Piston Coring with Synthetics
Lessons from AR64-02
Paul Walczak & Steve D'Hondt

MARSSAM

Marine Rock and Sediment Sampling Facility
@ Oregon State University

MARSSAM:

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Mitch Lyle

Special Guest Stars:

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Al Gagnon (WHOI)

Chris Griner (WHOI)

Charlie Brooks (SIO)

Royhan Augustine (SIO)

Andrew Naslund (SIO)

Tony D'Aoust (UNOLS Tech Pool)

Drew Cole (UNOLS Tech Pool)

Michael Tepper-Rasmussen (OSU)

****Did most of the work we're presenting today…**

What is the U.S. Marine Rock and Sediment Sampling (MARSSAM) Facility?

- Prior to 1997 National Science Foundation (NSF) ***investigators responsible on an individual basis*** for requesting all funding necessary for sediment coring

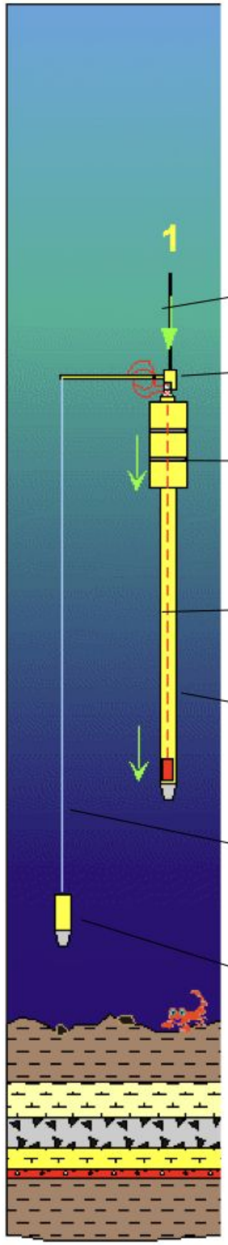
- However, all sediment cores collected with NSF funding become available to the broad scientific community after brief moratorium

- At 1997 Future of Marine Geoscience (FUMAGEGS) meeting, it was decided that ***a central facility should exist*** to support coring for all NSF-supported PIs

- Now a 25-year-old national facility based at Oregon State University supporting operations on NSF Academic Research Fleet

- As of 2022 offers equal support of ARF dredging

Typical Jumbo Piston Coring (JPC) System



Ship's rope or wire

Trigger arm (you could use an acoustic release here if desired). The SCOPE is the coiled part shown attached to the arm – feet of scope = feet free fall

Weight stack (it is hollow so that things can pass through it)

Pendant (RED – this part comprises the free fall part of the core and runs from the trigger arm to the piston.. The PISTON is the red block at the bottom.)

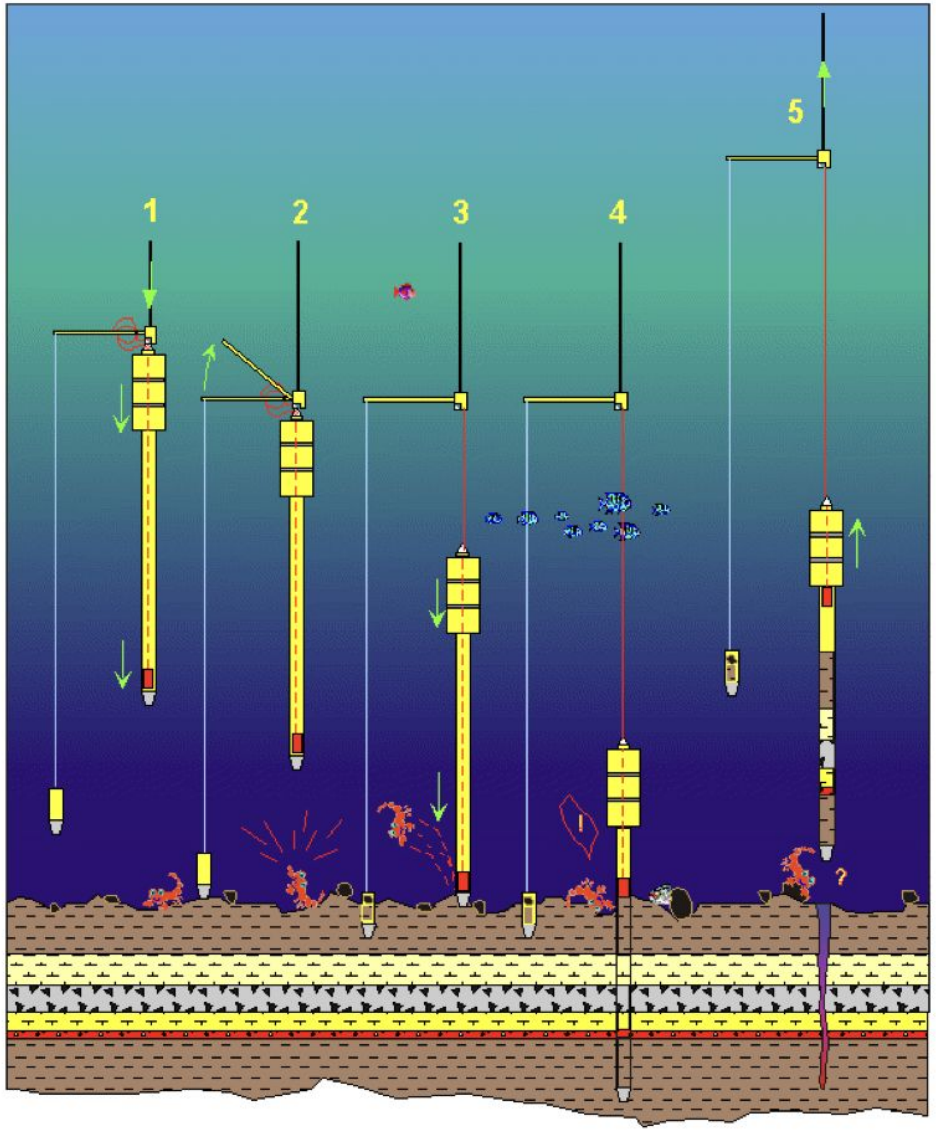
Core barrel (10' steel barrels lined with PVC for easy extrusion and archiving of sediment sample)

Trigger line (holds trigger core in appropriate position, allows trigger core load transfer)

Trigger core (small gravity core that provides the counterweight holding the jaw of the trigger arm closed – when this weight is slacked due to hitting the bottom the piston core falls freely into the sediment consuming the SCOPE of the pendant)

Figure from: http://geologie.mnhn.fr/Collection_Marine/moyens_mer/Engins_de_prelevements_eng.htm#PISTON_CORER

Typical JPC Coring Sequence



1) Piston core in deployed state.

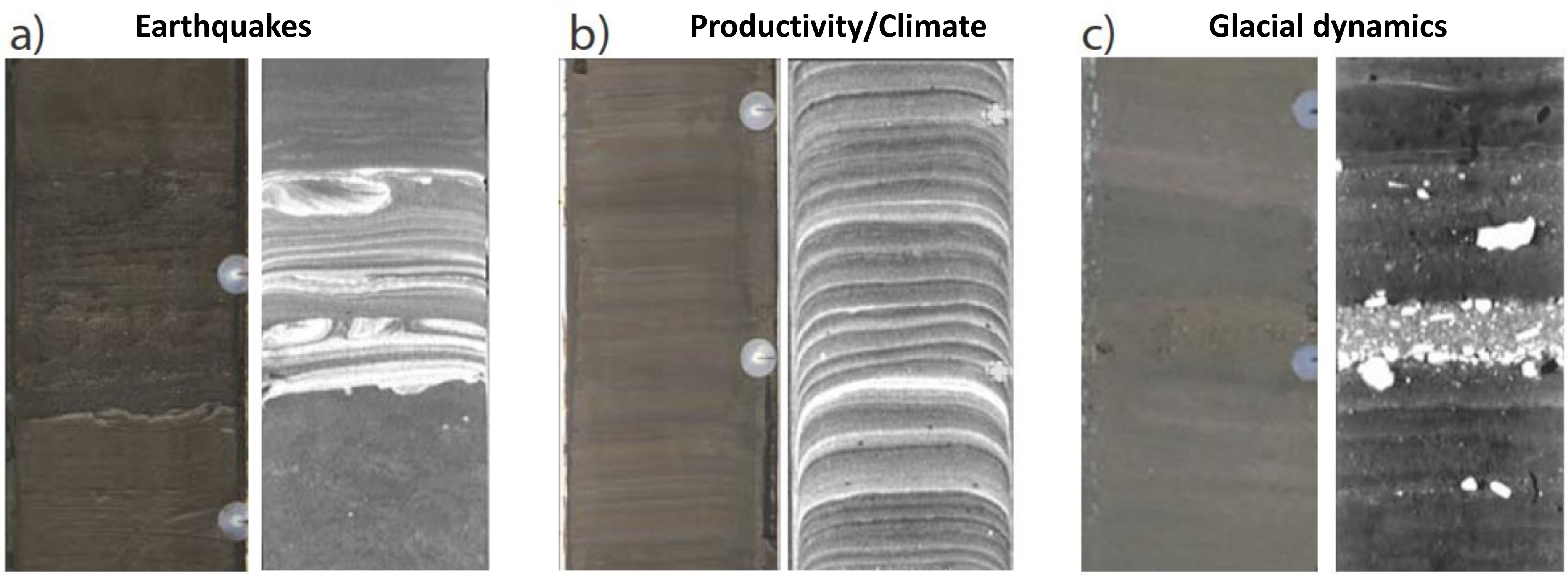
2) Piston core as trigger core hits the bottom. The trigger arm no longer has weight on it and rotates upward compared to the piston core. BETWEEN STEPS 3 AND 4 THE CORE FREE FALLS

3) Piston core hits the bottom. SCOPE is consumed, piston stops travelling just at the sediment/water interface.

4) Piston core slides into sediment until coming to a stop against the piston (the PISTON STOP internal to the piston core makes contact with the PISTON)

5) Piston and trigger core are pulled out of the bottom by ship's wire and make their way to the surface for recovery

Implications of core quality for science:



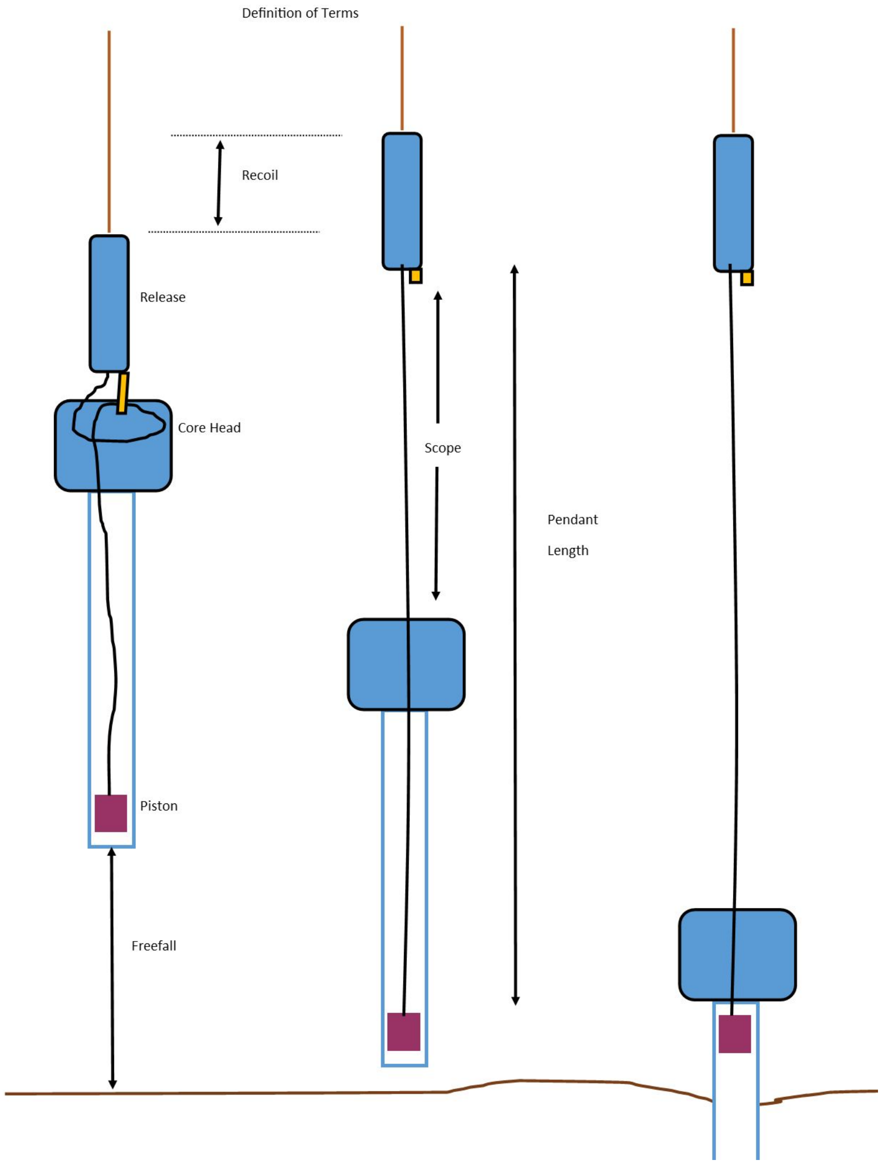
Sometimes physical variability in cores makes it easy to identify deformation - ***not always the case, but that doesn't mean it's not important!***

AR64-02

Steve D'Hondt, Doug Bartlett, Rob Pockalny, Ying Zhang

Sampled deepest part of Puerto Rico Trench - and hence deepest part of Atlantic Ocean

>8000 m of wire out = >11,000 lbs *trawl wire weight*



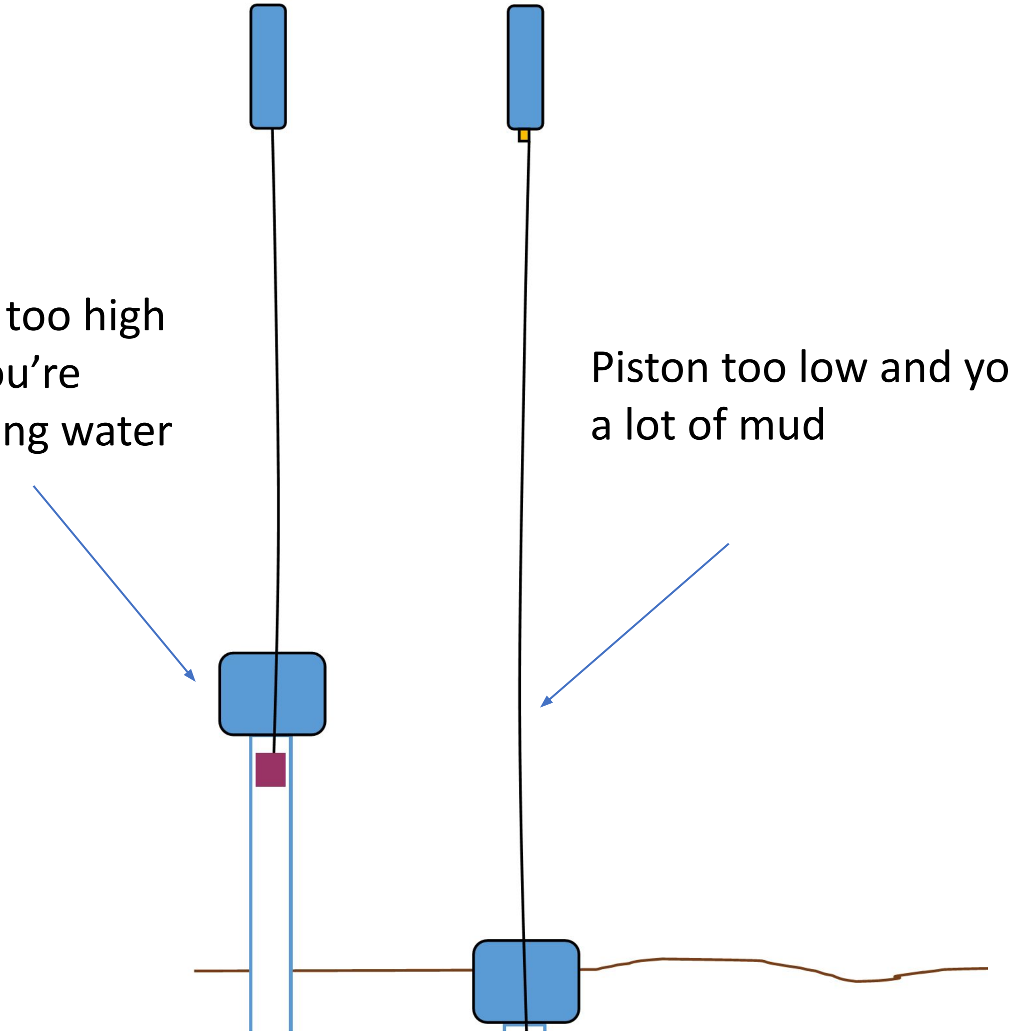
Piston action and placement determines core quality!

Scope = FreeFall + Recoil

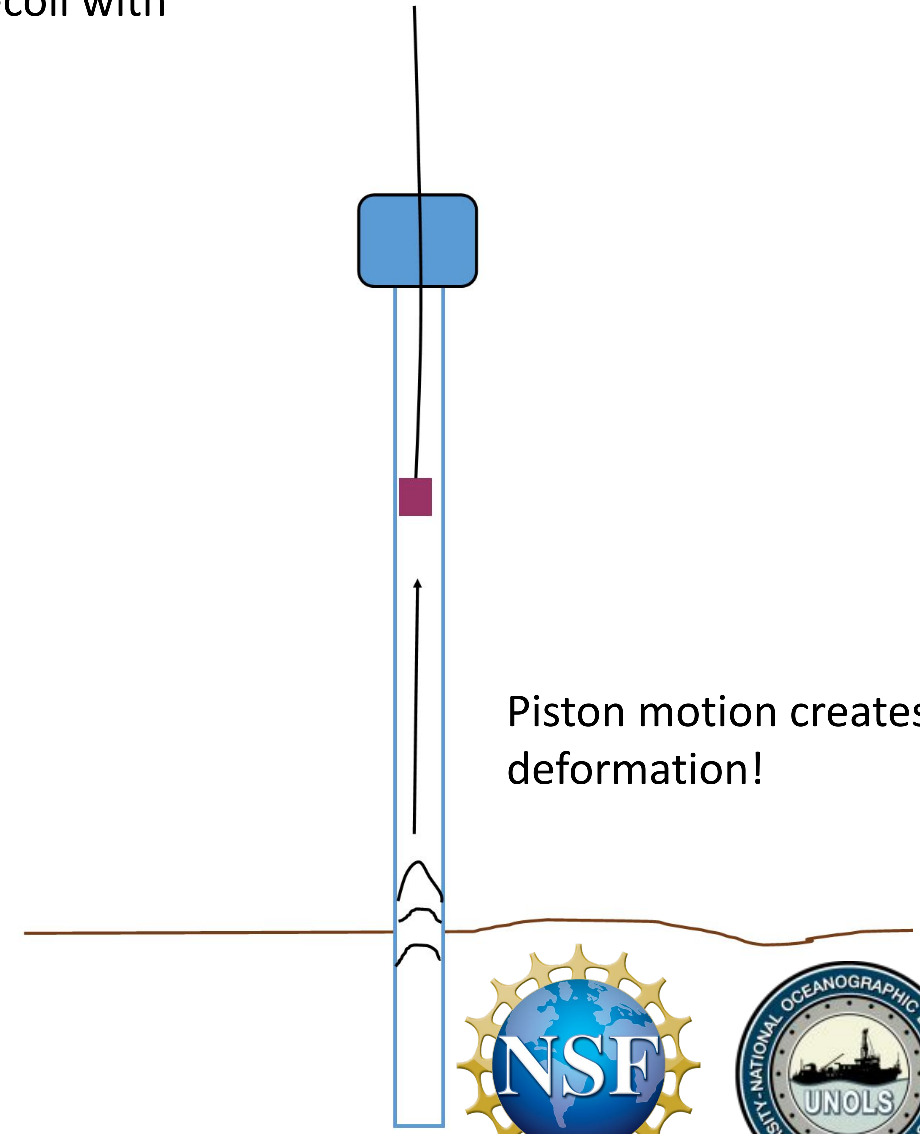
For 9/16 3x19 Trawl wire we increase scope by 6” for every 500m over 2000m to account for increasing recoil with depth

How much recoil is there with synthetic? *A lot more!*

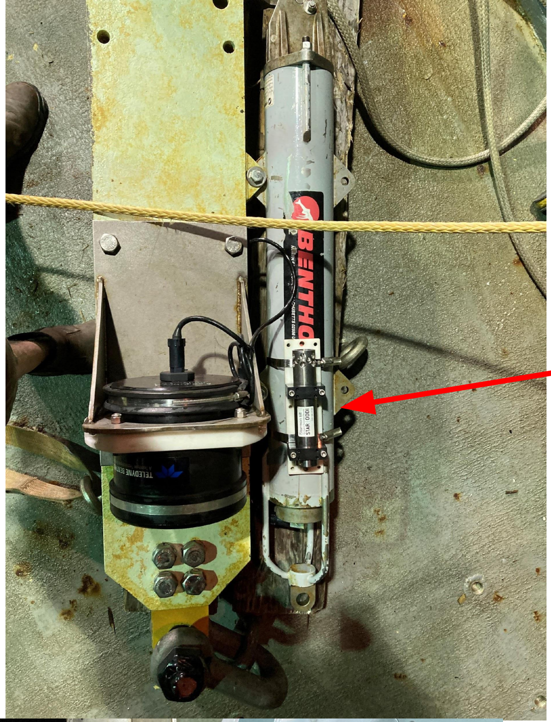
Piston too high and you’re sampling water



Piston too low and you’re missing a lot of mud

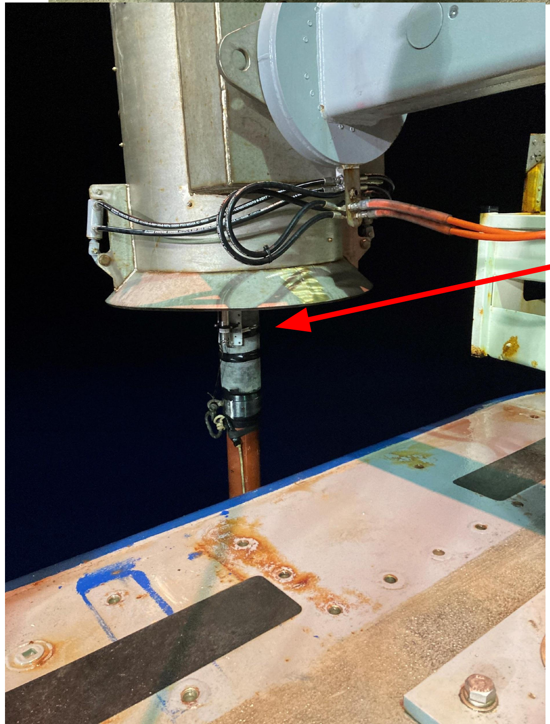


Piston motion creates deformation!

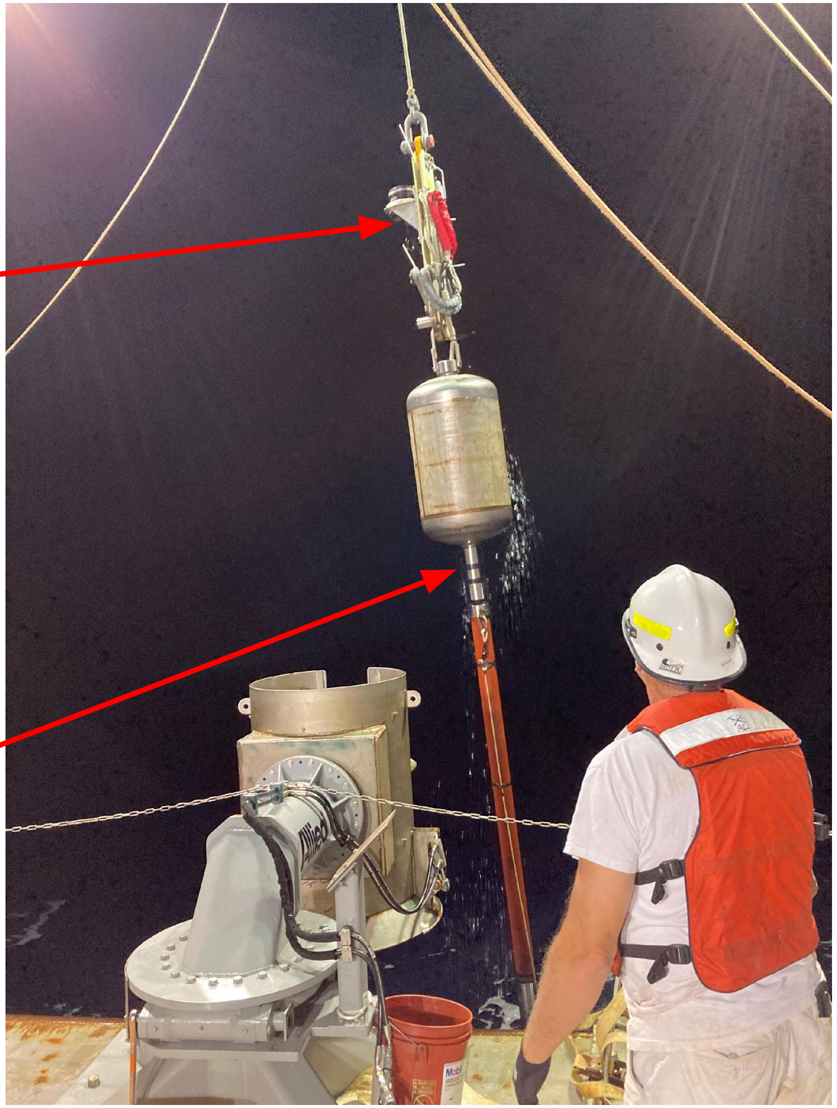


Sensors measure:
3-D acceleration
Depth
Temperature

Release Sensor



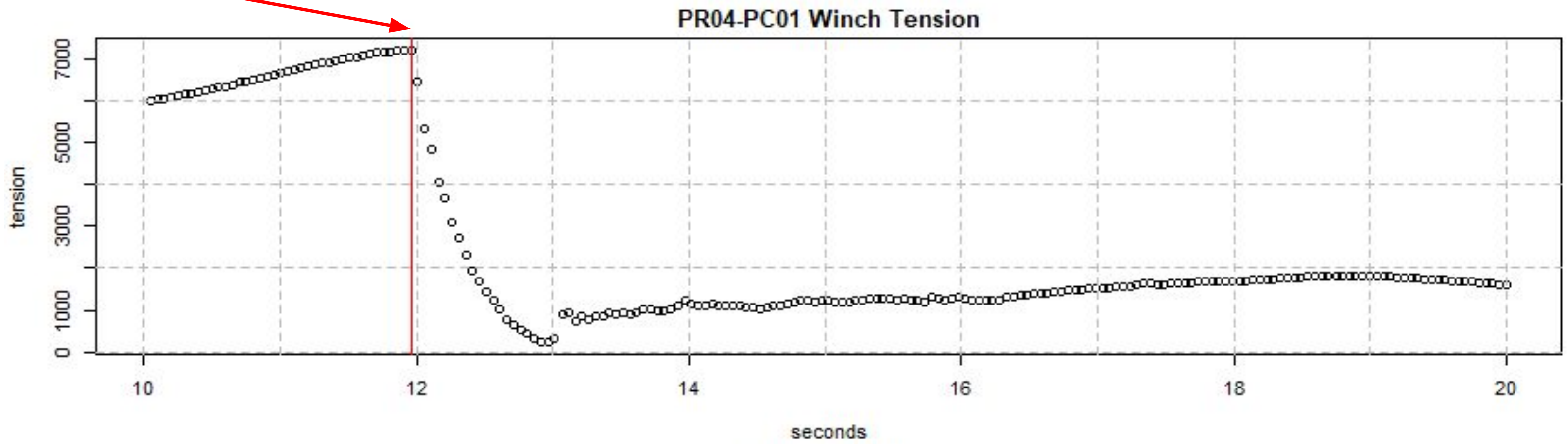
Corehead
Sensor



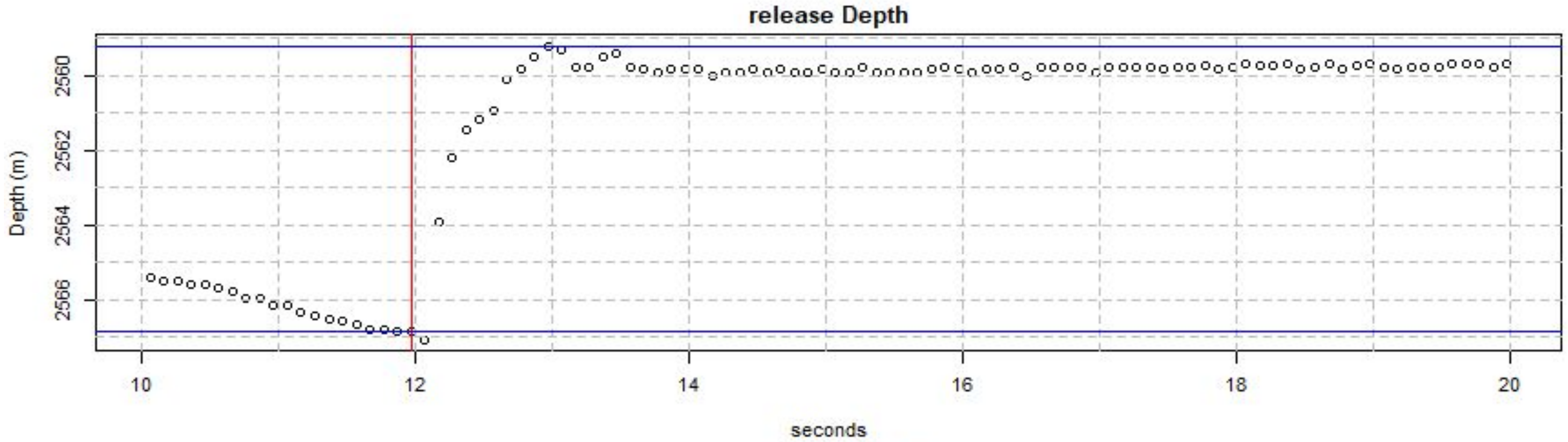
MOMENT OF PISTON CORE FREE FALL:

Sensor Data

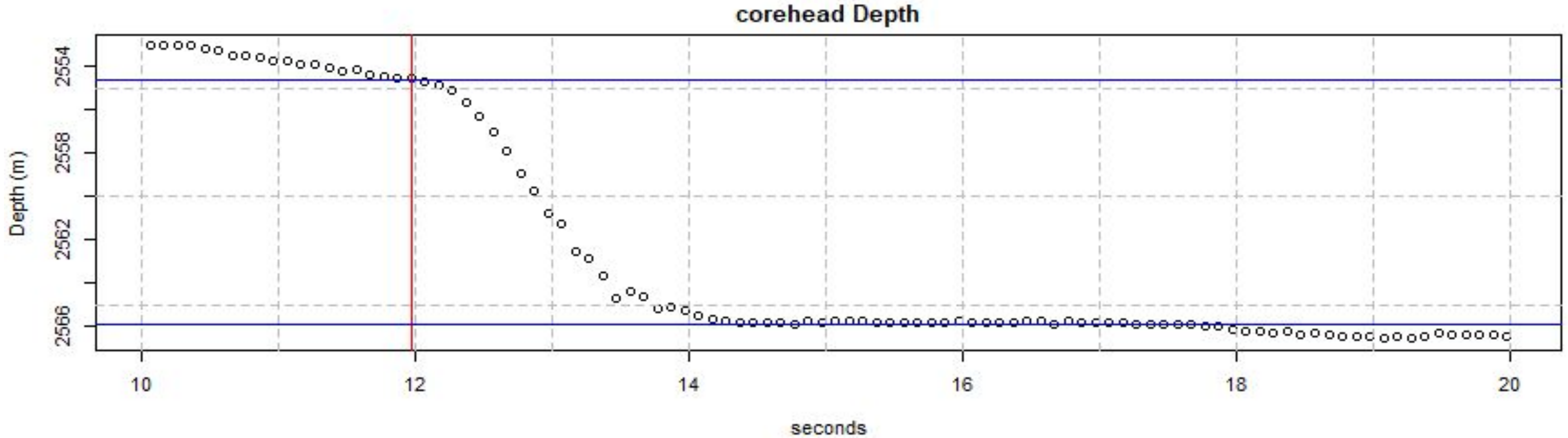
Wire Tension:



Release Depth:



Corehead Depth:



MOMENT OF PISTON CORE FREE FALL:

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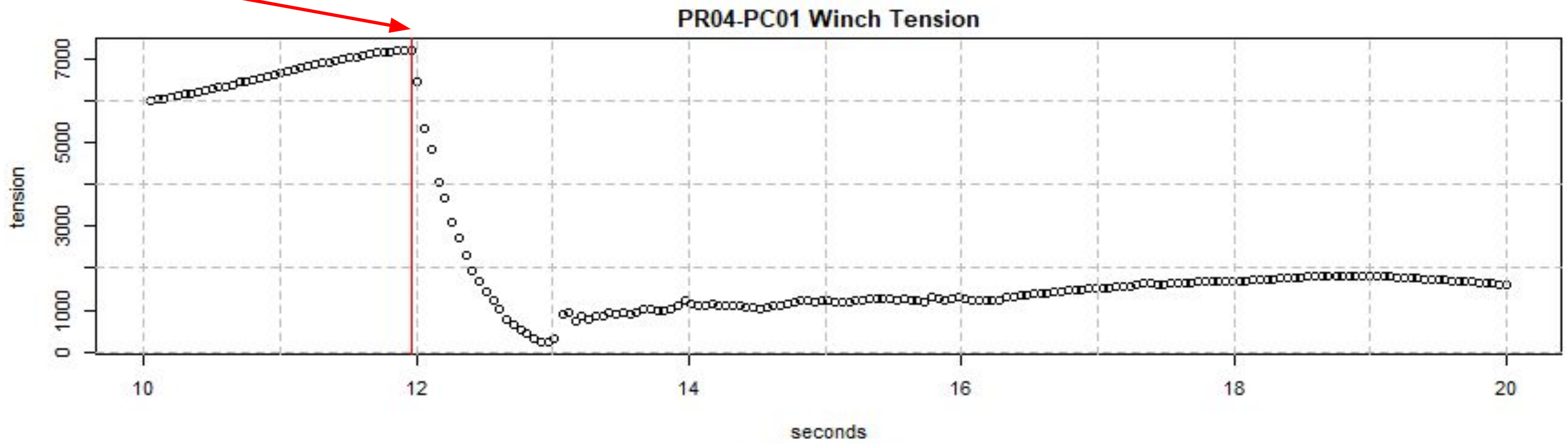
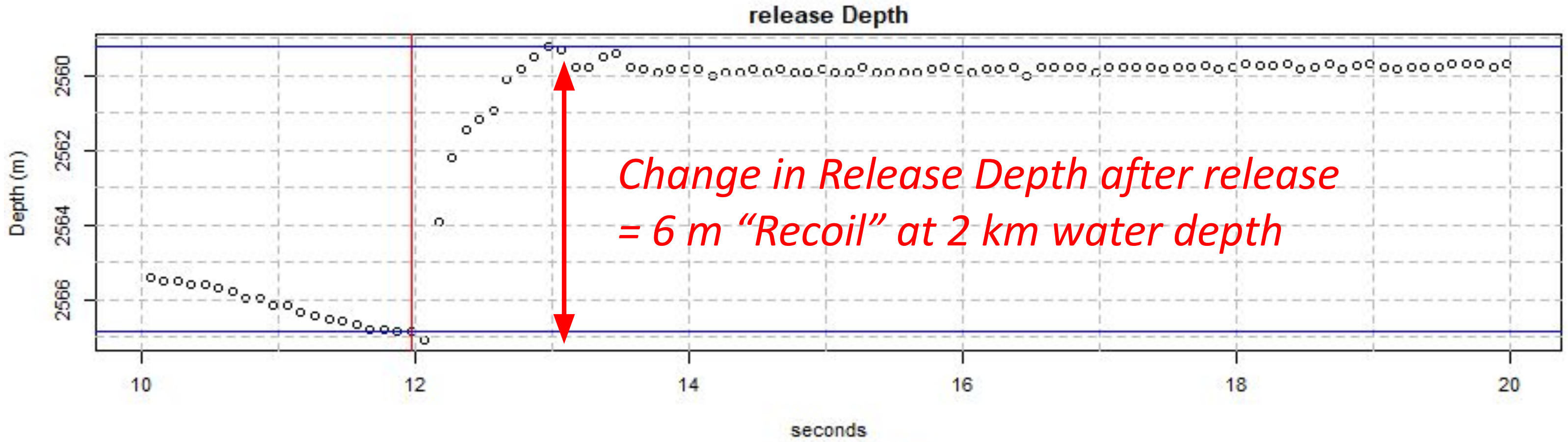
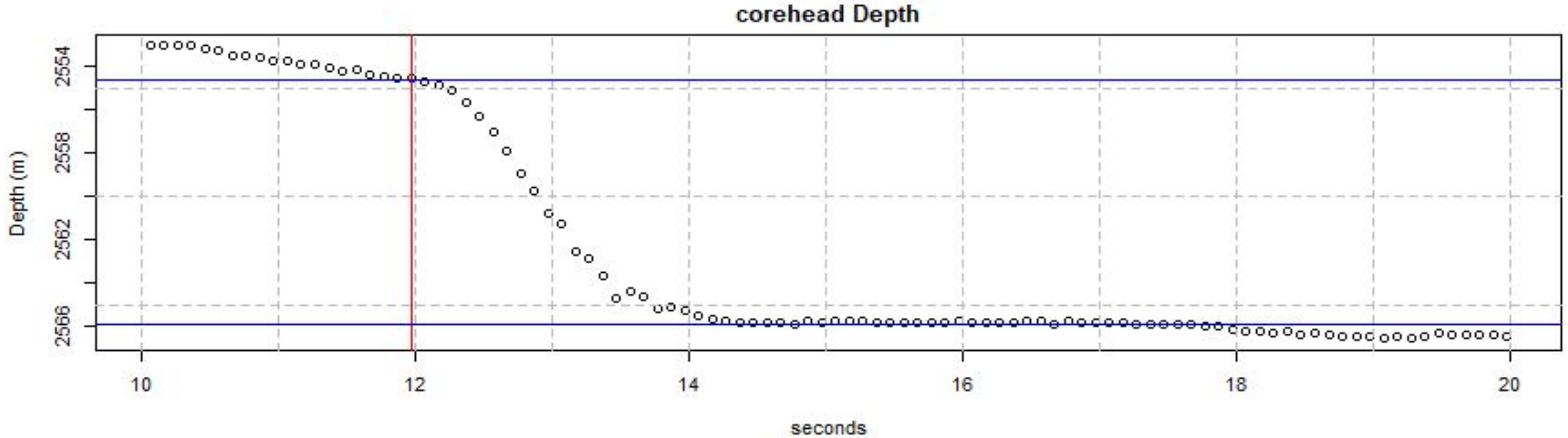
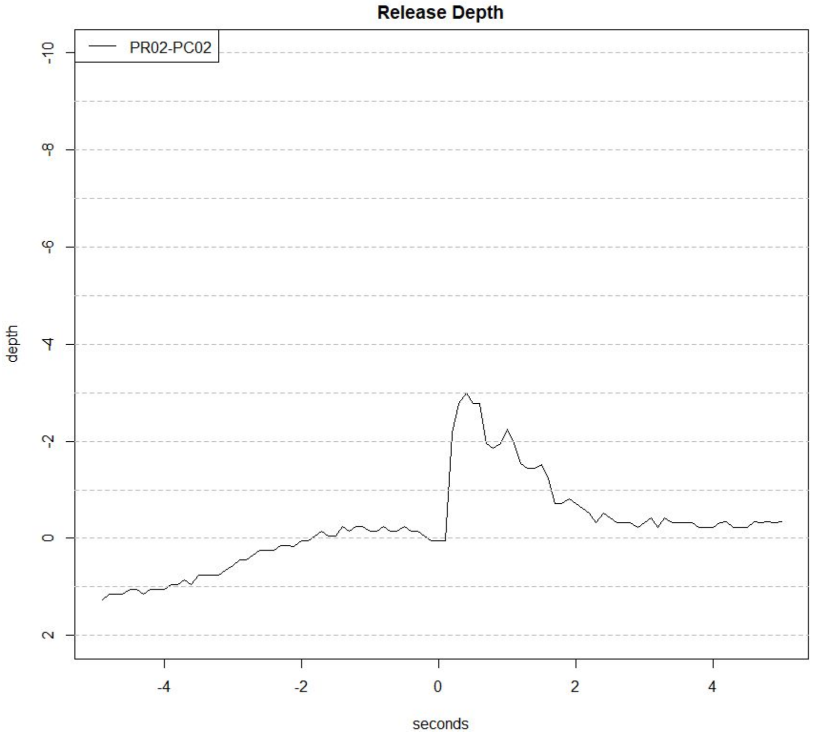


Release Depth:

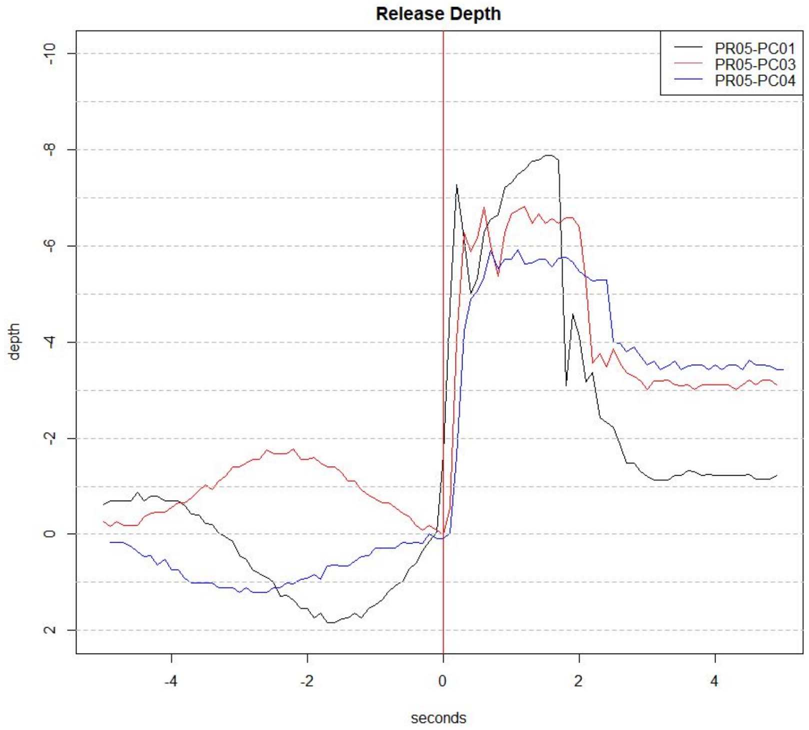


Corehead Depth:

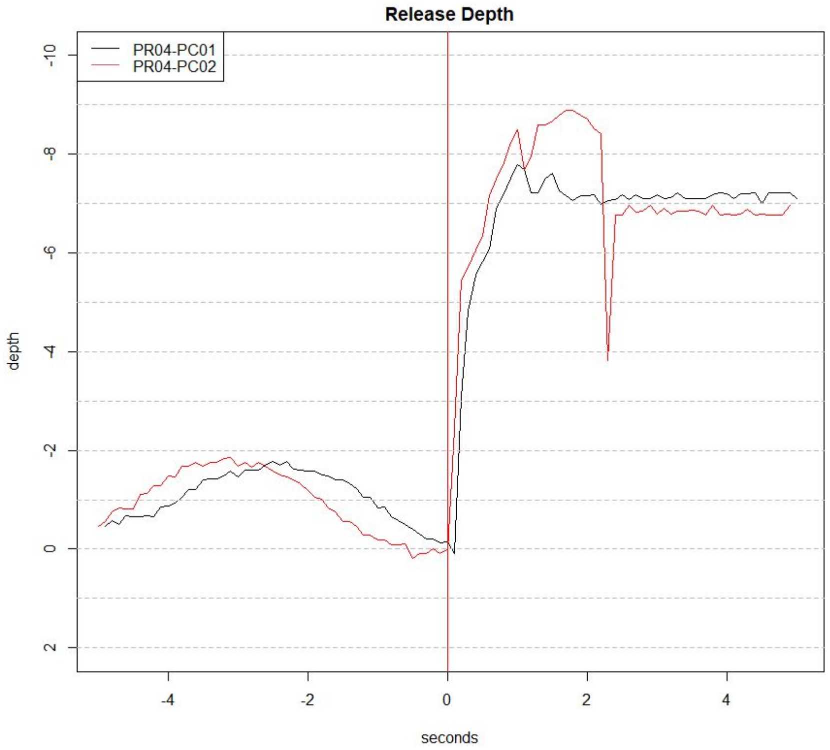




~3 m at 500m depth



~5 – 8 m at 1900m depth



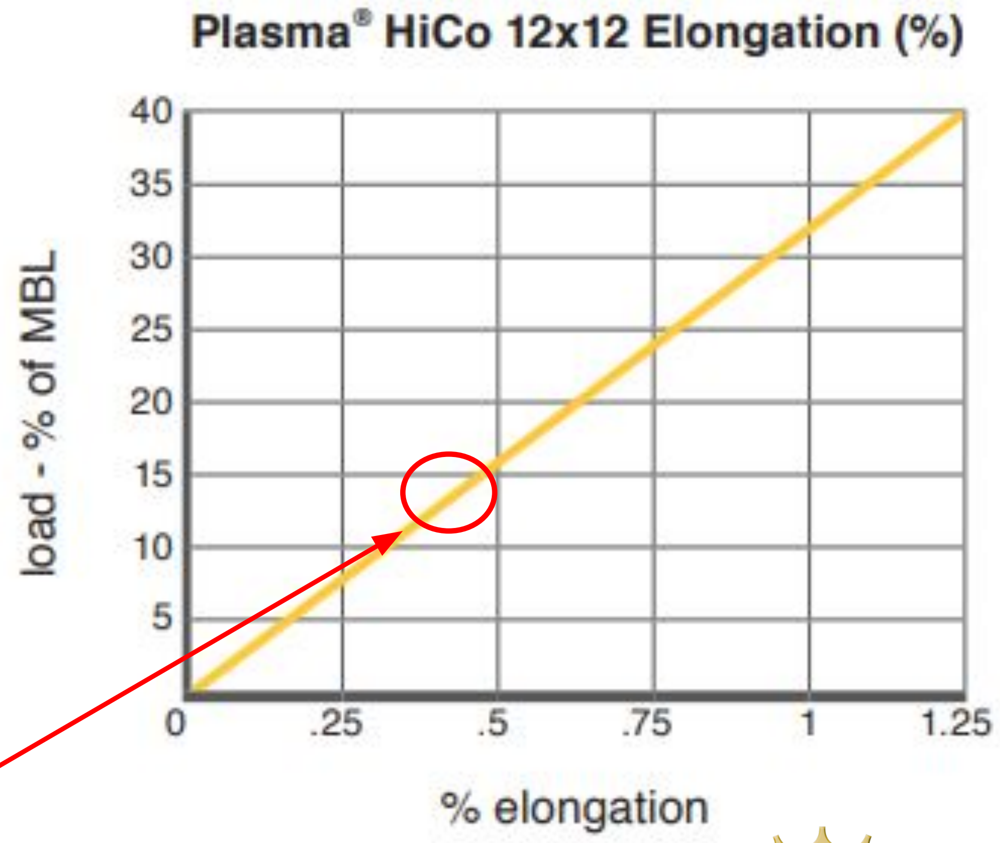
~7- 9 m at 2600m depth

Core	Depth	rebound distance	% elongation
PR02-PC02	492	3.04	0.62%
PR05-PC01	1900	7.89	0.42%
PR05-PC03	1900	6.73	0.35%
PR05-PC04	1900	5.92	0.31%
PR04-PC01	2600	7.64	0.29%
PR04-PC02	2600	8.93	0.34%

Elongation and therefore recoil is a function of the load/line strength:

The recoil distances we measured closely track values for elongation predicted by manufacturer:

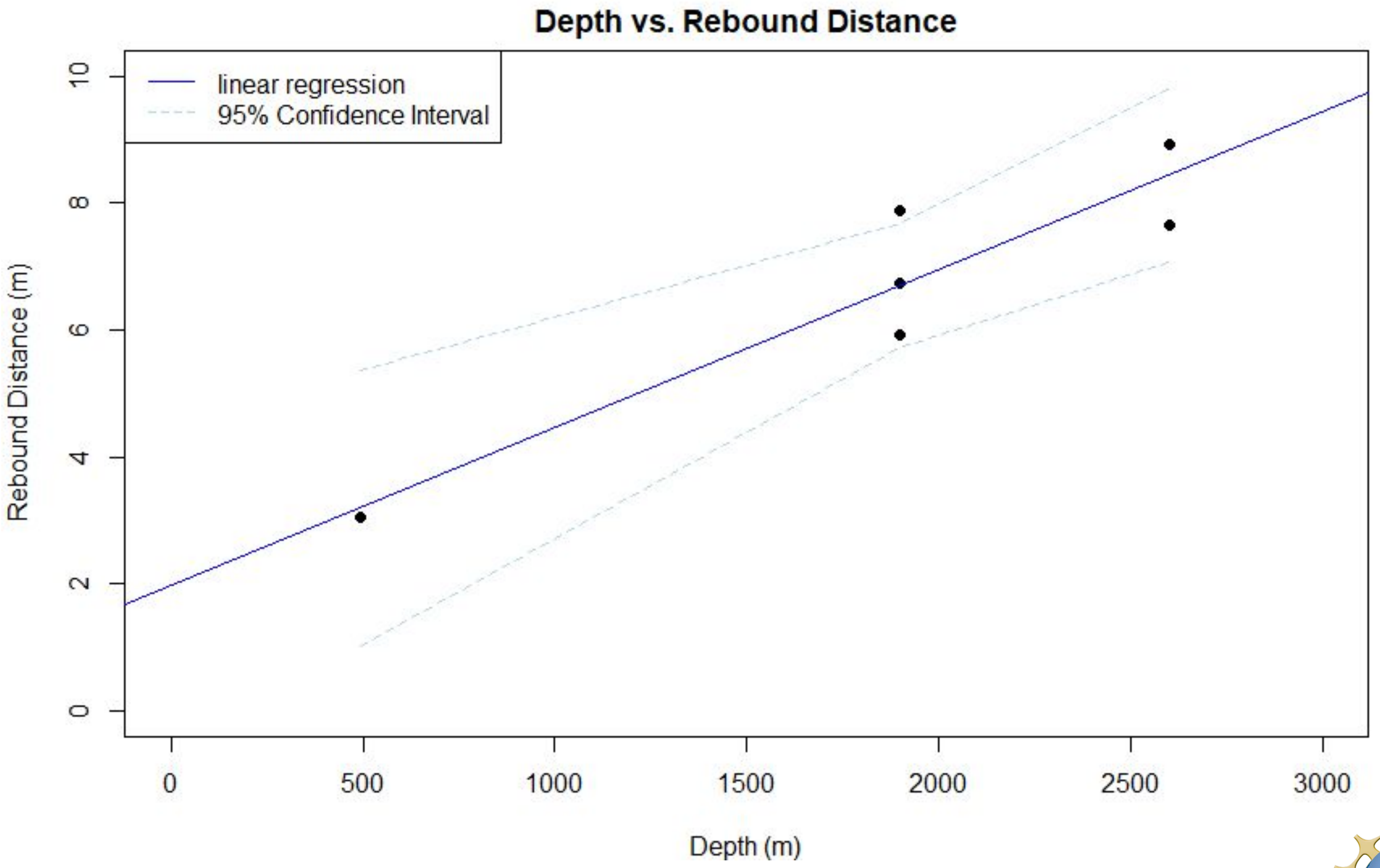
Core	Depth	recoil	% elongation
PR02-PC02	492	3.04	0.62%
PR05-PC01	1900	7.89	0.42%
PR05-PC03	1900	6.73	0.35%
PR05-PC04	1900	5.92	0.31%
PR04-PC01	2600	7.64	0.29%
PR04-PC02	2600	8.93	0.34%
		Average	0.40%



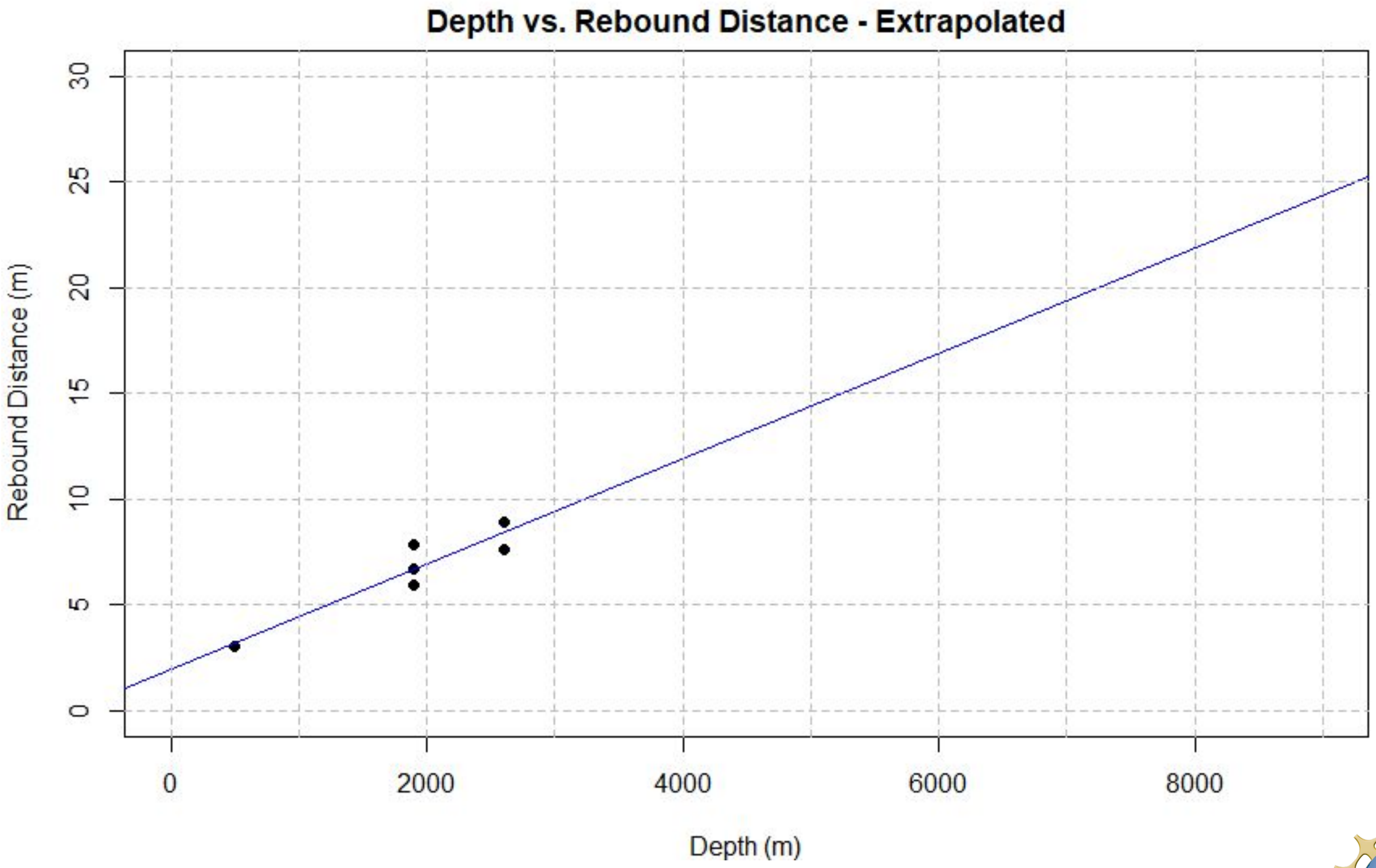
~6500 lbs (weight of corer)/42000 lbs (MBL of 9/16” HiCo) = ~15%

So should *expect* ~.4% Elongation

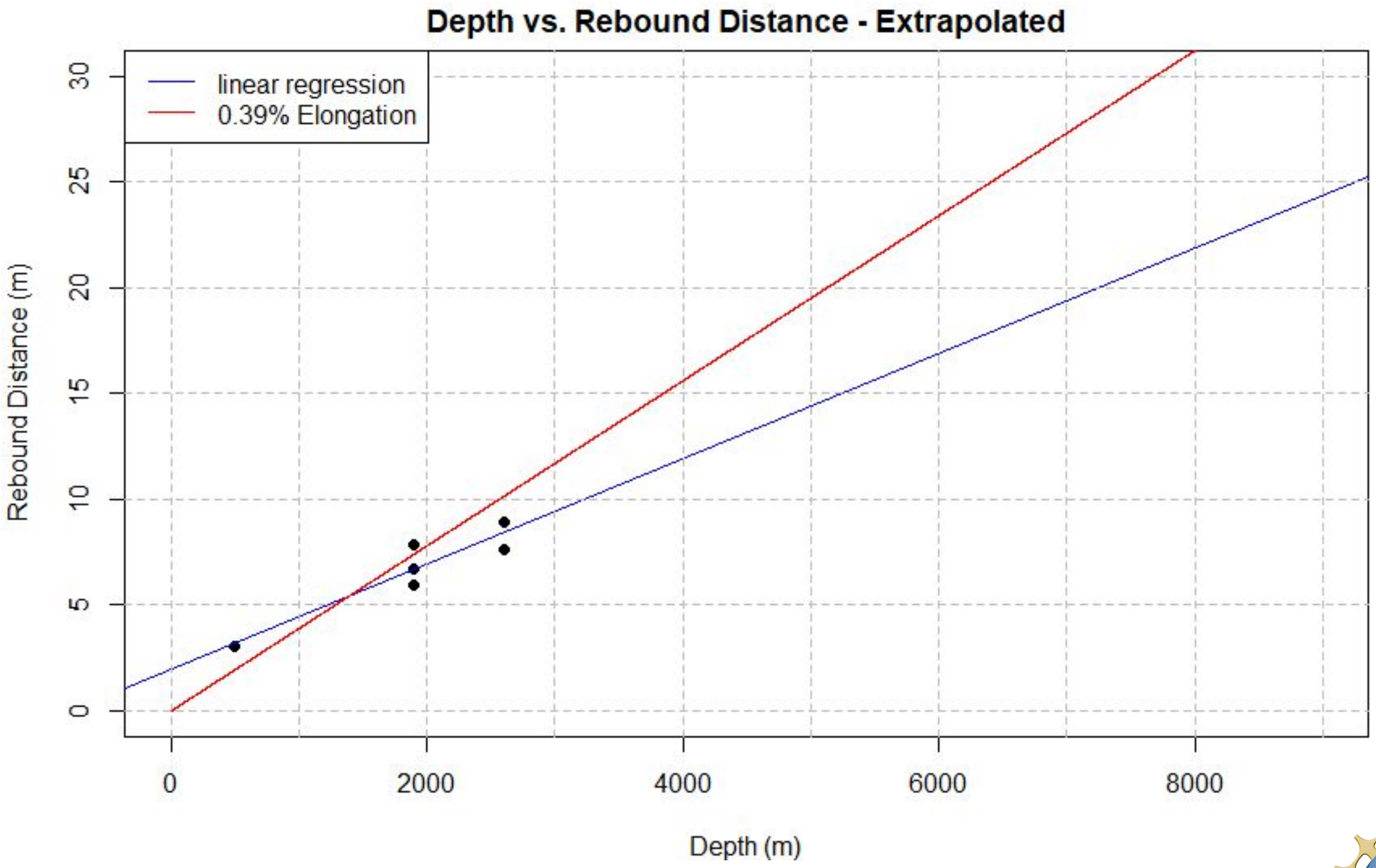
Limitations of sensors mean we only have observations for water depths <3 km – but those observations illustrate a trend:



Extrapolating out to 8 km water depth, might expect 20+ m of recoil (!)



Our trend is actually somewhat less than what would be expected from the manufacturer's tables…could be up to 30 m recoil (!!) at 8 km water depth



Implications of core quality for science:

AR64-02 PR05 PC03: 1901 m

AR64-02 PR06 PC03: 5359 m

AR64-02 PR07 PC01: 8360 m

Sediments in AR64-02 cores pretty homogenous w/re grain size – looking at deformation of redox fronts (i.e. color changes in core) to assess impacts. But sometimes deformation is worse than it looks…

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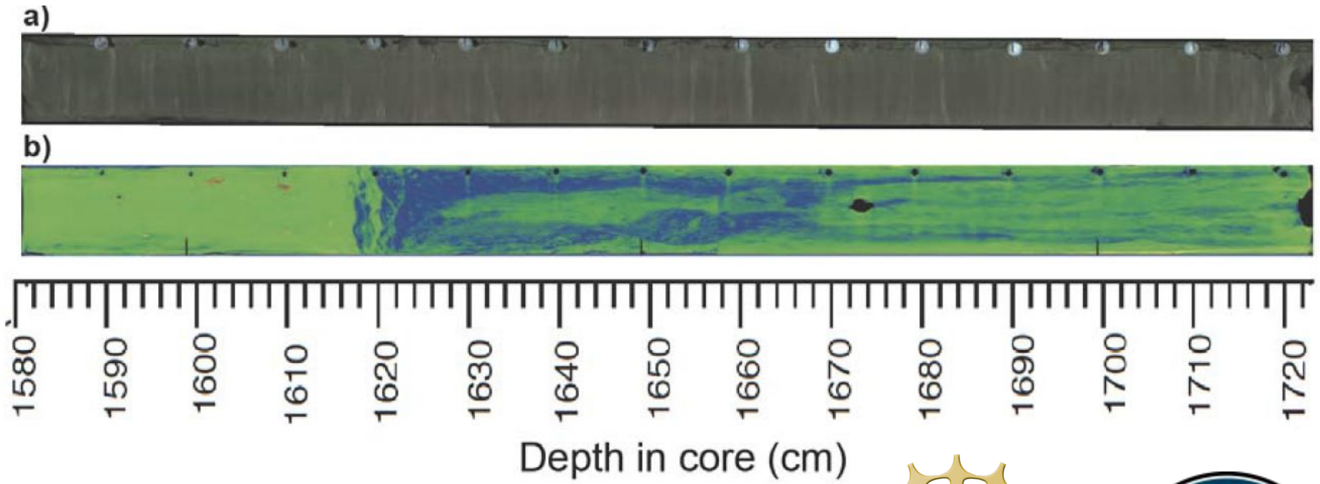

Greater water depth = More line out – More recoil – Greater deformation
We can compensate for <3 km of line out with scope – more than that and we're looking at a mess.

Conclusions:

- Synthetic is a great way to avoid issues of wire weight!
- Magic for multicoring
- Now using synthetic compatible with existing UNOLS handling systems, almost universally designed for 9/16" trawl wire - *have to be mindful of stretch and that for bottom sampling and heavy mooring deployment we're still working with similar breaking strengths*
- **Most of our international peers use synthetic now - but larger diameter (28 mm/1")**
  - Reduced elasticity
  - Stronger so working at appropriate FOS