# South American Paleozoic History

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## Outline

- Gondwanaland
- Two Paleozoic Orogenies:
  1. Pampean Orogeny (545-500 Ma)
     1. Santa Rosita Formation
  2. Famatinian Orogeny (520-430 Ma)
     - Passive Margin Formation
     - Late Orogenic event

## Gondwanaland

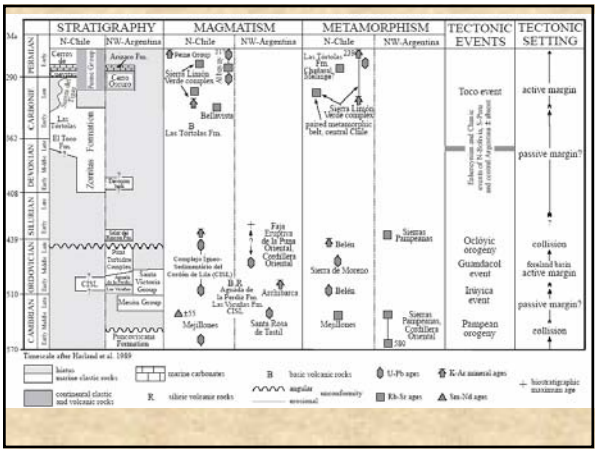
- Gondwanaland Movie
- South America, Africa, Antarctica, Australia, India, Madagascar
- West Gondwanaland: South America, Africa

# Evolution of South America: Early Paleozoic

**Jennifer Lougen**

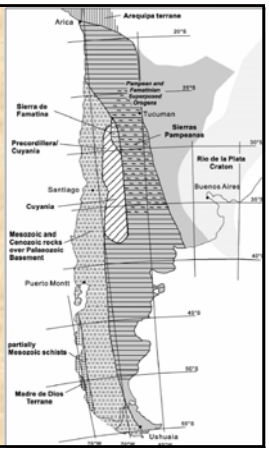
## Prior to Pampean Orogeny

- Puncoviscana Formation: deep marine passive margin
- Opening of Puncoviscana and Iapetus Oceans
- 530 – 534 Ma last passive margin deposition



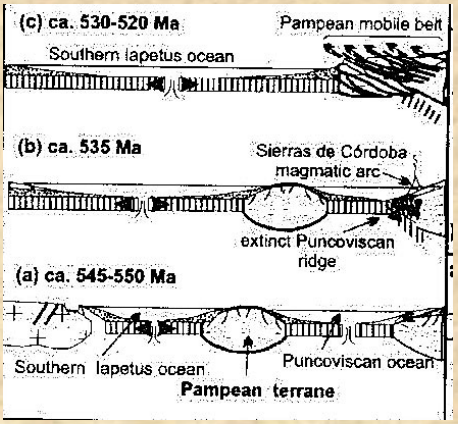
## Pampean Orogeny

- Pacific Margin: passive → active
- 530-520 Ma; Short lived subduction (west)
- Convergent processes between Rio de la Plata, Pampia, and Cordoba




## Cont'd

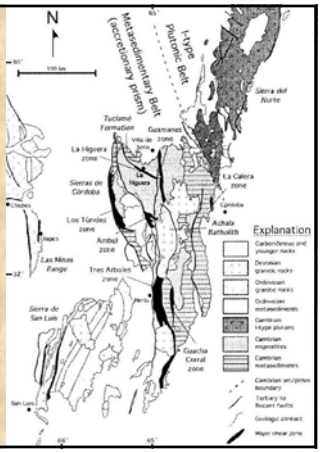
- Fold belts in W. Pampea (Puncoviscana) and E. Pampea (Sierra Cordoba)
- Pampean Mobile Belt: Sierras Pampeanas and Eastern Cordillera
- Peak metamorphism, Middle Cambrian




## Rocks of the Pampean Orogeny

- metasediments
- paragneisses and aluminous schists, migmatites and aluminous granites
- Calc-alkaline granitoids
- Dacites-rhyolites

Areas where Various Rock Types can be found




## After Pampean Orogeny

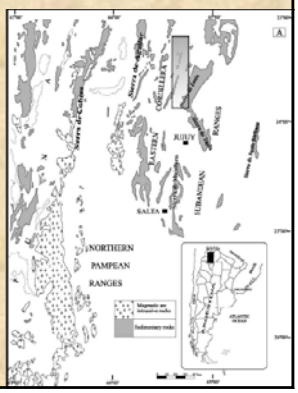
- No orogenic activity
- Passive margin(Meson Group)
- Little granitoid emplacement 515-490 Ma
- Arc magmatism stopped/decreased

## Meson Group

- Records passive margin formation
- Tide dominated shelf
- Trough and tabular quartzite
- Regionally extensive tidal deposits probably representing deposition in a gently dipping shallow marine ramp

## Santa Rosita Formation

- lies above the Meson Group
- Records infill of retro arc basin; Sea level fall
- depositional history: fluvial, tide-dominated estuarine, and wave dominated shallow marine
- Max thickness ~2300m
- 5 members: Tilcara, Casa Colorada, Alfarcito, Rupasca, Humacha (b→t)

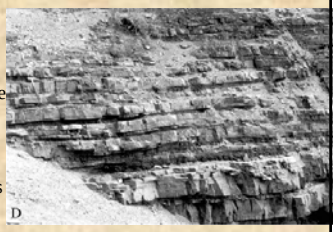



## Members

Tilcara Member
-conglomerate, tabular cross bedded quartzose ss
-interbedded ss and mudstone

Casa Colorada
-greenish gray mudstone
-thinly rippled interbedded ss

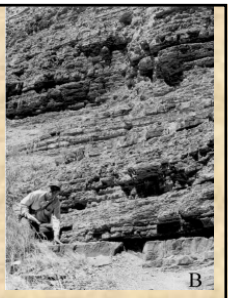
Alfarcito
-hummocky cross stratified ss
-interbedded rippled mudstone and ss

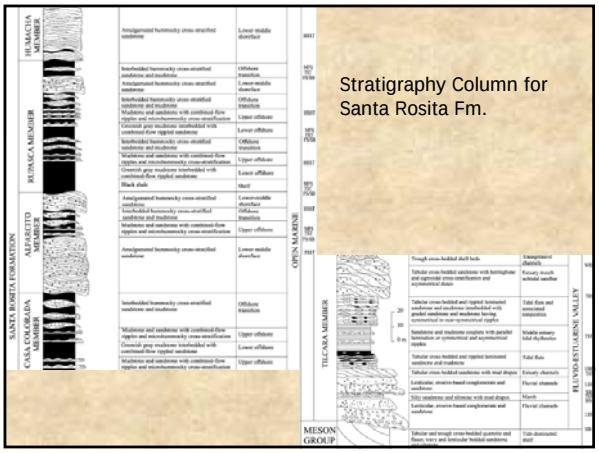



## Cont'd.

Rupasca
-mudstone
-thinly interbedded rippled ss
-transgressive→regressive events (early Ordovician)

Humacha
-hummocky cross stratified ss




Stratigraphy Column for Santa Rosita Fm.

## Analogs to North America

- Passive Margin Formation in Proterozoic (Puncoviscana Fm.)
- Followed by orogeny (Antler Orogeny vs. Pampean Orogeny)
- Followed by quiet period (passive margin formation)

# SA West Coast events Ordovician-Early Carboniferous 495 - 350 mya

Wil Shaffer

## The BIG picture

- Break up of Super Continent Rodinia
- Laurentia moving along west Gondwana eventually colliding with it

PLATES 3.mpeg

## Early Ordovician (490-470 mya)

- Famatinian Subduction
  - Irúyica event
    - Cambrian metaturbidites and plutons overlain by an angular unconformity and shallow marine sediments (qrtz. SS and SH) [Meson Grp.]
    - Sediments derived from the east
  - Magmatic arc further west (basaltic-andesitic lavas
  - Pillow basalts and sills further East
    - Indicative of extension
    - Formation of a back arc basin (eruption of calc-alkaline volcanics)

## Mid Ordovician (470-450 mya)

- Tectonic subsidence rates increased from 65m/my to 600m/my
  - Change in basin evolution from extension to compression
    - Eastern side of basin there was development of silicicalstic rxs
      - Response to loading in the west (peripheral bulge)
    - Further East in Cordillera Oriental there is noted eastward subduction by trondhjemite plutons
      - Trondhejemite → Phaneritic Qtz-Alb rich plag rxs
- Docking of Precordillera
  - Controversial topic

## Late Ordovician (450-440 mya)

- Fold pattern
  - East of basins →West verging folds
  - West of basins → East verging folds
- Folding accompanied by peraluminious granitoids in N. Chilie, E. Puna basin, and Cordillera Oriental (syn-post tectonic)

## Oclóyic Orogeny models

- Amalgamation of the exotic *Precordilleran terrane* during mid-Ordovician
  - The "missing" piece of Texas (Ouachita embayment)
  - Three "excepted" hypothesis of docking mechanisms
    - 1) *Precordillera micocontinent* was rifted from Laurentia (during Cambrian) and collided with Gondwana
      - Independent of Laurentian Taconic Orogeny
    - 2) *Continent-Continent collision* producing a continuous Taconic- Oclóyic orogenic belt. Upon rifting of the continents Precordillera was Left attached to Gondwana
    - 3) Precordillera was at the tip of a *distal plateau* on a greatly stretched Laurentian crust that collided with Gondwana and separated from Laurentia.

## Precordillera Sediments

- Southward and westward there is a transition from shallow-marine carbonates to black shales.
  - Initial flexural subsidence of a foreland basin
- Shales grade into flysch-like synorogenic clastic wedges (flow direction from East)
  - Mudstones- >Sandstones- >Conglomerates
- Regionally diachronous unconformity
  - Migration of peripheral bulge and flexural extension down going Precordillera plate

## Ign. Rx clues

- Bentonites within mid-Arenig to Llanvirn Rxs (the aforementioned transition from LS -> Sh)
  - Document proximity to volcanic arc!
  - Contradict *Continent-Continent* type collision
- Plutons in Sierras Pampeanas yield Early-Late Ordovician ages
  - Stopped ~445 mya after Precordillera was docked

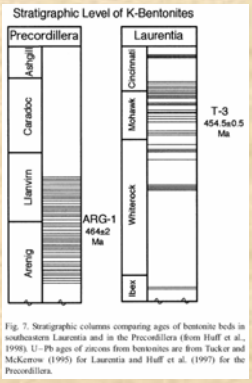
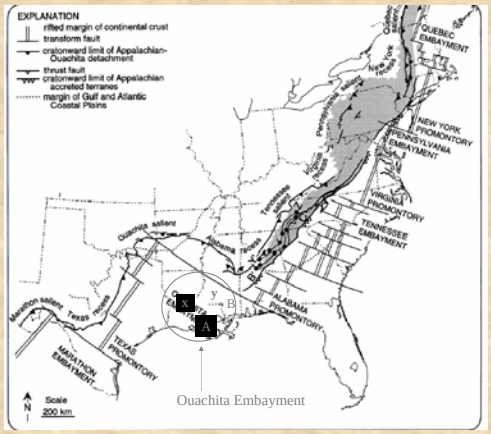
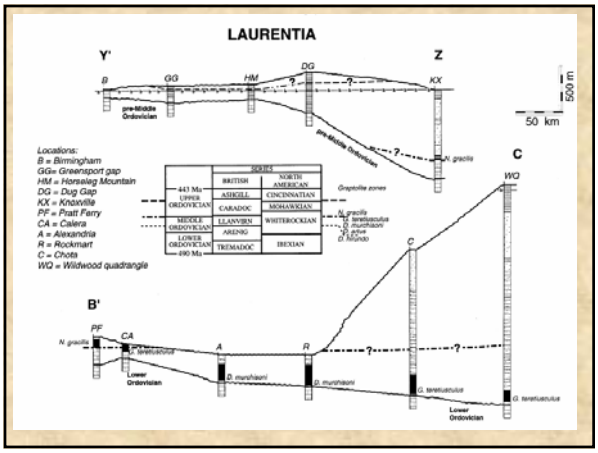


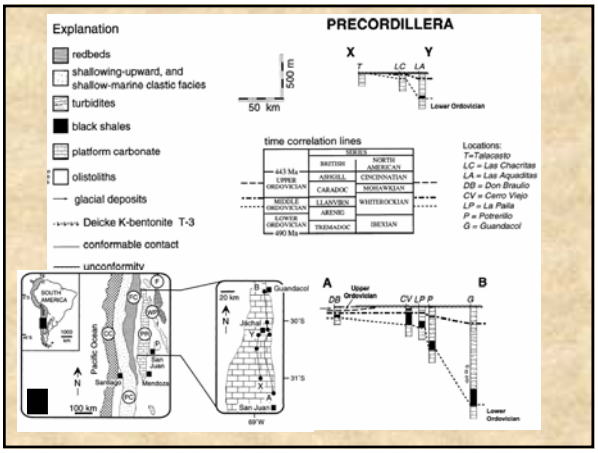

Fig. 7. Stratigraphic columns comparing ages of bentonite beds in southeastern Laurentia and in the Precordillera (from Huff et al., 1998). U–Pb ages of zircons from bentonites are from Tucker and McKerrow (1995) for Laurentia and Huff et al. (1997) for the Precordillera.

## Clues closer to home

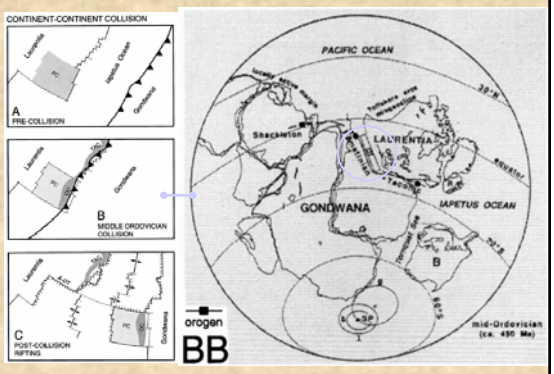
- Ages of synorogenic clastic wedge in Tenn. is older than events further north.
- Tenn. Embayment
  - 1) flexural subsidence of foreland basin
    - Upward transition from Mid. Ord. carbonates to black shales
    - Shales prograde into turbidites (coarsen upward)
      - Flow direction from orogenic terrain in then east



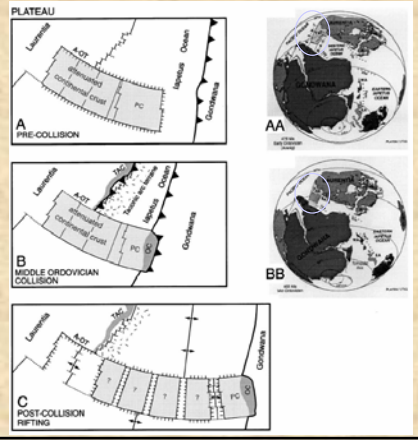
3) *Continent-Continent collision*




*Continent-Continent collision cont.*

- Contrasting Paleontological data
- Contrasting lithological assemblages in synorgenic clastic wedges in Taconic foreland of SE Laurentia and Ocloyic foreland of the Precordillera terrain indicate two separate basins
- Bentonite beds in both locales indicate separate dispersal systems
- Gondwanan glacial deposits extend from the sub Andean ranges into Precordillera but are not found in Laurentia- >considerable latitudinal separation by late Ordovician time
- **Eliminates possible continuity of Taconic and Ocloyic orogenic belts

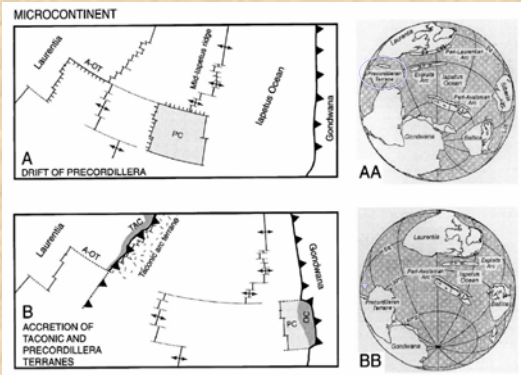
2) *Distal plateau*




## Distal plateau cont.

- Modern analog- > Malvinas plateau
- Used to explain Paleontological data
- Abandons the continuity of strike between Oclóyic and Taconic belts
- Requires departure of continental crust from Ouachita embayment
  - No post-Taconic extension has been recognized on Alabama promontory
  - Southward-facing shallow marine carbonate self and equivalent deep-water self facies surround the Ouachita embayment indicating a passive margin from Late Cambrian to Early Mississippian

1) *Precordillera micocontinent*




Aforementioned data points to this possibility

# Late Paleozoic Tectonic Evolution of South America

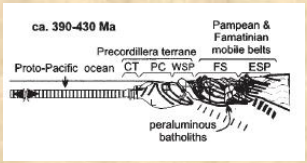
**Paul Agle**

## Silurian-Devonian (440-350 mya)

- Ign. and meta. activity dies down.
- Marine deposition westward to N. Chilie
  - – Transgress into soil horizon
    - Denudation (erosion) during Silurian
- Subsidence rate goes to 18m/my
  - – Subsidence balanced by detrital input from East

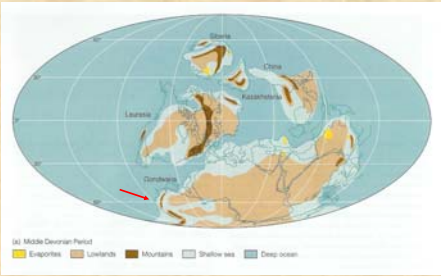
## End of Famatinian Orogeny

- Docking of Chilenia Terrane
  - Middle to Late Devonian
- Followed by ~100my of tectonic quiescence




Modified from Rapela et al, 1998

## Middle Devonian Paleogeography




From Wicander and Monroe, 2000

## Silurian to early Late Carboniferous

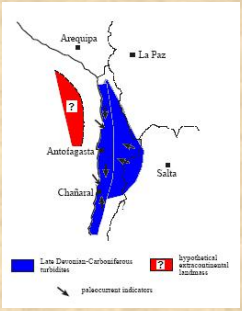
- Passive Margin
  - **Zorritas Formation**
  - Overlies unconformity that spans most of Silurian time, indicating massive erosion
  - East- derived onlapping sequence of shallow marine siliciclastics
  - 2700m thick
  - Subsidence rates typical of passive margin

## Early Carboniferous

- **Zorritas Formation** is punctuated by an erosional unconformity near end of Early Carboniferous
  - Probably related to tectonic uplift
- Passive margin clastic turbidites persist to West
  - **Las Tortolas, El Toco, and Sierra del Tigre Fms**
  - Western Source!

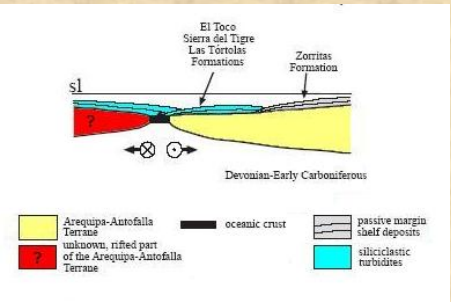
## Late Carboniferous

- Must have been an out-board source
- Many invoke a "Pacific Continent"
  - No evidence of its existence
- More likely a rifted fragment of SA




Modified from Bahlburg and Herve, 1997

## Schematic Cross Section




Modified from Bahlburg and Herve, 1997

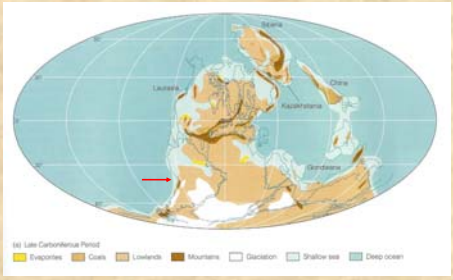
## Toco Event (Late Carboniferous)

- Syn-sedimentary deformation in **Las Tortolas** and **Sierra del Tigre Fms**
  - Slumps, folds, and dismembered bedding
  - Fold axes trend N–S
  - Fold vergences towards West
  - Erosional unconformity in **Sierra del Tigre Fm**
  - **Zorritas Fm** unaffected

## Problems with Model

- No evidence for rifting of outboard "Pacific" terrane
- Terrane has not been found
  - May be accreted to Laurentian margin
  - May have been removed by tectonic erosion
  - Strike-slip component carried it N-ward

## Late Carboniferous Paleogeography

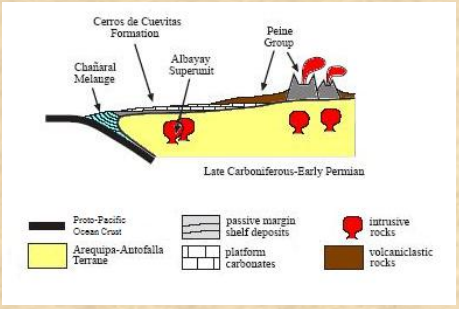


From Wicander and Monroe, 2000

## Latest Carboniferous through Permian

- Onset of Eohercynian Orogeny
  - Subduction of Proto-Pacific plate on W margin
- Folded turbidite units intruded by intrusive and extrusive calc-alkaline volcanism
- Deformed and incorporated into **Chanaral mélange** (accretionary prism)
- **Zorritas Fm** intruded and overlain by **Peine Group** (volcanic arc)
  - Volcanics and volcano-clastic sediments
- Regional High Pressure Metamorphism

## Schematic Cross Section




Modified from Bahlburg and Herve, 1997

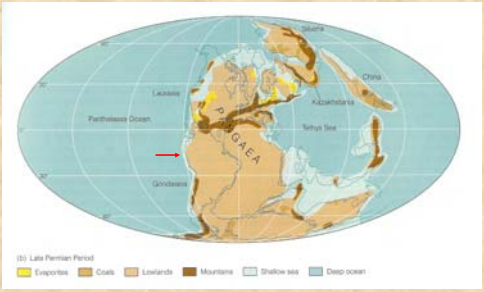
## Late Paleozoic Volcanics

- **Sierra Limon Verde Complex** (309–276Ma)
  - Gneiss, Amphibolite, Granodiorite
  - High-pressure metamorphism
- **Bellavista** (318Ma) and **Albayay** (292–217Ma)
  - Granite
- **Puna** (275–248Ma)
  - Granodiorite
- **Peine Group** (305–268Ma)
  - Granitoids

## Overview

- Passive Margin
- Rifting of W margin (?)
- Deposition in basin from E (**Zorritas Fm**) and W (**Las Tortolas**, **El Toco**, and **Sierra del Tigre Fms**)
- Toco Event, folding of Western units
- Eohyrcynian Orogeny, subduction begins and rift basin (?) closes
- Pangaea is largely assembled
- Volcanic arc persists along western margin into Mesozoic

## Late Permian Paleogeography




From Wicander and Monroe, 2000

## South American Paleozoic Suggested Reading


- Bahlburg, H., Herve, F., 1997. Geodynamic evolution and tectonostratigraphic terranes of northwestern Argentina and northern Chile: GSA Bulletin v. 109, 869-884.
- Rapela, C.W., Pankhurst, R.J., Casquet, C., Baldo, E., Saavedra, J., Galindo, C., 1998. Early evolution of the Proto-Andean margin of South America: Geology v. 26, 707-710.
- Thomas, W.A., Astini, R.A., Bayona, G., 2002. Ordovician collision of the Argentine Precordillera with Gondwana, independent of Laurentian Taconic orogeny: Tectonophysics v. 345, 131-152.