Journal of Structural Geology 32 (2010) 725–726

Contents lists available at ScienceDirect

Journal of Structural Geology

journal homepage: www.elsevier.com/locate/jsg

Photograph of the Month: Flexural slip folding of foresets in cross-bedded sandstones

Photograph F. Bastida ©F. Bastida

It is well known that the strains due to folding of bedded rocks can lead to the geometrical modification of sedimentary structures. Cross-bedding is a sedimentary structure that consists of a set of surfaces inclined to the main surface of sedimentation. These oblique surfaces or foresets have angles of inclination governed by the critical angle of rest of the sand when it was deposited. Foresets are usually bounded on their upper side by a truncation surface produced by erosion.

In deformed rocks the inclination angles of foresets can be modified by the effect of strains associated with folding. Modelling of the effects of fold strains on these angles around individual folds suggests that pattern of variation of the angles of obliquity of foresets may permit the identification of the folding mechanism (Ramsay, 1967, p. 491–517, Bobillo-Ares et al., in press). These models assume that the foresets deform as mechanically passive planar markers.

The folded cross-bedding in the photograph is seen in a loose boulder at the harbour at Burela, Galicia, Spain though the identical structure is also seen in situ in the cliffs. The photo shows foreset angles that vary across the fold with the largest angles seen on the left limb. In fact, locally on this limb the foresets are themselves folded, producing angles with the main bedding that exceed 90° (i.e. overturned foresets) in this two dimensional section. Although overturning of this kind observed in other regions have been attributed to deformation of a liquefied sand by current drag (Allen and Banks, 1972), water escape during fluidization (Owen, 1995) or synsedimentary slumping, the evidence here points to tectonic folding of the foresets. This evidence consists of the stepped geometry of the erosion surface above the overturned foresets. The sense of the steps is consistent with the flexural slip folds within the coset on the left limb of the main fold. The operation of this mechanism points to a non-passive mechanical behaviour of the foresets during folding. It appears that slip is concentrated at the top of individual foresets where the sandstone is darker and more micaceous. The folding instability of these cross-beds may in part be due to the initial concave-upwards curvature of these cross-beds.

We are grateful to Miguel Gutiérrez-Medina, Carlos López-Fernández, David Pedreira and Josep Poblet for organizing the excellent YORGET fieldtrip to Galicia in July 2008.

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0191-8141/$ – see front matter
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11 October 2008
Available online 22 May 2009