Downhole acceleration detection of poor drilling performance related to bit damage

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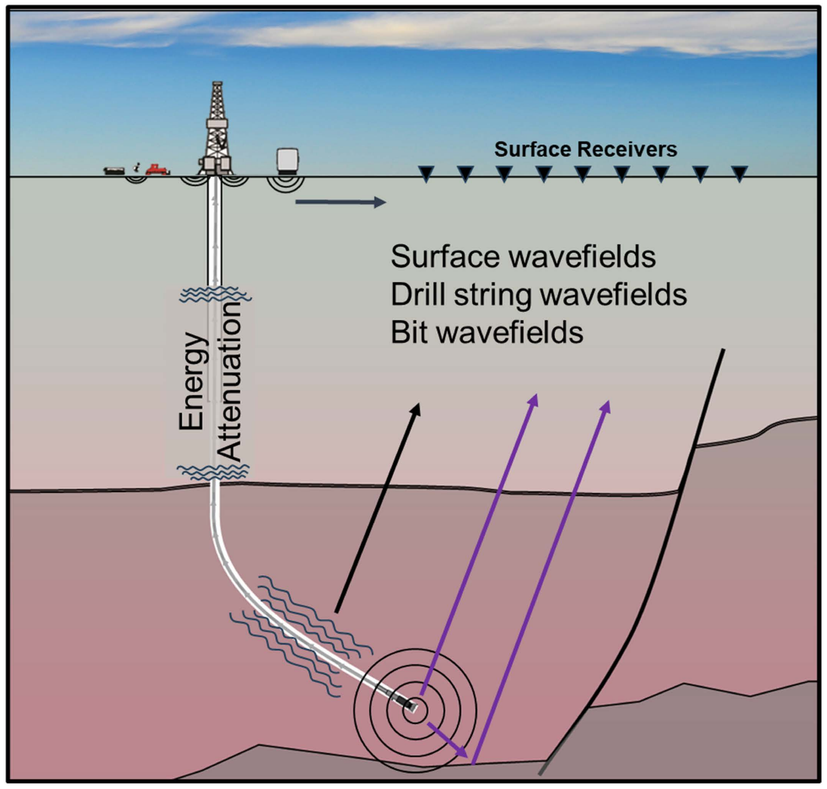
Drilling Optimization

Real-time monitoring of drilling operations is crucial to maintain system integrity and optimize performance. Downhole vibrations along the drill string and at the bit are common drilling dysfunctions that decreases rates of penetration (ROP) and increase the likelihood of bit damage.

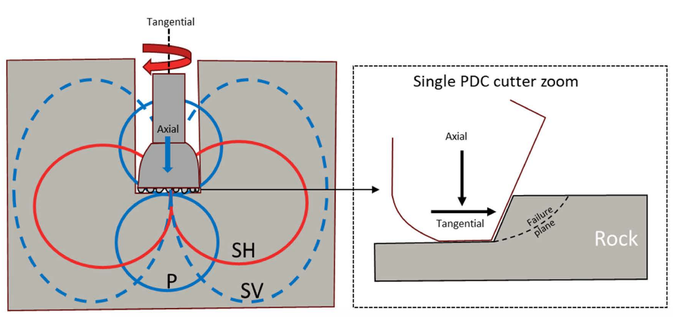
Existing Vibration Detection Solutions

- Surface rig data
  - \- Sampled at 1-10 Hz
  - \+ Model downhole dynamics
  - \+ Accessible in real-time
  - \- Attenuation of energy along the drill string
- Downhole sensor data
  - \+ Sampled at 10's to 1000's Hz
  - \+ Measure the downhole dynamics
  - \- Telemetry required for real-time use
  - \- Sensor operating limits



Proposed Vibration Detection Solution

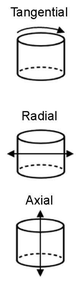
- Bit source Seismic-While-Drilling
  - \+ Sampled at 100's Hz
  - \+ Measures vibrations at the surface
  - – Modelled sources, location, medium
  - – Multiple wavefields generated
  - – Bit wavefield attenuation at depth

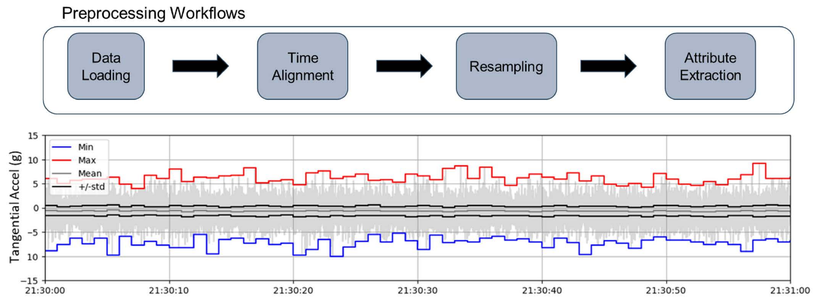


Downhole Acceleration Data

In this study, 3-component high frequency downhole acceleration data sets are evaluated for potential relationships that can be used to isolate drilling performance windows. Two drilled intervals in the same well show distinct trends of acceleration attributes that correspond to poor drilling performance at the end of the bit runs.

BHA Run	Downhole Sensor	Sensor Location	Bit type/size (inches)	Downhole Mud Motor	Depth Interval (ft)	ROP Limited	Slide Drilling
BHA01	VSS + Temp HF in-bit	Shank	PDC/12.25	Yes	8027 - 9240	No	No
BHA02	VSS + Temp HF in-bit	Shank	PDC/8.5	Yes	13858 -14494	Yes	Yes





BHA01

BHA02

The cross plots of standard deviation and maximum amplitude attributes have distinct trends of increased tangential values (black) that correspond to poor drilling performance at the end of the bit run. Within this subset (black ovals), the axial values for BHA02 are higher and have a larger spread than BHA01. A potential explanation for this difference could be related to the extent of damage to each bit, with much larger damage for BHA02, which could be responsible for the increased axial vibrations. It's common in drilling to monitor for higher tangential vibrations in the bottomhole assembly, as the indication of either drill bit dysfunction, or formation change. In this case, the memory data indicated minor variation in the drilling environment (including formation, drilling parameters, and wellbore geometry). Therefore, the increased tangential acceleration attributes indicated the onset or extent of bit damage.