Origin of Central Andean collapse calderas *Vortrag*

Ulrich Riller[1]

Regional strains in tectonically active volcanic provinces may have a profound influence on the mode of collapse caldera formation. Conversely, the deformation pattern, more specifically, the symmetry of plan-view strain fields imparted to caldera floors may assist in elucidating the regional deformation active during caldera formation. The symmetry of plan-view strain fields is chiefly controlled by the mode of floor subsidence, particularly whether subsidence is uniform, symmetric or asymmetric, portraying collapse mechanisms known respectively as plate, downsag and trapdoor. Plate and downsag subsidence generates centro-symmetric strain fields characterized by radial and concentric discontinuities and subvolcanic dikes. Such strain fields appear to develop preferably where magma pressure controls collapse. By contrast, rectilinear horizontal strain fields form under unidirectional stretching and generate normal faults and subvolcanic dikes transverse to the stretching direction. Rectilinear strain fields are typical for trapdoor subsidence but also for straight orogenic belts and suggests that the formation of both may be related. This was tested for six central Andean collapse calderas that formed between 10.5 and 2 Ma and are located on prominent NW–SE striking fault zones.

A combined geochronological and structural analysis of the Miocene Negra Muerta Caldera in particular was designed to better understand caldera formation associated with the prominent Olacapato – El Toro Fault Zone. Rb-Sr ages of the caldera outflow facies indicate that caldera formation occurred in two volcano-tectonic episodes. The first episode commenced with explosive eruption of the 9.0 ± 0.1 Ma andesitic Acay Ignimbrite followed by a period of volcanic quiescence and moderate tectonic activity. Dominant volcanic and tectonic activity occurred during the second episode, which is bracketed by eruption of the 7.6 ± 0.1 Ma rhyolitic Toba 1 Ignimbrite and effusive discharge of the 7.3 ± 0.1 Ma rhyodacitic to andesitic lava flows. Structural relationships between rocks of the Negra Muerta Volcanic Complex and collapse-induced normal faults, notably NE-striking normal faults, agree with simultaneous volcanic activity and floor subsidence of the caldera during the second episode. Floor subsidence was achieved by tilting on an outward dipping reverse fault to the northwest of the caldera floor around a hinge zone located south of the caldera floor. This induced horizontal extension of the caldera floor and was accomplished by fragmentation of, and intrusion of dikes into, the floor. Collapse-induced and post-collapse fault populations of the caldera do not differ significantly in the directions of their axes of maximum extension and are in this respect kinematically compatible with left-lateral slip on the nearby Olacapato – El Toro Fault Zone. This furnishes evidence for a kinematic control by prominent faults on the formation of collapse calderas in the central Andes.

Similar to the Negra Muerta Caldera, other Central Andean calderas adhere to a rectilinear strain field pointing to trapdoor subsidence and uniform

[1] Humboldt-Universität Berlin, Museum für Naturkunde, Invalidenstrasse 43, 10115 Berlin

stretching sub-parallel to the orogen axis. The colinearity of Neogene orogen-scale stretching direction deduced from the geometry of large-scale folds and faults with stretching evident from collapse-induced strain fields suggests that caldera formation in the southern central Andes was assisted, if not controlled, by regional tectonism. This implies that rectilinear strain fields of collapse calderas may serve as indicators of regional paleostrain imparted to upper crustal rock at the time of collapse caldera formation.