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A diachronous opening of the Iapetus Ocean in the Neoproterozoic

Boris Robert[1], Mathew Domeier[1], Johannes Jakob[1]

[1]Centre for Earth Evolution and Dynamics, University of Oslo, Norway

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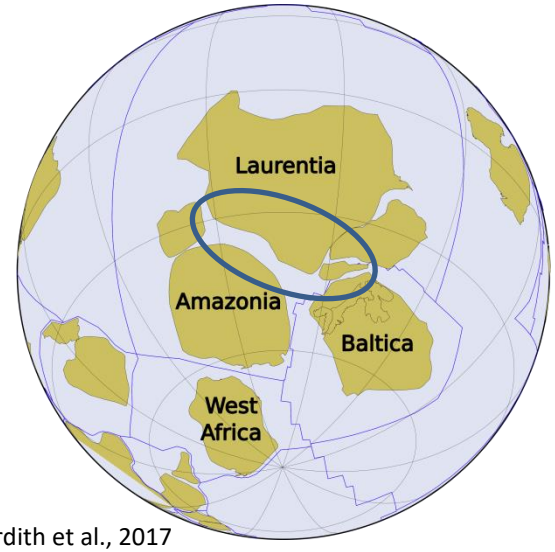
UiO : University of Oslo

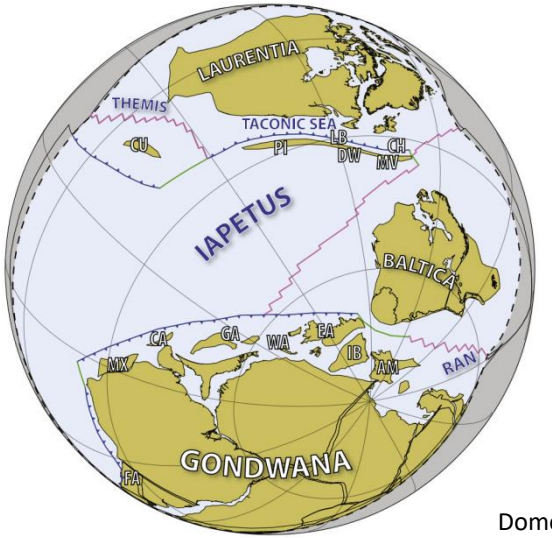
The Iapetus Ocean

Opening
~700-550 Ma

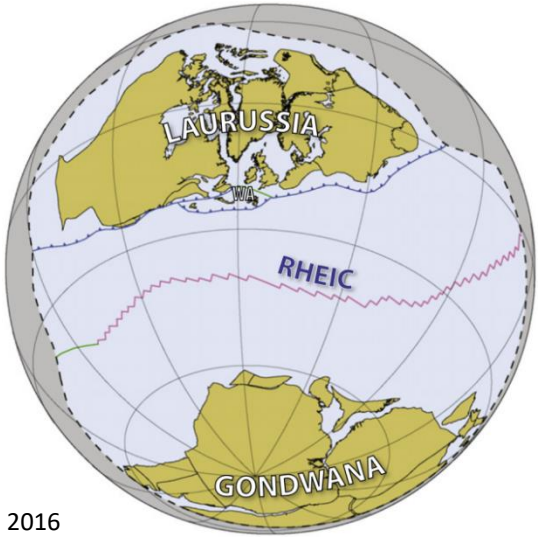


Merdith et al., 2017

500 Ma



Closure
~430 Ma



Domeier, 2016

When does the Iapetus Ocean open?

Three distinct times proposed for the opening between Laurentia and Amazonia :

(1) 550-530 Ma (e.g. Pisarevsky et al. 2008)

(2) 615-570 Ma (e.g. Cawood et al. 2001)

(3) 750-680 Ma (e.g. Li et al. 2013)

In this study, **review of the geological observations** from 750 to 520 Ma to test these scenarios.

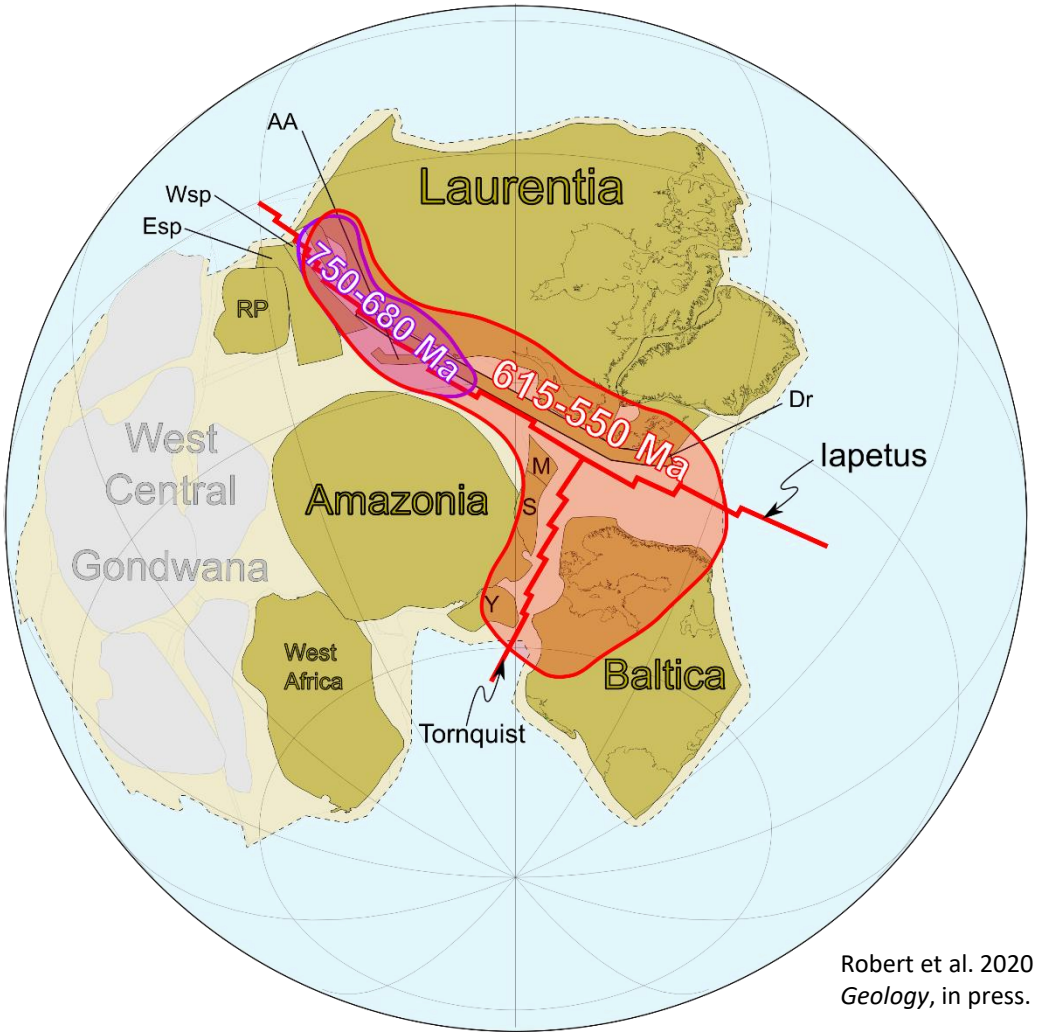
Distribution of magmatism linked to rifting

Two main phases of rifting at
750-680 Ma and 615-550 Ma.

Phase (II) usually interpreted as leading to breakup.

Phase (I) only found between Laurentia and Amazonia.

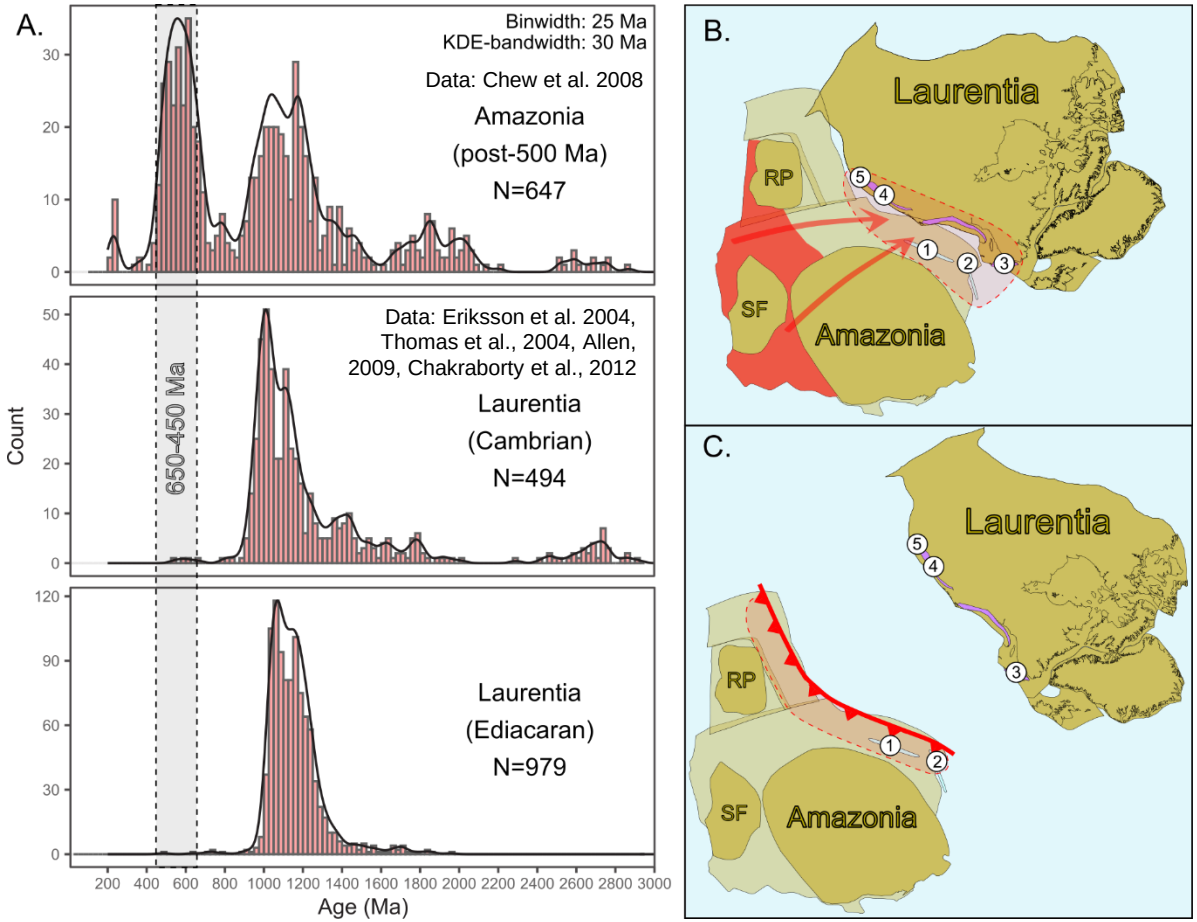
Which one lead to breakup?



Robert et al. 2020
Geology, in press.

Rift-related magmatic pulses at 750–680 Ma (purple) and 615–550 Ma (red) in Laurentia, Amazonia and Baltica. Esp: Eastern Sierra Pampeanas, Wsp: Western Sierra Pampeanas, AA: Antofalla-Arequipa, RP: Rio de la Plata, Dr: Dashwoods ribbon, Y: Yucatan, S: Sierra Madre, M: Mixteca Oaxaca.

Detrital zircon record



Robert et al. 2020, *Geology*, in press.

A. Histograms and kernel density estimates of detrital zircon U-Pb ages of post-500 Ma metasedimentary rocks from western Amazonia, early Cambrian and Ediacaran synrift sediments along eastern Laurentia. B & C: Two alternative scenarios that may explain the provenance of the 650–500 Ma zircons along West Amazonia. Sampling sites: 1: Marañon Complex, 2: Cordillera Real of Ecuador, 3: Humber zone in Newfoundland, 4: Blue Ridge inlier, 5: Birmingham basement graben system.

Almost no Neoproterozoic rock exposures along west Amazonia.

An enigmatic 650-500 Ma detrital zircon age peak in younger sediments along west Amazonia.

Three possible origins:

- Magmatism related to Iapetus rifting
- 0.9-0.48 Ma magmatism from the Brasiliano orogenic system
- A hidden magmatic arc along western Amazonia (Chew et al. 2008)

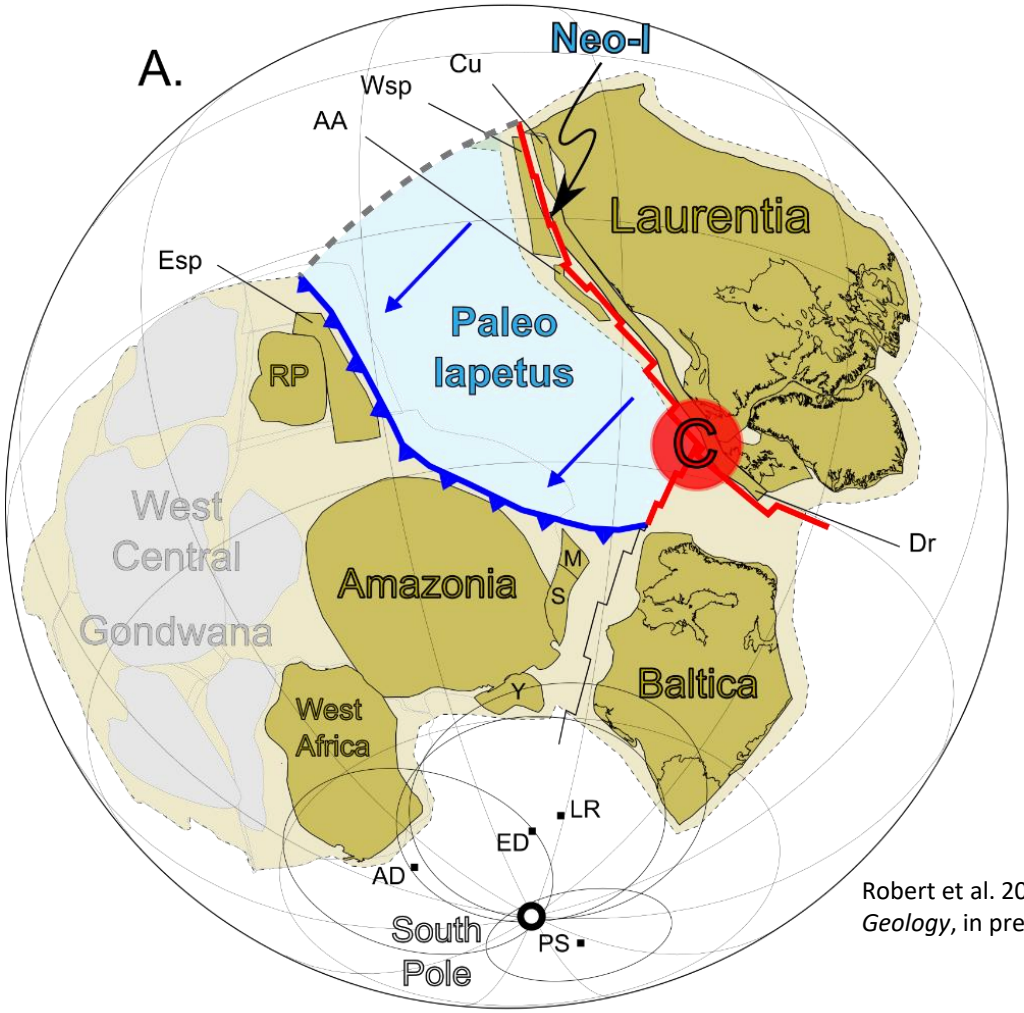
There is no direct observation of this arc but this scenario better explains amplitude and temporal restriction of the peak, and detrital zircon record in Laurentia.

Our favorite scenario: opening of 2 oceans

- Opening at ~700 Ma of Paleo-Iapetus, opening ~600 Ma of Neo-Iapetus, explain:
  - the 2 pulses of rift-related magmatism
  - the presence of a subduction zone along western Amazonia by 650 Ma.

- Paleomagnetic data at 615 Ma are in agreement with an early opening between Amazonia and Laurentia.

- Between 750 and 615 Ma, paleomagnetic data are sparse, which preclude any paleomagnetic test.



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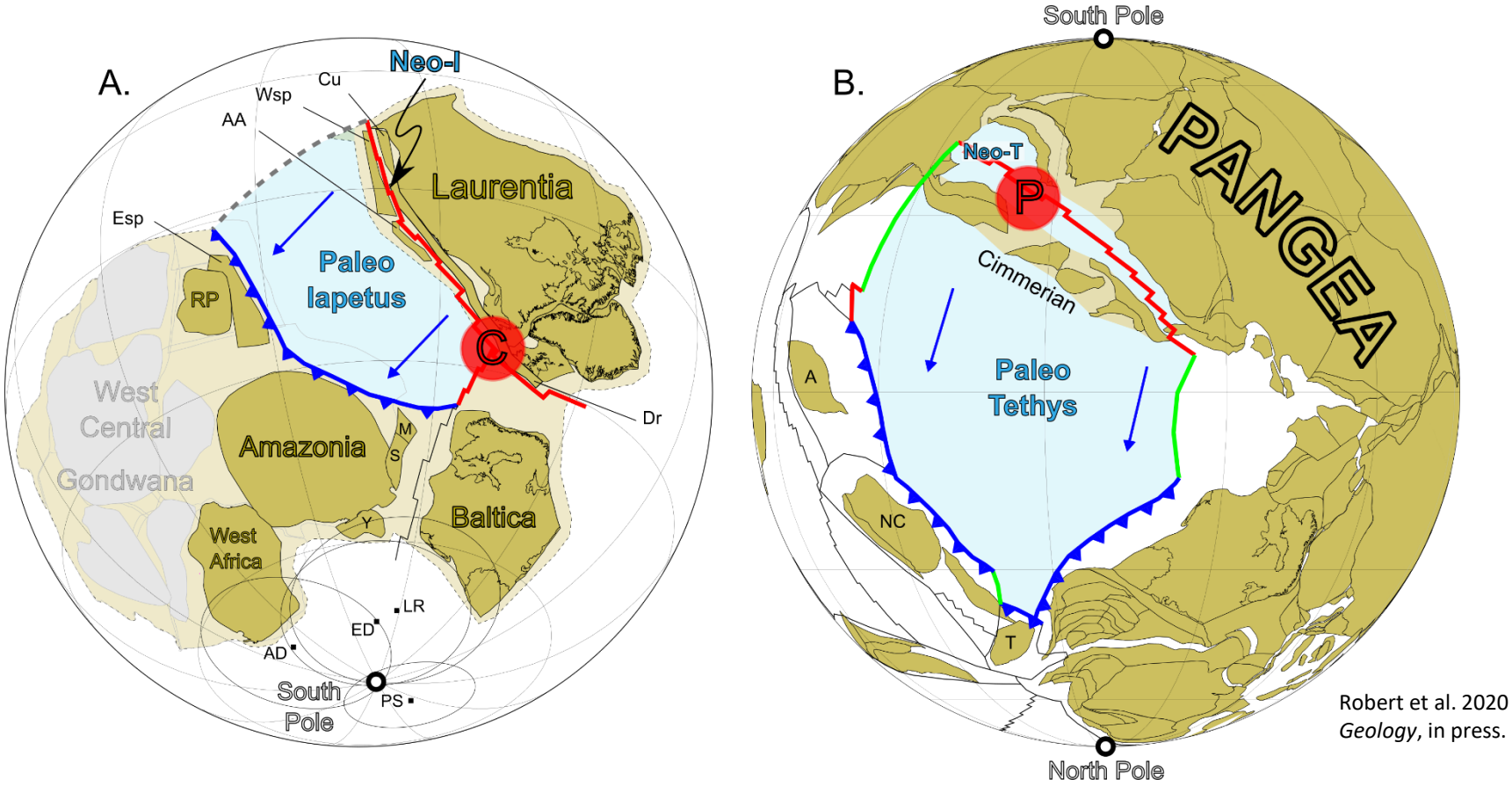
Paleomagnetic poles:
LR: Long Range dyke (Murthy et al. 1992; Hodych et al. 2004)
ED: Egersund dykes (Walderhaug et al. 2007)
AD: Adma Diorite (Morel, 1981)
PS: Planalto da Serra complex (Garcia et al. 2013).

Iapetus, an analog to Tethys?



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- A possible mechanism:
  - Subduction of the Paleo-Iapetus oceanic ridge puts under tension the Laurentia plate, which could have detached continental slivers from Laurentia.
  - A similar mechanism is invoked for the opening of Neo-Tethys (Stampfli and Borel, 2002).
  - The emplacement of the Central Igneous Magmatic Province (C) may have facilitated the detachment of a thin continental ribbon, similar to the Panjal traps (P) in Tethys.

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