PALEOMAGNETIC EVIDENCE OF A LATE EDIACARAN OCEAN IN SOUTH AMERICA?

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ABSTRACT

In recent years, a controversy arose on whether a large ocean, called Clymene, existed between the Amazonian craton and the Rio de la Plata / Congo-Sao Francisco cratons in the late Ediacaran. Comparison of the available reliable paleomagnetic poles from the latter two cratons, West Africa and Laurentia for the interval 615-560 Ma suggests that by ca. 575 Ma a large ocean existed between Laurentia-Amazonia-West Africa on one side and Río de la Plata and Congo-Sao Francisco on the other. This conclusion is still valid whether the "high latitude" or the "low latitude" option is chosen for Laurentia. However, paleomagnetic data from the proper Amazonia are needed for definite conclusions.

Keywords: Clymene Ocean, Amazonia, Rio de la Plata, Paleomagnetism, Ediacaran, Laurentia

RESUMEN

En años recientes ha surgido una controversia sobre la existencia de un gran océano, llamado Clymene, entre el cratón de Amazonia y los cratones de Río de la Plata y Congo-Sao Francisco en el Ediacarano tardío. La comparación de los polos paleomagnéticos confiables disponibles de los últimos dos cratones, Africa Occidental y Laurentia para el intervalo 615-560 Ma sugiere que para los 575 Ma existió un gran océano entre Laurentia-Amazonia-Africa Occidental por un lado y Río de la Plata y Congo-Sao Francisco por el otro. Esta conclusión es válida no importa que se elija la opción de alta o baja latitud para Laurentia en el Ediacarano. Sin embargo, son necesarios datos de la propia Amazonia para conclusiones definitivas.

Palabras Clave: Océano Clymene, Amazonia, Rio de la Plata, Paleomagnetismo, Ediacarano, Laurentia

Introduction

The global paleogeographic evolution in the interval between Rodinia break-up and Gondwana assembly is a matter of long-standing contoversies (e.g. Li *et al*., 2008, Pisarevsky *et al*., 2008, Murphy *et al*., 2013, and many others). In particular, the assembly of Western Gondwana apparently was a diachronous and long process that involved several cratons and terranes. In recent years, a controversy arose around the time of accretion of Amazonia to other South American blocks. Trindade *et al.* (2006) and Tohver *et al.* (2012) proposed that during the late Ediacaran and earliest Cambrian a large ocean, called Clymene, existed between the Amazonian craton and the Congo-Sao Francisco (C-SF) and Río de la Plata (RP) cratons. According to this model, accretion occurred sometime around 525 Ma, being the last major block accretion in the Gondwana-forming process. However, Cordani *et al*. (2013) disputed this model suggesting that

closure of the ocean between these blocks (Goias Ocean) occurred prior to 600 Ma. Reliable paleomagnetic poles from the intervening crustal blocks in the interval *ca.* 620-520 Ma may solve this dispute. Although paleomagnetic data is still scarce in that time span, the available information suggests that a large ocean probably existed between Amazonia and C-SF/RP in the late Ediacaran.

Paleomagnetic Data and Discussion

In most Rodinia reconstructions (see Li *et al*., 2008 and references therein) Amazonia is placed attached to Eastern Laurentia. Geologic information has set break-up of these last pieces of Rodinia at around 565-550 Ma (Cawood *et al*., 2001). Therefore, in most paleogeographic models Amazonia and Laurentia were still together in the middle to late Ediacaran. This is supported by the coincident positions of the 615 Ma Adma Diorite pole (Morel, 1981) from the West Africa craton and the coeval Long Ranges dykes pole (Hodych *et al*., 2004) from Laurentia in a traditional reconstruction of this region of Rodinia (Fig. 1). There is important geologic evidence that West Africa and Amazonia remained as a single plate from the Paleoproterozoic until the opening of the South Atlantic in the Cretaceous (*e.g*. Klein *et al*., 2005), which may allow us to take the Adma Diorite pole as also representative of Amazonia. Under this analysis, Amazonia and Laurentia were still attached by 615 Ma consistent with most paleogeographic models and the much younger age of rifting magmatism in Eastern Laurentia.

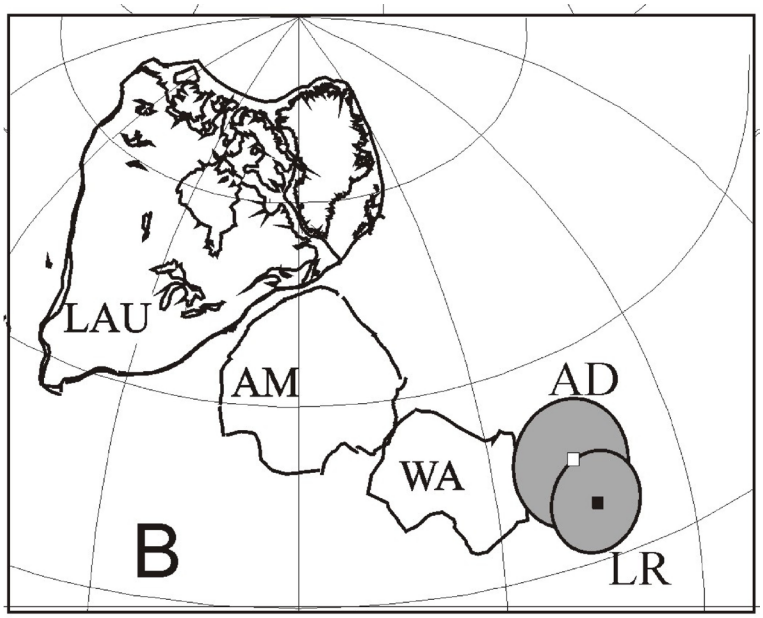

Figure 1. Paleomagnetically supported reconstruction of Laurentia (LAU), Amazonia (AM) and West Africa (WA) for around 615 Ma. AD: Adma Diorite pole (Morel, 1981), LR: Long Range Dykes pole (Hodych *et al.*, 2004).

Moloto-A-Kenguemba *et al.* (2008) obtained a reference paleomagnetic pole for C-SF at 571 Ma (Nola dykes pole), while Rapalini *et al.* (2015) have just published a reference pole for RP at 578 Ma (Sierra de las Ánimas pole). Both poles indicate that these blocks were close to each other or already accreted by those times. Comparison with the available poles for Laurentia for that interval (*e.g*. Callander Complex, 577 Ma, Symons and Chiasson, 1991) indicates a very large ocean between Laurentia and RP-C-SF (Fig. 2). Unfortunately, no paleomagnetic data of around 575 Ma is yet available for Amazonia (or West Africa). However, if Amazonia was still part of Rodinia by 615 Ma as shown in Figure 1, its separation must be correlated with the 565-550 Ma magmatic event in Eastern Laurentia and should still be in the same relative position (or close to it) by 570-580 Ma. This is illustrated in Figure 2, in which a large ocean looks unavoidable between Amazonia and RP-C-SF under the above mentioned circumstances.

The high latitude position of Laurentia in the middle Ediacaran has been a matter of long and yet unsettled debate. Although a few well-dated poles of high quality supports this reconstruction, several researchers

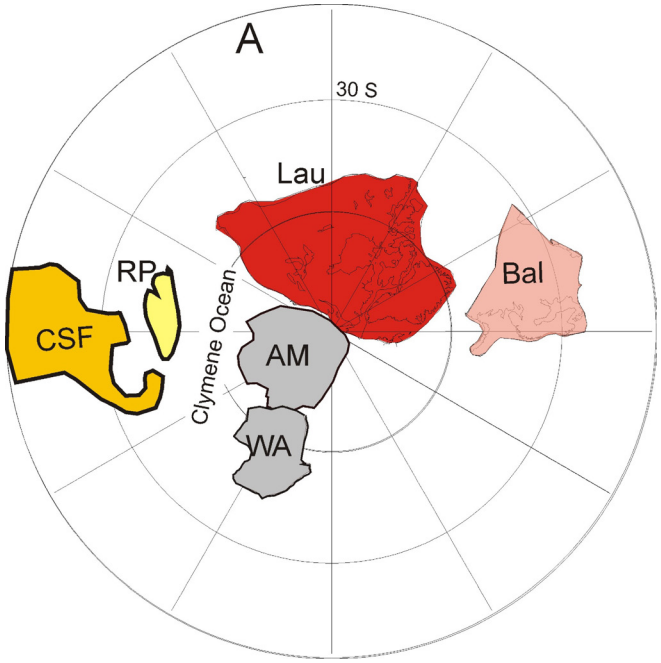

Figure 2. Paleomagnetically supported reconstruction of Río de la Plata (RP), Congo-Sao Francisco (C-SF), Laurentia (Lau), Amazonia (AM), West Africa (WA) and Baltica (Bal) for *ca*. 575 Ma. RP and C-SF have been positioned according to the Sierra de las Animas pole (Rapalini *et al*., 2015), Laurentia according to the Callander complex pole (Symons and Chiasson, 1991) and Baltica according to the 555 Ma Baltica mean (Meert *et al*, 2007). AM and WA remain attached to Laurentia as in Fig. 1.

oppose it as it would mean very fast polar wandering of Laurentia from polar to equatorial latitudes in a short interval (580-565 Ma, Pisarevsky *et al.* 2008), and prefer a virtually unchanged equatorial position of Laurentia in the whole Ediacaran. This alternative is shown in Figure 3. In this case, again, the positions of RP and C-SF do not permit to avoid a large ocean between them and the Amazonian craton (and Laurentia).

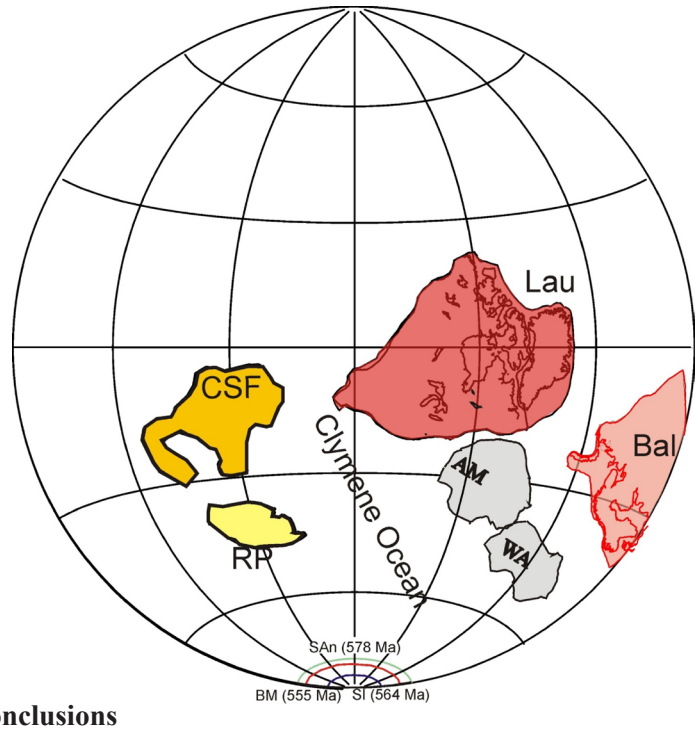

Figure 3. idem Fig.2 but adopting the low-latitude option for Laurentia, based on the Sept-Iles pole (Tanczyk *et al*., 1987)

Conclusions

The available paleomagnetic data from Laurentia, Congo-Sao Francisco, Río de la Plata and West Africa supports the existence of a large Ediacaran ocean (Clymene) between Amazonia and the other South American cratons. Mid to Late Ediacaran reliable paleomagnetic poles from Amazonia are needed for final confirmation or refusal of the present interpretation.

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