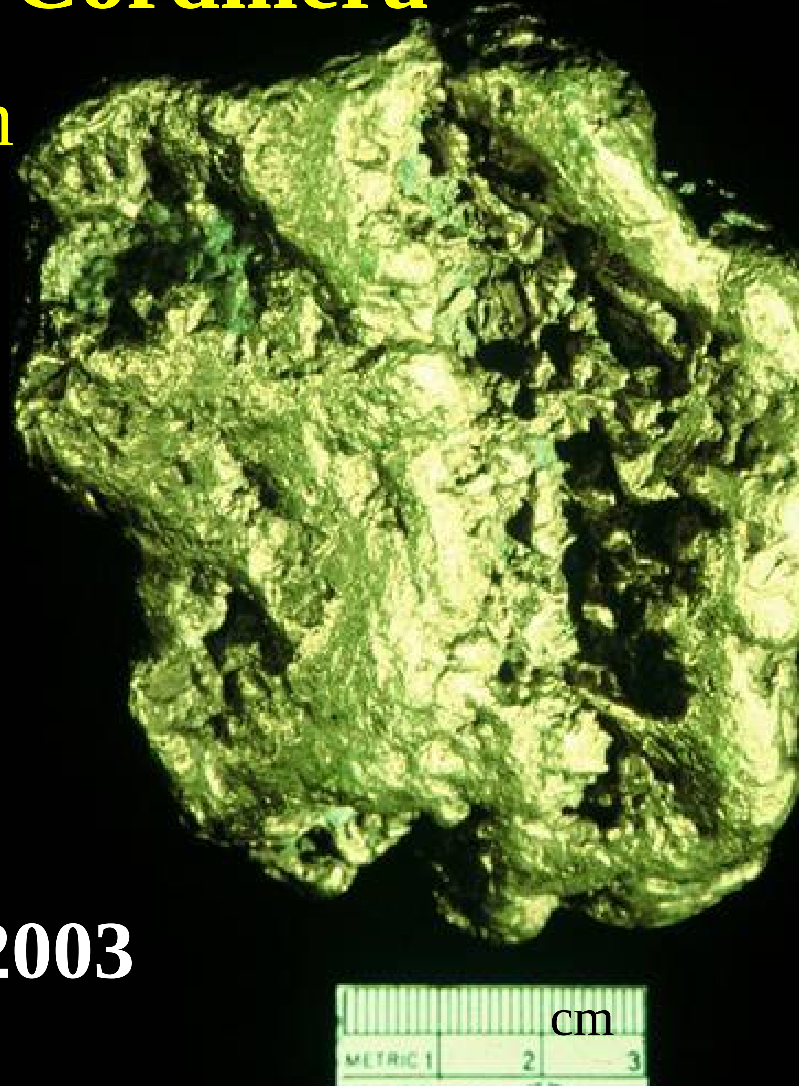
Exploration Guidelines for GOLD-QUARTZ VEINS in the Canada-US Cordillera

Chris H. Ash



May 2, 2003

BRITISH COLUMBIA
Ministry of Energy and Mines

Abbreviated Abstract

An assessment of the lithological and tectonic setting of gold-quartz veins and derived placers in the Canada – US Cordillera, including all major producers (> 1 million ounces), reveals a consistent set of relationships that are useful for both regional and detailed property evaluations.

On the basis of host lithologies, gold-quartz vein deposits can be divided into two main types:

- (1) **Ophiolite-hosted gold veins**, such as those at Bralorne, Cassiar and Atlin in British Columbia and the Grass Valley and Alleghany mining camps in California, are contained in fault-bounded, internally imbricated lenses of oceanic igneous crust. Listwanite-altered ultramafic rocks are consistently associated with the ophiolite-hosted gold veins, but rarely host them. This type contains very high-grade, coarse native gold occurring in quartz veins hosted by ophiolitic mafic igneous crustal rocks (gabbro, diabase, basalt) close to listwanite-altered ultramafic rocks.
- (2) **Mixed mafic igneous-sedimentary hosted gold veins** include most of the significant deposits of the Mother Lode belt, California; Alaska-Juneau gold belt in SE Alaska and the Carolin Mine in SW BC. Host rocks of these deposits consist of Mesozoic sequences of mafic igneous rocks alternating with slate and phyllite. Vein-marginal replacement ore is a characteristic feature of this type.

The following presentation is taken from Ash (2001) BC Geological Survey, Bulletin 108 which contains detailed explanations and data sources for the individual illustrations.

A digital copy (pdf format) is available at:
http://www.em.gov.bc.ca/mining/Geolsurv/Publications/Bulletins/Bull108/toc.htm

Gold Quartz-veins ?

- Descriptive:
  Mesothermal gold-quartz veins
  Shear-hosted lode gold
  Low-sulphide gold-quartz veins
  Gold only deposits
- Area Specific:
  Mother Lode
- Historic:
  Lode gold
- Tectonic:
  Orogenic Gold
- Age and Host Specific:
  Phanerozoic lode gold - Archean lode gold
  1) Ophiolitic - Greenstone gold
  2) Basinal-Vol Arc gold

Recent Research History

- Research focus over the last two decades:
  1) Nature and origin of mineralizing fluids
  2) Paleo-tectonic environment of vein formation
- Demonstrated a consistency in the composition and physical character of the mineralizing fluids irrespective of age or geographic location.

- A combination of metamorphic and magmatic fluids generated in response to orogenic activity.

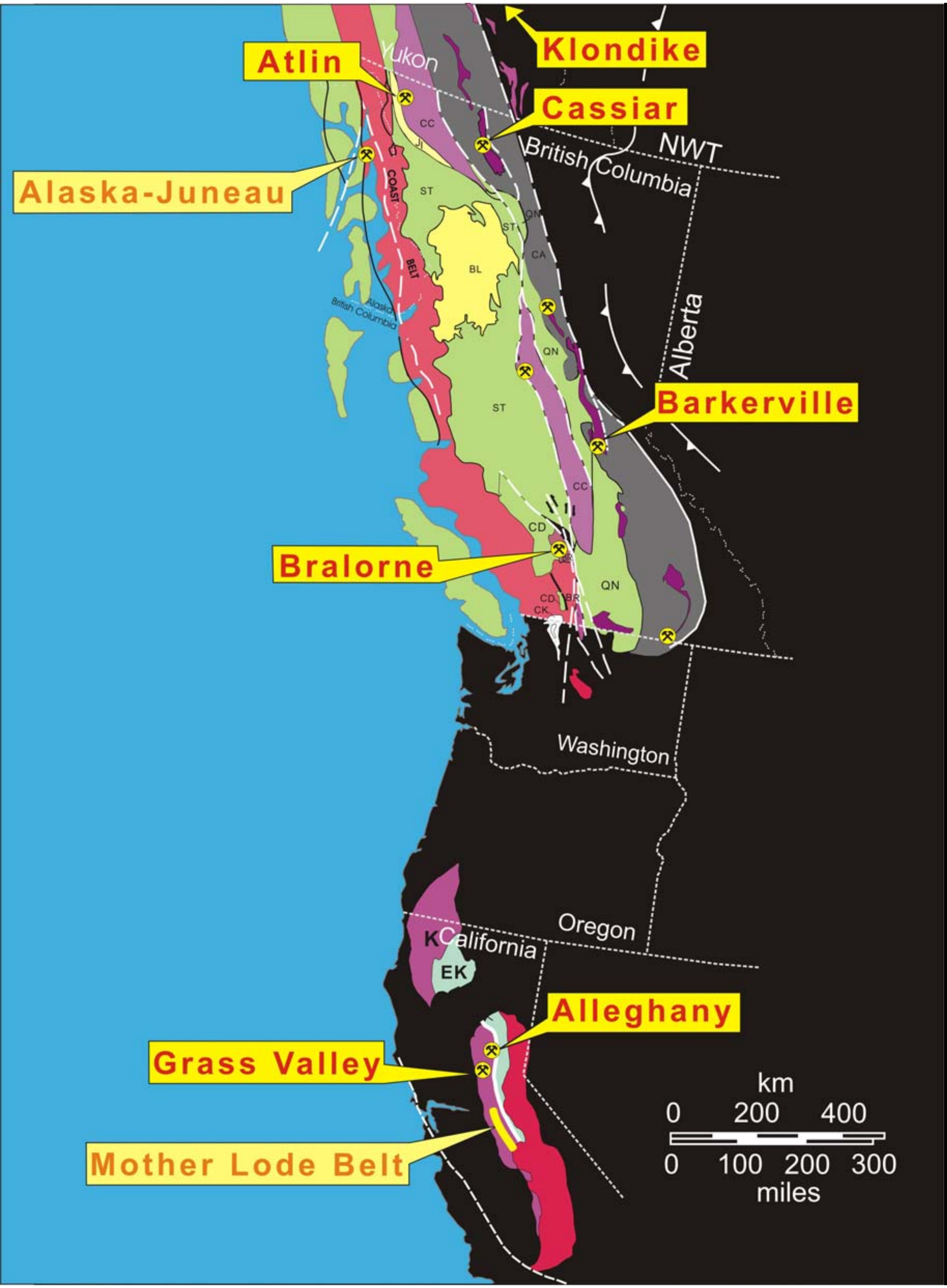
Why? When? and **How?** these deposits form?
Involves considerable interpretation of quantitative numerical empirical data.

Focus of this Presentation

WHERE? - Regional and Local Geological Setting

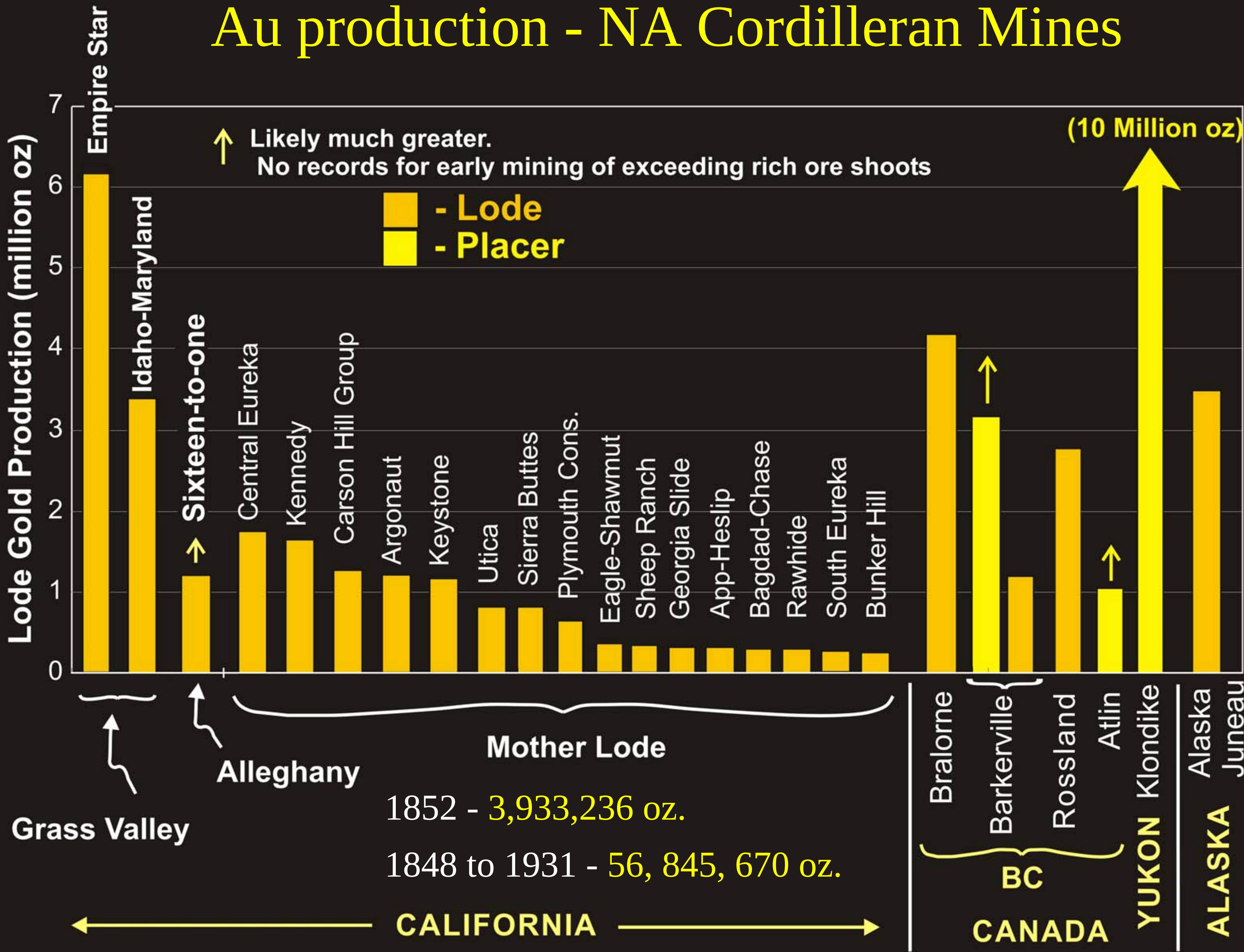
Observable lithological relationships - Qualitative

1. What rock types or association of rock types?
2. How does host lithology affect the **SIZE** and **GRADE** of the deposits?
3. What are the **EXPLORATION** implications of these consistent relationships?



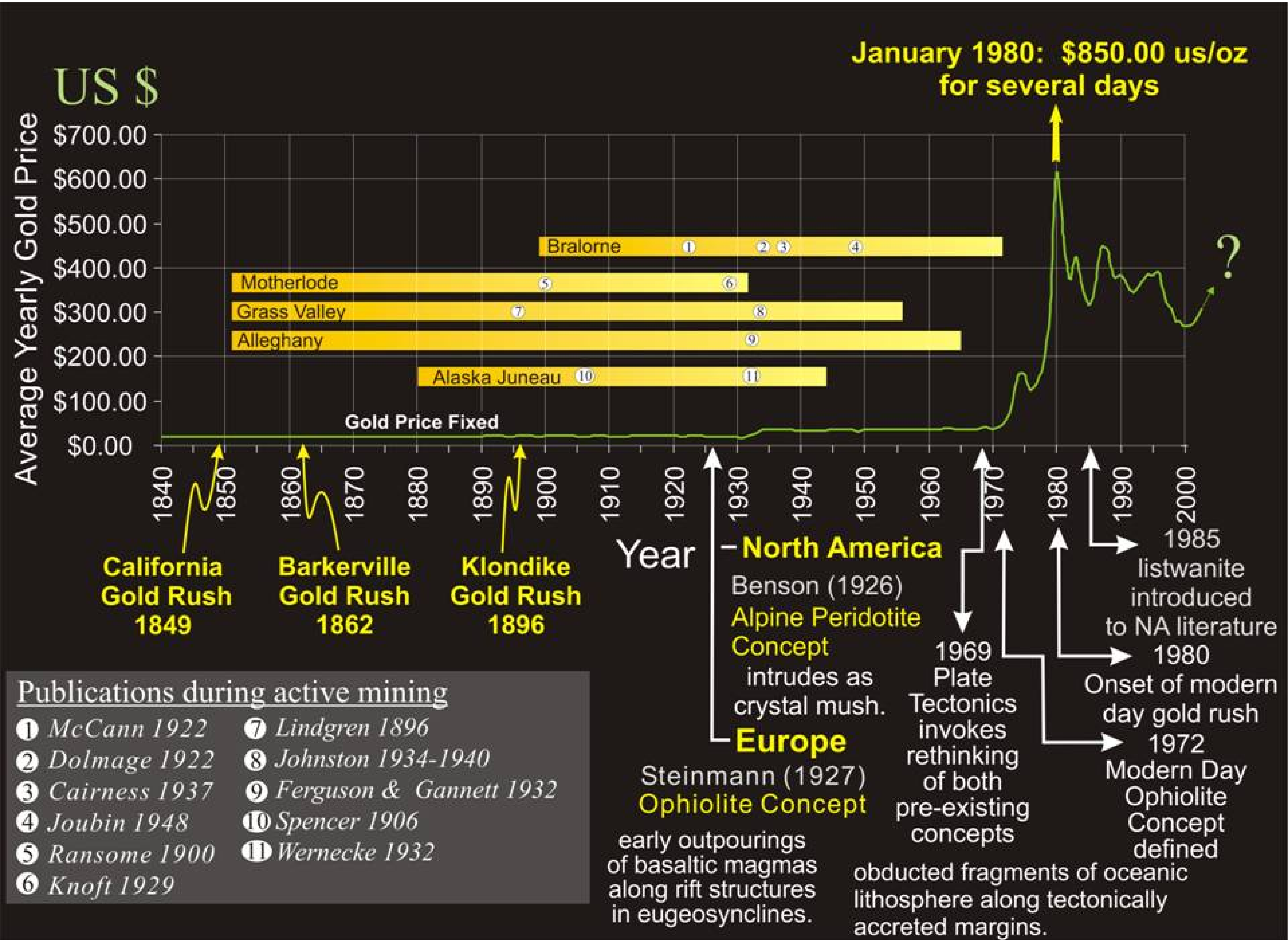
Geological setting of 1,000,000 plus producing Gold-Quartz Vein or related placer camps in the US-Canadian Cordillera

Au production - NA Cordilleran Mines

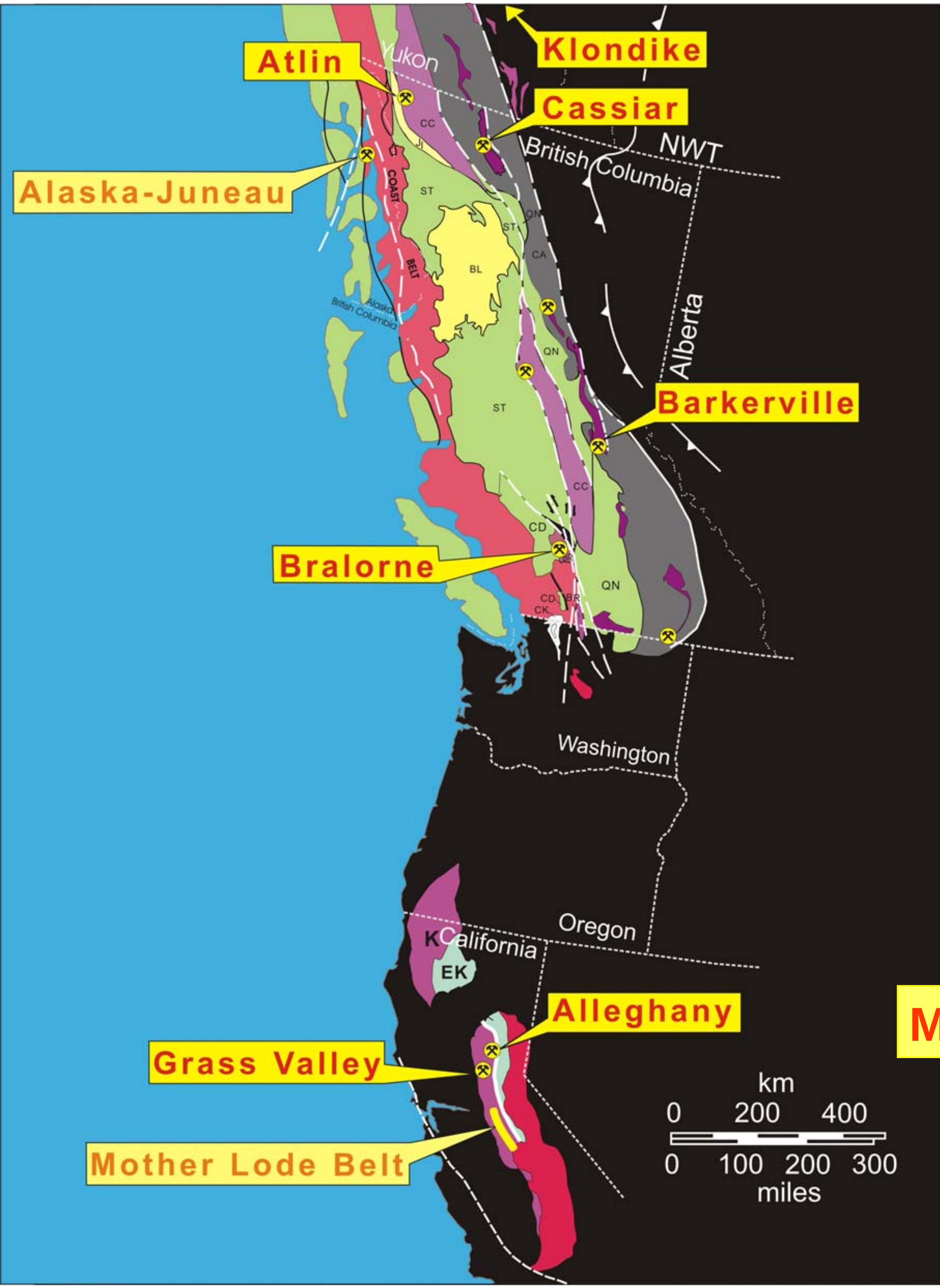


1852 - 3,933,236 oz.

1848 to 1931 - 56, 845, 670 oz.



January 1980: $850.00 us/oz for several days
US $
Average Yearly Gold Price
$700.00
$600.00
$500.00
$400.00
$300.00
$200.00
$100.00
$0.00
Bralorne
Motherlode
Grass Valley
Alleghany
Alaska Juneau
Gold Price Fixed
?
1840
1850
1860
1870
1880
1890
1900
1910
1920
1930
1940
1950
1960
1970
1980
1990
2000
Year
California Gold Rush 1849
Barkerville Gold Rush 1862
Klondike Gold Rush 1896
North America
Benson (1926)
Alpine Peridotite Concept
intrudes as crystal mush.
Europe
Steinmann (1927)
Ophiolite Concept
early outpourings of basaltic magmas along rift structures in eugeosynclines.
1969 Plate Tectonics invokes rethinking of both pre-existing concepts
1985 listwanite introduced to NA literature
1980 Onset of modern day gold rush
1972 Modern Day Ophiolite Concept defined
obducted fragments of oceanic lithosphere along tectonically accreted margins.
Publications during active mining
1 McCann 1922
2 Dolmage 1922
3 Cairness 1937
4 Joubin 1948
5 Ransome 1900
6 Knoft 1929
7 Lindgren 1896
8 Johnston 1934-1940
9 Ferguson & Gannett 1932
10 Spencer 1906
11 Wernecke 1932



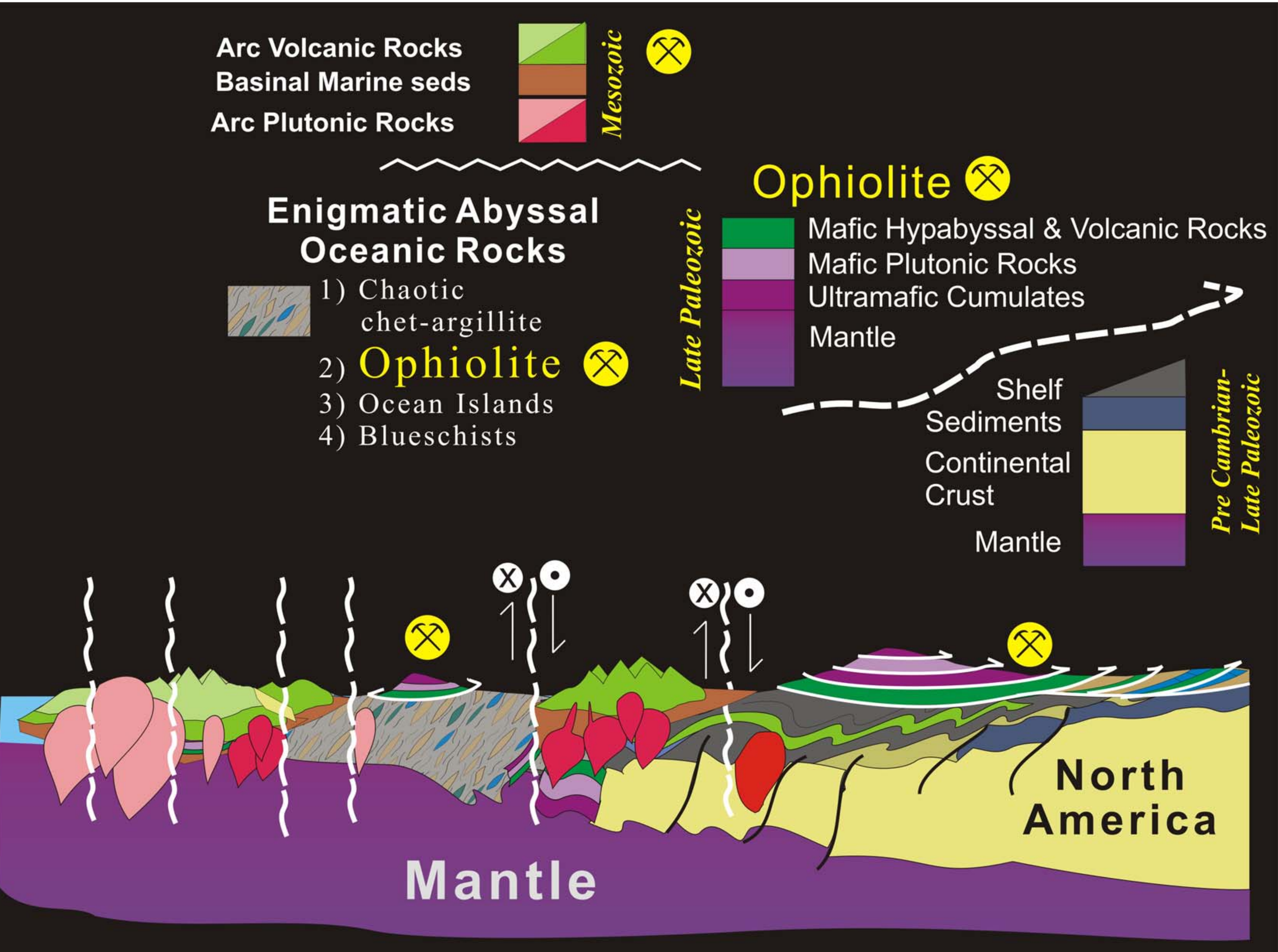
Geological setting of 1,000,000 plus producing Gold-Quartz Vein or related placer camps in the US-Canadian Cordillera

Ophiolitic

Anorogenic	Apparent Anorogenic
Bralorne	Cassiar
Grass Valley	Barkerville
Alleghany	Klondike
Atlin	

Mixed mafic igneous- sedimentary

Mother Lode Belt
Alaska-Juneau



Arc Volcanic Rocks
Basinal Marine seds
Arc Plutonic Rocks
Mesozoic
Enigmatic Abyssal Oceanic Rocks
1) Chaotic chet-argillite
2) Ophiolite
3) Ocean Islands
4) Blueschists
Late Paleozoic
Ophiolite
Mafic Hypabyssal & Volcanic Rocks
Mafic Plutonic Rocks
Ultramafic Cumulates
Mantle
Shelf Sediments
Continental Crust
Mantle
Pre Cambrian-Late Paleozoic
North America
Mantle

Lithological Classification of Gold-Quartz Vein Deposits

Mixed mafic igneous-sedimentary

Steeply inclined Mesozoic sequences of alternating slate and mafic igneous rocks.

- Lower Grade
- Vein marginal replacement ore common

Ophiolitic

Tectonic blocks of Paleozoic oceanic igneous crust, proximal to ophiolitic ultramafic rocks.

- Higher Grade
- Vein marginal replacement ore not common

Anorogenic

***Alaska-Juneau**
***Mother Lode Belt**

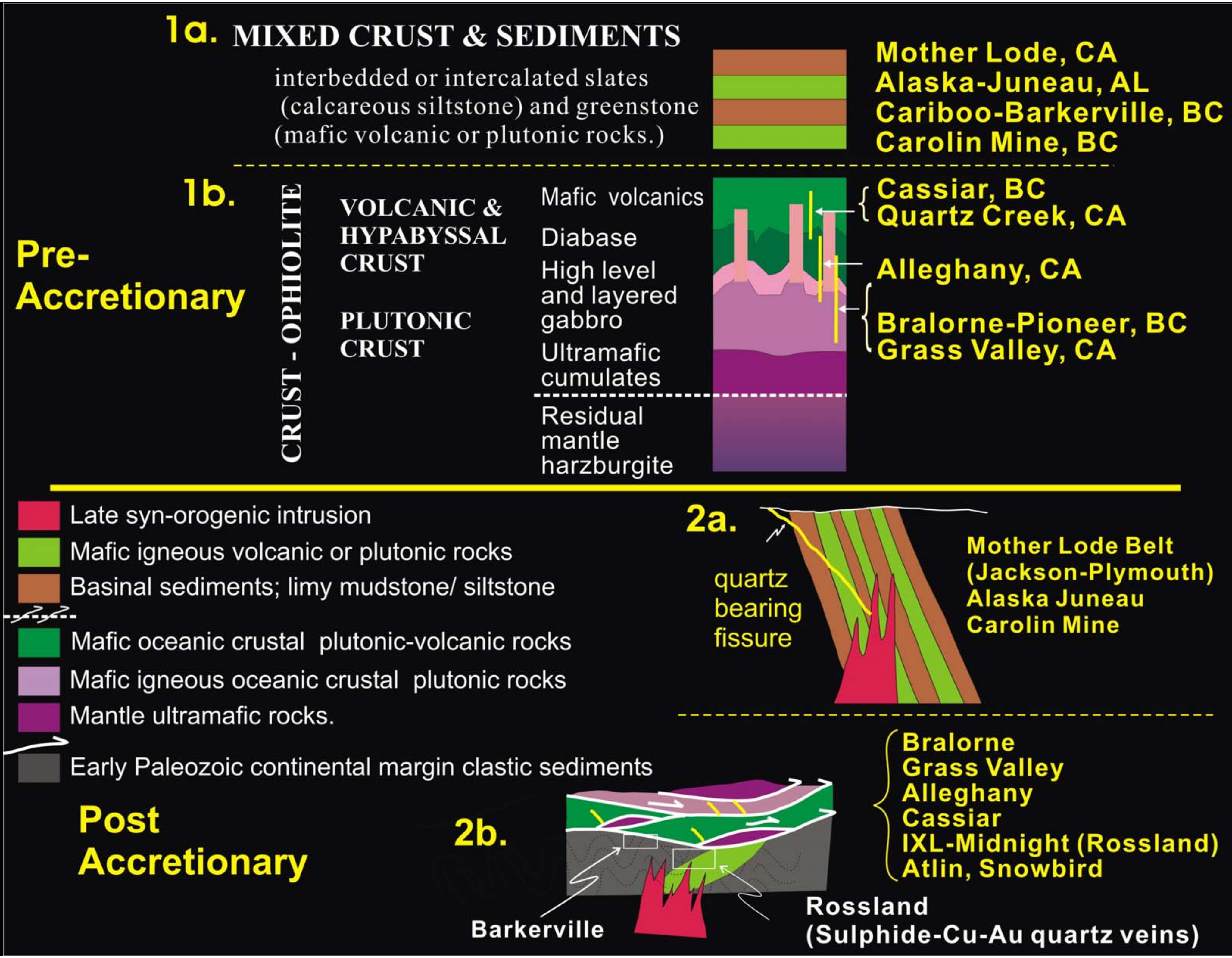
***Bralorne**
***Grass Valley**
^Alleghany
Atlin

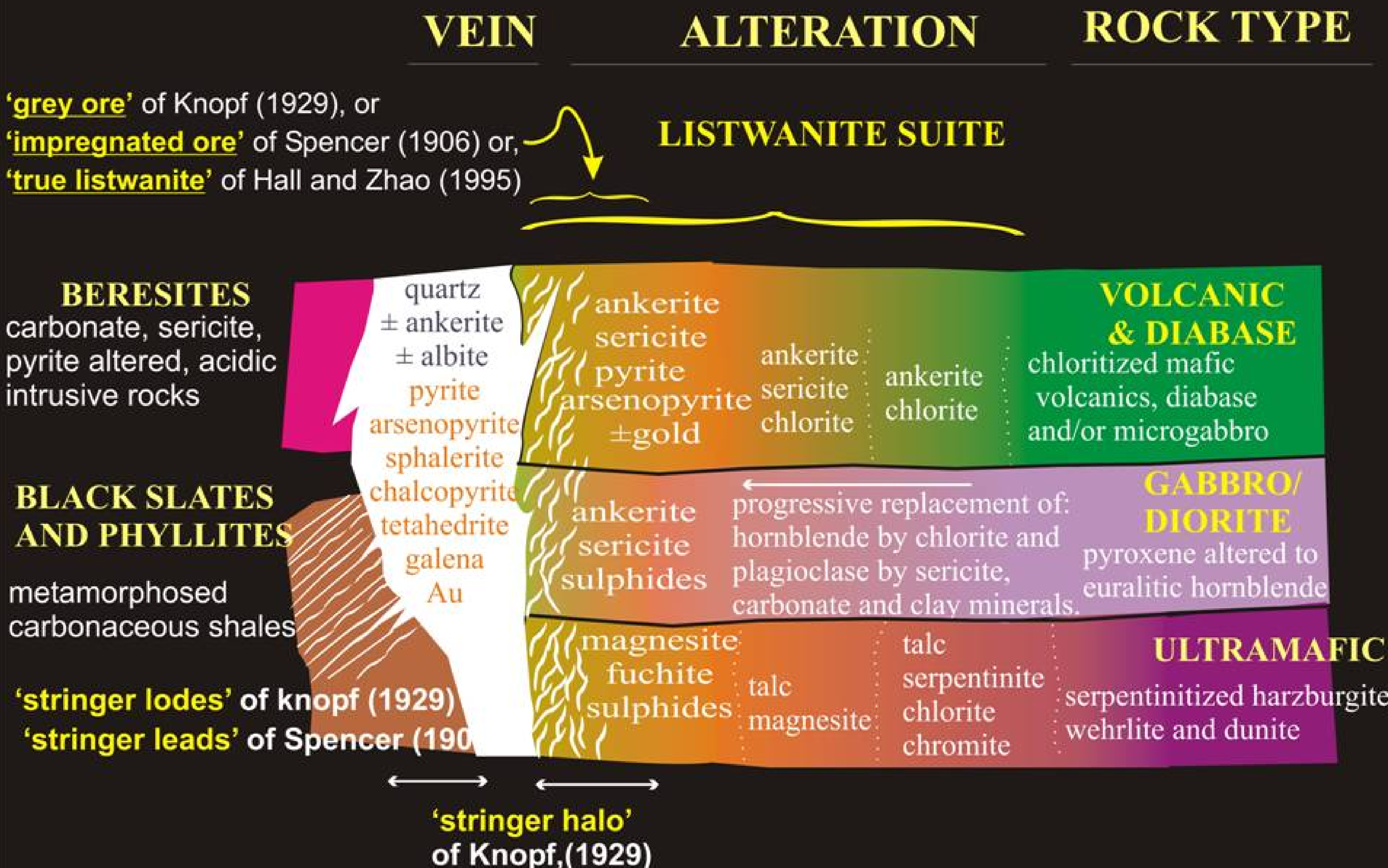
Associated coeval magmatism, flysch sedimentation & metamorphism
*vertically extensive ore
^may be Anorogenic

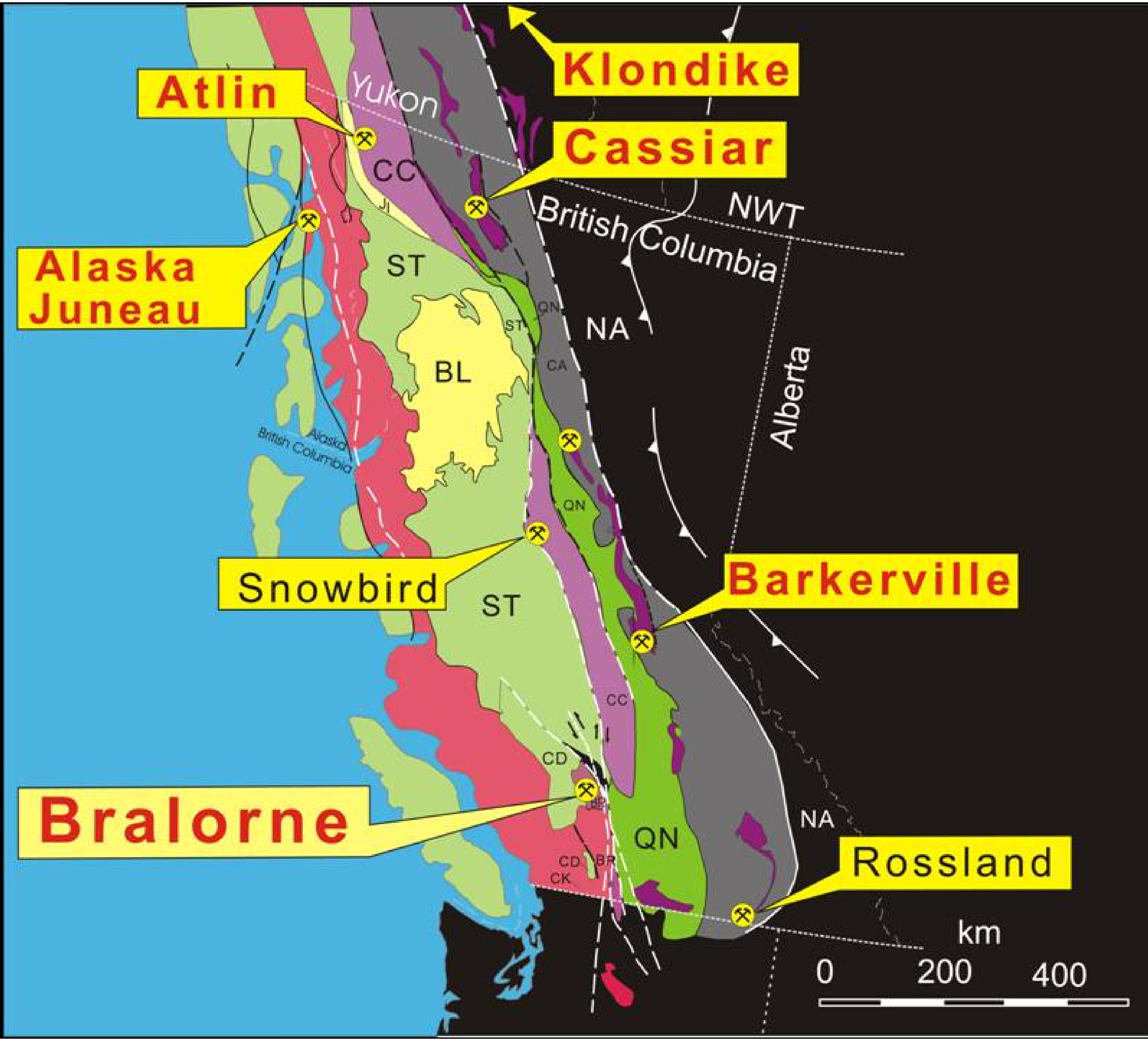
Apparent Anorogenic

Klondike
Cassiar
Barkerville

Lack all features described for Anorogenic Deposits, vertically limited ore

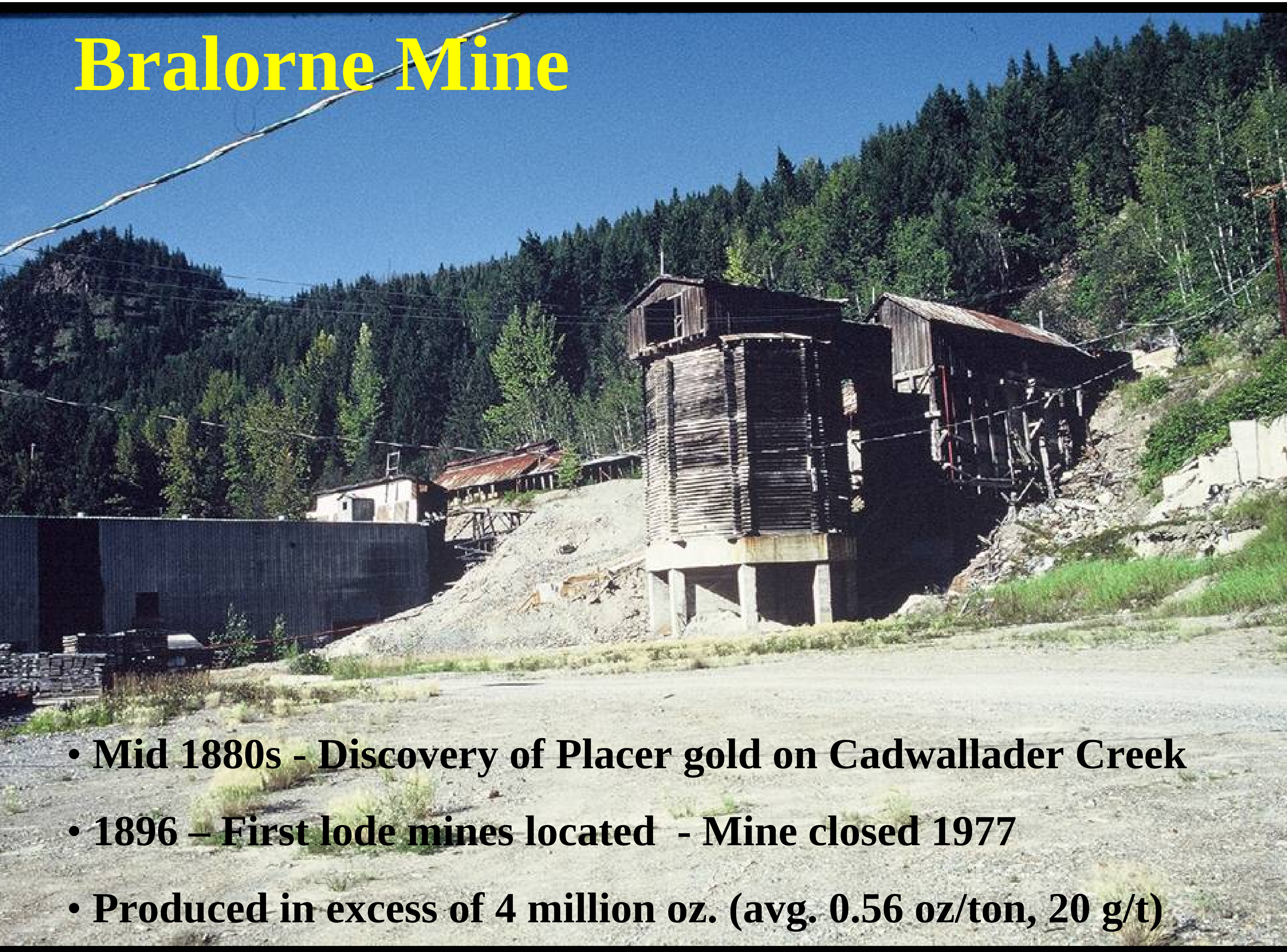

1a. MIXED CRUST & SEDIMENTS
interbedded or intercalated slates (calcareous siltstone) and greenstone (mafic volcanic or plutonic rocks.)
Mother Lode, CA
Alaska-Juneau, AL
Cariboo-Barkerville, BC
Carolin Mine, BC
1b.
Pre-Accretionary
CRUST - OPHIOLITE
VOLCANIC & HYPABYSSAL CRUST
PLUTONIC CRUST
Mafic volcanics
Diabase
High level and layered gabbro
Ultramafic cumulates
Residual mantle harzburgite
Cassiar, BC
Quartz Creek, CA
Alleghany, CA
Bralorne-Pioneer, BC
Grass Valley, CA
Late syn-orogenic intrusion
Mafic igneous volcanic or plutonic rocks
Basinal sediments; limy mudstone/ siltstone
Mafic oceanic crustal plutonic-volcanic rocks
Mafic igneous oceanic crustal plutonic rocks
Mantle ultramafic rocks.
Early Paleozoic continental margin clastic sediments
2a.
quartz bearing fissure
Mother Lode Belt (Jackson-Plymouth)
Alaska Juneau
Carolin Mine
Post Accretionary
2b.
Bralorne
Grass Valley
Alleghany
Cassiar
IXL-Midnight (Rossland)
Atlin, Snowbird
Barkerville
Rossland (Sulphide-Cu-Au quartz veins)


VEIN
ALTERATION
ROCK TYPE
'grey ore' of Knopf (1929), or
'impregnated ore' of Spencer (1906) or,
'true listwanite' of Hall and Zhao (1995)
LISTWANITE SUITE
BERESITES
carbonate, sericite, pyrite altered, acidic intrusive rocks
quartz
± ankerite
± albite
pyrite
arsenopyrite
sphalerite
chalcopyrite
tetahedrite
galena
Au
ankerite
sericite
pyrite
arsenopyrite
±gold
ankerite
sericite
chlorite
ankerite
chlorite
VOLCANIC & DIABASE
chloritized mafic volcanics, diabase and/or microgabbro
BLACK SLATES AND PHYLLITES
metamorphosed carbonaceous shales
ankerite
sericite
sulphides
progressive replacement of: hornblende by chlorite and plagioclase by sericite, carbonate and clay minerals.
GABBRO/ DIORITE
pyroxene altered to euralitic hornblende
magnesite
fuchite
sulphides
talc
magnesite
talc
serpentinite
chlorite
chromite
ULTRAMAFIC
serpentinitized harzburgite, wehrlite and dunite
'stringer lodes' of knopf (1929)
'stringer leads' of Spencer (190
'stringer halo' of Knopf,(1929)

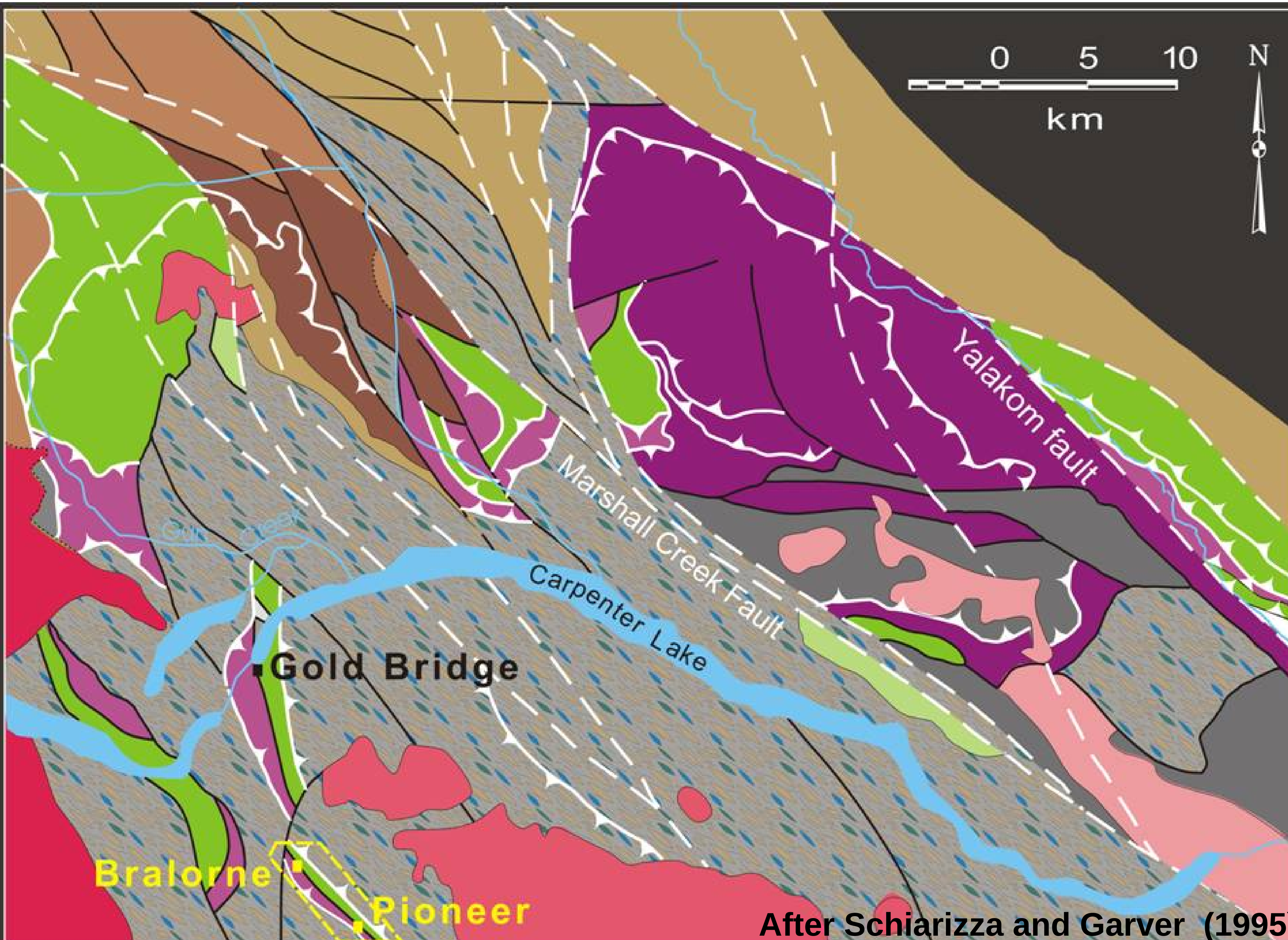


Klondike
Atlin
Yukon
Cassiar
CC
JI
Alaska
Juneau
NWT
British Columbia
ST
QN
ST
NA
BL
CA
Alberta
Alaska
British Columbia
QN
Snowbird
ST
Barkerville
CC
CD
Bralorne
QN
NA
CD
BR
CK
Rossland
km
0
200
400

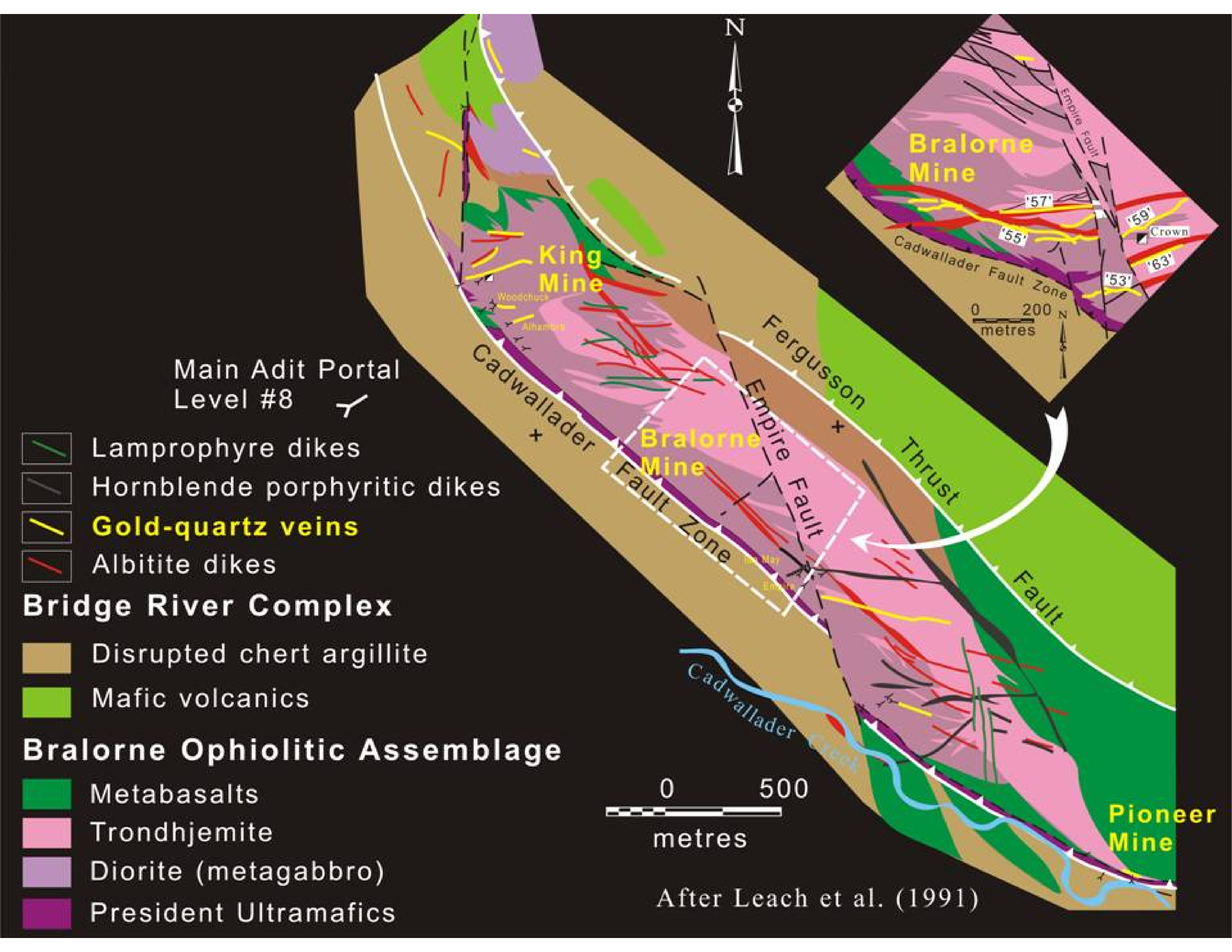
Bralorne Mine



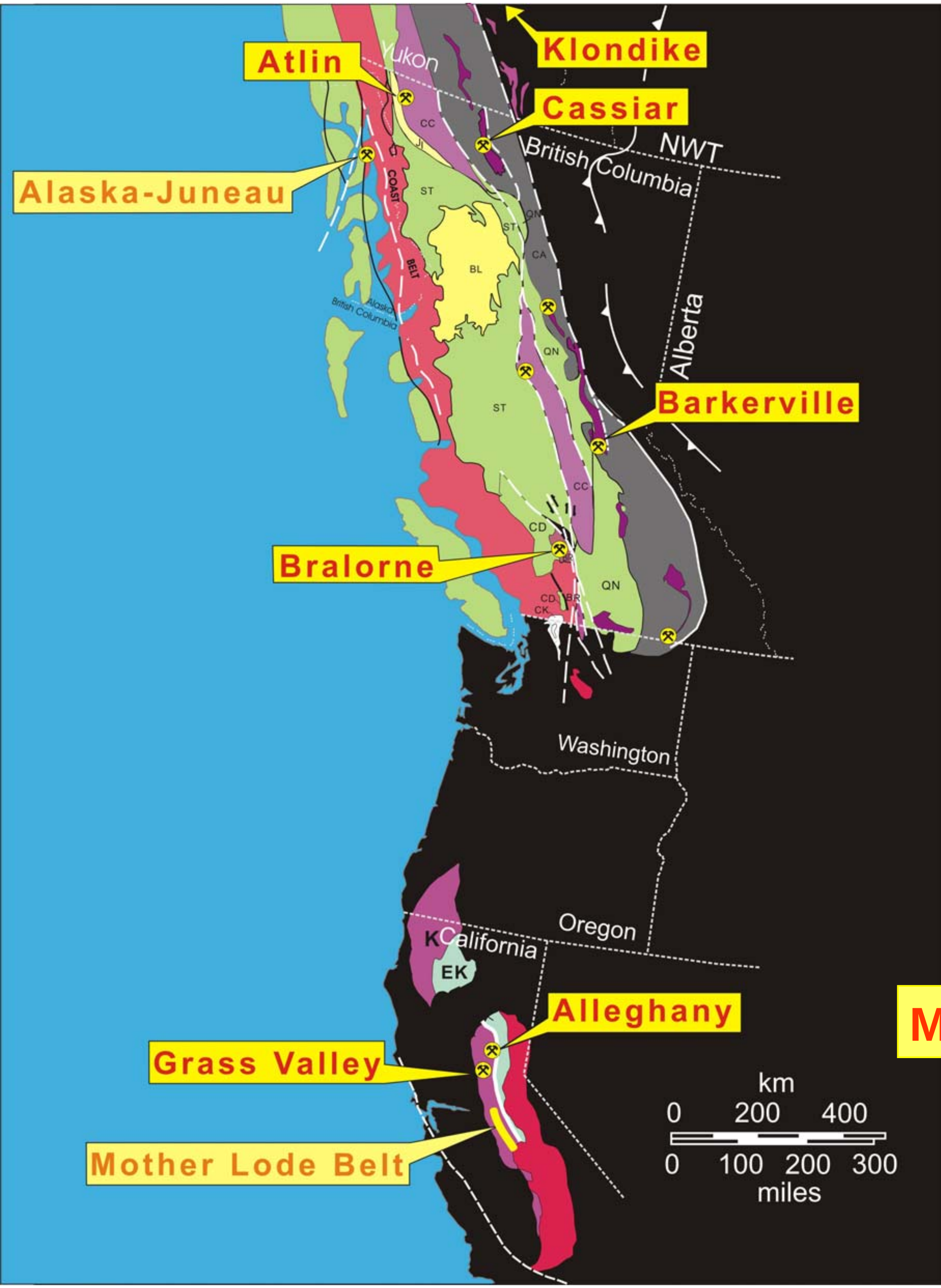
- **Mid 1880s - Discovery of Placer gold on Cadwallader Creek**
- **1896 – First lode mines located - Mine closed 1977**
- **Produced in excess of 4 million oz. (avg. 0.56 oz/ton, 20 g/t)**



After Schiarizza and Garver (1995)



N
Bralorne Mine
Empire Fault
'57'
'59'
'55'
Crown
Cadwallader Fault Zone
'63'
'53'
0 200
metres
N
King Mine
Woodchuck
Alhambra
Main Adit Portal
Level #8
Cadwallader Fault Zone
Fergusson Thrust Fault
Empire Fault
Bralorne Mine
Ida May
Empire
Lamprophyre dikes
Hornblende porphyritic dikes
Gold-quartz veins
Albitite dikes
Bridge River Complex
Disrupted chert argillite
Mafic volcanics
Bralorne Ophiolitic Assemblage
Metabasalts
Trondhjemite
Diorite (metagabbro)
President Ultramafics
Cadwallader Creek
0 500
metres
Pioneer Mine
After Leach et al. (1991)



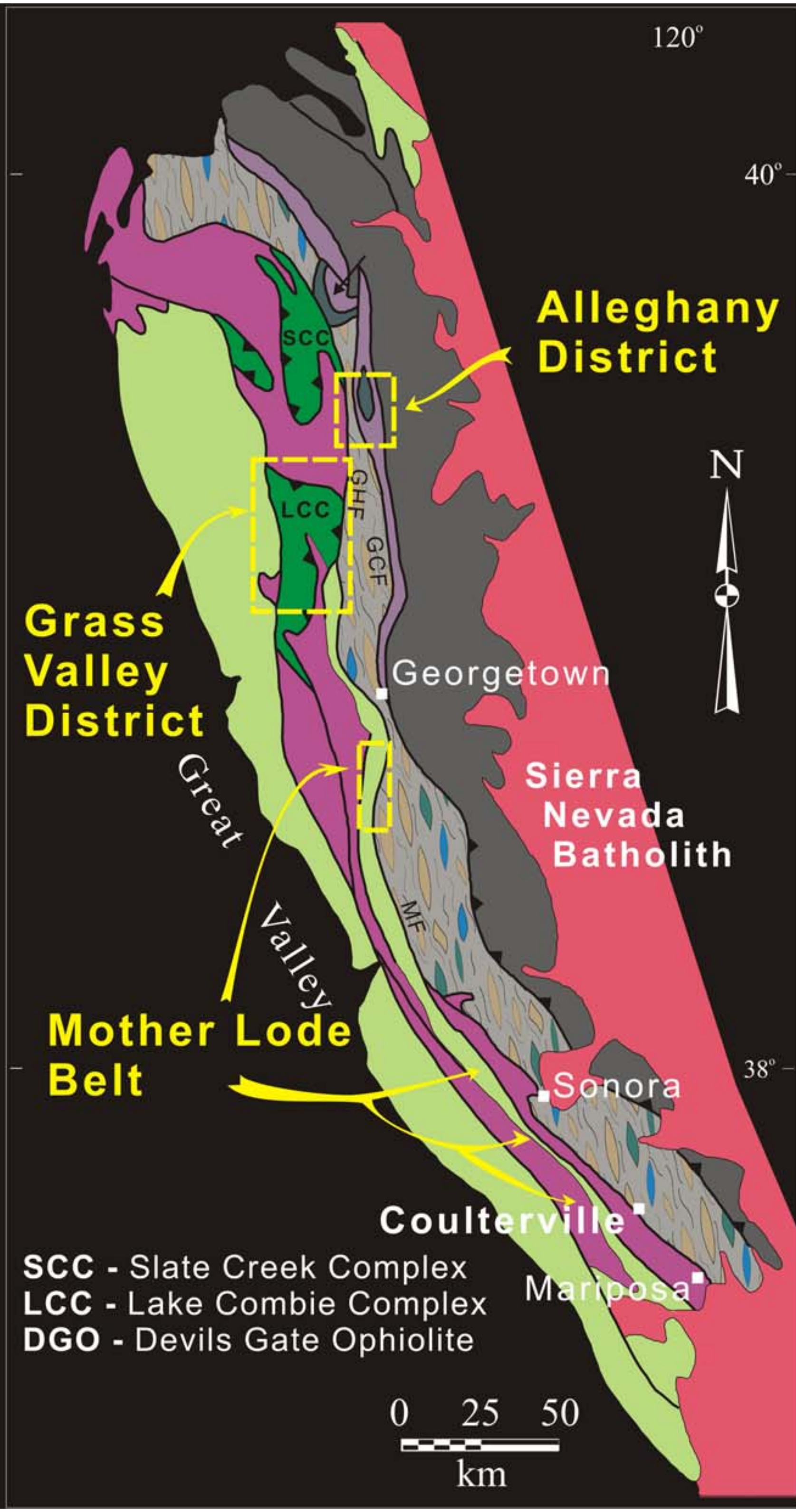
Geological setting of 1,000,000 plus producing Gold-Quartz Vein or related placer camps in the US-Canadian Cordillera

Ophiolitic

Orogenic	**Apparent Anorogenic**
Bralorne	
Grass Valley	Klondike
Alleghany	Cassiar
Atlin	Barkerville

Mixed mafic igneous- sedimentary

Alaska-Juneau
Mother Lode Belt



Post Accretionary

intrusions

Accreted Terranes

Middle to Late Jurassic

Smartville Complex

flysch and mafic volcanics

Late Triassic - Early Jurassic

Slate Creek & Lake Combie Complex

fore-arc igneous complexes

Paleozoic to Early Triassic

Calaveras Complex

chaotic chert-argillite complex with lesser limestone and mafic volcanics

Red Ant Schist

pre-Middle Jurassic blueschists facies rocks

Paleozoic

Fiddle Creek Complex

ophiolitic assemblages with Middle Triassic and Early Jurassic volcanics and sediments

Feather River Belt

polygenetic ophiolitic assemblages

North America

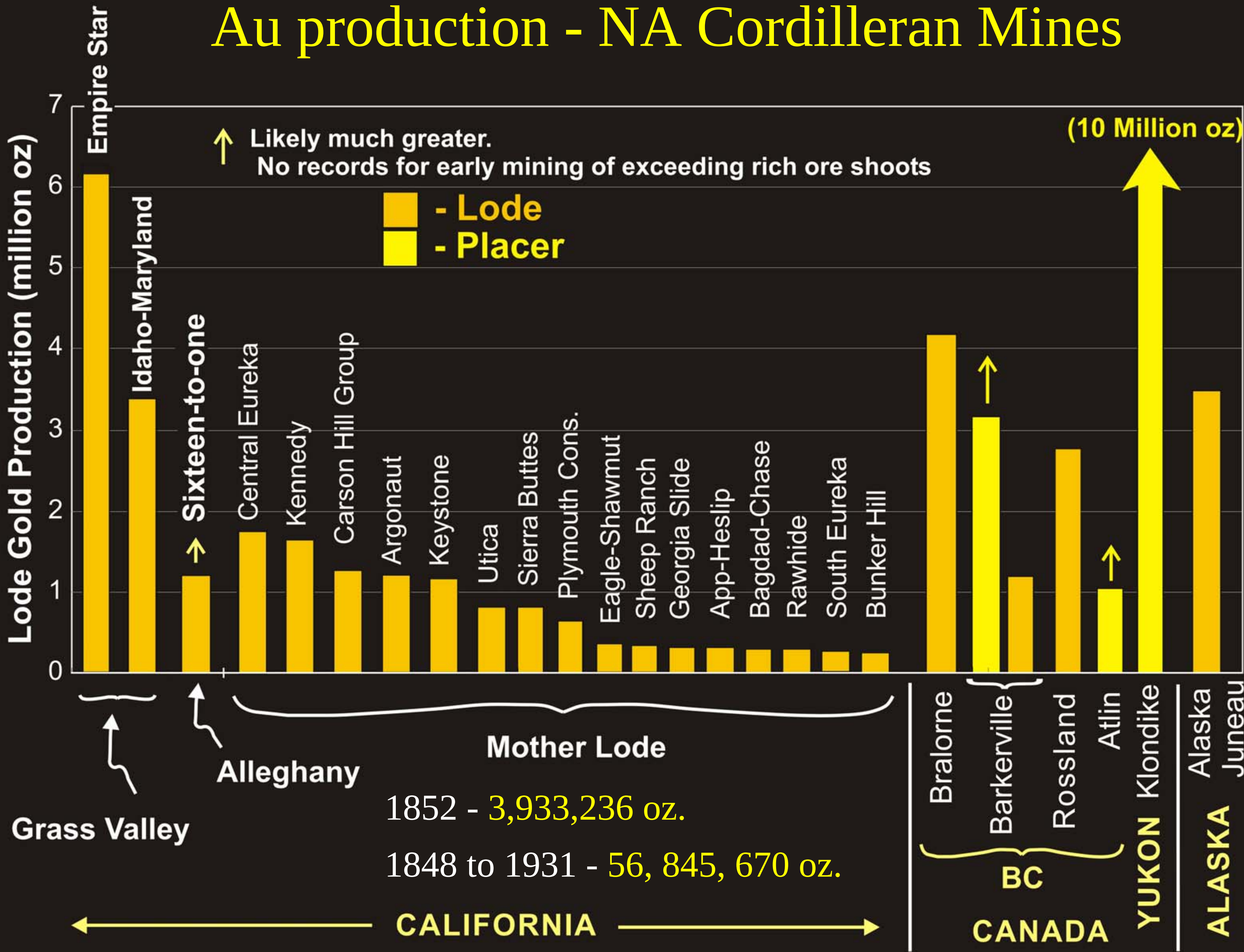
Eocambrian to Early Paleozoic

Northern Sierra Terrane

continental derived clastics with pre and post accretionary overlap volcanics and sediments

after Edelman and Sharp (1989).

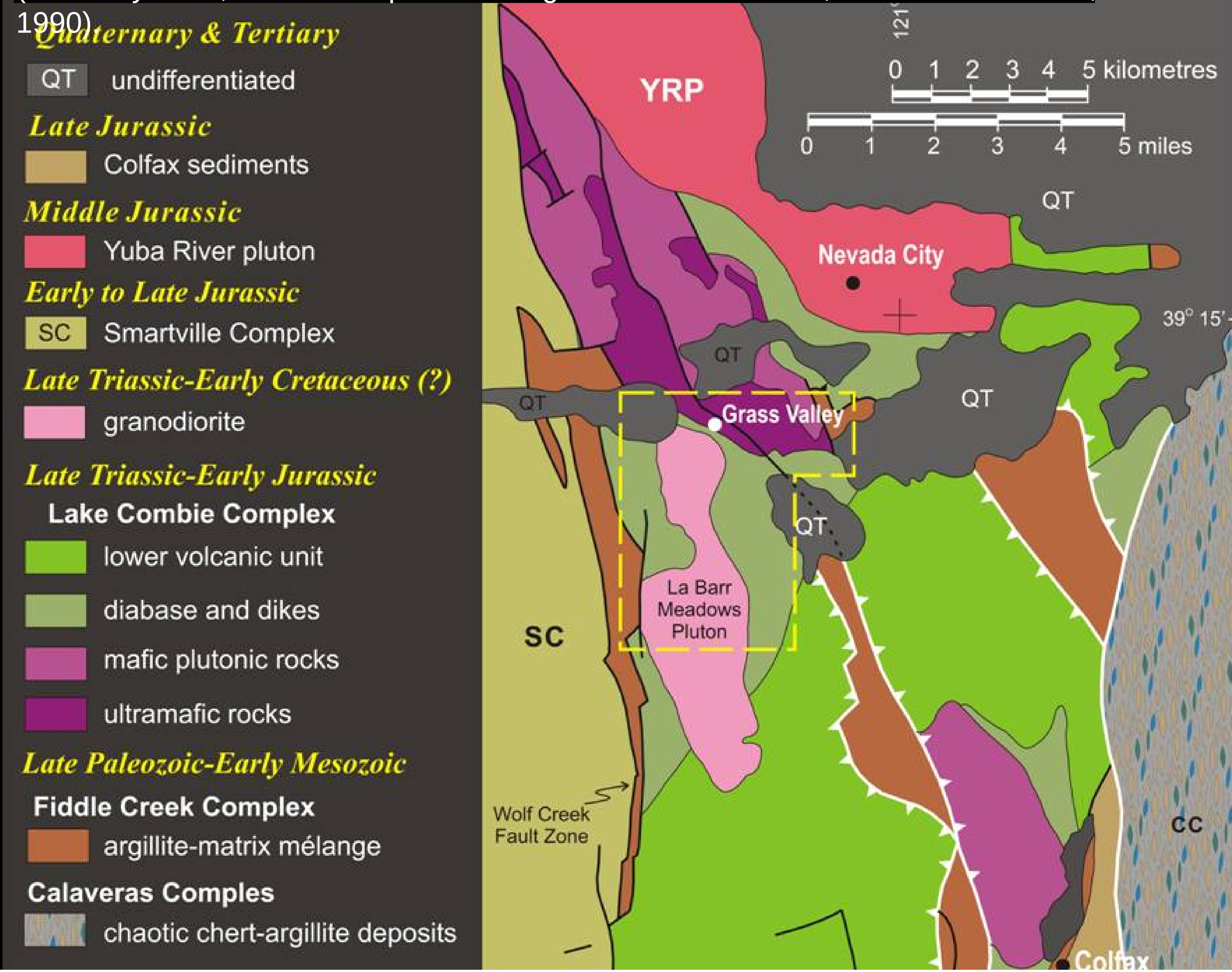
Au production - NA Cordilleran Mines

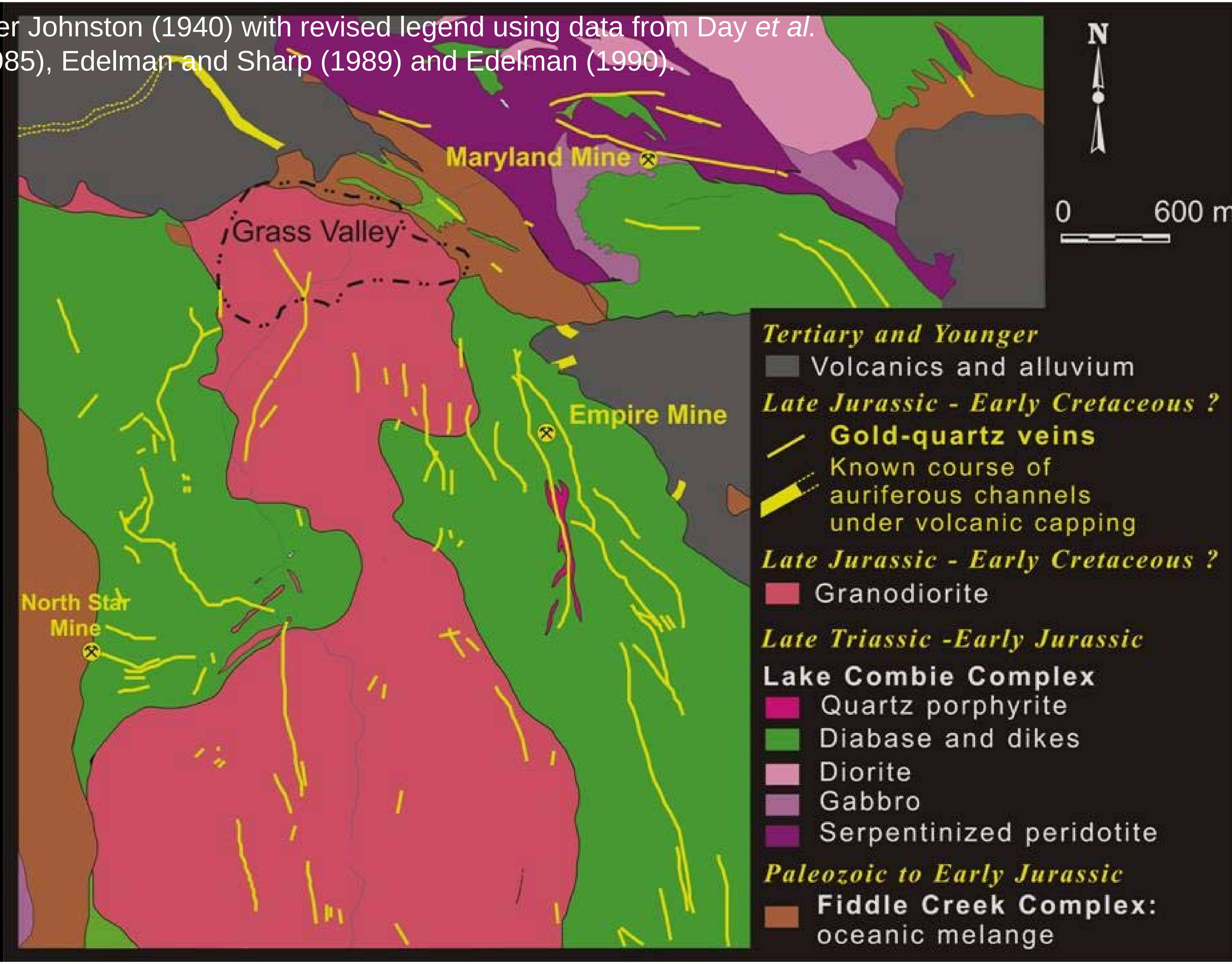


1852 - 3,933,236 oz.

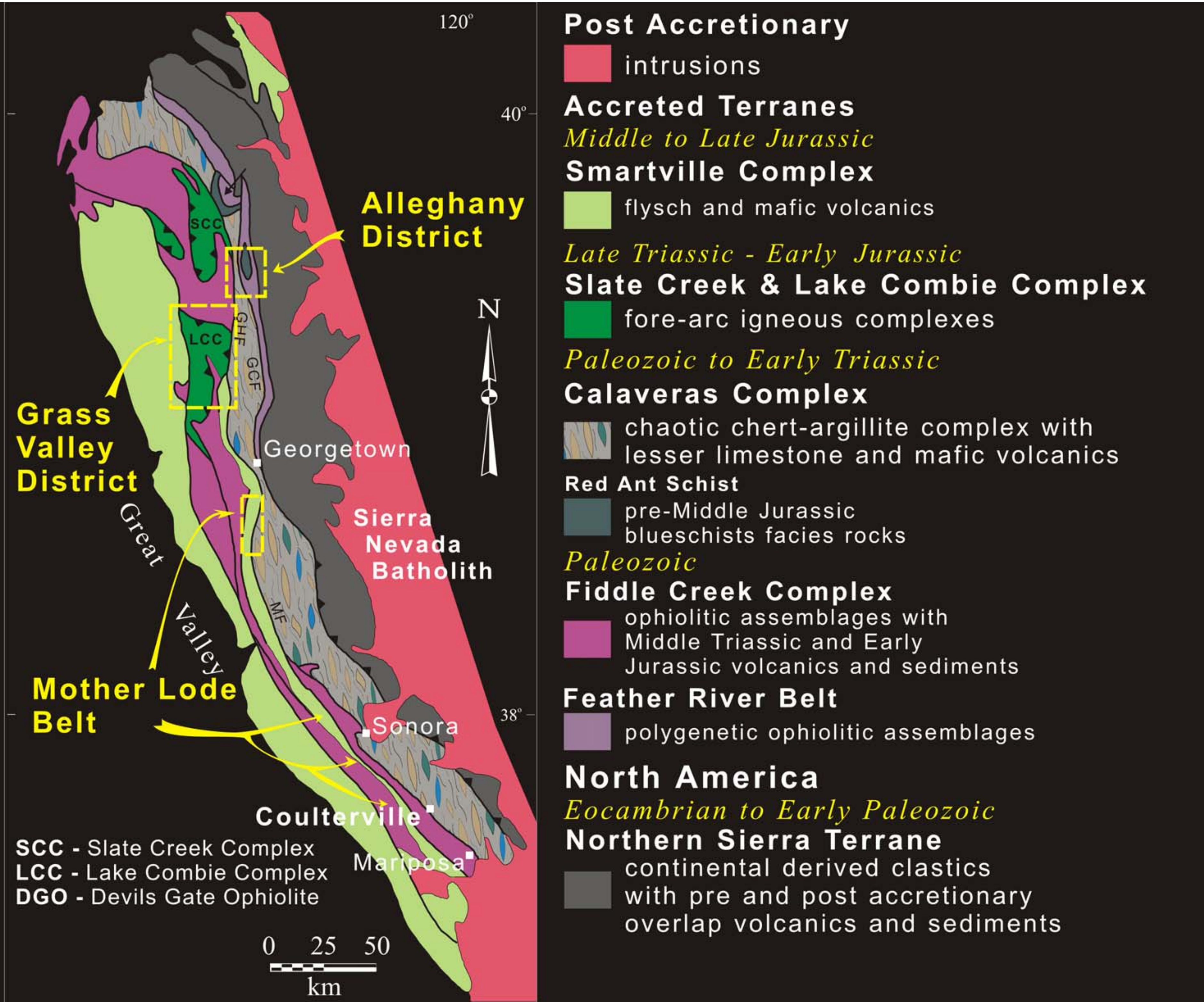
1848 to 1931 - 56, 845, 670 oz.

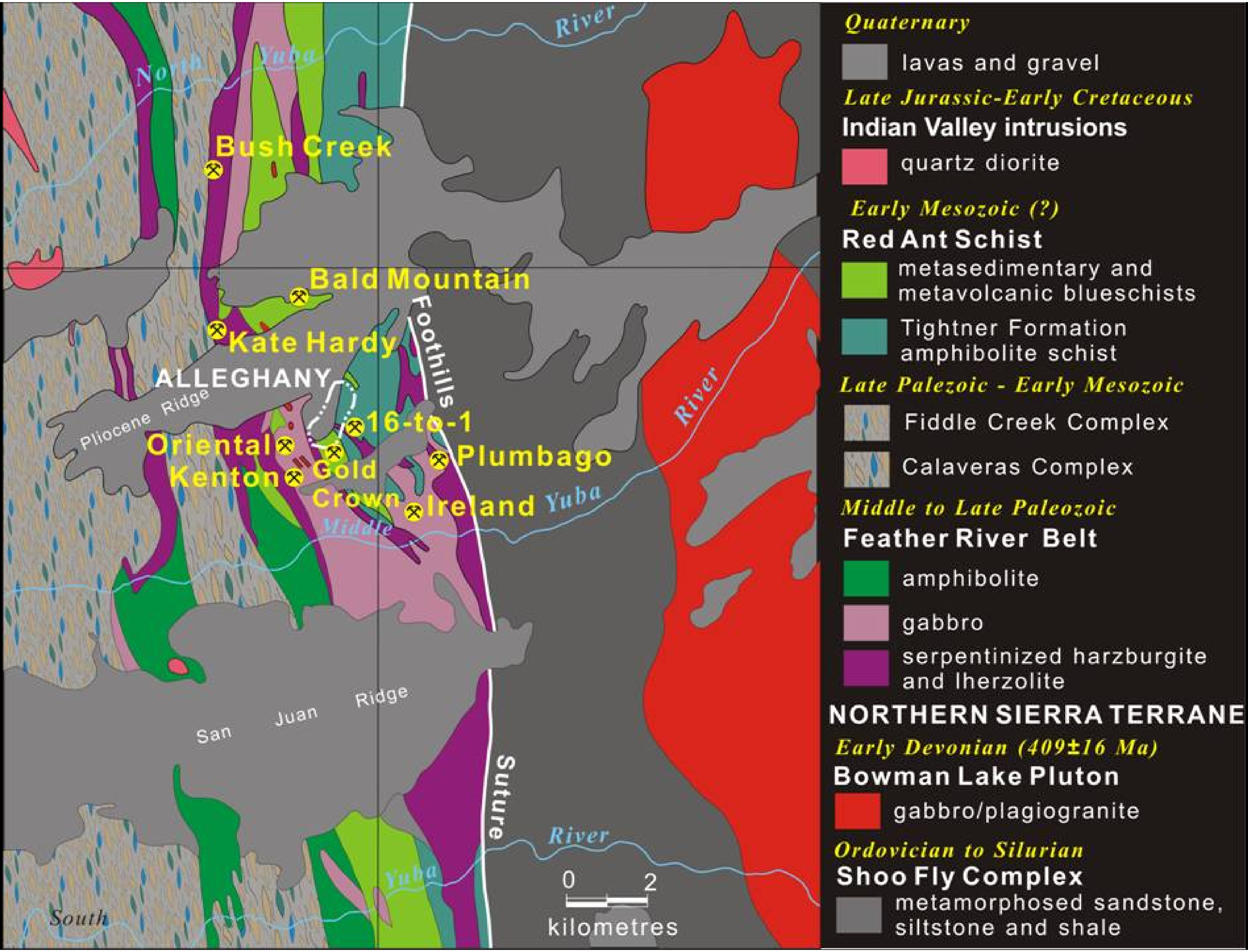
(after Day *et a*l., 1985 with updates to legend from Dilek *et al*., 1990 and Edelman, 1990)



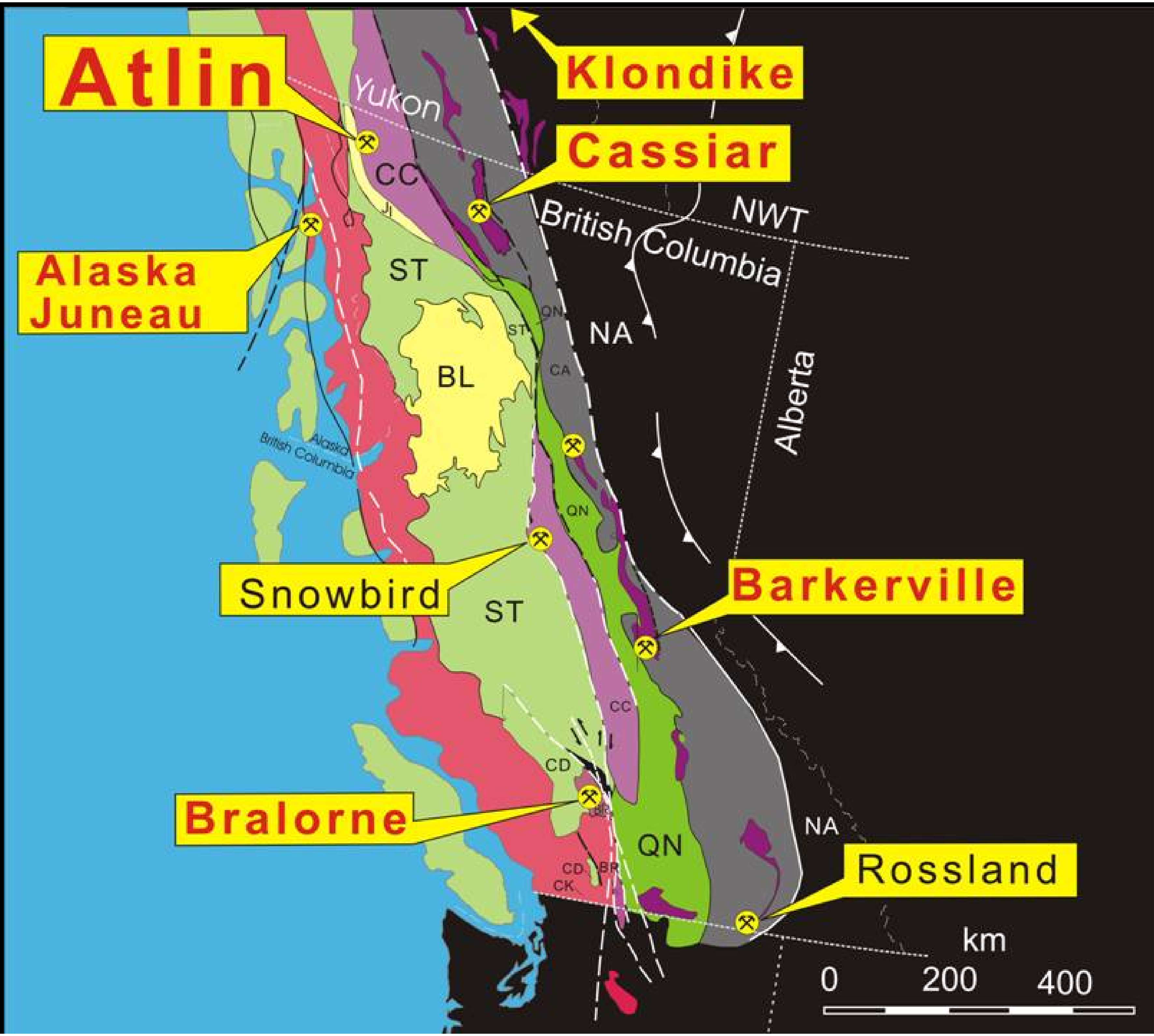


after Johnston (1940) with revised legend using data from Day *et al.* (1985), Edelman and Sharp (1989) and Edelman (1990).


120°
40°
38°
SCC
LCC
GHF
GCF
MF
Allegheny
District
Grass
Valley
District
Mother Lode
Belt
Georgetown
Sierra
Nevada
Batholith
Great
Valley
Sonora
Coulterville
Mariposa
N
SCC - Slate Creek Complex
LCC - Lake Combie Complex
DGO - Devils Gate Ophiolite
0 25 50
km
Post Accretionary
intrusions
Accreted Terranes
Middle to Late Jurassic
Smartville Complex
flysch and mafic volcanics
Late Triassic - Early Jurassic
Slate Creek & Lake Combie Complex
fore-arc igneous complexes
Paleozoic to Early Triassic
Calaveras Complex
chaotic chert-argillite complex with
lesser limestone and mafic volcanics
Red Ant Schist
pre-Middle Jurassic
blueschists facies rocks
Paleozoic
Fiddle Creek Complex
ophiolitic assemblages with
Middle Triassic and Early
Jurassic volcanics and sediments
Feather River Belt
polygenetic ophiolitic assemblages
North America
Eocambrian to Early Paleozoic
Northern Sierra Terrane
continental derived clastics
with pre and post accretionary
overlap volcanics and sediments



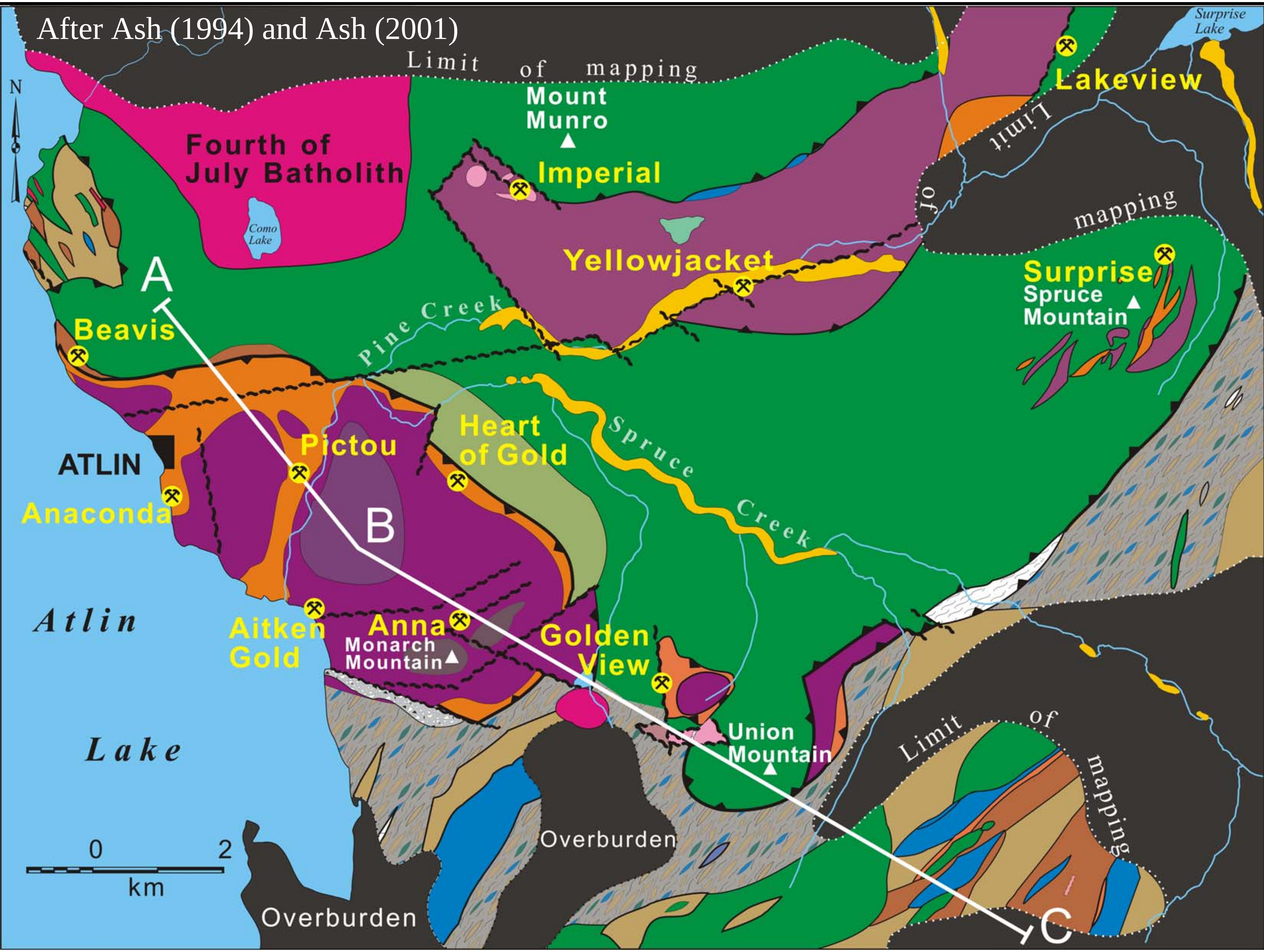
Quaternary
lavas and gravel
Late Jurassic-Early Cretaceous
Indian Valley intrusions
quartz diorite
Early Mesozoic (?)
Red Ant Schist
metasedimentary and metavolcanic blueschists
Tightner Formation amphibolite schist
Late Palezoic - Early Mesozoic
Fiddle Creek Complex
Calaveras Complex
Middle to Late Paleozoic
Feather River Belt
amphibolite
gabbro
serpentinized harzburgite and lherzolite
NORTHERN SIERRA TERRANE
Early Devonian (409±16 Ma)
Bowman Lake Pluton
gabbro/plagiogranite
Ordovician to Silurian
Shoo Fly Complex
metamorphosed sandstone, siltstone and shale
North Yuba River
Bush Creek
Bald Mountain
Kate Hardy
ALLEGHANY
Pliocene Ridge
16-to-1
Oriental
Plumbago
Kenton
Gold Crown
Ireland
Middle Yuba River
Foothills Suture
San Juan Ridge
South Yuba River
0 2
kilometres


Atlin
Klondike
Yukon
Cassiar
CC
JI
Alaska
Juneau
British Columbia
NWT
ST
QN
NA
BL
CA
Alberta
Alaska
British Columbia
Snowbird
Barkerville
CC
CD
Bralorne
BR
QN
NA
Rossland
CD
CK
km
0
200
400

Atlin Placer Mining

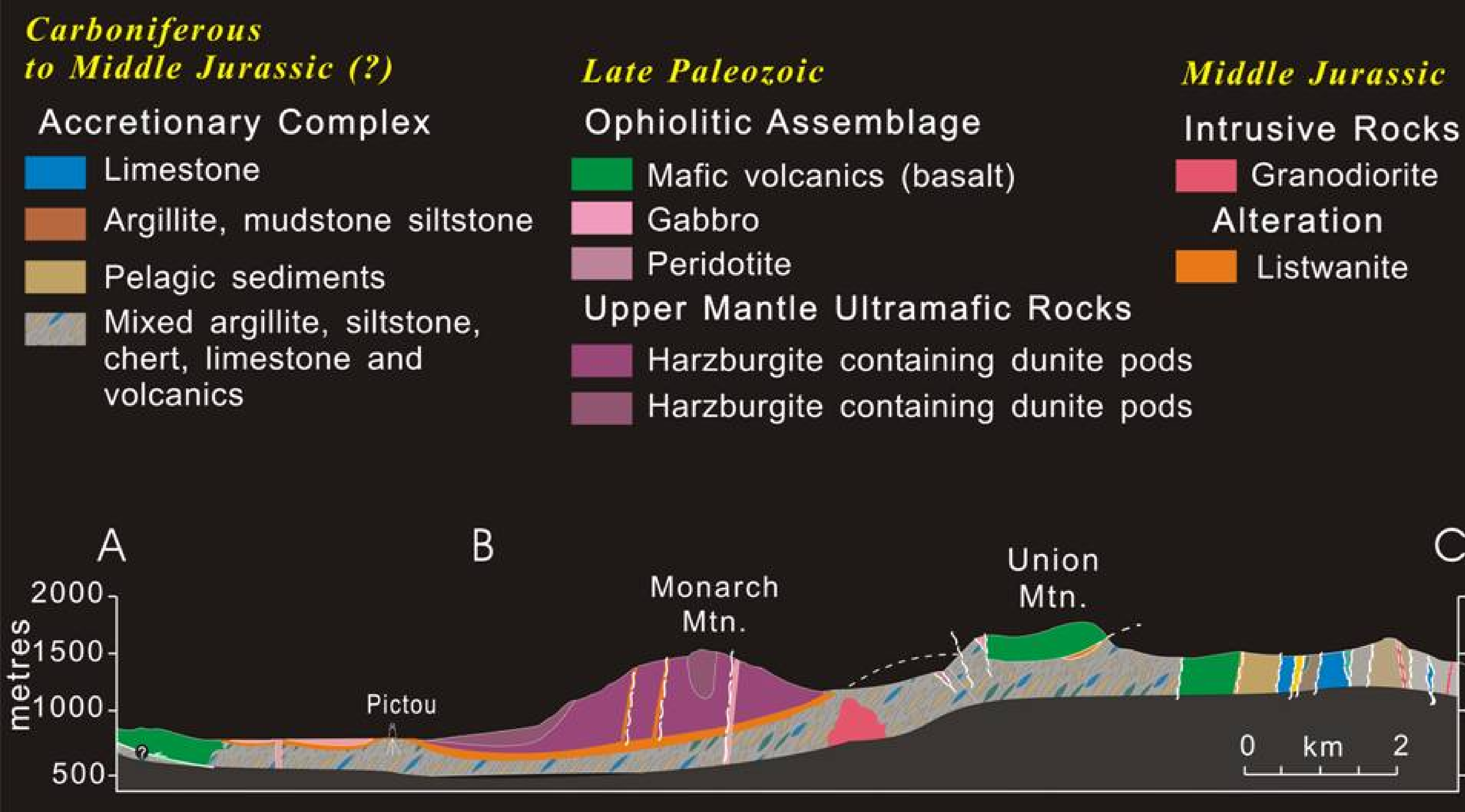
- 1897 - Gold discovered
- Produced in excess of 1 million oz Au

Atlin Placer Gold Camp



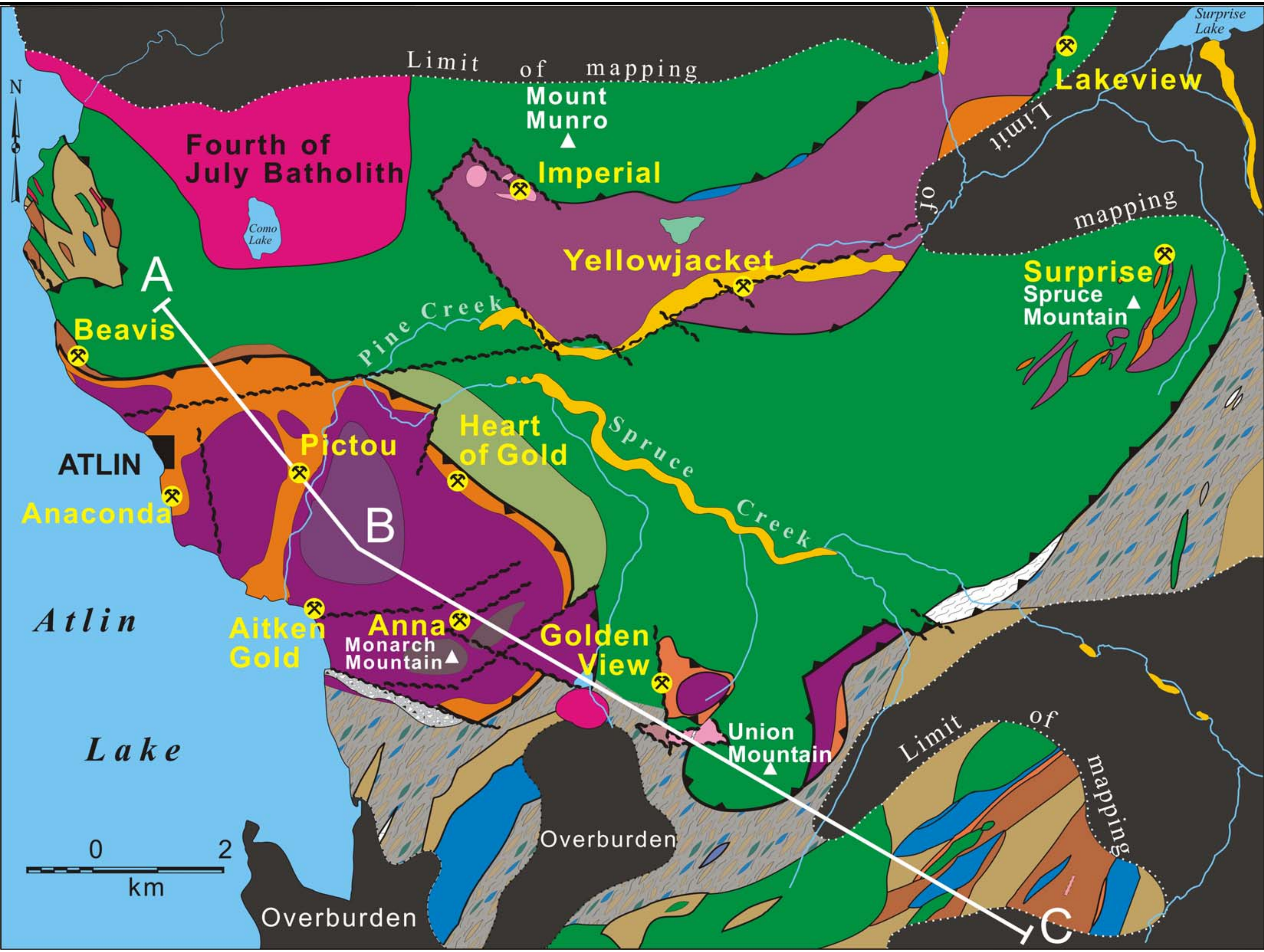
After Ash (1994) and Ash (2001)
Limit of mapping
Mount Munro
Fourth of July Batholith
Como Lake
Imperial
Yellowjacket
Lakeview
Surprise Lake
Surprise
Spruce Mountain
Limit of mapping
A
Beavis
Pine Creek
Spruce Creek
Heart of Gold
Pictou
ATLIN
Anaconda
B
Aitken Gold
Anna
Monarch Mountain
Golden View
Union Mountain
Atlin Lake
Overburden
Overburden
0 2 km
N
C

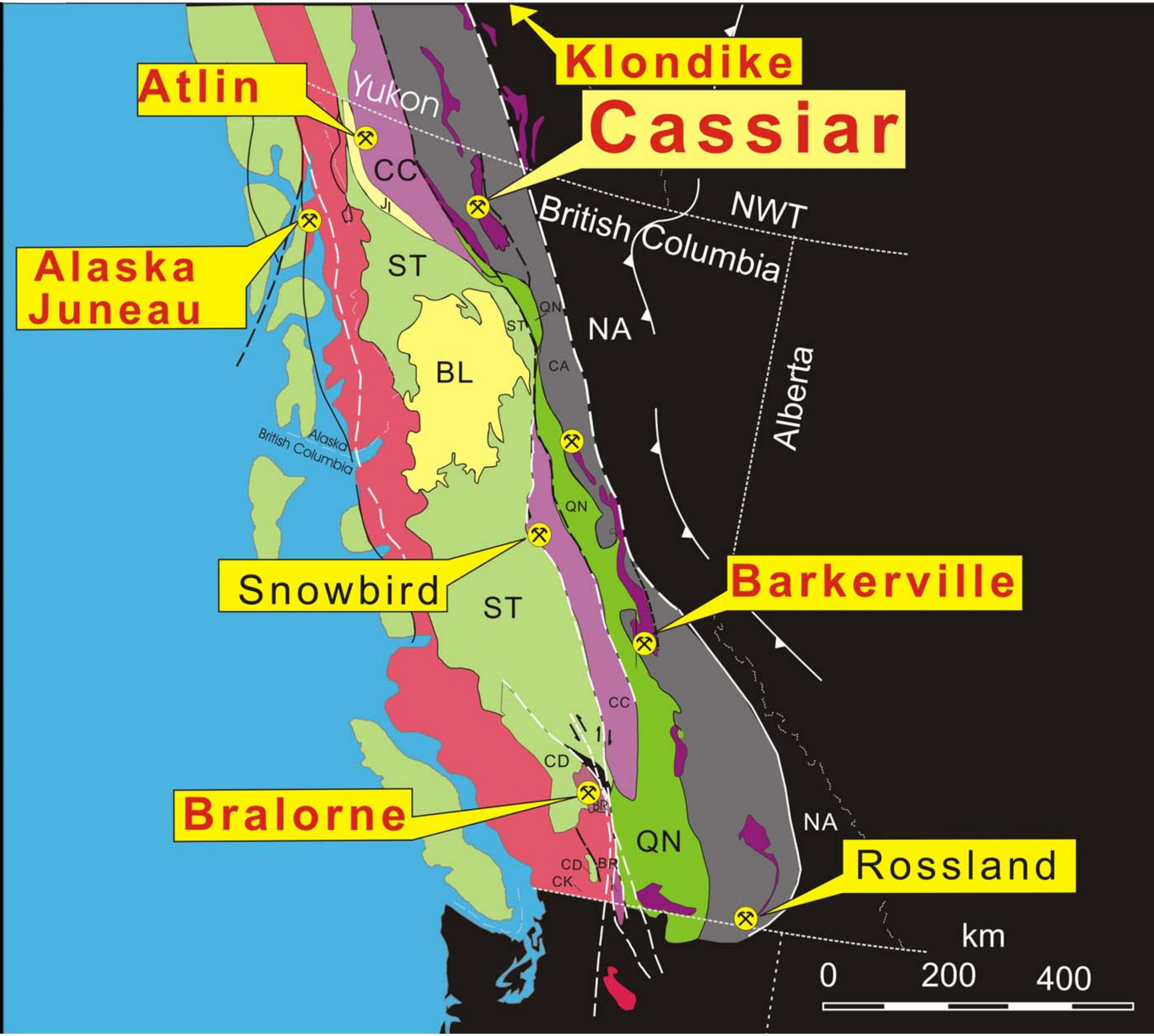
Atlin - Geological Cross-Secrtion



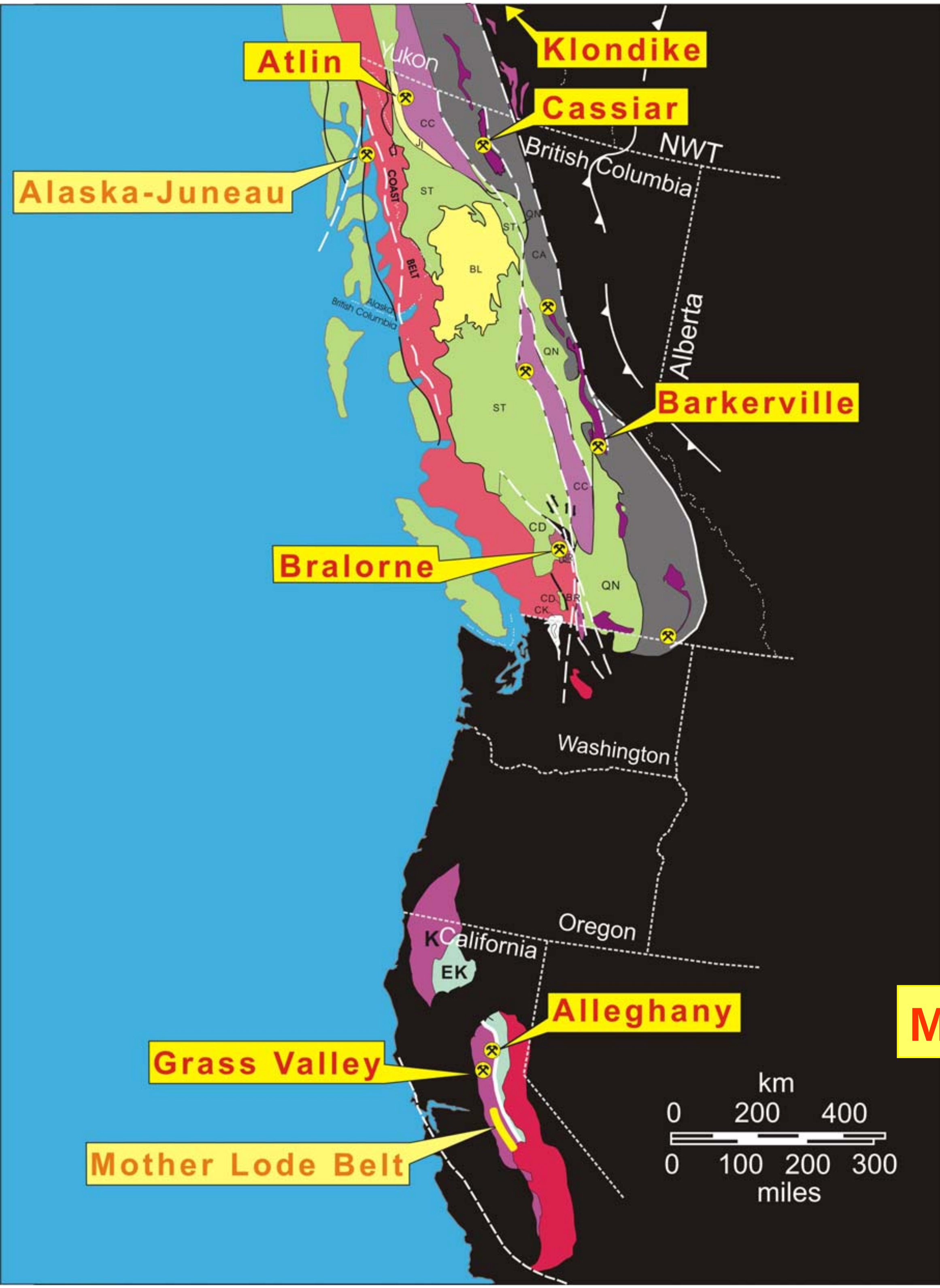
After Ash (1994) and Ash (2001)

Pictou Property


Limit of mapping
Mount Munro
Fourth of July Batholith
Como Lake
Imperial
Yellowjacket
Lakeview
Surprise Lake
Limit of mapping
Surprise
Spruce Mountain
A
Beavis
Pine Creek
Pictou
Heart of Gold
Spruce Creek
ATLIN
Anaconda
B
Atlin
Lake
Aitken Gold
Anna
Monarch Mountain
Golden View
Union Mountain
Limit of mapping
Overburden
Overburden
0
2
km
N
C



Klondike
Atlin
Yukon
Cassiar
CC
JI
NWT
British Columbia
Alaska Juneau
ST
QN
ST
NA
CA
BL
Alberta
Alaska
British Columbia
QN
Snowbird
Barkerville
ST
CC
CD
Bralorne
BR
QN
NA
CD
BR
CK
Rossland
km
0
200
400



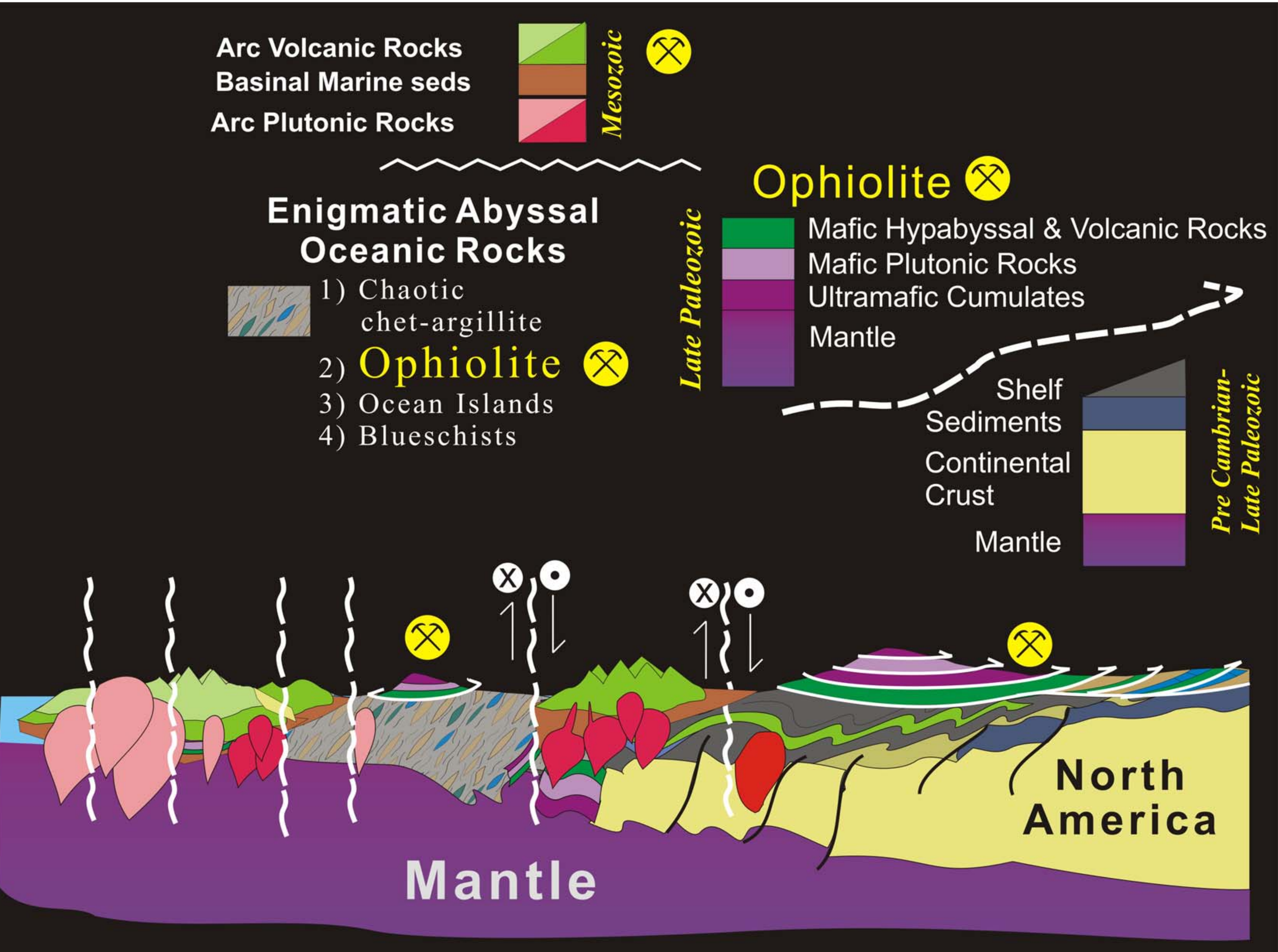
Geological setting of 1,000,000 plus producing Gold-Quartz Vein or related placer camps in the US-Canadian Cordillera

Ophiolitic

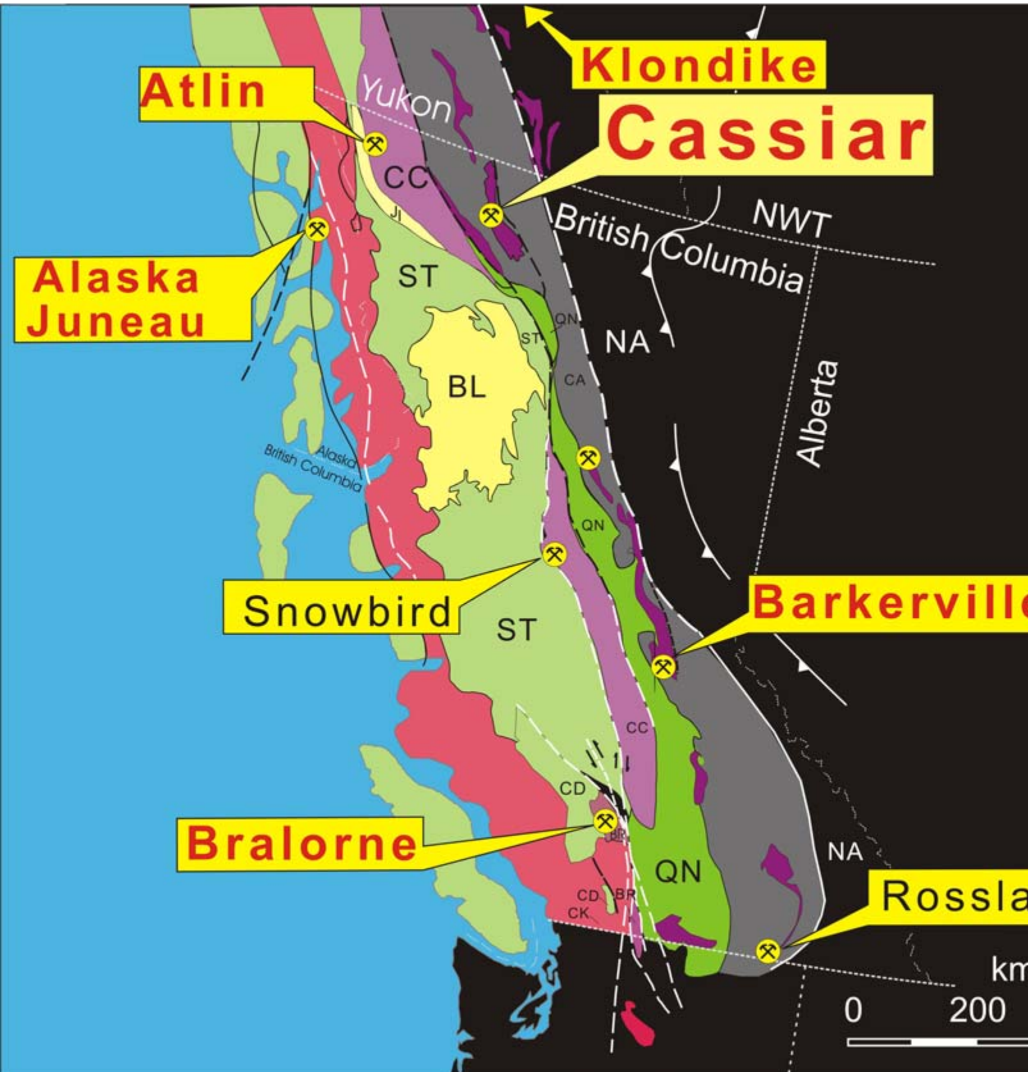
<u>Anorogenic</u>	<u>Apparent Anorogenic</u>
Bralorne Grass Valley Alleghany Atlin	Cassiar Barkerville Klondike

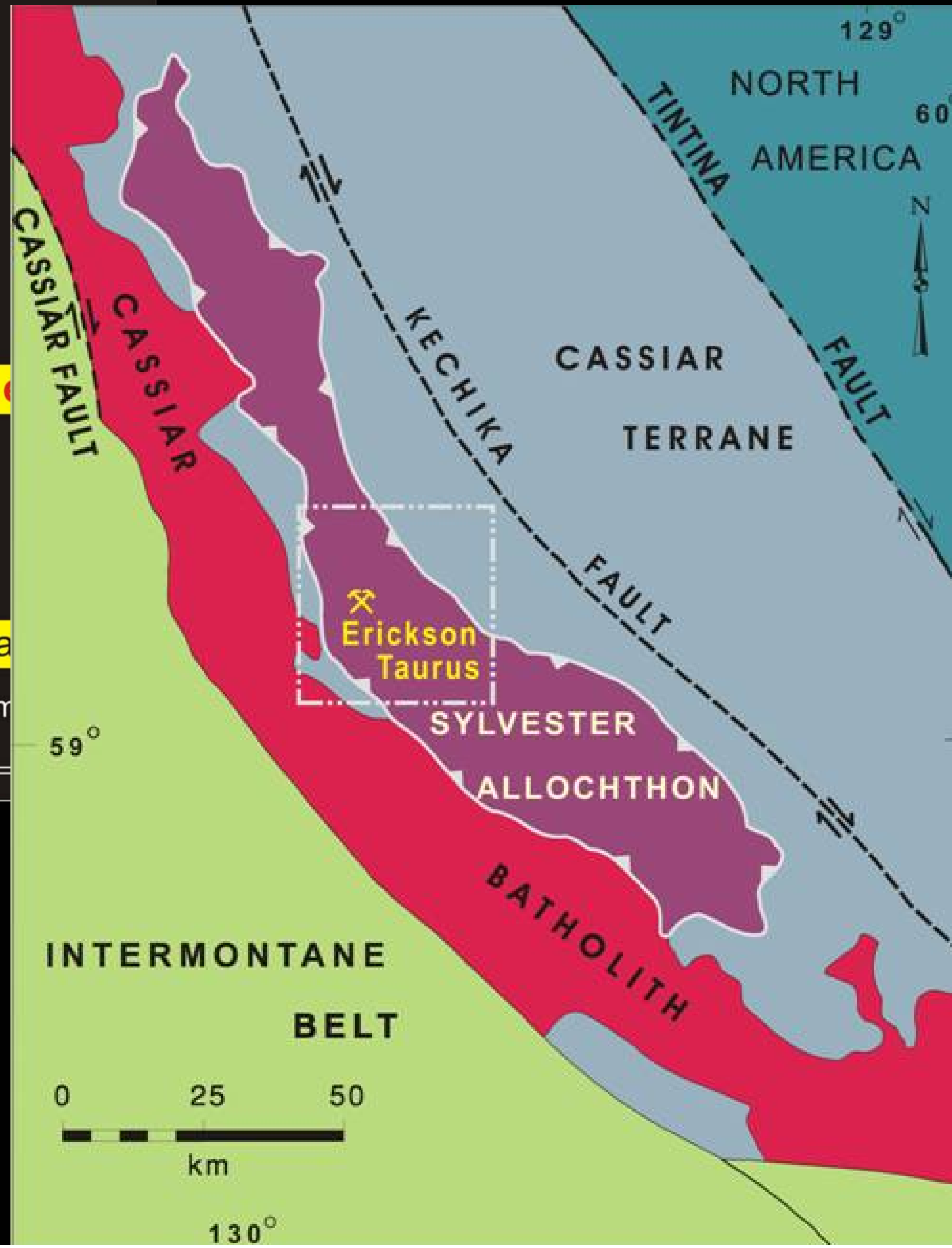
Mixed mafic igneous- sedimentary

Mother Lode Belt
Alaska-Juneau

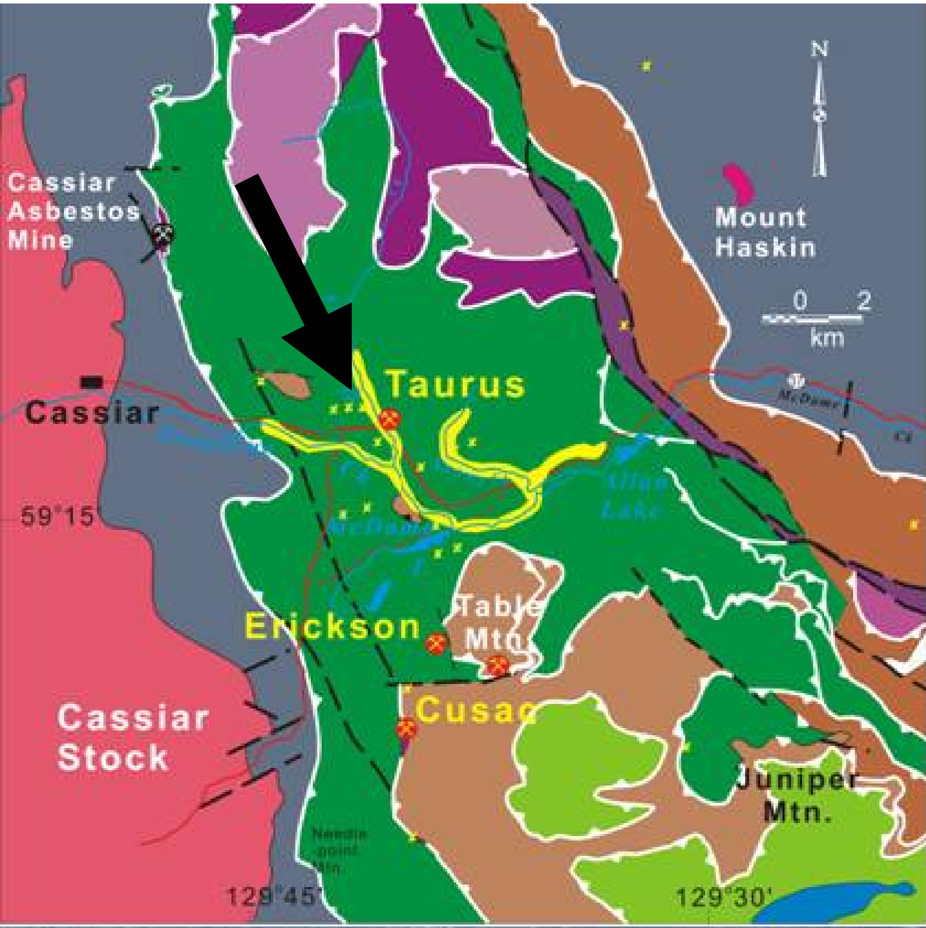

Arc Volcanic Rocks
Basinal Marine seds
Arc Plutonic Rocks
Mesozoic
Enigmatic Abyssal Oceanic Rocks
1) Chaotic chet-argillite
2) Ophiolite
3) Ocean Islands
4) Blueschists
Late Paleozoic
Ophiolite
Mafic Hypabyssal & Volcanic Rocks
Mafic Plutonic Rocks
Ultramafic Cumulates
Mantle
Shelf Sediments
Continental Crust
Mantle
Pre Cambrian-Late Paleozoic
North America
Mantle

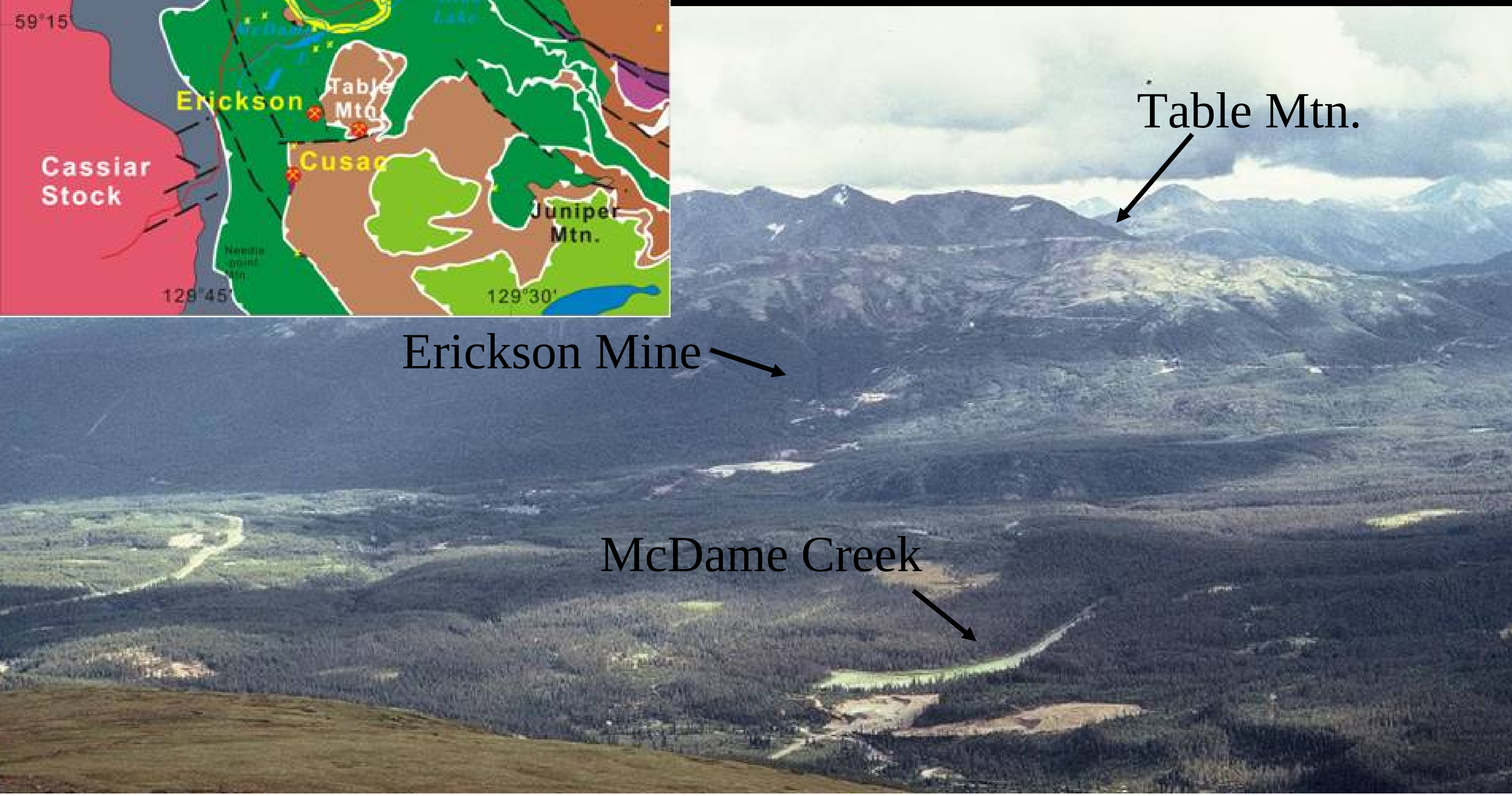
Cassiar Gold Camp





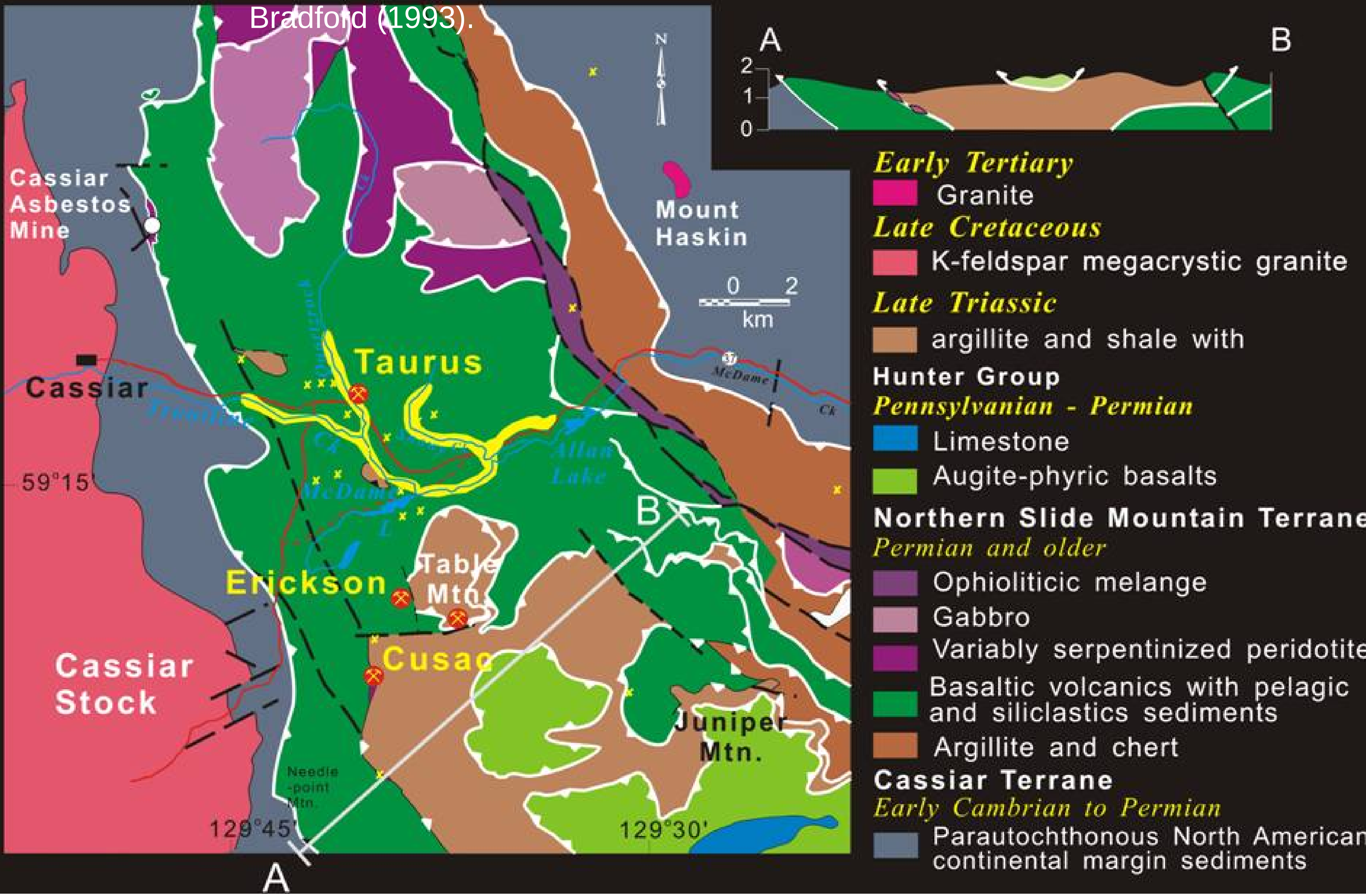
Erickson Mine looking south from the Taurus Mine

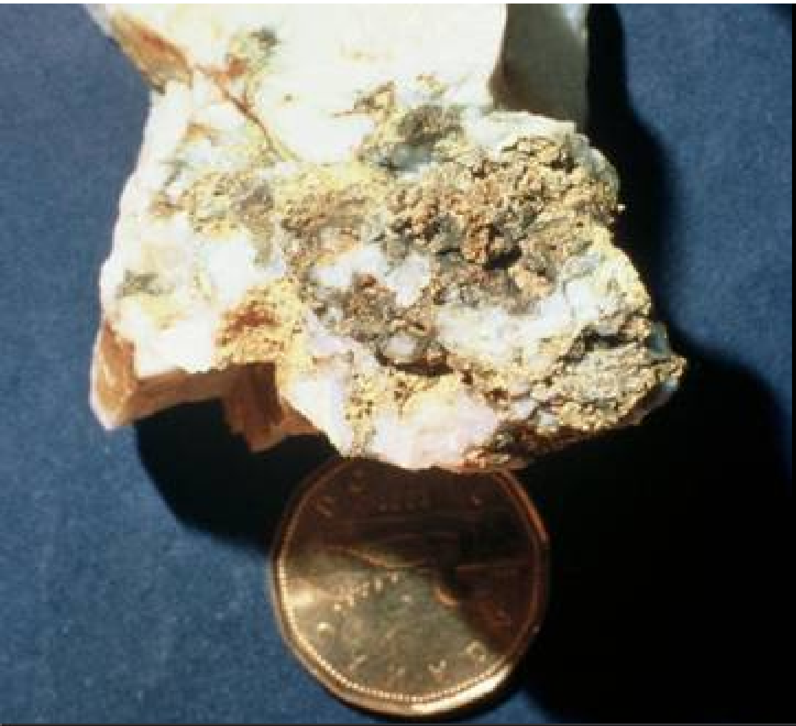




Cassiar Gold Camp Geology

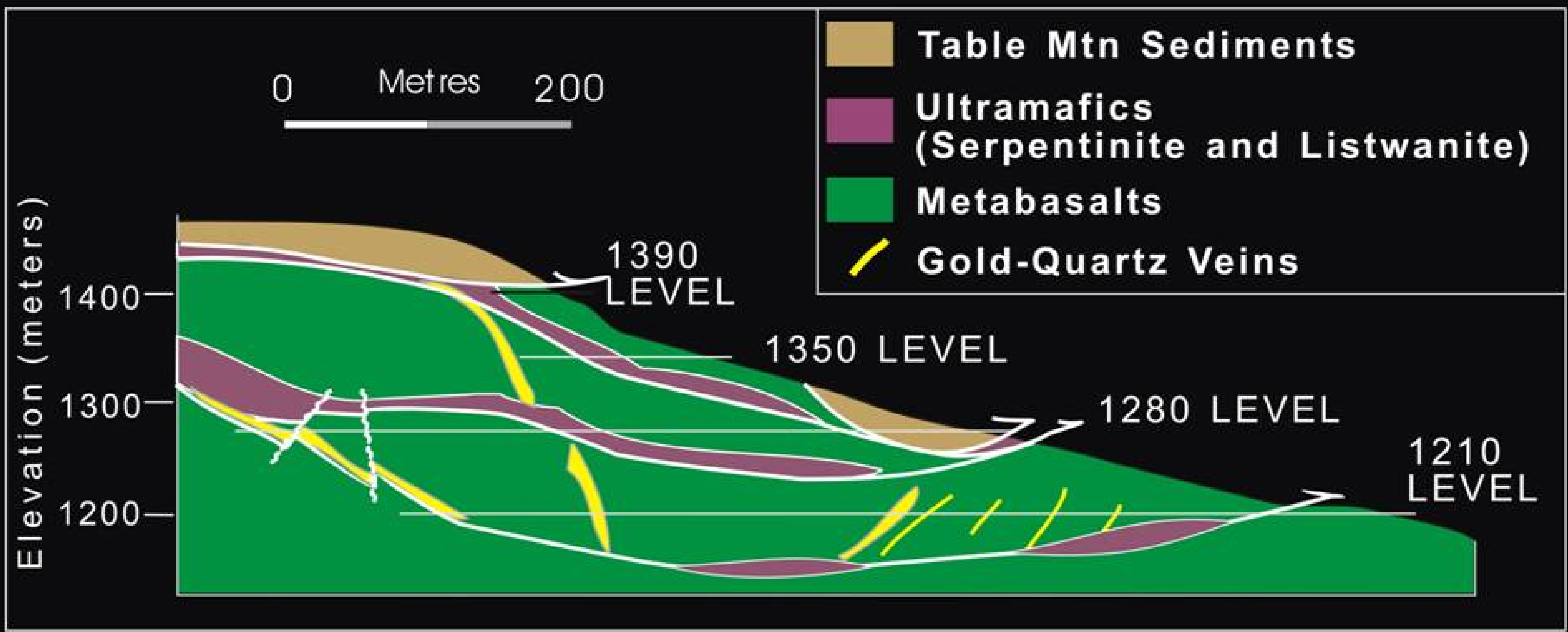
Modified after Harms (1989) and Nelson and Bradford (1993).

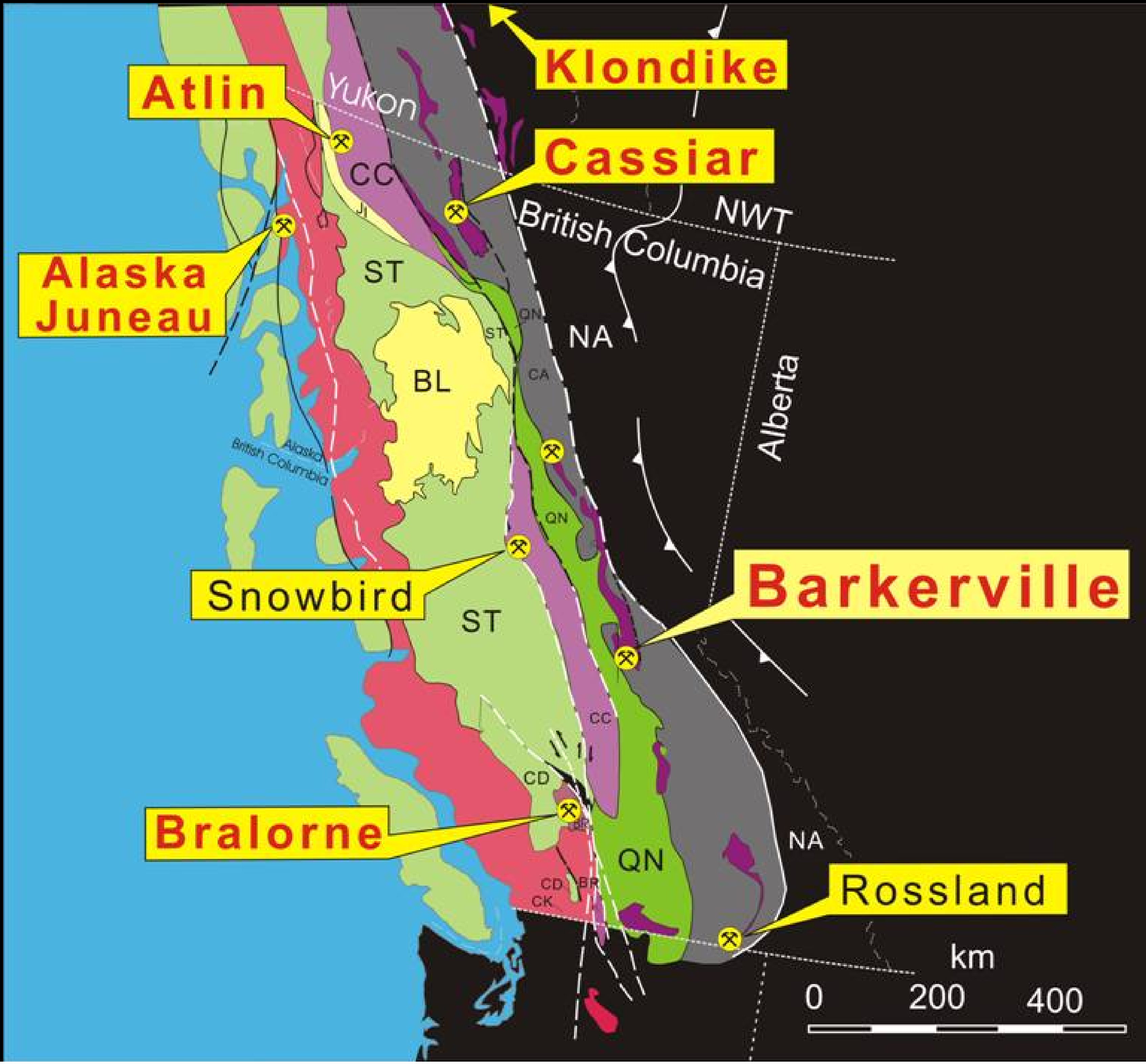




Erickson Mine Section

Compiled after Sketchley (1986), Boronowski (1988) and Anderson and Hodgson (1989).

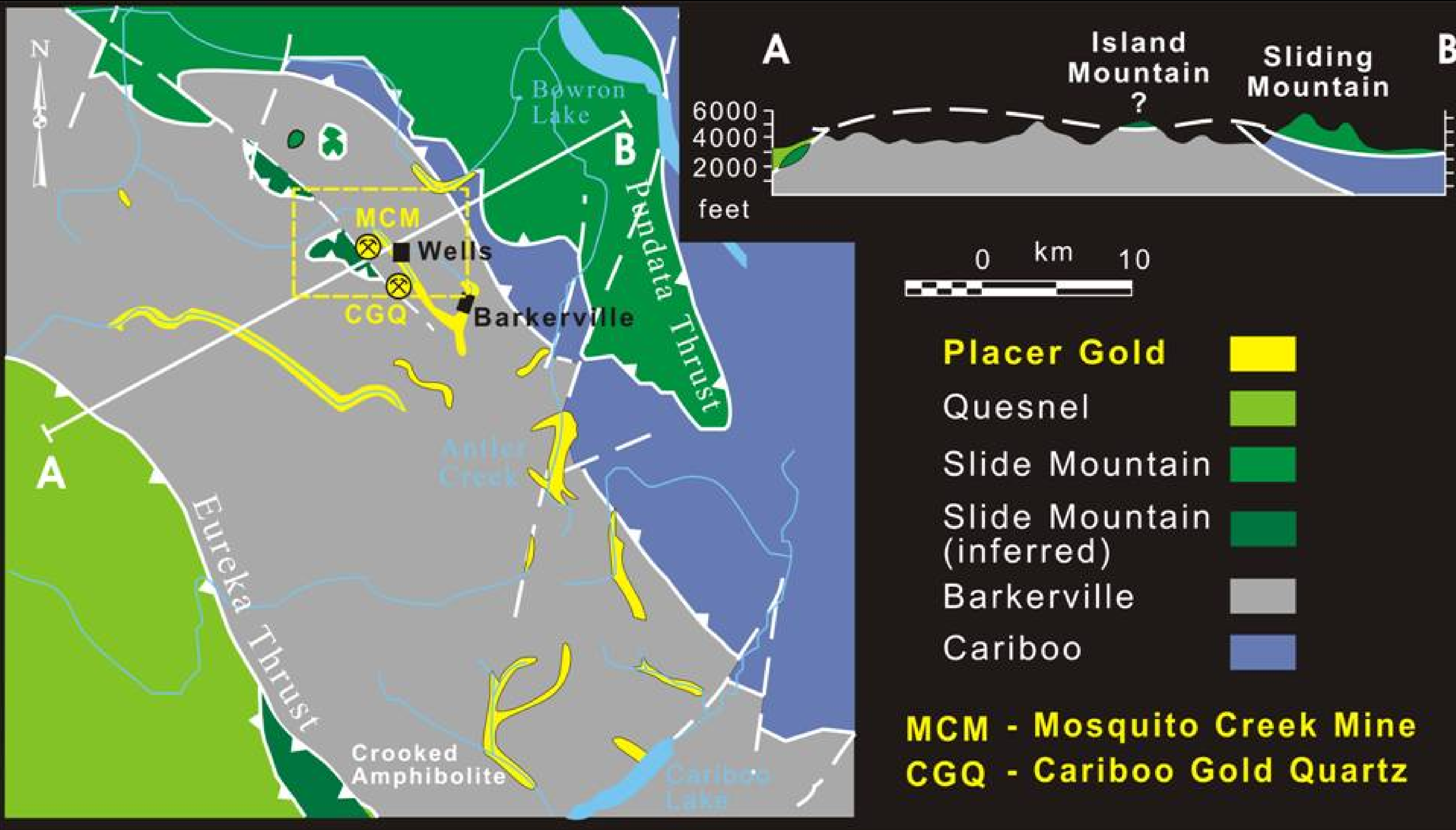



Klondike
Atlin
Yukon
Cassiar
CC
NWT
British Columbia
Alaska
Juneau
ST
QN
NA
BL
CA
Alberta
Alaska
British Columbia
QN
Snowbird
Barkerville
ST
CC
CD
Bralorne
QN
NA
Rossland
CD
BR
CK
km
0
200
400

Placer Mining – Antler Creek 1992

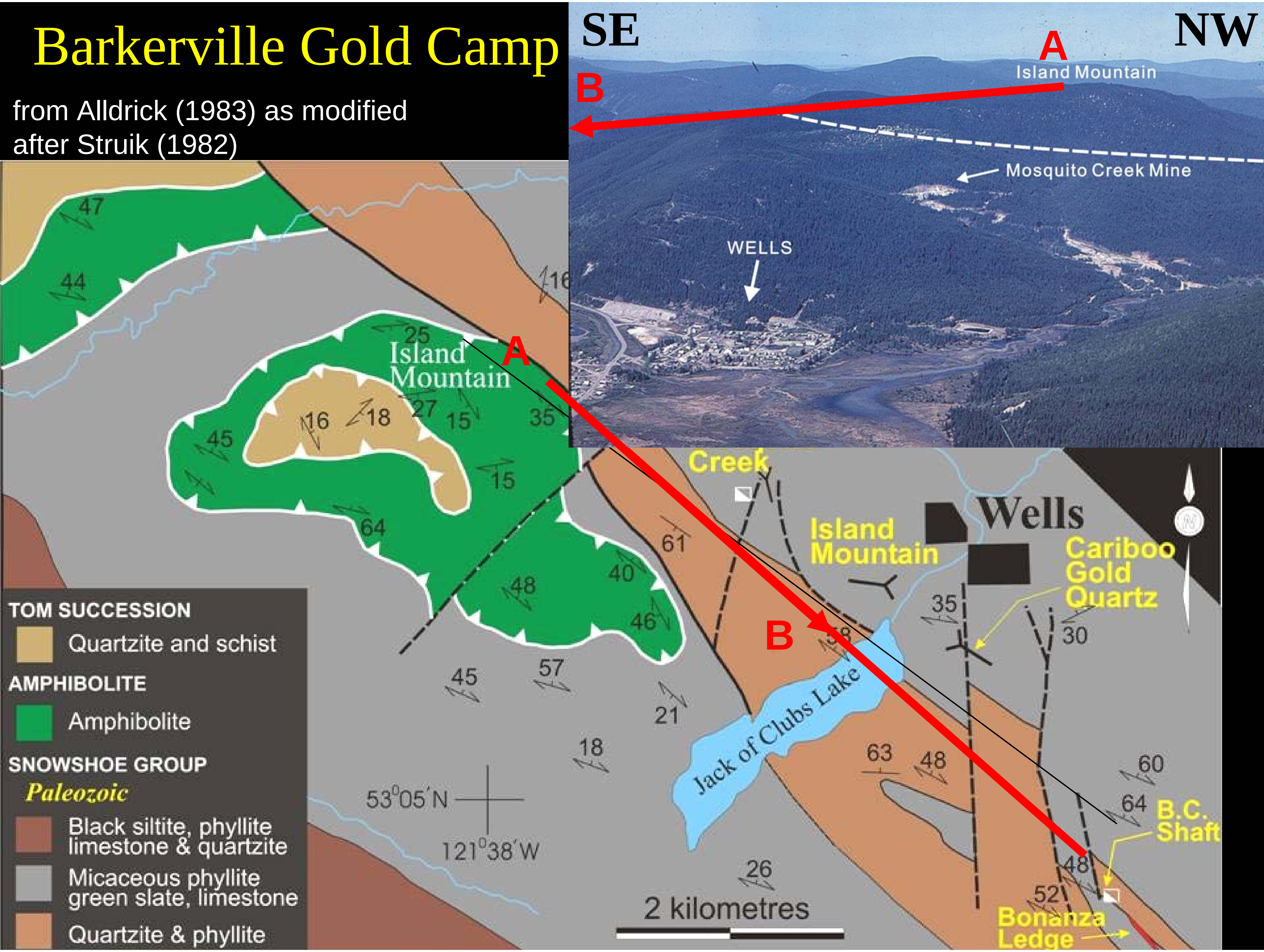
Barkerville Camp

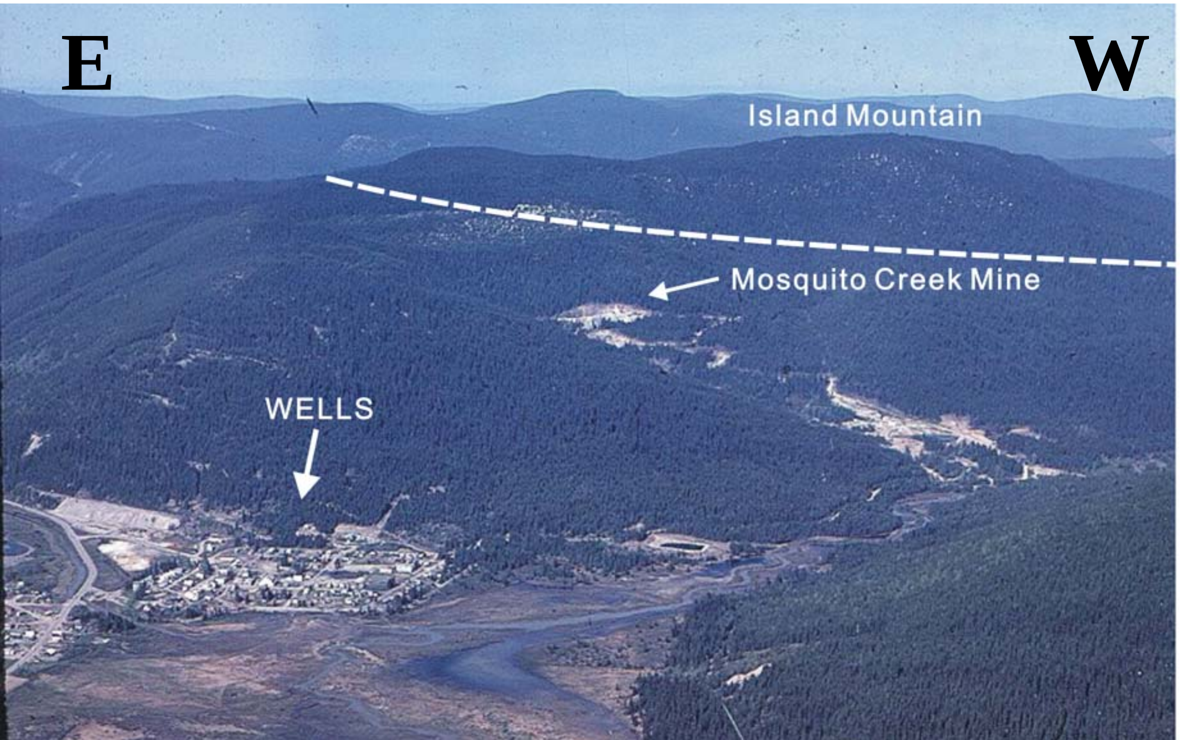
Geology after Struik (1988)



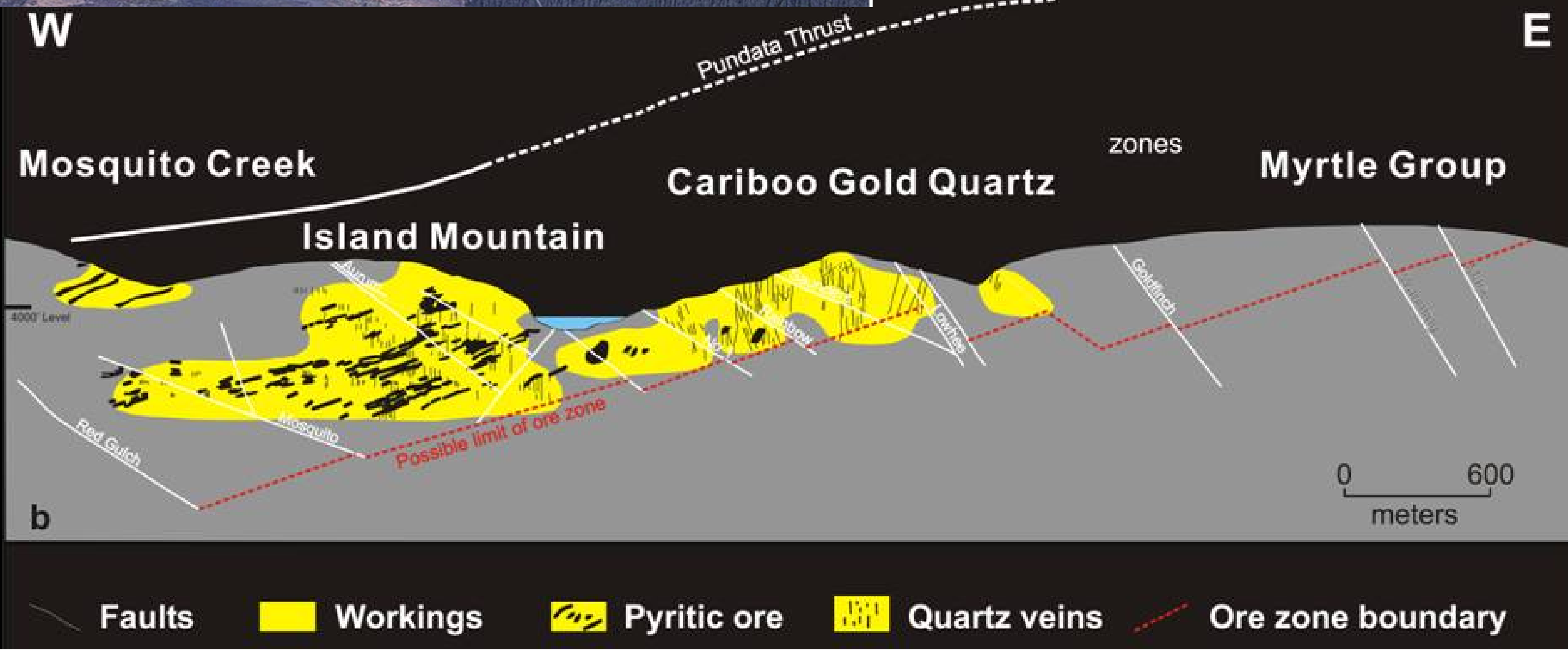
Barkerville Gold Camp

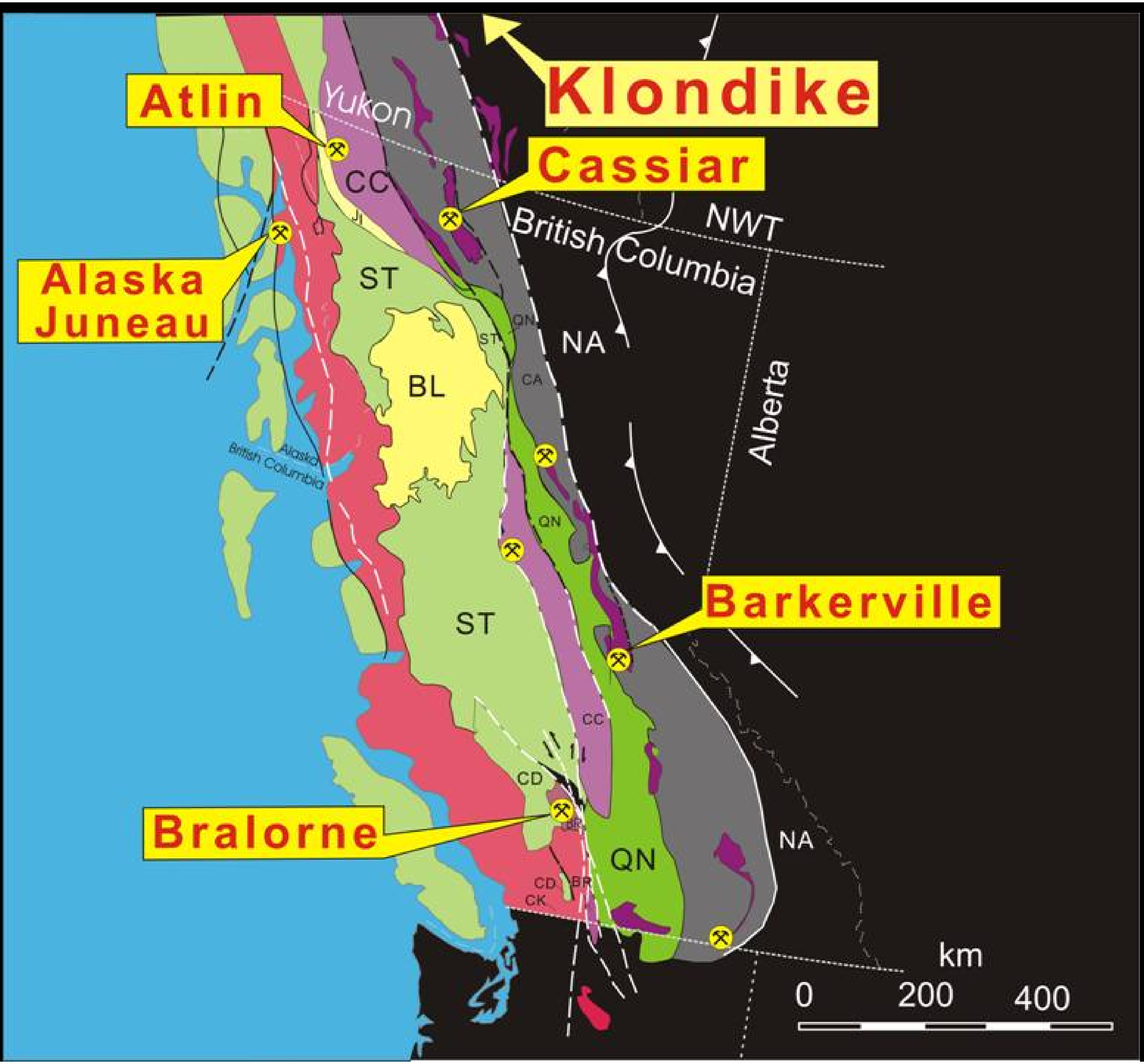
from Alldrick (1983) as modified
after Struik (1982)



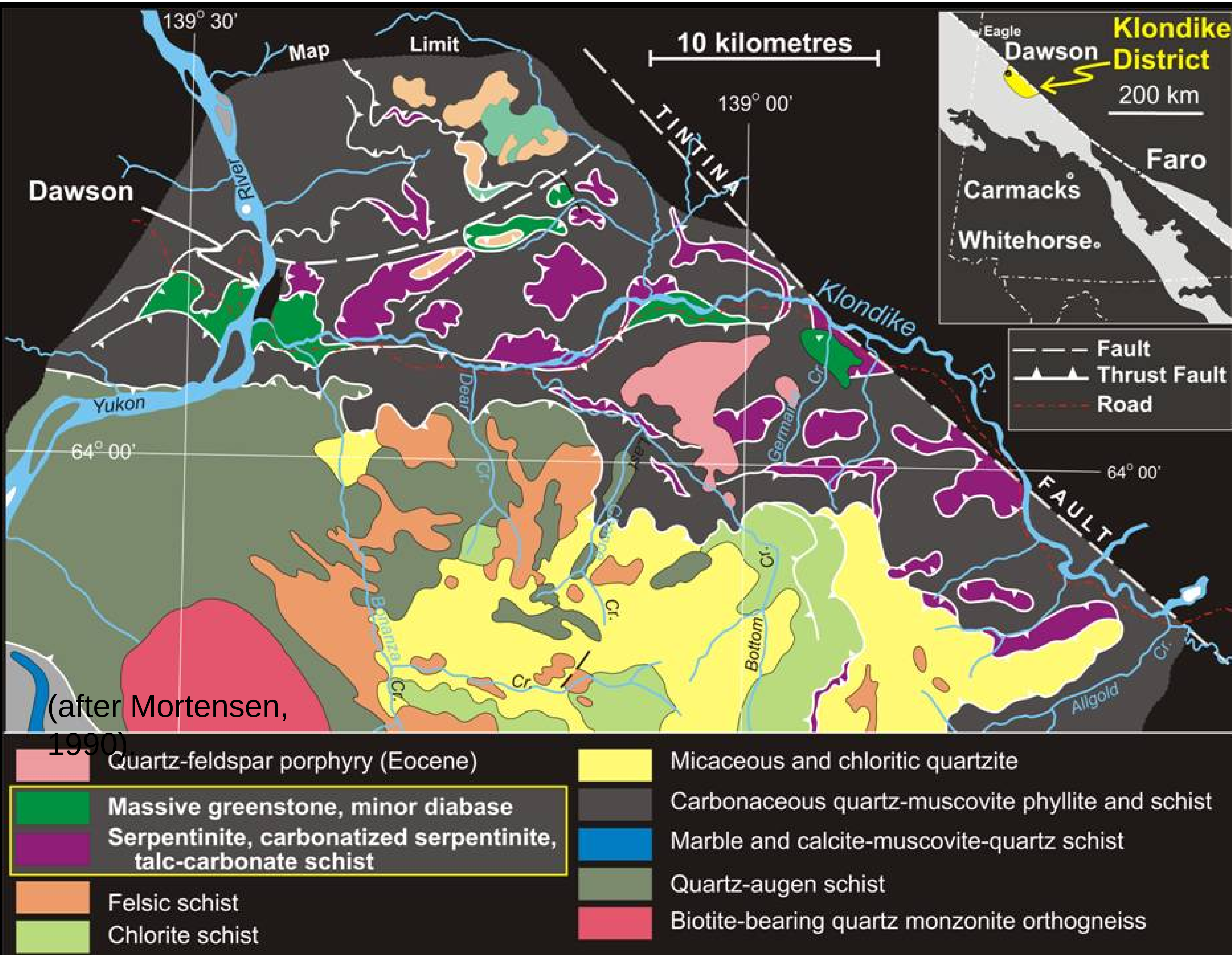


after Skerl,1948 and Poulsen *et al* ,2000)

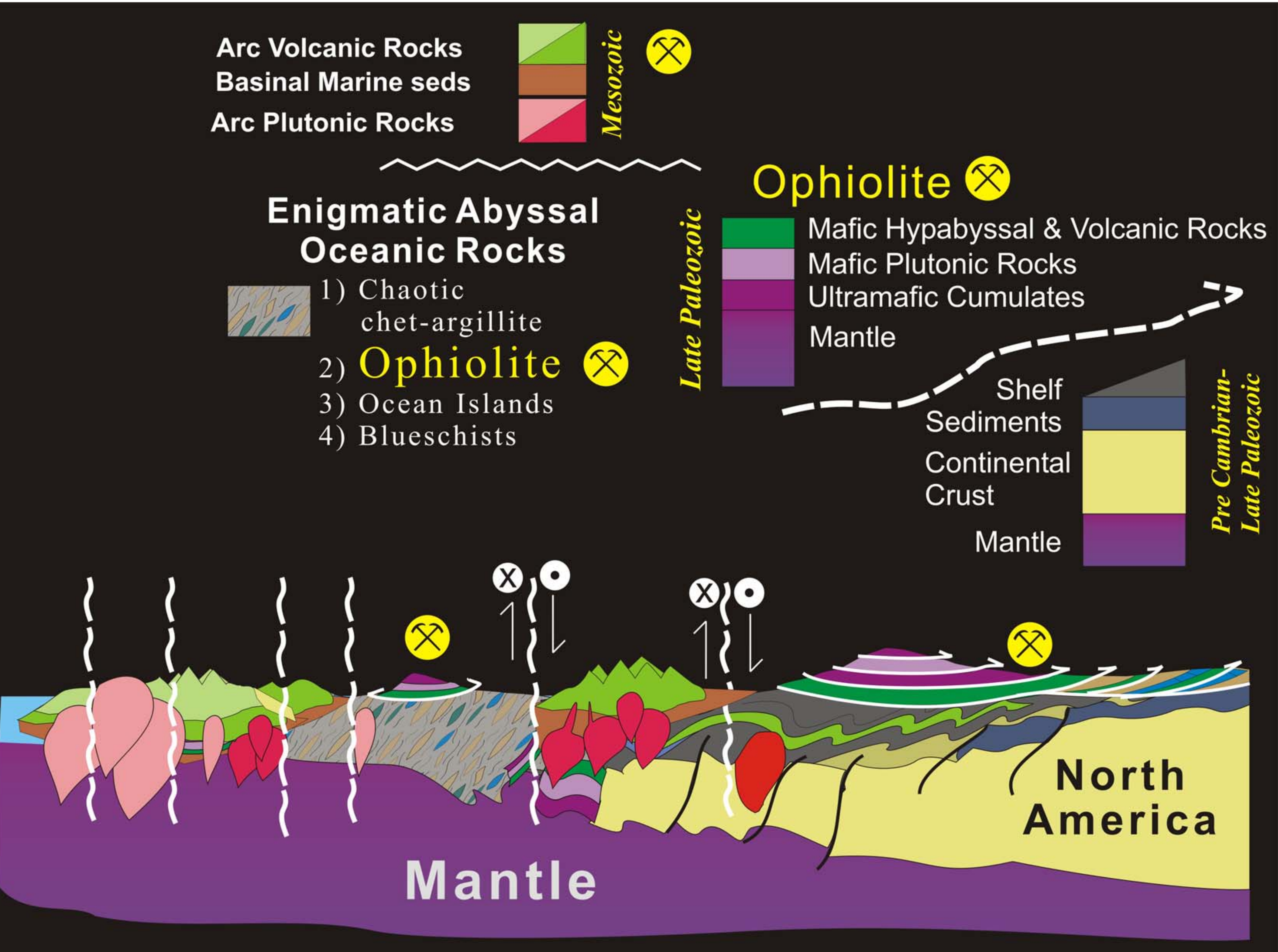


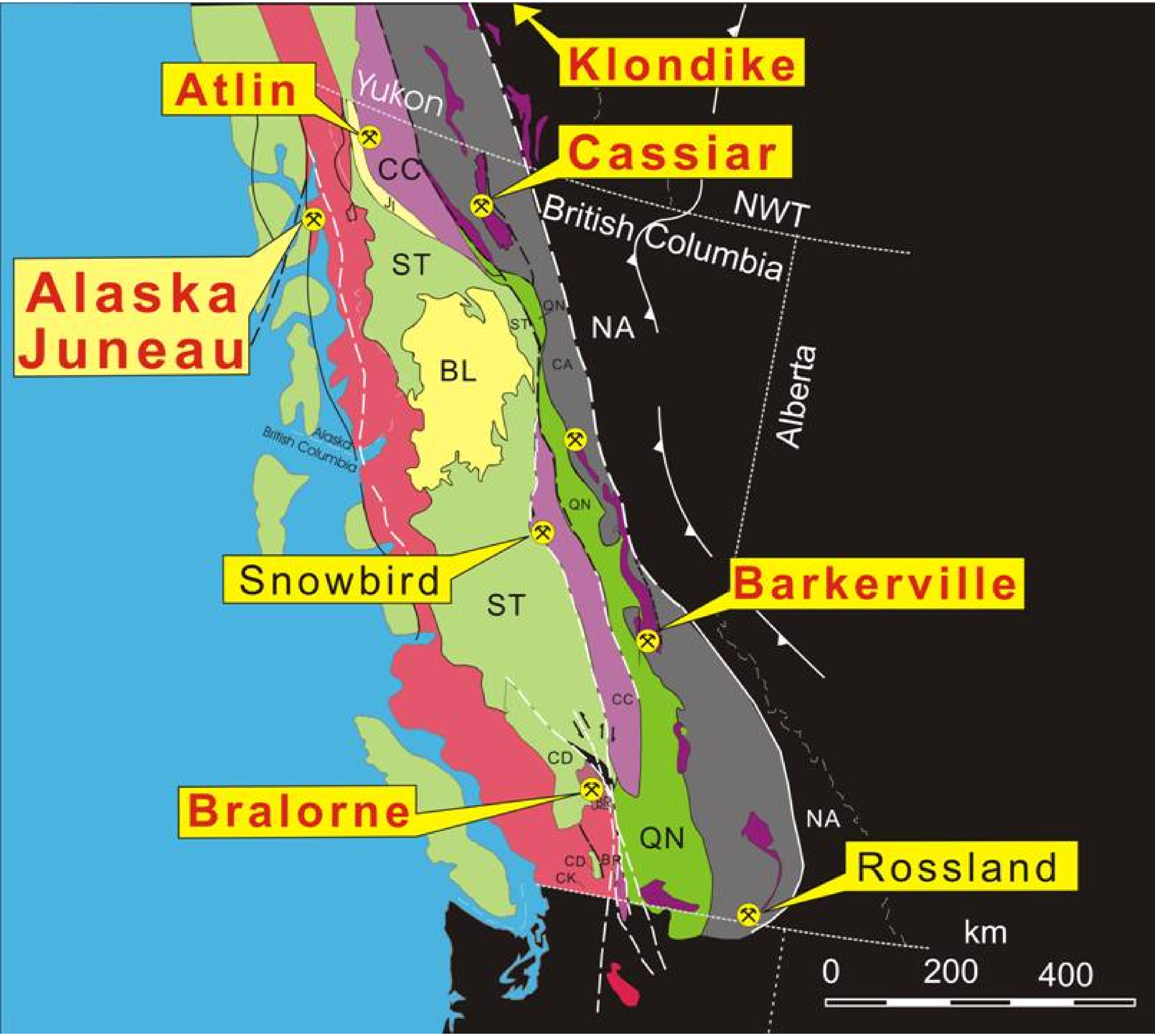


Klondike
Atlin
Yukon
CC
Cassiar
NWT
British Columbia
Alaska
Juneau
ST
QN
ST
NA
CA
BL
Alberta
Alaska
British Columbia
QN
ST
Barkerville
CC
CD
Bralorne
BR
QN
NA
CD
BR
CK
km
0
200
400



(after Mortensen, 1990).


Arc Volcanic Rocks
Basinal Marine seds
Arc Plutonic Rocks
Mesozoic
Enigmatic Abyssal Oceanic Rocks
1) Chaotic chet-argillite
2) Ophiolite
3) Ocean Islands
4) Blueschists
Late Paleozoic
Ophiolite
Mafic Hypabyssal & Volcanic Rocks
Mafic Plutonic Rocks
Ultramafic Cumulates
Mantle
Shelf Sediments
Continental Crust
Mantle
Pre Cambrian-Late Paleozoic
North America
Mantle

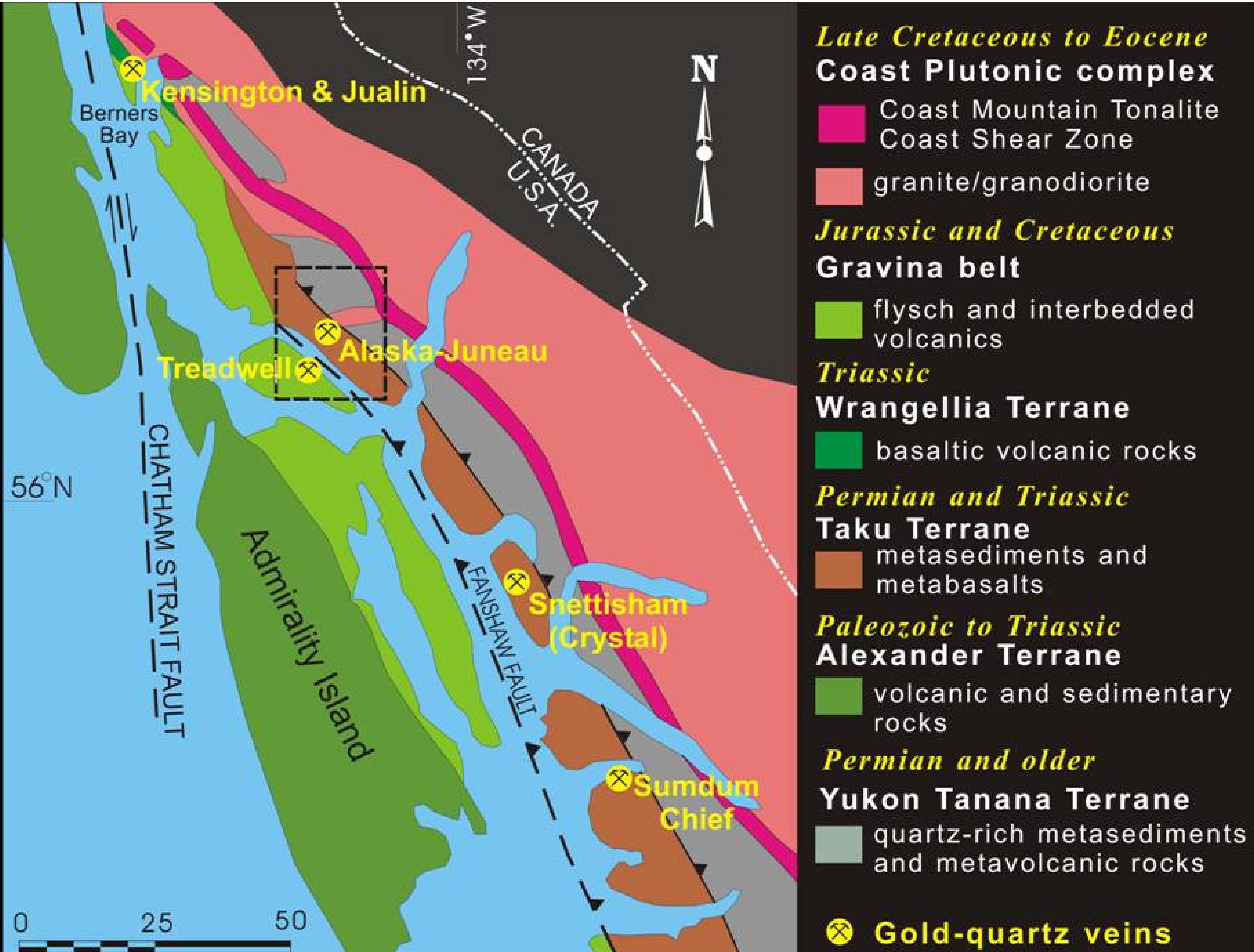


Klondike
Atlin
Yukon
Cassiar
CC
NWT
British Columbia
Alaska Juneau
JI
ST
QN
ST
NA
BL
CA
Alberta
Alaska
British Columbia
QN
Snowbird
ST
Barkerville
CC
CD
Bralorne
BR
NA
QN
CD
BR
CK
Rossland
km
0
200
400

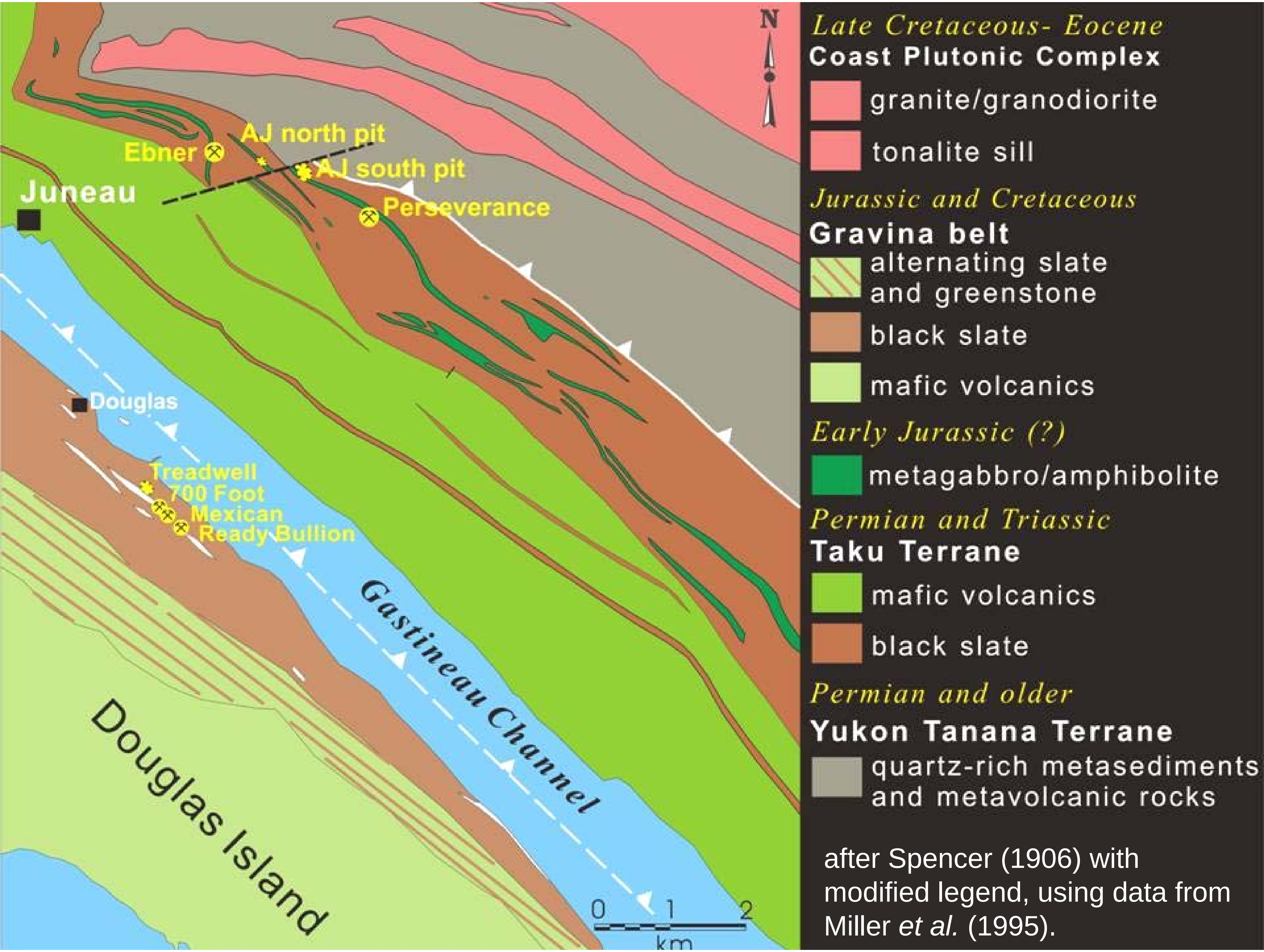
Alaska Juneau Deposit

- Discovered in 1880
- 40 years production 1885-1944
- Lowest-grade underground mine ever developed

1.34 g/t, 0.04 oz/ton

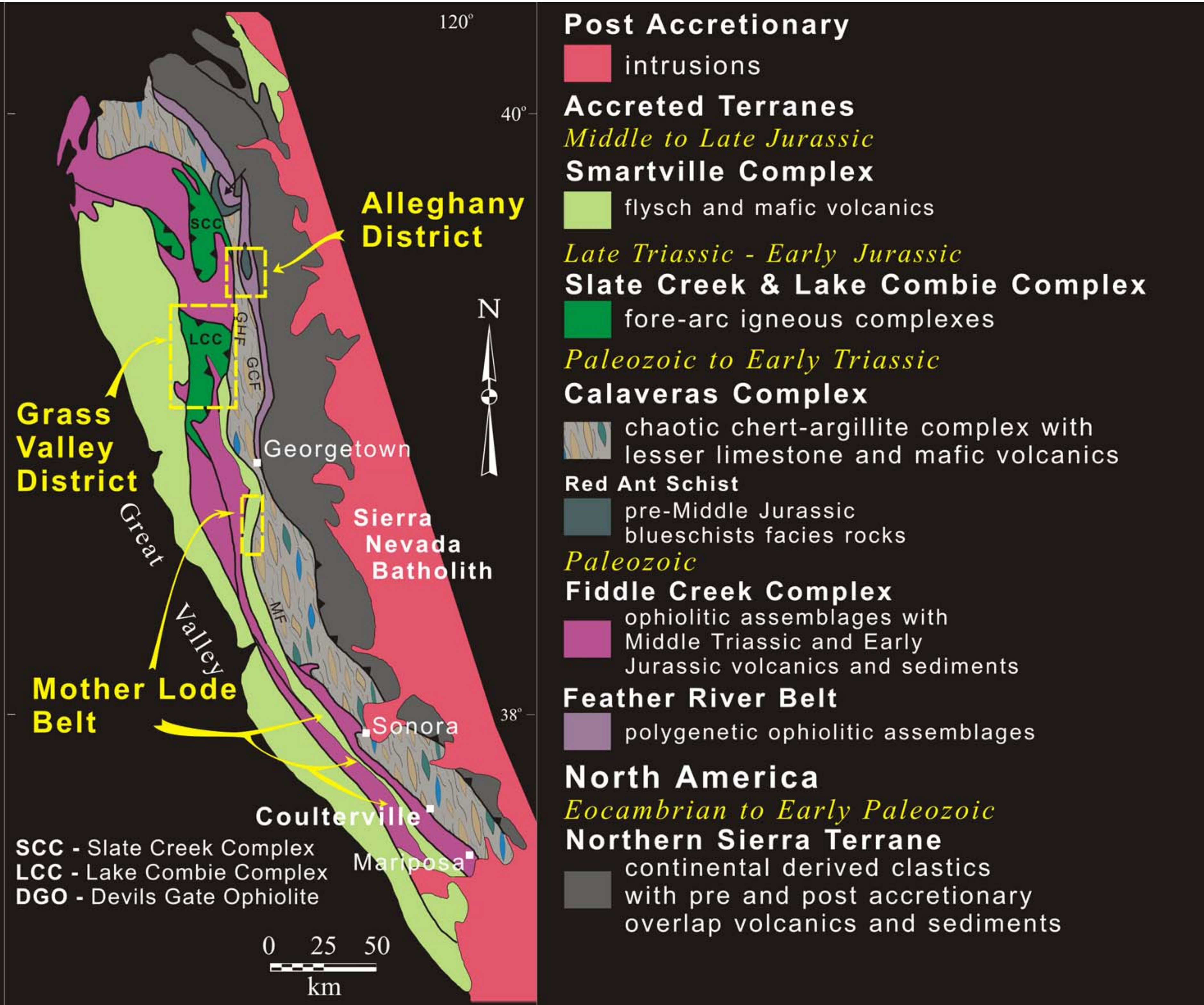


after Miller *et al.* (1995, Figure 1).



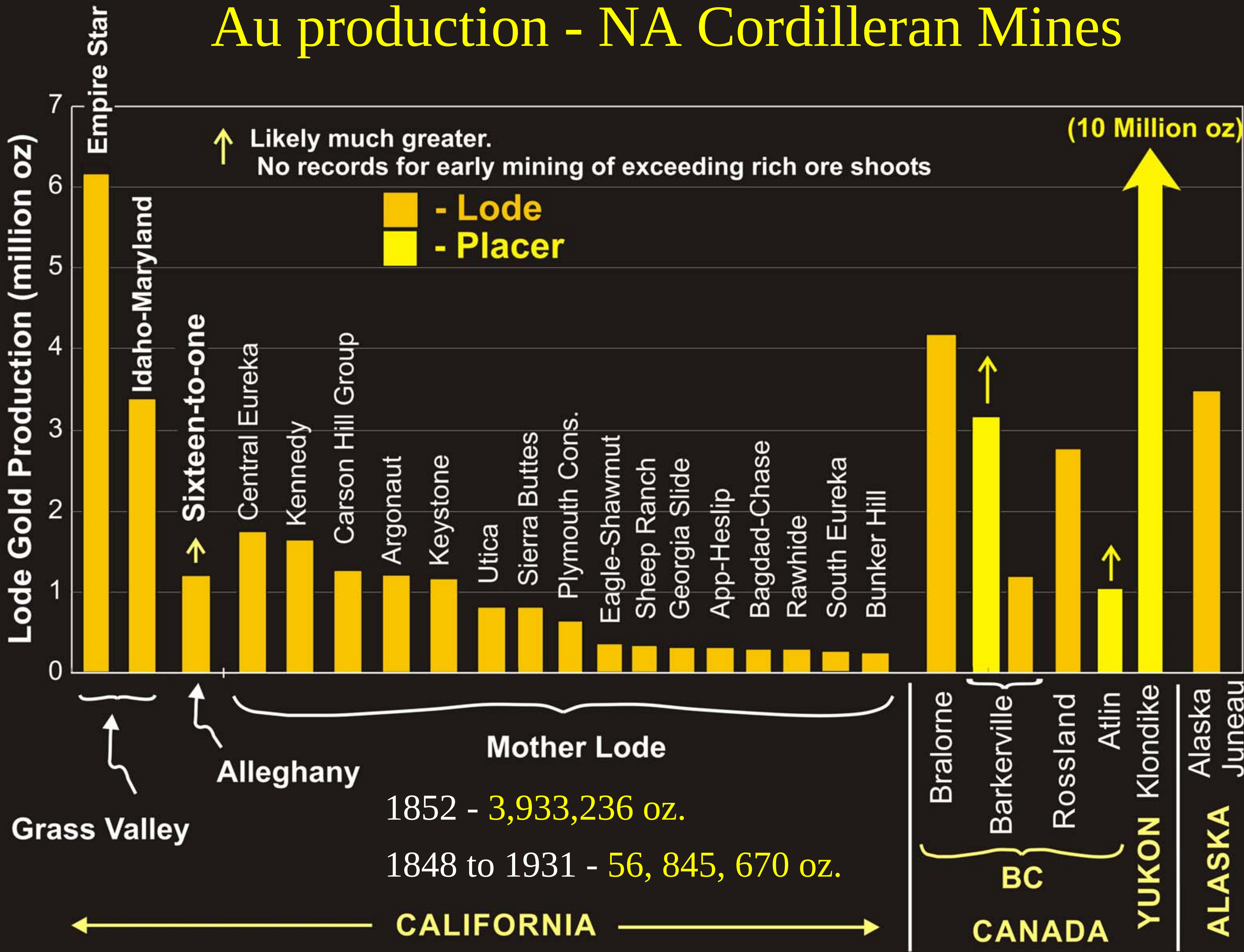
after Spencer (1906) with modified legend, using data from Miller *et al.* (1995).

Looking north along the Mother Lode Belt from Pine Tree Mine, Coulterville



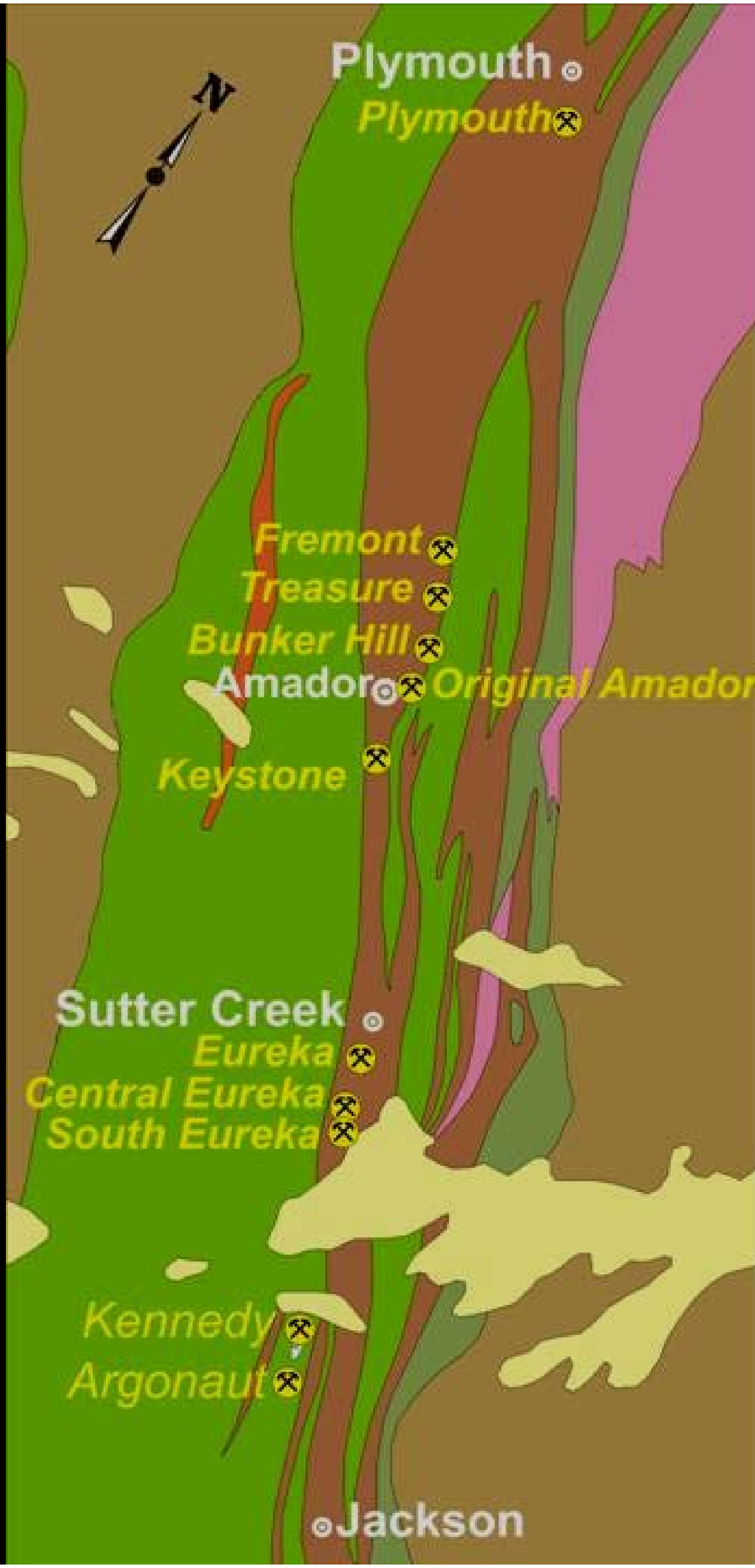
120°
40°
38°
Alleghany District
Grass Valley District
Mother Lode Belt
SCC
LCC
GHF
GCF
MF
Georgetown
Sierra Nevada Batholith
Great Valley
Sonora
Coulterville
Mariposa
N
SCC - Slate Creek Complex
LCC - Lake Combie Complex
DGO - Devils Gate Ophiolite
0 25 50
km
Post Accretionary
intrusions
Accreted Terranes
Middle to Late Jurassic
Smartville Complex
flysch and mafic volcanics
Late Triassic - Early Jurassic
Slate Creek & Lake Combie Complex
fore-arc igneous complexes
Paleozoic to Early Triassic
Calaveras Complex
chaotic chert-argillite complex with lesser limestone and mafic volcanics
Red Ant Schist
pre-Middle Jurassic blueschists facies rocks
Paleozoic
Fiddle Creek Complex
ophiolitic assemblages with Middle Triassic and Early Jurassic volcanics and sediments
Feather River Belt
polygenetic ophiolitic assemblages
North America
Eocambrian to Early Paleozoic
Northern Sierra Terrane
continental derived clastics with pre and post accretionary overlap volcanics and sediments

Au production - NA Cordilleran Mines



1852 - 3,933,236 oz.

1848 to 1931 - 56, 845, 670 oz.

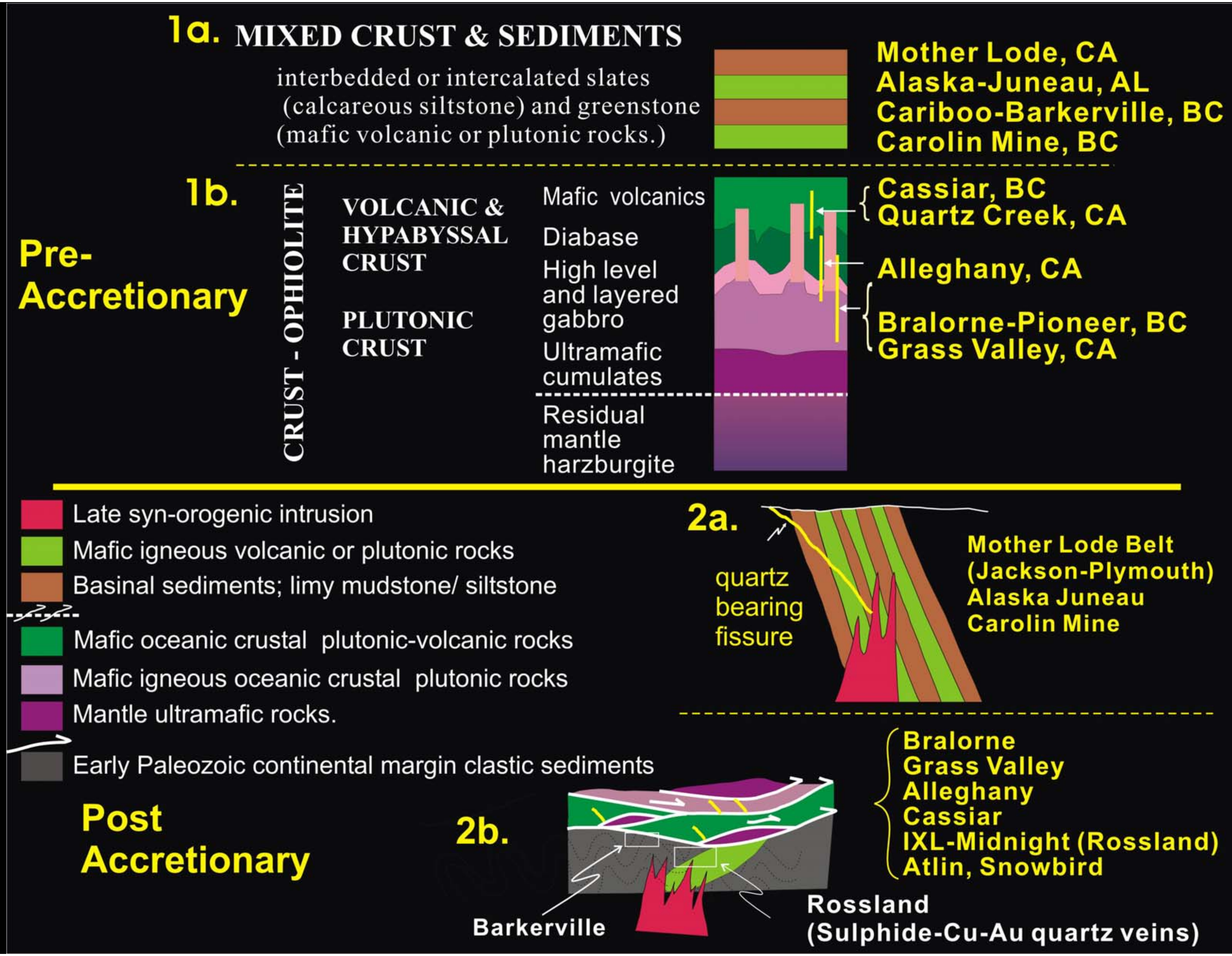


Post Accretionary
Tertiary
andesite tuff

Accreted Terranes
Mother Lode Terrane
Late Jurassic
Mariposa Formation
slate and conglomerate
Middle to Late Jurassic
Logtown Ridge Formation
Diabase porphyry
Mafic volcanics
Late Triassic-Early Jurassic
Penon Blanco Formation
Amphibolite
Metadiorite
Paleozoic to Early Triassic
Fiddle Creek Complex
chaotic chert-argillite
Calaveras Complex
chaotic chert-argillite
- gold quartz mine

0 2
kilometres

after Knopf (1929, Figure 3) with revised legend using data from Graymer and Jones

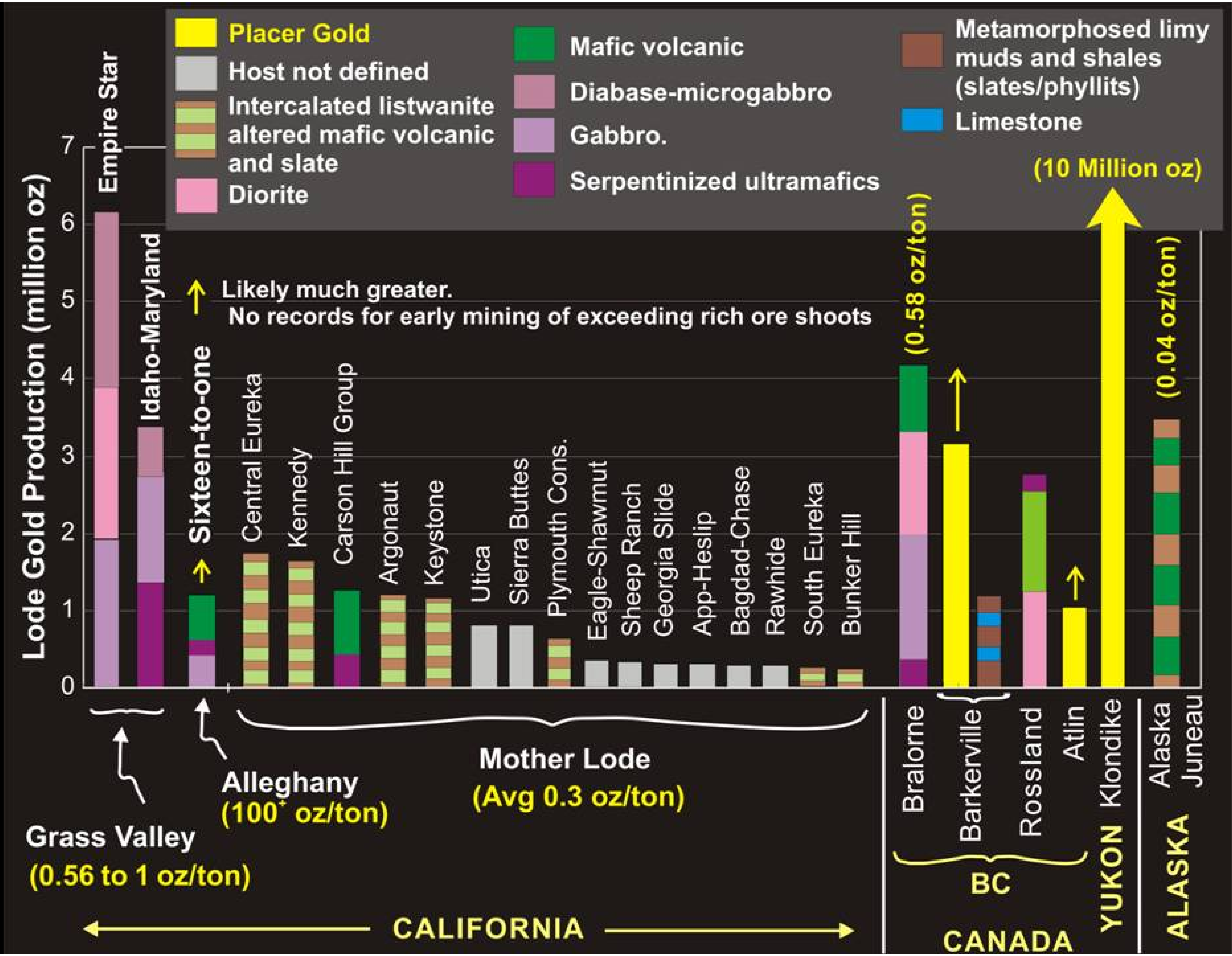

1a. MIXED CRUST & SEDIMENTS
interbedded or intercalated slates
(calcareous siltstone) and greenstone
(mafic volcanic or plutonic rocks.)
Mother Lode, CA
Alaska-Juneau, AL
Cariboo-Barkerville, BC
Carolin Mine, BC
1b.
Pre-
Accretionary
CRUST - OPHIOLITE
VOLCANIC &
HYPABYSSAL
CRUST
PLUTONIC
CRUST
Mafic volcanics
Diabase
High level
and layered
gabbro
Ultramafic
cumulates
Residual
mantle
harzburgite
Cassiar, BC
Quartz Creek, CA
Alleghany, CA
Bralorne-Pioneer, BC
Grass Valley, CA
Late syn-orogenic intrusion
Mafic igneous volcanic or plutonic rocks
Basinal sediments; limy mudstone/ siltstone
Mafic oceanic crustal plutonic-volcanic rocks
Mafic igneous oceanic crustal plutonic rocks
Mantle ultramafic rocks.
Early Paleozoic continental margin clastic sediments
2a.
quartz
bearing
fissure
Mother Lode Belt
(Jackson-Plymouth)
Alaska Juneau
Carolin Mine
Bralorne
Grass Valley
Alleghany
Cassiar
IXL-Midnight (Rossland)
Atlin, Snowbird
Post
Accretionary
2b.
Barkerville
Rossland
(Sulphide-Cu-Au quartz veins)

Setting of High-Grade Au-quartz Veins

e.g. Bralorne
Alleghany
Cassiar
Grass Valley
Rossland - IXL

1) Quartz veining with associated
2) sulphides (trace to several %), locally much higher, and
3) potassic alteration (mariposite-sericite)

IMPORTANTLY, broad areas of carbonate altered mafic and ultramafic rocks without the above are common.



Placer Gold
Host not defined
Intercalated listwanite altered mafic volcanic and slate
Diorite
Mafic volcanic
Diabase-microgabbro
Gabbro.
Serpentinized ultramafics
Metamorphosed limy muds and shales (slates/phyllits)
Limestone
Lode Gold Production (million oz)
0
1
2
3
4
5
6
7
Empire Star
Idaho-Maryland
Sixteen-to-one
Likely much greater.
No records for early mining of exceeding rich ore shoots
Central Eureka
Kennedy
Carson Hill Group
Argonaut
Keystone
Utica
Sierra Buttes
Plymouth Cons.
Eagle-Shawmut
Sheep Ranch
Georgia Slide
App-Heslip
Bagdad-Chase
Rawhide
South Eureka
Bunker Hill
(0.58 oz/ton)
(10 Million oz)
(0.04 oz/ton)
Bralorne
Barkerville
Rossland
Atlin
Klondike
Alaska
Juneau
Grass Valley
(0.56 to 1 oz/ton)
Alleghany
(100+ oz/ton)
Mother Lode
(Avg 0.3 oz/ton)
BC
CANADA
YUKON
ALASKA
CALIFORNIA

Conclusions:

1) **Two types of host rock associations for gold-quartz veins**
   a. Igneous Crustal (ophiolitic) - mainly Palaeozoic
   Higher grade with associated coarse gold
   b. Mixed Igneous- Sedimentary – mainly Mesozoic
   Lower grade with associated fine gold
   Often associated with replacement ore

2) **Productive veins <u>DO NOT</u> occur in ultramafic rocks**
   However, richest deposits, with associated coarse nugget gold (1 – 100+ oz/ton) occur in veins contained in igneous crustal rocks immediately adjacent to them.

3) **Direct correlation between coarse, nugget placer gold and remnant ophiolitic rocks occurring structurally above such placers.**
   Crustal plutonic and hypabyssal rocks which are the most productive host, are typically absent from the most productive placer camps.