Active Strike-slip Faulting in the Southern Kirthar Fold Belt, Pakistan: An Integrated Interpretation of Remote Sensing Data Field Data and Earthquake Characteristics

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The mechanism of foreland-vergent strike-slip deformation, independent of folding, in the foreland fold belt is poorly understood. This work establishes the existence of such foreland-vergent active strike-slip faults, detached deeper than folds and their kinematics in the Southern Kirthar Fold Belt (SKFB), Pakistan. SKFB is the southernmost continuation Himalayan-Suleiman-Kirthar orogenic belt, which developed due to continent-continent collision Plate with Eurasian Plate. Kirthar Fold Belt is located adjacent western margin of the Indian Plate represented by the Ornach-Nal-Chaman Fault System (ONCF). It is bounded Sindh monocline to the east and Suleiman fold belt in the north. In the south-west Kirthar Fold Belt passes into the Offshore SW-NE trending Murray Ridge. Present study area is located in the southeastern front of Kirthar Fold Belt. In this work we utilized Digital Elevation (DEM) of Shuttle Radar Topographic Mission (SRTM) and Landsat 8 imagery, both with ground resolution of 30 m. These satellite imageries provided indispensable insights regarding identification of structural landforms, such as ridges, valleys, lineaments and drainage. The remote sensing analysis was then integrated with available geological maps of different scales to refine and update the regional geology. The areas of structural anomalies, such as sharp breaks in stratigraphic contacts, deviations in structural trends, elevation profile and drainage pattern were visited for their ground-truthing and then marked on updated geological map along-with locations of earthquake epicenters 50 years. This integrated approach enabled us to

identify two generally E-W trending active strike-slip faults and associated second-order faults. Kinematics of these faults was tested through strain ellipsoid analysis, which proved their structural configuration. The southern strike-slip fault has right-lateral (dextral) sense of movement as "Karachi-Keenjhar Boundary Fault (KKBF)" as it passes through Karachi city and Keenjhar Lake. This fault is characterized by alternate releasing and restraining bends. Releasing bends consists of lakes and sag-ponds, while restraining bends consists of ridges. The northern strike-slip fault has left-lateral (sinistral) sense of movement as "Dureji-Lakhra Fault (DLF)" as it passes through Dureji and Lakhra areas. DLF fault, left step-over north of Thano Ahmed Khan city. This step-over bends the NS trend of Kambhu anticline to NE-SW. Both DLF and KKBF run nearly parallel and have curved map fault traces, concave. These faults also justify the surface structural configurations, which were previously not understood. More than 10 earthquake hypocenters are located at the depth of 10Km, which are interpreted as the depth of detachment for strike-slip faults. Previously, thin-skinned folding detached from top Jurassic and Lower Cretaceous sequences in the depth range of 3.5 to 5 Km is reported. Therefore, strike-slip faults are interpreted to be detached deeper than folds. These faults accommodate differential east-vergent slip of Southern Kirthar Fold Belt and are developed due to east-ward drift sedimentary pile above a weak detachment.