Inferred Wellbore Position

Pete Clark

Chevron CTC Wells, Wellbore Placement Focal Point

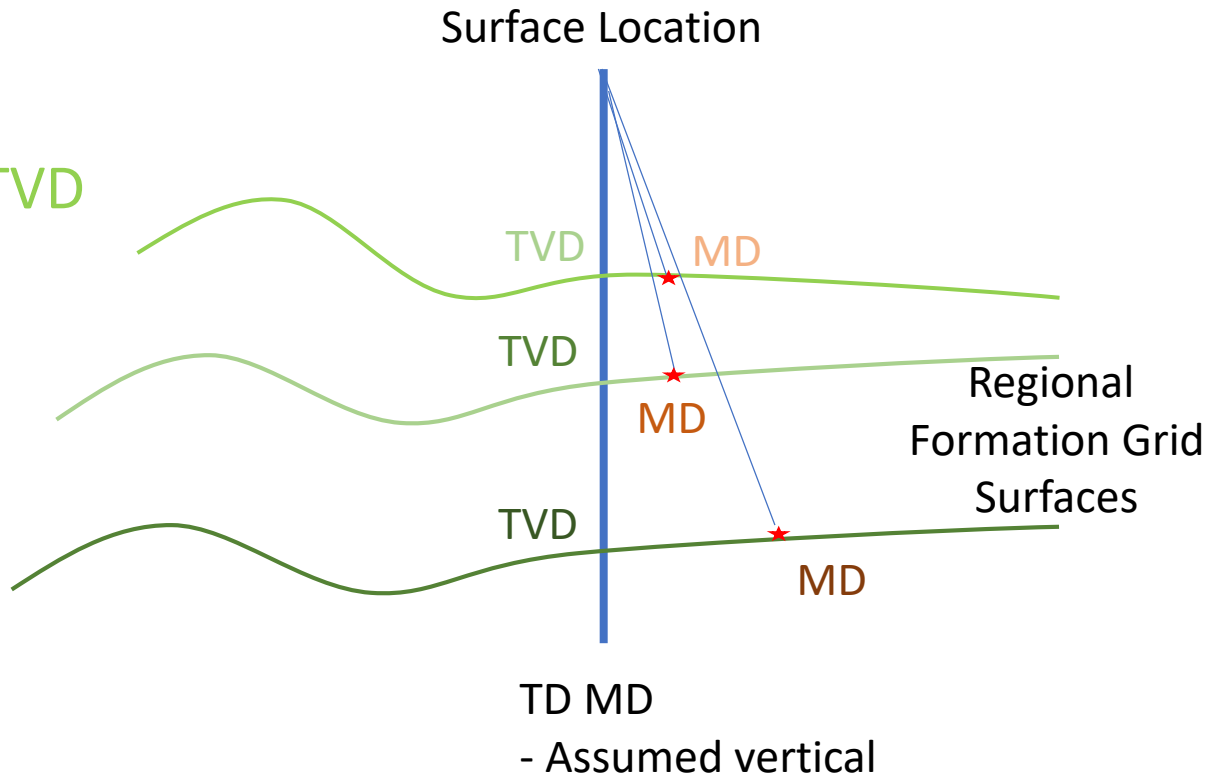
01/13/22

Inferred Wellbore Position - Challenge

- Challenge
  - Many downhole wellbore positions defined by
    - Surface location
    - TD MD
  - No directional survey information
- Leads to
  - Assign “Blind” positional uncertainty model
  - ~46° cone
  - at TD error radius is greater than depth
    - Additional cost due to directional drilling to avoid possible well’s placement
    - Inefficiency risk assessing potentially unlikely well collision
      - Discount Blind wells as no risk

Inferred Wellbore Position – Proposal

- From existing measurements & models
  - Calculate TVD for formation grid using
    - Surface location
    - Regional formation top surfaces
  - Compare recorded top MD to projected TVD
    - Calculate **Sustained Inclination (SustInc)**
      - **SustInc** = ArcCosine(TVD / MD)
      - If **SustInc** < 5°
        - Assign “Inc-Only-Planned” PU model
        - ~7.26° cone @ 3σ
      - If 5° ≤ **SustInc** < 10°
        - Assign “Inc-Only-Planned-10” PU model
        - ~14.52° cone @ 3σ
      - If **SustInc** ≥ 10°
        - Assign “Blind” PU model
        - Not credible to consider this as a near vertical well
        - Means there’s no surveys for a deviated well & is why Blind is an appropriate model



Process & Rules

- For SustInc to be valid
  - Calculated from at least two credible formation top comparisons
  - SustInc = Maximum of all available comparisons

- Individual calculation outcomes
  - No match, no calculation
  - MD ≥ TVD, potentially valid calculation
  - MD < TVD, invalid calculation
    - Realistic situation as recorded top may be deep to true or formation grid may be shallow to true
    - Assign value to this comparison of 5°

Credible Calculations

- Safeguard against gross error
  - Recorded top and formation grid refer to different items
  - Set delta length tolerance
    - ABS(delta formation grid to recorded top) < tolerance

  - Suggested tolerance value =
    deepest target horizon / cos(10°) - deepest target horizon
    e.g. if deepest target horizon = 10,000ft, tolerance = 154ft, or less
  - Exceeding tolerance assigned “Blind” PU model

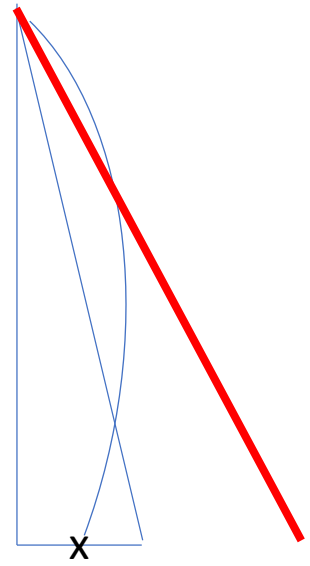
  - Counter of credible calculations (cumulative credible calculations)
  - Must exceed two
    - If ABS(delta formation grid to recorded top) ≥ tolerance then
    cummulative credible calculations = cumulative credible calculations - 1

Implementation

- Anticipated to be by machine
  - Hence algorithmic approach

Inferred Wellbore Position – Surface Issue

- Is this only a geometric issue?
- It's always possible to generate a wellpath that exceeds the error bounds at surface
- Example
  - SustInc calculated to be less than 5°
  - Inc-Only-Planned generates ~7.26° cone (red line)
  - Hypotenuse is MD
  - Vertical side is TVD
  - Keeping TVD and reducing displacement provides "slack"
    - Generate curve (hyperbola / parabola?)
  - Assumes initial inclination > 7.26°
    - Realistic?



Proposal

- Form a CA sub-committee work group

- Review this proposal
- Consider alternate approaches
- Optimize method
- Identify issues
- Produce guidance
  - To include the statement that good surveying practices should always be employed and resurveying wells missing surveys is best practice

Thanks!