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Drainage Network Response to Geological Structures: A Case Study of Joya Mair Oil Field (Pakistan)

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Abstract

The Joya Mair Oilfield is part of the folded and imbricated Himalayan thrust sheet in Pakistan. Its drainage networks with transverse streams intersect different geological structures at their highest structural position. This dynamic interaction can be studied by their mutual superposition and different quantitative behaviours. We use drainage network extracted from Shuttle Radar Topographic Mission (SRTM 90 m) digital elevation data. We use digital image processing techniques on SRTM data and already published maps to prepare lineaments database of the area. The stream power law under steady state condition can be used to calculate incision rates. We extracted 18 streams of the area in the form of longitudinal elevation profiles and catchment area profiles. Then we use this information with stream power law to calculate geomorphic indices i.e. concavity, steepness and incision rates of different stream segments. The fractal dimension of drainage network and lineaments was calculated using box counting method to understand their spatial distribution. We calculate correlation integral between lineaments and drainage to characterise their mutual relationship. We prepare rose diagrams of drainage network and lineaments to observer their individual orientations. Their similar orientation shows that the drainage network has high potential to study structural setting of the area. The derived values of concavity and steepness indices in the study area lie between 0.5 to 3.0 and 40 to 200 respectively. We mark knickpoints location on drainage network and show spatial variation in lithologies and faults distribution. We prepare geomorphic indices maps with marked knickpoints. We observed values of fractal dimension of lineaments and drainage network and comes out to be 1.21 and 1.35 respectively. These values show spatial limitations of lineaments and drainage network of the area. We calculated correlation integral between lineaments and drainage network with higher correlation in the range of 200m of lineaments. This shows that the stream network is influenced by the geological structures. The geomorphic indices maps show that it is a faulted anticline. Thus stream profile analysis can help us to understand geological features regarding oil and gas exploration and reduce the exploration risk. Remote sensing technique is a salient tool to make quick analysis in a cost effective way over all range of scales. The detailed analyses shows structure behaviour and reduce the exploration risk. The nonlinear analysis on lineaments and drainage shows the validity of the derived results.