# PSEUDO EN-ECHELON PATTERNS CAN MASK THE IMPORTANT STRIKE SLIP FAULTS

**Nasir Ahmad [1], Talat Qureshi [1], and Tariq Majeed Jaswal [2]**

[1]Eni Pakistan Limited, Karachi
[2]Pakistan Oilfields Limited

## ABSTRACT

Middle Indus Basin of Pakistan is well known gas prone area, witnessed by many producing fields. The area of study falls in south eastern part of basin and most of the discoveries in this part are made from structural-cum-stratigraphic reservoirs constrained by three way dip closure with one side bounded by strike-slip fault. Since the fault-trap integrity is critically important, therefore regional geomechanical model of the study area has due implications on local traps. Hence, fault-trap integrity is strongly influenced by the state of stress resolved on the reservoir bounding faults. Combining knowledge of the regional stress state with prospect level detailed representation of the reservoir-bounding faults from 3D seismic attribute data has provided an unprecedented opportunity to quantify the risk of these faults being critically-stressed or not.

The fault system with continuity in space and time, trending in NNW-SSE direction and is parallel to minimum horizontal stress ($SH_{min}$) i.e. ~$123^{o}$ - $130^{o}$ calculated for study area, has minimum seal failure risk. This system is proven to be sealing at Lower Goru E-Sand level of Cretaceous age. Consequently, the lateral continuity of the fault gains key importance in establishing traps integrity if proper risk quantification is done in regional prevailing stress regime. The challenge becomes even bigger where seismic data has low frequency content and/or poor-to-fair S/N ratio. It is evident from 3D seismic data that strike-slip fault vertical growth is supported by antithetic faulting which eventually evolved into en-echelon pattern at its crown. Also, seismic records stages of faulting through time and space. First, phase involved Basement-Chiltan-E-Sand level. Therefore, E-Sand on seismic attributes clearly portrays the en-echelon features representing fault crown of reservoir age. At places, where the data becomes week at E-Sand Reservoir which sits at an intermediate level in Lower Goru sand package, exhibits overriding en-echelon pattern towards main strike-slip fault whereby masking its continuity. This paper presents a method to establish whether the field bounding fault could be revealed confidently in the midst of extending en-echelon (splays) approaching towards it.

Riedel Shear (Y Shear) perpendicular to Principal Displacement Zone (PDZ or Y Shear) regime arranged in en echelon fault pattern, having relatively larger throws and therefore are prominent on seismic, while the main strike slip fault either show poor lateral continuity or completely masked by Y Shear. To resolve this issue a method adopted was to look for some strong reflectors above and below the main reservoir, and then run seismic attributes to these strong reflectors as well as of the main reservoir. This method worked very well in Middle Indus basin especially in Kadanwari gas field and Gambat Exploration License where the prospectivity was hampered by pseudo extension of en-echelon fault patterns. The method identifies obscured faults to be a continuous strike slip fault, and their existence has been proved by drilling results.