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Structural pattern and ascent model in the Central Extremadura batholith, Hercynian belt, Spain: Discussion

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IN A RECENT paper, Castro (1986) proposed an emplacement model for the granitic plutons of the Central Extremadura region (Spain) according to which, both their intrusion and deformation are related to the activity of an E–W, dextral, intracontinental shear zone which developed during the second deformation phase (D_2). In his model, the author places great importance on the possibility that the plutons might have been emplaced in extensional fractures oriented N135°, i.e. at 45° to the assumed shear direction, normal to the line of maximum infinitesimal extension. For the model to be acceptable, not only must the maximum infinitesimal extension be compatible with the simple shear mechanism proposed, but the direction of maximum finite shortening must be, too. This would imply the development of subvertical planar fabrics with a strike ranging between N45°E and almost E–W, depending on the intensity of the associated finite strain. However, in some plutons (Montánchez, Alijares) the planar fabrics which developed during deformation have a strike of N–S to N30°E. This direction is incompatible with an E–W, dextral simple shear, particularly if there has been a clockwise rotation of the plutons after formation of the fabric (see Castro 1986, fig. 17). Moreover, the S_2 schistosity in the host rocks has a direction ranging between E–W and N150°E (*op. cit.* figs. 1 and 15), which is equally incompatible with an E–W dextral shear zone.

In his interpretation of the internal deformation of the plutons Castro misunderstands the nature of progressive deformation during simple shear. He states (p. 643): "When a pluton reached a N–S orientation during rotation, it passed through a critical field of the hypothetical incremental strain ellipse associated with the E–W shear zone (fig. 16). The lines of positive infinitesimal longitudinal strain fall into this critical field, thereby produc ing the transverse shortening perpendicular to the major axis of the pluton". We consider this statement incorrect, and that the field in which the infinitesimal longitudinal strain is positive to be wrongly represented in fig. 16: that field is not only Zone 2, but also Zone 1 of the ellipse (Ramsay 1967, figs. 3–62 and 3–64). It is precisely in Zone 1 where the positive infinitesimal longitudinal strain reaches its maximum value. In fact, the maximum infinitesimal shortening would only be perpendicular to the major axis of the pluton or, to be more exact, to the material line which initially coincides with that axis, when that line is rotated until it reaches a N45°E direction instead of N–S, as the author seems to suggest. The planar fabric should be considered as a finite strain structure and, even if it was formed in a relatively short period of time, its initial strike would be somewhat more than N45°E; and a later clockwise rotation would tend to place it nearer to E–W rather than N–S, as found, for example, in Montánchez. The direction of shortening proposed by the author for the early intrusions depicted in Castro's fig. 17 illustrates the confusion regarding this matter.

An important point of Castro's argument is that ". . . all the plutons which have an orientation other than NW–SE, exhibit structures which indicate a dextral rotation either during or after emplacement". These structures are N–S sinistral shear zones on the borders of some plutons (Montánchez, Plasenzuela, Santa Cruz). It is surprising that these structures are only found in one margin of the plutons, since if they are the result of the rotation of the plutons with respect to the host rock, they should appear on the opposite margin, too.

An alternative interpretation is to assume that the sinistral shear zones are not a product of the rotation of the plutons but rather that they were formed as discrete structures in a sinistral shear regime and were then rotated, together with the plutons themselves, by a later deformation phase. The history of the deformation in the granites might then be as follows: some plutons, the earliest ones, were first deformed, acquiring planar fabrics subparallel to the S_1 schistosity of the metasediments and small conjugate shear zones. Later, the same plutons, and others somewhat younger, were affected by sinistral shear zones with an orientation subparallel to that of the D_1 structures, located in narrow bands, commonly on their margins, but also inside them (Alijares) and locally affecting the host rocks (Santa Cruz). Finally, the eastern part of the region underwent an important clockwise rotation during a later phase of folding. From the asymmetry of the folds which were produced, this deformation could be related to dextral simple shear; its strike in no case would be E–W, but might range between 135 and 170°, according to the observed S_2 schistosity, which is parallel to the axial plane of the folds (Castro 1986, fig. 1). This interpretation implies the possibility that the earlier plutons were emplaced at the end of the first deformation phase, D_1.

The succession of the regional deformational events suggested here, together with the emplacement

mechanisms of each pluton, could account for all the structural characteristics described by Castro. This would not imply that it is necessarily correct, but it is not incompatible with a well-established mechanical model such as that of simple shear. In our opinion, the data provided by Castro (1986) do not demonstrate that the plutons of the Central Extremadura batholith were emplaced in a E–W, dextral shear zone. Therefore, they cannot be considered as confirmation that granitic bodies of considerable size can be emplaced in extensional fractures arranged along shear zones as a consequence of the existence of high fluid pressures. Whereas such a mechanism seems to be very common in the development of small extension veins in shear zones of any size, its extrapolation as an emplacement mechanism for granitic plutons remains to be proved.

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