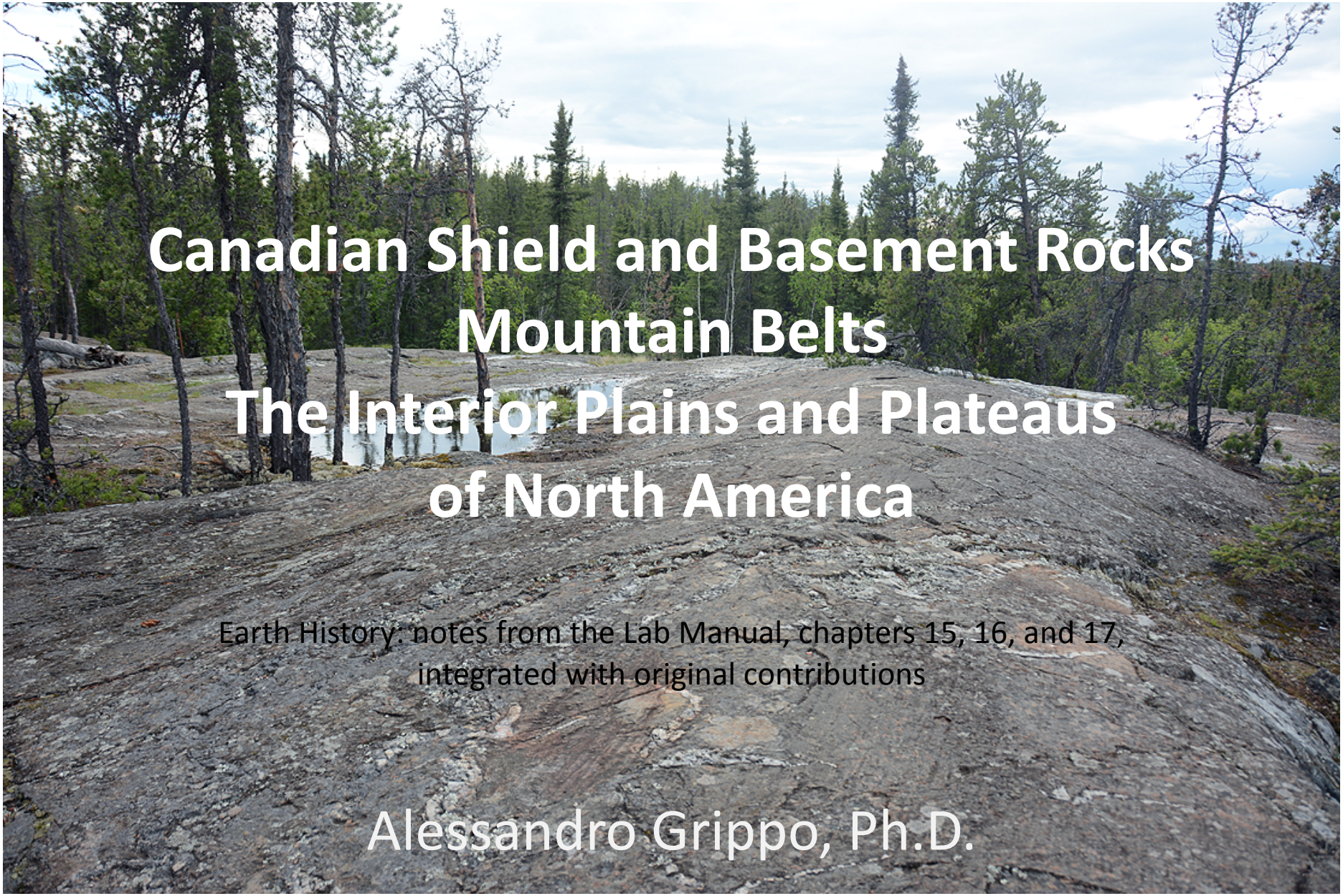


Canadian Shield and Basement Rocks
Mountain Belts
The Interior Plains and Plateaus of North America

Earth History: notes from the Lab Manual, chapters 15, 16, and 17, integrated with original contributions

Alessandro Grippo, Ph.D.

Precambrian metamorphic rocks from the Canadian Shield (with glacial striations)
Ingraham Trail, Yellowknife, Northwestern Territories, Canada

Cratons vs. Orogens

- **Cratonic and orogenic settings** were defined in Lab Manual chapter 5 as:
  - Cratonic setting
    - Stable areas with small vertical movements, with slow uplift associated with slow subsidence
      - These are the stable part of a continent
  - Orogenic setting
    - Unstable areas with big vertical movements, with rapid uplift associated with slow subsidence
      - These are those continental edges where plate tectonics, namely mountain building, is going on

The North American Craton

- In North America, the stable part, or the **craton**, consists of rocks that have not undergone significant orogenic deformation for hundreds of millions of years

- This means that
  - orogenesis, or mountain building, has not happened in this area for a long time
  - rocks can potentially be very, very old
  - only subtle changes have occurred in these areas

A craton: shield + platform

- A craton can thus either show very old rocks at the surface, or be covered by younger rocks

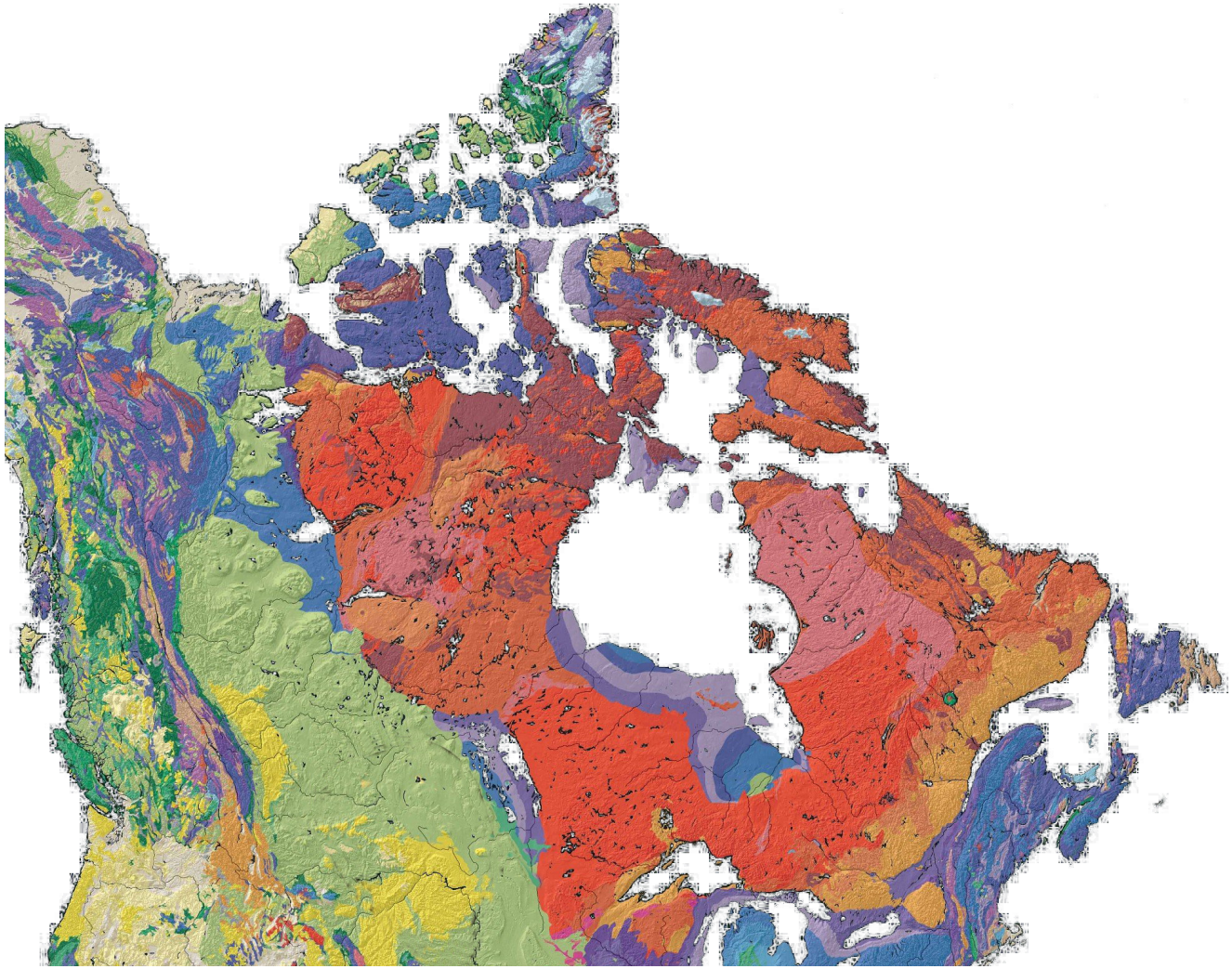
- Precambrian crystalline rocks (igneous or metamorphic rocks) exposed at the surface make up the **shield**
- Phanerozoic sedimentary rocks covering the shield make up the **platform**

Crystalline Basement

- A shield is so called because of its arched shape in profile
- The rocks making up the shield are part of the **crystalline basement**
- **The crystalline basement is by definition Precambrian in age and made by either igneous or metamorphic rocks**
  - There are also small amounts of Precambrian sedimentary rocks

Canadian Shield

- The shield of the North American continent is called the **Canadian Shield**
  - Most of the North American shield shows up in Canada, from the Northwestern Territories all the way to Quebec and Newfoundland
  - It also crops out in limited areas in Minnesota, Michigan, Wisconsin and upper state New York



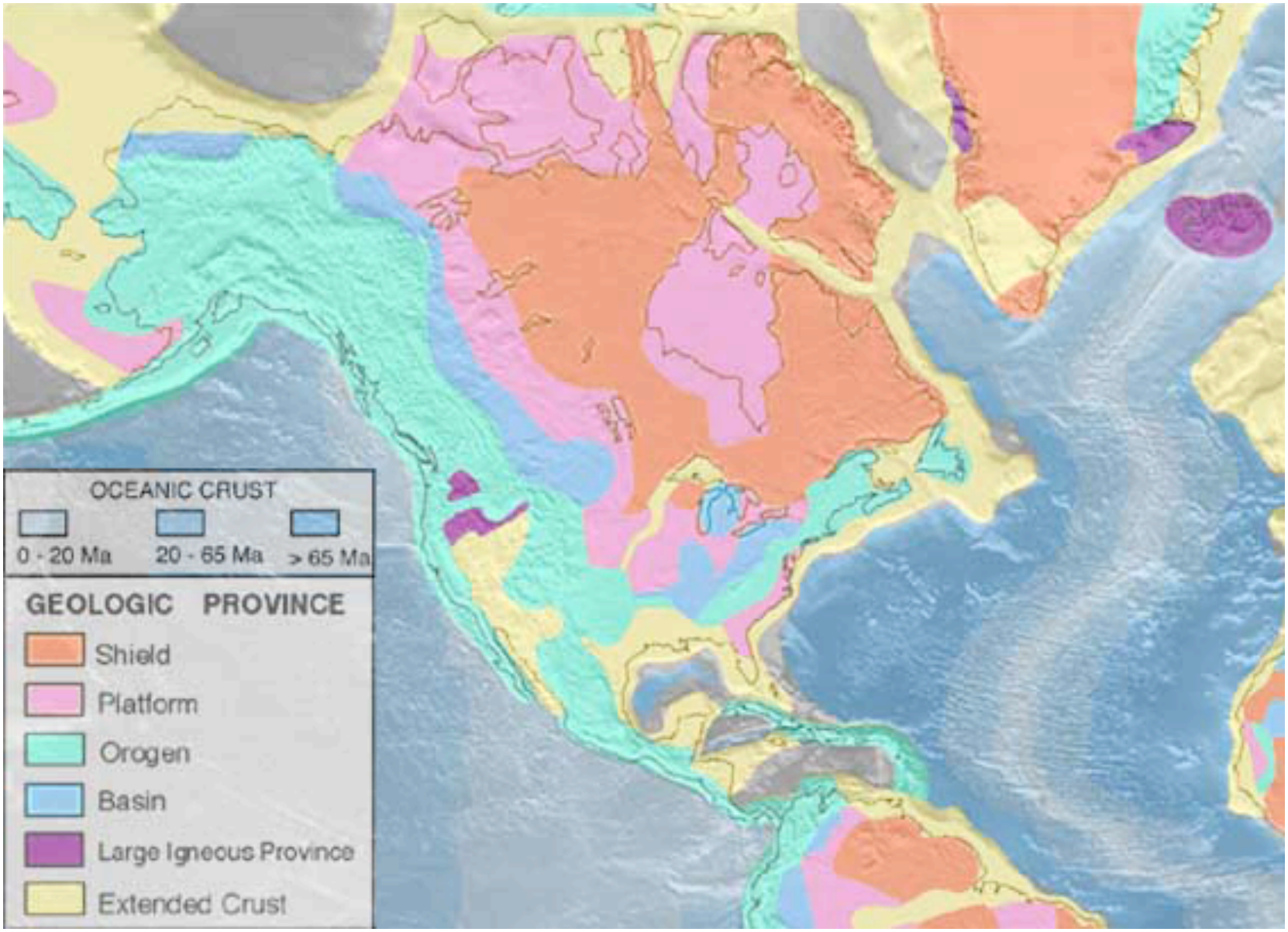
The red colorations around Hudson Bay denote the extension of the Canadian Shield

Platform

- The Canadian Shield is surrounded by generally flat-lying sequences of sedimentary rocks formed because of the erosion of the shield itself

- So, the shield is showing because it has been eroded, and the sediment that forms out of that erosion constitutes the **platform**

- The platform is **Phanerozoic in age**


OCEANIC CRUST
0 - 20 Ma
20 - 65 Ma
> 65 Ma
GEOLOGIC PROVINCE
Shield
Platform
Orogen
Basin
Large Igneous Province
Extended Crust

- So the crystalline basements always exists underneath the platform

- If the platform is missing because of erosion, the rocks of the crystalline basement make up the shield

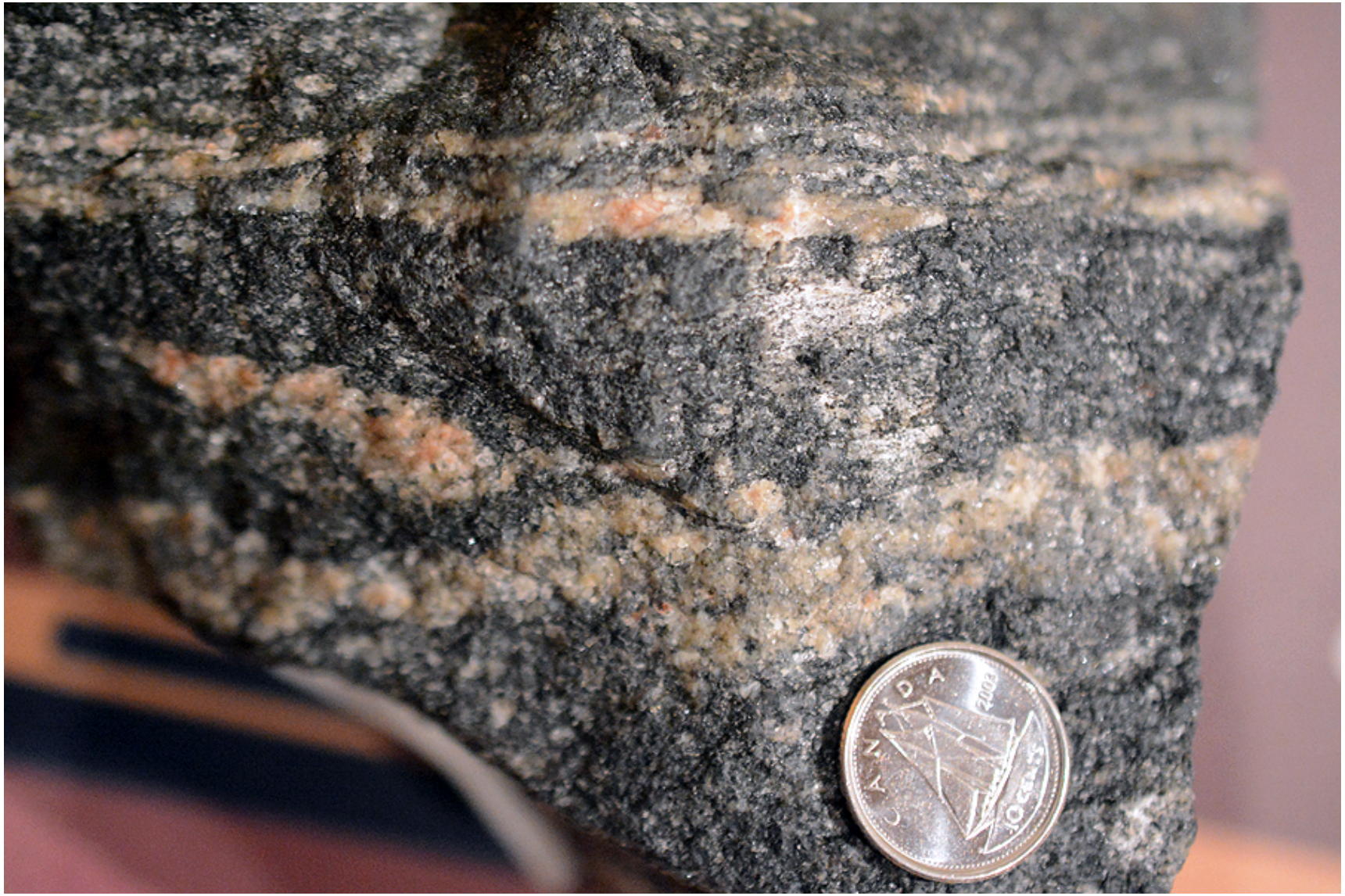
- This means that if we drill through the platform, we are able to reach and find the crystalline basement

Where do we see the crystalline basement?

- As a matter of fact, you can see or encounter the crystalline basement in these four geological context:
  - Directly exposed at the surface, as it is in the Canadian Shield
  - At variable depths, by drilling (from 800 to 3000 m from the surface)
  - At the front of thrust faults in the Canadian Rockies and in the Rockies of Montana and Wyoming
  - Because of uplifting and deep erosion, at the bottom of the Grand Canyon in Arizona

- Most crystalline rocks in the Canadian Shield are granite **gneisses** (meaning, a gneiss containing the same minerals of a granite)

- The oldest rock in the world is the Acasta Gneiss from the Northwestern Territories, Canada, dated at 3.96 billion years

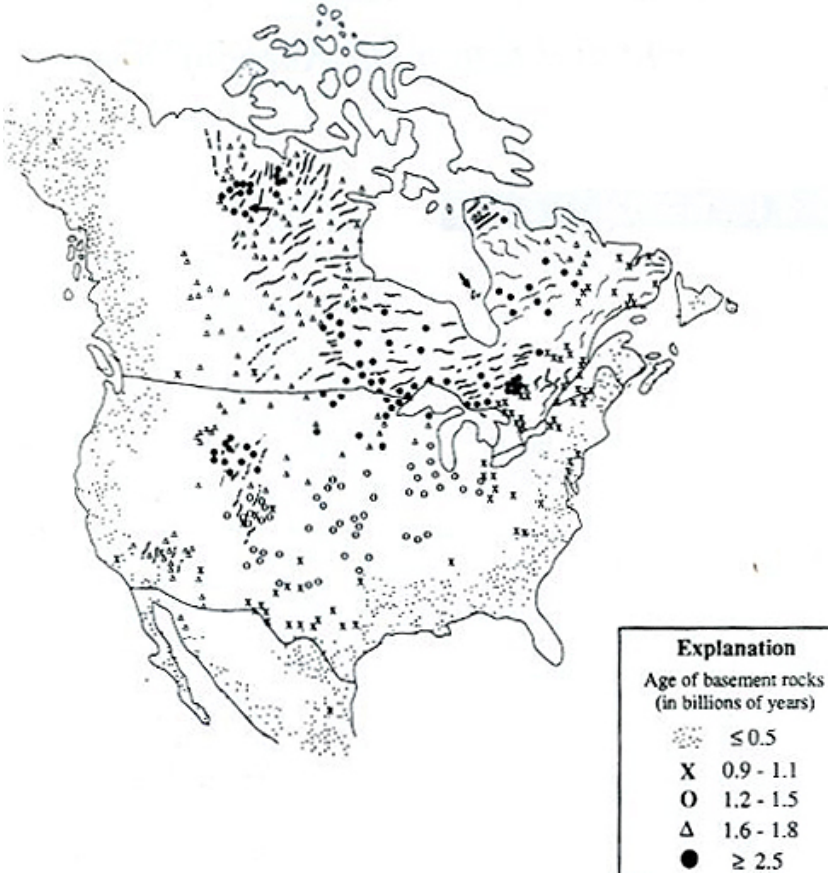


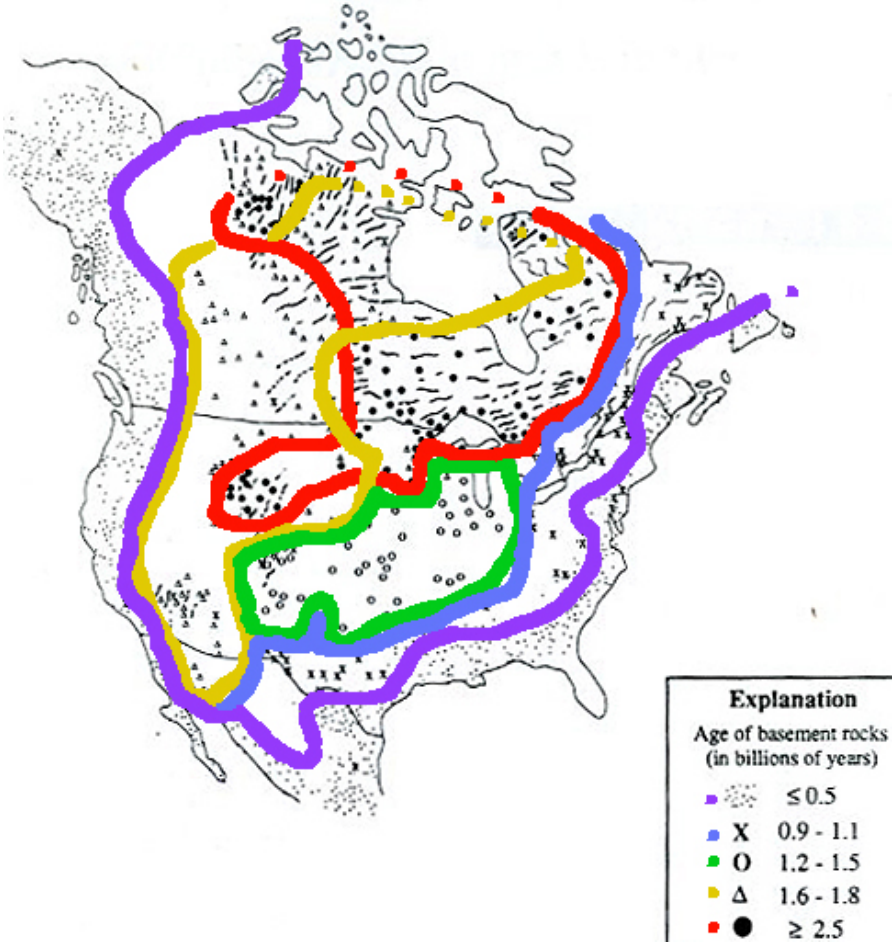
The Acasta Gneiss

Northwestern Territories Provincial Museum, Yellowknife, NT, Canada

The Canadian Shield is made of smaller continents that collided in the past

- The Canadian Shield is not uniform in age, but it shows regions where certain ages are clustered
- These are defined as separated Precambrian geologic provinces
- Every one of these provinces is inferred to represent an orogenic belt
- So these were each their own microcontinent which, upon collision over geologic time, came to form the North American continent of today


Explanation
Age of basement rocks
(in billions of years)
≤ 0.5
X 0.9 - 1.1
O 1.2 - 1.5
Δ 1.6 - 1.8
● ≥ 2.5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Accretionary tectonics

- When smaller continents (microcontinents) collide, they build in time bigger continents

- When they are just added at the margin of a continent, we talk about **accretion**