Carbonate/Fractured Reservoirs: Highlighting Draining Features (Pipe-Layers & Pipe-Channels) Based on Borehole Image Analyses

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Abstract

Borehole Image Logs, available in logging oil industry since 1980s are very valuable data able to bring further intelligence to characterise reservoirs. The electric high resolution imager tools such as FMI (Schlumberger), STAR (Baker Hughes) and XRMI (Halliburton & CNLC) are the appropriate ones to acquire data.

Once data is processed, QC-ed, the interpretable output images generated, and the basic study carried out, it is important to focus on the potential/actual **draining features**. This is based on a well known fact observed in reservoirs and expressed under different notions by geoscientists, that fluids have preferential paths.

Carbonate/fractured reservoirs, once the specific **geologic planar** features are manually picked, need more attention such as determination of -i) **Structural** dips per Fm and **Paleohorizontal** dip of the appropriate section(s), -ii) and/or **constraining** unconformities & faults (minor & major), -iii) Paleocurrent directions to constraint **polarity** of the carbonate platform, -iv) **SHmax** & its shear directions; and –v) to carry out cautiously at least two major types of **zonation** based on image fabric reflecting :-a) **sedimentologic** attributes (e.g.; stratified, homogeneous, different types of vuggy matrix, breccias...) and –b) **deformation/alteration** facies (e.g. Fracture Zones, Fault Zones, Vertical Fractures, Fractured/Cataclastic Zones, Fracture Network, Stylolite Associated Fractures, Karstic Zones...).

Based on studied fractured reservoirs, from different parts of oil productions areas, notions of **draining** features are further characterised in two major types I call them: Pipe-Layers and Pipe-Channels.

Pipe-Layer is defined as a layer with a thickness modelled in 3D as a plane characterised by its location and orientation (MD within the well path, Dip-magnitude & Dip-azimuth); while a **Pipe-Channel** is modelled as an axis (MD, Dip-magnitude & Dip-azimuth).

At start of the analysis process when defined, they are named as potential/actual based mainly on geological features, further other data are needed (such as production tests, flow meter for example) to differentiate between potential and actual.

Examples from several reservoirs will illustrate different types of these draining features:

-1) **Pipe-Layers**: Fracture Zone1 (one fracture set), Stylolite Associated Fracture Zone, Vertical Fracture Zone, Layer of Interconnected Vugs, Cataclastic/Breccia Zone and Karstic Zone

-2) **Pipe-Channel**: Intersection of two Pipe-Layers and/or Fracture Zone2 (two fracture sets), Fracture Zone3 or more (three or more fracture sets intersecting along an axis).

The challenge is, once these draining features are defined and characterised at well scale, to correlate and model them at reservoir scale.

Speaker Biography (2010) Dr Abdelkader Saadallah (66) is a consultant based in Stavanger expert in *Enhanced Reservoir Characterisation based on Borehole Images*, with a background of Structural Geology (BabEzzouar University, Algiers). He is the author of 100+ publications and projects, among them 60+ projects of Borehole Images/Dipmeter of the main logging companies (Baker Huges, CNLC, Halliburton and Schlumberger). From North Sea, Middle East, Italia, Kazakhstan & Vietnam for several companies (BP, ConocoPhilips, Maersk, PGS, Pertra, Saudi Aramco, Shell, Statoil, Talisman, DNO, Aral, Chevron and Gazprom).