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Tectonic geomorphological investigations of antiforms using differential geometry (Permam Anticline, Northern Iraq)

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Modern differential geometrical methods are applied to compute and analyze curvature quantities of the Permam Anticline, which is part of the Zagros fold and thrust belt in Northern Iraq, northeast of the city of Erbil. Since this particular anticline comprises, among others, weathering-resistant limestones, the surface topography strongly resembles the antiformal fold shape. This makes it an ideal area, where numerical curvature analysis applied to SRTM digital elevation models allows one to draw not only geomorphological, but also tectonic conclusions. The curvature analysis is based on the computation of the Gaussian and mean curvatures, and is used to classify the folded surface into 8 geologically relevant shapes (antiform, synform, plane, dome, basin, and three types of saddles). The performed curvature analysis investigates in detail the effects of two adaptable parameters: i) the cut-off wavelength of the low-pass filter that is applied to the digital elevation model prior to curvature calculation, and ii) the curvature threshold that is applied to the principal curvature values prior to the calculation of the Gaussian and mean curvatures. The analysis demonstrates that these two parameters strongly influence each other, and that they together determine the information content and interpretability of the results. By using an appropriate choice of parameter combinations, geomorphological-oriented studies as well as tectonic-oriented studies are viable via the same digital elevation model. It is discussed how tectonic-oriented studies can be used to determine fracture-patterns or -densities in folded layers. Further suggestions are made to combine curvature analysis of digital elevation models with similar studies applied to seismically mapped surfaces in 3D seismic data sets, where erosion is absent.