

# Preventing Reservoir Sand Movement into the Wellbore Using Locally Developed Filter

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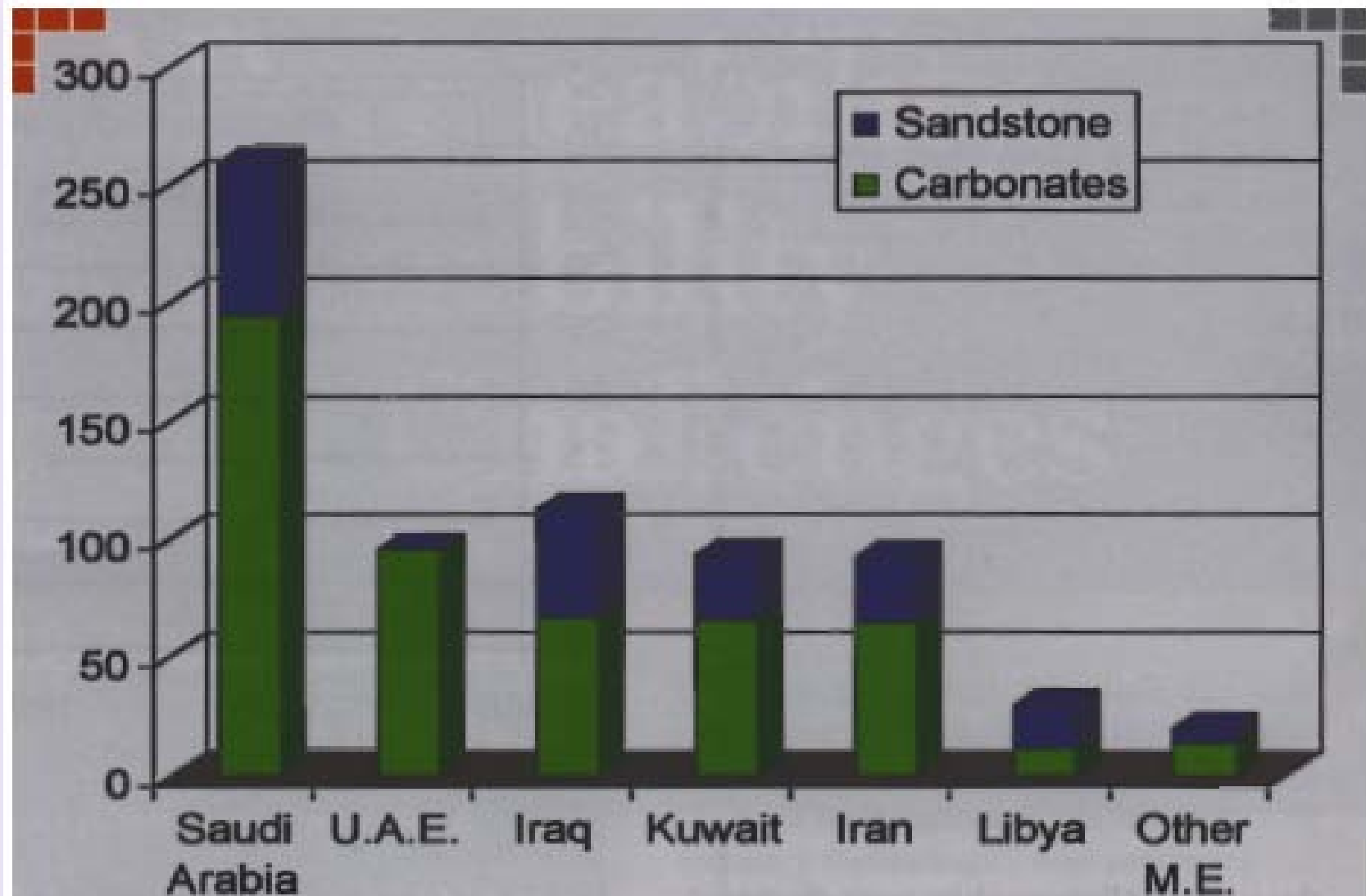
By  
Musaed N. J. Al-Awad

**Sand production prediction, control, management,  
and mitigation concerns are essentially:**

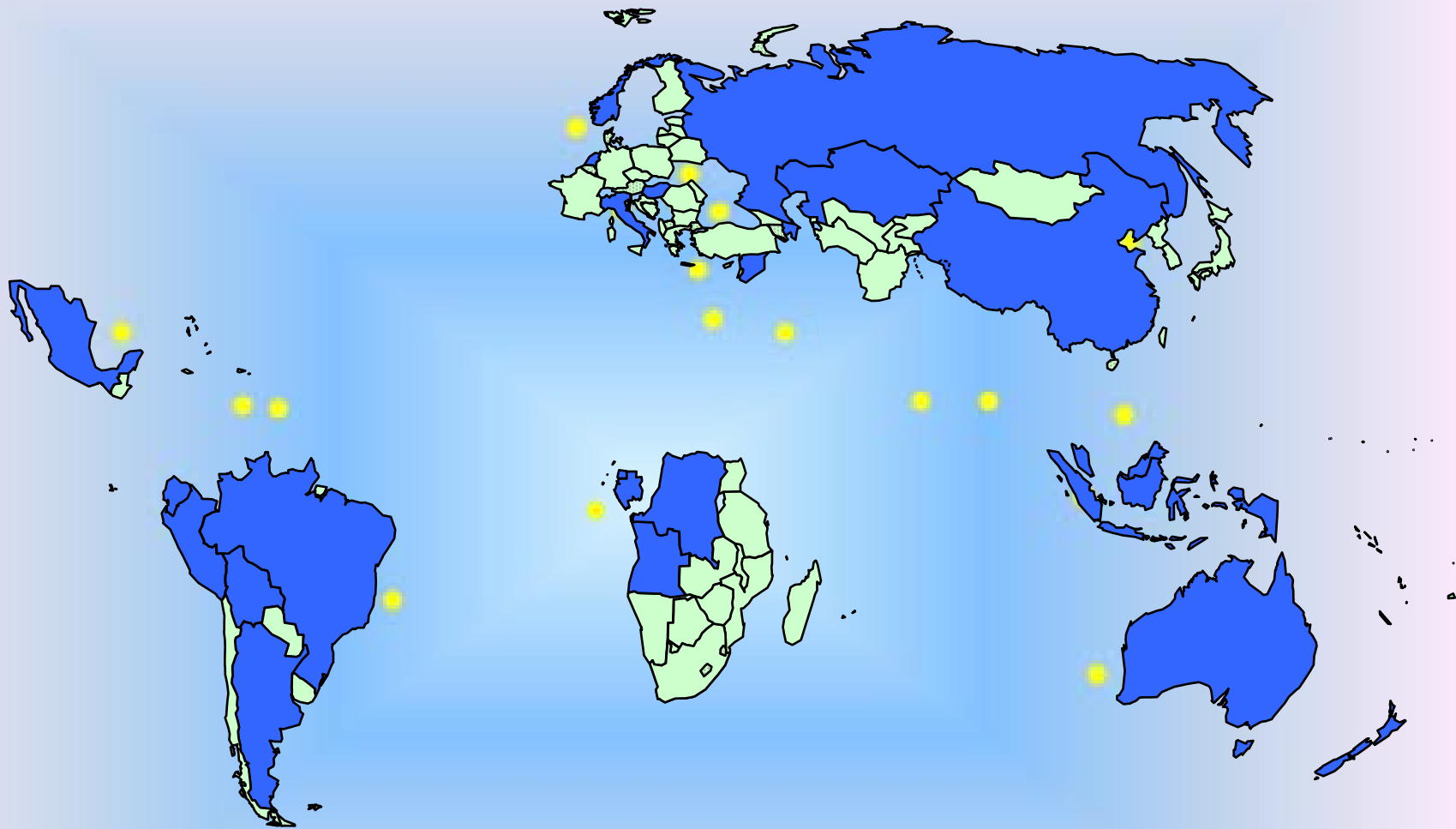
**Economics**

**and Safety**





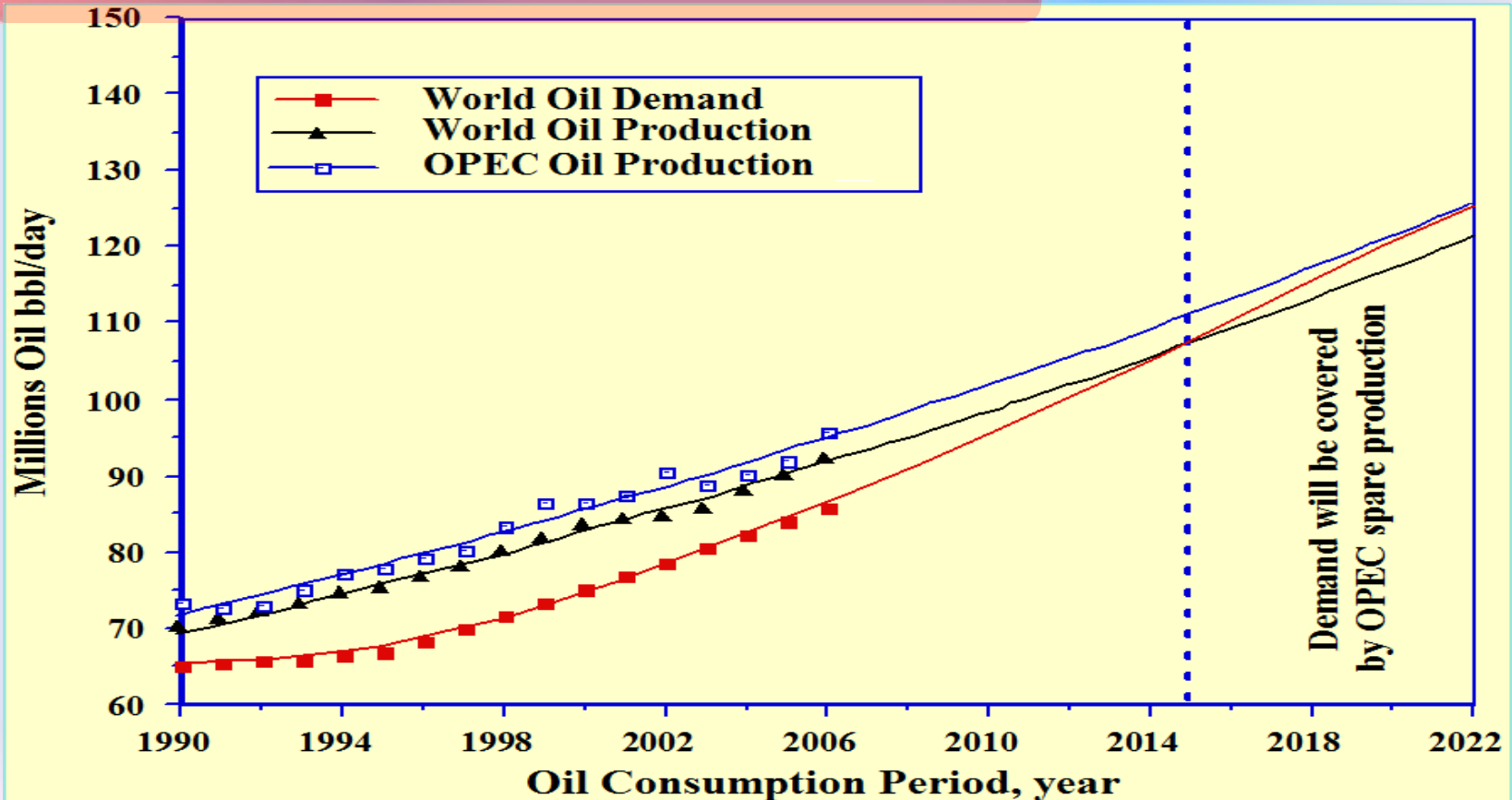
+ Fig.5. Distribution of Middle East oil reserves in both carbonate and sandstone reservoirs. Some 75% of Middle East proven oil reserves is contained in carbonate reservoirs.



**Current and potential Worldwide Sand Productive Formations**

# Production from Worldwide Oil Fields

Average Productivity, bbl/day	No. of Oil Fields		Percentage of World Total Production		Fields Size
9,000	4000+		53%		Small
130,000	61	116	12%	47%	Giant
560,000	41		15%		
993,000	14		20%		





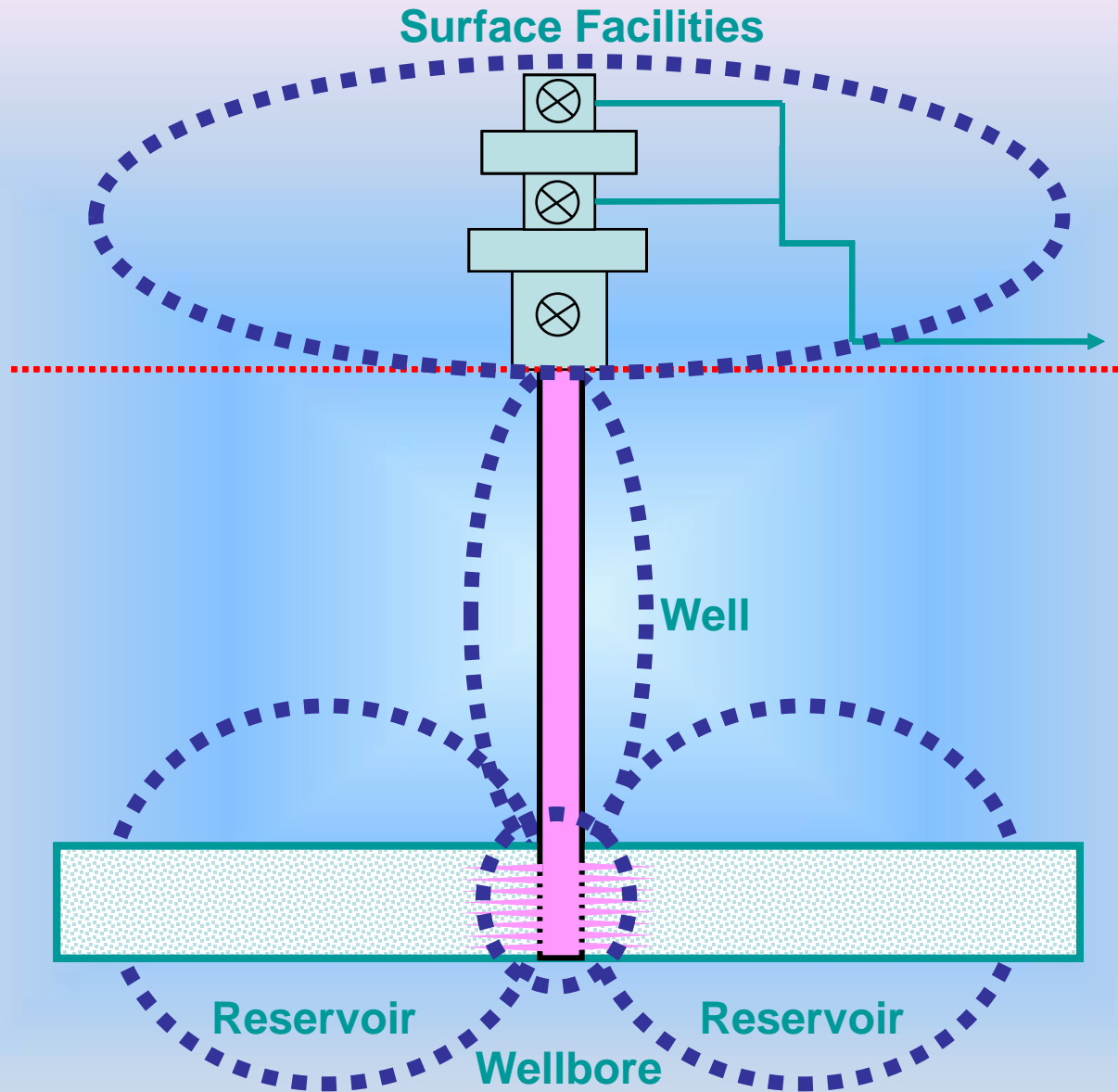


# What is Sand Production?

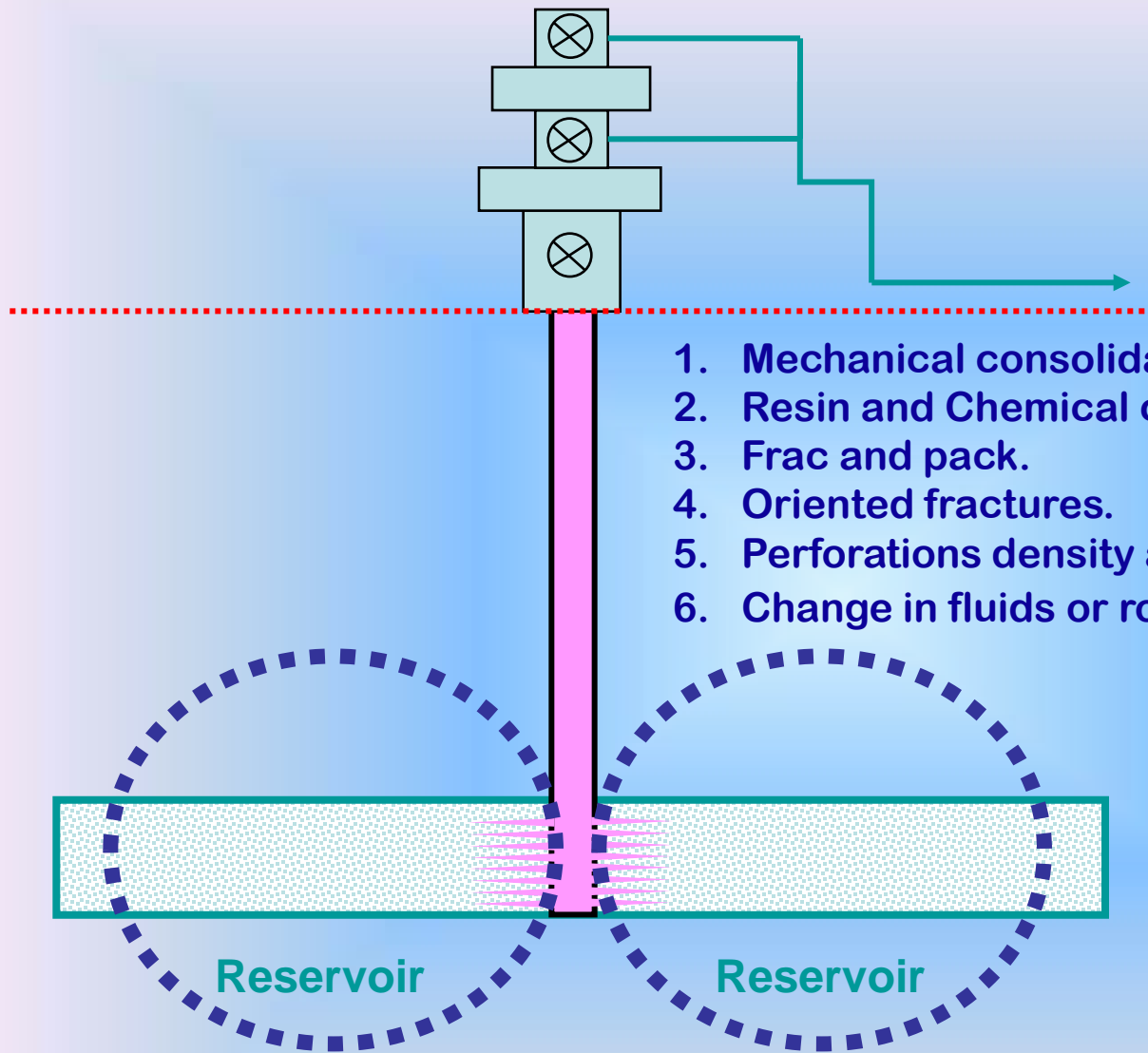
- Sand production refers to the production of solid particles which support the overburden.
- One of the oldest problems of the oil and gas fields. It is usually associated with shallow formations of Cenozoic age, but in some areas sand problems may be encountered to depths of 12,000 feet or more.
- The rock needs to fail for solids to be produced.
- Once the induced forces overcome the formation strength, the rock will fail.
- Fine particles production (< 90 percentile) is NOT sand production because it is not considered part of the mechanical structure of the formation.
- Sand production will follow if sand can be transported.

**Sand**  
**Control / Management**  
**Philosophy**

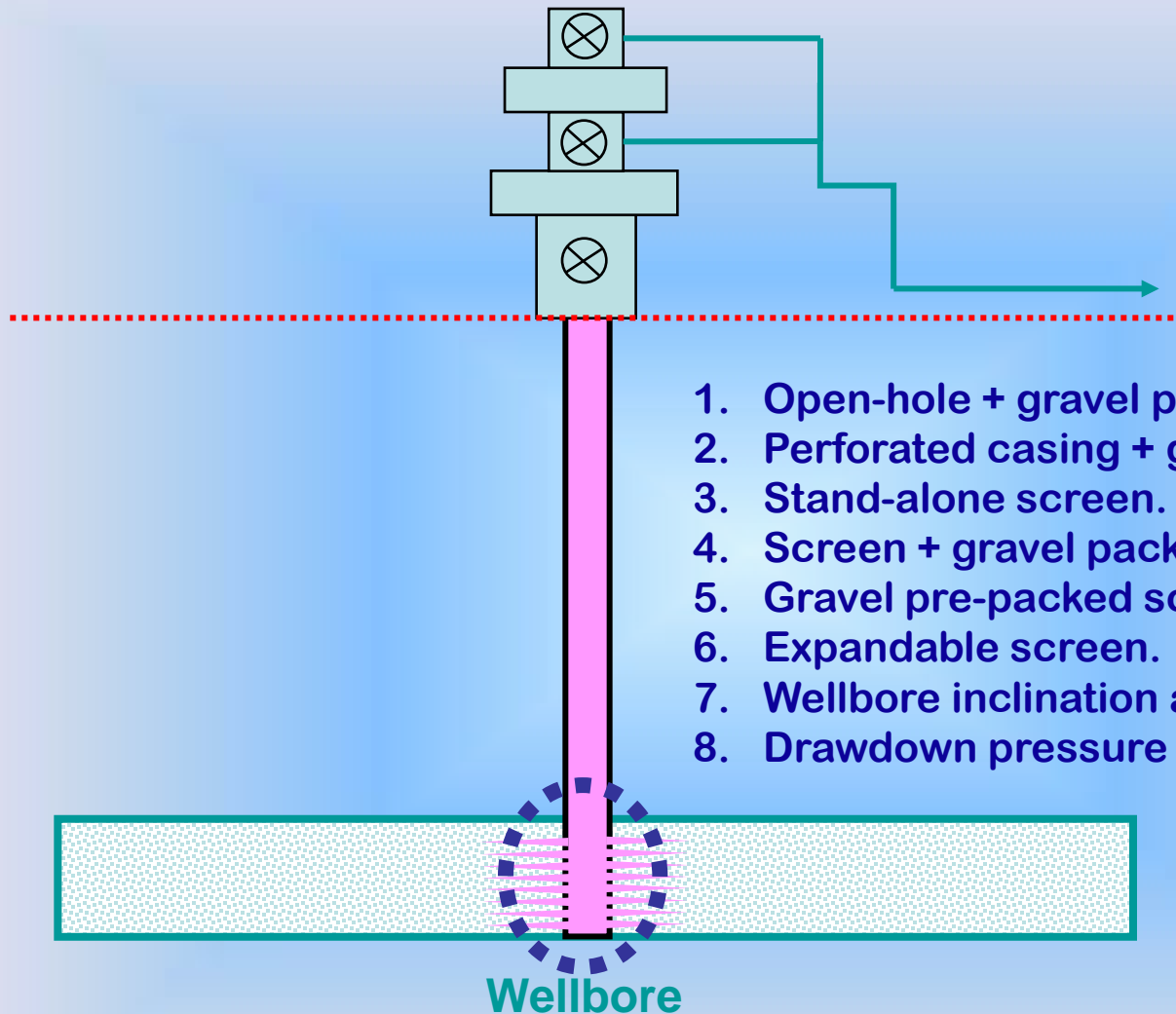




**Sand Control / Management Philosophy**

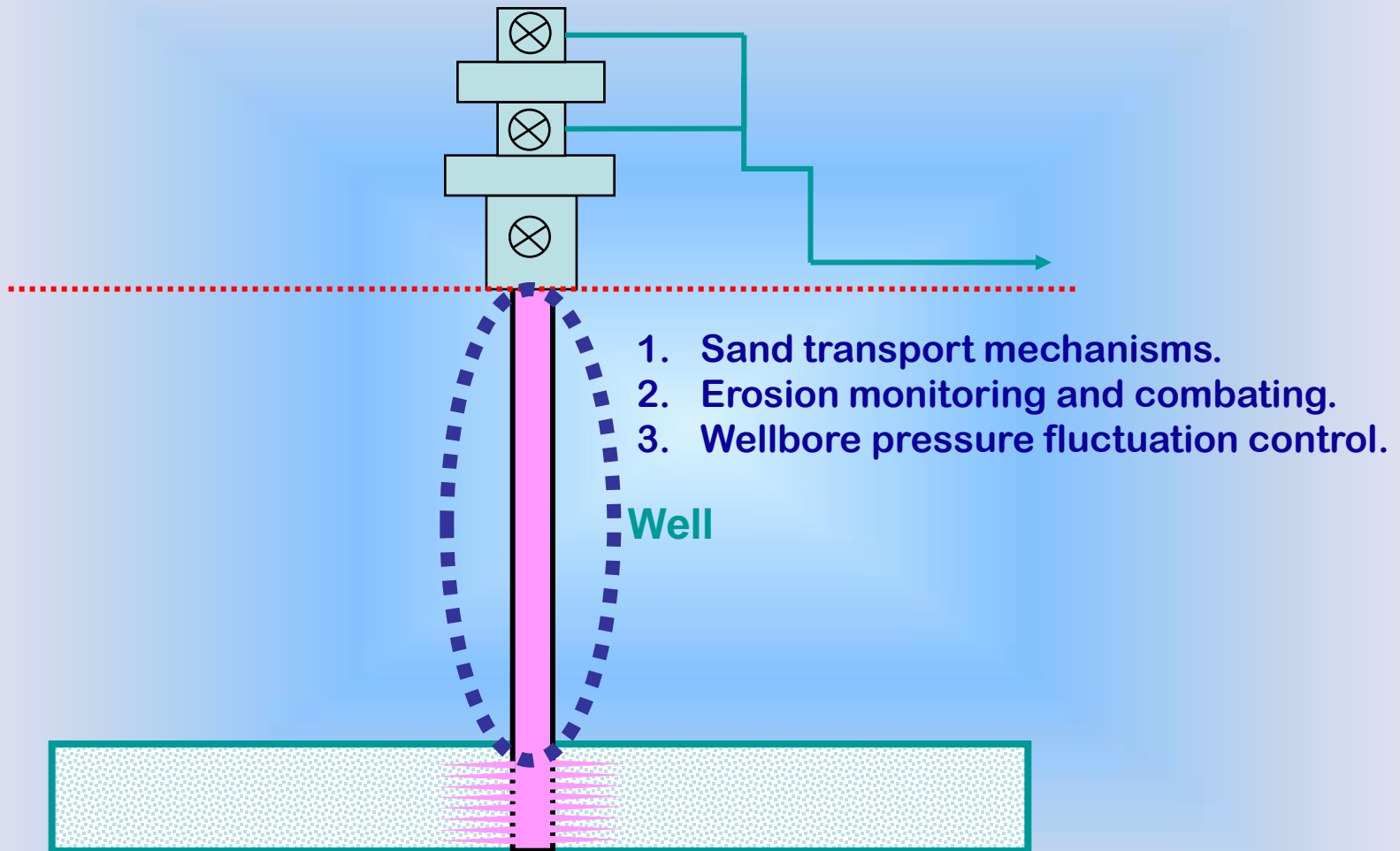


## **Sand Control / Management Philosophy**

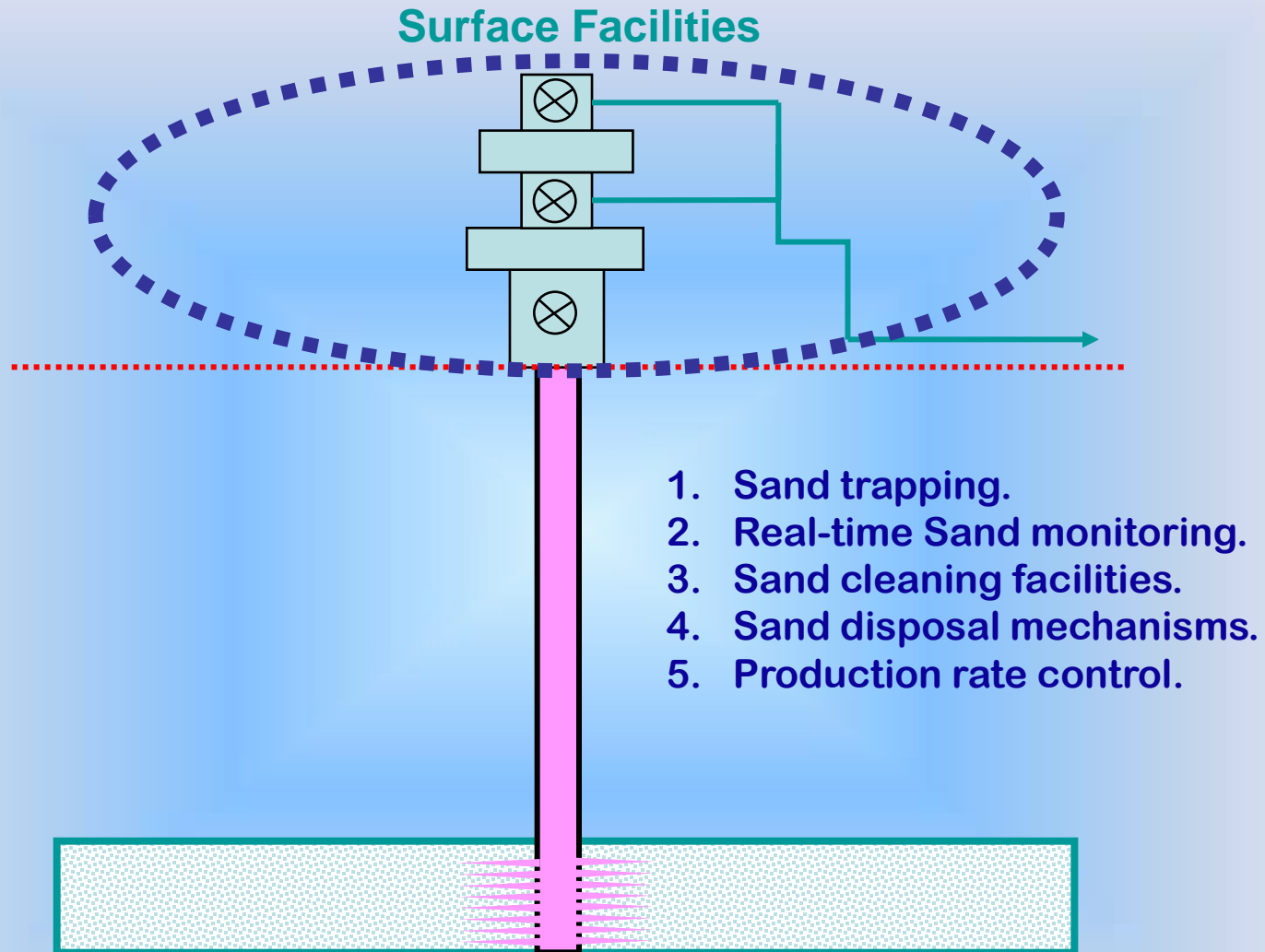


1. Open-hole + gravel pack.
2. Perforated casing + gravel pack.
3. Stand-alone screen.
4. Screen + gravel pack.
5. Gravel pre-packed screen.
6. Expandable screen.
7. Wellbore inclination and orientation.
8. Drawdown pressure control.

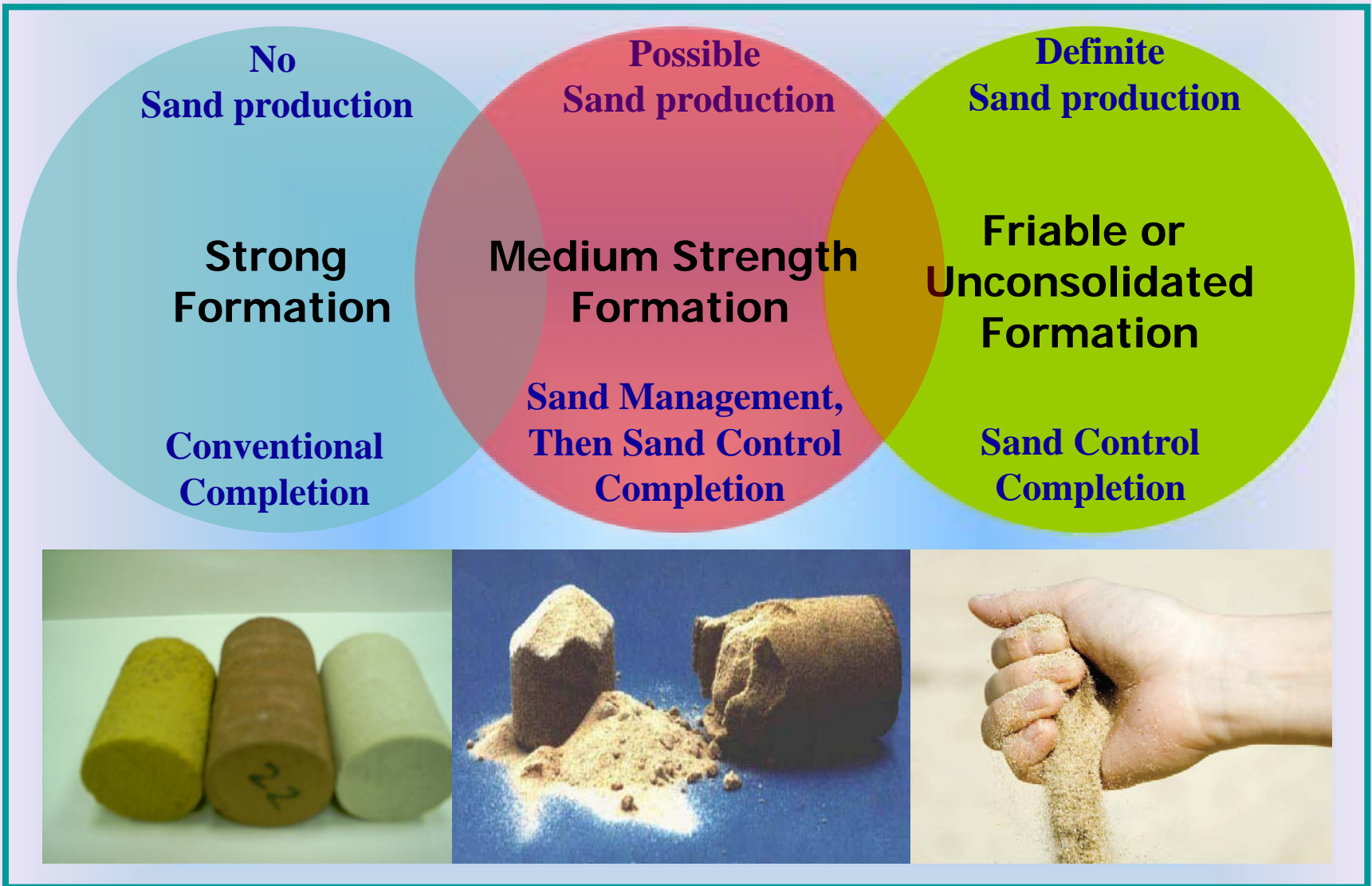
## **Sand Control / Management Philosophy**



## **Sand Control / Management Philosophy**

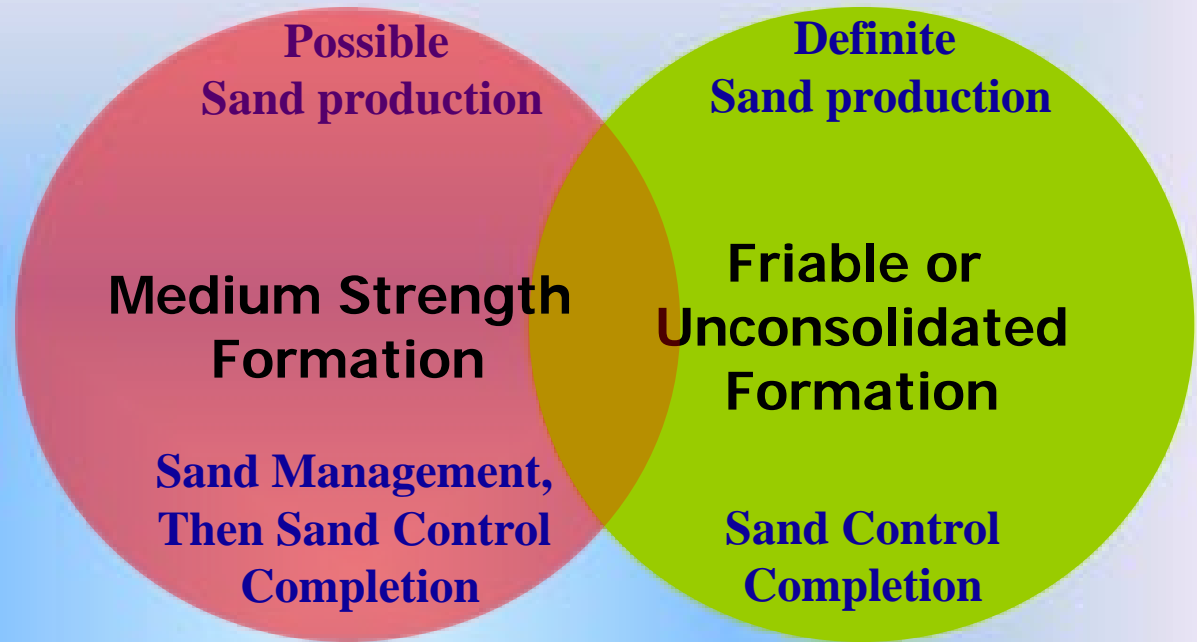


## Sand Control / Management Philosophy



## Screening Sandstone Reservoirs for Potential Sand Production



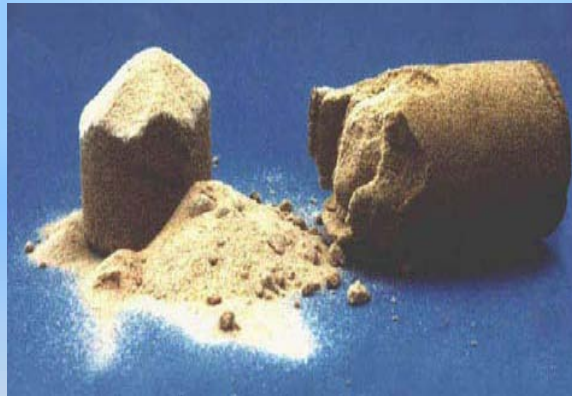


**Screening Sandstone Reservoirs for Potential Sand Production**

**Possible  
Sand production**

**Medium Strength  
Formation**

**Sand Management,  
Then Sand Control  
Completion**

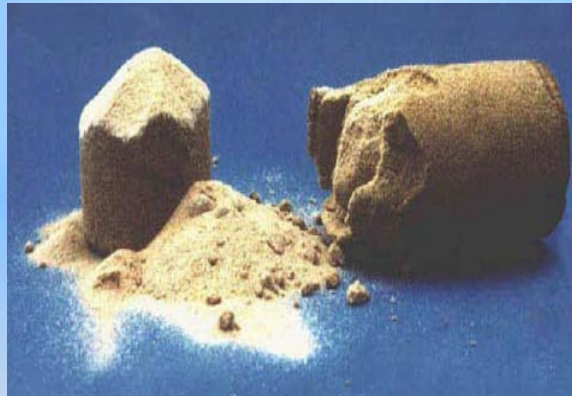


**Screening Sandstone Reservoirs for Potential Sand Production**

Possible  
Sand production

Medium Strength  
Formation

# Sand Management or Sand Control Completion ???



**Screening Sandstone Reservoirs for Potential Sand Production**

## **Well Completion Decision in Moderate Strength Sandstones:**

Well completion decision is dependent on several factors such as: productivity, initial cost, future remediation, workover, and associated risk.

### **1. Sand Management Choice:**

Low initial cost + High initial productivity.

High future remedial and workover cost.

High future risk may lead to complete loss of the well.

### **2. Sand Control Choice:**

High initial cost + Restricted initial productivity.

Low future remedial and workover cost.

Low future risk lead to long well life.

## **Sand Management:**

Processes that must be put into place to provide co-production of formation sand and fluids.

## **Sand Management Strategies:**

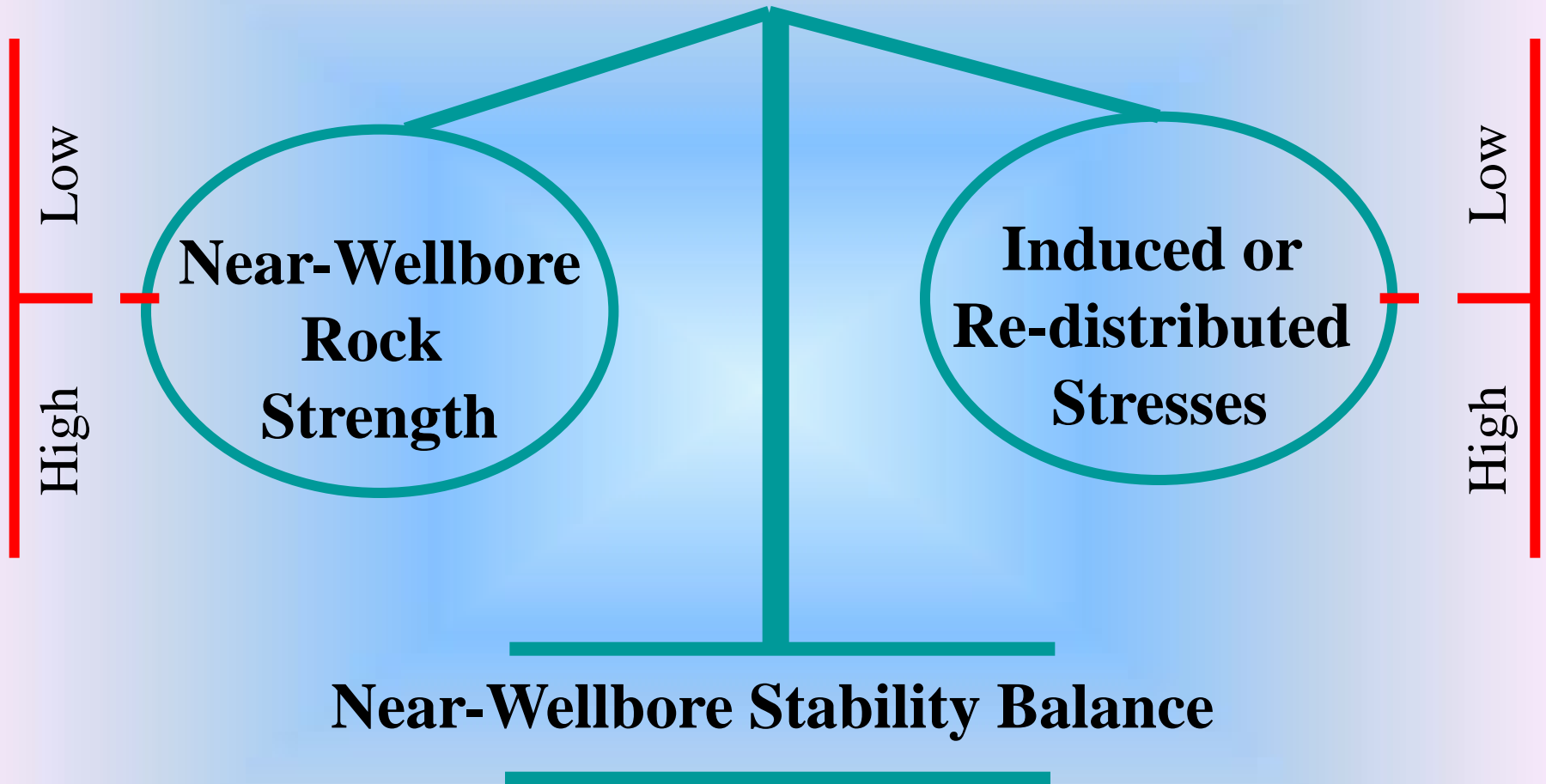
1. Installing completion to maximize productivity.
2. Monitoring techniques to determine when sand is produced.
3. Surface equipment for handling produced sand.
4. Workover equipment for performing remedial operations.

## **Sand Control:**

All technologies, processes, and completion techniques that must be put into place to provide production of sand-free fluids from weak sandstone or unconsolidated sand.

## **Sand Control Technologies:**

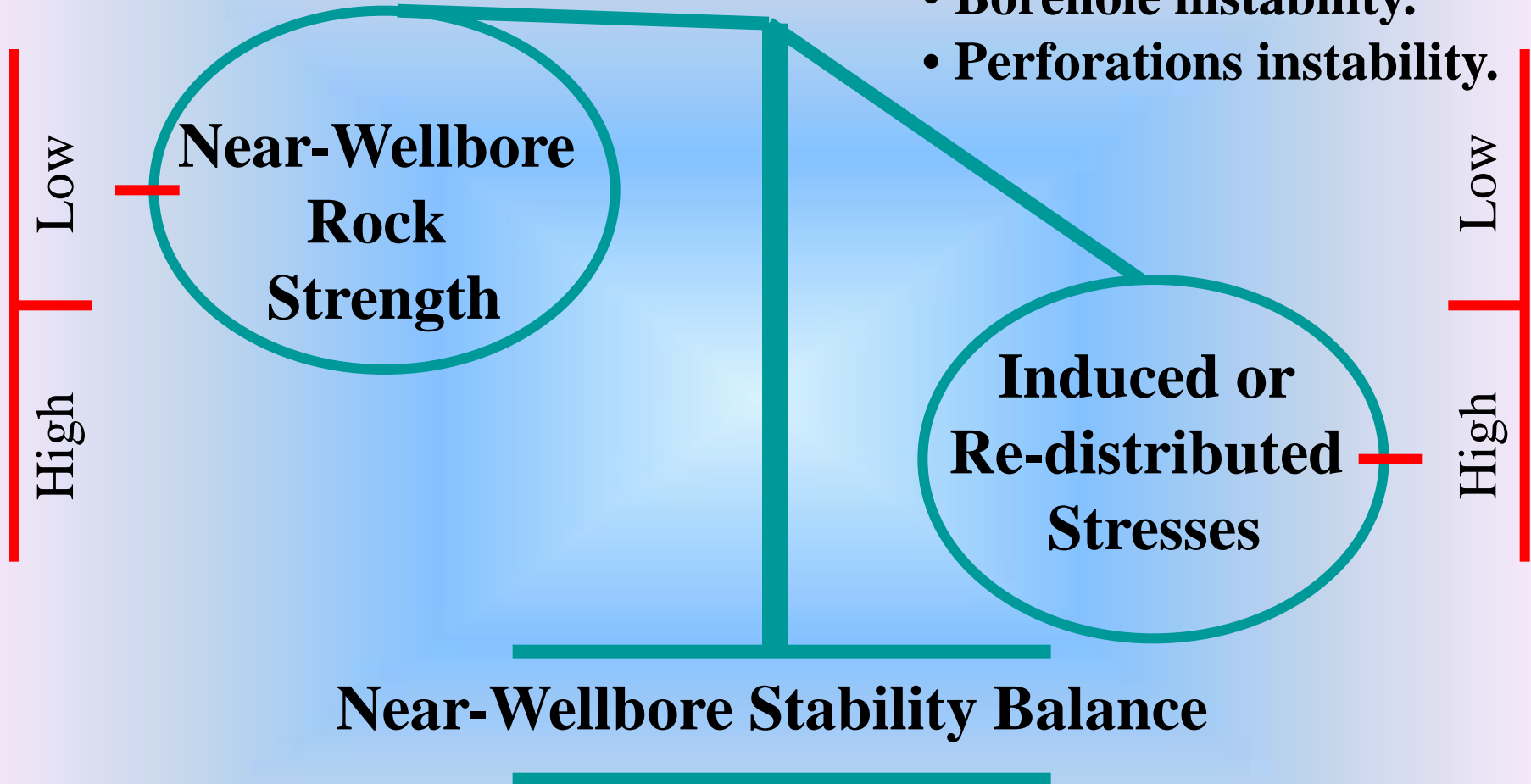
1. Theoretical models to predict sand production tendencies.
2. Field techniques to prevent formation failure.
3. Downhole equipment to prevent failed formation material from entering the wellbore.





## Consequences:

- Sand production.
- Borehole instability.
- Perforations instability.



# Factors Governing Sand Production

1. In-situ principal stresses.
2. Near-Wellbore rocks properties.
3. Reservoir fluids properties.
4. Completion type.
5. State of reservoir depletion.
6. Drag forces related to  $\mathbf{V}$  and  $\mu$ .

Near-Wellbore  
Reservoir  
rock  
strength

Balance

6. Production rate (Drawdown).

Redistributed  
or induced  
stresses

## **Sand Control and Management** Hot Research Issues:

### **1. Sand Production Prediction:**

Theoretical sand failure models.

Techniques for rock property evaluation.

Evaluation of formation strength over reservoir productive life.

### **2. Sand production prevention (control):**

Maximum sand-free rate determination.

Maximum allowable drawdown.

Formation stabilization.

Sand exclusion techniques and installation technologies.

### **3. Sand production management:**

Produced sand monitoring.

Design and selection of surface facilities.

Remediation.

Produced sand cleaning and disposal techniques.

### **4. Overall economics including cost of completion, and workover.**

**Sand control and management studies can be categorized as follows:**

**1. Sand Production Prediction:**

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Techniques for rock property evaluation.

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## A Filter Made for Natural Environmentally Friendly Cheap Materials

### Objectives:

- 1- Avoid gravel pack permeability damage caused by formation sand.
- 2- Reduce initial cost.
- 3- Reduce future maintenance cost.



### **A Filter Made for Natural Environmentally Friendly Cheap Materials**

**Composition: 4 components.**

**Curing Temperature: 25° C or more**

**Unconfined Compressive Strength, UCS (Dry): 1300 psi or higher**

**Reduction in UCS (Immersion in Kerosene for 7 days): Negligible**

**Reduction in UCS (Immersion in Saline Water for 7 days): Negligible**

**Density: 1.4 g/cc**

**Permeability: 25 to 30 Darcy**

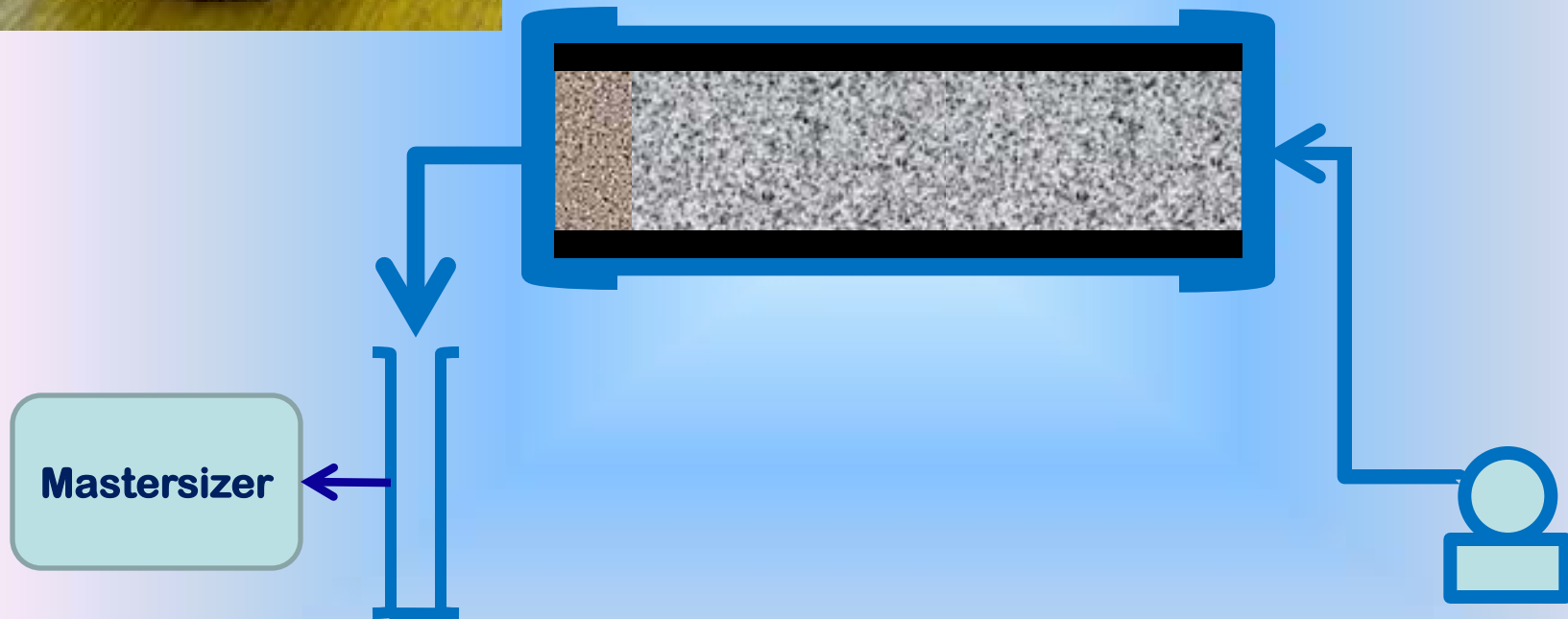




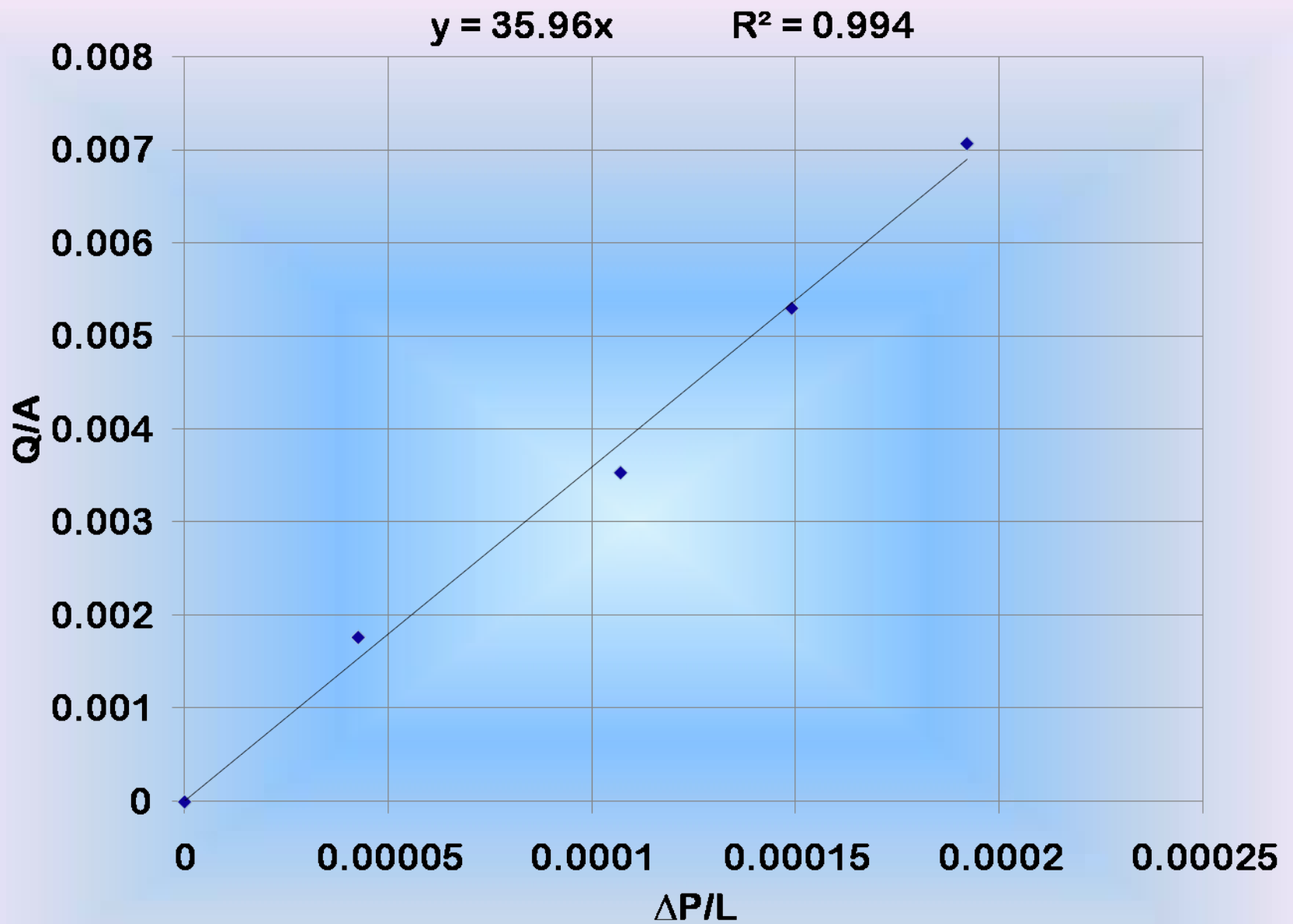
Test Cell Dimensions:

Total length = 12.5 inch

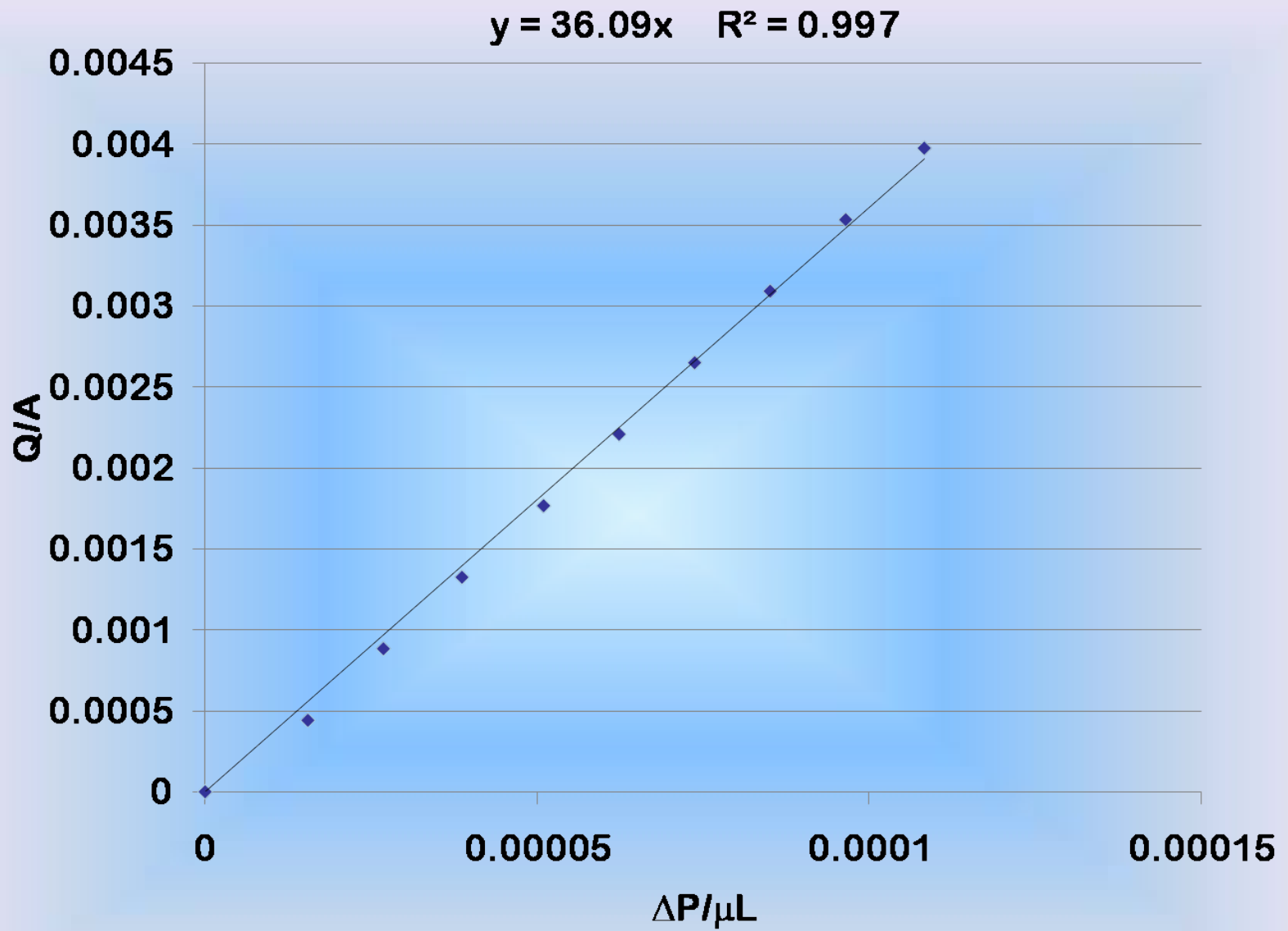
Inside diameter = 2.0 inch



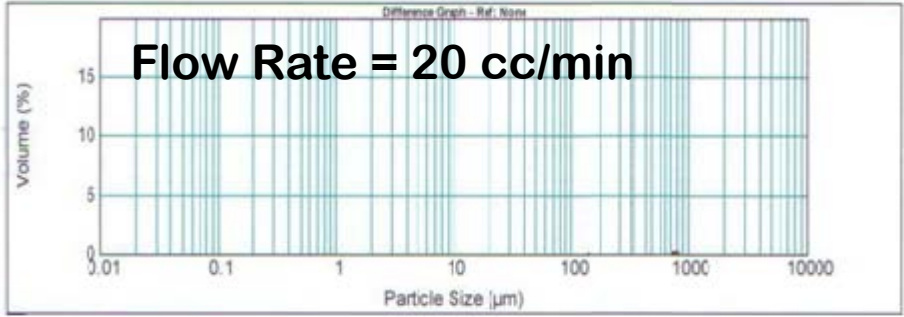
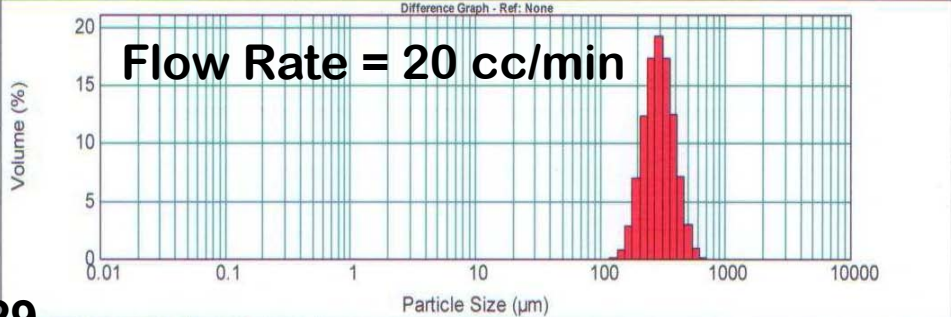
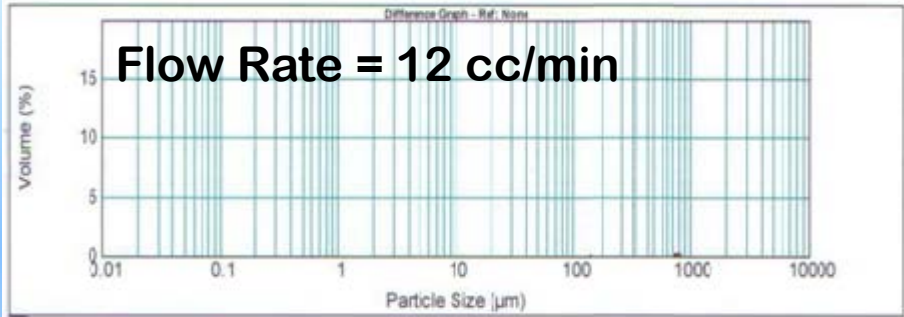
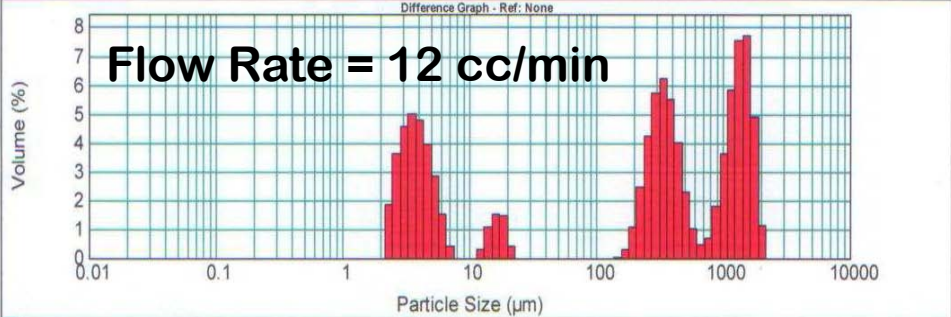
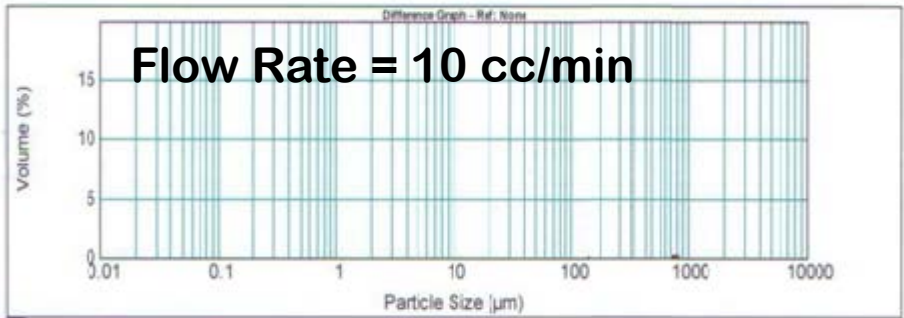
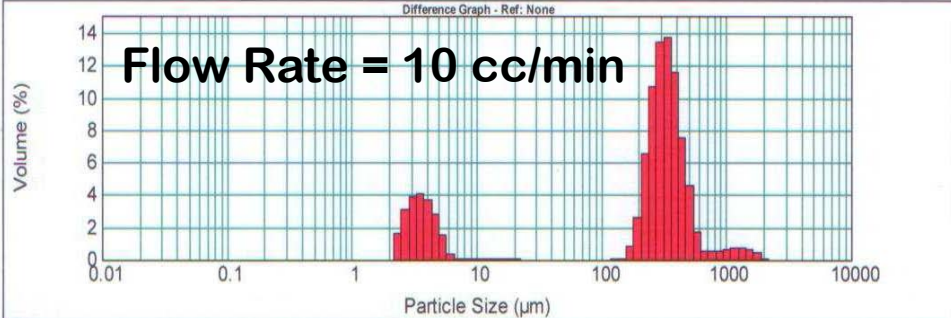
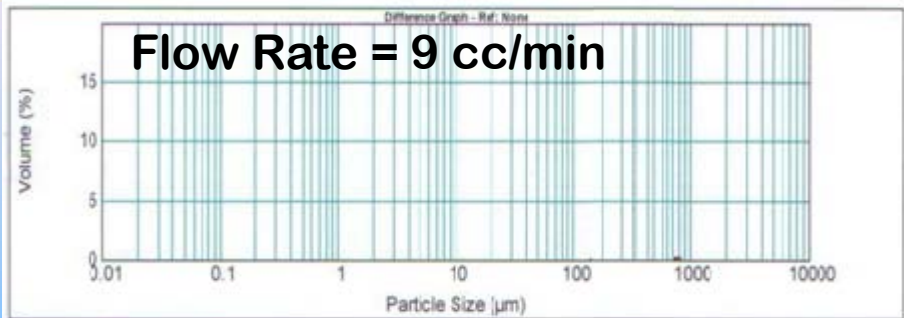
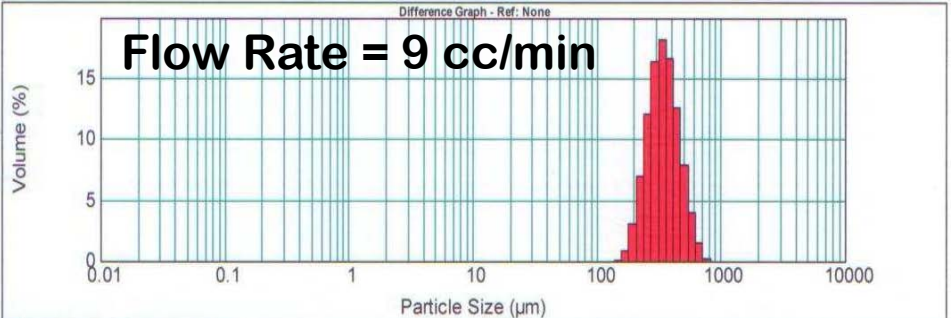
**Experimental Set-Up**

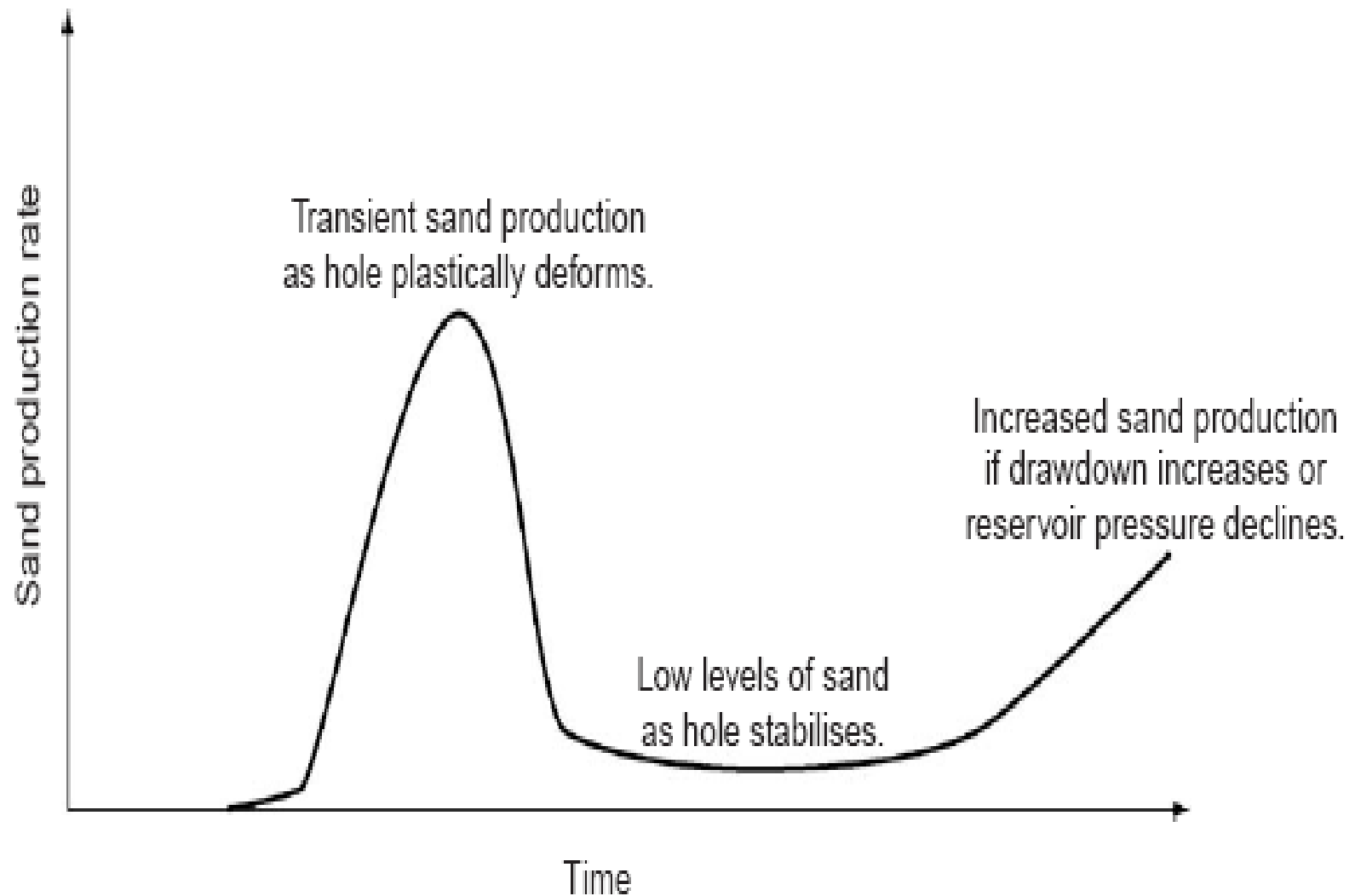


(Sand Pack) Permeability Measurement using Fresh Water

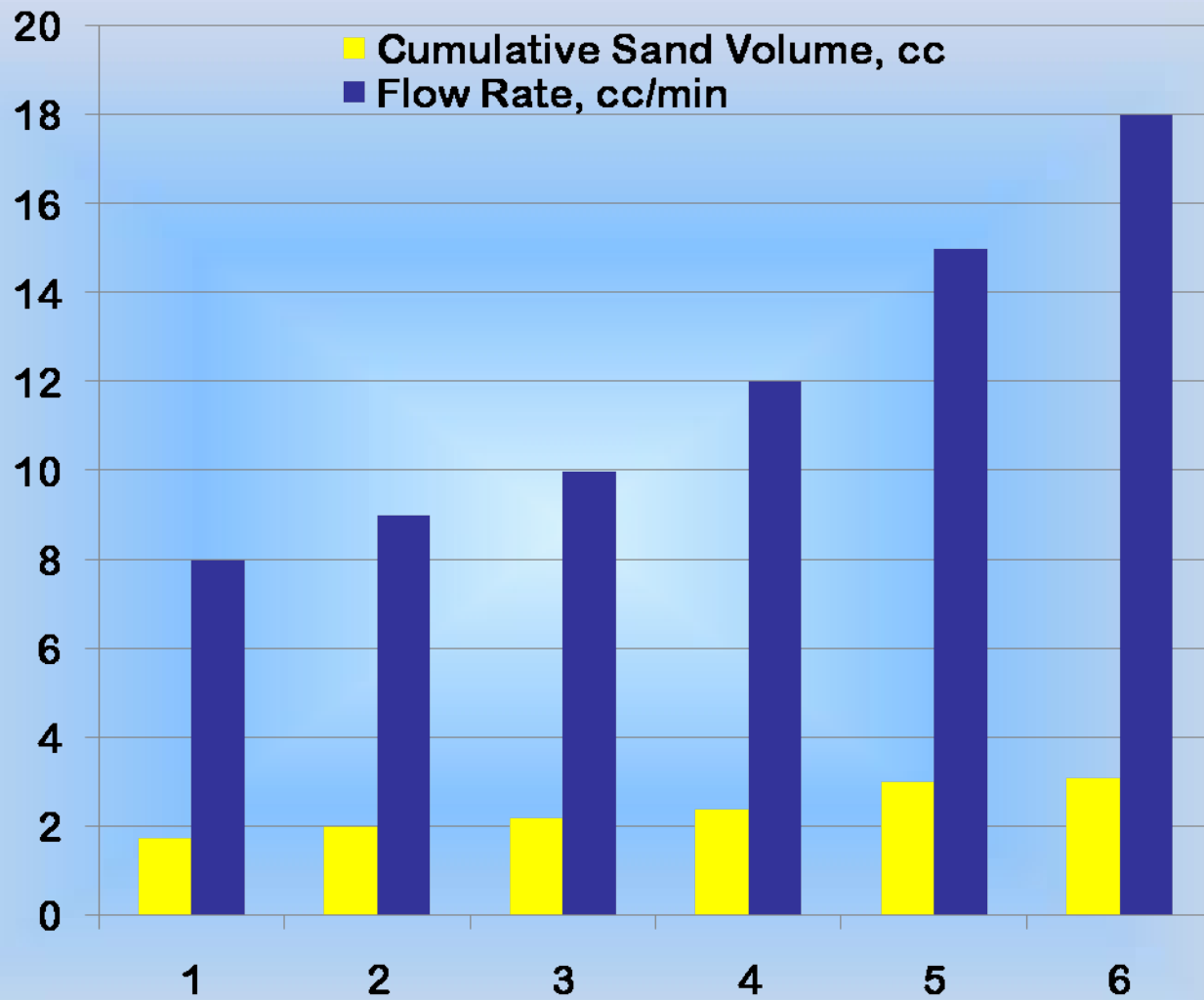


(Sand Pack + Filter) Permeability Measurement using Distilled Water



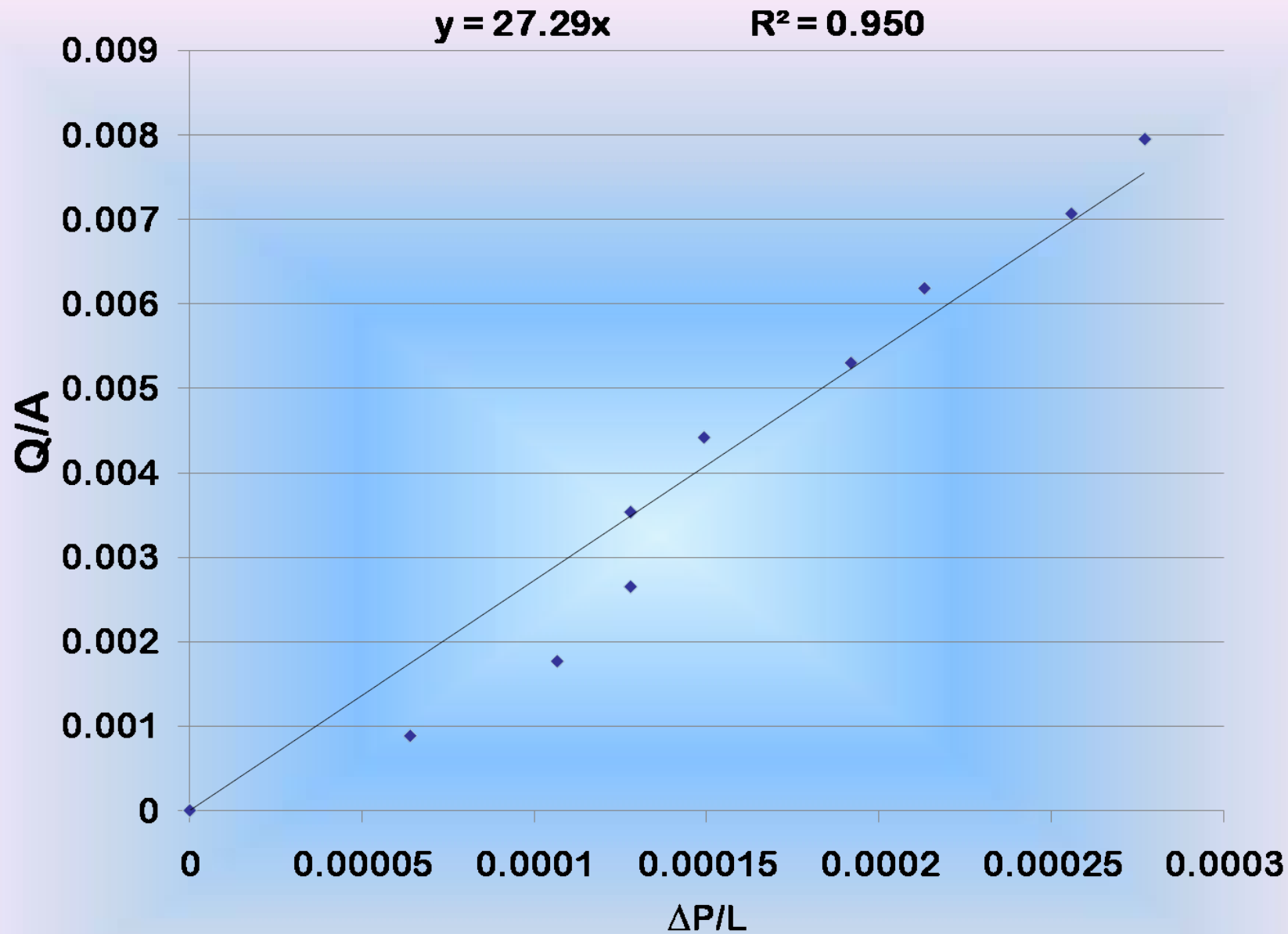


Typical sand production trends



**Sand Pack Only - Flooding with Distilled Water**



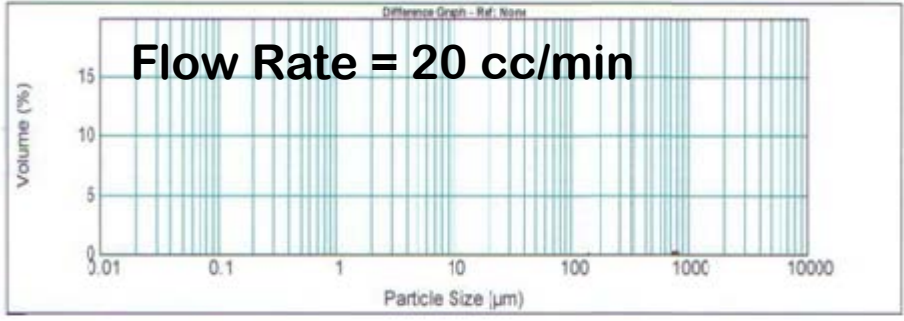
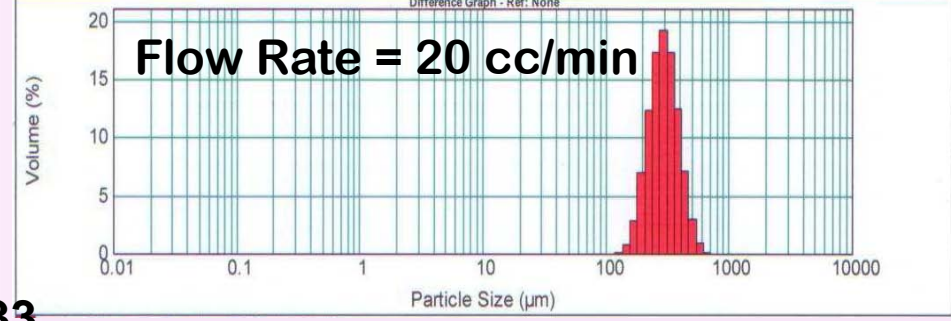
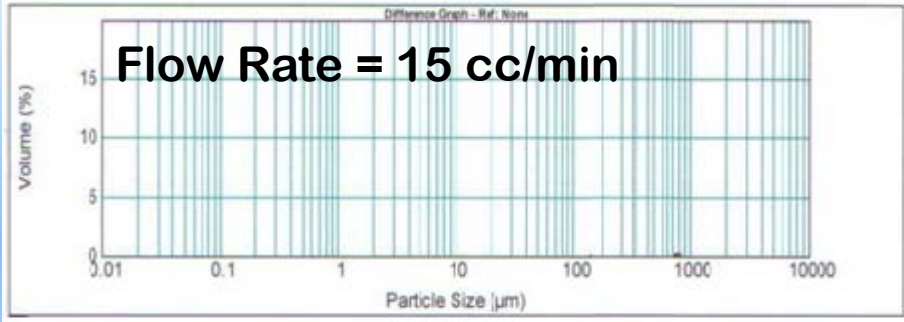
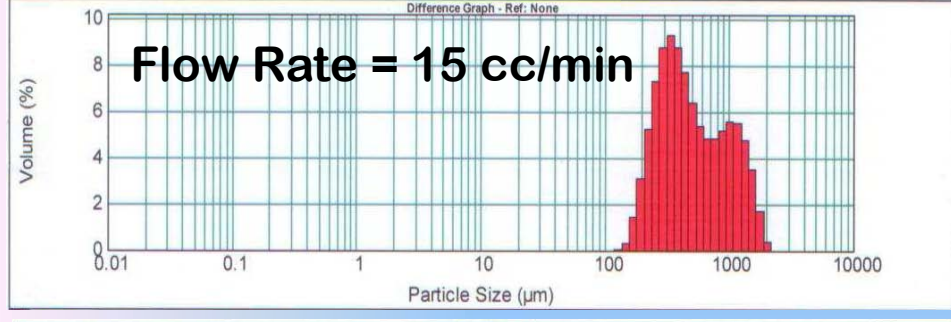
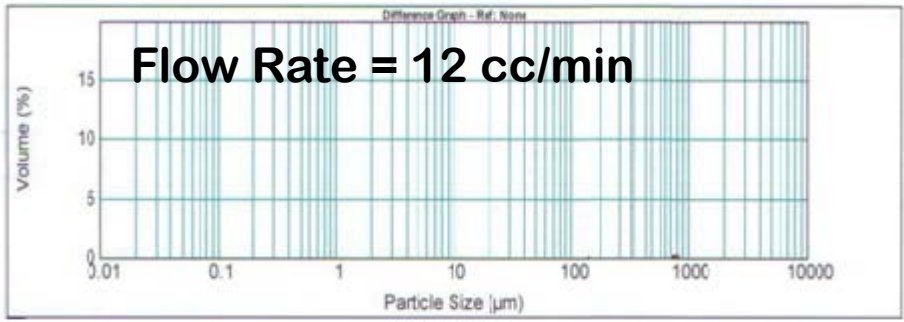
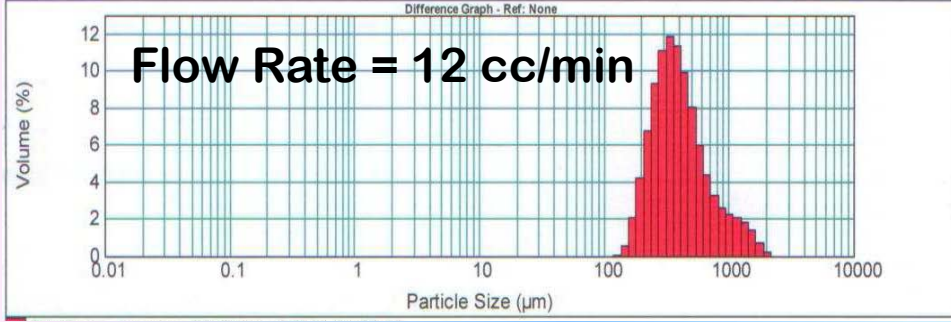
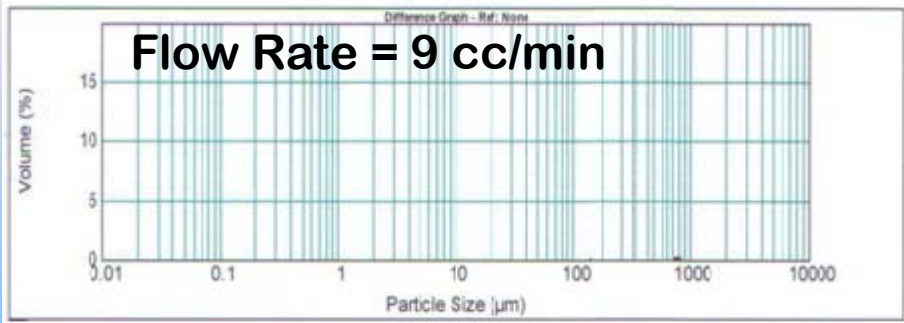
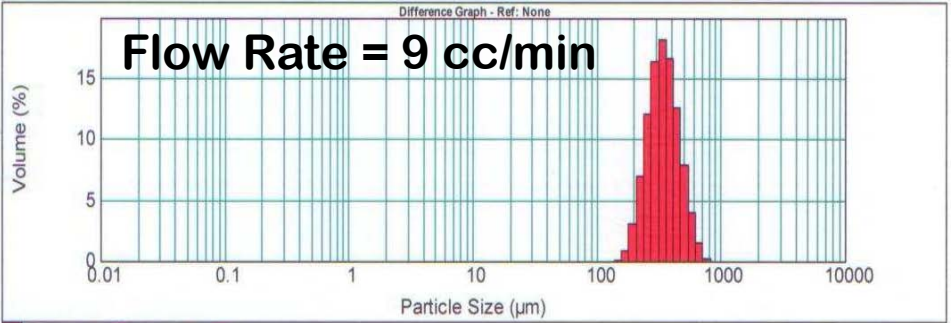


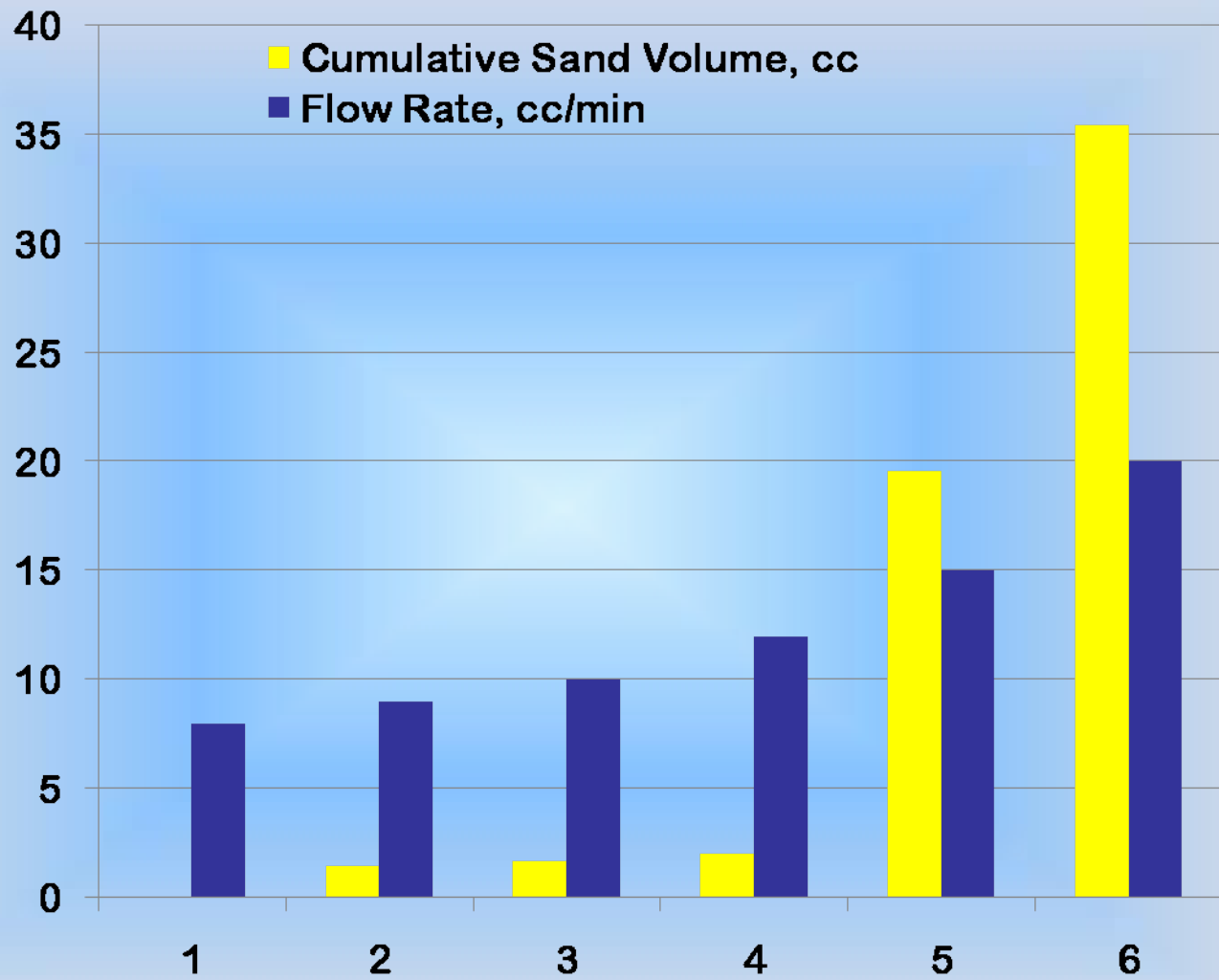
(Sand Pack + Filter) Permeability Measurement using Crude Oil

Sand Pack Only

Flooding with Crude Oil

Sand Pack with Filter



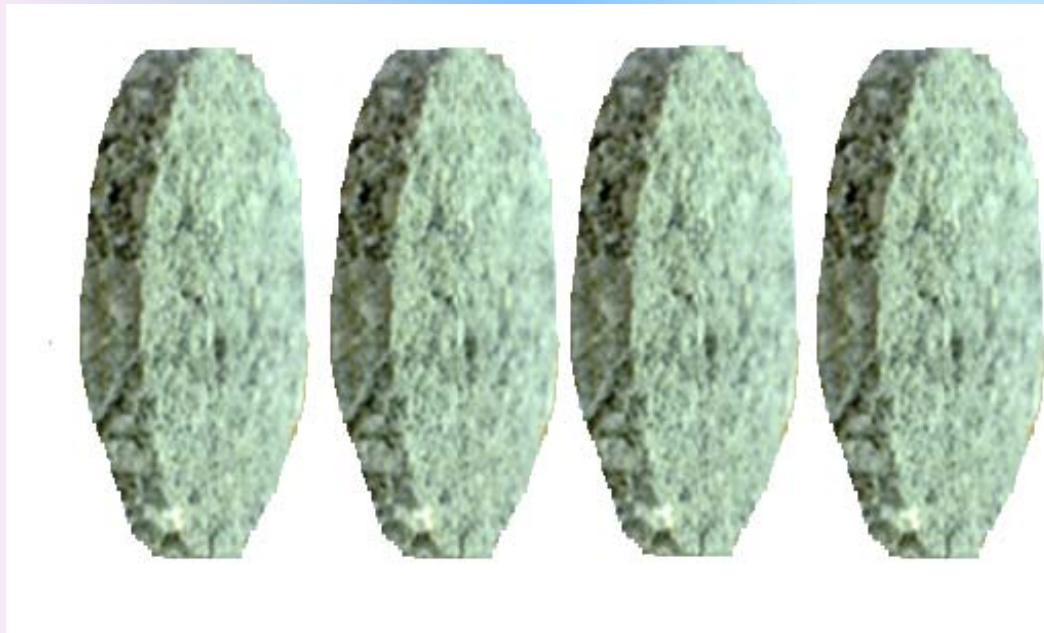


Sand Pack Only - Flooding with Crude Oil

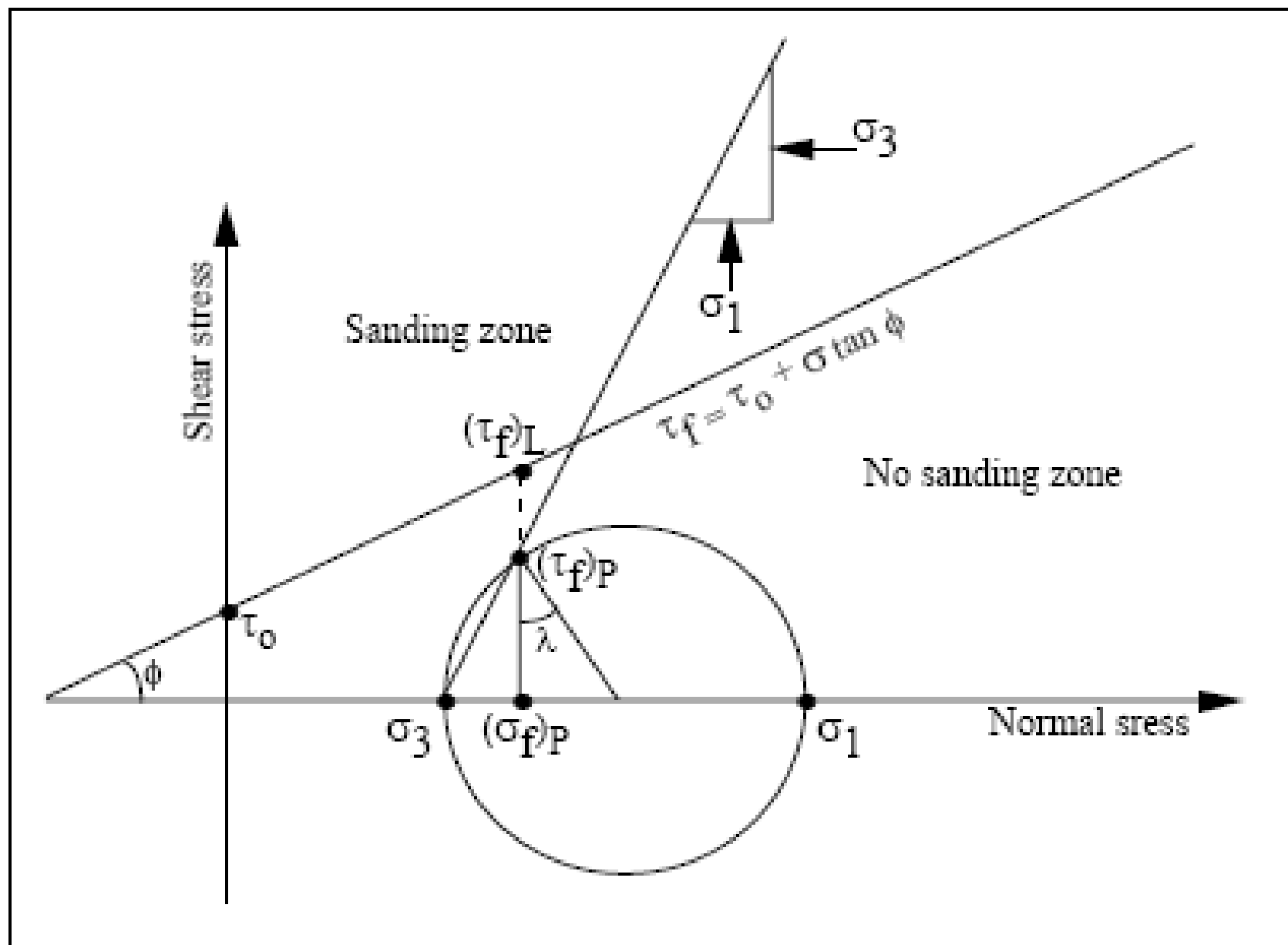


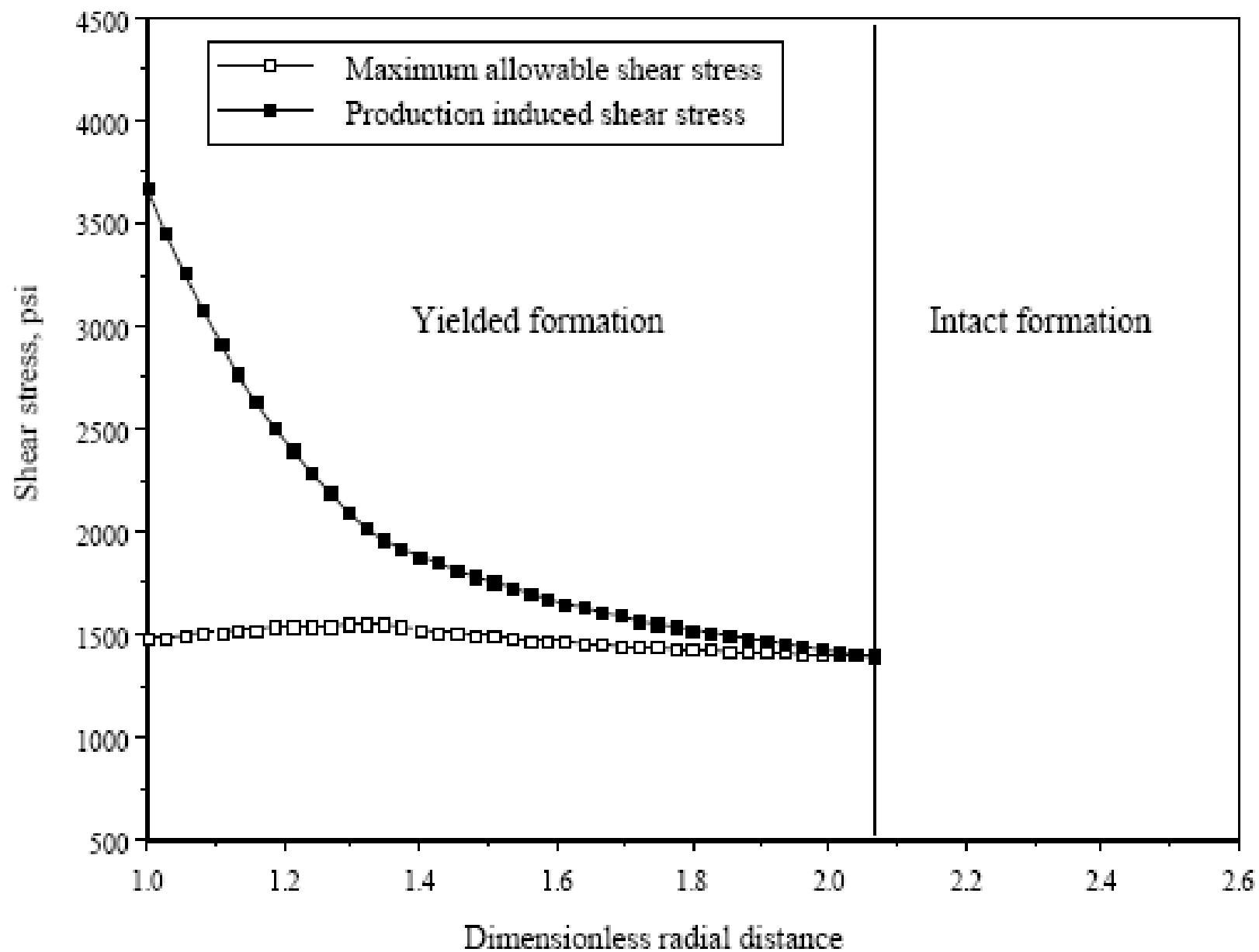
## Future Work

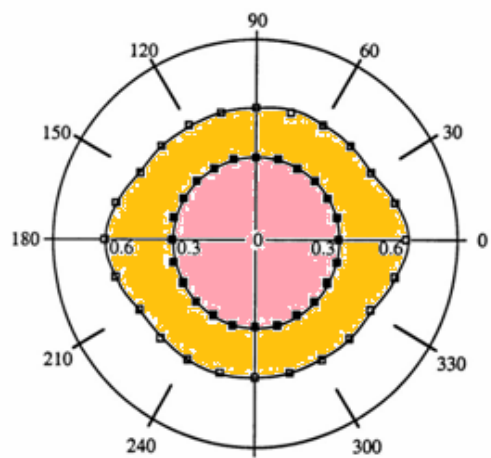
- 1- Effect of Long Term Flow Conditions
- 2- Investigation of Long Term Strength Loss
- 3- Curing at Different Environments (P, T, etc.)
- 4- Investigation of Long Term  $k$  Loss
- 5- Investigation of  $k$  Loss Treatment



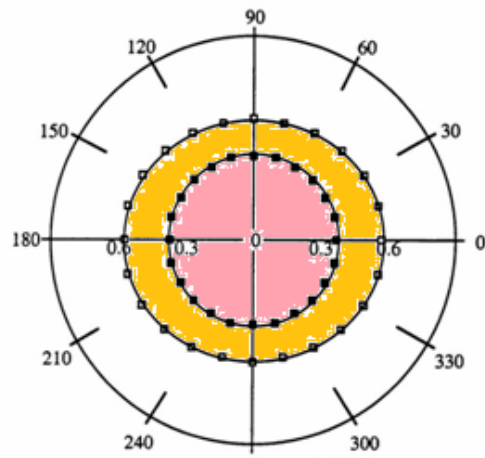
# **Prediction of Sand Volume Ready to Move from the Yield-Zone into the Wellbore**



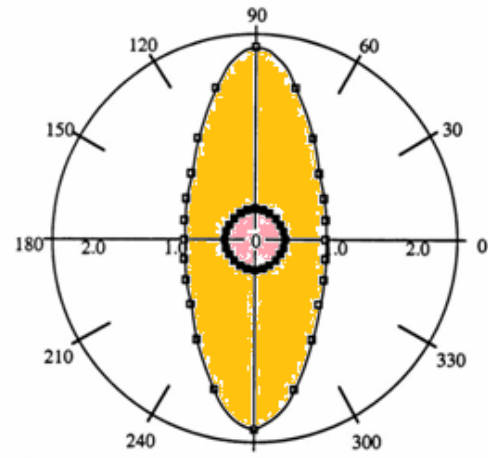




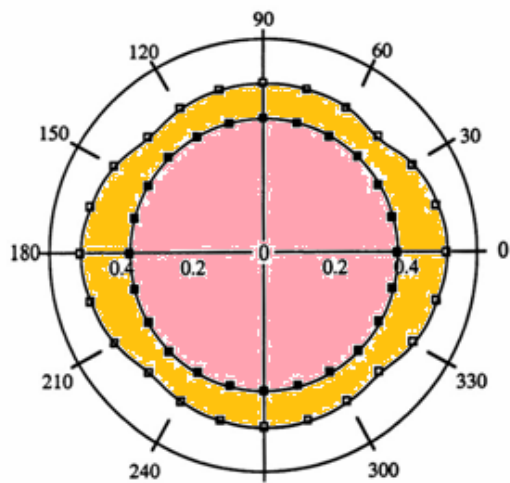
(A) Horizontal orientation at  $\beta=0^\circ$



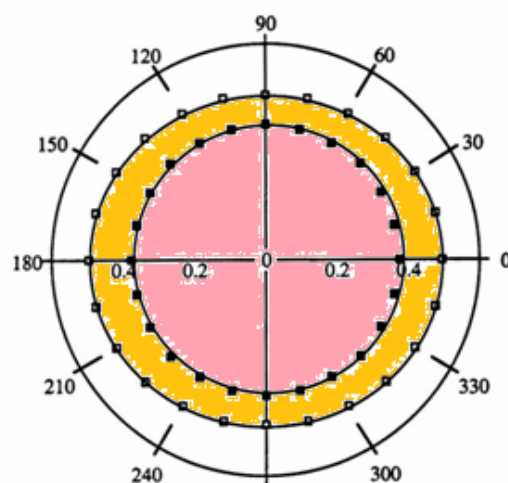
(B) Horizontal orientation at  $\beta=45^\circ$



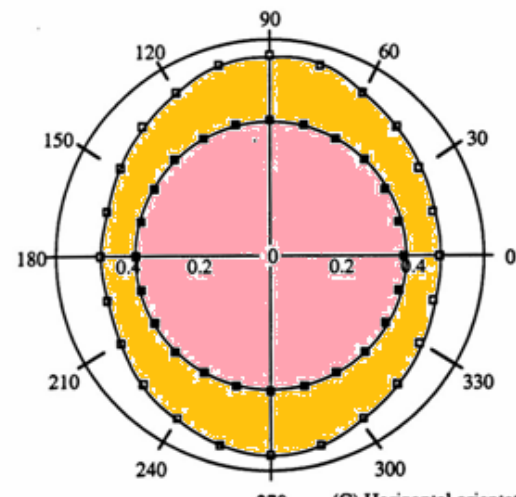
(C) Horizontal orientation at  $\beta=90^\circ$



(A) Horizontal orientation at  $\beta=0^\circ$

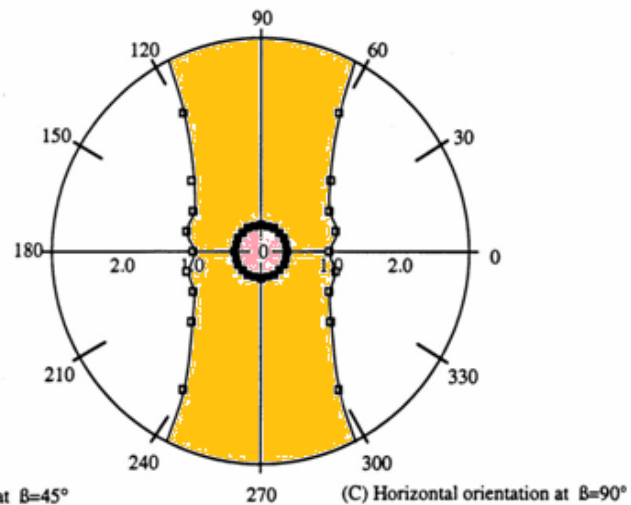
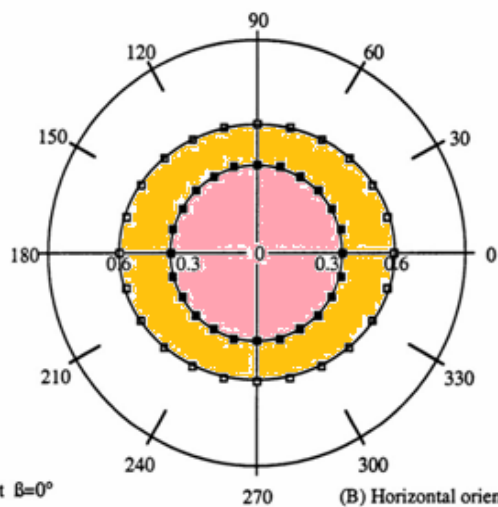
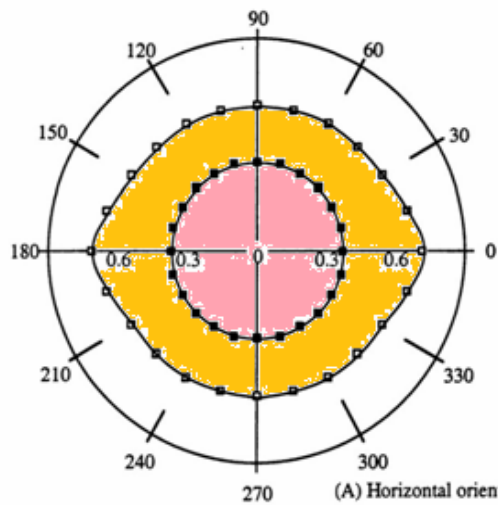
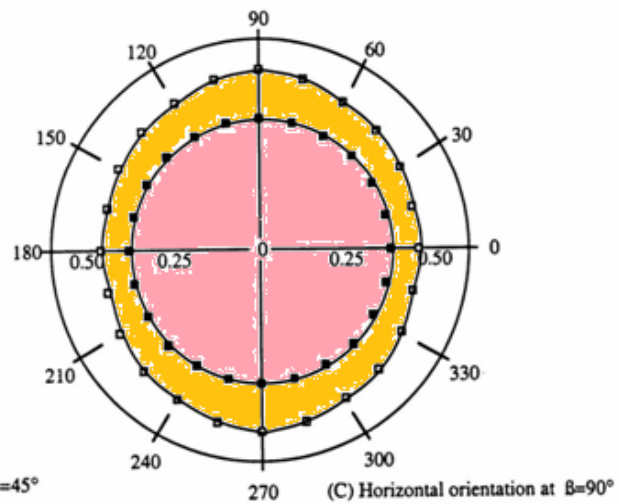
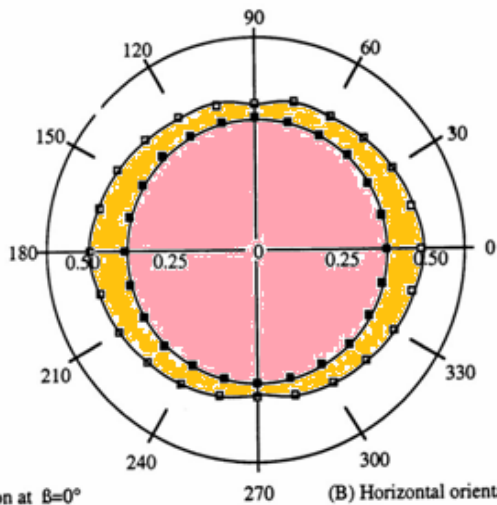
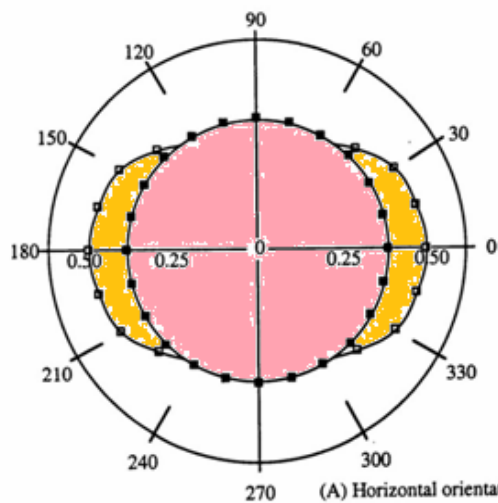


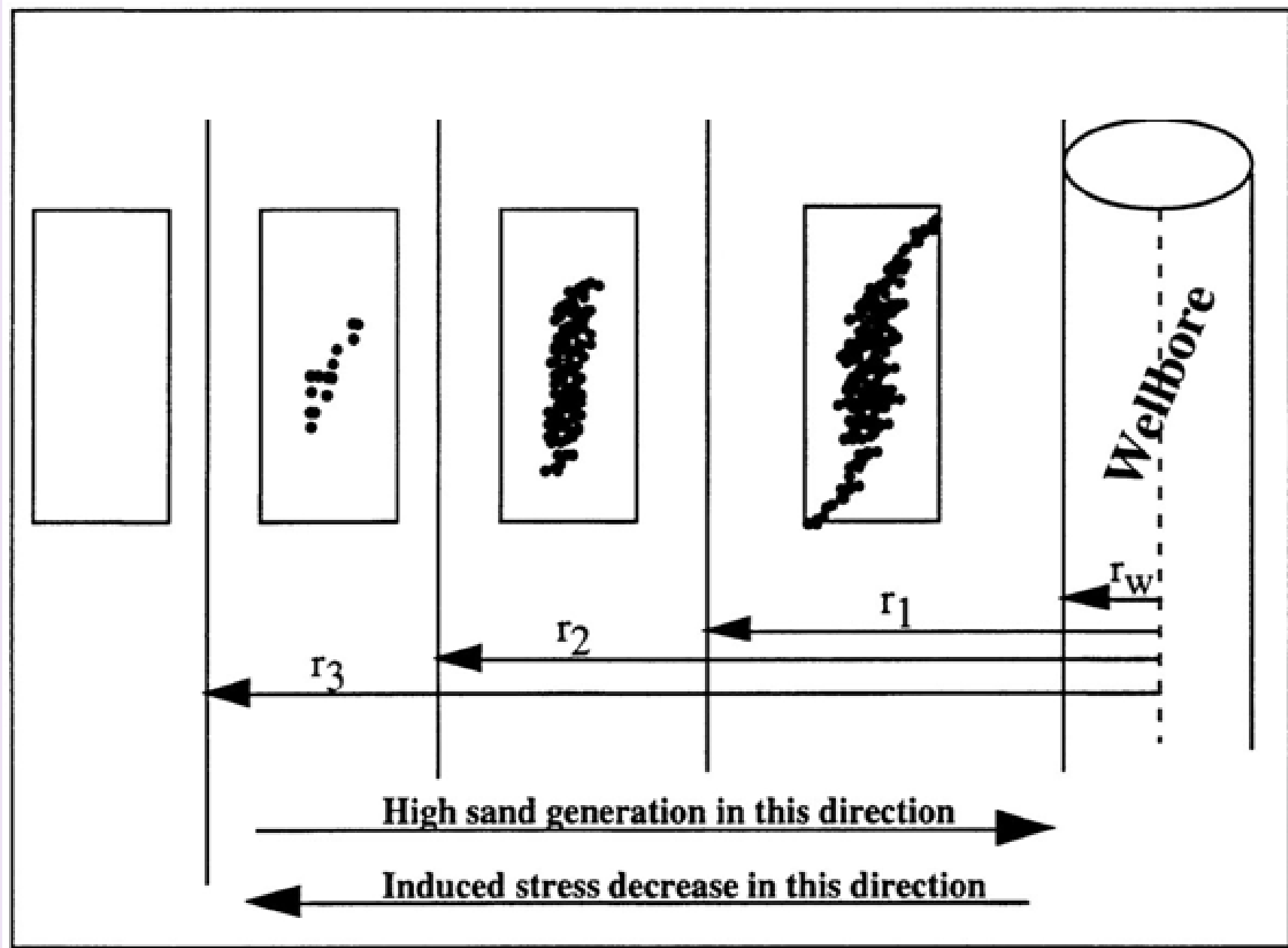
(B) Horizontal orientation at  $\beta=45^\circ$



(C) Horizontal orientation at  $\beta=90^\circ$

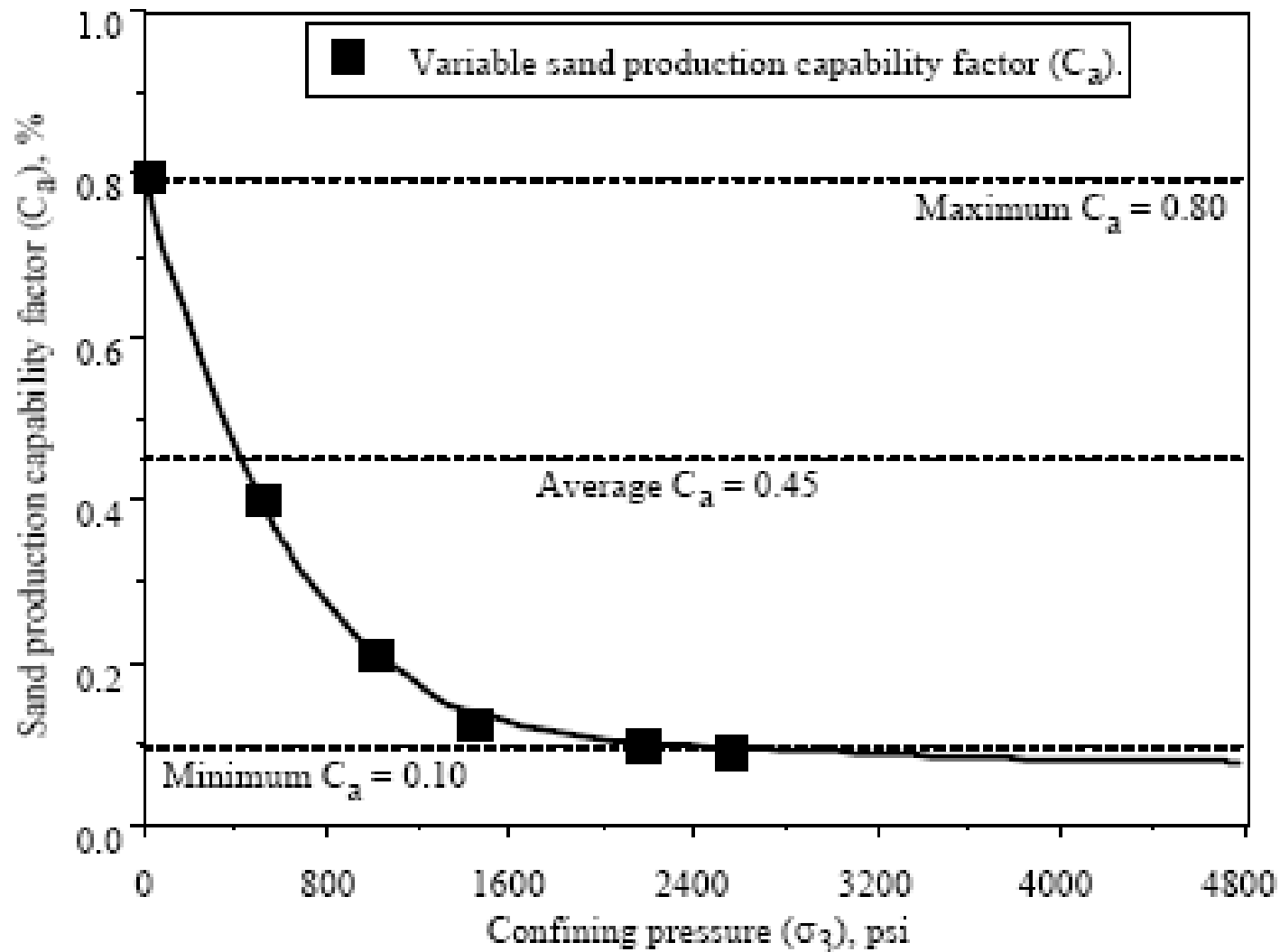


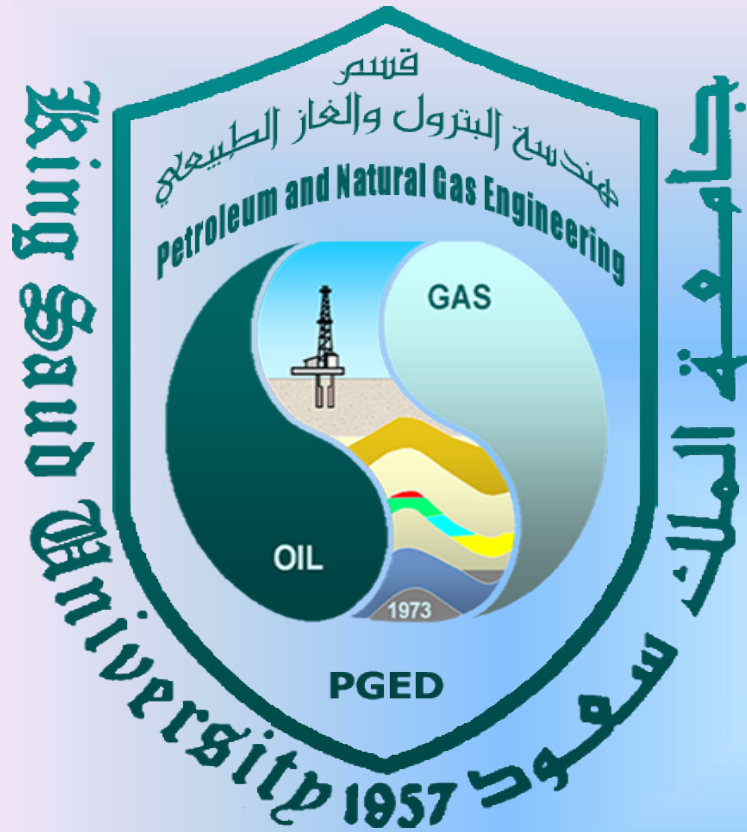






$$C_a = a_0 + a_1 \sigma_3 + a_2 \sigma_3^2 + a_3 \sigma_3^3 + a_4 \sigma_3^4 + \dots$$





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جامعة الملك سعود

King Saud University

College Of Engineering



Questions & Answers