Tectonic assembly and individualisation of the Caribbean plate : the case of La Désirade island, French Antilles
A structural, petrogeochimical and geochronological approach

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INTRODUCTION

The island of La Désirade in the Guadeloupe archipelago (Fig. 1 a), is the only evidence in the Lesser Antilles arc of a Late Jurassic subduction zone with an eastern vergence along the Nord-South American margins.

This pluridisciplinary study clarifies the geodynamic context of the formation of the island's magmatic basement (Fig. 1 b), consisting of basaltic (155-145 Ma; *Cordey & Corney, 2021*) to differentiated units, intruded by dyke complexes.

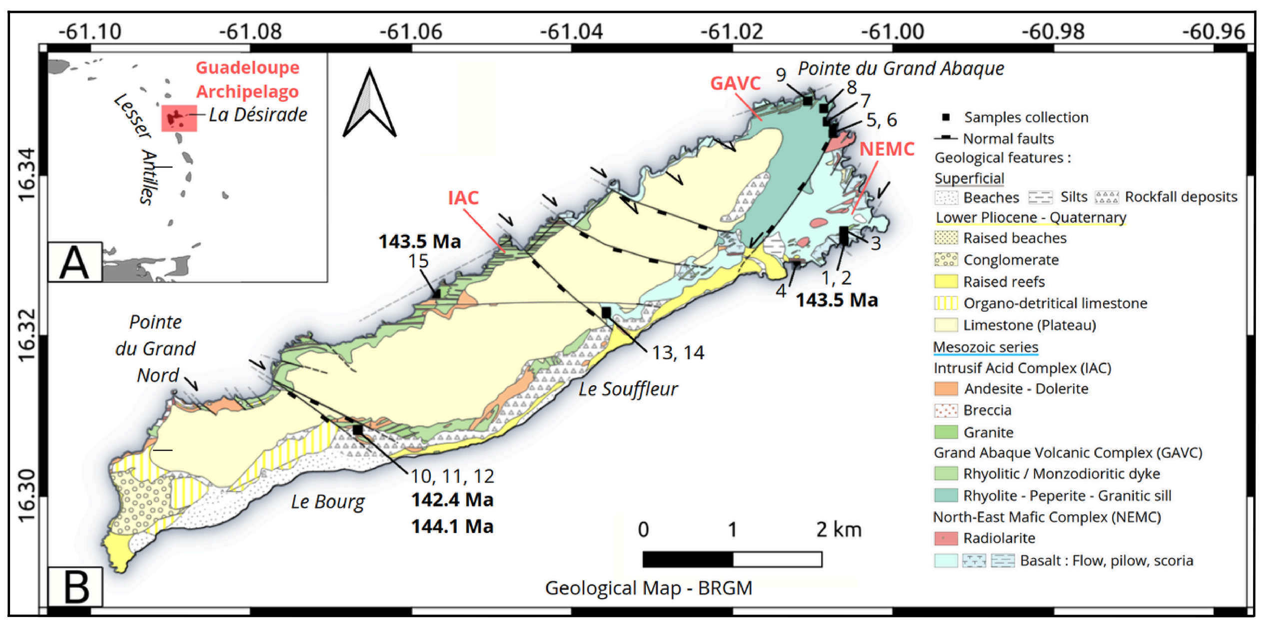

Fig. 1 a) Location of La Désirade in the Lesser Antilles arc
b) Geological map of La Désirade island

RESULTS

Field observations :

This part of the study enabled the characterisation of the three basement units (Fig. 1), juxtaposed by a system of conjugate vertical strike slip faults, oriented N050°E and N120°E (Fig.1).

Petrological analysis :

Apart from the basaltic units already studied (*Neil et al., 2010*), three lithologies have been identified : granitoids, monzodiorites and rhyolites, all affected by generalised hydrothermalism (presence of epidote and chlorite), evidence of fluid circulation (Fig. 2).

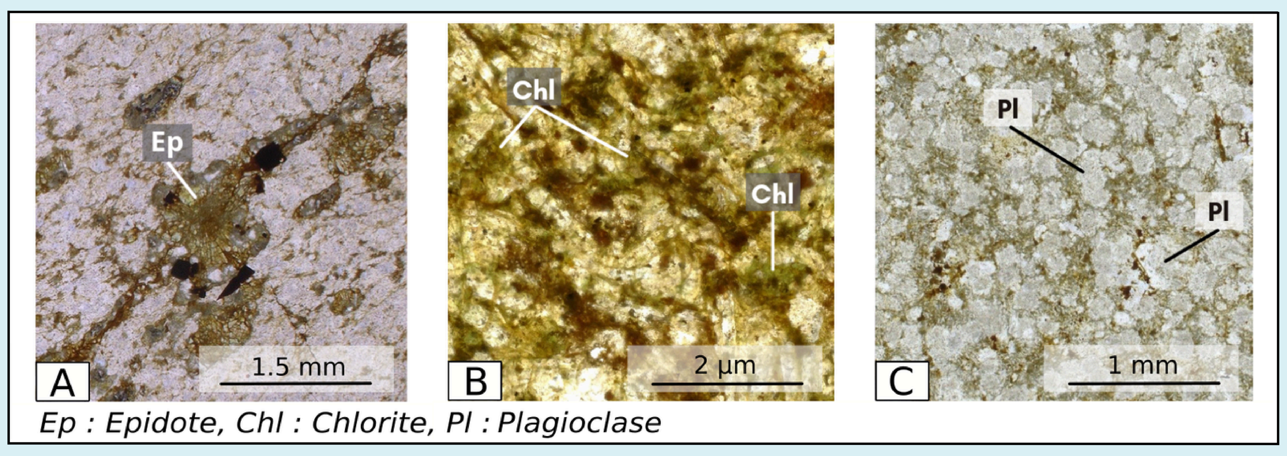

Fig. 2 Minerals indicative of hydrothermalism - LPNA
a) Automorphic epidote - 5 b) Pervasive chloritisation - 7 c) Sericitisation plagioclases - 6

Absolute geochronology :

Four samples (granitoid and rhyolite) were dated using the U-Pb method on zircon (LA-ICP-MS). Most of the grains are colourless, translucent and automorphic (consistent with magmatic crystallisation). Analyses of a single sample were performed on a thin section (in situ), while for the others, the separated grains were placed on epoxy plots. Plotted on the Concordia diagram (Fig. 3), the points are concordant or discordant and intersect the Concordia (sample 11). They range from 142,4±1,3 Ma to 144,1±2,1 Ma (Fig. 3), confirming the age of Upper Jurassic - Lower Cretaceous magmatism, considering their margin of error.

No age was obtained for the least differentiated samples (monzodiorites) due to the abscence of accessory minerals.

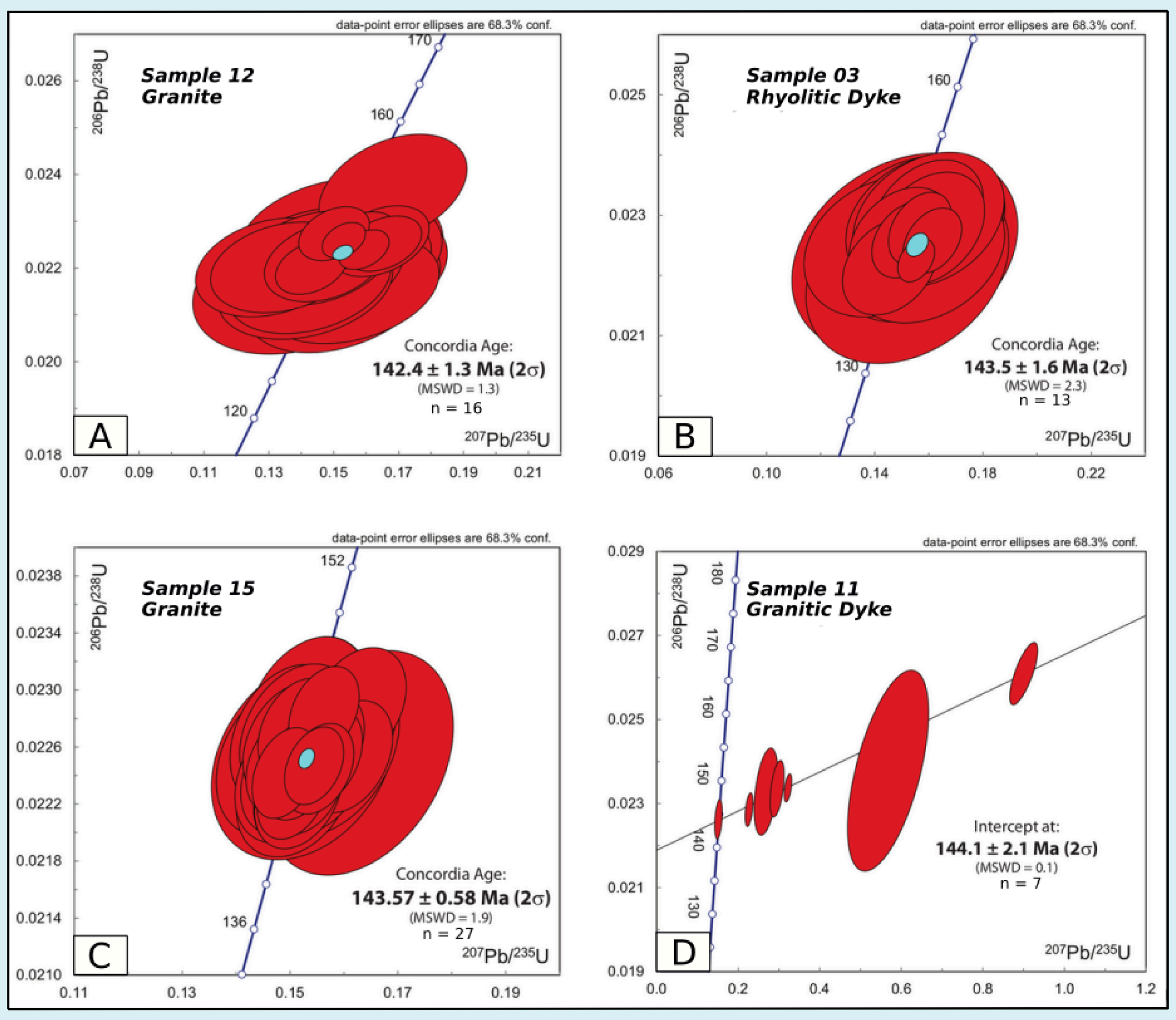

Fig. 3 U-Pb Concordia diagrams on zircons :
a) Sample 12 - Granite b) Sample 03 - Rhyolitic dyke
c) Sample 15 - Granite d) Sample 11 - Granitic dyke
- MSWD : Mean Square of Weighted Deviation -
These analyses were performed using natural zircon 91500 (primary standard) and GJ1 (secondary standard).

Geochimical analysis : Majors elements

Plotted on the TAS diagram, the 11 samples selected can be divided into 2 groups :

- Monzodiorites (SiO_2 = 53.5 - 55 %, LOI > 2 %, low to moderate alteration)
- Granites and rhyolites (SiO_2 = 70.4 - 76.9 %, LOI < 1.75%, low alteration)

Alkali contents (Na_2O+K_2O) range from 6.73 to 8.5 %. The two groups established above on the basis of petrological observations can be distinguished once again.

Traces elements

The rare earth spectra (Fig. 4 a) are homogeneous and flat, with an enrichment factor of 8-30 compared to chondrites and slight negative anomalies in Eu (granitoids). The spider diagram (Fig. 4 b) reveal marked negative anomalies in Nb-Ta and Ti, characteristic of a subduction magmatic series. However, the low enrichment in highly incompatible elements indicates a limited sedimentary contribution from the magmatic sources of the ancient arc.

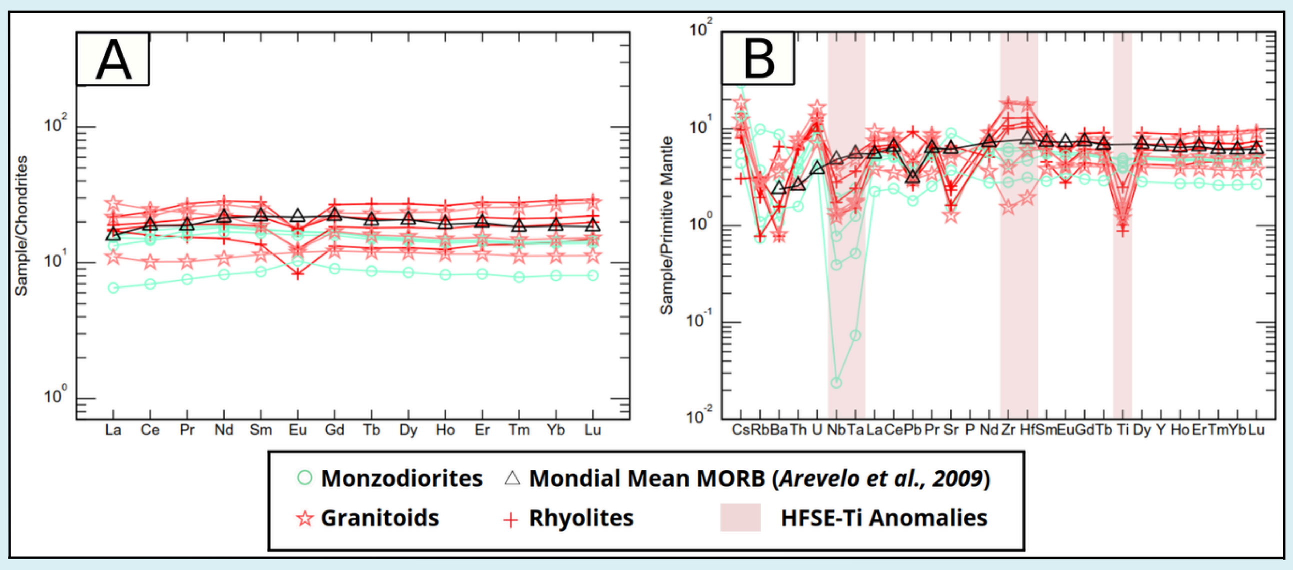

Fig. 4 a) Rare Earth Elements (REE) spectra normalised to the chondrites (CHUR)
b) Spider diagram (from most incompatible to most compatible)
normalised to the primitive mantle [ppm]
a) Normalisation : *Sun and McDonough, 1995* - b) Normalisation : *Sun and McDonough, 1989*.

Pb-Sr-Nd-Hf isotopes

The isotopic ratio values in this study are homogeneous and belong to the global arc domain, in the least evolved part (Fig. 5).

The Sr-Nd-Pb-Hf isotopes indicate a strong mantle component (8.6 < $\varepsilon Nd_{(i)}$ < 9.34, 11.3 < $\varepsilon Hf_{(i)}$ < 13.1 (*Fernandez et al., 2020*) which, in a subduction context, may be characteristic of a back-arc domain.

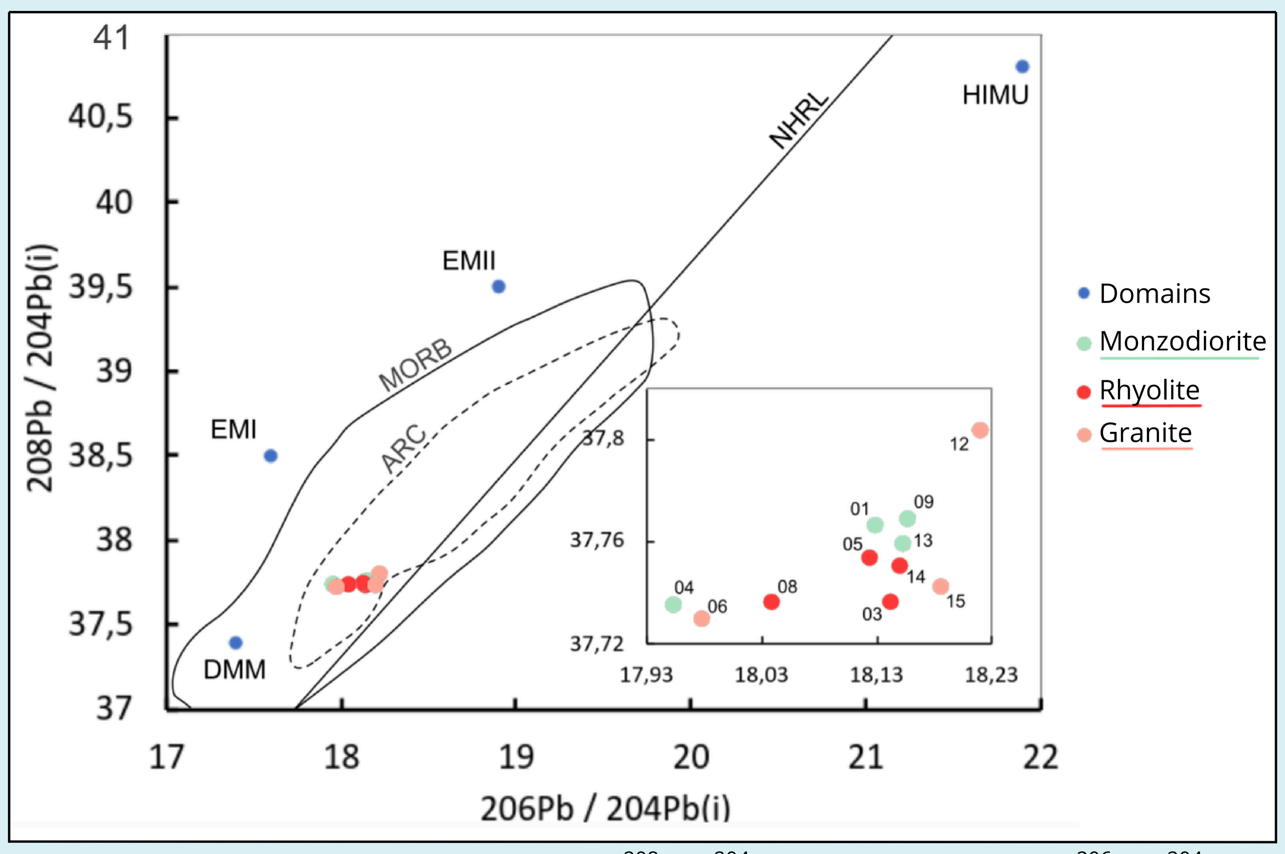

Fig. 5 Lead isotope diagram : ratio of $^{208}Pb/^{204}Pb_{(i)}$ as a function of $^{206}Pb/^{204}Pb_{(i)}$.
The MORB and ARC domains are plotted from databases available on GEOROC.
Global reference reservoirs are reported according to *Zindler and Hart, 1984* : DMM (Depleted Morb Mantle, EMI et EMII (Enriched Mantle I et II) and HIMU (High-µ) with the NHRL (North Hemisphere Reference Line) (*Hart, 1984*).

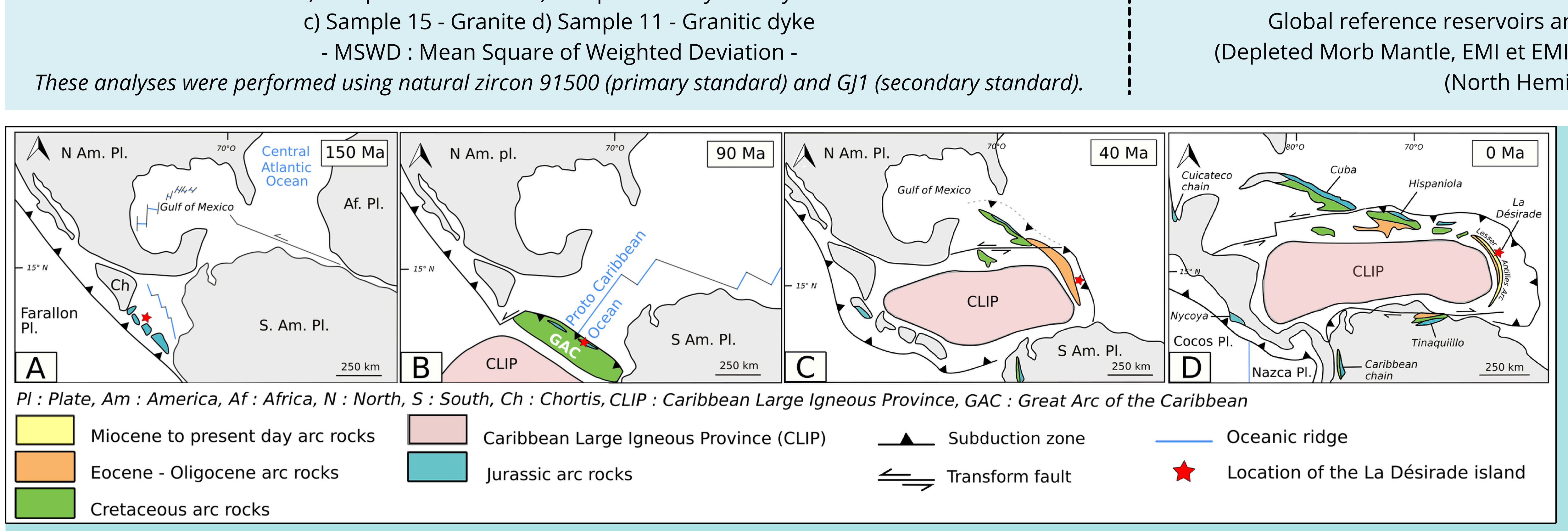

Fig. 6 Geodynamic reconstitution of La Désirade from the Late Jurassic to the present day - Caribbean scale
Based on *Brazsus et al. 2021*, *Denyer et al. 2006*, *Lapierre et al. 2022*, *Montheil et al., 2025*, *Pindell et al. 2006*, *Seyler et al. 1998*.

CONCLUSION

The study suggests that the acidic magmatic rocks of La Désirade were formed in a back-arc setting at 144 Ma, after the basalts that have an arc signature (*Neill et al., 2010*). The evolution of this system would have been recorded over 15 Ma (Fig. 6).

Following seafloor spreading in back arc settings in the upper plate of the Farallon plate subduction system the entrance of the Caribbean Large Igneous Province (CLIP) in the subduction zone collide with the arc and back arc system and suture the east dipping subduction. Since then La Désirade as been accreted at the eastern end of the CLIP forming the Caribbean plate that moved in between the North and South American plates.

La Désirade is affected by Neogene brittle deformation (Fig. 6), observable on a large scale to the east of the Caribbean plate, accomodating the progressive curvature of the subduction trench (*Legendre et al., 2018* and *Boucard et al., 2021*). The island is now located in the forarc domain of the Lesser Antilles.

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