Thus, The Lowly Stabilizer

The Most Important Tool We're Using Wrong

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Stabilizer Discussion Points

Whirl Management: *The lowest hanging and sweetest fruit*

- **Whirl design**
- **Whirl suppression**
- **Bit life and ROP**
- **Vibrational borehole patterns, tight hole and reaming**

Inclination Control: *If Lubinski only knew about whirl*

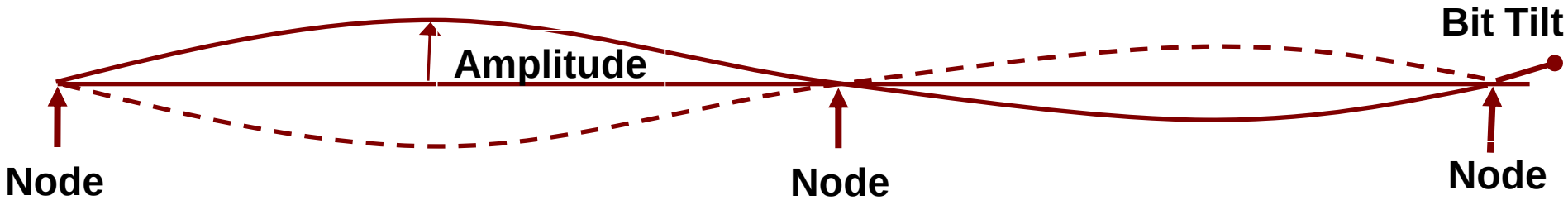
- **Three points still define a curvature**
- **Packed good, pendulum bad**

Filter Cake Management: *How to cheat and win with stabilizers*

- ***How stabilizers change cake morphology and fluid design***
- ***Drill and Seal***

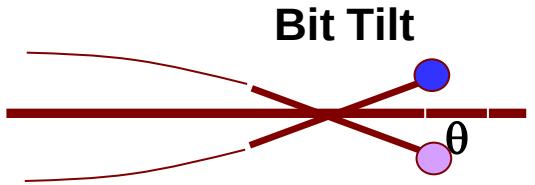
Whirl as Shape. Minimize the Shape and Bit Tilt

Whirl is a sine wave. The bit is screwed on the end of the wave and it's tilted by the wave. The tilting is the cause of damage to outside cutter, reduce ROP, increase MSE, some steering problems, and it contribute greatly to the side-cutting that forms vibrationally induced borehole patterns



Other Implications of Vibrational Shape

Where the shape crosses the center of the wellbore, it is always quiet (nodes). An LWD sensor at a node does not see the vibration. Use MSE as indicator of whirl at the bit



Depending on the shape created in a given BHA, the same amplitude in the BHA can result in different levels of tilt at the bit. Design to reduce tilt

Managing the Amplitude of the Vibrational Shape (Whirl)

Two choices to reduce the amplitude of the shape (root cause)

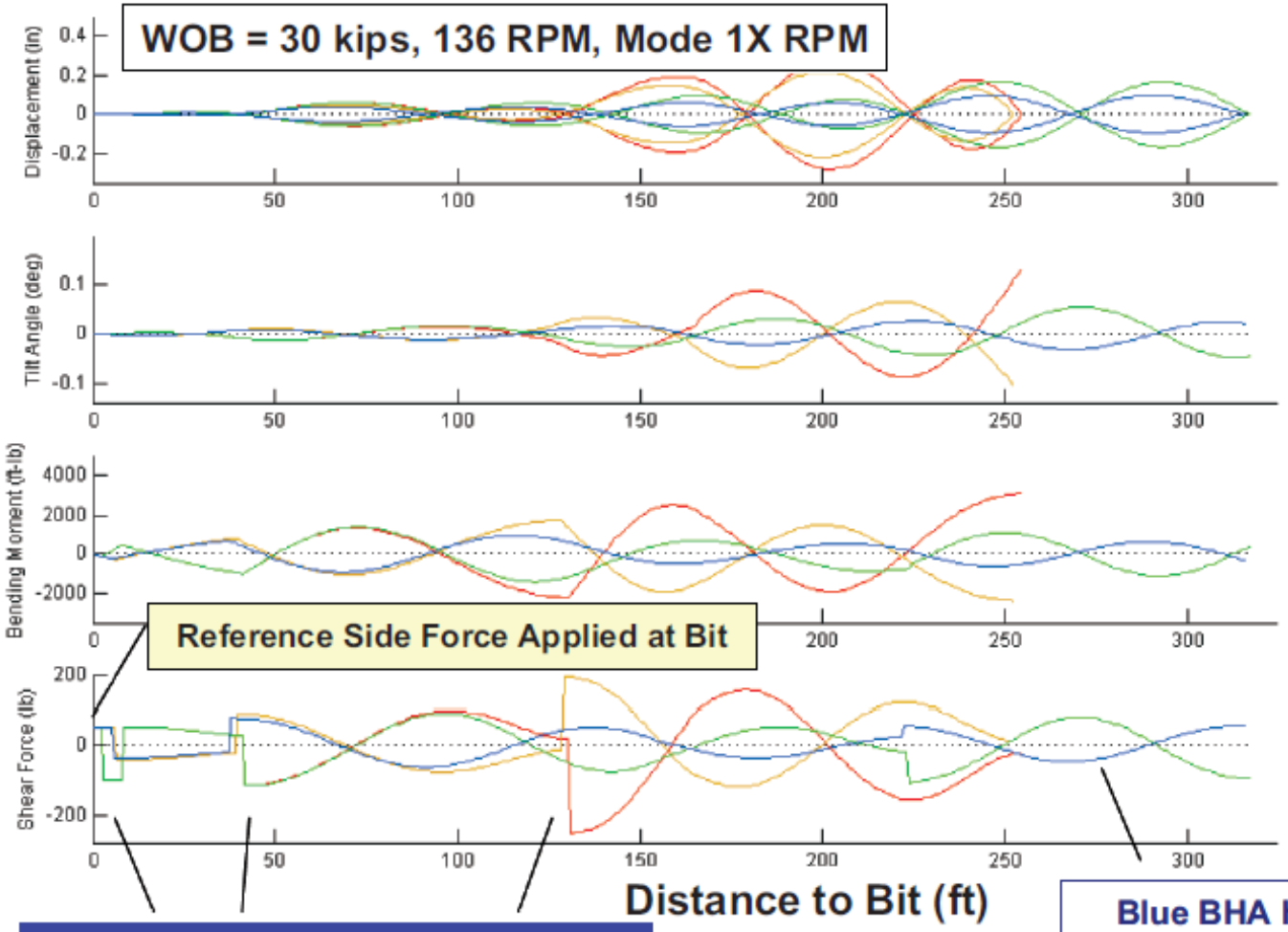
- Change the RPM to a speed that is not resonant
- Change the BHA so that it is not resonant at the current speed

Resonant frequency depends on many factors that change mass, stiffness and dampening. But operationally our choices are usually limited. **Move the stabilizers (nodal points)**

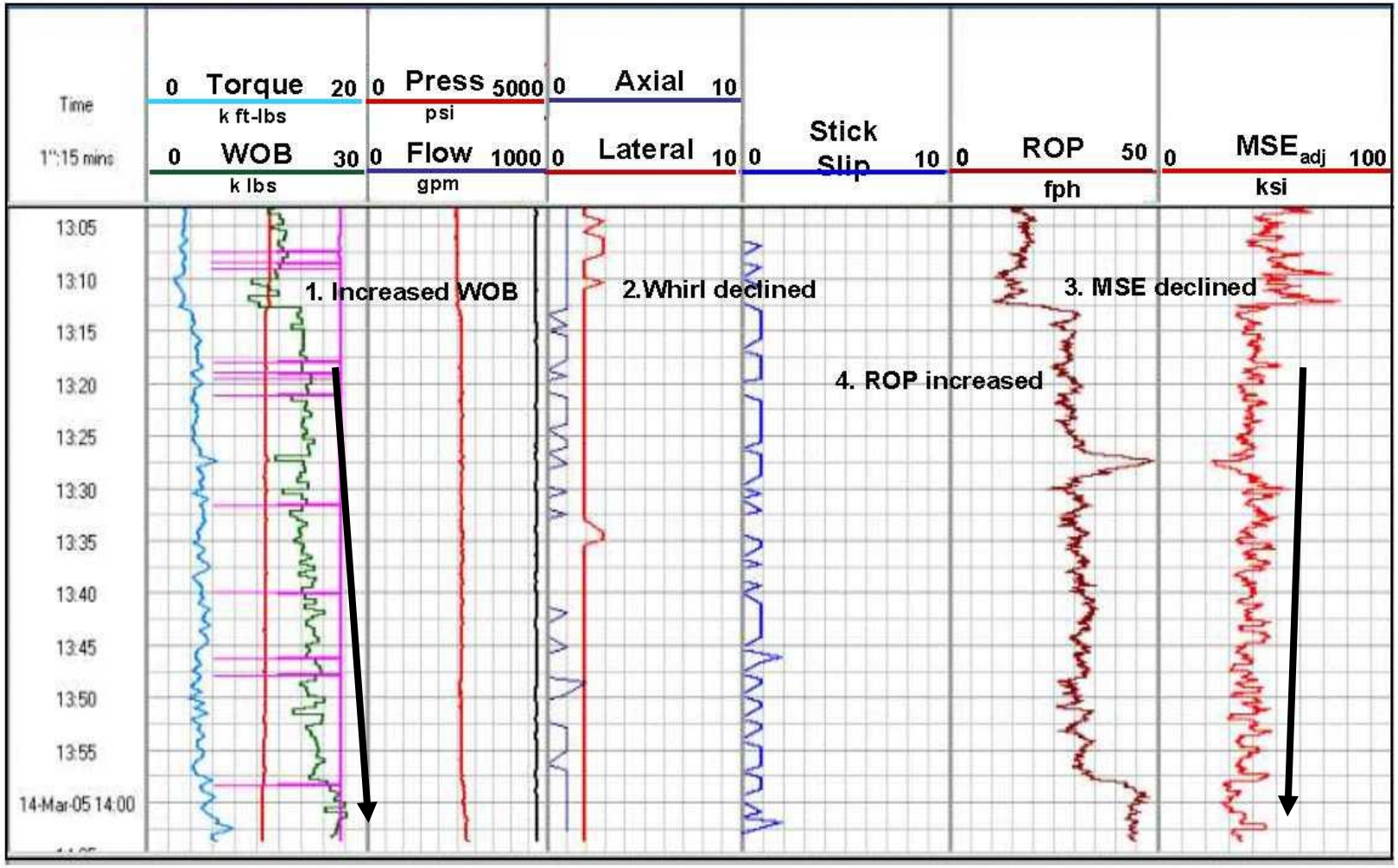
Two choices to suppress the effects of the shape (treat symptoms)

- Increase the WOB. Depth of cut resists lateral motion
- Increase the gauge length of the bit
- There are others but these are the big hitters……

Move Stabilizers to Change the Amplitude and Bit Tilt

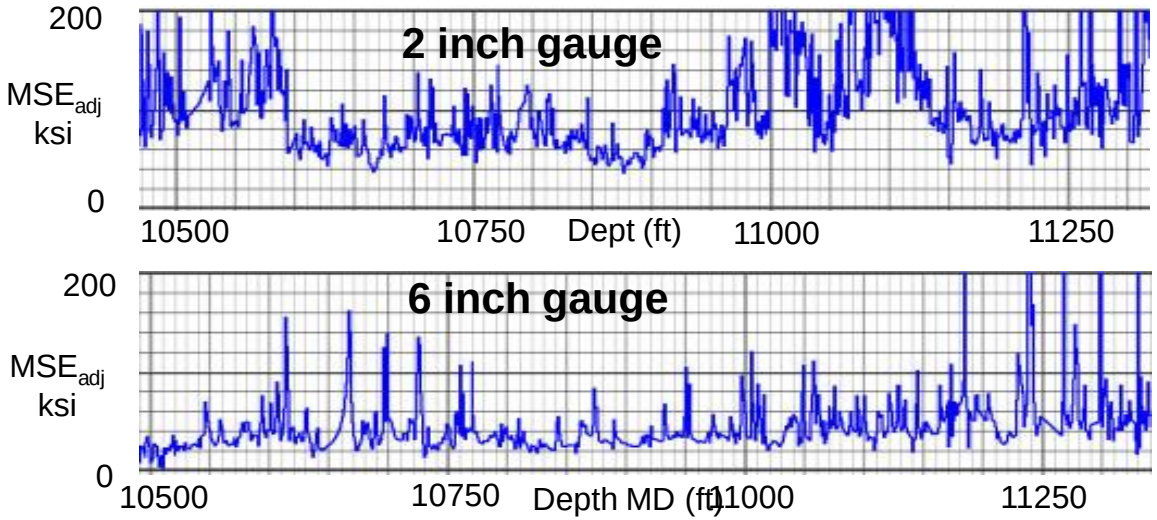


MSE Virtually Always Shows Bit Whirl Declining with WOB



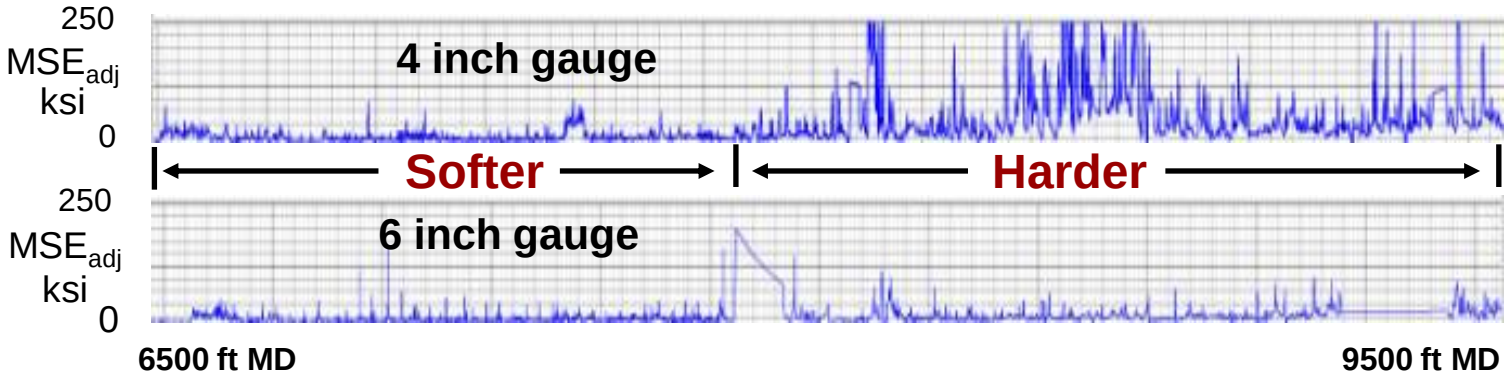
Maximize Gauge Length

MSE pattern is similar, but reduced



Comparison of well with different gauge lengths

Less effect in softer formations where amplitude is lower to start with



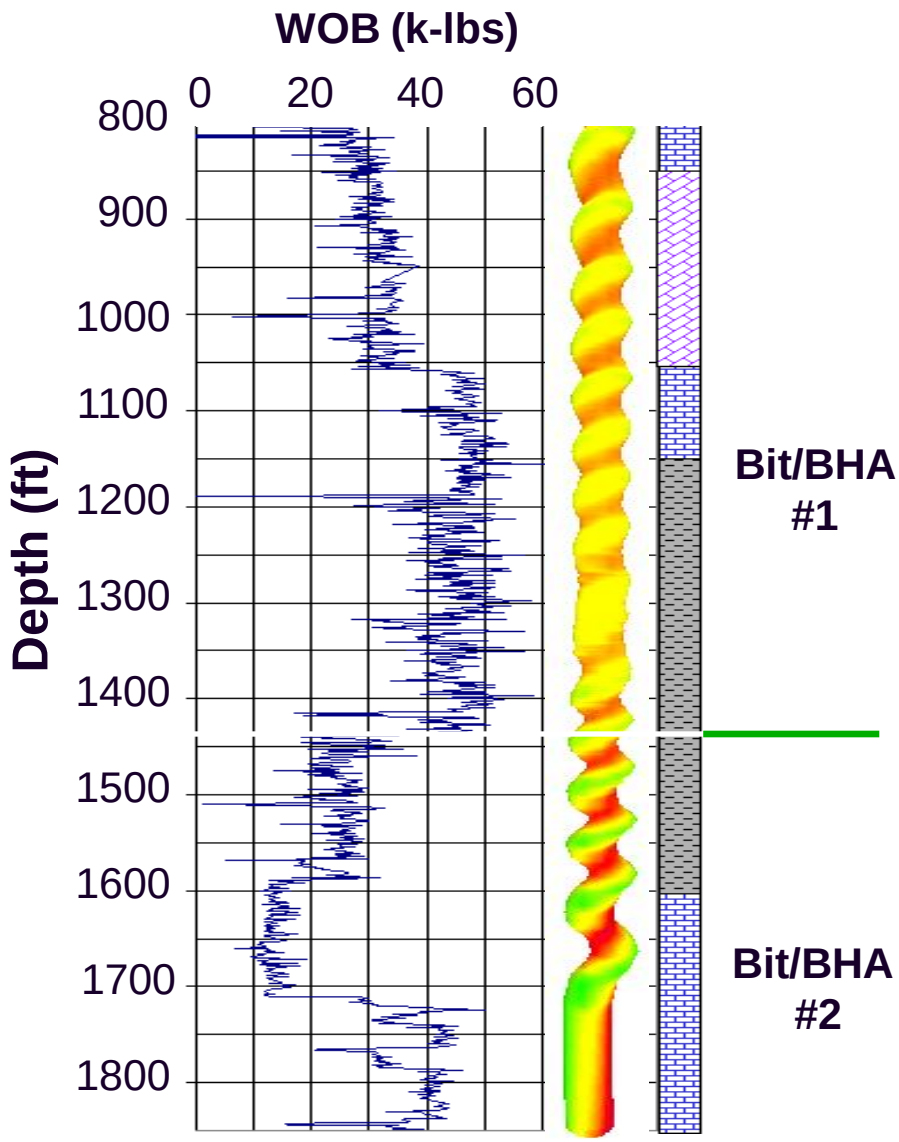
Effect of WOB, Gauge Length, and Stab Placement Redesign

BHA w/ higher amplitude shape

- Severe pattern at moderate WOB
- Pattern can be suppressed with higher WOB (50k lbs), but not eliminated

BHA w/ lower amplitude shape

- Still creates pattern at low WOB
- But pattern suppressed completely by moderate WOB (40k lbs)
  - PDC with 4” gauge length
  - Effect of increased ROP
  - Adequate WOB to suppress whirl



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So Why Don't We Move Our Stabilizers?

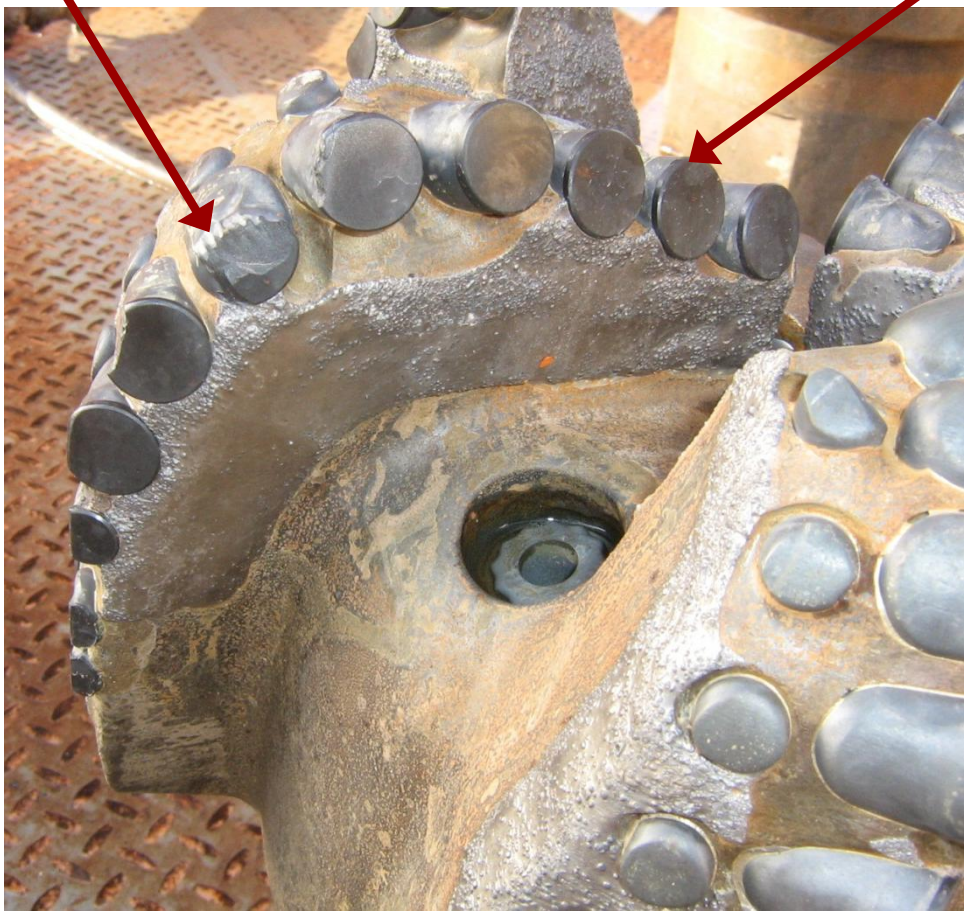
Vibrations have been reduced to levels that seem "normal" in most operations (2± g's) and BHA components achieve a "normal" life. In short, we don't know how much it's worth

- Moving the stabilizers is a lot of work – modeling, iterative field trials, engineering surveillance of trials, new data (i.e., MSE), and rig site training
- LWD vibrations tools do not report what is happening at the bit. MSE has illuminated the impact of even low vibes on rock cutting efficiency
- Industry is not aware of the major gains in drill rate that can be achieved from further reduction in "non-damaging" whirl ("there is no hard rock")
- Significant additional gains in bit life at < 2g's are important in long intervals. Shoe to shoe bit life is now expected in 10k ft intervals
- Lateral force from low levels contributes to torque, which causes stickslip, which forces us to back off on WOB and live with lower ROP than necessary
- The industry is not fully aware of the stunning cost of vibrationally induced patterns requires very low levels of whirl

Modern PDCs are “Worn” by Vibrations, not Rock

Damage or accelerated wear due to bit tilt and lateral force

No wear, even though bits are designed for all cutters to carry load



Beach marks radiating from lateral direction of impact

Vibrationally Induced Patterns are the New Frontier

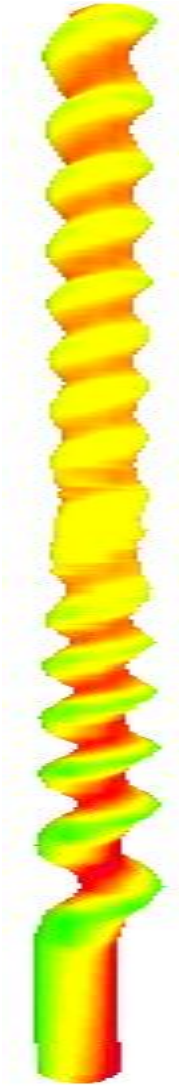
If we can achieve such low levels of vibrational shape in the BHA, there are major hidden cost and routine operations that are considered "normal" that can be eliminated

- **Almost all tight hole on connections is due to vibrational patterns. Eliminate patterns and you eliminate reaming**

  Swelling clays are rarely a cause of tight hole. These types of formations break and the hole gets bigger, not smaller

- **Majority of tight hole and reaming on trips can also be eliminated. Primary exception is undergauge filter cake**
- **Eliminate mechanically stuck pipe**
- **Eliminate the Spiral of Death, which is the worst case scenario for vibrational patterns, Usually results in < 5-10 fph, no matter what rock hardness we're drilling**

Whirl Diagnostics: The Spiral of Death (firm formations)



"Spiral of Death"

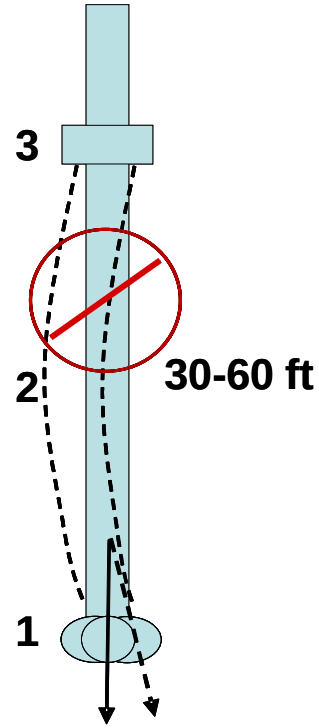
1. Stab sits down on spiral hump
2. WOB declines as stab takes weight
3. Bit whirls more severely due to loss of WOB and spiral amplitude increases
4. Stab takes even more WOB
5. Stab torque drives stickslip
6. Driller reduces WOB some more to prevent stickslip. Whirl gets worse
7. Repeat at the top……

Lower shoulder is attempting to drill humps in pattern, removing weight from bit

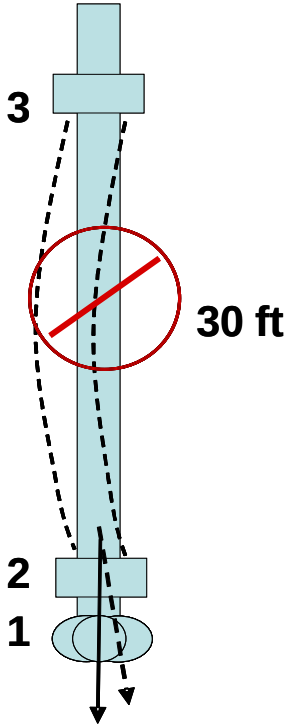
Anytime a firm interval drills much more slowly in one well than an offset, no matter what you try, check your stabilizers for this wear pattern.

Use Packed BHA as the Base Case for Vertical Wells

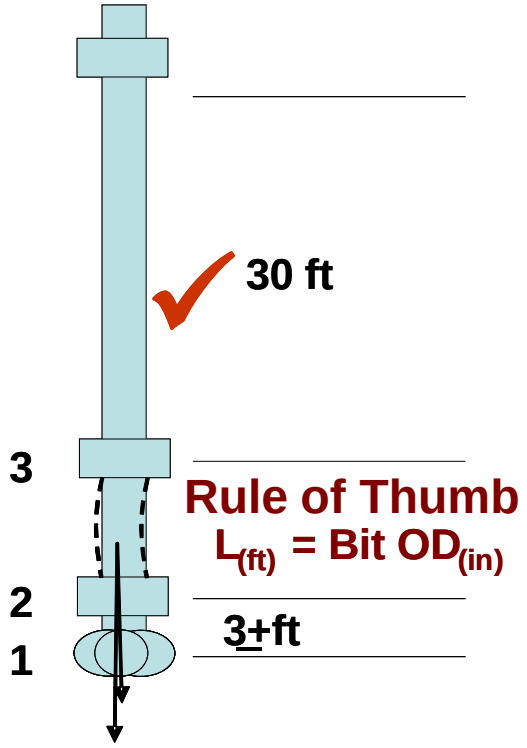
Packed assemblies allow high WOB to mitigate whirl. **Pendulums and Semi-Packed BHAs may build aggressively, requiring light WOB. First three contact points determine potential build. If build rate with packed assembly is too high, shorten pony collar.**



"Pendulum"
Builds at high WOB

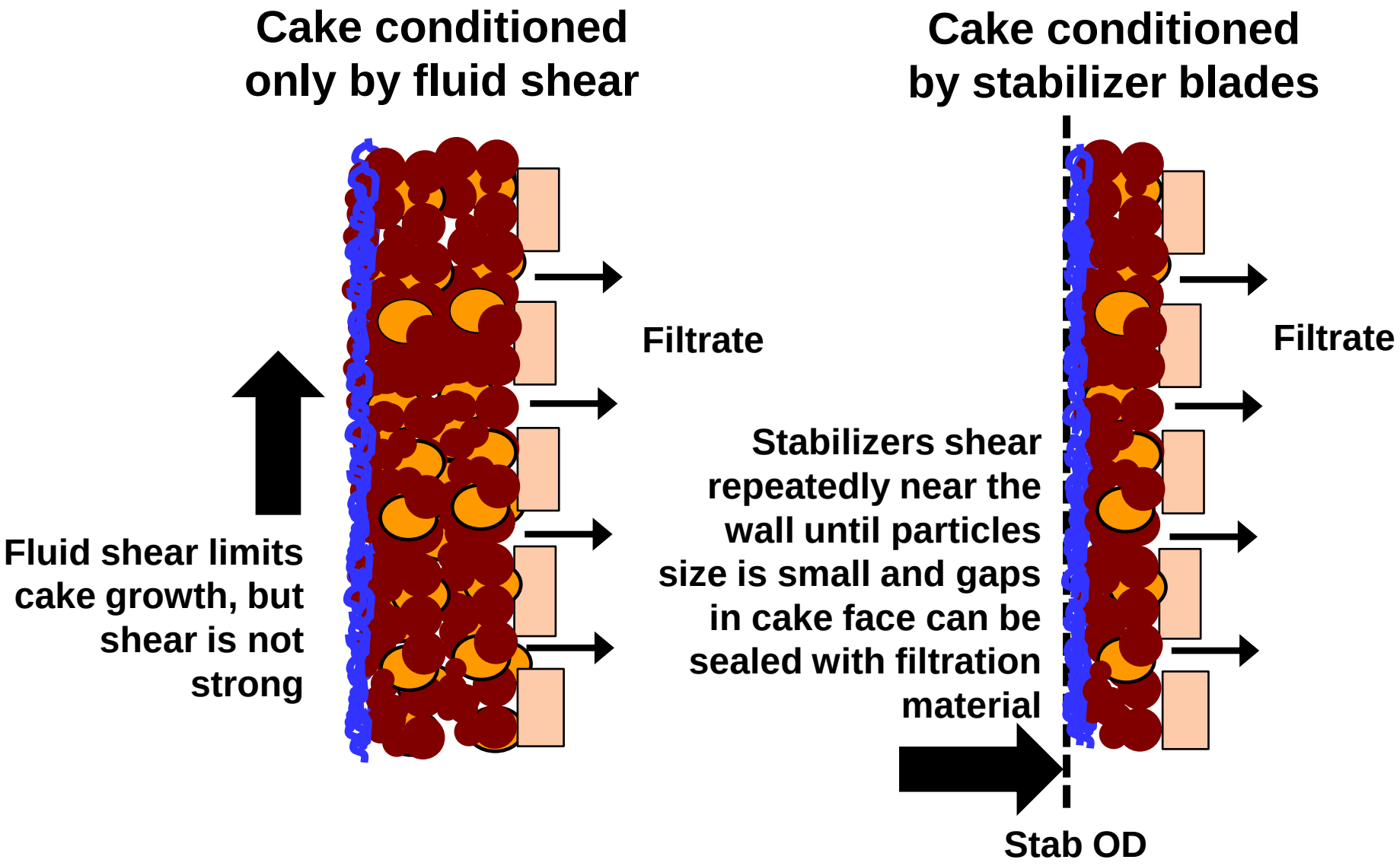


"Semi-Packed"
Builds at high WOB



"Packed"
Allows High WOB

Stabilizers Condition the Cake – Extremely Important



Cake Conditioning

- **Do not drill sands with slick assemblies. If you don't shear off the original solids-ladden cake with stabilizers, it will be there forever**
- **Do not use native mud and drill solids to build your cakes, unless you want to spend rig time on connections and trips reaming them later**
- **Design mud to achieve adequate cakes with only the reaming that occurs from stabilizers. Attempt to eliminate reaming on connections**
- **In high perm, add blocking solids sized for pore throats. Same for fractured shales and cleated coals. Barite may not be large enough**
- **Run blocking solids and stabilizers in unconsolidated sands. Sands fail due to lack of sealing cake AND adequate mud weight. Sands do not "wash out"**
- **Ream at non-whirl RPM, or your bit will cut the cake off that you're conditioning**
- **In very high overbalance, or history of cake regrowth, consider Drill and Seal treatments**

Drill and Seal

Consider special reaming operations in severely depleted intervals where overbalance will cause filter cakes to have greater thickness and very high strength due to effective stress. Ream the initial leaky cake with stabilizers in the presence of a pill designed to create a high quality cake

1. Drill a stand down into, or through, the depleted sand
2. Pump a Drill and Seal and displace to the bit. Pill volume should fill about 150 ft of annulus
3. As the pill exits the bit and starts up the annulus, reduce the pump rate to 2-3 bpm and begin reaming to remove the original cake in the presence of the highly efficient cake-building pill
4. After the pill passes the top of the stabilizers stop circulating, make the connection, and go back to drilling

The process should require about 30 minutes. The pill should be designed with 10-15 ppb of properly designed blocking solids and sufficient filtration material to achieve very low fluid loss (< 4ml).

Summary

- **Run stabilizer unless you have a very good reason not to**
- **Redesign to eliminate the reason not too**
- **The most practical redesign to change the vibrational shape is usually to move the stabilizers and other contact nodes**
- **Many of our practices are effective to some degree, but they treat the symptoms and not the whirl itself (i.e., gauge length)**
- **Expect the redesign to be iterative. Use MSE to quantify its effects, and LWD accelerometers, borehole behavior, and bit forensics as trailing indicators**
- **Quantify the hidden costs of low levels of vibrations, borehole patterns, and filter cake growth. Scale your organization's redesign effort accordingly**