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Sedimentary provenance of the inner segments of the Paraguay Belt: Paleogeographic domains from a distal passive margin?

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Orientador: Prof. Dr. Mario da Costa Campos Neto

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RESUMO

Frugis, G.L. 2022. Proveniência sedimentar dos segmentos internos da Faixa Paraguai - Domínios paleogeográficos distais de uma margem passiva? [Tese de Doutorado], São Paulo, Instituto de Geociências, Universidade de São Paulo, 319 p.

A aglutinação final de Gondwana Ocidental é registrada em faixas orogênicas diacrônicas no neoproterozoico-paleozoico com ambientes tectônicos distintos e envolvendo diversos blocos continentais. A Faixa Paraguai, o braço orogênico mais ocidental da Província Tocantins, é o resultado da interação entre os cratons Amazônico, Paranapanema e São Francisco-Congo. O segmento mais oriental da faixa compreende sequências metassedimentares e metavulcânicas que registraram o contexto de rifte à margem passiva durante o toniano-criogeniano. Este trabalho apresenta geoquímica elemental e isotópica de Nd-Sr em rocha-total e U-Pb, Lu-Hf e O em zircão em rochas metassedimentares, metavulcânicas e metavulcanoclásticas assim como em ortognaisses e granitoides da Faixa Paraguai Oriental e da sequência mais ocidental do Arco Magmático de Goiás do Orógeno Brasília. A abordagem através da geoquímica e geocronologia sugere que a Sequência Metavulcanossedimentar Nova Xavantina registrou estágio de abertura de rifte em 715-750 Ma no contexto de retro-arco em resposta à formação do Arco Magmático de Goiás devido ao regime convergente do Oceano Goiás-Pharusiano. Dados de Hf-O em zircão de tufos sugerem influência de material juvenil de ca. 710 Ma a partir de astenosfera rasa. A presença de material evoluído e mais antigo nestes tufos propõe a erosão de embasamento antigo nas ombreiras do rifte. O vulcanismo de ca. 750 Ma registrado pela Sequência Metavulcanossedimentar Bom Jardim de Goiás, no lado do Orógeno Brasília, provavelmente está associado a evolução de um arco magmático juvenil acrescido ao Arco Magmático de Goiás. A Unidade Glaciomarinha, uma sequência tipo-Grupo Cuiabá, registra a erosão de embasamento meso a paleoproterozoico e deposição em ambiente de margem passiva na borda cratônica do Amazonas. Resultados de Hf-O em zircão indicam acresção juvenil do mesoproterozoico nas províncias do cráton. A pequena quantidade de material criogeniano-toniano no registro sedimentar sugere maior distância entre o Arco Magmático de Goiás e a bacia de margem passiva. As rochas metassedimentares da Unidade Foreland documentam a erosão direta de fonte

juvenil de 700-800 Ma localizado no Arco Magmático de Goiás com menor influência de material mais antigo. Os resultados obtidos sugerem que a história geológica da Faixa Paraguai Oriental começou em resposta da evolução do Orógeno Brasília, onde o rifteamento no ambiente de retro-arco separaria as paleoplacas do Amazonas e Paranapanema em 715-750 Ma. A evolução do rifte teria aberto a possibilidade da formação de crosta oceânica dando espaço a uma bacia proto-oceânica. A margem passiva da Unidade Glaciomarinha teria se estabelecido na borda cratônica do Amazonas com influência de regime marinho e glacial até ca. 650-630 Ma. A mudança do regime extensional para contracional é registrada pela Unidade Foreland em ca. 550-530 Ma, sendo depositada no Arco Magmático de Goiás, retratado por ortognaisses de 615-630 Ma encontrados no embasamento, indicando a prolongação do arco para oeste além dos limites das orógenos Paraguai-Brasília.

Palavras-chave: Faixa Paraguai; proveniência sedimentar; rifte; formação do Gondwana Ocidental; geocronologia em zircão; geoquímica isotópica.

ABSTRACT

Frugis, G.L. 2022. Sedimentary provenance of the inner segments of the Paraguay Belt: Paleogeographic domains from a distal passive margin? [PhD Thesis], São Paulo, Institute of Geosciences, University of São Paulo, 319 p.

The Western Gondwana final agglutination is recorded in diachronic Neoproterozoic-Paleozoic orogenic belts with distinct tectonic settings englobing several continental blocks. The Paraguay Belt, the westernmost orogenic arm of the Tocantins Province, is the result of the interaction between the Amazonian, Paranapanema and São Francisco-Congo cratons. The easternmost segment of the belt comprises metasedimentary and metavolcanic sequences which recorded a rift to passive margin setting during Tonian-Cryogenian times. This work present whole-rock elemental and Nd-Sr isotopic geochemistry and zircon U-Pb, Lu-Hf and O on metasedimentary, metavolcanic and metavolcaniclastic rocks as well as on orthogneiss and granitoids from the Eastern Paraguay Belt and westernmost sequence of the Goiás Magmatic Arc from the Brasília Orogen. The geochemical and geochronological approach suggest the Nova Xavantina Metavolcanic-sedimentary Sequence recorded a 715-750 Ma rifting stage at the back-arc setting as response to the Goiás Magmatic Arc rising due to the Goiás-Pharusian Ocean convergent regime. Zircon Hf-O systematics on tuffs suggest ca. 710 Ma juvenile material input at shallow asthenosphere. The presence of evolved older material on the tuff zircon record propose erosion of old basement rift edges. The ca. 750 Ma volcanism recorded by the Bom Jardim de Goiás Metavolcanic-sedimentary Sequence, on the Brasília Orogen side, is likely associated to the evolution of a juvenile magmatic arc accreted to the Goiás Magmatic Arc. The Glaciomarine Unit, a Cuiabá Group-like sequence, registers the Meso to Paleoproterozoic basement erosion and deposition on passive margin environment at the Amazonian cratonic edge. Zircon Hf-O results indicate juvenile accretion on Mesoproterozoic provinces in the craton. The small amount of Cryogenian-Tonian material on the sedimentary record suggest greater distance between the Goiás Magmatic Arc and the passive margin basin. The Foreland Unit metasedimentary rocks document the direct erosion of a 700-800 Ma juvenile source located at the Goiás Magmatic Arc with lesser influence of older material. The obtained results suggest the Eastern Paraguay Belt geological history

started in response to the Brasília Orogen evolution, where the rifting in the back-arc setting would separate the Amazonian and the Paranapanema paleoplates at 715-750 Ma. The rift evolution could have opened the possibility to oceanic crust formation giving space to a proto-oceanic basin. The Glaciomarine Unit passive margin environment would have been stablished on the Amazonian cratonic edge with influence of marine and glacial regimes until ca. 650-630 Ma. The switch from extensional to contractional regimes is recorded by the Foreland Unit at ca. 550-530 Ma, being deposited on the Goiás Magmatic Arc, depicted by 615-630 Ma orthogneiss from the basement, indicating a prolongation of the arc westward beyond the Paraguay-Brasília orogens limits.

Keywords: Paraguay Belt; sedimentary provenance; rift; Western Gondwana formation; zircon geochronology; isotopic geochemistry.

INTRODUCTION

Thesis Organization

This thesis is organized into seven chapters being the first an introduction chapter to provide general information regarding the theme, justificative, objectives and location of the project. The second chapter describes all the methods and analytical procedures applied to fulfill the objectives. The third one is a scientific paper submitted to Precambrian Research journal and written by the PhD candidate, Mario da Costa Campos Neto and Alice Westin. It comprises all the whole-rock elemental and isotopic geochemistry along zircon U-Pb data, which allowed building a new tectonic discussion on the Eastern Paraguay Belt evolution. The fourth chapter is another scientific paper submitted to Precambrian Research journal, written by the PhD candidate, Prof. Mario da Costa Campos Neto, PhD, and Prof. Christopher Mark Fanning, PhD. It comprises zircon Lu-Hf and O isotopic analyses, which permitted new insights on the isotopic reservoirs of the studied rock protoliths and tectonic scenario of the Eastern Paraguay Belt. The fifth chapter englobes general conclusions enabled by all the geochemical and geochronological data presented in the previous two scientific papers. The sixth one comprises and summarizes the main conclusions of the study. The last chapter lists the references cited in both papers and the thesis. Supplementary material such all the microscopic descriptions of the thin sections and analytical charts are at the end of the thesis as appendix.

Introducing the Theme

Building and breaking up continental masses are cycles that involve complex processes, mainly when the study object is hundreds of thousands million years old. The Neoproterozoic Era witnessed innumerous tectonic changes breaking apart important continuous landmasses such as Rodinia and forming other important supercontinents such as Gondwana. The paths the continental fragments took before agglutinating to form Gondwana are as important as the formation of the supercontinent itself. Global-scale events can help to solve parts of the tectonic puzzle and tools such as paleomagnetism, fossiliferous record, sedimentary

provenance and volcanism can improve the comprehension of the tectonic evolution through more precise paleogeographic reconstructions.

The Gondwana formation occurred diachronically and involved many of Rodinia's descendants. Larger continental masses such as the Amazonian Craton are well known, and paleogeographic reconstructions of its path along the Neoproterozoic are quite satisfactory, although conflicting visions exist. On the other hand, smaller continents, mainly those now covered by sedimentary basins, such as the Paranapanema Block, have their trajectories unknown. Therefore, indirect ways of studying those smaller blocks are of great importance. Studying orogenic scars along their cratonic edges can help to understand their basement composition and the timing of their interaction with neighboring blocks.

The Tocantins Province, in Brazilian territory, is the main orogenic system resulted from the Brasiliano-Pan African event, which led to the Western Gondwana formation. It comprises three of the longest belts involving at least four continents. The Paraguay Belt and the Brasília Orogen are part of this diachronic system.

Justification and Objective

The Paraguay Belt is represented by a predominantly sedimentary sequence related to a rift stage, continental slope and glacial influence. In the easternmost portion of the belt, besides the occurrence of metasedimentary rocks mapped as Cuiabá Group, it also occurs a metavolcano-sedimentary sequence entitled Nova Xavantina Sequence. Further to the southeast of the belt, the Transbrasiliano Lineament would mark the geological contact of the Paraguay Belt with the Brasília Orogen, where, to the east, outcrops a metavolcano-sedimentary sequence comprised in the Goiás Magmatic Arc.

The region chosen for the project has little comprehension of the outcropping units and lithotypes and, therefore, their geological evolution. Through whole-rock elemental and isotopic geochemistry (FRX, ICP, Sm-Nd and Rb-Sr) and zircon isotopic analyses (U-Pb, Lu-Hf and O) on metasedimentary, metavolcanic, metavolcaniclastic rocks and orthogneiss, the main objective is to investigate the geotectonic environment of the Paraguay Belt inner units and their relation with the sequences of the Goiás Magmatic Arc that make contact through the Transbrasiliano Lineament.

This project wanted to answer the following questions: what is the relationship between the Cuiabá Group and the Nova Xavantina Metavolcanic-sedimentary Sequence? What is the timing of the volcanism and sedimentation of all the units outcropping in the study area? Was there oceanic crust generation, posterior subduction and development of continental magmatic arc along the Paraguay Belt? What is the relationship between the volcano-sedimentary sequences on both sides of the Transbrasiliano Lineament?

Study Area

Geologically the study area object of this thesis is the easternmost portion of the Paraguay Belt in which its units make geological contact with the Goiás Magmatic Arc from the Brasília Orogen. Geographically, the area is located between southeast of the Mato Grosso State and northwest of the Goiás State, encompassing the cities of Nova Xavantina, Barra do Garças and Bom Jardim de Goiás.

GENERAL CONCLUSIONS

Tectonic Segmentation of the Eastern Paraguay Belt Lower Units

Through field works, analytical data and previous works available, it was possible to segregate the study area into four tectonic units: Nova Xavantina Metavolcanic-sedimentary Sequence, Bom Jardim de Goiás Metavolcanic-sedimentary Sequence, Glaciomarine Unit and the Foreland Unit.

The Nova Xavantina Metavolcanic-sedimentary Sequence, the oldest one, comprises a pile of metavolcanic, metavolcaniclastic, chemical and detrital rocks (Frugis et al submitted., Silva, 2007, 2018; Lacerda Filho et al., 2004; Sousa, 2012; Pinho, 1990) which outcrops at the Nova Xavantina City surroundings, not being of large occurrence. The metavolcanic rocks of this unit host important gold deposit known as the Araés deposit, associated to large quartz veins correlated to 500-550 Ma orogeny (Geraldes et al., 2008).

The Bom Jardim de Goiás Sequence, old as the Nova Xavantina Sequence, outcrops at the eastern side of the Transbrasiliano Lineament, on the southernmost portion of the study area. It comprises metavolcanic, metavolcaniclastic and detrital

rocks (Guimarães et al., 2012; Seer, 1987; Seer and Nilson, 1985) from the westernmost sequence of the Goiás Magmatic Arc.

The Glaciomarine Unit, mapped as Cuiabá Group in the Northern and Southern Paraguay Belt, outcrops mainly in the north of the study area and comprises a pile of metapelitic and metapsamitic rocks.

The Foreland Unit is a newly segregated one, formerly mapped as the undivided unit of the Cuiabá Group, outcropping mainly between Rondonópolis and Coxim (Pelosi, 2017; Vasconcelos, 2018). Its occurrence is wider than previously expected, outcropping between the north of Barra do Garças and Bom Jardim de Goiás. It was possible to differentiate it from the Glaciomarine Unit/Guiabá Group mainly due to the geochemical and geochronological behavior, suggesting different source areas and tectonic scenarios. While the Cuiabá Group *stricto sensu* is correlated to passive margin deposits through the erosion of Meso to Paleoproterozoic basement, the newly proposed unit is associated to the direct erosion of the Goiás Magmatic Arc during late-Ediacaran and Cambrian subduction/collisional times (Frugis et al., submitted). The Foreland Unit whole-rock Nd isotopic features are distinct from the Glaciomarine Unit/Cuiabá Group since it presents younger NdT_{DM} model-ages and less negative εNd_0 (Frugis et al. submitted).

Source Areas, Crystallization Ages and Maximum Depositional Ages

The metasedimentary rocks from the Nova Xavantina Metavolcanic-sedimentary Sequence present very similar U-Pb age patterns with two main peaks at 0.73-0.90 Ga and 1.8-2.1 Ga, being the latter the most important. The tuffs present the same important Tonian and Orosirian age densities however, 1.13-1.54 Ga, ca. 1.75 Ga and 2.4-2.6 Ga are also present. The Stenian-Calymmian, Statherian-Orosirian and Siderian ages can be found in the Amazonian Craton and suggest erosion of the main Meso to Paleoproterozoic provinces. The tuffs youngest age of ca. 715 Ma (Frugis et al., submitted) is interpreted as the timing of volcanism of the sequence. The Tonian ages suggest erosion from the Goiás Magmatic Arc and source in the Nova Xavantina volcanism itself, since the volcanic activity occurred at 750-715 Ma (Silva, 2018; Frugis et al., submitted). The maximum depositional age of

the sequence is ca. 690 Ma stablished through the two youngest zircon grains. Geochemically, the metasedimentary rocks suggest depleted to upper crust sources with intermediate to high rates of sedimentary recycling.

The U-Pb analyses of the metapelitic and metapsamitic rocks of the Glaciomarine Unit indicate main concentration of Meso to Paleoproterozoic ages of 0.9-1.2 Ga, 1.45-1.55 Ga, 1.75-1.80 Ga and 1.9-2.0 Ga, suggesting erosion of the most important provinces found in the Amazonian Craton, with highlight to the Sunsás and Rondonian-San Ignacio provinces, mainly to the Santa Helena and Alto Guaporé magmatic arcs. The high density of Stenian-Calymmian ages and the small amount of Neoproterozoic ages differ this unit from the previous one, indicating, together with the geochemical behavior, distinct tectonic setting and source areas. For the Glaciomarine Unit, the Goiás Magmatic Arc as source for the Tonian ages was more distal in comparison to the Nova Xavantina Sequence. The maximum depositional age was set at ca. 870 Ma, resulted from two young crystals. Babinski et al. (2018) set the maximum depositional age of the Cuiabá Group as 652 ± 5 Ma through the youngest single zircon grain and correlated its deposition to the Marinoan glaciation at ca. 636 Ma in the Northern Paraguay Belt, although the southern prolongation of the group could have been deposited in different times. Whole-rock elemental geochemistry indicates predominance of upper crust sources with intermediate igneous to quartzose sedimentary provenance and high rates and sedimentary recycling.

The Foreland Unit display a unique age pattern in comparison to the other studied units, exhibiting a dominant Neoproterozoic age density with smaller older peaks with 0.97-1.35 Ga and 2.0-2.1 Ga. The main concentration is between 0.6-0.8 Ga and suggests a direct erosion of the Goiás Magmatic Arc, proposing proximity to the arc. The ages younger than 0.6 Ma are interpreted to reflect the erosion of the syn-orogenic granitic plutons found in the inner domains of the Paraguay Belt. The maximum depositional age was set at 535 Ma, similar to the ca. 535 Ma crystallization age found in one of the granitoid samples, proposing a very fast sedimentation cycle of the foreland basin. 615-630 Ma orthogneiss with ca. 2.5 Ga inherited zircon crystals are interpreted as basement and as being part of the Goiás Magmatic Arc. Geochemical data on whole-rock material suggest felsic igneous provenance in the upper to intermediate crust and median sedimentary recycling.

The only metasedimentary sample analyzed for U-Pb from the Bom Jardim de Goiás Sequence exhibit a high density of ages between 1.71 Ga and 2.23 Ga indicating a Goiás Massif source area. The 685 Ma orthogneiss represents the Goiás Magmatic Arc itself and worked as source for the Foreland Unit metasedimentary rocks. The volcanism age is set at 750 Ma as determined by Guimarães et al. (2012). The elemental geochemistry indicates depleted to upper crust sources with intermediate to felsic igneous provenance.

Isotopic Behavior of the Rock Protoliths

Whole-rock Nd analyses display different patterns throughout the studied units. Comparatively, the volcanic rocks present T_{DM} model-ages of 2.13-2.27 Ga and εNd_t between -12.5 and -10.2 for the Nova Xavantina Unit and 1.61-1.76 Ga and 1.03-1.16 Ga with εNd_t between -2.6 and -4.7 and +2.8 and +4.3, respectively, for the Bom Jardim de Goiás magmatic arc Sequence. These results indicate two different volcanic geneses, suggesting a more primitive depleted and younger origin for the volcanic rocks of the Bom Jardim de Goiás Sequence and more evolved with important old crustal material input for the Nova Xavantina Sequence. The tuffs exhibit distinct patterns as well, in which the T_{DM} model-ages are 2.14-2.22 Ga and εNd_t between -10.6 and -11.8 for the Nova Xavantina Sequence and 0.91-1.12 Ga and εNd_t between +3.26 and +5.60 for the Bom Jardim de Goiás Sequence, suggesting great input of young juvenile material for the Bom Jardim de Goiás tuffs and mixture of old crustal rocks for the Nova Xavantina tuffs.

The Glaciomarine Unit metasedimentary samples display NdT_{DM} modal-ages of 1.64-1.83 Ga with εNd_t between -4 and -8, while the Foreland Unit samples exhibit NdT_{DM} model-ages 1.40-1.76 Ga and εNd_t between -4 and -7.8. Although the εNd_t are similar, the model-ages and εNd_0 differ them, suggesting younger material input for the Foreland Unit.

Zircon Hf and oxygen analyses display distinct patterns for each unit. The ca. 710 Ma zircon grains from the Nova Xavantina Sequence tuffs indicate mantle-derived source since its $\delta^{18}O$ values are ca. 4.8-4.9‰ and present εHf_t value of 0. The older zircon crystals record input of older supracrustal material as the $\delta^{18}O$ values increases and the εHf_t decreases. In similar range of age, the ca. 715 Ma and ca. 810 Ma zircon grains of the Foreland Unit suggest depleted mantle-like derivation

with $\delta^{18}O$ values between 4.68-4.83‰ and εHf_t of +7. Other grains suggest crustal reworking or addition of crustal material. The Bom Jardim de Goiás orthogneiss and metasedimentary rocks present quite similar εHf_t range between -8 and +7 and $\delta^{18}O$ values between 5.27‰ and 9.71‰ which could indicate magmatic differentiation and evolution through depleted original materials. The Glaciomarine Unit may indicate depleted sources for its Mesoproterozoic zircon grains since they display εHf_t of 0 and -1 and $\delta^{18}O$ values of 5.14‰ and 5.83‰. The remaining zircon crystals suggest input of supracrustal material.

Tectonic Setting

Whole-rock elemental geochemistry on metasedimentary rocks of the Nova Xavantina Sequence indicate oceanic island arc tectonic setting while Nd-Sr isotopic data suggest passive to active margin array, while geochemical data on the metavolcanic and metavolcaniclastic rocks point to E-MORB sources at shallow depths and within-plate tholeiites or volcanic arc basalts affinities.

Elemental geochemistry on the Bom Jardim de Goiás Sequence metasedimentary rock point to active continental margin setting while the metavolcanic and metavolcaniclastic rocks indicate volcanic arc affinities along magma-crust interaction in proximity to the subduction zone and with deep origin. The orthogneiss sample from the same unit suggest volcanic arc environment as well.

Geochemical data on the metasedimentary rocks of the Glaciomarine Unit are not well conclusive regarding tectonic setting, suggesting both passive and active margin environment. In other hand, data from the Foreland Unit metasedimentary samples clearly indicate active continental margin setting. Orthogneiss samples at the Foreland Unit basement mark a trend between within-plate anomalous ocean ridge and volcanic arc.

Considering all the results obtained and the data provided by literature, and although the age similarities between the volcanism recorded by the Nova Xavantina Sequence of ca. 715-750 Ma (Frugis et al., submitted; Silva, 2018) and the Bom Jardim de Goiás Sequence at ca. 750 Ma (Guimarães et al., 2012), the tectonic scenario for both units are distinguishable: the Nova Xavantina Sequence geneses is probably related to rift opening and incipient oceanic crust formation (marginal

basin?) while the Bom Jardim de Goiás Sequence is more likely to be associated to a juvenile magmatic arc. The Glaciomarine Unit sedimentation is associated to passive margin tectonic setting while the Foreland Unit is correlated to an active margin environment.

Tectonic Evolution

The ca. 715-750 Ma volcanism (Frugis et al., submitted; Silva, 2018) on the Nova Xavantina Sequence marks the extensional regime with the rift opening which could have broken apart a larger continent separating the Amazonian Craton and the Goiás Magmatic Arc crust (Paranapanema Block?). At similar period, the Bom Jardim de Goiás Sequence would have been formed as a juvenile arc accreted to the Goiás Magmatic Arc (Guimarães et al., 2012; Frugis et al., submitted).

The Nova Xavantina metasedimentary rocks records the erosion of the basement and important input of volcanic detritus both of the rift volcanism itself and from the Goiás Magmatic Arc, not at great distance at the time. Incipient oceanic crust correlated to a restrict sea would promote the distancing between the magmatic arc and the Amazonian Craton after 680 Ma. The Glaciomarine Unit, sedimented through the erosion of most of the Amazonian Craton provinces, would have been deposited at ca. 650-630 Ma on its passive margin edge, influencing marine and glacial regimes. The Goiás Magmatic Arc would have been distal for sediment supply since Cryogenian-late-Tonian detrital zircon is scarce or absent.

The syn-tectonic granitic intrusions at ca. 540-550 Ma (Godoy et al., 2010) mark the tectonic regime shift to contractional and the Foreland Unit sedimentation takes place through the direct erosion of the Goiás Magmatic arc and the syn-tectonic granites as subduction/collisional-controlled foreland.

MAIN CONCLUSIONS

- The Nova Xavantina Metavolcanic-sedimentary Sequence records the rift opening and volcanism at ca. 715-750 Ma with incipient oceanic crust formation. The metavolcanic rocks indicate E-MORB affinities of old material originating at shallow depths. According to the Hf-O systematics, the tuffs document mantle-derived volcanism at ca. 715 Ma and the Nd whole-rock data indicate significant input of

evolved old basement material into the rift basin. The erosion of Meso to Paleoproterozoic rocks of the Amazonian Craton and Paranapanema basement is registered in the tuffs and metasedimentary rocks.

- The Bom Jardim de Goiás Metavolcanic-sedimentary Sequence genesis is related to a ca. 750 Ma juvenile arc accreted to the Goiás Magmatic Arc, since the metavolcanic and metavolcaniclastic rocks exhibit primitive depleted origin. The ca. 685 Ma orthogneiss possibly indicate magmatic differentiation from depleted material.

- The Glaciomarine Unit represents a metasedimentary sequence deposited in a passive margin environment with glacial and marine influence. Meso to Paleoproterozoic basement erosion from the Amazonian Craton provinces gives origin to the sediments, which filled the basin. The Goiás Magmatic Arc would be at such distance that would contribute with sediments but in a lower scale.

- The Foreland Unit, the youngest of the studied units, is the representative of the direct erosion of the Ediacaran-Cryogenian Goiás Magmatic Arc during subduction/collisional times and records the tectonic switch to contractional regime. 615-630 Ma orthogneissic basement outcrops in the area and 535 Ma intrusive granitoid marks the end of sedimentation and the fast dynamics character of the foreland basin.

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