Isotope Signatures Over-mature Shale Gas Well, China

Isotope logging to determine landing zone & provide horizontal guidance in shale gas well

DETERMINING LANDING ZONE | PART 1

Isotope analysis provides key intel on various properties in shale gas wells. For several different wells in an over-mature shale gas field, isotope logging was used to determine the landing zone using trend patterns of methane & ethane isotope ratios. The patterns develop three (3) distinct profiles which signify different formation signatures to easily identify landing target. During the drilling of a new post mature gas well (bright red dash-dot curve), an offset well, D7V had typical isotope patterns for C₃ & C₄. Methane (red line) initially gets heavier above the shale formation, Lower LMX (-31% to -28%). Furthermore, once drilling begins to enter the LMX formation, δ¹³C₂ begins to shift lighter (1-2%). Finally, when entering the pay zone PP, δ¹³C₂ shifts back heavier (1-2%). For Ethane (blue line) the trend is similar, initially, δ¹³C₂ trends lighter (4-8%) entering the LL formation, peaking at the 2nd isotope reversal (*). Similar to the methane isotope pattern, δ¹³C₂ shifts heavier (2-6%) in the pay zone, PP. Based on the signatures, 3 distinct cases (trends) can be used to determine landing position.

LANDING PROFILES

CASE A: Lateral lands according to red dashed above and stays in PP
CASE B: Lateral lands above PP
CASE C: Lateral lands in PP and drills into lower LL

HORIZONTAL GUIDANCE | PART 2

In addition to providing key intel for landing the curve, isotopic signatures were performed throughout the lateral well-bore to determine high production zones (Sweet Spot ID, SSID) based on distinct isotopic signatures and identifying chemical processes associated with high gas production. This process is established on principles called condensate reform (C₂-C₄→CH₄). The SSID methodology identifies four (4) key characteristics to determine higher zones of production in the lateral pictured below (depth in meters):

1. δ¹³C₂→trends lighter
2. δ¹³C₂→trends heavier
3. δ¹³C₁→close together
4. δ¹³C₂<δ¹³C₁→isotope reversal

Results:

- The two PP (PP1 & PP2) have the four (4) key characteristics for SSID
- Heel & toe of lateral are SSID
- Both PP1 & PP2 contain isotope reversals

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- High Production Zones
- GOR-Isotope Modeling
- Maturity
- Landing Horizontal Wells
- Lateral Sweet Spot ID
- Isotopic Profiles
- Condensate Reform (C$_2$-C$_6$→CH$_4$)

Shale gas applications differ from oil drilling in regards to isotopic interpretation. For shale gas, isotope mud gas data is used to provide key parameters attributing to production, maturity, gas generation processes, lateral zonal assessments and more. For shale gas drilling, it is important to integrate GOR-Isotopes Software (GeolsoChem) to model the reservoir conditions. Find out more about the software email: info@paladingeo.com

- Lateral data set: green depth ranges [●, ●, ●] linked to highest maturity & contain all key characteristics for SSD (case study on back)
- Plots generated by GOR-Isotopes software