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From Space to Ground: The seismogenic landscape of Lake Ohrid

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The region along the southernmost border of Macedonia (FYROM) with Albania evolved as an extensional basin-and-range-like system, which is influenced by the roll-back and detachment of the subducted slab of the Northern Hellenic Trench. Especially the Lake Ohrid Basin which is bound by major N-S trending active faults is of interest concerning the seismogenic evolution of the area. The lake is located on 693 m a.s.l. stretching over a length of c. 30 km and a width of c. 15 km. It is surrounded by the steep flanks of the Galicica and Mokra Mountain ranges that reach heights of max. 2,265 m. The seismicity record of the area lists frequent shallow earthquakes with magnitudes of up to 6.6 and few strong historical events, which account for the morphology of this tectonically active landscape. Many features as long-lived reflections of repeated surface faulting are preserved in the surroundings of Lake Ohrid. Linear step-like fault scarps can be traced on land and within the lake. Other morphological features such as wind gaps, wineglass-shaped valleys and triangular facets, are accompanying morphological expressions. Secondary seismic effects like mass movement bodies can be found within the lake and also onshore (rockfalls, landslides, sub-aquatic slides, homogenites, turbidites). Multichannel-seismic studies reveal evidence for wedge-like growth strata incorporating mass movement bodies, rather pointing to sudden earthquake-triggered events than to fault creep. An integrated multidisciplinary approach was chosen to investigate the neotectonic history of the basin, using tectonic morphology and a variety of geophysical and remote sensing methods. High resolution Terrasar-X data were used to trace and to characterize the faults onshore. Field measurements result in profiles of more than 30 fault scarps on the Galicica and Mokra Mountains. The heights of these fault scarps range in general between 2 and 45 m, fault lengths vary between 10 and 20 km and consist of several segments. As these bedrock fault scarps form distinct landscape marks today, they were considered to be post glacial, as the slip-rate along the fault planes needs to be higher than the erosion-rate, to preserve the step-like morphology. The calculation of slip-rates - stating a post-glacial development of these scarps- ranges between 0.27 (0.18) mm/a and 2.30 (1.57) mm/a for the last 15 (22) ka. These values exceed by far the slip-rates calculated by e.g. Benedetti et al. (2003) for dated scarps in Greece. Therefore the natural conclusion would be, that the higher the scarps, the faster is the movement on the fault plane, which is unlikely, or the postulated age of these higher scarps is simply too young. A theory that could cope with this problem is the concept of "stop and go" faults. Here the older, outer faults would slip every time a younger fault evolves and would therefore create a higher relief than the younger ones. This also fits with the observation that the average scarp heights decrease towards the lakeshore.