# Temporal and spatial constraints on multi-phase crustal rotation in the forearc of Northern Chile

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The forearc of northern Chile between ~23-29°S records some of the largest paleomagnetically detected crustal rotations reported to date in the Central Andes (Figure 1). In contrast to much of the rest of the Central Andes, rotations appear to pre-date the main uplift and shortening of the Andean plateau between 25 Ma and the present time. We report new studies in which we have endeavoured to investigate both the scale of the rotated area and timing of the rotation in the forearc area between 27-30°S. Several authors have documented clockwise rotations in Mesozoic to Eocene units of up to 55° which, previously, appeared to decrease very sharply from about 30° of rotation at 28°S to near zero at ~30°S near La Serena. We present new data from over 120 sites from a range of Mesozoic to Eocene units in both the Coastal Cordillera and Precordillera. New data from two latest Cretaceous - Paleocene plutons in the Quebrada Los Choros - Tres Cruces area (29°S) combined with existing information from contemporary plutons (66-62Ma) from as far north as Inca De Oro (26°S) show the rotation to decrease smoothly suggesting a continuum in the deformation gradient controlling the rotations between these latitudes (Table 1, Figure 2). These data, it can be argued, also suggest that there may have been a distinct, if small ~10°, rotation in Cretaceous times. In order to better constrain the age of the main rotation we also present new data from Triassic to Eocene units in the La Guardia area, east of the city of Copiapó (27°S), in which we are able to demonstrate a variation in rotation during the period 60-40 Ma (Figures 1 and 3). In total these data strongly suggest to us that the large rotations of this region vary relatively uniformly and slowly with distance N-S and that a substantial part of this rotation pre-dates both the Andean orogeny and, we suspect, also the Incaic Orogeny of this part of the Central Andes. We suggest that the bulk of rotation was associated with the period of maximum obliquity of convergence between the Nazca and South American plates between ~ 55-40 Ma. In addition, in the older rocks, of the Coastal Cordillera there is a small late Early Cretaceous component of rotation.

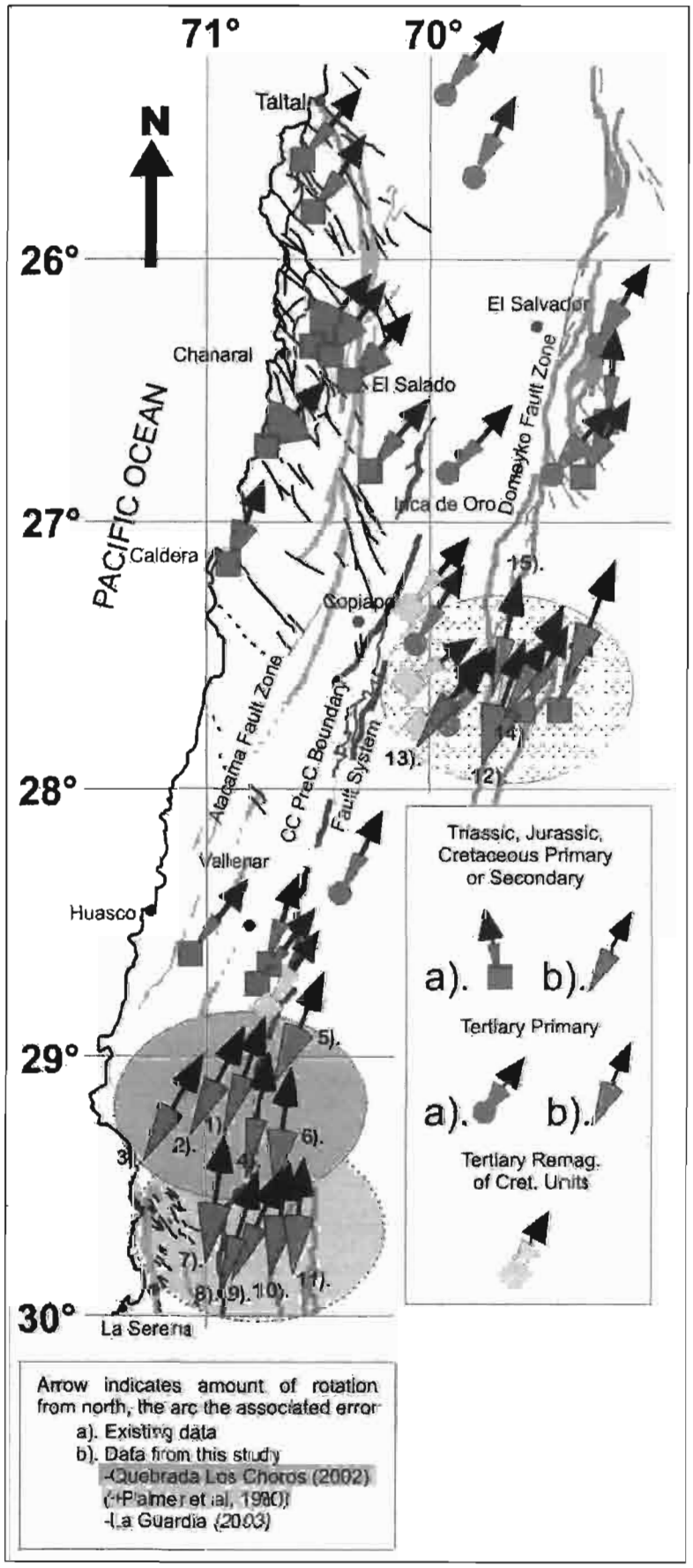


Figure 1. Compiled palaeomagnetic rotations for the forearc of Northern Chile between 25-30°S. Arrows indicate the amount of rotation, arcs the associated errors and symbols the suspected age of magnetisation. Also shown are the major fault systems of the region (after (Grocott and Taylor, 2002).

Data Compiled from (Forsythe et al., 1987), (Riley et al., 1993), (Randall et al., 1996), (Randall et al., 2001), (Taylor et al., 2002), Gipson (unpublished PhD) plus this study and reanalysed data from (Palmer et al., 1980). Data from east of Inca de Oro (Fernández et al., 2000) are in close agreement with these data as well.

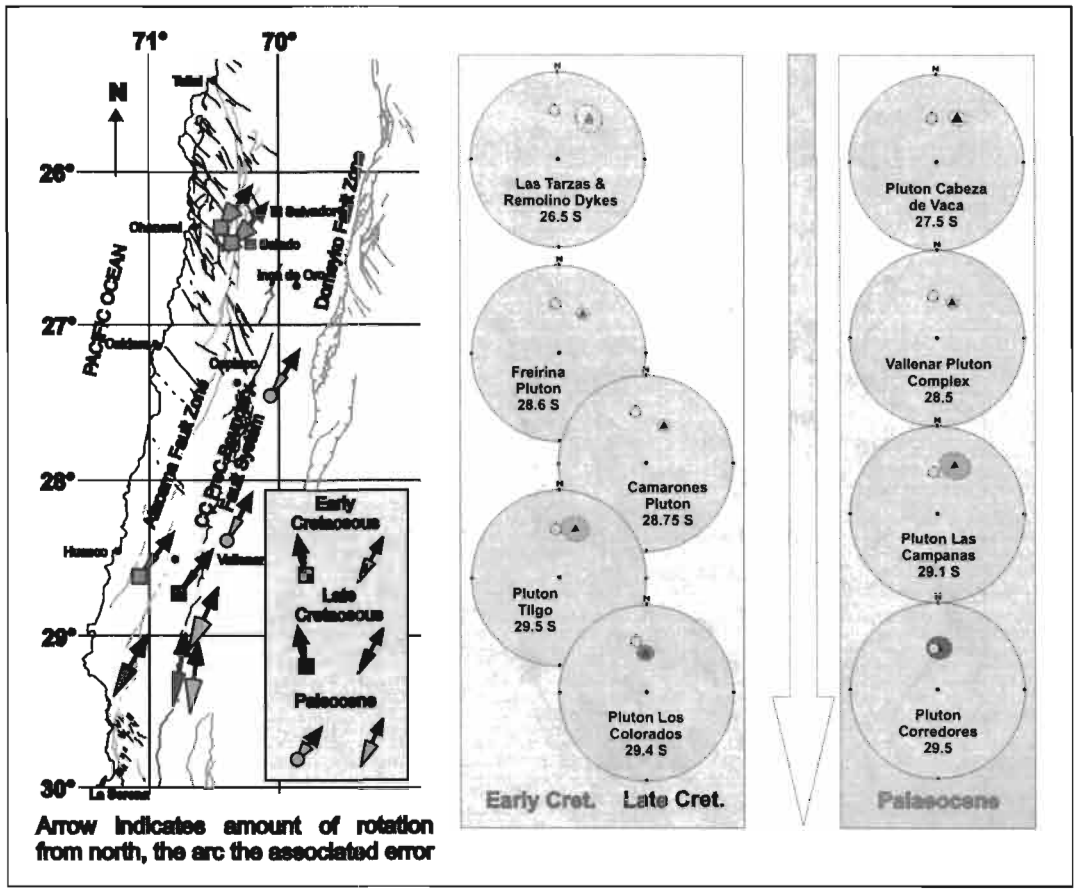


Figure 2. N-S gradient in observed rotation forunits of theEarly and Late Cretaceous,and latest Cretaceous-Paleocene magmatic arcs. Data from this study as well as from Gipson (Unpublished data), Randall et al, 1996, Randall et al, 2001. Diagrams show the distinctive decrease in rotation in all units southward.

| | Sampling UNIT | Age | Clockwise Rotation R | error |
|---|---|---|---|---|
| 1). | Punte del Cobre/Bandurrias Formation | Early Cretaceous | 12.1 | 11.5 |
| 2). | Dyke-swarm intruding PDC/Bandurrias | Early Cretaceous | 19.2 | 12.7 |
| 3). | Pluton Tilgo | 110-130 Ma | 21.7 | 13.3 |
| 4). | Pluton los Colorados | 93-96 Ma | 10.1 | 10.0 |
| 5). | Pluton las Campanas | Early Paleocene? | 25.5 | 15.0 |
| 6). | Pluton Corredores | Early Paleocene? | 7.4 | 14.7 |
| 7). | Arqueros Formation | Early Neocomian | 8.8 | 16.0 |
| 8). | Quebrada Marquesa Formation | Late Hauterivian | 17.3 | 9.3 |
| 9). | Quebrada la Totora Formation | Aptian-Cenomanian | 21.9 | 11.5 |
| 10). | Vinita Formation | Aptian-Cenomanian | 6.9 | 16.4 |
| 11). | Equinos Formation | Maastrichtian | 5.6 | 14.4 |

Table 1. Palaeomagnetically observed clockwise rotations about a vertical axis from this study(Quebrada Los Choros (c.29-30 °S, Orange), La Guardia (c.28 °S, Green) field areas, as well as reworked data from the east of La Serena (c.30 °S, Palmer et al, 1980, Yellow). All rotations are calculated using the reference poles of Randall (1998) or Lamb & Randall (2001).

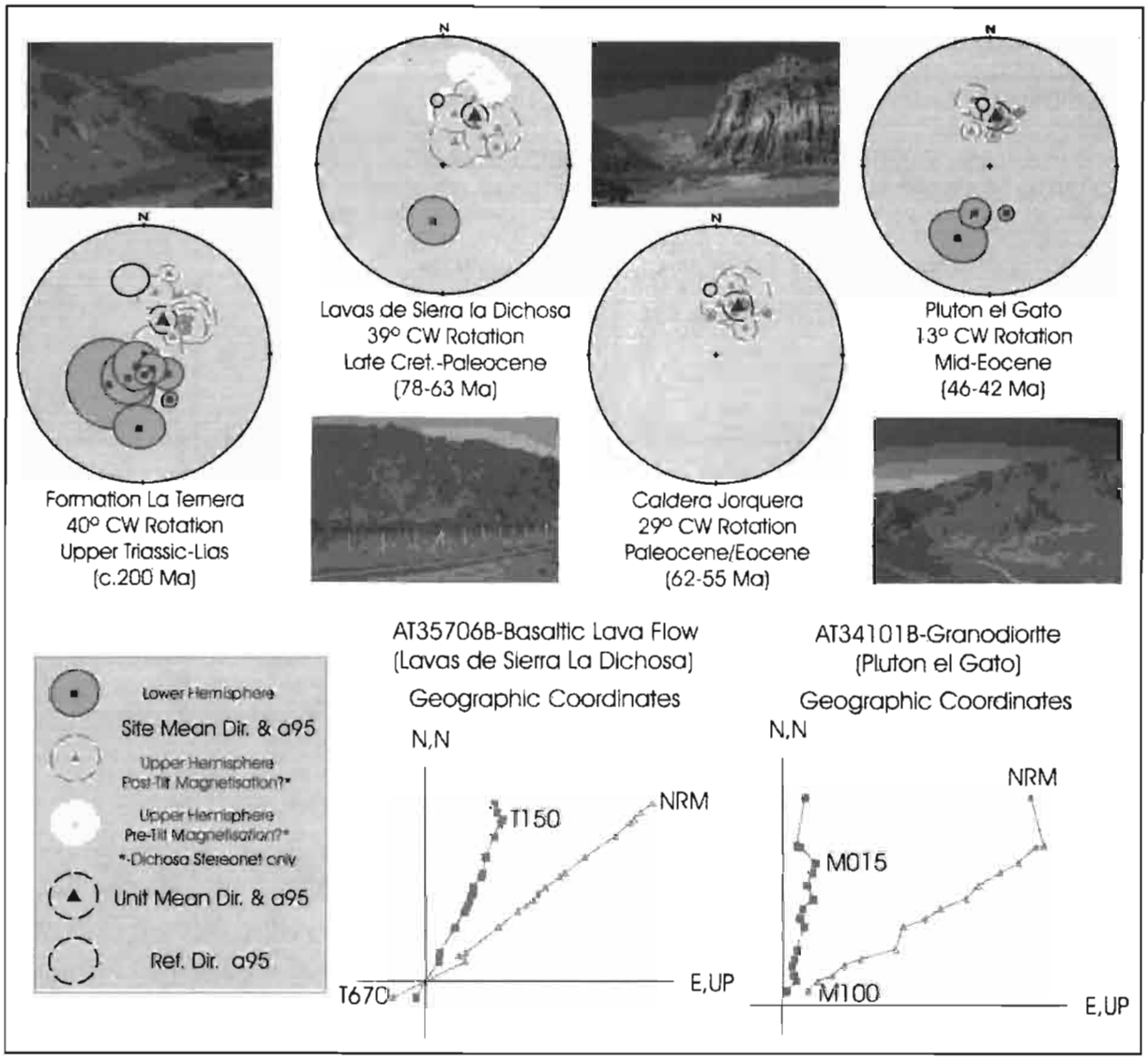


Figure 3.-Clockwise crustal rotations about a vertical axis calculated for sampling units from the La Guardia area 27.5° S, Atacama Region (IV), northern Chile + example Zijderveld diagrams

## References


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