CENOZOIC THRUSTING AND WRENCHING IN THE CORDILLERA ORIENTAL, COLOMBIA: FIELD DATA AND EXPERIMENTAL INSIGHTS.

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The high plateau (about 3000 m) of the Cordillera Oriental is mainly due to post-Miocene crustal thickening, but the Cordillera is far from being a simple linear fold-and-thrust belt. Instead it has a V-shape on a map, the apex pointing eastward.

In the area of the apex (Boyacá), the cordillera is bounded by active faults in the foothills to the east (Llanos basin) and west (Magdalena valley). The entire Cordillera is here a large pop-up. Within the Cordillera are folds and thrusts of Cenozoic age. Prominent is the flat-lying Soapaga thrust, which has carried basement rocks (Precambrian and Paleozoic metamorphic rocks of the Floresta massif) eastwards over Tertiary sediments, the transport direction being about 105°. Another prominent reverse fault, possibly of higher angle, is the Boyacá fault, which cuts out the inverted eastern flank of the Arcabuco anticline. Large anticlines such as this one have cores of Jurassic rocks: these are inverted Jurassic rifts.

To the north (Santander and Norte de Santander), the Cordillera Oriental strikes NNW. It is sharply bounded to the west by the Bucaramanga fault zone. This is an oblique-slip zone, with components of westwards overthrusting (over 4 km vertical throw) and left-lateral wrenching (perhaps 200 km). Individual faults in this zone are sometimes nearly pure thrusts, sometimes nearly pure strike-slip faults, more often oblique-slip faults, all with nearly parallel strikes. The geometry is that of half a flower structure. There are also antithetic faults with right-lateral offsets: these often bound blocks that have rotated clockwise by a domino mechanism. Finally, there are flat-lying thrust faults with northerly strikes. Prominent amongst these is the Falla de las Mercedes, which dips 15° or so westward and has put Precambrian basement on top of Tertiary sediments.

The southern Cordillera Oriental has a northnortheasterly strike. It is bounded by active thrusts and strike-slip faults, right-lateral in this area. Strike-slip motions appear to dominate the active tectonics, but thrusting was more important in the Tertiary.

Thus the entire Cordillera Ortiental appears to have been generated at the restraining intersection between conjugate wrench systems, left-lateral in the north, right-lateral in the south. This may account for the high plateau, uplifted some 3500 m since the Miocene. It may also account for a component of shortening along strike (north-south) in the apex (Boyacá), where the Mesozoic and Tertiary cover has been folded into tight domes and basins.

Near the Caribbean coast, the Sierra Nevada de Santa Marta and the Serranía de Perijá span another, more acute, restraining intersection, this time between the Santa Marta-Bucaramanga fault system in the southwest and the right-lateral Oca system that parallels the continental margin to the north. In this area, wrenching has predominated over crustal thickening. The general direction of contraction is northwest. Thus on a continental scale, the Cordillera Oriental marks a transition between crustal thickening with east-west contraction in the south and right-lateral wrenching in the north.

We have done two series of experiments with analogue models scaled for gravity. The first set investigated coeval wrenching and thrusting upon parallel faults, either at the scale of sedimentary basins (flower structures), or at the scale of mountain belts. The experiments show that partitioning of fault motions, between almost pure thrusting and almost pure strike-slip faulting, is possible under certain conditions, especially in the presence of detachment horizons at depth. These experiments we believe explain the structures observed in the Bucaramanga fault zone.

The second set of experiments investigated lateral transitions between crustal thickening and strike-slip faulting at continental scale. The transitions were obtained by applying suitable lateral boundary conditions upon the model continents. The use of a rigid indenter provided transitions between pure crustal thickening in front of the indenter and pure wrenching at the side. On this basis we attribute the structural style of the northern Andes to a transition between convergent plate motions in the south (Nazca and South America) and transcurrent motions in the north (Caribbean and South American plates).