Horizontal stress orientation from breakout analysis in the Neuquén Basin

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The object of this paper is obtaining a map of the principal horizontal stress field in the foreland of Mendoza and Neuquen provinces. The principal horizontal stress field orientation was deduced from borehole breakout analysis of 120 wells distributed along the study area. The significance of this work is that in this sector of Argentina there was not this type of information.

The studied area is located in the central Andes, among the 34° S and 39° S within the Neuquen basin (Figure 1). The Neuquen basin constitutes one of the major producers of oil and gas in Argentina. The Neuquen basin is one of the foreland sub-andean basins systems that extends through the eastern margin of the Andes cordillera (Parnell and Carey, 1995). In this Andean segment the Nazca plate is subducting under the Pacific margin with a convergence angle of 73°.

Subsequent to drilling, the cross sectional shape of many boreholes is deformed, usually over limited, discrete vertical intervals, into an ellipse known as a breakout (Hills y Williams, 1992). Breakouts are well bore enlargements caused by stress – induced failure of a well occurring 180° apart (Zoback *et al.*, 2003). It has been demonstrated that breakout orientation around a borehole is aligned with the least in situ horizontal stress (Bell and Babcock, 1986; Plumb and Cox, 1987). Breakouts are spalled regions on each side of the well bore which are centered at the azimuth of the least horizontal principal stress where the compressive stress concentration was greatest (Gough and Bell, 1981; Bell and Gough, 1982); because of this borehole breakouts are an important indicator of horizontal stress orientation (Reinecker et al., 2004).

For a given well we analyzed the four-arm dipmeter caliper data and calculated the mean orientation and the standard deviation of each interval with breakout and we also calculated the mean breakout orientation and standard deviation of the whole well. The breakouts data were classified using the World Stress Map criteria. In spite of the method limitations it is possible determine the well bore breakouts orientations taking into account a number of criterions enumerated by different authors (Plumb and Hickman, 1985; Zajac and Stock, 1997). Within the conditions to identify borehole breakouts all the wells whose vertical deviation was higher than 5° were discharged to avoid borehole elongations due to the tool friction in the wall of the well. To identify the borehole breakouts we used the software *Elipticidad de Pozos* (Cristallini and Guzmán, 2002). This software identifies breakout intervals along a well and classifies the data considering the World Stress Map Project criterions.

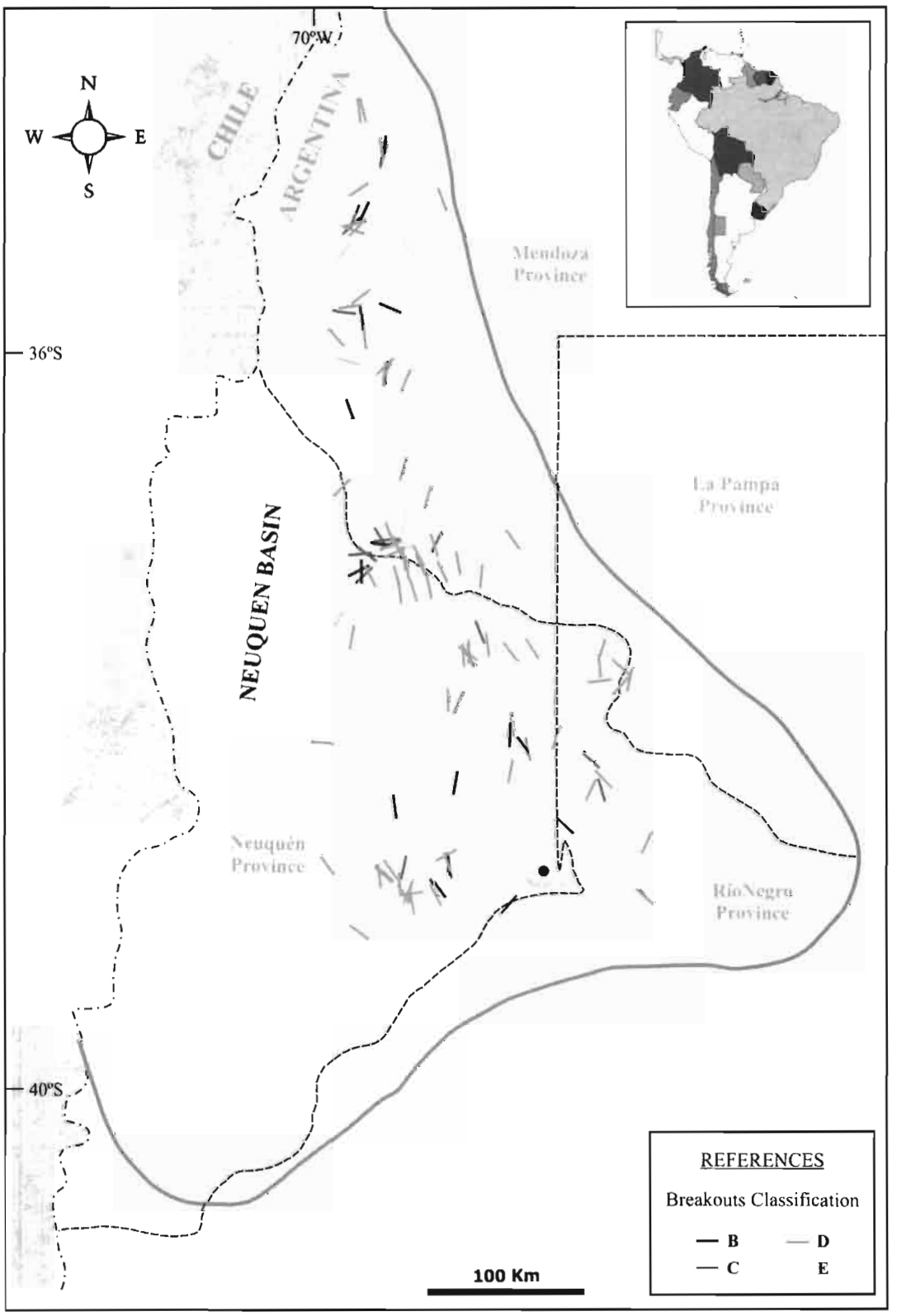

Figure 1: Borehole breakouts distribution, orientation and classification from 120 wells distributed along the Neuquen basin. The different colors correspond to borehole breakouts classification; the breakouts were classified using the World Stress Map criteria.

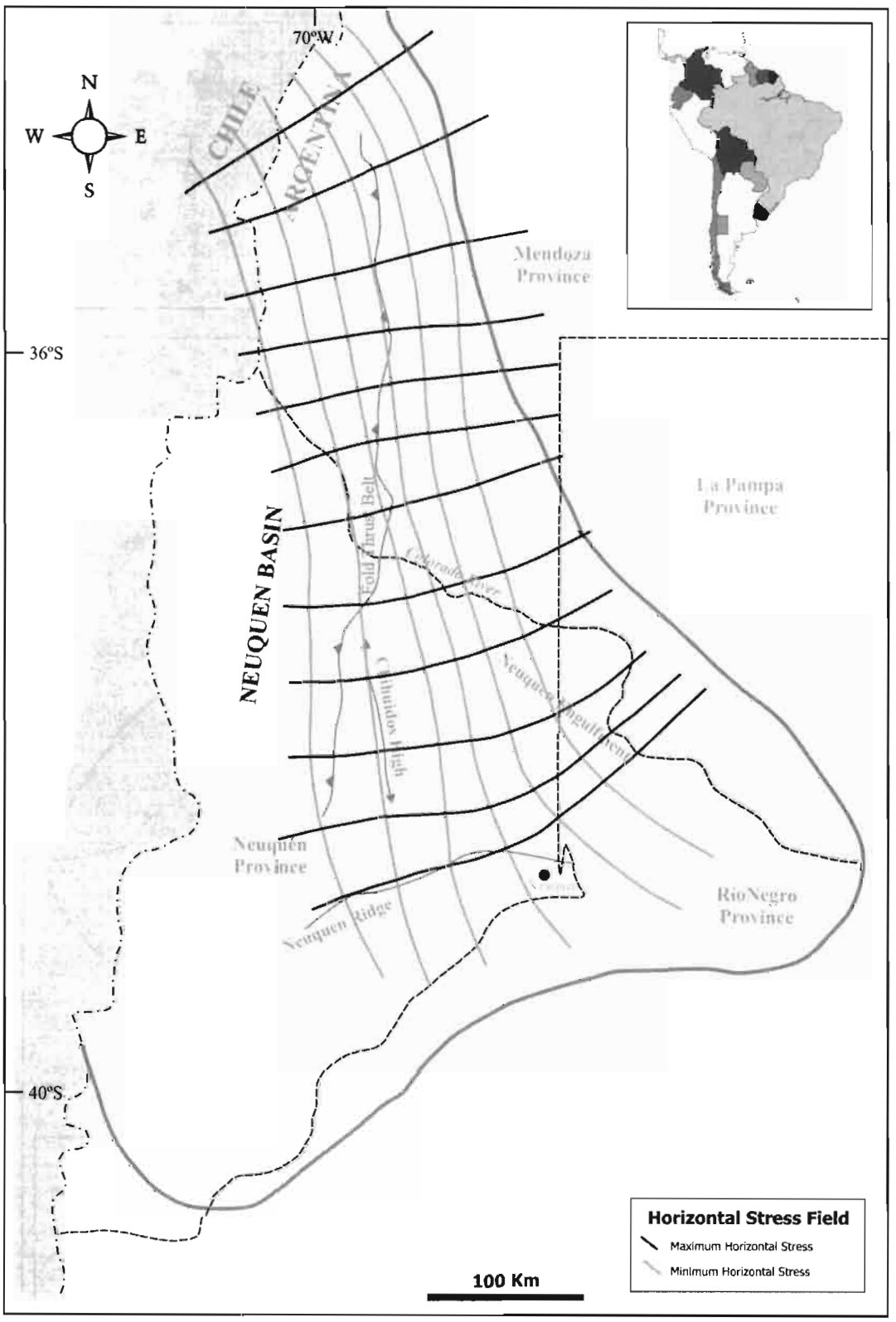

Figure 2: Horizontal stress field in the Neuquen basin calculated from borehole breakouts. The horizontal stress rotations located to the eastern part of the basin have been interpreted as a response of a basement structures control. The maximum horizontal stress to the north of the Colorado river has mainly an azimuth parallel to the convergence vector between the Nazca and South American plate. To the south if we discharge the eastern values controlled by the basement structures, the maximum horizontal stress has an azimuth of 90°.

To visualize the orientation of the principal horizontal stress and to study their distribution we constructed a map with the borehole breakout orientations (Figure 1). Using the borehole breakouts we made a maximum horizontal stress field map (Figure 2). The horizontal stress field in the study area is not uniform; to the east the maximum horizontal stress is parallel to the north edge of the Neuquen basin and to the Colorado river lineament. This fact is interpreted as a response of a basement structures control. There is a difference in the maximum horizontal stress orientation to the north and to the south of the Colorado river. To the north the maximum horizontal stress has mainly an azimuth parallel to the convergence vector between the Nazca and South American plates. On the other hand, to the south if we discharge the eastern values controlled by the basement structures, the maximum horizontal stress has an azimuth of 90°. These stress rotations can be interpreted in terms of stress partitioning.

The calculated breakouts directions are regionally inside the prospective values for this area of the Neuquen basin where the subduction has an azimuth of 73°. However to the west there are a number of breakouts directions that are not consistent with the regional tendency. This is interpreted as produced by local structure controls on the stress orientations.

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