be Proterozoic and early Paleozoic. Granulite- and upper amphibolite-facies metamorphism probably occurred in Late Cretaceous time

SOUTHEASTERN BORDERLANDS OF THE YUKON-KOYUKUK BASIN

LPP (eKmJ)$_2$

Prehnite-pumpellyite-facies oceanic metabasaltic and metasedimentary rocks—See unit description in Western and Central Brooks Range section

GNS (eKmJ)$_1$

Greenschist-facies metagraywacke, phyllite, metasiltstone, metalimestone, and chert—See unit description in Western and Central Brooks Range section

GNS (eKmJ)$_2$

Greenschist-facies schist, quartzite, marble, and semischist—Probable Paleozoic protolithic age. Metamorphism probably bracketed between Middle Jurassic and Early Cretaceous time

GNI, H (eKmJ)

Undifferentiated intermediate- and locally high-pressure greenschist-facies schist, quartzite, and metasedimentary and mafic metavolcanic rocks—Unit also includes metacarbonate rocks and metachert. Proterozoic(?) and Paleozoic protolithic age. Presumed Middle Jurassic to Early Cretaceous metamorphic age

LPP (eKlTR)

Prehnite-pumpellyite-facies oceanic rocks—Metabasalt, metadiabase, metachert, shale, and metatuff of Mississippian to Triassic protolithic age. Metamorphism bracketed between Late Triassic and Early Cretaceous time

GNS (eKmPz)

Greenschist-facies phyllite, schist, quartzite, greenstone, metachert, and metalimestone—Proterozoic(?) to middle(?) Paleozoic protolithic age. Metamorphism bracketed between middle Paleozoic and Early Cretaceous time

GNS (pO)

Greenschist-facies metavolcanic and metasedimentary rocks—Late Proterozoic felsic metavolcanic rocks and pre-Ordovician schist, sheared grit, quartzite, phyllite, argillite, marble, and mafic metavolcanic rocks. Metamorphism is also pre-Ordovician in age

AMP (peK)

Amphibolite-facies quartzite, gneiss, and schist—Protolithic ages are presumed to be Proterozoic and (or) Paleozoic. Metamorphism is pre-Early Cretaceous in age

AMP (peK)+ GNS (eKmJ)

Polydeformed and polymetamorphosed amphibolite-facies mylonitic metasedimentary and meta-igneous rocks—Schist, marble, quartzite, siliceous blastomylonite, phyllonite, paragneiss, augen gneiss, amphibolite, and metabasite. Protolithic ages of metasedimentary rocks are unknown but are probably Proterozoic and (or) Paleozoic; protolithic age of augen gneiss is Devonian. Both metamorphic episodes are pre-late Early Cretaceous; second metamorphic episode probably occurred sometime during Middle Jurassic to Early Cretaceous time

AMP (peK)+ AMP (eKmJ?)

Amphibolite-facies metasedimentary and meta-igneous rocks—Polymetamorphosed schist, gneiss, quartzite, marble, calc-silicate rocks, and amphibolite and singly metamorphosed crosscutting granitoid gneiss. Protoliths probably Proterozoic and Paleozoic in age. Both metamorphic episodes are pre-late Early Cretaceous in age; second metamorphic episode probably occurred sometime during Middle Jurassic to Early Cretaceous time

AMP (mPzY)+ GNS (mPzY)

Mylonitic and retrograded amphibolite-facies rocks—Pelitic schist, calc-schist, semischist, quartzite, phyllite, mafic and felsic metavolcanic rocks, and schistose metaplutonic rocks. Protoliths of meta-igneous rocks are Middle Proterozoic in age, and those of metasedimentary rocks are thought to be pre-Ordovician in age. Prograde and retrograde metamorphism occurred sometime between Middle Proterozoic and middle Paleozoic time

YUKON-TANANA UPLAND

LPP (IKD)

Prehnite-pumpellyite-facies sedimentary and mafic igneous rocks—Metaclastic rocks, metachert, metacarbonate rocks, and minor mafic meta-igneous rocks of early and middle Paleozoic protolithic age. Age and tectonic origin of metamorphism unknown; metamorphism bracketed between Devonian and Late Cretaceous time

LPP (eKPz)

Prehnite-pumpellyite-facies sedimentary rocks—Quartzite, argillite, phyllite, metacarbonate, and weakly metamorphosed grit. Protoliths are Proterozoic and (or) Paleozoic in age. Metamorphism bracketed between Paleozoic and Early Cretaceous time

GNI (eKPz)

Intermediate-pressure greenschist-facies quartzite and muscovite-quartz schist—Unit also includes subordinate pelitic or felsic schist, greenschist, calc-silicate rocks, and rare marble. Probable Paleozoic protolithic age. Metamorphism bracketed between Paleozoic and Early Cretaceous time

AMI (eKPz)

Intermediate-pressure amphibolite-facies metasedimentary and meta-igneous rocks—Polydeformed pelitic schist and gneiss and minor quartzite, augen gneiss, calc-silicate rocks, marble, and amphibolite. Protolithic ages are middle Paleozoic and older. Metamorphism bracketed between Paleozoic and Early Cretaceous time

AMI (eKPz?)

Intermediate-pressure amphibolite-facies metasedimentary rocks—Fault-bounded slivers of structurally complex schist, marble, and chert. Metamorphism bracketed between an assumed Paleozoic age of the protoliths and Early Cretaceous time

LPP/GNS (eJlTR)

Transitional prehnite-pumpellyite- to lower greenschist-facies oceanic rocks—Thrust remnants of greenstone and associated metasedimentary rocks. Unit is associated with ultramafic rocks and forms part of a dismembered ophiolite. Protolithic ages are uncertain but may be, in part, Permian. Metamorphism probably occurred during latest Triassic and Early Jurassic time

AMH (OЄ)+ GNS (eK)

Eclogite-bearing terrane of high-pressure amphibolite-facies rocks—Calc-magnesian metamorphic rocks interlayered with or intruding basic schists, pelitic schists, or quartzite. Protoliths are Proterozoic or early Paleozoic in age. Locally rocks partly retrograded to greenschist-facies mineral assemblages. High-pressure metamorphic episode is Cambrian and (or) Ordovician in age; retrograde metamorphic episode is Early Cretaceous in age. Rocks occur as klippen

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[1] Standard abbreviations for metamorphic ages are: T, Tertiary; K, Cretaceous; J, Jurassic; TR, Triassic; Mz, Mesozoic; M, Mississippian; D, Devonian; O, Ordovician; Є, Cambrian; Pz, Paleozoic; P, Proterozoic; Z, Late Proterozoic; Y, Middle Proterozoic