Tectonic evolution of S. America from Gondwana to the present: Everything you wanted to know, and more

Ajay Limaye - July 2010
Tectonic provinces

NASA

Tectonic Evol. S. Amer. (TESA), 2000
North and South margins: transpression

• Both: pull-apart basins, local crustal shortening, strike slip, lithospheric flexure. Active since early Cenozoic.


• SA-Scotia plate (South): Magallanes-Fagnano fault. Left-lateral.
Gondwanaland: Predecessor to modern southern continents. How did we get from this to modern picture?

Early Jurassic (205-195 Ma)

Amalgamated by 570-510 Ma

R. Blakely, N. Arizona Univ.
Pre-Gondwana: Building the continental shields

• Brasiliano-Panafrican Cycle: landmass divergence, marine sedimentation, collisions, metamorphism, magmatism...built crust.

• Amalgamation of landmasses these landmasses made “nucleus” of Gondwana.

• today only mtn roots left: metamorphic and igneous belts in S Brazil.

Southern Brazil: remains of the ancient Brasiliano-Panafrican Cycle that helped build the SA platform.

Corcovado Mtn. above Rio de Janeiro, Brazil


I hope we do better in 2014…
Gondwanaland: proto-West Africa and South America together in the Proterozoic

Fig. 1. The Borborema Province and its place in the context of the Pan-African orogeny before the opening of the South Atlantic Ocean.
Quiz: Which Doctor named Gondwanaland?

Dr. Seuss

Eduard Suess (1831-1914)

Wikipedia
Permian *glossopteris* fossil...found across several continents, including S. America - India

Gondwanaland: from Sanskrit *gondavana*, or “forest of the Gonds.” Suess studied classic Permian-Triassic sedimentary section in India.  
Wikipedia
Breakup of Gondwanaland

- Breakup began ~200-170 Ma
- Africa, SA start separating thereafter
- Antarctica, SA separate much later, ~30 Ma
- Finally, SA connects with Panama

R. Blakely, NAU
Separating SA and Africa looks easy. But...

- Separation happened in stages spanning ~90 Myr! 4 segments.
  - Late Triassic (N Brazilian margin)
  - Early Jurassic (Argentina)
  - Early Cretaceous (E Brazil)
  - Mid Cretaceous (equatorial Atlantic areas)
Cratonic South America

• Amazonian craton one of world’s largest. Stable since ~1.0 Ga.
• Brazil, F. Guiana, Guyana, Suriname, Venezuela, Colombia, Bolivia
• 2 Precambrian shields
• Basement: generally medium- to high-grade metamorphics, and many granitoid plutons

TESA, 2000
Intracratonic sedimentary basins

- The rifting that separated SA and Africa also led to extension within the SA craton.
- Some basins filled with lakes, others with Atlantic seawater. Mostly siliciclastic sediments, but some salts and carbonates.
- Sedimentary units bounded by unconformities: several periods of regionally extensive erosion.
• Big swaths of Argentina, Uruguay, Paraguay
• Thick accumulations of sediment and mafic volcanics (related to Gondwana rifting?)
• Several episodes of subsidence and filling; over both crystalline basement and older sediments. Several km thick. How?
SA western margin

• > 200 Myr nearly continuous convergence
• Argentina: deformation belt called Gondwanides records sed./tectonics/migmatism similar to modern Andes; terrane accretion
• N Andes: accreted oceanic terranes

TESA, 2000; Audin, 2010
Andes review

• High topography. Potential causes: crustal shortening, magmatism, isostatic adjustment due to focused erosion, mantle/lower crustal flow, crustal delamination, ....

• Geochemistry suggests plateau high prior to 25 Ma

• 12 Ma: Nazca Ridge subduction begins

Audin, 2010
Figure 8. Schematic cross section showing our interpretation of the lithospheric structure of the central Andes from geophysical and geological studies. Red and blue indicate upper mantle P wave velocities that are slower and faster, respectively, than the reference IASPEI-91 model [Myers et al., 1998]. See color version of this figure at back of this issue.

SA craton influences E flank of the Andes
Panama and SA

• The two finally connected ~3 Ma. One hypothesis:
  – Subduction of Pac beneath Carib plate -> uplift; volcanoes, above water by 15 Ma
  – Sediment derived from NA, SA filled in the gaps
• Drastic consequences for ocean circulation, global climate (i.e., Gulf Stream)
• Land bridge effects:
  – opossum, armadillo, and porcupine ancestors travel north
  – bear, cat, dog, horse, llama, and raccoon ancestors head south
Antarctica

- Separation ~30 Ma
- Water able to flow all the way around – circumpolar current
- Isolation from warmer waters -> cold climate, glaciation
- “the mightiest current”

Thank you!

Me encanta la geología de Sudamérica...
References

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