

**Course: Sequence-stratigraphic analysis of shales: Key to paleoclimate archives, subsurface fluid flow, and hydrocarbon source, reservoir, and seal.**

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**TRAINERS: Kevin M. Bohacs, Jeffrey D. Ottmann**

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**Duration:**

1 day

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**About the course:**

**Course: Sequence-stratigraphic analysis of shales: Key to paleoclimate archives, subsurface fluid flow, and hydrocarbon source, reservoir, and seal.**

A hands-on workshop on the expression and correlation of depositional sequences in seismic, well-log, core, and outcrop data using Paleozoic, Mesozoic, and Cenozoic examples.

Mudstones contain the most detailed records of earth history and are sources, reservoirs, and seals of hydrocarbons, as well as serving as key elements in reservoir and aquifer models as baffles and barriers. Sequence stratigraphy provides an excellent framework within which to integrate the many scales of observations of physical, chemical, and biological attributes necessary to understand these rocks across the spectrum of depositional settings. This workshop combines interactive lectures and exercises addressing the expression of depositional sequences in mudstones on seismic, well-log, core, and outcrop data. Examples include the New Albany Shale, Barnett Shale, Shublik Formation, Kimmeridge Formation, Vaca Muerta Formation, Kingak Formation, Hue Shale, Mowry Shale, Eagle Ford Shale, and Monterey Formation. Participants will practice recognition and correlation of significant stratigraphic packages through seismic stratigraphy, stacking pattern

analysis of well-log, core, and outcrop data, shale sedimentology, and thin-section and geochemical data.

Although flooding surfaces and depositional-sequence boundaries may be subtly expressed in mudstones, they can be recognized through distinct changes observed in commonly available physical, chemical, and biological data. Beyond the chronostratigraphic utility of the correlative conformity, abundant paleoenvironmental information is recorded in fine-grained strata— depositional sequences do not just fade away into obscurity in distal reaches, but have objective attributes that allow extension of stratigraphic frameworks and play-element predictions over very large areas.

Flooding surfaces fundamentally record a critical increase in accommodation relative to sediment supply, commonly recorded in mudstones by laterally extensive accumulations of authigenic and pelagic components, along with evidence of sediment starvation and low bottom-energy levels. Even in mudstones, some may record minor erosion, reworking, and lag formation due to low sediment supply, but all are marked by a significant decrease in advected clastic input-- contrasting with sequence boundaries.

Depositional-sequence boundaries record a critical decrease in accommodation relative to sediment supply, commonly accompanied by an increase in depositional energy or a significant change in sediment supply, or both, over hundreds to thousands of square kilometers in both fine- and coarse-grained lithologies. This is recorded even in fine-grained lithofacies by regional erosional truncation with subsequent onlap, exposure, reworked fossils, decreased continuity at lamina to bedset scale, along with increased accumulations of advected clastics and fossils or secular changes in biogenic lithology. All of these attributes (except subaerial exposure) are observed in physically correlative distal reaches of unconformities across their correlative conformities.

Interactions of sediment supply and accommodation with pre-existing topography control the expression of depositional sequences. Marine environments tend to have the most widespread, gradually varying facies tracts, whereas paralic facies tracts tend to be most localized and abruptly changing. Lacustrine sequences vary according to lake-basin type, and range from very similar to shallow-marine siliciclastic sequences to very dissimilar

## **Program**

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Example Agenda:

(we may want to think about scheduling 1.5 or 2 days for this, given that it is a full day when done in the USA)

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|-------|----------|---|
| 08:00 | Exercise | <ul style="list-style-type: none"><li>• Introduction of participants, description of mudstone hand specimens</li></ul>                              |
| 08:15 | Lecture  | <ul style="list-style-type: none"><li>• Introduction to Workshop &amp; Sequence Stratigraphy in Mudstones</li></ul>                                 |
| 09:00 | Exercise | <ul style="list-style-type: none"><li>• Stacking pattern analysis of outcrop, core, and well-log data (Mz, Cz examples – Mowry, Monterey)</li></ul> |

09:45	Break	
10:00	Exercise	<ul style="list-style-type: none"> <li>• Sequence analysis and correlation of core and well-log data (Pz examples- New Albany, Barnett)</li> </ul>
11:30	Lecture	<ul style="list-style-type: none"> <li>• Shales as reservoirs, sources, and seals—common attributes, common controls</li> </ul>
12:15	Lunch	
13:15	Lecture	<ul style="list-style-type: none"> <li>• Elements of Successful Shale Reservoirs</li> </ul>
14:15	Exercise	<ul style="list-style-type: none"> <li>• Mudstone sequences within a genetic basin framework, 1: Seismic data (Mz example— Shublik, Kingak, Hue)</li> </ul>
15:15	Exercise	<ul style="list-style-type: none"> <li>• Mudstone sequences within a genetic basin framework, 2: Well-log data (Mz example— Shublik, Kingak, Hue)</li> </ul>
16:15	Break	
16:30	Exercise	<ul style="list-style-type: none"> <li>• Mudstone sequences within a genetic basin framework, 3: Geochemical data and mapping (Mz example— Shublik, Kingak, Hue)</li> </ul>
17:30	Discussion	<ul style="list-style-type: none"> <li>• Wrap-Up</li> </ul>
18:00	Adjourn	