Identification and Quantification of Upward Cleaning and Upward Dirtying Parasequences Using Kuwahara and Expectation Maximization Filters

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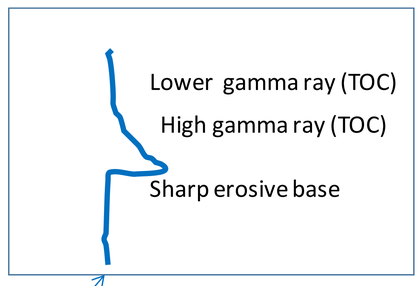
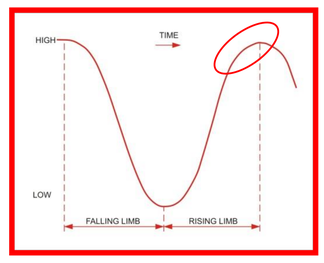
Parasequences:

- Are key in reservoir characterization
- Hold special importance in unconventional plays
- Traditionally require human interpretation of upward-fining, upward-coarsening (cleaning/dirtying) patterns

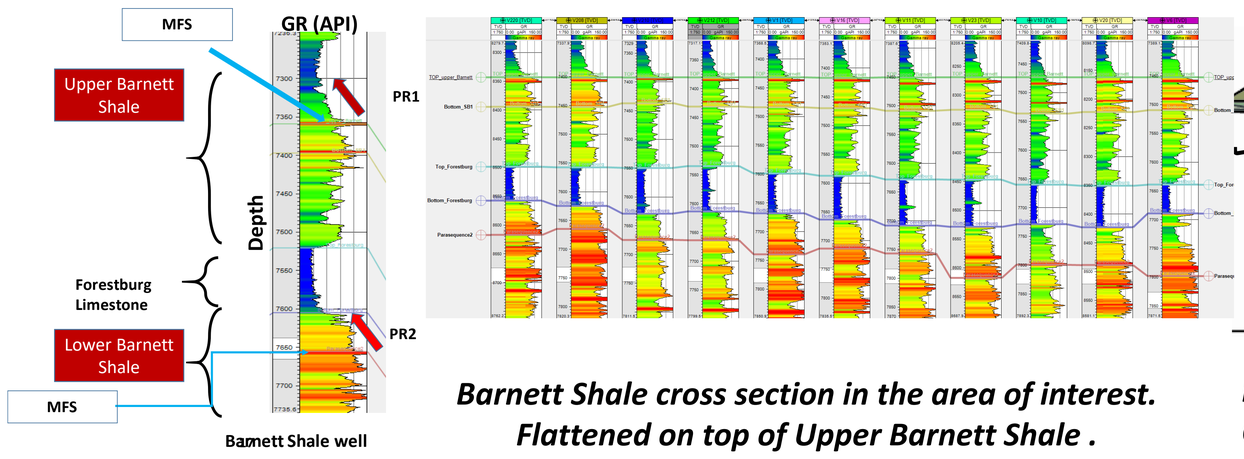
Given the high density of wells in mature fields and in resource plays, can I develop tools to more efficiently map parasequence thicknesses and patterns?



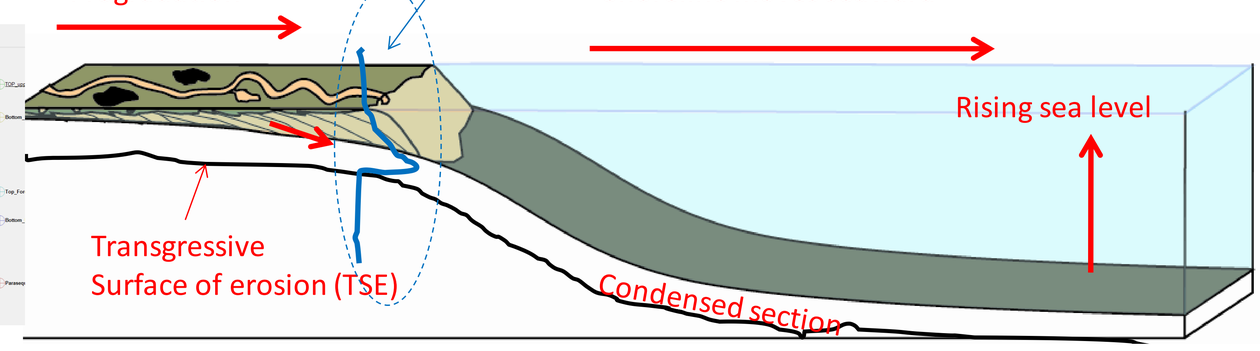
Deposition over 2MM years



Well log characteristics



Barnett Shale cross section in the area of interest. Flattened on top of Upper Barnett Shale .



Highstand Systems Tract and the corresponding well log signature. (Dr. Roger Slatt Class notes)

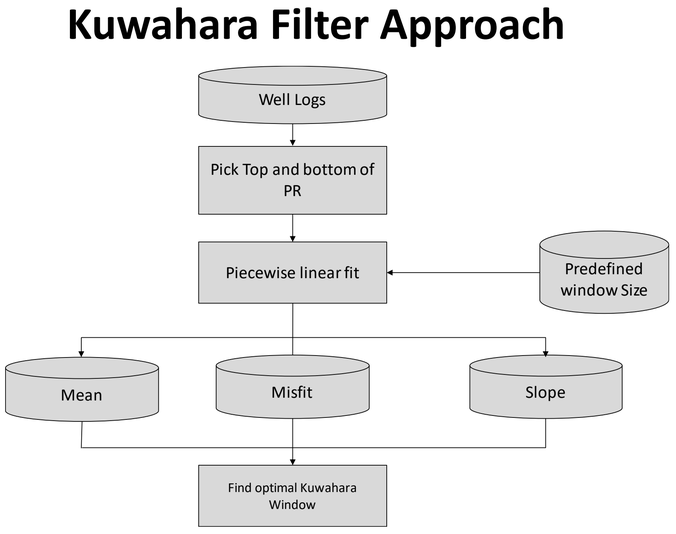
Barnett shale well log shows:

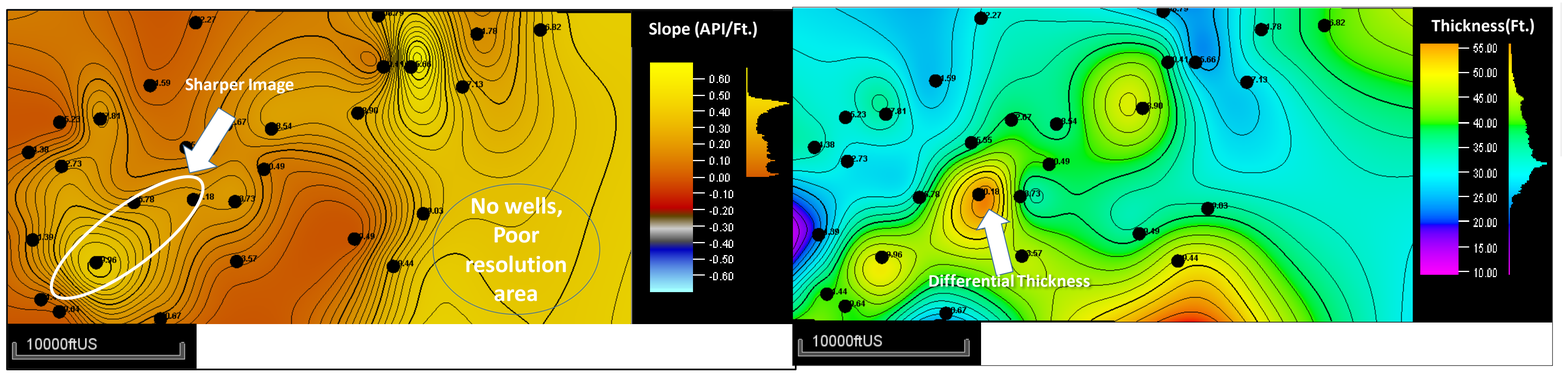
- upward cleaning/dirtying sequences
- Maximum Flooding surfaces
- Stratigraphy consisting of shales and carbonates

Questions to be answered :

1. Can the process of picking parasequences be automated ?
2. Can quantitative attributes be extracted from these parasequences ?
3. Can these attributes assist in interpretation of depositional environment ?
4. Can these attributes be correlated to seismic data ?

Kuwahara Filter Approach

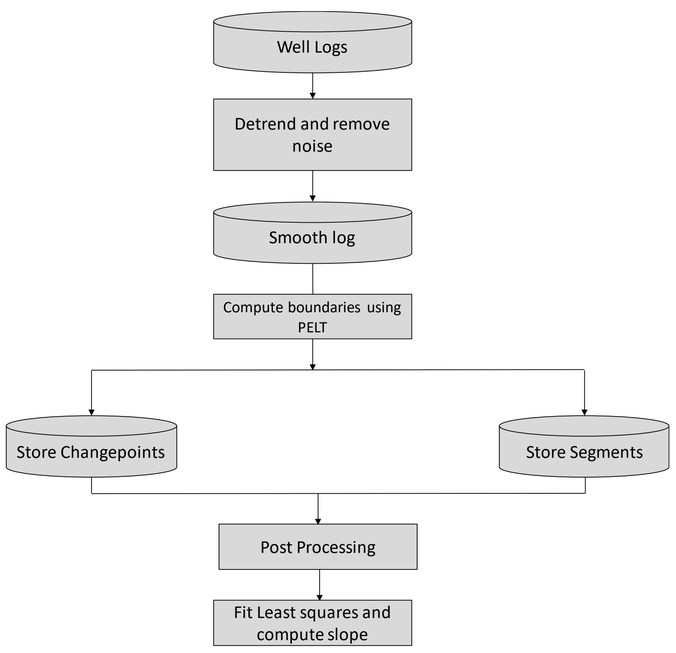




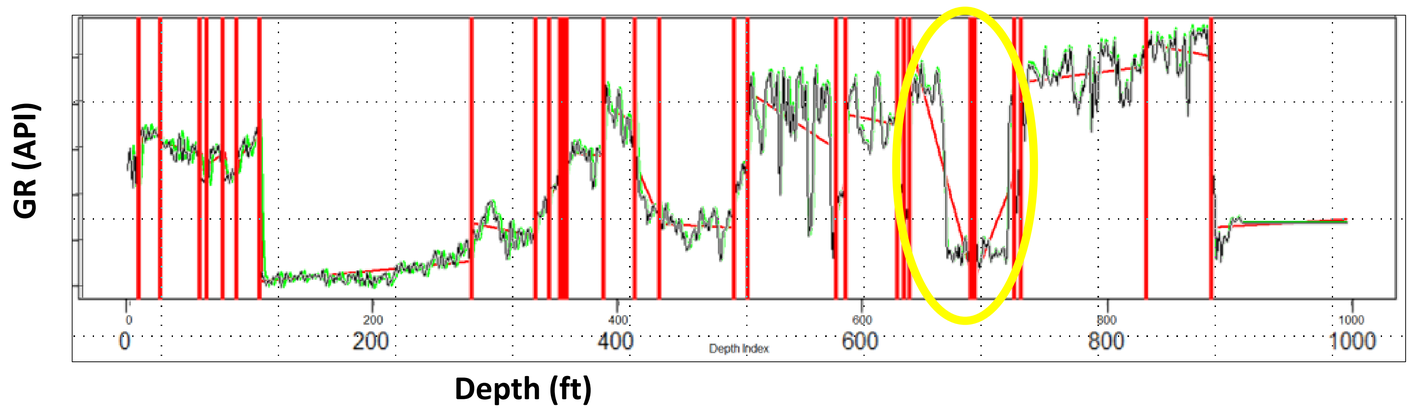
Slope of Kuwahara (Parasequence 1)

Thickness (Parasequence 1)

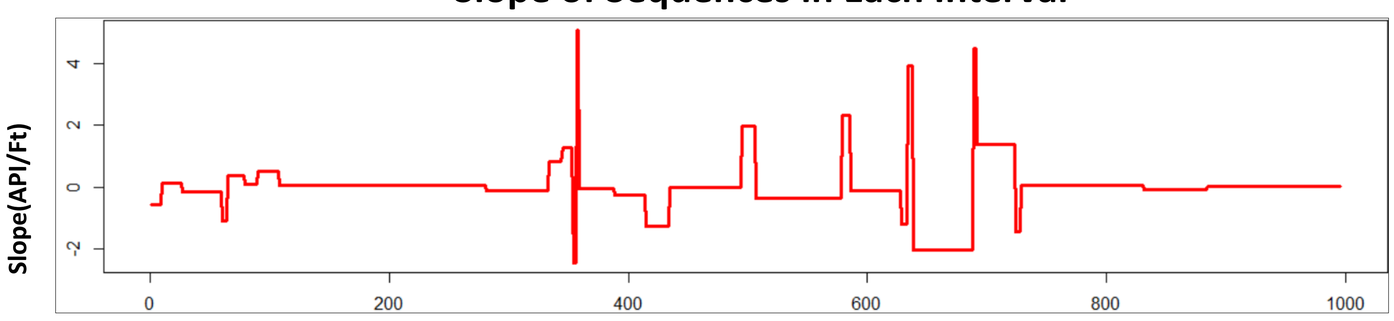
Multi Changepoint Approach (Expectation Maximization)



Gamma ray log, Sequence Boundaries and Least-Square Fit



Slope of Sequences in Each Interval



Conclusions:

- Our algorithm show promising initial results
- Our algorithm does not required training like machine learning methods
- Our algorithm is scalable to small number of wells to thousands of wells
- Our algorithm is statistical hence less affected by noise

Future Work:

- Use co-kriging to link impedance inversion volumes to well control
- Extract different attributes such as peaks removed etc.
- Build a user interface