Integrating Structural Geology and GIS: Wrench Tectonics and Exploration Potential in the Eastern Sulaiman Fold Belt

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For the Eastern Sulaiman Fold Belt (SFB), available 2D seismic data, remote sensing data, digital elevation data, earthquake data, stress data and available geological maps were analysed using full visualisation and interpretation power of Geographic Information Systems (GIS) and in order to develop an integrated tectonic and structural model. Combined Landsat imageries and SRTM digital elevation data were utilized for fault & fracture identification and for geo-morphological analysis on different scales. Structural geologic interpretations were compared to published analogue sand-box models. The Eastern SFB is interpreted as a huge, elevated, wrench related, positive flower structure which is in contrast to earlier thin-skinned "passive roof complex" models. Terrain elevations are around 1500 meters, with rugged mountain peaks up to approximately 3000 meters. Four different structural domains can be differentiated by seismic and surface data: From NW to SE these are (1) SE-vergent, fold and high-angle reverse fault domain outside the wrench zone, (2) structural low area with NW-directed pop-up structures comprising the western branch of the flower structure, (3) highly uplifted central wrench corridor domain with large scale en-echelon folds, (4) frontal, SE-directed pop-up anticlines domain (Zinda-Pir trend) forming the eastern branch. All zones have their own tectonic style and associated trap, seal and reservoir potential.

Thick-skinned, SE-vergent folds and thrusts are present in the interior of the SFB whereas the eastern margin is dominated by the huge, over 300 km long transpressive left-lateral wrench system. Many 40-100 km long enechelon anticlines exist in the central wrench corridor comprising the structurally most uplifted and deformed zone, which must have acted as hydrocarbon accumulation area. Deeper Cretaceous, Jurassic and Triassic reservoir levels are the potential targets in this wrench zone. The western area (W of Kingri fault) is characterised by NW-vergent pop-up structures which represent the westernmost branch of the flower structure. The eastern branch of the wrench zone is defined by the Zinda-Pir anticline trend, including its en-echelon sub-anticlines, which form east-vergent pop-up structures. Crestal faults and fractures indicate strong left-lateral transpression. The existence of gas fields (Dhodak and Rhodo) in the young Zinda-Pir anticlinorium proves that charging is still ongoing. The predominance of high-angle reverse and strike-slip faults facilitate hydrocarbon migration and charging of traps. The doubly plunging en-echelon anticlines, related to transpression, provide 4-way closures. Transpressive shear caused increased fracture density in anticline cores – potentially increasing fracture porosity of the reservoirs, but also compromising on integrity of topseals.