PERGAMON

Journal of Structural Geology 25 (2003) 409–420

JOURNAL OF STRUCTURAL GEOLOGY

www.elsevier.com/locate/jsg

Rheologically induced structural anomalies in transpressive regimes

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Received 20 December 2000; received in revised form 7 March 2002; accepted 15 March 2002

Abstract

Local structural anomalies are sometimes found in transpressive regimes. They can be related to strain partitioning processes but in some cases other types of heterogeneities could affect the deformation style. This paper shows that rheological heterogeneities can radically influence the geometry of faults in transpression zones and cause them to be markedly non-planar.

In the Marão region of northern Portugal, a zone in which Variscan structures are SW-facing is found within the regional NE-facing geometry. This anomaly is adjacent to a complex shear zone (Mina/Ribeira das Cestas) where the fault plane is curved; however the surrounding material does not show any signs of a related folding event. Detailed field studies, mainly concerning the rheological contrasts between the deformed lithostratigraphic units, show a close relationship between the structural anomaly and the movement along rheological anisotropies. These observations, complemented by experimental deformation of multilayers composed of analogue materials, allow the construction of a generic model.

Strain partitioning during the initial stage of the sinistral transpressive Variscan deformation produced the juxtaposition of lithostratigraphic units with strongly different rheological contrasts. Subsequent flattening deformation induced heterogeneous indentation phenomena, producing the non-planar geometry of the complex shear zone. The structural heterogeneities caused could have an important role in the evolution of a transpressive domain.

Keywords: Variscides; Transpression; Wedge; Rheology; Heterogeneities; Analogue modelling

1. Introduction

Transpressive regimes are inevitable in plate tectonics. Irregular lithospheric plates moving on a spherical Earth should produce oblique collisions (Harland, 1971).

The geometry and kinematics of structures developed within transpression zones are often not homogeneous. Heterogeneous behaviour has frequently been described as the result of strain partitioning along planar anisotropies (e.g. Oldow et al., 1990; Richard and Cobbold, 1990; Holdsworth and Strachan, 1991; Cashman et al., 1992; Pinet and Cobbold, 1992; Jones and Tanner, 1995; Goodwin and Williams, 1996; Curtis, 1997; Lallemant, 1997; Barnes et al., 1998; Dewey et al., 1998; Lee et al., 1998; Prosser, 1998; Lallemand et al., 1999). A very different type of structural heterogeneity can occur during transpressional deformation of multilayers in which mechanical anisotropy can greatly influence the geometry of related structures, a situation already referred to by Harland (1971, pp. 32–33). Such processes could produce a tectonic style in the vicinity of the discontinuities that strongly contrasts with structures developed in the surrounding regions. This shows that adjacent sectors did not share a common deformation path.

The heterogeneity of mechanical properties of deformed multilayers has been previously used to explain localised structures that differ from the regional structural pattern, not only in the folded thrusts of the Jura Mountains (Laubscher, 1977) but also in fault-related folds (Muraoka and Kamata, 1983; Dominic and McConnell, 1994). This paper analyses a similar situation in the Iberian Variscan Fold Belt, where the mechanical behaviour between different structural lithic units plays a major role during progressive deformation in a sinistral transpressive regime.

2. Geological setting

The Variscan orogeny is a dextral transpressive fold belt caused by the oblique closure of the Rheic Ocean between

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PII: S0191-8141(02)00043-3