Alternate Fault Activity at Oil Field and Basin Scale, Analogy with Outcrops and with Seismicity Patterns*

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Abstract

Alternate fault activity is a very common phenomenon that can be vital in understanding fault geometries and timing of activity, their importance in controlling sedimentation and the location of the next structural closure to be drilled. Evidence of such alternate fault activity will be shown at oil field and basin scale; analogy and mechanism will be evidenced from outcrop exposures and from seismicity pattern through time. Canadian analogues will be mentioned when not of exploration significance. All cases invoke a direction of maximum stress oblique to the preexisting fault system. Creation of new faults seems to coincide with the time of switch between active fault systems.

Introduction

The oil field example will review the sedimentation of the Brent Group in the Tern Field and the faults that are alternatively controlling deposition of these sediments (Figure 1 and Figure 2). Similarity will be drawn to the structural evolution of the Baram delta between the Jerudong and Baram faults (Brunei/Sarawak) and to the Maracaibo and Norte Monagas Basin evolution during the Cenozoic.

The last series of examples will focus on the New Madrid Seismic Zone (US) with a 4D view of the recent alternate fault activity (earthquakes) and the major shift of sedimentation every 400 years, linked to switching between the two dominant fault systems. Canadian analogues will be mentioned when not of exploration significance. All cases invoke a direction of maximum stress oblique to the preexisting fault system (Figure 3). Creation of new faults seems to coincide with the time of switch between active fault systems.

Observations from two outcrop analogues (Ecuador (Figure 4) and Sarawak) will outline alternate motion between vertical faults and horizontal detachments that will be complemented by a 4D view of the earthquakes associated with the Tsunami of December 26, 2004, when three main fault systems are successively/alternatively active.

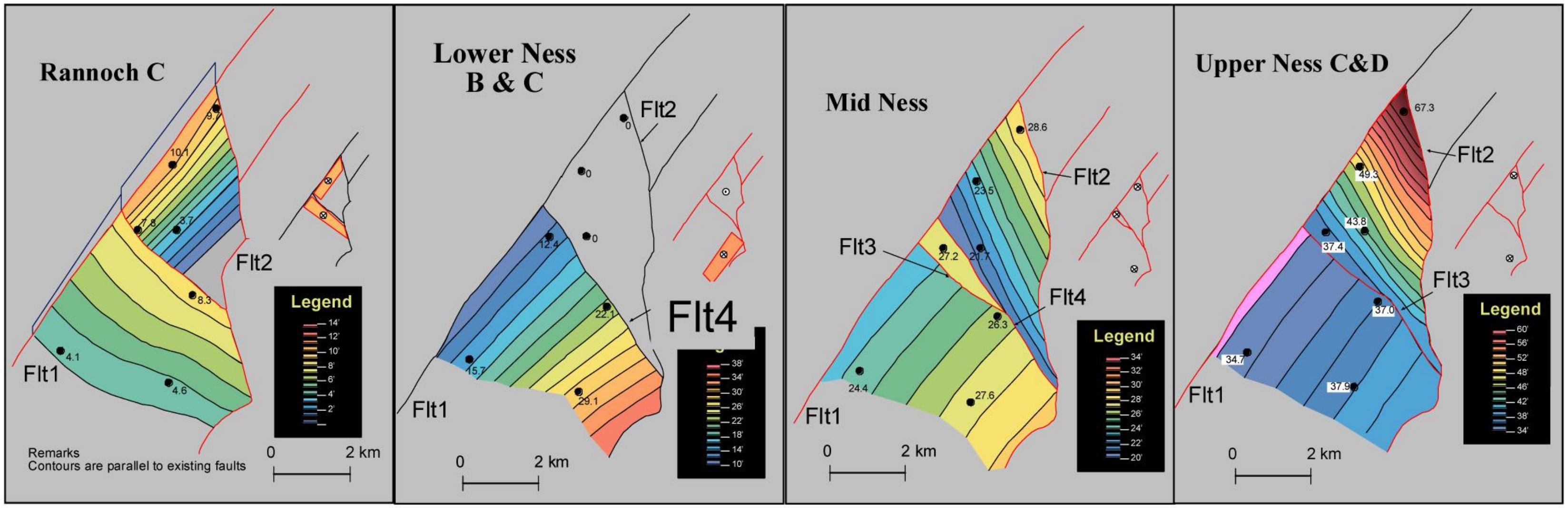

Figure 1. A selection of views through time showing different faults controlling the sedimentation in the Tern Field (Northern North Sea).

Lithostratigraphy			Depositional Environment	Active faults within the Tern Field
Brent Group	**Tarbert**		Shallow Marine	
	Ness	Upper	Flood Plain	Flt 3
		Middle	Open lagoonal/ lacustrine	Flt 3 & Flt 4
		Lower	Back Barrier / Lagoon	Flt 4
	Etive		Barrier	Sedimentation too thick to tell
	Rannoch	a = Upper	Upper shoreface	Flt 3
		b = Middle	Middle Shoreface	
		c = Lower	Lower Shoreface	
Dunlin Group	**Broom**		Fan Delta	No Fault control
	Drake		Marine	

Figure 2. Alternate fault control of the Jurassic sedimentation in the Tern Field (Northern North Sea).

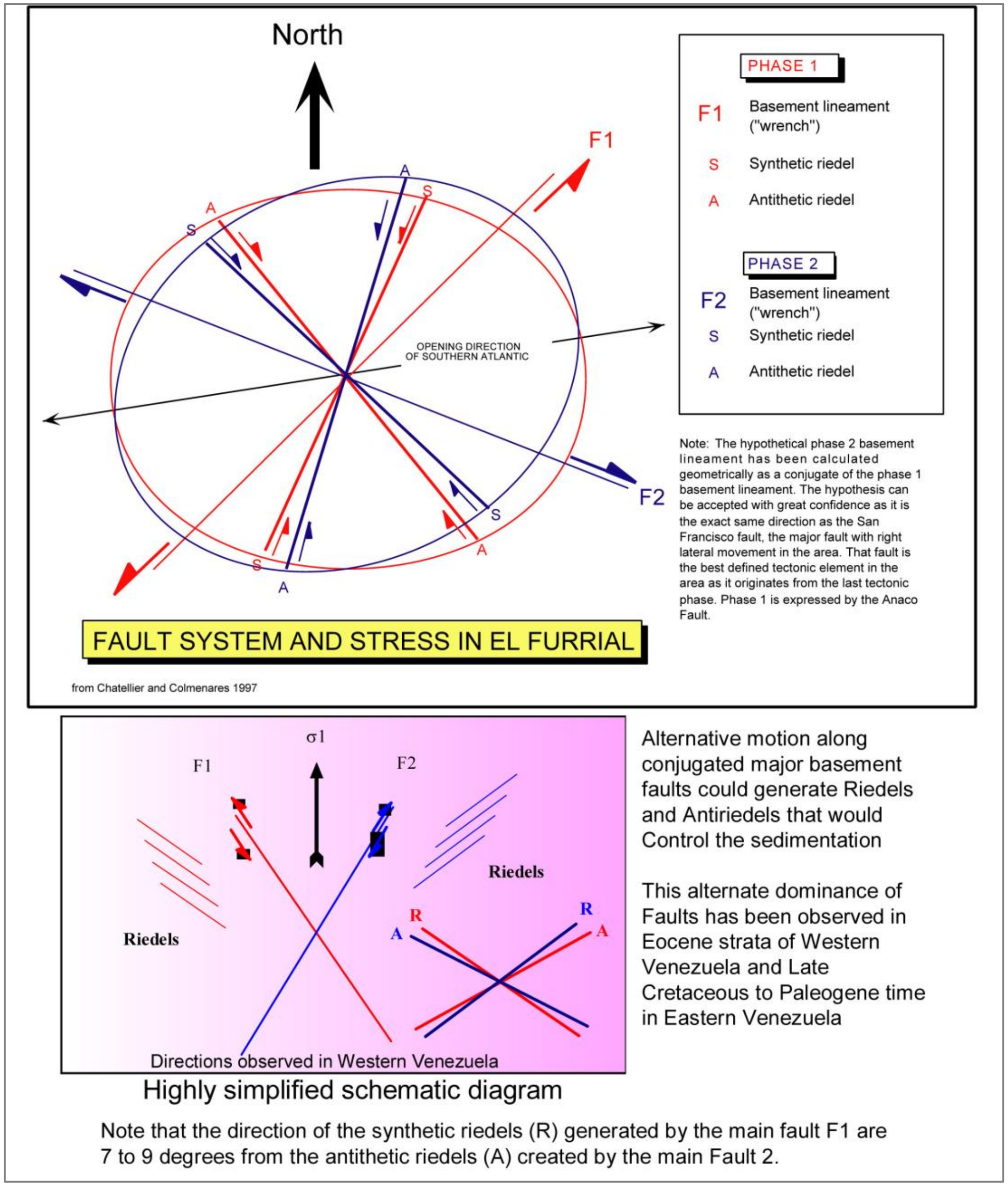

Figure 3. Compilation of fault types and directions associated with alternate dominance and activity.

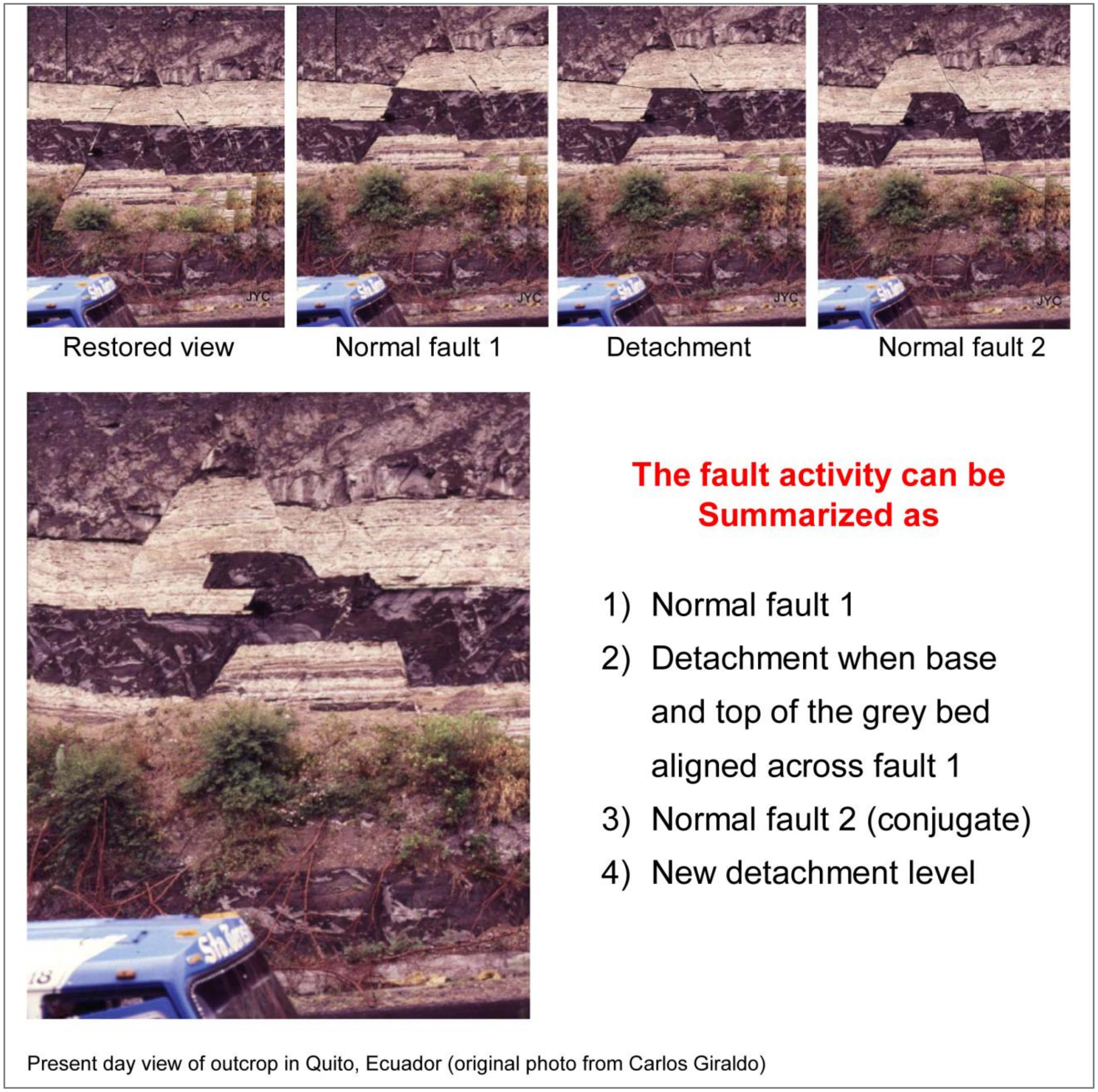

Figure 4. Geometrical complexity associated with alternate fault activity – outcrop view and reconstruction.