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Tectonic flattening in pumiceous rocks: A new regional strain marker?

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Porous volcaniclastic rocks are capable of accommodating both brittle and ductile deformation at low burial depths (0.5-1.5 km, Cavailhes and Rotevatn, 2018). Both at the outcrop scale and sample scale, these rocks show markers, which reflect well the larger regional deformation in response to tectonic scale plate motion. At Shihtiping, in the Coastal Range of Taiwan, a significant part of the deformation is accommodated into the volume of the andesitic volcanic tuffs by penetrative deformation. Indeed, deformation is not fully accommodated within discrete and/or localized structural heterogeneities e.g. deformation bands, fractures, faults; there is also additional distributed deformation throughout the rock volume. With the help of a morphometric outcrop structural analysis of pumice clast shapes, we quantify pumice tectonic flattening in the context of a deformed volcanic arc that has undergone tectonic shortening during plate convergence, at a burial depth of 1.5 km or shallower. The measured direction of shortening associated with the flattening of the pumice is sub-parallel to the general relative motion between the Philippine and Eurasian plates, which drives the collision between the Chinese continental margin and the Luzon arc. In detail, the direction of pumice flattening shows a rotation in the vicinity of brittle volcanic bombs in a similar way to how a foliation rotates around porphyroblasts. The sheltered zones (shadow zones) in the "tails" of volcanic bombs have made it possible to characterize and quantify the initial shape and aspect ratio of the pumice (i.e., before shortening). Pumice at the periphery of low-porosity brittle volcanic bombs exhibits secondary deformation, in response to a strong rheological contrast, and accentuates pumice flattening by plastic punching. Tectonic flattening appears related to the presence of highly porous pumices in the studied volcaniclastics with the ability to accommodate changes in volume, elongation and shear by collapse/crushing of their microvesicular pores. The rheology of pumice shows a remarkable ability to express tectonic flattening, notably through the collapse of the vesicles structuring it. The tectonic flattening of cooled pumices in response to regional post-cooling deformation, and its role as a powerful regional tectonic marker, has to our knowledge not been documented previously in the scientific literature, with the exception of the mention by Okubo (2012) where pumice clasts are only documented as crushed by the compaction of vacuolar voids.

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