The Geology of Sculpting Stone

British Columbia Nephrite

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Why Should You Care about the Geology of Sculpting Stone?

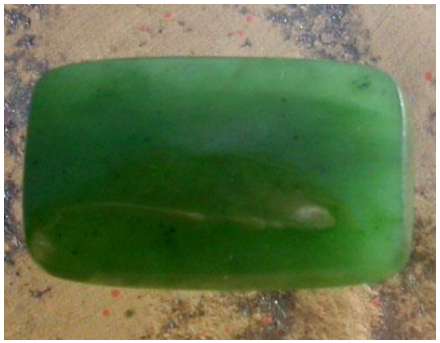
- Stone makes our chosen art form unique from all others
- Knowing more about the stone will allow you to:
  - Select stone that has a compelling history
  - Marvel at its various elements of grain, color and texture as you work it
  - Consider how your chosen artistic form relates to the science of the stone
  - Weave into your final art work story a geologic component that enhances the interest in the your work by the potential buyer

Outline

- The Stone Defined
  - General Description, Physical/Chemical Properties and Historic Use
  - Specimens (macro and thin section)
  - Specific Occurrences
- Geology
  - Age and Geologic Description
  - Formation Environment and Processes
  - Global Paleogeographic Setting
  - Modern Analogs
- Select Creations
  - Art
  - Architecture

General Description, Physical/Chemical Properties and Historic Use

- Jade is a generic term that includes the minerals jadeite and nephrite (although this presentation will focus on local B.C. Nephrite, the two minerals will be compared and contrasted for reference). B.C. nephrite is located in a central B.C. south-north corridor running from the U.S. border into the Yukon Territory.
- Historically, three major areas have been quarried for B.C. nephrite
  - The southern Lillooet (Bridge River) segment, NE of Vancouver.
  - The central Omineca segment (Mount Ogden), NW of Prince George
  - And the Cassiar (Cry and Derse Lakes) segment, just south of the B.C. – Yukon border
- First Nations use began as early as 1000BC across the British Columbia Plateau, with early uses as tools/weapon material evolving into precious stone used for prized art objects. Jade became the official mineral emblem of British Columbia in 1968.
- For the past 25 years, exports of BC nephrite have averaged over 200 tons/year, therefore extracting more "jade" than in the entire history of mankind

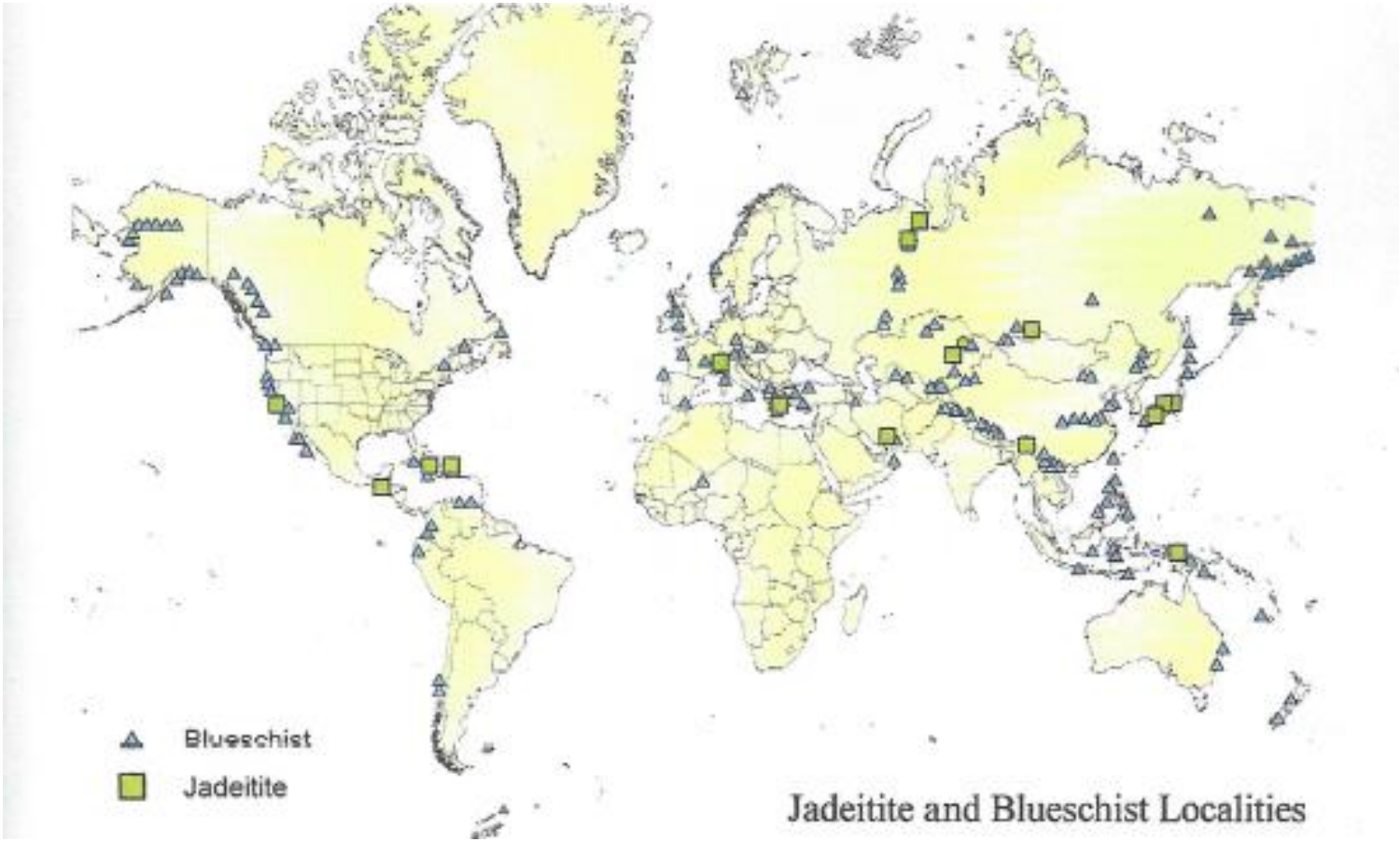


Chemical Composition of:

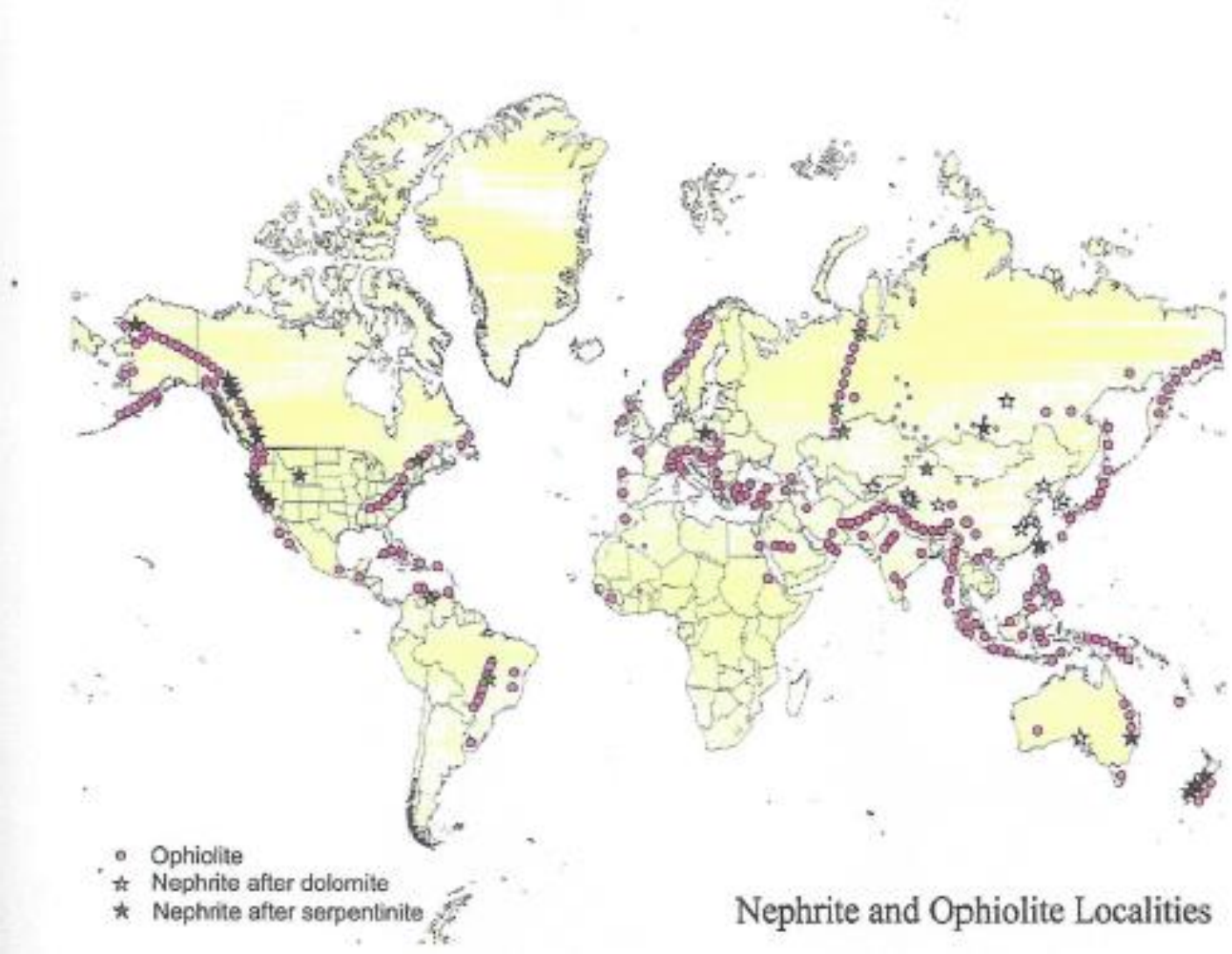
Jadeite:
$NaAlSi_2O_6$

Nephrite:
$Ca_2(Fe,Mg)_5Si_8O_{22}(OH)_2$

Global Jadeite Locations

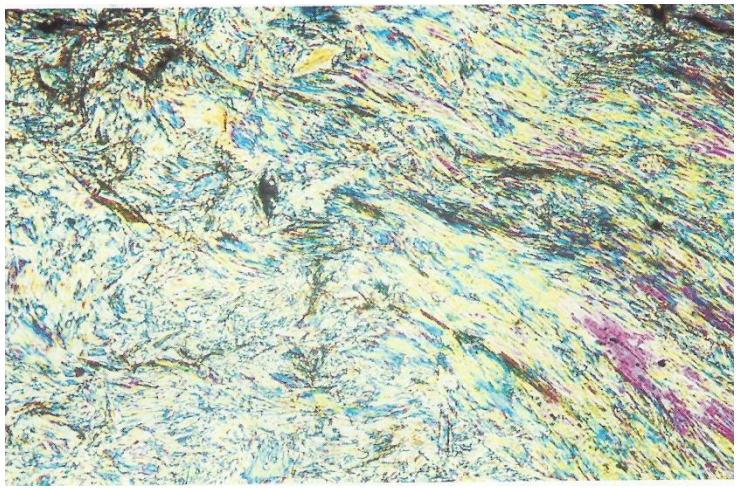


Global Nephrite Locations



Specimens: Macro

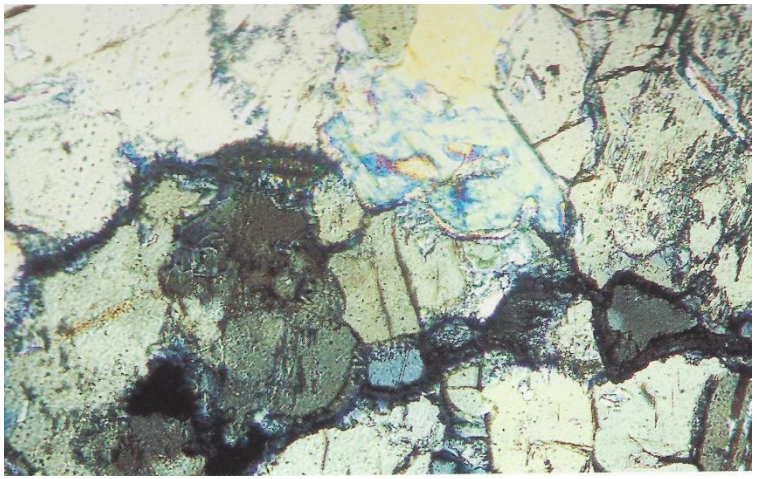
Specimens: Thin Sections
(Polarized light at About 100X Magnification)



Nephrite

Fibrous Interwoven Grains

For comparison

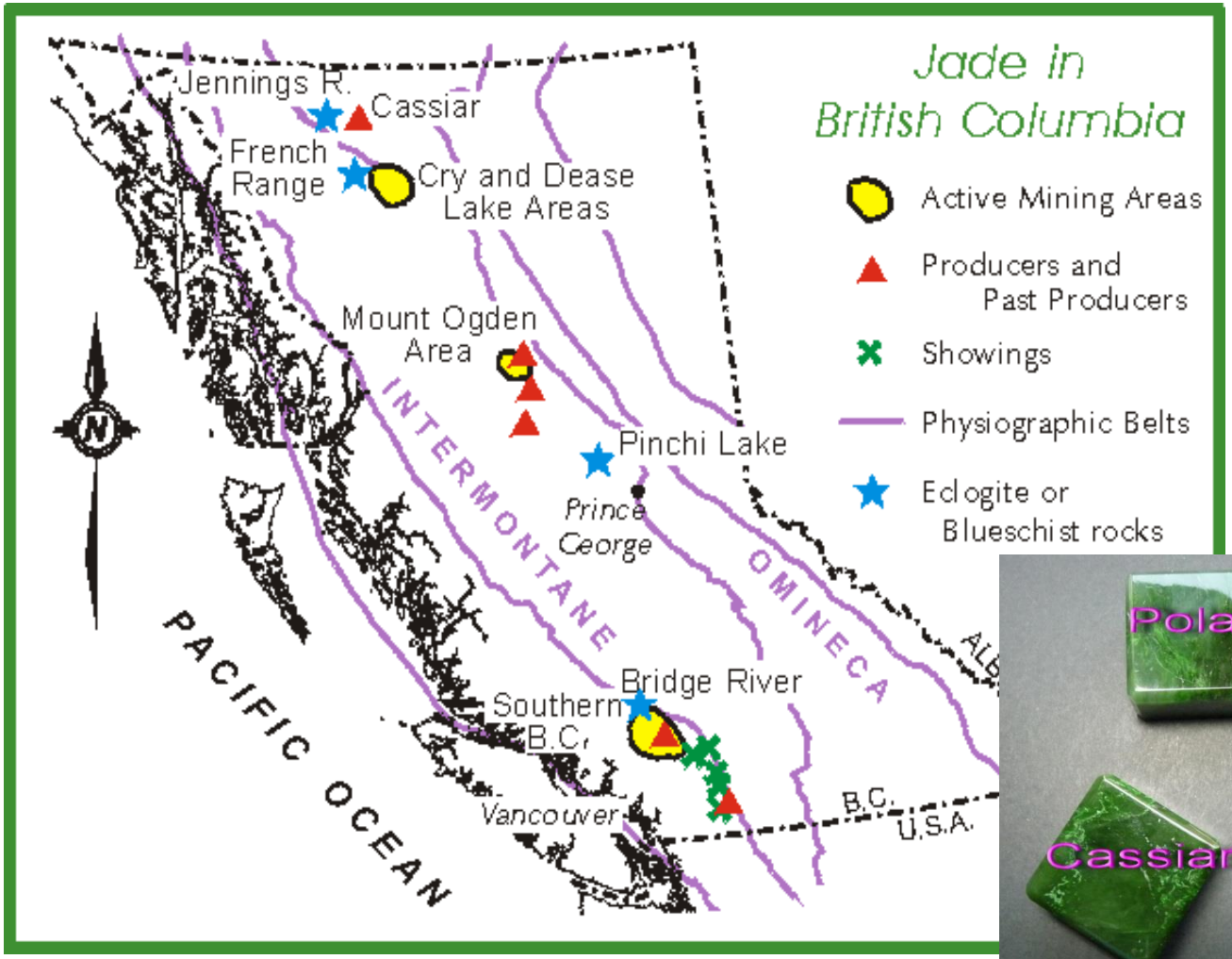


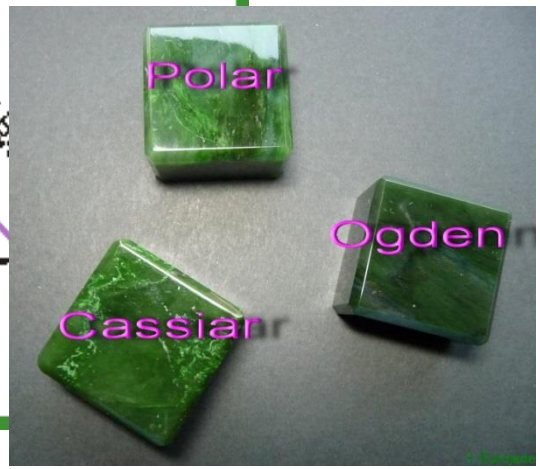
Jadeite

Granular Interlocking Grains

Specific Occurrences

Overview of B.C. Nephrite Locales

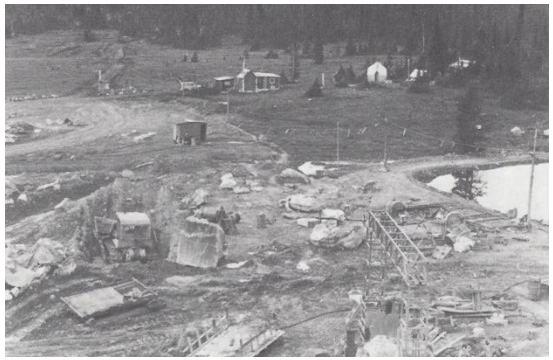




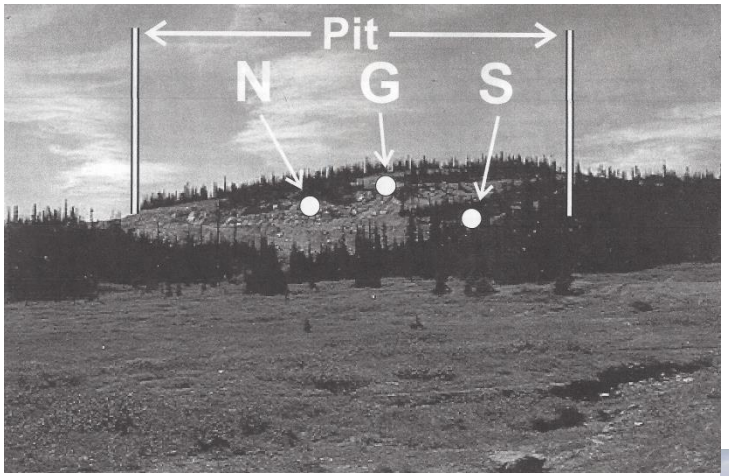
Specific Occurrences

Example: Mount Ogden Area

- The Mount Ogden nephrite occurrences are located in central British Columbia on the southwestern slopes of Mount Ogden
- The initial discovery was made in 1969
- Production of quarried, glacial erratic and alluvial nephrite has all occurred in this area



Base Camp and operations in the early 1970's



View of "Deposit 1" in 1997

N: nephrite
G: a small granitic intrusion probably unrelated to the nephrite deposit
S: serpentinite country rock

Current operations

Age and Geologic Description

First a few basics

There are three types of rock:

- **Sedimentary:** A rock formed from the accumulation and consolidation of sediment, usually in layered deposits. (e.g. sandstone)
- **Igneous:** A rock formed by the crystallization of a liquid magma (intrusive, e.g. granite) or lava (extrusive)
- **Metamorphic:** A rock formed by the alteration of the minerals, textures and/or composition of another rock (sedimentary, igneous of metamorphic) caused by exposure to heat, pressure and/or chemical actions. (e.g. quartzite)

- **Jadeite and Nephrite are specific types of common metamorphic rocks…**

- **Pyroxene (jadeite is a subset)**

- **Amphiboles (nephrite is a subset)**

Age and Geologic Description

Pyroxene

Chemical Composition	$(NaCa)(Mg,Fe,Al)(Al,Si)_2O_6$– Sodium Calcium Magnesium Iron Aluminum Silicate
Color	Usually dark green, dark brown or black, but some varieties are white to light green
Cleavage	Two directions, that meet at nearly right angles (87° and 93°), **uneven fracture**
Hardness	**5 to 6 (harder than glass)**
Specific Gravity	3.2 to 3.5 (average), increases with iron content
Luster	Vitreous (glass-like), in dark colors can be mistaken as metallic
Streak	White, greenish white or gray

Amphibole

Chemical Composition	$NaCa_2(Mg,Fe,Al)_5(Al,Si)_8O_{22}(OH)_2$ Fe, Mg, and Al ions substitute freely for one another
Color	Dark green, dark brown, black
Cleavage	Two directions that meet at 56 and 124 degrees, **uneven fracture**
Hardness	**5 to 6 (harder than glass)**
Specific Gravity	3.0 to 3.4, increases with iron content (average)
Luster	Vitreous (glassy) to dull, opaque
Streak	White to gray

Jadeite
$NaAlSi_2O_6$

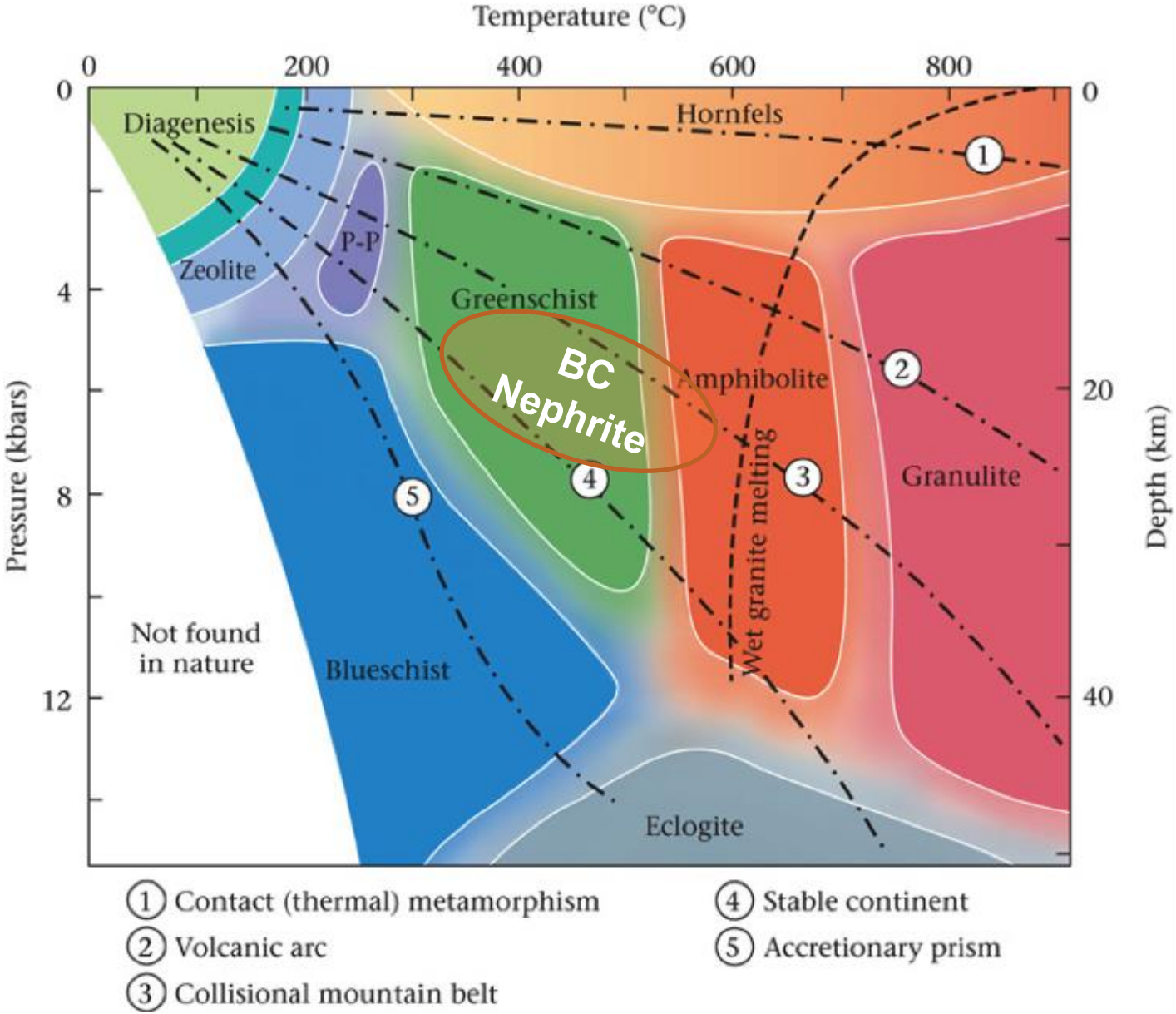
Hardness	**7 (Steel is 4.5)**
Fracture Strength	**100 MN/m^2 (Steel is 50 MN)**

Nephrite
$Ca_2(Fe, Mg)_5Si_8O_{22}(OH)_2$

Hardness	**6.5**
Fracture Strength	**200 MN/m^2**

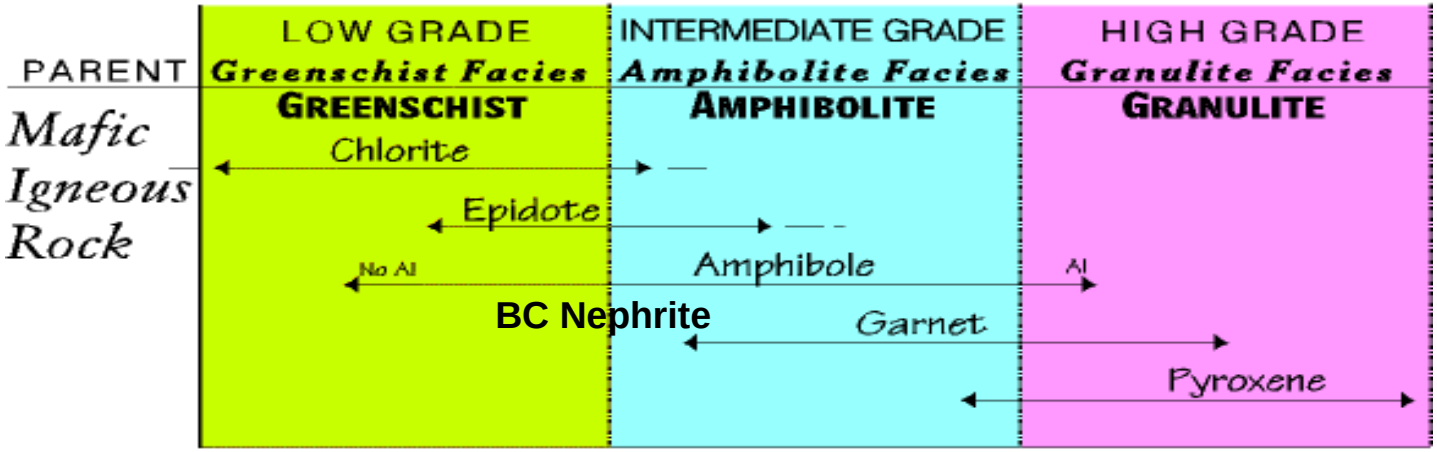
Age and Geologic Description

Metamorphic Facies and BC Nephrite

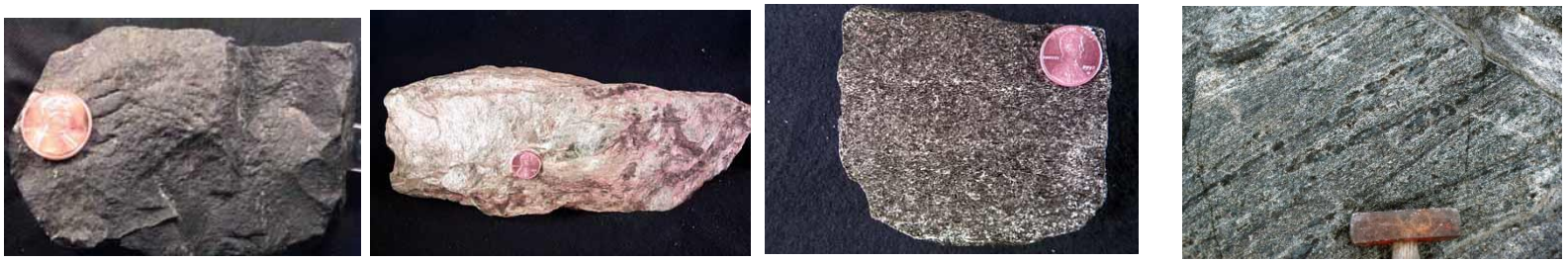


Age and Geologic Description

Metamorphic Grades and Index Minerals



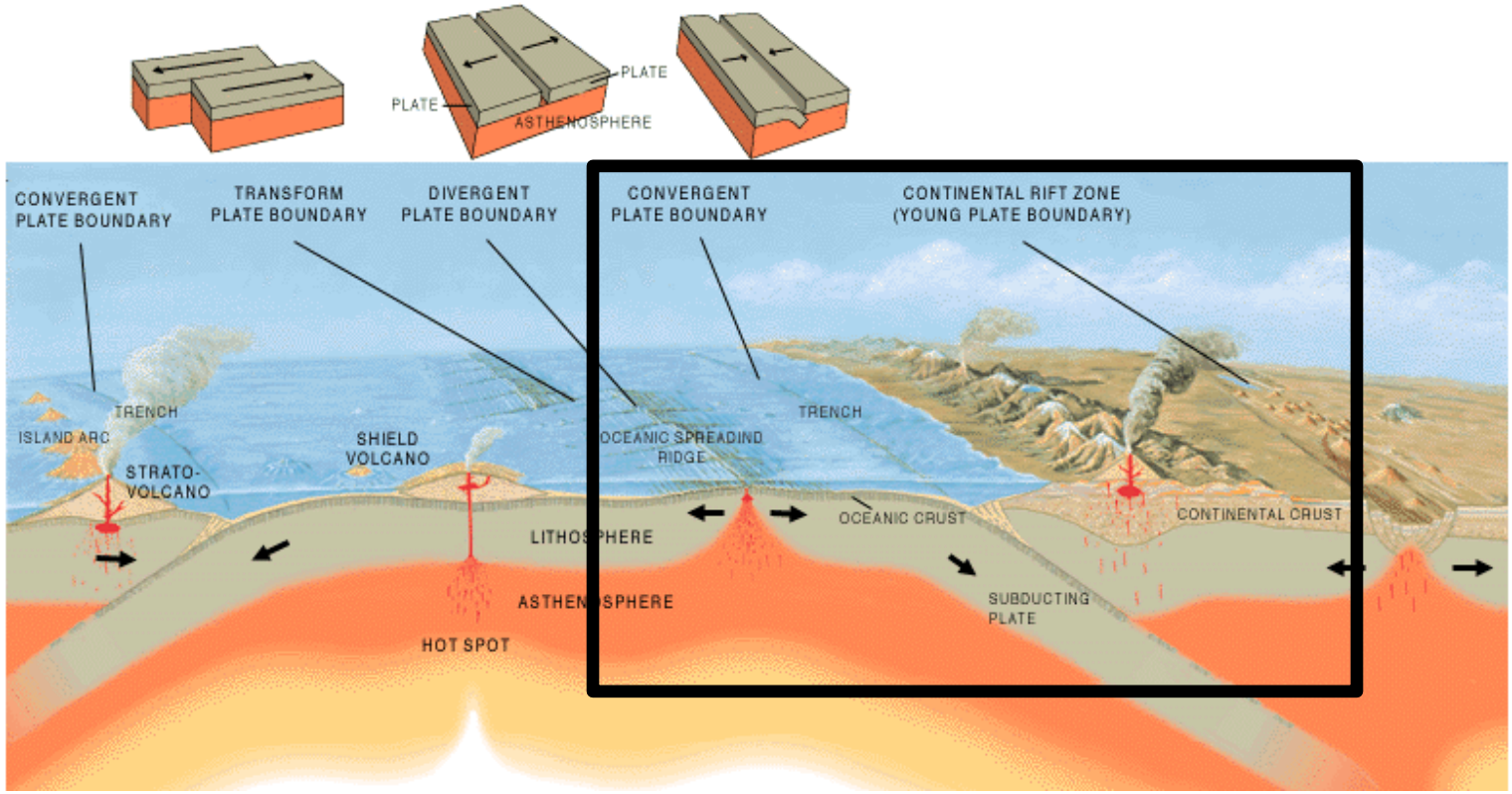
From Basalt…. to Greenstone… to Amphibole Schist... to Pyroxene Granulite



Increasing Temperature and Pressure

Formation Environment and Processes

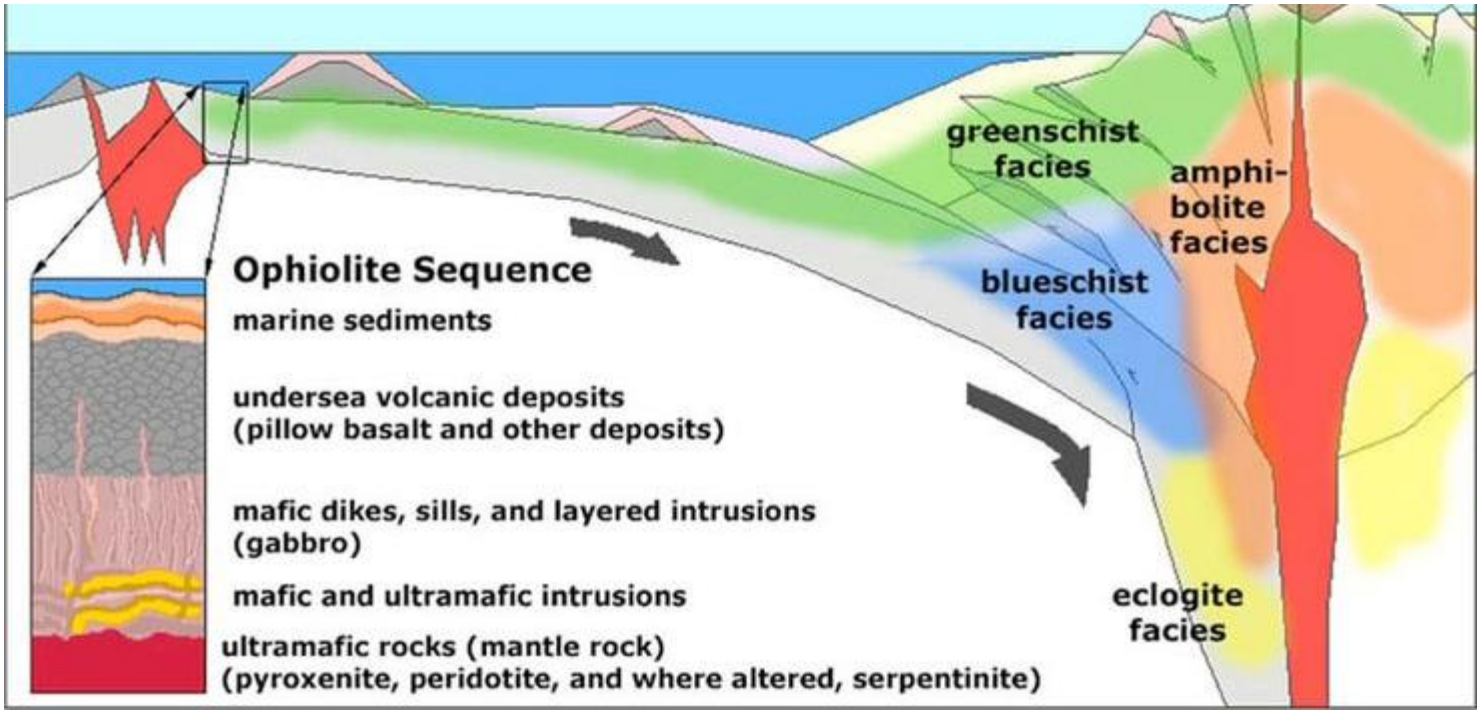
Plate Tectonics Overview



- The Lithosphere is made up of relatively thin plates which move slowly about the surface.
- These plates interact by converging, diverging or sliding (transform) past one another.
- PNW granites were formed at a convergent boundary where the North American craton collided with the (mostly) oceanic Pacific plates

Formation Environment and Processes

How Plate Tectonics Relate to Metamorphic Facies



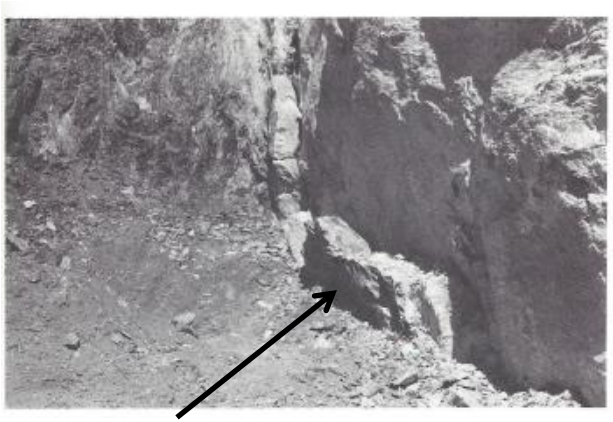
- As ophiolites are subducted at a convergent plate boundary and undergo green to blue schist metamorphism, sometimes the lower sequence ultramafic rocks are scraped off the descending plate.
- If these scraped off ultramafic rocks come in contact with silica-bearing rocks an interchange of chemicals can occur (metasomatic exchange) producing nephrite and impurity minerals including chromite, magnetite, diopside, chlorite, and talc.

Formation Environment and Processes

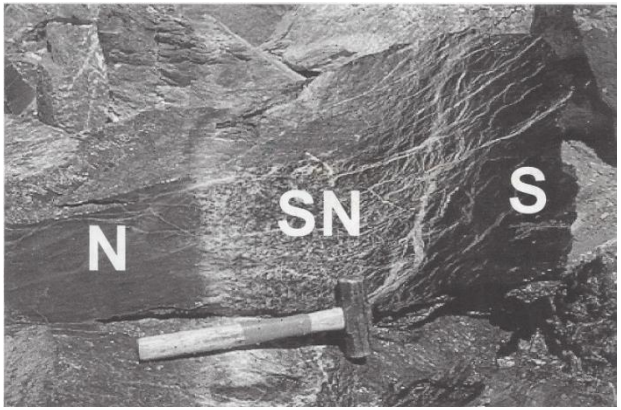
Nephrite Deposits Description (examples from Mount Ogden Area)

Idealized Cross Section

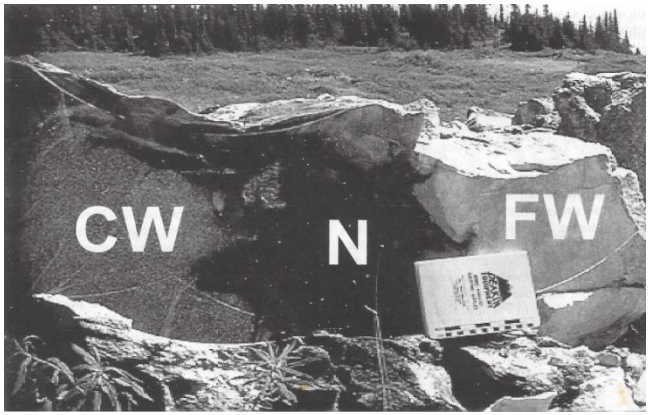
Often with fault contact



Nephrite rim with serpentinite on the left and "whiterock" on right



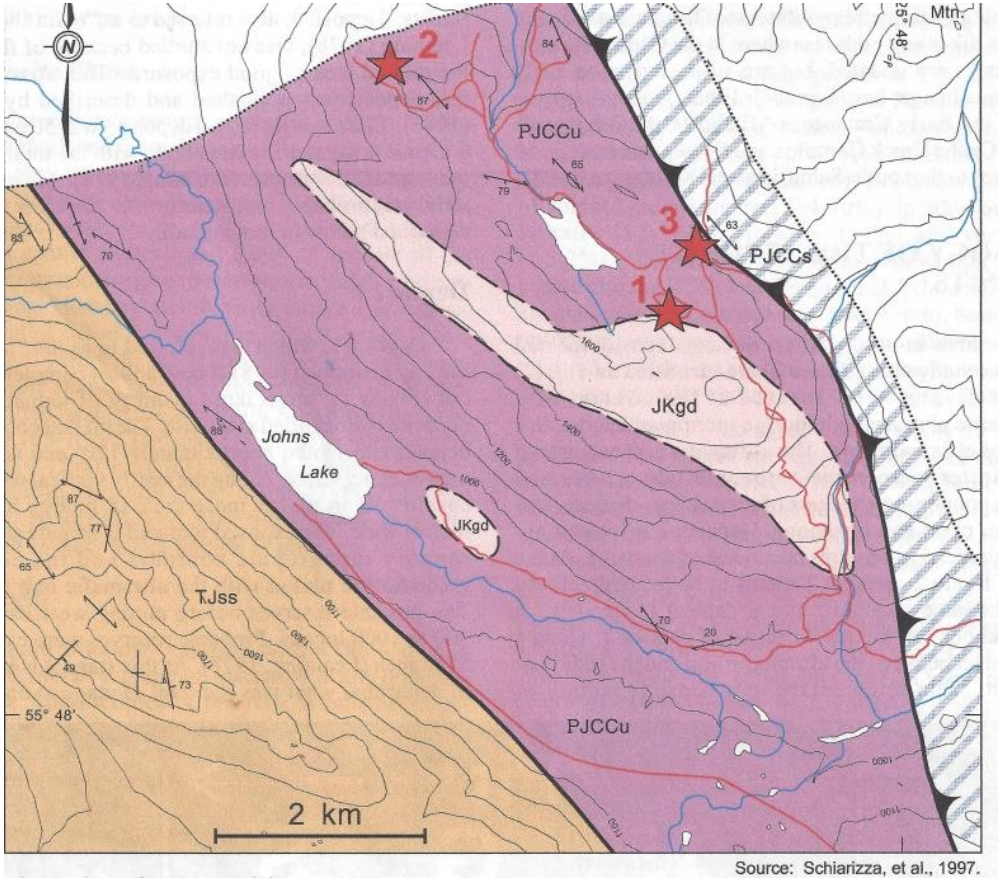
Nephrite – serpentinite contact grading from pure nephrite (N) to semi-nephrite (SN) to serpentinite (S) within a few feet

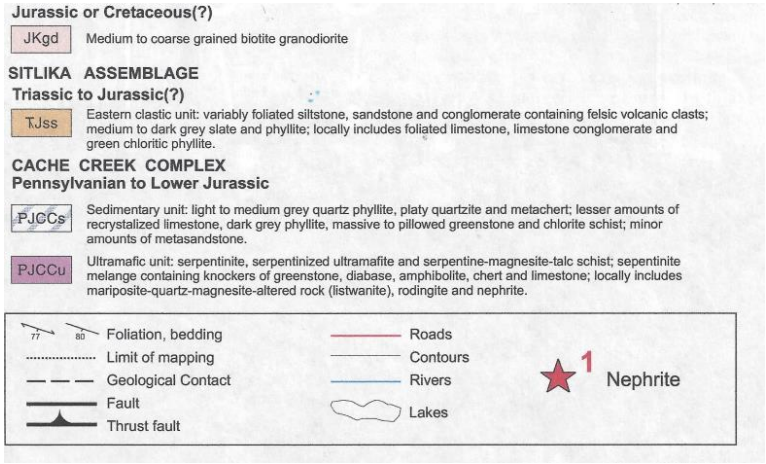


Nephrite in contact with both coarse grain and fine grain "white rock" (CW and FW)

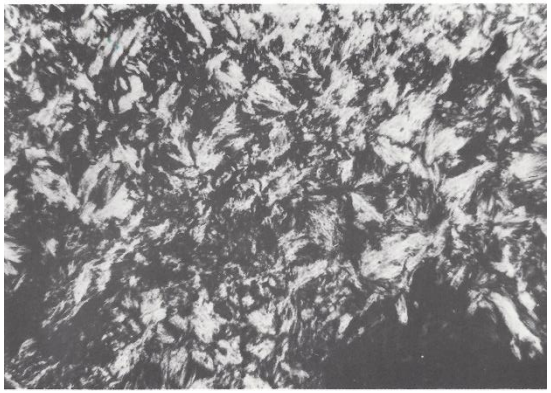
Formation Environment and Processes

Mount Ogden Area





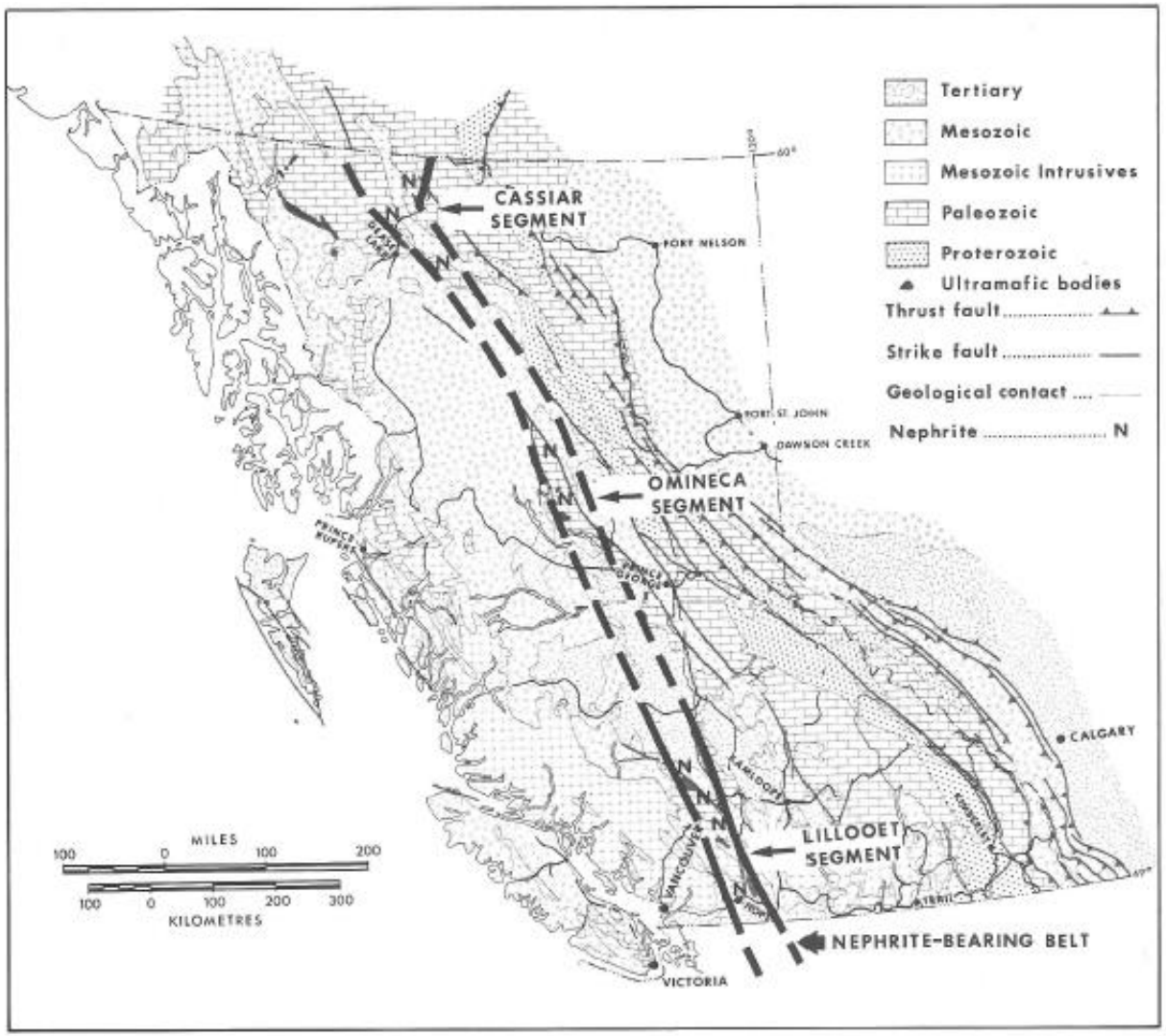
Geologic map showing “starred” nephrite deposits within the purple ultramafic unit



Cross section 63x magnification showing interlocking fibrous grains

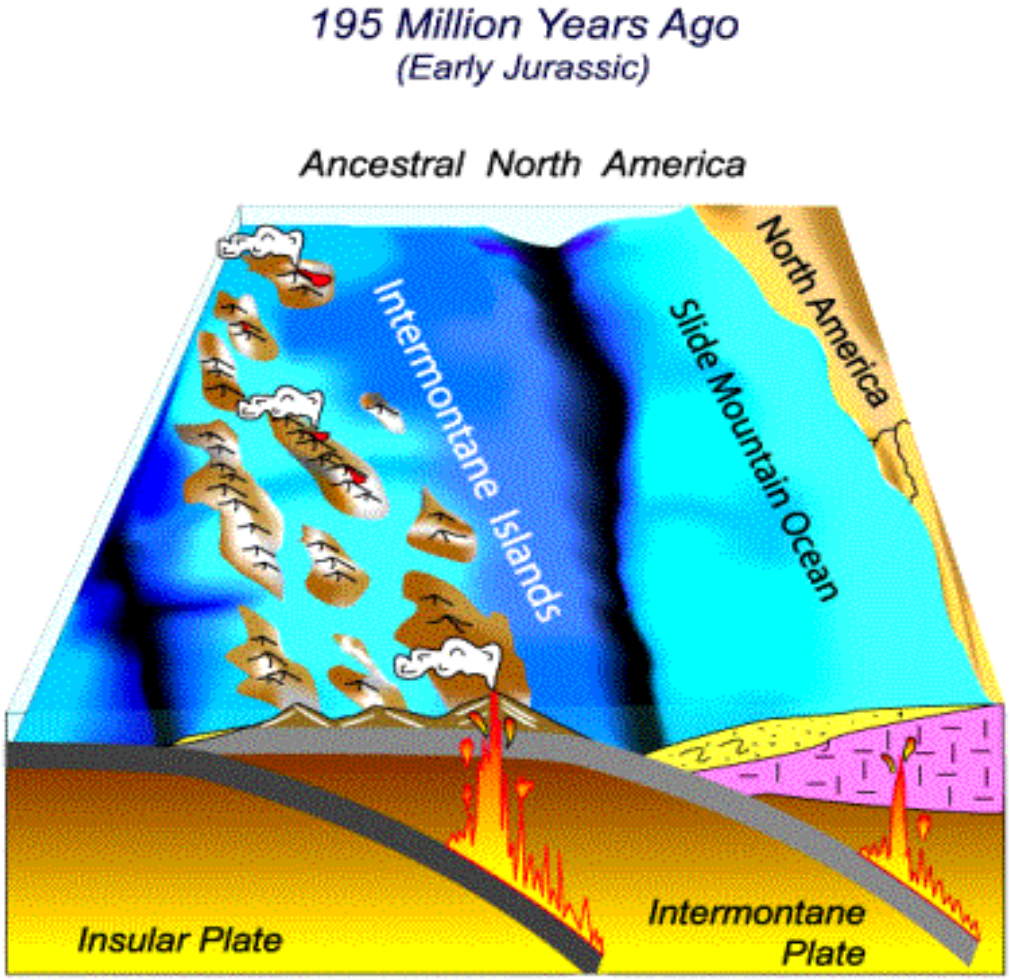
Formation Environment and Processes

Geologic Setting of B.C. Nephrite Occurrences

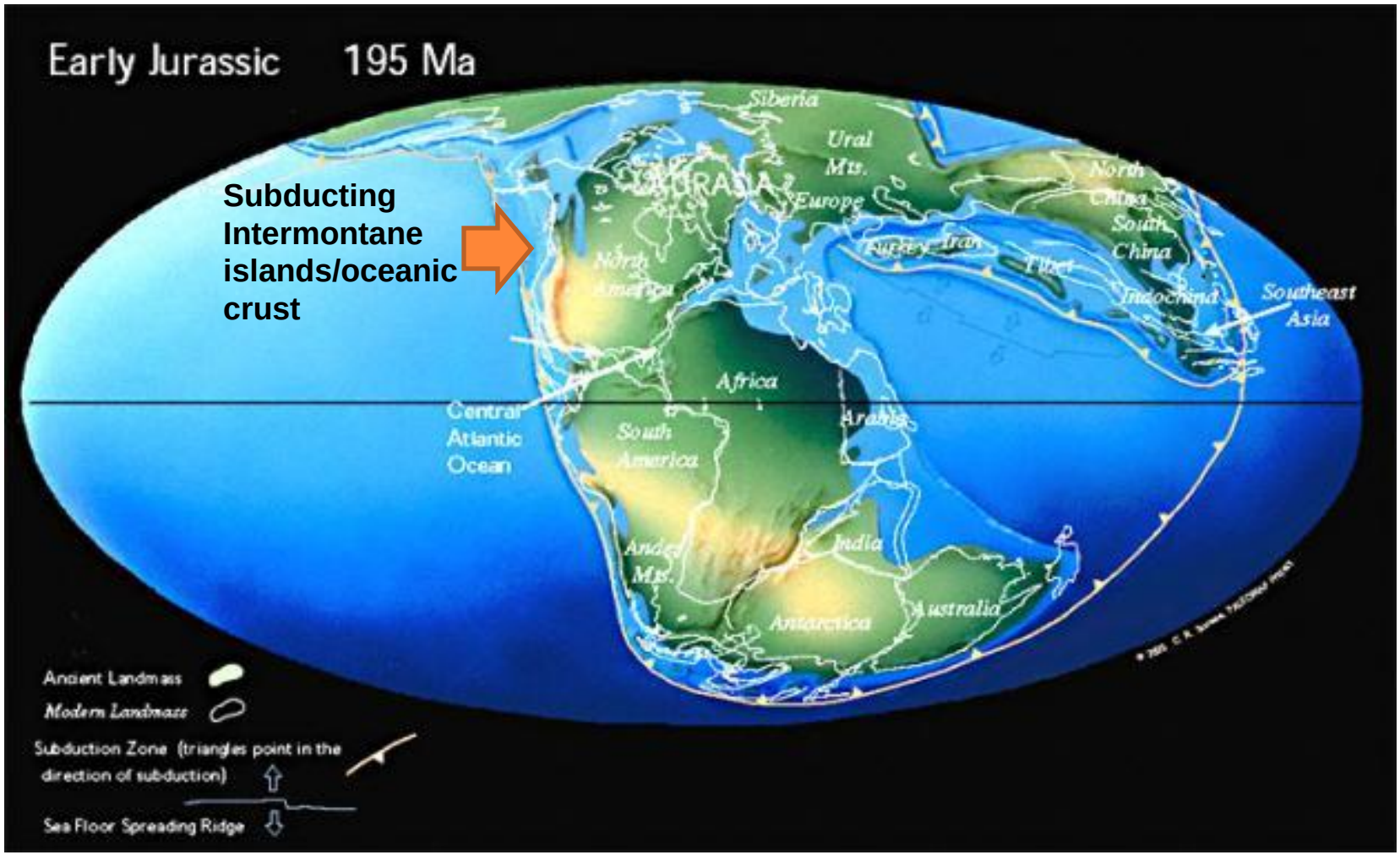


Formation Environment and Processes

- The breakup of the Pangaea began the 200 million year conveyer belt aggregation process for the Pacific NW
- The first in a series of oceanic island chains (the Intermontane Islands) began to move towards the NW, riding an oceanic plate which began to subduct under the North American craton
- Further west another subduction center which had created the Intermontane Islands continued to be active



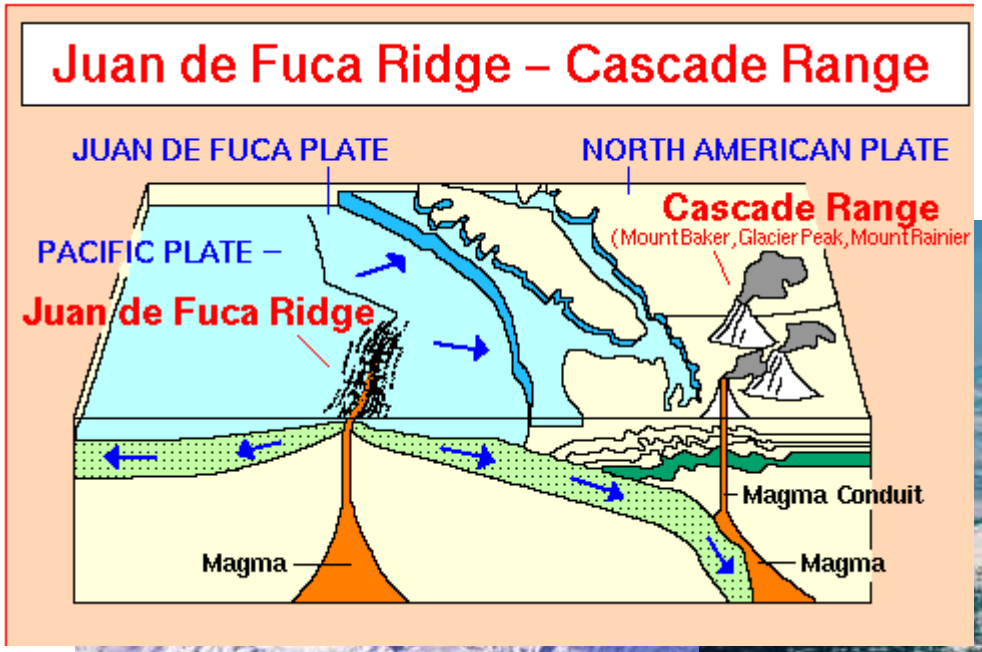
Global Paleographic Setting

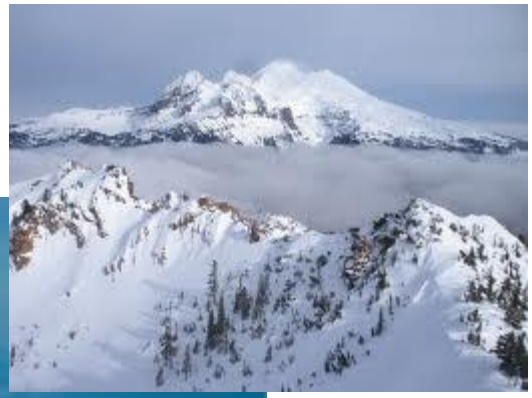


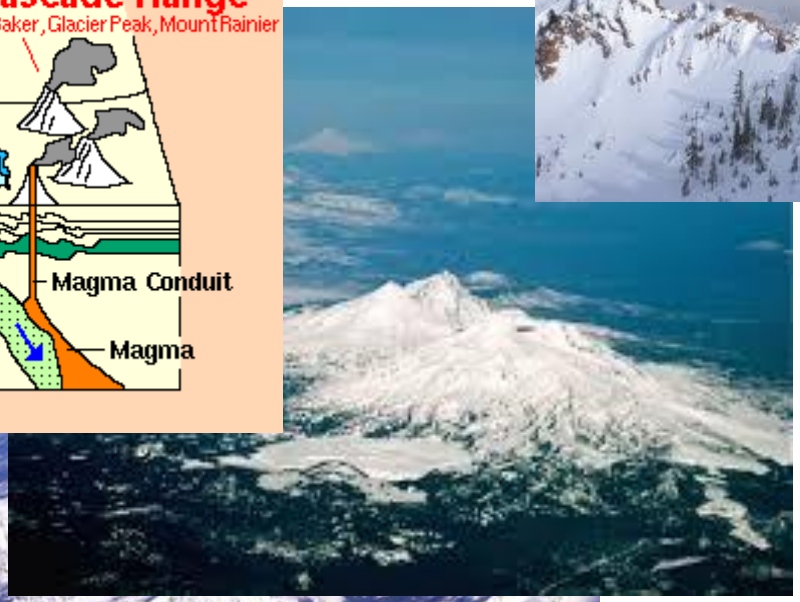
Modern Analogs

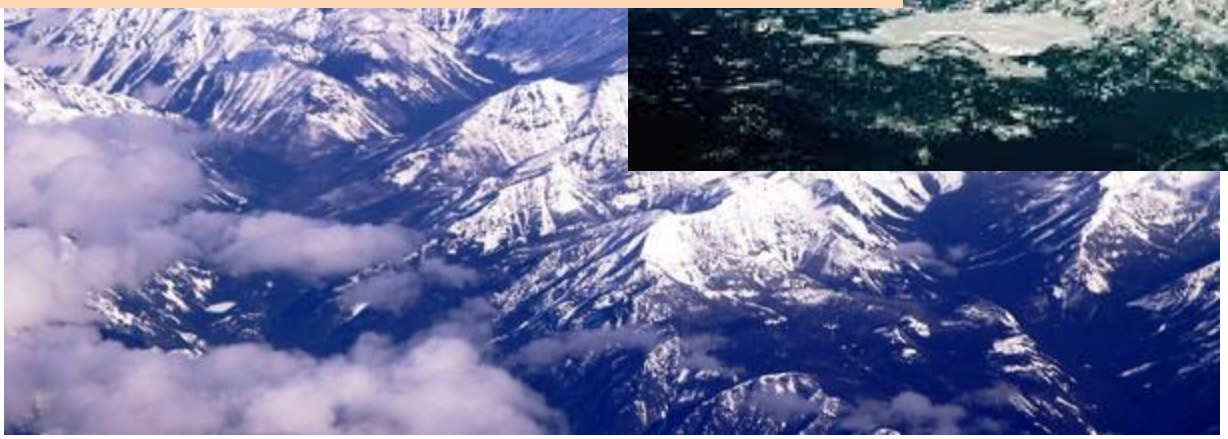
Present Day Cascadia?

Are Ophiolites From the Juan de Fuca plate Being scraped off the Subducting Plate?



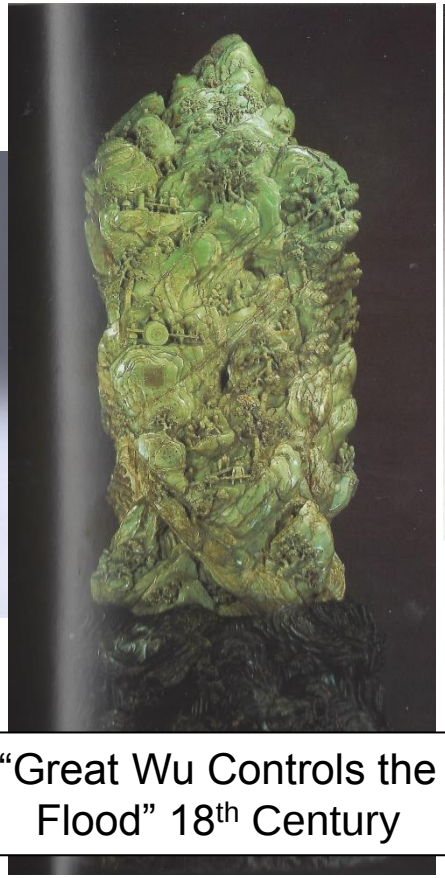






Art

Cong 4000 BC



"Great Wu Controls the Flood" 18th Century

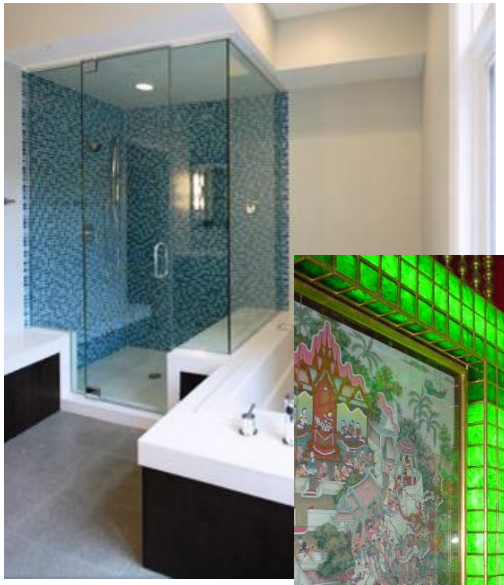
Faberge Cases 1899

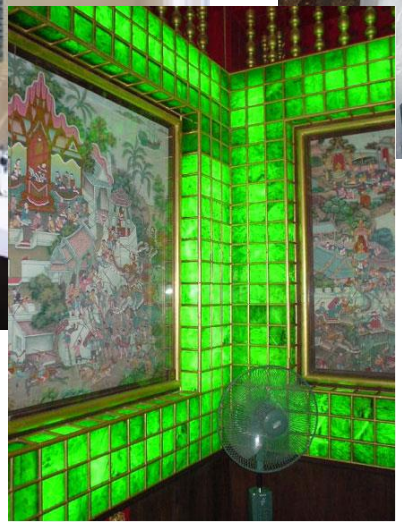
Deborah Wilson

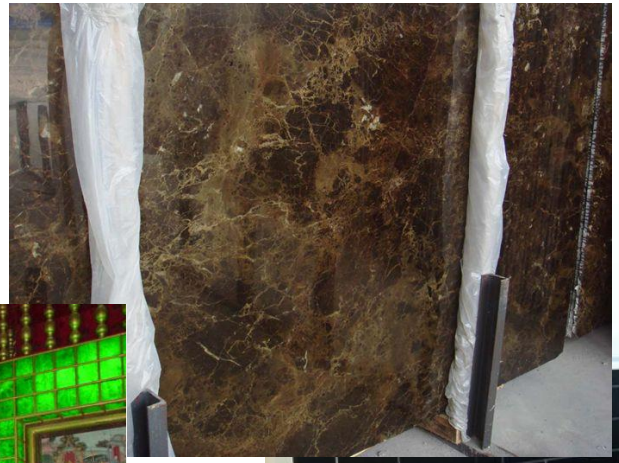
Architecture

Are you Kidding?
We are talking about Jade!

The closest you get is the use of lower grade Nephrite as composite Jade Tiles and Counter tops







Main Sources

- Harlow, George E., The Geology of Jade Deposits, 2104
- Leaming, S. F., Jade in Canada, 1978
- Makespeace, Kirk and Simandl George J,. Jade (nephrite) in British Coumbia, Canada, 2002
- Simandl, G.J., Riveros, C. P. and Schiarizza, P., Nephrite (Jade) Deposits, Mount Ogden Area, Central Britisch Columbia (NTS093N 13W), 1999