Caribbean-South American plate tectonics and Trinidad/Tobago neotectonics from GPS

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Global Positioning System (GPS) data from eight sites on the Caribbean plate and five sites on the South American plate were inverted to derive an angular velocity vector describing present-day relative plate motion. Both the Caribbean and South American velocity data fit rigid-plate models to within ±1–2 mm/yr, the GPS velocity uncertainty. The Caribbean plate moves approximately due east relative to South America at a rate of ~20 mm/yr along most of the plate boundary, significantly faster than the NUVEL-1A model prediction, but with similar azimuth. Pure wrenching is concentrated along the approximately east-striking, seismic, El Pilar fault in Venezuela. To measure motions in Trinidad we estimated horizontal velocities at 25 sites first surveyed in a 1901–1903 British Ordnance Survey triangulation and then resurveyed with GPS in 1994–1995. We identify Trinidad's principal active on-land faults, quantify fault-slip-rates, and test for elastic locking. Our best-fit single-fault elastic dislocation model put 12±3 mm/yr of dextral strike-slip on the Central Range Fault (1–2 km locking depth), an apparently aseismic active fault. The estimated motions also showed statistically insignificant horizontal motion (2.2±1.8 mm/yr of right-slip; 2.7±2.0 mm/yr of N–S shortening) on the eastward on-strike extension of the El Pilar Fault. Repeat GPS measurements made between 1994 and 2005 at two sites spanning Trinidad north to south showed a 14±3 mm/yr eastward (plate-motion-parallel) dextral velocity differential, consistent with our best-fit historic (1901–1995) fault-slip-rate. The existing 1901–1995 and 1994–2005 geodetic data alone cannot resolve whether the Central Range Fault is essentially creeping (1–2 km locking depth) or locked to a more standard depth of 10 km. Paleoseismology trenching, however, show that the Central Range Fault cuts <5000-year-old sediment and is capped by ~550-year-old sediment, suggesting that it may be locked and may have ruptured at least once during this time interval. About ~5 mm/yr of slip could be taken up on the Los Bajos Fault and additional faults in the offshore south of Trinidad. The ocean-continent boundary between Tobago and continental South America was the site of the largest (M 6.6) recorded earthquake in the Trinidad-Tobago segment of the plate boundary zone. During this event (April 22, 1997) an ~E-W striking (250° azimuth), shallowly dipping (30°) dextral- normal fault ruptured the seafloor ~10 km south of Tobago. We will also describe this earthquake and its associated seismic sequence, GPS-determined coseismic offsets, fault plane and fault slip geometry, and the reactivation neotectonics related to this event. The event is anomalous and of interest because of its large normal-slip component and ~E-W strike is unexpected given the current ~E-W dextral shearing in the plate boundary, because it ruptured a normal fault plane with an extremely low (30°) dip angle, and because it reactivated the Tobago terrane -South American continent (former thrust) boundary.