Comunicaciones Nº 42 - 1991: 146 - 151
Departamento de Geología, Universidad de Chile, Santiago

TRANSTENSIONAL NATURE OF SUSPECT TERRANE BOUNDARIES IN SOUTHERN MEXICO

Martin Meschede, Lothar Ratschbacher, Ulrich Riller, Uwe Herrmann, and Wolfgang Frisch
Institute of Geology, University, Sigwartstr. 10, D-7400 Tuebingen, Germany

The structural and isotopic relationships between four terranes in the Sierra Madre del Sur in southern Mexico were investigated (Fig. 1). These crustal units were considered "suspect allochthonous terranes" by Coney et al. (1980), Campa and Coney (1983), Coney (1983), Campa (1985), and Campa and Coney (1985). The Xolapa terrane consists of migmatites and undeformed intrusive rocks of Late Mesozoic to Tertiary age (Ortega-Gutierrez 1981). The Guerrero terrane comprises mainly Tertiary volcanic rocks and Cretaceous to Tertiary sedimentary rocks. The Mixteca terrane includes a multistage deformed and metamorphosed Paleozoic basement covered by unmetamorphosed Mesozoic and Tertiary volcanoclastic and carbonatic sediments. The Oaxaca terrane encompasses a Grenvillian basement unconformably overlain by Paleozoic and Mesozoic sedimentary rocks (Ortega-Gutierrez 1981, Ramirez-Espinosa 1984).

We studied the structural evolution of several transects across proposed boundaries of the Xolapa terrane with the Juarez, Oaxaca, Mixteca, and Guerrero terranes, respectively. In all sections examined, the terrane boundaries are characterized by east-west to northeast-southwest striking mylonite zones with normal or oblique-normal fault geometry. Extension is consistently subhorizontal and approximately north-south (Fig. 1).

The structural and kinematic data are from the following localities (Fig. 1). The Xolapa - Oaxaca boundary near Pochutla/Huatulco is dominated by L-mylonites (cf. Mattauer 1973) and ultramylonites separating anorthosites and gneisses of the Oaxaca basement from Xolapa migmatites. A 200 m thick zone of mylonites, ultramylonites and cataclasites near San Juan Juchatengo separates a small complex of late Paleozoic volcaniclastic and carbonatic sediments from Xolapa migmatites. This complex is designated the Juchatengo mini terrane (F. Ortega-Gutierrez, 1991, pers. comm.). An approximately one kilometer thick zone of mylonites, ultramylonites, and cataclasites occurs near Tierra Colorada. The mylonites derived from Xolapa migmatites and dacitic-rhyolitic rocks and separate the migmatites from marble and limestone of the sedimentary cover of the Mixteca terrane. Micaschists of the Mixteca terrane (the Acatlán complex) are juxtaposed on the Xolapa migmatites near Ayutla in a shear zone with mylonites and cataclasites. Near Zihuatanejo the Xolapa - Guerrero boundary is represented by marble mylonites of the Guerrero terrane.

Steeply inclined brittle-ductile normal faults and flat reverse faults of an early stage of brittle deformation in the mylonite zone are grouped as conjugate fault sets. They define inclined extension directions. Younger sets of faults successively display less inclined, and finally horizontal extension directions and thus reflect syndeformational tilting of the mylonite zone. This is interpreted in terms of progressive uplift of the Xolapa terrane.

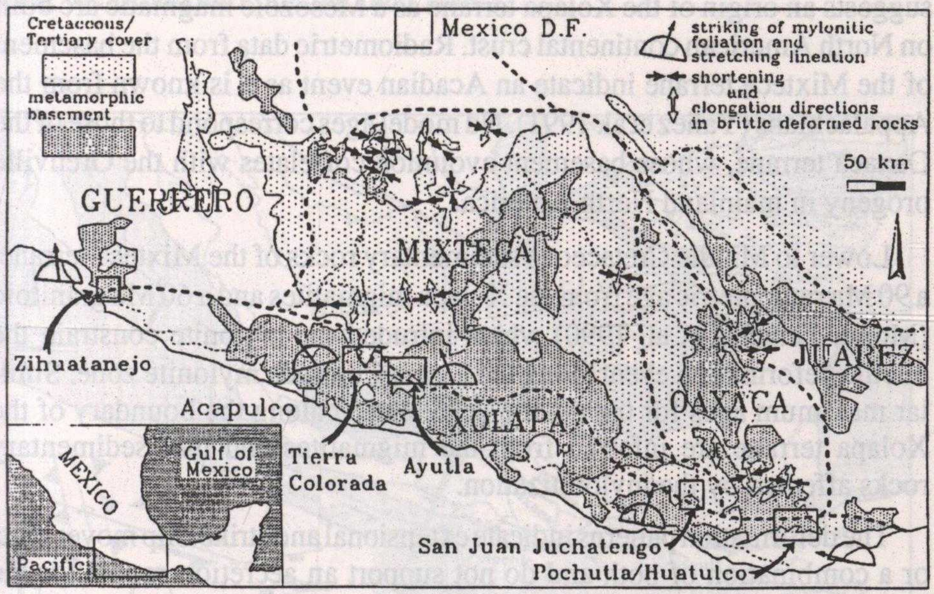

Fig. 1: Tectono-stratigraphic map of southern Mexico (redrawn from Campa and Coney, 1983 and Coney and Campa, 1987) showing basement and cover distribution, studied localities (rectangles), average strike of motion plane and average plunge of motion direction at these localities, and shortening and elongation directions derived from fault-striae and fold-thrust imbrication data.

Extensional and compressional directions derived from analysis of brittly deformed rocks in southern Mexico are approximately north-south and east-west, respectively (Fig. 1). We obtained the orientations of the principal stress tensor axis from fault-striae data from all studied terranes using mathematical methods and field evidence for subset identification.

According to Campa and Coney (1983) and Campa (1985), the Xolapa terrane accreted to the North American craton during the Late Cretaceous to Early Tertiary. Paleomagnetic and isotopic data from granitic rocks of the Xolapa terrane and from basement rocks of the Mixteca terrane restrain the suspect terrane interpretation. The paleomagnetic drift paths of the Xolapa, Guerrero, and Mixteca terranes from mid-Cretaceous to present are similar (Böhnel et al. 1989), and paleopoles of Early Cretaceous sedimentary rocks in the Mixteca terrane coincide with those of North America (Urrutia-Fucugauchi 1988). The Xolapa terrane shows Precambrian Nd model ages (Moran-Zenteno et al. 1990) and inherited Precambrian zircons (Herrmann et al. 1991) that correspond with ages found in the basement of the Mixteca and Oaxaca terranes (Yañez et al. 1991). This suggests an origin of the Xolapa terrane as a Mesozoic magmatic arc built on North American continental crust. Radiometric data from the basement of the Mixteca terrane indicate an Acadian event as it is known from the Appalachians (Yañez et al. 1991). Nd model ages correspond to those of the Oaxaca terrane, whose basement evolution correlates with the Grenville orogeny in mainland North America.

Lower to Middle Cretaceous sedimentary rocks of the Mixteca terrane, a 90 Ma radiometric age from the Xolapa migmatites and a 60 Ma granitoid (Moran-Zenteno et al. 1990) which intruded the mylonite constrain the ductile deformation event along the Tierra Colorada mylonite zone. Similar maximum ages for the ductile deformation along the boundary of the Xolapa terrane are inferred from the migmatites and metasedimentary rocks affected by the mylonitization.

The deformation patterns indicate extensional and strike-slip movements or a combination of both and do not support an accretion model for the Xolapa terrane. The tectonic uplift of the Xolapa terrane may be explained by three different models, each producing distinct deformation patterns in the fore- and hinterland (Ratschbacher et al. in press): (1) Extension due to back-arc rifting where sediments of the Mixteca terrane may be interpreted as back-arc sediments. (2) Gravitational collapse model with extension due to spreading of the upper crust. This would restrict the extensional structures to upper crustal levels. (3) Transtensional model with extension in a large-scale sinistral strike-slip regime associated with the formation of the Caribbean plate. This process should produce contemporaneous compression oriented appoximately east-west.

The regional plate tectonic framework from the Cretaceous to the Cenozoic in southern Mexico is dominated by large-scale sinistral strike-slip movements (Pindell et al. 1988, Ross and Scotese 1988) (Fig. 2a, b). This is backed up by our data which indicate sinistral transtension and thus support the transtensional model (Fig. 2c). The north-south extension directions obtained in the Mixteca and Oaxaca terranes (Fig. 1) contradict gravitational collapse, which would require north-south compression in the hinterland except when back-arc extension operates. Large areas with Cretaceous limestone and turbiditic sedimentary rocks in the Mixteca terrane support back-arc extension. Therefore, we propose a combination of back-arc extension, gravity spreading, and transtension/strike-slip tectonics producing the sedimentary accumulation with subsequent transtensional tectonics due to the major sinistral strike-slip movement along the Motagua-Polochic fault zone.

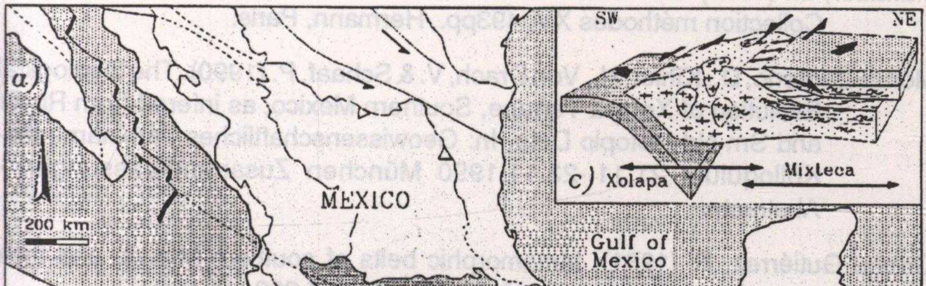

Fig. 2: a: Terranes and major Late Cretaceous-Cenozoic tectonic features of Mexico (compiled after Campa and Coney, 1983; Coney and Campa, 1987; Pindell et al., 1988 and references therein). b: Features of sinistral transtension. c: Tectonic scenario for normal faulting and transtensional northward displacement along the northern boundary of the Xolapa magmatic arc.

REFERENCES

Bõhnel, H., Alva-Valdivia, L., Gonzales-Huesca, J., Urrutia-Fucugauchi, J., Moran-Zenteno, D.J. & Schaaf, P. (1989). Paleomagnetic Data and the Accretion of the Guerrero Terrane, Southern Mexico Continental Margin, In: Hillhouse, J.W. (Editors), Deep Structure and Past Kinematics of Accreted Terranes, Washington, D.C.

Campa, M.F. & Coney, P.J. (1983). Tectono-stratigraphic terranes and mineral resource distributions in Mexico, Can. J. Earth Sci., 20, 1040-1051.

Coney, P.J., Jones, D.L. & Monger, J.W.H. (1980). Cordilleran suspect terranes, Nature, 288 (5789), 329-333.

Coney, P.J. (1983). Un Modelo Tectonico de Mexico y sus relaciones con America Del norte, America del Sur y el Caribe, Rev. del Inst. Mexicano del Petr., 15 (1), 6-15.

Coney, P.J. & Campa, M.F. (1987). Lithotectonic terrane map of Mexico, U.S. Geol. Surv., MF 1874-D

Herrmann, U.R., Nelson, B.K. & Ratschbacher, L. (1991). Structural, isotopic and petrogenetic evidence for the origin of the Xolapa terrane, southern Mexico, Geol. Soc. Am. Annual Meeting Abstr. 1991.

Mattauer, M. (1973). Les déformations des matériaux de l'écorce terrestre, In: Collection méthodes XV, 493pp., Hermann, Paris.

Moran-Zenteno, D., Kîhler, H., Von Drach, V. & Schaaf, P. (1990). The Geological Evolution of Xolapa Terrane, Southern Mexico, as infered from Rb-Sr and Sm-Nd Isotopic Data, In: Geowissenschaftliches Lateinamerika-Kolloquium 21.11.-23.11.1990 München Zusammenfassungen - Abstracts.

Ortega-Gutiérrez, F. (1981). Metamorphic belts of southern Mexico and their tectonic significance, Geof. Int., 20 (3), 177-202.

Pindell, J.L., Cande, S.C., Pitman III, W.C., Browley, D.B., Dewey, J.F., Labreque, J. & Haxby, W. (1988). A plate-kinematic framework for models of the Caribbean evolution, In: Scotese, C.R. & Sager, W.W. (Editors), Mesozoic and Cenozoic Plate Reconstructions, Tectonophysics, 155, pp. 121-138.

Ramírez-Espinosa, J. (1984). La accreción de los terrenos Mixteco y Oaxaca durante el Cretácico inferior. Sierra Madre del Sur de México, In: Simposio de la tectónica de la Mixteca, Bol. Soc. Geol. Mex., XLV (1-2), 7-19.

Ratschbacher, L., Riller, U., Meschede, M., Herrmann, U., and Frisch, W. (in press): A second look at suspect terranes in Southern Mexico, submitted to Geology.

Ross, M.I. & Scotese, C.R. (1988). A hierarchical tectonic model of the Gulf of Mexico and Caribbean region, In: Scotese, C.R. & Sager, W.W. (Editors), Mesozoic and Cenozoic Plate reconstructions, Tectonophysics, 155, pp. 139-168.

Ruiz, J., Patchett, P.J. & Ortega-Gutiérrez, F. (1988). Proterozoic and Phanerozoic basement terranes of Mexico from Nd isotopic studies, Geol. Soc. Am. Bull., 100 (2), 274-281.

Urrutia-Fucugauchi, J. (1988). Paleomagnetic study of the Cretaceous Morelos Formation, Guerrero State, southern Mexico, Tectonophysics, 147, 121-125.

Yañez, P., Ruiz, J., Patchett, J,, Ortega-Gutierrez, F., Gehrels, G.E. (1991). Isotopic studies of the Acatlan complex, southern Mexico: Implications for Paleozoic North American Tectonics, Geol. Soc. Am. Bull., (in press).