DEFORMATION PROCESSES IN THE ANDES

Collaborative research centre 267, Project C1

SFB 267

KINEMATIC EVOLUTION AND STRUCTURAL GEOMETRY OF THE CHILEAN PRECORDILLERA (21,5-23°S): INVERSIONAL TECTONICS IN THE LATE CRETACEOUS-PALEOGENE MAGMATIC ARC

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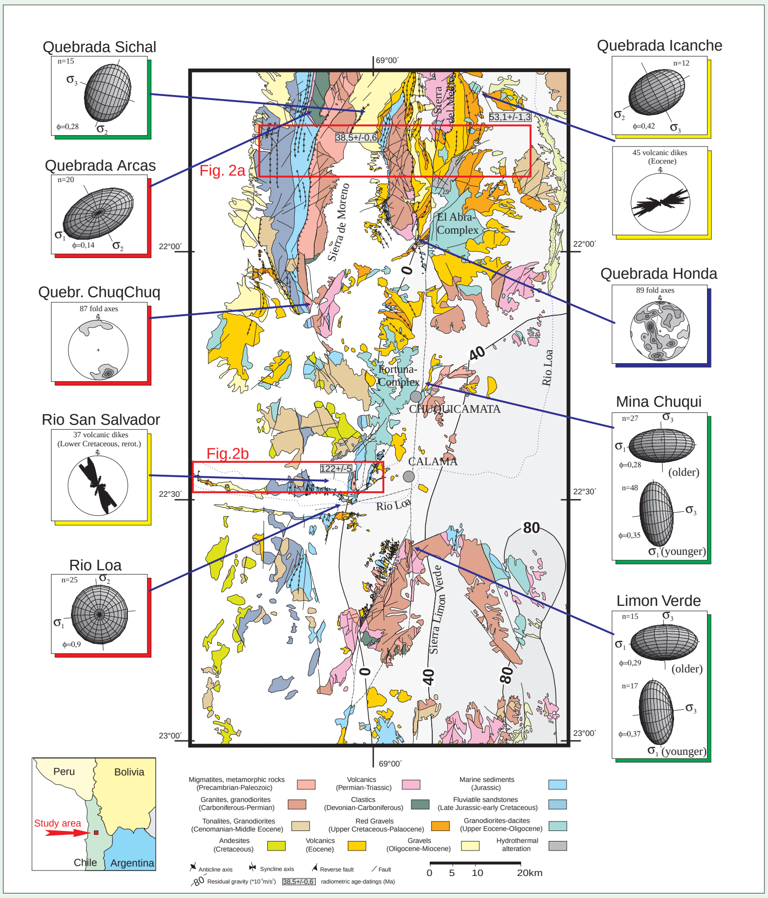

Figure 1: Geological map of the studied area with normalised paleostress-ellipsoids and stereographic plots of fold axes (density distribution diagrams) and volcanic dikes (orientation roses). Reduced paleostress tensors were derived from fault-stria data-pairs using the direct inversion method of (**8**). Also plotted: Selected radiometric age datings of magmatic rocks (own K/Ar, Ar/Ar after **9**) and isolines of the Central Andes residual gravity field according to (**10**).

Tectonic setting:

The structural style of the Chilean Precordillera between 21,5-23°S reveals strong differences parallel and perpendicular to the roughly N-S oriented trend of the Upper Cretaceous-Paleogene magmatic arc seated in the Precordillera, therefore allowing a seperation of the study area into a nothern and a southern segment: North of ~22,5° S (lat. of Calama) strong Upper Eocene (Incaic) contractional-transpressional tectonics are exposed wich caused the reverse faulting of basement-blocks both to the east and west onto folded Mesozoic and Cenozoic strata (**Figs 1 and 2**). Incaic contraction is less developed in the region south of Calama, where only moderate folding in Jurassic sediments and a slightly tilting of Eocene volcanics can be observed. Incaic contraction was preceeded by strong tensional tectonics prior to arc-emplacement in the northern segment as indicated by the formation of intramontane basins and the deposition of continental clastics without magmatic intercalations at the Upper Cretaceous-Paleogene boundary. This time-span in the southern segment was, in turn, already characterised by arc-volcanism wich migrated into the northern segment in Eocene times, where it was concentrated in a narrower zone.

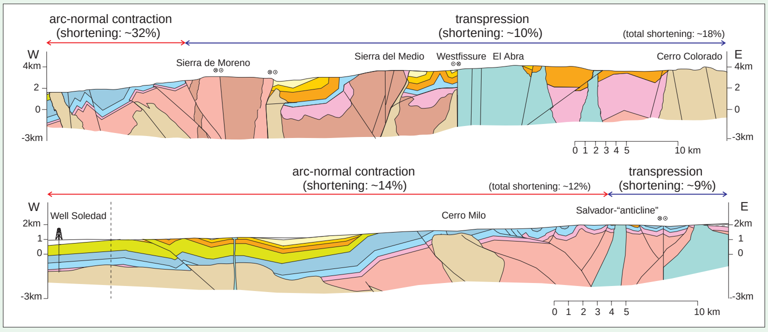

Figure 2: Geological cross-sections through the studied area (for legend and location: Fig.1)

Deformation history:

The timing of structural evolution could be seperated in four phases, where the latter three roughly coincide with the cenozoic development of the andine convergence system (**Fig. 3**).

Preandean development:

-Formation of crustal inhomogeneties due to Permian graben-setting (**1**)
-Origin of mayor fault-zones (**2**)
-First exhumation of the basement of Sierra de Moreno

Preincaic rifting:

-Extensional fabrics and paleostress-reconstructions evidence different tensional tectonic regimes from Lower Cretaceous times on (**Fig.1**)
-Horst-and-graben topography in northern segment could be inferred from intramontane-basin evolution

Incaic contraction/ transpression:

-Strain-partitioning from arc-normal contraction in the W to arc-parallel transpression in the E of northern segment as deduced from analyses of contractional fabrics and paleostress-reconstructions (**Fig.1**)
-Contraction at backarc-boundary in southern segment (**3**)
-N-S strain-transfer due to dextral ENE strike-slip at lat. 22,5°S

Postincaic reversal:

-Decreasing convergence at ~33Ma causes decoupling of upper and lower plate and inversion of the local stressfield in the area of the Westfissure wich changed in movement-sense from dextral to sinistral (**4**)

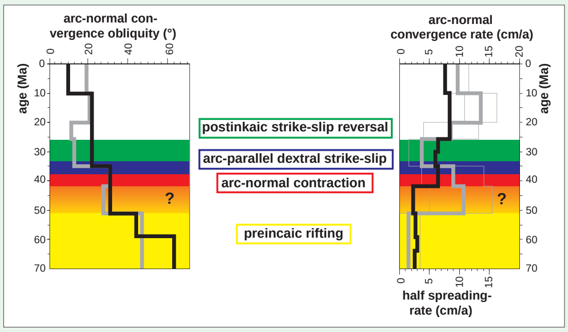

Figure 3: Timing of Incaic deformation events related to the evolution of plate-convergence at he South American continental margin. Gray lines: reconstructions after (**5**), black lines: Obliquity and half-spreading rates of the Pacific-Farallon (Nazca)-rise after (**6**). Note that increasing of sea-floor spreading occured significantly later than the increasing of the convergence rate after the reconstructions of (**5**).

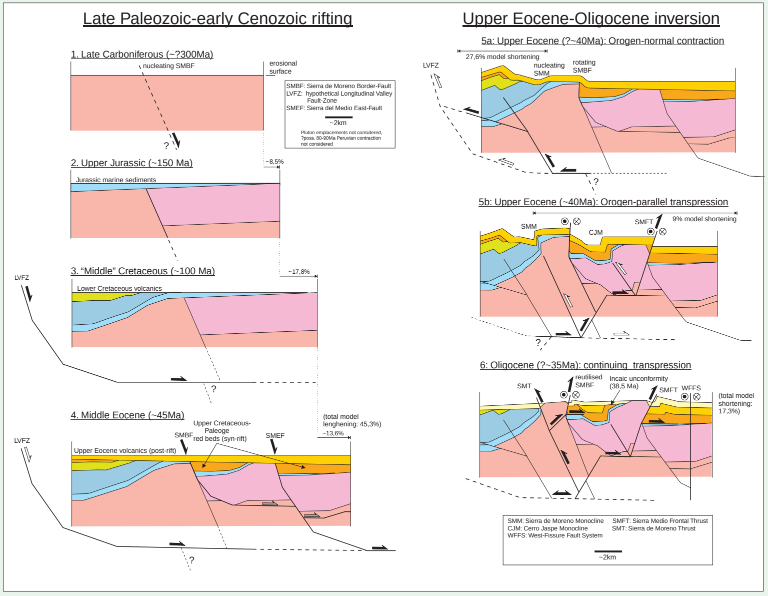

Figure 4: From extension to contraction: Conceptual forward-modelling of Incaic structures in the northen segment. The resulting asymmetric bivergent structural setting probably orginated due to the oblique inversion of a former down-stepping half-graben structure. Staircase up-stepping of Incaic reverse-faults caused the progressive monoclinal flexuring of the western flanks of the paleo-horsts. Modelling was carried out under plane-strain assumptions using the "fault-parallel flow" algorithm of the "2dmove"-sofware-package of Midland Valley Corporation.

Conclusions:

The heterogenities in the structural setting of the Precordillera in the studied area are mainly caused by strong tensional tectonics wich affected the northern segment before the onset of arc-volcanism and wich are interpreted according to the NW-propagation of the Salta-rift during the Upper Cretaceous. Incaic shortening was restricted to the relatively narrow zone of the magmatic arc in the northern segment, wheras it was transferred to the backarc-transition in the southern segment (**Fig.5**). This strain-transfer might have been facilitated by the presence of a dense body in the upper crust in the SE-part of the studied area, acting as a mechanical "free-face". Incaic shortening in the northern segment concentrated with depht into the central zone of the magmatic arc wich acts as a subvertical zone of crustal weakness, where ductile deformation occured at very shallow crustal levels (~7km). The bulk transpressive deformation-field was partitioned into arc-normal contraction in the W and arc-parallel transpression in the central zone of the arc and caused the oblique inversion of the former half-graben setting (**Fig.4**). The resulting structural geometry of the Precordillera thus appears like an assymetric positive flower-structure. South of 22,5°S FTB-like tectonics developed at the backarc-boundary. N-S-variations at ~22,5°S are still present in today´s structural setting of the Central Andes and are expressed by the differences between Altiplano and Puna (**7**).

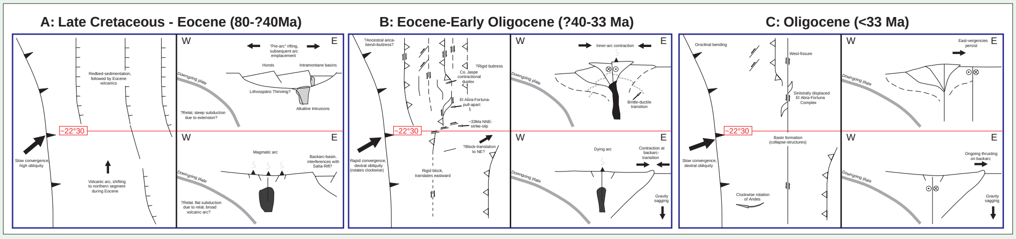

Figure 5: Schematic structural evolution of the precordillera in the studied area with regard to the differences in the structural setting N and S of 22,5°S. Left mapview, right cross-section view, respectively.

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