



Authentic Drilling Inc.

Geotechnical • Environmental • Exploration • Specialty Drilling

SONIC DRILLING PRESENTATION

South East Denver, Colorado

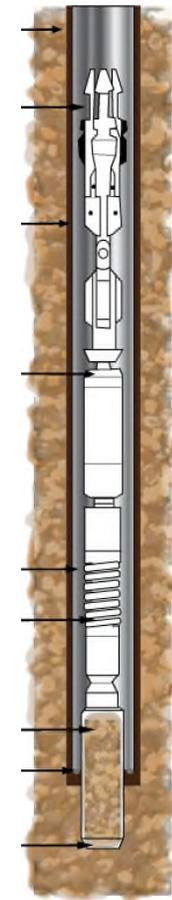
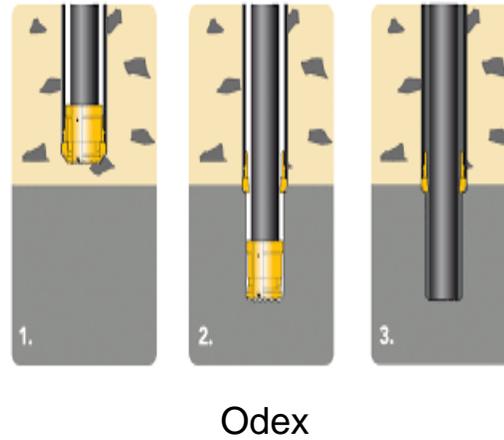
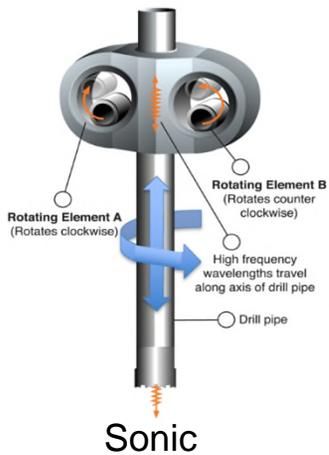
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Selecting the Right Drill and Method(s)

- Geology and the Subsurface Site Conditions
- Borehole Stabilization
- Project Goals
- Penetration Rate
- Diameter and Depth
- Samples Required
- Borehole Smearing
- Cross Contamination
- Drill Cuttings (Offsite Removal and IDW Disposal Cost)
- Site Access
- Budget
- Ability to Accommodate Changes During Exploration
- Water Source

AUTHENTIC DRILLING - METHODS OFFERED



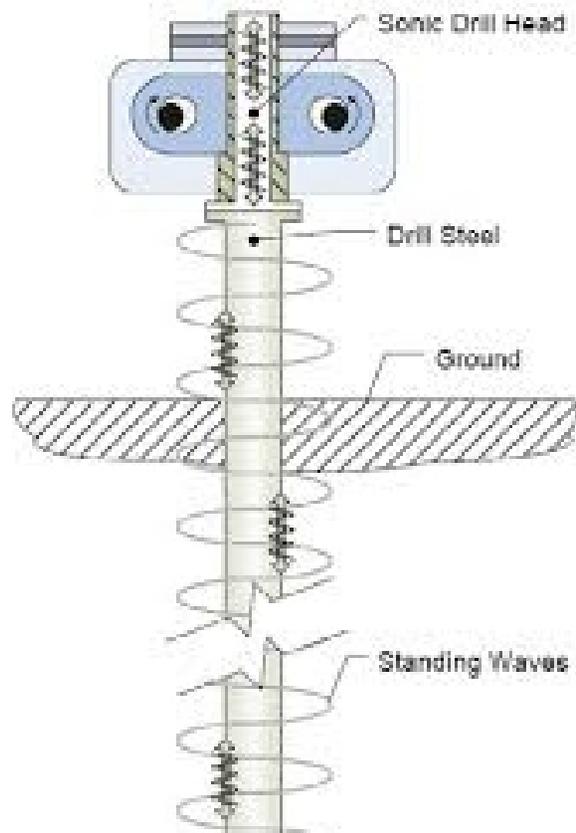
Rock Coring

Air or Mud Rotary

Solid Stem Auger v.
Hollow Stem Auger

Casing Advancer

WHY SONIC?



Authentic
Drilling Inc.

Sonic drilling is a soil penetration technique that strongly reduces friction on the drill string and drill bit due to liquefaction, inertia effects and temporary reduction of porosity of the soil. The combination makes penetrating for a large range of soils easy.



Projects that require a continuous in situ sample to capture the formation layer by layer for lithologic inspection.

Better samples representative of difficult sampling formations of subsurface materials, regardless of the material size.

CONTINUOUS CORE



Close key data gaps created by a conventional drilling method by incorporating longer, larger and continuous sonic cores

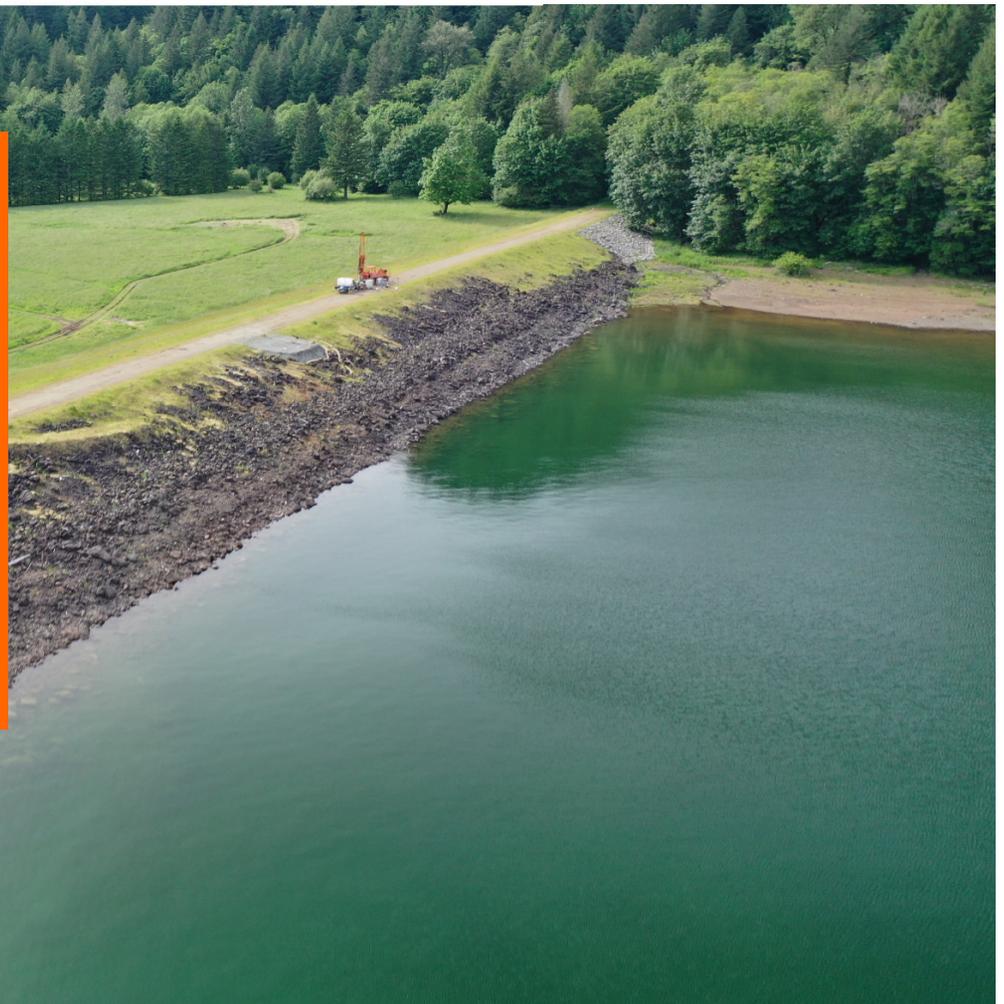


DRILL DRY

Sonic drilling can be performed with little or no water for contaminated and environmentally sensitive areas

For sensitive and fragile formations, such as earthen embankments, Sonic can be performed completely dry without the use of fluids.

This technique eliminates the concern of increasing formation core pressures (such as with muds, water, or air) which can contribute to hydrofracturing and embankment failure.



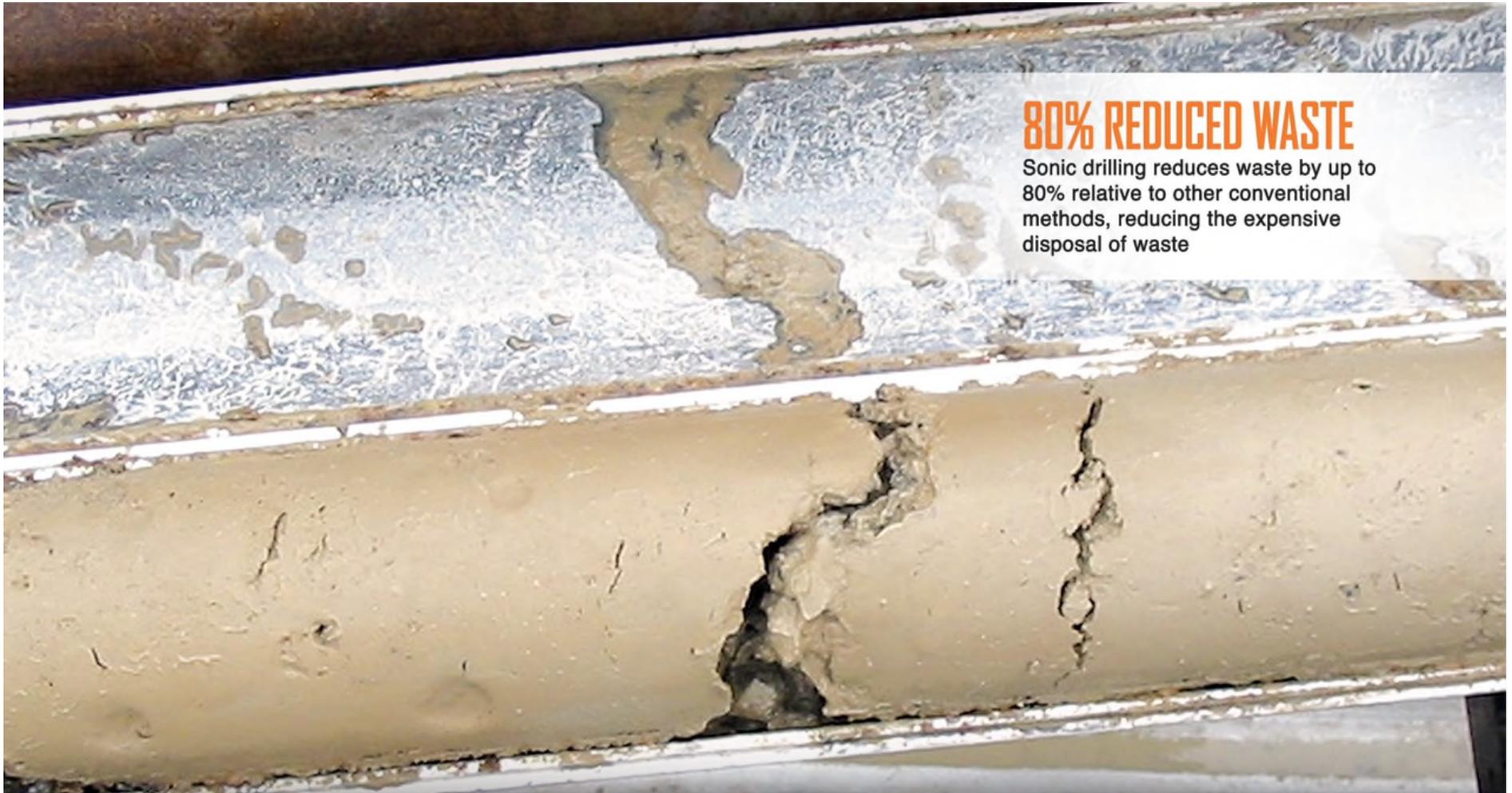
EROSION / LANDSLIDE

In a mining project, specifically a leach pad, adding water or air is a disturbance and can influence the mechanical properties of the soil. In extreme cases it can cause erosion which could lead to a failure such as a partial landslide.





IDW REDUCED WASTE



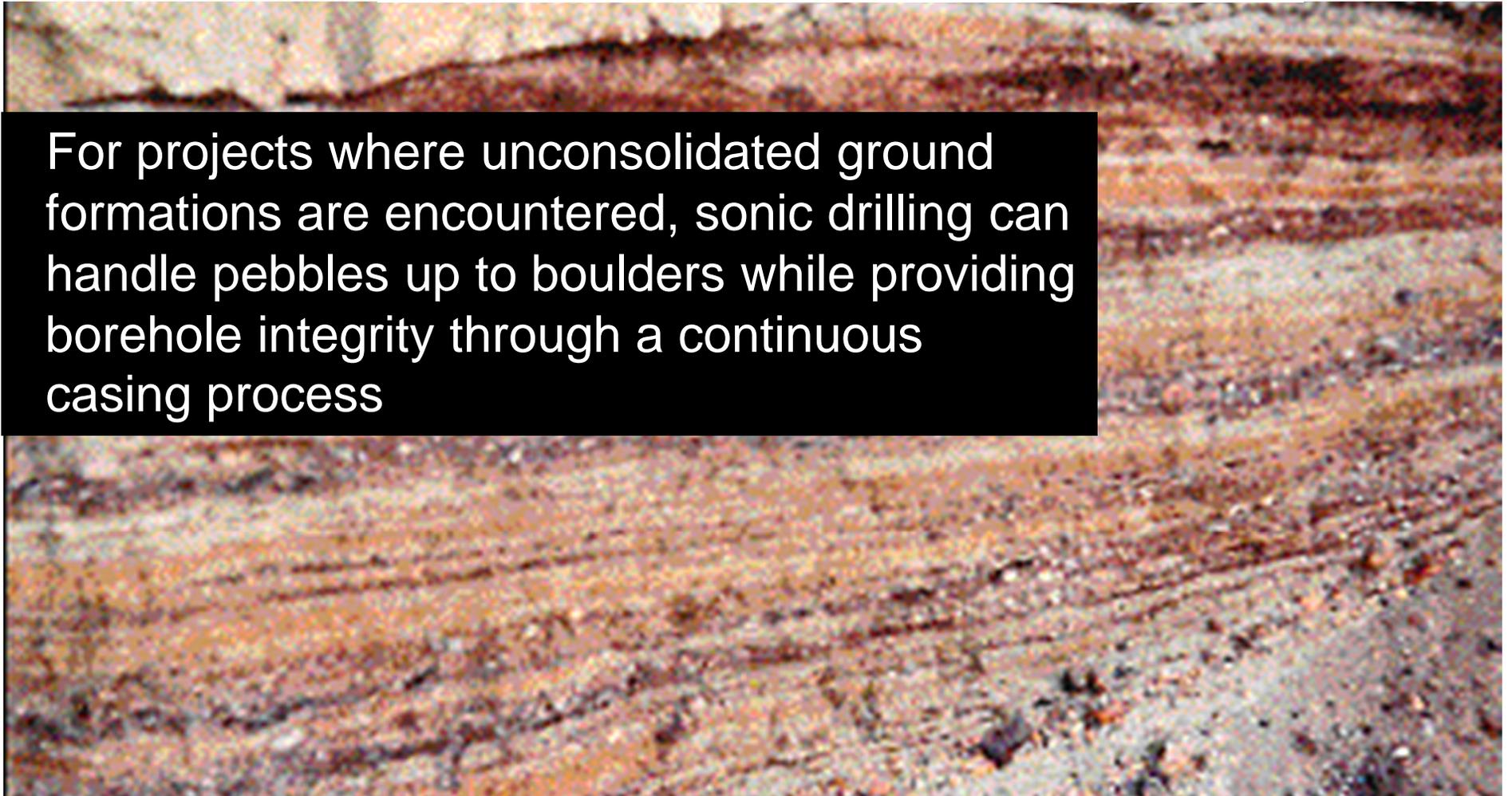
80% REDUCED WASTE

Sonic drilling reduces waste by up to 80% relative to other conventional methods, reducing the expensive disposal of waste



UNCONSOLIDATED FORMATIONS

For projects where unconsolidated ground formations are encountered, sonic drilling can handle pebbles up to boulders while providing borehole integrity through a continuous casing process



<1% DRILL DEVIATION

Accurately produce a continuous relatively undisturbed core quality sample within 1% deviation even on an angle for intercepting desired subsurface target.





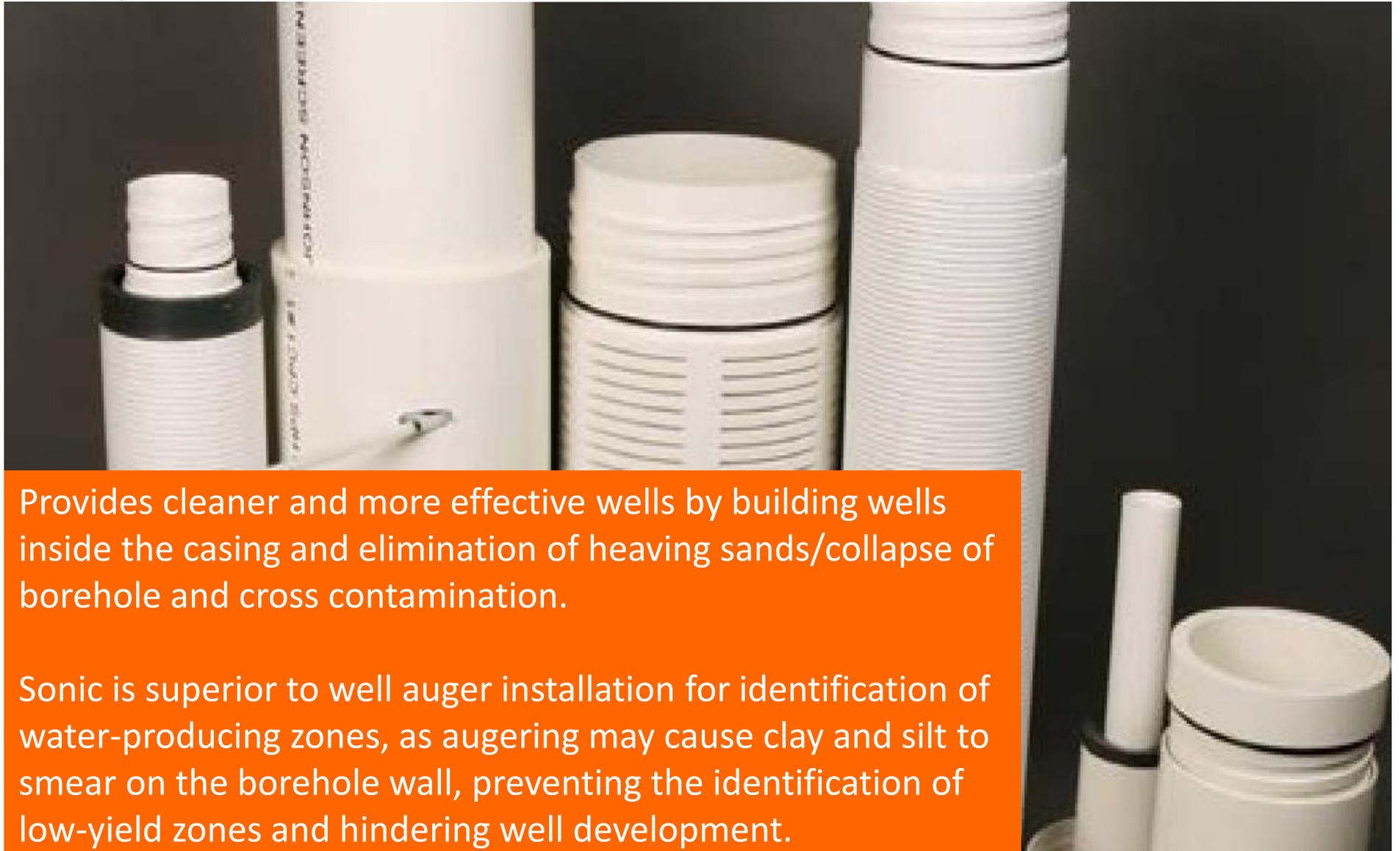
PENETRATION RATE



2X FASTER

Sonic is twice as fast as conventional overburden sampling methods

WELL INSTALLATION



Provides cleaner and more effective wells by building wells inside the casing and elimination of heaving sands/collapse of borehole and cross contamination.

Sonic is superior to well auger installation for identification of water-producing zones, as augering may cause clay and silt to smear on the borehole wall, preventing the identification of low-yield zones and hindering well development.

GROUNDWATER PROFILING



Contaminant flow in a saturated zone is based upon the varying transmissivities of each strata through which groundwater (and the contaminant mass) move. In profile or cross-section plans, contaminant plumes do not typically exhibit “teardrop” shapes. Instead, they are actually elongated lobes mimicking the mass-flux of the subsurface. This is the primary reason that groundwater samples collected from long-screened monitoring wells may not be representative of actual groundwater quality; data are flow-weighted (based upon the individual transmissivities the good screen intersects) and depth-averaged (a single groundwater sample collected from a long-screened well is more of a composite sample of the screened interval).

Discrete groundwater samples during borehole advancement helps clarify the dissolved-phase plume anatomy. It permits more targeted placement of well screens within a precise interval and identifies whether the contaminant mass may be confined to high or low transmissive zones. It may help answer whether persistently detected impacts are a result of back-diffusion from finer strata, often considered a secondary source.

AUTOMATION = SAFER

- Automatic Rod Handling - Manipulator arm with hydraulic pliers and accumulators lift and set drill rods / casing without physical contact.
- Pinch Points
- Less Physical Contact
- Break out jaws tighten & loosen pipe joints
- Reduces the amount of hand injuries
- Less Labor Intensive Less spoils to shovel



REDUCED FRICTION

- Reduced friction on the length of the drill string
- Prevents torsional forces on the drill string.
- High frequency results in the ease of retrieving the drill string, even in quick expanding clays or boulders and difficult conditions.
- All the drilling rods, casings and tooling are pulled faster and easier.





SUMMARY

Sonic drilling is most often used in scenarios when the drilling (whether through particular ground materials, or to a particular depth) is rather difficult and the integrity of the core sample is extremely important.

SONIC CASING AND SAMPLING SIZES

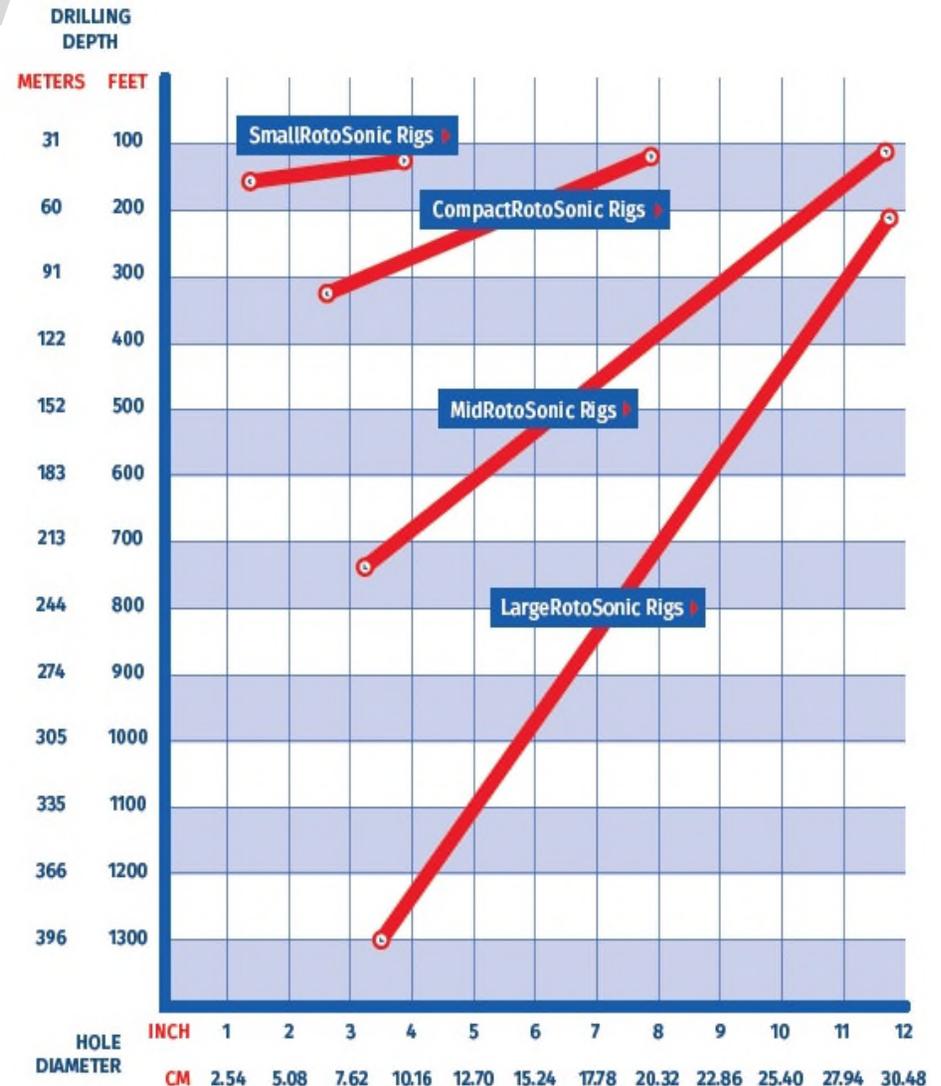
- **Sample Sizes – 3, 4, 5, 6, 7, 8 & nominal 9” inch**
- **Casing Sizes - 5, 6, 7, 8, 9, 10 & 12 inch**



MidRotoSonic Rig



- Sonic Depths up to 700'+ (depths are dependent upon casing size and formations).
- High penetration rates reduce with depth.



Eijkelkamp - MidRotoSonic MRS Duo XL 275 Max Sonic Crawler Rig

- Duo System (instantly change between sonic to core)
- Sonic Frequency: 0-150 Hz
- 50k lb/ft Sonic Drillhead
- 275 HP Cat 6 Cylinder Engine
- Manipulator arm with hydraulic plyers for lifting/loading drill pipe
- Drill up to 45 degree angle
- Bean, Bredel and water pumps
- Rubber pad wide tracks
- SPT Autohammer
- CPT Prep (could add CPT)



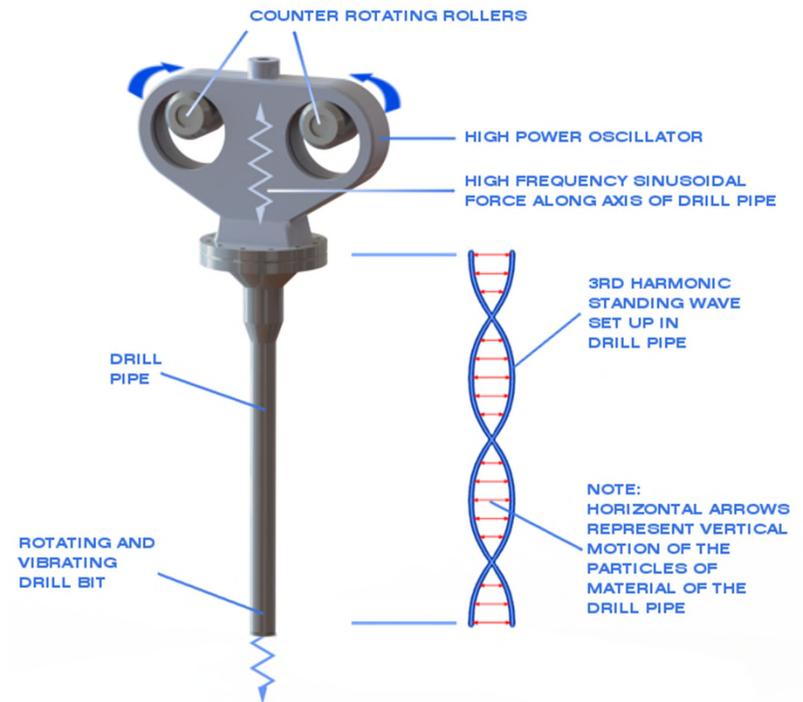
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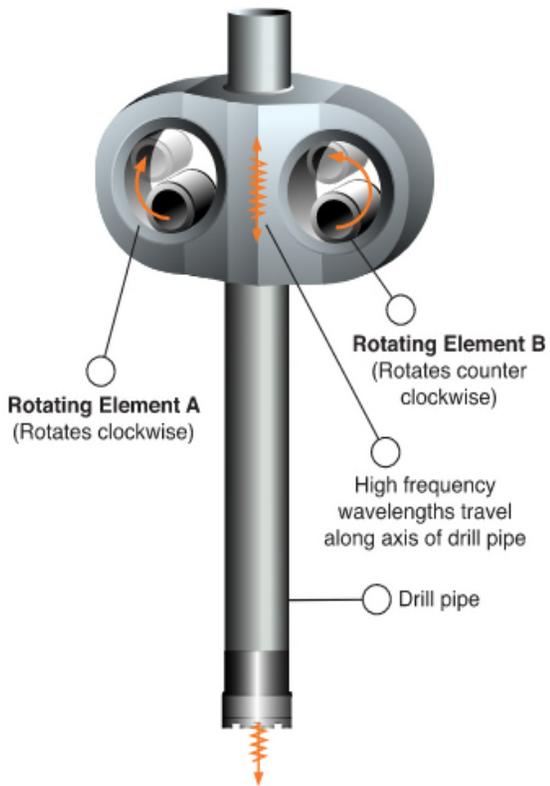
HOW SONIC DRILLING WORKS

Sonic drilling uses high-frequency vibration (resonance) to reduce friction and advance the drill string and bit where surrounding particles are either liquified (in loose materials) or fractured (in hard rock)

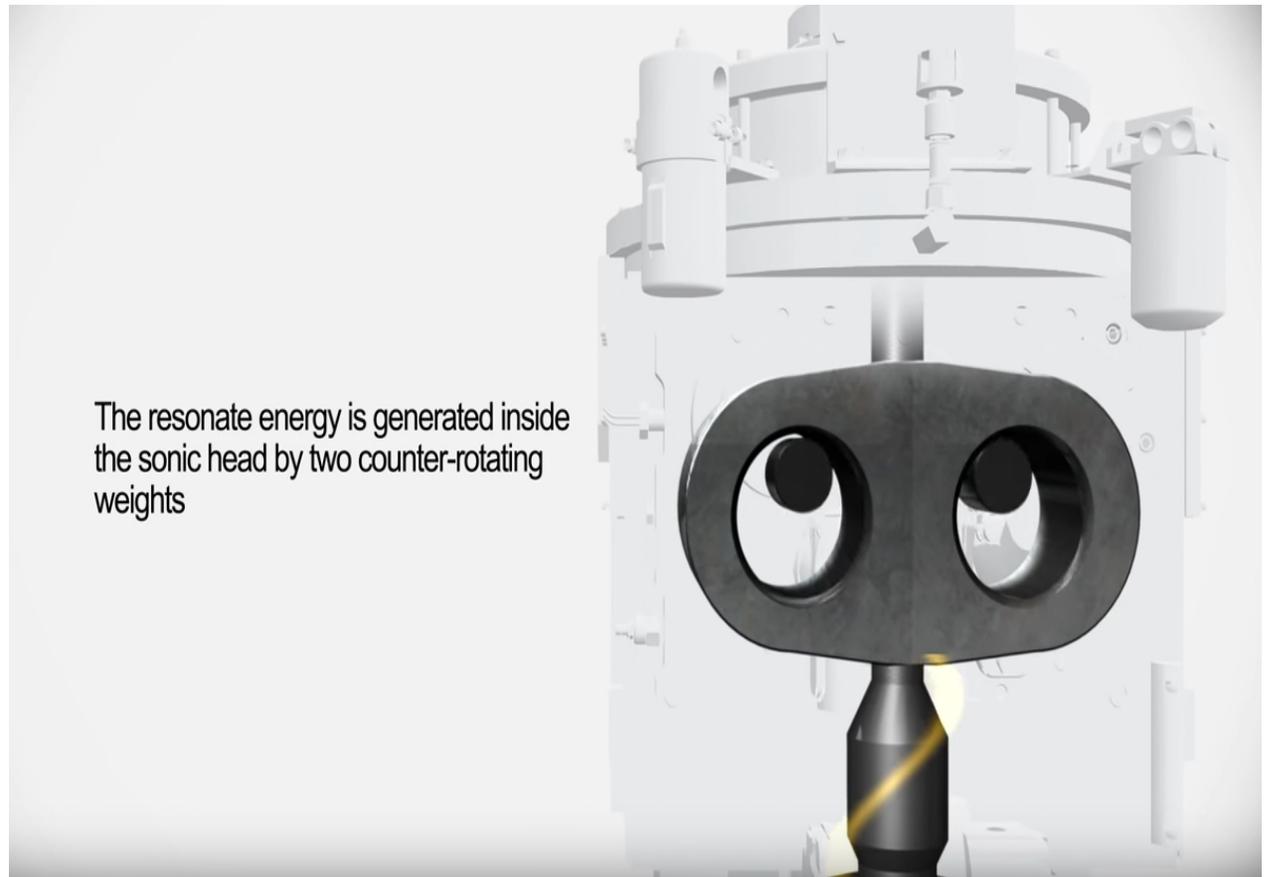
Rotation can be added when drilling in harder geologic formations.



Sonic Oscillator Diagram



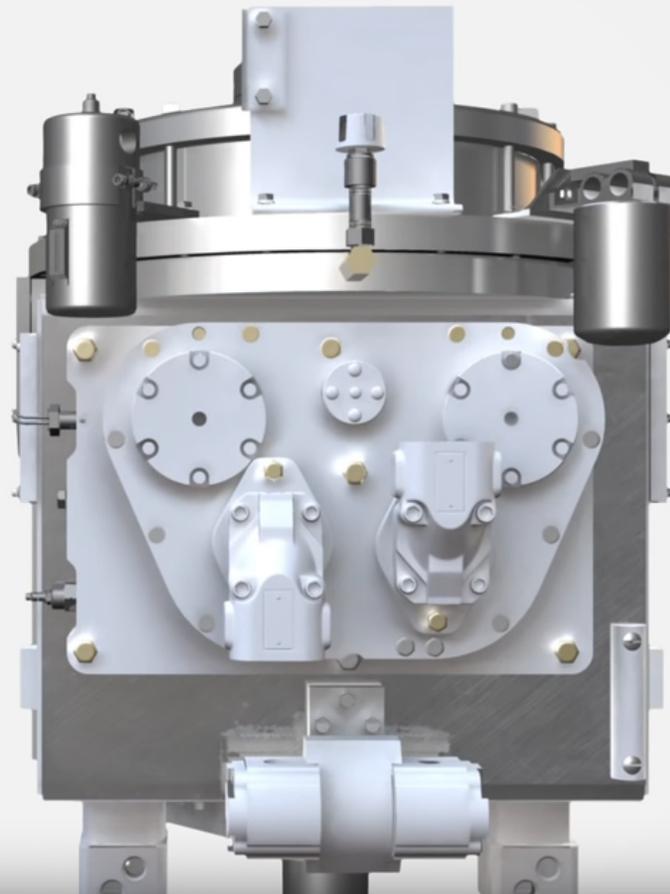
The resonate energy is generated inside the sonic head by two counter-rotating weights



RESONANT FREQUENCY

- Resonant frequencies of 50 to 200 Hertz are audible and the driller controls the resonant energy generated by the Sonic head's oscillator to match the formation being encountered to achieve maximum drilling productivity.
- When the resonant Sonic energy coincides with the natural frequency of the drill string, resonance occurs. This results in the maximum amount of energy being delivered to the face. At the same time, friction of the soil immediately adjacent to the entire drill string is substantially minimized, resulting in fast penetration rates.
- Compared to conventional drilling – Sonic is Low Force and Low Torque

Superior information of unconsolidated
formations and difficult overburden





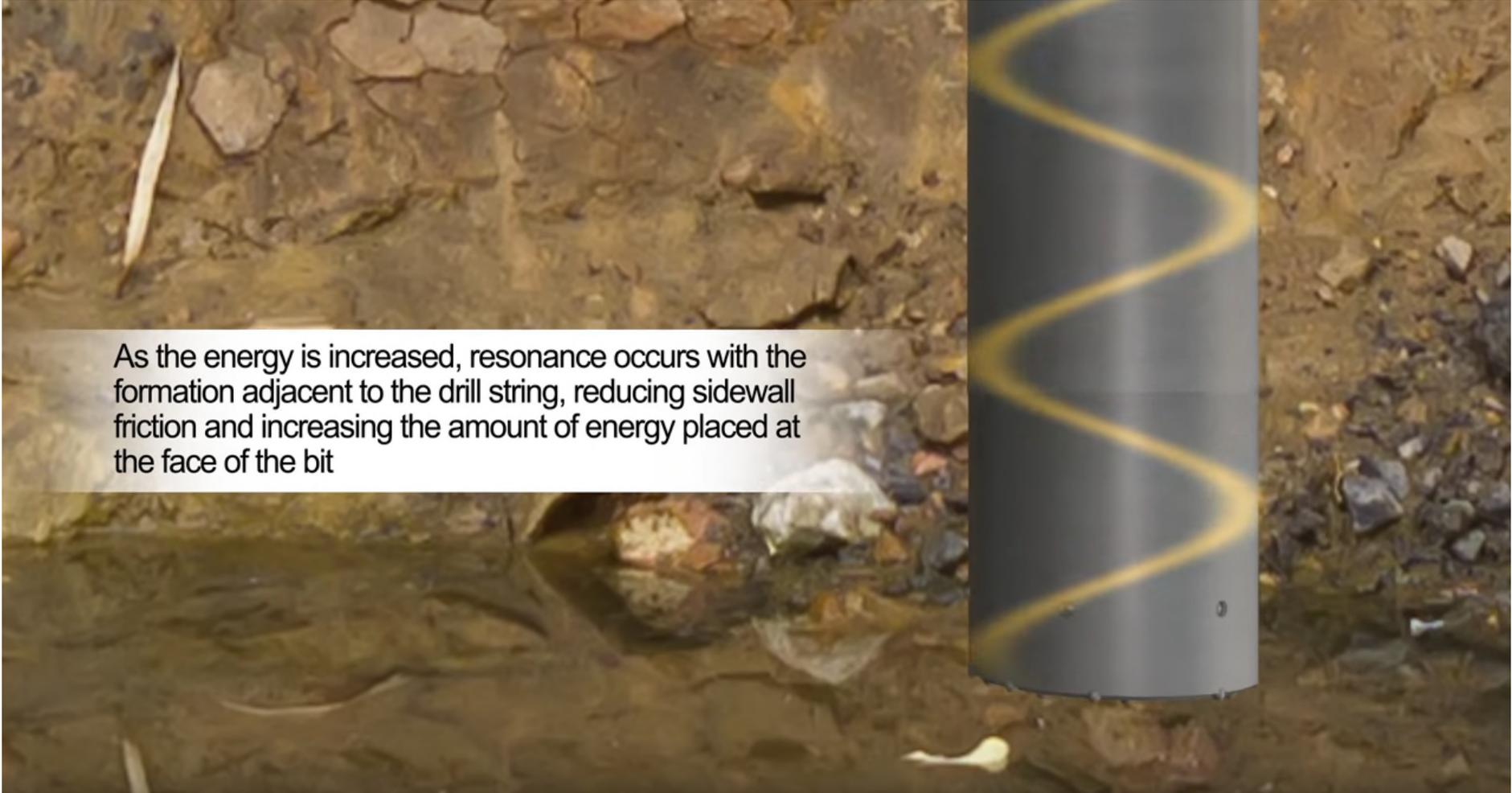
SONIC CAPABILITIES

- Sonic is a good alternative for odex, air rotary and mud rotary
- Effective in difficult drilling conditions like heaving sands, boulders and fill/landfill, and softer formations, unconsolidated gravel-rich material to sandstone/shale sequences to clay-rich glacial till, limestone or weathered basalt.
- Ability to obtain large (up to nominal 9") continuous core samples without the use of air or drilling fluid.
- Continuous cores have been obtained at depths as great as 700 feet.
- No refusal with boulders, wood, concrete, debris BUT ... Stress on the drill pipe produced during resonance causes internal damages.
- Not ideal for hard rock but Sonic rig has ability to continue with DTH or switch to core.

STEP 1: CORE BARREL ADVANCEMENT

The core barrel is advanced using sonic frequencies. When necessary this step can be performed using no fluids, air, or mud.

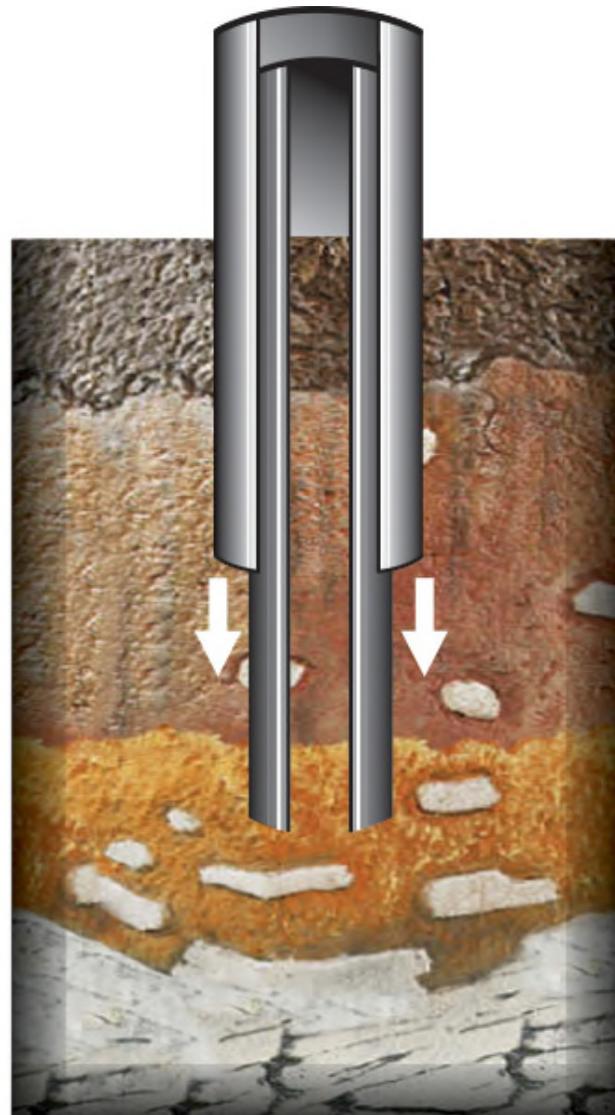


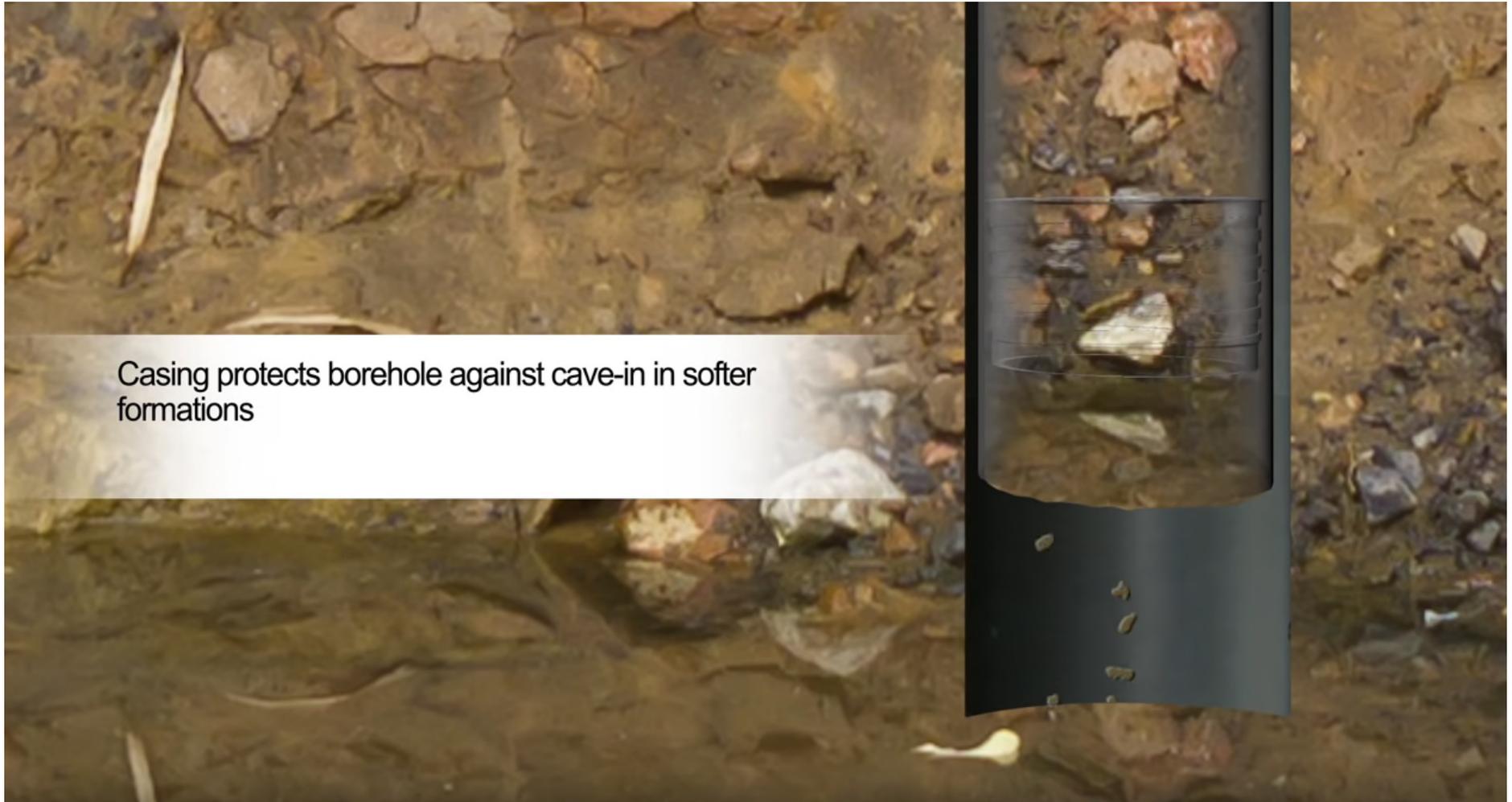


As the energy is increased, resonance occurs with the formation adjacent to the drill string, reducing sidewall friction and increasing the amount of energy placed at the face of the bit

STEP 2: CASING OVERRIDE

Once the sample is contained in the core barrel, the casing is sonically advanced over the core barrel





Casing protects borehole against cave-in in softer formations

STEP 3: CORE RETRIEVAL

The core barrel is retrieved, producing a relatively undisturbed sample with near 100% core recovery.



STEP 4 - REPEAT CORE ADVANCEMENT

Steps 1 through 3 are repeated to depth, producing a continuous core sample through unconsolidated formations





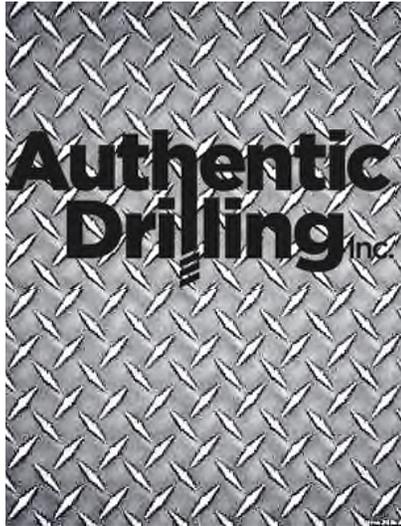
MARKETS SERVED:

Environmental, Geo-technical/
Geo-construction, Water, Mining



SONIC DRILLING APPLICATIONS

- Air rotary drilling
- Aggregate exploration
- Anchors, earth and rock
- Angle drilling: 45 – 90 degrees
- Anode installation
- Aquifer exploration
- Blast hole drilling
- Boulder clay drilling
- Cast-in-place concrete piles
- Compaction grouting
- Construction drilling
- Continuous coring
- De-watering projects
- Earth dam investigations
- Earthquake studies
- Environmental investigations
- Extraction wells
- Geo-Construction drilling
- Geological explorations
- Geo-technical investigations
- Geothermal drilling
- Groundwater sampling
- Hydro-fraction drilling
- Hydro tower tie backs
- Injection wells
- Irrigation wells
- Jet grouting
- Landfill gas extraction wells
- Landfill site investigations
- Landslide prevention
- Mine rehabilitation and infilling
- Mine tailings investigations
- Mineral exploration
- Micro piles
- Monitoring wells
- Multi-cased wells
- Multi-level wells
- Mud rotary drilling
- Overburden drilling
- Percussion drilling
- Permafrost drilling and coring
- Piezometer installations
- Pile driving
- Pile extraction
- Placer gold exploration
- Quaternary stratigraphic studies
- Railway right-of-way investigation
- Recovery wells
- Retaining wall construction
- Reverse circulation drilling
- Rock coring
- Rock drilling
- Sand and gravel exploration
- Seismic shot hole drilling
- Sparging wells
- Soil sampling
- Soil vapor extraction wells
- Steam injection wells
- Tar sand exploration
- Tie back installations
- Tunnel pre-drilling
- Underpinning
- Undisturbed sampling
- Water profiling
- Water wells



SAMPLES

- Collect sub-samples using a clean trowel after first removing any soil that may have smeared on the outside of the sample. Place sub-sample in the appropriate jar, fasten the lid firmly and then complete the label.





SONIC CORE SAMPLING

- Sonic has the ability to provide continuous, highly representative, relatively undisturbed core samples through any geological formation including boulders and bedrock.
- Core samples are extruded into plastic sleeves, minimizing the loss of volatile organic compounds and reducing the risk of operator exposure to in-ground contaminants.
- Sonic Sampling:
 - Optional auto hammer
 - Ability to shift to split spoons, shelby tubes and/or coring
 - Ability to collect discrete water samples and inject remediation fluids
 - Screen the core by puncturing holes in the plastic to take PID along the core.
 - Elevated PID sub-samples may be collected by scraping smeared soil from the outside of the core to collect a relatively unexposed sub-sample.
- Dense Non-Aqueous Phase Liquids (DNAPL) investigations can be performed effectively by casing off contaminated zones.

SONIC DRILLING BENEFITS

- ✓ **Speed:** Drilling rates range up to 260 feet or more per day.
- ✓ **Superior Information:** Continuous core samples -
Lithology/geochemistry/hydrogeology
- ✓ **Vibration** associated with sonic drilling eases casing removal for grouting projects and the use of air reduces borehole wall smearing for geotechnical and environmental sampling and downhole testing.
- ✓ **Waste Minimization**
~70-80% less IDW than conventional drilling due to cased hole
- ✓ **Ability to “dry” drill** BUT drilling fluids are required through significant hard rock units and in deeper holes. (Less need for water onsite)
- ✓ **Well Construction –**
 - Less development time/better yield.
 - Angle wells/multi-cased wells without leaving casing in ground



SONIC WELL ADVANTAGES

- Drill and core through landfill debris.
- Take water samples at any depth.
- Install multi-chamber well tubing.
- Install large diameter extraction, remediation and sparing wells.
- Drill without using mud.
- Drill very straight holes.
- Drill angled holes.
- Easy identification of perched water tables.
- Economical delineation of the contamination plume prior to remediation is easily achieved.
- The Sonic Drill is a safer machine to operate due to the use of smooth rods and casing. A tilting drill head, hydraulic rod handling system, hydraulic break-out wrenches reduce manual labor and no auger flights increase operator safety.
- Overall risk to the client is minimized due to better knowledge of subsurface conditions and the ability of Sonic Drilling to tackle difficult ground conditions.

SONIC DISADVANTAGES

- Drilling vibration can, however, disturb surrounding formations or cause new fractures in hard bedrock, affecting structural or aquifer testing.
- The drill stem may heat up as it advances into the ground potentially volatilizing contaminants present in the soil.
- Drilling heat generated by this method in some geologic formations may change texture, moisture or contaminant conditions, but this side effect may be controlled using drilling fluid.
- Sonic vibrations may require more hearing protection.
- Equipment cost and cost of preventative maintenance

SONIC DISADVANTAGES

Drilling Cost:

- Not cost effective for few or shallow borings, easier drilling conditions or in hard bedrock
- ~3x+ cost of Rotary
- ~2x cost of Odex
- ~1.5x cost of RC
- Costs range from \$70 to \$300 per foot depending upon the drilling system used, the drilling approach, the site geology, etc.

Despite this cost, sonic can be ideal for remote areas where:

- Fixed logistics costs are already high,
- Exploration seasons may be short lived, and
- Excellent recovery and penetration rates are demanded.

Sonic is certainly not the answer for every project, but it holds the potential of achieving results that prove the feasibility of projects previously unsampled or considered unviable.



EIJKELKAMP SONIC RIG ADVANTAGES (1 of 2)

- MidRotoSonic Drilling Rig - Eijkelkamp MRS Duo XL 275 Max
- 50k Head
- Head Energy Speed 150 Hertz
- Fraste Carrier:
 - ~3 mph carrier speed
 - Wide tracks (lower ground pressure, increased stability)
- SPT hammer
- 17' Stroke gives more options for sample depths
- Dual Mounted Head System - Sonic and high speed coring/rotary heads allow head change in mere seconds (saves minimum 30 minutes per hole)
- Multiple drilling method options:
 - Sonic
 - Wireline coring,
 - DTH,
 - Air rotary,
 - Mud rotary, and
 - CPT (Rig Prepped)



EIJKELKAMP SONIC RIG ADVANTAGE (2 of 2)

- Manipulator Rod Handler – Rig carries 210'/casing or 400'/rod (faster production)
- Tooling - Heavy Duty Matrix thick wall casing and 4 ½” rods – transfers the sonic energy better and has less energy loss than thinner wall tooling
- We believe we are only one of two DBE/WBE sonic drilling companies in the US
- Water tank 130 gallon on board
- Triple hydraulic rod breaking clamp
- Drill up to 45 degree angle off vertical
- Mast Dump (slides the feed frame into place)
- Winches
 - Hydraulic Winch 8000 lb (3600 dAn)
 - Hydraulic Jib Boom with wireline winch
 - Mast winch 4000 lb
 - 20 Ton Hydraulic Winch / Remote
- Pumps:
 - Bean/FMC L1122, Type L11 Triplex Piston Mud Pump
 - SPX 40 Bredel pump
 - HP Water Pump CAT5120