Erosion influence on the evolution of compressive system constrained by analogue modelling

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Introduction

In the last decade, the relations between mass transfer, climate and deformation have been studied at orogenic scale (Molnar y England, 1990; Beaumont et al., 1992; Zeitler et al., 1991; Avouac y Burov, 1996; Willett, 1999; Montgomery, 2001; Lamb y Davis, 2003), and structures scale (Colleta et al., 1991; Cobbold et al. 1993, Mugnier et al. 1997). The effect of synkinematic mass transfer in front of compressive systems has been recently studied using experimental or numerical modelling (Storti & McClay 1995; Hardy et al. 1998; Nalpas et al. 1999; Leturmy et al. 2000; Bonini 2001, Casas et al. 2001; Barrier et al. 2002, Nalpas et al., 2003). A major outcome of these works is that high sedimentation rates in front of a compressive structure favours steepening of active thrusts.

The aim of this study is to understand the role of erosion in the evolution of compressive system at upper crustal scale using analogue modelling which present variations in the spatial repartition of erosion.

Analogue modelling – Experimental procedure

The modelling techniques used are similar to those usually applied in experiments on brittle systems at the Laboratory of Experimental Tectonics of the Geosciences department, Rennes University, and have been described in previous studies (e.g. Faugère and Brun, 1984; Vendeville et al., 1987). Dry quartz sand with an angle of internal friction close to 30°, and a density of about 1400 kg/ m^3 was used to model the brittle behaviour. The experiment was constructed on a table with a mobile wall pushed by a screw jack driven at constant velocity (2 cm/hr) by a stepper motor (Fig. 1).

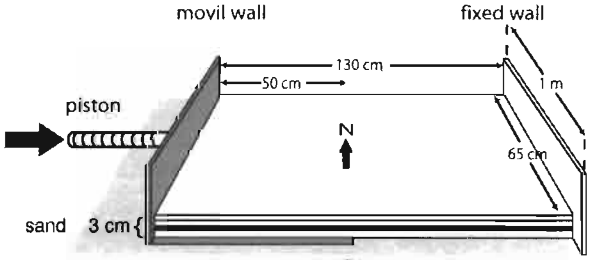


Figure 1: Experimental modelling apparatus.

The dimensions of the experiment are sufficiently large to ensure that a large part of the model escapes boundary effects. Attached to the mobile wall, was a horizontal rigid sheet, which created a linear velocity discontinuity at the limit of the sheet at the base of the experiment (cf. Malavielle, 1984; Allemand et al., 1989; Nalpas et al., 2003). The models consisted of 3 cm-thick sand layer. Experiments were carried out in the Laboratory of Analogue Deformation at the department of Geology, University of Chile. The sand pack was made of thin alternating coloured layers, which allow the identification of faults and folds on cross-sections. The erosion of very fine layers of sand is carried out regularly using a vacuum cleaner. During experiments, photographs of the surface of models were taken at regular time intervals to study the progressive evolution of structures (Fig. 2). At the end of each experiment, the geometry of structures and their changes along strike were observed on serial cross-sections.

Results

For purposes of description deformation features are referenced by an arbitrary cardinal system, with N pointing to the top in figures 2 and 3.

Development of the experiment without erosion: the beginning of the deformation took place when completing the first centimetre of shortening, at this moment two faults of opposite sense are created forming a pop-up symmetrical with respect to the edge of the movable plate. After the formation of the pop-up, the shortening is concentrated in the antithetic main fault, of West vergency. With the development of this antithetic fault the system became asymmetric, causing a series of synthetic transitory secondary faults, of East vergency. The permanent activity of the main fault generates an important rise in the zone on the DV. The increase of the shortening forms new systems of faults of pop-up in direction of the East.

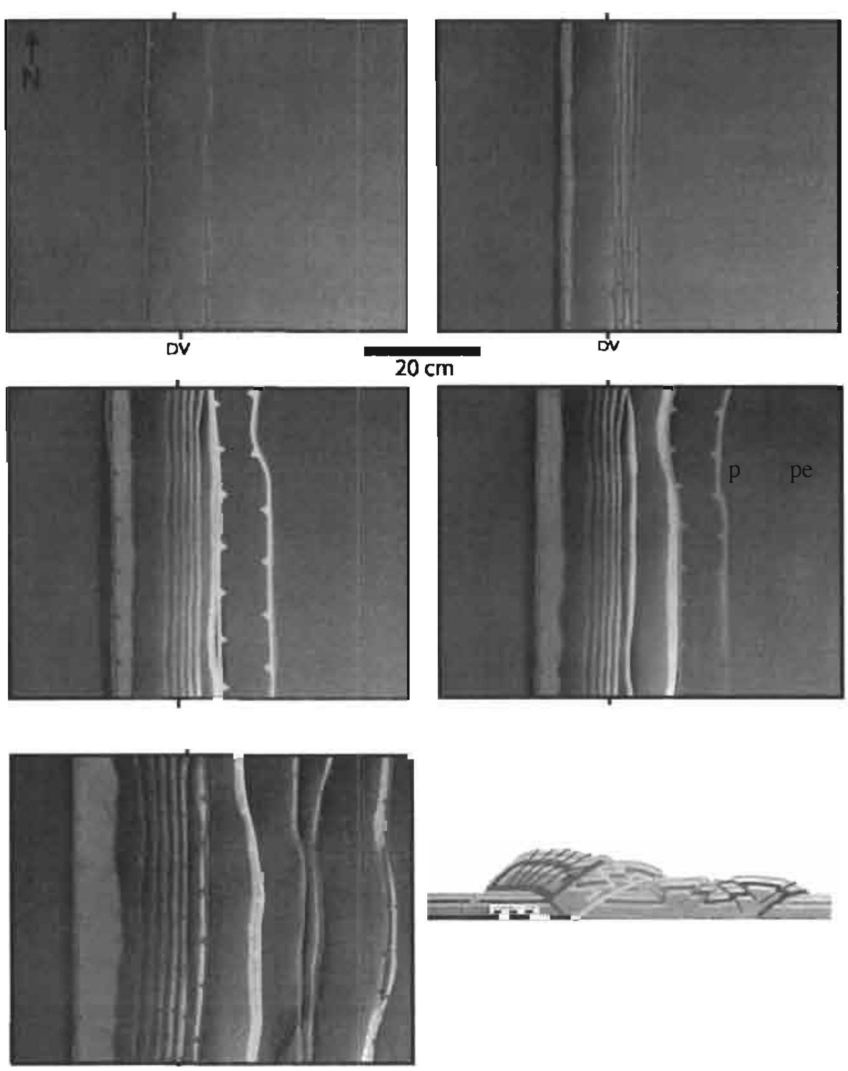
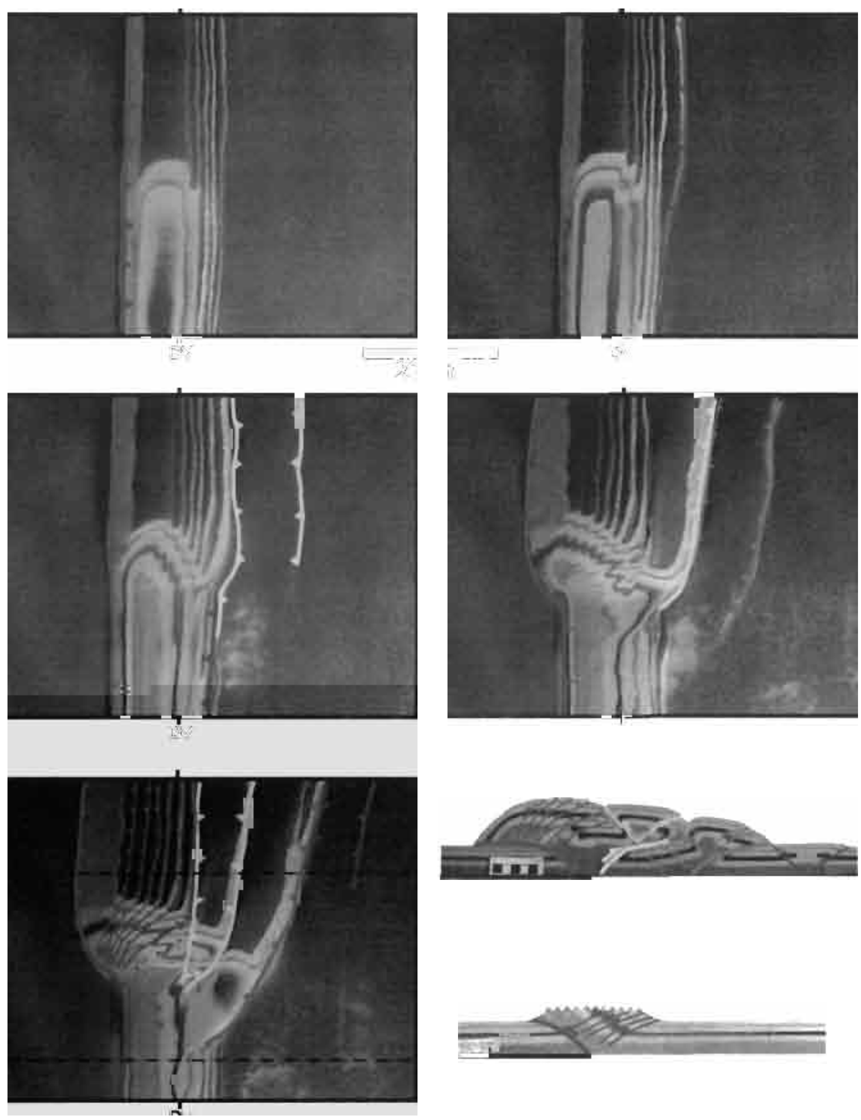


Figure 2: Surface views and cross-section of experiment without erosion.

In synthesis in the East-West profile the four systems of d bl th mf | d



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