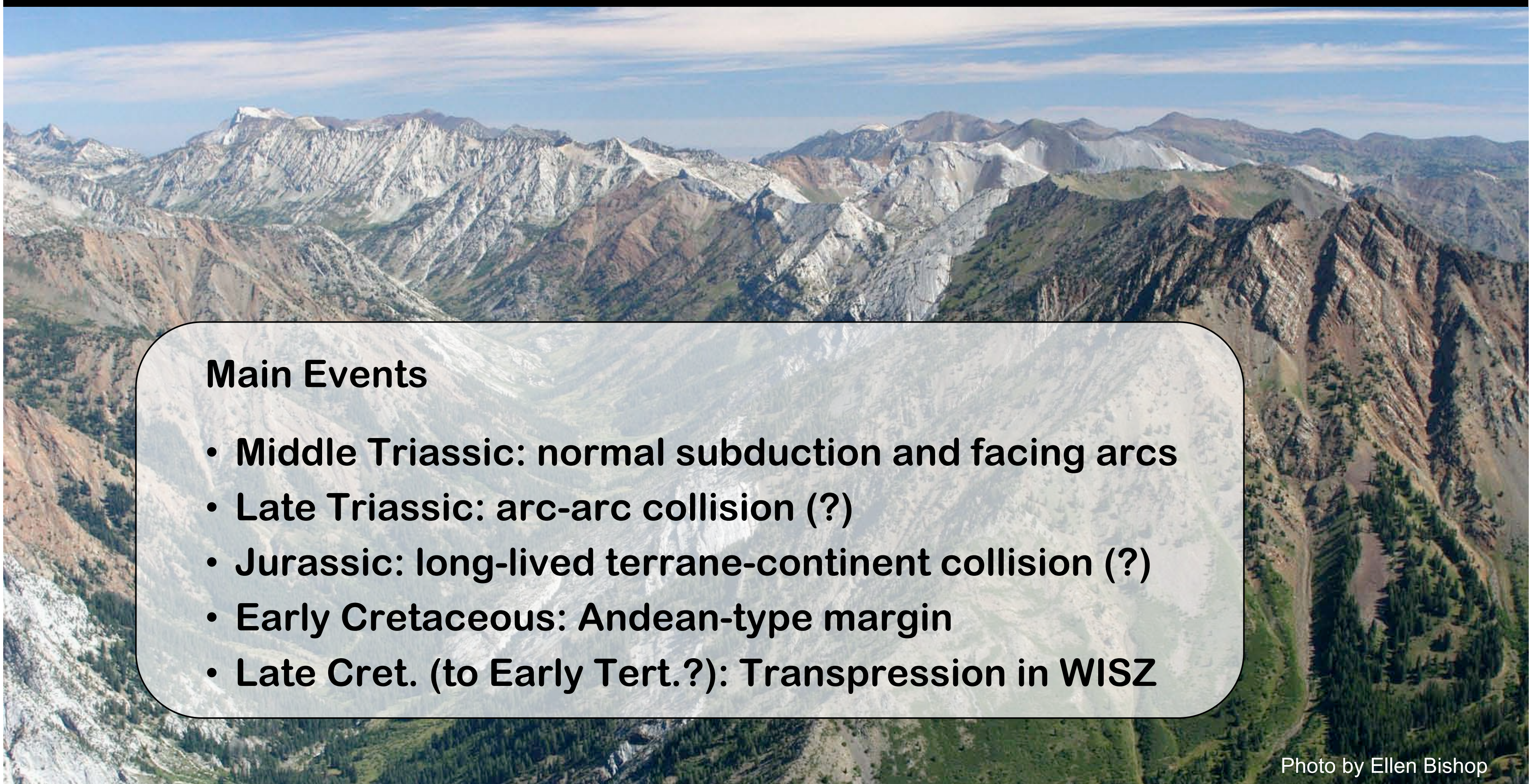
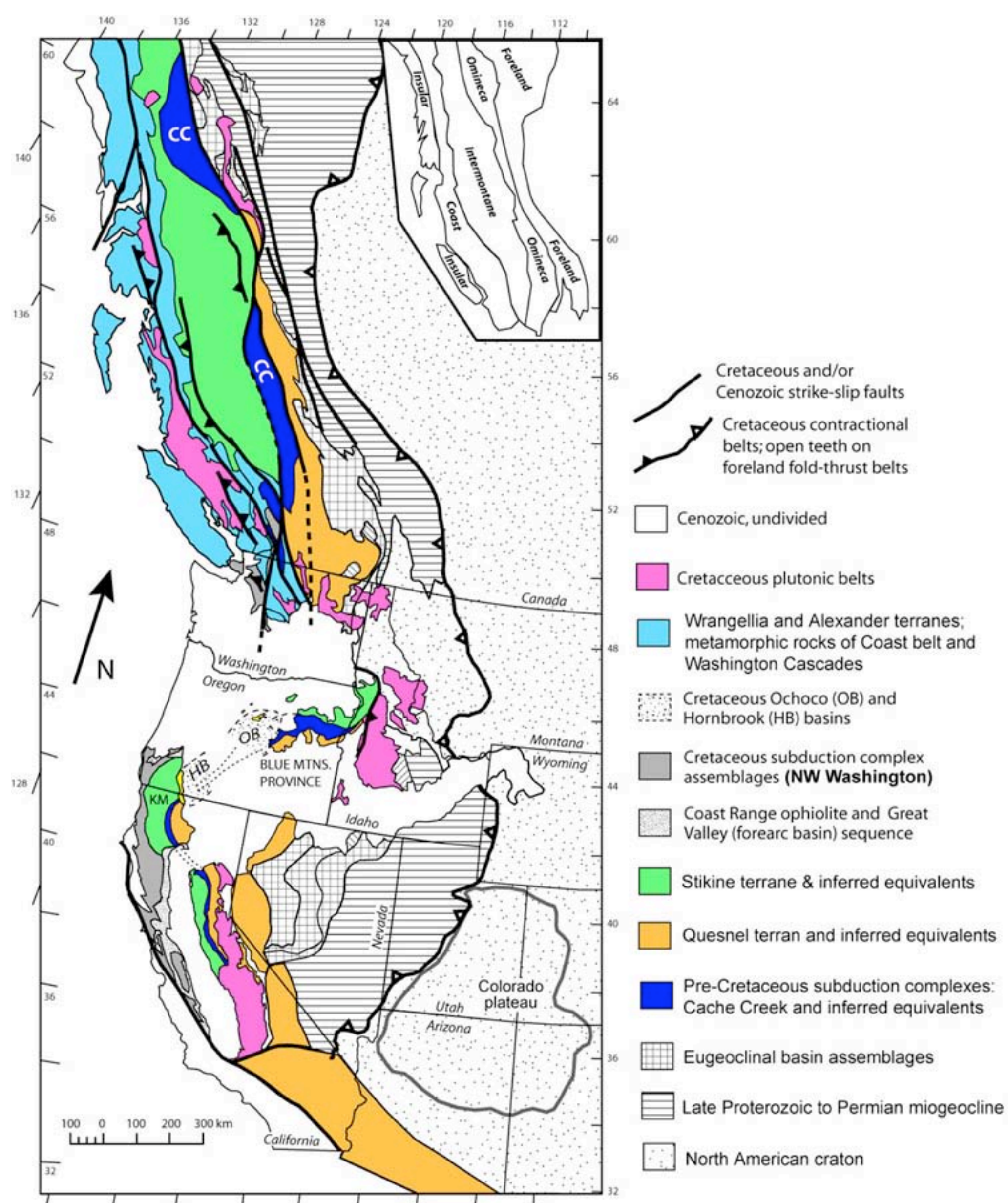
Mesozoic Tectonics of the Blue Mountains Province



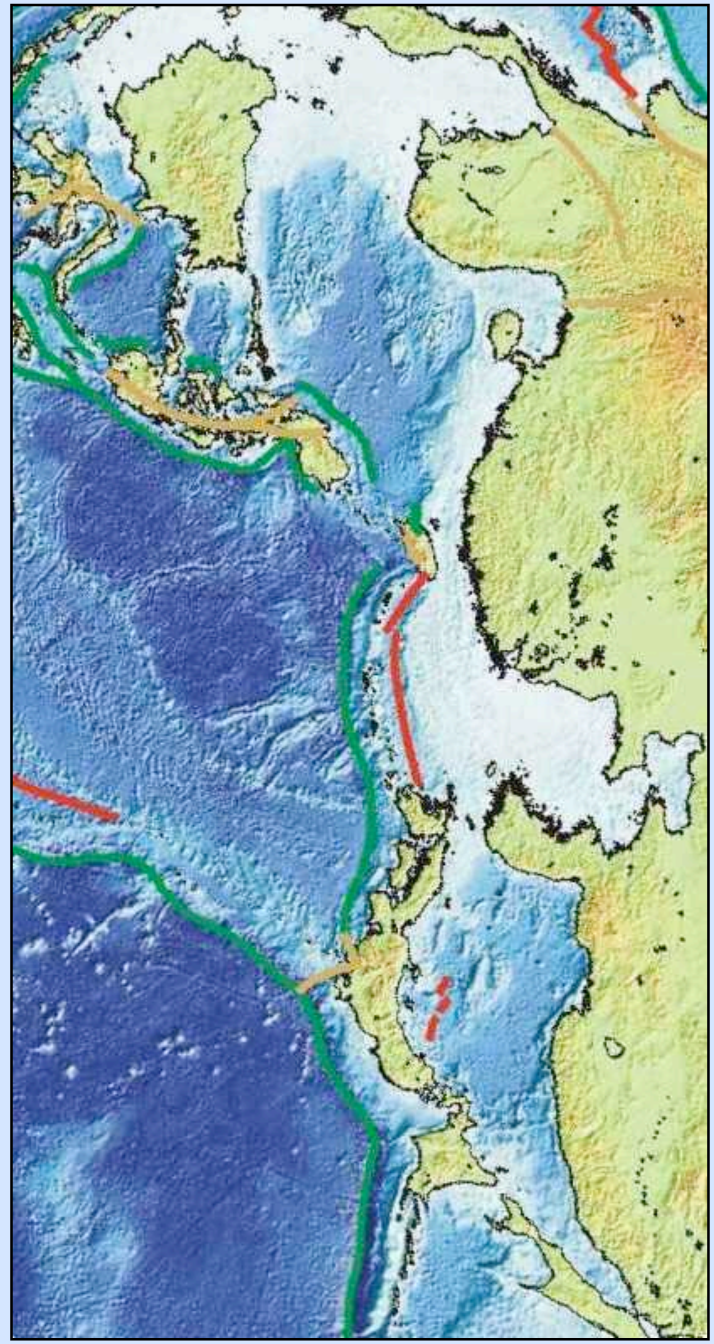
Main Events

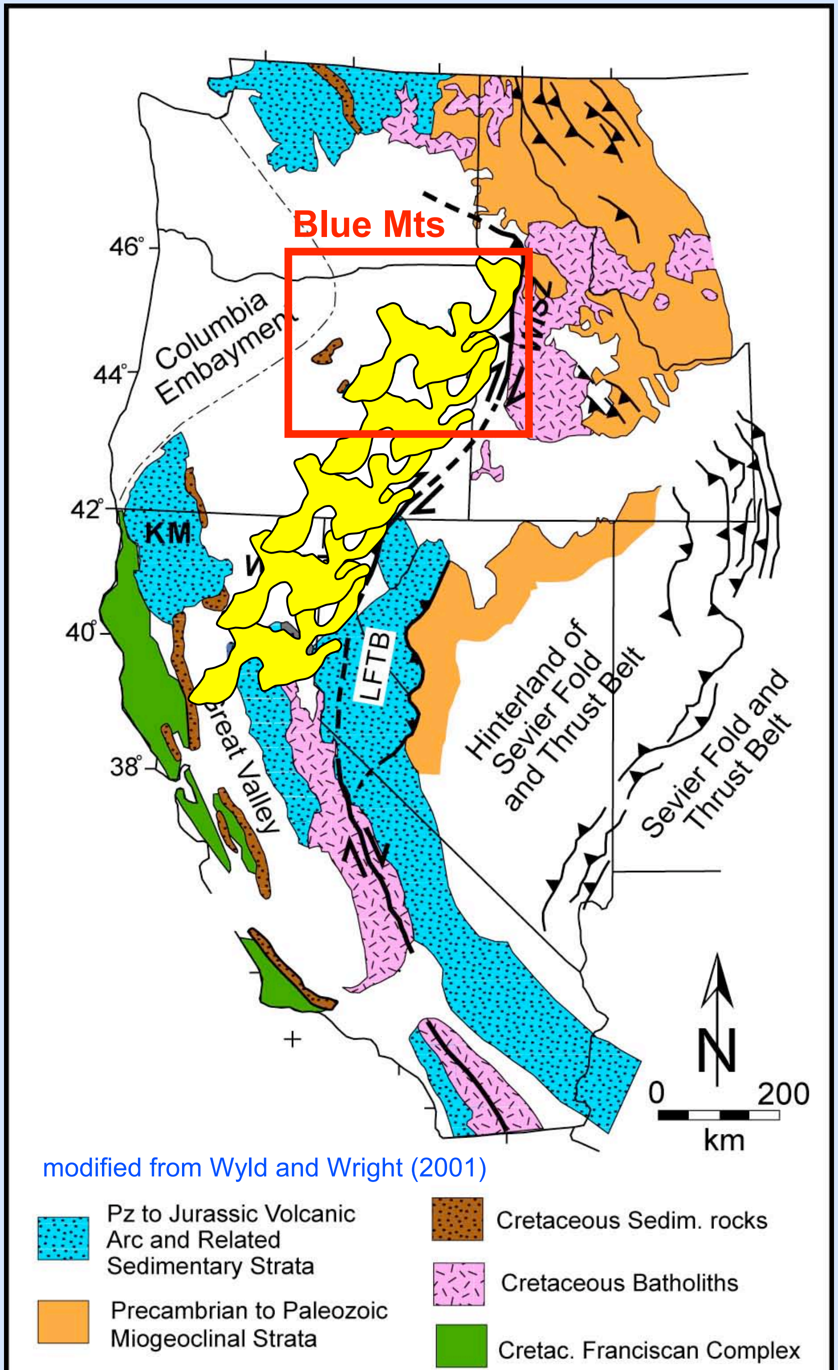
- Middle Triassic: normal subduction and facing arcs
- Late Triassic: arc-arc collision (?)
- Jurassic: long-lived terrane-continent collision (?)
- Early Cretaceous: Andean-type margin
- Late Cret. (to Early Tert.?): Transpression in WISZ

Photo by Ellen Bishop



Umhoefer and Blakey (in press)





Western U.S. Cordillera:

- Complex history of Mesozoic terrane amalgamation, accretion, and translation.

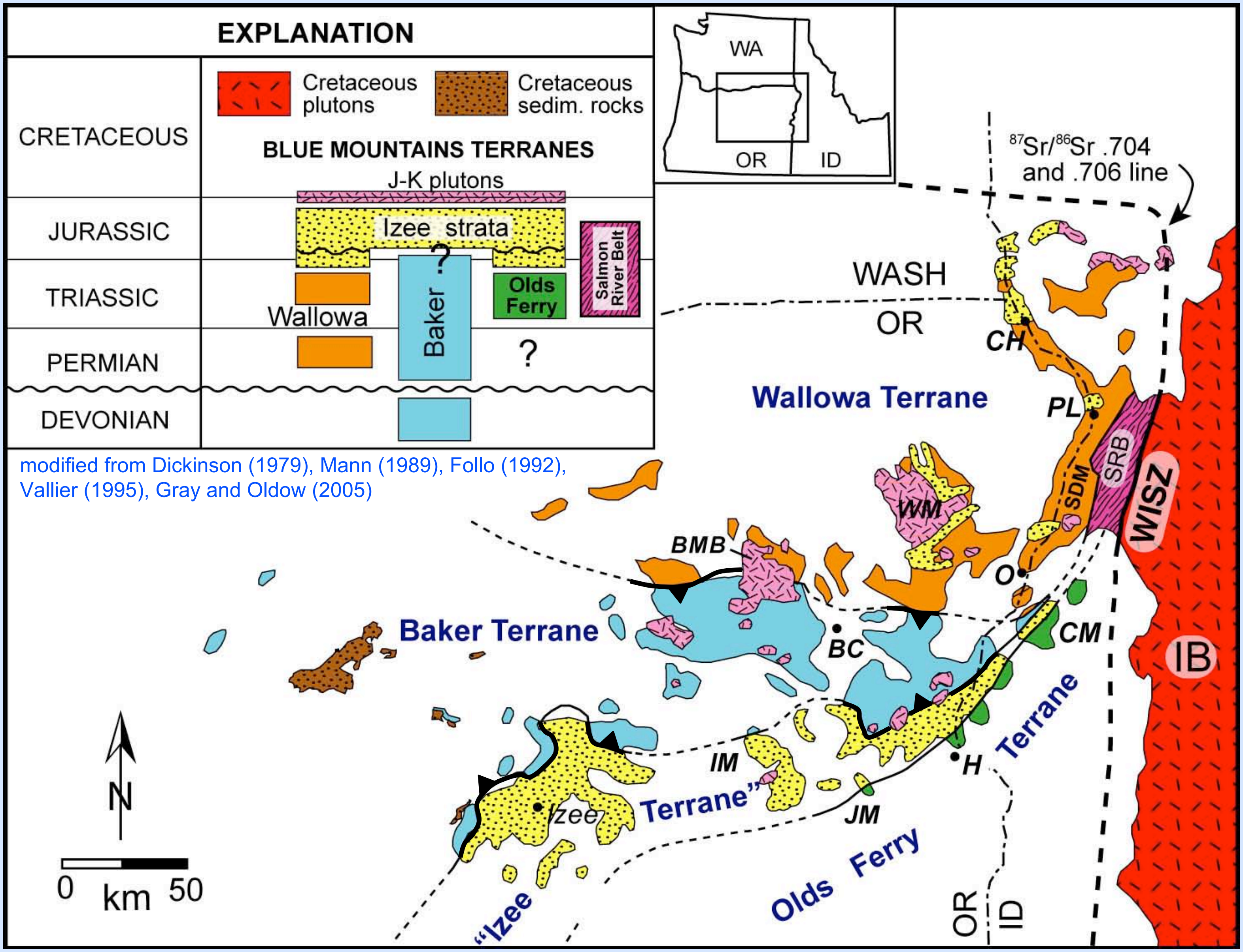
- Possible correlation of Blue Mts to NW Nevada (Wyld and Wright, 2001) …

Correlation requires further testing, good working hypothesis. It allows us to ask:

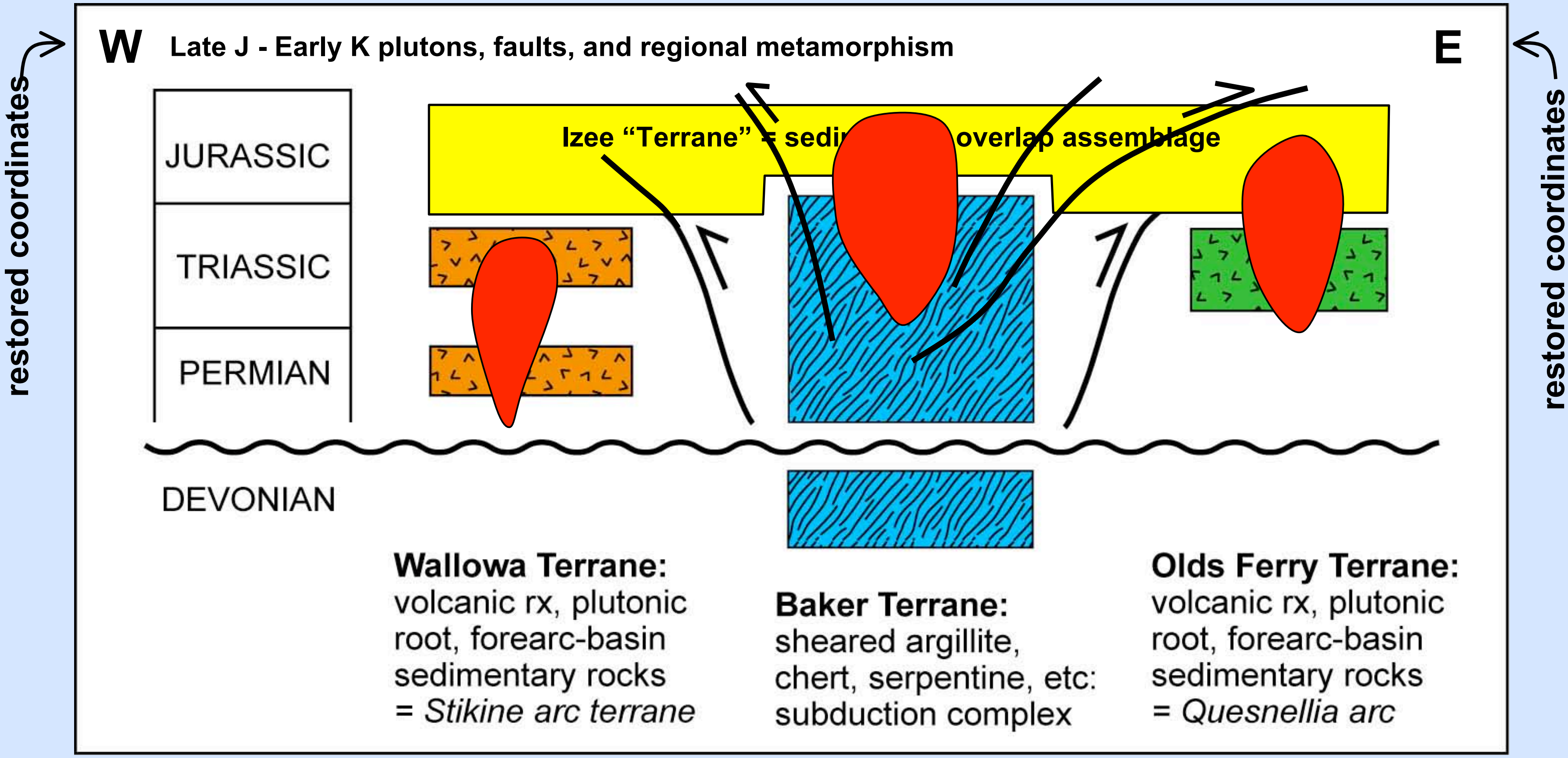
What was the timing and geometry of plate interactions that resulted in accretion of arc terranes to North America in Triassic and Jurassic time ??

What was the timing and amount of later translation along the Mojave-Snow Lake-Nevada-Idaho fault system (MSNI)?

Mesozoic Geology of the Blue Mountains



Terranes of the Blue Mountains

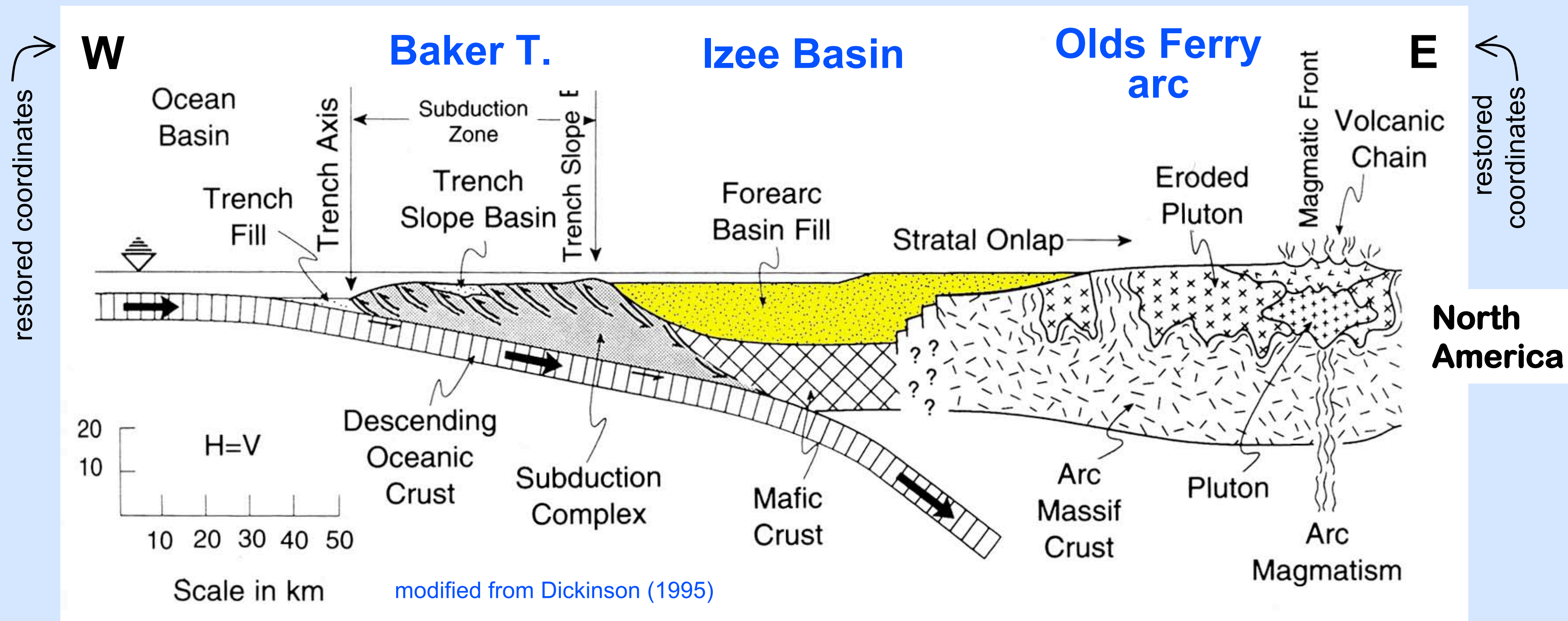


- **What were the subduction geometries and changes through time?**
- **When and how were different terranes assembled?**
- **How did the Izee basin form, what was the tectonic setting?**

Existing Model:

Long-lived, Late Triassic - Late Jurassic west-facing forearc basin

(Dickinson and Thayer, 1978; Dickinson, 1979)



Other workers have proposed variations on this model, but this is the <u>leading conventional wisdom</u> for the Izee basin and Blue Mountains

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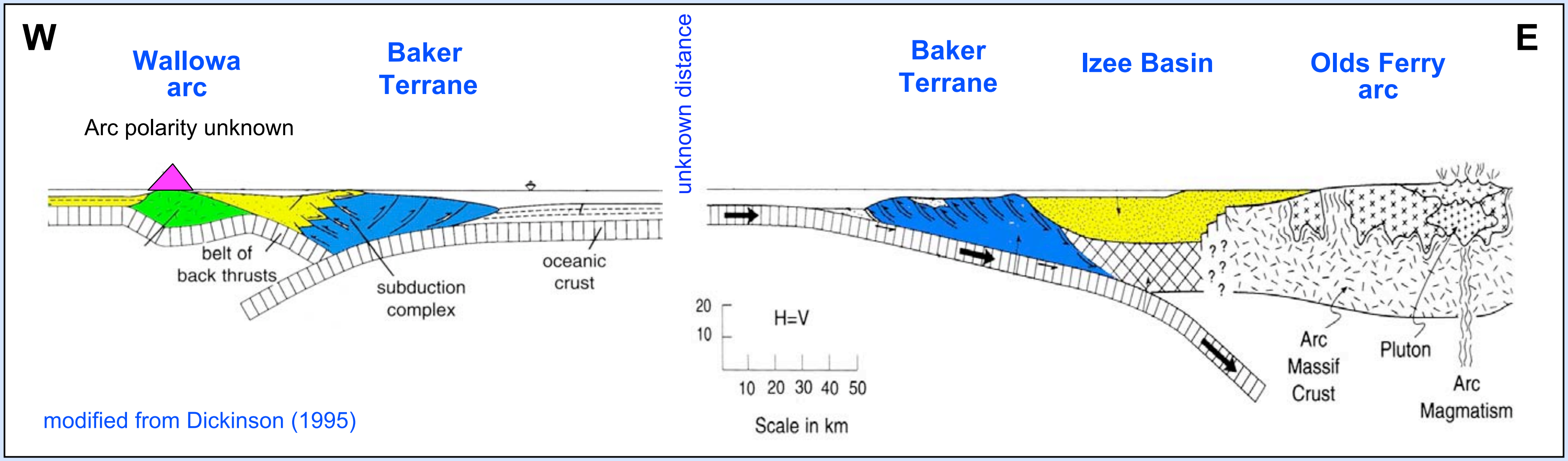
(Dickinson and Thayer, 1978; Dickinson, 1979)

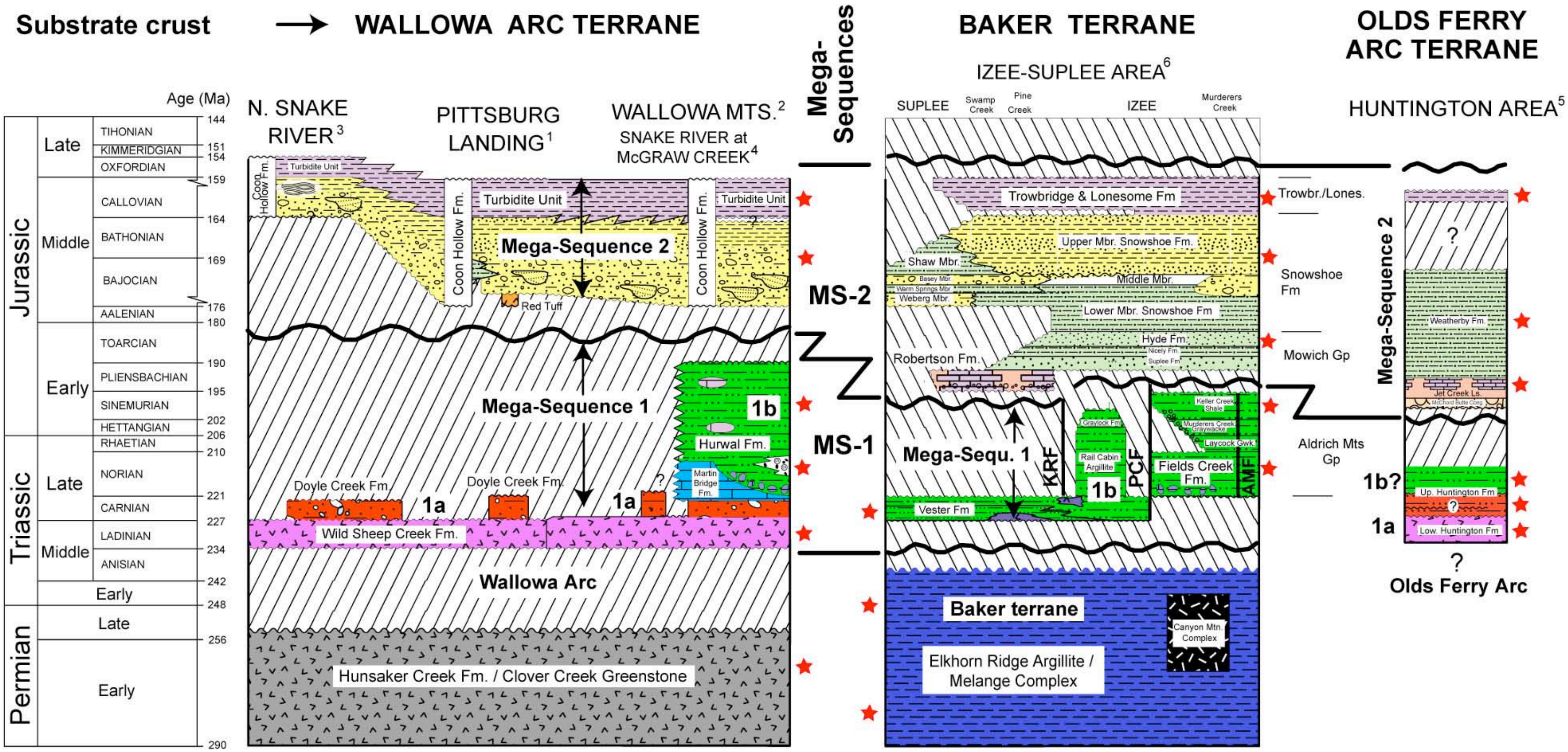


According to this Model:

- Izee Basin formed above an east-dipping, west-vergent subduction zone

  … same tectonic setting from Late Triassic to Middle/Late Jurassic
- Baker terrane is a composite of both subduction complexes
- Wallowa arc collided with Olds Ferry arc in LATE JURASSIC time

Stratigraphy of the Blue Mountains



★ indicates positions of samples to be collected for provenance analysis

- Norian shallow- to deep-water carbonate facies
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- Middle to upper Upper Jurassic shale and sandstone
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- Middle Jurassic sandstone and shale
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1. White et al. (1992); White (1994); White and Vallier (1994)
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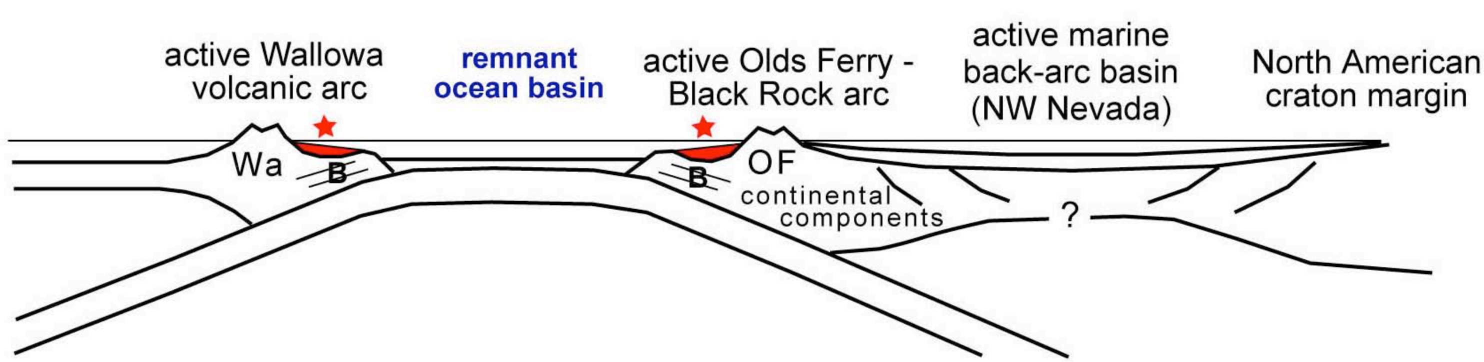
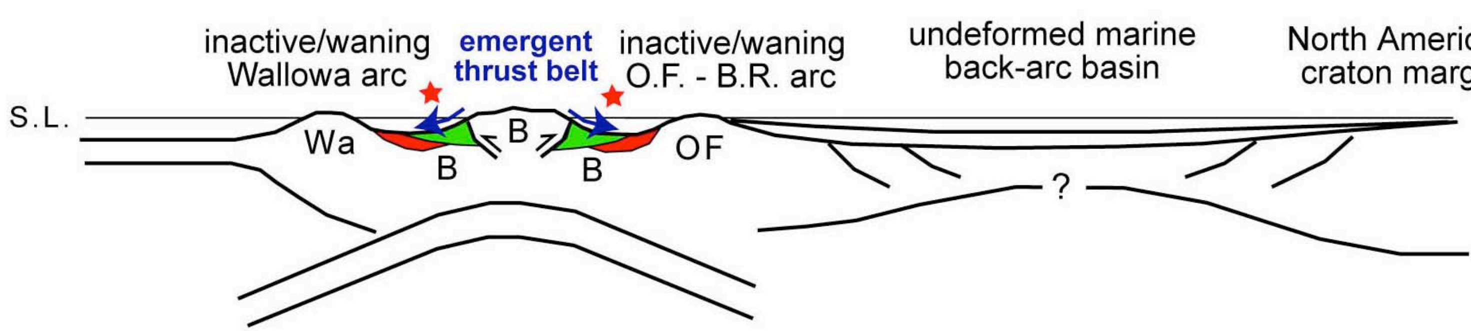
compiled by Todd LaMaskin

Alternate Hypothesis:
Arc-Arc followed by Terrane-Continent Collision

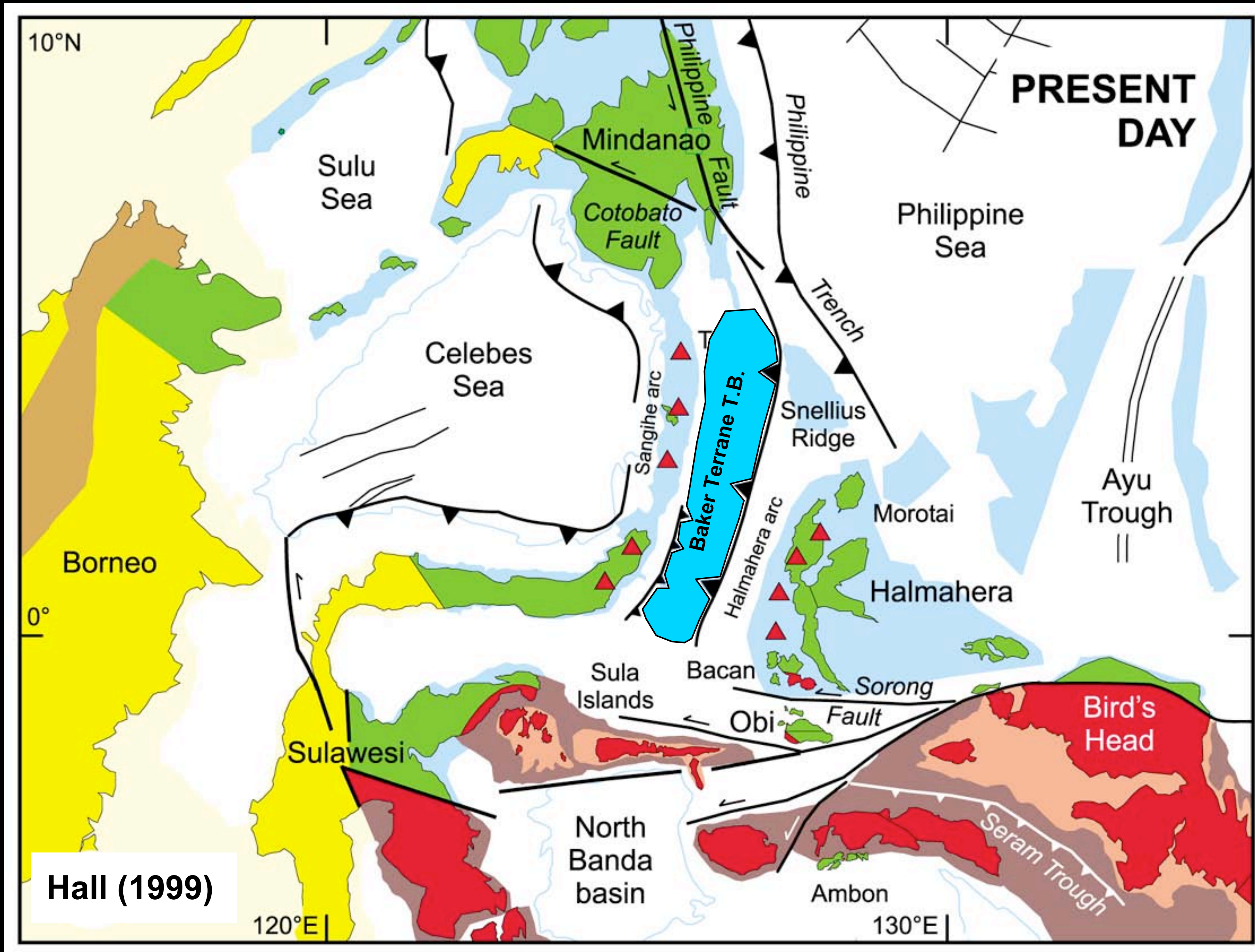
Middle to Late Triassic (Ladinian - Carnian): **Pre-collisional facing arcs, closing ocean basin**



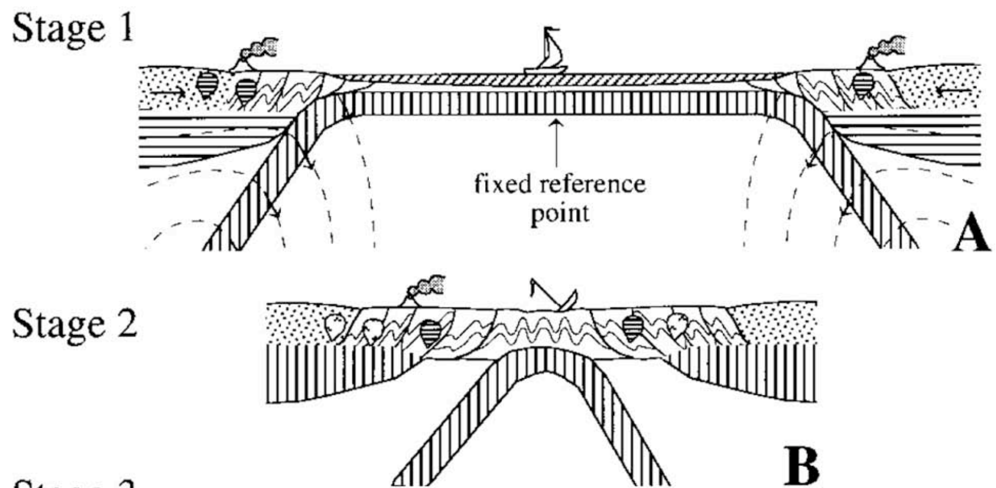
Late Triassic (Carnian - Norian): **Molucca Sea-type arc-arc collision, Baker terrane thrust belt**

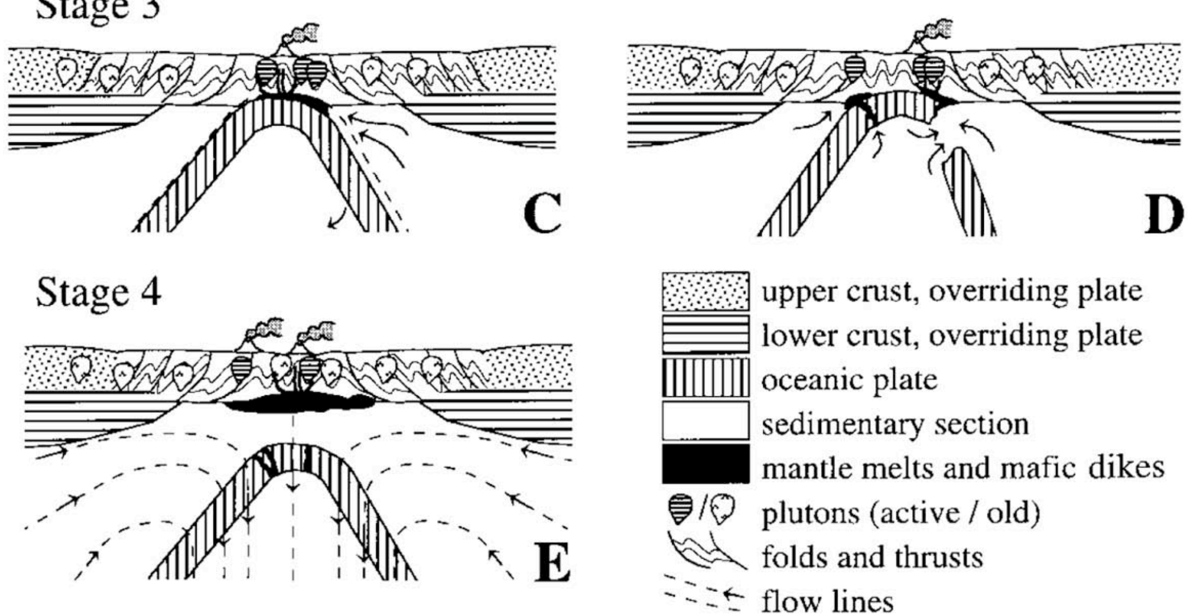


Molucca Sea: early stages of arc-arc collision



A Related Tectonic-Petrologic Model





Soesoo et al. (1997)

1. Precollisional, converging arcs.

2. Closure of ocean basin, end of convergence by normal subduction. Convergence continues by crustal shortening (and thickening).

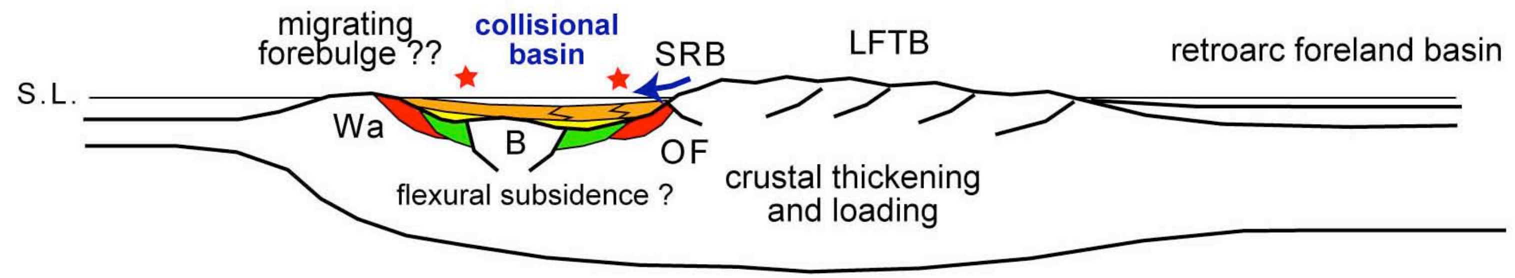
3. Detachment and sinking of oceanic plate. Mantle-derived melt fills space and drives more volcanism.

4. Further sinking of oceanic slab, significant flow of mantle and melt. Bimodal magmatism occurs above hinge zone.

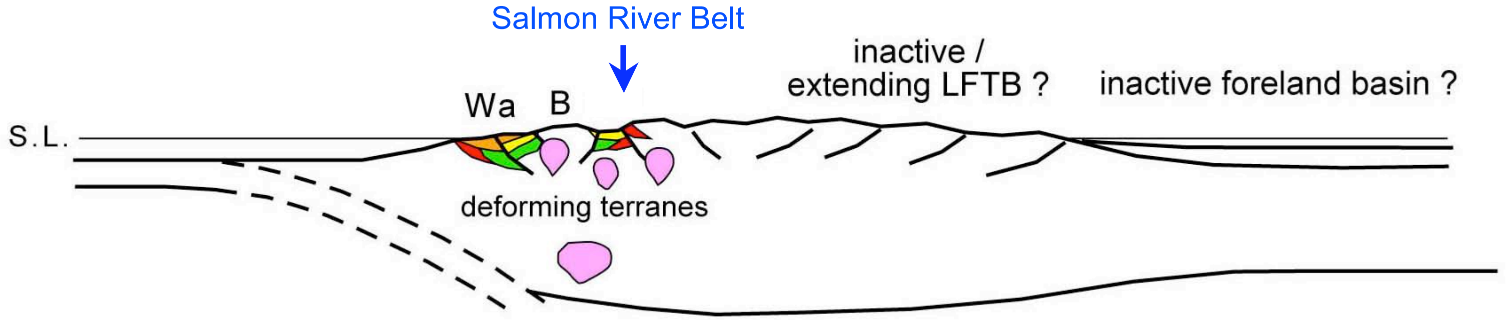
… ignores surface processes and basinal effects of crustal thickening and loading.

Alternate Hypothesis:
Arc-Arc followed by Arc-Continent Collision

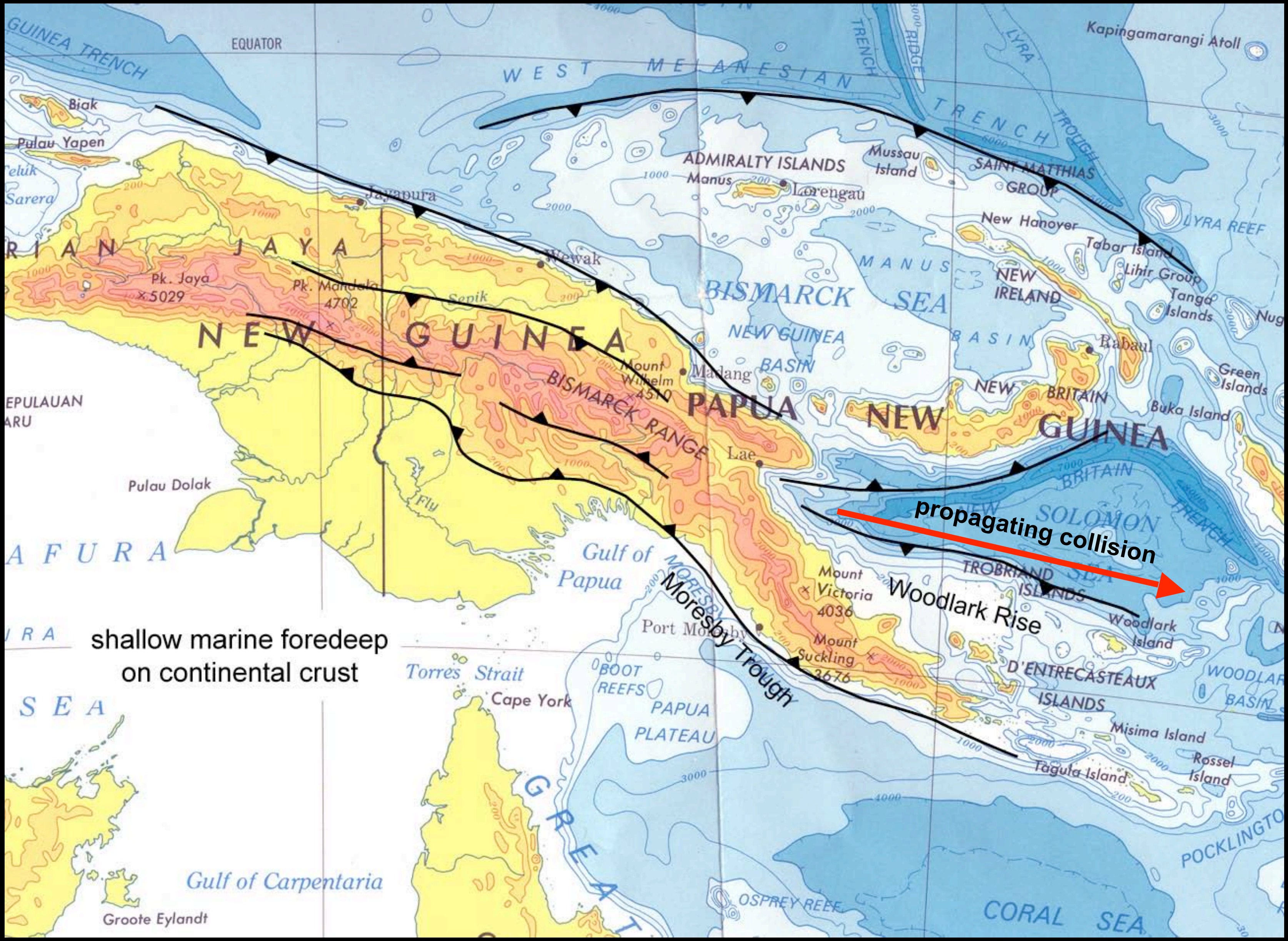
Early to Late Jurassic: **Flexural subsidence in collisional basin, thick overlap assemblage**



Late Jurassic - Early Cretaceous: **Strong crustal shortening, metamorphism, plutonism**



Papua New Guinea



Supporting Evidence (previous studies):

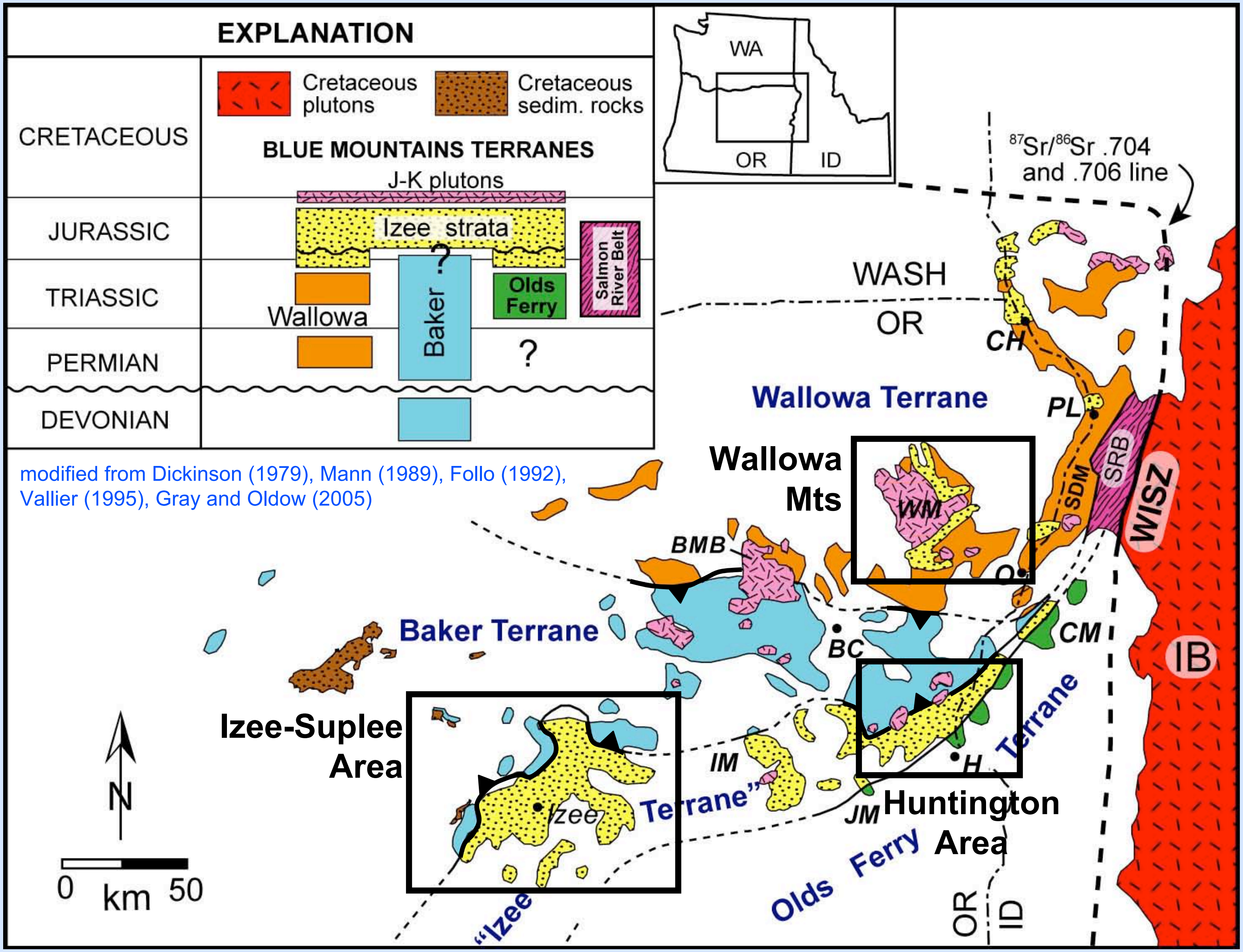
• **Mid-Late Triassic**: Pre-collisional volcanic arcs and forearc basins (MS-1a) well documented in Wallowa and Olds Ferry terranes.
Vallier (1974, 1977, 1995); Brooks and Vallier (1978); Walker (1986, 1995); White and Vallier (1994).

• **End of Arc Magmatism** at end of Carnian time in both arcs, transition to complex Late Triassic sedimentation and mountain building. ibid.

• **Late Triassic**: Chert-bearing marine olistostromes and conglomerates, locally in thrust-bounded basins, record uplift and erosion of large thrust belt in Baker terrane … transport into flanking basins on opposite sides (MS-1b).
Dickinson and Vigrass (1964); Dickinson and Thayer (1978); Follo (1986, 1992, 1994).

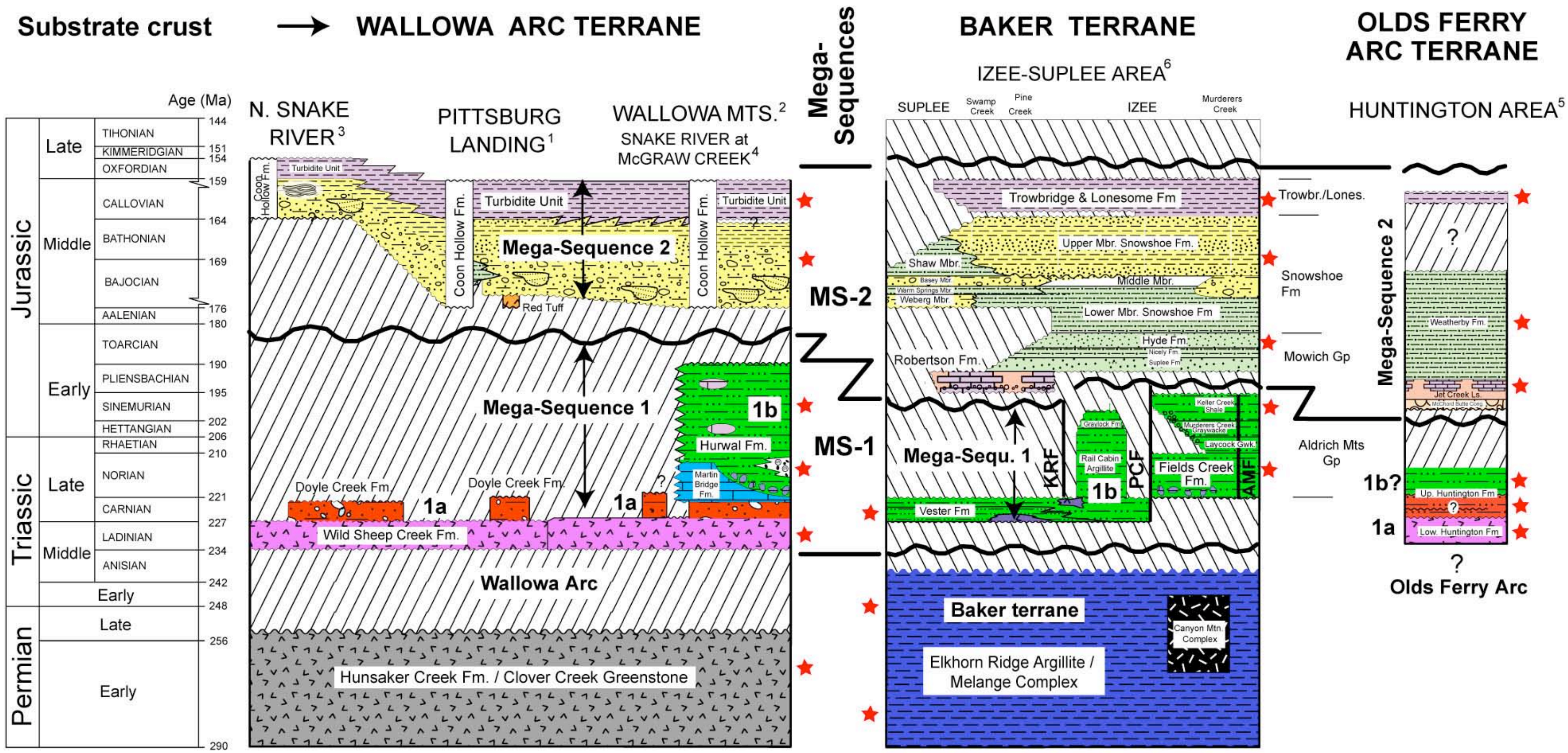
• **Early to Late Jurassic**: Baker terrane thrust belt buried beneath ~10 km of marine sediments (MS-2). Dickinson and Thayer (1978); Dickinson (1979); Brooks and Vallier (1978); Brooks (1979); White et al. (1992); Follo (1986, 1992, 1994); Goldstrand (1994).
We think this is due to widespread flexural subsidence in the Izee basin that resulted from crustal thickening and loading in LFTB (PNG-style collision).

Mesozoic Geology of the Blue Mountains



modified from Dickinson (1979), Mann (1989), Follo (1992), Vallier (1995), Gray and Oldow (2005)

Stratigraphy of the Blue Mountains



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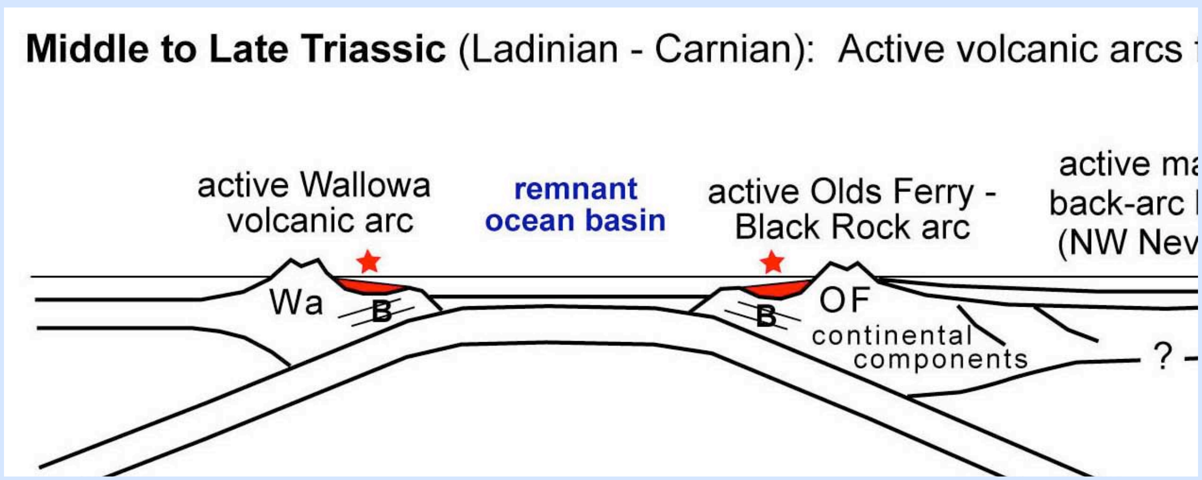
compiled by Todd LaMaskin

Doyle Creek Formation: forearc basin strata

fine-grained marine turbidites and …

coarse volcaniclastic sst & pebble cgl



εNd +7 (new results from Vervoort's lab), indicates juvenile crust with no continental input.

Martin Bridge L.S.

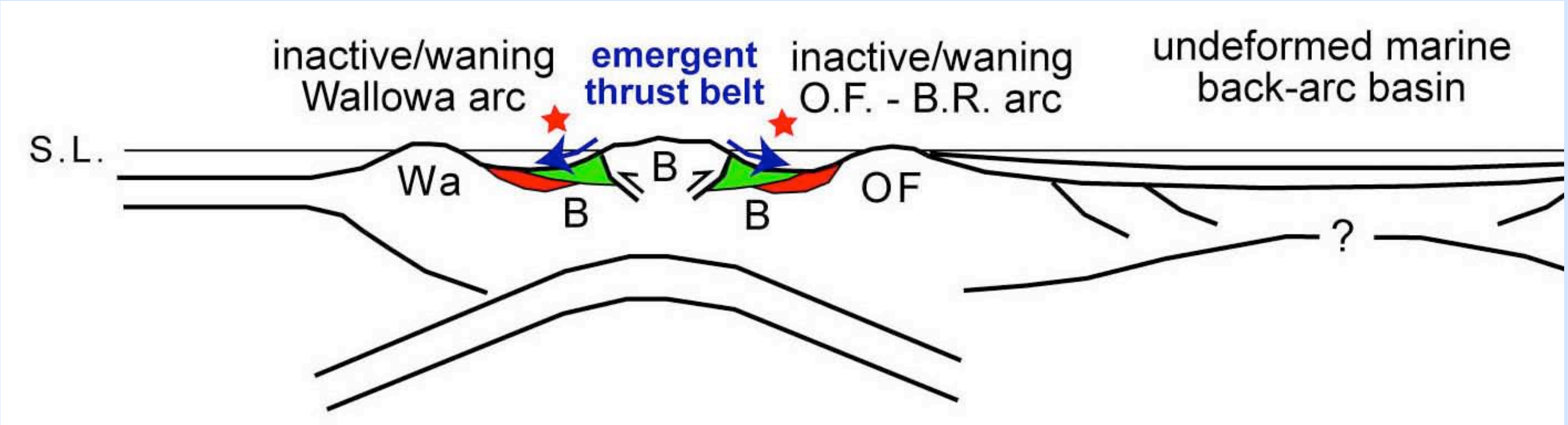
Widespread regional unit: shallow platform carbonate w/ diverse fauna (corals, sponges, crinoids) and sedimentary structures.

Records end of Mid Triassic arc volcanism … end of subduction due to collision of accretionary prisms.

Transition to Hurwal Fm

Carbonate turbidites record deepening and foundering of carbonate platform … why?

Rise and fall of the Martin Bridge LS may record migration of a flexural bulge due to loading in the Baker terrane thrust belt.



Hurwal Fm

Late Triassic - Early Jurassic

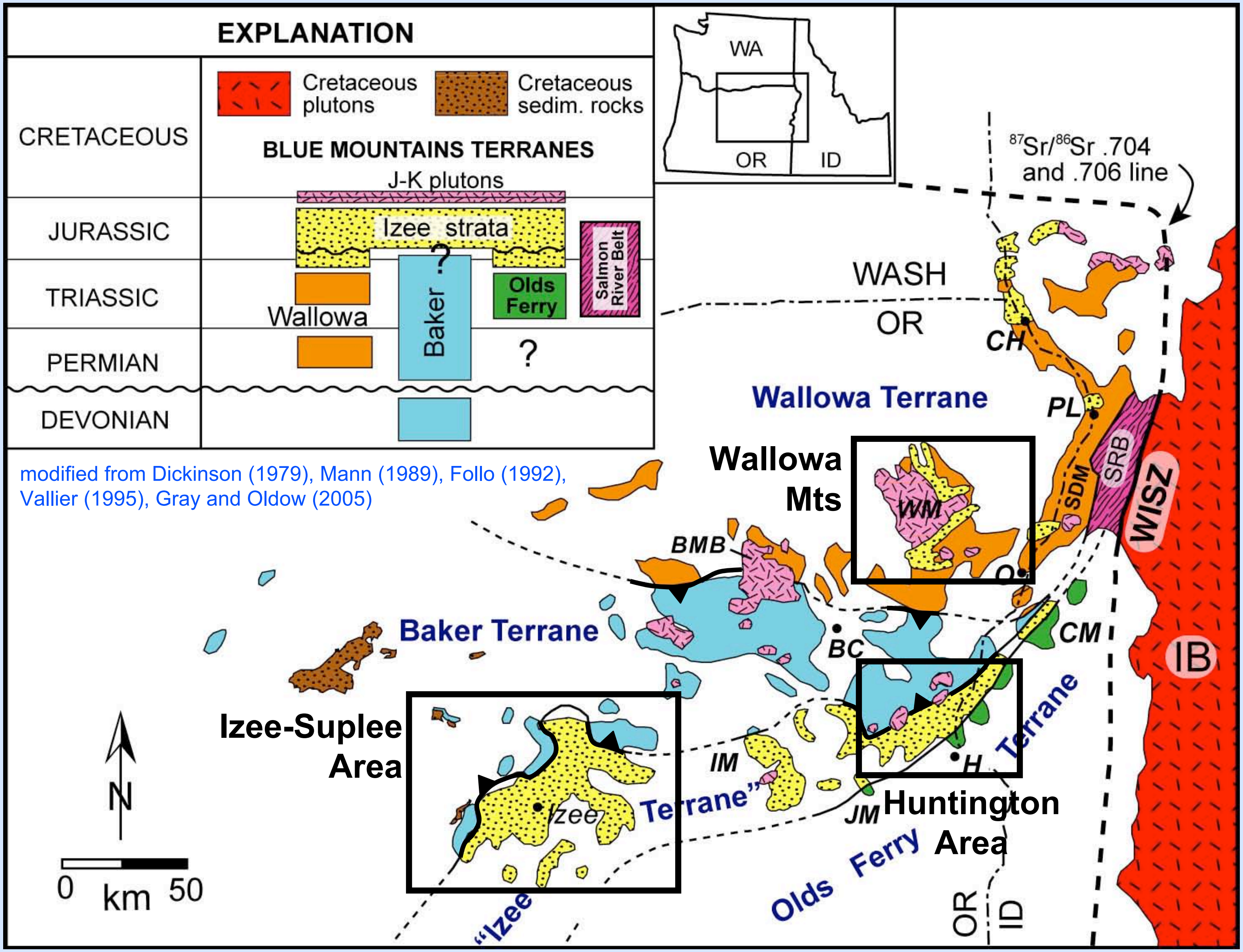
Fine-gr. turbidites & argillite, deep marine basin, partially equivalent to Martin Bridge L.S.

Excelsior Gulch Conglomerate: clasts include limestone, chert, volcanics, plutonic rx ... eroded from Baker terrane T.B.

(Follo, 1986; 1992; 1994)

εNd +4 to +2, some mixing with continental clay.

Mesozoic Geology of the Blue Mountains



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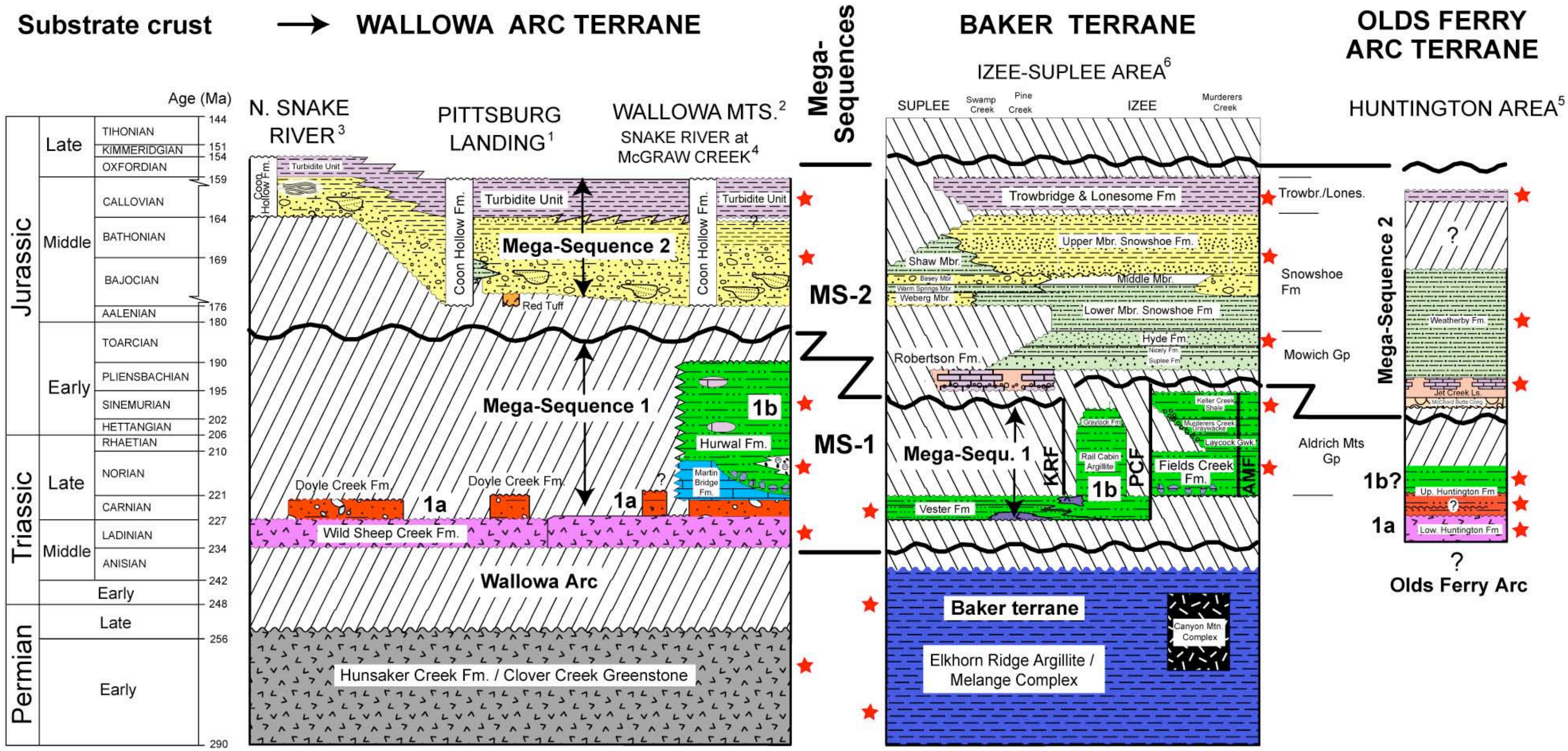

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compiled by Todd LaMaskin

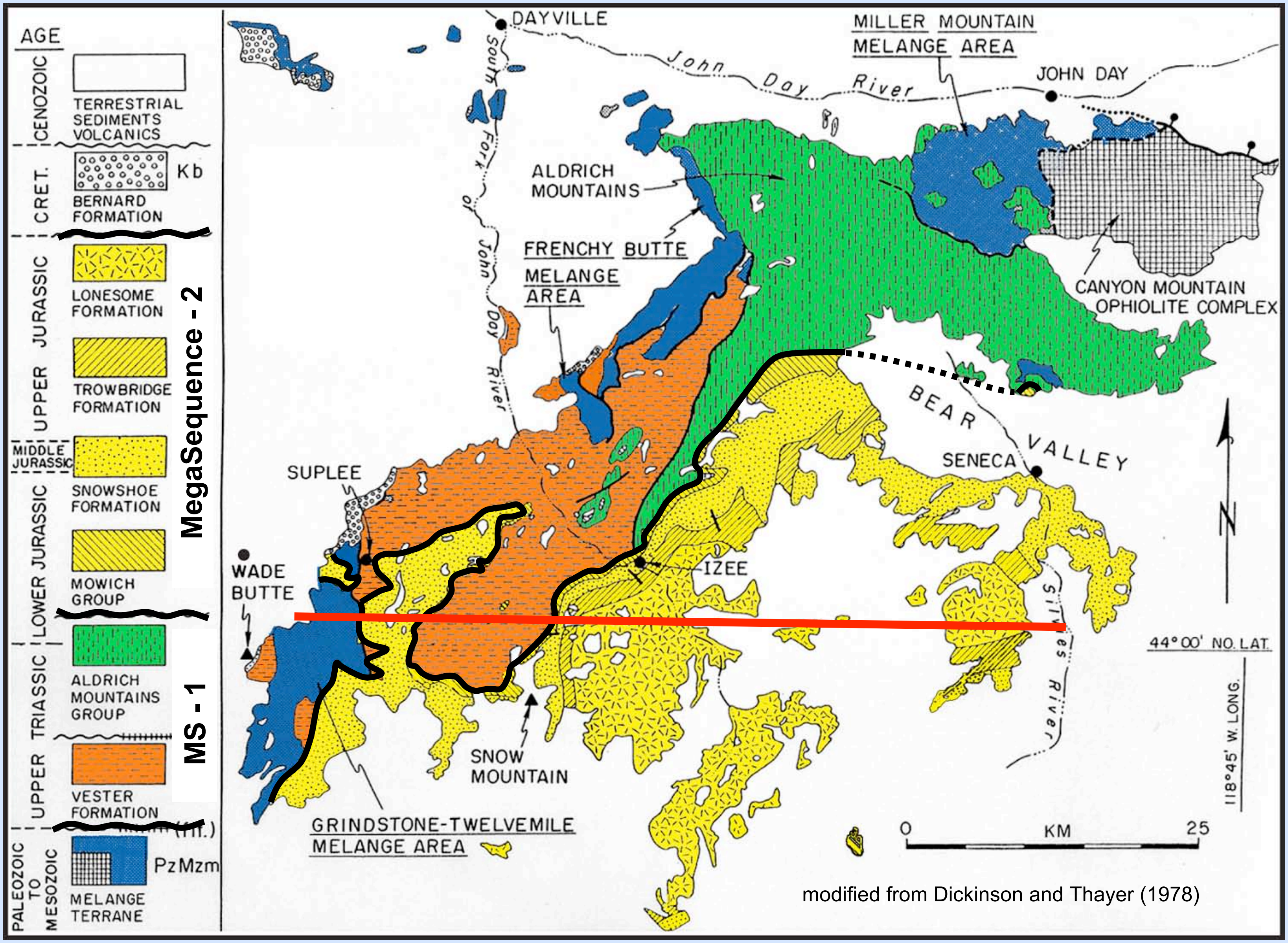
Vester (Carnian) and Fields Creek (Norian) Fms

Bedded turbidites, argillite, cgl, slumps, & breccias w/ large olistostromes (submarine slide blocks) … clasts include chert, serpentine, and plutonic rocks from adjacent Baker terrane.

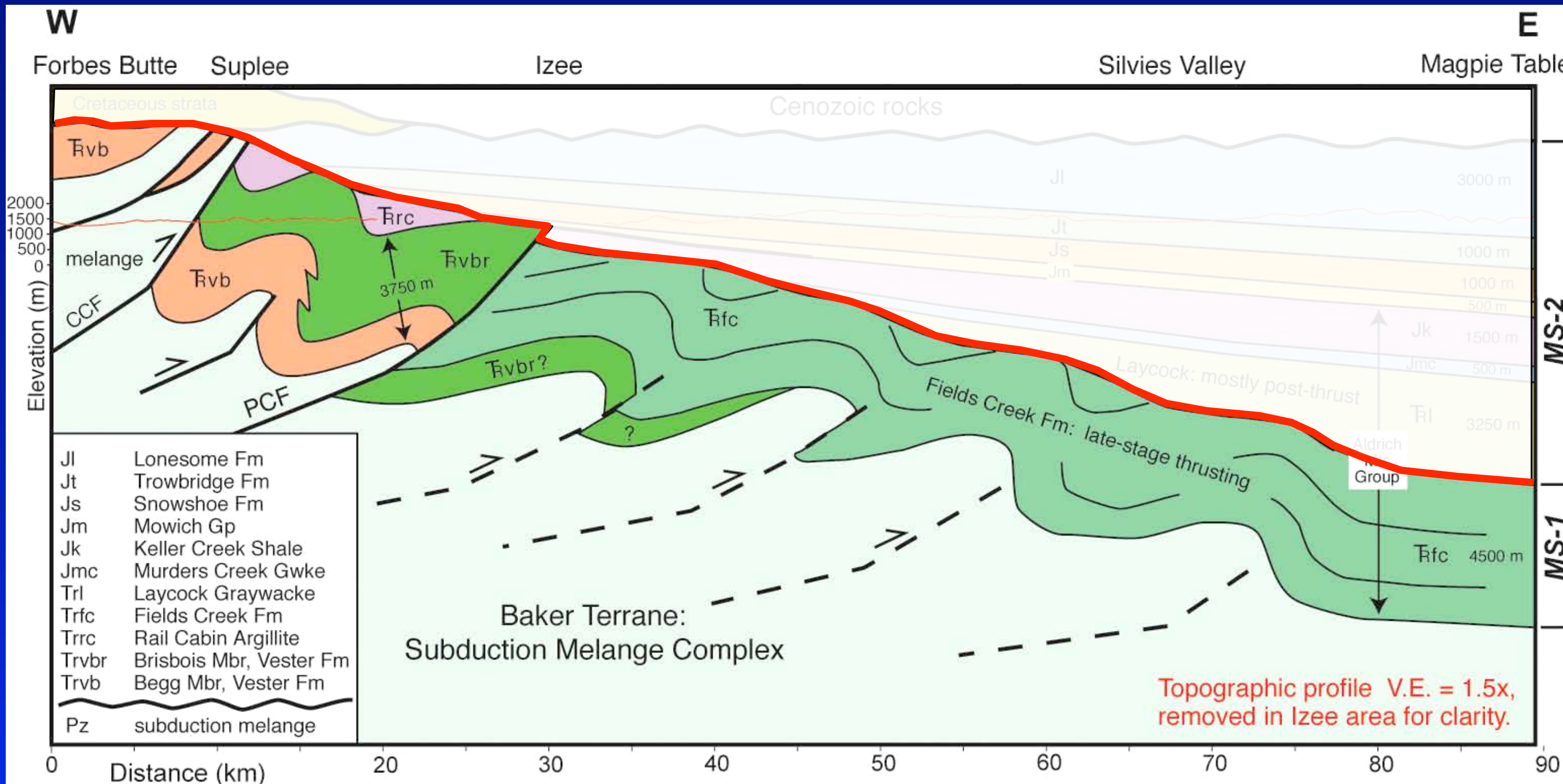
Unstable steep margin of tectonically active marine basin

Dickinson and Thayer (1978)

Izee-Suplee area

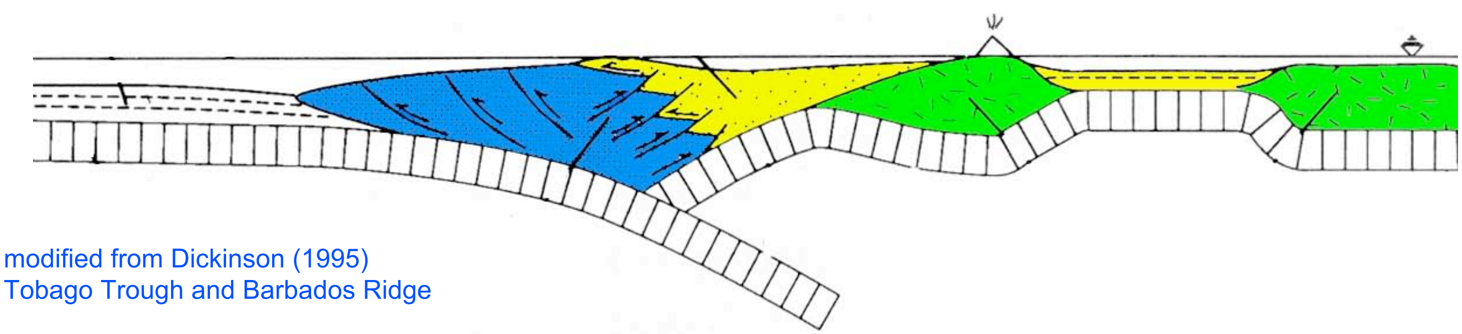


modified from Dickinson and Thayer (1978)



Constructed using data from Dickinson and Thayer (1978), Dickinson and Vigrass (1965), Brown and Thayer (1966)

Dickinson (1979): backthrusting on edge of accretionary prism above "normal" east-dipping subduction zone

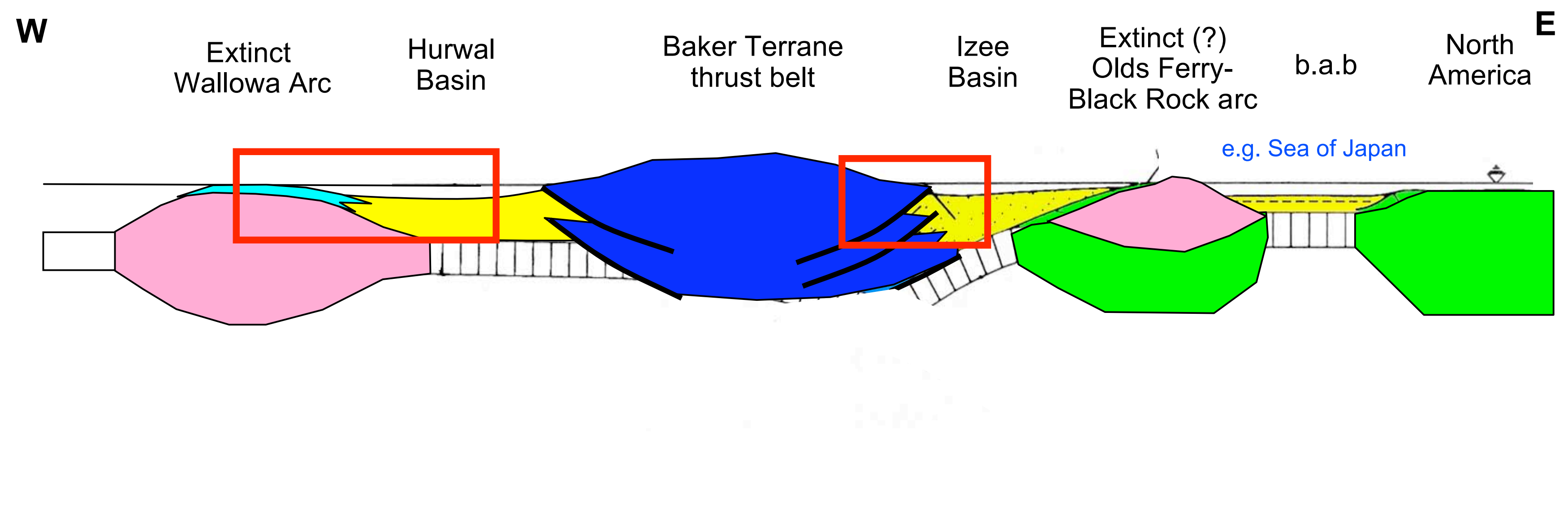


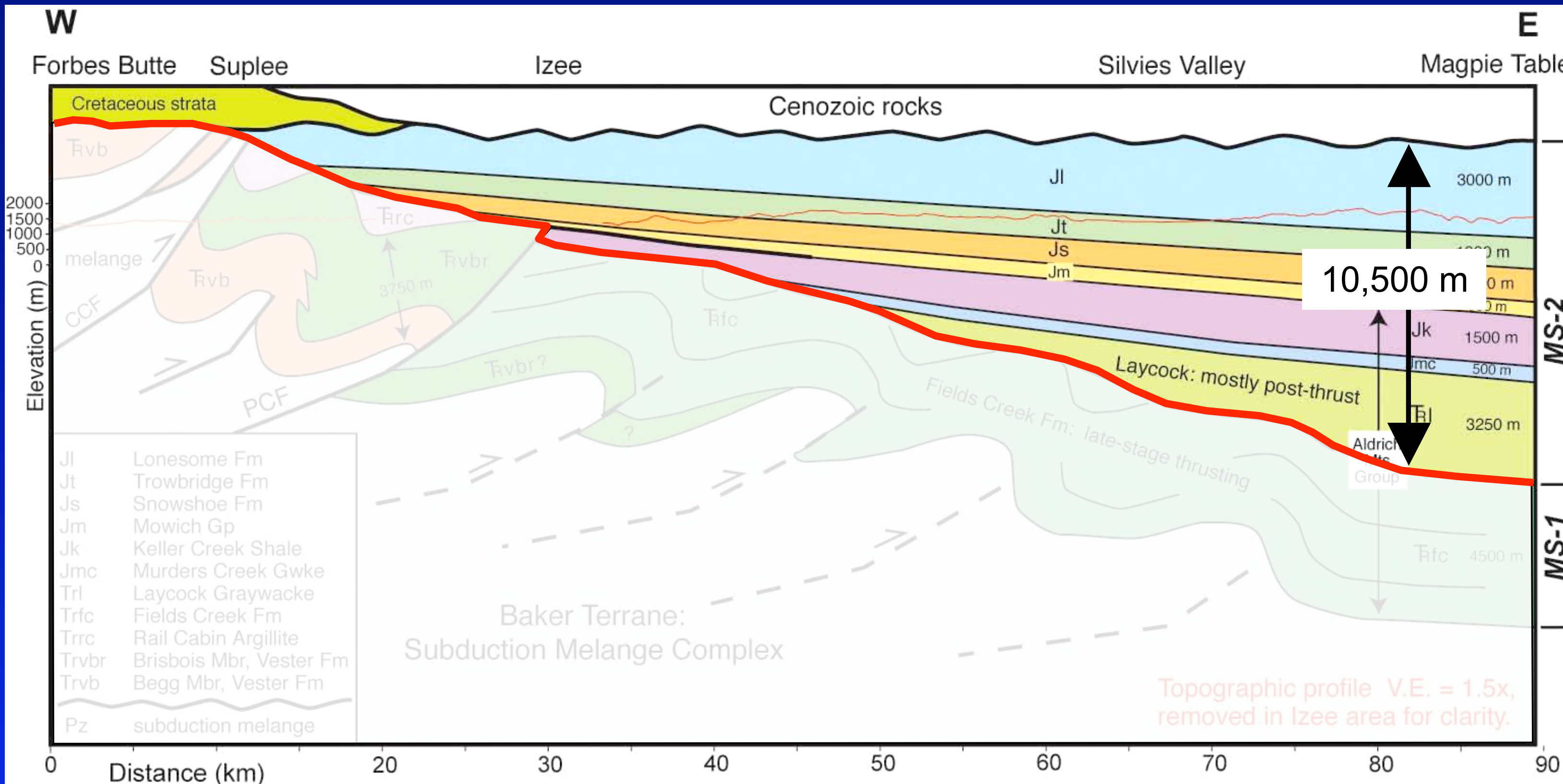
modified from Dickinson (1995)
Tobago Trough and Barbados Ridge

Late Triassic

Dickinson (1979): backthrusting above "normal" east-dipping subducting plate

Alternate Hypothesis: doubly vergent Baker t. thrust belt and flanking flexural basins





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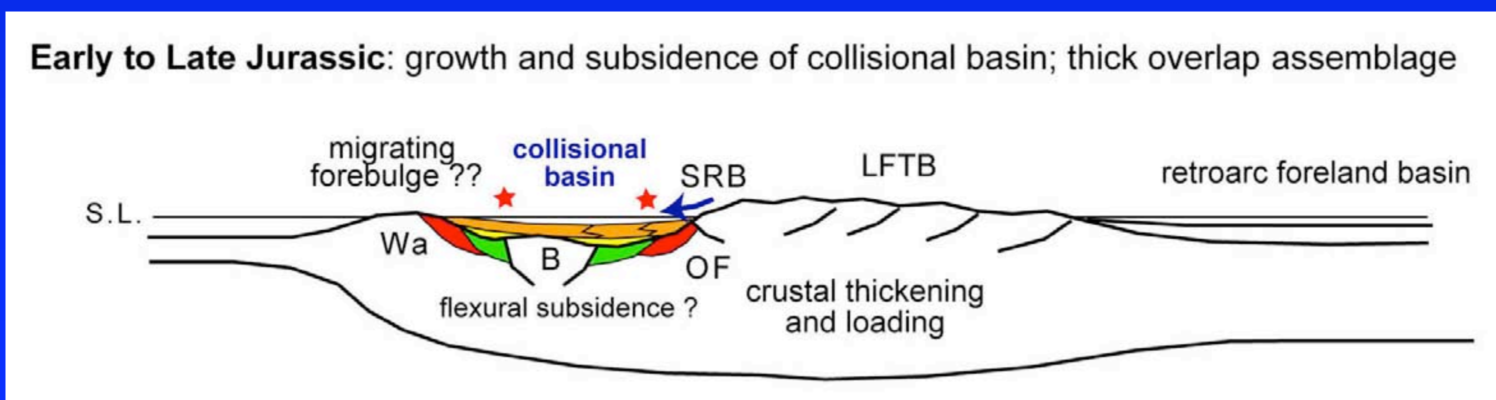
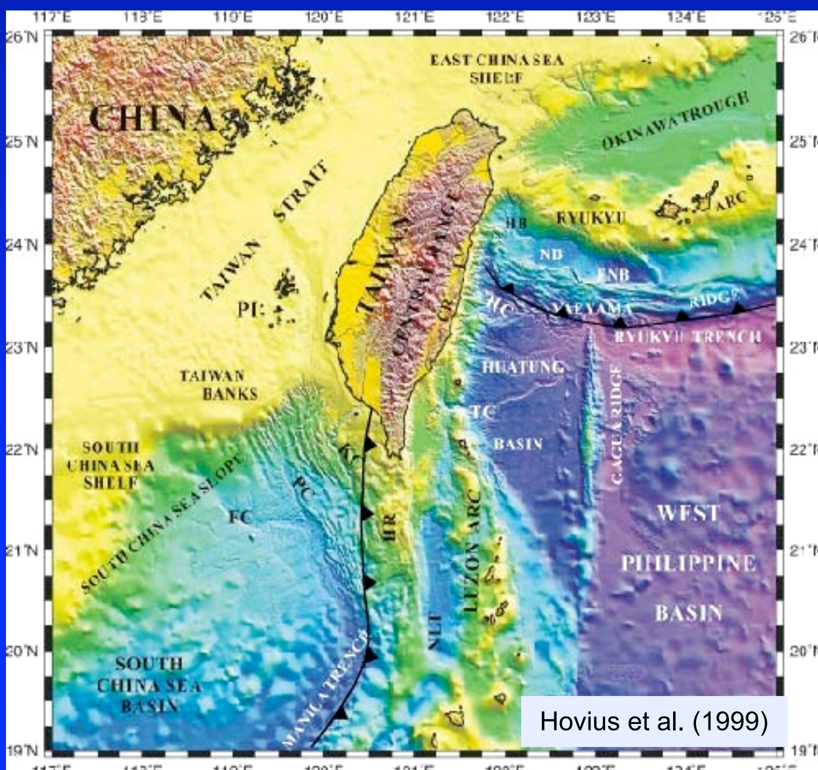


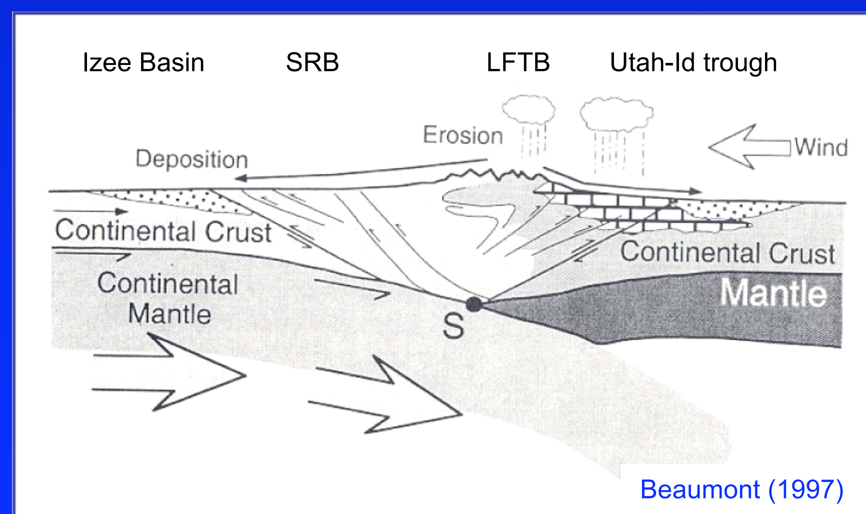
Possible Modern Analogs:

Transpressional doubly-vergent collisional mountains belts and flanking sedimentary basins: Taiwan, Yakutat, Papua N.G …

Mazzotti and Hyndman (2002)



Hovius et al. (1999)



Beaumont (1997)

Ongoing Work with Jeff Vervoort (Todd):

**The collisional hypothesis is supported by previous studies …
but the hypothesis remains untested.**

Our hypothesis makes specific predictions about:

- trace-element and Nd-isotopic signatures in shales
- detrital zircon age populations in sandstones
- framework mineralogy of sandstones
- regional stratigraphic relationships in the Izee basin.

These predictions are distinct from those of the traditional model for a non-collisional arc and forearc basin. Carefully designed tests allow us to discriminate between the two hypotheses and evaluate the role of arc-arc and PNG-style “terrane-continent” collision in the NW Cordillera.