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Sub-aerial granite and gneiss weathering rates in Spanish Central System and their implications for terrestrial cosmogenic nuclide dating

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Terrestrial in situ cosmogenic nuclides are used for chronological applications. As in many other dating techniques, several corrections are needed to include the multitude of factors affecting the rock surface to be dated. One of these factors is the erosion rate of the rock. Independent measurements of erosion rates from the Spanish Central System have been carried out in order to correct ongoing ^{10}Be analyses. The Spanish Central System is an elongated succession of massifs and ranges from the Portuguese border to central Spain, with large summit regions exceeding 2000 m asl., and a maximum elevation of 2592 m asl. The dominant lithologies in the Spanish Central System are granites and gneisses. In this region, the bare rock is frequently cropping out due to predominant erosive processes in the ranges. The higher sectors of the Spanish Central System hosted several glaciers during the Last Glacial Period, which were totally extinct prior to the onset of the Holocene. Preliminary dates from the region suggest that the age of deglaciation is similar to other regions of the Iberian Peninsula and that ice retreat was fast.

Weathering was measured on granite and gneiss rocks polished by glaciers. The measurement sites are elevated sheepback rocks (roches moutonnées) in which no water flow from rivers or concentrated runoff affect local erosion rates. We quantified erosion by measuring the height difference between outstanding large feldspar phenocrysts and quartz veins and the rest of the rock. The erosion of quartz and feldspar crystals is assumed to be negligible as evidenced by the sharp edges and preservation of polished faces and occasional fine striations. The weathering rates are calculated by assigning each site an ice-retreat age in relation to its deglaciation stage at 19 or 15 ka BP. The weathering rates show a clear linear relationship with altitude (r^2=0.94). The erosion rates range from 0.3 to 0.7 mm/ka at altitudes from 1400 to 2100 m asl, with greater erosion rates at higher elevations. The increase of erosion with altitude is likely related to the effectiveness of cryofracturing at higher elevations as suggested by diminution of rock compressive strength measured with a Schmidt hammer and the increase of rock roughness indicating the shattering of the crystals.

The Spanish Central System has a low weathering rate, although zero erosion rates have been demonstrated to be unrealistic. Calculation of ^{10}Be ages considering zero erosion rates causes the dates to be biased by hundreds to over a thousand years towards younger ages in the time frame of interest. Consequently, age corrections taking into consideration these weathering rates are needed to achieve an accurate chronology with which carry out precise correlations. As the weathering rates in the altitude range where glacier features to be dated resulted to be more than double at higher altitudes than in the lower sectors, each date should be corrected with an individual erosion rate rather than using an unique regional weathering rate.