



## **Geologic Evolution of the eastern Panama Isthmus from biostratigraphic, tectonic and geophysical data**

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Panama is located at the junction of Nazca, Cocos, Caribbean and South America Plates, and reflects a complex geological history: the isthmus is mainly an island arc, formed by the convergence between the oceanic Farallon and Caribbean Plates during Late Cretaceous-Paleogene, deformed by extension from the beginning of the Miocene, and shortened during the Middle Miocene collision of the Panama-Choco block with the South America Plate.

We focused our researches on the eastern part of Panama, mainly in the Darien province, the least explored territory of the country, combining field work data, remote sensing analyses (SAR images) and geophysical data in order to better constrain the geological history of Panama since the Late Cretaceous.

New field observations and detailed biostratigraphic data (nannoflora) allow us to precise the stratigraphic units of eastern Panama.

We recognize from bottom to top: (1) the Upper Cretaceous basement of the Caribbean plate consists of basalts, pillow basalts, with minor intercalations of radiolarian cherts, outcropping in the Gulf of San Miguel, San Blas Massif and Sapo Massif; (2) an early volcanic arc, Upper Cretaceous in age, composed by breccias, basalts, intrusive volcanic rocks, limestones and siliceous tuffs, outcropping in the Portobelo Peninsula and San Blas-Darien Massif, attributed to the Ocù formation; (3) a Paleocene-Middle Eocene island-arc magmatic rock suite, outcropping in the Massifs of San Blas-Darien, Mahé and Sapo, attributed to the San Blas Formation; (4) a thick package of Lower-Middle Eocene-Oligocene epiclastic volcanosedimentary rocks, tuffs, with few basaltic lavas, observed in the Mahé Massif, attributed to the Darien Formation; (5) Several sedimentary formations, composed by carbonated and siliceous fine sediments and conglomerates, Upper Middle Eocene to Upper Miocene in age, which outcrop in the basins of Chucunaque-Tuira and Sambu (Porcona, Clarita, Tapaliza, Tuira, Chucunaque formations). We also identified a magmatic episode during the Lower Miocene in Mahé and Sapo Massifs.

We present a new structural map of eastern Panama and five geological transects across the isthmus, summarizing the complex history.

Our study documents: (1) a southwestward compression phase (in its present-day position) between Late Campanian and Middle Eocene, along the Pacific coast, in agreement with the subduction activity; (2) a Middle Eocene extension phase (Chucunaque-Tuira forearc basin formation); (3) a Middle Miocene compression phase, inverting some of the inherited normal faults and reactivating geological structures; (4) and a Plio-Quaternary transpressive tectonic regime, evidenced by several left-lateral strike-slip faults with en echelon folds in the areas of Mahé Massif, Sanson Hills, Pirre Massif and Sapo Massif. These deformations are the result of the collision of Panama Choco block with the South America Plate.