CENOZOIC KINEMATICS OF THE ANDES - STRAIN PARTITIONING AND DISPLACEMENT

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A particular problem of contractional continental plate boundary zones is the way in which the rate and direction of slip between adjacent plates is converted into strain, displacement and rotation within the zone. Few continental plate boundary zones experience purely orthogonal shortening; most have a substantial strike-parallel displacement component leading to transpression within the zone. The oblique plate slip vector causing transpression may be decomposed into an orthogonal coaxial contractional component and a strike-parallel non-coaxial single shear component. How these components are expressed, in space and time, in continental plate boundary zones determines the structure style of the zone. The two possible end members are complete partitioning into a single thrust and a single strike-slip fault versus homogeneous oblique penetrative incremental and finite shortening parallel into the plate convergence vector. We know of no plate boundary zone in which either of these end members is perfectly achieved; most obliquely convergent zones exhibit partitioning into orthogonal, strike slip and plate slip vector parallel components of strain and displacement from the regional to the outcrop scale.

In the Andean plate boundary zone, approximately 90 mma^{-1} of plate convergence is absorbed. The pattern of active tectonics shows great variation in the way in which the plate slip vector is partitioned into displacement and strain and the ways in which compatibility between and within different segments is solved. Along any Andean traverse, the sum of relative velocities between points must equal the relative plate motion. We have developed a kinematic synthesis of displacement and strain partitioning in the Andes from 47°S to 5°N relevant for the last 5 ma based upon: 1) relative plate motion deduced from oceanic circuits giving a roughly constant azimuth between 075 and 080; 2) moment tensor solutions for over 120 crustal earthquakes since 1960; 3) structural studies of deformed Plio-Pleistocene rocks; 4) topographic/geomorphic studies; 5) palaeomagnetic data and 6) geodetic data. We recognize four neotectonic zones, with subzones and boundary transfer zones, that are partitioned in different ways. These zones are not coincident with the 'classic' zones defined by the presence or absence of a volcanic chain or differences in finite displacements and strains and tectonic form; the long term segmentation and finite evolution of the Andes may not occur in constantly-defined segments in space and time. In segment 1 (47° - 39°S), the slip vector is partitioned into roughly orthogonal Benioff Zone slip with large magnitude/large-slip-surface earthquakes and both distributed dextral shear giving clockwise rotations of up to 50° and dextral slip in the curved Liquine-Ofqui Fault System giving 5° - 10° of anticlockwise forearc rotation. In segment 2 (39° - 20°S), the slip vector is partitioned into Benioff Zone slip roughly parallel with the slip vector, Andean crustal shortening and a very small component of dextral slip. Between 39° and 34°S, a cross-strike dextral transfer, which deflects the Chile Trench and the volcanic arc, absorbs the shortening contrast between segments 1 and 2. In segment 3 (20° - 6°S), the slip vector is partitioned into roughly orthogonal Benioff Zone slip, crustal shortening trench-parallel faulting and NE-SW extension. Compatibility between segments 2 and 3 is maintained by the sinistral ESE-trending Cochabamba shear zone and N-trending dextral faults. In segment 4 (6°S to 5°N), the slip vector is partitioned into roughly orthogonal Benioff Zone slip and dextral strike-slip faulting in the fore-arc and volcanic chain.