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Unravelling the genetic relations between the Grenada Basin, the Aves Ridge, and the Lesser Antilles: a structural and stratigraphic analysis

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Located in the southeastern Caribbean, the Grenada Basin is bounded to the east by the modern Lesser Antilles island arc, to the west by the Aves Ridge, commonly interpreted as a Cretaceous-Paleocene extinct volcanic arc, and to the south by the transpressive plate boundary with South America. The Grenada Basin has long been regarded as a classical back-arc basin until recent studies suggest alternative models, such as forearc opening or Wernicke-type simple shear. The genetic relations between the Grenada Basin and its adjacent arcs remain therefore controversial. Our analysis of seismic reflection and refraction data acquired during the GARANTI cruise (May-June 2017 onboard R/V L'Atalante) sheds light on basement nature and topography, depositional history and deformation of the sedimentary infill, including vertical motions, of the Lesser Antilles back-arc area. Correlations with well logs located on the northern Venezuelan shelf, DSDP sites on the Aves Ridge, and IODP sites off the west coast of Martinique Island, also provide chronostratigraphic constraints.

Seismic lines across the Grenada Basin reveal a significant asymmetry: the basement deepens from 5 to 10 km southeastwards while flat-lying sediment units thicken from 2 to 7 km. A 6.5 to 7 km thick oceanic crust underlies the southeastern half of the basin over a width of about 80 km. The Grenada Basin comprises three major depositional sequences defined by unconformities and/or changes in the seismic facies, from bottom to top:
- Sequence 1: undifferentiated Eocene sediments represented by strong reflectors that drape the acoustic basement, as well as syntectonic deposits.
- Sequence 2: Oligocene to Middle Miocene distal turbidites, probably originating from the Orinoco River that flowed from the south into the Grenada Basin at that time. Sequence 2 lies unconformably over Sequence 1.
- Sequence 3: Late Miocene to Recent arc-derived turbidites and pelagic sedimentation, with little detrital input from South America, due to the emplacement of the eastward drainage of the Orinoco River south of the northern Venezuelan coastal range during Middle Miocene. Sequence 3 lies unconformably over Sequence 2.

Since the oldest syntectonic sediments date from the Eocene, the last tectonic event that shaped the present-day basement topography dates back from the Eocene. Given the horizontality of Sequences 2 and 3 within the basin and along the Aves Ridge, no differential vertical motions occurred between the Grenada Basin and the Aves Ridge since then. This raises questions about the subsidence mechanisms that led to the current depth of the oceanic crust in the southeastern Grenada Basin. By contrast, reflectors in Sequences 2 and 3 are bent upwards along the Lesser Antilles slope, reflecting the uplift of the Neogene Lesser Antilles arc. These observations will be integrated in a future model for the evolution of the Lesser Antilles back-arc area, as part of the ANR GAARAnti project.