XV SIMPÓSIO NACIONAL DE ESTUDOS TECTÔNICOS
IX INTERNATIONAL SYMPOSIUM ON TECTONICS
18 a 21 de maio de 2015
Vitória - ES

THE RIBEIRA BELT AND THE ROLE OF INTRACONTINENTAL DEFORMATION IN THE SUPERCONTINENT ASSEMBLY: A NEW HYPOTHESIS TO BE TESTED

Vinícius Tieppo Meira[1], Caetano Juliani[2], Johann Hans Daniel Schorscher[3], Renato Paes de Almeida[2], Thais Hyppolito[1], Antonio Garcia-Casco[4,5], Haakon Fossen[6]

[1]Programa de Pós-Graduação em Geoquímica e Geotectônica–IGc-USP, viniciusgeologia@gmail.com; [2]Departamento de Geologia Sedimentar e Ambiental– IGc-USP, [3]Departamento Geoquímica e Geotectônica– IGc-USP, [4]Departamento de Mineralogía y Petrología–Facultad de Ciencias–Universidad de Granada, Spain, [5]Instituto Andaluz de Ciencias de la Tierra–CSIC–Universidad de Granada, Spain, [6]Department of Earth Science–Museum of Natural History–University of Bergen, Norway

Introduction

Intracontinental deformation is an important tectonic process in the global tectonics that has drawn recent attention within the geoscience community. Several intracontinental orogens have been recognized worldwide in the last three decades and the most spectacular examples comprise the modern Central Asia Orogen (Cunningham, 2005), the Tertiary intracontinental orogen of southeastern Australia (Dyksterhuis and Muller, 2008) and the Ediacaran and Paleozoic intracontinental orogens of Central Australia (Shaw et al., 1991; Raimondo et al., 2010). These examples of unequivocal significant intraplate tectonism far from plate boundaries challenge classic ideas of Plate Tectonics theory assuming lithospheric plates as rigid bodies moving over a viscous mantle (e.g., Tackley, 2000; Bercovici, 2003) and orogeny restricted to plate boundaries (e.g. Dewey and Bird, 1970; Sengör, 1990). Not only these classic ideas must be reevaluated, but also the relevance of intracontinental orogeny in the tectonic reconstruction of ancient global-scale events must be taken into account.

Within this perspective, we propose a new tectonic panorama for the evolution of the Neoproterozoic Brasiliano Cycle based in new geological, structural, geochemical and geochronological data from the Central Ribeira Belt (Meira, 2014; Meira et al., in press). In our model, the Ribeira and Araçuaí belts evolved in an intracontinental environment (hinterland) between two subduction/collisional systems (Brasilia and Dom Feliciano orogens), rather than through multiple collision events between independently drifting terranes.

Geological Overview

The Ribeira Belt comprises the central segment of the Mantiqueira Province (Almeida et al., 1981), limited by the Luis Alves cratonic block and Araçuaí Belt in the south and north, respectively. The Ribeira Belt is characterized by a major NE- to ENE-trending orogen-parallel strike-slip shear system that cuts through basement composed of Paleoproterozoic crystalline inliers, Mesoproterozoic and Neoproterozoic metasedimentary sequences and large volumes of syn-orogenic Neoproterozoic granitic plutons (Silva et al., 2005). Voluminous post-orogenic Ediacaran granitoids and numerous small Ediacaran/Cambrian fault-bounded volcano-sedimentary basins complete the geological framework of the Ribeira Belt (e.g., Janasi et al., 2001; Almeida et al., 2010).

The Central Ribeira Belt includes metavolcano-sedimentary units, orthogneisses and voluminous granitic batholiths, separated by major strike-slip shear zones into three different geological domains: the Serra do Itaberaba-São Roque, Embu and Costeiro domains. The Serra do Itaberaba and São Roque groups comprise Mesoproterozoic and Neoproterozoic metavolcano-sedimentary sequences, respectively, and voluminous Late Neoproterozoic granitic batholiths (Juliani et al., 2000). The Embu Domain comprises stretched Paleoproterozoic inliers invariably reworked during the Brasiliano Orogeny (Rio Capivari Complex), low- to high-grade metasedimentary rocks (Embu Complex) and abundant syn-tectonic granitic stocks and batholiths (Meira, 2014). The Costeiro Domain is represented by high-grade orthogneisses, metamafic and metasedimentary rocks (Costeiro Complex), including metatexitic and diatexitic migmatites, and syn-tectonic granitoids (Meira, 2014).

Tectono-metamorphic evolution of the Embu and Costeiro domains (Central Ribeira Belt)

The geodynamic interpretation of the new geological, structural, petrological, geochemical and geochronological data presented by Meira (2014) reveals some discrepancies with current tectonic models available for the Ribeira Belt based, mostly in successive terrane accretion in an active subduction-related margin. A first order constrain of the new data is that the widespread Cryogenian magmatism and metamorphism present in virtually all domains of the Central Ribeira Belt, including within-plate mafic magmatism in the Costeiro Domain, suggest that these domains were already juxtaposed by this time.

Two successive metamorphic stages recorded in the Embu and Costeiro domains corroborate the coherent tectonic evolution of both domains during the Ediacaran period. The prograde M1 metamorphic stage yielded ages of 650–600 Ma while the ensuing extensional and

wrench-related M2 metamorphic stage took place at around 600–560 Ma. The P–T paths for the Embu Complex indicate burial of metasedimentary rocks up to 0.8 GPa (~25 km-depth) at temperature around 600 °C (M1), followed by near-isothermal decompression to 0.3 GPa (~10 km depth) (M2). In turn, after a similar M1 stage in the Costeiro Complex, M2 metamorphism shows moderate decompression down to 0.4–0.6 GPa (circa of 12–18 km-depth) and heating up to 650–750 °C, followed by final cooling and decompression. The contractional tectono-metamorphic event (M1) is interpreted as the result of an intracontinental orogeny associated with coeval collisions in the Southern Brasilia and Dom Feliciano belts, whereas the extensional and wrench-related metamorphism (M2) is linked to the orogenic collapse and escape tectonics. The upper amphibolite facies metamorphism in the Costeiro Domain generated widespread partial melting of the middle crust during decompression, forming migmatitic rocks and peraluminous leucogranites. U–Pb SHRIMP zircon data obtained on these diatexites and leucogranites constrain the migmatization event at circa 585–560 Ma. Crustal flow in the partially melted middle crust produced migmatite-cored gneiss domes in an extensional regime.

In this context, the voluminous Ediacaran granitic magmatism of the Ribeira Belt is not interpreted as subduction-related volcanic arc magmatism, but as post-thickening (post-collisional) magmatism in an extensional- and wrench-dominant environment, related to the orogenic collapse, escape tectonics and deposition of rift-related basins all over the Mantiqueira Province.

Final Remarks

New data from the Central Ribeira Belt argue against most of the widely accepted tectonic models for the Ediacaran evolution of the Ribeira Belt. The coherent tectonic evolution of the Embu and Costeiro domains of the Ribeira Belt and of at least part of the Southern Brasilia Belt during the Late Neoproterozoic points to an intracontinental environment for important segments of the Brasiliano mobile belts, including the Ribeira and Araçuaí belts. The new proposed tectonic model demonstrates the relevance of intracontinental orogeny for the reconstruction of the processes related to supercontinent assembly. Furthermore, new constraints on the depositional age of the Bambuí Group indicate an important intracontinental deformational event younger than Cambrian along the São Francisco Craton borders.

References

Almeida, F.F.M., Hasui, Y., Brito-Neves, B.B. and Fuck, R.A., 1981. Brazilian Structural Provinces: an introduction. Earth-Science Reviews 17, 1–29.

Almeida, R.P., Janikian, L., Fragoso-Cesar, A.R.S. and Fambrini, G.L., 2010. The Ediacaran to Cambrian Rift System of Southeastern South America: Tectonic Implications. The Journal of Geology 118, 145–161.

Bercovici, D., 2003. The generation of plate tectonics from mantle convection. Earth and Planetary Science Letters 205, 107–121.

Cunningham, W.D., 2005. Active intracontinental trans- pressional mountain building in the Mongolian Altai: Defining a new class of orogen. Earth Planetary Science Letters 240, 436–444.

Dewey, J.F. and Bird, J.M., 1970. Mountain Belts and the New Global Tectonics. Journal of Geophysical Research 75, 2625–2647.

Dyksterhuis, S., and Müller, R.D., 2008. Cause and evolution of intraplate orogeny in Australia, Geology 36, 495–498.

Janasi, V.A., Leite, R.J. and Van Schmus, W.R., 2001. U–Pb chronostratigraphy of the granitic magmatism in the Agudos Grandes Batholith (West of São Paulo, Brazil) - implications for the evolution of the Ribeira Belt. Journal of South American Earth Sciences 14, 363–376.

Juliani, C., Hackspacher, P., Dantas, E.L. and Fetter, A.H., 2000. The mesoproterozoic volcano-sedimentary Serra do Itaberaba Group of the Central Ribeira Belt, São Paulo State, Brazil: implications for the age of the overlying São Roque Group. Revista Brasileira de Geociências 30, 82–86.

Meira, V.T., 2014. Evolução Tectono-Metamórfica Neoproterozoica dos complexos Embu e Costeiro no contexto de formação do Gondwana Ocidental (leste do Estado de São Paulo). Unpublished doctoral thesis, IGc-USP, São Paulo, 266p. Available at: http://www.teses.usp.br

Meira, V.T., García-Casco, A., Juliani, C., Almeida, R.P., Schorscher, J.H.D., in press. The role of intracontinental deformation on supercontinent assembly: insights from the Ribeira Belt, Southeastern Brazil (Neoproterozoic West Gondwana). Terra Nova, doi: 10.1111/ter.12149.

Raimondo, T., Collins, A.S., Hand, M., Walker-Hallam, A., Smithies, R.H., Evins, P.M. and Howard, H.M., 2010. The anatomy of a deep intracontinental orogen. Tectonics 29, TC4024, doi:10.1029/2009TC002504.

Sengör, A.M.C., 1990. Plate Tectonics and Orogenic Research after 25 years: A Tethyan Perpective. Earth-Sciences Review 27, 1–201.

Shaw, R.D., Etheridge, M.A. and Lambeck, K., 1991. Development of the Late Proterozoic to Mid Paleozoic, Intracratonic Amadeus Basin in central Australia: A key to understanding tectonic forces in plate interiors. Tectonics 10, 688–721.

Silva, L.C., McNaughton, N., Armstrong, R., Hartmann, L. and Fletcher, I., 2005. The Neoproterozoic Mantiqueira Province and its African connections. Precambrian Research 136, 203–240.

Tackley, P.J., 2000. Mantle convection and plate tectonics: toward an integrated physical and chemical theory. Science 288, 2002–2007.