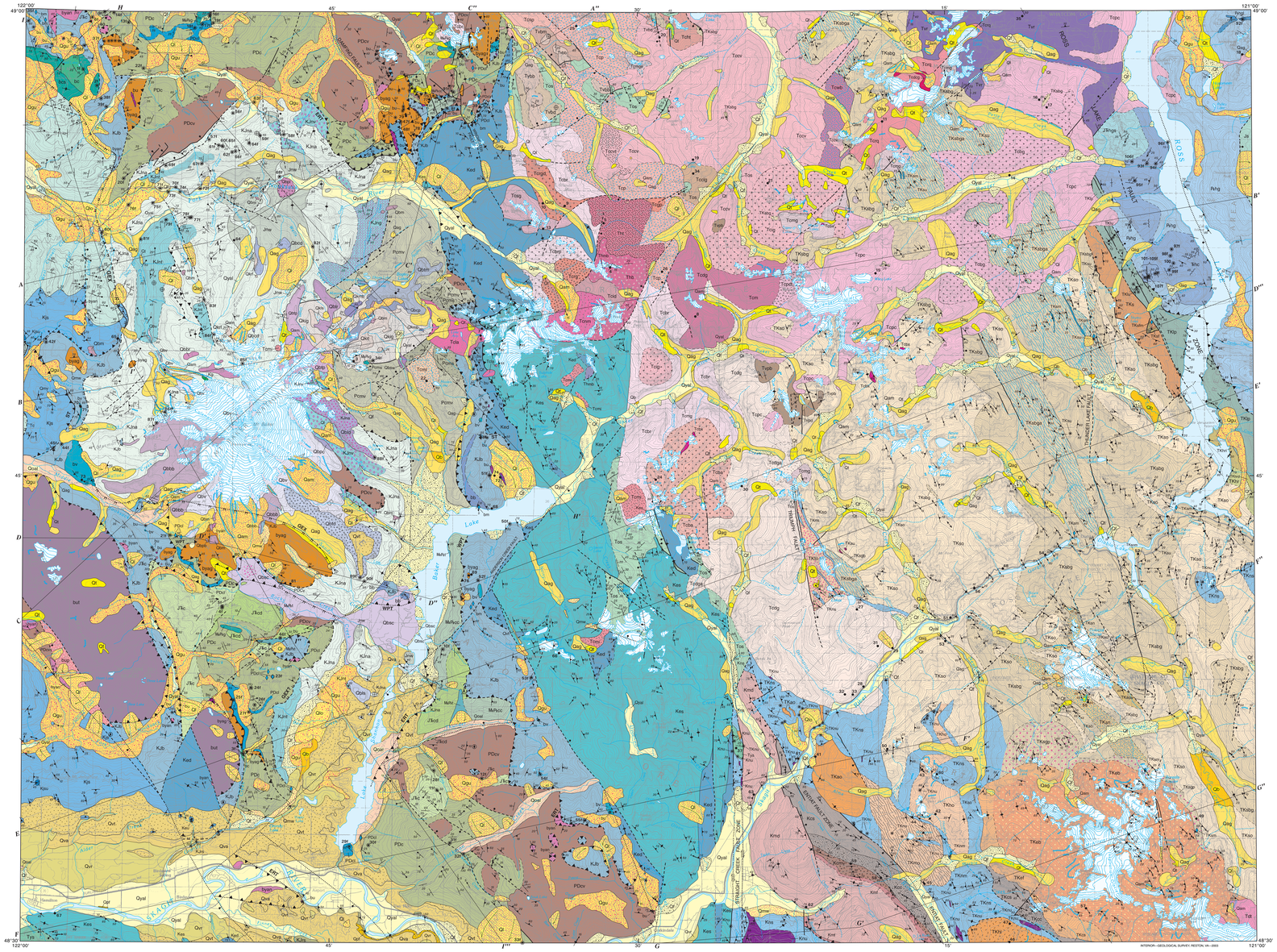
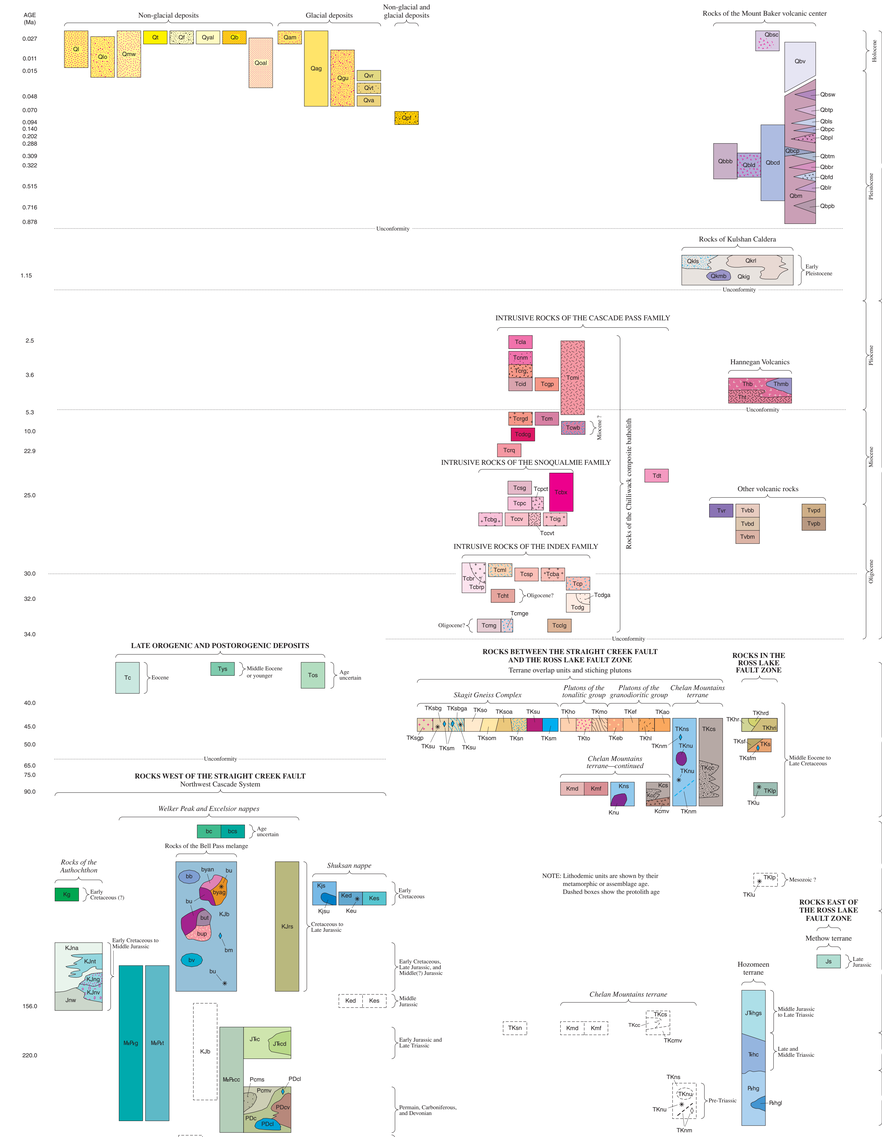
U.S. DEPARTMENT OF THE INTERIOR
U.S. GEOLOGICAL SURVEY

Prepared in cooperation with the
WASHINGTON STATE DEPARTMENT OF NATURAL RESOURCES
DIVISION OF GEOLOGY AND EARTH RESOURCES

GEOLOGIC INVESTIGATIONS SERIES I-2660
SHEET 1 of 2
Pamphlet accompanies map



CORRELATION OF MAP UNITS



Base from U.S. Geological Survey, 1979
Universal Transverse Mercator projection

Some shorelines and glacier outlines shown on this base map may not coincide with map-unit boundaries, which were captured from scanned and vectorized linework

APPROXIMATE MEAN DECLINATION, 2003 (at center of map)

SCALE 1:100 000
1 0 1 2 3 4 5 6 7 8 9 10 KILOMETERS
1 0 1 2 3 4 5 MILES
5000 0 5000 10000 15000 20000 25000 FEET
CONTOUR INTERVAL 50 METERS
NATIONAL GEODETIC VERTICAL DATUM OF 1929

WASHINGTON
AREA OF QUADRANGLE

INTERIOR—GEOLOGICAL SURVEY, RESTON, VA—2003

Geology mapped by R.W. Tabor (1966-1967, 1984-1995), E.H. Brown (1971-1986), R.A. Haugerud (1978-1995), E.W. Hildreth (1992-1995), D.B. Booth (1984-1991), M.H. Ort (1984-1985), Patrick Goldstrand (1985), Carolyn Ortenburger (1985-1986), Janet Slate and Robert Filmore (1986), Kathleen Duggan (1987-1988), Scott Spees (1987), Eric Roth (1988), Kris Alvarez (1990-1991), Tom Grundy (1990), David Maher and Jim Montgomery (1991), and Chad Nelsen and Cathryn Dwyre (1992)
GIS database by R.W. Tabor and R.A. Haugerud
Edited by Julia Thomas and Jan Zigler; digital cartography by Kathryn Nimz with assistance from Susan Mayfield and Richard D. Koch
Manuscript approved for publication September 10, 1998

LIST OF MAP UNITS

[See pamphlet for complete unit descriptions. Small unlabeled units and symbols and overprinted symbols are attributed in the database]

SURFICIAL DEPOSITS

Non-glacial deposits

- **Ql** — **Landslide deposits (Holocene)**—Locally includes:
- **Qls** — **Older landslide deposits (Holocene and Pleistocene)**
- **Qmw** — **Mass-wastage deposits (Holocene and Pleistocene)**
- **Qt** — **Talus deposits (Holocene)**
- **Qf** — **Alluvial-fan deposits (Holocene)**
- **Qyal** — **Younger alluvium (Holocene)**
- **Qb** — **Bog deposits (Holocene)**
- **Qoal** — **Older alluvium (Holocene and Pleistocene)**

Glacial deposits

- **Qam** — **Alpine glacial moraine (Holocene)**
- **Qag** — **Alpine glacial deposits (Holocene and Pleistocene)**
- **Qgo** — **Glacial deposits, undivided (Holocene and Pleistocene)**

Deposits of the Yashon stade of the Fraser glaciation of Armstrong and others (1965) (Pleistocene)—Divided into:

- **Qvr** — **Recessional outwash deposits**
- **Qvt** — **Till**
- **Qva** — **Advance outwash deposits**

Non-glacial and glacial deposits

- **Qpf** — **Non-glacial and glacial sedimentary deposits older than Fraser Glaciation (Pleistocene)**

ROCKS OF THE CASCADE MAGMATIC ARC

Rocks of the Mount Baker volcanic center (Holocene and Pleistocene)—Divided into:

- **Qbsc** — **Basalt of Sulphur Creek (Holocene)**—Scoria cone indicated by pattern
- **Qbv** — **Andesite of present-day Mount Baker stratovolcano (Holocene and late Pleistocene)**
- **Qbm** — **Miscellaneous lava-flow remnants (Pleistocene)**—Locally shown as:
- **Qbsw** — **Andesite of Swift Creek (late Pleistocene)**
- **Qbtp** — **Andesite of The Portals (late Pleistocene)**
- **Qbls** — **Basalt of Lake Shannon (late Pleistocene)**
- **Qbod** — **Andesite of Cougar Divide (middle Pleistocene)**
- **Qbpc** — **Andesite of Park Creek (late Pleistocene)**
- **Qbpl** — **Andesite of Pinus Lake (middle Pleistocene)**
- **Qbbb** — **Andesite of Black Buttes (middle Pleistocene)**
- **Qbcp** — **Andesite of Coleman Pinnacle (middle Pleistocene)**
- **Qbtm** — **Andesite of Table Mountain (middle Pleistocene)**
- **Qbld** — **Andesite of Lava Divide (middle Pleistocene)**
- **Qbbr** — **Andesite of Bastille Ridge (middle Pleistocene)**
- **Qbfd** — **Andesite of Forest Divide (middle Pleistocene)**
- **Qbli** — **Andesite of Lasiocarpa Ridge (middle Pleistocene)**
- **Qbpb** — **Basalt of Park Butte (and associated rocks) (middle Pleistocene)**

Rocks of Kulshan caldera (early Pleistocene)—Divided into:

- **Qkrl** — **Rhyodacite lava flows, domes, dikes, and shallow intrusions**
- **Qkls** — **Caldera-lake sedimentary deposits**
- **Qkig** — **Ignimbrite of Swift Creek**
- **Qkmb** — **Caldera-collapse megablocks**

Hannegan Volcanics (Pliocene)—Divided into:

- **Thb** — **Volcanic breccia**
- **Thmb** — **Monolithologic breccia**
- **Thl** — **Tuff**

Other volcanic rocks

- **Tvr** — **Volcanic rocks of Mount Rahm (Oligocene)**

Volcanic rocks of Big Bosom Buttes (Oligocene)—Divided into:

- **Tvbb** — **Breccia**
- **Tvbd** — **Ductile tuff**
- **Tvbm** — **Monolithologic granite breccia**

Volcanic rocks of Pioneer Ridge (Oligocene)—Divided into:

- **Tvpd** — **Ductile flows**
- **Tvpb** — **Mudflow breccia**

INTRUSIVE ROCKS OF THE CASCADE PASS FAMILY

- **Tdt** — **Tonalite of Cascade Pass dike (Miocene)**

Rocks of the Chilliwack composite batholith (Pliocene and Miocene)—Divided into:

- **Tcla** — **Lake Ann stock (Pliocene)**
- **Tcmi** — **Miscellaneous granodiorite intrusions (Pliocene and (or) Miocene)**
- **Tcnm** — **Quartz monzonite and granite of Nooksack cirque (Pliocene)**
- **Tcrg** — **Granite of Ruth Mountain (Pliocene)**
- **Tcrd** — **Quartz diorite and quartz monzodiorite of Icy Peak (Pliocene)**
- **Tcgp** — **Granite porphyry of Egg Lake (Pliocene)**
- **Tcrgd** — **Ruth Creek pluton (Miocene)**
- **Tcm** — **Mineral Mountain pluton (Miocene)**
- **Tcwb** — **Granite of western Bear Mountain (Miocene?)**
- **Tcdcg** — **Granite of Depot Creek (Miocene)**
- **Tcrq** — **Quartz monzodiorite of Redoubt Creek (Miocene)**

INTRUSIVE ROCKS OF THE SNOQUALMIE FAMILY

Rocks of the Chilliwack composite batholith (Miocene and Oligocene)—Divided into:

- **Tcbx** — **Intrusive breccia (Miocene and (or) Oligocene)**
- **Tcsg** — **Mount Sefrit Gabbronorite of Tepper and others (1993) (Miocene)**
- **Tcpc** — **Perry Creek phase (Miocene and Oligocene)**—Locally includes:
- **Tcqd** — **Tectonized tonalite**
- **Tcbg** — **Biotite granodiorite of Little Beaver Creek (Oligocene)**
- **Tcov** — **Chilliwack valley phase (Oligocene)**—Locally includes:
- **Tcovt** — **Dark tonalite**
- **Tcig** — **Indian Mountain phase (Oligocene)**

INTRUSIVE ROCKS OF THE INDEX FAMILY

Rocks of the Chilliwack composite batholith (Oligocene)—Divided into:

- **Tcbr** — **Baker River phase (Oligocene)**—Locally includes:
- **Tcbrp** — **Price Glacier pluton**
- **Tcmt** — **Tonalite of Maiden Lake**
- **Tcsp** — **Silesia Creek pluton (Oligocene)**
- **Tcbp** — **Biotite alaskite of Mount Blum (Oligocene)**
- **Tcp** — **Pocket Peak phase (Oligocene)**
- **Tcht** — **Heterogeneous tonalite and granodiorite of Middle Peak (Oligocene?)**
- **Tcdg** — **Granodiorite of Mount Despair (Oligocene)**—Locally includes:
- **Tcdga** — **Agmatite**
- **Tcmg** — **Miscellaneous gabbros and diorites (Oligocene?)**—Locally includes:
- **Tcmge** — **Inclusion-rich diorite of Ensawkwatch Creek**
- **Tcclg** — **Gabbro of Copper Lake (Oligocene)**

LATE OROGENIC AND POSTOROGENIC DEPOSITS

- **Tc** — **Chuckanut Formation (Eocene)**
- **Tys** — **Younger sandstone and conglomerate (middle Eocene or younger)**
- **Tos** — **Older sandstone and conglomerate (age uncertain)**

ROCKS WEST OF THE STRAIGHT CREEK FAULT

Northwest Cascades System

Welker Peak and Excelsior nappes

- **bc** — **Conglomerate of Bald Mountain (age uncertain)**—Locally includes:
- **bcs** — **Sandstone and argillite**

Rocks of the Bell Pass mélange (Cretaceous to Late Jurassic)

- **KJb** — **Bell Pass mélange, undivided**—Locally includes as tectonic blocks:
- **bb** — **Blueschist of Baker Lake (Cretaceous to Jurassic metamorphic age)**
- **Yellow Aster Complex of Misch (1966) (Paleozoic protolith age)**—Divided into:
- **byan** — **Non-gneissic rocks**
- **byag** — **Gneissic rocks**
- **bu** — **Ultramafic rocks**—Locally includes:
- **but** — **Twin Sisters Dunite of Ragan (1961, 1963)**
- **bup** — **Pyroxenite**
- **bv** — **Vedder Complex of Armstrong and others (1983) (Permian metamorphic age)**
- **bm** — **Marble**
- **KJns** — **Slate of Rinker Ridge (Cretaceous to Late Jurassic)**
- **MzPg** — **Gabbroic intrusions (Mesozoic and Paleozoic)**
- **MzPd** — **Tonalitic intrusions (Mesozoic and Paleozoic)**
- **MzPcc** — **Chilliwack Group of Cairnes (1944) and Cultus Formation of Brown and others (1987) undivided (Mesozoic and Paleozoic)**
- **JTrc** — **Cultus Formation of Brown and others (1987) (Early Jurassic and Late Triassic)**—Locally includes:
- **JTrcd** — **Dacite and associated tuffaceous sedimentary rocks**
- **PDc** — **Chilliwack Group of Cairnes (1944) (Permian, Carboniferous, and Devonian)**—Locally divided into:
- **Pomv** — **Volcanic rocks of Mount Herman (Permian)**
- **Poms** — **Sedimentary rocks of Mount Herman (Permian)**
- **PDcv** — **Volcanic rocks (Permian, Carboniferous, and Devonian)**
- **PDcl** — **Limestone and marble (Permian, Carboniferous, and Devonian)**

Rocks of the Autochthon

- **Kg** — **Gabbroic intrusions (Early Cretaceous?)**

Nooksack Formation (Early Cretaceous to Middle Jurassic)—Divided into:

- **KJna** — **Argillite and sandstone**
- **KJnt** — **Thick-bedded sandstone and argillite**
- **KJng** — **Grit and thick-bedded sandstone**
- **KJnv** — **Volcanic-rich conglomerate and sandstone**
- **Jnw** — **Wells Creek Volcanic Member**

Shuksan nappe

- **Kjs** — **Semischist and phyllite of Mount Josephine (Early Cretaceous?)**—Locally includes:
- **Kjsu** — **Ultramafic rocks**

Eastern Metamorphic Suite (Early Cretaceous)—Divided into:

- **Ked** — **Darrington Phyllite (Early Cretaceous)**
- **Kes** — **Shuksan Greenschist (Early Cretaceous)**
- **Kesu** — **Ultramafic rock (Early Cretaceous)**

ROCKS BETWEEN THE STRAIGHT CREEK FAULT AND THE ROSS LAKE FAULT ZONE

Terrane overlap units and stitching plutons

Skagit Gneiss Complex

Skagit Gneiss Complex (Middle Eocene to Late Cretaceous)—Divided into:

- **TKggp** — **Granite pegmatite**
- **TKdg** — **Banded gneiss, mostly biotite gneiss**
- **TKdga** — **Banded gneiss, mostly amphibole gneiss and amphibolite**
- **TKso** — **Orthogneiss**—Locally includes:
- **TKsom** — **Mafic orthogneiss**
- **TKsoa** — **Mafic migmatite**
- **TKsn** — **Orthogneiss of The Needle**
- **TKsu** — **Ultramafic rocks**
- **TKam** — **Marble and calcsilicate rocks**

Plutons of the tonalitic group

- **TKho** — **Orthogneiss of Haystack Creek (Middle Eocene to Late Cretaceous)**
- **TKmo** — **Orthogneiss of Marble Creek (Middle Eocene to Late Cretaceous)**
- **TKto** — **Orthogneiss of Mount Triumph (Tertiary and Late Cretaceous)**

Plutons of the granodioritic group

- **TKeb** — **Eldorado Orthogneiss (Middle Eocene to Late Cretaceous)**—Locally includes:
- **TKef** — **Flaser gneiss border zone**
- **TKhi** — **Hidden Lake stock (Middle Eocene to Late Cretaceous)**
- **TKao** — **Orthogneiss of Alma Creek (Middle Eocene to Late Cretaceous)**

Chelan Mountains terrane

- **TKns, Kns** — **Napeequa Schist (Middle Eocene to Late Cretaceous)**—Locally includes:
- **TKam** — **Marble and minor amphibolite**
- **TKnu, Knu** — **Ultramafic rocks**
- **TKns, Kns** — **Cascade River Schist (Middle Eocene to Late Cretaceous)**—Locally includes:
- **TKgn, Kgn** — **Metaconglomerate**
- **TKmv, Kmv** — **Metavolcanic rocks**
- **Kmd** — **Marblemount pluton (Late Cretaceous)**—Locally includes:
- **Kmf** — **Flaser gneiss border zone**

ROCKS IN THE ROSS LAKE FAULT ZONE

- **TKhr** — **Ruby Creek Heterogeneous Plutonic Belt of Misch (1966) (Middle Eocene to Late Cretaceous)**—Locally includes:
- **TKhri** — **Prominent inclusions of mafic metagabbro and ultramafic rocks**
- **TKhrd** — **Diorite**
- **TKs** — **Skyms Complex of Wallace (1976) (Middle Eocene to Late Cretaceous)**—Locally includes:
- **TKsf** — **Fine-grained granulites**
- **TKsm** — **Marble**

Little Jack terrane

- **TKlp** — **Phyllite and schist of Little Jack Mountain (Middle Eocene to Late Cretaceous)**—Locally includes:
- **TKlu** — **Ultramafic rocks**

Hozomeen terrane

Hozomeen Group (Mesozoic and Paleozoic)—Divided into:

- **J'Rngs** — **Greenstone, clastic sedimentary rock, limestone, and chert (Middle Jurassic to Late Triassic)**
- **Thc** — **Chert (Late and Middle Triassic)**
- **PzPg** — **Greenstone with minor argillite, chert, and limestone (Permian and Pennsylvanian)**—Locally includes:
- **PzPgl** — **Limestone, chert, and minor greenstone and metatuff**

ROCKS EAST OF THE ROSS LAKE FAULT ZONE

Methow Terrane

- **Js** — **Sandstone and argillite (Late Jurassic)**

Contact—Long dashed where approximate; short dashed where inferred; dotted where concealed. Shown without contact where units are gradational and (or) location is very approximate

High-angle fault—Long dashed where approximate; short dashed where inferred; dotted where concealed. Bar and ball on downthrown side. Arrows indicate direction of movement

Thrust fault—Long dashed where approximate; short dashed where inferred; dotted where concealed. Sawteeth on upper plate

Extensional fault—Dashed where inferred; dotted where concealed. Hachures on upper plate

Direction of downslope movement of landslides or blocksslides

Strike and dip of bedding

- **Inclined**
- **Inclined, top known**
- **Horizontal**
- **Crumpled**
- **Overturned, top known**
- **Vertical**
- **Vertical, top towards ball**

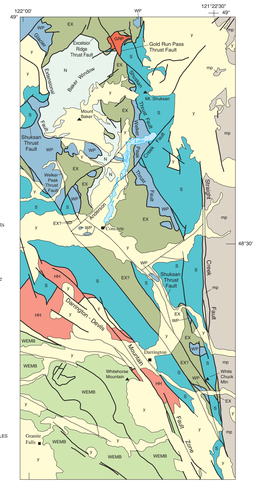
Strike and dip of foliation—In igneous and metamorphic rocks

- **Inclined**
- **Horizontal**
- **Vertical**

Bearing and plunge of lineation—May be combined with other symbols

- **Inclined**
- **Horizontal**

- **Minor fold**
- **Dated sample locality**—See table 3 in pamphlet
- **Fossil locality**—See table 2 in pamphlet
- **Outcrop of limestone or marble**—Too small to show at map scale; also shown with symbol for fossil locality. Dashed where beds mapped
- **Outcrop of ultramafic rock**—Too small to show at map scale
- **Crest of moraine**
- **ERT** — **Excelsior Ridge Thrust**
- **GEX** — **Glacier Extensional Fault**
- **ST** — **Shuksan Thrust**
- **WPT** — **Welker Peak Thrust Fault**



EXPLANATION

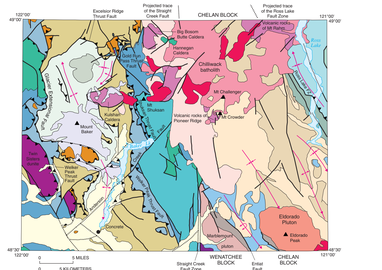
- Y — Deposits and rocks younger than assemblage of nappes and mélanges
- WEMB — Western and eastern mélange belts (Tabor and others, 2002)
- HH — Helena-Haystack mélange (Tabor and others, 2002)

Nappes of the Northwest Cascade System

- GRP — Gold Run Pass Nappe
- S — Shuksan Nappe
- WP — Welker Peak Nappe
- EX — Excelsior Nappe
- N — Autochthon (Nooksack Formation)
- mp — Pre-Oligocene metamorphic and plutonic rocks east of the Straight Creek Fault

0 10 KILOMETERS
0 10 MILES

Figure 4. Generalized map of nappes of the Northwest Cascade System and mélange belts to the southwest.



EXPLANATION

- Geologic contact
- High-angle fault—Dotted where concealed
- Thrust fault—Dotted where concealed
- Extensional fault—Dotted where concealed
- Major folds—Showing plunge where known
  - Antiform or anticline
  - Synform or syncline
  - Overturned antiform
- Unconsolidated deposits
- Sandstone and conglomerate

ROCKS OF THE CASCADE MAGMATIC ARC

- Deposits of Mount Baker volcanic center
- Plutons of the Cascade Pass family
- Volcanic rocks
- Plutons of the Snoqualmie family
- Plutons of the Index family

ROCKS WEST OF THE STRAIGHT CREEK FAULT

Northwest Cascade System

- Autochthon — Nooksack Formation, Jw, Wells Creek Volcanic Member
- Welker Peak and Excelsior nappes — Bell Pass mélange (Shown at assemblage age) bpyk, Yellow Aster Complex of Misch (1966) bpya, ultramafic rocks
- Shuksan nappe — Eastern Metamorphic Suite: Ked, Darrington Phyllite (includes minor greenschist and phyllite of Mount Josephine); Kes, Shuksan Greenschist
- Chilliwack Group of Cairnes (1944) and Cultus Formation of Daly (1912) (includes slate of Rinker Ridge)

ROCKS BETWEEN THE STRAIGHT CREEK FAULT AND THE ROSS LAKE FAULT ZONE

- Older orthogneiss
- Skagit Gneiss Complex TKgn, orthogneiss
- Rocks of Little Jack Mountain, Ruby Creek Heterogeneous Plutonic Complex of Misch (1966), and Skyms Complex of Wallace (1976)

ROCKS IN THE ROSS LAKE FAULT ZONE

- TKhp — Mesozoic ?
- TKu

ROCKS EAST OF THE ROSS LAKE FAULT ZONE

Methow terrane

- Js — Late Jurassic

Hozomeen terrane

- J'Rngs — Middle Jurassic to Late Triassic
- Thc — Late and Middle Triassic
- PzPg — Pre-Triassic
- PzPgl

Chelan Mountains terrane

- TKns
- TKnu
- TKmv
- pSn, Napeequa Schist
- pSnu, ultramafic rocks
- Tes, Cascade River Schist
- Tets, Marblemount pluton

Hozomeen Group

- Sedimentary rocks

Early Eocene and Late Cretaceous; Early Cretaceous and Late Jurassic; Jurassic, Triassic, Permian, Pennsylvanian, and Devonian

TERTIARY AND CRETACEOUS; MESOZOIC; MESOZOIC AND PALEOZOIC

Figure 2. Generalized geologic map of the Mount Baker quadrangle, Washington. Units of the Northwest Cascades System, the Chelan Mountains terrane, the Hozomeen Group, and sedimentary rocks are shown with protolith ages.

Geologic Map of the Mount Baker 30- by 60-Minute Quadrangle, Washington

By

R.W. Tabor, R.A. Haugerud, Wes Hildreth, and E.H. Brown

2003

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