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Combination of hand mapping and automatic mapping to reveal the Miocene high elevation Pyrenean peneplain

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A striking feature of the morphology of the Pyrenees is the occurrence of high-elevation, low-relief surfaces, which are interpreted as remnants of a single Miocene planation surface. Whether the original surface was uplifted or developed at high altitude is debated. This "Miocene Pyrenean peneplain" has been dissected by fluvial and glacial erosion during the Quaternary. Reworking by glacial erosion also provides new smooth surfaces such as glacial cirque floors that must not be confused with the remnants of the original planation surface. The later are convex-up landforms whereas glacial cirque floors are concave-up landforms. To reveal the Miocene high-elevation Pyrenean peneplain, we combined hand mapping and automatic mapping at the scale of the whole chain. From previous mapping in literature and from our own field work, we first perform a map of both the Miocene planation surface remnants and the Quaternary glacial cirque floors. Using Digital Elevation Models, numerical parameters were extracted from this map to characterize the two types of smooth surfaces. The slope is the parameter that helps to delimitate and differentiate the smooth surfaces from the rest of the Pyrenean topography. To distinguish between the two types of smooth surfaces we used the Topographic Index (TPI). This parameter is the difference between the elevation of a point and the mean elevation. Choosing the pertinent radius according to the scale of the landform to map, and the pertinent values interval, we can differentiate the planation surface (convex-up) from the glacial cirque floors (concave-up). A sensitivity test was performed to determine the best radius and the best interval for TPI and slope values to distinguish between the two types of smooth surfaces. Finally, we used a combination of slope values, TPI values and radius to determine automatically the high-elevation, low-relief surfaces in the entire Pyrenees. We verified in the field the presence of the newly mapped high-elevation, erosional surfaces. We conclude that the combination of hand mapping and automatic mapping gives more consistent results than the two methods used separately. Automatic mapping, in addition to be less time consuming, is more objective and precise than hand mapping. Hand mapping is required to determine the main characteristics of the landform. The final comparison between the two mappings is necessary to verify the cartography and to discuss the results.