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Geometrical analysis of deformation bands and ladder fractures: a case study from Hopeman, Scotland

Abdullah Awdal (1), David Healy (2), and Ian Alsop (2)

(1) Department of Natural Resources Engineering and Management, School of Science and Engineering, University of Kurdistan Hewlêr, Erbil, Kurdistan Region, Iraq (abdullah.awdal@ukh.edu.krd), (2) Department of Geology and Petroleum Geology, School of Geosciences, University of Aberdeen, Aberdeen, AB24 3UE, United Kingdom

Deformation bands are planar structures that record strain localization due to faulting in porous rocks such as sandstones. Deformation bands can impact fluid flow in sandstone hydrocarbon reservoirs. Therefore, understanding the geometrical attributes of individual bands and their patterns is a critical step in quantifying their connectivity. We present a geometrical study of deformation bands and ladder fractures that developed in faulted sandstones from the Moray Firth (Scotland). We quantify 3D geometrical attributes of cataclastic deformation bands and associated ladder fractures in faulted sandstone, using interpreted and sliced rock samples as input for 3D geometrical models. The geometry of ladder fractures is antithetic and displays a 45o obliquity to the orientation of deformation bands. Based on their geometry, we propose a Riedel shear model that accommodates conjugate sets of ladder fractures between sub-parallel sets of deformation bands. Furthermore, we examine connectivity of deformation bands in different sections. Horizontal sections are better connected and nodal percentage points on ternary plot show clustering, whereas they show scattering for vertical sections. The better connection of horizontal sections is attributed to the anastomosing patterns of deformation bands in horizontal view. Deformation bands show a reduction in permeability which would affect fluid flow in subsurface hydrocarbon reservoirs.