Improved Subsurface Reservoir Characterization Using Cuttings-Based Advanced Image Analysis, Elemental Analysis and AI Algorithms: An Example from the Devonian, Awali Field, Bahrain

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Abstract

Drill cuttings are an invaluable source of quality geological data and yet are often underutilized in our industry. Hundreds of thousands of cuttings samples are stored in warehouses and repositories across the globe. With the onset of new AI based technologies, these data can be quickly and consistently analyzed, and utilized to help better understand subsurface characterization and key surfaces definition.

This study utilizes 240 cuttings samples from a circa 1,200ft Devonian section in 2 vertical wells across the Awali Field, south central on-shore Bahrain. Other log and core data were made available for review. The objective of the study was to utilize advance AI image analysis of cuttings data together with elemental and other supporting data in order to generate a consistently measured, high resolution lithotype scheme applicable to both wells and ultimately the field.

The drill cuttings samples were prepared, rapidly analyzed using portable custom-made benchtop equipment (portable Image Studio and benchtop XRF) and interpreted for color extraction and particle texture using various AI-based image analysis algorithms together with collected elemental data (32 elements and various key elemental ratio data). The data was cross-checked against the MWD Gamma, and depth matched as required.

This consistently measured analytical process together with supporting log and core analysis data enabled the construction of a robust lithotype scheme applicable to the Devonian section from these wells. Each sample was systematically classified in terms of the lithotype scheme, resulting in the generation of improved sub-surface understanding.

8 detailed lithotypes S1 to S8 grouped into 3 lithotype associations (S1-S2, S3-S5 and S6-S8) were identified, based on changes in color (a derivative known as Brightness) together with key elemental ratio data such as average Mg (%), average Zn/Nb, average Th/K and average Th/Al. The data were then further classified into 3 Gross Sedimentary Packages (1, oldest to 3, youngest) defined by medium scale darkening upwards or transgressive cycles.

With this generated information, it was possible to accurately compare these cycles well-to-well and identify key correlative surfaces and trends. For example, the regionally significant D-3B marker was identified in each well and defined as the top of one such darkening upwards

cycle. In addition, and of particular importance, Well A to the south, contained a much higher percentage of brighter lithotypes (S1-S2) particularly in the younger sections when compared to Well B further north, which was dominated by darker lithotypes (S3-S8). This, along with key supporting elemental data may suggest a change in depositional environment and/or sediment sourcing across the field which could have implications for spatial changes in reservoir quality.

Utilizing an AI-driven drill cuttings-based approach to better understand subsurface Plays, normally requires a substantial initial investment and long analyses times. However, the workflow presented here offers increased efficiencies by providing a cost-effective and rapid method to collect, analyze, define, and predict key reservoir drivers. The ability to identify specific lithotypes from fresh and legacy drill cuttings will allow operators to better predict spatial reservoir definition and understanding across the field, thus improving sub-surface model build and overall field development.