

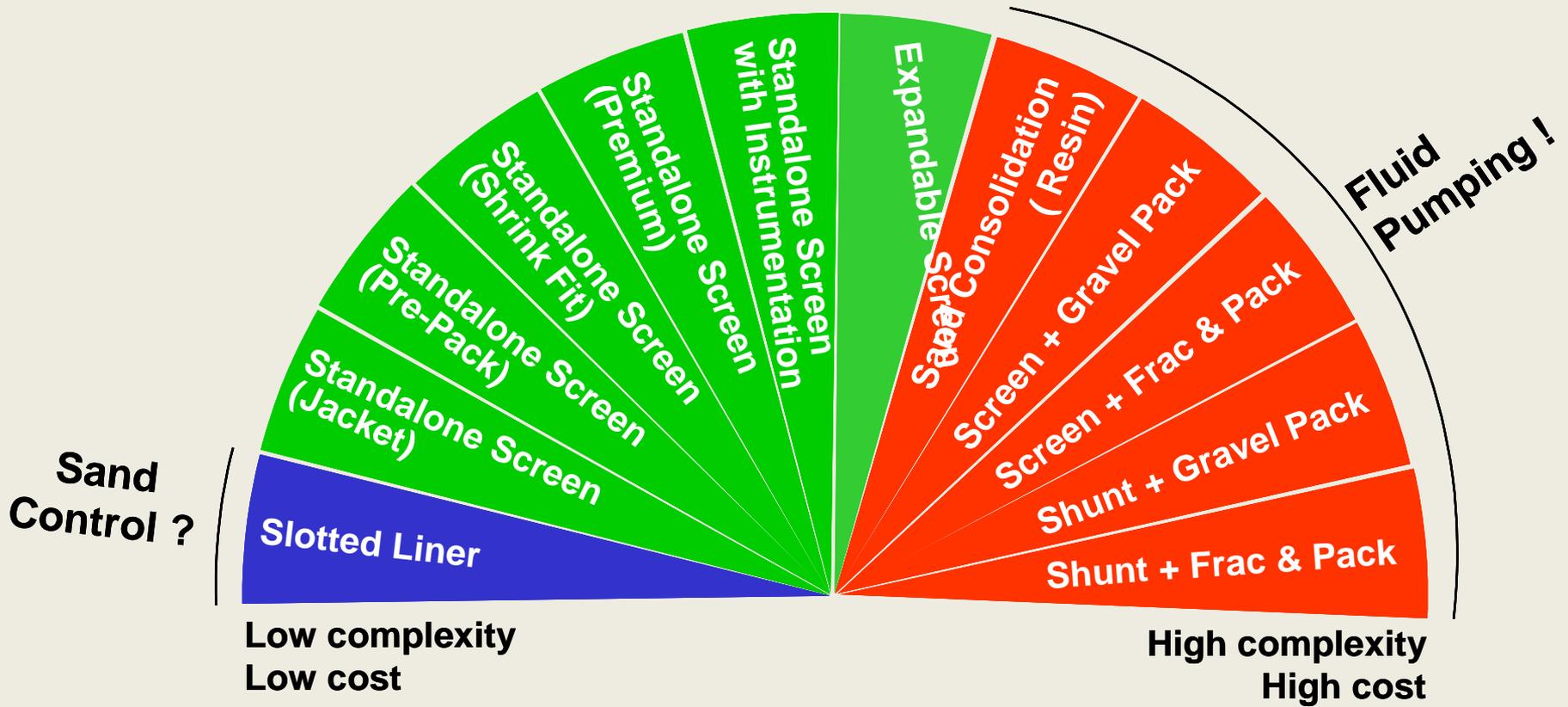
Sand Control Methods

- Open Hole and Cavities
- Cased and Perforated
- Stand Alone Screen
- Slotted Liner
- Expandable Screen
- Resin Consolidation
- Cased Hole Gravel Pack
- Open Hole Gravel Pack
- High Rate Water Pack
- Fracturing
- Tip Screen Out Fracture

Mechanical Behavior of Rock

- Intrinsic Properties
 - Composition
 - Grain size
 - Porosity
 - Permeability
 - Depositional Environment
 - Initial Discontinuities
- Production Factors
 - Depletion induced stress
 - Phase changes
 - Pore fluid chemistry
 - Pore pressure
 - Temperature (a variable)

Which completion method?

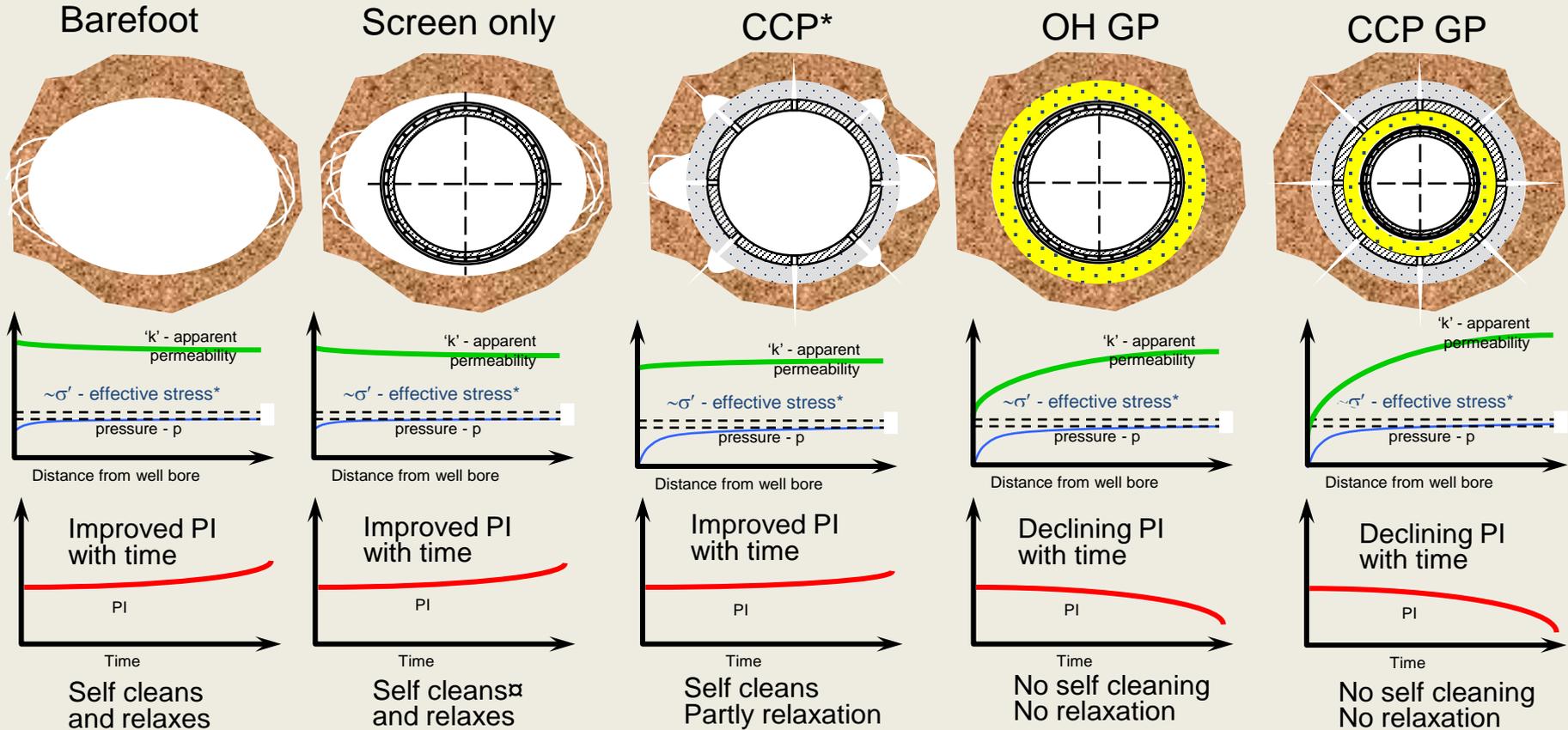


When selecting completion method, one have to consider:

Design Complexity Installation Complexity Mechanical Robustness Sanding Risk Plugging Risk Erosion Risk Well Productivity Total Cost

What are the advantages and drawbacks of the completion type for the specific application?

Completion type and well performance



Depletion > Compaction > Crushing > Stress ↑ > K ↓ *Effective stress = Weight of overburden – pore pressure

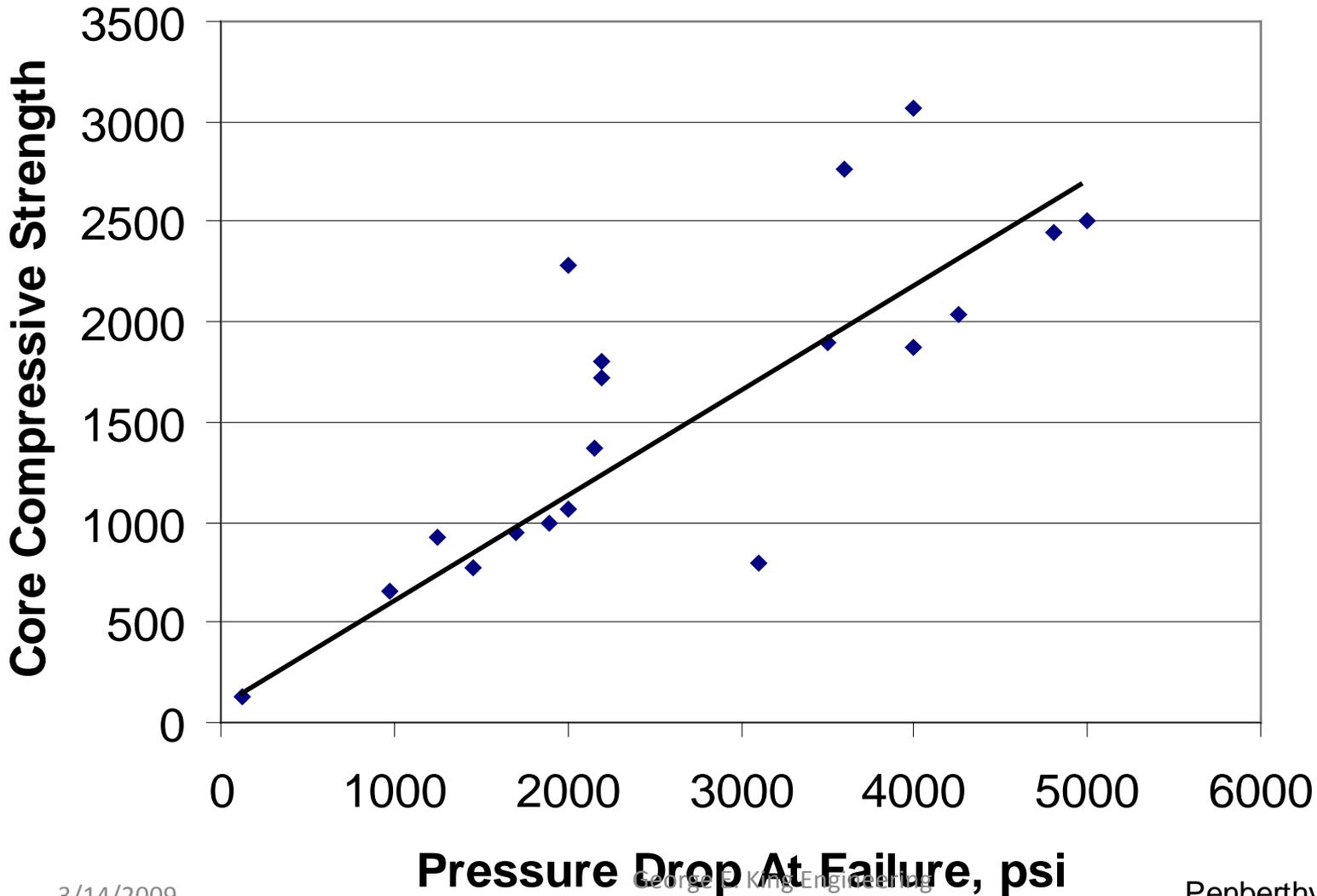
SPE 71673: J.Tronvoll, M.B. Dusseault, F. Sanfilippo, and F.J. Santarelli

SPE 56813: J.P. Davies, SPE, Chevron USA Inc., and D.K. Davies, SPE, David K. Davies & Associates, Inc.

SPE 36419: A.P. Kooijman, P.J. van den Hoek, Ph. de Bree, C.J. Kenter, Shell, Z. Zheng, and M. Khodaverdian, TerraTek Inc.

SPE 27360

Compressive Strength vs. Pressure Drop at Failure



If formation sand is mixed with the gravel, the permeability drops sharply. This one problem may result in skins as high as 300 in high rate wells.

The more clean gravel that is outside the casing, the better the flow path.

Efforts to clean the crushed sand in the perforations before packing are a good investment.

PERFORATION PRESSURE DROP-PSI

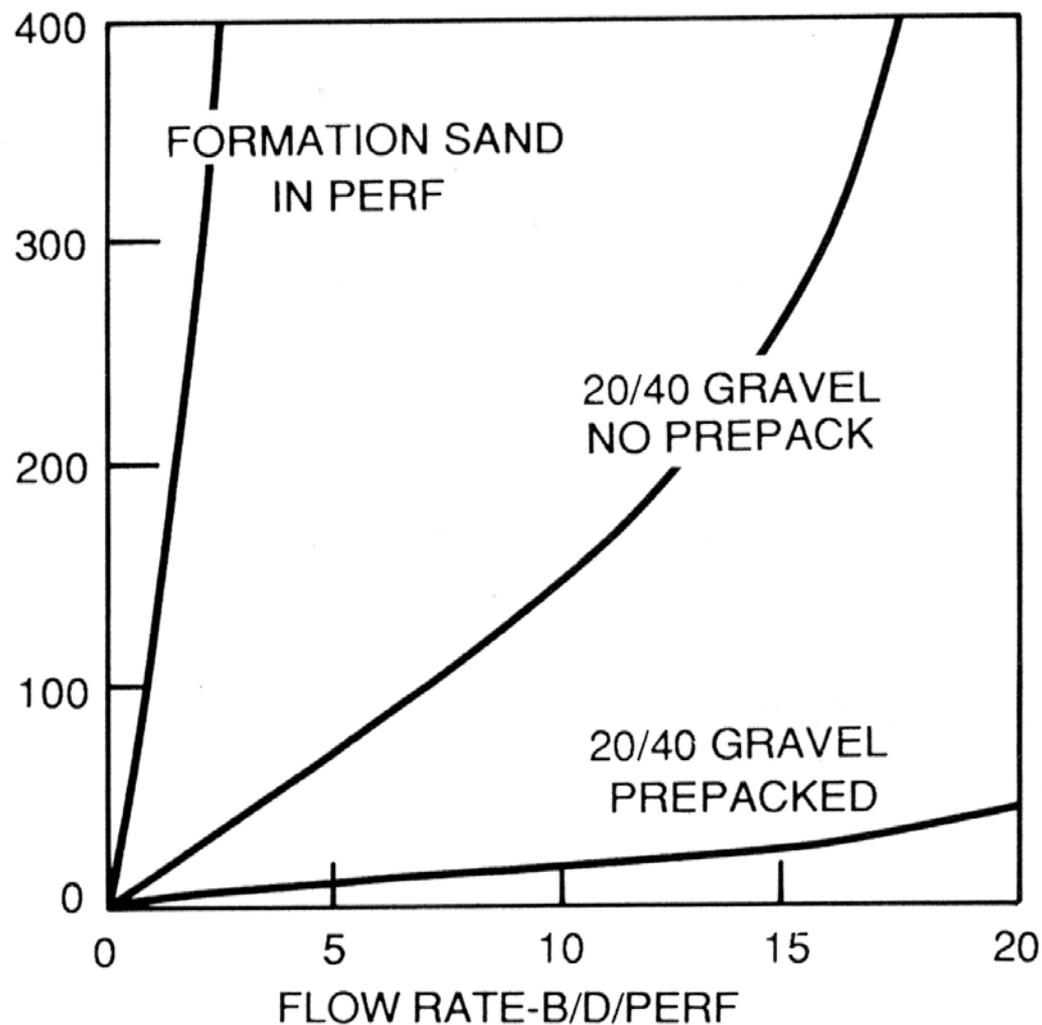
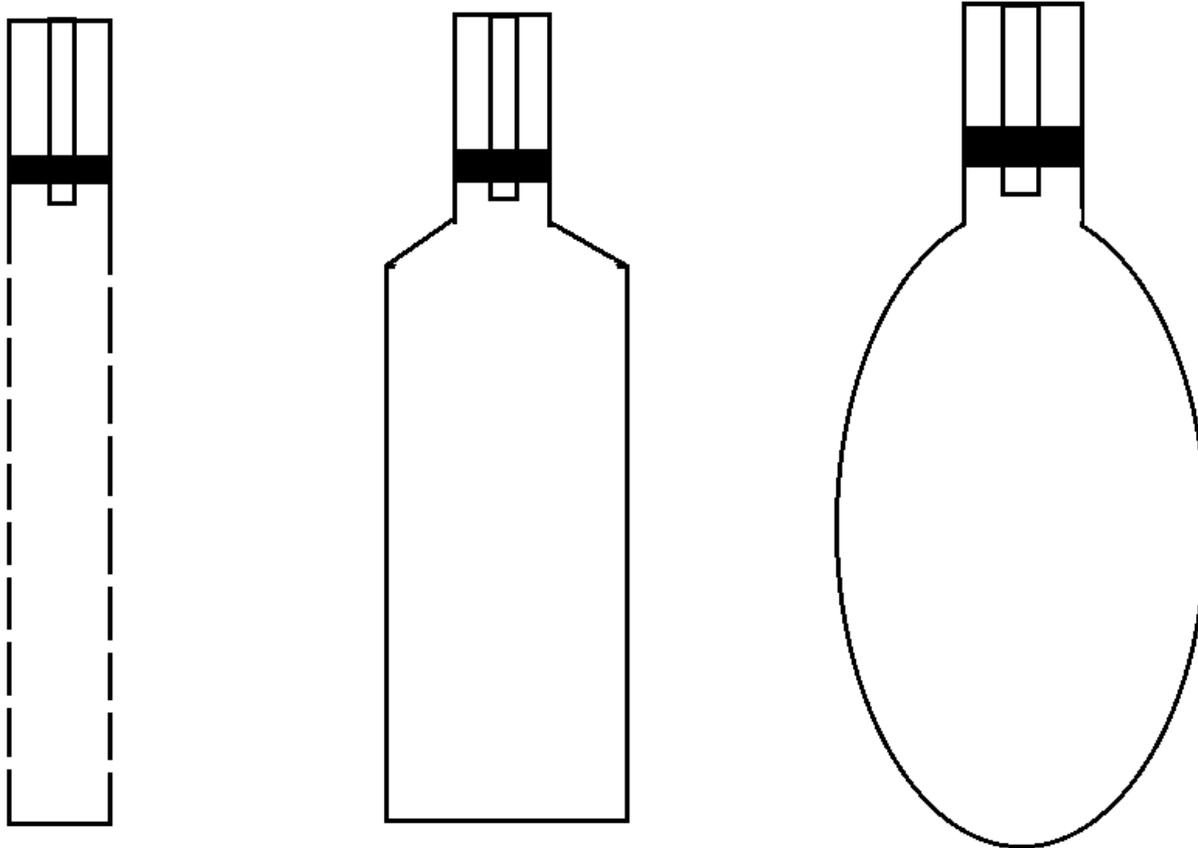


Fig. 3.13—Productivity with prepacking, without prepacking, and with formation sand in the perforations.

Formation Strength and Sand Movement

- Rocks below 1000 psi may need sand control
- Rock fails when the drawdown is about 1.7 times the compressive formation strength.
- Brinnell hardness related to strength, hard to use.
- Sonic
 - <50 sec is strong formation
 - >90 sec is weak formation
 - >120 sec is near unconsolidated formation
- Porosity
 - <20% usually stronger formation
 - 20 to 30% - gray area
 - >30% - unconsolidated

Open Hole Completion



Area open to flow = 100 to 500%

Skin = -2 to 2

Advantages

lowest cost

simplest completion

least resistance

Disadvantages

no zone/water control,

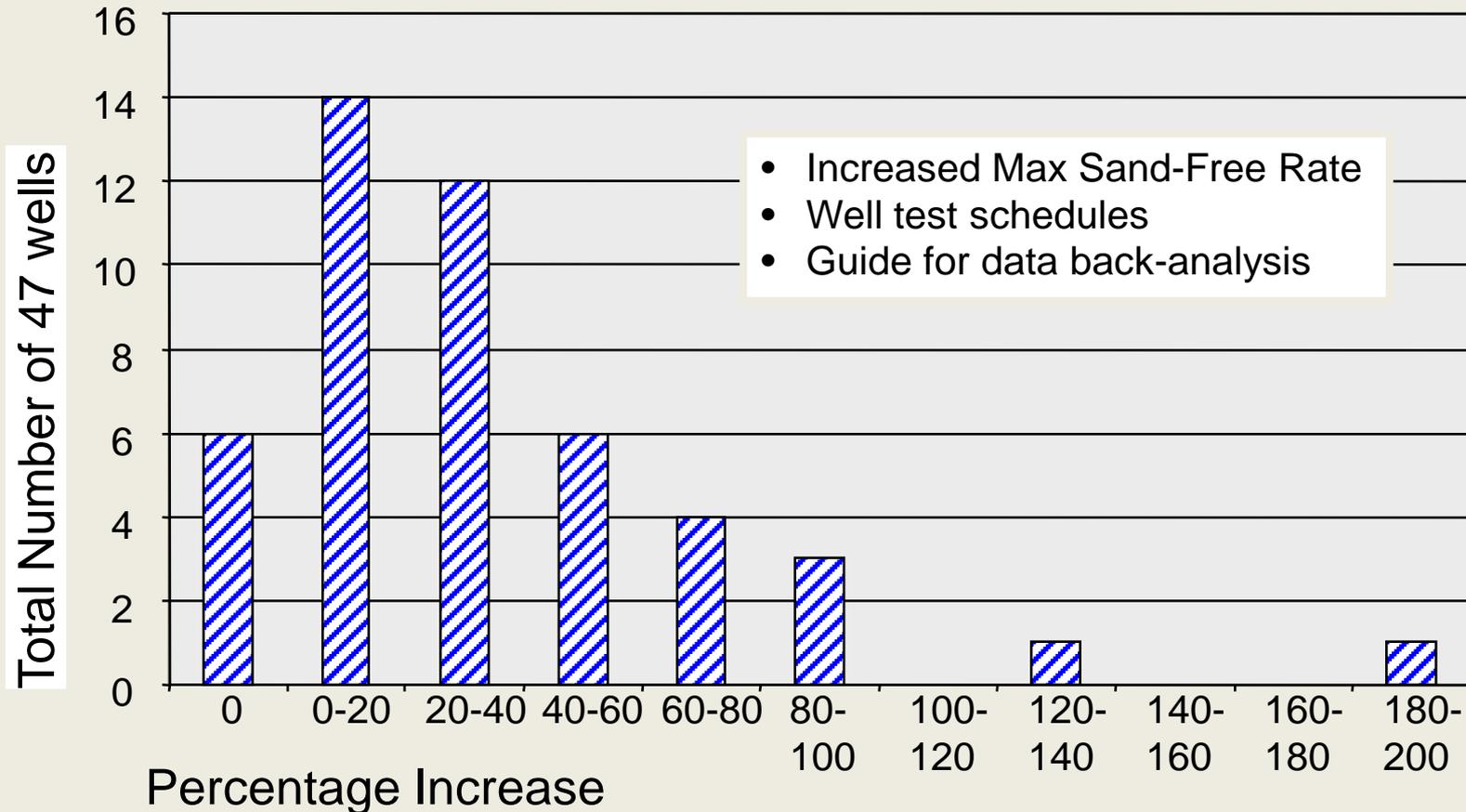
sand restrained only by choke

low reliability

possible loss of hole

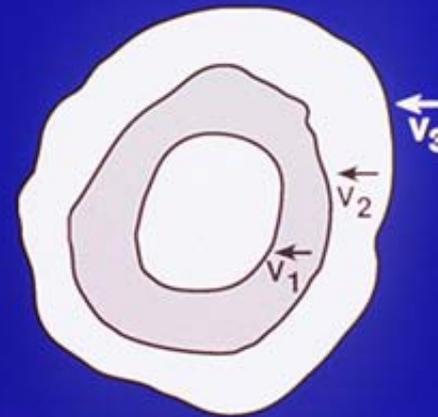
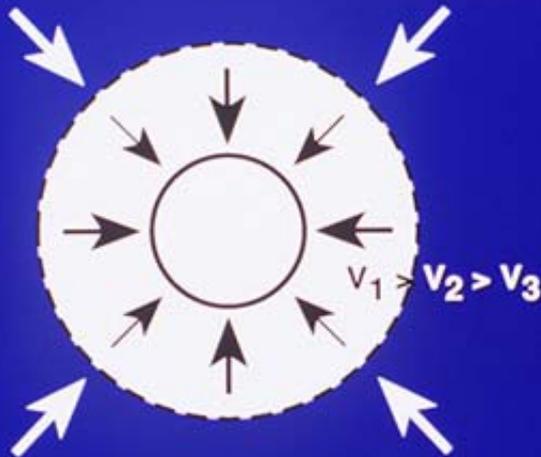
Rate Increase through Sand Management

Sand Management: Allow controlled sand production.
North Sea Field: Three platforms, Mean increase 36%



Cavity creation by producing sand from the formation face in a formation that will support a cavity. If the UCS (unconfined compressive strength) is low ($\sigma < 500$ psi), the formation may not support a stable cavity.

Flow Velocity

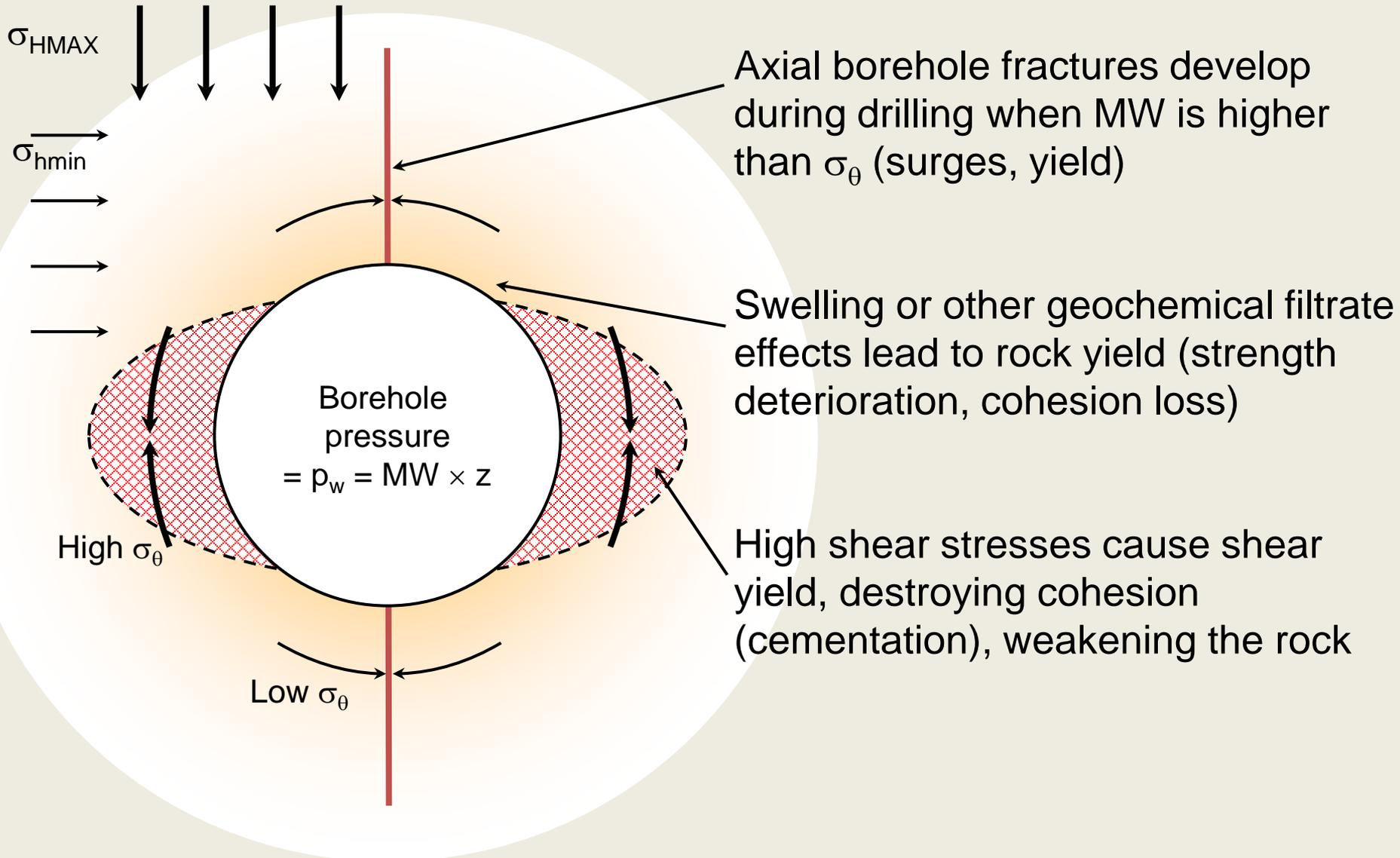


The cavity will grow outward until the velocity of the flowing fluid is no longer able to pull formation grains from the matrix.

Cavity Size and Shape

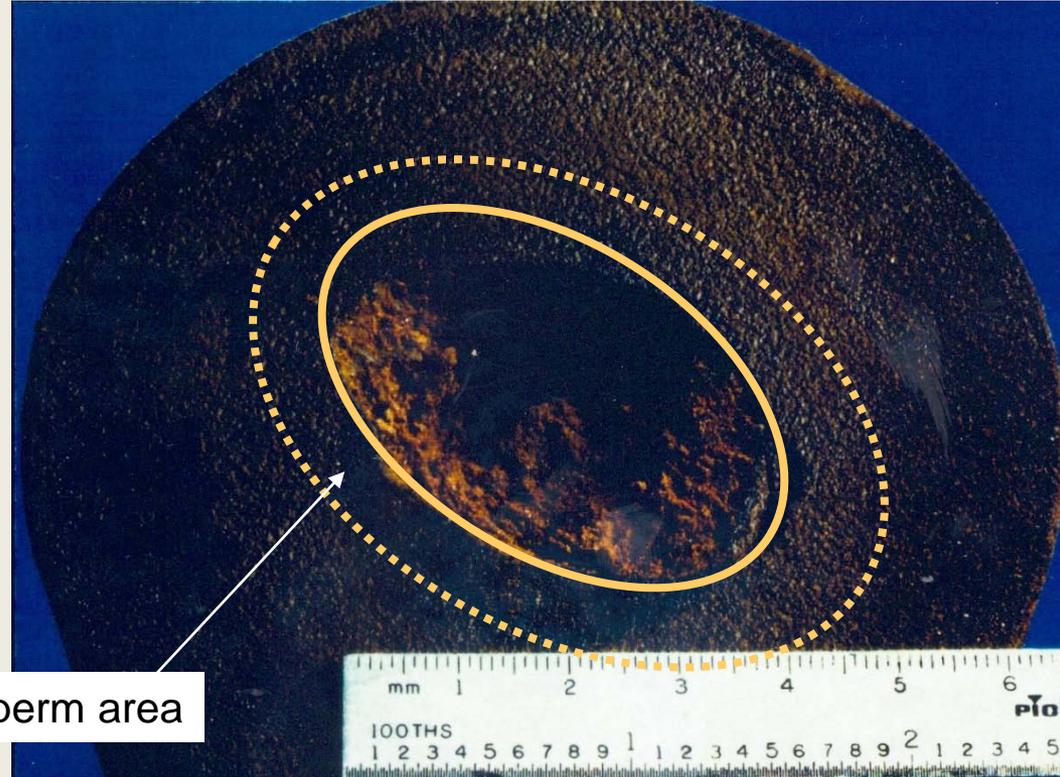
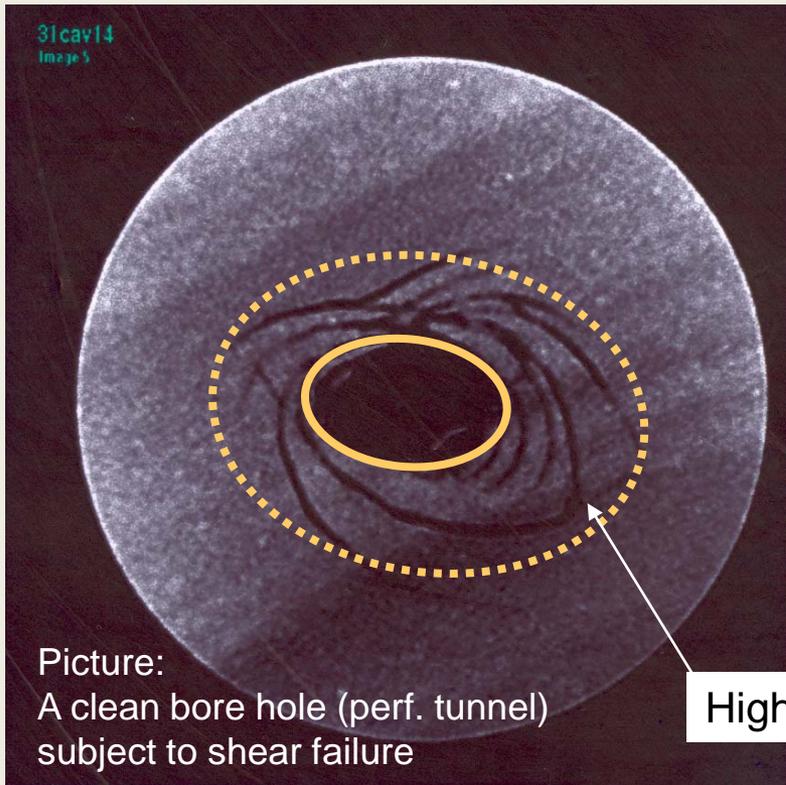
- Cavity size will depend on formation strength, differential pressure, mechanical assistance (under-reaming or explosives), effect of fluid movement, etc. Average sizes measured by sonic caliper runs indicated cavity radii from ~6" to ~6'.
- Cavity shape by sonic caliper and downhole cameras indicate selective cavity enlargement in what appears to be brittle layers and weaker formation layers. Stress direction undoubtedly has a significant impact.

Failure (Yield) of Rock



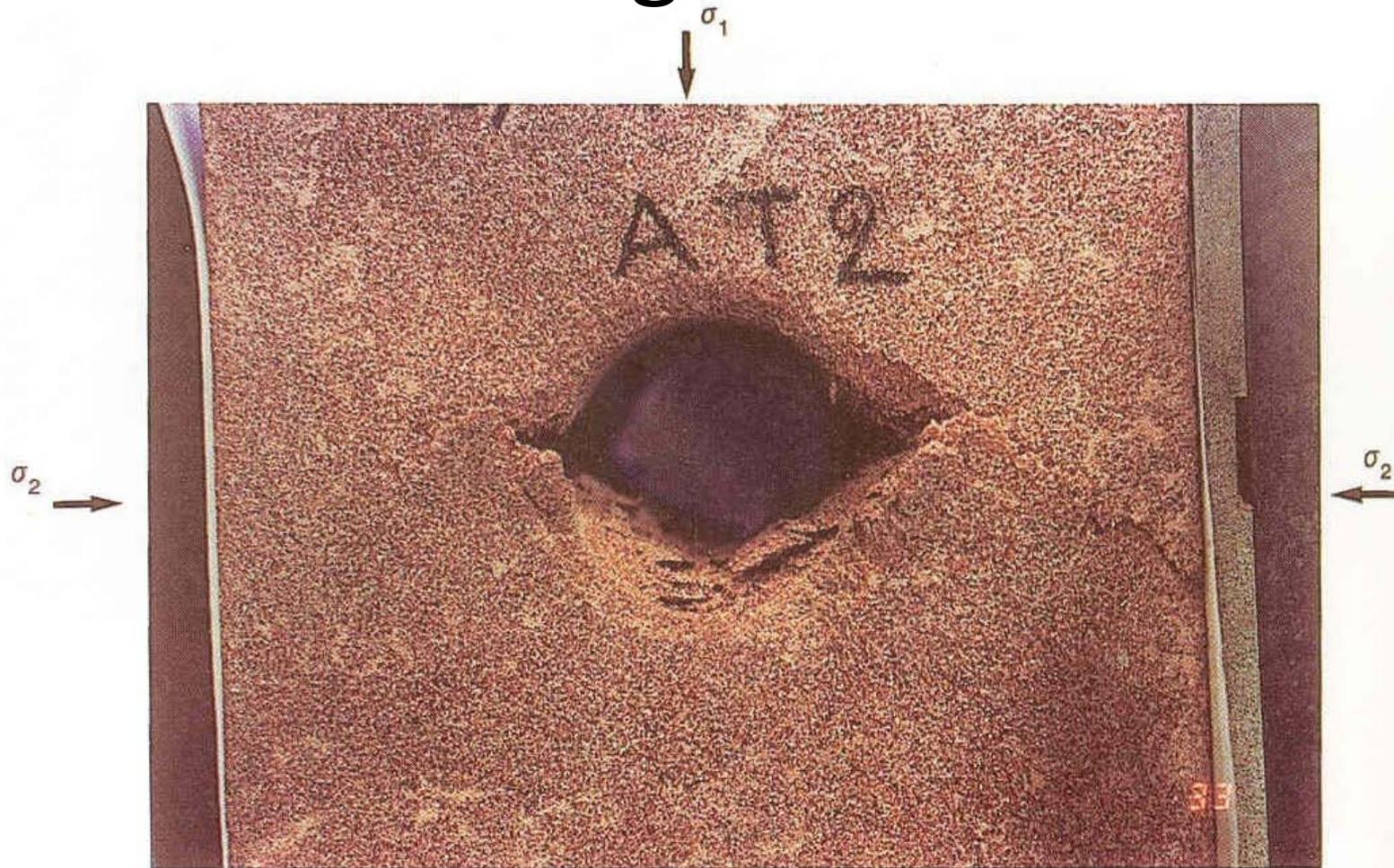
Does the completion type allow self cleaning, formation de-stressing & relaxation?

Lab testing: Shear failure



Shear failure causes cracks around the bore hole (or perforation tunnel). Known as dilation. Rock dilation leads to volume expansion. When (if) the failed material is produced out of the well, the near wellbore porosity and permeability increase. **When \emptyset increase from 30% to 40%, K increase 3 fold.** If the failed material is trapped (eg. by a depth filter screen), plugging (increased skin) and reduced productivity may be the result.

Lab testing: Shear failure

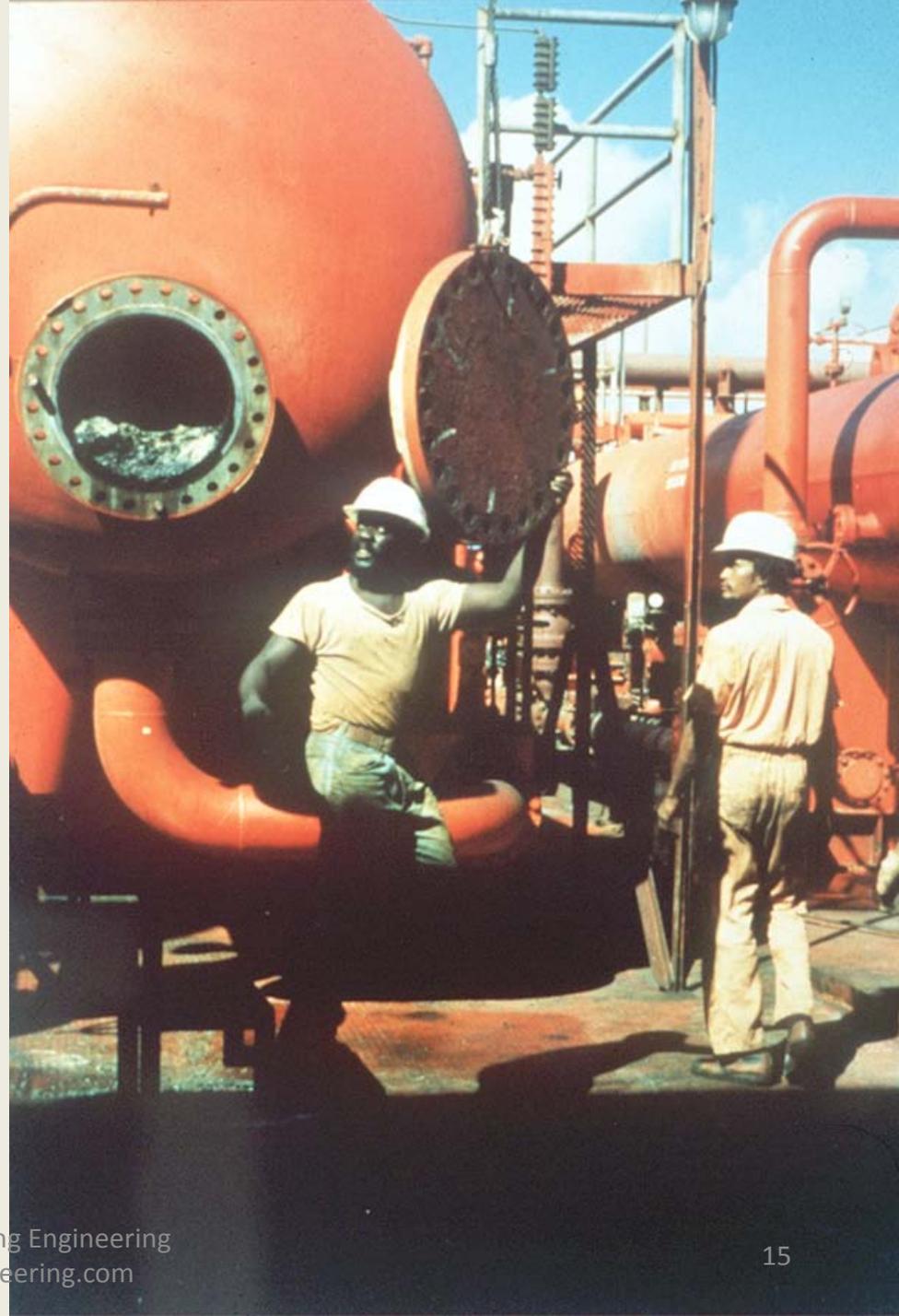


$\sigma_1 = 491 \text{ bar}$ ($\sigma_2 = 200 \text{ bar}$)
End of test

What are the long term effects of sand production? Is it just a surface problem or are there down hole problems too? Will higher permeability flow paths collapse?

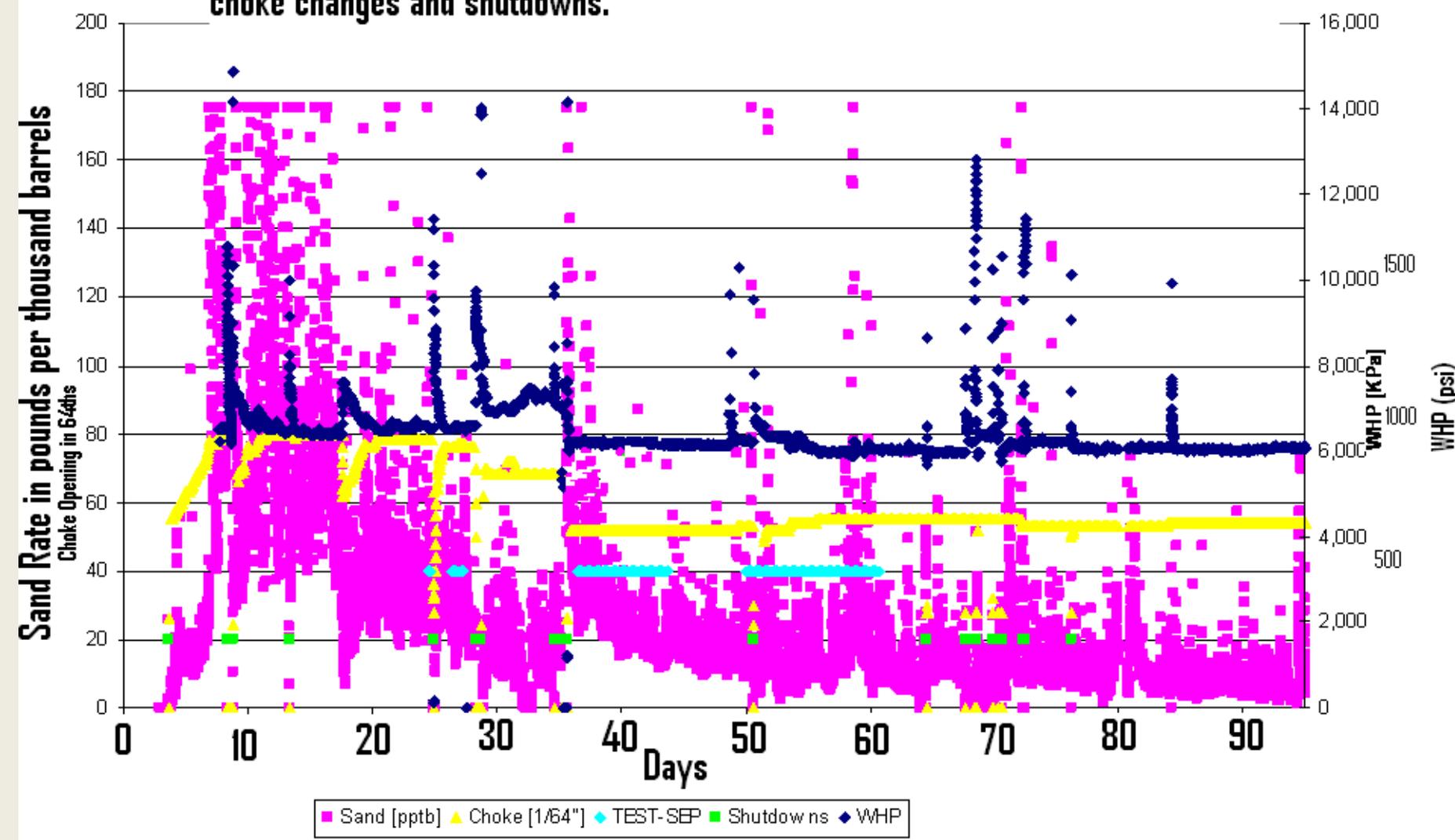
Formation strength may decrease sharply when water moves into the pores of a gas or oil saturated formation. The combination of relative permeability effects from an extra phase and added “lubrication” between the grains that alters oil cementing forces will lower strength in a weak rock.

On the positive side – will production increase as sand is produced? Cavities and flow paths may open.



High rate well performance showing sand volumes produced and cleanup over time. Note – production increased with sand flowed.

Comparison of sand production over time. Note how sand spikes upward after choke changes and shutdowns.



Cased and Perforated

Area open to flow = 6% to 8% for
12 spf, 0.75" EH (assumes all perfs
open),

4% open area in base pipe

Skin = -1 to 5

Advantages

lower cost than full sand control

routine completion

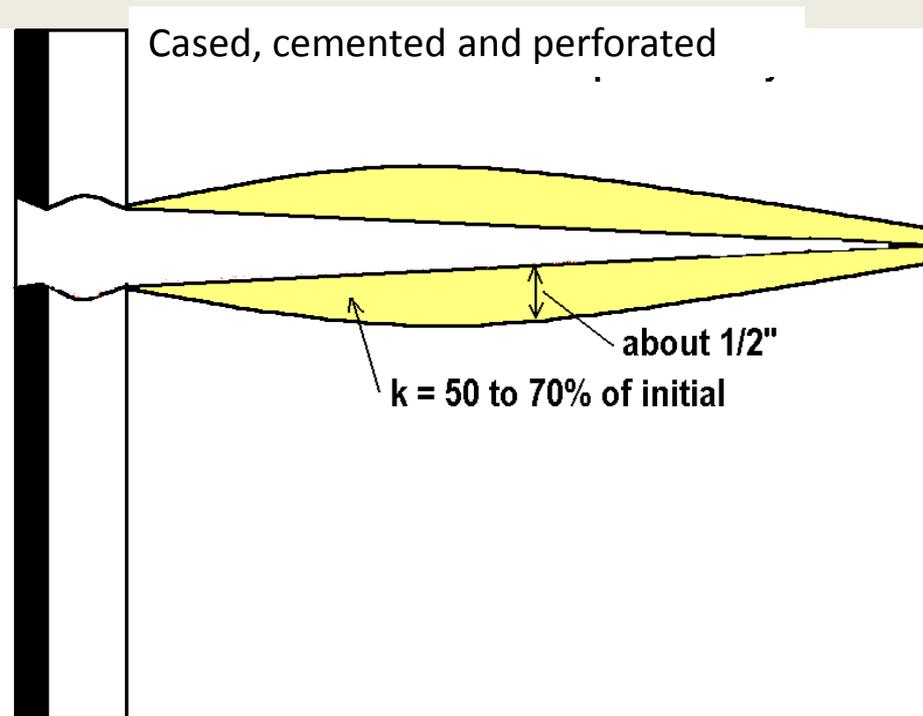
zone and water control

Disadvantages

sand restrained only by choke

low reliability in many cases

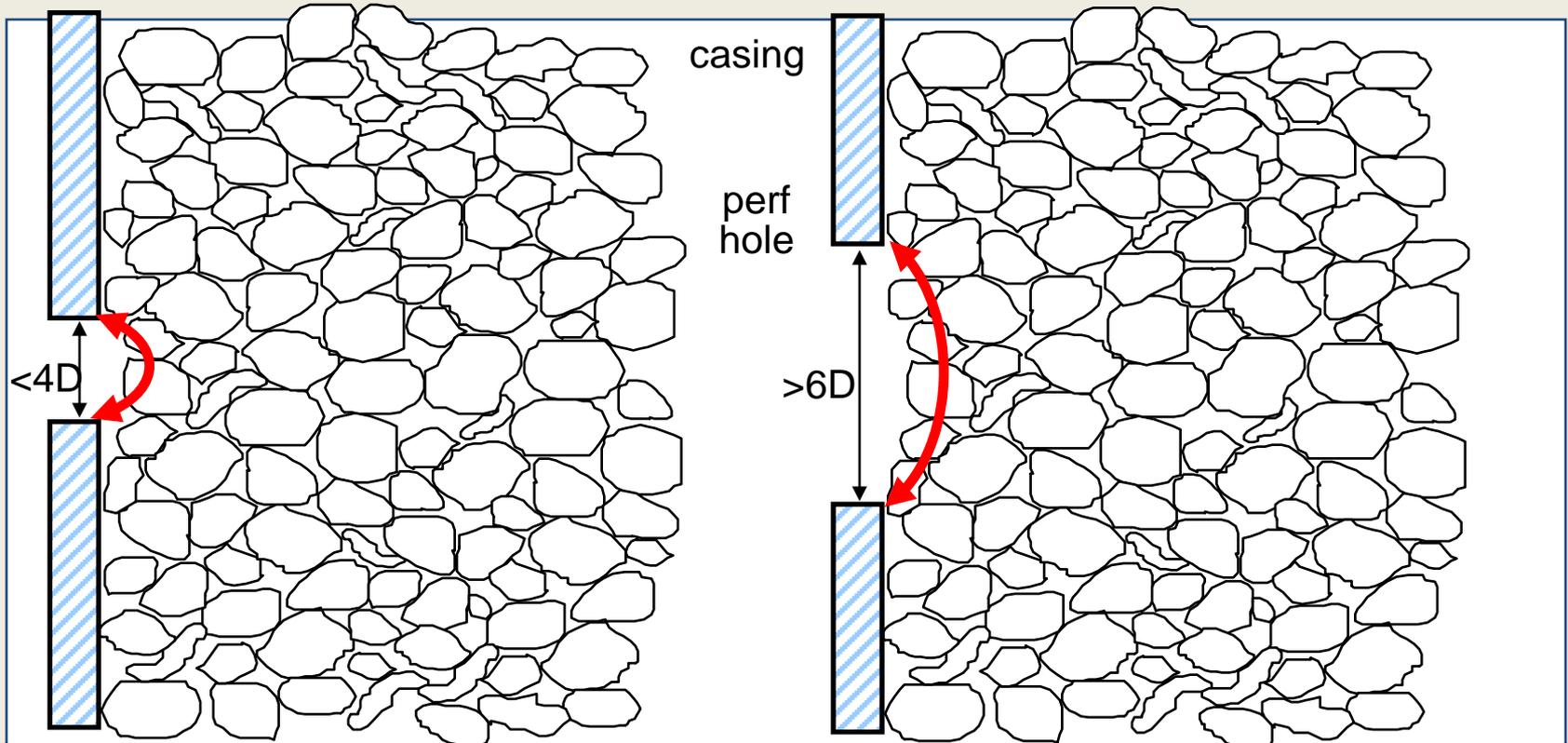
low inflow area



Bridging Lab Experiments

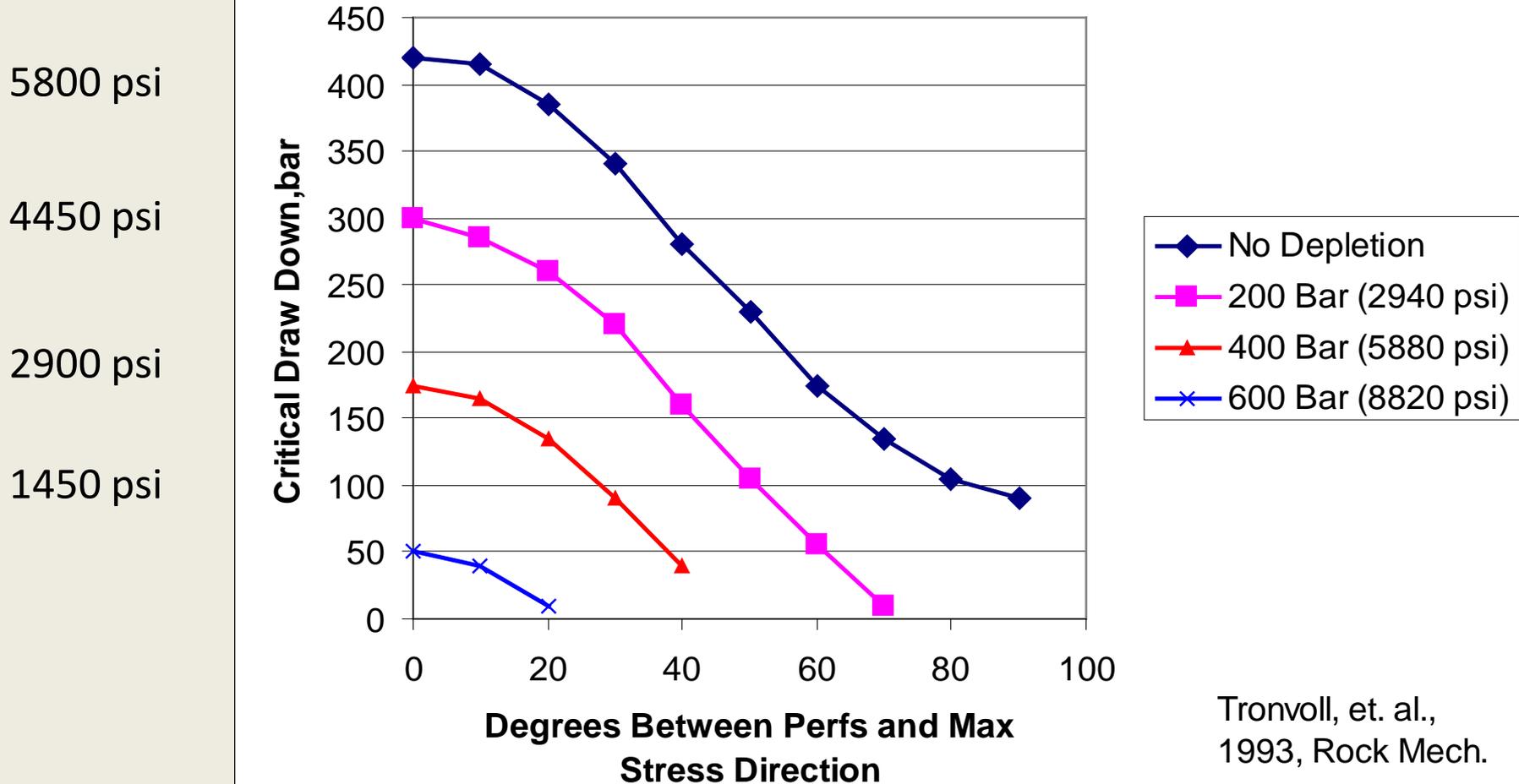
Numbers are from experiments performed on uniform, rounded quartz sand

Narrow openings relative to the size of the particles are easier to bridge and more stable.



The arches formed are only stable so long as a steady pressure from flow is exerted. Then the differential pressure from flow is stopped, the arches collapse

Pressure at Onset of Sand Production vs. Degrees Away From Maximum Horizontal Stress



Tronvoll, et. al.,
1993, Rock Mech.

Stand Alone Screen

WIRE WRAPPED PIPE BASE. ALL-WELDED SCREEN



Area open to flow = 4% to 10%+ (base pipe open area = 9%)

Skin = 2 to >10

Advantages

moderate cost (lower than G.P.)

some solids control

Disadvantages

screen running problems

subject to erosion

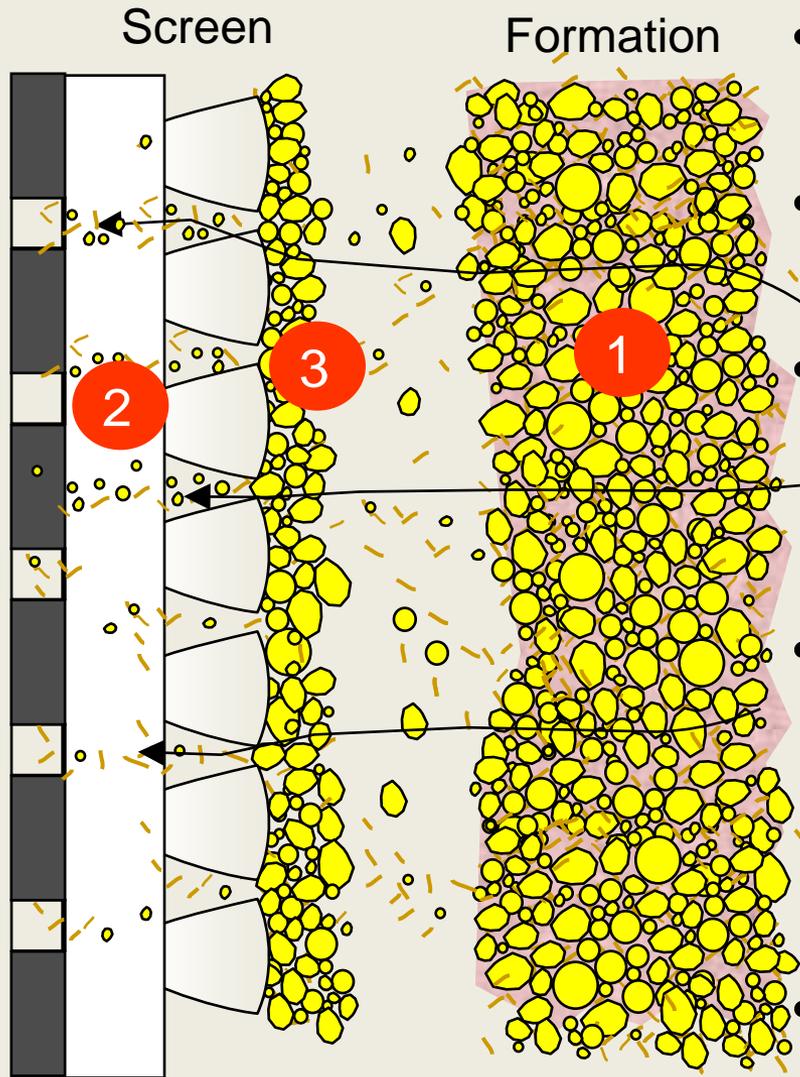
easy to plug

low reliability with high rate/fines

Screen Types

- Wire Wrapped
 - Pre-Packed
 - Woven screens
 - Special Designs
-
- Which? Depends on the well needs?

Stand Alone Wire Wrap Screen Behavior in OH



- Formation (1) consist of:
 - Load bearing (UCS) and non load bearing structure
- Load bearing structure is:
 - Sand grains + cementing material (Feldspar, Calcite ++)
- Non-load bearing structure:
 - Fines (2) = (Silt and clay), 0-60 micron
 - **When properly engineered, fines are allowed to be produced through the wire wrap screen**
 - **Plugging is prevented** (SPE 38187, 38638)
- Screen construction & slot sizing must ensure that fines can be produced unhindered through the screens
 - Remaining, non-produced sand (3) bridge on the screen surface, and creates a natural sand pack (zero UCS) with higher porosity and perm than formation (1)
- Formation relaxation/de-stressing: *
 - Depletion leads to increased formation stress, which can result in significant permeability reduction. (SPE 36813, 36419, 71673)
 - Barefoot and SAS completions ALLOW

Wire Wrapped Screen

- Simplest and cheapest
- Most difficult to plug
- Cannot withstand erosion
- Best in the lower part of a vertical well
- Easily damaged in running operations

Pre-Packed Screen

- Moderately expensive
- Easiest to plug
- Can withstand some erosion
- Best in the upper part of a vertical well and in horizontal wells
- Easily damaged in running operations

Woven Screen

- Expensive
- Relatively easy to plug
- Can withstand some erosion
- Best in the upper part of a vertical well, in horizontal wells, and in bare screen completions
- Easily damaged in running operations

Slotted Liner

Area open to flow = 2% to 4%

Skin = 4 to >10

Advantages

moderate cost

ease of installation

good for well sorted sands

Disadvantages

low rotational strength

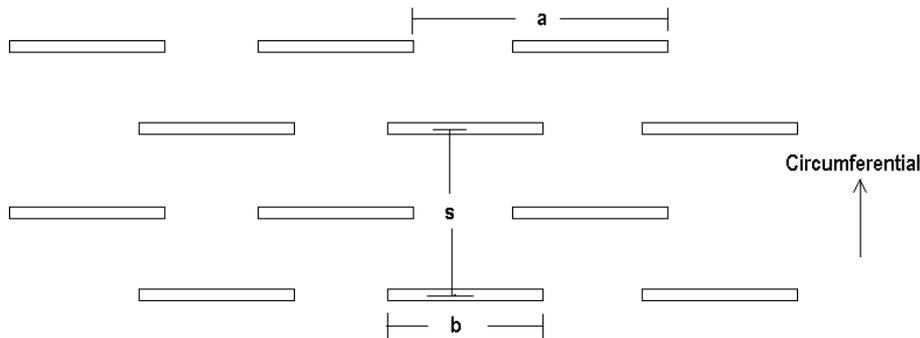
low inflow area

subject to erosion

low reliability

easily plugged

Strength Reduction for Staggered Slot Arrangement



Strength Reduction = $c (1 - (b/a))$

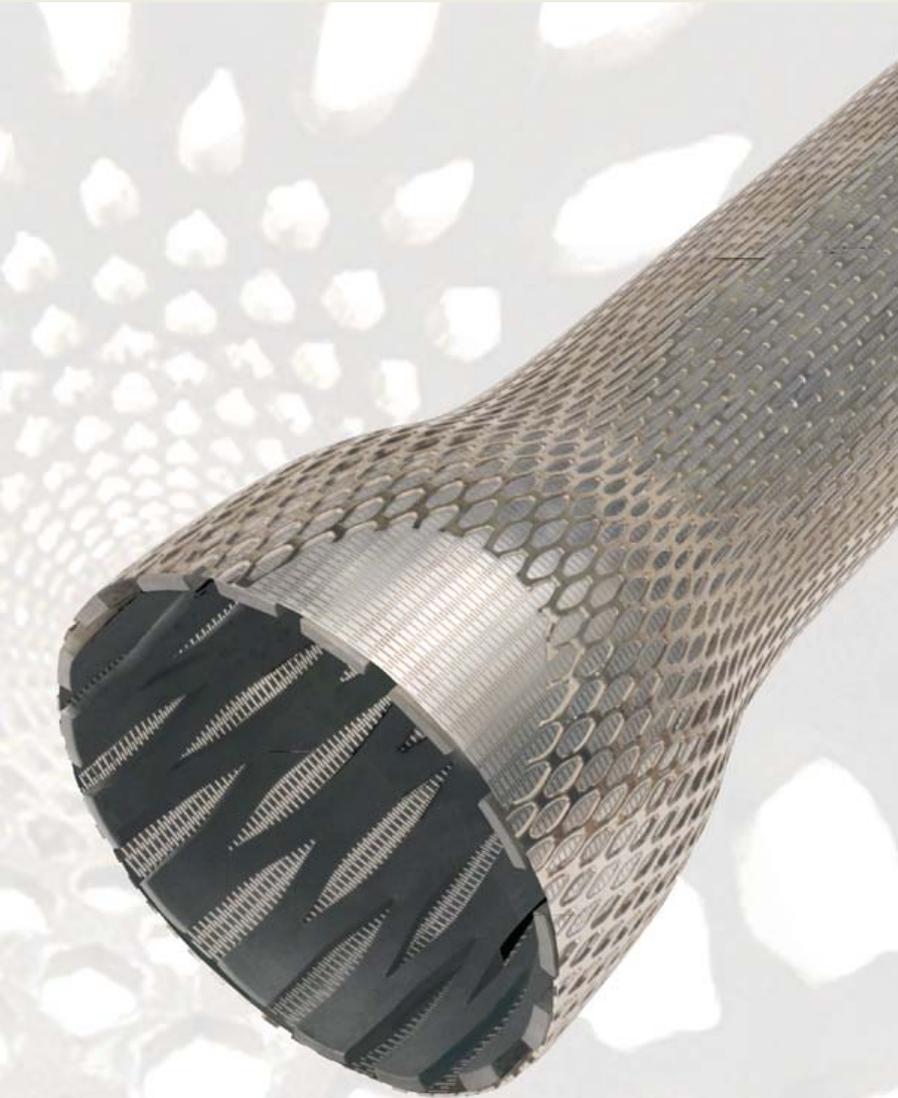
where:

$c = 1$ for $s \geq b$

$c = 0$ for $s \leq 0.1 b$

$c = \frac{(s - 0.1b)}{(0.9 b)}$

Expandable Screen



Area open to flow = 6% to >10%

Skin = 0 to >5

Advantages

largest screen possible

little or no annulus

potential isolation capacity

Disadvantages

higher cost

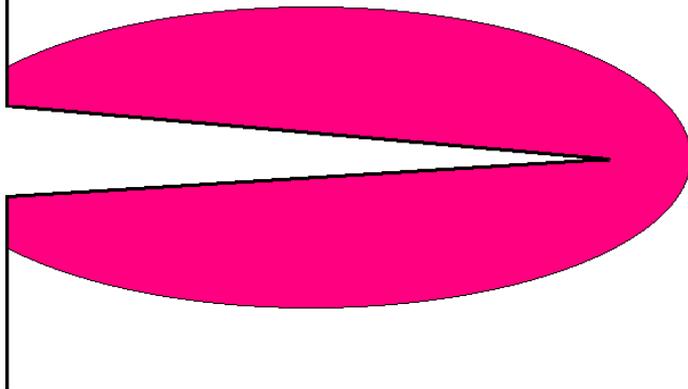
new, unproven reliability

subject to erosion in cased hole

compliant expansion not proved yet

Resin Consolidation

Resin success depends on application of resin in every perforation



Resin cements the grains together – adds strength to the matrix.

Area open to flow = 3% to 6%

Skin = 10 to >50

Advantages

leaves wellbore open

relatively low cost

Disadvantages

limited zone height (6' to 10')

longevity limited: months - few years

temperature sensitive ($t < 250F?$)

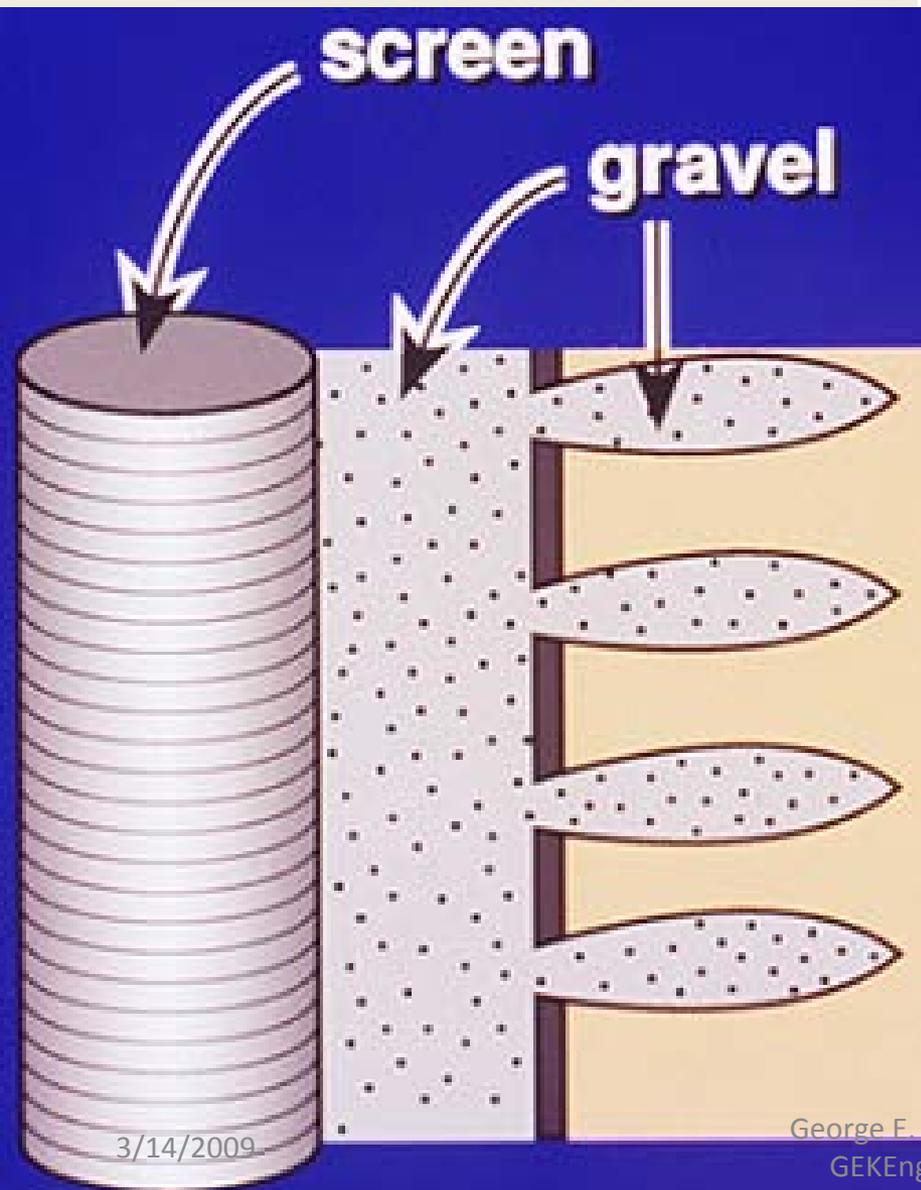
can't use on failed well

very difficult to evenly apply

sand cleaning issues

reduces matrix perm by 10 to 60%

Cased Hole Gravel Pack



Area open to flow = 6% to >10%

Skin = 10+

Advantages

- known/trusted method

- moderate reliability

Disadvantages

- higher cost

- low inflow area

- subject to erosion

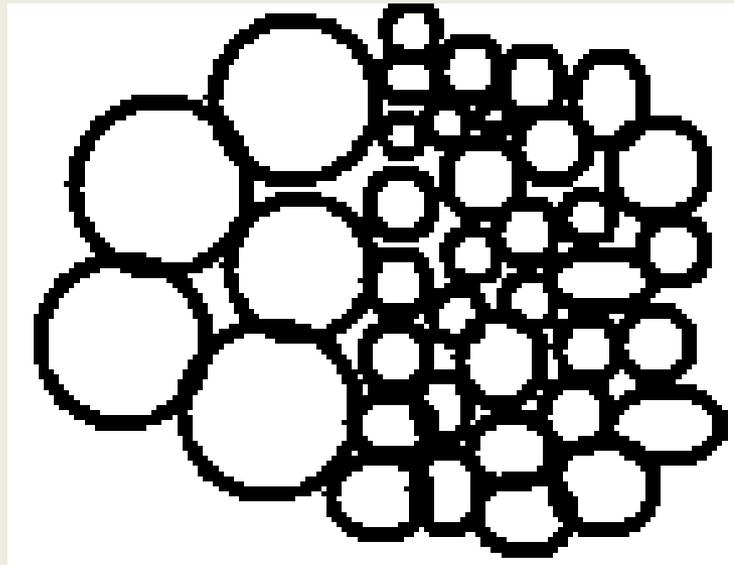
- low reliability

- moderately easily plugged

The heart of a gravel pack is the sizing of the gravel to stop the formation sand. If the sand invades the pack, the 100 to 400 darcy permeability level of the gravel pack drops to 50 to 500 md and skins of 300 are possible.

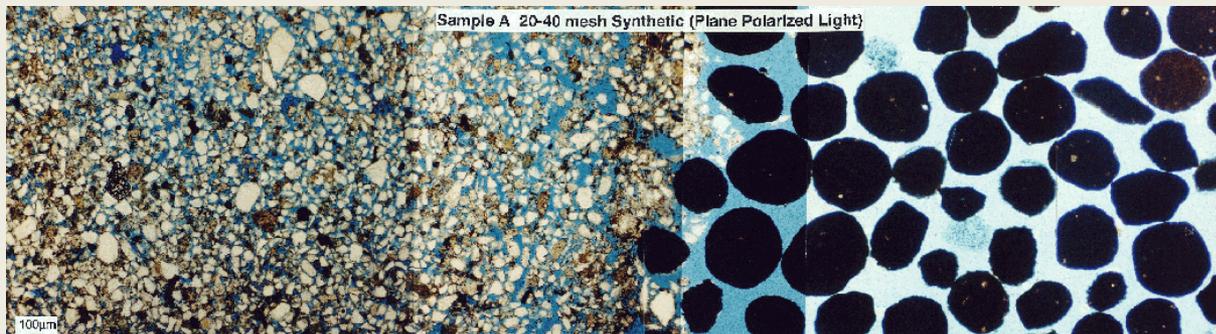
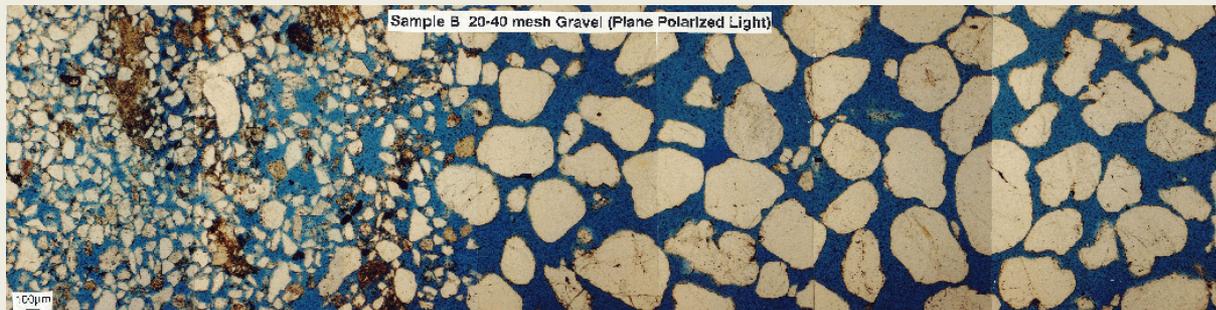
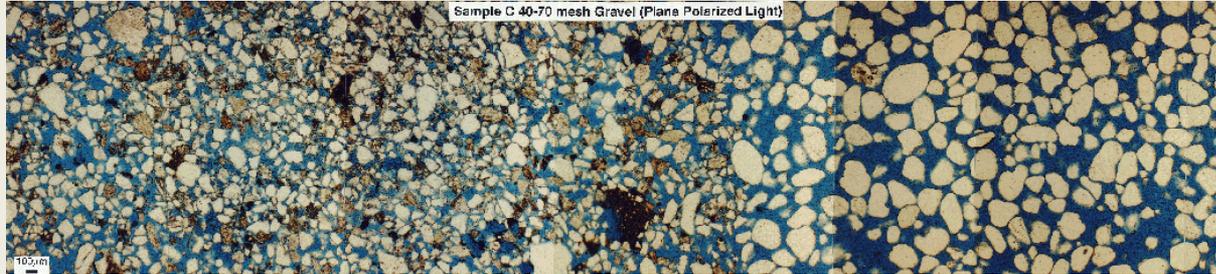
gravel

Formation sand

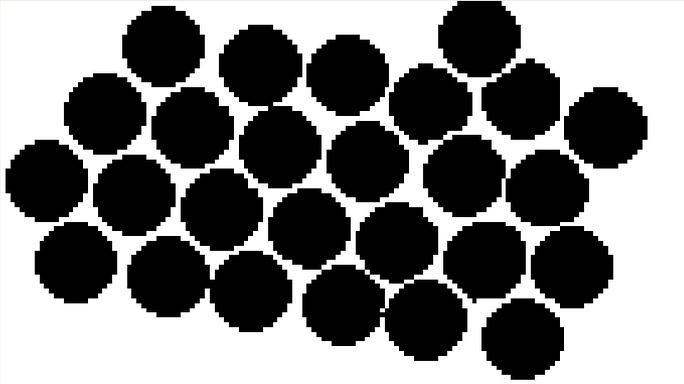


flow

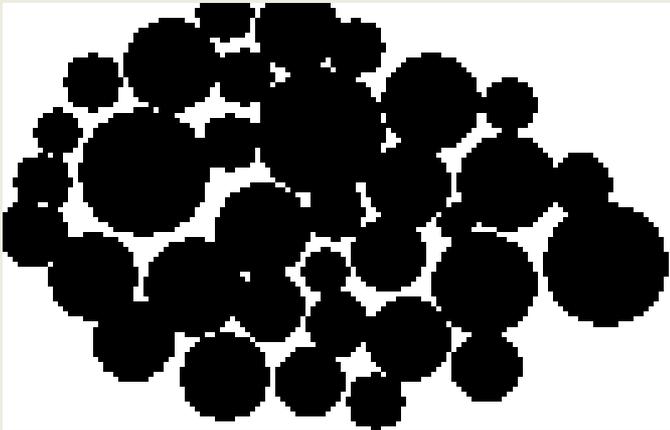
Thin Sections of Case A with Different Gravels



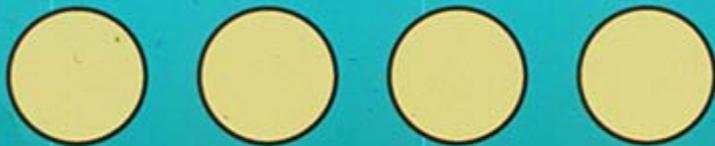
Similar size particles versus a range of particles



Which is likely to flow more?



Proppant Shape



round \Leftarrow better permeability



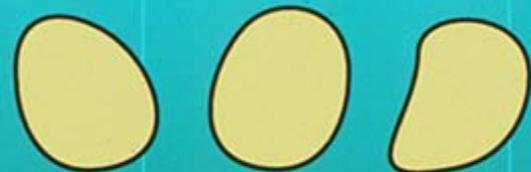
angular \Leftarrow lower permeability

Except at stresses
less than \approx 3-4000 psi



Proppant Size

10 mesh screen



-10/+20

20 mesh screen



-20/+40

40 mesh screen



-40/+60

60 mesh screen



gek04402.fh3

Gravel Permeabilities

Gravel Size	typical, unstressed perm
-12+20 mesh	450 darcies
-20+40	120
-25+30	140 to 160
-40+60	65
-50+70	45
100 mesh (-70+140)	0.6

Narrower ranges of gravel sizes can have much higher permeability than wider ranges of sizes.

Permeabilities of Gravel Pack Sands

US Mesh Range	Permeability (Darcy)	Permeability (Darcy)	Permeability (Darcy)
6/10	2703		
8/12	1969		
10/20	652	500	
12/20			668
16/30		250	415
20/40	171	119	225
40/60	69	40	69
50/70			45
	Spurlin	Gurley	Cocales

Accupack	Typical Mean % Retained on Individual Screens					
US Sieve Mesh (ASTM E-11)	12/20	16/30	20/30	20/40	30/40	40/60
12						
16	22.7					
18	59.4	6.9				
20	17.1	54.4	0.4	0.4		
25	0.8	36.7	72.1	14.1		
30		1.8	26.7	29.3	0.5	
35		0.1	0.8	47.3	74	
40				8.1	24.7	0.6
45				0.8	0.8	40.9
50						48.3
60						9.3
70						0.9
Pan						

The pore size flow area presented by a pack of either gravel or formation sand. The gravel used in traditional gravel packing presents a pore throat from about 80 microns to about 180 microns. The formation sand can bridge on this pore – usually using the 1/3th rule.



US Mesh Size	Perm. darcy	Porosity %	Pore Throat microns	Fines retained microns	Fines produced microns
10/20	325	32	225	90	< 90
10/30	191	33	174	70	< 70
20/40	121	35	139	46	< 46
40/60	45	32	86	34	< 34
Formation	10	32	40	16	< 16
Formation	2	32	18	7	< 7



$$\text{Log } r_{\text{apex}} = -0.117 + 0.475 \text{ Log } K - 0.099 \text{ Log } \phi$$

K md, ϕ is in % [ref. (1)]

Gravel Size Ranges

- Gravel sizes were initially and arbitrarily set based on availability of sand in the mined deposit.
- Typical selection is 12/20, 16/30, 20/40 mesh etc., but any range can be blended.
- What would be the best gravel size? Special blends of gravel with narrow ranges can maximize permeability.

Gravel Types

- Sand:
 - \$0.10 to \$0.15/lb., roundness = 0.8
 - average size is typically in finer end of range
 - handling produces fines
- Man made:
 - \$0.25/lb. and up.
 - roundness = 0.9+
 - larger average size in any range
 - higher perm than sand
 - stronger, less fines.
- For narrow range gravel – about double price.

Use correctly sized, clean, round, well sorted gravel

- The gravel is selected and placed to stop the formation sand.
- Correct size? About 6 times the d50 of the formation sand in most cases, but there are some cases where larger gravel is acceptable and more productive.
- Fracs and open hole completions in formations that are well sorted with minimum mobile fines might utilize larger sands if drawdown is controlled.

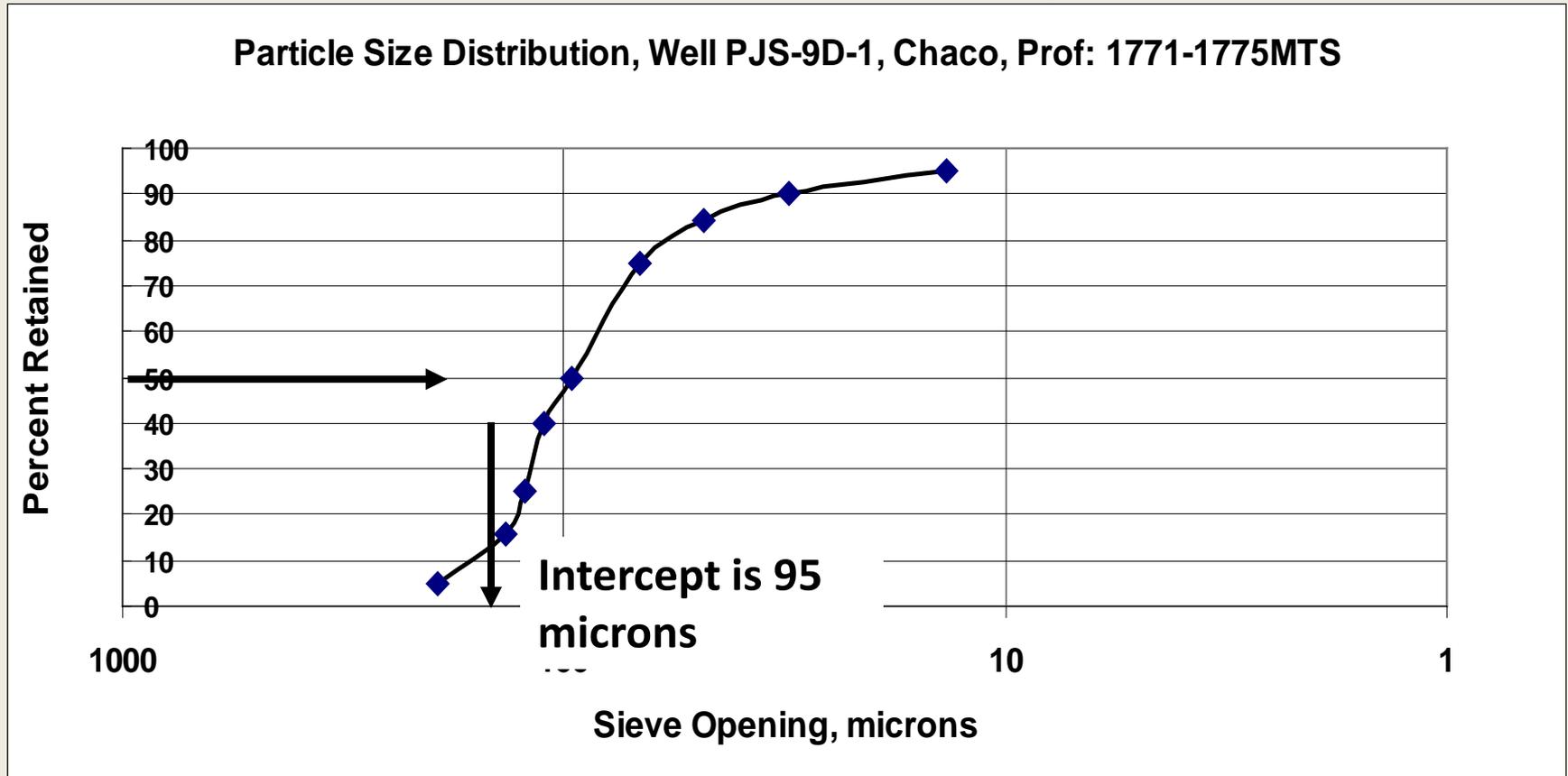
Gravel Sizing

- Conventional (Saucier's method)
- Sorting and fines as influences
- Ordering special gravels?

First: determine the gravel size necessary for the completion

Step one: plot the formation size distribution

Step two: determine the 50% intercept grain size



Step three: gravel size –

for gravel pack: $6 \times 95 \text{ micron} = 570 \text{ micron} = 32 \text{ mesh}$. Use 20/40

for frac pack: $8 \times 95 \text{ micron} = 760 \text{ micron} = 24 \text{ mesh}$. Use 16/30

What size gravel?

- 95 microns is the 50% intercept
- Saucier's method
 - 6 x 50% intercept gives gravel that will not allow invasion of grains into pack.
 - The 6 x is an experience factor but it also describes the maximum pore opening between a pack of similar sized grains.
- Sorting influence – can use 8x in frac pack or cases where sorting is good and fines are limited.

	mesh	inch	mm	microns
	18	0.0394	1	1000
	20	0.0331	0.84	840
	25	0.0278	0.71	710
	30	0.0234	0.59	590
	35	0.0197	0.5	500
	40	0.0165	0.42	420
	45	0.0139	0.35	350
	50	0.0117	0.3	300
	60	0.0098	0.25	250
	70	0.0083	0.21	210
	80	0.007	0.177	177
	100	0.0059	0.149	149
	120	0.0049	0.125	125
	140	0.0041	0.105	105
	170	0.0035	0.088	88
	200	0.0029	0.074	74

Sorting and Grain Size Distribution

- Sand screens are numbered by wires per inch so the opening size decreases with increasing screen number. The size of the opening compared to the cumulative amount of sand retained – the “D” number is useful for describing the sorting.
- To get sand sorting on a D10/D95 basis, go to the curve of cumulative retained and read the opening size. Divide the D10 opening by the D95 opening to get the sorting number.

Sorting?

- Sorting is a measurement of how similar the grain sizes are between largest and smallest.
- A sand with a D10 of 0.0075" and a D95 of 0.0025" would have a $D10/D95 = 3$ (well sorted)
- A sand with a D10 of 0.006" and a D95 of 0.00008" would have a $D10/D95=75$ (very poorly sorted)



Well Sorted –
similar size grains
with large pores



Poorly Sorted –
wide range of
grains with very
small pores

Sorting – Now What?

- For the $D_{10}/D_{95} = 3$ formation, the completion may be a screen only or a gravel pack.
- For the $D_{10}/D_{95} = 75$ formation, the assortment of particles resembles a fluid loss additive – this formation requires a completion that will maximize formation exposure since flow rates will likely be very low.

Conventional Screen Sizing

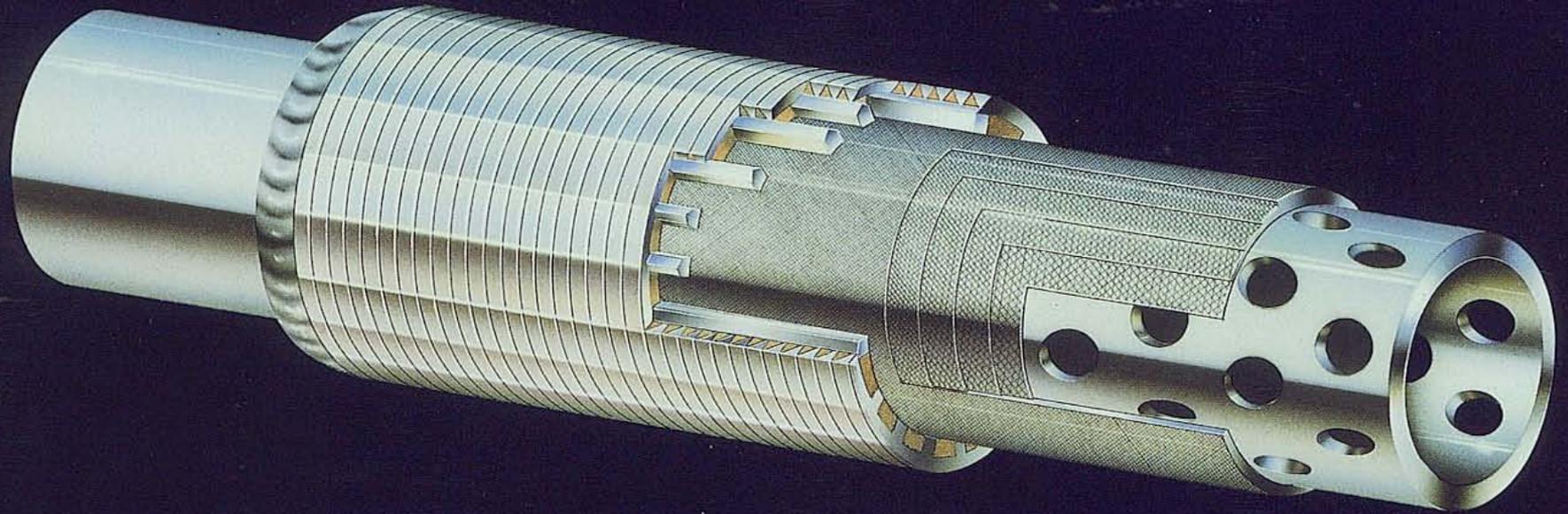
- slot size stops gravel (inches or gauge)
- gravel in range, pick the smallest
 - -20+40 mesh
 - 40 mesh is 0.0165"
 - pick the slot at 50% to 75% of this small size
 - $0.0165'' \times 0.75 = 0.012$ or 12 gauge

Prepacked Screen – minimum thickness prepack



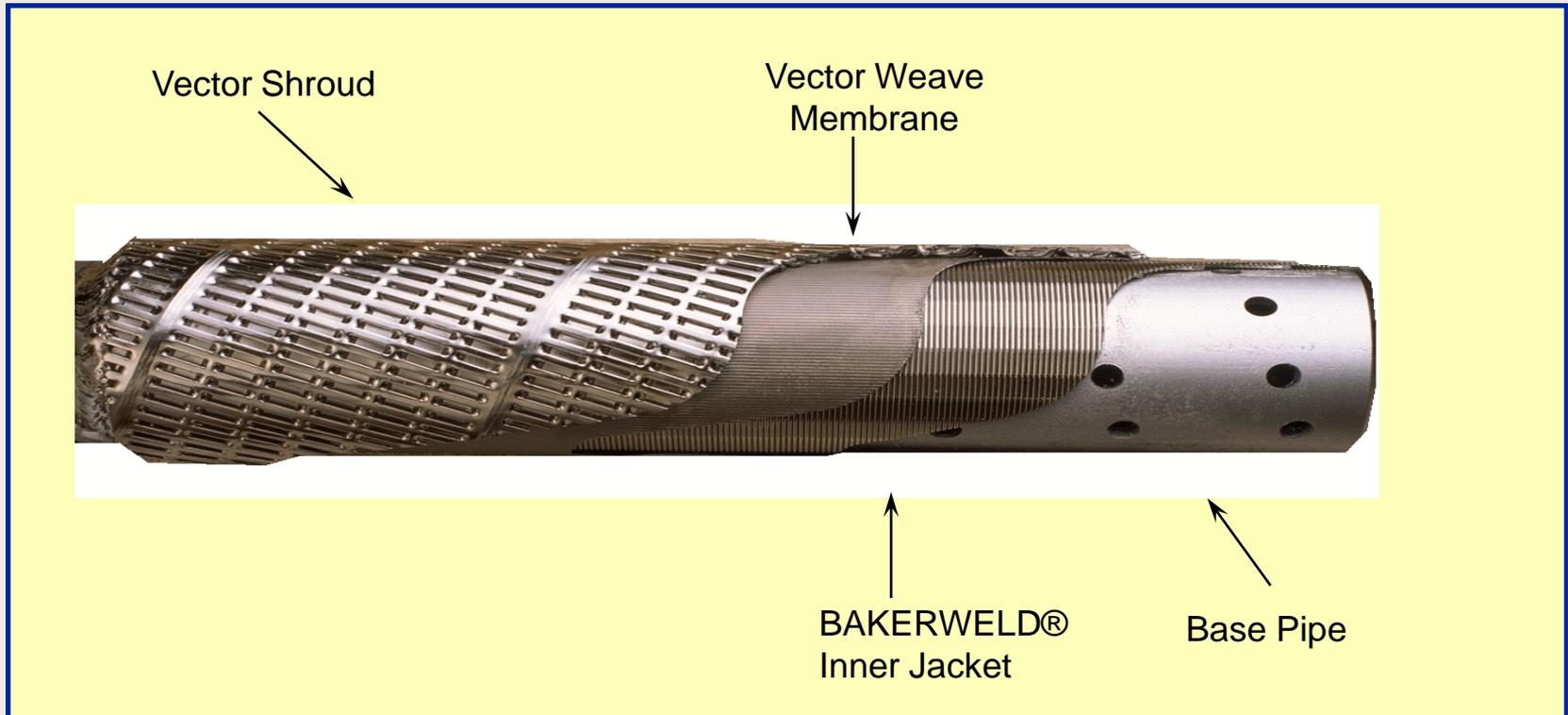
Prepacked liner with center screen – very durable but plugs easily with fines.





The EXCLUDED™ Screen

A leading layered mesh or weave screen





Shroud Assembly

The rugged outer shroud and inner deflector shield provide mechanical strength and superior erosion resistance.

Pleated Design

The pleated style has more than twice the filtering surface area of traditional screens. This patented feature greatly increases the contaminant capacity. The results are reduced plugging tendencies and greater flow throughput.

Cylinder Design

The PoroPlus cylinder design provides a low-profile screen—approximately 1/2" larger than the outside diameter of the base pipe. This feature allows for a larger diameter base pipe than pre-packed screens allow. The cylinder design is also preferred when backwash conditions are expected.

Features

- 316L stainless steel wire mesh filter media
- Multiple layers sintered together
- 125-micron and 250-micron media grades
- Surface filter media
- Two-layer shroud (patent pending)
- High-strength base pipe

Purolator



Gravel and Screen Combos

Gravel

-8+12

-12+20

-16+30

-20+40

-40+60

-50+70

Screen

30 gauge

24 gauge

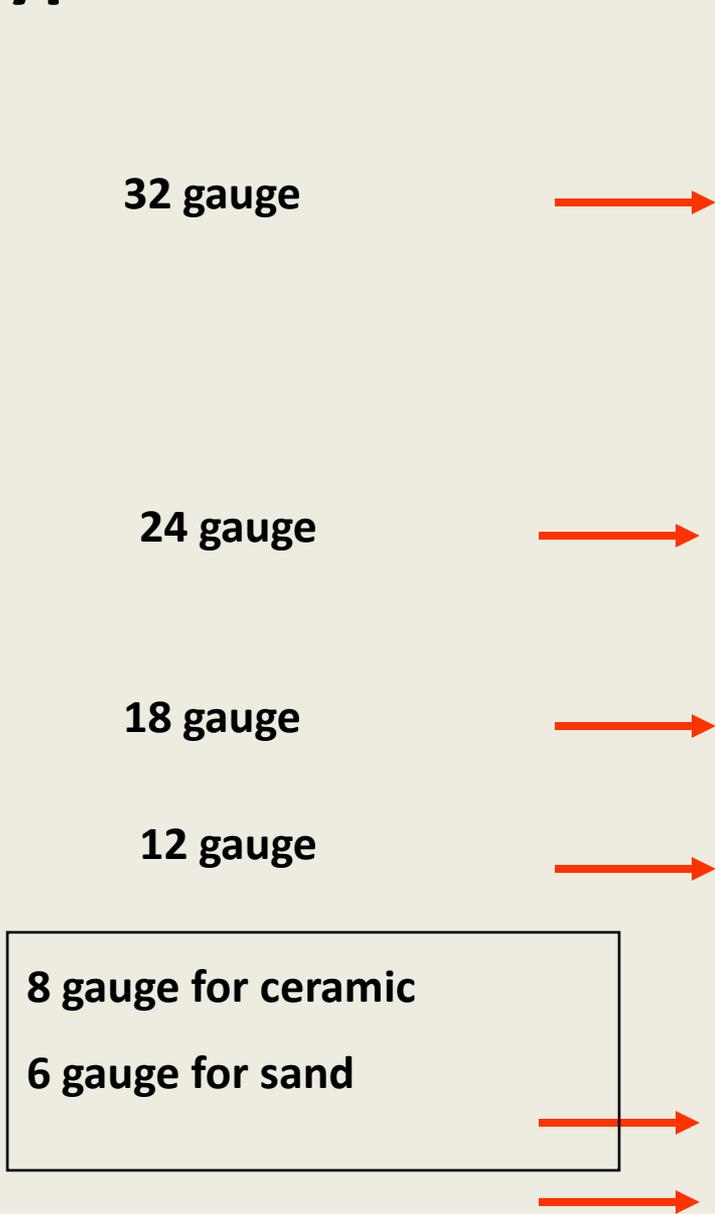
18 gauge

12 gauge

6 to 8 gauge (6 gauge for natural 40/60)

6 gauge

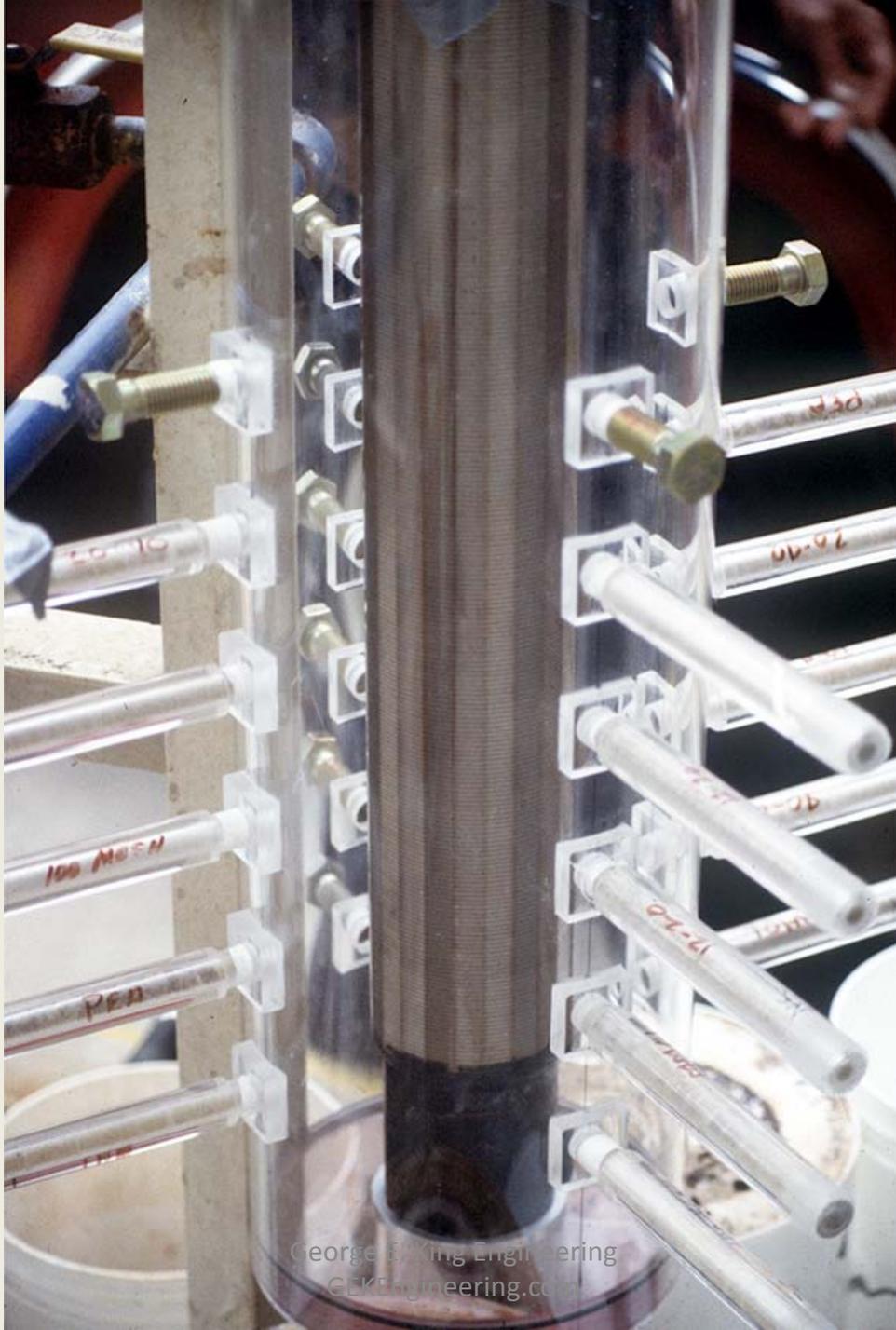
Typical Screen Picks



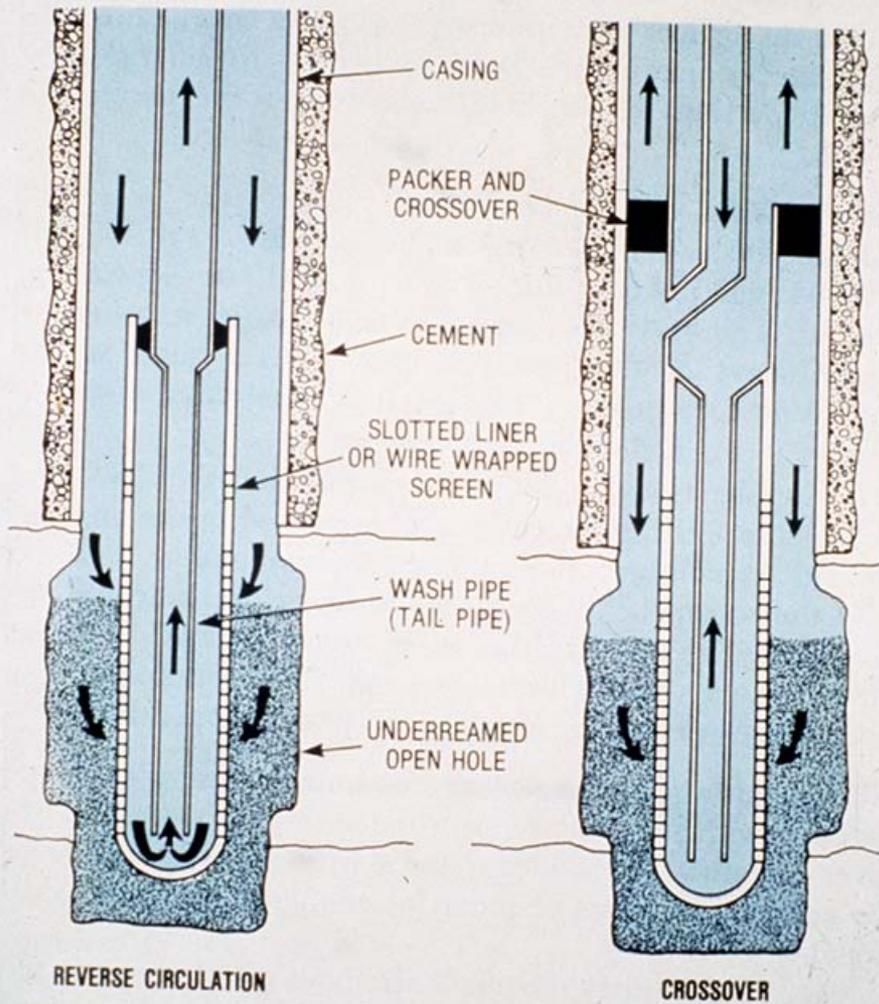
mesh	inch	millimeters	microns
8	0.093	2.38	2380
10	0.078	2	2000
12	0.066	1.68	1680
14	0.056	1.41	1410
16	0.047	1.19	1190
18	0.0394	1	1000
20	0.0331	0.84	840
25	0.0278	0.71	710
30	0.0234	0.59	590
35	0.0197	0.5	500
40	0.0165	0.42	420
45	0.0139	0.35	350
50	0.0117	0.3	300
60	0.0098	0.25	250
70	0.0083	0.21	210
80	0.007	0.177	177

Gravel Packing Design and Operations

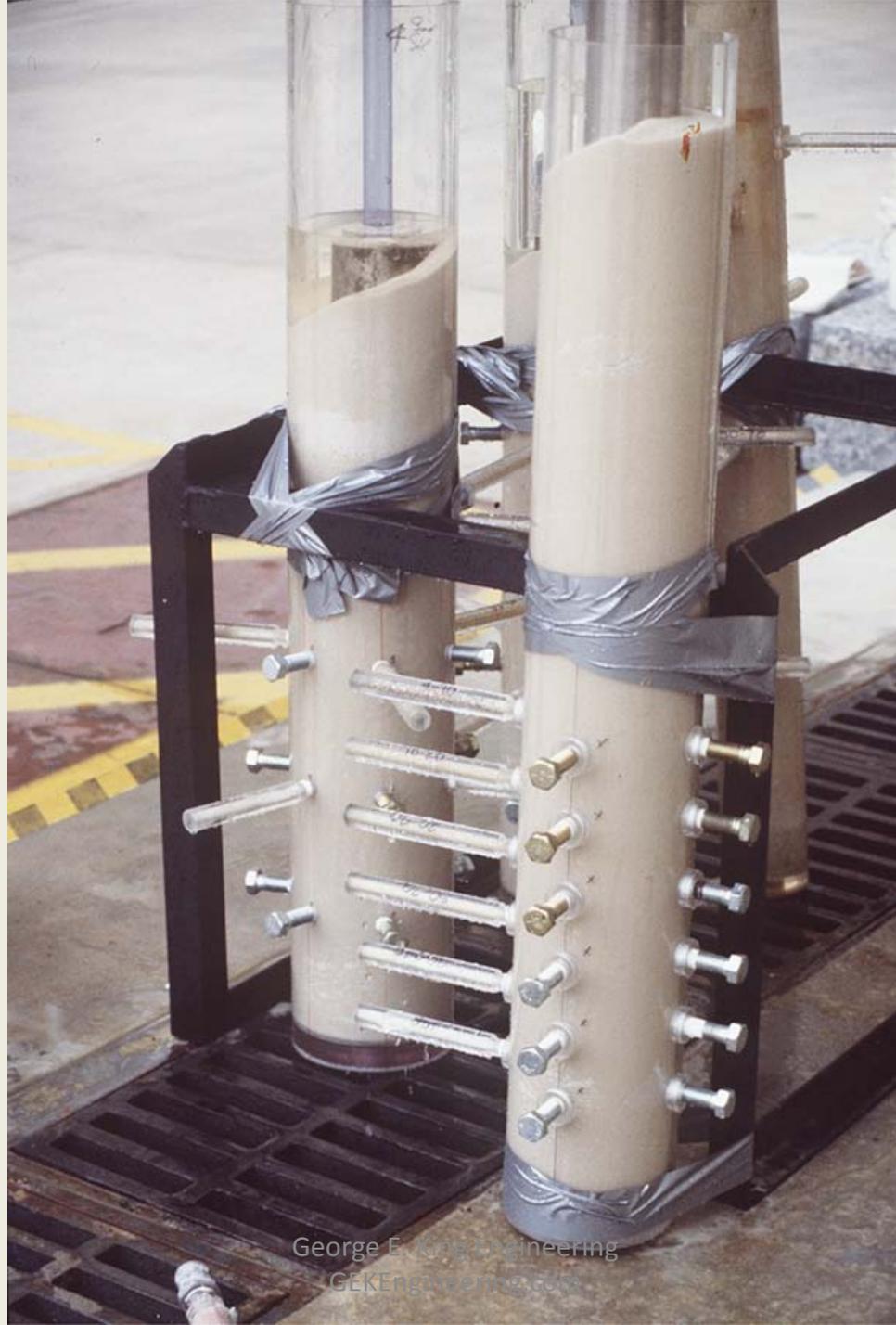
- Some experience
- Some opinions

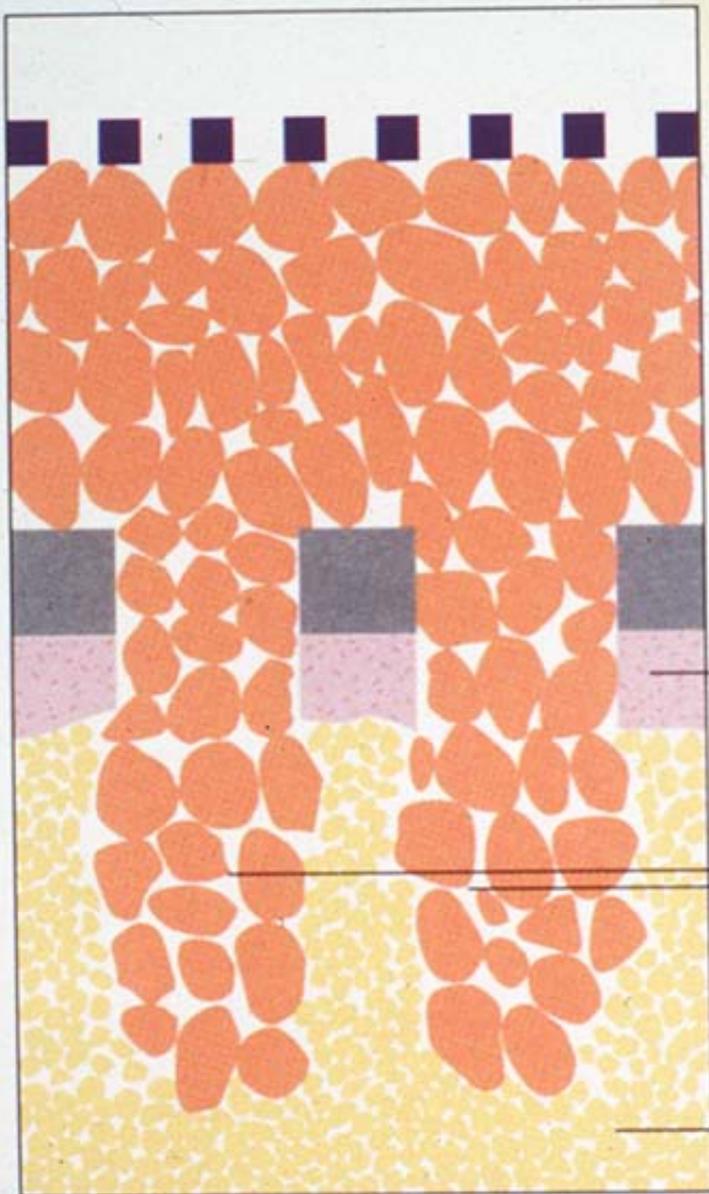


OPEN HOLE GRAVEL PLACEMENT TECHNIQUES



Reverse circulation and crossover gravel packing techniques are commonly used in relatively short open hole intervals, or where wells are not greatly deviated and separation of zones is not necessary. (AFTER SUMAN)





Screen

Gravel-packed annulus

Perforated casing

Cement

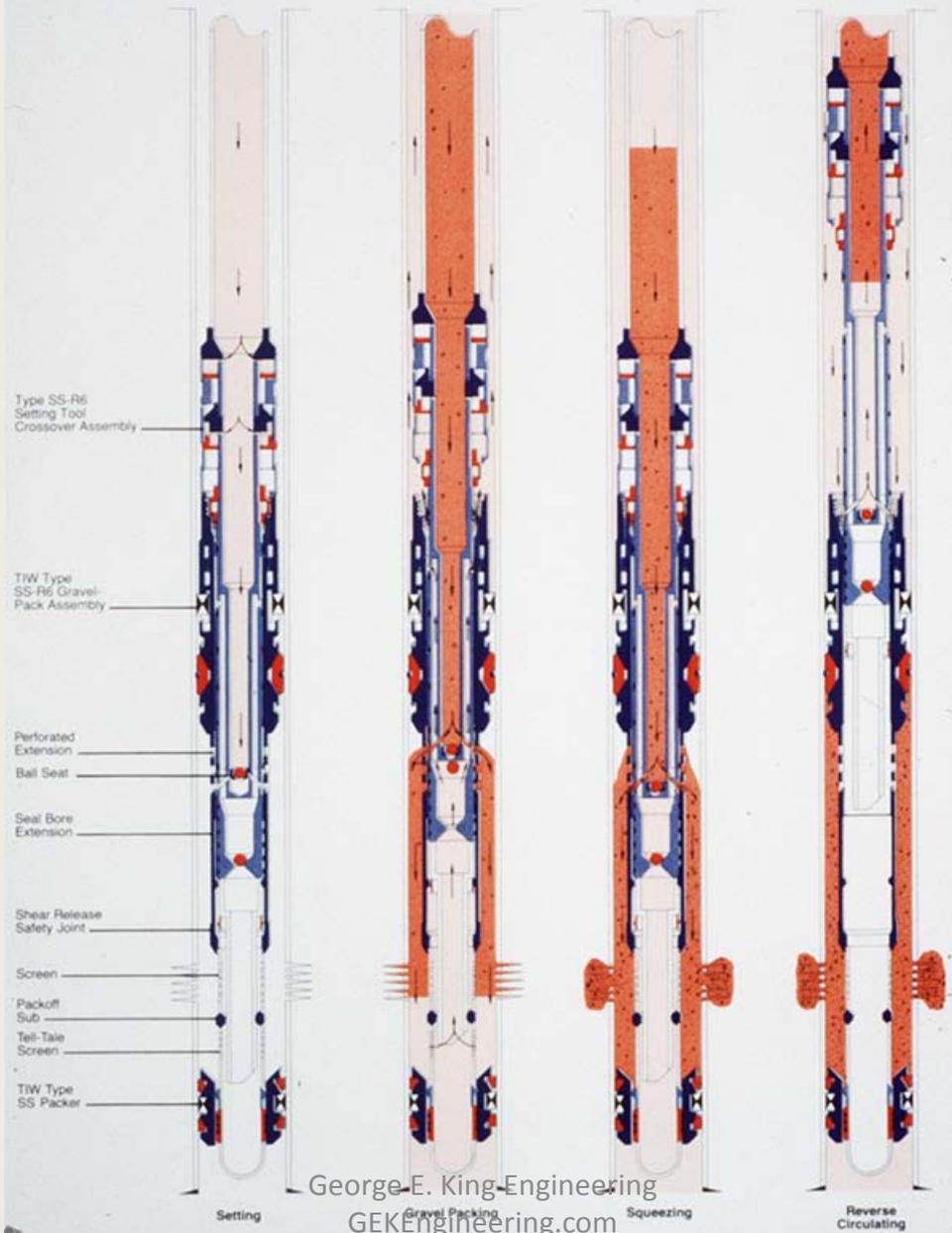
Gravel-packed perforations

Formation sand





SS-R6 Gravel-Pack Packer



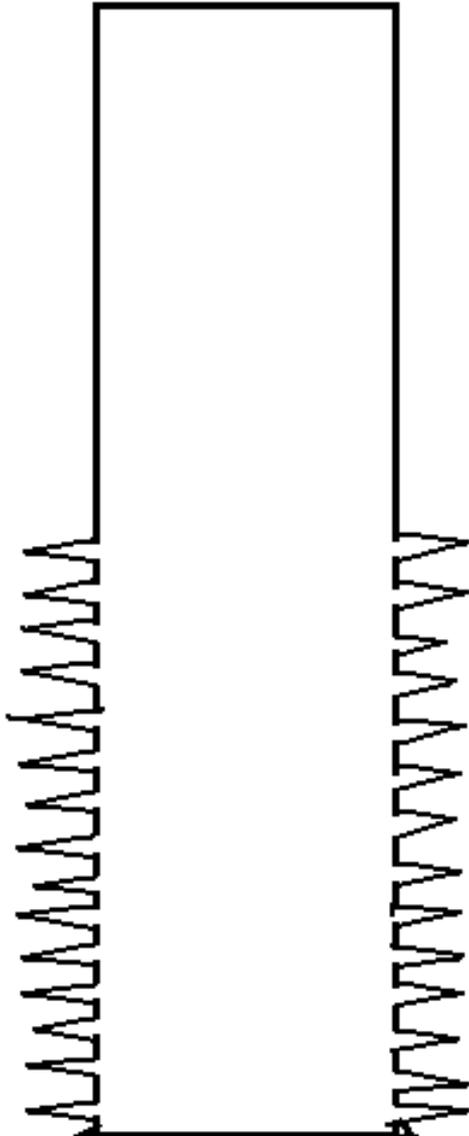
George E. King Engineering
GEKEngineering.com

Amount of Gravel?

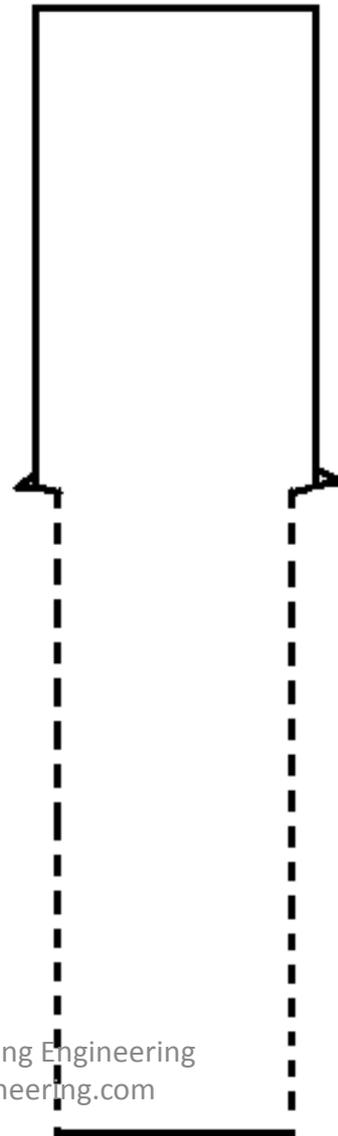
- length of perforated or open hole interval
- annular dimensions
- volume of perfs
- target for gravel outside the perfs
- excess

What is size and shape of the hole?

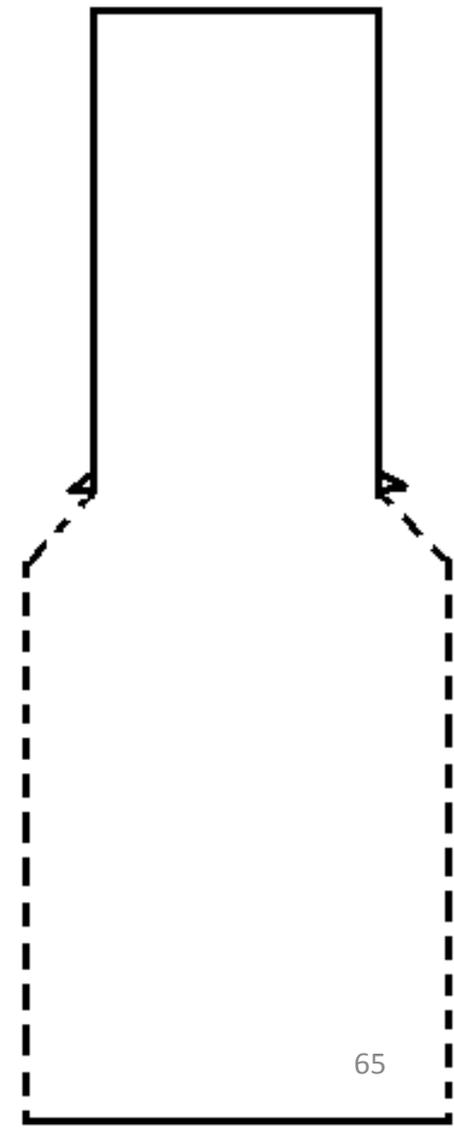
Perforated



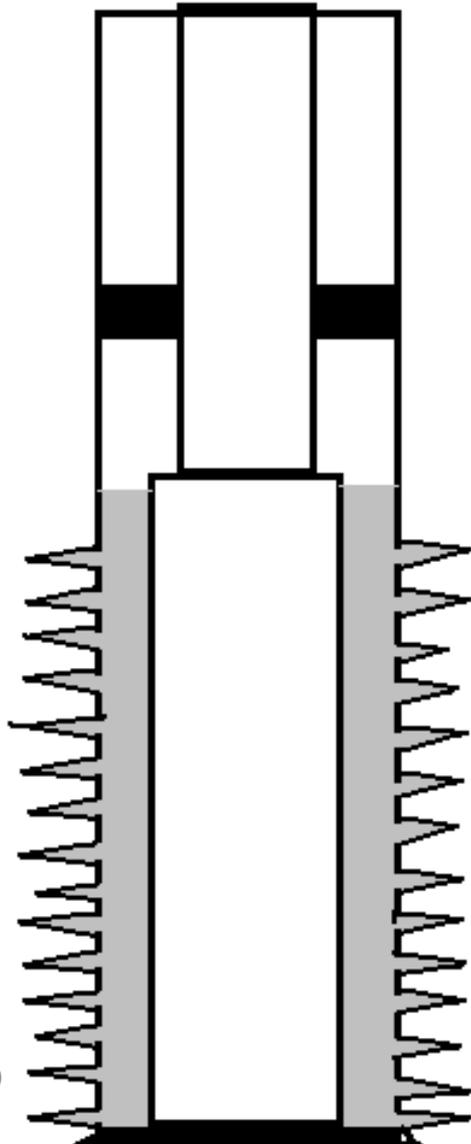
Openhole



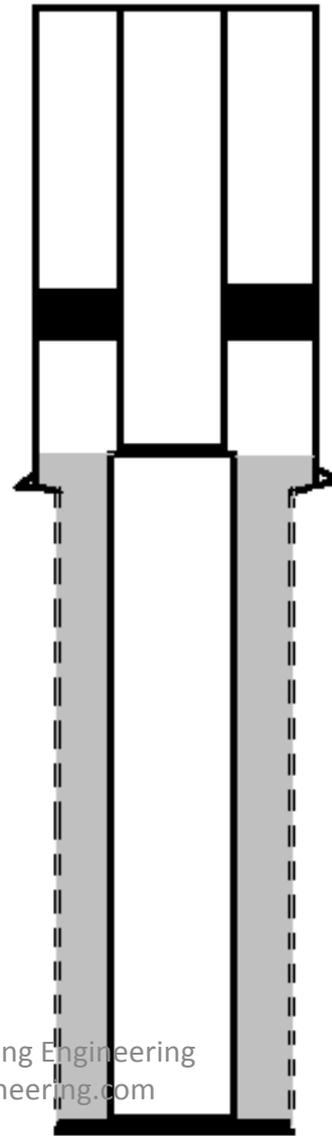
Under Reamed



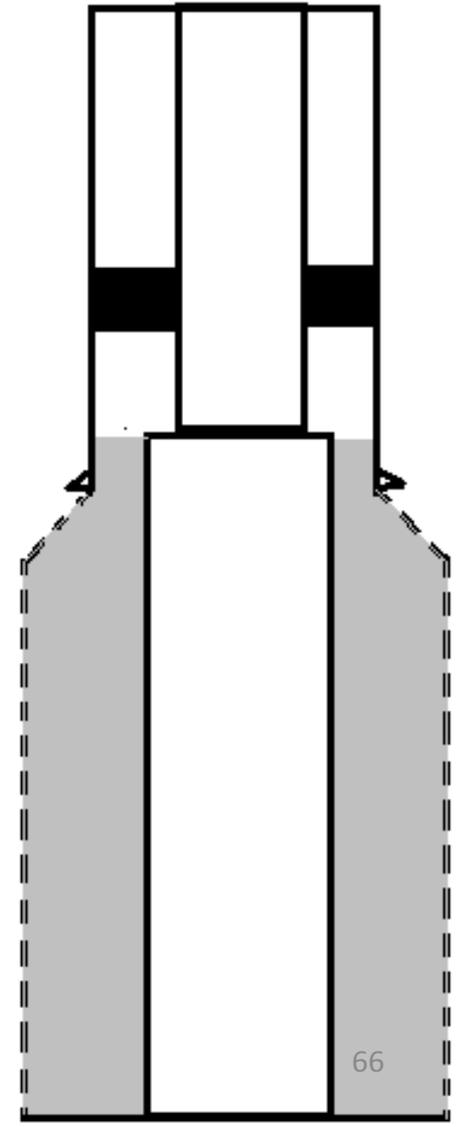
Perforated

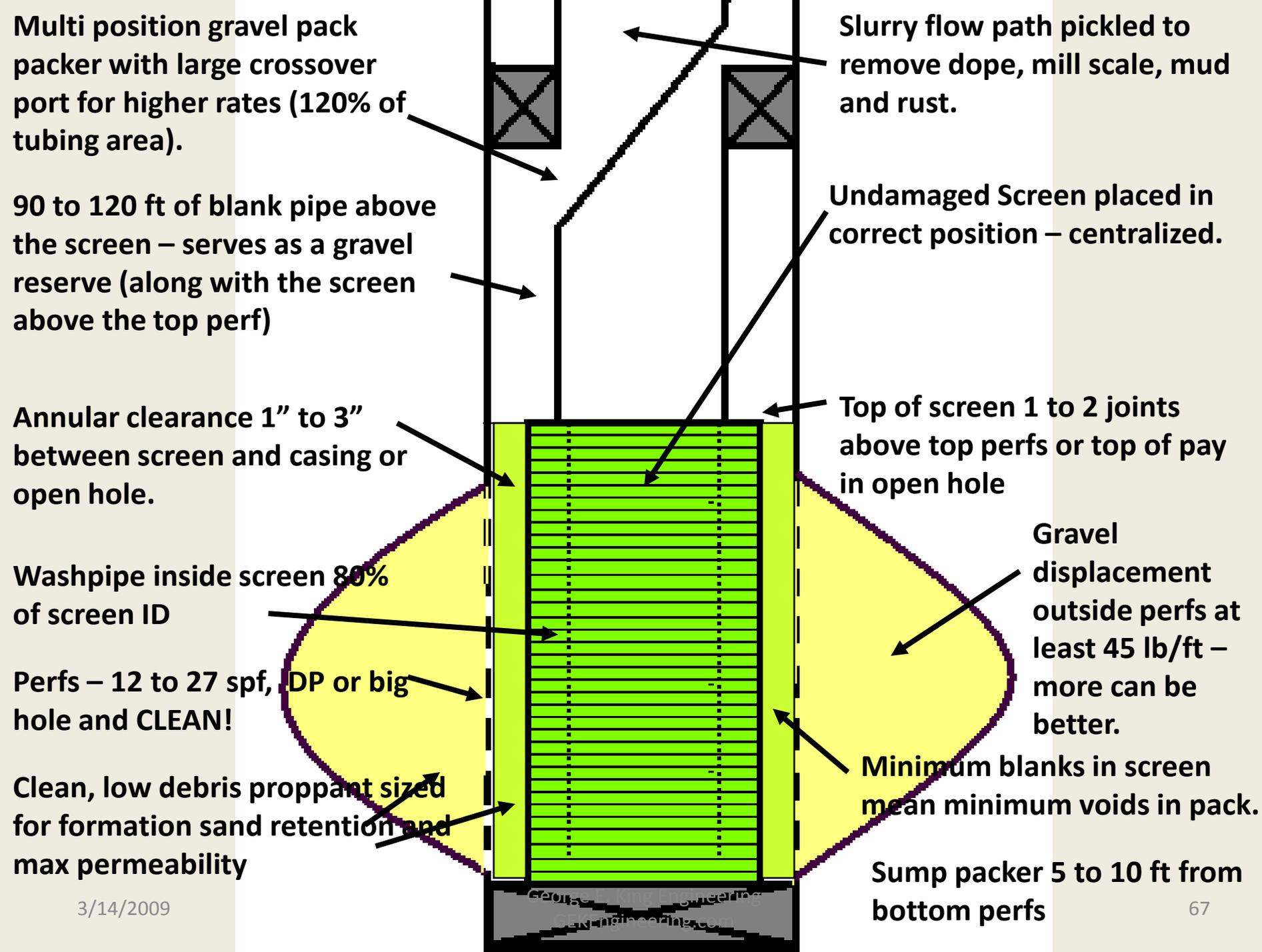


Openhole



Under Reamed





Understand how much mobile fines are present

- What is the effect of fines?
 - Stopped by the gravel? –No! Stopping requires a small, probably restrictive gravel to stop the fines.
 - If the fines can invade the gravel, the gravel permeability or the screen conductivity may be reduced.
 - Solutions? What causes the movement?

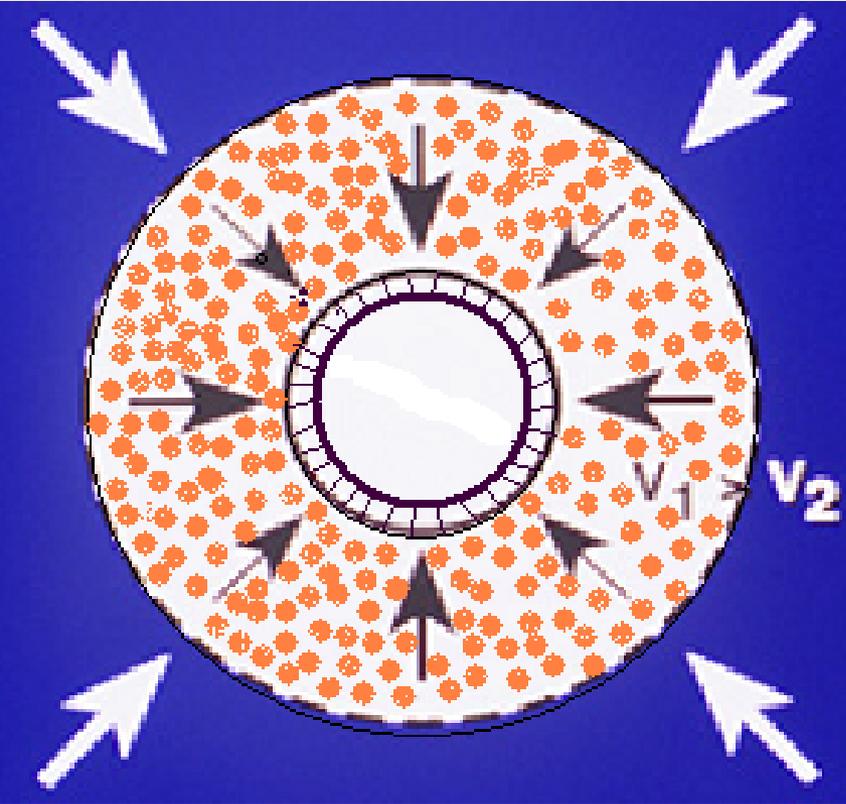
Why are fines a problem? Even 1% (one gram in a 100 grams of formation) of mobile fines contributes millions of particles. If the fines can move, then the potential for plugging rises sharply.

Screen mesh opening	Particle size microns	Particle size inch	individual grain vol. cc	individual grain wt grams	Number of particles in one gram or one weight percent
20	841	0.0331	0.000311	0.000824156	1213
100	149	0.00587	1.7346E-06	4.59663E-06	217,551
325	44	0.00173	4.4404E-08	1.17669E-07	8,498,382
625	22	0.00087	5.6473E-09	1.49652E-08	66,821,592
	1.9	0.00007	2.9415E-12	7.79506E-12	128,286,352,864

Avoid perforating shale

- Why? Exposed shale bleeds fines and debris that can plug screens or packs.
- Can shale be identified from logs? Is a shaley pay really a source of production.
- Can you non perforate a section of the well and still have a good producer with better completion longevity?

Open Hole Gravel Pack



Screen area open to flow = 6% to >10%

Skin = 0 to 5

Advantages

- maximum unfractured contact

- high flow in big kh formations

Disadvantages

- more difficult to design/place

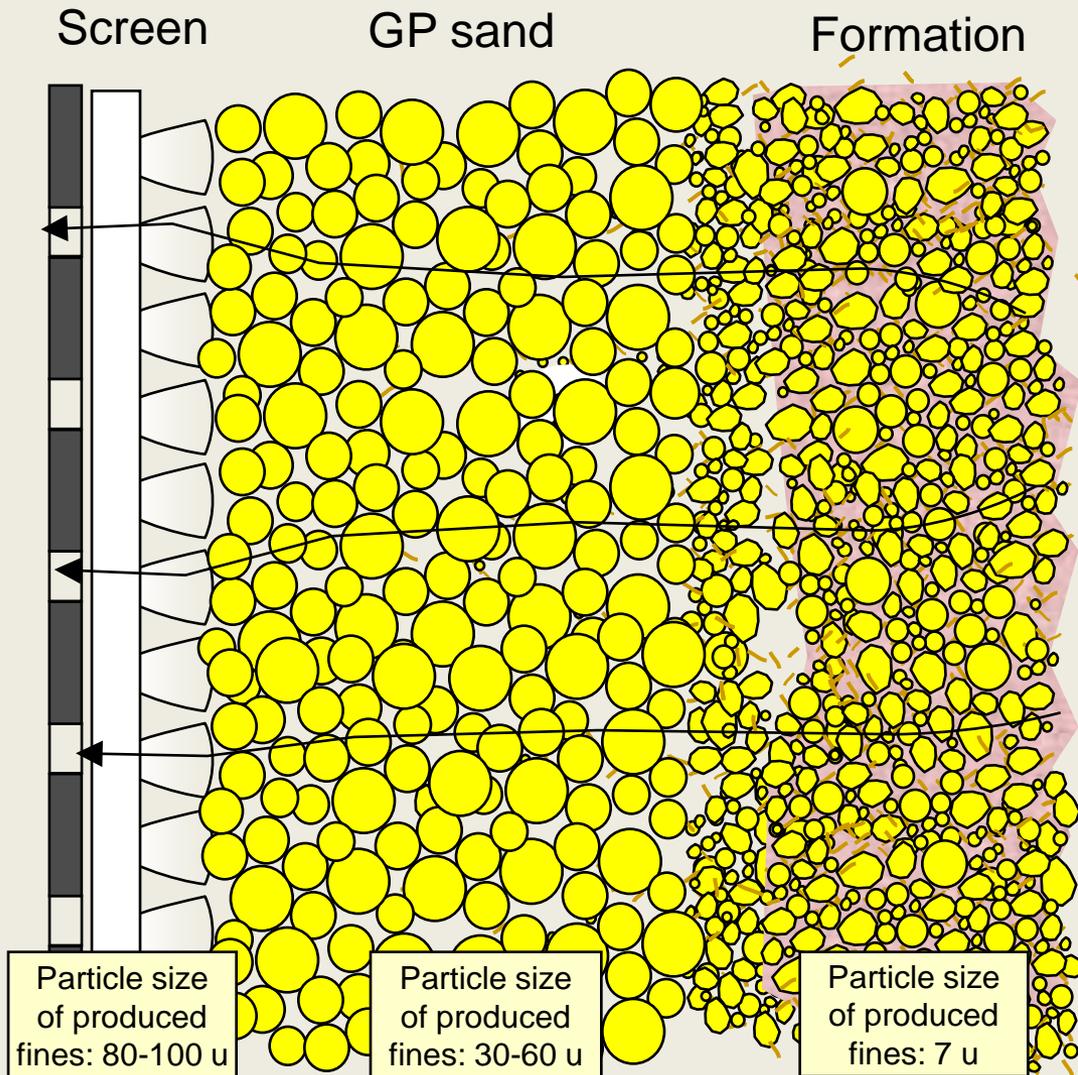
- limited application experience

- problems with high perm streaks?

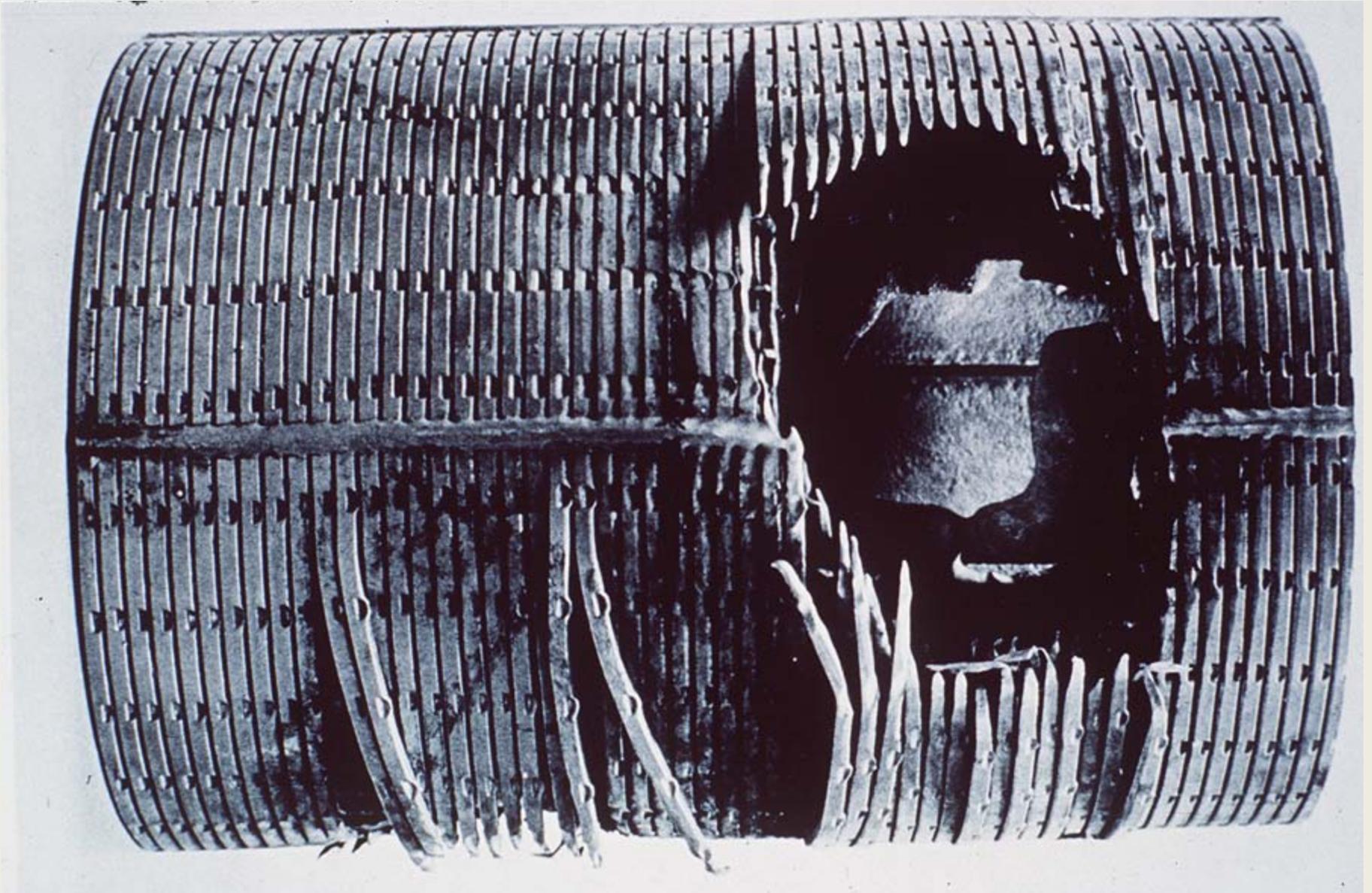
- limited zone/water control

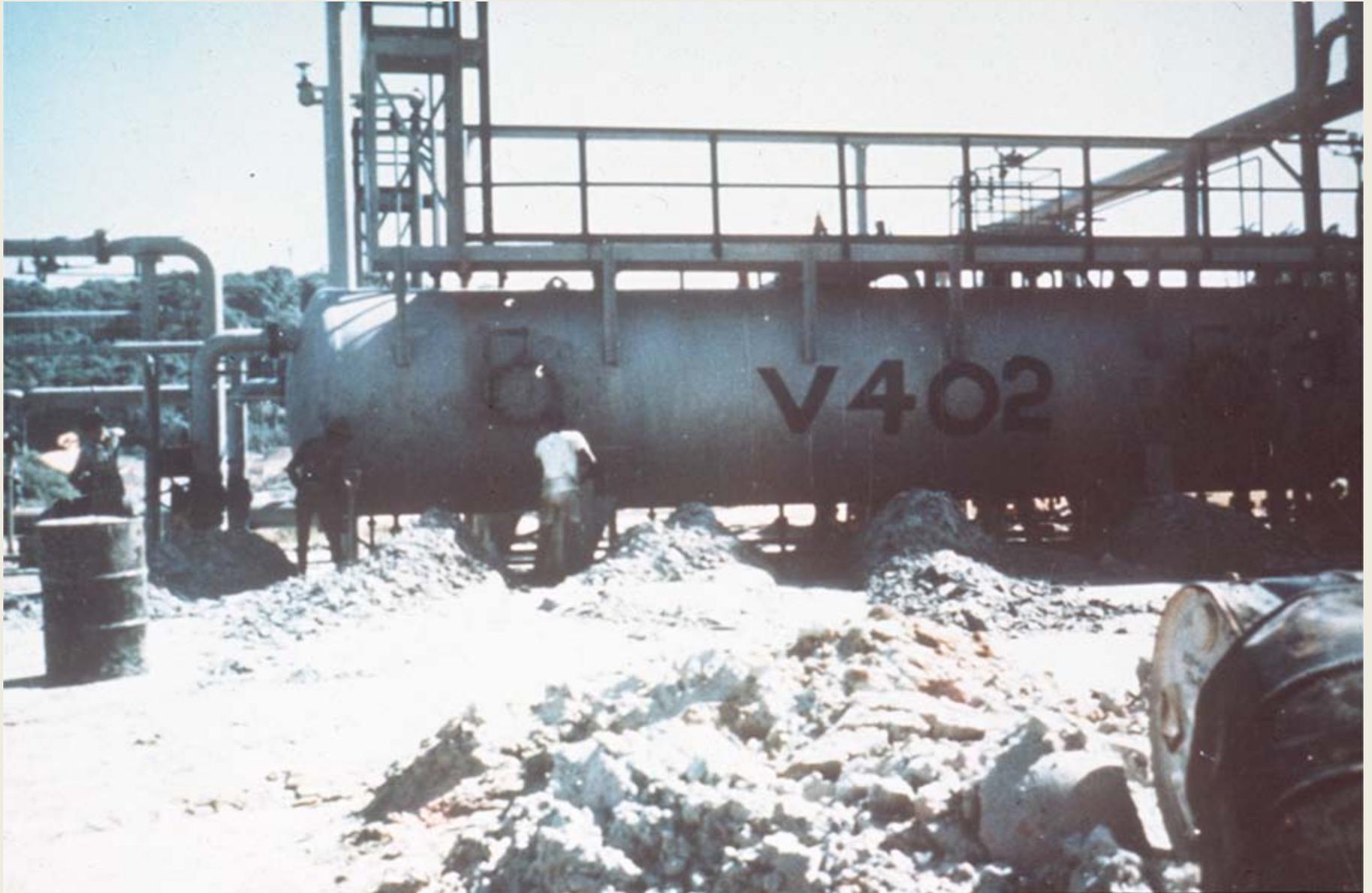
- formation wall is close to screen

OH Gravel Pack



- GP sand is (by design) 5-6 times larger than formation sand d50.
- GP'ing **does not alter** screen behavior.
- GP'ing **will arrest** annular flow, i.e. transport of moveable material.
- GP screen **must allow** production of fines, otherwise completion will plug.
- Pore throat of most GP sands **will restrict** production of fines.
- GP'ing will **arrest/trap formation filter cake on the formation surface**.
- GP'ing **will not allow** formation to relax/de-stress.





Pressure Drop Through the Sand Control Completion

- Press drop based on:

$$P = 19.03 [(q_o \mu_o) / (k_h k_h)] S$$

P = press drop due to sand control

q_o = test rate in m³ per day

μ_o = viscosity in cp

k_h = permeability in mD

k_h = height of perfs in meters

S = formation and sand control skin.

Total Skin – from formation tests

- $S_t = [S/b] + S_p$

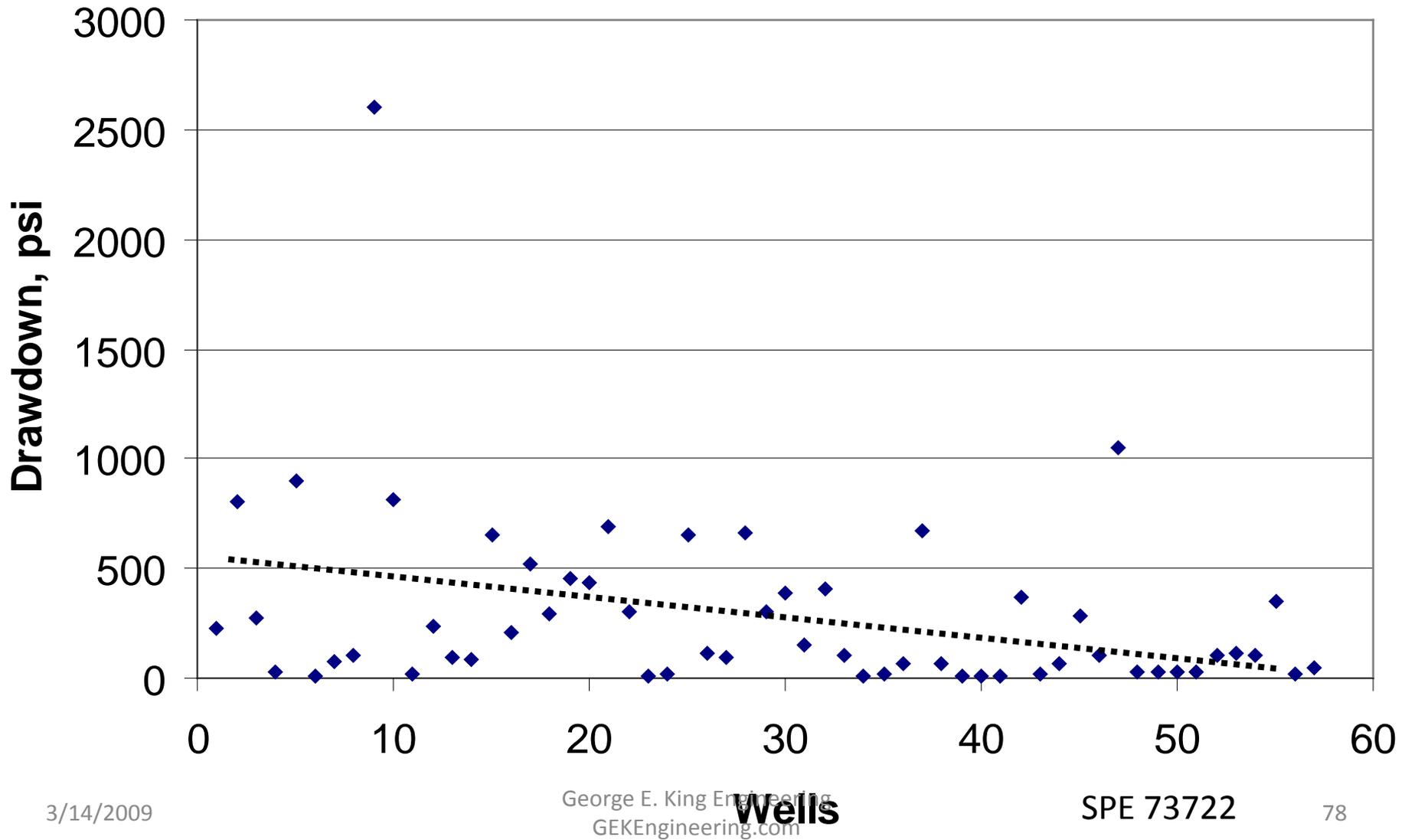
S_p = skin due to partial perforation

$$b = h_p/h$$

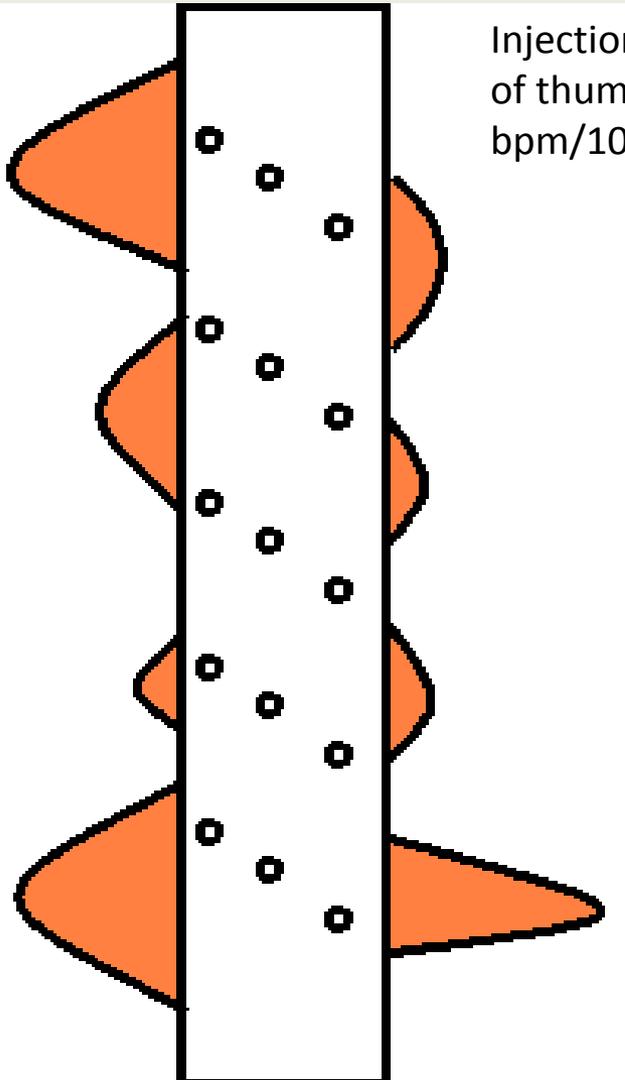
h_p = perforated pay height

h = total pay height

Calculated Pressure Drop Through Frac Pack in Campos Basin



High Rate Water Pack



Injection rate rule
of thumb: 1
bpm/10 ft of perfs

Screen area open to flow = 6% to >10%

Perf area open 6 to 10%

Skin = -1 to 10

Advantages

- pressured packing of perfs

- easier design/apply than frac pack

- Good flow in mod. kh formations

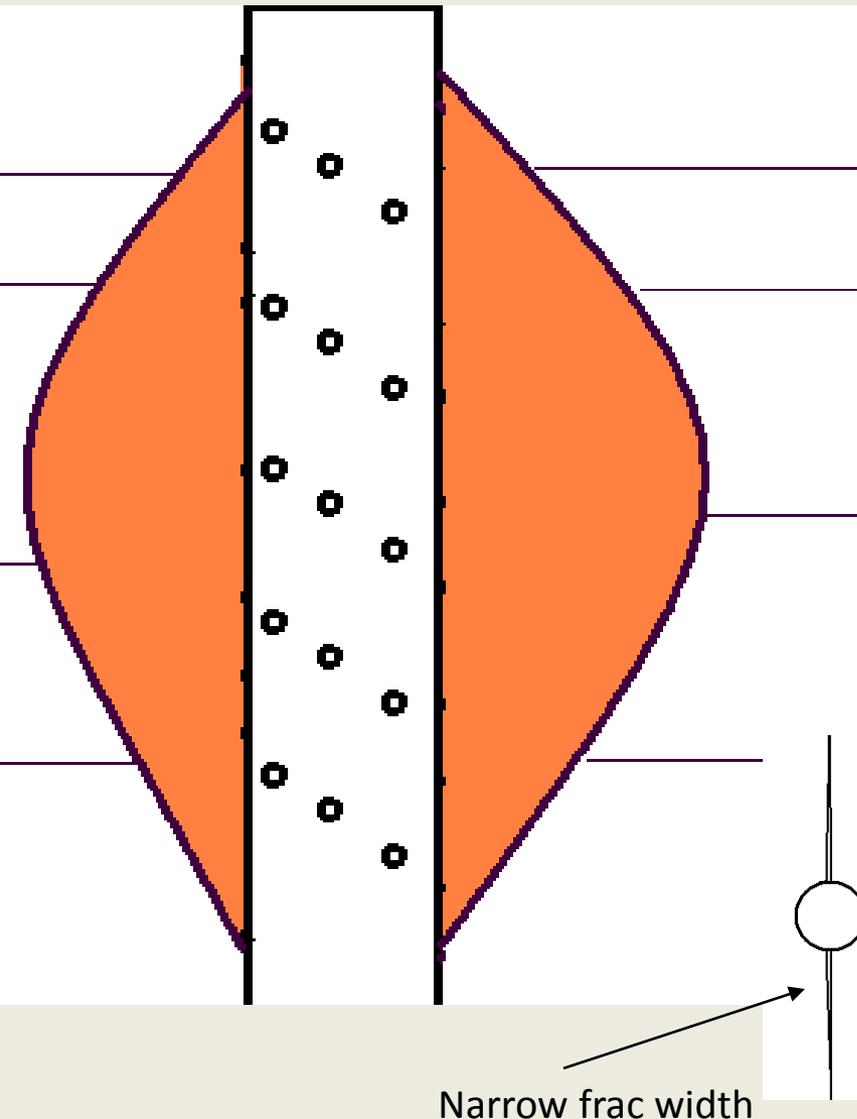
Disadvantages

- lower flow capacity than frac

- limited zone/water control

- Unequal packing of gravel per foot

Fracture placement of Gravel (no TSO)



Screen area open to flow = 6% to >10%

Perf area open 6 to 10%

Skin = -1 to 10

Advantages

links across layers and low vertical k

easier design/apply than TSO

Good flow in very low kh formations

Disadvantages

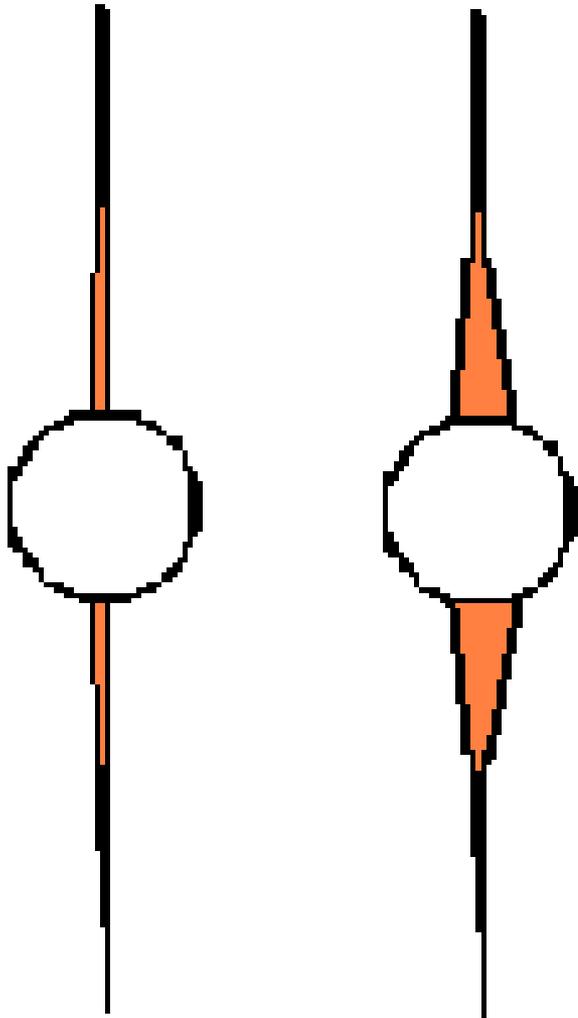
very low conductivity

frac capacity vs. perm contrast critical

height growth uncertainty?

proppant stability problem at > depth

Tip Screen Out (TSO) Fracturing



Screen area open to flow = 6% to >10%

Perf area open 6 to 10%

Skin = -3 to 10

Advantages

stimulation

links across layers and low vertical k

highest reliability sand control method

good flow in moderate to higher kh

Disadvantages

usually most expensive

harder to design and apply

frac capacity vs. perm contrast critical

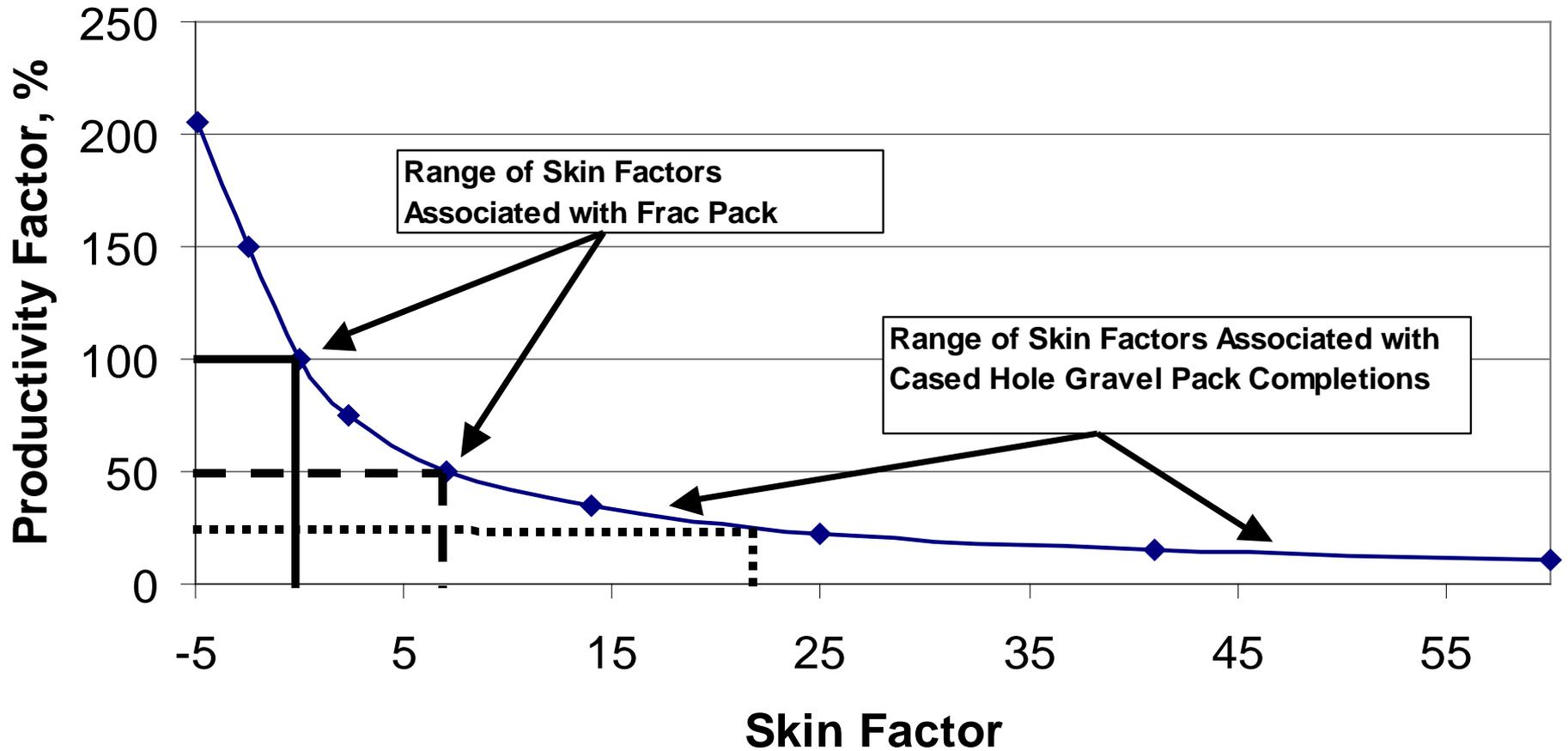
height growth uncertainty?

some proppant stability problem at depth

Observations – DW Frac Pack

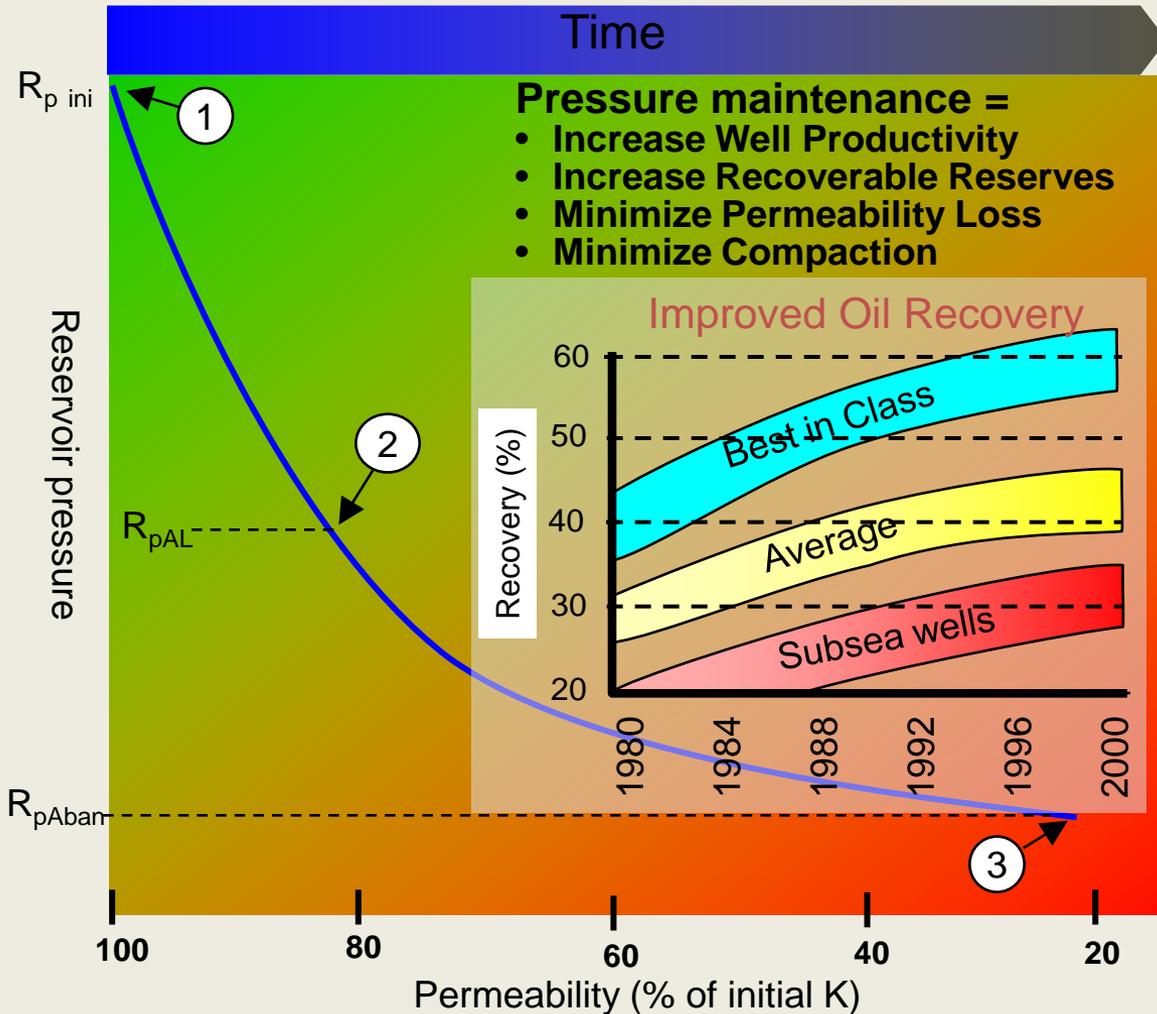
- Frac Pack process very similar on every well
 - Hard to evaluate ‘job quality’ from DIMS as data not reported
- Average sand placed is 84% of sand pumped
 - Without 2 lowest jobs average is 89%
- Frac Screenout reported on 9 wells
- Annular Pack Processes Variable
 - 6 wells with 8 BPM final rate
 - 4 wells with less than 2 BPM final rate
 - 1 well reported 0.5 BPM to get annular pack
- Loss rate Post-Frac pack on 7 wells reported at less than 25 BPH losses (13 reported losses, 7 did not)

Productivity Ratio vs. Skin Factor



Depletion, Compaction, Perm Loss

What has depletion to do with Well Productivity *



- (1)
 Initial Reservoir pressure
 Maximum energy to drive production
 Maximum permeability
 Single phase production
 No depletion, No compaction, Min. formation stress
 Minimum production cost
- (2)
 Artificial lift required (gas lift, ESP, etc)
 Sharp increase in production cost
 Multi phase production > reduced saturation, loss of capillary pressure
 Loss of cohesive forces
- (3)
 Abandonment pressure
 Minimum energy to drive production
 Maximum depletion, compaction, formation stress
 Minimum remaining permeability

* (SPE 56813, 36419, 71673)

Formation Sand Production Handling

Well Type	Effect of Sand
Gas Wells	Unacceptable in most
HPHT	Unacceptable
Subsea	Unacceptable in most
DW Spar	Unacceptable
Horiz Wells	Depends on application
Oil Wells	May be beneficial
Inj. Wells	Depends on completion
Heavy Oil	Usually beneficial
Damaged Wells	Usually beneficial