



## **The morphometry and location of glacial cirques on Sierra de Guadarrama National Park (Iberian Central System)**

Javier Pedraza (1), Rosa M. Carrasco (2), Rodrigo L. Soteres (3), Theodoros Karampaglidis (4), and Javier Villa (2)

(1) Department of Geodynamics, Stratigraphy and Paleontology, Complutense University of Madrid, Spain (javierp@ucm.es), (2) Department of Geological and Mining Engineering, University of Castilla-La Mancha, Spain (rosa.carrasco@uclm.es, javier.villa@uclm.es), (3) Institute of Geography, Pontifical Catholic University of Chile, Chile (rlsoteres@uc.cl), (4) Department of Geoarchaeology, National Research Centre on Human Evolution, Spain (theodoros.karampaglidis@cenieh.es)

The Sierra de Guadarrama in the eastern sector of the Iberian central System is a recently reactivated mountain range (Alpine Orogeny), structured in fracture blocks and running in a general NE-SW direction. Its basement is formed by crystalline rocks (Variscan and pre-Variscan lithologies), local sedimentary cover (Cretaceous and Tertiary lithologies) and superficial Quaternary deposits. The summits in the central sector rise to over 2000 m asl (Pico de Peñalara, 2428 m asl) with frequent morphologies originated by ancient glaciers. Mostly of these paleoglaciers correspond to cirque and slope type with occasional valley and meseta type glaciers. Their evolutive sequence had three main stages (Palacios et al., 2012; Bullón, 2016; Carrasco et al., 2016): maximum extent (local MIE), assigned to both MIS2 (around 26 ka BP) and MIS3 (around 35 ka BP); a later retreat-readvance-stabilization stage, ending around 17/15 ka BP; and deglaciation which ended around 11-10 ka BP.

Almost all earlier studies of this area highlight the predominance of the eastern location of the paleoglaciers and link this to climatic factors. However, this is a general opinion but is not based on quantitative analysis, which led us to undertake this present study.

The basis for this study is the geomorphological mapping of the cirques, carried out using morphotopographic criteria. The description of the cirques, including morphometry, aspect, floor altitude, etc., follows updated classical methods (Barr and Spagnolo, 2015). The mapping and statistical analysis of the data was completed using ArcGIS 10.4 with ACME tools (Spagnolo et al., 2017) and the programme WinIDAMS 1.3

In total 79 glacial cirques were analysed, with the following results: the most frequent general aspect found is SE and NNW, and to a lesser extent SSW. The cirque physiognomy is predominantly circular and concave, although elongated oval cirques are often found, and also some trough-shaped and stairway cirques.

The explanation of these configurations can be linked to various factors: the overall NE-SW orientation of the mountain range; the previous morphology of the western scarp slopes compared with the eastern stepped slopes; the structural control exerted by the pre-glacial river valleys which channelled the ice; flat summits which facilitated oversupply on eastern slopes from snow and ice transfer; and the mainly slope-type glacier typology.

### References

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