Introduction to Petroleum Geomechanics

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About the GTS and Webinar Series

- The SPE Geomechanics Technical Section (GTS) is devoted to the development and understanding of geomechanics knowledge and technologies within the SPE community.

  Not a member of GTS? Join at:

  https://connect.spe.org/geomechanics/home
- The GTS offers a monthly newsletter, hosts networking events, and supports geomechanics-related workshops and forums.
- This webinar, part one of a three-part series, provides an overview of geomechanics, while the other two parts will get into specific details of the components of geomechanics.

Outline

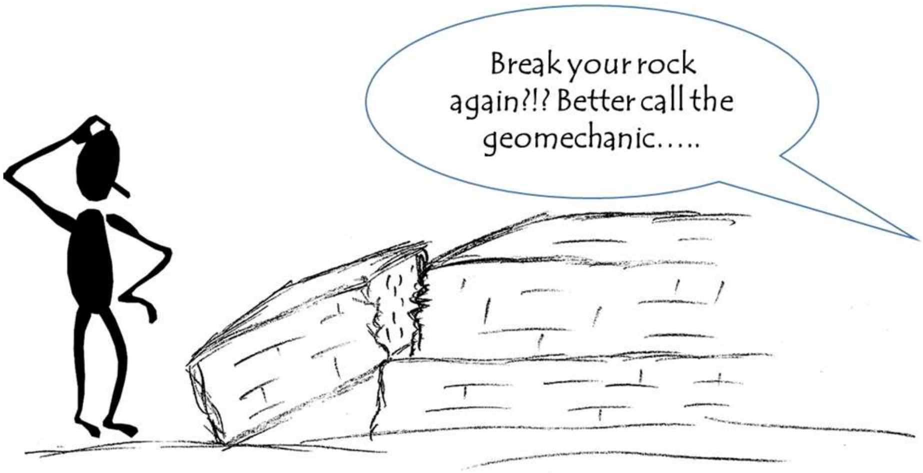
I. What is Geomechanics
- Definition, history, professional associations and role

II. The Value of Geomechanics
- The benefits and costs of geomechanical support

III. Basic Geomechanics Workflow
- Sources of data and possible analyses

IV. Common Petroleum Geomechanics Applications
- From production forecasting and reserves to operations

What is Geomechanics



What is Geomechanics

Various organizations and authors have defined geomechanics:

- "***Geomechanics is the study of how soils and rocks deform, sometimes to failure, in response to changes of stress, pressure, temperature and other parameters***" – John Cook, SLB Scientific Advisor
- "***Geo + mechanics: Mechanics of geological materials (soils, rocks, fluids in the rocks…) and the deformation-yield-flow behavior of geomaterials exposed to changes in stresses, pressures, temperatures and chemistry***" – Professor Maurice Dusseault
- "***Geomechanics is the geologic study of the behavior of soil and rock***" – New York State Dept. of Transportation Geotechnical Design Manual, 2014
- "**Geomechanics: This branch of engineering focuses on determining the mechanical properties and behavior of soil and rock for use as foundation and construction materials**" – South Dakota School of Mines, Geology and Geological Engineering

Geomechanics Professional Societies

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american rock mechanics association

ISRM

International Society
for Rock Mechanics

The field of Rock Mechanics is taken to include all studies relative to the physical and *mechanical behavior of rocks and rock masses* and the applications of this knowledge for the better understanding of geological processes and in the fields of Engineering (ISRM Statutes).

Geomechanics: A Succinct Definition

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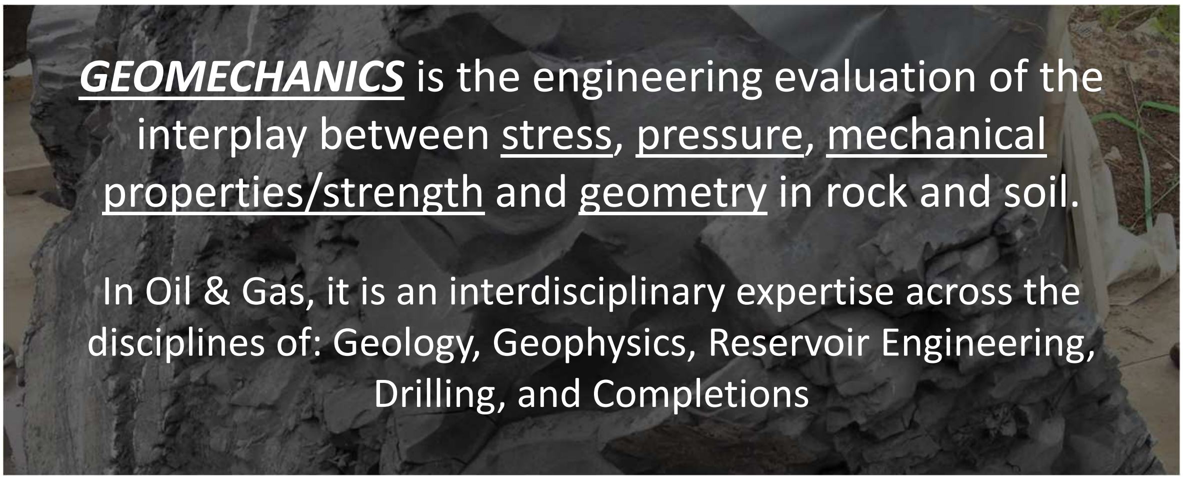

Defining Geomechanics: Analogies

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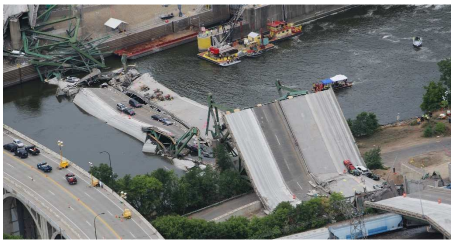
Airplane Crash



Bridge Collapse

Tunnel Collapse

Mine Collapse

History of Geomechanics

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- The early efforts that form modern geomechanics can be traced to the work of Coulomb in 1773.
- The professional societies have their founding after the first international conferences in the early 1950s and 1960s (ISRM was founded in 1962).
- The early history was dominated by issues related to mining, tunneling, and dam construction.
- Initially, the field was called Rock Mechanics and/or Rock Engineering. Geomechanics arose later in order to encompass the field of soil mechanics and rock mechanics together.
- Within the United States, there is no professional licensure for geomechanics (or rock mechanics). A professional engineering license holder, for example in petroleum engineering, would have few, if any, questions about geomechanics.
- Social/technical communities for geomechanics have developed in recent years under SPE (the Geomechanics Technical Section), AAPG, SEG, EAG and LinkedIn.

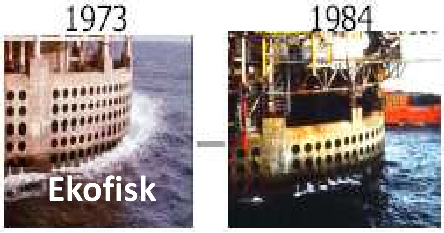
Geomechanics Education

- There is no undergraduate degree available in geomechanics; the closest options are mining engineering or geological engineering.
- Few, if any, petroleum engineering undergraduate programs require a course in geomechanics (rock mechanics). Some, but not all, petroleum engineering programs present geomechanics concepts.
- Graduate programs in geomechanics are commonly available, primarily via mining or petroleum engineering programs.
- Continuing Education opportunities are available via SPE, AAPG, EAG and other professional associations.
- Geomechanics training courses are also available through consultants/service companies.

Value of Geomechanics

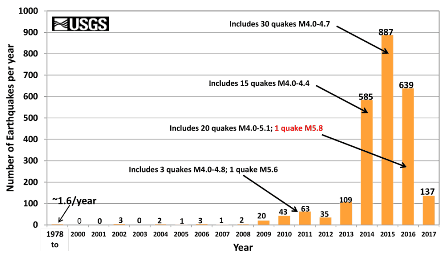
- Geomechanics has primarily been a call-out service or, more simply, “firefighting”.
- Again, historically, few companies had even a single geomechanics engineer let alone a geomechanics group.
- This began to change in the 1980s with costly efforts like Ekofisk subsidence, deepwater developments, and extended reach wells.
- Today, even smaller independents might have a dedicated geomechanics specialist.

Why Geomechanics is Important



Subsidence of the Ekofisk platform, North Sea.

Steam injection that erupted at the surface.

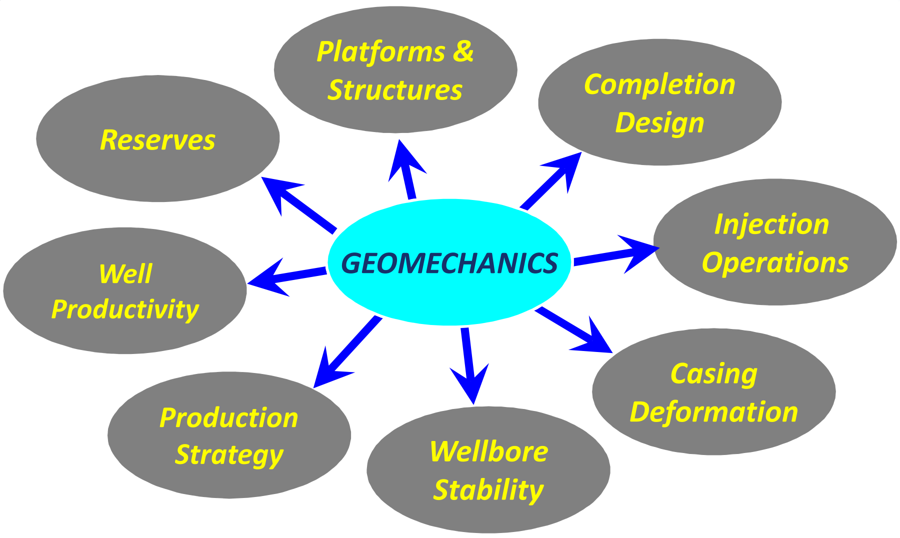


Injection-triggered seismicity

Offshore well blowout.

Massive solids production from a well

Petroleum Geomechanics…Where's The Beef?



Where Geomechanics Applies

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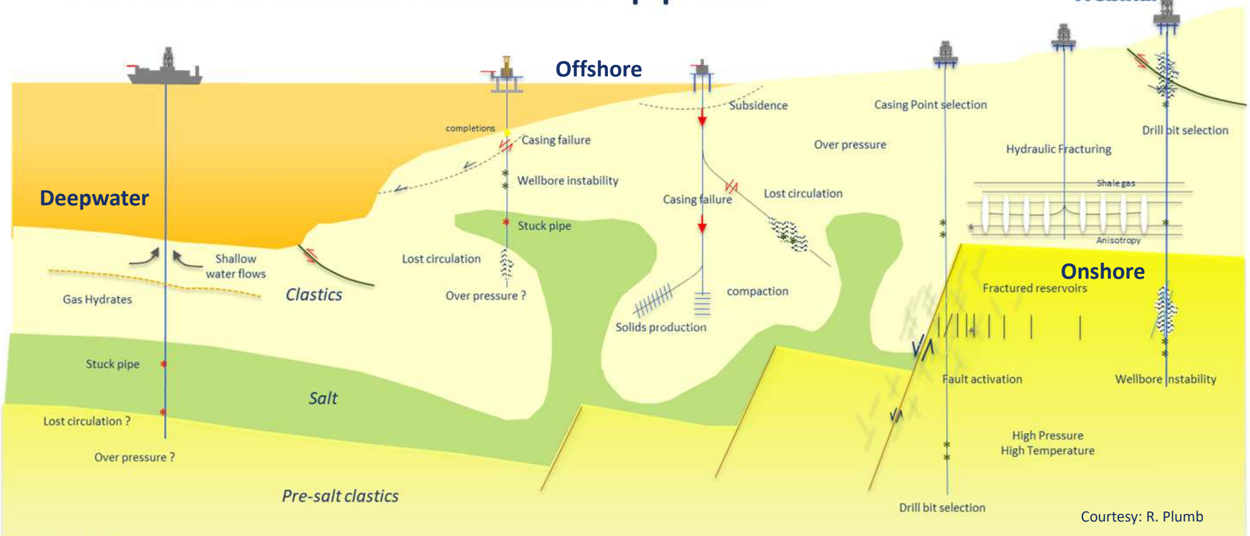

Courtesy: R. Plumb

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Geomechanics over Life-of-Field

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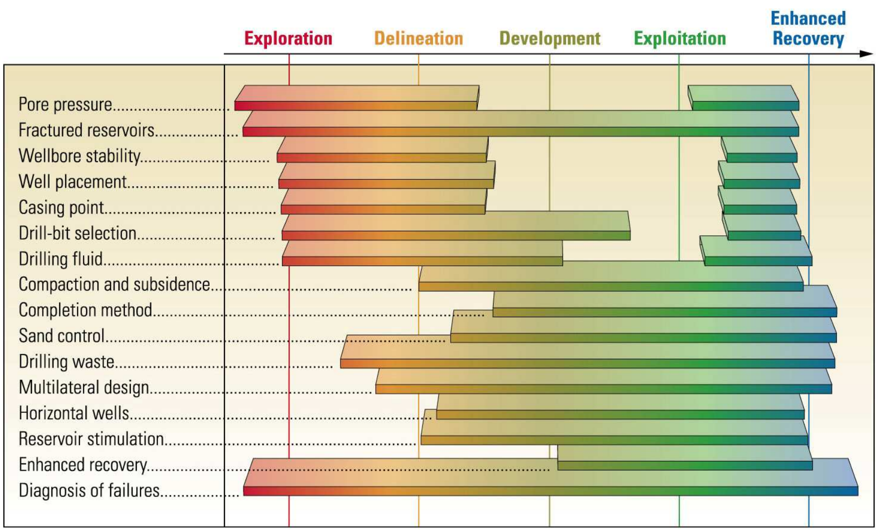

(After Plumb et al., 2004)

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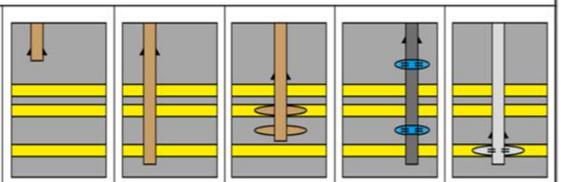
Value of Geomechanics: Mars Field Case History

CHALLENGE: The Shell-operated Mars basin reservoirs in the Deepwater Gulf of Mexico have been on production since 1996 with depletion as much as 5000 psi. Several planned wells were deemed un-drillable and many more would become un-drillable if reservoirs continued to deplete due to changes in the depleted fracture gradient thereby significantly affecting the value of this multi-billion dollar asset.

SOLUTION: The asset recognized that the success of a challenging depleted drilling program along with an efficient waterflood program required a thorough understanding of the subsurface stresses.

METHODOLOGY: Development of an “In-situ Stress Measurement Program”.

In Situ Stress Measurment Program for the Mars Basin



	Casing Shoe Leak-off Tests	Open-hole xLOT with LCM	Lost Circulation Events while Drilling	Microfrac in caprock during well abandonment	Mini-Frac at Producers (stress changes in sands)
Formation	Shale	Depleted Sands and Shale	Any	Shale	Sand
Injected Fluid	Synethic-based Mud	Synethic-based Mud with LCM	Synethic-based Mud with (or without) LCM	Brine	Completion Fluids
Typical Injected Volume	5-10 bbls	20-30 bbls	>100 bbls	5-30 bbls	>100 bbls

ARMA 18–0171: “An Integrated In-Situ Stress Measurement Program for Deepwater Brown Field Developments”, Chan, A.W., Cuttitta, M. and O’Reilly, G., 2018

Value of Geomechanics: The Challenge

- The oil & gas industry operates with a high risk tolerance.
- There is continuing pressure to cut costs.
- It is often difficult to quantify the financial benefits of geomechanics.
- It is (even more) difficult to quantify the benefits of geomechanics on production.
- Many geomechanical analyses have high uncertainty; managing expectations is critical.
- It is very difficult to manage unknown unknowns.
- Delivering continuous (if not increasing) value is difficult.

Geomechanics Workflow

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- As geomechanics consists of the evaluation of earth stresses, formation pressures, mechanical properties and geometry – and, critically, operations-induced changes in these – then a complete geomechanics workflow must consider each of these four components.
- Stress evaluation, pressure evaluation, mechanical properties testing or structural evaluations, by themselves, are not geomechanics (though geomechanics may be employed to do these). Rather these represent geomechanical data acquisition.

A Simple Geomechanics Workflow

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Geomechanics Data	+	***Field Data***	+	***Engineering Analyses***	→	***Geomechanics Results***
Stress Orientation **Stress Magnitude** **Pore Pressure** **Mechanical Properties**		**Geometry** ***•Inclination*** ***•Azimuth*** **Structural Data** ***•Lithology*** ***•Faulting*** **Historical Data** ***•Failure*** ***•Production***		**Software** **•Continuum** **•DEM** **Constitutive Model** **Other Parms**		**Results:** ***•Mud Weight Window*** ***• Subsidence Prediction*** ***•Sanding*** ***•Frac Growth*** ***• Triggered Seismicity***

Asset-based Geomechanics Workflow

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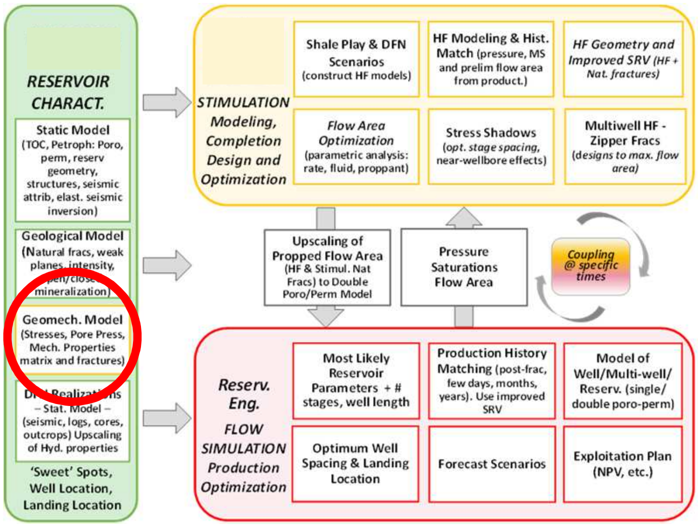

In an asset team based workflow, geomechanics is primarily part of reservoir characterization, with an intimate link into reservoir engineering, drilling, and completions operations.

The Geomechanical Model

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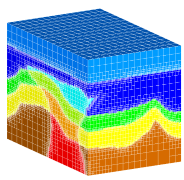
The Geomechanical Model is the necessary starting point of ALL geomechanical analyses.

Definition: A Geomechanical Model is the quantitative description of:

- Magnitude and orientation of in-situ stresses (Sv, SHmax, Shmin)
- Pore pressure
- Rock Mechanical properties
- Geometry



The model is used to evaluate the changes in hydro-thermo-mechanical conditions due to hydrocarbon production operations or geological processes.

Geomechanical Model Updating

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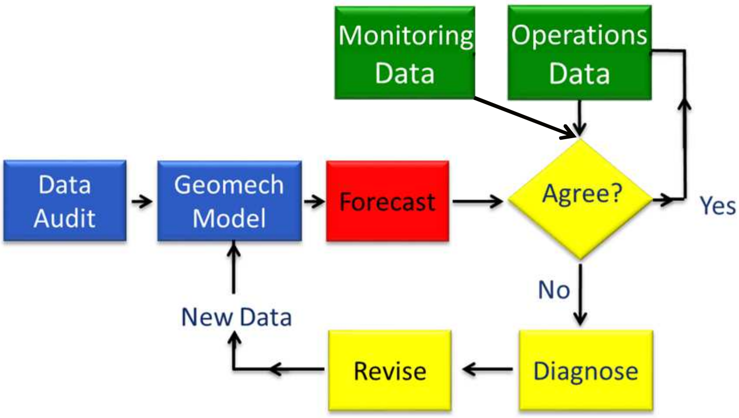

Geomechanical modeling should be considered as an iterative process.

For example, a poorly calibrated pre-drill model may be calibrated while drilling. And as additional wells are drilled, the predictive capabilities of the geomechanics model will be tested and improved.

Geomechanical Models 1D vs. 3D

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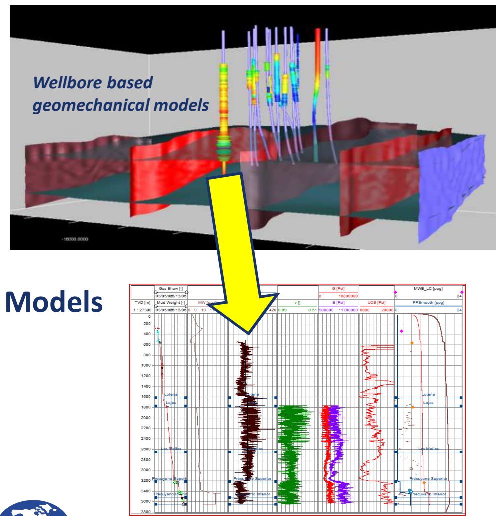
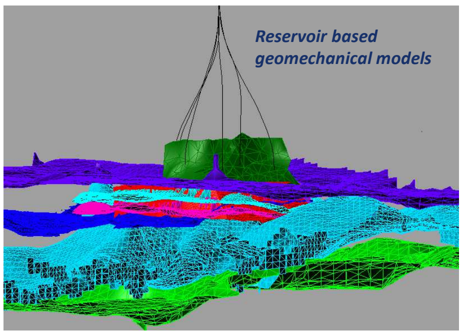


1D Models

- In-situ stresses
- Pore pressure
- Mechanical properties

3D Models



1D Geomechanical Model

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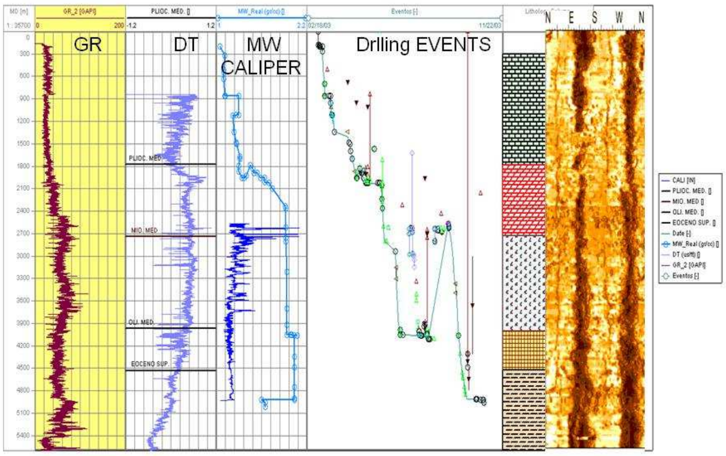
A 1D Geomechanical model is constructed and calibrated with information gathered *along a single well*....

- **Log data (sonic, density resistivity, image logs, caliper)**
- **Injectivity test data (mini-fracs, LOTs, DFITs)**
- **Pore pressure data (logs, RFTs, MDTs)**
- **Drilling information**



Drilling event analysis

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1D Geomechanical Model

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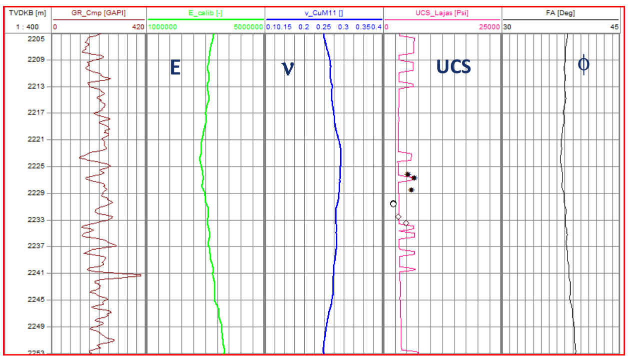
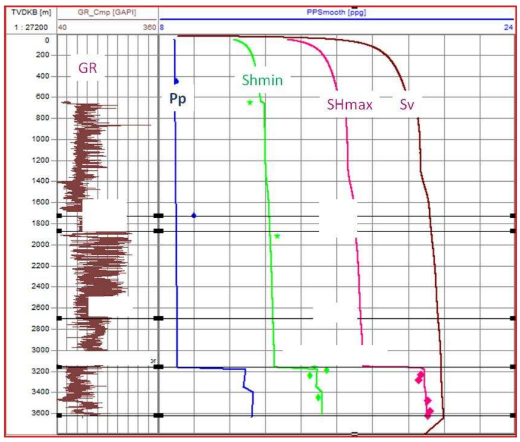


Mechanical properties vs. depth

Stresses vs. depth



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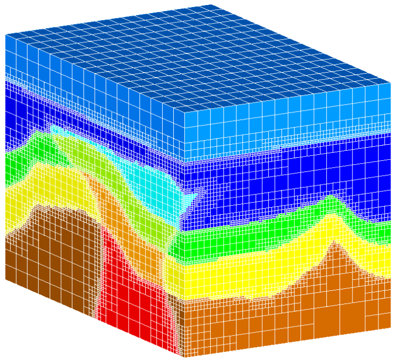
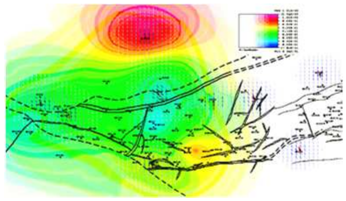
3D Geomechanical Model

A 3D Geomechanical model is constructed at a reservoir or sector scale using information from geology, seismic, reservoir and multiple well data.





A 3D Geomechanical model can account for:

- **Structural complexity**
- **Lateral stress variations**
- **Dynamic production/injection effects**
- **Field-scale effects**

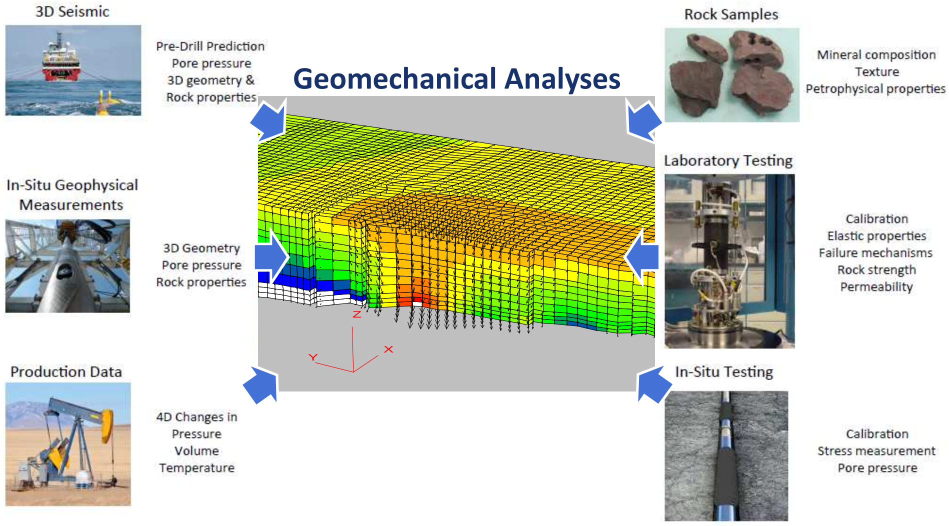
3D Geomechanical Models – Issues

- **Problem definition:**
  - ✓ ***What are we trying to solve? Stress? Strain? Thermal?***
- **Model selection, geometry (mesh) and construction**
  - ✓ ***FEM vs DEM, Structural data, lithology, faults, data import, tools***
- **Boundary conditions**
  - ✓ ***Plane strain conditions? Tectonics?***
- **Input data (stress, pore pressure, mechanical properties)**
  - ✓ ***Needed for the entire model limits***
- **'Driving' data or process**
  - ✓ ***Pressure? Temperature? Stress/strain?***
- **Analysis of results**
  - ✓ ***Evaluating and understanding the correct results***
- **Parametric considerations**
  - ✓ ***Accounting for uncertainties***

Geomechanical Models: Summary

1. The model must be fit-for-purpose – based upon the objective, available data, risk tolerance, timing and cost.
2. The tools exist to correctly (from first principles) model most (all?) petroleum geomechanics problems.
3. Data collection remains a major issue – but data is becoming more available as people see the value of models. Data vs. physics.
4. Most geomechanical evaluations still use simple, 1D geomechanical models. These cannot be used to *extrapolate* results.
5. 3D geomechanical models, while time consuming ($$) and data intensive, can more than pay out at today's costs.
6. Particularly for fracture-related evaluations, DEM codes are the proper codes to use as these model the unique interactions between fractured rock.

Geomechanics Data Sources



Courtesy: R. Plumb

Critical geomechanics data comes from seismic, logging, core, cuttings, in-situ testing and production operations. Capturing this data is a major challenge to future geomechanical analyses.

Geomechanics Applications

- Historically, the most common petroleum geomechanics efforts have focused on wellbore stability problems.
- Compaction/subsidence, stress-dependent reservoir production, sanding, solids injection and completion design have also been major petroleum geomechanics applications.
- With Unconventionals, a significant contribution of petroleum geomechanics is to completion optimization, wellbore stability/casing deformation and triggered seismicity.

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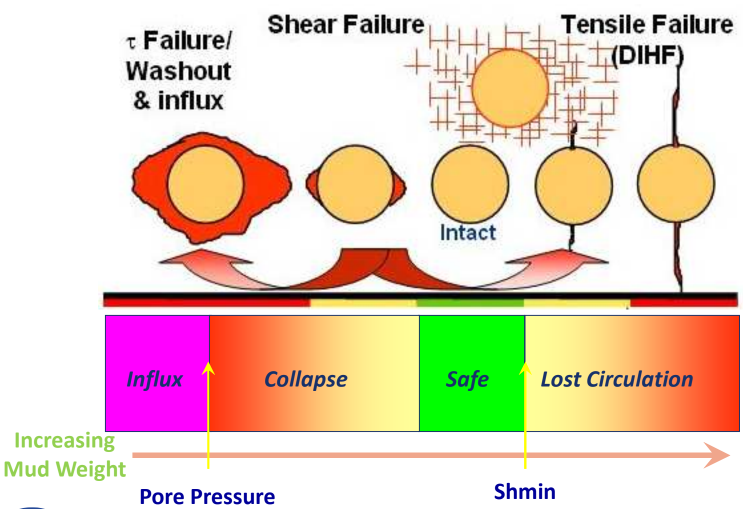
Geomechanics: Wellbore Stability



A wellbore stability study is a geomechanical evaluation of the mudweight limits to prevent pressure kicks, formation failure, and losses during drilling operations.

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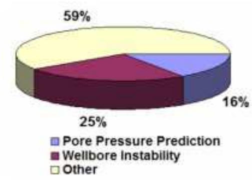
Geomechanics: Wellbore Stability

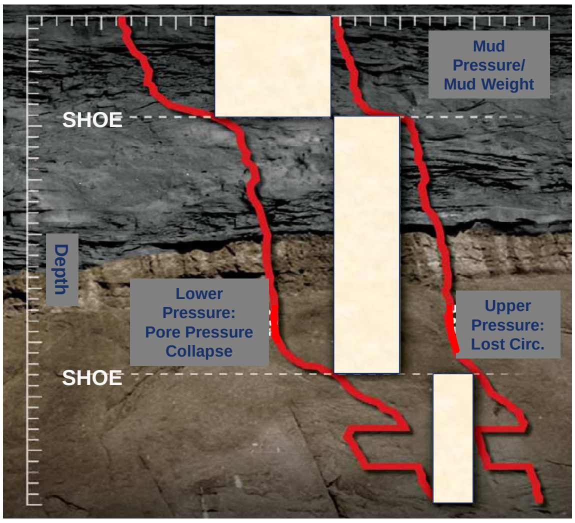
"Perhaps no other aspect of the pre-drill planning process is more critical for a successful drilling operation than the determination of the allowable mud weight window." Senior Drilling Engineer

Industry experts estimate annual costs upwards of $6 billion for wellbore stability problems during drilling operations alone. "Many of the opportunities to reduce risk and cost in drilling operations today are linked to understanding the geomechanical forces the well will encounter and incorporating that understanding into the well design process, said John Gibson, president and CEO of Landmark.



"Problems in these areas - Stuck Pipe; Kicks; Lost Circulation; Sloughing Shale; Flows; Wellbore Instability, some *41% of total NPT* - are estimated to cost the industry a combined $8 billion per year. Significant savings await companies willing to challenge the current "best practice" by focusing on total project costs and placing additional money on products and tools that help the driller avoid trouble time." *Offshore Magazine January 2004, James K. Dodson Co.*

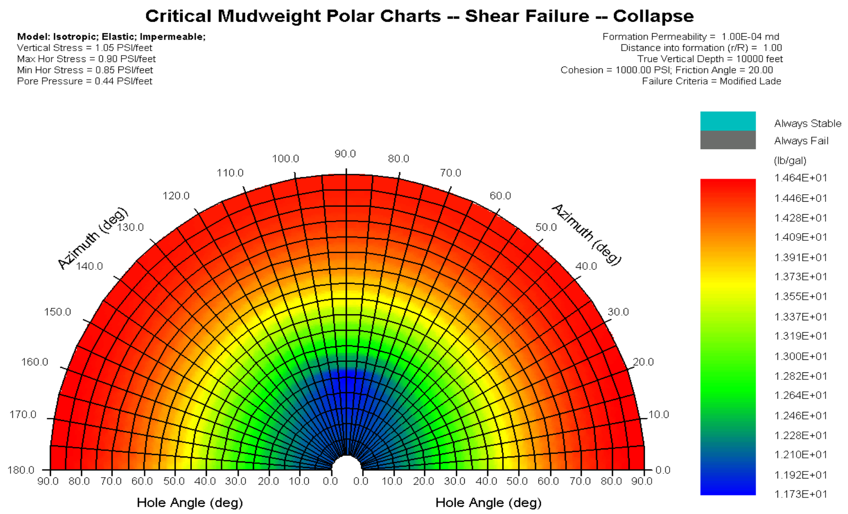
Geomechanics: Wellbore Stability



A proper wellbore stability study can not only optimize ROP – reducing drilling days – but also optimize casing shoe locations and potentially reduce the number of casing strings to reach planned well TD.

A major challenge in mature fields is the impact of pressure depletion on wellbore stability.

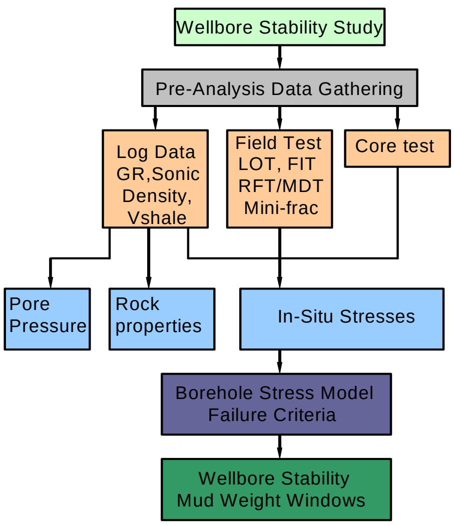
Geomechanics: Wellbore Stability



A common deliverable from a wellbore stability study is a polar plot, which shows required mudweight for a given formation as a function of well deviation and azimuth.

With a polar plot, the optimal trajectory through a problem formation can be determined.

Geomechanics: Wellbore Stability



A wellbore stability study involves the four main components of any geomechanics study: stress, pressure, mechanical properties, and geometry.

Log, field/operational, and laboratory data are applied to evaluate the geomechanical effects of drilling a well in a particular formation at a particular depth.

Geomechanics: Compaction/Subsidence

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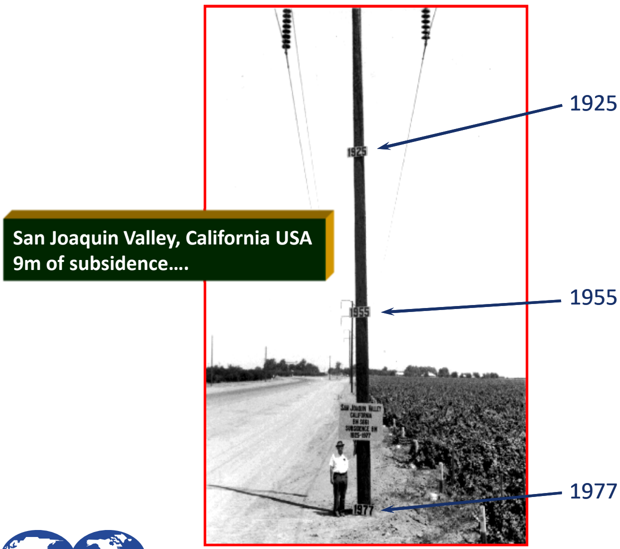

Compaction and surface subsidence challenges are presented world-wide from California to New Orleans and from Mexico City to the North Sea to Venice, Italy.

The common driver is formation pressure reduction, caused by fluid production, and the geomechanical effects induced on the subsurface formations.

Geomechanics: Compaction/Subsidence

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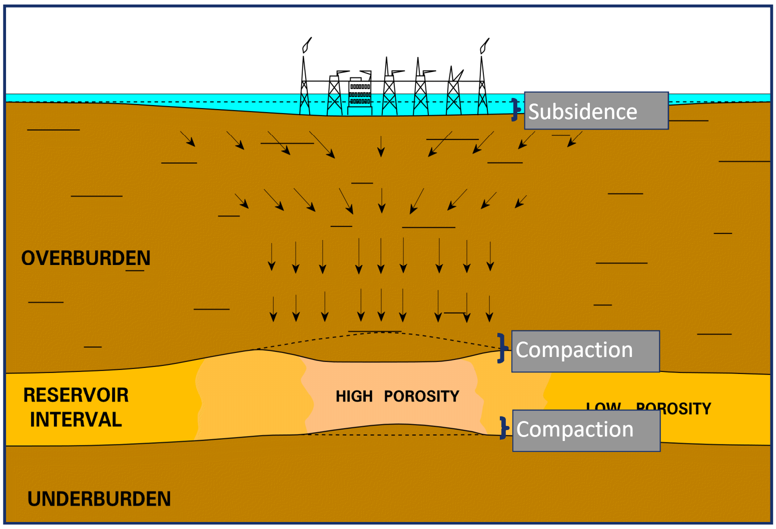
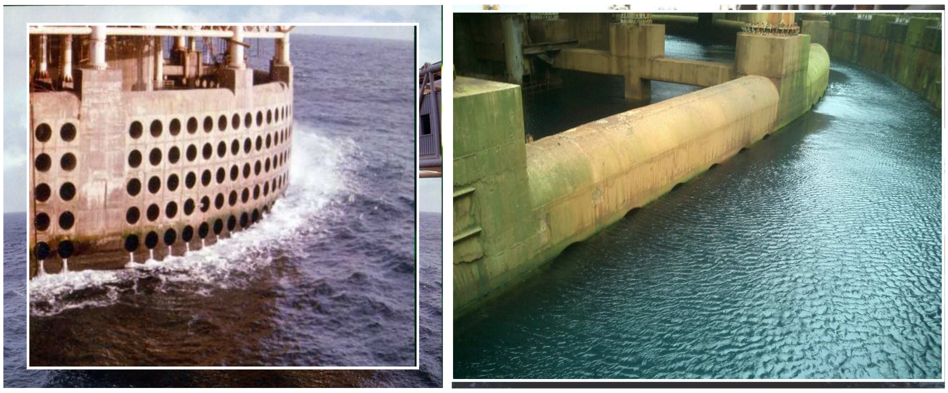


Compaction is the thinning of, typically, thick, high porosity, high pressure formations due to pressure depletion associated with production operations.

Compaction is caused by the increased stress acting on the weak formation and often leads to surface subsidence.

Geomechanics: Compaction/Subsidence



Seabed subsidence can be significant – in the case of the Ekofisk Field in the North Sea more than 10m at the crest of the field. Remediation of surface facilities to address subsidence issues can cost billions of dollars.

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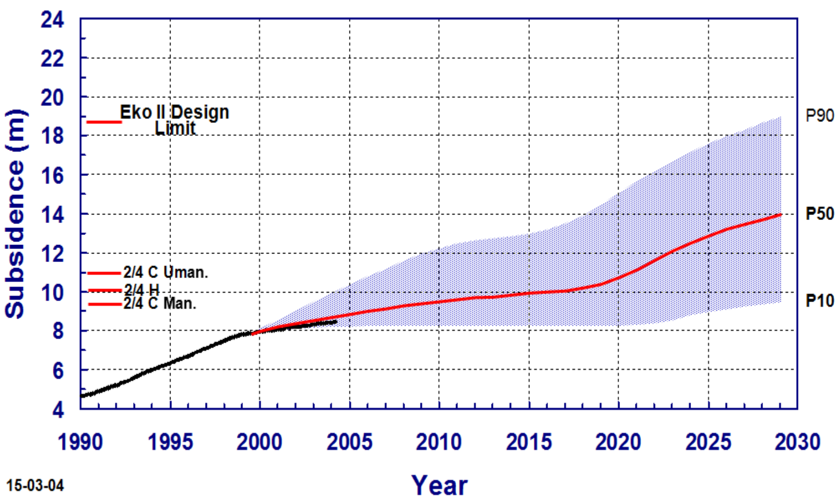
Geomechanics: Compaction/Subsidence



The geomechanical prediction of future subsidence is challenging. A significant uncertainty in a subsidence prediction is future reservoir management and the associated formation pressures.

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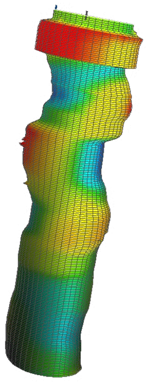
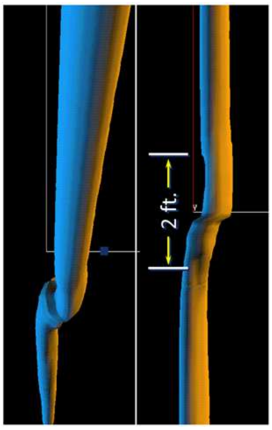
Geomechanics: Casing Deformation

Reservoir Buckling



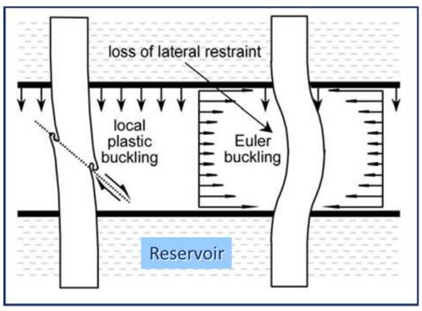


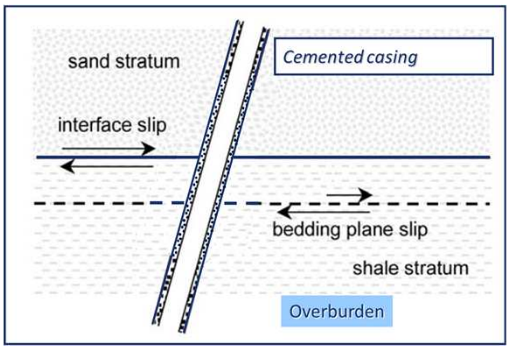
Overburden Shear

Historically, casing deformations were related to compacting and/or highly over-pressured reservoirs. With pressure depletion, the stress in and around the reservoir was altered leading to formation deformation or failure.

With Unconventionals, casing deformation has become a growing problem as deformations have restricted hydraulic fracturing operations in heel-side stages.

Geomechanics: Casing Deformation

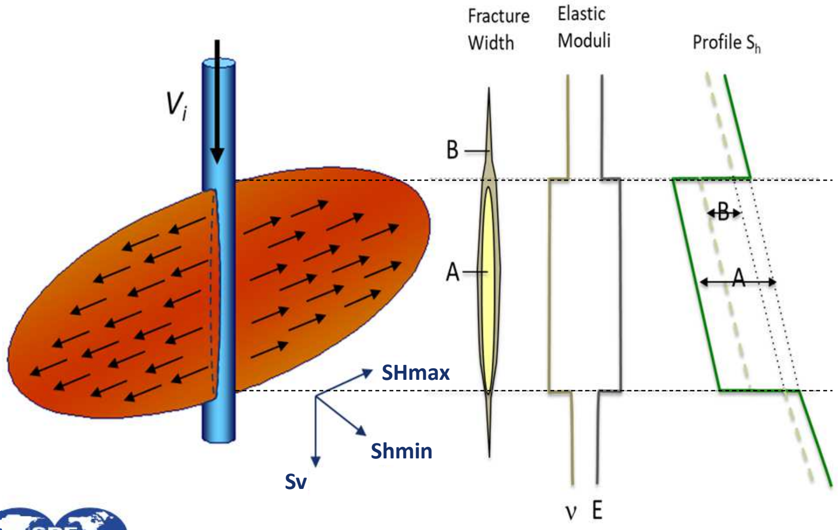




In the reservoir, formation compaction-induced deformations lead to casing deformations

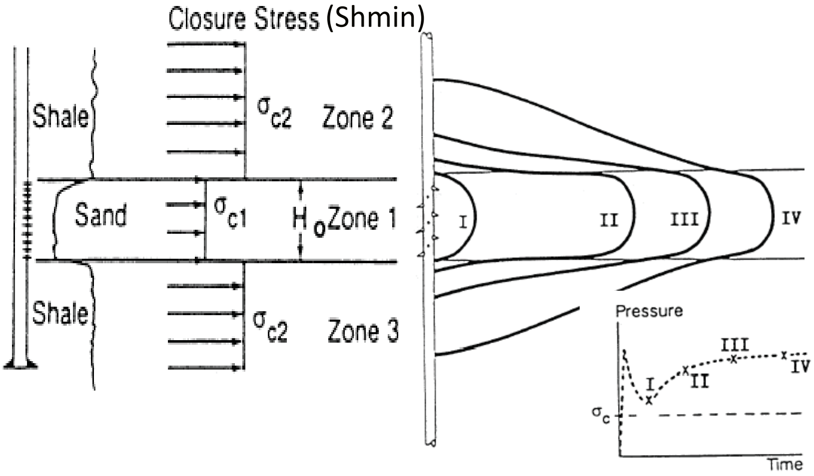
Around and above the reservoir, bedding or fault slip induced by hydraulic fracturing or production operations can lead to casing deformations

Geomechanics: Hydraulic Fracturing



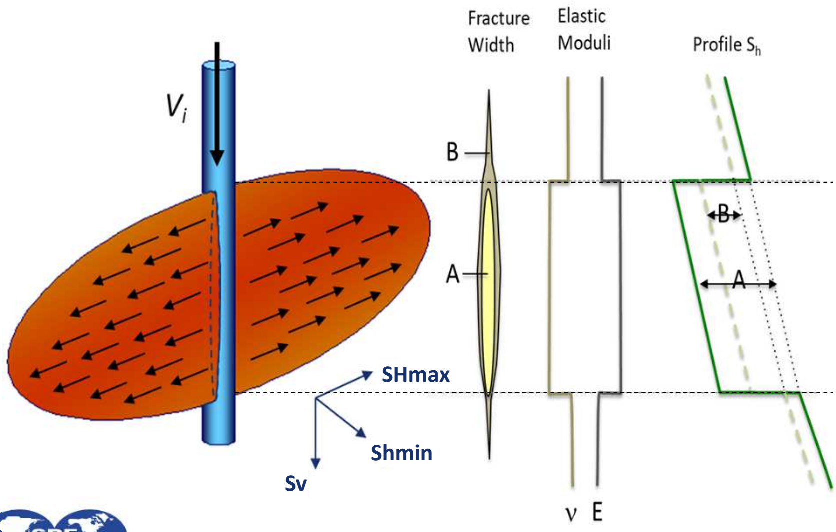
Traditionally, hydraulic fracture propagation was considered to be dominated by the profile of the minimum stress, Sh. Elastic properties were considered important primarily in fracture width and fracture conductivity.

Geomechanics: Hydraulic Fracturing



When hydraulic fracture propagation is dominated by the profile of the minimum stress, Shmin, vertical growth is primarily influenced by the ratio of net pressure (pressure in the fracture minus Shmin) to the stress increase in overlying and underlying formations.

Geomechanics: Hydraulic Fracturing



The bi-wing, planar hydraulic fracture concept is built on two assumptions:

- ***Uniform stresses laterally away from the wellbore.***
- ***Rock heterogeneity is secondary to stress effects on propagation.***

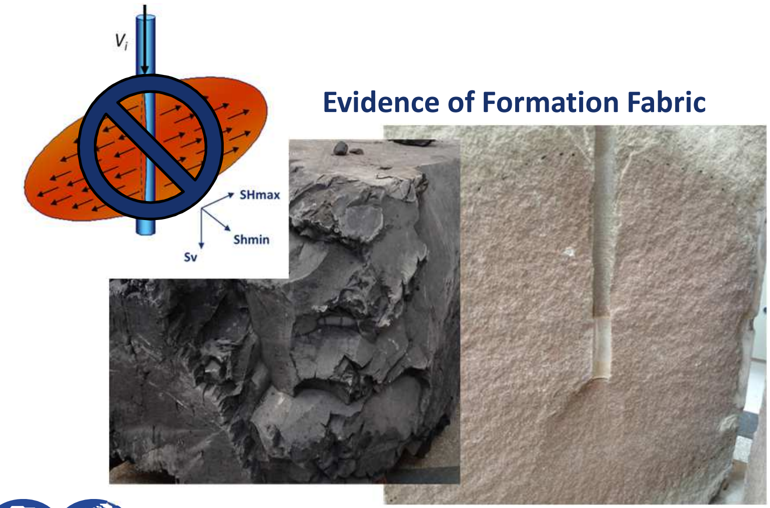
Geomechanics: Hydraulic Fracturing

Critical Points:

- **First, the hammer we have to break the formation is net pressure – and net pressure for many situations is only 200 to 300 psi (and an order of magnitude or more smaller than the shear strength of the formation).**
- **Second, when we use that hammer (net pressure), the formation is going to tend to fail in tension rather than shear (i.e., the formation is weaker in tension, typically by 1/10th of shear, ergo a tensile hydraulic fracture will be created).**
- **Third, the created tensile hydraulic fracture will (in a normal faulting stress environment) tend to grow vertically and propagate toward the maximum horizontal principal stress (SHmax) as this is the path of least resistance.**
- **Finally, the created hydraulic fracture will stop growing when the formation can handle the rate of fluid injected – either because the pumps have been shut down and no fluid is being injected or because leakoff into the formation matrix and/or natural fractures exceeds the injection rate; however, the hydraulic fracture path will remain the path of least resistance unless that path is blocked in some fashion.**

Geomechanics: Hydraulic Fracturing in Unconventionals

Webinars



Hydraulic fracture operations in Unconventionals tend to be dominated by:

- ***Non-uniform stresses laterally away from the wellbore.***
- ***Significant rock heterogeneity in mechanical and strength properties.***

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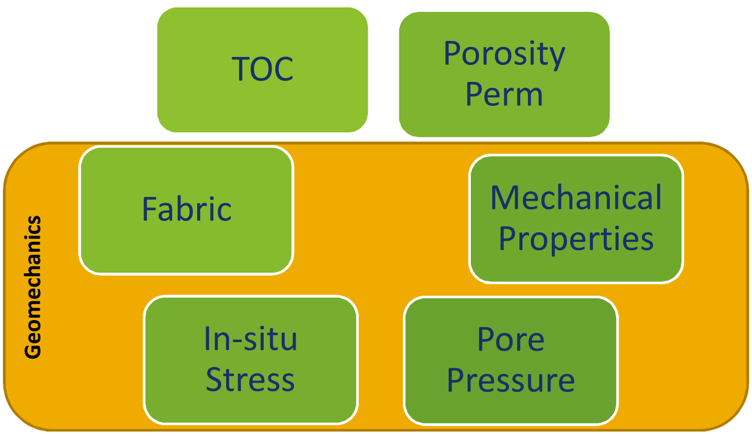
Geomechanics: Unconventionals

Webinars



Geomechanics serves as a significant component of reservoir quality and reservoir characterization in Unconventionals. Shown here, this example of Unconventional Reservoir Quality Indicators is dominated by geomechanical parameters.

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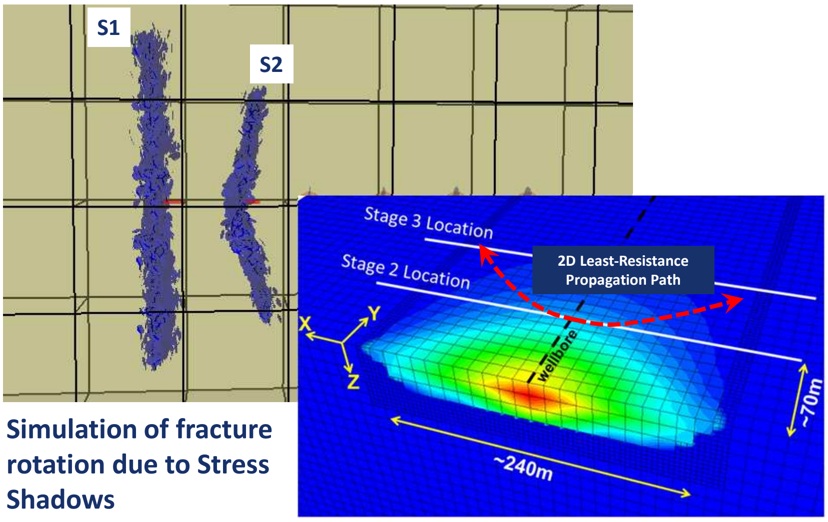
Geomechanics: Unconventionals

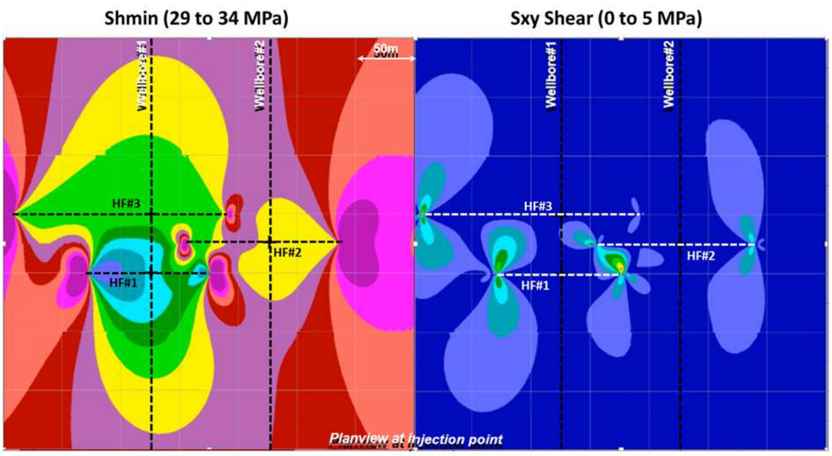


Simulation of fracture rotation due to Stress Shadows

The deformations induced by a hydraulic fracture alter the local stress field and this stress alteration is called the Stress Shadow.

The Stress Shadow can impart a rotation to hydraulic fractures along a horizontal lateral as well as increase injection pressures and ISIP values.

Geomechanics: Unconventionals

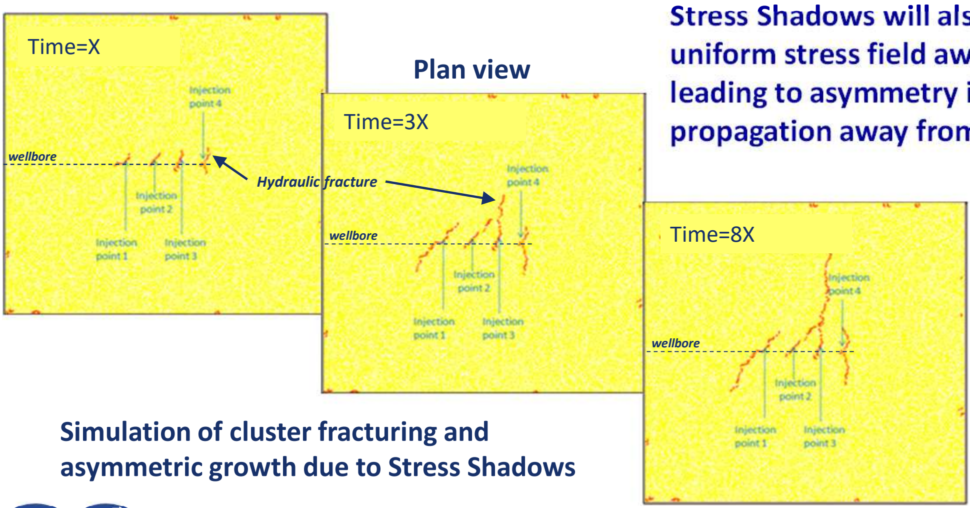


Simulation of multi-well, multi-fracture Stress Shadows

The deformations from multi-well completions (‘Zipper’ fracs) create a highly complicated Stress Shadows which can affect:

- **Fracture width and conductivity.**
- **Fracture length asymmetry (i.e. drainage volume and well spacing).**
- **Shear stresses and monitoring (microseismics).**

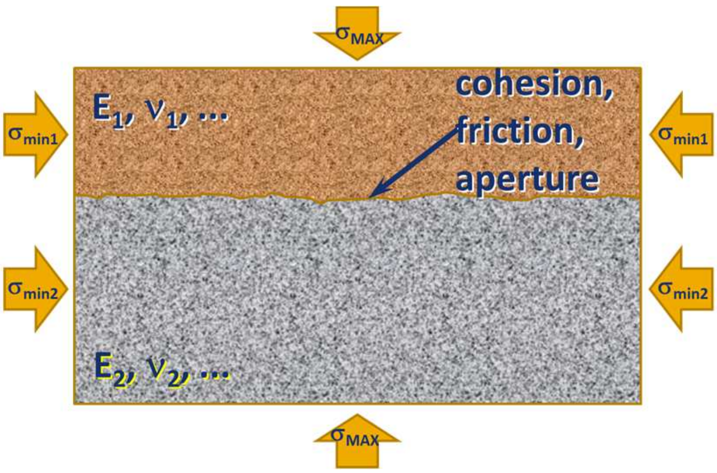
Geomechanics: Unconventionals



Stress Shadows will also create a non-uniform stress field away from a lateral – leading to asymmetry in hydraulic fracture propagation away from the lateral.

Simulation of cluster fracturing and asymmetric growth due to Stress Shadows

Geomechanics: Unconventionals



Hydraulic fracturing in Unconventionals is often dominated by the interaction of the fracture with rock fabric. Rock fabric may create changes in mechanical properties and strength, changes in stress, changes in pressure, and changes in properties at the interface between the rock fabric (e.g., natural fractures and bedding planes).

Geomechanics: Unconventionals

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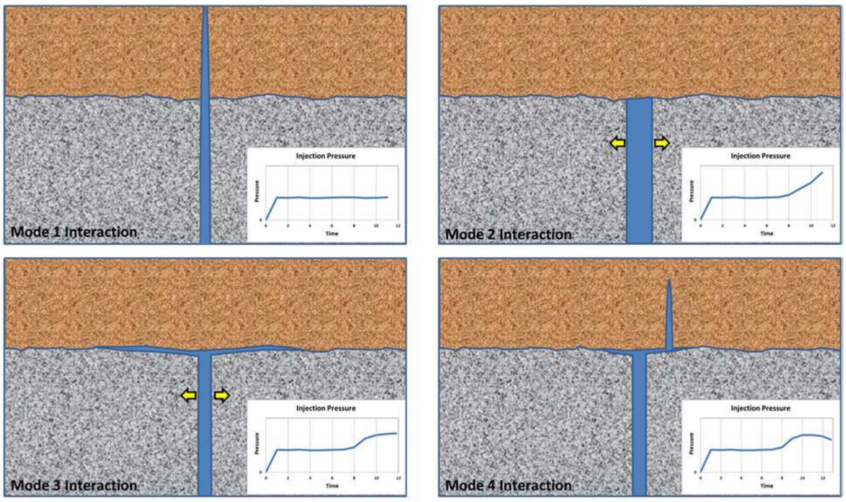

Hydraulic fracture propagation through an interface can be a complicated geomechanical effect. However, this behavior affects:

- **Fracture height, length, and width.**
- **Drainage volume.**
- **Well spacing.**

Geomechanics: Unconventionals

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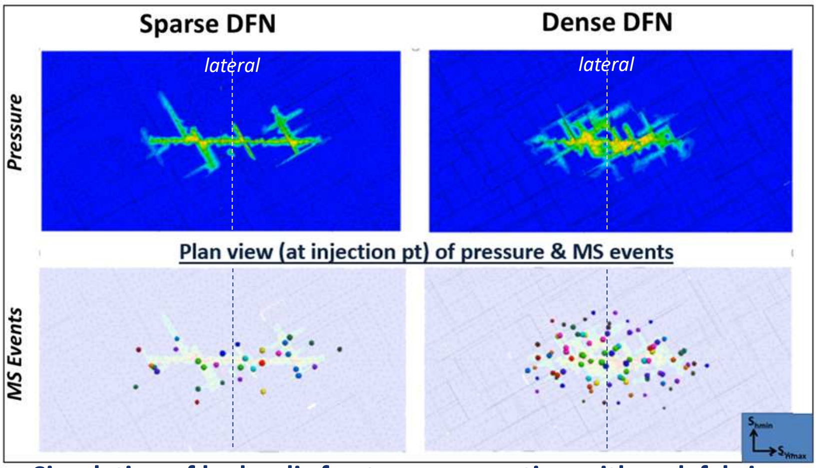
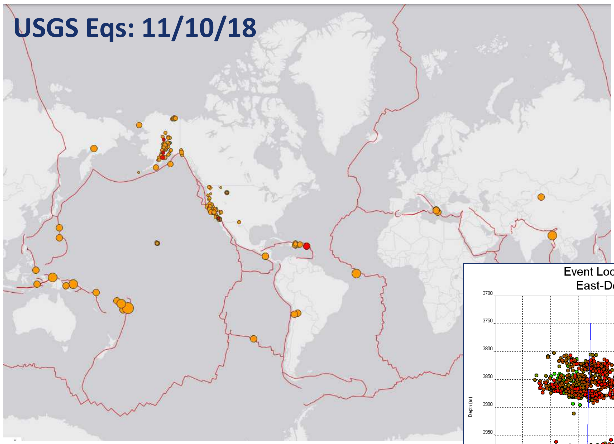
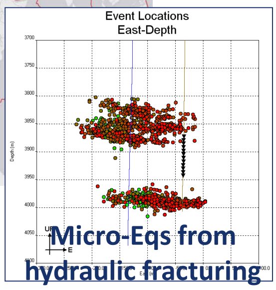


Simulation of hydraulic fracture propagation with rock fabric

Hydraulic fracture propagation in the presence of fabric creates complicated drainage fields as well as monitoring behavior. Note that the length of the hydraulic fracture in the Dense case is shorter than in the Sparse case.

Geomechanics: Seismicity





Seismicity – whether of the magnitude of an earthquake that can be felt or a much smaller magnitude from hydraulic fracturing or water disposal operations – is essentially the failure of the earth due to stress and or pressure changes. Geomechanical evaluations are critical to both predicting future events as well as understanding the significance of measured events.

Geomechanics: Seismicity

Triggered or Induced??

Common usage has been to call almost all seismicity "induced". However, this may be misleading.

An "induced" seismic event suggests that all the energy for the event is added to the system as part of a human-related operation.

A "triggered" seismic event suggests that a human-related operation added a small, last bit of energy to an already high-energy system leading to the event.

Geomechanics: Seismicity

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Normal Effective Stress x Friction Coefficient < Shear Stress

$$(\sigma_{Tn}-P_p) \times \tan(\phi) < \tau$$

σ_{Tn} =Total normal stress on fault;
P_p = Pressure on fault plane;
Φ = Friction angle; and
τ = Shear stress on fault plane.

The simplest model for rock failure and fault slip shows that slip is triggered when the shear stress acting on the fault (whether pre-existing or added) exceeds the resistance force (which is the total normal stress on the fault minus pressure multiplied by the friction property of the fault).

This reflects the critical role of: *1) pre-existing shear, 2) fault/fabric orientation, 3) total stress changes and 4) pressure changes*.

Geomechanics: Microseismicity

Webinars

Microseismicity is the acoustic representation of the energy release from rock failure; in field data, this is rock shear failure.

Generating Mechanism (Transduction) → **Acoustic Wave Propagation** → **Reception (Transduction)**

Geomechanics

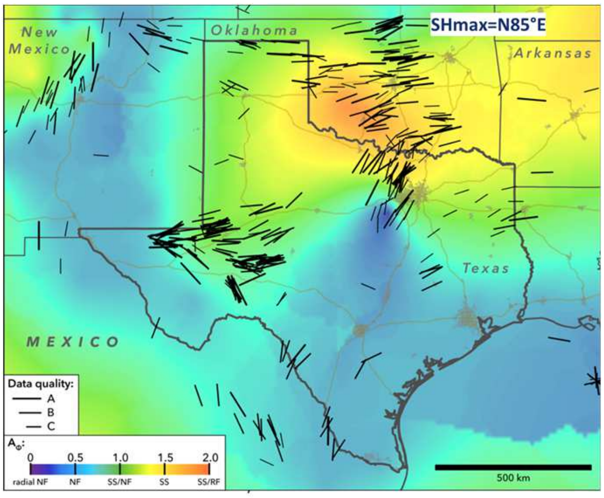
Velocity Model
Ray Paths

Geophones
Array Setup
Signal/Noise

Microseismicity evaluation considerations

Geomechanics: Seismicity

Webinars



Not surprisingly, Oklahoma, which has experienced a significant increase in seismicity over the last decade, has high horizontal shear stresses.

These shear stresses are a primary driver for the seismicity.

Cornelius Langenbruch, and Mark D. Zoback Sci Adv 2016;2:e1601542

Geomechanics: Seismicity

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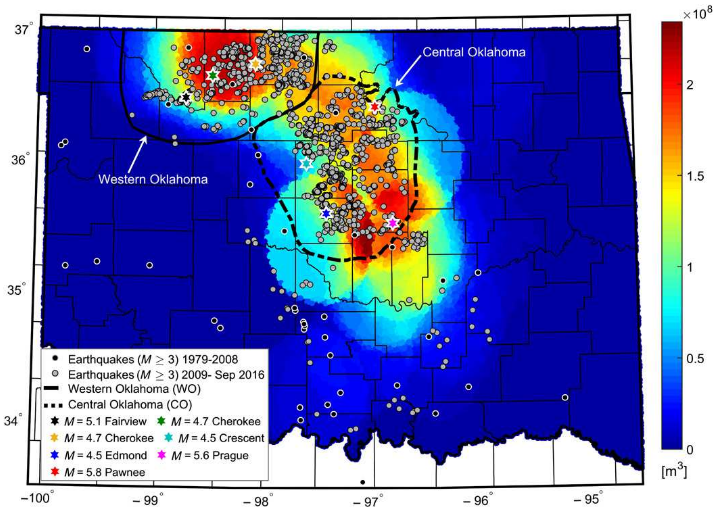

Where Oklahoma has experienced the increase in seismicity over the last decade, there has been areas of high salt water disposal operations.

Water disposal is a focus due to the potential role of pressure changes on seismicity.

Cornelius Langenbruch, and Mark D. Zoback Sci Adv 2016;2:e1601542

Geomechanics: Seismicity

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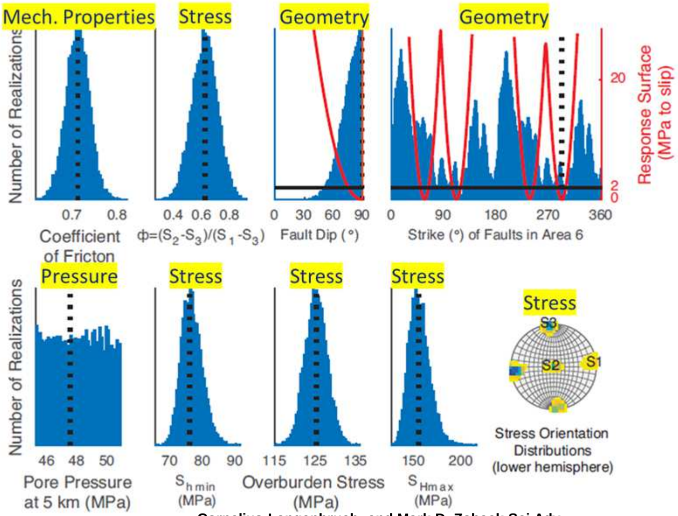

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Quantitative risk assessments for seismicity must account for the four primary components of a geomechanical evaluation:

- **Stress**
- **Pressure**
- **Mechanical properties**
- **Geometry**

Geomechanics: Seismicity

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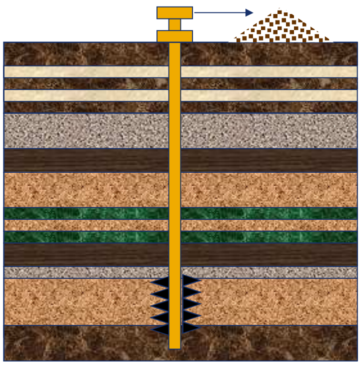
Saltwater Disposal Operational Factors	Formation Characteristics	Injection Operations	Operating Experience
Significant	Injection horizon likely incommunication with basement, underpressured injection interval	High cumulative injection volumes and rates	Limited injection experience in region, past earthquakes clearly or ambiguously correlated with operations
Moderate	Injection horizon potentially in communication with basement, slightly underpressured injection interval	Moderate cumulative injection volumes and rates	Moderate injection experience in region with no surface felt ground shaking
Minor	Injection horizon not in communication with basement	Low cumulative injection volumes and rates	Extensive injection experience in region with no surface felt ground shaking

TABLE G.1. *After R.J. Walters et al.: Factors related to saltwater disposal operations that contribute to the level of risk at an injection site. Source: SCITS 2015.*

Qualitative risk assessments can also be developed from field experience reflecting the primary components of a geomechanical evaluation.

Geomechanics: Sand Production "Sanding"

Webinars



Sand handling in the surface

Erosión and damage of bottomhole and surface equipment

Well intervention, deferred production and Casing collapse

Rock failure occurs at high values of stress and the rock mass is destabilized due to high flow rates and erosive forces.

Sand particles are removed from the rock mass and flow into the wellbore.

Rock failure modes: *Shear* (high stresses, low wellbore pressure, low rock strength); *tensile* (high flow rate, perm damage at the cavity surface); *Erosion* (high seepage forces).

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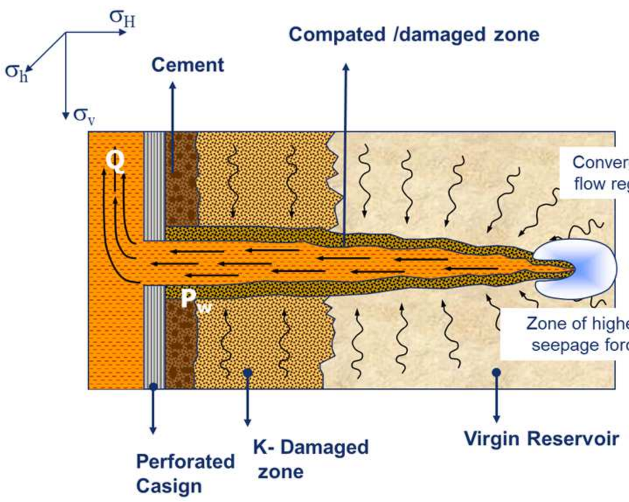
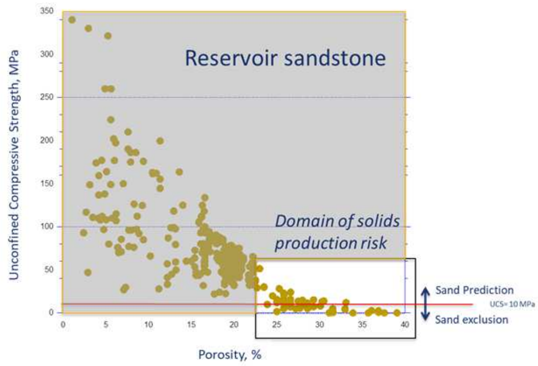
Geomechanics: Sand Production

Webinars





Sanding occurs in high porosity, weak formations as stress changes and fluid flow destabilizes the perforation tip.

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Geomechanics: Sand Production

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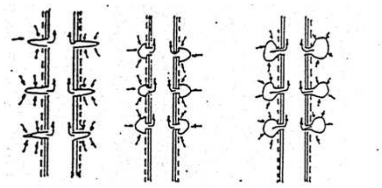
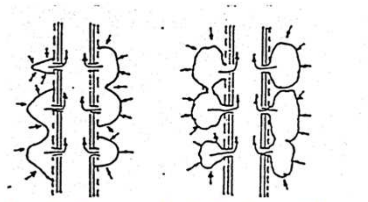
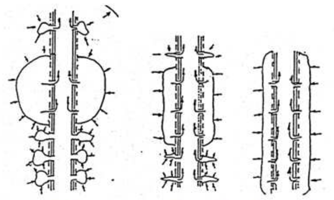


Early stages of sanding

As Sanding progresses, the created cavity tends to stabilize (stress) and the seepage forces decline with surface area. Often sand production volumes decrease and may stop.



Spherical or cylindrical cavities



Lack of support behind casing

When sand production does not abate, the completion can be loss and the well may fail.

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Geomechanics: Sand Production

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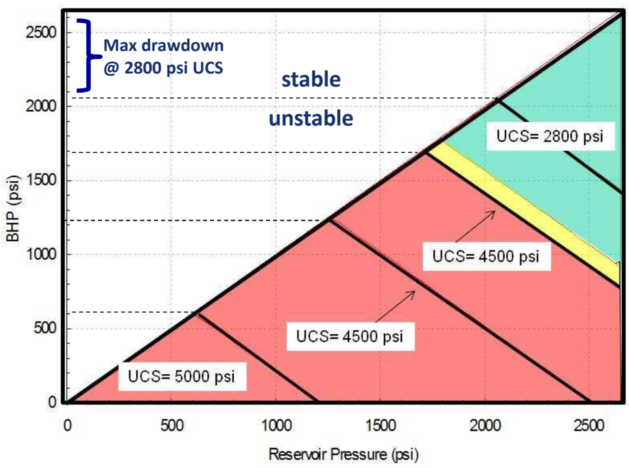

The typical geomechanical analysis for Sanding predicts the minimum allowable bottomhole pressure (BHP), for a given reservoir pressure, as a function of completion type and rock strength.

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Geomechanics: Solids Injection

Webinars

Drill cuttings

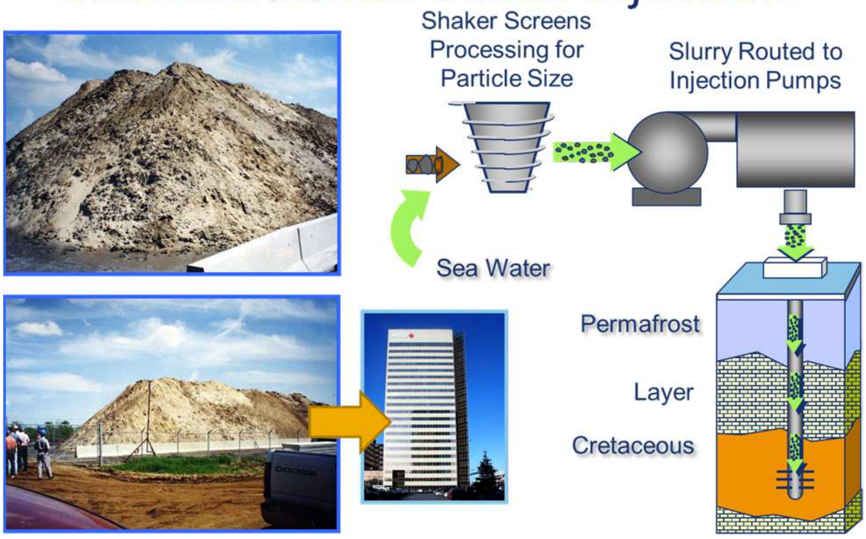
Solids production

Every well will produce cuttings during drilling operations and many wells, in weak formations, will produce solids during production operations.

These are commonly disposed of via downhole injection operations.

Geomechanics: Solids Injection

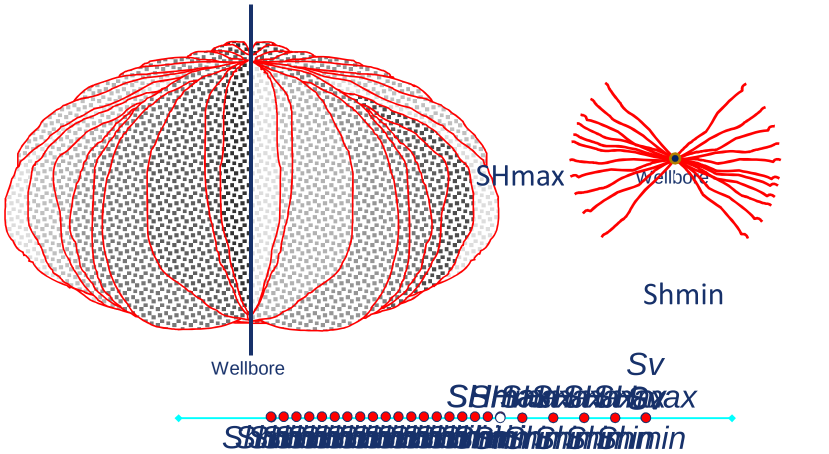
Webinars



Solids injection, this example from Alaska's North Slope, involves the geomechanics of long-term (years!), multi-cycle injection of slurrified solids while maintaining safe containment of the solids.

Geomechanics: Solids Injection

3D View of Domain *Plan View w/Stress Field*



With each storage fracture, the surrounding stress field is altered (known as the Stress Shadow). Subsequent hydraulic fractures will follow a lower stress path creating a "Disposal Domain". Geomechanical evaluations are critical to knowing the pressure behavior and storage volume.

Introduction to Geomechanics: Summary

- The goal of this presentation has been to provide a *definition of geomechanics*, provide some *background and history*, present a typical *geomechanics workflow*, consider the *value of geomechanics* and present a brief summary of typical *petroleum geomechanics applications*.
- The SECOND webinar of this GTS-sponsored webinar series will discuss the specific aspects of in-situ stress and formation pressure.
- The THIRD webinar will develop the geomechanics of mechanical properties and strength and geometry aspects.

Poll Question

Webinars

Are you a member of the SPE Geomechanics Technical Section?

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Thank you!

Webinars

Questions?

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