

Brazilian geological diversity: initiatives and potential for geoconservation

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GEO DIVERSITY
WORKSHOP 4 *collecting*
THE INTERNATIONAL GEO DIVERSITY DAY

ProGEO

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Geological and tectonic bases of Brazilian geodiversity

The sequences of events that gave origin to the geological diversity we see nowadays

Brazilian territory

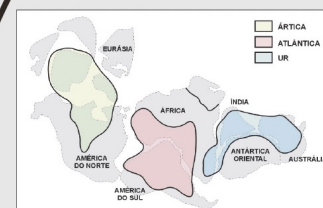
Totally inserted in the South-American Plataform, estabilised in the Ordovician



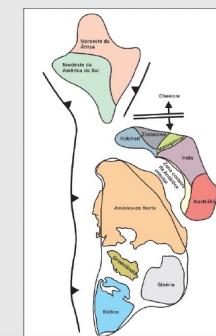
Schobbenhaus and Brito Neves (2003)

Basement of the platform made up of rocks from 3.5 to 0.58 Ga

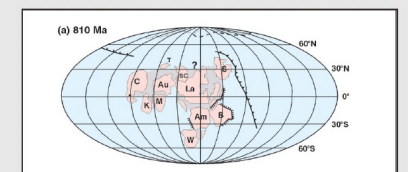
(fragments of older Paleo- to Mesoproterozoic supercontinents)



Atlantida



Columbia



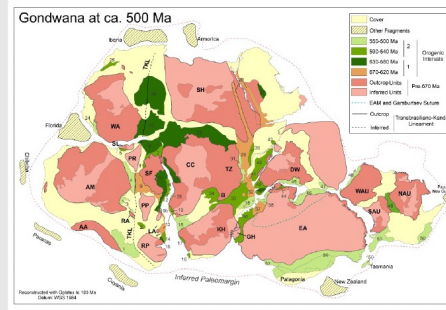
Rodinia

Schobbenhaus and Brito Neves (2003)

Neoproterozoic / Ordovician

Amalgamation of Gondwana

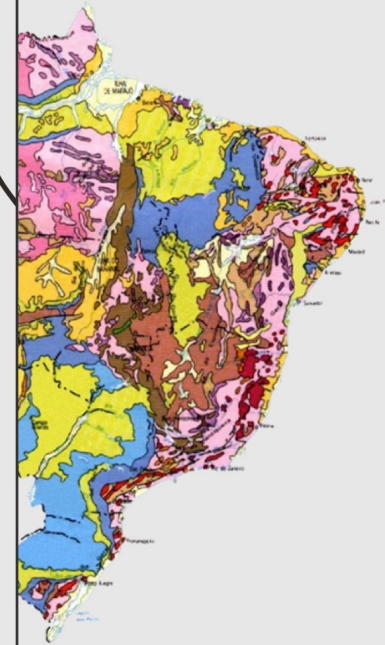
- Neoproterozoic orogenic belts
 - Syn- to Late orogenic magmatism
- Subduction, continental collision, metamorphism
 - Marine to continental sedimentary basins developed over Gondwana



Schmitt et al. (2017)



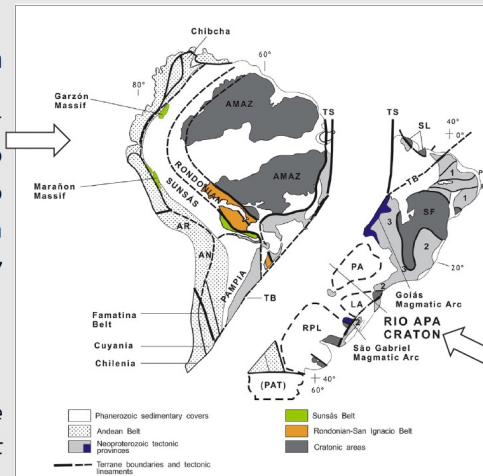
Pedreira et al. (2003)



The establishment of Gondwana marks a great contrast in the Brazilian geological evolution

Amazonian Domain

Associated to the North-American Laurentia. No structures related to West Gondwana orogeny



Brito Neves and Fuck (2013)

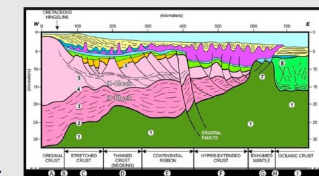
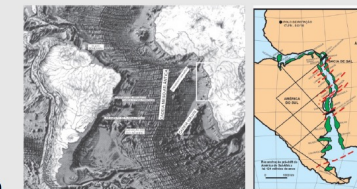
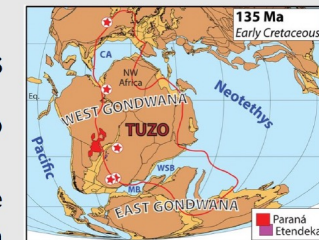
Brasiliano Domain

Related to the Brasiliano-Pan African Orogeny, which gave origin to West Gondwana

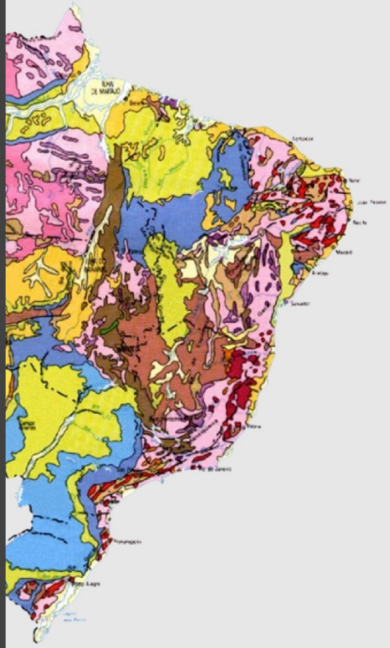
Jurassic / Cretaceous

Gondwana breakup

- Marked by extensive basaltic volcanism
- Opening of South Atlantic ocean
- Passive margin basins



Mohriak (2003), Svensen et al. (2017), Zalán (2015)



All this geological history
gave origin to the
geodiversity of Brazil



Mairi Gneiss Complex, formed by mafic and felsic banded gneisses (3.6 Ga), the oldest rocks in South America.



Itabirite, a banded metasedimentary rock deposited at 2,4 Ga, formed by quartz and iron oxides. Important iron ore.



The Iguazu Falls, in the homonymous national park, example of the ~ 1,35 Ma volcanic rocks of the Paraná-Etendeka Province, which record the breakup of West Gondwana.



Active sand dunes and freshwater lagoons from the Lençóis Maranhenses, the largest record of Quaternary sedimentation of South America.

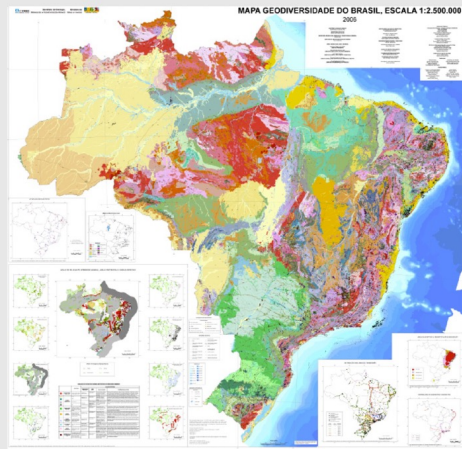
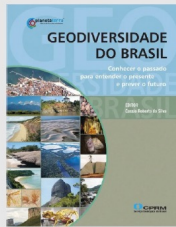
Studies on geodiversity

Project geodiversity *Geological Survey of Brazil*

National and State maps

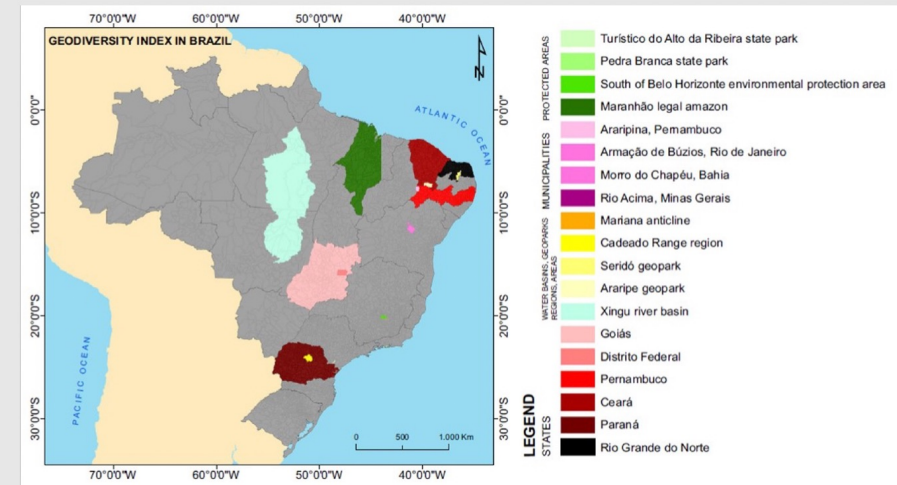
Geoenvironmental approach

Support for land use and
occupation plans



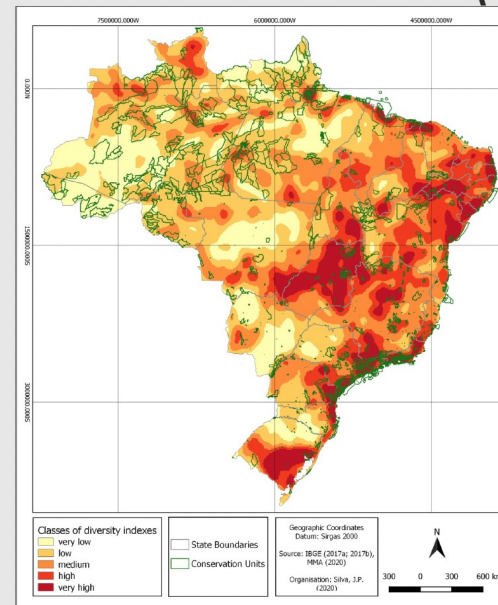
www.cprm.gov.br

Initiatives on maps of geodiversity indexes in Brazil



Geodiversity indexes and protected areas

- Analysis based on subindexes
- Causes of the distribution of the abiotic elements in the Brazilian territory
- Correlations between abiotic aspects and elements related to current and past climates and environments

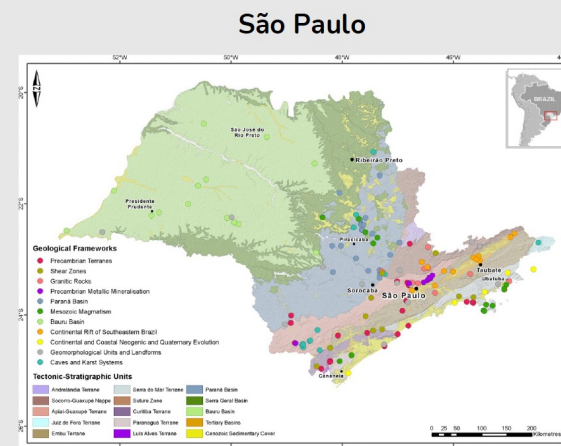
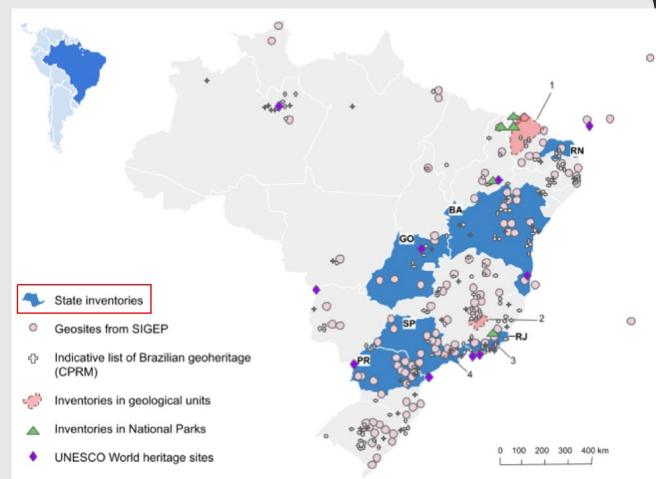


Silva et al. (2021)

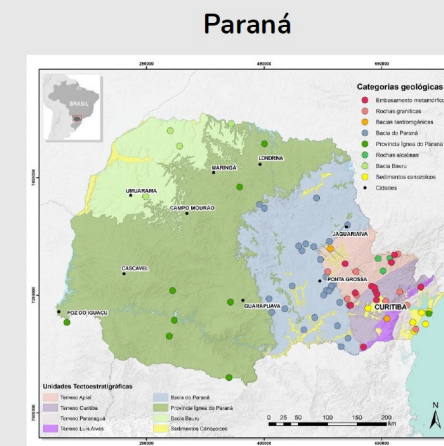
Inventories and other surveys

States of Rio Grande do Norte, Bahia, Goiás, Rio de Janeiro, São Paulo and Paraná

São Paulo: the first on a systematic basis



Garcia et al. (2018)



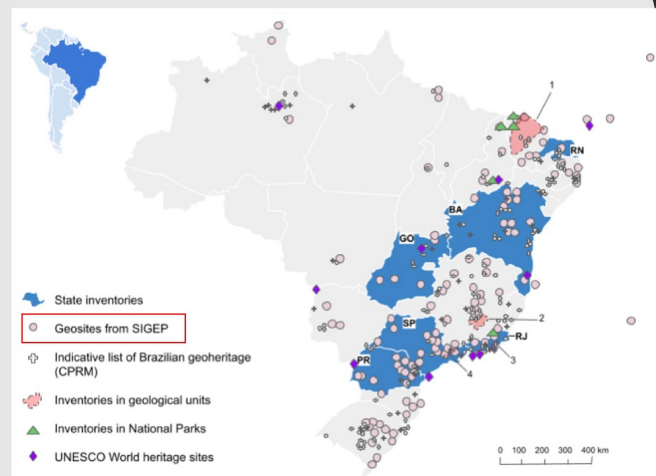
Xavier (2022)

SIGEP geosites

Brazilian Commission on
Geological and
Paleobiological Heritage

116 geosites published

66 geosites approved but
not published



Araguainha Dome - the largest known astrobleme in South America



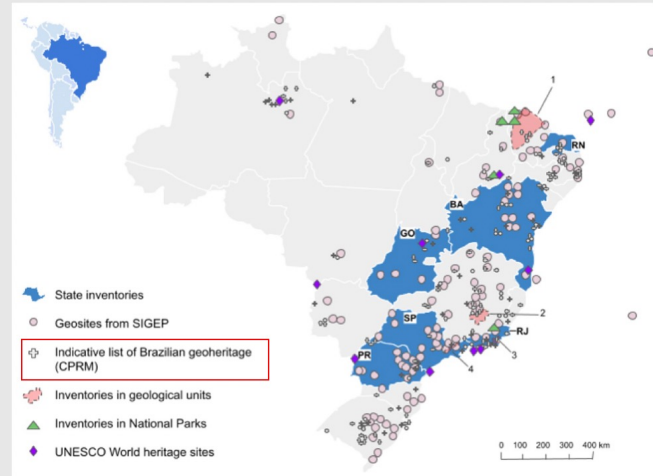
Crósta (2002)

Indicative list of the Brazilian geoheritage

461 geosites

21 themes

Classified on high, moderate and low values



Sites inscribed in GEOSSIT, the online platform developed by the Geological Survey of Brazil

Quantitative assessment of scientific value, potential for education and tourism use and degradation risk

Arrecife Ranch - Neoproterozoic stromatolites



Srivastava and Rocha (2002); data from GEOSSIT

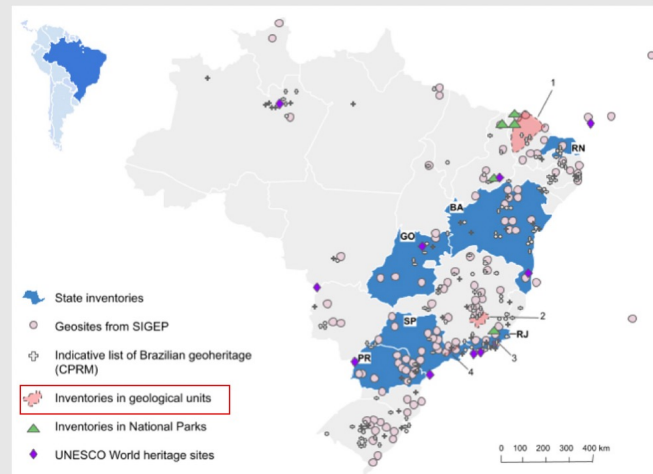
Inventories in geological units

Ceará Central Tectonic Domain

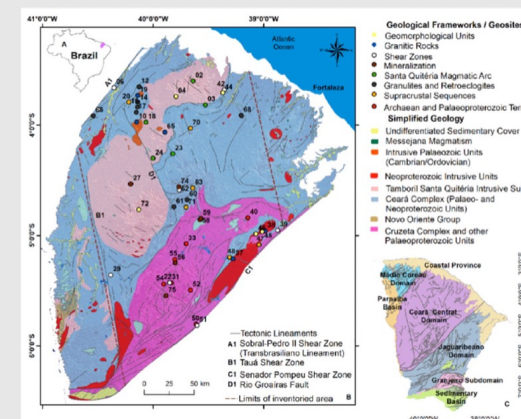
Iron Quadrangle (Quadrilátero Ferrífero)

Cabo Frio Tectonic Domain

Taubaté Sedimentary Basin

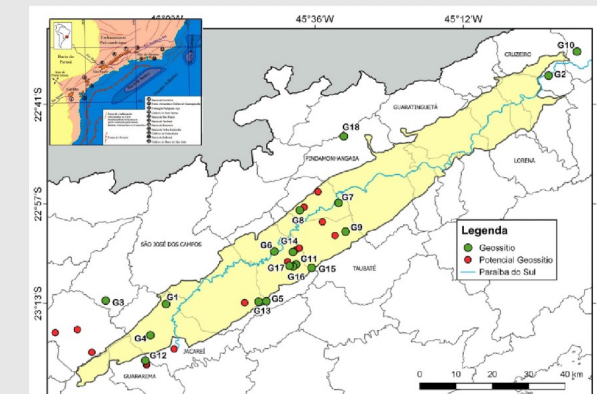


Ceará Central Domain



Moura et al. (2017)

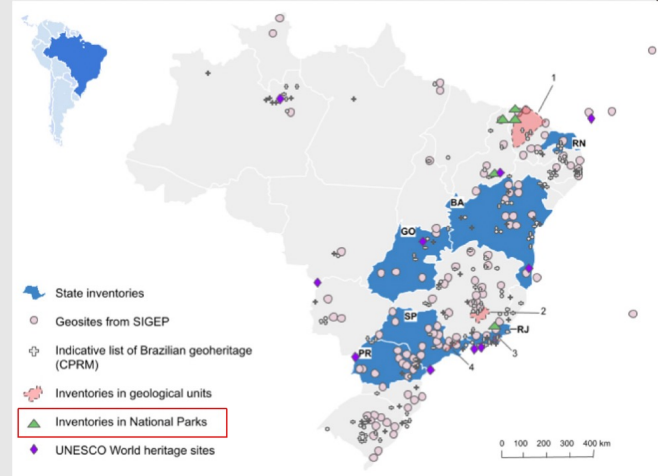
Taubaté Basin



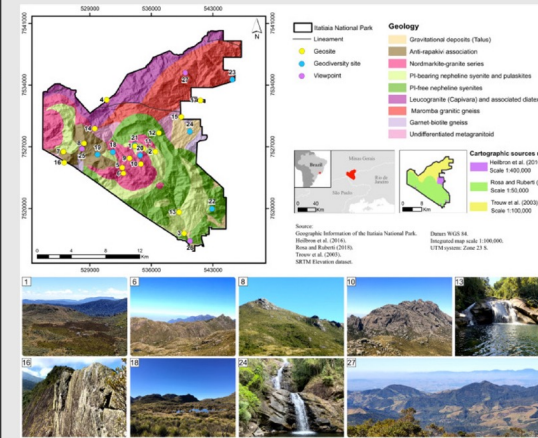
Reverte et al. (2018)

Inventories in National parks

- Itatiaia National Park
- Sete Cidades National Park
- Ubajara National Park
- Serra da Capivara National Park
- Jericoacoara National Park



Itatiaia National Park



Mucivuna et al. (2022)

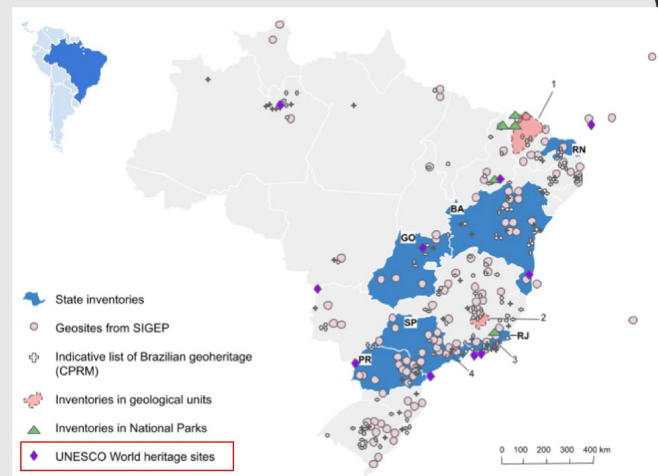
Serra da Capivara National Park



Prochoroff and Brilha (2017)

UNESCO World Heritage sites

- 6 natural sites
- 2 cultural sites related with geodiversity
- 1 mixed site



Natural

- Iguazu National Park
- Atlantic Forest South-East Reserves
- Discovery Coast Atlantic Forest Reserves
- Central Amazon Conservation Complex
- Pantanal Conservation Area
- Brazilian Atlantic Islands: Fernando de Noronha and Atol das Rocas Reserves
- Cerrado Protected Areas: Chapada dos Veadeiros and Emas National Parks



Cultural

- Rio de Janeiro: Carioca Landscapes between the Mountain and the Sea
- Serra da Capivara National Park



Mixed

- Paraty and Ilha Grande – Culture and Biodiversity

Geotourism and geoparks

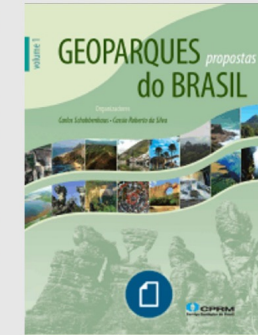
Project geoparks Geological Survey of Brazil

Started in 2006

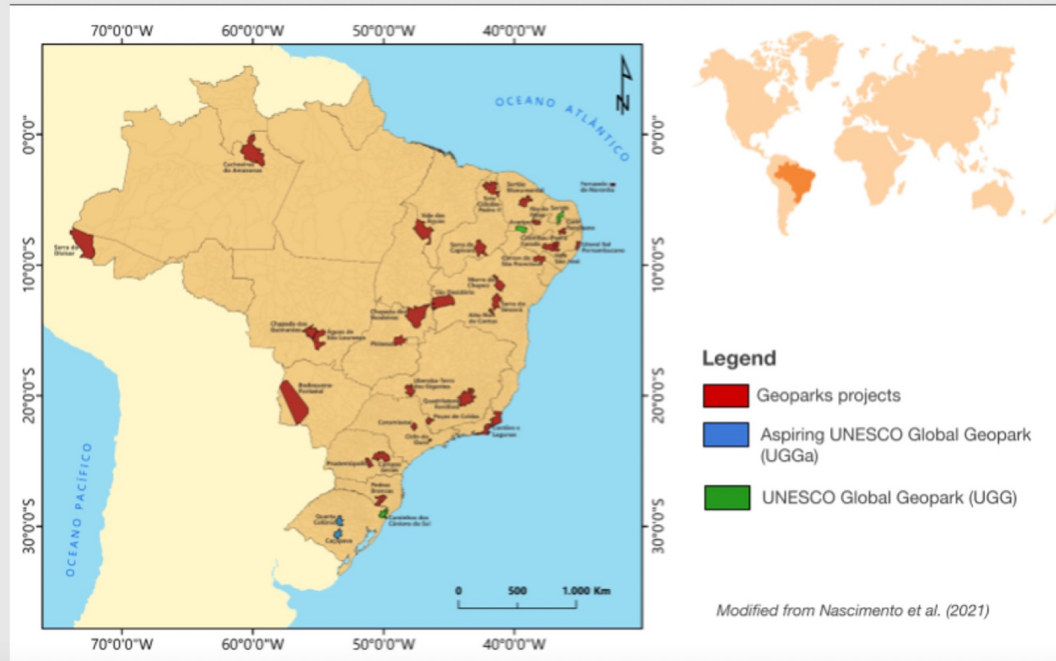
Part of the territorial management
section

Foster initiatives on the
development of geoparks projects

Two volumes

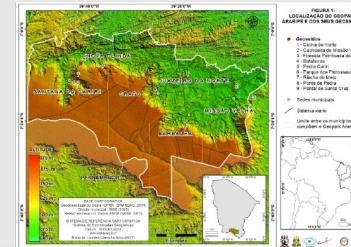


www.cprm.gov.br



Araripe Geopark

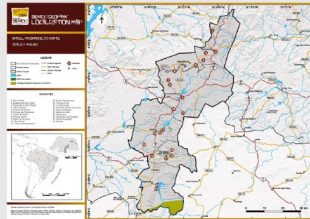
- 2006
- 6 municipalities
- 3,789 km²
- Cretaceous (150 - 90 Ma)
geological records
- Highly preserved fossils



Carvalho-Neta et al. (2018); <http://geoparkararipe.urca.br/>

Seridó Geopark

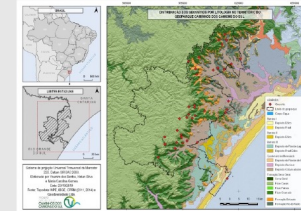
- 2022
- 6 municipalities
- 2,802 km²
- Geosites represent regional geological history from Mesoproterozoic to recent



<http://geoparqueserido.com.br/>

Caminhos dos Cânions do Sul Geopark

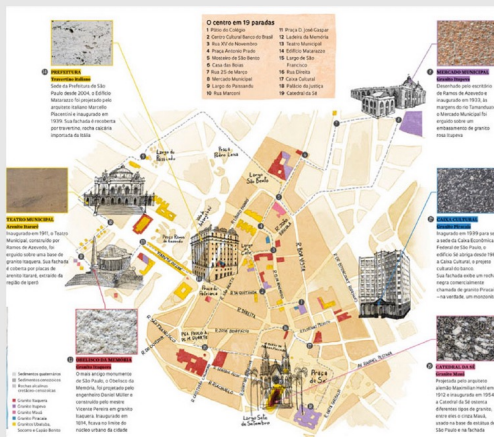
- 2022
- 7 municipalities
- 2 states
- 2,830 km²
- Final stages of sedimentation of Paraná Basin and West Gondwana breakup



<https://canionsdosul.org/>

Urban geotourism

Old Centre of São Paulo City



Del Lama et al. (2015)

Historic Centre of Natal City



Nascimento et al. (2018)

Outreach

Interpretative panels



Geological Paths Project, State of Rio de Janeiro

Started in 2000, main objective was to popularise geology. Influenced the development of other geoconservationist initiatives



Other examples of initiatives, in the states of Paraná, São Paulo and Bahia



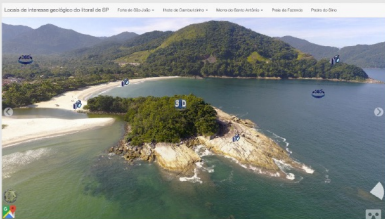
Books



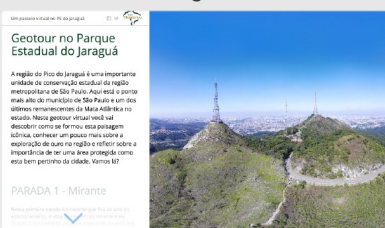
Themes related to geodiversity, geoheritage, dinosaurs, and general geosciences for kids.

Virtual products

360° panoramic virtual tour - North coast of São Paulo

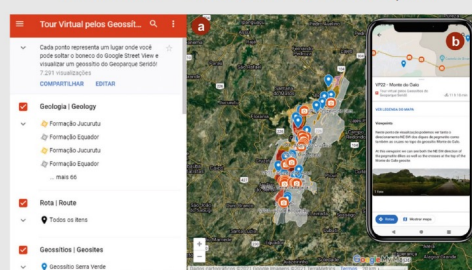


Geotour - Jaraguá State Park



<https://geohereditas.igc.usp.br/>

Virtual tour - Geosites of Seridó Geopark



Costa et al. (2022)

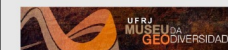
Virtual tour to the exhibition "Earth Memories"



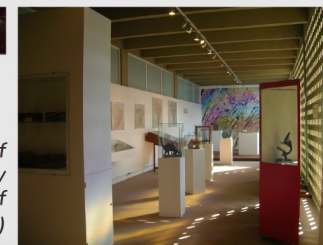
<http://www.museu.igeo.ufrj.br/>

Places and events

Brazilian Symposium on Geological Heritage - 6th edition (<https://www.ageobr.org/>)



Museum of Geodiversity (Federal University of Rio de Janeiro)



National (AGeoBR)

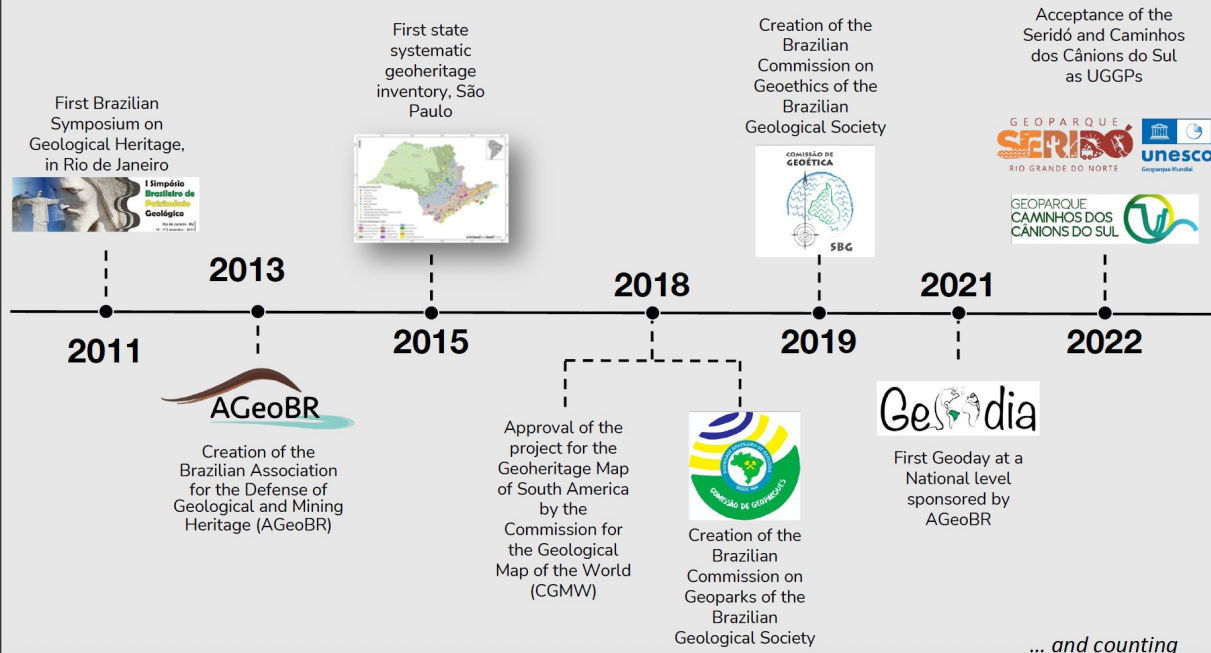
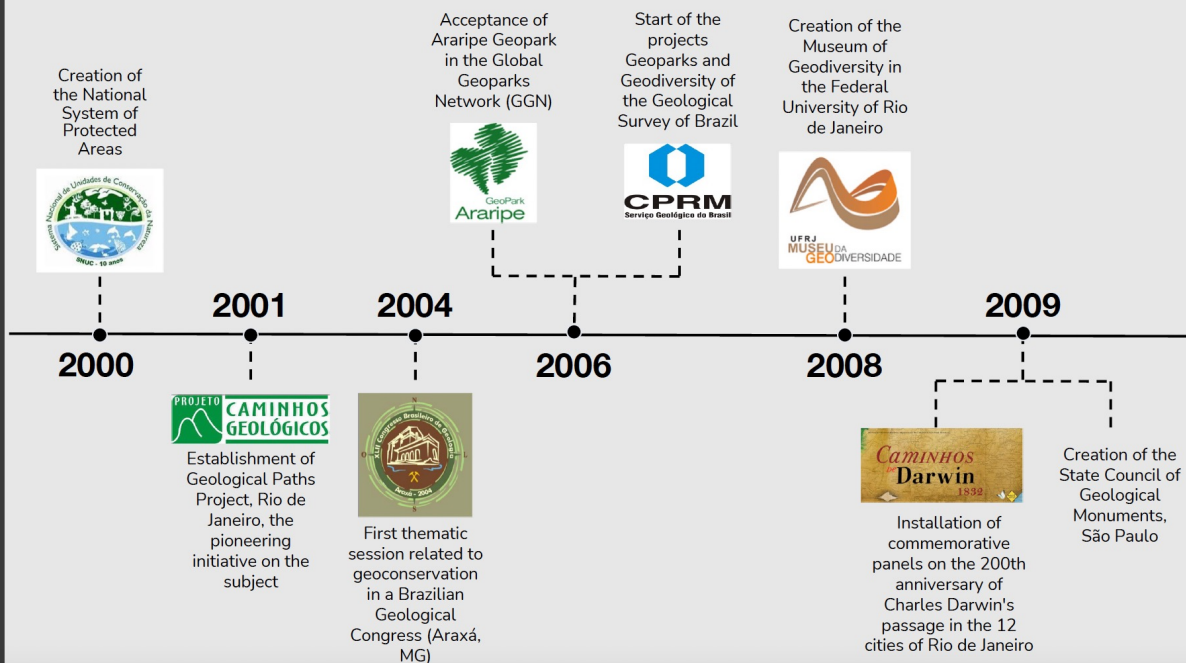
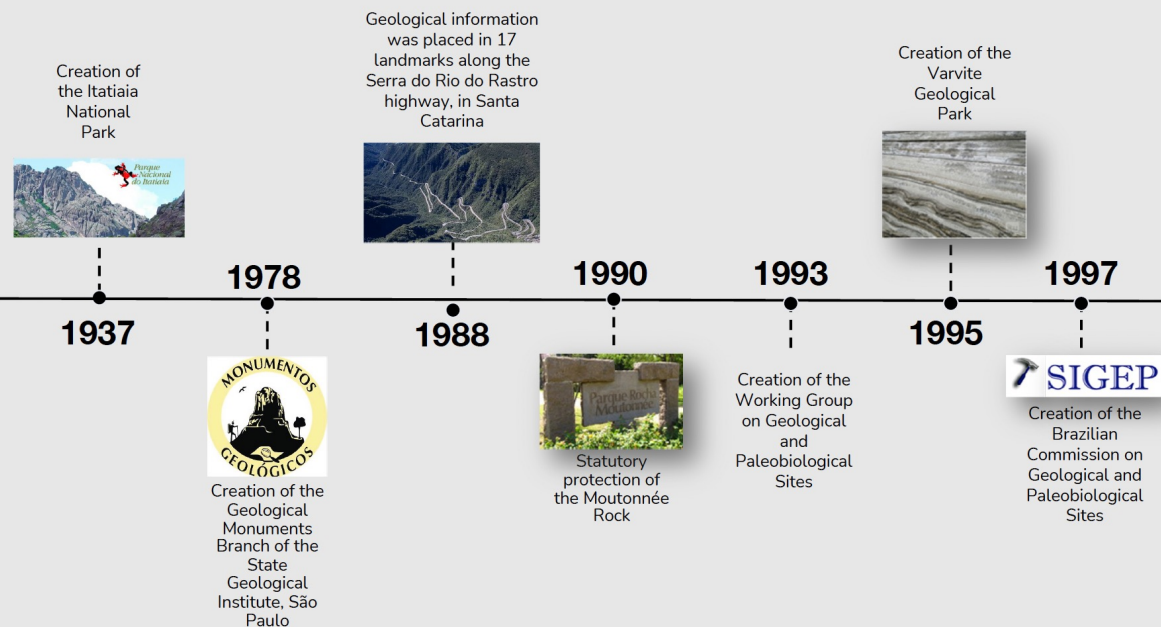
Local

Caçapava Aspiring Geopark



Costões e Lagunas Geopark Project

A timeline for geoconservation in Brazil



... and counting

Geodiversity and modern ecosystems in Brazil

Areas biologically diverse are commonly associated with diverse substrates

Pantanal Basin, Nhecolândia region
(Central-Western Brazil)



Fault-controlled modern sedimentary basin with permanently flooded areas. One of the most important tropical wetlands in the world, hosting impressive aquatic ecosystems with rich biodiversity.

Amazon region, Anavilhanas National Park
(Northern Brazil)



A series of fluvial islands along Negro River, inserted in the intracratonic Amazonas Basin. Great ecological relevance for studies regarding the sedimentary dynamics and the response of biodiversity to geomorphological changes in the islands.

References

- Brito Neves, B.B., Fuck, R.A. 2013. Journal of South American Earth Sciences. 47, 72-89. <http://dx.doi.org/10.1016/j.jsames.2013.04.005>
- Costa, S.S.S., Nascimento, M.A.L., Silva, M.L.N., 2022. Terrae Didactica 18, e022004. <http://dx.doi.org/10.20396/td.v18i00.8667435>
- Crósta, A.P. 1999. Sítios Geológicos e Paleontológicos do Brasil. Vol. 1, p. 531-540. <http://sigep.cprm.gov.br/sitio001/sitio001.htm>
- Del Lama, E.A., Bacci, D.L., Martins, L., Garcia, M.G.M., Dehira, L.K. 2015. Geoheritage, v. 7, n.2, p. 147-164. <https://doi.org/10.1007/s12371-014-0119-7>
- Garcia, M.G.M., Brilha, J., Lima, F.F. et al. 2018. Geoheritage 10, 239-258. <https://doi.org/10.1007/s12371-016-0215-y>
- Mohriak, W. 2003. Bacias Sedimentares da Margem Continental Brasileira. In: Geologia, Tectônica e Recursos Minerais do Brasil. L. A. Bizzi, C. Schobbenhaus, R. M. Vidotti and J. H. Gonçalves (eds.) CPRM, Brasília, p. 87-165.
- Moura, P., Garcia, M.G.M., Brilha, J., Amaral, W.S. 2017. Annals of the Brazilian Academy of Sciences, 89(4): 2625-2645. <http://dx.doi.org/10.1590/0001-3765201720170600>
- Mucivuna, V.C., Garcia, M.G.M., Reynard, E., Rosa, P.A.S. 2022. International Journal of Geoheritage and Parks. Vol. 10, Issue 2, p. 252-272. <https://doi.org/10.1016/j.ijgeop.2022.04.004>
- Nascimento, M.A.L., Silva, M.L.N., Bezerra, G.B. 2018. Terr@Plural, v.12, n.2, p. 238-253. <https://doi.org/10.1016/j.ijgeop.2022.04.004>
- Nascimento, M.A.L., Costa, S.S.S., Borba, A.W., Sell, J.C. 2021. Aspirantes e Projetos de Geoparques no Brasil em 2020. Relatório Técnico, Natal: Comissão de Geoparques da Sociedade Brasileira de Geologia, 7 p.
- Pedreira da Silva, A.J., Lopes, R.C., Vasconcelos, A.M., Bahia, R.B.C. 2003. Bacias sedimentares paleozóicas e meso-cenozóicas interiores. In: Geologia, Tectônica e Recursos Minerais do Brasil. L. A. Bizzi, C. Schobbenhaus, R. M. Vidotti and J. H. Gonçalves (eds.) CPRM, Brasília, p. 55-85.
- Prochoroff, R., Brilha, J. 2017. Comunicações Geológicas, vol.104, 1.
- Reverte, F.C., Garcia, M.G.M., Brilha, J., Moura, T.T. 2019. Pesquisas em Geociências, v. 46, n. 1: e0779. <https://doi.org/10.22456/1807-9806.93252>
- Schobbenhaus, C., Brito Neves, B.B. 2003. A geologia do Brasil no contexto da plataforma Sul-Americana. In: Geologia, Tectônica e Recursos Minerais do Brasil. L. A. Bizzi, C. Schobbenhaus, R. M. Vidotti, J. H. Gonçalves (eds.) CPRM, Brasília, p. 5-54.
- Silva, J.P., Alves, G.B., Ross, J.L.S., et al. 2021. Geoheritage, vol. 13, 75. <https://doi.org/10.1007/s12371-021-00598-0>
- Srivastava, N.K., Rocha, A.J.D. 2002. Sítios Geológicos e Paleontológicos do Brasil. Vol. 1, p. 63-71. <http://sigep.cprm.gov.br/sitio061/sitio061.htm>
- Svensen, H.H., Torsvik, T.H., Callegaro, S., et al. 2017. Geological Society, London, Special Publications, 463, 17-40. <https://doi.org/10.1144/SP463.7>
- Xavier, F.B. 2022. Inventário do patrimônio geológico do Paraná. PhD Thesis, Federal University of Paraná, Brazil
- Zalán, P.V. 2015. Similarities and Differences between Magma-Poor and Volcanic Passive Margins – Applications to the Brazilian Marginal Basins. In: 14th International Congress of the Brazilian Geophysical Society, Expanded Abstracts SBGF-107.

Thank you

Obrigada

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