THE WADATI-BENIOFF ZONE AROUND COPIAPO, NORTHERN CHILE USING LOCALLY RECORDED DATA: PRELIMINARY RESULTS

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INTRODUCTION

The area studied is included in the rupture area of the last large earthquake that affected the region of Copiapó, northern Chile, namely the 1922, Atacama earthquake (Figure 1). The main seismotectonic characteristics of the studied area are: (1)The southern end of the Quaternary volcanic chain, that again reappears southward around 33°S. (2)The transition from normal to a subhorizontal subduction geometry. (3) An abrupt change in the bathymetry along the trench located south of 27°S.

The subduction process is able to generate large thrust events along the interplate contact in the Copiapó region. There are reports of two historical events with $M_S \geq 8.0$, the April 11, 1819 and the November 11, 1922 great earthquakes, with associated destructive tsunamis. However, they are not the only earthquakes that produced serious damages in the Copiapó region, in fact this zone has a very high seismic activity with at least eight events with magnitude $M_S \geq 7.5$ during the last 200 years. Moreover, the region of Copiapó had also experimented "swarm" periods of seismic activity, like that observed during July and August, 1973, without any large earthquake occurring before or after this period. Ten years later, the October 4, 1983 (M_S=7.4) thrust earthquake occurred re-rupturing the northern part of the great 1922 earthquake (M_S=8.5), remaining still intact its southern part.

The November 11, 1922 Atacama Earthquake.

Beck et al. [1997] determined the focal mechanism of the 1922 great earthquake using the available first motion polarities of the stations located at teleseismic distances, concluding that this event is an underthrusting earthquake. The duration and complexity of the 1922 source was constrained by the inversion of the *P* wave record from the DNB station, where the focal mechanism was fixed with a shallow plane striking parallel to the trench and dipping 20° to the east. Beck et al. [1997] showed the difficult to determine the 1922 focal depth due to the long duration of the source (at least 75 sec), and they assumed a shallow depth (0-40 km) considering its local tsunami along the coast of 9 m and a far field tsunami in Japan of less than 50 cm [Lomnitz, 1971].

The 1973 Seismic "Swarm" Activity.

The 1973 swarm activity was an unusual increase of seismicity with magnitudes $5.0 \leq m_b \leq 6.0$ mainly observed during the months of July and August. Cifuentes [personal communication] relocated the 1973 "swarm" events recorded at teleseismic distances with respect to the greatest ones. The relocated longitude was the parameter that strongly changed. this behaviour is usual when only phases recorded at teleseismic distances are used, because of the smaller number of stations in the E-W azimuths. Cifuentes also modelled the *P* and *S* waveforms of the 1973 "swarm" events recorded in the long-period stations of the WWSSN. The majority of the events exhibits inverse or thrusting fault mechanisms, with an average depth of about 19 km. Cifuentes suggests that if the events of the 1973 seismic "swarm" were on the main thrust zone, it could indicate that the region to the north of the 1922 rupture zone was not ready to break in 1973. However, she also wondered whether the 1973 "swarm" events were not on the main thrust zone, they could be related with the deformation of the continental crust. Therefore, the sequence of events would indicate thrust motion along a series of high angle planes in a complex interface. But, considering the ability of the Copiapó region to generate great earthquakes like the 1922 one, if a geometrical complex interface exits there, it does not inhibit the nucleation of great earthquakes.

The 1983 Earthquake.

Mendoza [personal communication] analysed three events occurred in the region of Copiapó, the August 3, 1978 (M_S=6.7), the October 4, 1983 (M_S=7.4) earthquakes and its most energetic aftershock occurred on October 9 (M_S=6.3). He computed a JHD station adjustments and weights using the *P* wave arrival time data of the 1978 and the 1983 main shock and aftershock and, then they were used in a single-event computation of all the hypocenters with moderate magnitude seismicity (m_b>4.8) associated with the 1983 main shock. Mendoza concludes that the 1978 and the 1983 earthquakes represent two types of faulting occurring at virtually the same epicentre, but with different depths. The October 4, 1983 earthquake is a thrust faulting event that was followed by several aftershocks, including the M_S=6.3 one which has a thrust mechanism similar to that of the main shock. These two October 1983 earthquakes occurred at similar shallow depths (35 km) and are consistent with reverse slip along the interplate contact. The August 1978 earthquake was a normal faulting event that occurred within the downgoing slab as a result of extension in the direction of the plate dip.

LOCAL DATA AND PRELIMINARY RESULTS

Considering that the southern edge of the Copiapó seismic gap associated with the 1922 rupture zone had not been studied in detail with using locally recorded events, a temporary seismic network of 28 portable seismic stations in the area located between 26.5° and 28.5°S, along with 10 OBSs (Ocean Bottom Seismometers) located between the coast and the trench (Figure 1) were deployed between September and November, 1998. The use of the OBSs stations is particularly important due to the high seismic activity located close to the trench, so that a reliable control of the hypocenters recorded by the inland and the off-shore networks can be performed.

The inland network consisted in 11 vertical short period stations with EDA digital recorders, 8 three components short period stations with GEOSTRAS digital recorders, and 8 telemetric vertical short period stations that sent the signals to a central stations equipped with a three components seismometer. The telemetric network continuously recorded the microseismicity, and the EDA and GESOTRAS stations recorded the data using a trigger algorithm. The OBS stations were equipped with three components seismometer and they worked in continuous recording; the depth of the off-shore network was between 1300 and 4500 m.

The first 500 events recorded during the 1998 Copiapó field work are presented along a cross-section oriented normal to the trench with origin in 27°S (Figure 2), corresponding to about 15 days. The local data analysed show a clear tendency to a subhorizontal way of subduction; there is shallow seismicity that will be studied in order to see if it could correspond with some fault systems present in the region. It is interesting to point out that the events with depths >180km are all located between 27.5°S and 29.0°S, suggesting that at these latitudes the slab is still present in that depth range.

Finally, we just want to remark the importance to use locally recorded data to analyse detailed characteristics of the shape and the seismotectonic behaviours of the subducted Nazca plate along the South American margin. For instance, Cahill and Isacks (1992) using more than 20 years of events recorded at teleseismic distance had less resolution to follow the Wadati-Beniof zone in the region of Copiapó with respect to that obtained with some weeks of locally recorded microearthquakes.

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