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Short communication

Comment on: the structural configuration of the eastern Sierra de los Filabres, SE Spain by H. Bakker: *Geologie en Mijnbouw 70: 287–298, 1991*

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In a recent article Bakker (1991) attempts to explain the regional tectonic evolution of the Mulhacen Complex in the eastern Sierra de los Filabres. A central theme of this article is the discussion of an upwards increasing strain during the D_{X+1} phase of Bakker (*op. cit.*), which is envisaged on the basis of quartz *c*-axis preferred orientation fabrics, reorientation of D_X and D_{X+1} lineations and progressive development of extensional crenulation cleavages (ECCs). In my opinion this is an erroneous view based on wrong interpretations of (micro-)fabrics and field relations. Proper interpretation of D_{X+1} structures, sensu Bakker (*op. cit.*), is essential as they are related to emplacement of the Alpujarride Complex on the Mulhacen Complex. The timing proposed by Bakker (*op. cit.*) implies a relatively early formation of this ductile nappe contact. However, a system of large-scale S to SW vergent folds and associated thrusts (De Jong 1985, 1991, fig. 2.15), interpreted by Bakker (*op. cit.*) as D_{X+2} structures, has not influenced the nappe contact. Instead, regional mapping revealed that these structures are truncated by the basal thrust of the Alpujarride Complex (De Jong 1991). Bakker's proposed timing of structures in the Mulhacen Complex related to emplacement of the Alpujarride Complex is thus inconsistent with relative timing of the nappe contact based on mapping in relation to a regional tectonic study of the Betic Zone. Therefore, I would like to check the validity of the interpretations on which Bakker (*op. cit.*) based the relative timing of D_{X+1} structures.

The Mulhacen Complex experienced a polyphase tectonic evolution as discussed in a number of recent articles (García Dueñas et al. 1987, 1988, Bakker et al. 1989, Frizon de Lamotte 1989, Zevenhuizen 1989, De Jong 1990). Polyphase deformation might, obviously, result in reorientation of earlier structures. Bakker (*op. cit.*) seriously underestimates the effects of late-stage deformation and associated movements on the orientation of older, i.e. D_X and D_{X+1} lineations, of which a reorientation is envisaged in the uppermost 800–900 m of the Mulhacen Complex during D_{X+1}. In the highest structural level of the Tahal Schists, directly below a major detachment, the youngest penetrative cleavage, S_{X+3} according to Bakker (*op. cit.*), is overprinted by chevron folds and associated brittle-ductile extensional shear zones related to post-D_{x+3} thrusting and subsequent extension concentrated in this zone (De Jong 1985, 1991). Mapping revealed that in the central part of the area discussed, the top of the Tahal Schists and the Carrasca Marbles are, going from east to west, in contact with progressively higher litho-stratigraphic levels of the series above, the La Yedra Marbles and Schists (De Jong & Bakker 1991, encl. I, between coordinates 5_{75} and 5_{80}). This shows excision of a rock pile of several hundred metres. The detachment contact is accentuated by a zone of carbonate breccias with rock fragments containing S_{X+3} and is therefore related to important late-stage extensional deformation. The D_X and D_{X+1} stretching lineations measured by Bakker (*op. cit.*) deviating most from the other lineations (Stereograms A and B in Bakker's fig. 2) are found near the basal detachment fault. Their presence at this structural level implies that rotation after D_{X+3} is a more likely explanation for the deviating trend than a rotation as a result of upwards increasing D_{X+1} strain, proposed by Bakker (*op. cit.*).

Bakker (*op. cit.*) presents nine quartz *c*-axis preferred orientation fabrics and discusses fabric development without taking into account results of recent studies (García Dueñas et al. 1987, Zevenhuizen 1989, Vissers 1989). In spite of possible complexities, discussed by these authors, Bakker (*op. cit*) claims that the presented fabrics indicate the prominent kinematics at the structural level from which they were taken: a westward sense of shear in deeper levels, followed by a zone of coaxial deformation in the constrictional field, eastward shear at middle level and coaxial deformation in the flattening field at the highest structural level of the Mulhacen Complex. Because all fabrics are relatively ill-defined this seems to me an overinterpretation of the information contained in the diagrams and a jumping to conclusion that there should be an upward D_{X+1} strain gradient. In fact, fabric diagrams 85 Bhe 09, 10 and 17 from different levels (Bakker *op. cit.*, fig. 2) are strikingly similar, pointing rather to absence of a strain gradient in the entire section than in favour of it.

Development of quartz *c*-axis preferred orientations is intimately associated with establishment of ECCs, as Bakker (*op. cit.*, p. 292) states that 'grain-size reduction and optical reorientation is extended from the ECCs into the main foliation'. This observation has two major implications. Firstly, because ECCs are only penetrative in the uppermost 100 m of this section, these structures underline the absence of a D_{X+1} strain gradient in the major part of the Mulhacen Complex, further invalidating the rotation of lineations during D_{X+1} envisaged by Bakker (*op. cit.*). At the same time this demonstrates that lattice preferred orientations due to D_{X+1}, sensu Bakker (*op. cit.*), might only be expected in the uppermost part of the complex (fabrics 83 Bhe 72 and 85 Bhe 17). Secondly, the significance of these lattice preferred orientations depends on the interpretation of the relative timing of the ECC in the deformation scheme of the Mulhacen Complex. In the scheme of Bakker et al. (1989) ECC development was interpreted to take place before D_{X+2} folding, although clear overprinting was never observed. New investigations, however, in the area studied by Bakker (*op. cit.*) and data collection in the entire eastern Betic Zone have revealed that the ECC in the top of the Mulhacen Complex immediately below the Alpujarride Complex is in fact developed after D_{X+2}. This conclusion is based on truncation of D_{X+2} folds by ECC zones and deformation of syn to post-D_{X+2} albite in shear bands (De Jong 1991, 1992a). Consequently, the relative timing of ECC development and associated lattice preferred orientations by Bakker (*op. cit.*) is wrong.

In conclusion, the rotation of lineations in the entire section of the Mulhacen Complex envisaged by Bakker (*op. cit.*) cannot be the result of an upward increasing D_{X+1} strain, as the deformation phase sensu Bakker (*op. cit.*) is only penetrative in the uppermost 100 m of the section discussed. Deviating lineations in the lower part of the section are probably due to reorientation during post-D_{X+3} deformation, concentrated at this structural level. The development of the quartz lattice preferred orientations cannot be discussed in a model of progressive overprinting of the D_X flow plane by D_{X+1} strain as is proposed by Bakker (*op. cit.*), because the D_X flow plane is strongly modified by D_{X+2} folding and thrusting and, in addition, ECCs and associated lattice preferred orientations related to emplacement of the Alpujarride Complex are developed after the D_{X+2} event. This points to a late formation of the Mulhacen-Alpujarride contact, in agreement with results of a regional tectonic study in the Betic Zone (De Jong 1991), as will be discussed in two papers submitted to this journal (De Jong 1992a, b).

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