MICROSTRUCTURAL CHARACTERIZATION OF METASOMATIZED GABBROIC ROCKS OF THE BARRANCO DA GRAVIA UNIT (B.A.O.C.) AT THE GUADIANA RIVER

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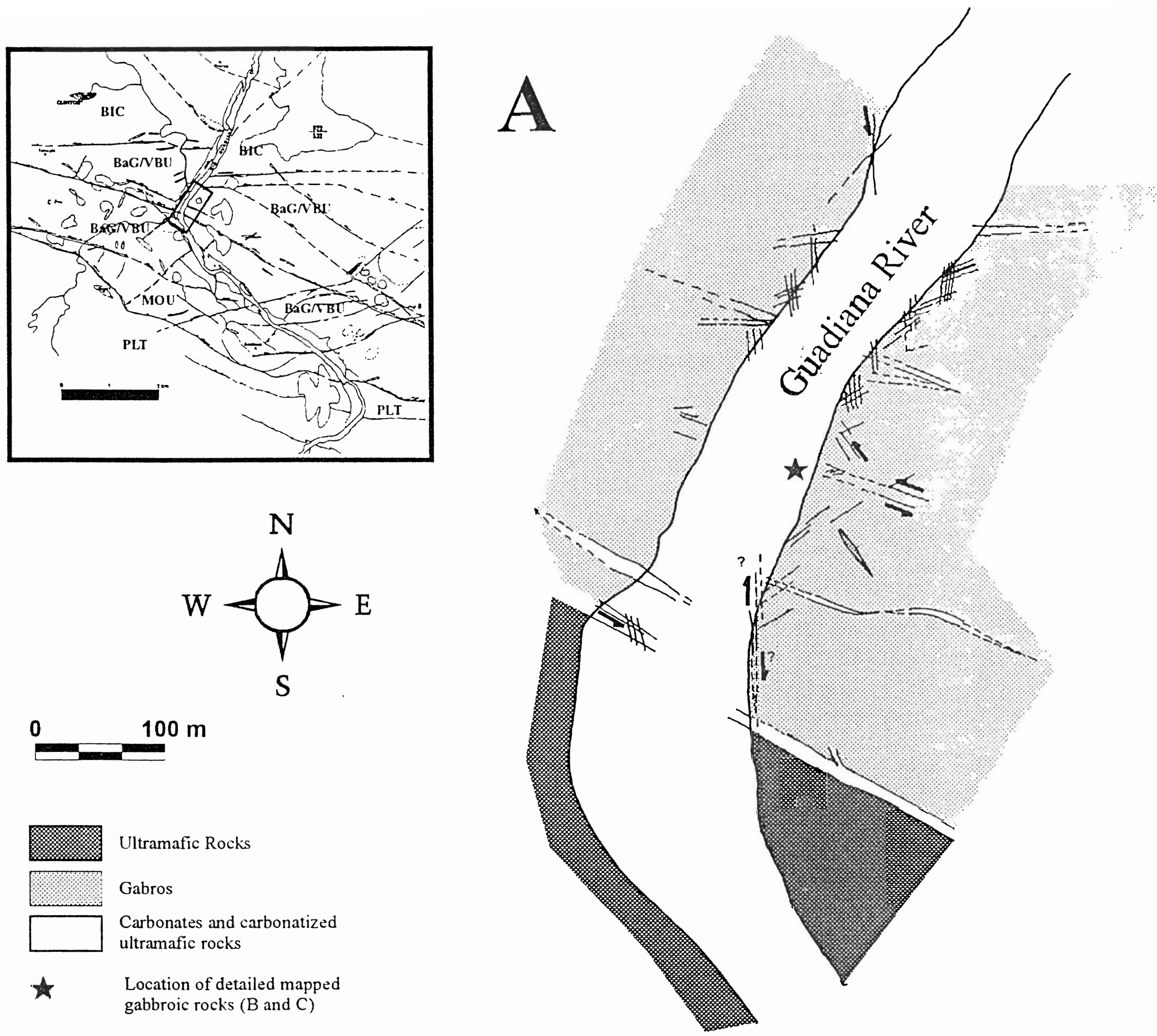
The present work is a preliminary report on results obtained from the gabbroic rocks of the Beja Acebuches Ophiolitic Complex (B.A.O.C.) at the Guadiana Valley (Barranco da Gravia Unit), and presents a microstructural analysis of features originated by the earlier events of deformation affecting this meta- and flaser gabbros as well as plagiogranites (Quesada *et al.*, 1994).

The studied gabbroic rocks are located in the Moinho dos Machadinhos area at the margins of the Guadiana River (Fig. 1A). This area shows a predominantly reverse left-lateral shear zone striking WNW-ESE and dipping North associated to polyphasic carbonate-silica precipitates and metasomatized basic and ultrabasic rocks. This structure brings to contact serpentinized ultrabasic rocks to the South and gabbroic rocks to the North. The detailed mapping of some gabbroic outcrops (1/10 scale), as well as a reconnaissance of the surrounding areas revealed a complex network of shear zones which can be preliminary assigned to the different deformation phases previously identified in the B.A.O.C. (Quesada *et al.*, 1994).

The events related to the late-D_2/D_3 deformation phases are the best preserved in the area, as can be seen along the Guadiana River, and comprise mainly brittle to semi-brittle ENE-WSW shears, especially to the North. This system clearly post-dates the development of N120 shears subparallel to the major WNW-ESE shear zones, but is earlier than their late reactivation as left-lateral shears. A right-lateral N-S shear system seems to be the latest expression of the deformation in the area. In zones of excellent exposure, it can be shown that there is a deformation continuum between all these events which gives rise to a complex geometry of ductile shear zones (Figs. 1B and 1C), closely associated to severe mineralogical transformations experienced by the gabbroic rocks. In fact, the development of large crystals of amphibole and plagioclase, with or without precipitation of quartz, is restricted to these shears, which in turn record the several events of the D_2 deformation phase (Fig. 1D). Of particular interest is the importance of the early-D_2 NNW-SSE left-lateral shear zones which, most probably, lead to the development of the earlier microstructures observed, and of several right-lateral D_2 ENE-WSW shears (Fig. 1B) and their N-S conjugates, locally marked by mylonitic structures (Fig. 1C).

The examined rocks have a primary gabbroic nature and comprise predominantly plagioclase (often zoned crystals) and variable contents of amphibole, quartz, chlorite (sometimes after amphibole), carbonate, ilmenite, and sparse relics of metasomatized pyroxene. Usually they show a granoblastic texture with local variations resulting from the presence of subidioblastic amphibole (which often display a decussate texture), and from the mineralogical responses to successive metasomatic events that modify (sometimes severely) primary relationships; relics of flaser textures can also be observed in some samples. Detailed characterization of the available samples reveals that an important metasomatic event of relatively high temperature (probably synchronous of amphibolitic facies conditions at the B.A.O.C.) is responsible for the strong alteration of pyroxene, late non-twinned plagioclase coronas development around primary plagioclase, and interstitial deposition of quartz, as well as discordant amphibole aggregates. This most important fluid influx into the gabbroic rocks was preceded by an earlier deformation phase, occurred under T/T_M ratios higher than 0.3 and favouring plastic yielding of plagioclase. This yielding lead to the overall granoblastic texture observed, which is mainly the result of interlocking plagioclase irregular/equigranular crystals that display rare serrated boundaries and a moderate to strong intracrystalline deformation inferred from the presence of bent or kinked twin lamellae, deformation bands and wavy extinction; the ubiquitous twinned crystals show also periodic to quasi-periodic exsolution lamellae substructures (segregation bands). The mechanical origin of the plagioclase twins is clearly demonstrated by: i) the lenticular shape of most lamellae, wedging out within the grains; ii) the occasional development of twin lamellae restricted to



B

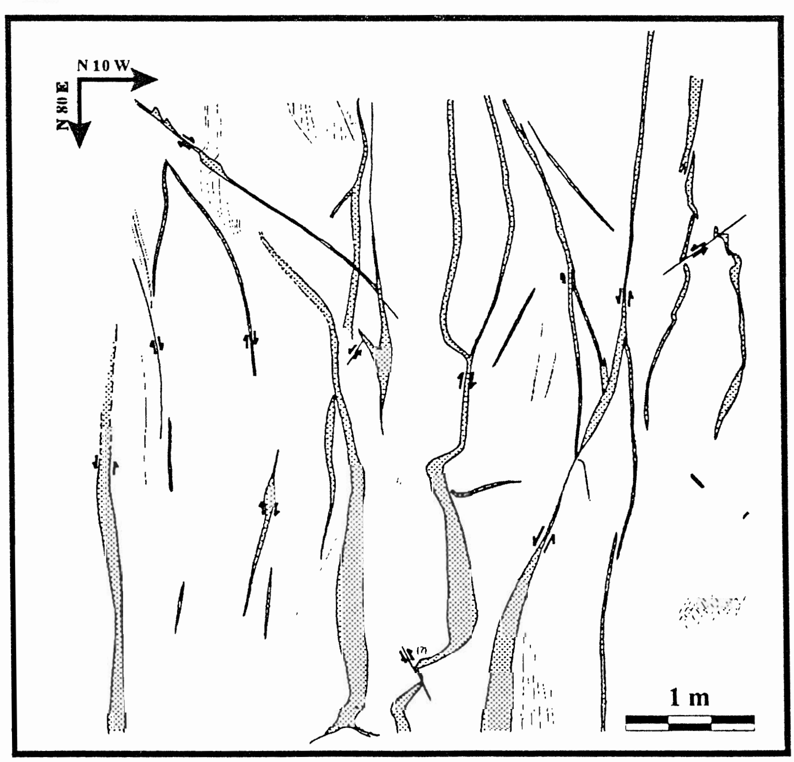
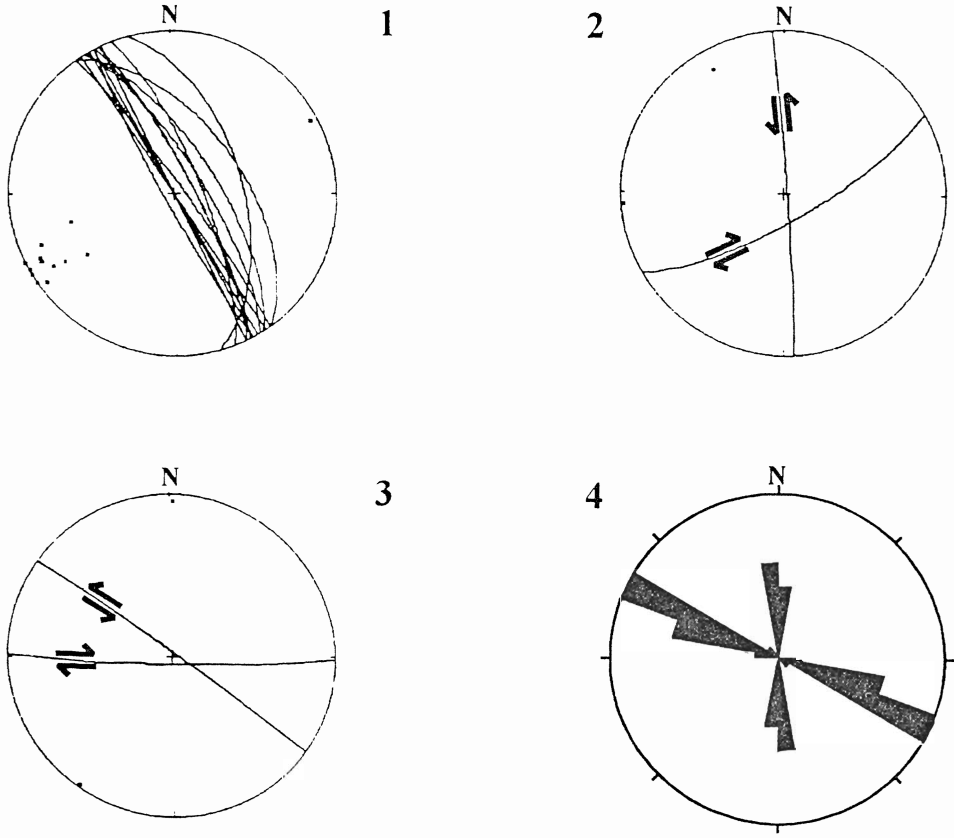


Figure 1. A: Location map of the Moinho dos Machadinhos area (inset) and the respective detailed map; **BIC:** Beja Igneous Complex. **BaG/VBU:** Barranco da Gravia and Vau de Baixo Units. **MOU:** Moinho da Ordem Unit. and **PLT:** Pulo do Lobo Terrane. **B and C:** Detailed maps of the studied gabbroic roks showing the main shear zones (in C the location of the samples is also shown). **D:** Stereograms and rose diagram of the main structures observed in the gabbroic rocks; **1:** stereogram with the earlier D_2 left shear structures (n=13); **2:** stereogram with the combined left and right shears (post quartz precipitation; see text). considering the mean planes of each family - N176. 88E (n=6) and N60. 76S (n=33) respectively; **3:** stereogram with the combined left and right late D_2 shears considering the mean planes of each family - N126. 88N (n=18) and N91. 86S (n=43) respectively; **4:** rose diagram showing the main directions of the later shear zones (no dip available) - N-S right-lateral shears (n=14) and WNW-ESE left-lateral shears (n=27).

D



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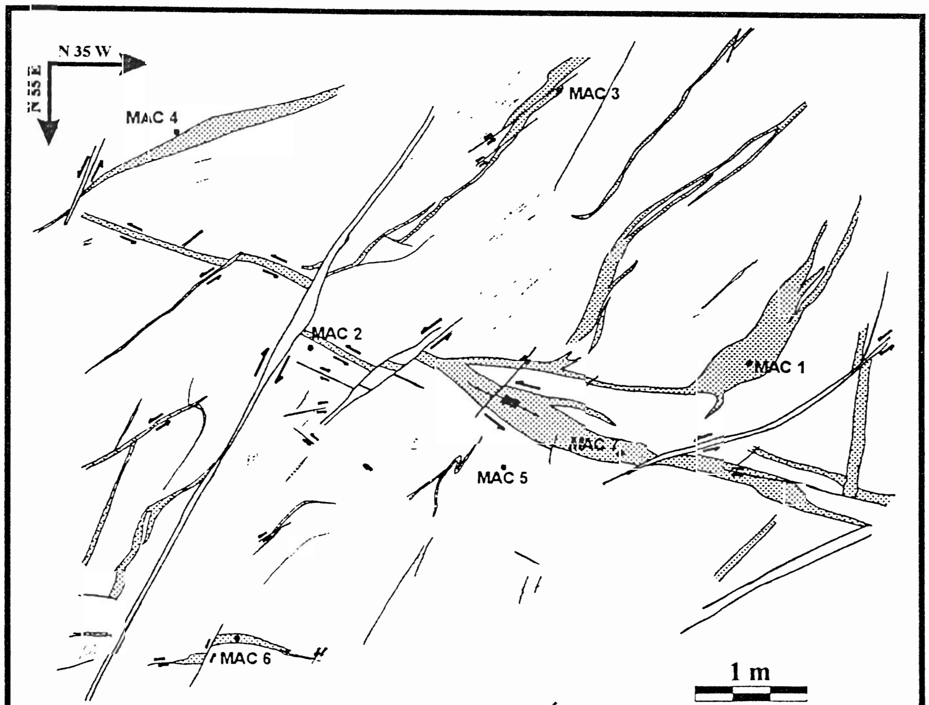

marginal areas, especially in boundary domains where stress concentration might be expected; and iii) the spatial coexistence with other optical features or microstructures due to intracrystalline plastic strain. Two different twinning laws are observed; from the published data set on plagioclase we expect them to be the albite and pericline laws. If, as usual, the albite law predominates over the pericline law, then mechanisms involving dislocation pile-ups on (010) slip planes would have been favoured, since the albite and pericline laws require almost the same amount of macroscopic shear deformation, and there is no reason to admit a primary preferred orientation of the crystals (or an inhomogeneous global chemical composition of the plagioclase). There is no evidence for subgrain development. Recrystallized annealed grains seem also to be absent. Therefore, one may conclude that the temperatures under which the earlier deformation phase took place did not favour either the recovery mechanisms of plagioclase (promoted by the stability of intermediate disordered structures), or the chemical nucleation of deformation-free crystals accomplished by strain enhanced diffusion rates during late (after deformation), static recrystallization processes. For these reasons, a relatively dry environment and minimum temperatures ranging from 550 to 600°C may be inferred; these temperatures did not prevail enough time for significant boundary diffusion leading to static recrystallization.

The genesis of the mapped semi-ductile - semi-brittle shears occurred after the above mentioned metasomatic event. Within these structural corridors that sometimes comprise relics of mylonite rocks, trending N-S, the brittle behaviour of plagioclase crystals contrasting with plastic deformation and dynamic recrystallization of quartz aggregates, indicates a most probable temperature of 350-400°C; local fluid inflows, coeval with or later than the strain accommodation (via geometrical or chemical softening) trigger plagioclase saussuritization and quartz + chlorite deposition. Within the mylonitic rocks the presence of asymmetric sigma structures enabled the determination of a left sense of shear, therefore relating these structures with the N-S D_2 shears observed macroscopically. Subsequent reactivation of these shear zones under temperatures below 300°C enables the development of microstructures typical of brittle regime. Most of these structures are fractures filled by chlorite ± carbonate and sometimes by an unidentified mineral; they show a wide range of directions which makes it difficult to relate them unambiguously with the late fractures and shears macroscopically observed. The ENE-WSW striking fractures are responsible for local development of cataclasis in several plagioclase crystals, although the shear sense was not determined; the NE-SW fractures show left sense of shear which is also indicated by the development of *en échelon* tension gashes in some plagioclase crystals; finally, a set of N-S fractures are observed with no remarkable microstructures present.

Acknowledgments

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