SEISMOTECTONICS OF THE CENTRAL PERUVIAN ANDES FROM PRECISE SEISMOLOGICAL DATA

R. Lindo[1,2], A. Cisternas[1], L. Dorbath[3,1] and C. Dorbath[3,1] and L. Rivera[1]

(1) Institut de Physique du Globe. 5 rue René descartes, 67084 Strasbourg, Cedex. France.
(2) Instituto Geofísico del Peru. Apartado 3747, Lima 100, Peru.
(3) ORSTOM, 213 rue La Fayette, 75480 Paris Cedex 10, France.

KEY WORDS: Central Andes, Seismotectonics, Subhorizontal Subduction, Microseismicity, Tectonics Stress, Local Tomography.

The Andean Cordillera is the result of the convergence between the Nazca and the South American Plates. The Central Peruvian segment is characterized by subhorizontal subduction, absence of recent volcanic activity and subsidence of the coastal region.

High quality seismic data obtained in five field seismic experiments with dense portable networks during the period 1980-86 have been used in order to obtain hypocenters, focal mechanisms, stress shape and orientation, and local tomography. The geometry of subduction, the velocity structure of the crust and upper mantle and the state of stress and deformation in Central Peru are thus determined. In particular, a cross section is made from the coastal area to the subandean region showing a precise picture of the subduction and the subandean crustal seismicity.

Stress tensors are obtained from focal mechanisms (Figure 1), both for the subduction zone under the coast, and for the subandean region. A comparison is made with the focal mechanisms calculated from teleseismic data, and a scale independent behaviour is established. A similar analysis is made for the Cordillera Blanca (North Peru) by using neotectonic and seismic information together. The resulting stress tensor is in a state of extension with a σ_3 axis oriented N60°, namely orthogonal to the trend of the Cordillera. This is consistent with the fact that the main tectonic feature is the outstanding Cordillera Blanca normal fault which strikes along the western margin of the chain.

Tomographic studies from P and S travel times show an uprising of high velocity lower crust material under the coast (Figure 2), a possible explanation for the presence of normal faulting related to bending at the continental shelf. Similar tomography in the subandean region (Figure 3) shows a thickening of the brittle crust due to continental subduction of the Brasilian Shield under the Eastern Cordillera.

Two recent earthquakes (1190, M_S = 6.5 and 1991, M_S = 6.8) in the Moyobamba region of the Subandean region of Norther Peru show thrusting at a low angle that may be continued into visible scarps at the surface, east of the epicenters. This mechanisms are compatible with the compressional stress regime obtained for the Subandean region of Central Peru.

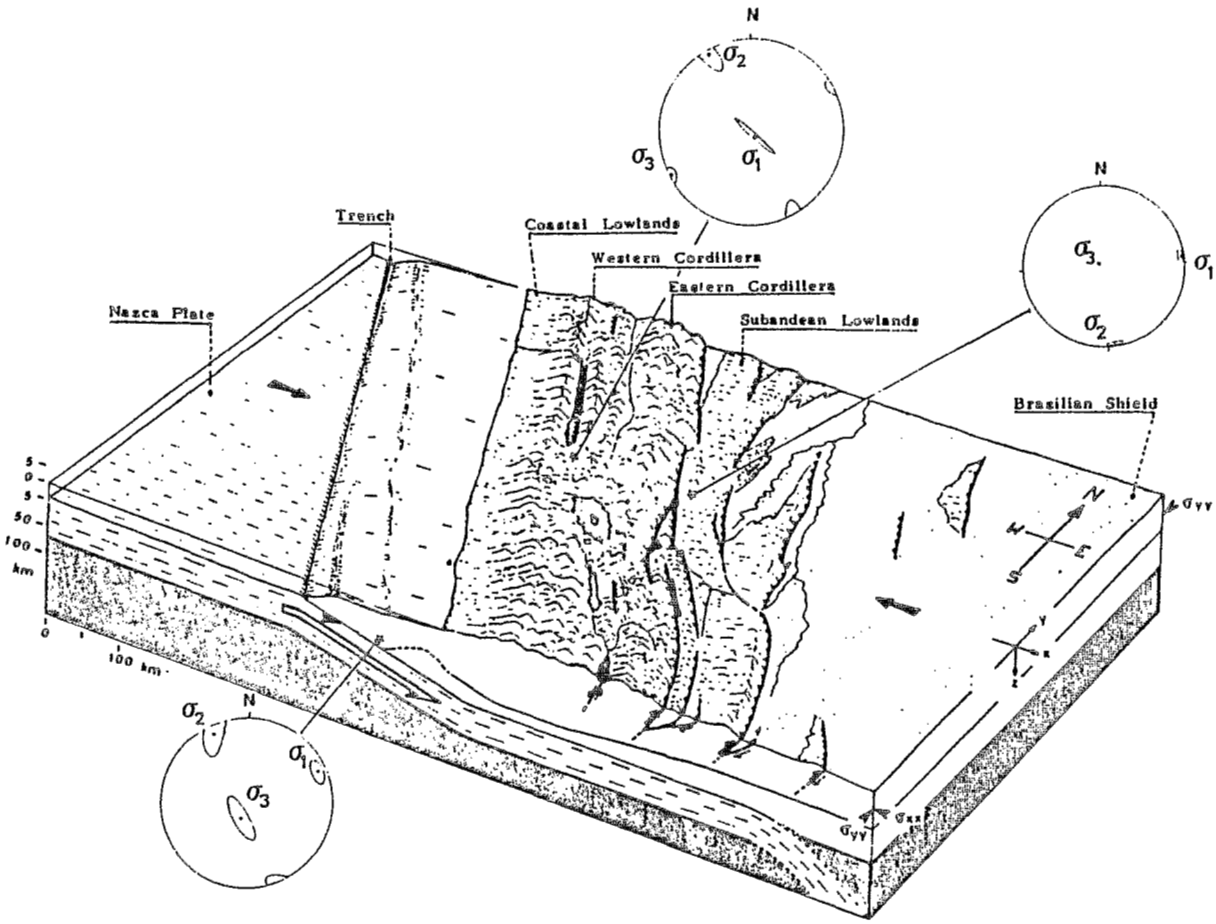

Figure 1: Principal axes of stress in the Coastal Subduction region, and in the Subandean region of Central Peru, and in the Cordillera Blanca, from focal mechanisms of local earthquakes (modified from Sébrier et al., 1988). Representation in the lower hemisphere of a Schmidt equal area projection.

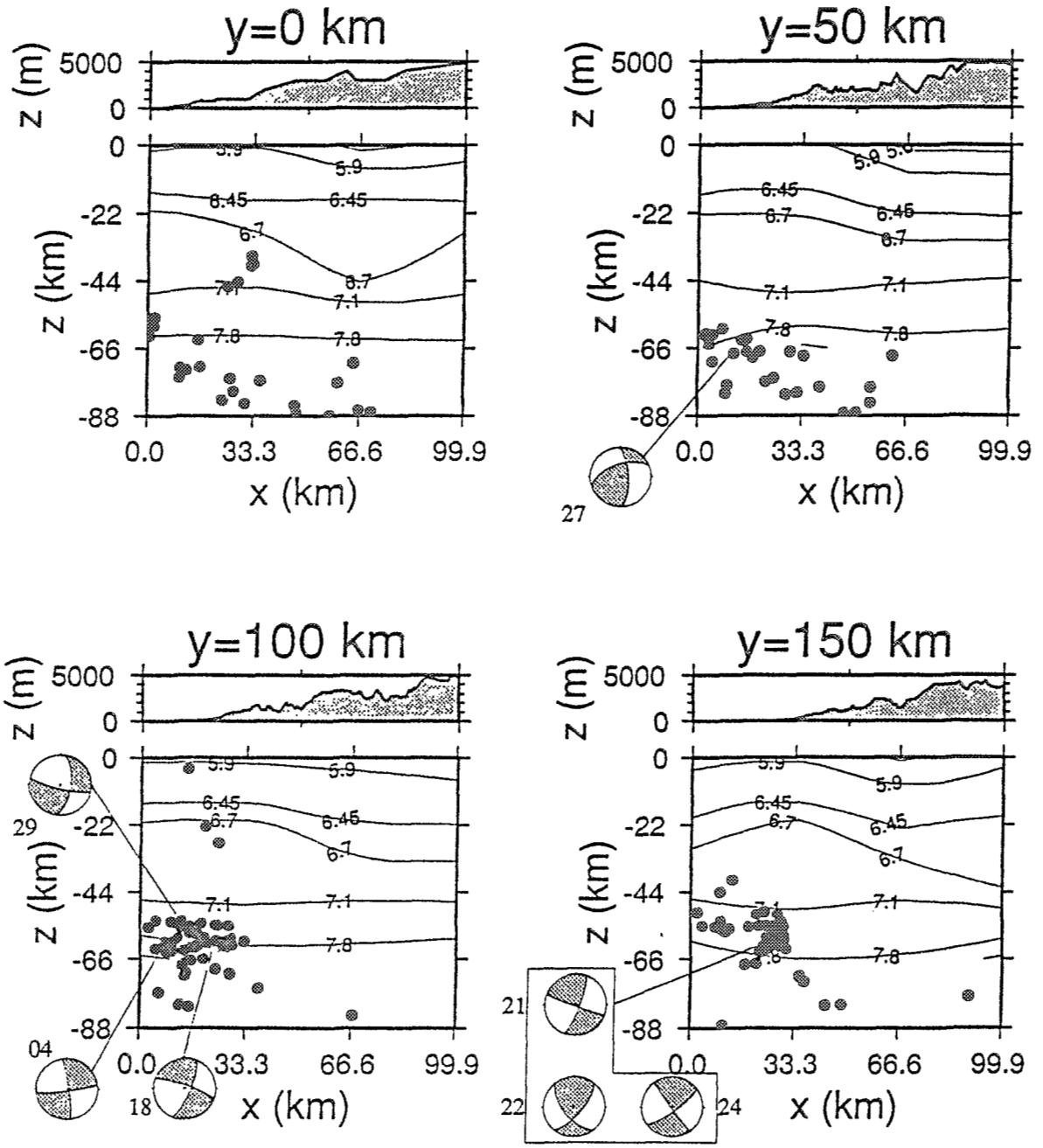

Figure 2: Vertical cross-sections (Azimuth N50°E) of tomography in the Coastal region of Central Peru showing: a) the seismicity within a 50 km wide block. b) focal mechanisms on a backside Schmidt projection. c) the topography. The y-values increase from south to north. The isovelocity line of 6.7 km/sec shows lower crust surrection under the Coastal region.

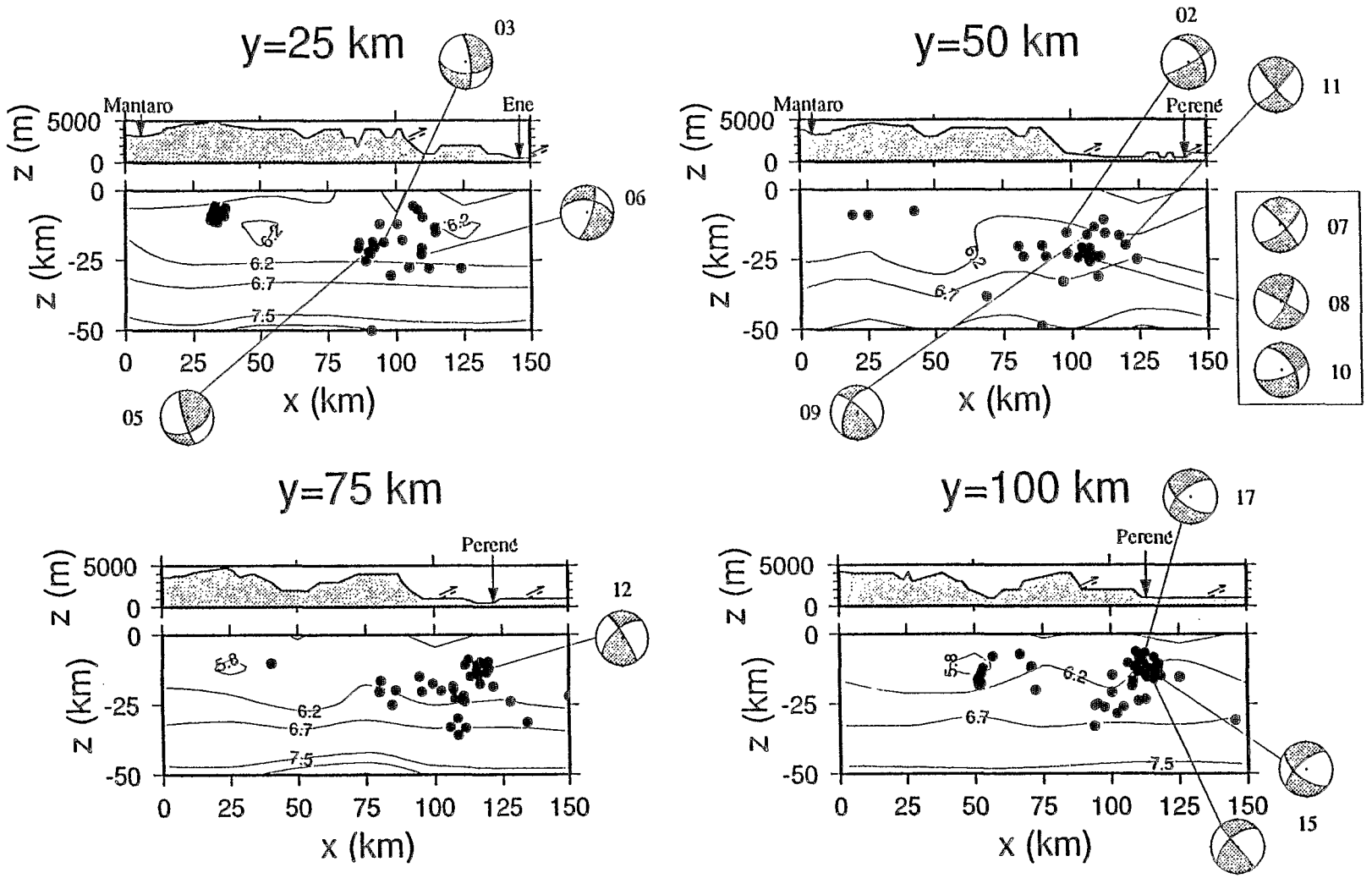

Figure 3: Vertical cross-sections (Azimuth N50°E) of tomography in the Subandean region of Central Peru showing: a) the seismicity within a 25 km wide block. b) focal mechanisms on a backside Schmidt projection. c) the topography, rivers Mantaro, Ene and Perene, and surface trace of thrusts. The y-values increase from south to north. The isovelocity line of 6.2 km/sec shows crustal thickening under the Andes.