Summary

At the beginning of 1994, the PISCO'94 experiment (*Proyecto de Investigación Sismológica de la Cordillera Occidental*), which is part of the so-called Collaborative Research Center 267 (*SFB 267*) "Deformation Processes in the Andes" (*FU-Berlin, TU-Berlin, GFZ Potsdam, U. Católica del Norte and U. de Chile*), was carried out in northern Chile. PISCO '94 focused on active and passive seismological investigations of the upper plate and the Benioff zone. During a period of 100 days, a network of 32 continuous and digital recording stations with three components registered the local seismicity between the Pre-Cordillere and the volcanic arc between 21,8° and 24,3°S. Stations were arranged over a surface of 230 x 180 km² with an average distance to each other of 40 to 50 km. The geometry of this temporal seismological network was laid out primarily for registering the Benioff-zone seismicity in the subducted Nazca Plate. During this period, about 5300 events were recorded (*PISCO-Catalog*). Apart from the large number of earthquakes in the Benioff zone, some events in the upper plate (*described in this work as crustal events*) were also registered. Their low magnitude and small number of about 2 events/day as compared to the Benioff zone events (~100 events/day) made the recognition of these crustal earthquakes more difficult.

It was the aim of this work to identify those earthquakes which occur in the upper plate and which were not registered in the PISCO-Catalog. In order to distinguish those events lying in the upper plate of the Benioff zone, different criteria were investigated:
(1) S and P travel time differences
(2) P travel time differences as well as signal amplitudes
(3) the spectral frequency.
The former proved to be the most successful method for recognizing crustal earthquakes.

The search for crustal events produced about 300 events, of which 215 earthquakes were selected to be further investigated. The remainder were comprised of events with a very small magnitude (mb<0,5) or occurred outside the network (gap>200°). The P and S onsets-determination was undertaken using the program PITSA, the localization using the routine HYPO71 with a 1-D-velocity model. Relocalizations were carried out using the routine VELEST. For earthquakes occurring above the depth of 15 km, the vertical error can amount to 10 km, for deeper events, on the contrary, only to 3-5 km.

The seismicity is distributed unevenly in the crust. A concentration of earthquakes can be recognized in the pre-Andean Depression south of 22,7°-23°S. The number of hypocenters decreases at the northern part of the investigation area in the Western and Pre-Cordillere. Most of the events lie between 5 and 30 km in depth. At the north-west part of Salar de Atacama (*Cordillera de Domeyko-Cordillera de la Sal*) a cluster of earthquakes occur at a depth of 40-50 km. At a depth of 60-70 km, a further group of events can be recognized under the Pre-Cordillere around 22,8°S. These events lie about 10 km above the Benioff zone. The seismicity in the Western Cordillere appears to be related to the volcanic activity. Earthquakes are situated between the surface and a depth of 20 km. In the Pre-Cordillere earthquake, clusters also lie at about 20 km in depth. In the transition zone between the Western Cordillere and the pre-Andean Depression as well as between the pre-Andean Depression and the Pre-Cordillere, two zones without seismicity can be identified.

Zones without seismicity under the Pre-Cordillere and under the pre-Andean Depression (*Atacama Block*) are explained by taking into consideration in these areas an elastic deformation in a rigid rock. Contrarily the cluster at about 40-50 km depth at the north-west part of Salar de Atacama and the seismicity at 60-70 km depth under the Pre-Cordillere show that the deformation here takes place in a brittle zone.

Magnitudes of the most events vary between 0,2 and 2,5. As focal mechanisms of these events show, local stress field presents strong changes in its direction. A variable direction of main stresses determines the type of mechanism. Both reverse and normal mechanisms characterize the observed pattern above a depth of 30 km. Those earthquakes being situated at a depth of about 40-50 km show a predominant reverse mechanism, while those situated at 60-70 km depth a normal mechanism.

The derived b-value varies between 0,5 and 1,2. Such a variation does not allow to make clear conclusions about the predominant stress field.

Finally, reflections about the rheology and tectonic are proposed. The regional W-E-effect of isotherms in the upper plate as well as the changing regional stress appear to be due to the heterogeneous structure of the upper plate both in the upper crust and above a depth of 60 km – a condition for the observed seismological data. The volcanic arc shift to the east and the supposed existence of an anomalous rigid body (*Atacama block*) correspond with the data processed in this study.