Depositional environments of the Permian Lucaogou Formation, Junggar Basin, NW China and implications for tight oil exploration

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The depositional enviroments and lithofacies of the Permian Lucaogou Formation (P_2l) in the Jimusar Sag, Juggar Basin, northwest China were investigated using chemostratigraphy and chemo-sedimentary facies analyses. X-ray fluorescence (XRF) 1D logging with a spacial resoltion of 3-5 cm and 2D (facies) mapping with a spacial resoltion of 50 μm were employed to characterise a 70 m-long fully cored tight oil reservoir section within the P_{2l} formation in the J-305 well in great detail.

A series of elements and elemental ratios were used as proxies to reconstruct the depositional enviroments of the P_{2l} formation, which was deposited in a lacustrine setting with complex lithologies comprising mudstone, silty mudstone, dolomitic mudstone, argillaceous dolomite, argillaceous silstone, dolomitic silstone and calcareous silstone. The upper P_{2l} Formation was deposited during a prolonged period of humid climate with frequent short interruptions of dry climate, whereas the lower P_2l Formation was deposited during a period of alternating humid and dry climate setting.

Mudstones in both the lower and upper P_2l Formation were primarily deposited in a reducing environment. The lake remained mostly deep and saline during their deposition with frequent short shallowing-up. Some mudstones are quite rich in organics with TOC up to 13%. The high TOC intervals coincide with periods of cliamte changing from humid to dry, maximum lake level, high sality and reducing environment. The interbedded siltsone, dolomitic siltstone and muddy siltstone are rich in Al, K, Si and show good continuous parallel beddings on 2D map, indicative of strong hydrodynamic setting. They form good reservoirs with porosity up to 23% and horizontal permeability (K_h) up to 137 mD. The better oil-bearing reservoir intervals were mainly deposited during humid climate but low lake level, with good porosity and K_h silty intervals being sandwitched inbetween organic-rich mudstones deposited during humid climate, deep water, higher sality and reducing environment. It is demonstrated that depositional environments controlled lithofacies, TOC, reservoir petrophysical properties and thus sweet spots of tight oil in the P_2l Formation.

Key words: Lucaogou Formation, Depositional environments