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The Sparta Fault, Southern Greece: From Segmentation and Tectonic Geomorphology to Seismic Hazard Mapping and Time Dependent Probabilities

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The Sparta Fault system is a major structure approximately 64 km long that bounds the eastern flank of the Taygetos Mountain front (2.407 m) and shapes the present-day Sparta basin. It was activated in 464 B.C., devastating the city of Sparta. This fault is examined and described in terms of its geometry, segmentation, drainage pattern and postglacial throw, emphasizing how these parameters vary along strike. Qualitative analysis of long profile catchments shows a significant difference in longitudinal convexity between the central and both the south and north parts of the fault system, leading to the conclusion of varying uplift rate along strike. Catchments are sensitive in differential uplift as it is observed by the calculated differences of the steepness index ksn between the outer (ksn<83) and central parts (121<ksn<138) of the Sparta fault along strike the fault system. Based on fault throw-rates and the bedrock geology a seismic hazard map has been constructed that extracts a locality specific long-term earthquake recurrence record. Based on this map the town of Sparta would experience a destructive event similar to the 464 B.C. approximately every 1792 $\pm$ 458 years. Since no other major earthquake M$\sim$7.0 has been generated by this system since 464 B.C., a future event could be imminent. As a result, not only time-independent but also time-dependent probabilities, which incorporate the concept of the seismic cycle, have been calculated for the town of Sparta, showing a considerably higher time-dependent probability of 3.0 $\pm$ 1.5% over the next 30 years compared to the time-independent probability of 1.66%. Half of the hangingwall area of the Sparta fault can experience intensities $\geq$IX, but belongs to the lowest category of seismic risk of the national seismic building code. On view of these relatively high calculated probabilities, a reassessment of the building code might be necessary.