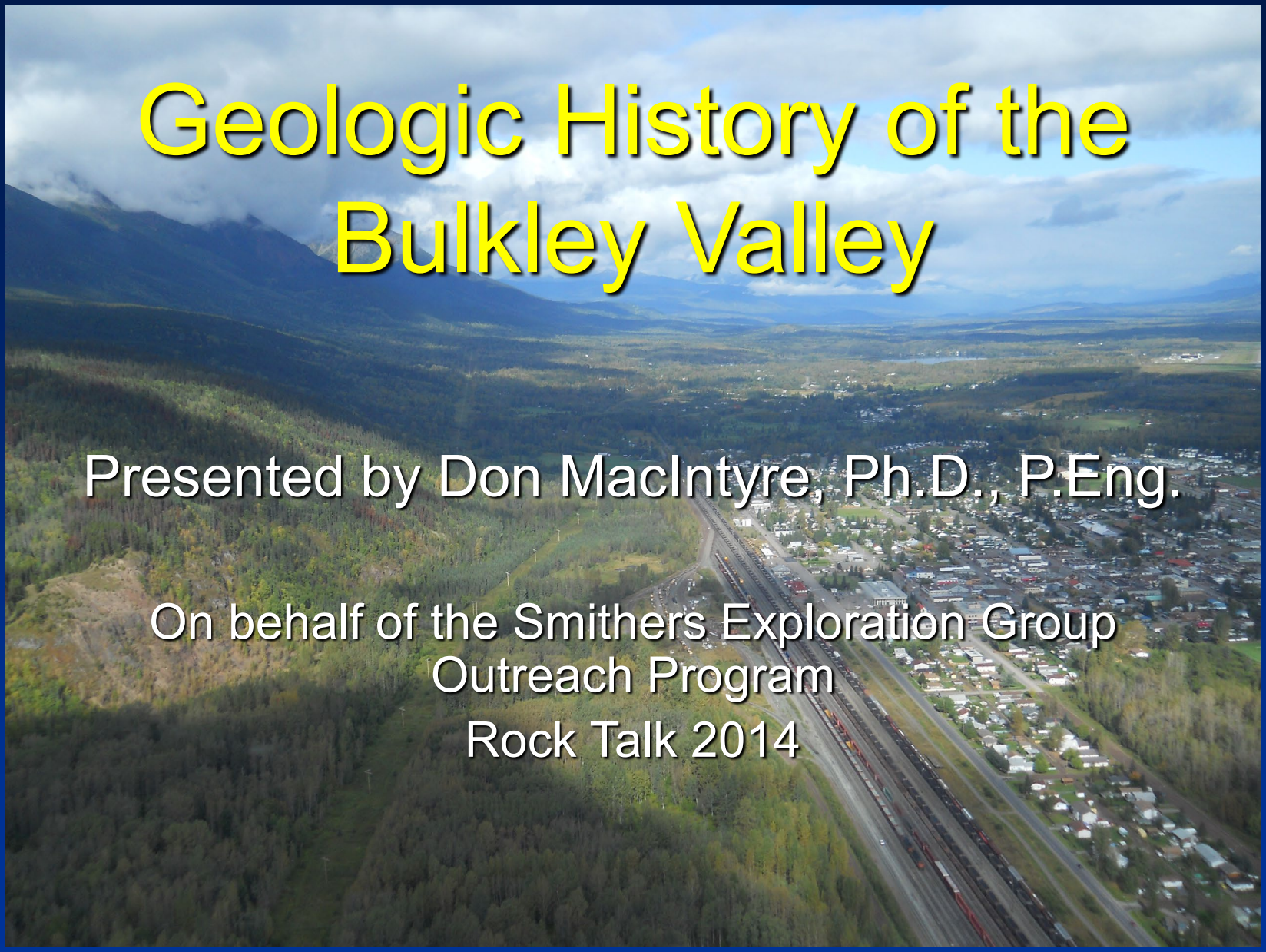


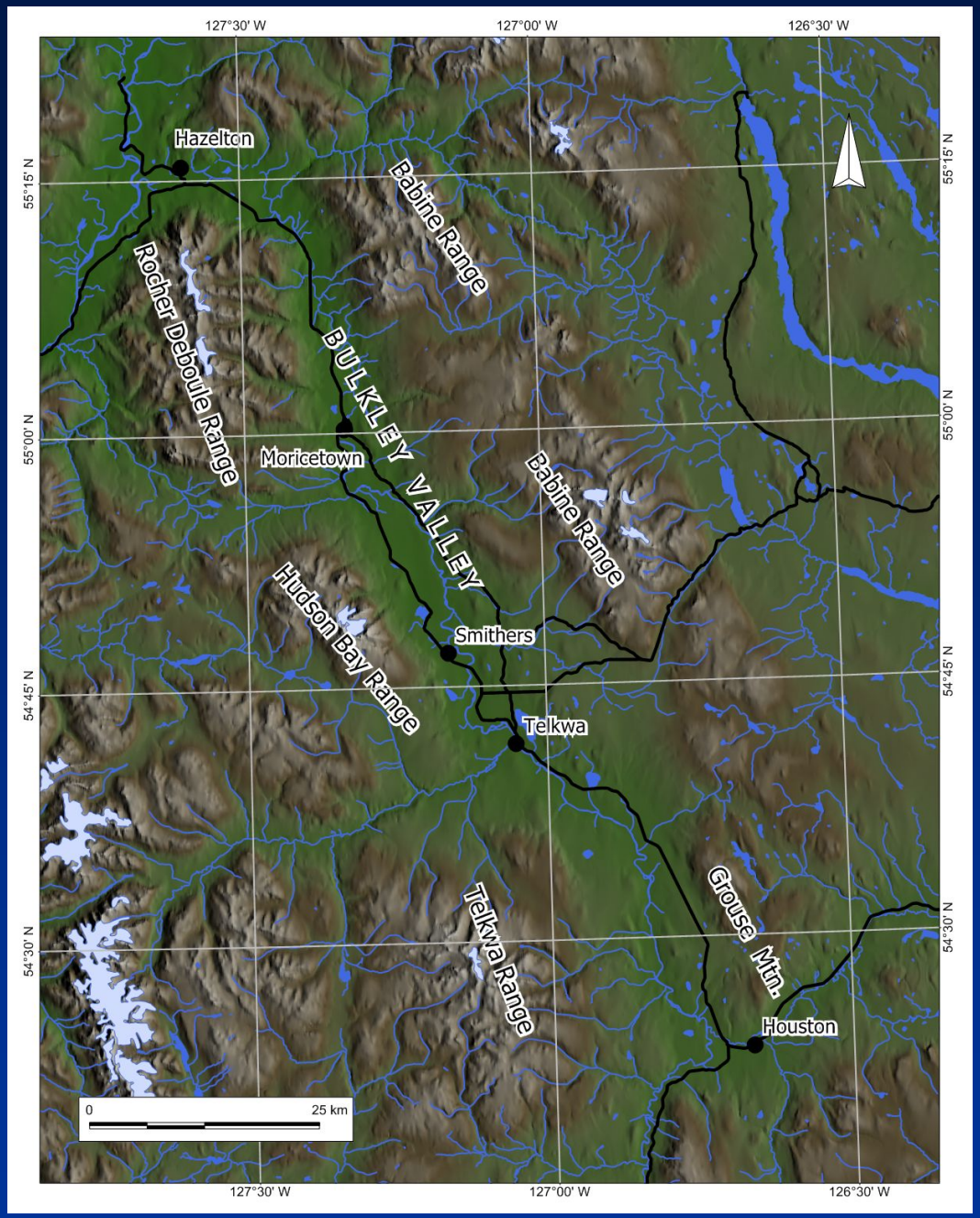
Geologic History of the Bulkley Valley

Presented by Don MacIntyre, Ph.D., P.Eng.

On behalf of the Smithers Exploration Group
Outreach Program
Rock Talk 2014

Introduction

- Prototype talk for the S.E.G. outreach program (first attempt)
- Target audience is the general public & schools
- Feedback would be most appreciated
- Talk is based on mapping done by myself and others in the late 1980's while with the B.C.G.S.



The Bulkley Valley

- a broad valley bounded by the Babine, Hudson Bay, Rocher Deboule & Telkwa ranges
- extends from Hazelton to Houston
- 115 km long, 10-15 km wide
- a relatively young geologic feature

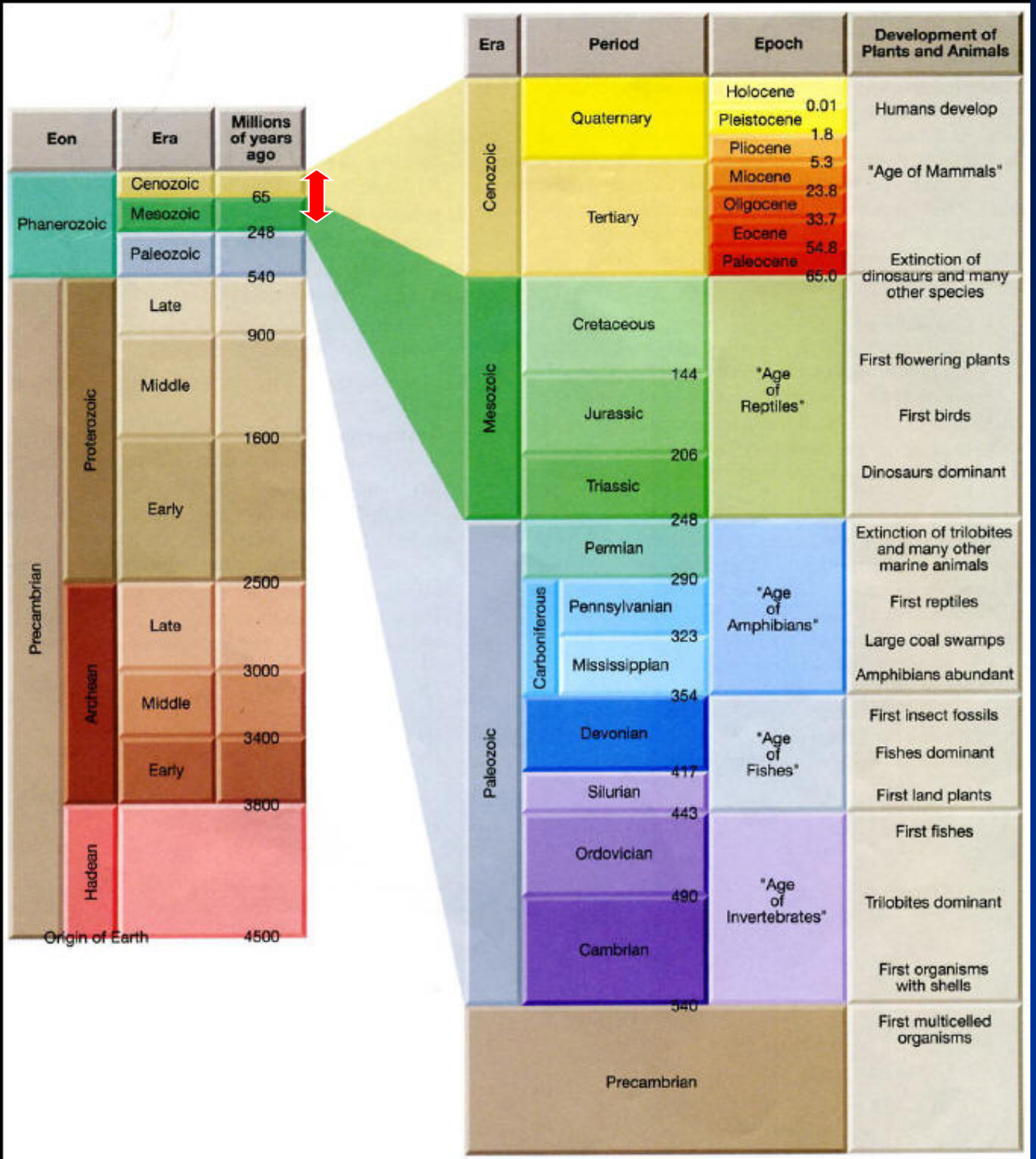
Four Key Points to Remember

- The mountain ranges surrounding the valley are mainly volcanic rocks of Jurassic & late Cretaceous age while the valley floor is mainly early Cretaceous & Eocene sedimentary rocks
- The volcanic rocks and related granitic intrusions are host to a variety of metallic mineral deposits; the Cretaceous sedimentary rocks host important coal deposits
- The Bulkley Valley is a graben that started to formed around 50 m.y. ago during a time of crustal extension
- Many of the current features of the valley are a result of the last glacial period of the current ice age

Geologic History

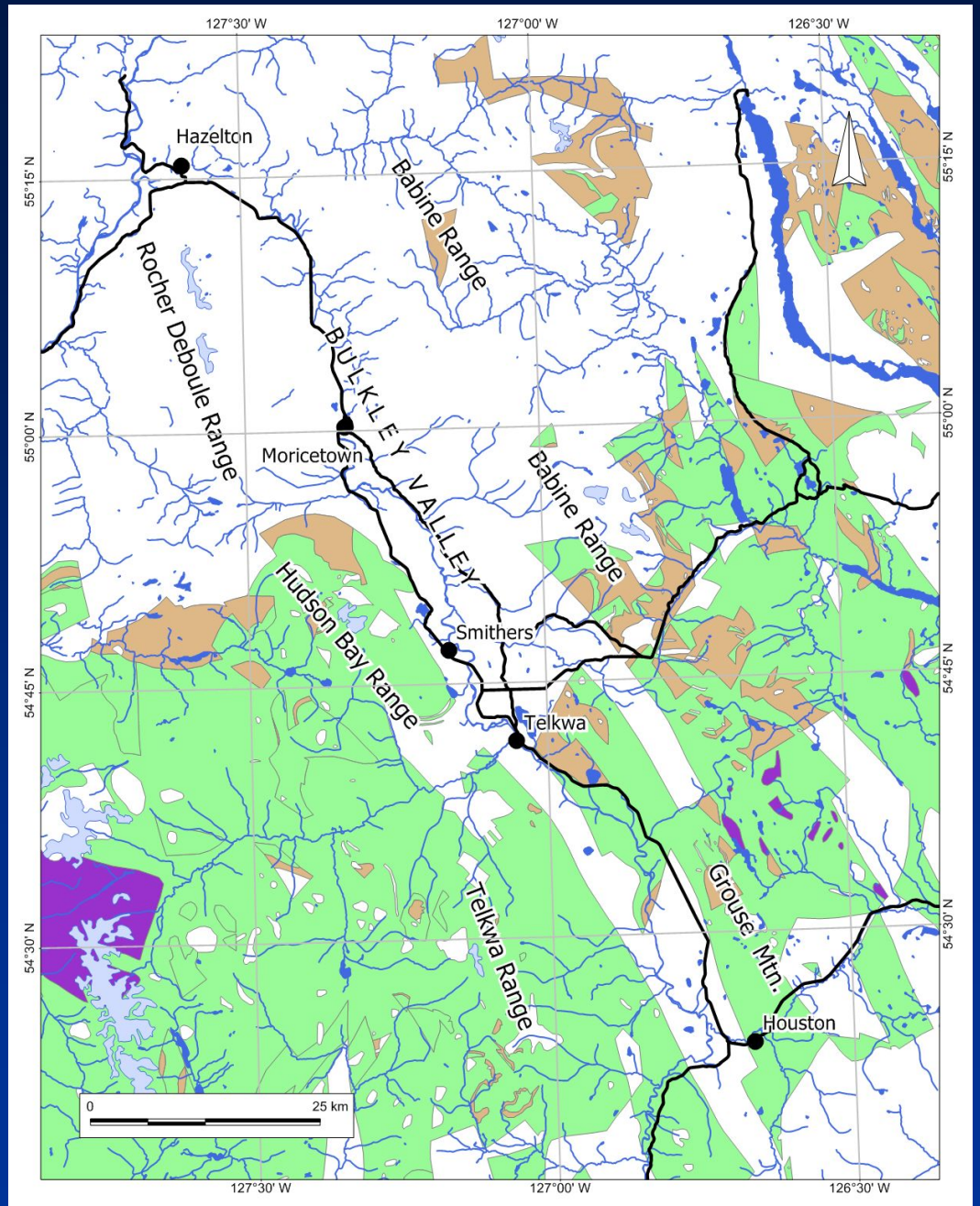
Before the Valley Was Formed

Going from oldest to youngest….



The geology of the Bulkley Valley area only covers the last 205 million years of earth history – the Jurassic, Cretaceous, Tertiary & Quaternary time periods

Geology – it's about time!



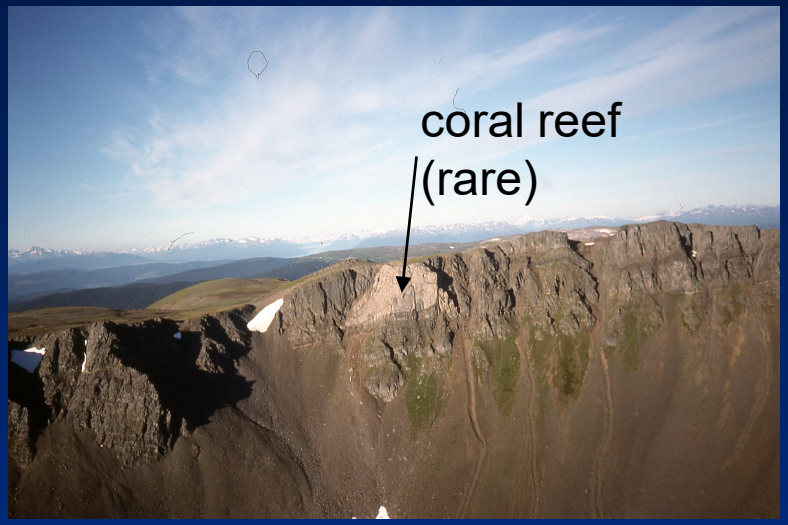
The Early to Mid Jurassic

A time of extensive volcanism followed by marine sedimentation

- oldest rocks in the area (205-155 Ma)
- mainly volcanic rocks (green on map) overlain by marine sedimentary rocks (brown on map)
- these rocks are collectively called the Hazelton Group
- main rocks forming the Hudson Bay & Telkwa Ranges & Grouse Mtn.
- not exposed in the Bulkley valley north of Telkwa
- Topley intrusions (purple on map) are the roots of major volcanic centers

* Ma = million years before present

Typical outcrops, Hazelton Group



Bedded volc. rocks & coral reef, Telkwa Range

Massive volcanic rocks, Hudson Bay Mtn.

Bedded air fall volcanic rocks, Telkwa Range

Shallow marine sedimentary rocks, Telkwa Range

Typical Rock Types, Hazelton Group

Maroon coloured pyroclastic rocks

Massive volcanic flow rocks

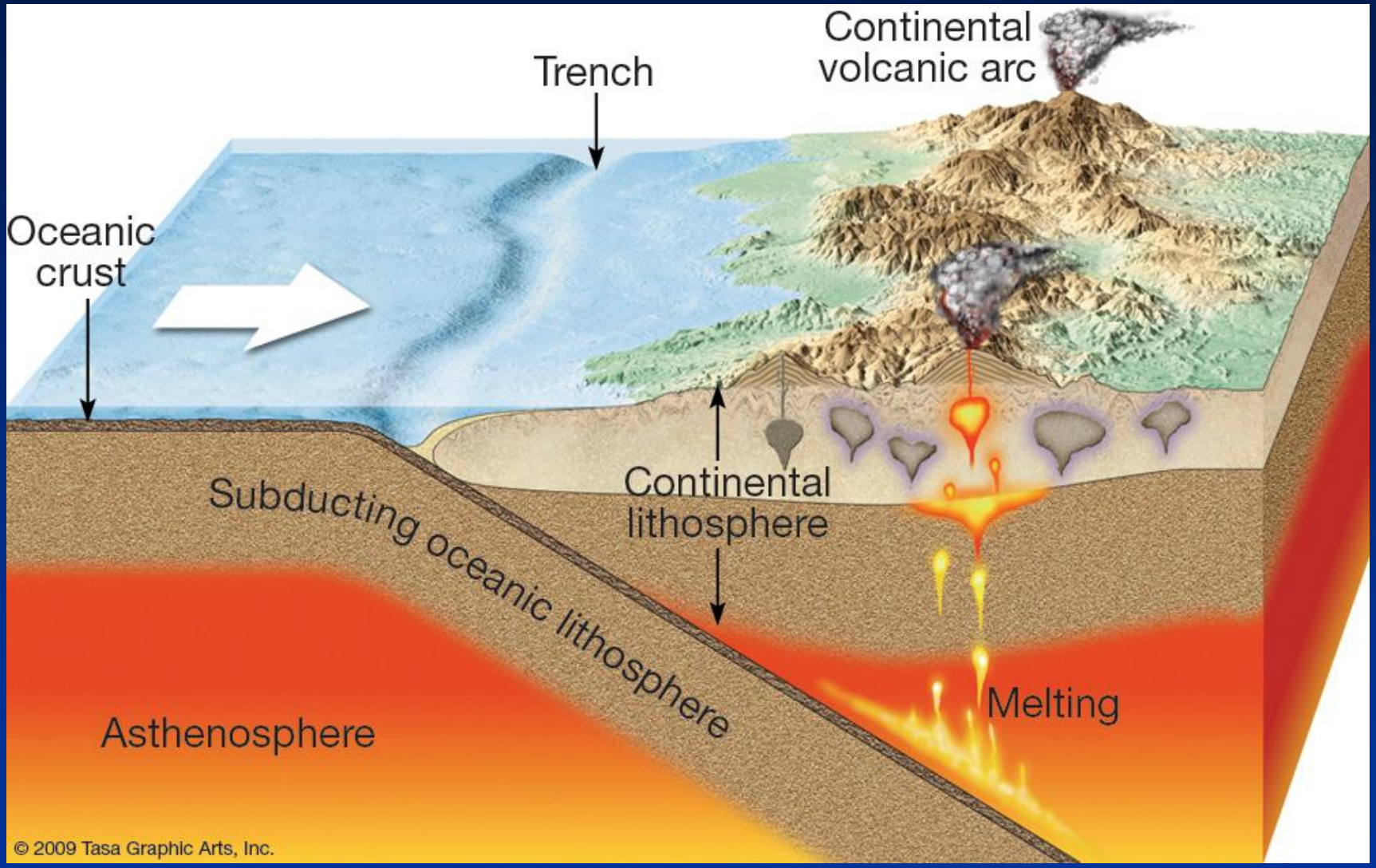
Ash flow volcanic rocks

Marine fossils in sandstones

What the Smithers area might have looked like in Jurassic time

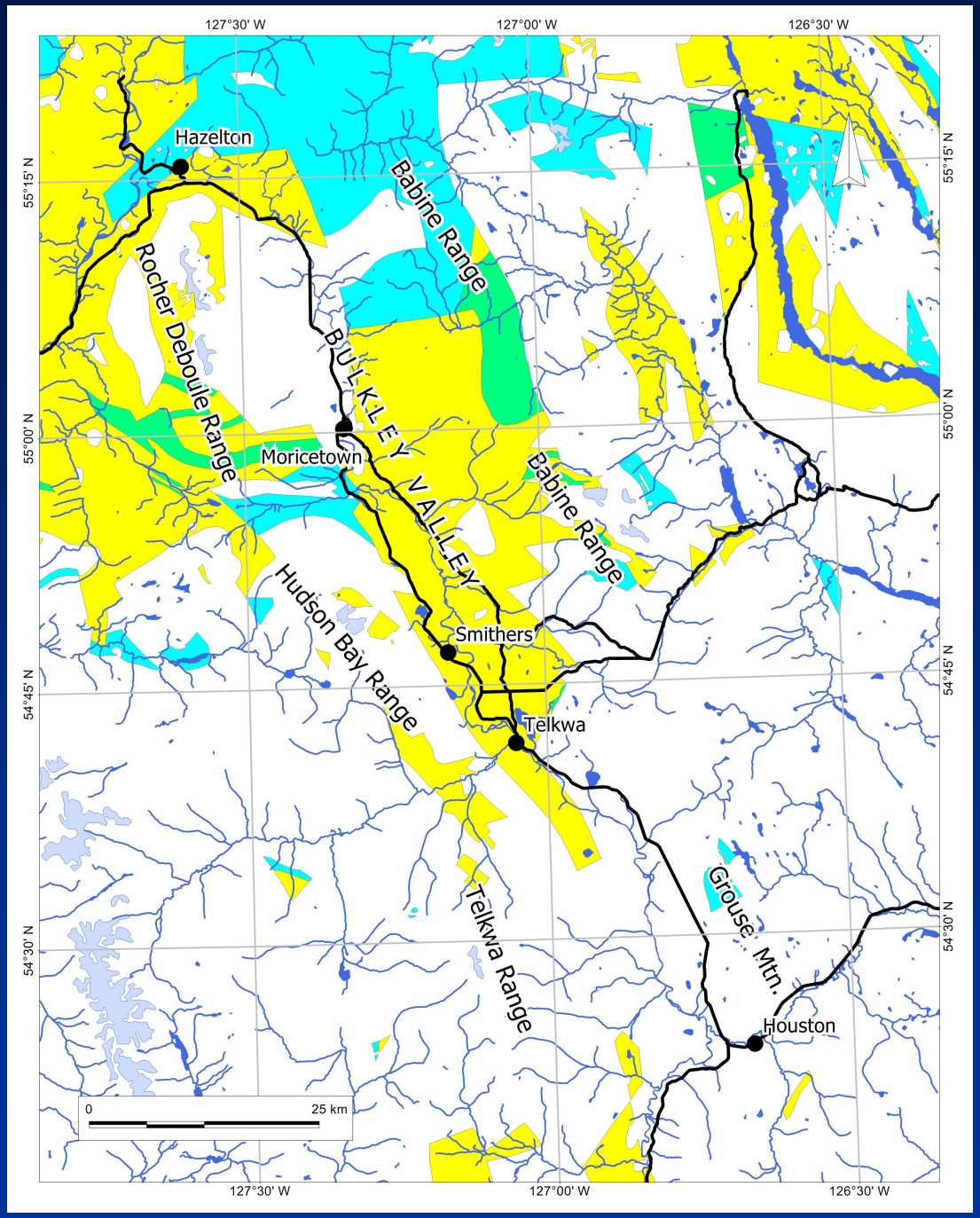
- Early in the Jurassic there were many volcanic eruptions building up thick deposits of lava and pyroclastic debris
- By the mid Jurassic the area was covered by a shallow sea. Volcanic activity gradually came to an end.

Plate Tectonic Model for formation of Continental Volcanic Arcs



The Late Jurassic - A period of uplift and erosion

- Towards the end of the Jurassic (ca. 155 Ma), tectonic forces caused the area to rise.
- Rocks in the Smithers area were folded, faulted and eroded producing extensive deposits of non-marine conglomerates and sandstones such as those exposed at Trout Creek
- This event marked the start of a 50 m.y. period of non-marine sedimentation and little or no volcanism in the Smithers area
- North of present day Hazelton, thick accumulations of marine to non-marine sediment were deposited in the Bowser Basin from approx. 155 to 95 Ma (latest Jurassic to mid Cretaceous time)



The Late Jurassic to Early Cretaceous

A time of mainly non-marine sedimentation, minor volcanism

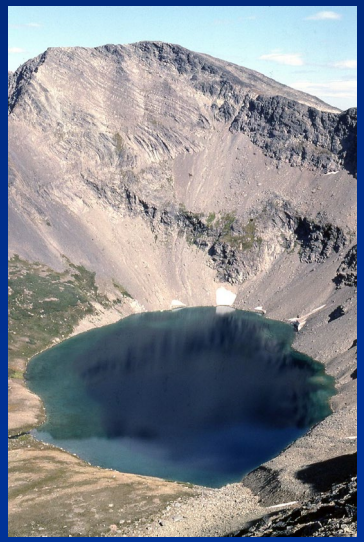
- **Bowser Lake group (blue) – Jurassic to Cretaceous (155-95 Ma)**
  - non-marine to marine sandstone, siltstone & shale
  - exposed on Blunt Mtn., Mt. Seton and the area north of Hazelton
  - good exposure of conglomerate along Trout Creek
- **Skeena Group (yellow) –mid Cretaceous (105-95 Ma)**
  - mainly non-marine sandstone, siltstone and conglomerate
  - underlie most of the Bulkley valley north of Telkwa, the western slopes of the Babine Range and along the Telkwa River (important coal beds)
- **Rocky Ridge volcanics (green) - Mid Cretaceous (105-95 Ma)**
  - exposed on Rocky Ridge and the area north of Mt. Cronin

Typical outcrops, Skeena Group

Thick bedded sandstone, Telkwa area

Bedded siltstone & sandstone, Telkwa coal fields

Steeply dipping beds in the Bulkley Valley



Bedded sandstone & siltstone, Babine Range

Typical Rock Types, Skeena Group

Conglomerate

Cross bedded sandstone

Rocky Ridge volcanics

Marine fossils in sandstones (rare)

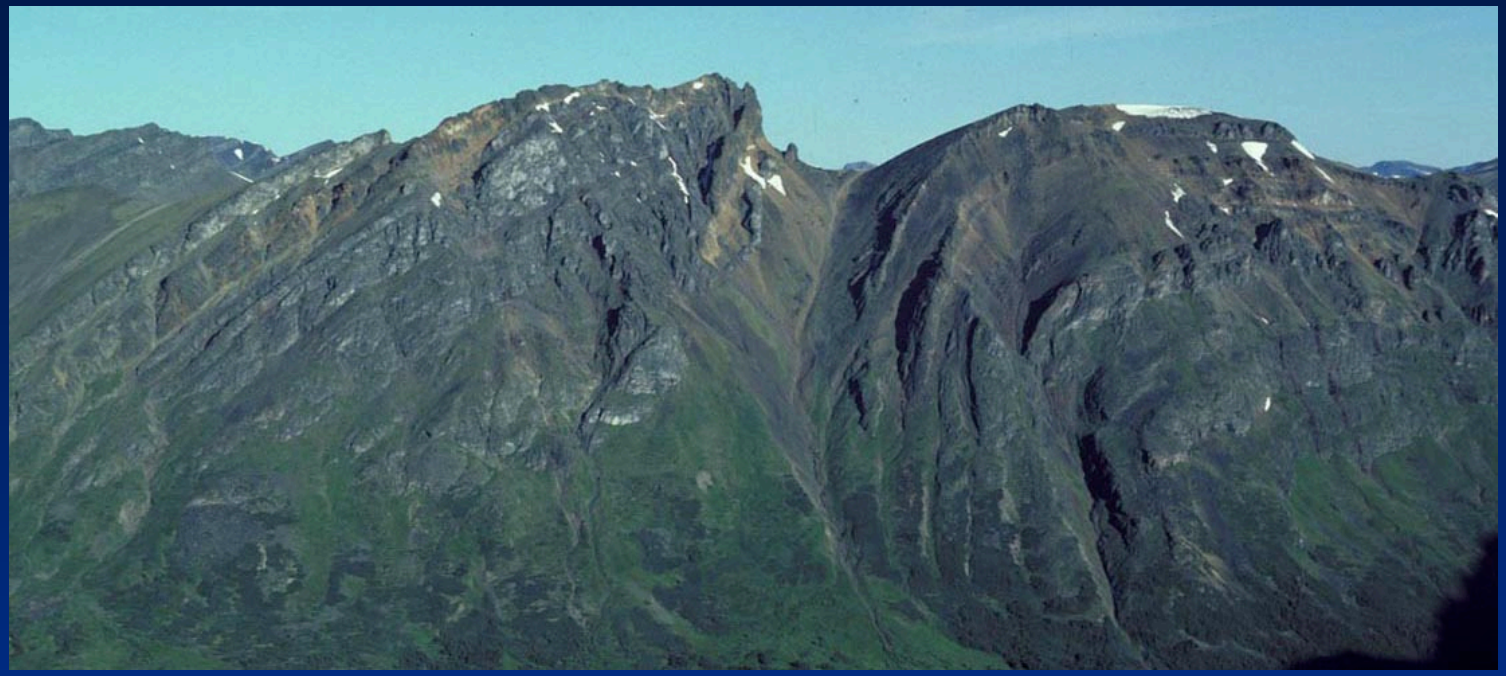
What the Smithers area might have looked like in the mid Cretaceous (ca 105-95 Ma)

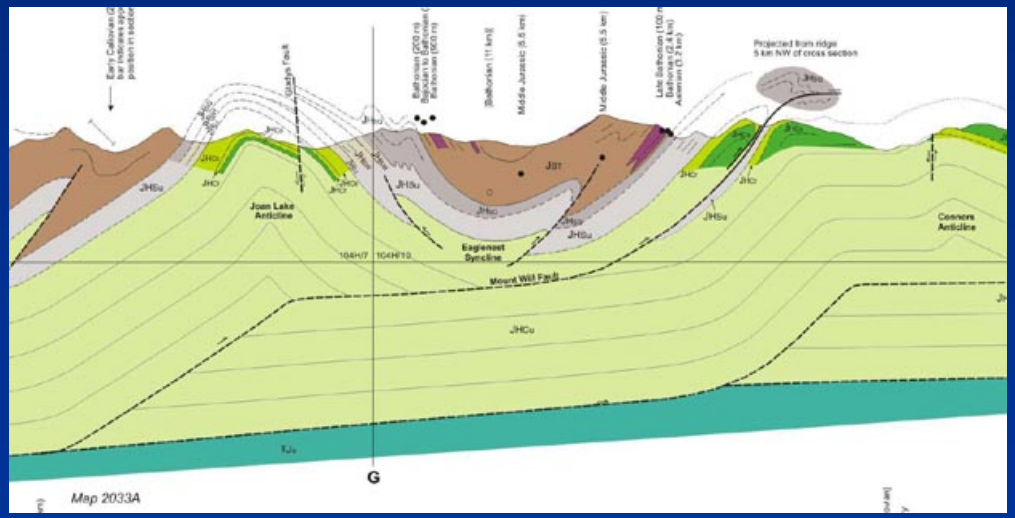
- During the mid Cretaceous the Smithers area was part of a coastal plain traversed by meandering rivers
- These rivers deposited sand and silt on their way to the sea building up extensive deltas
- Locally volcanic eruptions occurred forming a chain of volcanic islands and submarine calderas (Rocky Ridge volcanics)
- Swamps developed along the coastal plain providing organic material that eventually turned to coal

Mid Cretaceous Uplift and Erosion

- In the mid Cretaceous, circa 95-85 Ma tectonic forces caused the area to rise once again.
- This event may have been due to collision of tectonic plates along the coast of present day B.C.
- Jurassic and early Cretaceous rocks were folded, faulted and uplifted to form the Skeena Fold and Thrust belt
- In the Smithers area the uplifted terrain was largely eroded flat by 85 Ma, prior to the next major volcanic period

Typical fold structures, Skeena Fold & Thrust Belt

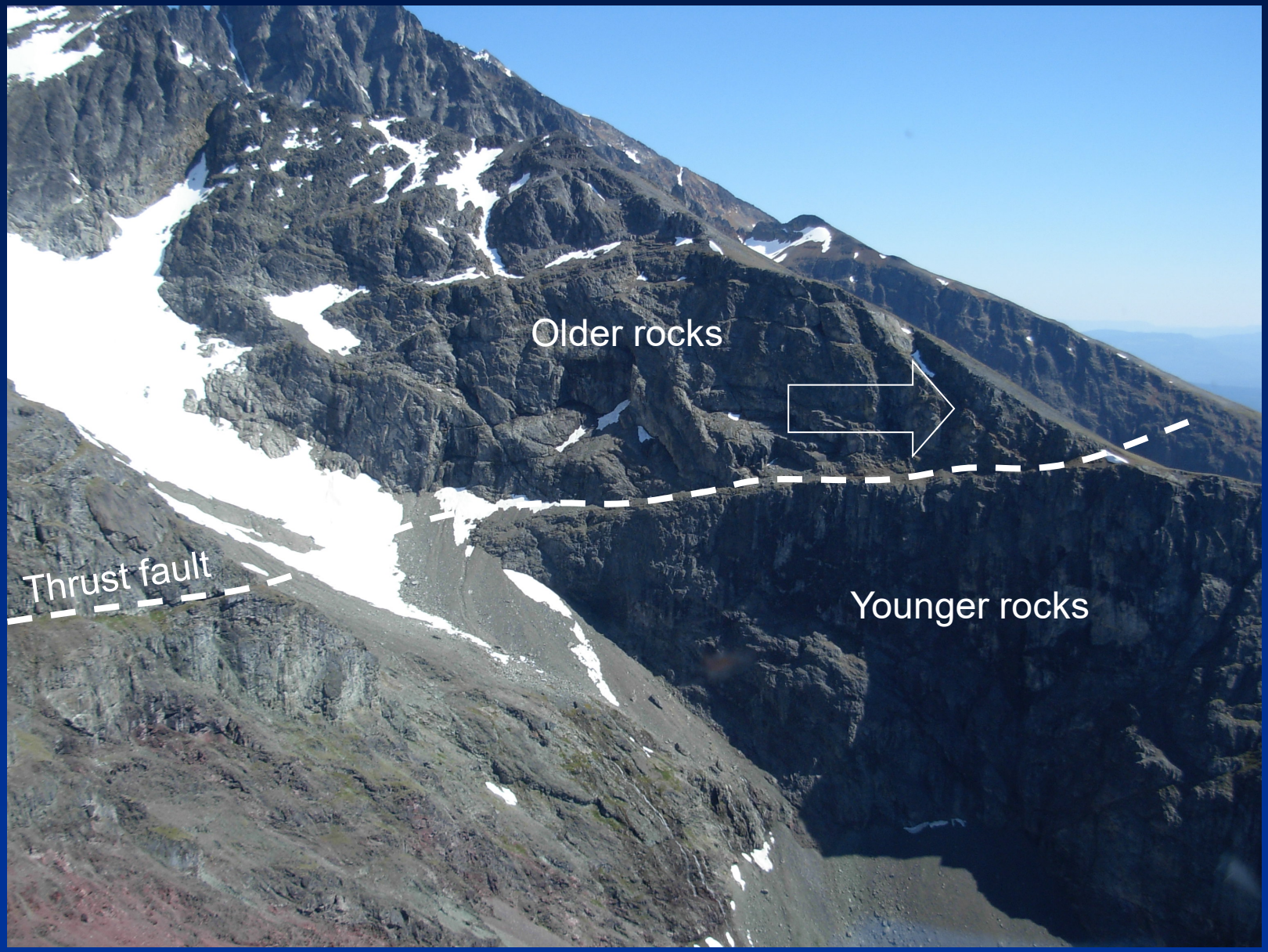


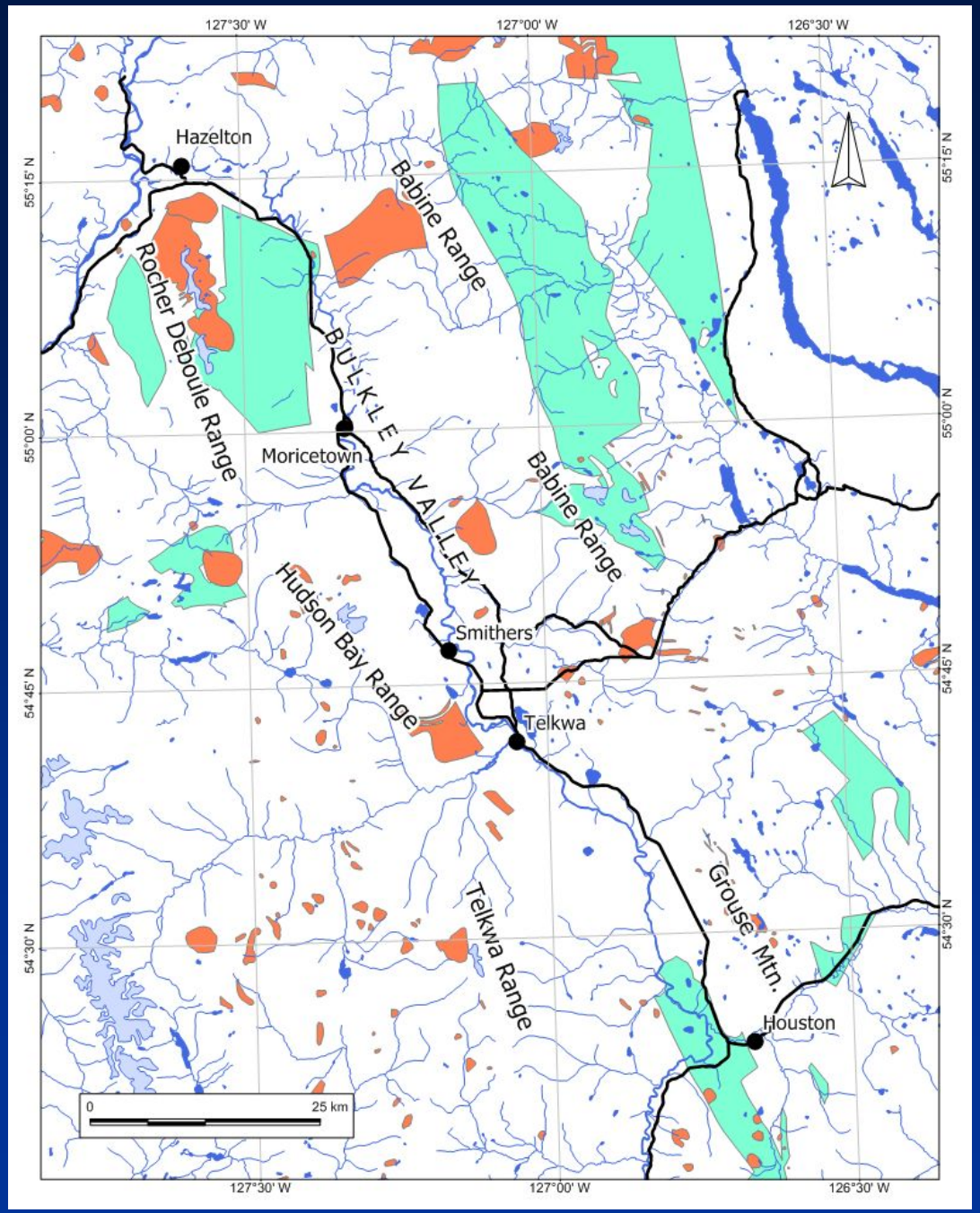


from Evenchick and Thorkelson, GSC Bull. 577, 2003

Overturned fold, west flank of Hudson Bay Mtn.

Thrust fault, west flank of Hudson Bay Mtn.



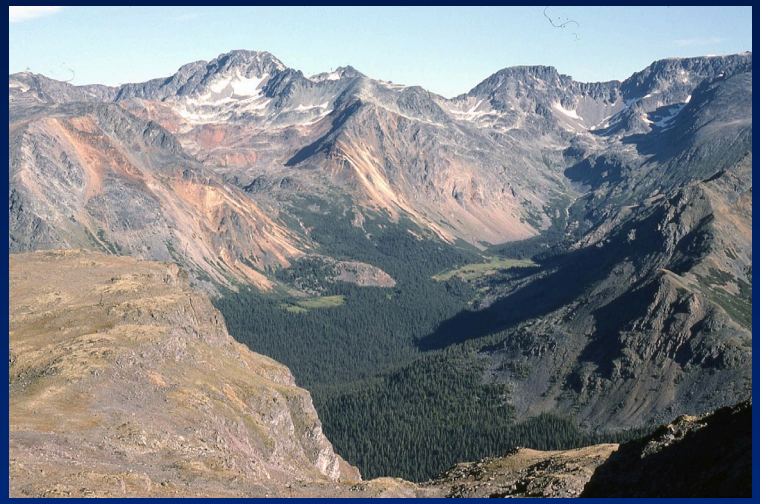


The Late Cretaceous

A time of extensive volcanic eruptions & building of volcanoes

- **Kasalka Group (green on map)**
  - volcanic flows & pyroclastic rocks of late Cretaceous age (85-65 Ma)
  - makes up most of the Rocher Deboule and eastern Babine ranges
- **Bulkley Intrusions (orange on map)**
  - granitic intrusive rocks of late Cretaceous age found throughout the area
  - Interpreted to be the intrusive roots of late Cretaceous volcanic centers
  - most of the mineral occurrences in the area are associated with these rocks

Typical outcrops, Kasalka Group



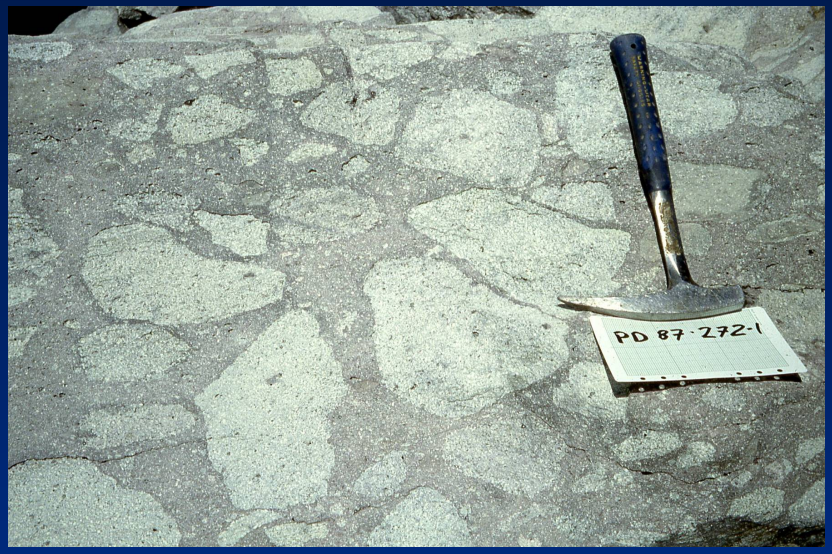
Mt. Cronin & Silver King Basin, Babine Range

Massive flows, Hagwilget Peak, Rocher Deboule Range

Volcanic flow (light grey) overlying bedded tuffs, Highway 16 near Porphyry Creek

Volcanic flows overlain by bedded sedimentary rocks north of Mt. Cronin, Babine Range

Typical Rock Types, Kasalka Group



Volcanic breccia (debris flow)

Porphyritic andesite flows

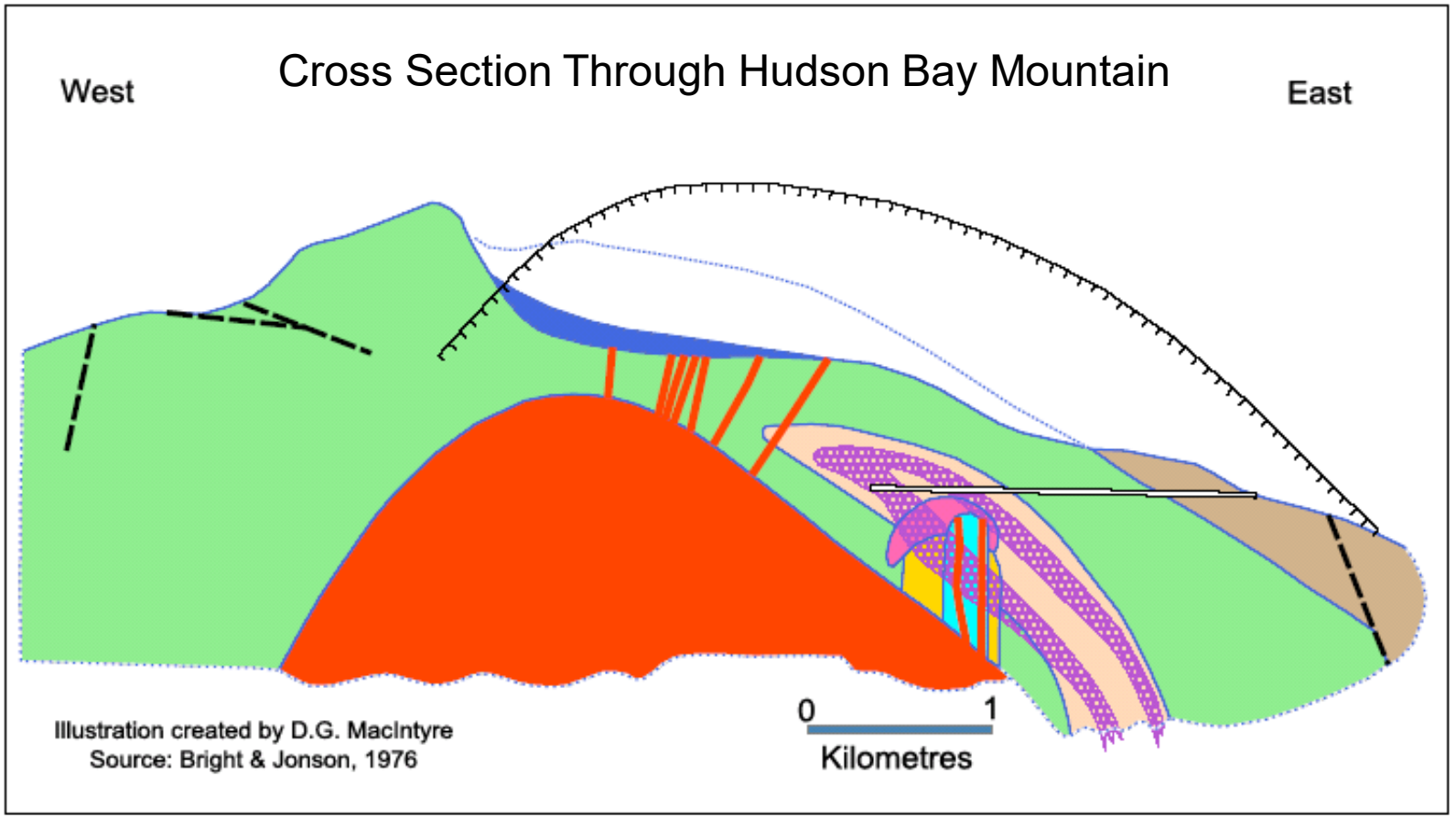
Typical outcrops, Bulkley Intrusions

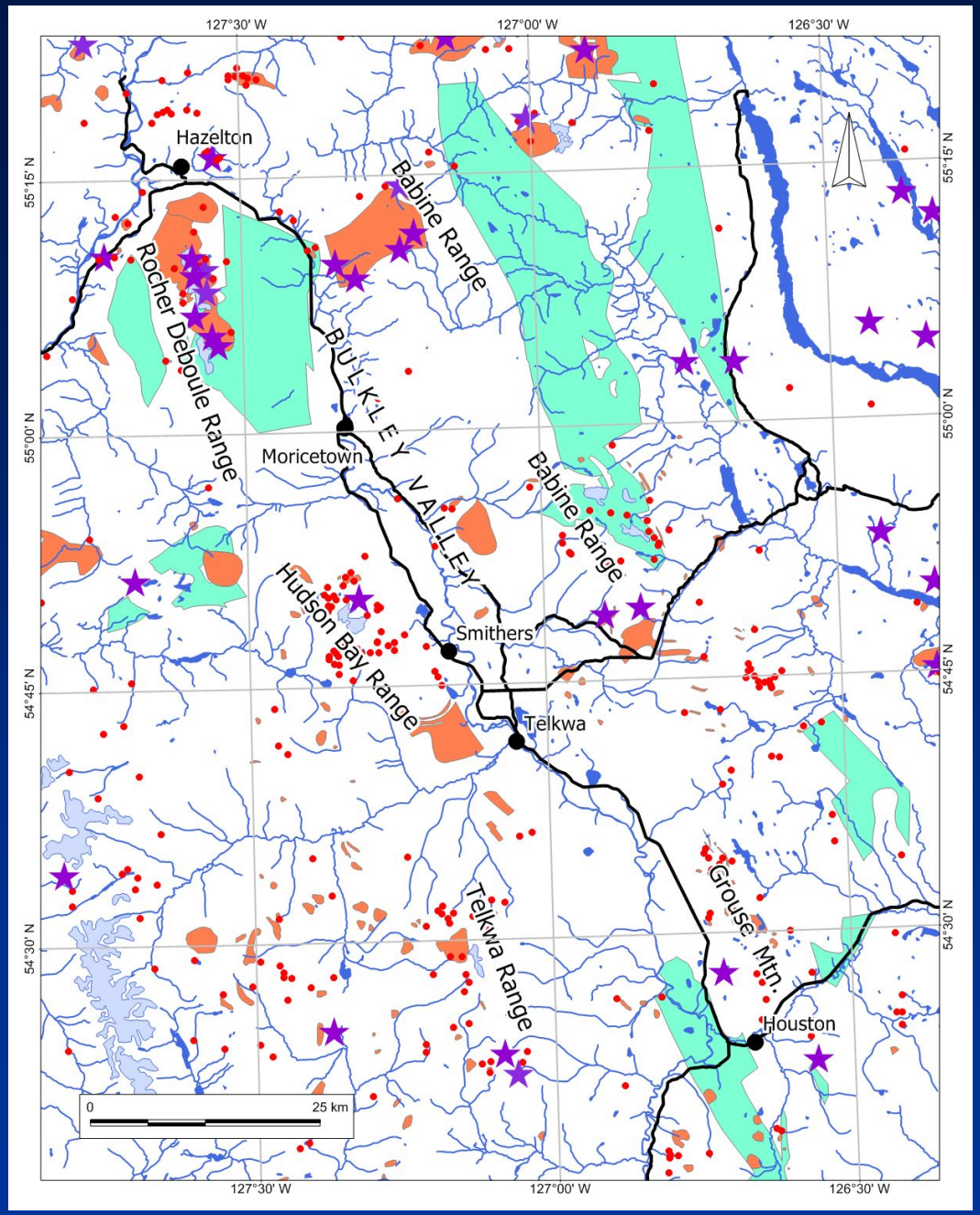
Porphyry intrusions (dikes) cutting Hazelton Group rocks, Hudson Bay Mtn.

Porphyry intrusion (dike), Hudson Bay Mtn.

Feldspar porphyry

Cross Section Through Hudson Bay Mountain

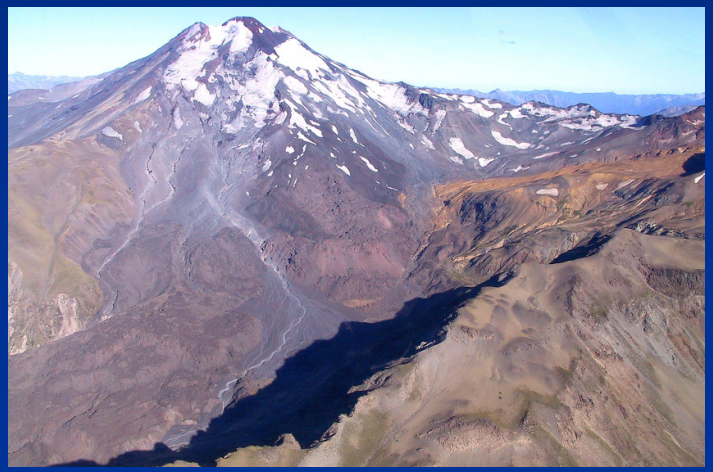




Mineral Occurrences

- There are many metallic mineral occurrences in the area (red dots on map)
- mainly veins containing variable amounts of Cu, Zn, Pb, Ag & Au
- most are associated with late Cretaceous Bulkley intrusions (orange on map)
- large, low grade porphyry Mo and porphyry Cu-Mo deposits (purple stars) occur in the Rocher Deboule, Hudson Bay, Telkwa & Babine ranges & at Grouse Mtn.

What the Smithers area might have looked like in the late Cretaceous (85-65 Ma)



- During the late Cretaceous the Smithers area was part of a continental volcanic arc that was built on an eroded plateau
- Volcanic activity built up thick deposits of lava and pyroclastic material to form tall stratovolcanoes like those in the modern day Andes of S.A. and the Cascade Range

And calderas

Caldera formation

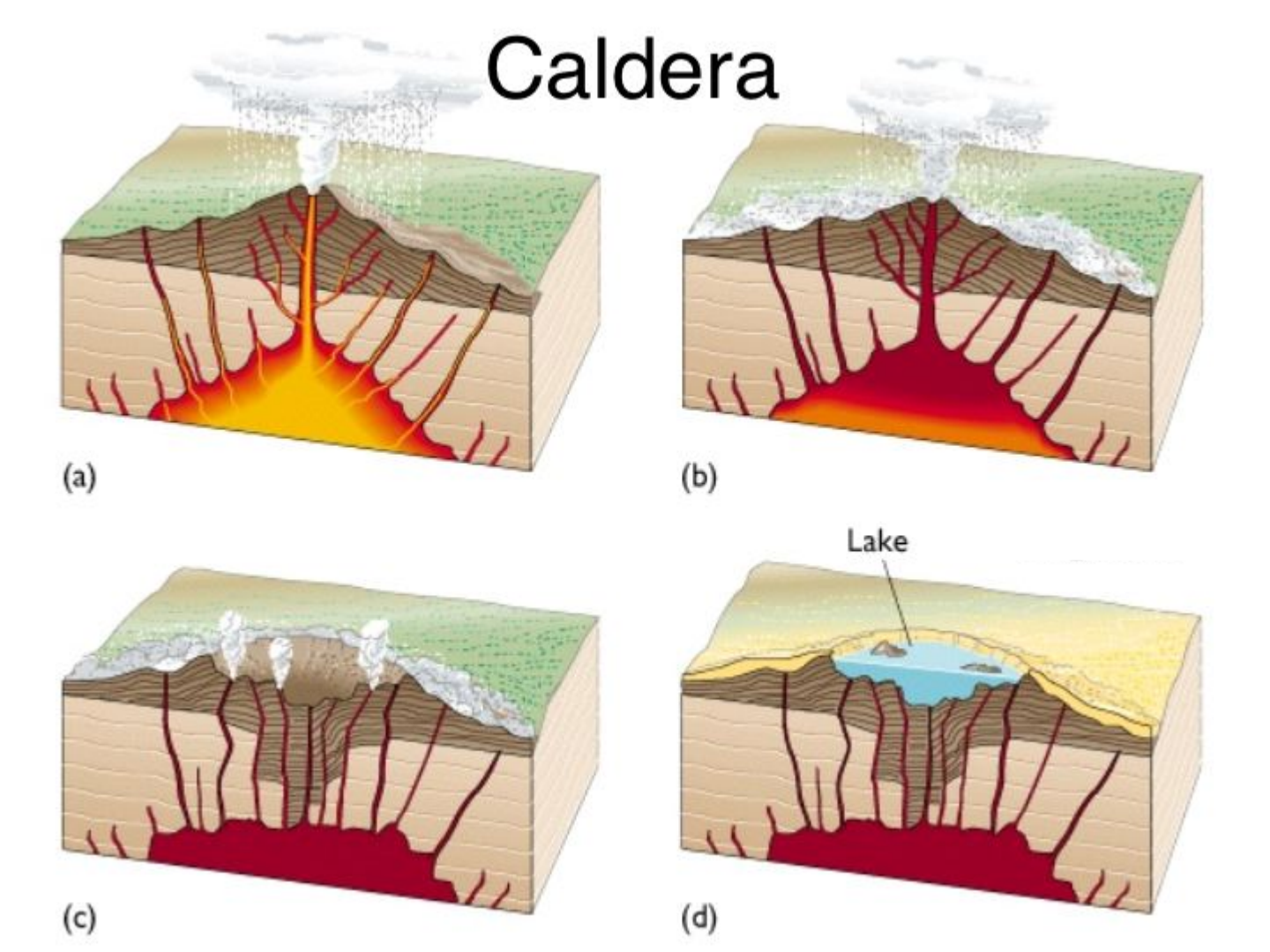
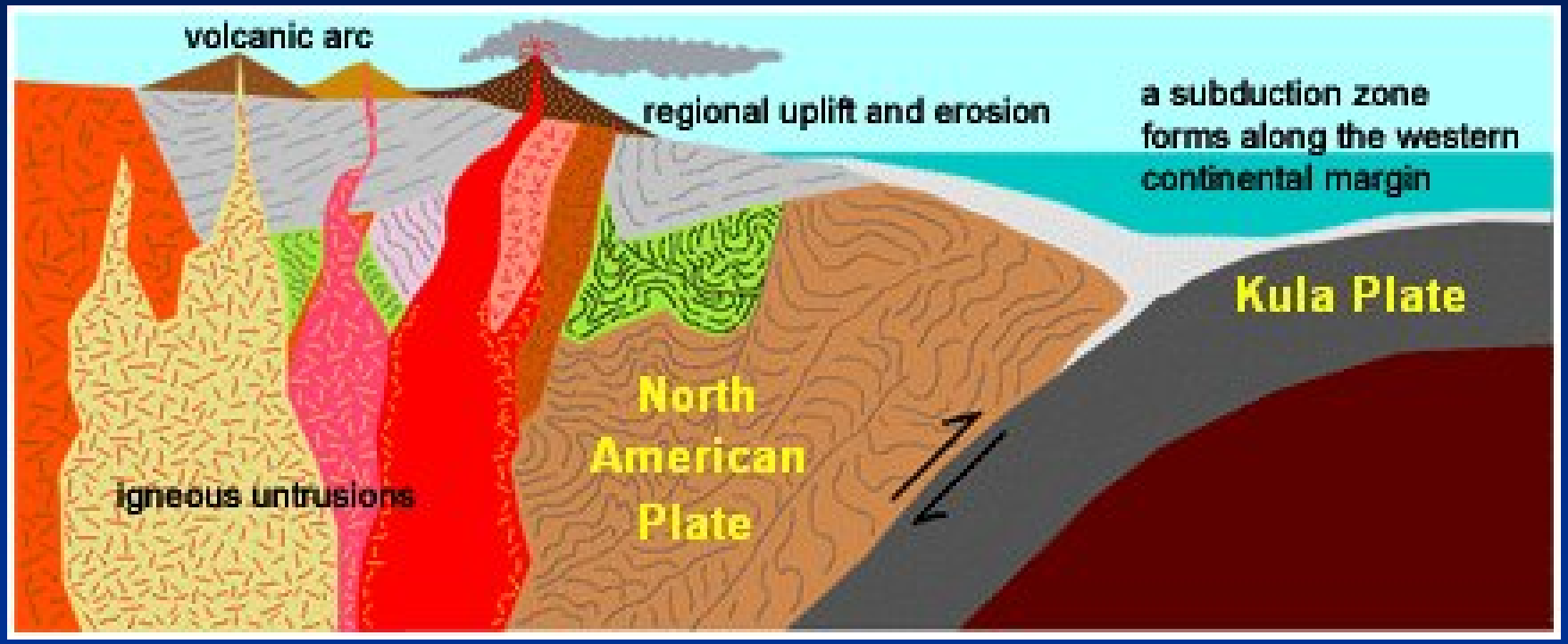
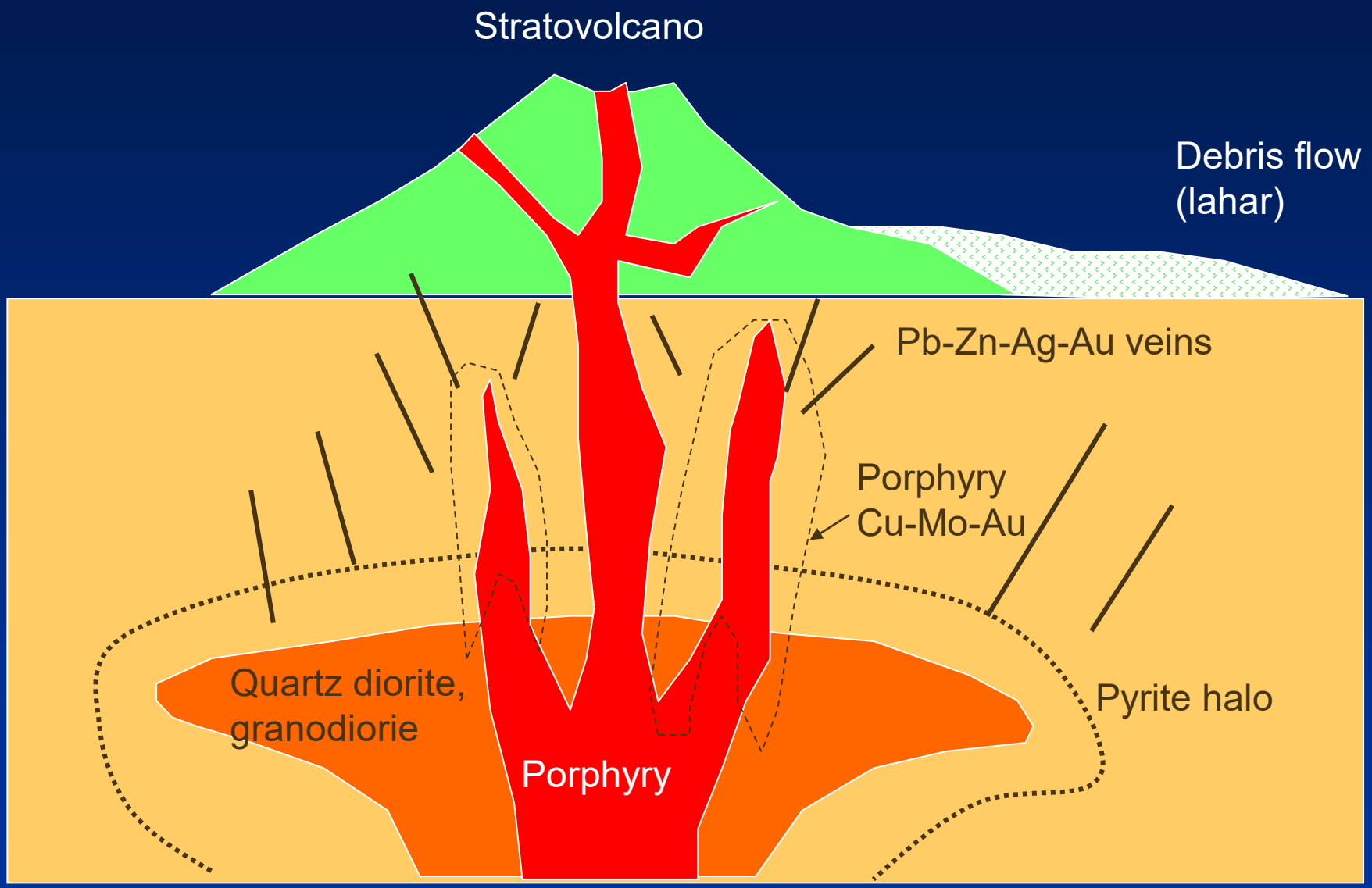


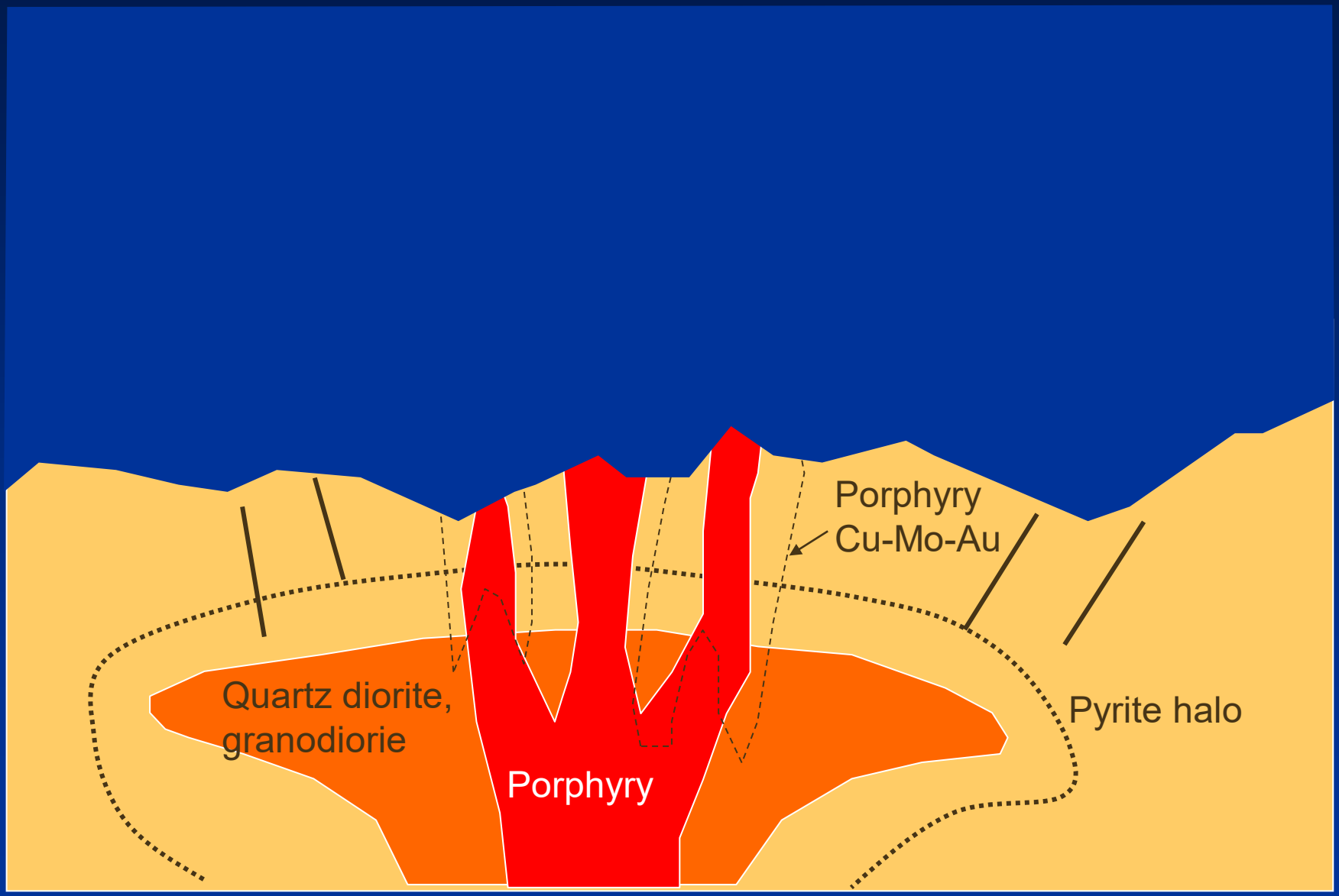
Plate Tectonic Model
Late Cretaceous Volcanic Arc

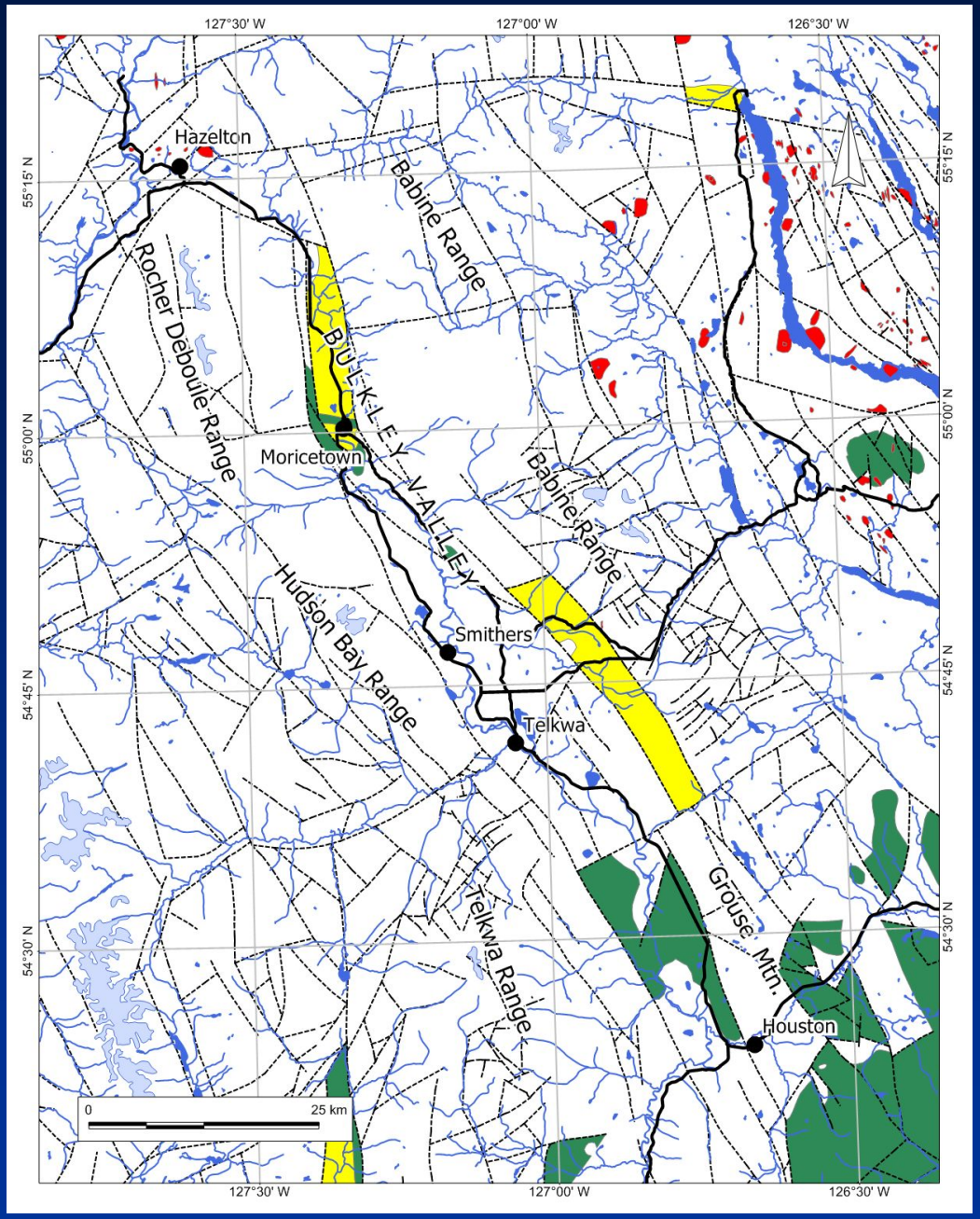


Model for Late Cretaceous volcanic centers



Late Cretaceous volcanic centers after erosion



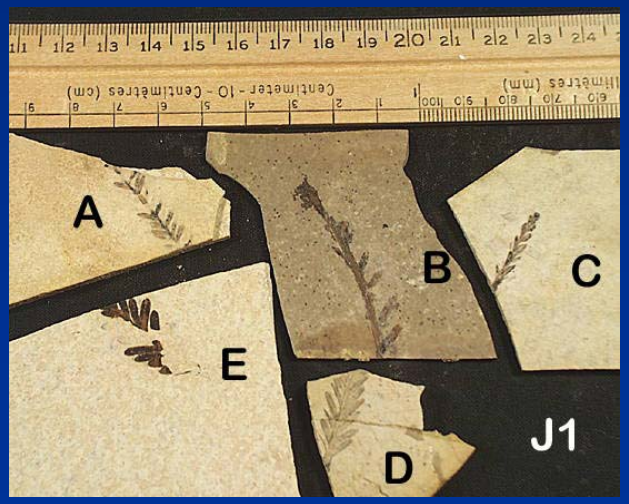


The Tertiary (ca. 50 Ma)

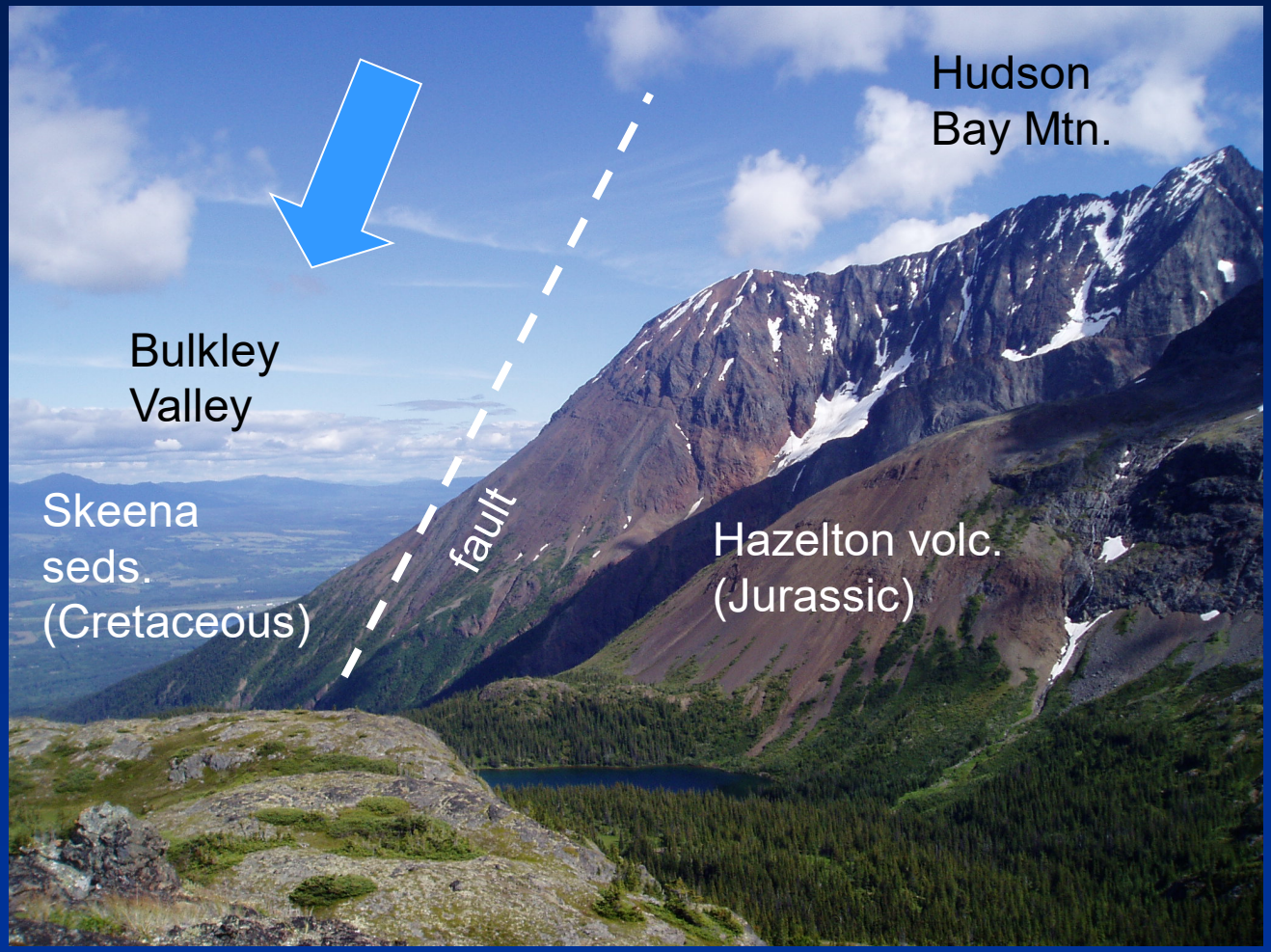
A time of lake sedimentation & local volcanic eruptions followed by block faulting & graben formation

- **Lake sediments (yellow on map)**
  - Lake sediments deposited locally
  - Well exposed at Driftwood Creek and elsewhere within the valley
- **Volcanic flows (green on map)**
  - Minor flows erupted near present day Moricetown (may be younger)
  - Extensive area of volcanic eruptions south of Houston (Nechako Plateau)
- the Bulkley Valley graben begins to form as a result of crustal extension and block faulting

Driftwood Fossil Beds

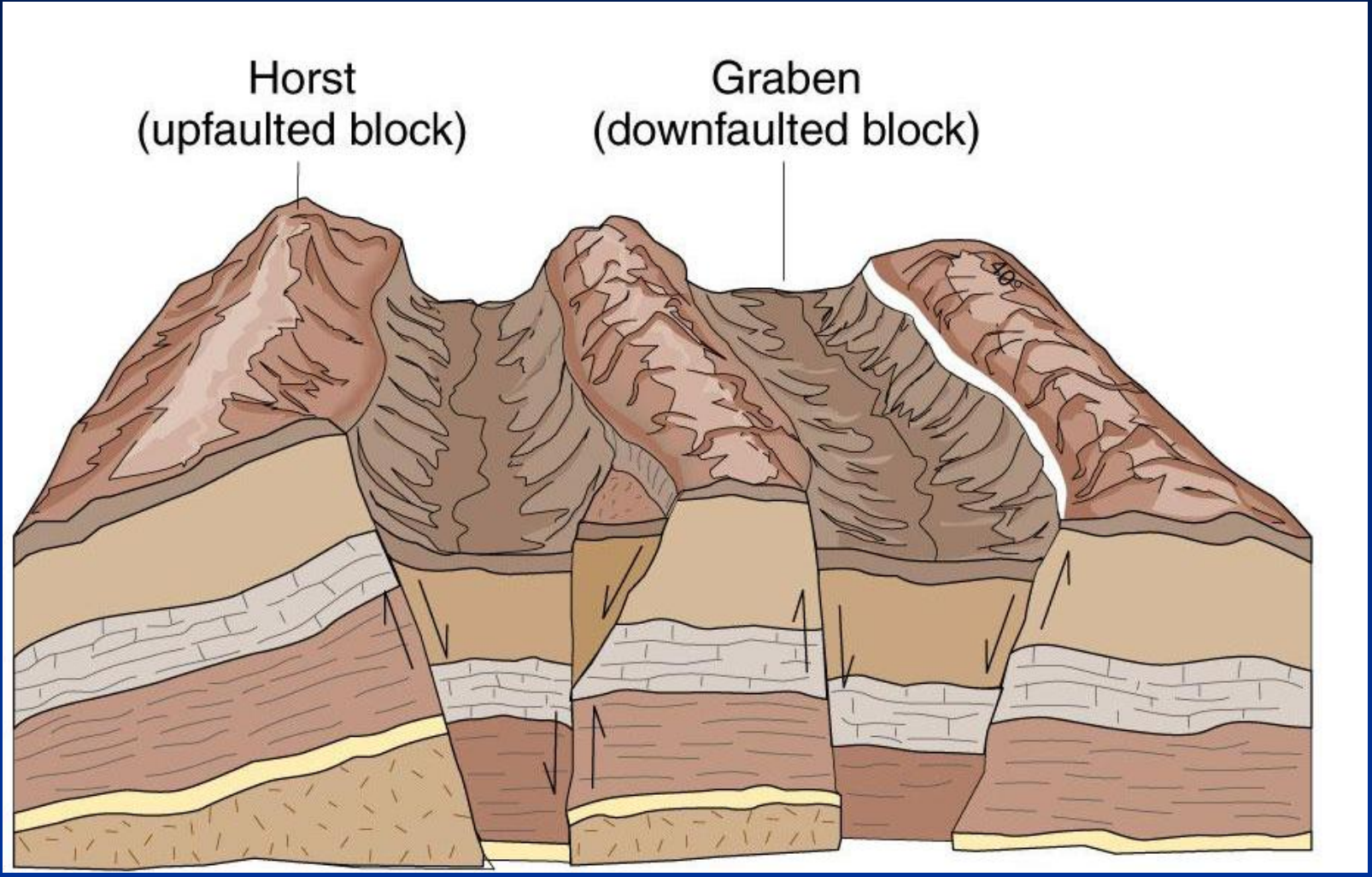


Formation of the Bulkley Valley



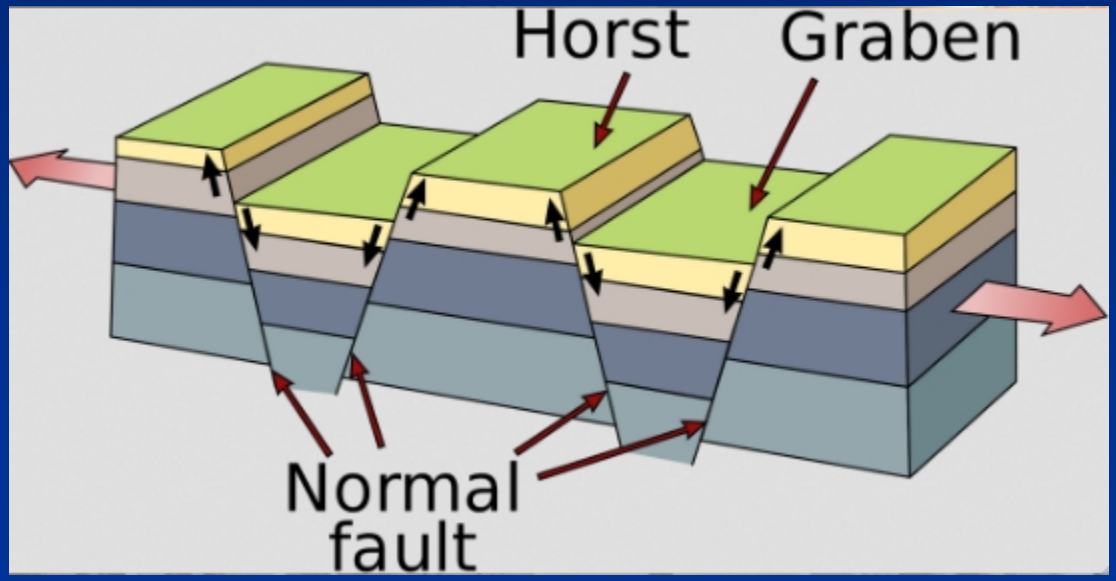
- Sedimentary rocks of the Skeena Group (early Cretaceous) are found within the valley and capping the eastern flank of Hudson Bay Mtn.
- indicates that the valley is a down-dropped fault block or graben bounded by high angle faults
- formation of the valley is believed to have started around 50 m.y. ago during a time of crustal extension

What is a graben?



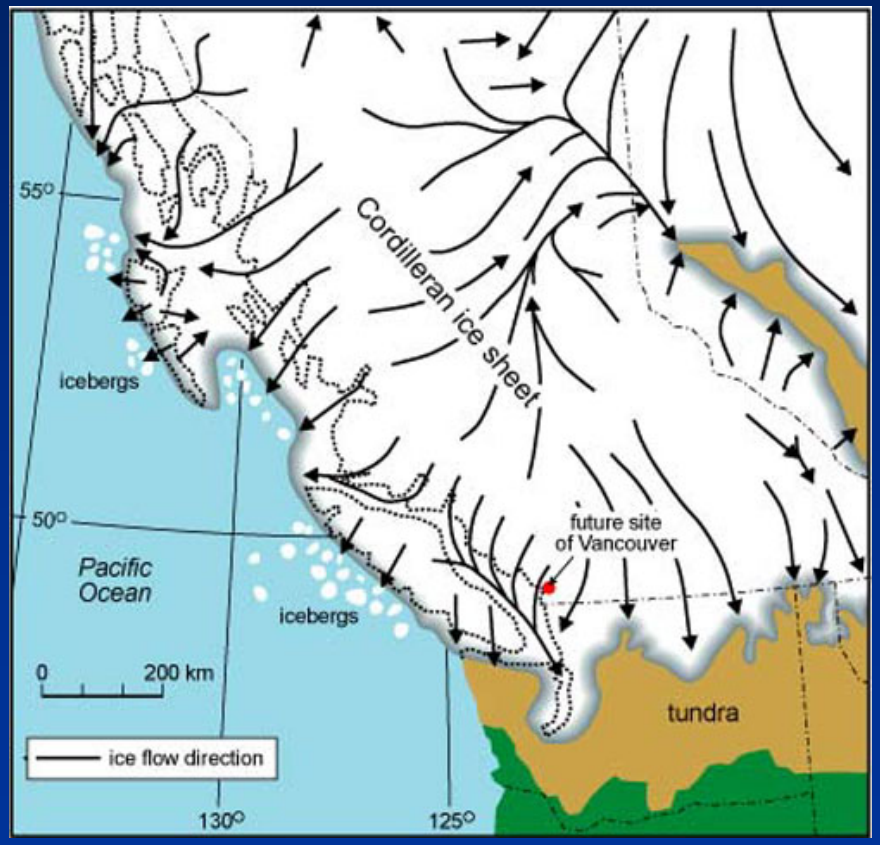
How are grabens formed?

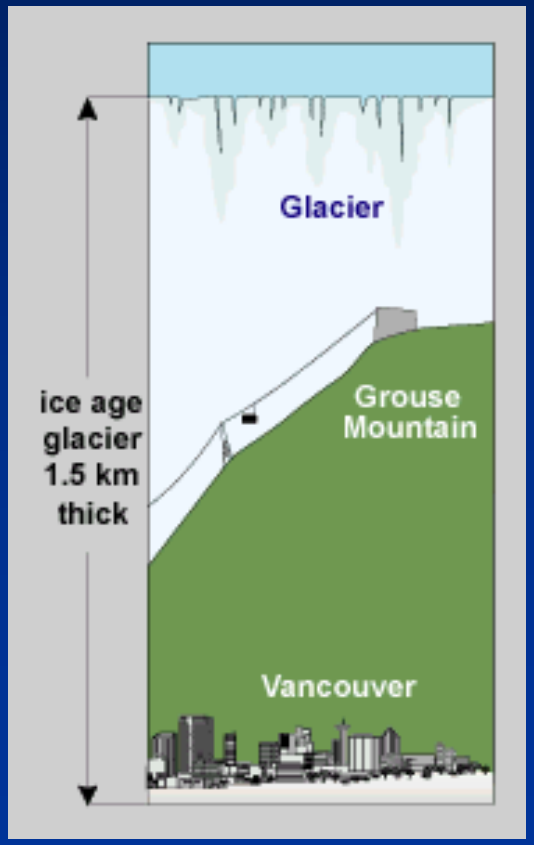
Grabens form when the earth's crust is pulled apart – this happened in the Smithers area around 50 m.y. ago



Then came the Ice Age

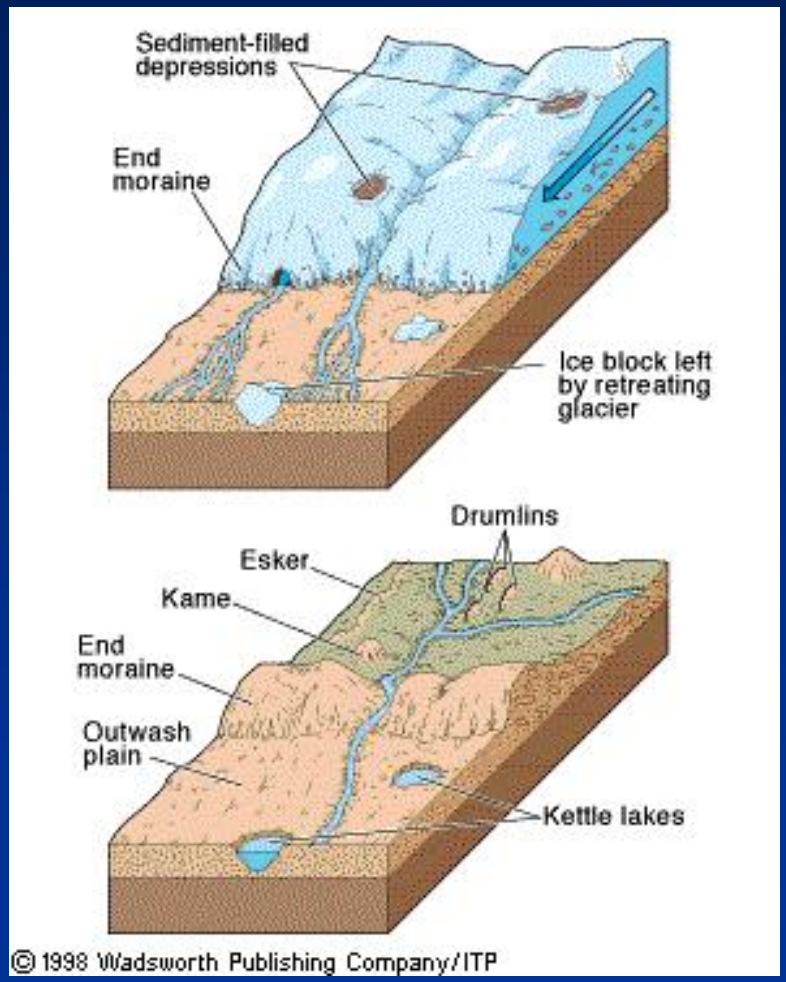
A thick pile of ice covered the Bulkley Valley and surrounding mountains over 10,000 years ago

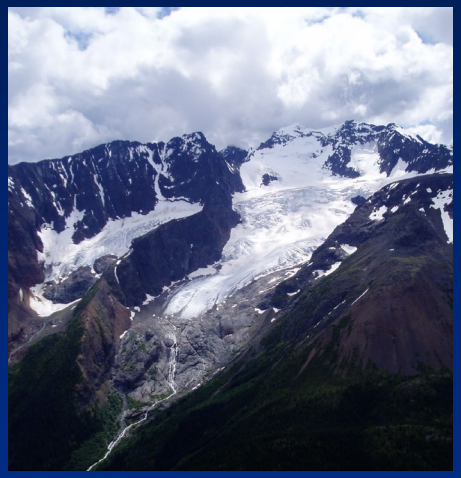


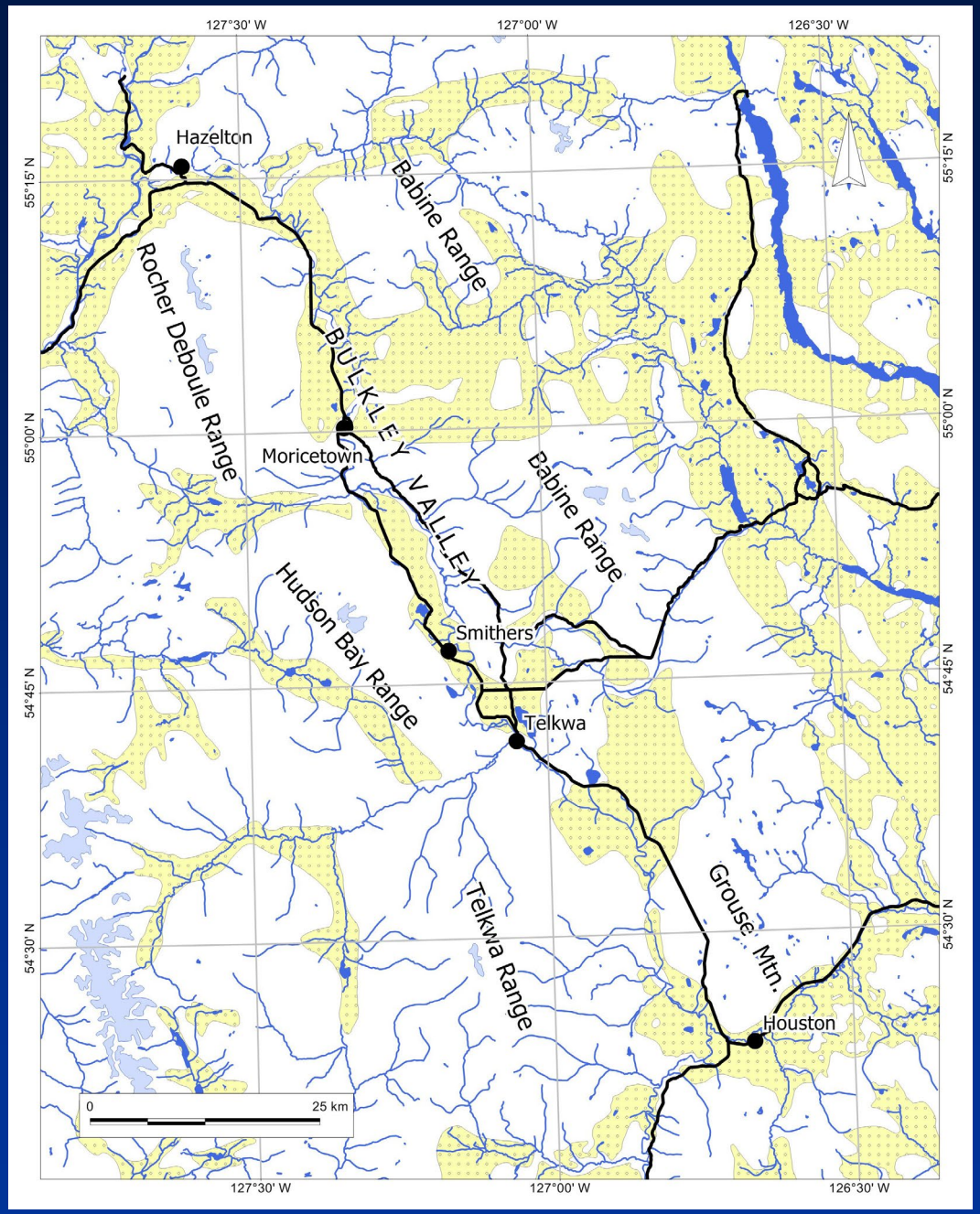


The last glacial period left its mark

- Rugged peaks, hanging glaciers, melt water lakes and piles of gravel are all that remain from the last glacial period of the current Ice Age







After the melt

- Extensive deposits of glacial debris (gravel, sand & clay) were deposited across the region (tan colour on map) filling much of the Bulkley Valley
- Mammals return to the valley as vegetation takes hold

Conclusion – the Four Key Points to Remember

- The mountain ranges surrounding the valley are mainly volcanic rocks of Jurassic & late Cretaceous age while the valley floor is mainly early Cretaceous & Eocene sedimentary rocks
- The volcanic rocks and related granitic intrusions are host to a variety of metallic mineral deposits; the Cretaceous sedimentary rocks host important coal deposits
- The Bulkley Valley is a graben that started to formed around 50 m.y. ago during a time of crustal extension
- Many of the current features of the valley are a result of the last glacial period of the current ice age

The End