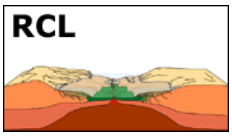
Lithospheric coupling as a possible driving force for Baja California



Award: MARGINS-Related

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Driving forces of terranes, like Baja California (BAJA), are still an open question in plate tectonics. Results from geologic (Michaud et al., 2004) and geodetic (Plattner et al., 2007) data analysis showed that the Baja California microplate is moving in the same direction as the Pacific (PAC) plate with respect to North America (NAM), at a rate of only 10% slower. These results suggest partial coupling between the PAC plate and BAJA. Using a numerical model that simulates PAC – NAM rigid plate motion on a sphere, we tested if mechanical coupling between the PAC plate and BAJA can explain the observed microplate and first order plate boundary kinematics (Plattner et al., submitted to Geology). For frictionless faults along the NAM-PAC plate boundary (in accordance to rigid plate assumption) we reproduce the entire GPS velocity field of the rigid BAJA microplate (where GPS velocities have been corrected for the imprint of the seismic cycle). Coupling of PAC – BAJA shifts the localization of the plate boundary deformation from west of BAJA into the Gulf of California and the collisional region of the Transverse Ranges. The observed kinematics are reproduced when BAJA is highly coupled to the PAC plate, with the associated stresses being of typical value for plate boundary processes. We interpret the coupling according to the theory of stalled slabs (Nicholson et al., 1994). The presence of a high coupling zone is also supported by phase velocity anomalies under the PAC - BAJA plate boundary region (Zhang et al., 2007).

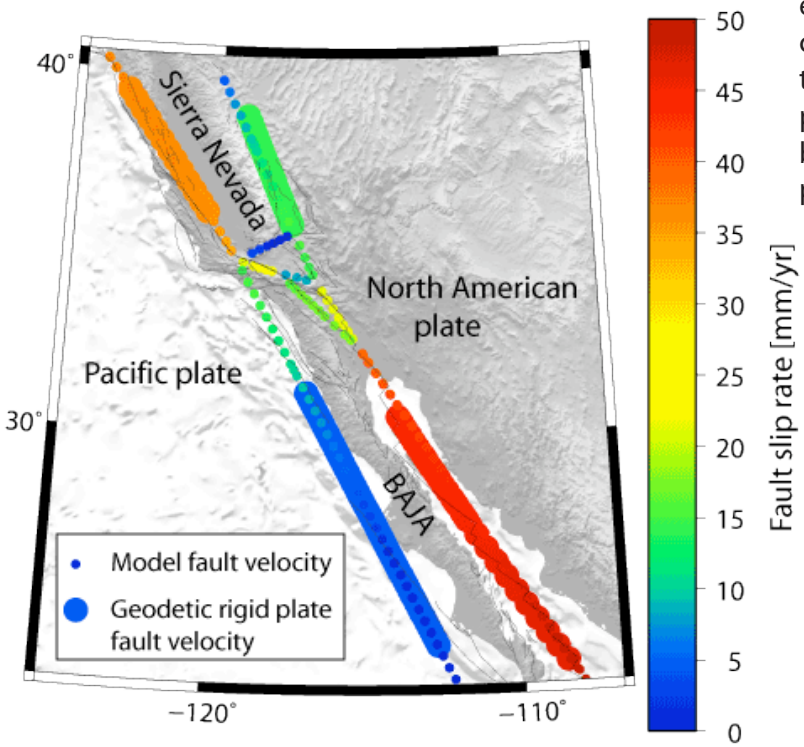

Figure: Model results from BAJA being driven by mechanical coupling with the Pacific plate, where the Pacific plate is moving with respect to the North American plate. Thick dots represent geodetic rigid plate relative motions, small dots fault slip rate from finite element model. Applying high coupling to the PAC-BAJA plate boundary, the model plate relative motions agree with the observations on BAJA (Plattner et al., 2007) and the Sierra Nevada microplate (Psencik et al., 2006). Figure adopted from Plattner et al. (subm. to Geology).

Michaud, F., Sosson, M., Royer, J.Y., Chabert, A., Bourgois, J., Calmus, T., Mortera, C., Bigot-Cormier, F., Bandy, W., Dyment, J., Pontoise, B., and Sichler, B., 2004, Motion partitioning between the Pacific plate, Baja California and the North American plate: The Tosco-Abreojos fault revisited: Geophys. Res. Lett., 31, doi 10.1029/2004gl019665.

Nicholson, C., Sorlien, C.C., Atwater, T., Crowell, J.C. and Luyendyk, B.P., 1994. Microplate capture, rotation of the western Transverse Ranges, and initiation of the San Andreas transform as a low-angle fault system. Geology, 22, 491-195.

Plattner, C., Malservisi, R., Dixon, T.H., LaFemina, P., Sella, G.F., Fletcher, J., and Suarez-Vidal, F., 2007. New constraints on relative motion between the Pacific Plate and Baja California microplate (Mexico) from GPS measurements: Geophys. J. Int., 170, 1373-1380.

Plattner, C., Malservisi, R., Govers, R., subm. to Geology, Can lithospheric coupling explain the transport of the Baja California microplate?

Psencik, K.O., Dixon, T.H., Schmalzle, G., McQuarrie, N., and McCaffrey, R., 2006, Improved present day euler vector for Sierra Nevada block using GPS: EOS Trans. AGU, Fall Meet. Suppl., Abstract G42A-04.

Zhang, X., Paulssen, H., Lebedev, S., and Meier, T., 2007, Surface wave tomography of the Gulf of California: Geophys. Res. Lett., 34, doi 10.1029/2007gl030631.