

SEISMOTECTONIC FEATURES OF THE WADATI-BENIOFF ZONE IN THE ANDEAN REGION

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INTRODUCTION

The interaction among the South American and Nazca plates forms one of the most typical Wadati-Benioff (W-B) zones existent on Earth. However, a detailed examination of that zone shows some peculiarities that cause controversies in the interpretation of its own structure, both in depth and laterally, and in the satisfactory explanation of some related phenomena, such as the origin and the mechanism responsible for the deep earthquakes in South America, among others. Some seismotectonic features of the W-B zone in the Andean region, based on the spatial distribution of hypocentres of selected earthquakes and the space-time distribution of the deep earthquakes, are presented with the purpose of contributing in the solution of some of the controversies mentioned above.

The data used in this work have been selected from the International Seismological Centre (ISC) Bulletin Data Base (BDB) CD-ROM, for the time interval January 1964 - August 1987, and from the Global Hypocenter Data Base (GHDB) CD-ROM, for the periods earlier than 1964 and after August 1987 up to December 1988. This data was complemented with hypocentre data contained in magnetic tapes furnished by the National Earthquake Information Center (NEIC/USGS), of earthquakes occurred up to June 1990. The selected earthquakes for the present work were past through a selection procedure using as reference the method of Barazangi & Isacks (1979). From a total of 9132 earthquakes with $m_b \geq 4.0$ compiled from those catalogues, only 2236 (24%) were selected as hypocentral determinations of good quality to be used in this work.

RESULTS

The spatial distribution of the selected hypocentres is made through epicentral maps and profiles corresponding to portions of the Andean region with the seismic foci projected into vertical sections that follow the assumed direction of the Nazca plate subduction. These projections clearly show several known seismotectonic features of this W-B zone, as for instance the flat portions of W-B zone located at around 30°S in Central Chile/NW Argentina and in Central/Northern Peru and the absence of seismic activity among 300 and 500 km of depth, as discussed in Barazangi & Isacks (1976, 1979), James (1978), Hasegawa & Sacks (1981), Boyd et al. (1984), Smalley & Isacks (1987), among others.

The seismic sections also show some evidences of a twisted W-B zone, specially beneath the Peru-Chile-Bolivia-Argentina borders region, as shown by Schneider & Sacks (1987), and the existence of some probable lateral discontinuities between portions of the W-B zone, that have different behaviour.

three important earthquakes occurred in the last two years, including the M_w 8.3 deep event of June 1994 and its aftershocks.

Time correlation between reliable hypocentral determinations for deep South American earthquakes is possible for events occurred since 1964. There is a clear correspondence among events in the Southern Segment with the earthquakes of the Northern Segment suggesting an interchange of energy from south to north, that during the 1964-1968 period used to occur with an interval of a few days to a few weeks. During the second half of 1968 that interchange suddenly stopped, the deep activity in the Northern Segment also stopped, a few months later occurred in the Central Segment of deep earthquakes an unusual event at around 13°S in the Peru-Bolivia border region, and the suggested flux of energy apparently inverted its direction, modifying completely the seismicity behaviour in the Southern and Northern segments, in relation to that observed in the 1964-1968 period. After this inversion, that lasted up to the end of 1969 or beginning, the M_w 8.2 deep earthquake of July 1970 occurred in southern Colombia. It was a milestone event in South American seismotectonic activity, because its occurrence was preceded and followed by clear changes in the seismic behaviour of the entire deep portion of the W-B zone beneath the Andean region, but specially in the Northern Segment, that presented very low rates of activity up to the end of 1982.

During the last five years, deep activity in South America has been very high, reaching very unusual rates, including the Central Segment. This, together with the changes occurred before and after the July 1970 deep event in the northern extreme of the Northern Segment, and the probable time correlation between the events of the Southern and Northern segments of deep earthquakes in South America, suggests the lateral continuity of the slab under the central portion of the Andean region.

CONCLUSIONS

The space-time correlation of deep South American earthquakes, and its apparent correlation with shallower seismic activity in the W-B zone, beneath the central portion of the Andean region, suggests the continuity of the slab, both in depth and laterally, in the central portion of that region. They also suggest the slab being twisted to the South, with more intensity in its southern deep extreme and almost nothing in the northern extreme, with its central portion bent to the West. This new model of the W-B zone under the Andean region may help to solve some of the existent controversies.

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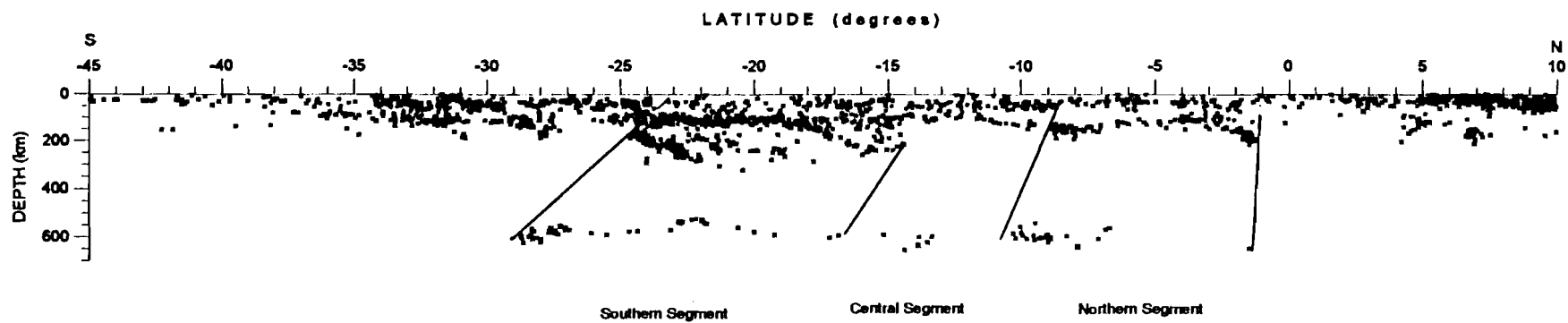


Figure 1.- South-North longitudinal section of Andean seismicity, showing only selected hypocentres in the time interval 1964 - 1990, except for the Central Segment where are included the deep earthquakes occurred after 1994.