Neotectonic surface structures between the Chile trench and the Western Cordillera are caused by active extension in the outer forearc domain, affecting Pliocene and Pleistocene deposits between the Mejillones Peninsula and the Atacama fault. The inner forearc domain and the western margin of the active magmatic arc are characterised by recent compression. Here Quaternary lacustrine sediments and Upper Miocene to Pleistocene ignimbrites are faulted by trenchward verging thrusts north of San Pedro de Atacama in the Rio Salado and Vilama areas and arcward verging thrusts, with the eastern most, the Talabre thrust, beneath the Tumisa and active Lascar volcanoes bounded in the east by a more than 100 km N-S trending lineament, the Miscanti fault, where post-Pliocene transpressive deformation can be observed (fig. 1).

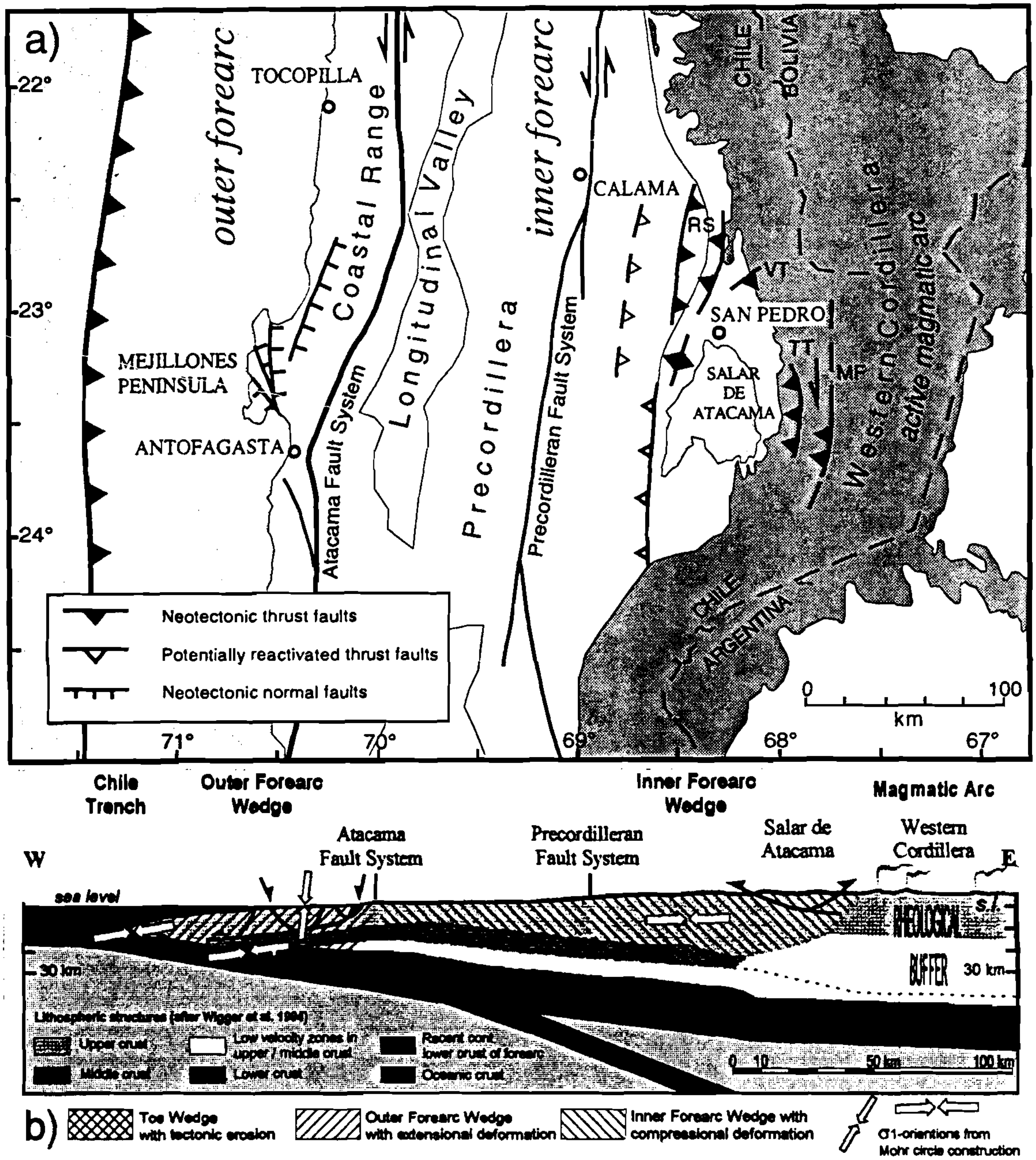
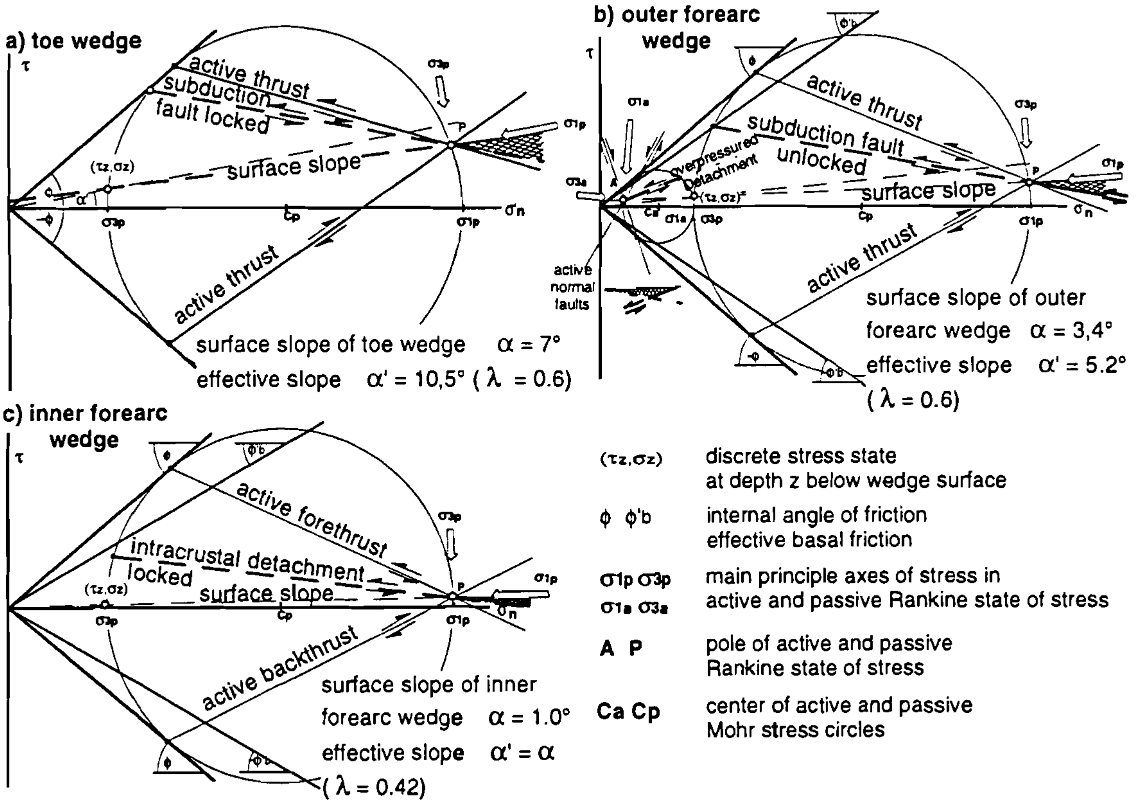


Fig. 1: a. Main structural features and neotectonics of the North-Chilean trench-arc system.
(RS Rio Salado Area, VT Vilama thrusts, TT Talabre Thrust, MF Miscanti Fault;
Atacama- and Precordilleran fault kinematics after Armijo & Thiele 1990; Yáñez et al. 1994).
b. Schematic dynamic cross section of the trench-arc system of Northern Chile.

WEDGE MECHANICS AND DYNAMICS

Active lithospheric stresses are transmitted from the subducting Nazca Plate onto the overriding South-America Plate due to high frictional resistance between the plates. For Northern Chile, between 18° S and 24° S, Tichelaar & Ruff (1991) estimated a plate coupling extending to depths of 45 - 48 km. The North-Chilean convergent plate margin is a non-accreting margin characterised by subduction erosion with removal and transport of rock material from the upper plate to greater depths (Huene & Scholl, 1991). In our dynamic model the rigid wedges of the forearc lithosphere are backstopped by the rheological buffer of the thermally weakened active magmatic arc (fig. 1 b).

Wedge mechanics illustrated by Mohr stress circles (fig. 2) demonstrate the limit stress conditions and required geometric relationships between the topographic slopes, subduction fault, crustal detachments, internal toe detachments, normal- and thrust faults, and stress field orientation of the rigid forearc wedges.



(τz,σz)	discrete stress state at depth z below wedge surface
φ φ'b	internal angle of friction effective basal friction
σ1p σ3p σ1a σ3a	main principle axes of stress in active and passive Rankine state of stress
A P	pole of active and passive Rankine state of stress
Ca Cp	center of active and passive Mohr stress circles

Fig. 2: Limiting stress conditions and fault mechanics in the North Chilean forearc system (a) toe wedge (b) outer forearc wedge (c) inner forearc wedge.

The compressional stress regime and similar rheological properties in the toe-wedge and along its base prohibit a discrete wedge base and a stable wedge geometry. Internal deformation favours west verging detachments with off-scraping of the basal part of the toe-wedge carried away with the subducting Nasca plate, stress conditions are shown in fig. 2a. Increasing pore fluid pressure and/or decreasing basal friction along the descending subduction fault lead to underplating of these crustal slices and thickens the outer forearc wedge. The basal accretion rises basement rocks into upper crustal levels (Platt 1986). This mechanism influences the uplift of the basement rocks of the Coastal Range in the north Chilean onshore outer forearc. Thrust faulting indicated by focal mechanisms of shallow earthquakes (depth ≤ 30 km, Comte et al. 1992) support this dynamic model. In contrast to this compressive basal accretion mechanism, neotectonic and active surface structures in the outer forearc show trench parallel extension. These normal faults are dynamically interpreted as a result of the extensional collapse of a supercritical wedge build up by continuous thickening during basal accretion. The simultaneous critical extensional and compressional stress conditions and the geometric relation of fault mechanics in the outer forearc wedge are modelled in the Mohr stress circles in figure 2 b.

The inner forearc wedge is characterised by neotectonic west-verging forethrusts and east-verging backthrusts, represented by out-of-the-sequence thrusts, favoured by numerous evaporitic layers within the rock succession and by older upper crustal discontinuities of former tectonic stages. This wedge is under active compression and in a subcritical stage (fig. 2 c).

CONCLUSIONS

Based on observations of surface structures in the Chilean trench-arc system frictional plastic wedge models have been developed which help to understand the dynamics of the rigid crust in the forearc region. Mohr circle constructions illustrate the varying rheological conditions in defined subwedges of the forearc system and explain the relationships between neotectonic deformation processes and the active state of stress. The uplifted basement rocks of the Coastal Range and neotectonic to active N-S trending normal faults in the onshore region of the outer forearc are governed by toe erosion and underplating processes and by contemporaneous internal extensional adjustment of wedge geometry. Synchronous post Pliocene/Pleistocene west verging forethrusts, East-verging backthrusts and folds in the inner forearc and along the western rim of the recent Andean magmatic arc reflect compressional internal deformation within a subcritical crustal wedge backstopped by the rheological buffer of the active magmatic arc.

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