AAPG Datapages/Search and Discovery Article #90253 © 2016, AAPG Asia Pacific Region, Geosciences Technology Workshop, Characterization of Asian Hydrocarbon Reservoirs, Bangkok, Thailand, March 31 - April 1, 2016

Origins, Descriptions, and Prediction of Complex Fault Patterns in the Cenozoic Rifts of Thailand

Chris K. Morley[1]

[1]Department of Geological Sciences, Chiang Mai University, Chiang Mai, Thailand (chrissmorley@gmail.com)

Abstract

Commonly in the Cenozoic basins of Thailand fault patterns are complex due to a variety of factors including local spatial rotation of stresses, stress rotation with time during multi-phase rifting, and the effects of inherited fabrics either from the pre-rift section, or from earlier rift phases. Fault geometries are affected at the regional to the field scale. The variations in geometries are seen as changes in fault dip amount, preferred dip direction, how faults link, fault orientation, displacement characteristics, and in transfer zone geometries. Within reservoirs, the main effects of faults are to act as partial, temporary or permanent barriers to fluid flow. Hence, faults can affect the direction of maximum permeability and cause compartmentalization of fluids, and formation fluid pressures. Consequently understanding the sealing properties of fault zones is important at the reservoir scale. This not only includes determination of classic fault seal parameters, but also understanding the location of potential leakage points, for example the distribution of relatively small-scale relay ramps, and other soft fault linkage geometries. Syn-depositional faults may also affect reservoir thickness and facies distribution. At the seismic scale very careful mapping and good quality 3D seismic data maybe required to have a realistic possibility of unlocking some of the complex fault geometries that exist at the reservoir and field scale. At the sub-seismic scale, predictions of fault characteristics rely on assumptions of the fractal nature of fault populations. This assumption may work for simple fault systems, but in more complex fault systems, the sub-seismic scale faults may be different from those observed at the seismic scale. There are a number of ways of representing geometric differences between fault systems, the simplest using steronets and rose diagrams; others include log-log plots of fault length-displacement, displacement-fault zone thickness, and cumulative number-length ratios. An emerging technique is the description of the topological variations in fault and fracture networks. 2D, map-view topological analysis of 10 natural rifts in Thailand and elsewhere, and two analogue fault networks is described. The fault arrays range from simple, low-displacement systems, to complex systems arising from multiple stages of deformation, or exhibiting complex local rotation of stresses. Classification of fault arrays was based on fracture terminations (I nodes), splaying/abutting join (Y nodes) and cross-cutting relationships (X-nodes), which permit relatively quick and simple ways of analyzing fault terminations and connectivity. Many of the fault networks are predominantly composed of I and Y nodes, with only a minor X node population. Subdividing Y-nodes into splaying (Y s) , abutting types (Y a) and cross-cutting types (Yc nodes) and displaying data on Ya, Ys, and Yc node triangular diagrams and generating equivalent networks defined by vertices and edges, provide additional ways of defining fault networks. Using one or two topological characteristics to define different networks characteristics the fault networks tend to fall into three broad groups (I, II, III) comprising simple, relatively immature fault systems (Group I), and two different types of complex fault system (II and III). When all the characteristics used are considered seven distinct types network can be identified. From the initial study topologically similar fault networks can be produced in a variety of ways (stress rotation with time, fabric inheritance, stress deflection) and cannot on their own discriminate between different mechanisms that cause complex normal fault geometries. Although with more examples, relationships may become more apparent. However, there is considerable utility in describing fault networks topologically, since they provide a basis for statistically controlling predicted fault and fracture populations in areas of low seismic data quality or resolution, or for determining fracture characteristics from core or outcrop.