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Active deformation structures using geomorphic indices from remote sensing in southern Hispaniola

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The Plantain Garden-Enriquillo fault zone splits off the northern part of the Caribbean plate forming the supposed Gonave microplate [Mann et al. 1995, DeMets & Wiggins 2007]. In southern central Hispaniola, the Plantain Garden - Enriquillo Faults is intersected Beata Ridge fault which separates the eastern from the western Caribbean Plate. In this tectonic framework, we analyzed the tectonically induced geomorphologic features. The southwestern part of Hispaniola is affected by left-lateral shear deformation by the Enriquillo fault Zone. The formation of back-thrusts on both sides of the fault and related extensional structures (grabens) occurred in the last three million years and seems to be still active.

The present work is based on the application of geomorphological methods and remote sensing tools, using specific image processing and interpretation of digital elevation models (DEM) of southern Hispaniola. In order to identify and evaluate of areas experiencing neotectonic deformation, geomorphic indices are used. We focused on the combination of different geomorphic indices to obtain more complete data set of the relative degree of activity and to compare the evolution of different landforms along the Enriquillo fault zone with the tectonic processes.

The analysis of geomorphologic features and drainage network of the Enriquillo-Cabo Rojo region allows us to get an insight into the evolution of the landforms affecting the entire region. The geometry, as well as the transverse Topography Symmetry Factor (T) of the basins located to the south of Cabo Rojo show lateral northwestward stream migration suggesting the existence of the tilted block asociated to a normal fault parallel to Beata Ridge. River profiles, in which the trend of the fault plane is approximately perpendicular to the river, also display several knickpoints in channels that cross the scarp, indicating a nonequilibrated state response to the normal faulting in which the downthrown (hangingwall) block is in the downstream direction causes a step. Some knickpoints have been migrated or propagated upstream, because the river is no longer in equilibrium and the effect of the erosion begins to adjust its longitudinal profile. Higher Hack index values in streams approximately perpendicular to the fold axis along the western hillside of the Sierra de Bohoruco suggest non-equilibrated river profiles, indicating active tectonic movement with a vertical component of deformation by the growing folds. The hypsometric curve describes high values of hypsometric integral in isolated basins indicating a youthful topography at the north hillside of the Sierra de Bohoruco. The relative low stream-gradient indices are associated with the major strike-slip fault (the Enriquillo fault) where horizontal movement produced zones with crushed rocks low in resistance to erosion. But the same behavior we could recognize in areas of outcropping soft sedimentary rocks. The vertical dissection map reveals an inhomogeneous distribution of the value of vertical changes and an imaginary line separating high and relativaly low dissectivity regions in the Sierra de Neiba. Thus, the greater dissection could be related to uplift resulting of thusting and folding of the Sierra de Neiba.

The geomorphological features and drainage patterns indicate that the Neogene to recent deformation features in Hispaniola are evided in three important structural elements (sinistral strike-slip and related normal faults as well as thrust faults and folds in constraining bends). The recent sinistral movement along the Enriquillo - Plantain Garden Fault zone could be part of the southward migration of the fault-related northern boundary of the Caribbean plate since the Late Eocene.

DeMets, C. & Wiggins-Grandison M., 2007. Deformation of Jamaica and motion of the Gonâve microplate from GPS and seismic data. Geophysical Journal International, 168, 362-378.

Mann, P., Taylor, F.W., Edwards, L R., Teh-Lung Ku. 1995. Actively evolving microplate formation by oblique collision and sideways motion along strike-slip faults: An example from the northeastern Caribbean plate margin in Tectonophysics, 246. 1-69