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Polyphase evolution of the Chaîne des Matheux frontal thrust (Haiti)

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The NW – SE trending Haitian fold-and-thrust belt (HFTB) is located in the western part of the Caribbean island of Hispaniola. It covers the suture between the Cretaceous Caribbean island arc in the north and the Late Cretaceous thickened oceanic crust in the south. The HFTB is bounded to the north and south by the left-lateral Septentrional (SFZ) and Enriquillo-Plantain Garden (EPGFZ) fault zones, respectively. Compressional deformation on the HFTB commenced as early as Eocene times. It was followed by transpressional deformation from the early Miocene onwards, with in sequence progressive stacking of thrust sheets towards the SW. Seismicity at the junction between the HFTB and the EPGFZ is recorded by the 12 January 2010 Mw 7.0 earthquake. Surface mapping did not reveal a rupture, as the main activity occurred on the steep NNW dipping oblique transpressional Léogâne fault, while aftershocks documented motion on a shallow SW dipping thrust segment.

The structural style of deformation of the HFTB, either the stacking of thrust sheets on basement heterogeneities or basement-involved thrusting, has not been studied in detail. Also lacking are conceptual models addressing the amount of convergence between the northern and southern domains, and describing how convergence was accommodated. To address these problems we conducted a detailed fieldwork on the southernmost thrust sheet, known as the Chaîne des Matheux front. Using stratigraphy, geological mapping, cross sections, kinematic fault slip data, analysis of mineralizations and fluid inclusions, and geochemical analysis of fluid seeps, we decipher the evolution of this anticlinal structure.

Stratigraphic data reveal stable Eocene platform sedimentation over the whole region, which preceded deepening of the basin throughout Oligocene and early Miocene times. A diachronous evolution is evident from the middle Miocene onwards. The NE flank displays a shallowing upwards trend and clastic sedimentation, while the region to the SW of the main thrust remains subject to basinal facies deposition. Our main focus was to deduce the relative chronology of deformation as recorded in the Eocene to Oligocene limestones. These series are characterized by a pervasive fracture network that originated prior to folding. The northern limb displays northeast-verging thrusts, while from the axial zone southwards structures are southwest-verging. These structures display decameter intra-formational folding and layer-parallel shortening. Structural observations indicate: (1) NW – SE faults mainly display reverse motions, (2) NNE – SSW faults display normal and strike-slip motions, and (3) E – W faults display left-lateral strike-slip motions. Mineralizations on fault planes striking parallel to the main thrust and on its backlimb indicate: (1) fluid circulation phase related to bedding perpendicular fracturing and (2) fluid circulation phase related to creation of the fault sets described above. The geochemical signature of the different fluid generations will be compared with the present-day escaping fluids. We conclude that: (1) deformation in the Chaîne des Matheux is associated with thin-skinned tectonics from the middle Miocene onwards, possibly under the influence of a continuous NE – SW directed transpressional regime, which was (2) preceded by a phase of bedding perpendicular fracturing.