DEFORMATION PROCESSES IN THE ANDES

Collaborative Research Centre 267, Project C1

STRUCTURAL AND MAGMATIC EVOLUTION OF THE LATE CRETACEOUS-EARLY TERTIARY PRECORDILLERAN ARC SYSTEM, NORTHERN CHILE, 21-26°S

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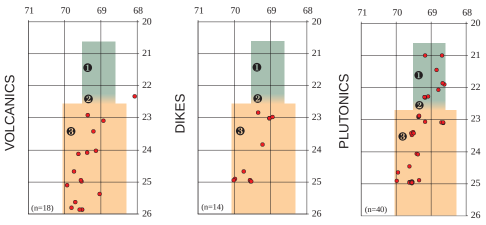
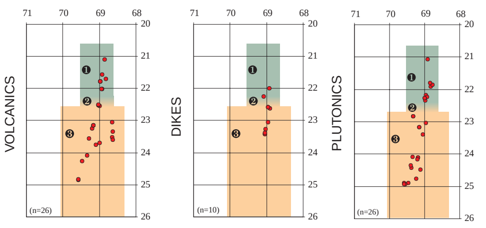
INTRODUCTION: The Chilean Precordillera between 21-26° S displays two contrasting tectonic styles along its N-S trending axis. We distinguish a northern section (north of 22.5° S), marked by intense late Eocene folding and faulting in the arc (38,5 Ma, "Incaic phase"), a transitional section at about 22.5°S and, south of Calama (22.5° S), a southern section where deformation occured mainly at the arc-backarc transition (Figs. 1 and 2). This structural subdivision coincides with a transitional N-S pattern of dated magmatic rocks, such that the oldest volcanic rocks exist in the southern section, whereas intrusives vary widely and concentrate in the northern section after the onset of incaic deformation (Fig. 3).

Magmatic evolution

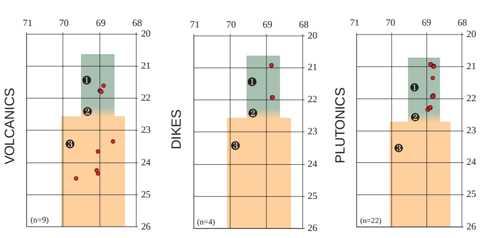
Age distribution of magmatic rocks



Late Cretaceous-early Eocene (72-54 Ma): for this time-interval an important lack of volcanic and subvolcanic rocks in the northern (**1**) and transitional (**2**) sections can be recognized. South of 25° volcanics only.



Early-late Eocene (53-39 Ma): the entire magmatic arc rock suite is distrbuited throughout all sections, but no magmatic rocks of this age are present south of 25° S in the southern section (**3**).



Late Eocene-early Oligocene (38-34 Ma): Plutonic and subvolcanic rocks occur only in the northern section (**1**). No magmatic rocks in the transitional section (**2**). A sparse presence of volcanics can be recognized in the southern section (**3**).

Fig. 3: Temporal and spatial distribution of late Cretaceous-early Oligocene magmatic arc rocks in the studied area (data compiled after **IV**, **V**, **VI** and own data).

Geologic map of the study area

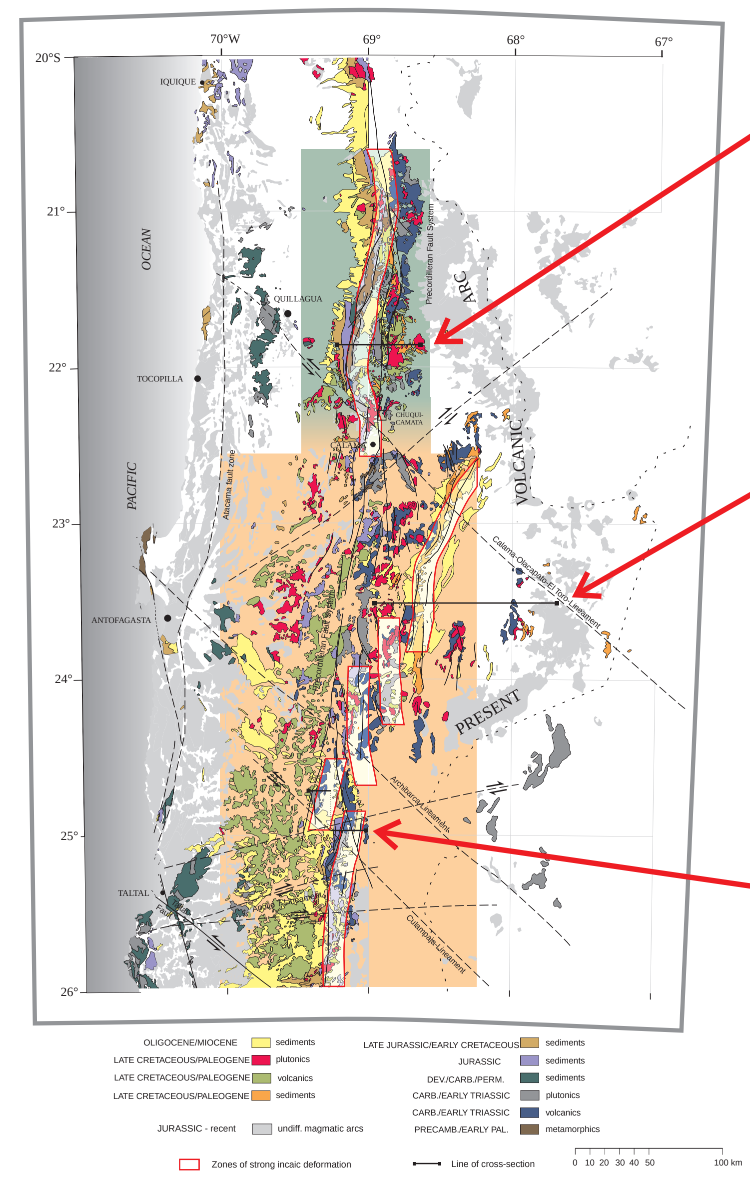
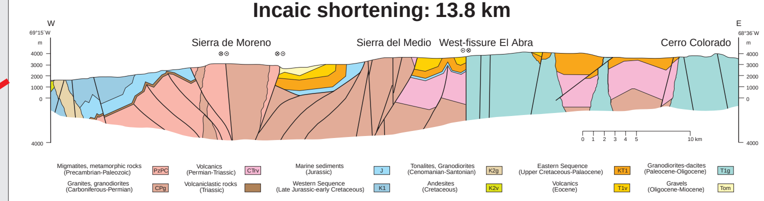


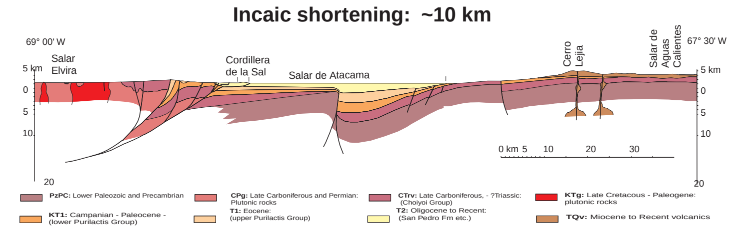
Fig.1: Geological map of the studied aera with major lineament zones (**I**, **II**), precordilleran fault sytem (PFS, **III**) and domains of intense incaic crustal shortening. Area underlain with green colour (north of Calama) indicates nothern section, orange color refers to southern section.

Structural evolution

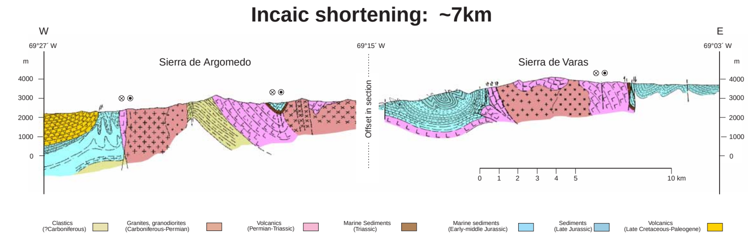
Geologic cross sections



Geological cross-section at 21°50´S. The Paleozoic basementridges of Sierra de Moreno and Sierra del Medio are thrust to the west and east, respectively. Eocene volcanics with preceeding clastics west of the Westfissure display folding and thrusting during Incaic deformation.



Geological cross-section at 23°32´S. Incaic deformation occured at the western border of the Salar de Atacama wich represent the arc-backarc boundary of the Precordillera arc. Late Cretaceous-Paleogene volcanics west of 69°W have not suffered incaic deformation.



Geological cross-section at ~24°50´S. The Jurassic sediments on the western flanks of the basement-cores of Sierra de Argomedo and Sierra de Varas have undergone strong folding during Incaic contraction. Late Cretaceous-Paleogene volcanics only show steepening at the western flank of Sierra de Argomedo.

Fig.2: Three geological cross-sections across the studied area showing different styles of incaic deformation along the strike of the upper cretaceous-paleogene magmatic arc in the precordillera.

Schematic model of magmatic evolution

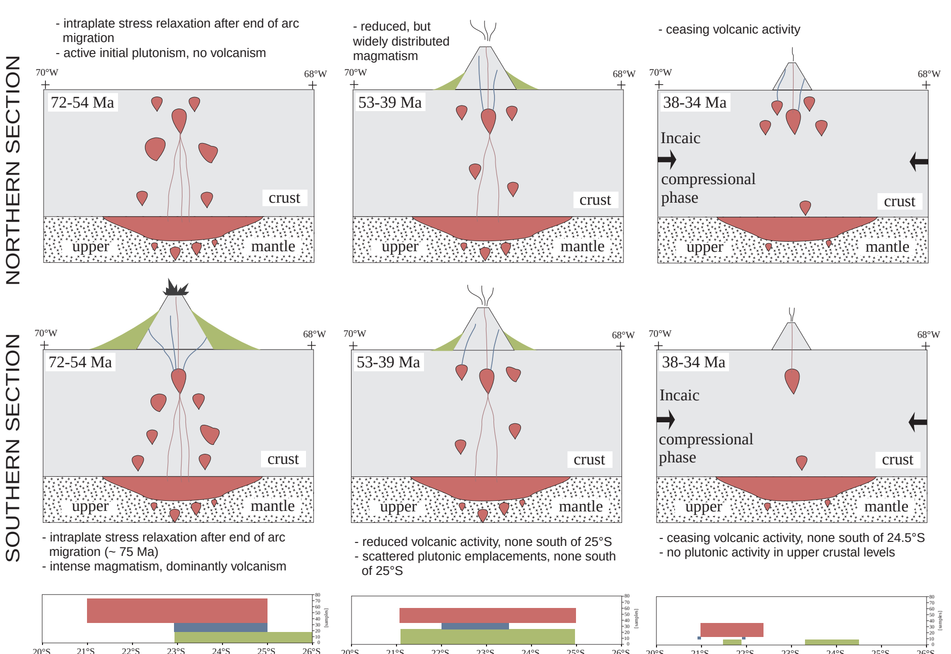
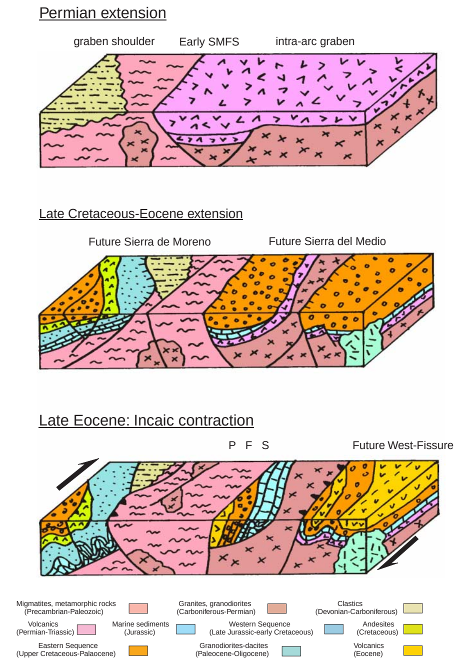


Fig. 4: Magmatic development in the Chilean Precordillera, 21-26°S.

Structural evolution of northern section



In late Paleozoic times, the Precordillera was part of an Carboniferous-Permian extensional magmatic arc (**VII**). The early Paleozoic basement exposed in the Sierra de Moreno (exhumed around 400 Ma, **VIII**) displays the western graben shoulder and is believed to be seperated from the intra-arc graben in the Sierra del Medio, where early Paleozoic basement do not outcrop, by a system of normal faults wich marked the origin of the Sierra-de-Moreno fault system (SMFS).

During the main activity stage of the late Cretaceous-Eocene volcanic arc seated in the precordillera, an extensional tectonic setting showing an horst-and-graben topography can be inferred from the formation of isolated continental basins seperated by uplifted areas during that time. The basins have been filled with continental deposits showing highly variable thicknesses ("Eastern Sequence", **IX**). From the fact that most depocenters were seated in the eastern segment of the arc, it could be inferred that the SMFS still exerted control on the tectonic evolution of the precordillera (scetch shows sitiuation before the onset of the even distributed eocene volcanics).

Strong contractional to transpressional deformations within the magmatic arc of the Precordillera took only place in the region north of Calama during the late Eocene (~38,5 Ma, **IV**). Contraction led to the formation of elongate basement ridges, thrust eastward and westward on Mesozoic-Paleogene strata wich have been strongly thrusted and folded. Contractional movements were accompanied by dextral, arc-paralell strike-slip movements revealed by numerous kinematc indicators (**III**, **X**) giving the Incaic structures of the Precordillera north of Calama the appereance of a positive flower structure. The SMFS was reactivated during that time and became incorporated into the Precordilleran Fault System.

Fig. 5: Schematic structural evolution of the Sierra-de-Moreno fault system (SMFS) as part of the Precordilleran Fault System (PFS) between Permian and late Eocene times.

CONCLUSIONS: The network of NW-SE/NE-SW and N-S lineaments leads to a crustal block pattern (Fig.1). These lineaments coincide with our tectono-magmatic subdivision along the Precordilleran arc-axis between 21 and 26°S. We suggest that the individual response of each crustal block to varying intra-plate stresses during time controlled both, the differences in nature and intensity of deformation and the spatial and temporal distribution of magmatic arc rocks. Based on field observations illustrated in Fig.5 we conclude that these faults originated during Paleozoic times. Their repeated reactivation, in particular during the Eocene Incaic deformation, is responsible for the present tectonic setting in this region. Some of these lineaments (e.g. Calama-Olacapato-El Toro Lineament) still control the structural development of the Central Andes.

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