FAULT REACTIVATION IN THE ESPINAL BLOCK, COLOMBIA

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INTRODUCTION

The Magdalena valley and the Eastern Cordillera represent, to varying intensities, an inverted Mesozoic rift system. The inversion has been achieved by extensional fault reactivation and back rotation. The rift system runs approximately NE-SW, coincident with the Carboniferous Caledonian collisional fabric.

Two stages of fault reactivation are apparent, namely the Permian to Jurassic extensional reactivation of the Caledonian fabric, recorded in the syn-rift deposits, and the Cenozoic compressional reactivation of this extension which is recorded in numerous inversion structures. This is an example of the positive feedback process that often occurs in continental reactivation. The Espinal block provides a clear example of the inversion (Fig.1).

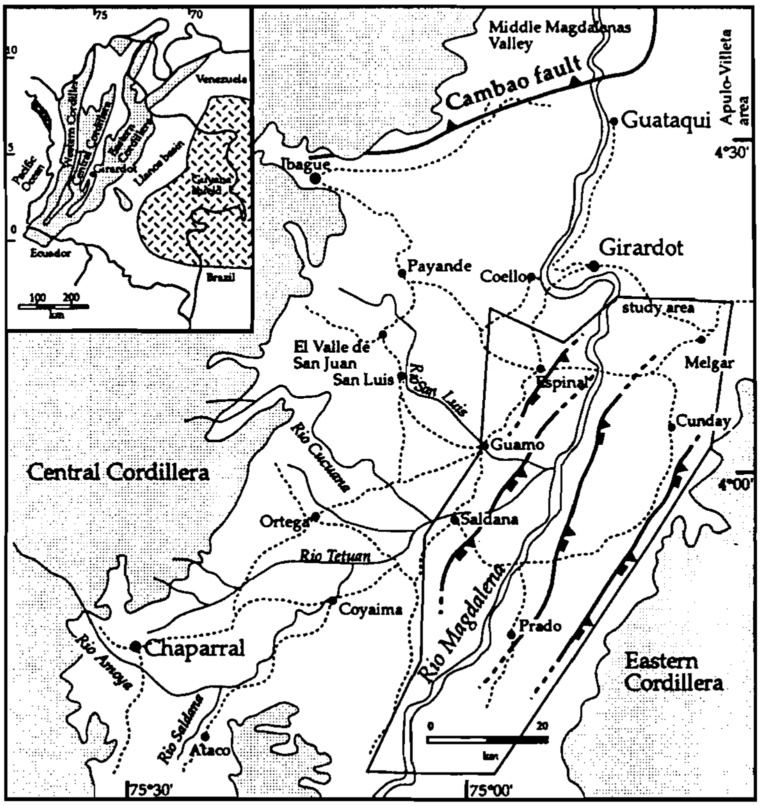

Fig.1 Location of study area showing the trend of the inverted extensional faults. Base map modified from Barrio and Coffield 1992

CHRONOLOGY OF INVERSION

A late Palaeocene to early Eocene series of thrusts has imbricated the Villeta, Guadalupe and Guadas formations and has then been erosionally truncated. It is postulated that these imbricates represent the tip of a gravitationally driven detachment forming at the base of the thick overpressured shale formation, the Villeta (Fig.2). Deformation at this time was mainly restricted to the Western and Central Cordilleras and is driven by the highly oblique dextral accretion of the Western Cordillera to Colombia. It is thought that a minor uplift of the Eastern Cordillera occurred during this time, for the following reasons. With convergence rates of around 200mm/yr (Daly 1989) and taking a force balance approach (McCaffrey 1992) dextral motions in southern Colombia of approximately 125mm/yr would have to be accommodated there. Due to the curvature of the Colombian margin the obliquity (the angle between the trench normal and convergence direction) rapidly decreases at 4^0N, the same latitude as the Espinal block; As a result no dextral motion would be expected in Northern Colombia the oblique convergence being accommodated in the subduction zone. This would cause a very high stress gradient around 4^0N and this may have driven an early, minor uplift of the Eastern Cordillera producing enough of a gravitational potential to cause slip along an overpressured horizon. This stress has also driven the oblique reactivation of the most westerly Jurassic fault that is included in the area of study (Fig.1). This has folded the syn-rift deposits producing a doubly plunging anticline which has been erosionally truncated, with the imbricate slip system, in the Late Palaeocene/Eocene.

The areas central extensional fault is reactivated in the Mid-Eocene producing a prominent inversion anticline, folding of the earlier imbricates and thrusting in the Cretaceous/Palaeocene post-rift and was active until the beginning of the Miocene (Fig.3). Reactivation of this steep primary fault is an effective way of producing vertical motion but not horizontal shortening. This has led to the formation of a footwall propagating shortcut thrust that is kinematically and mechanically more favourable for accommodating large scale horizontal displacement. An imbricate of the shortcut thrust active during the Oligocene has caused the uplift and erosion of growth and pre-growth strata (the Doima, Porterillo and Chicoral formations, the Gualanday group) producing a mid/late Oligocene unconformity. This shows that the fold growth rate was much greater than the sedimentation rate. Deeper footwall shortcuts have propagated along the decollement horizon that exists at the stratigraphic and mechanical boundary of the Villeta shales and the underlying Caballos quartzarenite-conglomerates. This has produced fault propagation folding during the early/mid-Miocene, folding the Cira and Honda formations and refolding the Gualanday group. A dimensionless growth rate (Suppe et al 1990) of 0.56 indicates that sedimentation rates in the fluvial Honda formation were high compared to the rate of fold growth. The absolute growth rate is unknown as stratigraphic horizons have not been accurately dated.

Folding of the Eocene imbricate system has inhibited the easy movement along it so that when the third and most easterly extensional fault is reactivated in the Late Miocene/Pliocene the motion was accommodated by the development of large overthrusting (Fig.4). The displacement on the overthrust would be the sum of the displacement on the inverted extensional fault (A) and the early Eocene slip plane (B). However, minor reactivation of the earlier imbricates has occurred tilting the Miocene strata so the overthrust displacement would in fact underestimate the motion on the extensional fault and slip plane. Reactivation of the extensional fault has folded the slip plane in this region so that it would now act as a buffer to strain propagation hence raising the possibility that overthrusting will occur in the region of this perturbation if another fault reactivated to the east.

CONCLUSIONS

The Espinal block provides an excellent example of the intimate relationship between the Mesozoic rift system and the subsequent Andean deformation as the extensional faults have been sequentially inverted from west to east. The study area may also indicate a Palaeocene uplift of the Eastern Cordillera that should be looked for elsewhere.

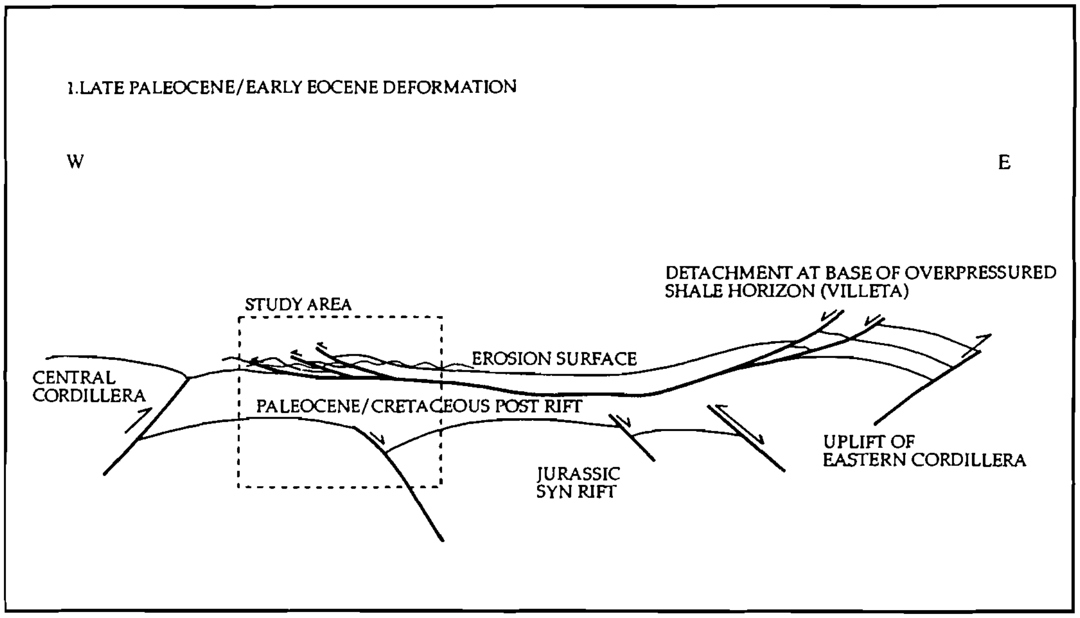

Fig.2 Phase 1- Detachment at base of Villeta driven by Eastern Cordillera uplift

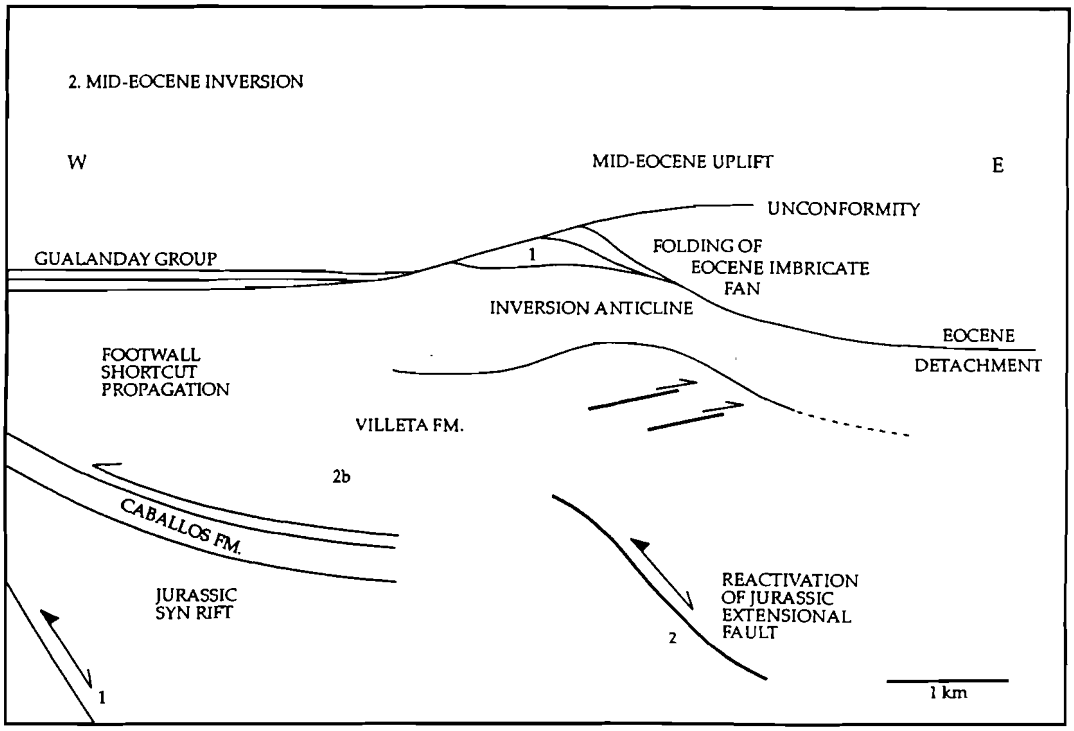

Fig.3 Phase 2- Reactivation of extensional fault
Phase 2b- Propagation of footwall shortcut along tilted Caballos/Villeta boundary. Tilting was driven by Phase 1 reactivation of westerly extensional fault

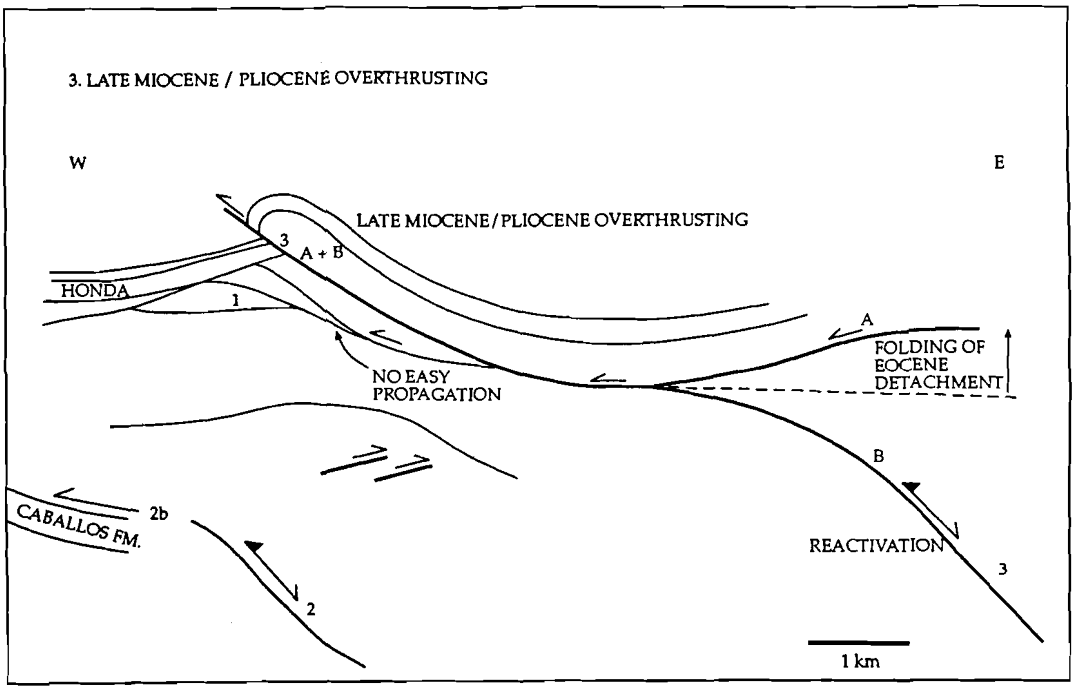

Fig.4 Phase 3-Reactivation of easterly fault drove overthrusting and folded earlier Villeta detachment

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