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Stress variations determined by measuring electromagnetic emissions along the active Southamerican plate boundary (southern Chile)

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The orientations of active crustal stresses in the uppermost lithosphere are reflected by electromagnetic wave directions. Electric and magnetic fields in the earth crust are generated by mechanical disturbances known as seismoelectromagnetic phenomena. The electromagnetic wave emission from rocks can be related to the formation of microcracks or to piezoelectric, piezomagnetic, or to electrokinetic effects in the earth crust experiencing recent tectonic stresses and / or topographic loading and gravitational stresses. The direction of the emitted waves is directly controlled by the orientation of the affecting stresses.

With high-sensitive geophysical electromagnetic investigations (NPEMFE – Method = measurements of the Natural Pulsed Electro Magnetic Field of the Earth with the CERESKOP instrument) we determined in southern Chile the current stress directions along the active South-American plate margin. The NPEMFE – Method detects peak-values in the geogenic electromagnetic field clearly exceeding the background noise and registers the orientation of the corresponding electromagnetic waves.

The explored area is flanked by the Pacific in the West and the Patagonian Andes in the East. Regional plate tectonic stresses are due to the current convergence between the oblique subducting oceanic Nazca Plate and the overriding continental South-America Plate. The regional stress field is overprinted and altered by stresses caused by irregular underplating that induces local uplift and by forearc and intraarc shearing processes. The different effects of these ongoing processes onto the upper plate are reflected in the subrecent to current regional and local fault and fold patterns. The shape and mechanical behaviour of evolving forearc wedges and crustal slivers govern the state of stress within sub-regional crustal domains. Local uplift areas are dominated

either by overall crustal extension or an extension parallel to the coast reflecting a minimum stress direction normal to the coast and a maximum horizontal stress direction parallel to the coast. Approaching potential active faults, the stress trajectories turn into parallel and normal directions to these crustal discontinuities. The determined direction of maximum electromagnetic emission agrees with modelled stress directions obtained from tectonic and gravitational stress analysis of deformation structures within recent sediments and soils carried out by the Hamburg Neotectonic group during the last years.