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RBR Webinar Series

RBR*quartz*³ BPR|zero: a “zero” drift bottom pressure recorder

Pressure gauges

Piezo-resistive
- Economical
- Moderate accuracy
- Moderate resolution

Quartz resonators
- Not economical
- High accuracy
- Resolution a function of integration time

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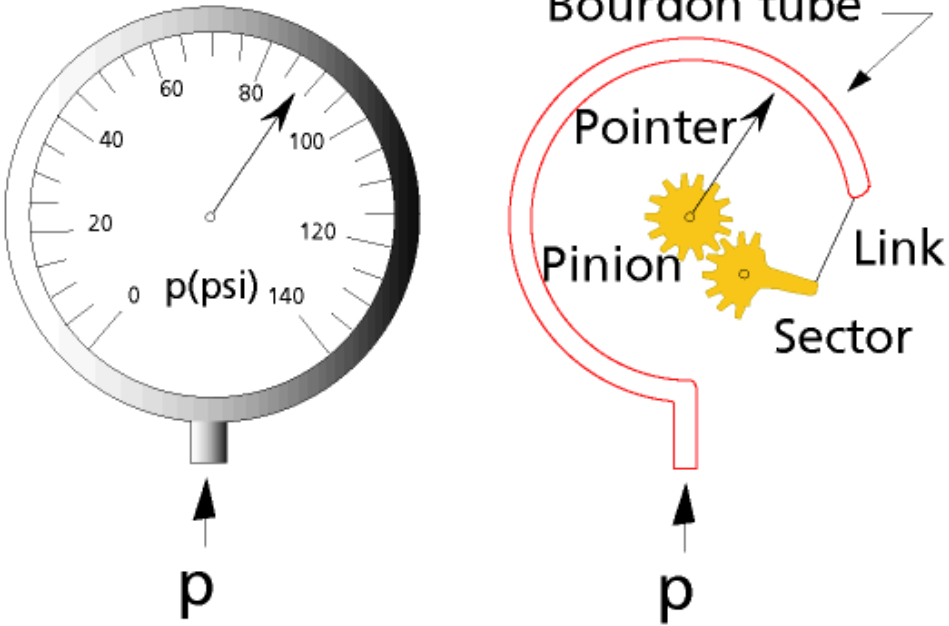
Bourdon tube – accurate high pressure measurements



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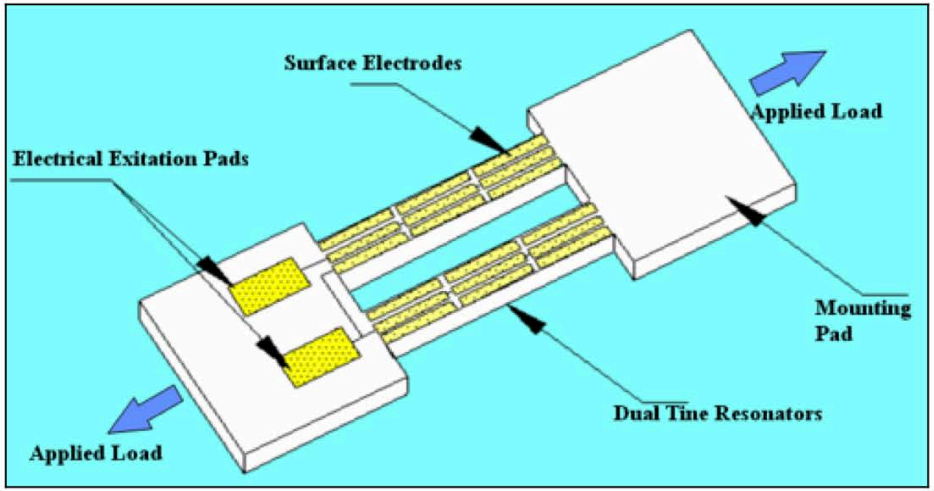

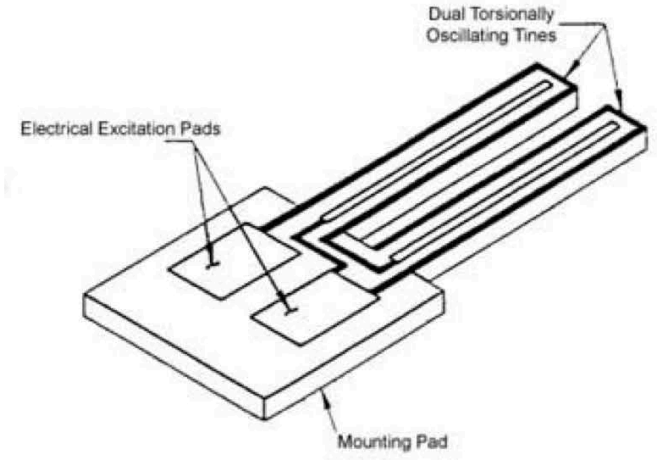

Force-Sensing Quartz Crystal

Temperature-Sensing Quartz Crystal

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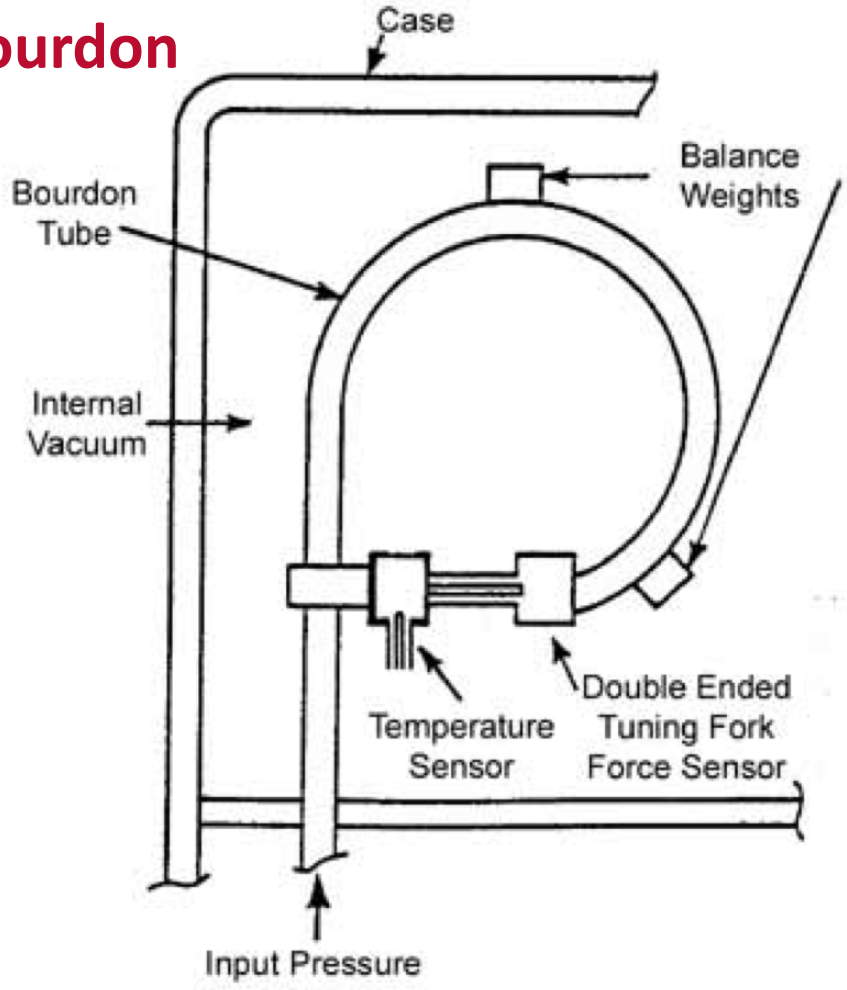
Paros quartz-bourdon



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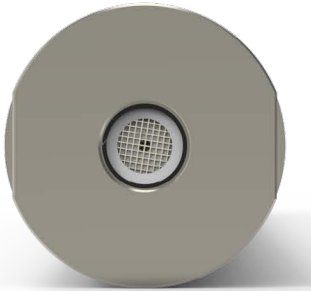
RBR*quartz*^{3} BPR

Pressure and temperature frequency counter
10ppb resolution (1s sampling period)

0.01%FS accuracy
Ratings up to 7000dbar
Ø60 x 540mm



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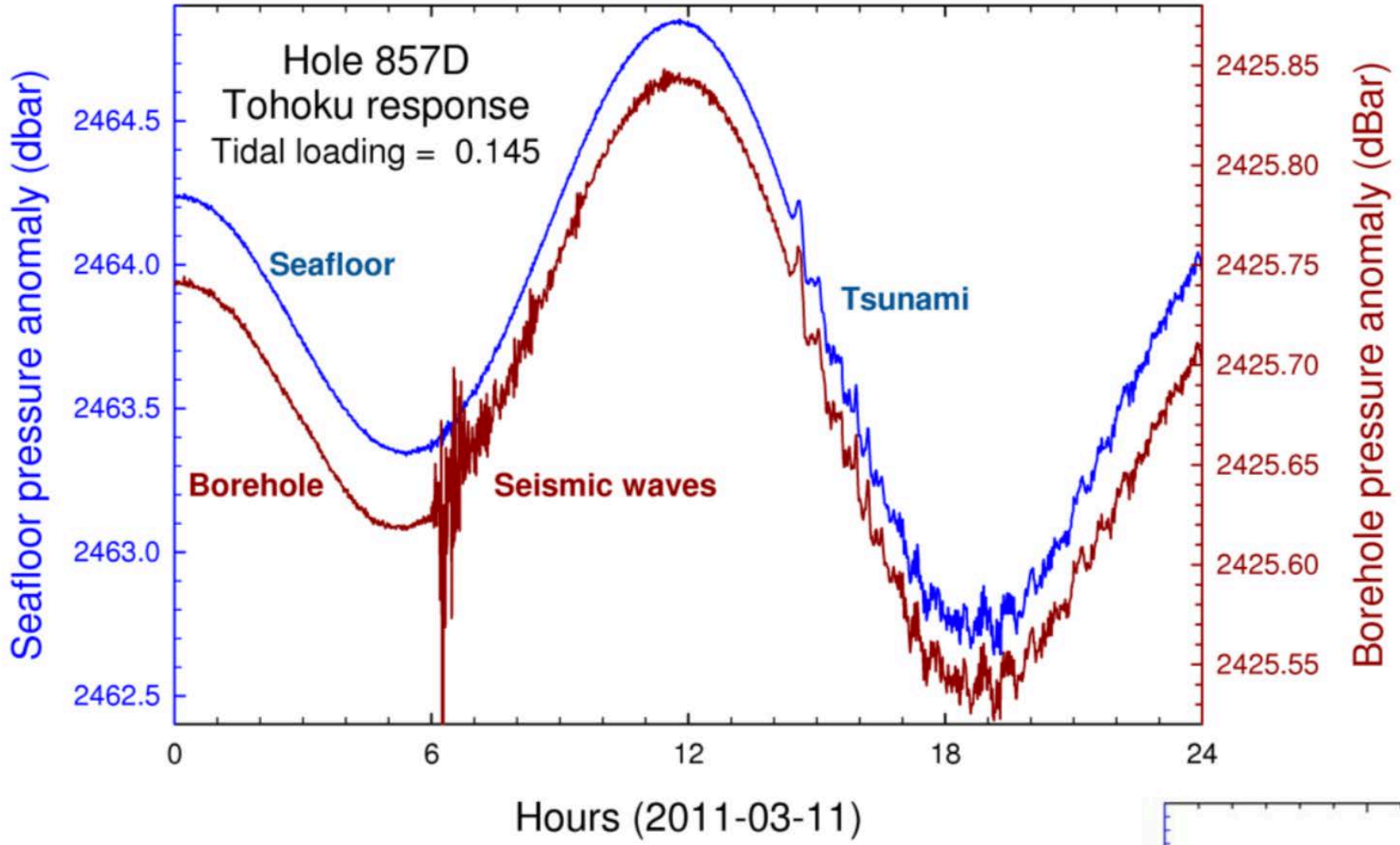
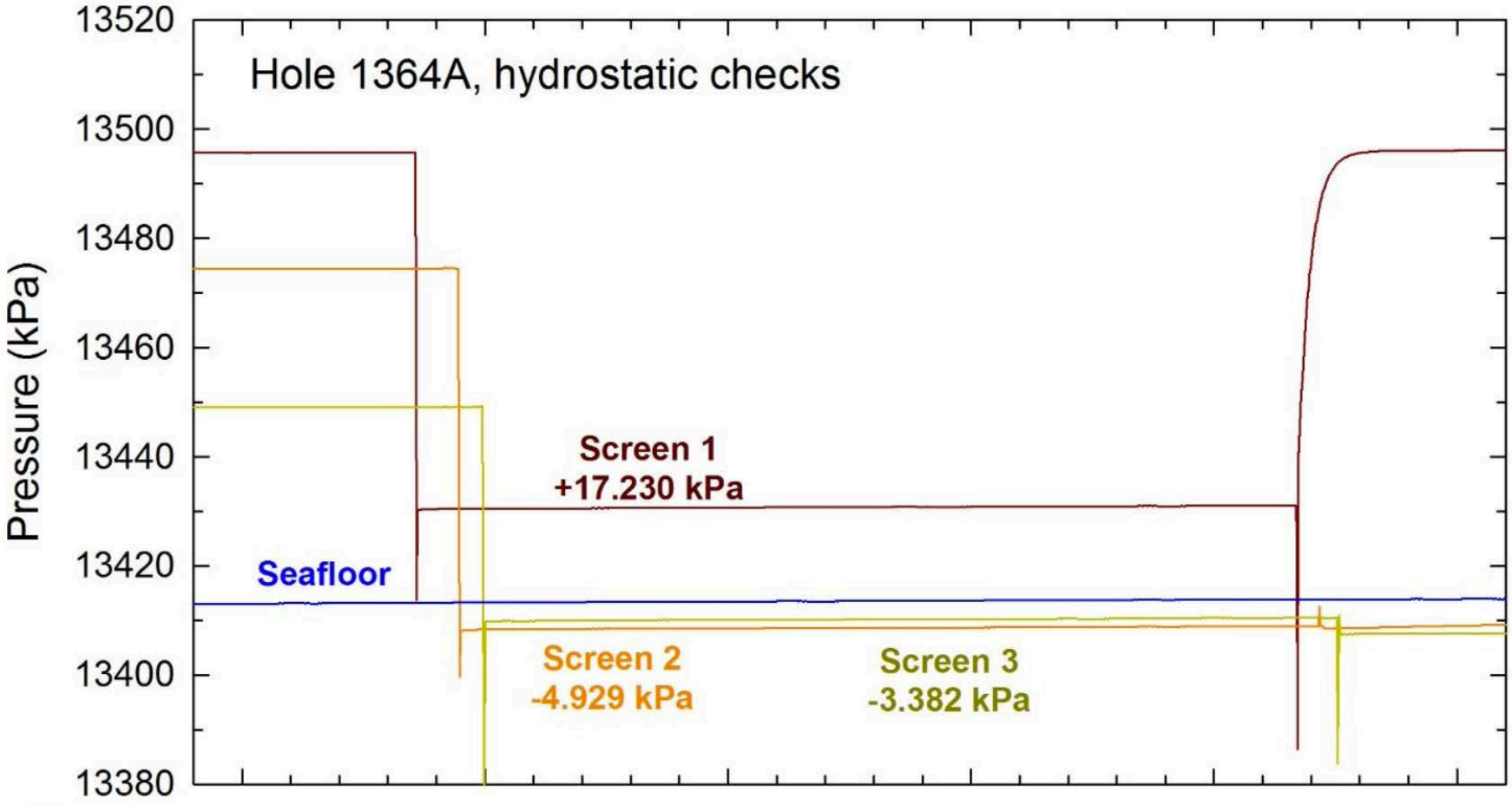
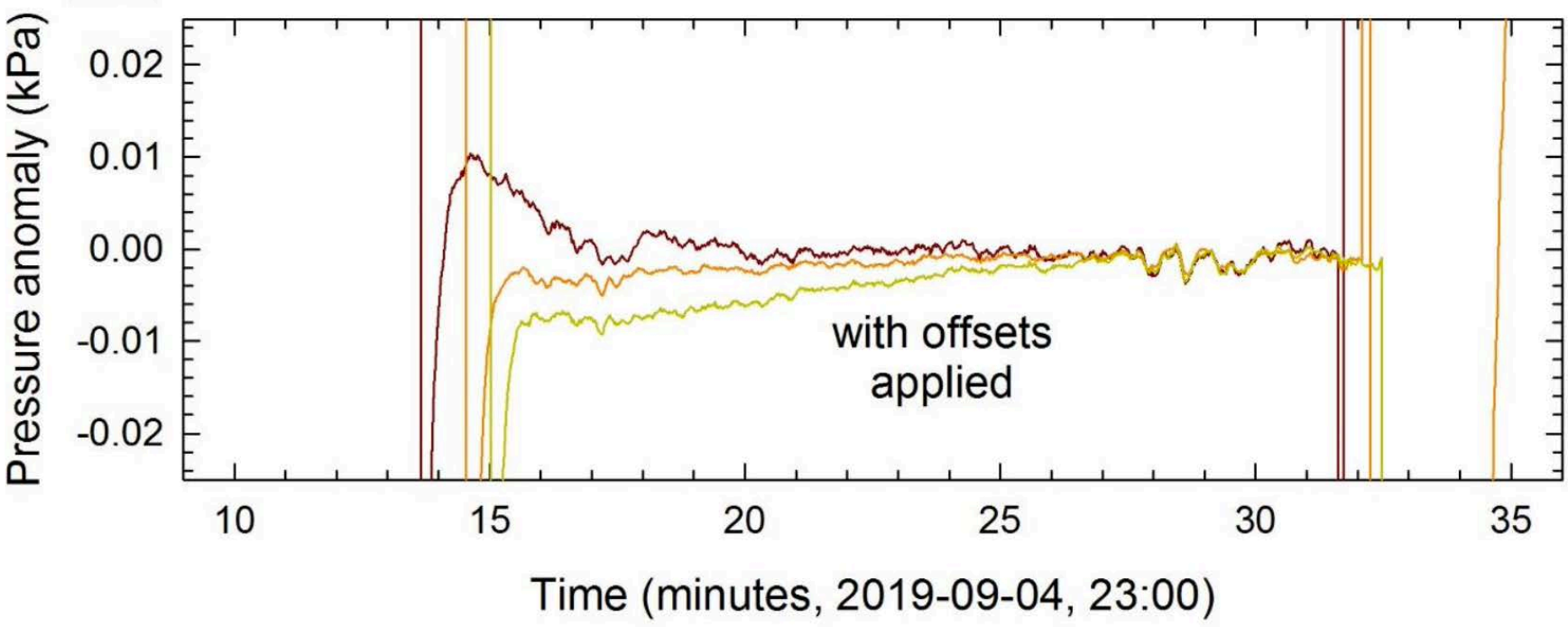

Hole 857D
Tohoku response
Tidal loading = 0.145
Seafloor
Tsunami
Borehole
Seismic waves
Seafloor pressure anomaly (dbar)
Borehole pressure anomaly (dBar)
Hours (2011-03-11)
2464.5
2464.0
2463.5
2463.0
2462.5
2425.85
2425.80
2425.75
2425.70
2425.65
2425.60
2425.55
0
6
12
18
24


Hole 1364A, hydrostatic checks
Pressure (kPa)
13520
13500
13480
13460
13440
13420
13400
13380
Screen 1
+17.230 kPa
Seafloor
Screen 2
-4.929 kPa
Screen 3
-3.382 kPa


Pressure anomaly (kPa)
0.02
0.01
0.00
-0.01
-0.02
10
15
20
25
30
35
Time (minutes, 2019-09-04, 23:00)
with offsets
applied

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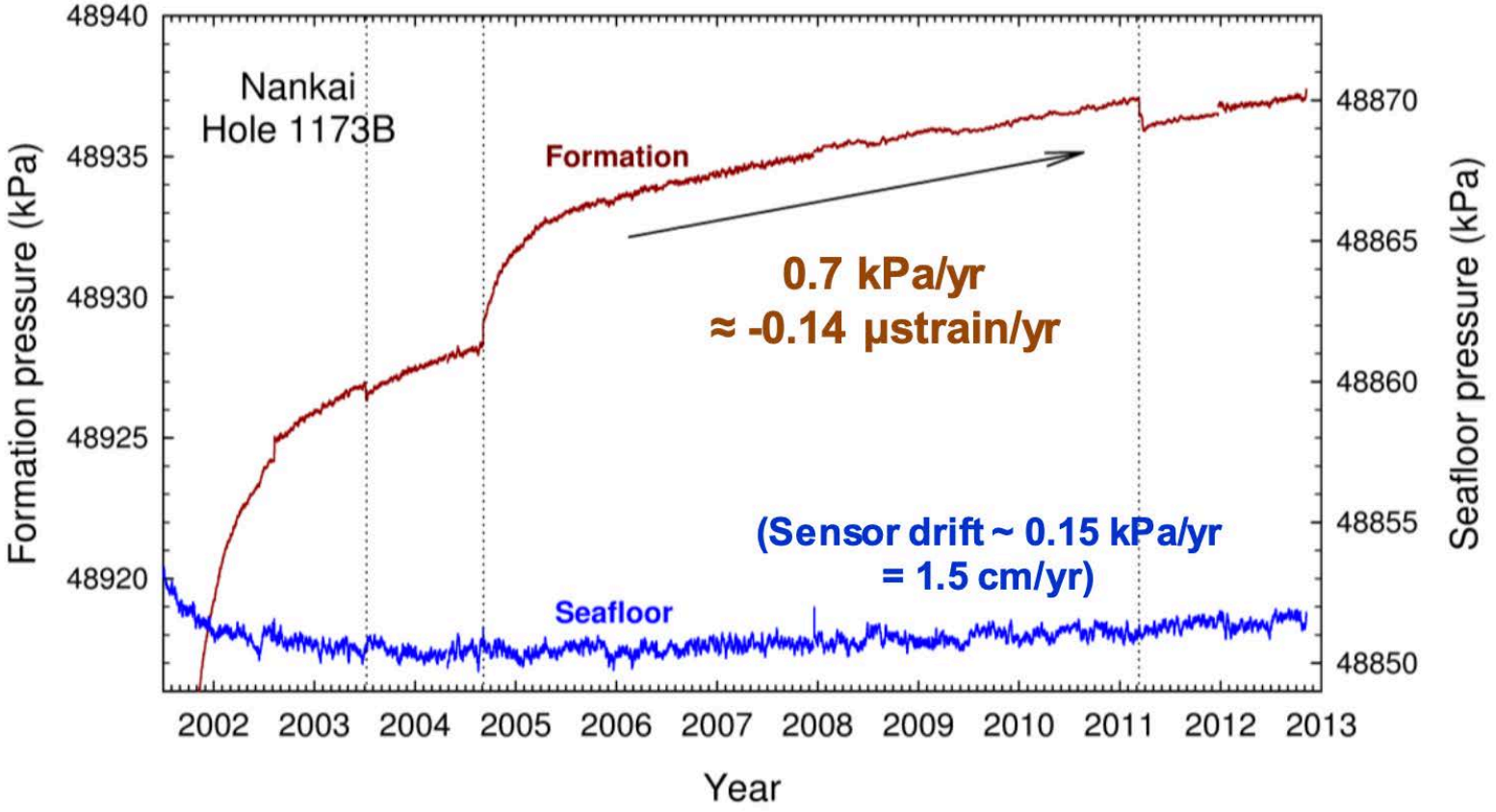
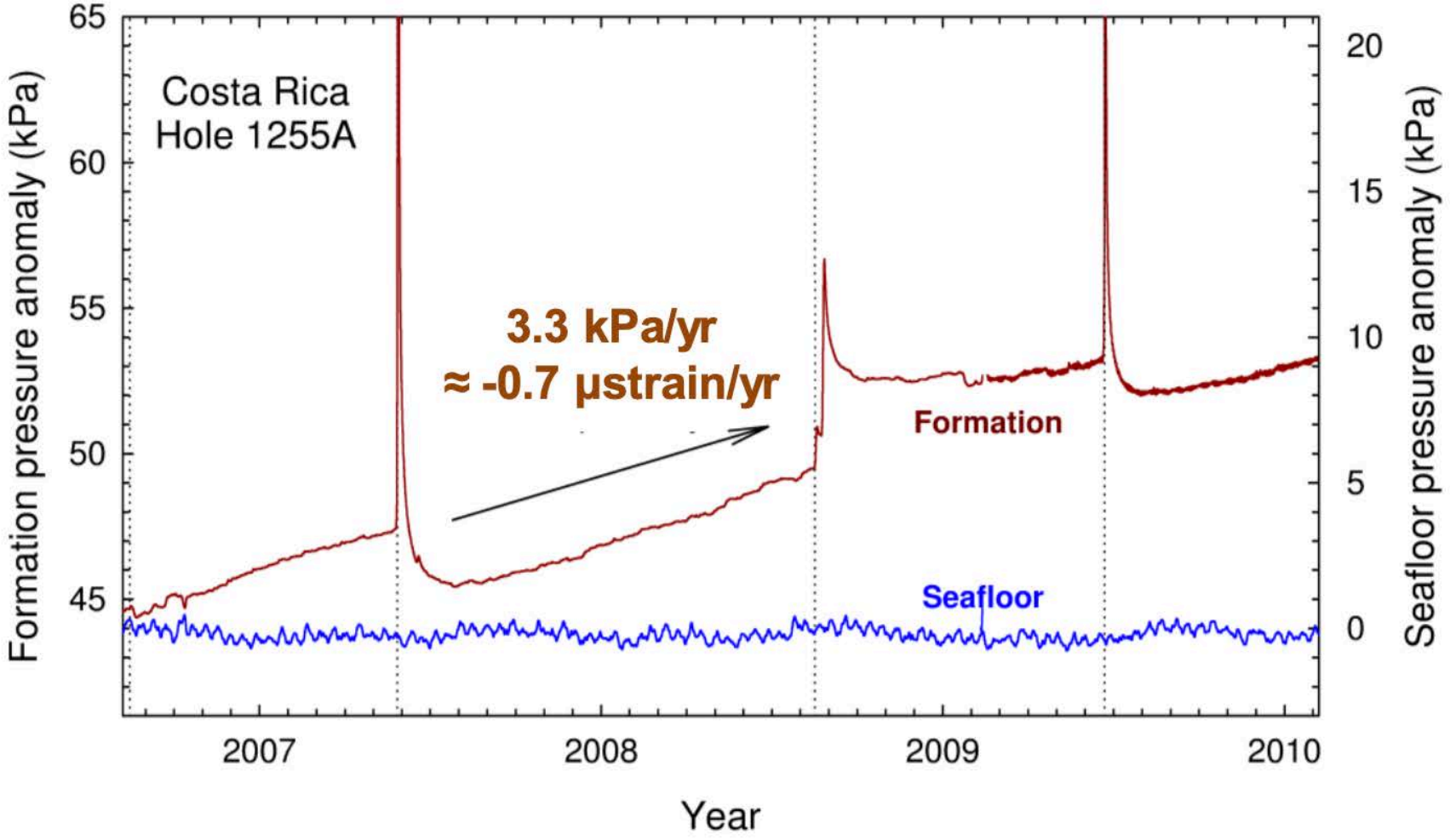
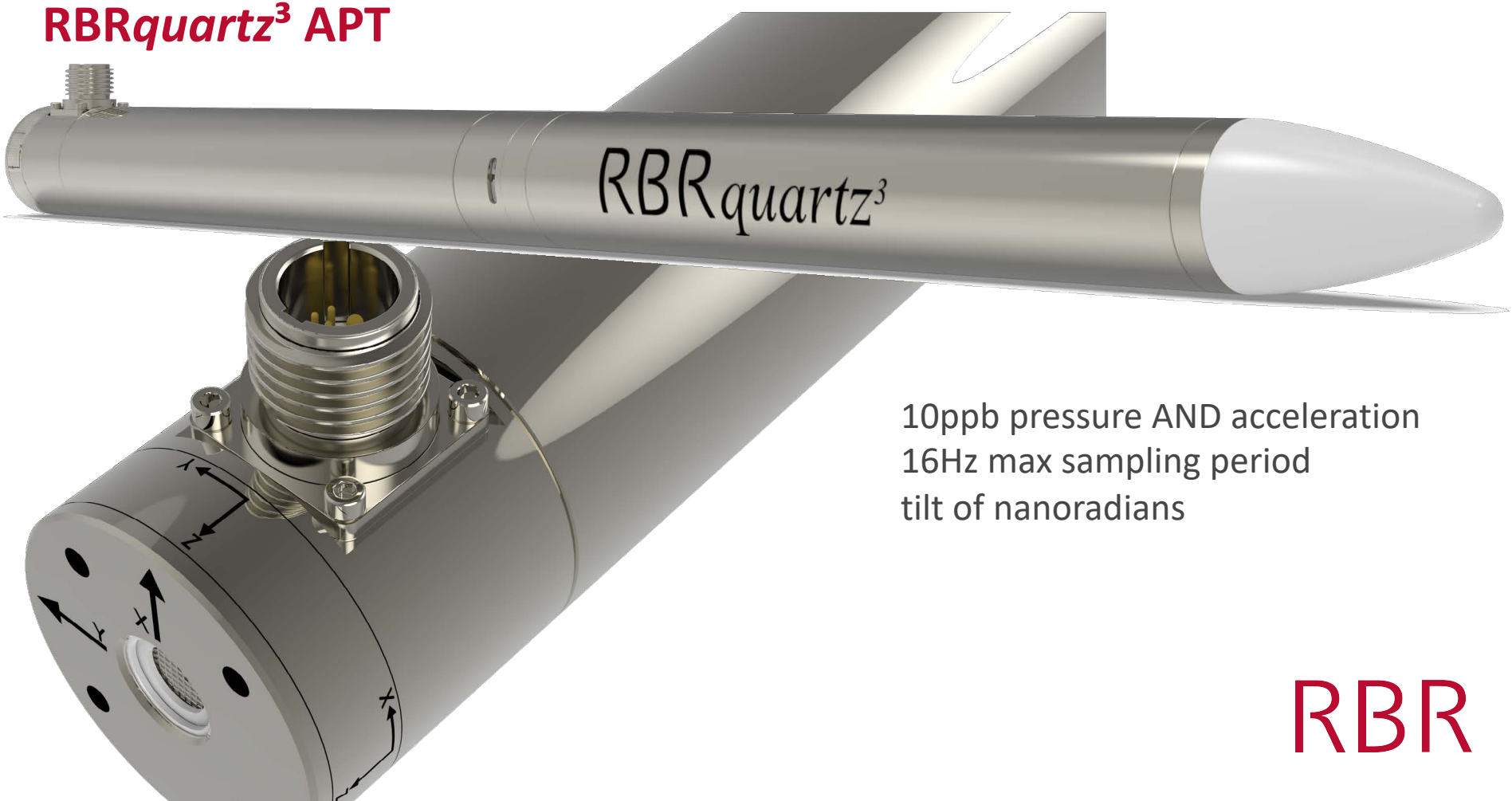
Secular strain accumulation and discrete slip events observable in hydrologically isolated formations




Costa Rica
Hole 1255A
3.3 kPa/yr
≈ -0.7 µstrain/yr
Formation
Seafloor
Formation pressure anomaly (kPa)
Seafloor pressure anomaly (kPa)
Year
65
60
55
50
45
20
15
10
5
0
2007
2008
2009
2010

RBR*quartz*³ APT



10ppb pressure AND acceleration
16Hz max sampling period
tilt of nanoradians

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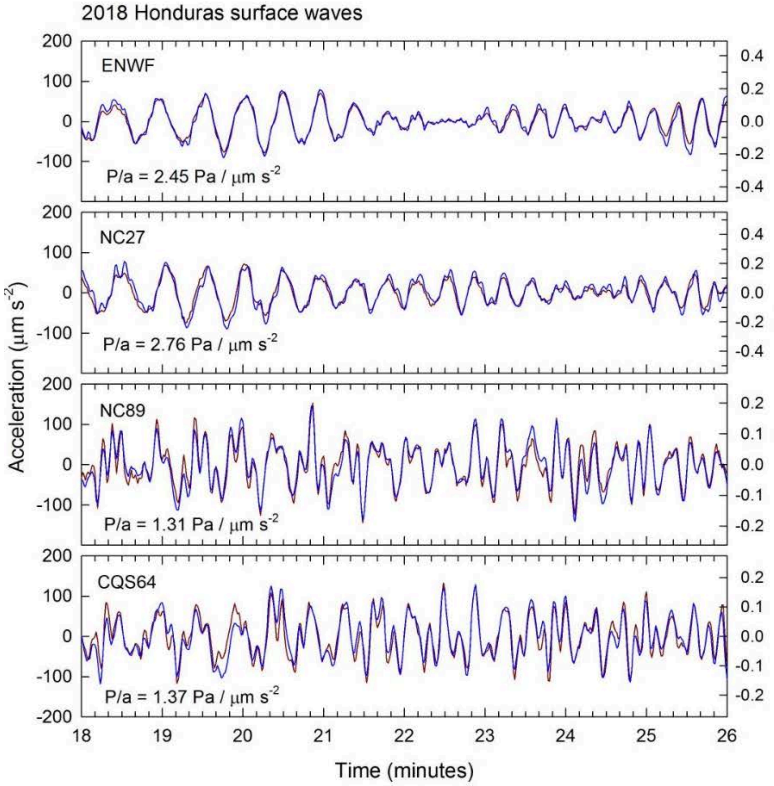
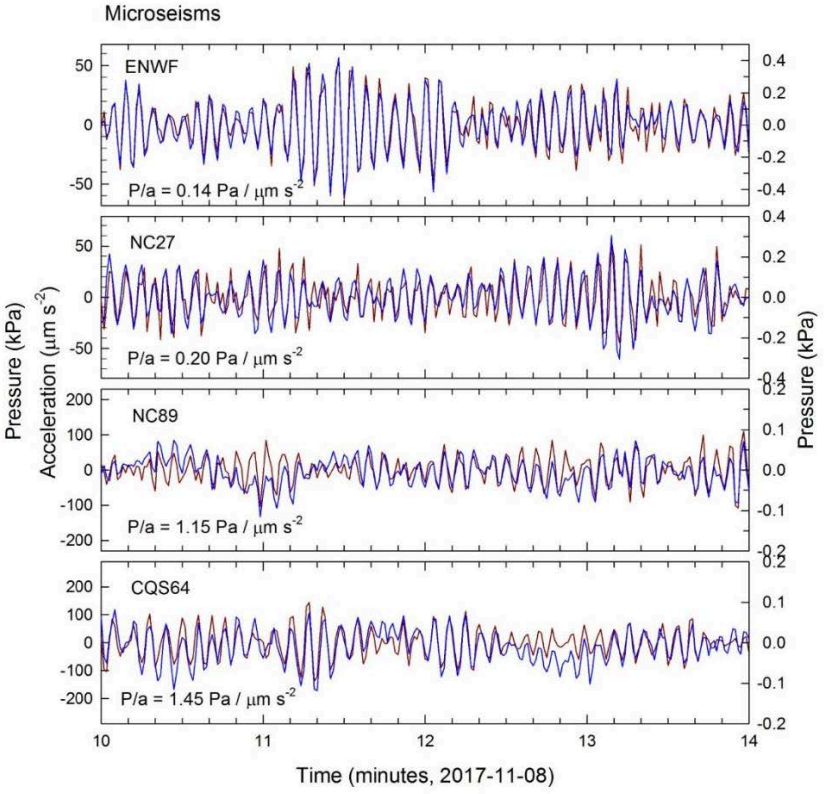
Relationships between pressure and ground motion

Seismic waves:
Pressure driven by acceleration



Microseisms (at their source):
Acceleration driven by pressure



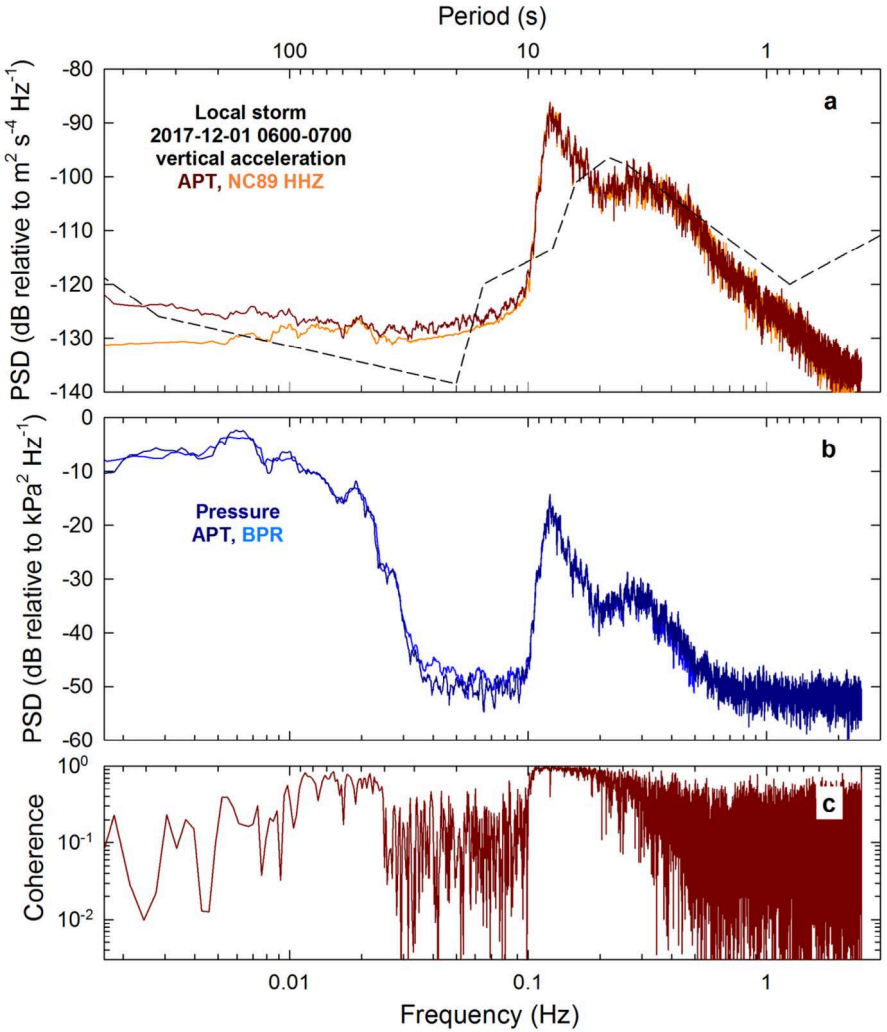

Period (s)
100
10
1
Local storm
2017-12-01 0600-0700
vertical acceleration
APT, NC89 HHZ
a
PSD (dB relative to m^2 s^{-4} Hz^{-1})
-80
-90
-100
-110
-120
-130
-140
b
Pressure
APT, BPR
PSD (dB relative to kPa^2 Hz^{-1})
0
-10
-20
-30
-40
-50
-60
c
Coherence
10^0
10^{-1}
10^{-2}
0.01
0.1
1
Frequency (Hz)

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Figure 7 | Comparison of spectra of acceleration (a) and pressure variations (b) calculated for a 1-hour segment of data spanning the records shown in Figure 6. Upper and lower background spectra of Peterson (1993) are shown as dashed lines. Correlation between APT acceleration and pressure seen in Figure 5 is confirmed by coherence between acceleration and pressure near unity within microseismic and infragravity bands (c).

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How to correct drift?

- Looking for signals in sea level rise OR geodesy of mm/year
- BUT drift is cm/year

- Drift is pure offset
- Reference measurement can be made at any pressure

- Earl Davis made seafloor comparisons (~10-100dbar delta) for relative alignment
- Glenn Sasagawa put a dead weight tester on the bottom (~0dbar delta)

- A-0-A – use “zero” as the reference. Atmospheric pressure inside the instrument.
- Quartz drift is a function of full scale – so use a barometer (full scale = 11dbar)

- Need to switch thousands of dbar from marine to ‘atmospheric’ reference

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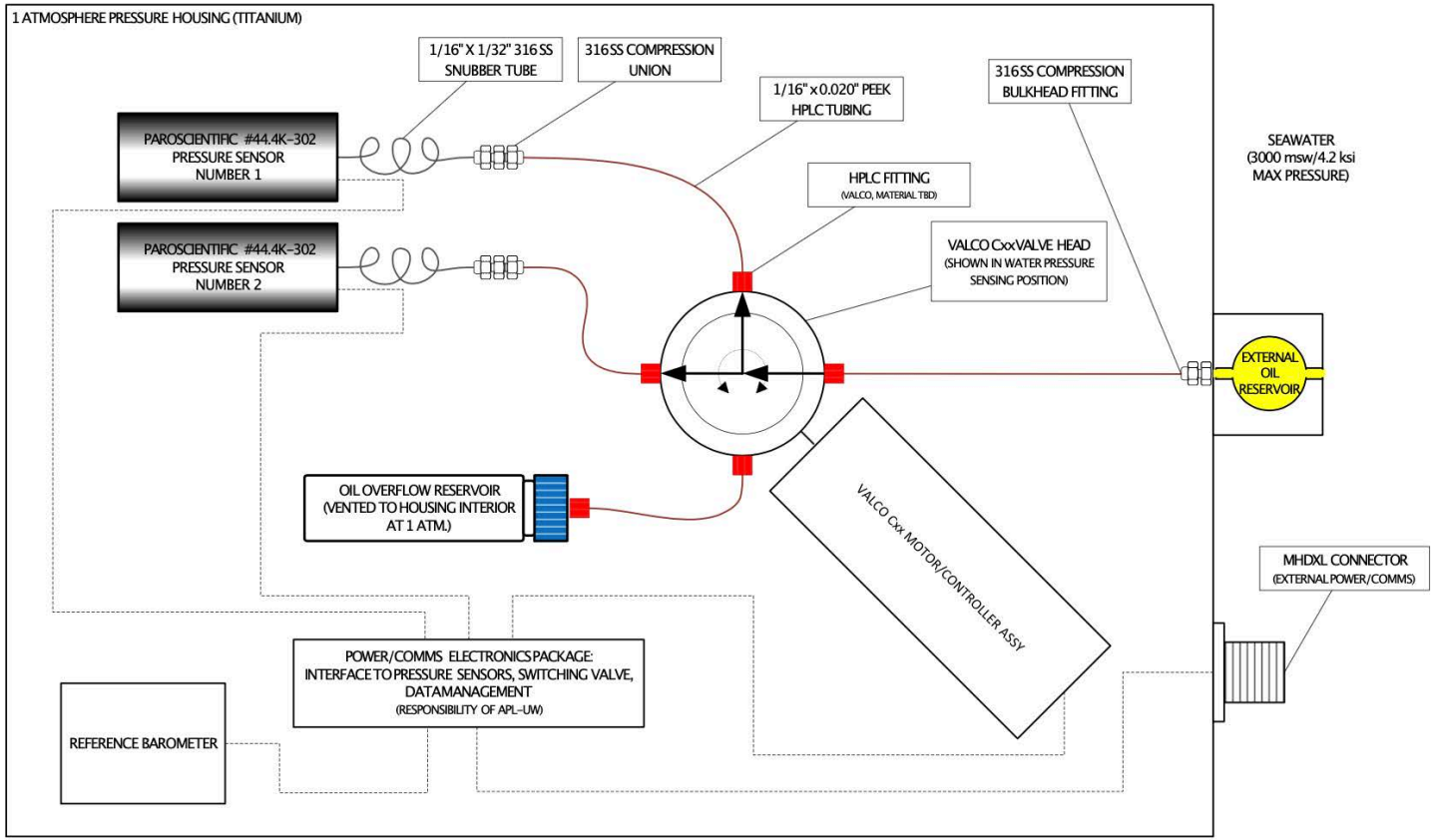

Schematic diagram of the A-0-A instrument deployed at Axial Seamount on the OOI Cabled Array.

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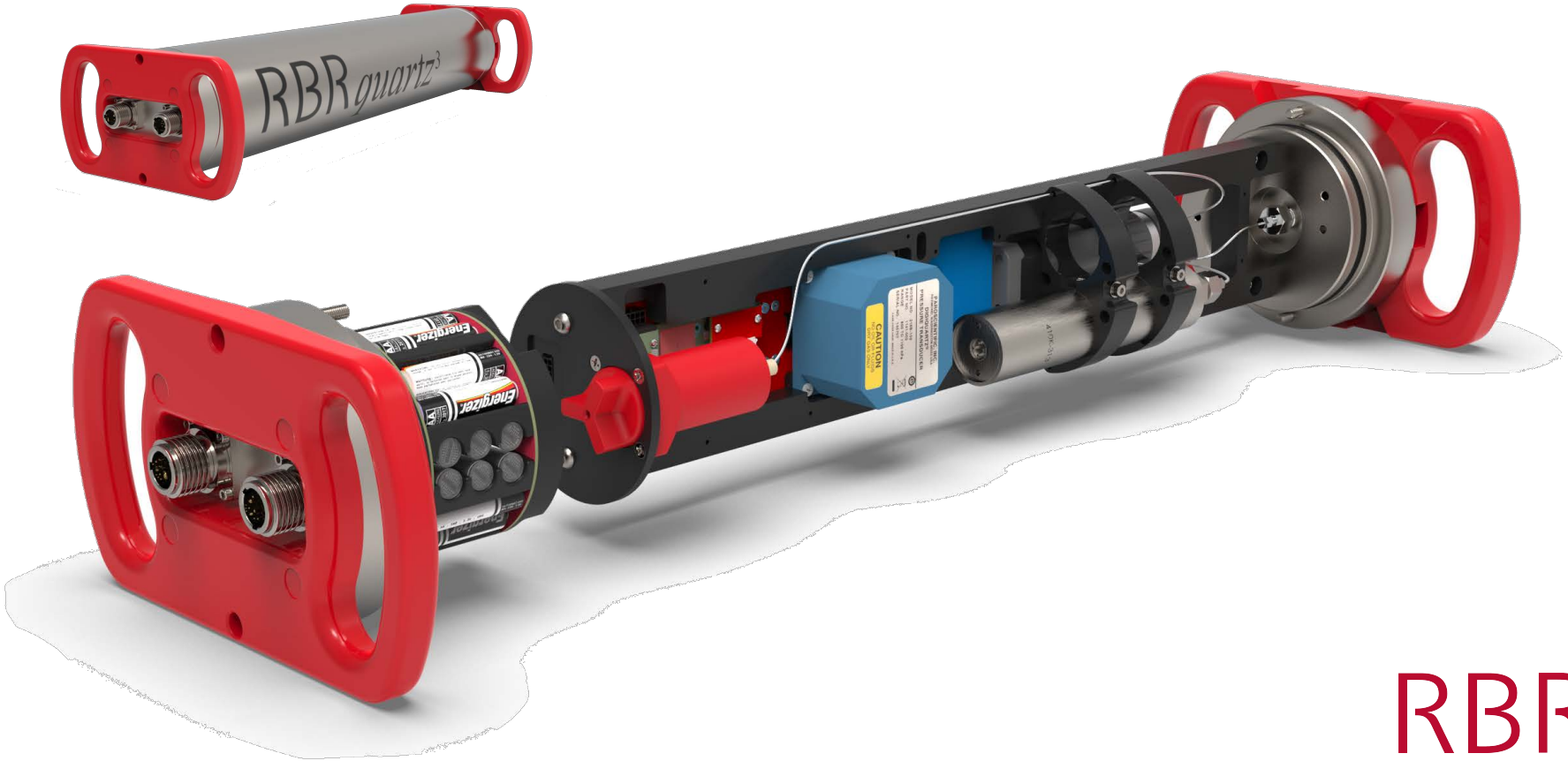

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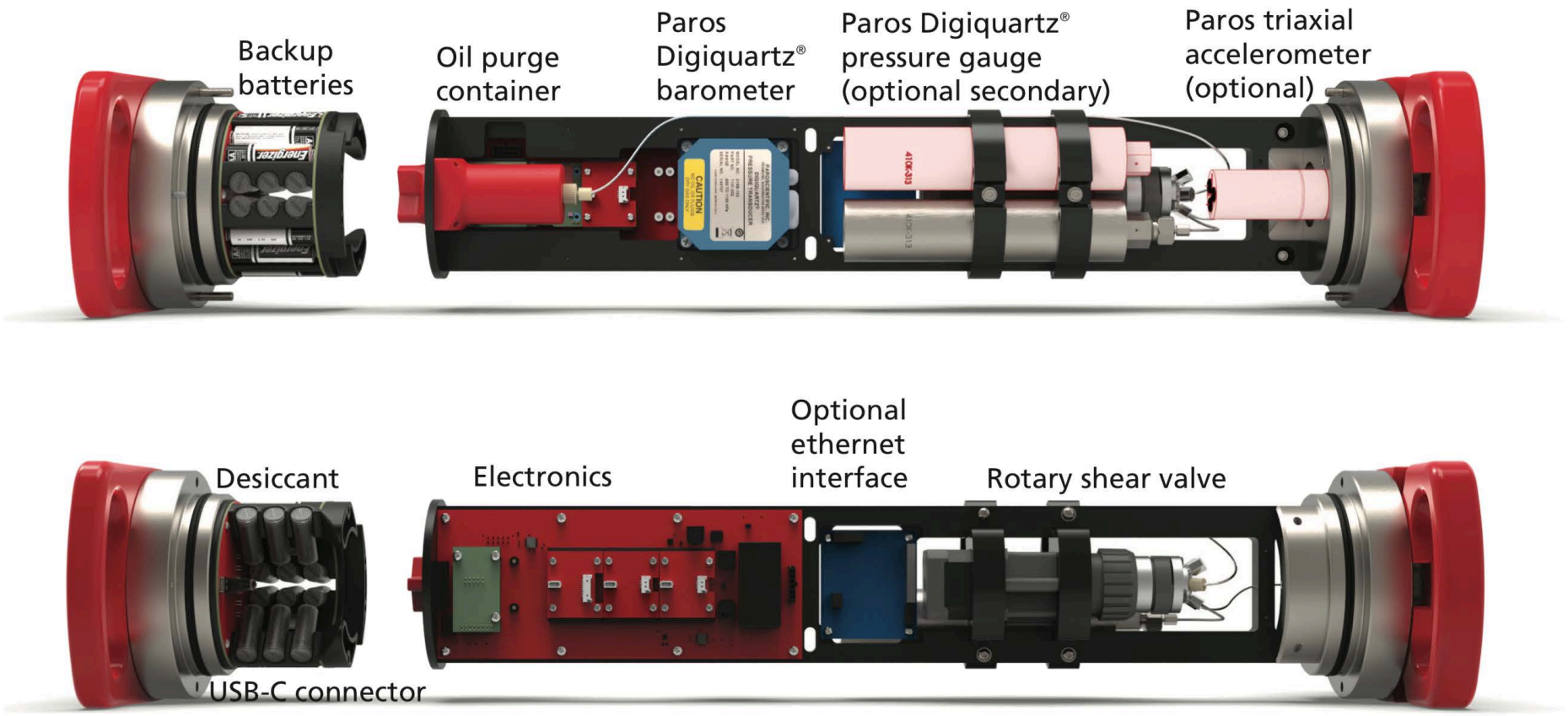
Explore the RBR*quartz*³ BPR|zero



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- Medium size instrument – ø140 x 700mm
- Titanium housing
- Pressure ranges to max of 7000m
- 10ppb resolution – 10µm in 1km water

- RBRfermata – pure power
- RBRcervata – power and storage
- ROV example of ‘sneakernet’

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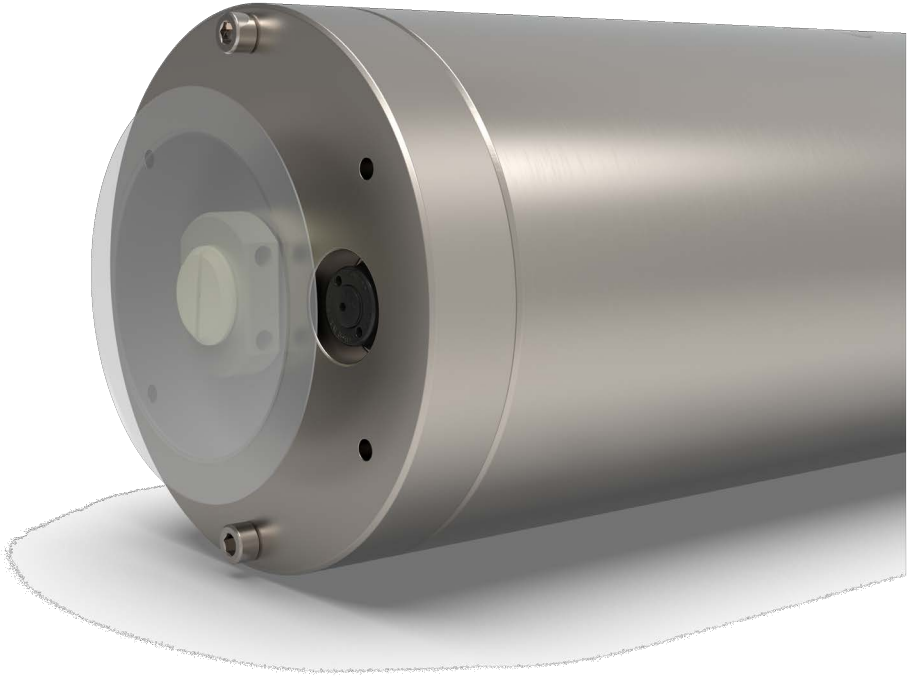

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All the RBR standards

- USB-C internal connection
- RS-232
- RS-485
- Ethernet

- Observatory connector options (MINK)

- External power packs (RBR*fermata*)
- External power and download packs (RBR*cervata*)

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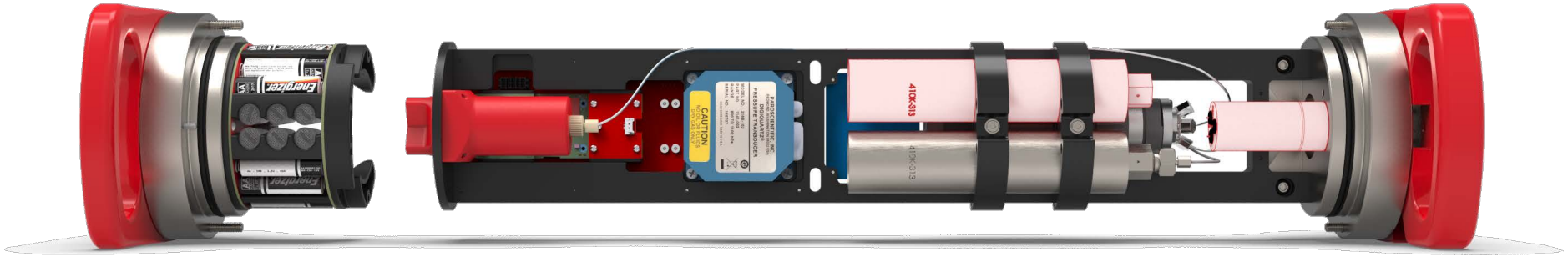
Many thanks to…



- Earl Davis, Bob Meldrum, Martin Heeseman, Joe Farrugia, John Dorocicz, John Bennest
- William Wilcock, Dana Manalang, Geoff Cram, Mike Harrington
- Jerry Paros, Paul Miglacio
- RBR BPR Team

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Thank You

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