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Remote sensing and GIS study of an eroded Miocene volcanic area (Hegau, SW Germany)

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Remote sensing techniques offer useful tools that can aid in evaluating the geomorphologic and geologic evolution of eroded volcanic landforms. Erosion provides insight into subsurface structural levels of a volcanic edifice, but it is difficult to correctly interpret the field observations, particularly if the exposed landforms have been modified by tectonic and fluvioglacial processes. An illustrative example is the Hegau volcanic field, located NW of Lake Constance near the northern margin of the Molasse Basin in the Alpine foreland (e.g., Schreiner, Samml. Geol. Führer 62, 2008). This region, situated on the periphery of the Upper Cretaceous-Quaternary mafic alkaline magmatic province in central Europe (e.g., Blusztajn and Hegner, Chem. Geol. 2002), was episodically active during the Miocene; K-Ar age determinations (mostly obtained in the 1960/70s) indicate emplacement ages ranging from about 15-7 Ma. Several eroded plugs and necks of olivine melilites and phonolites form prominent landmarks rising above the present-day Hegau landscape. The area also contains remnants of dikes, maar crater lakes, basalt flows, travertine and pyroclastic deposits (both pipe-filling and eruptive tuff sheets). The volcanic constructs were largely buried by Molasse sediments, due to continued flexural subsidence of the foreland lithosphere during the Tertiary. Since the cessation of the Molasse phase, the region has undergone exhumation and erosion of up to several hundred meters (increasing towards the Alpine front) as indicated by reconstructions of missing stratigraphic sections based on borehole studies (references in Rahn and Selbekk, Swiss J. Geosci. 2007). Pleistocene ice sheets repeatedly covered parts of the area and deposited moraines, gravel plains, and lake deposits (e.g., Fiebig and Preusser, Geograph. Helv. 2008). Furthermore, deep fluvioglacial valleys were carved out that were sequentially re-filled and partly re-eroded, resulting in a system of narrow basins and gravel aggradation terraces. The region has also been affected by tectonic faulting, particularly during the Miocene (graben formation), and is seismically active at present (e.g., Strehlau and Stange, in prep.). In an attempt to elucidate the combined effects of volcanism, tectonism, deposition, and erosion in this area, we have analyzed LANDSAT, ERS, ENVISAT-ASAR, TerraSAR-X, and SRTM data. Traces of two concentric oval features (with diameters of about 10-12 km and 18-24 km, respectively) centered roughly on the Hohenstoffeln volcanic pipe can be identified on morphometric maps derived from SRTM DEM data and on LANDSAT and satellite radar imageries. We believe that these arcuate structures are comparable to alkaline ring complexes that have been found in other igneous provinces worldwide. We suggest several possible interpretations of the observed structures that may eventually be resolved by further field investigations.