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*date:* May 19, 2017

*to:* WIPP Records Center

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*subject:* WIPP Milestone Report: 2016 Culebra Groundwater Level Fluctuations

The Sandia National Laboratories (SNL) long-term, high-frequency monitoring program collects pressure transducer data in Culebra, Magenta, Bell Canyon, and shallow subsurface wells across the Waste Isolation Pilot Plant (WIPP) facility. The transducers, which are generally installed at mid-formation depths, record water pressure at 15-minute intervals. The objective of this memo is to present and summarize pressure transducer data collected in Culebra wells for calendar year (CY) 2016.

In CY2016, SNL recorded pressure data across 38 Culebra wells. For the purposes of this memo, these pressure data are shifted and are reported in equivalent feet of fresh $H_2O$ (1 psi = 2.309 feet $H_2O$). Relative pressure transducer data for select wells are grouped by hydrologic response and geographic location (i.e., Figures 1-3). Plots of pressure transducer data for each monitoring location spanning CY2014 to the end of CY2016 are included as an appendix at the end of this memo. Table A-1 provides a brief description to highlight the most dominant effect observed in each transducer record.

Pressure fluctuations for several wells include shifts (e.g., H-3b2, H-5b, IMC-461, SNL-06, SNL-15, SNL-16, WIPP-13, and WIPP-19) or spikes (e.g., H-16, SNL-08, and SNL-10). These fluctuations are due to an adjustment to the transducer depth, the displacement of water during removal and replacement of the transducer, transducer failure, or the operation of other equipment (e.g., video loggers) in the well. Fluctuations of this type are not discussed in depth in this memo.

The primary event which has impacted Culebra pressures is the pumping of a well at Mills Ranch, located southwest of the land withdrawal boundary. Figure 1 shows the pressures observed in wells at the south end of the WIPP land withdrawal boundary and further south, which are most strongly affected by pumping at the Mills Ranch well. Figure 1 shows water levels back to the summer of 2013, before pumping began at Mills Ranch (September 11, 2013), to put the drawdown and partial recovery observed in these wells into perspective. The effects that pumping has had on these wells can be split into three intervals of time:

1) September 2013 to June 2014,
2) June 2014 to April 2015, and
3) April 2015 to January 2017.

Periods when drawdown at SNL-17 and H-4bR indicated Mills Ranch well was likely pumping are shaded in Figure 1. The three periods indicated are shaded using different colors. Based solely on the responses of wells SNL-17 and H-4bR, the pumping rate at the Mills Ranch well appears to be higher in time intervals 1 and 3 (blue and orange shaded areas in Figure 1), compared to pumping in interval 2 (green shaded area). During interval 2, the water levels in observation wells were recovering, even during periods of pumping. During intervals 1 and 3, water levels are generally declining during long periods of pumping. SNL-17 is the first to respond to changes in pumping at the Mills Ranch well, but despite its proximity to the pumping well, it exhibits less drawdown than other wells further from the pumping well.

In the center of the Land Withdrawal Boundary, multiple wells (i.e., C-2737, ERDA-9, H-2b2, H-3b2, H-15R, H-16, H-19b0, and WIPP-19) also respond to pumping at Mills ranch in a more "muted" fashion. Drawdown of several feet, consistent in timing and expected magnitude with pumping at the Mills Ranch well, is readily observable as far north as WIPP-19. Even though SNL-13 is located close to the Mills Ranch pumping well it responds like wells near the center of the WIPP Land Withdrawal Boundary.

Several wells in the vicinity of Nash Draw area show responses to significant rain events in Nash Draw. Figure 3 shows the range of responses to rain events in September 2014, October 2015, and August 2016. The wells show a range of response amplitudes and delays. Some wells respond promptly and with significant amplitude (SNL-16, IMC-461, SNL-19 and SNL-02), while others have muted responses with less amplitude (SNL-01, SNL-03, and WIPP-11). The precipitation events in 2014 and 2016 resulted in similar magnitude responses (with 2014 a bit larger than 2016), while the rainfall event in 2015 had a much smaller and less prompt impact on these wells. The rise associated with precipitation event in 2014 also appears to be due to multiple storms on successive days, while the storm in 2016 looks more like one event.

Figure 4 shows the recovery of the same wells shown in Figure 1, plotted on log-log scale showing time since recovery began (November 29, 2015 14:00) and change in water level. This is typical of the type of plot used to analyze aquifer pumping tests. The recovery in SNL-17 has notably different slope from the other wells. The characteristic slope (log time vs recovery) in SNL-17 is approximately one-third. A slope of ½ is indicative of "linear" flow in an infinite conductivity fracture, while a slope of ¼ is indicative of "bilinear" flow in a finite conductivity fracture (Bordet 2002). This likely indicates SNL-17 is in a large high-permeability feature in the Culebra, which is behaving like a large fracture on the scale of the recovery from Mills ranch pumping (several kilometers). SNL-17 responds quickest to changes in pumping rate at Mills Ranch, but it's drawdown at late time is less than most other wells in Figures 4 and 1. The slope of H-09bR is also slightly different from most of the other wells in Figure 4, but it is not nearly as different as SNL-17. SNL-13 responds in a much more muted fashion than the other wells close to Mills Ranch, and the drawdown at SNL-13 shown on Figure 4 has a similar slope to H-19b0 and H-15R which are further to the north. Both SNL-13 and SNL-17 are responding to the pumping at Mills Ranch in ways that are not typical, but they are also different from one another. These responses of the anomalous wells may warrant additional future analysis. The effects of the pumping at Mills Ranch on the Culebra have been like a very large-scale uncontrolled pumping test. This data could be used to better understand the flow models used in WIPP performance assessment, and to validate the system using a dataset not used in the system calibration (Thomas et al. 2017).

In general, most wells at WIPP fall into three categories: 1) wells impacted by Mills Ranch pumping since September 2014; 2) Wells responding to fall storms in Nash Draw; and 3) Low-permeability wells to the east that are not responding to either of these phenomena (AEC-7R, H-10cR, SNL-05, and SNL-16).

**Reference:**

Bourdet, D. (2002). *Well Test Analysis: The Use of Advanced Interpretation Models*, Elsevier.

Thomas, M.A., Kuhlman, K.L., & Ward, A.L. (2017). Anthropogenic influences on groundwater in the vicinity of a long-lived radioactive waste repository. *Hydrological Processes*, doi:10.1002/hyp.11214.

**Internal Distribution**

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| MS-1395 | D.O. Bowman | Org. 8882 |
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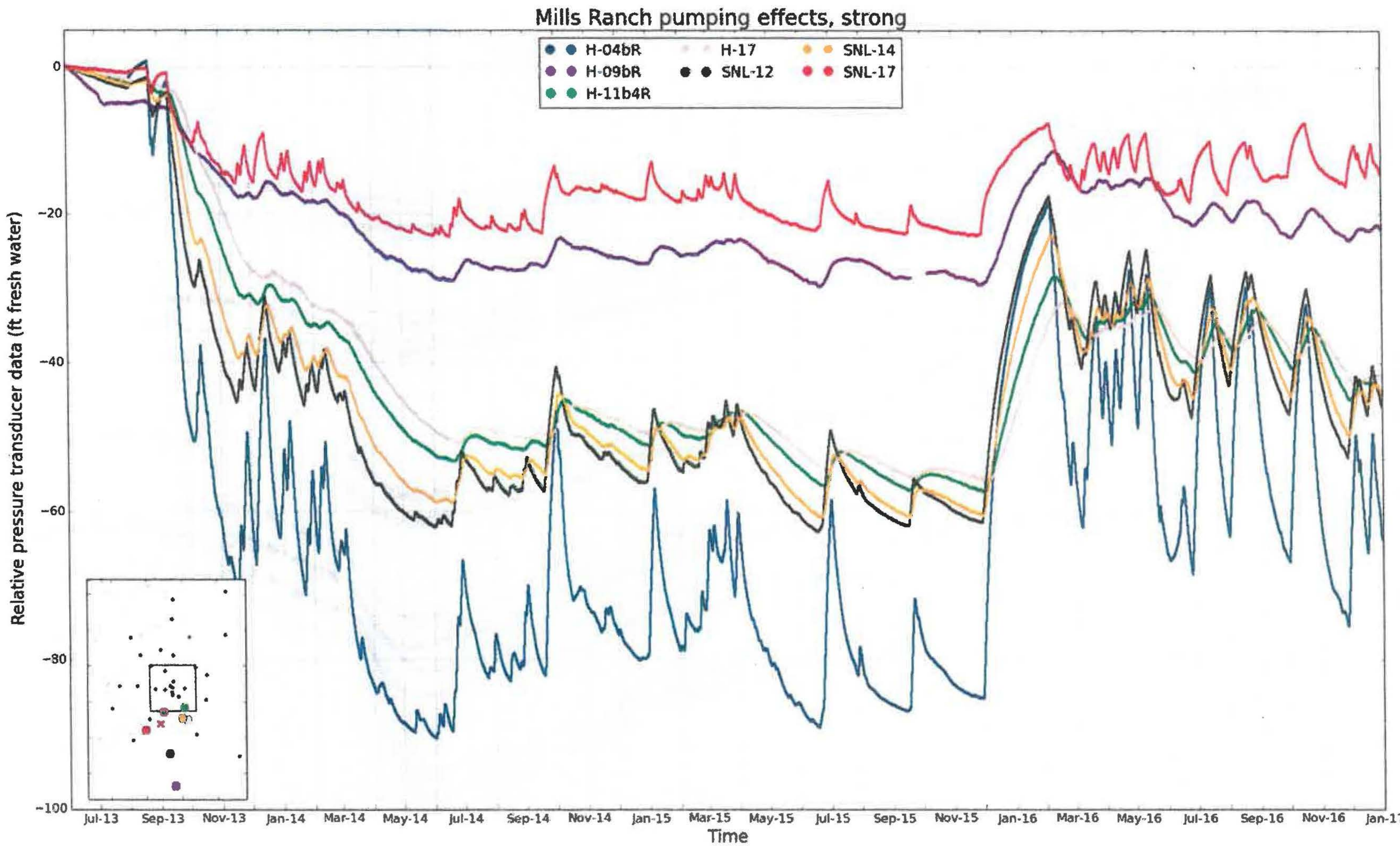



**Figure 1**. Seven Culebra wells (H-4bR, H-9bR, H-11b4R, H-17, SNL-12, SNL-14, and SNL-17) responding visibly to short-term cycles in pumping at Mills Ranch (likely periods of pumping shaded). Red "x" and large colored dots in location figure correspond to the Mills Ranch well and the SNL long-term, high-frequency Culebra monitoring network pressure transducer data plotted with colored lines, respectively.

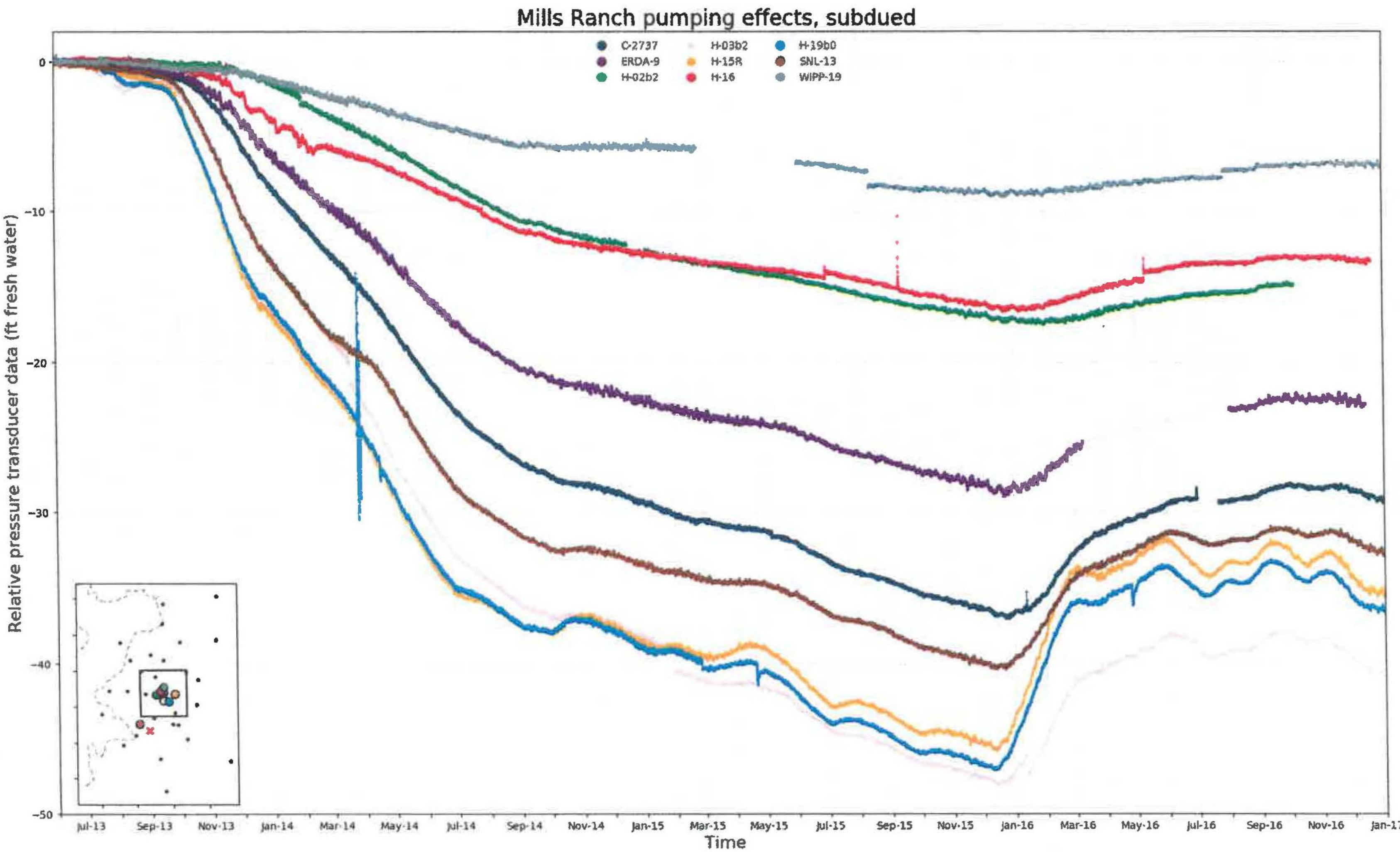



**Figure 2**. Nine Culebra wells (C-2732, ERDA-9, H-2b2, H-3b2, H-15R, H-16, H-19b0, SNL-13, and WIPP-19) responding less strongly to short-term cycles in pumping at Mills Ranch. Red "x" and large colored dots in location figure correspond to the Mills Ranch well and the SNL long-term, high-frequency Culebra monitoring network pressure transducer data plotted with colored lines, respectively.

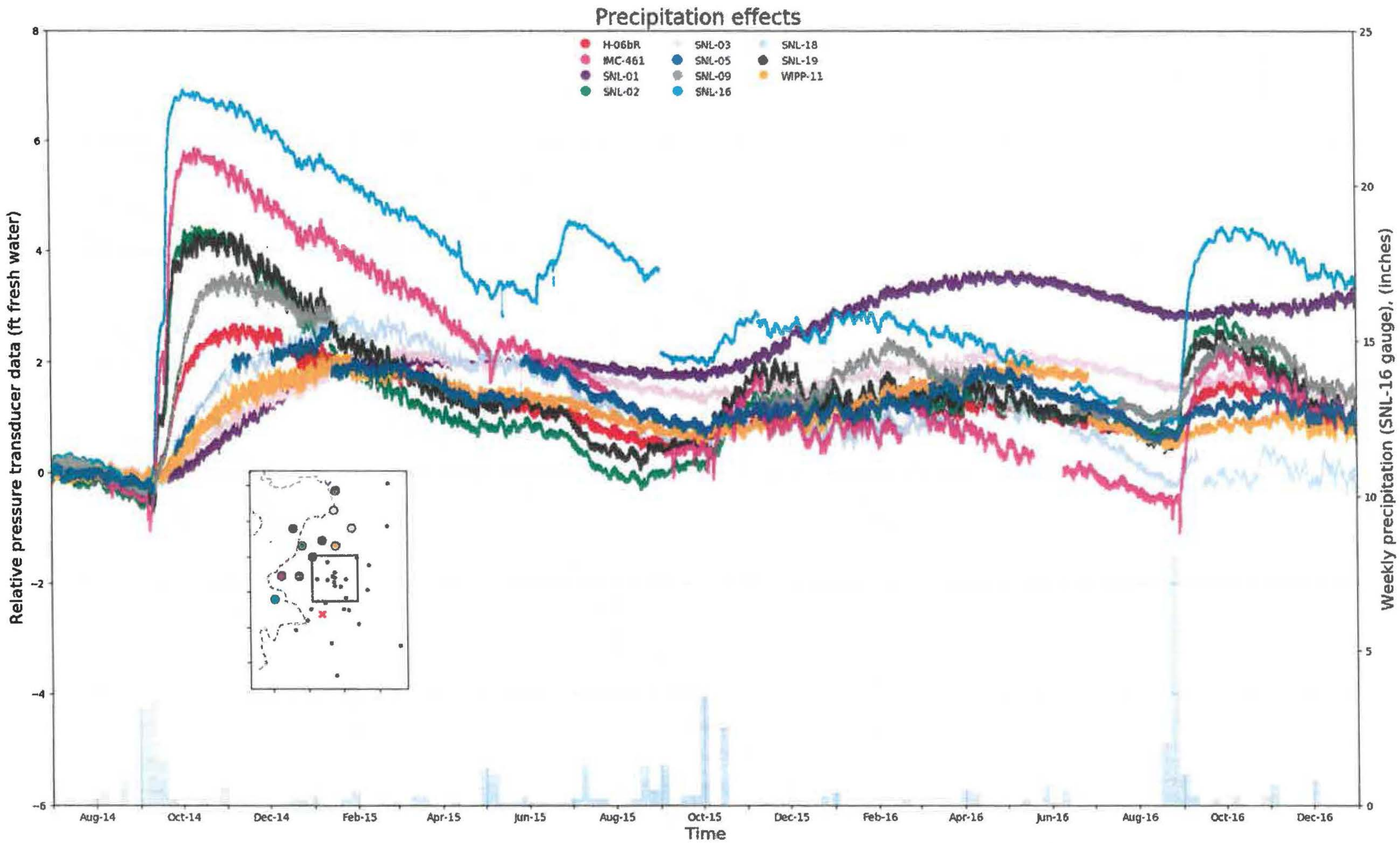



**Figure 3**. Eleven Culebra wells (H-6bR, IMC-461, SNL-01, SNL-02, SNL-03, SNL-05, SNL-09, SNL-16, SNL-18, SNL-19, and WIPP-11) near Nash Draw from the SNL long-term, high-frequency Culebra monitoring network comparing responses to precipitation in September 2014, October 2015, and August 2016. Weekly precipitation data totals at SNL-16 precipitation gage are plotted with bars. Red "x" and large colored dots in location figure correspond to the Mills Ranch well and the SNL long-term, high-frequency Culebra monitoring network pressure transducer data plotted with colored lines, respectively.

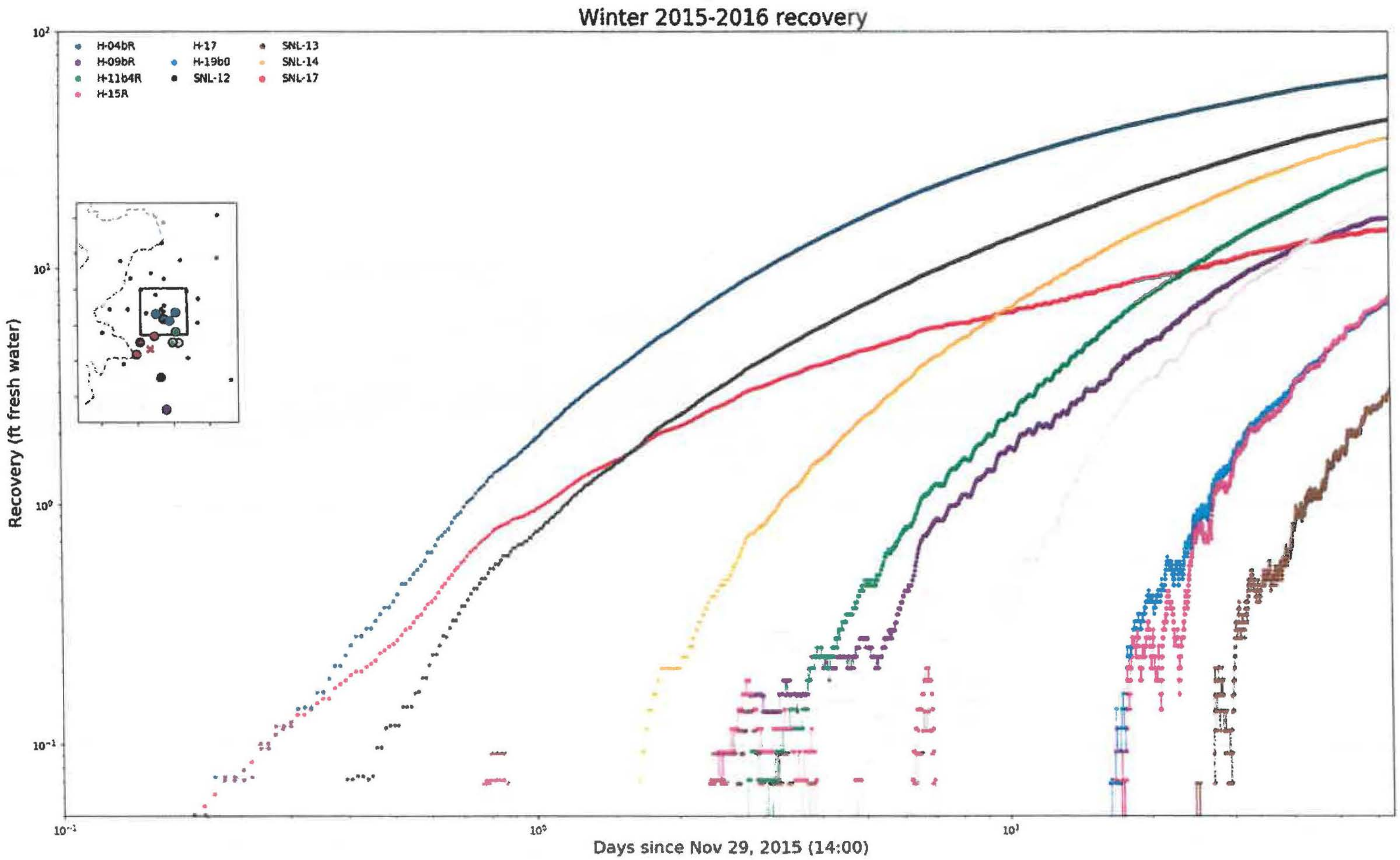



**Figure 4**. Recovery of ten Culebra wells (H-4bR, H-9bR, H-11b4R, H-15R, H-17, H-19b0, SNL-12, SNL-13, SNL-14, and SNL-17) near Mills Ranch well from the SNL long-term, high-frequency Culebra monitoring network for December 2015 and January 2016. Red "x" and large colored dots in location figure correspond to the Mills Ranch well and the SNL long-term, high-frequency Culebra monitoring network pressure transducer data plotted with colored lines, respectively. Recovery is computed as change in head and time since November 29, 2015 at 2PM, when the water level in SNL-17 began to rise.

## Appendix

Culebra pressure transducer records: CY2014-2016

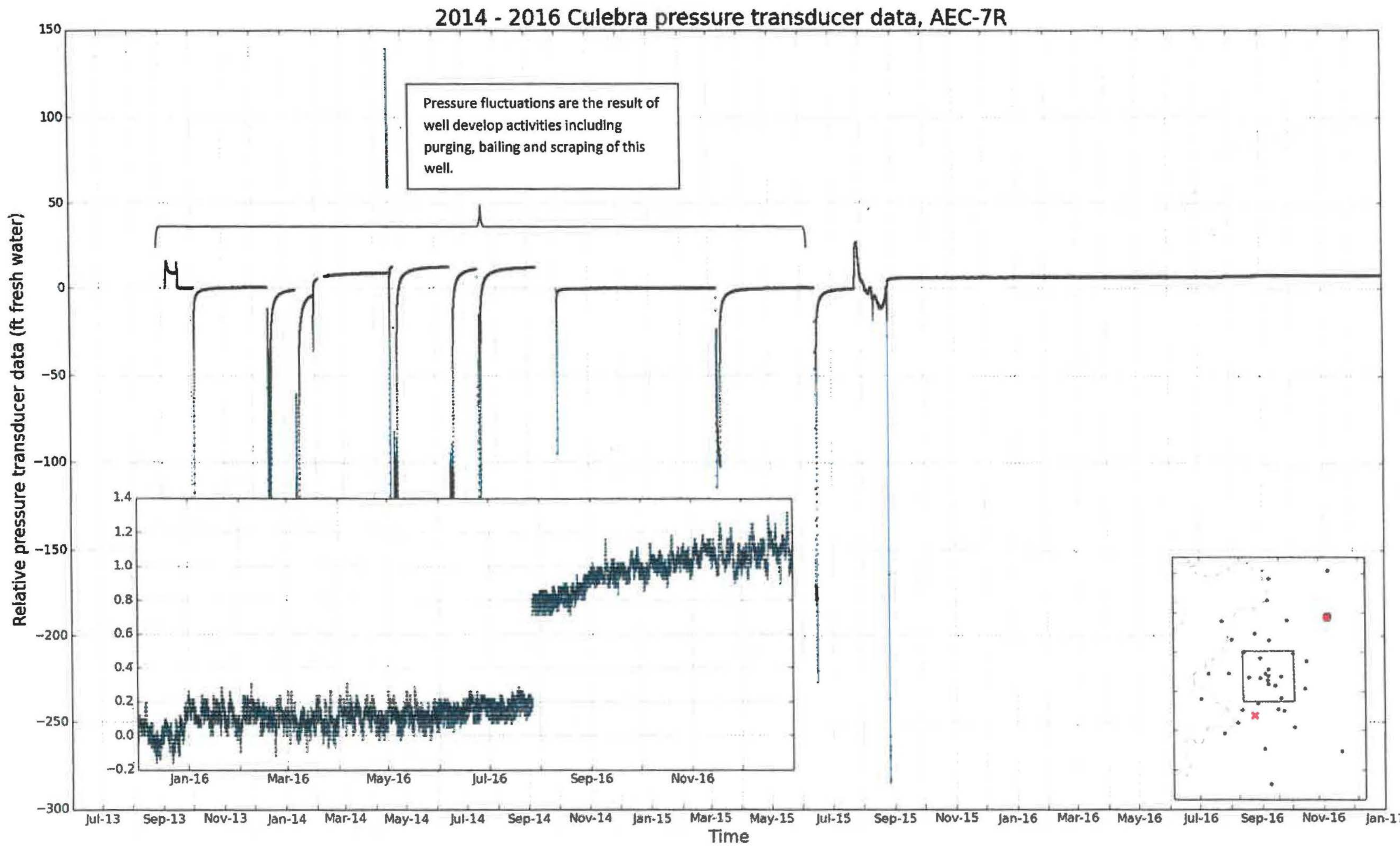
Table A-1 provides a list of the 40 Culebra wells monitored with pressure transducers from CY2014 to CY2016. A brief description is included in this table to highlight the most dominant observations for the two-year period. Relative pressure plots for each transducer follow after the table, with specific comments about breaks or shifts in data given on individual plots.

Table A-1. Dominant observations in Culebra pressure transducer records for CY2014-16.

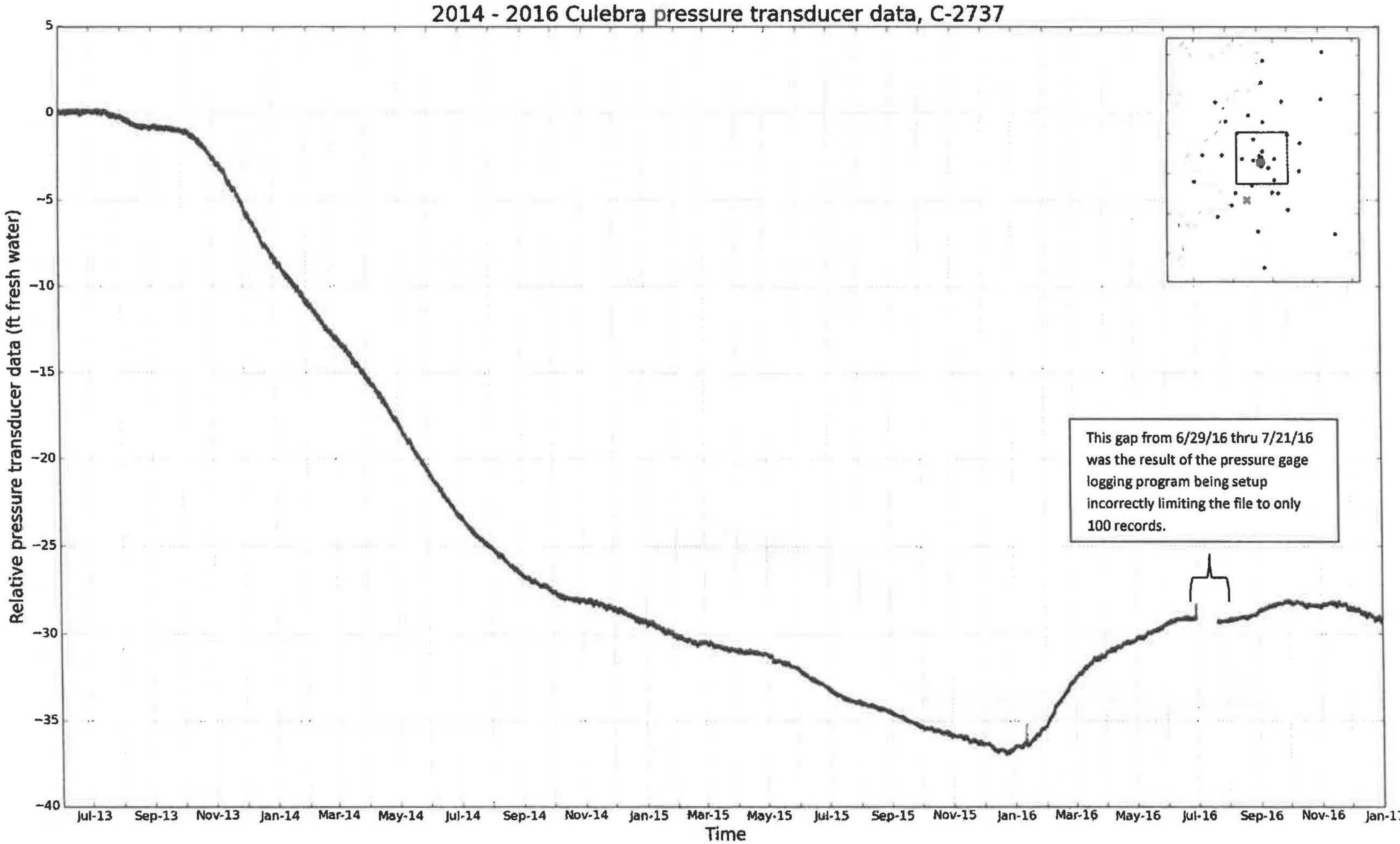
| Transducer | Dominant observation(s) |
|---|---|
| AEC-7R | Pumping (2014-15) |
| C-2737 | Mills drawdown |
| ERDA-9 | Mills drawdown |
| H-2b2 | Mills drawdown |
| H-3b2 | Mills drawdown |
| H-4bR | Mills drawdown |
| H-5b | Shifts in pressure at gauge changes |
| H-6bR | Precipitation events |
| H-7b1 | H-7 pad pumping and precipitation events |
| H-9bR | Mills drawdown |
| H-10c | Well P&Aed in late 2015 |
| H-10cR | Testing & recovery |
| H-11b4R | Mills drawdown |
| H-12 | H-12R development |
| H-12R | Well development and Mills drawdown |
| H-15R | Mills drawdown |
| H-16 | Mills drawdown |
| H-17 | Mills drawdown |
| H-19b0 | Mills drawdown; 2014 sinusoidal test |
| H-19b7 | Mills drawdown; 2014 sinusoidal test |

| Transducer | Dominant observation(s) |
|---|---|
| IMC-461 | Precipitation events |
| SNL-01 | Muted precipitation |
| SNL-02 | Precipitation events |
| SNL-03 | Precipitation events |
| SNL-05 | Precipitation events |
| SNL-06 | Long-term recovery |
| SNL-08 | Bailed sediment 2016 |
| SNL-09 | Precipitation events |
| SNL-10 | Precipitation events |
| SNL-12 | Mills drawdown |
| SNL-13 | Mills drawdown |
| SNL-14 | Mills drawdown |
| SNL-15 | Long-term recovery |
| SNL-16 | Precipitation events |
| SNL-17 | Mills drawdown |
| SNL-18 | Precipitation events |
| SNL-19 | Precipitation events |
| WIPP-11 | Precipitation events |
| WIPP-13 | Precipitation events |
| WIPP-19 | Mills drawdown |

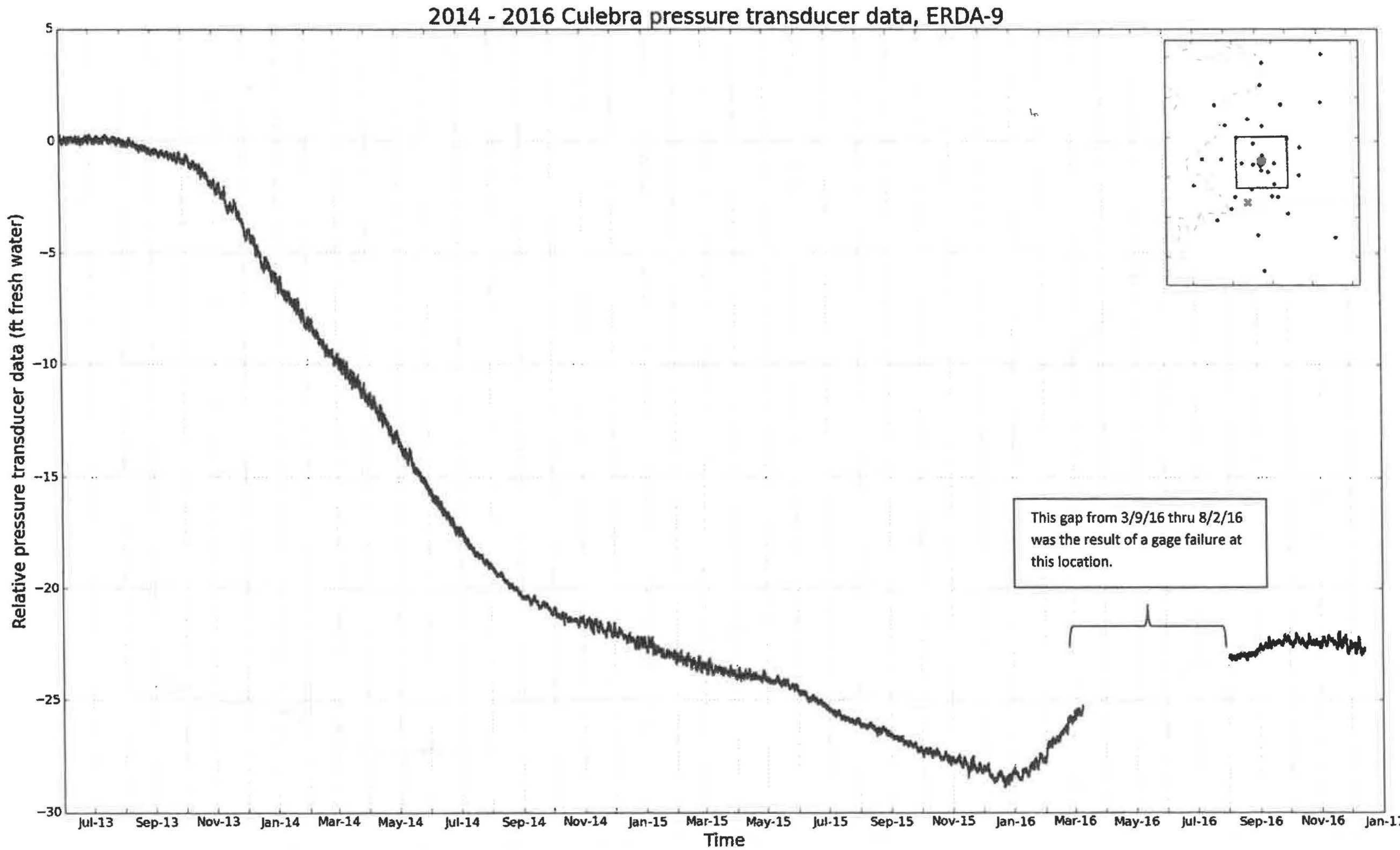
Individual data files in two wells (SNL-16 file C22 [April 2015-Sep 2015] and IMC-461 file C30 [Nov 2015-Feb 2016]) were shifted to make them match adjacent records in Figures 1-4, since these shifts are due to installing the gauge at different depths or doing maintenance in the wells, and do not reflect hydrological processes.

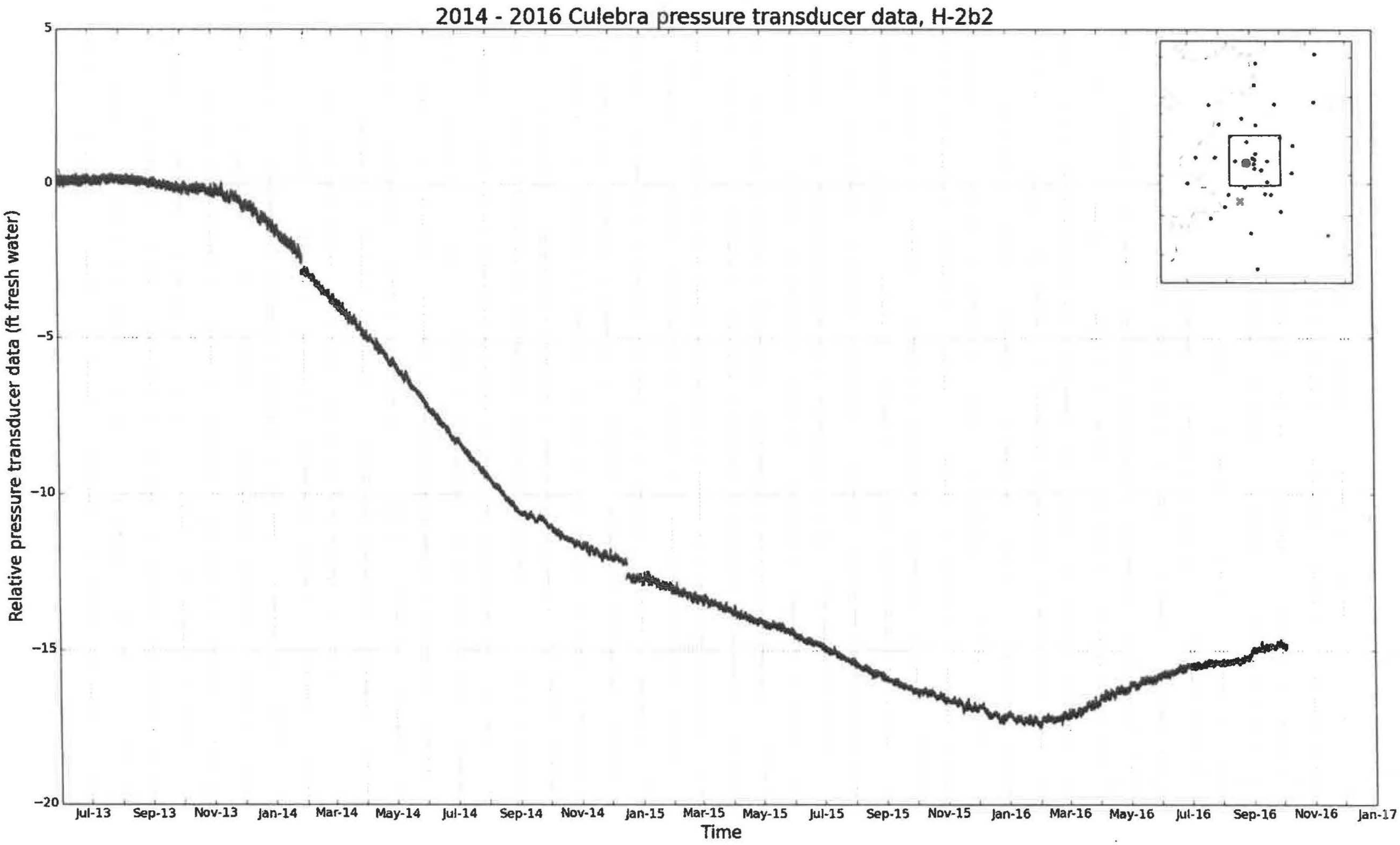


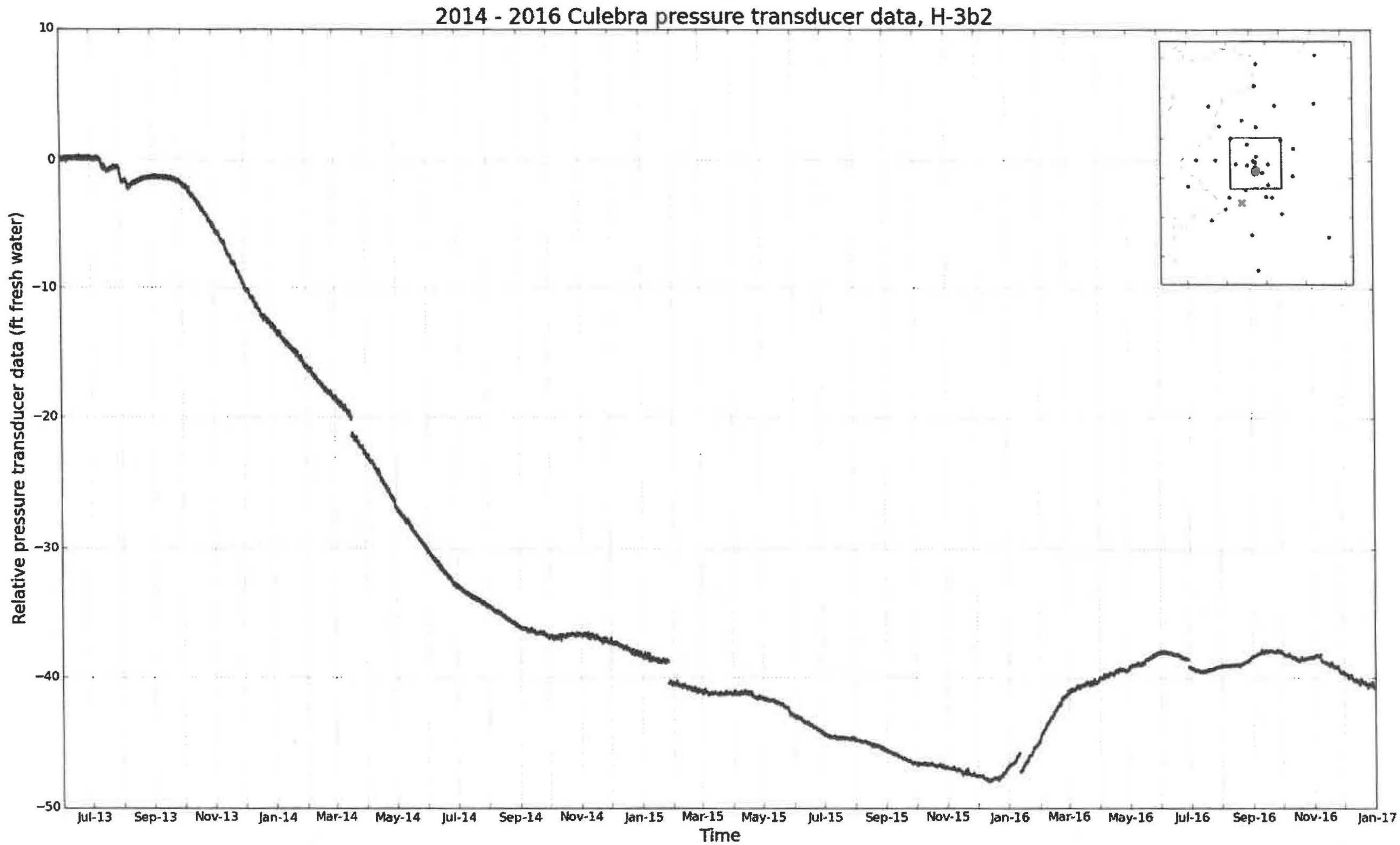
2014 - 2016 Culebra pressure transducer data, AEC-7R
Pressure fluctuations are the result of well develop activities including purging, bailing and scraping of this well.
Relative pressure transducer data (ft fresh water)
150
100
50
0
−50
−100
−150
−200
−250
−300
1.4
1.2
1.0
0.8
0.6
0.4
0.2
0.0
−0.2
Jan-16
Mar-16
May-16
Jul-16
Sep-16
Nov-16
Jul-13
Sep-13
Nov-13
Jan-14
Mar-14
May-14
Jul-14
Sep-14
Nov-14
Jan-15
Mar-15
May-15
Jul-15
Sep-15
Nov-15
Jan-16
Mar-16
May-16
Jul-16
Sep-16
Nov-16
Jan-17
Time

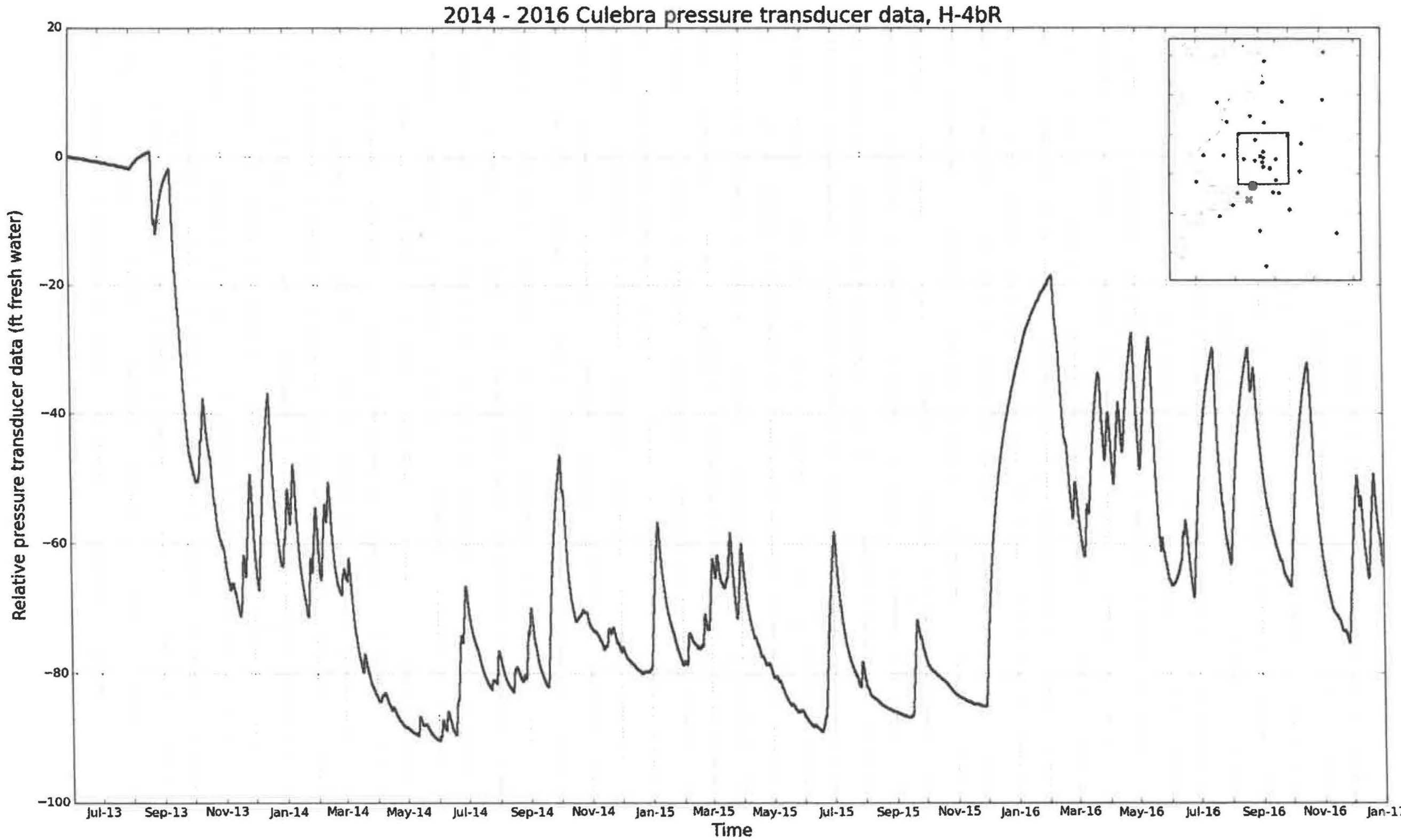


2014 - 2016 Culebra pressure transducer data, C-2737
Relative pressure transducer data (ft fresh water)
5
0
−5
−10
−15
−20
−25
−30
−35
−40
Jul-13
Sep-13
Nov-13
Jan-14
Mar-14
May-14
Jul-14
Sep-14
Nov-14
Jan-15
Mar-15
May-15
Jul-15
Sep-15
Nov-15
Jan-16
Mar-16
May-16
Jul-16
Sep-16
Nov-16
Jan-17
Time
This gap from 6/29/16 thru 7/21/16 was the result of the pressure gage logging program being setup incorrectly limiting the file to only 100 records.

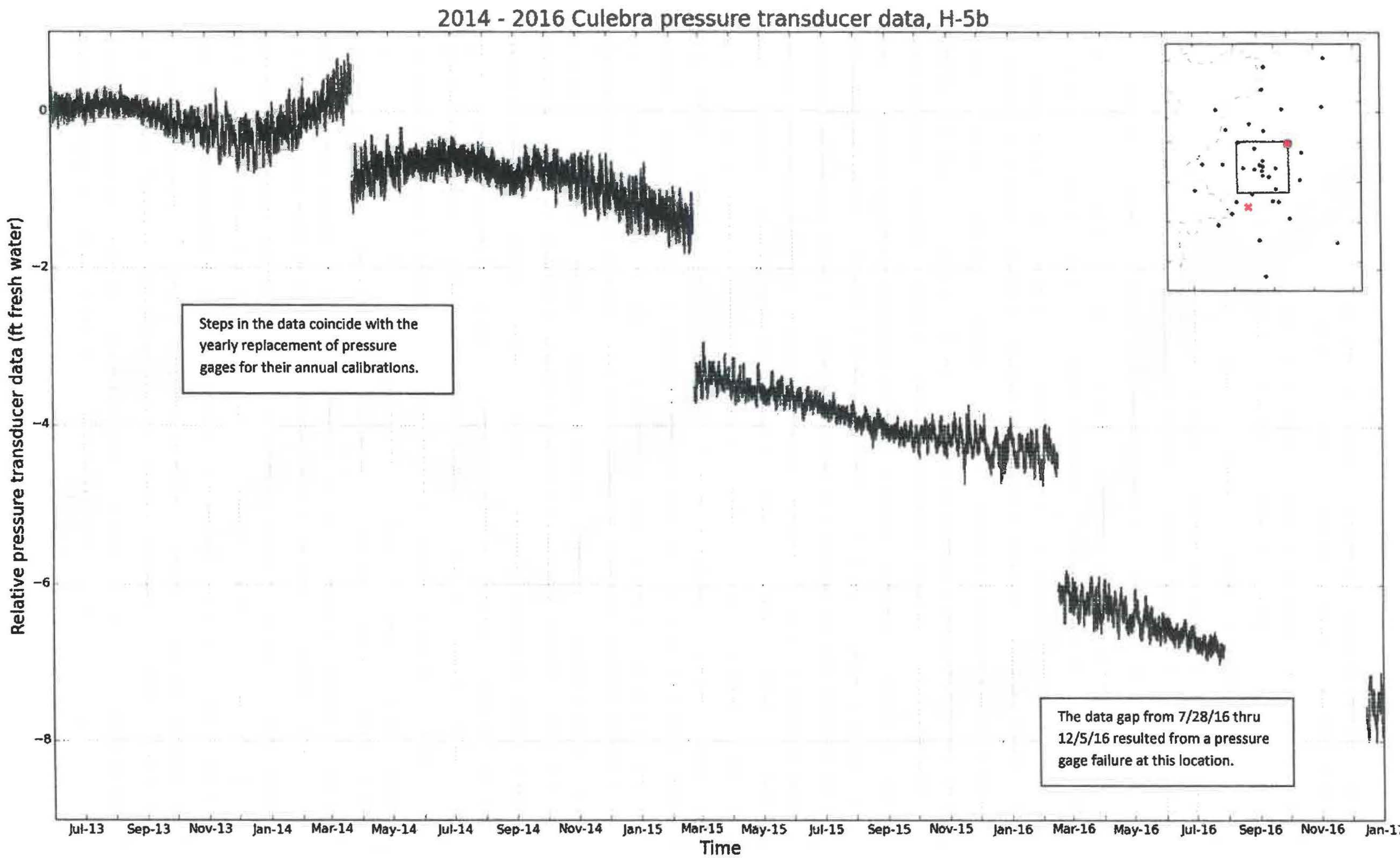

2014 - 2016 Culebra pressure transducer data, ERDA-9
Relative pressure transducer data (ft fresh water)
5
0
−5
−10
−15
−20
−25
−30
Jul-13
Sep-13
Nov-13
Jan-14
Mar-14
May-14
Jul-14
Sep-14
Nov-14
Jan-15
Mar-15
May-15
Jul-15
Sep-15
Nov-15
Jan-16
Mar-16
May-16
Jul-16
Sep-16
Nov-16
Jan-17
Time
This gap from 3/9/16 thru 8/2/16 was the result of a gage failure at this location.


2014 - 2016 Culebra pressure transducer data, H-2b2
Relative pressure transducer data (ft fresh water)
5
0
−5
−10
−15
−20
Jul-13
Sep-13
Nov-13
Jan-14
Mar-14
May-14
Jul-14
Sep-14
Nov-14
Jan-15
Mar-15
May-15
Jul-15
Sep-15
Nov-15
Jan-16
Mar-16
May-16
Jul-16
Sep-16
Nov-16
Jan-17
Time

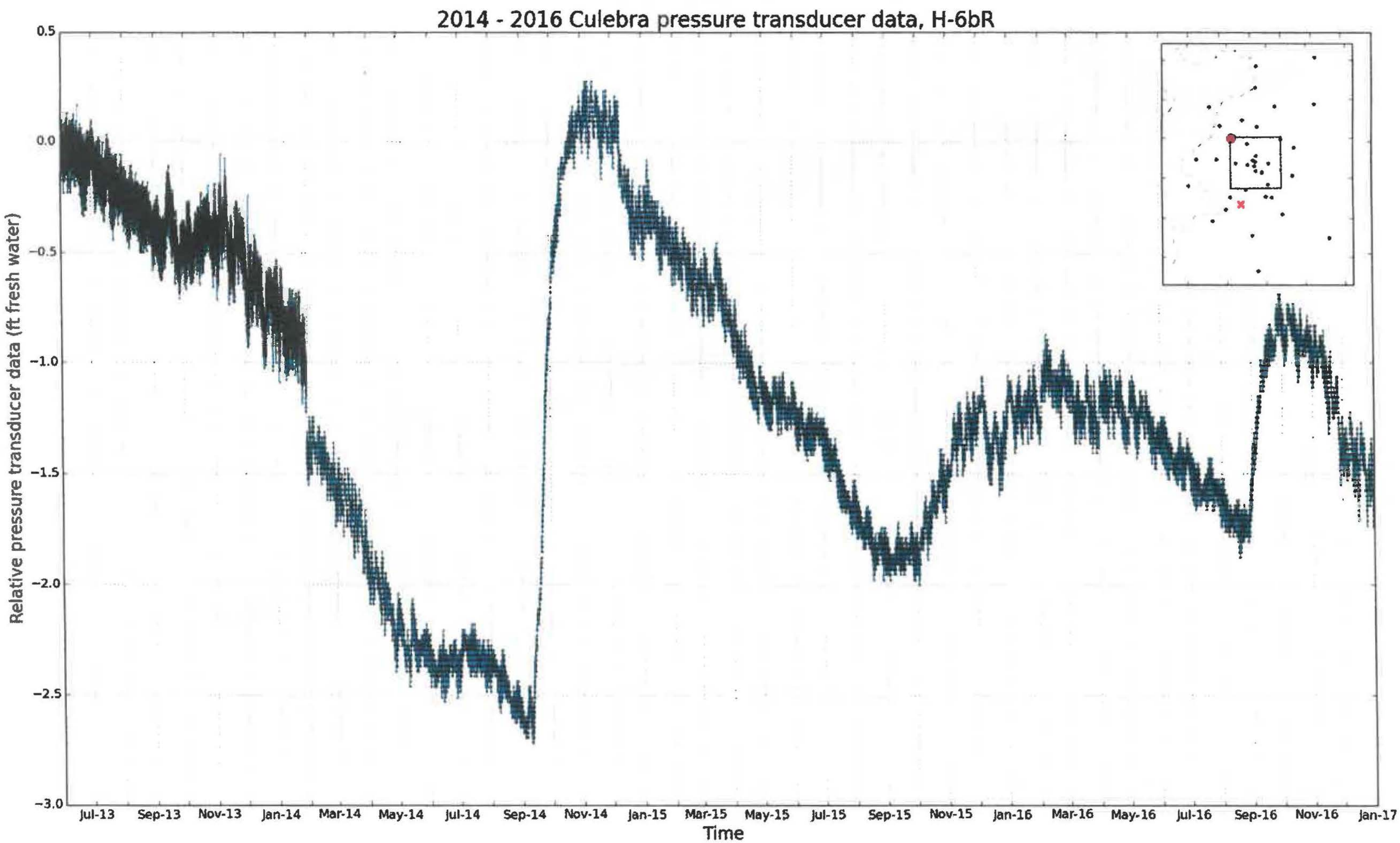

2014 - 2016 Culebra pressure transducer data, H-3b2
Relative pressure transducer data (ft fresh water)
10
0
-10
-20
-30
-40
-50
Jul-13
Sep-13
Nov-13
Jan-14
Mar-14
May-14
Jul-14
Sep-14
Nov-14
Jan-15
Mar-15
May-15
Jul-15
Sep-15
Nov-15
Jan-16
Mar-16
May-16
Jul-16
Sep-16
Nov-16
Jan-17
Time

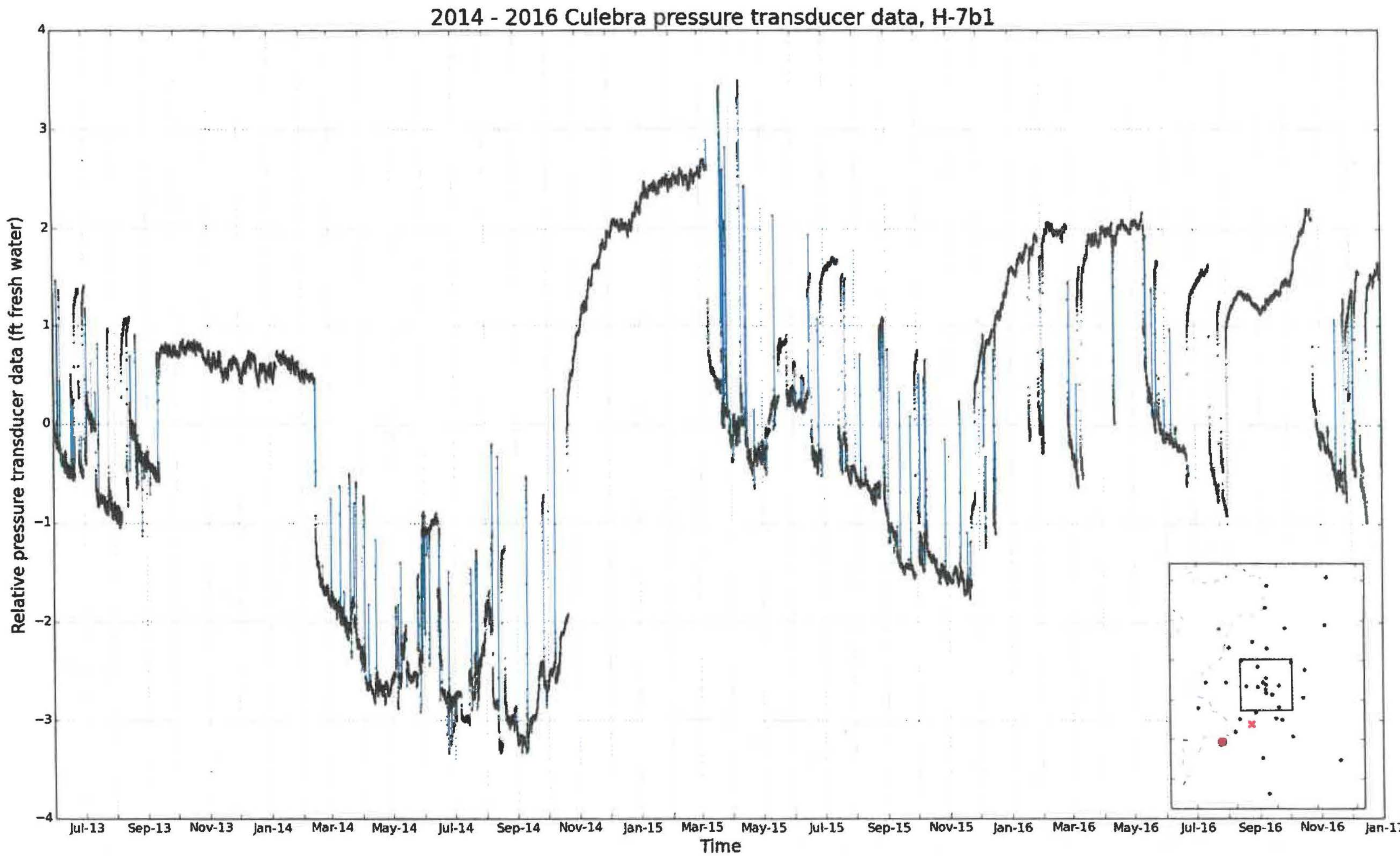


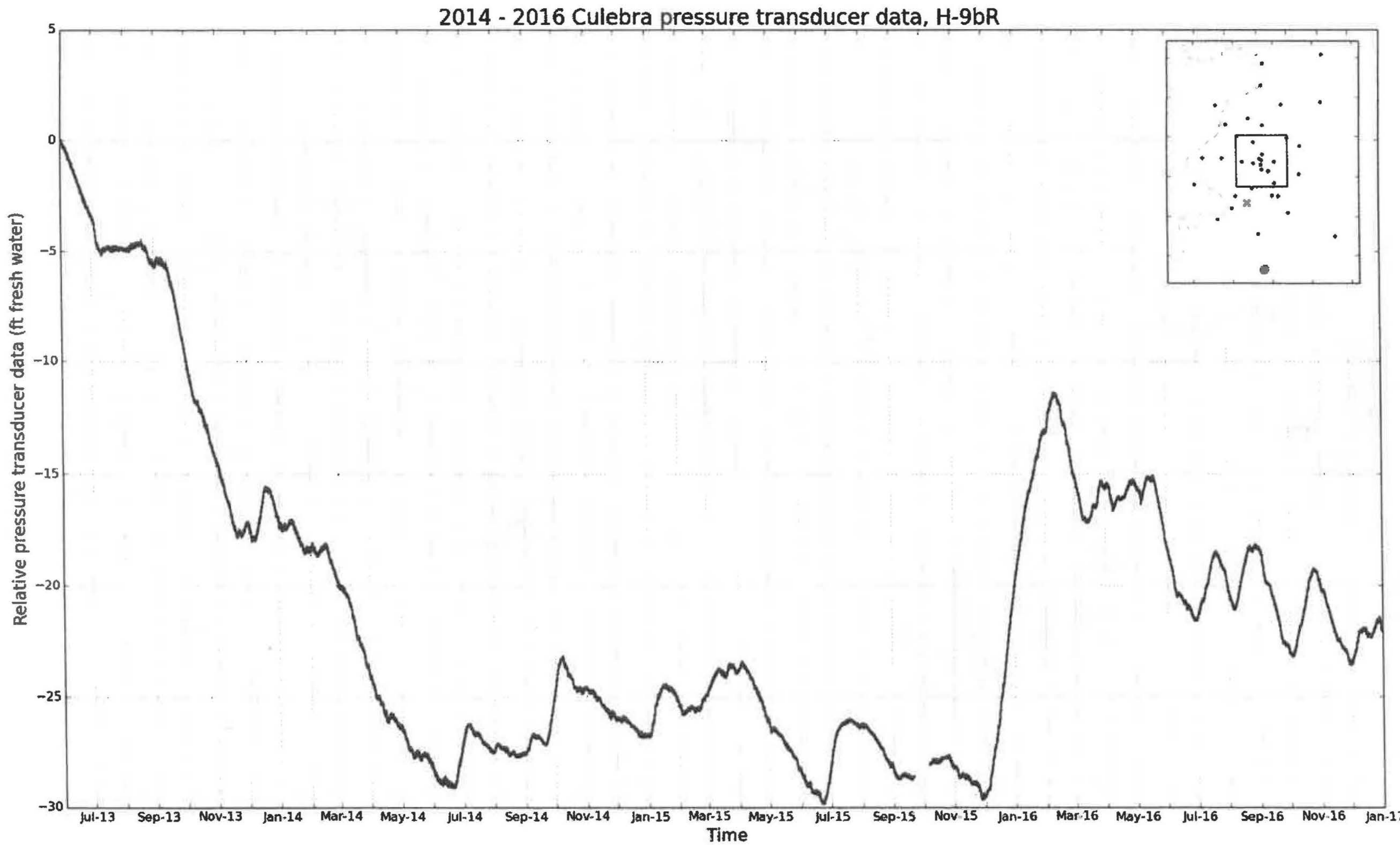
2014 - 2016 Culebra pressure transducer data, H-4bR
Relative pressure transducer data (ft fresh water)
20
0
−20
−40
−60
−80
−100
Jul-13
Sep-13
Nov-13
Jan-14
Mar-14
May-14
Jul-14
Sep-14
Nov-14
Jan-15
Mar-15
May-15
Jul-15
Sep-15
Nov-15
Jan-16
Mar-16
May-16
Jul-16
Sep-16
Nov-16
Jan-17
Time

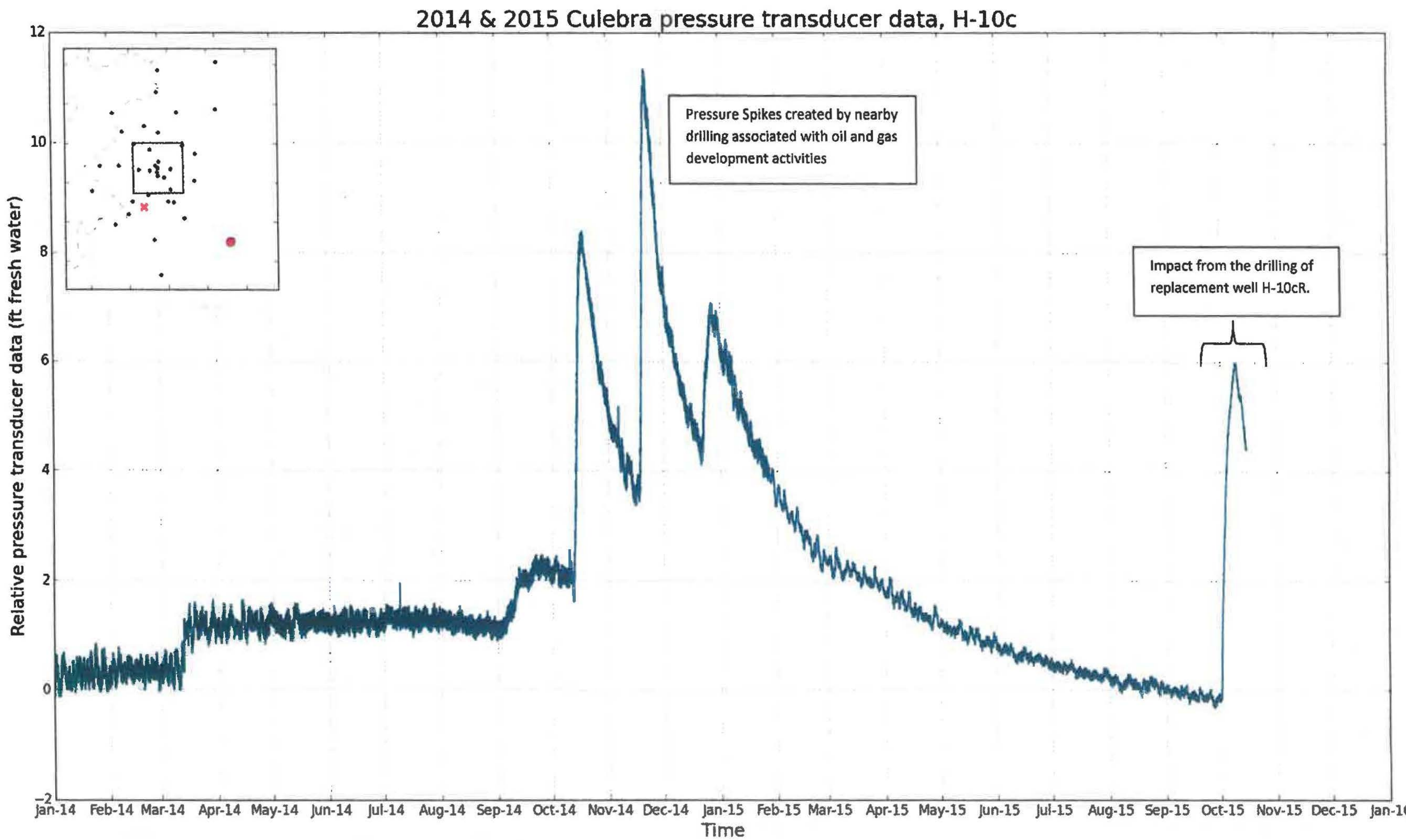


2014 - 2016 Culebra pressure transducer data, H-5b
Relative pressure transducer data (ft fresh water)
0
-2
-4
-6
-8
Steps in the data coincide with the yearly replacement of pressure gages for their annual calibrations.
The data gap from 7/28/16 thru 12/5/16 resulted from a pressure gage failure at this location.
Jul-13
Sep-13
Nov-13
Jan-14
Mar-14
May-14
Jul-14
Sep-14
Nov-14
Jan-15
Mar-15
May-15
Jul-15
Sep-15
Nov-15
Jan-16
Mar-16
May-16
Jul-16
Sep-16
Nov-16
Jan-17
Time

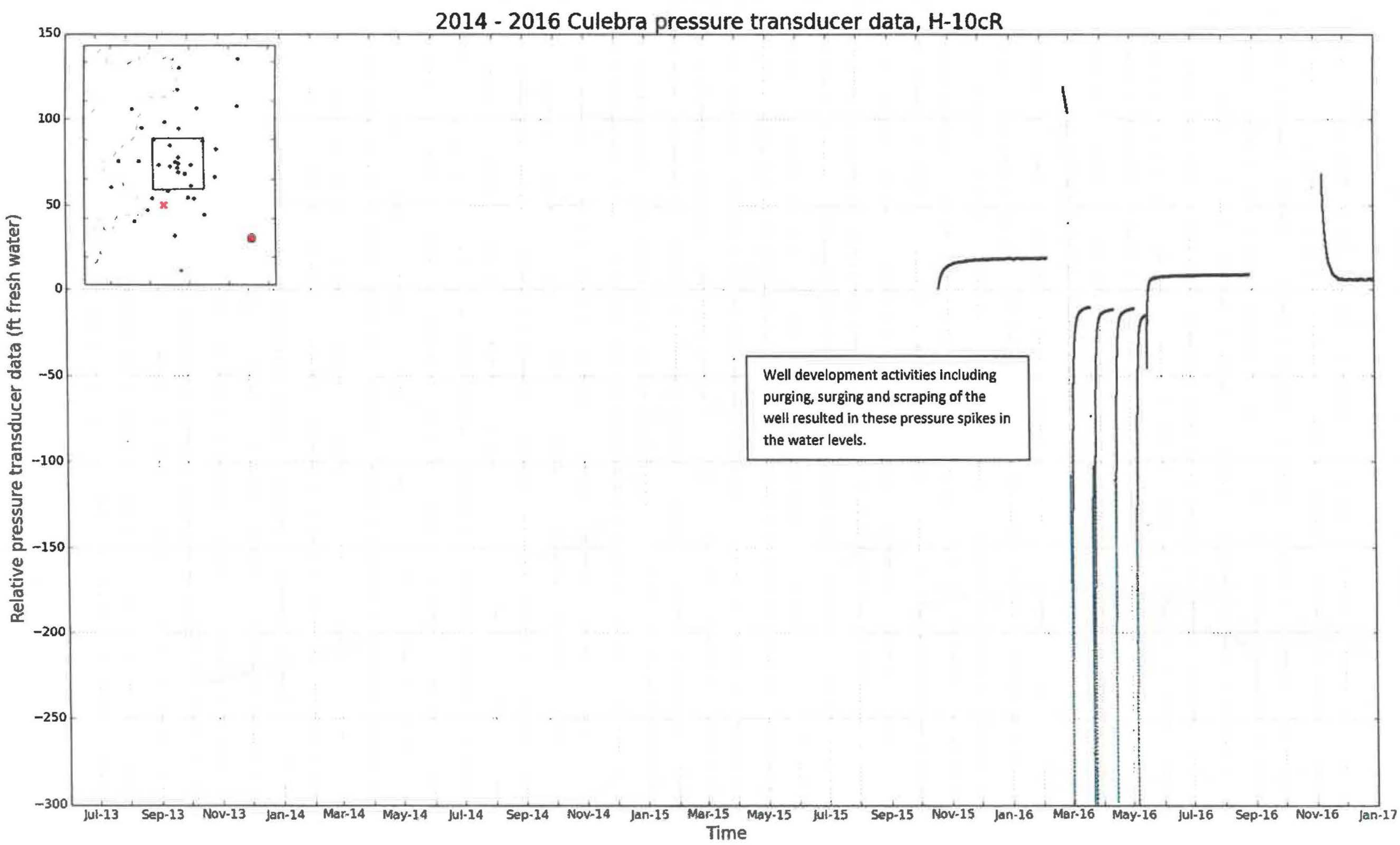

2014 - 2016 Culebra pressure transducer data, H-6bR
Relative pressure transducer data (ft fresh water)
0.5
0.0
−0.5
−1.0
−1.5
−2.0
−2.5
−3.0
Jul-13
Sep-13
Nov-13
Jan-14
Mar-14
May-14
Jul-14
Sep-14
Nov-14
Jan-15
Mar-15
May-15
Jul-15
Sep-15
Nov-15
Jan-16
Mar-16
May-16
Jul-16
Sep-16
Nov-16
Jan-17
Time

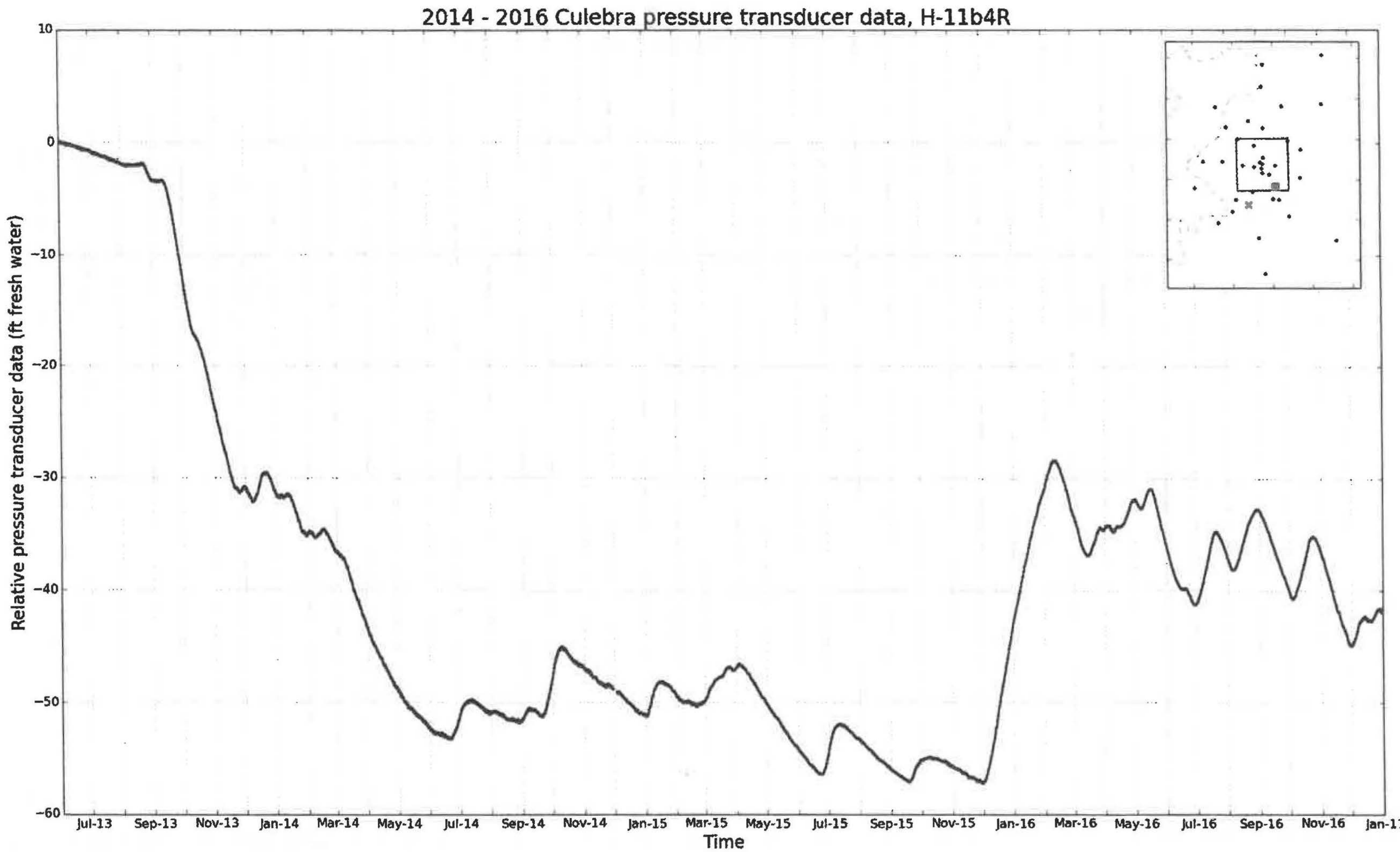

2014 - 2016 Culebra pressure transducer data, H-7b1
Relative pressure transducer data (ft fresh water)
4
3
2
1
0
-1
-2
-3
-4
Jul-13
Sep-13
Nov-13
Jan-14
Mar-14
May-14
Jul-14
Sep-14
Nov-14
Jan-15
Mar-15
May-15
Jul-15
Sep-15
Nov-15
Jan-16
Mar-16
May-16
Jul-16
Sep-16
Nov-16
Jan-17
Time

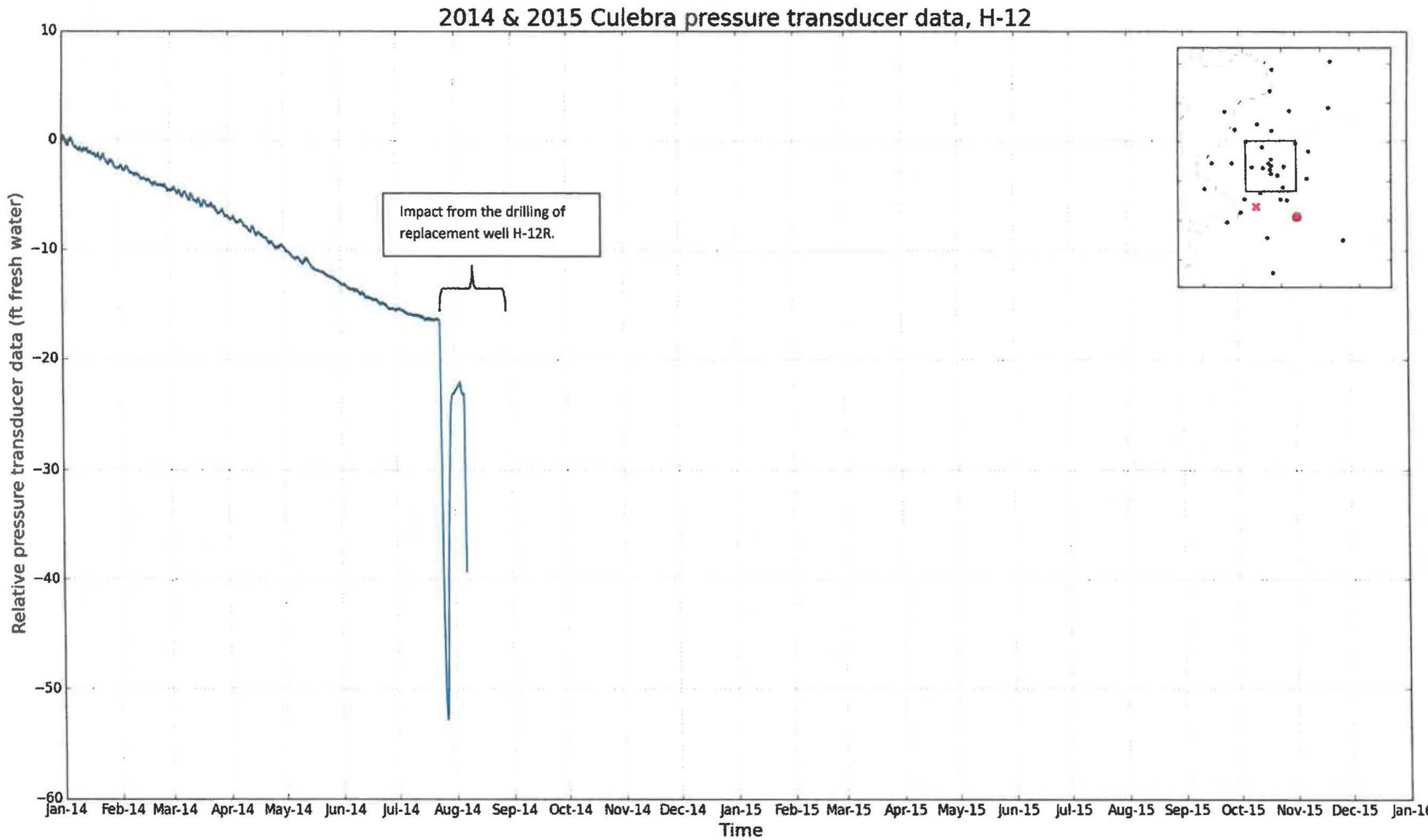

2014 - 2016 Culebra pressure transducer data, H-9bR
Relative pressure transducer data (ft fresh water)
5
0
−5
−10
−15
−20
−25
−30
Jul-13
Sep-13
Nov-13
Jan-14
Mar-14
May-14
Jul-14
Sep-14
Nov-14
Jan-15
Mar-15
May-15
Jul-15
Sep-15
Nov-15
Jan-16
Mar-16
May-16
Jul-16
Sep-16
Nov-16
Jan-17
Time



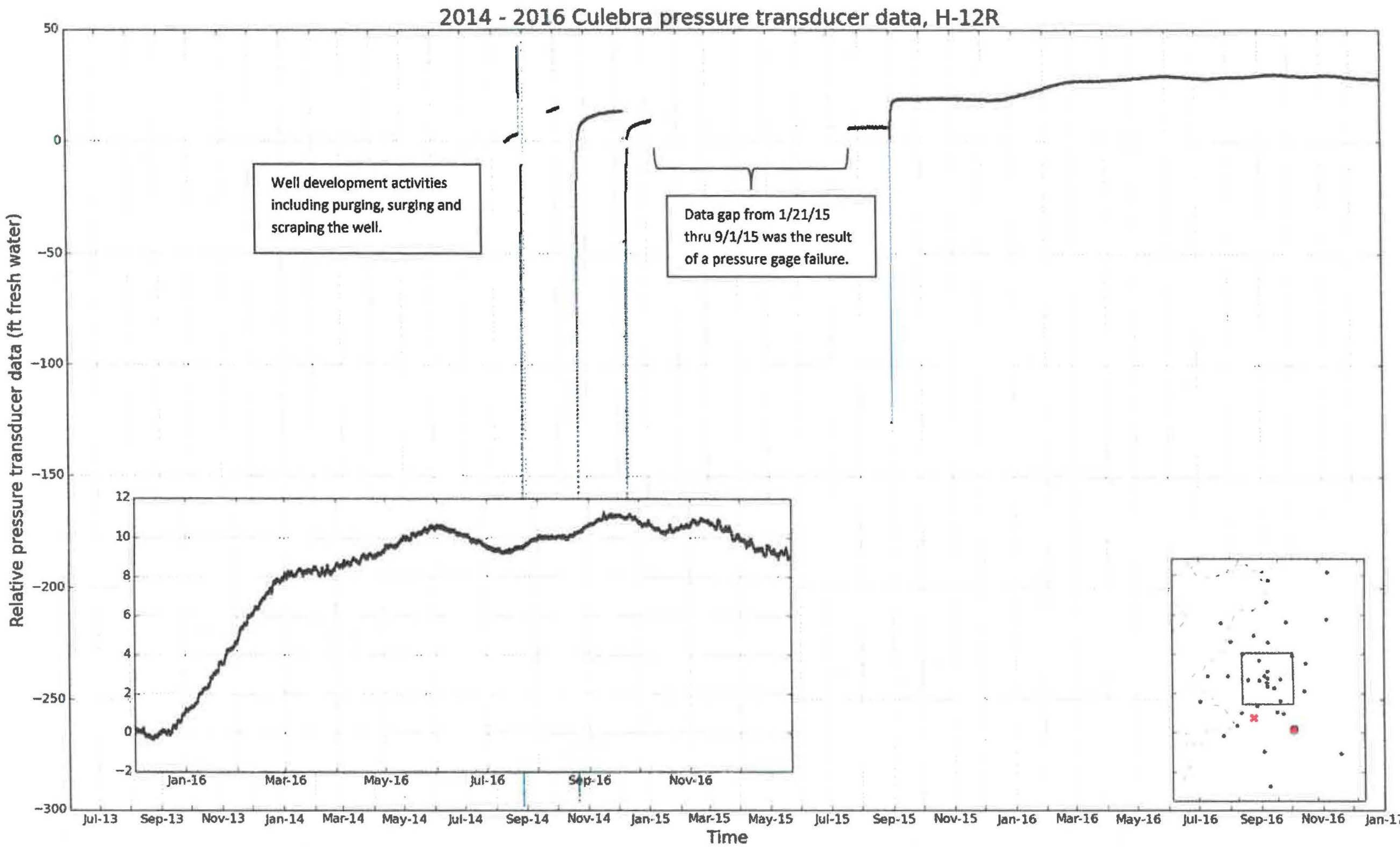
2014 & 2015 Culebra pressure transducer data, H-10c
Relative pressure transducer data (ft fresh water)
Time
12
10
8
6
4
2
0
−2
Jan-14
Feb-14
Mar-14
Apr-14
May-14
Jun-14
Jul-14
Aug-14
Sep-14
Oct-14
Nov-14
Dec-14
Jan-15
Feb-15
Mar-15
Apr-15
May-15
Jun-15
Jul-15
Aug-15
Sep-15
Oct-15
Nov-15
Dec-15
Jan-16
Pressure Spikes created by nearby drilling associated with oil and gas development activities
Impact from the drilling of replacement well H-10cR.


2014 - 2016 Culebra pressure transducer data, H-10cR
Relative pressure transducer data (ft fresh water)
150
100
50
0
−50
−100
−150
−200
−250
−300
Jul-13
Sep-13
Nov-13
Jan-14
Mar-14
May-14
Jul-14
Sep-14
Nov-14
Jan-15
Mar-15
May-15
Jul-15
Sep-15
Nov-15
Jan-16
Mar-16
May-16
Jul-16
Sep-16
Nov-16
Jan-17
Time
Well development activities including purging, surging and scraping of the well resulted in these pressure spikes in the water levels.

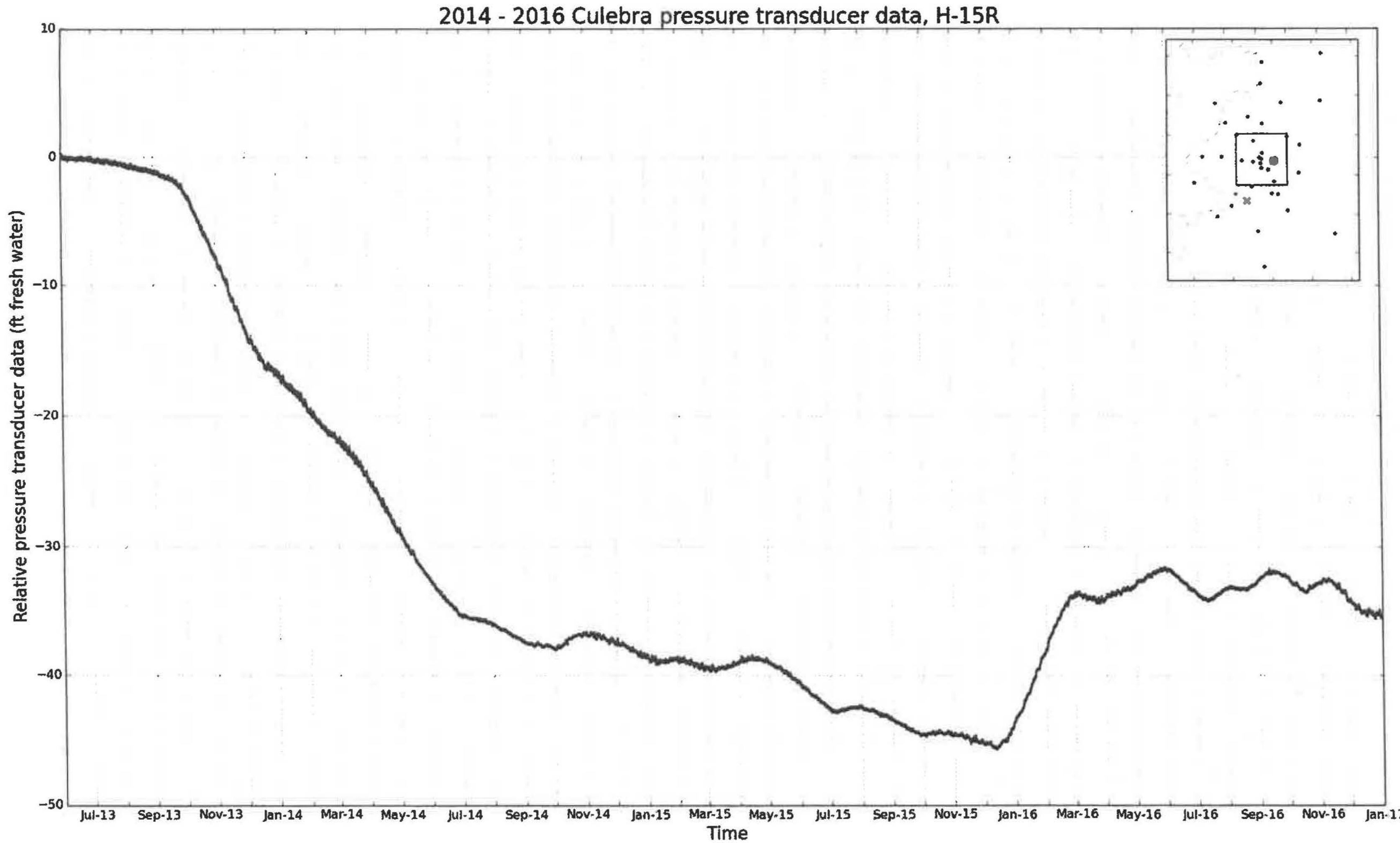

2014 - 2016 Culebra pressure transducer data, H-11b4R
Relative pressure transducer data (ft fresh water)
10
0
-10
-20
-30
-40
-50
-60
Jul-13
Sep-13
Nov-13
Jan-14
Mar-14
May-14
Jul-14
Sep-14
Nov-14
Jan-15
Mar-15
May-15
Jul-15
Sep-15
Nov-15
Jan-16
Mar-16
May-16
Jul-16
Sep-16
Nov-16
Jan-17
Time

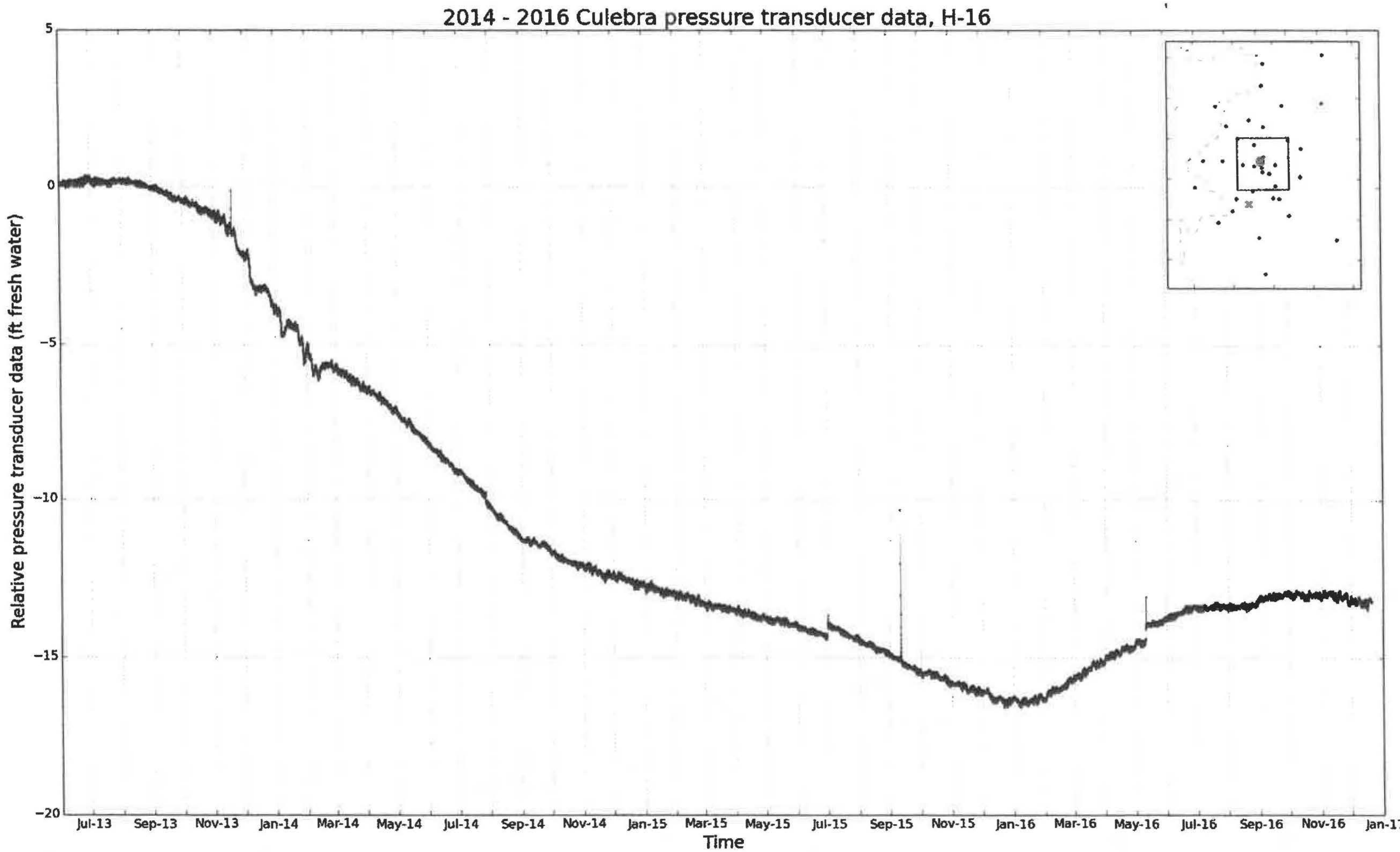


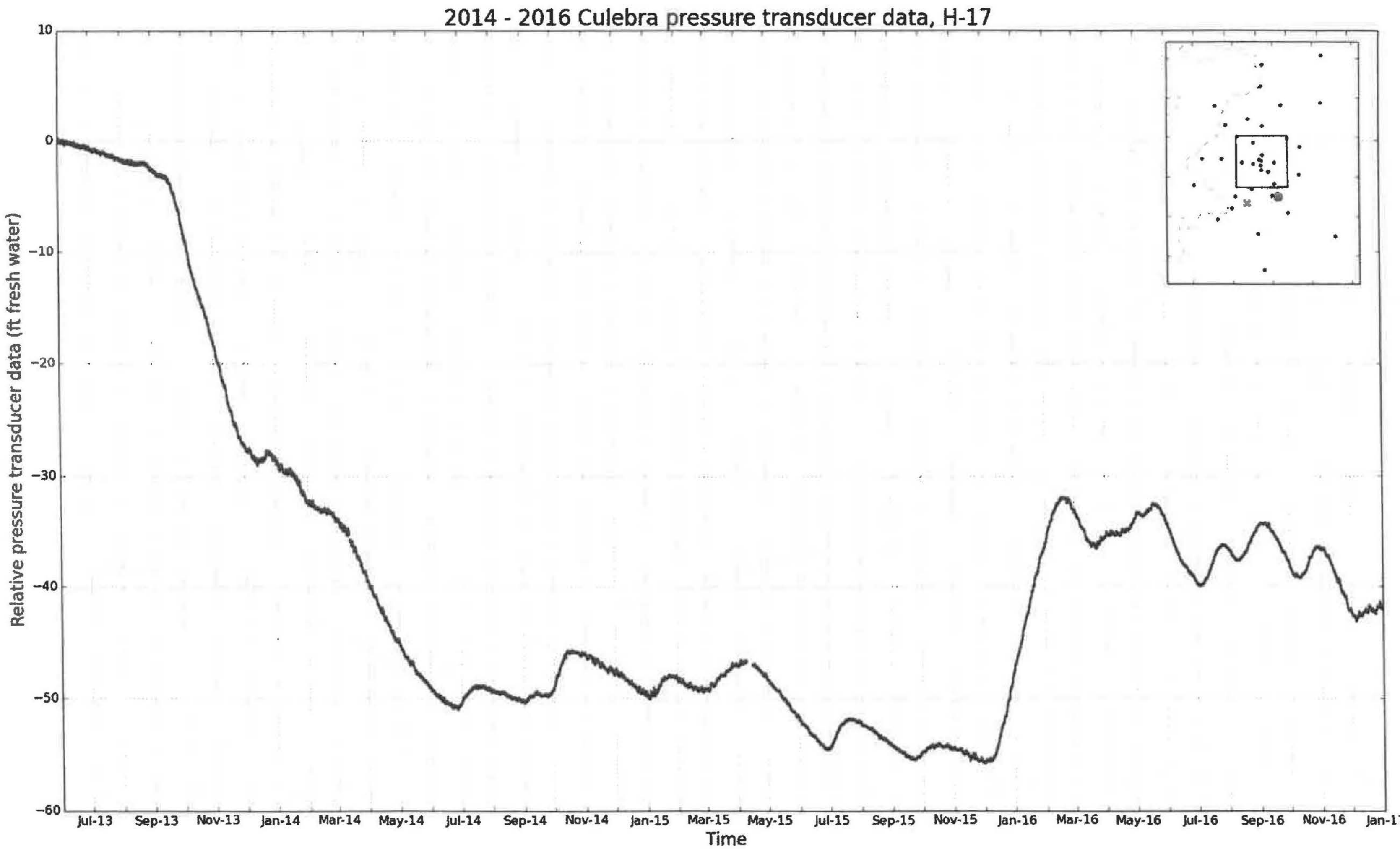
2014 & 2015 Culebra pressure transducer data, H-12
Relative pressure transducer data (ft fresh water)
10
0
−10
−20
−30
−40
−50
−60
Impact from the drilling of replacement well H-12R.
Jan-14 Feb-14 Mar-14 Apr-14 May-14 Jun-14 Jul-14 Aug-14 Sep-14 Oct-14 Nov-14 Dec-14 Jan-15 Feb-15 Mar-15 Apr-15 May-15 Jun-15 Jul-15 Aug-15 Sep-15 Oct-15 Nov-15 Dec-15 Jan-16
Time

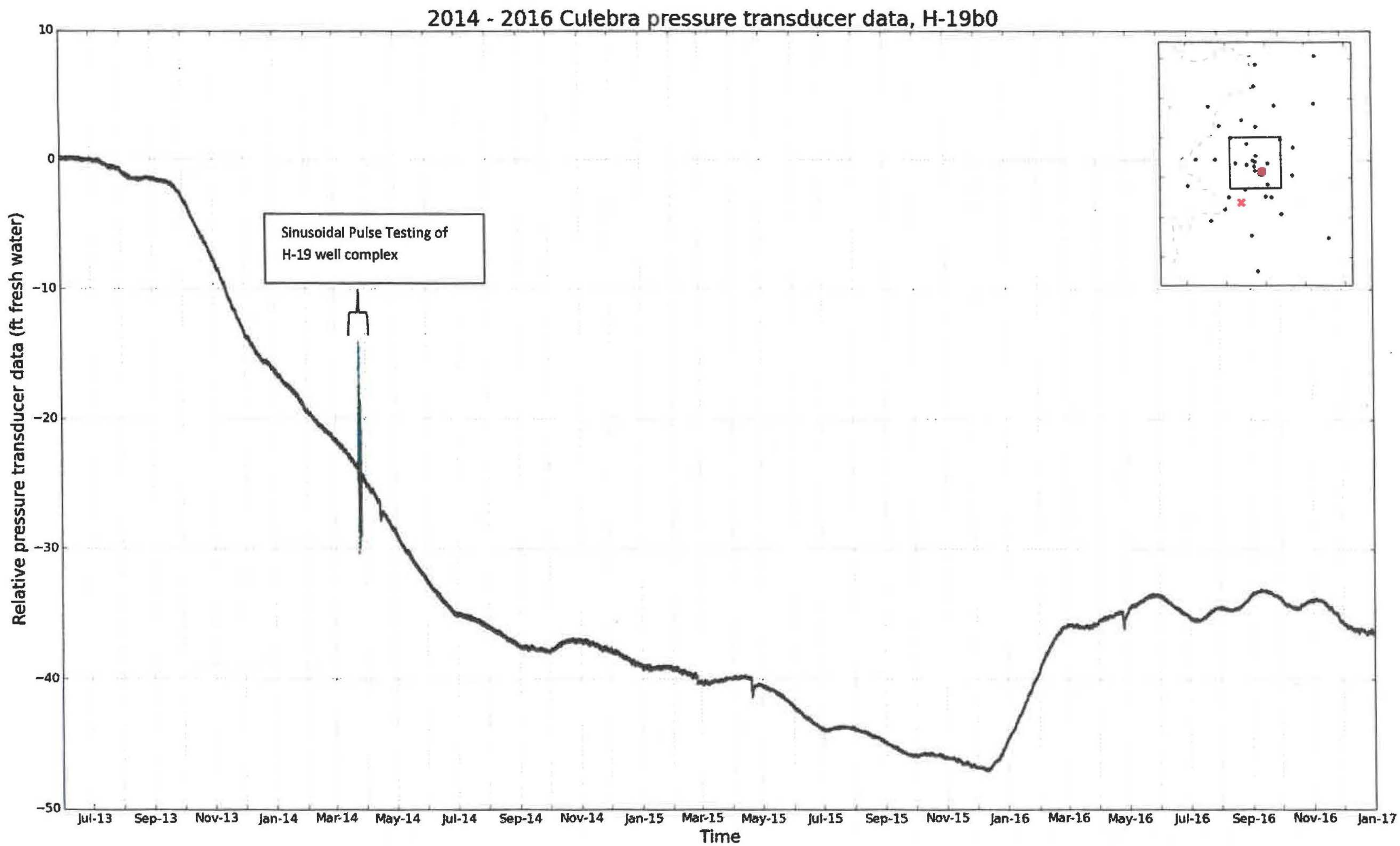


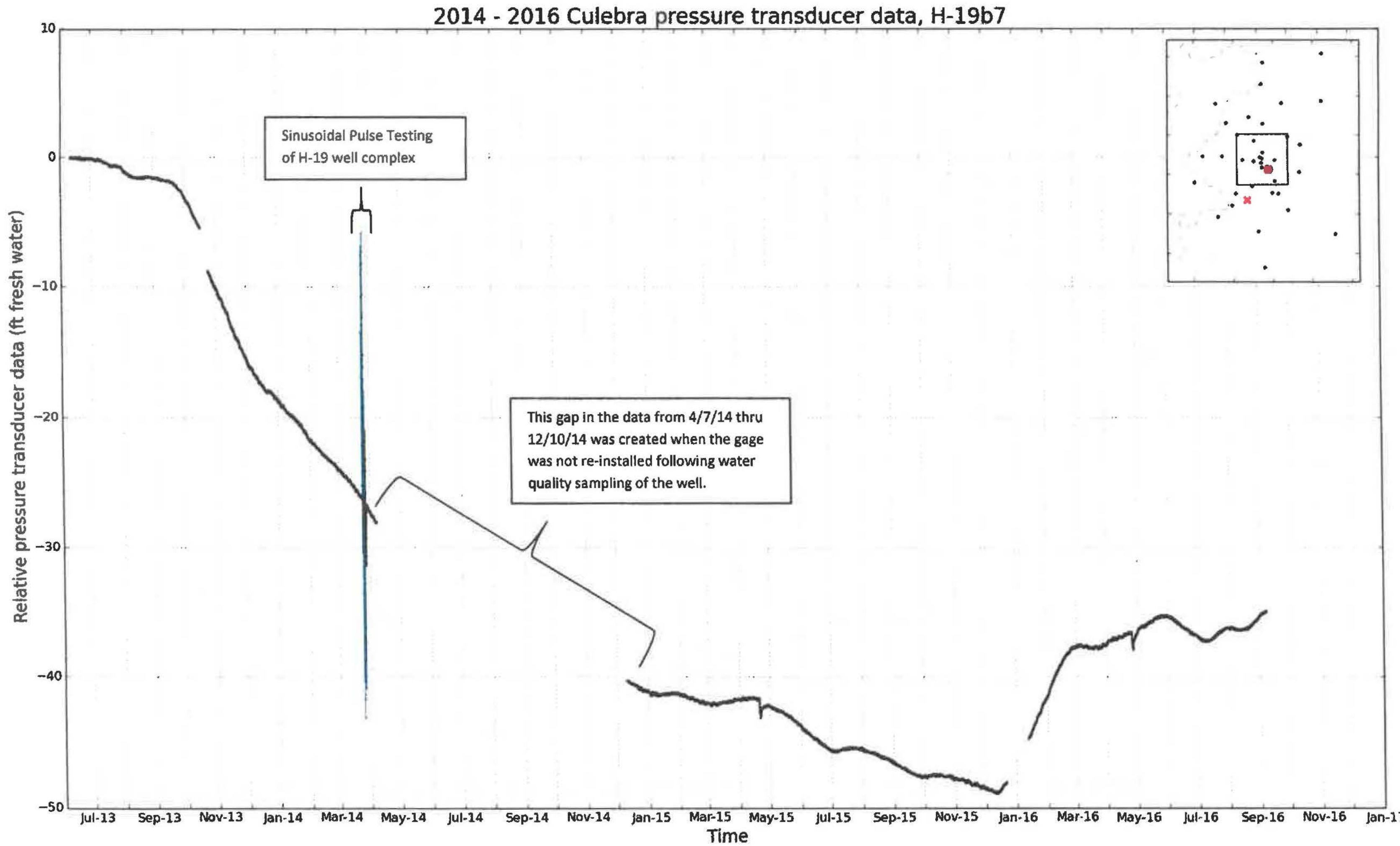
2014 - 2016 Culebra pressure transducer data, H-12R
Relative pressure transducer data (ft fresh water)
Time
50
0
-50
-100
-150
-200
-250
-300
Jul-13
Sep-13
Nov-13
Jan-14
Mar-14
May-14
Jul-14
Sep-14
Nov-14
Jan-15
Mar-15
May-15
Jul-15
Sep-15
Nov-15
Jan-16
Mar-16
May-16
Jul-16
Sep-16
Nov-16
Jan-17
Well development activities including purging, surging and scraping the well.
Data gap from 1/21/15 thru 9/1/15 was the result of a pressure gage failure.
12
10
8
6
4
2
0
-2
Jan-16
Mar-16
May-16
Jul-16
Sep-16
Nov-16

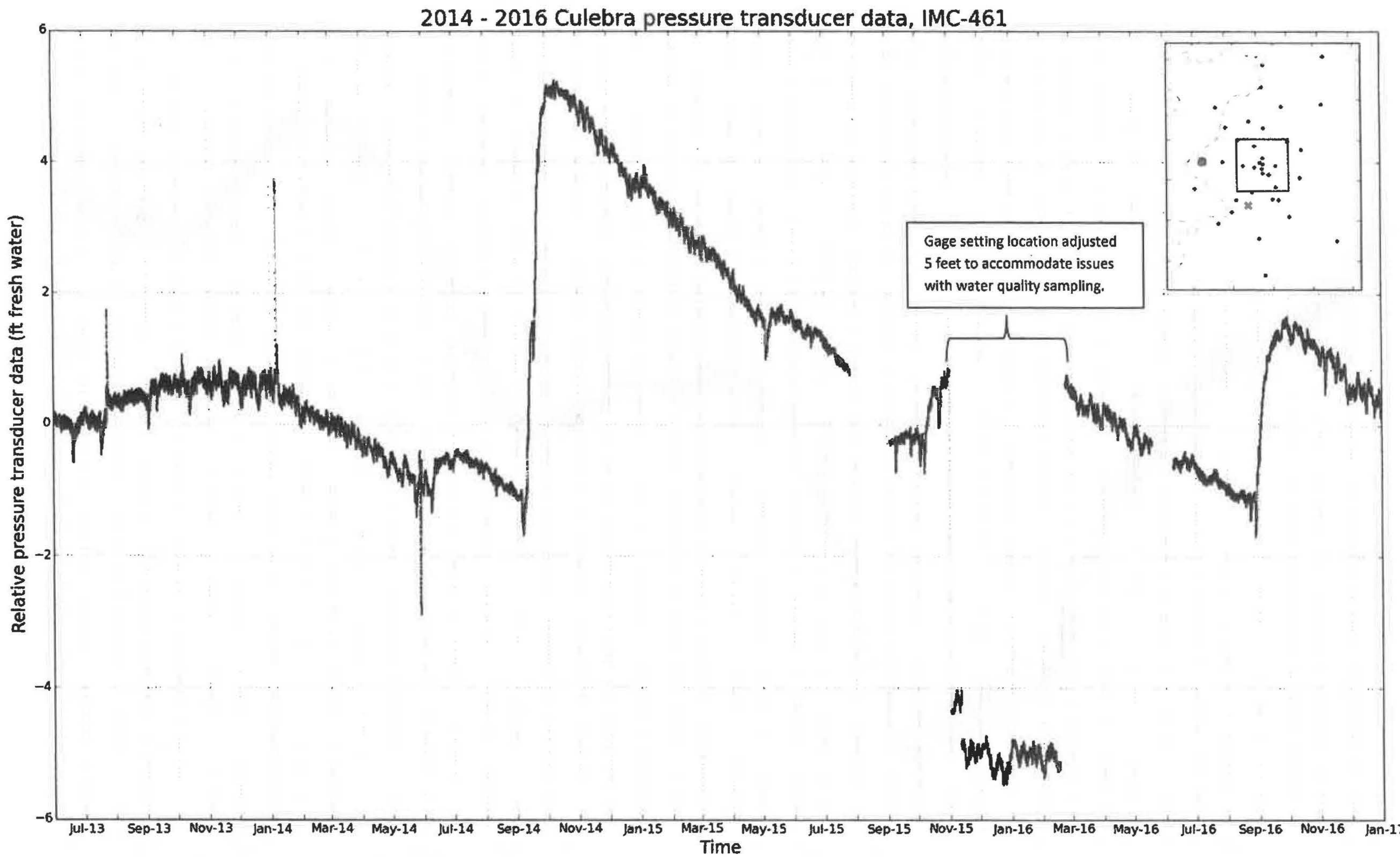

2014 - 2016 Culebra pressure transducer data, H-15R
Relative pressure transducer data (ft fresh water)
Time
10
0
−10
−20
−30
−40
−50
Jul-13
Sep-13
Nov-13
Jan-14
Mar-14
May-14
Jul-14
Sep-14
Nov-14
Jan-15
Mar-15
May-15
Jul-15
Sep-15
Nov-15
Jan-16
Mar-16
May-16
Jul-16
Sep-16
Nov-16
Jan-17

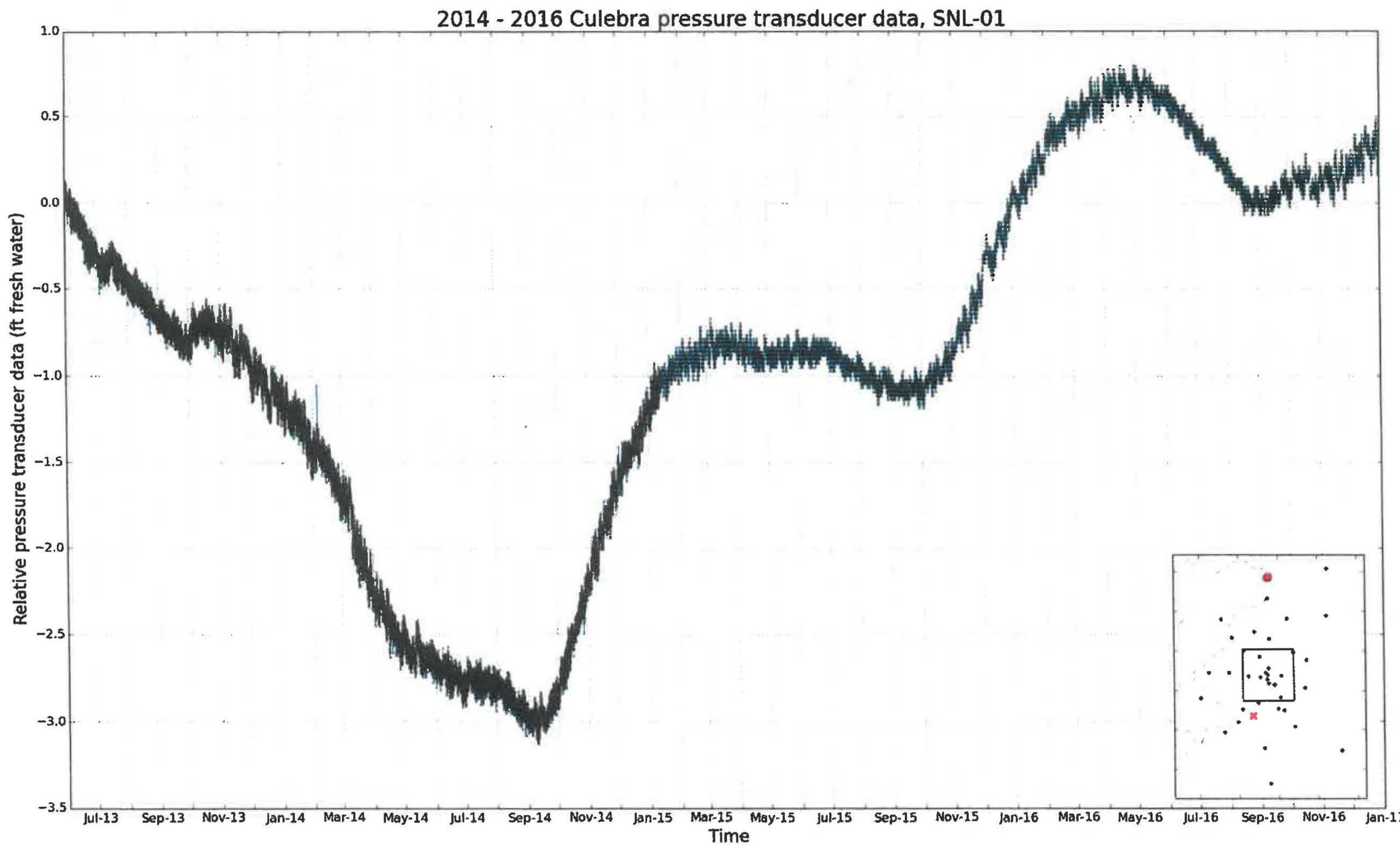

2014 - 2016 Culebra pressure transducer data, H-16
Relative pressure transducer data (ft fresh water)
5
0
-5
-10
-15
-20
Jul-13
Sep-13
Nov-13
Jan-14
Mar-14
May-14
Jul-14
Sep-14
Nov-14
Jan-15
Mar-15
May-15
Jul-15
Sep-15
Nov-15
Jan-16
Mar-16
May-16
Jul-16
Sep-16
Nov-16
Jan-17
Time

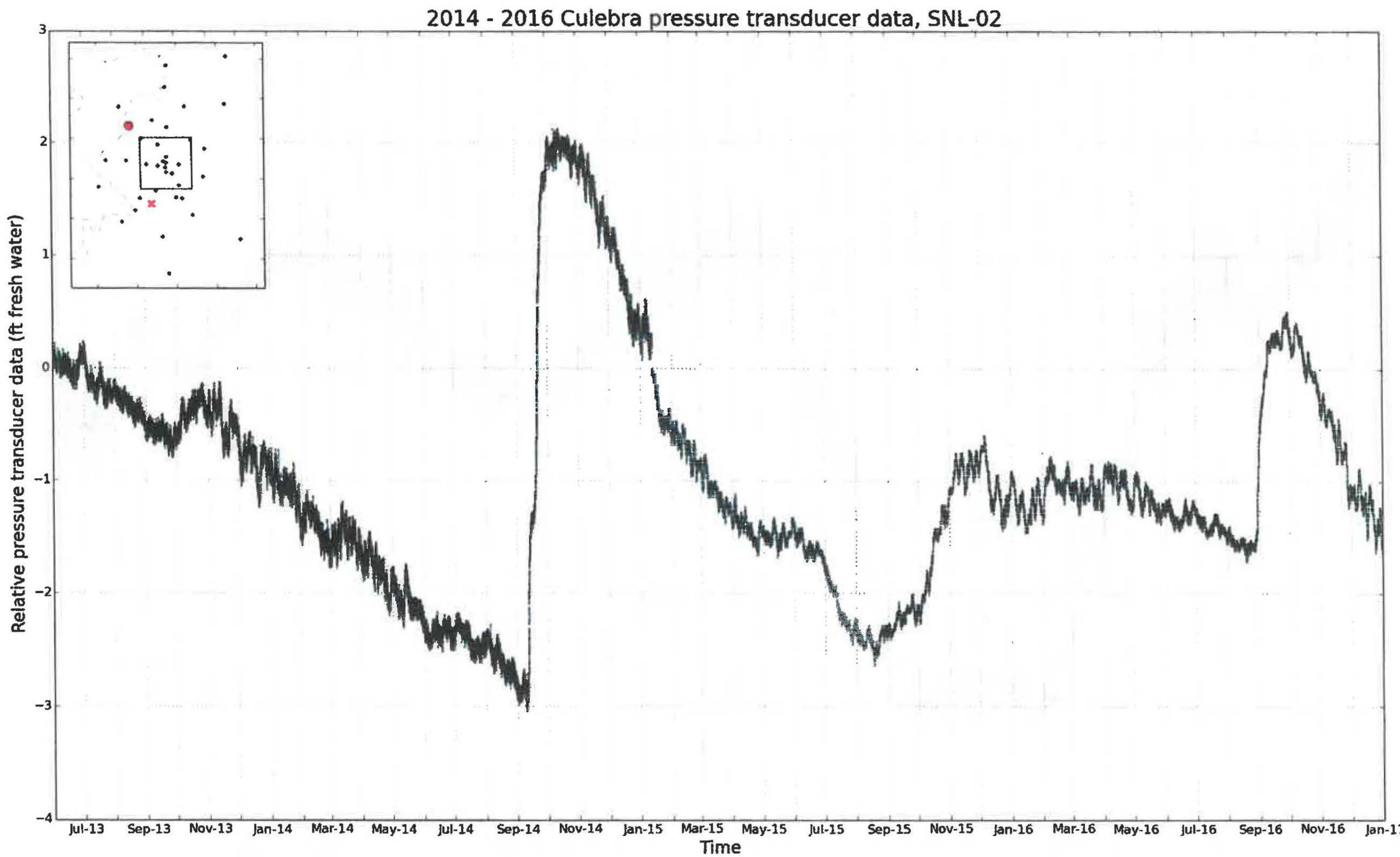

2014 - 2016 Culebra pressure transducer data, H-17
Relative pressure transducer data (ft fresh water)
10
0
−10
−20
−30
−40
−50
−60
Jul-13
Sep-13
Nov-13
Jan-14
Mar-14
May-14
Jul-14
Sep-14
Nov-14
Jan-15
Mar-15
May-15
Jul-15
Sep-15
Nov-15
Jan-16
Mar-16
May-16
Jul-16
Sep-16
Nov-16
Jan-17
Time

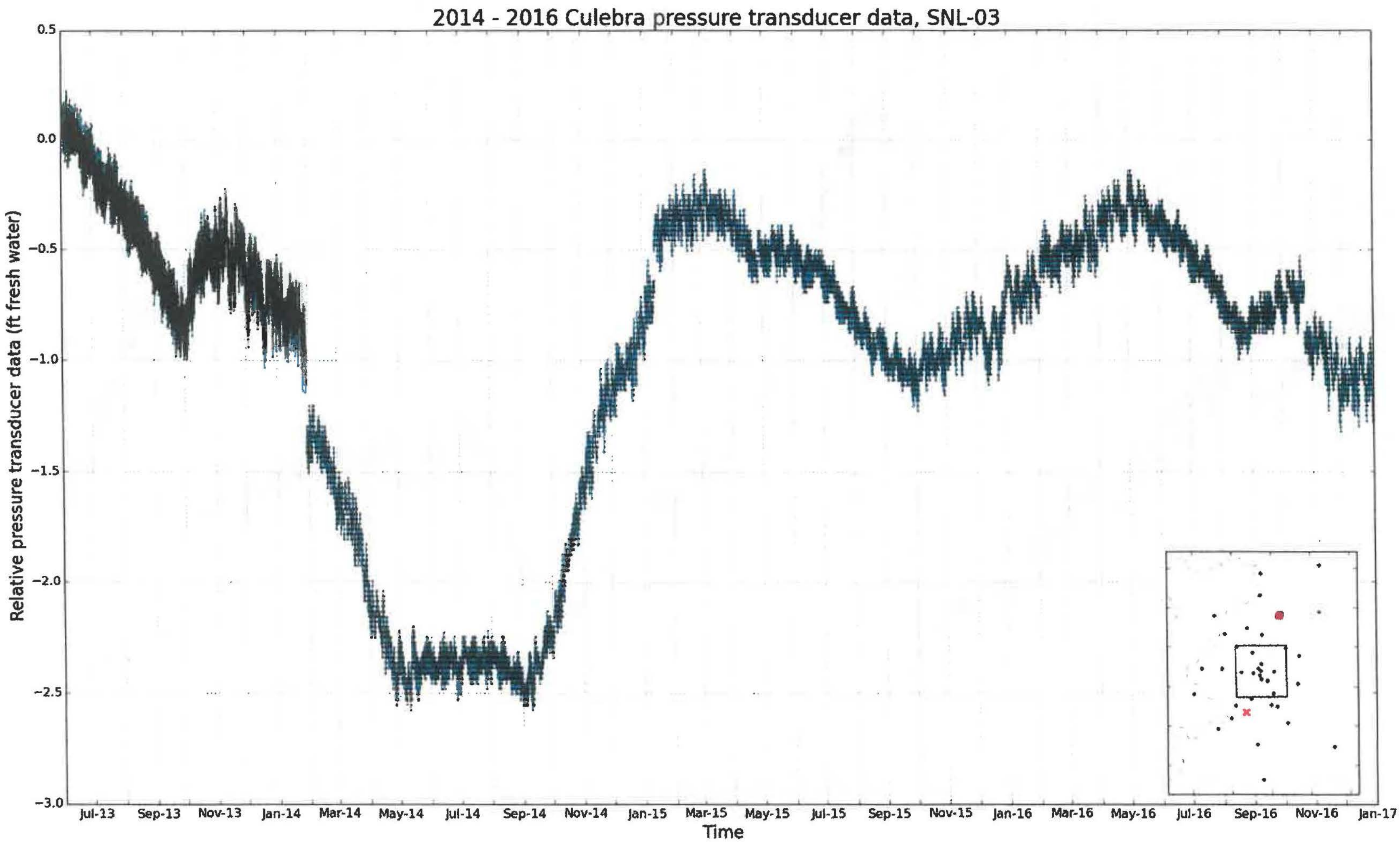

2014 - 2016 Culebra pressure transducer data, H-19b0
Relative pressure transducer data (ft fresh water)
10
0
−10
−20
−30
−40
−50
Sinusoidal Pulse Testing of
H-19 well complex
Jul-13
Sep-13
Nov-13
Jan-14
Mar-14
May-14
Jul-14
Sep-14
Nov-14
Jan-15
Mar-15
May-15
Jul-15
Sep-15
Nov-15
Jan-16
Mar-16
May-16
Jul-16
Sep-16
Nov-16
Jan-17
Time

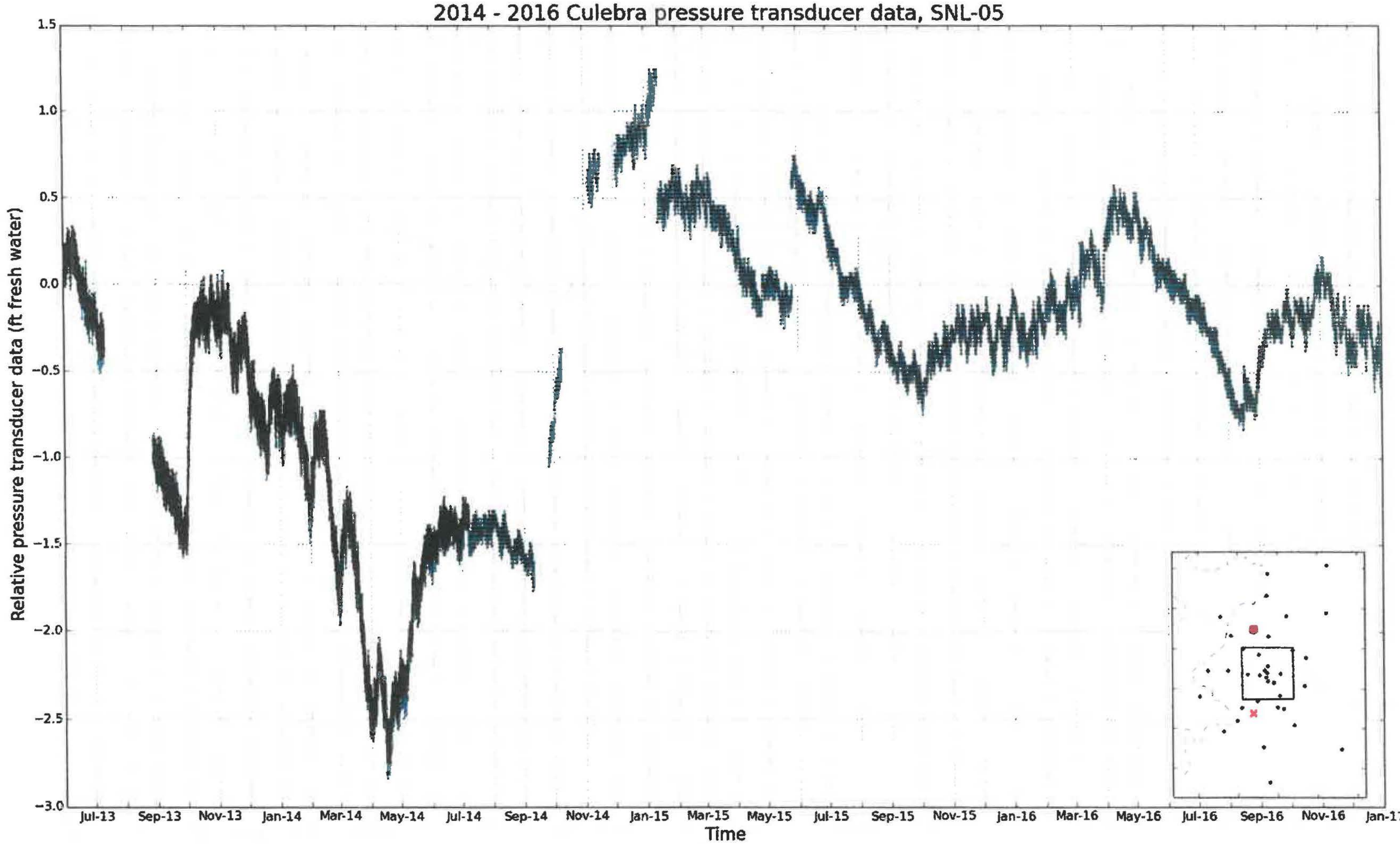

2014 - 2016 Culebra pressure transducer data, H-19b7
Sinusoidal Pulse Testing of H-19 well complex
This gap in the data from 4/7/14 thru 12/10/14 was created when the gage was not re-installed following water quality sampling of the well.
Relative pressure transducer data (ft fresh water)
10
0
−10
−20
−30
−40
−50
Jul-13
Sep-13
Nov-13
Jan-14
Mar-14
May-14
Jul-14
Sep-14
Nov-14
Jan-15
Mar-15
May-15
Jul-15
Sep-15
Nov-15
Jan-16
Mar-16
May-16
Jul-16
Sep-16
Nov-16
Jan-17
Time


2014 - 2016 Culebra pressure transducer data, IMC-461
Relative pressure transducer data (ft fresh water)
6
4
2
0
-2
-4
-6
Jul-13
Sep-13
Nov-13
Jan-14
Mar-14
May-14
Jul-14
Sep-14
Nov-14
Jan-15
Mar-15
May-15
Jul-15
Sep-15
Nov-15
Jan-16
Mar-16
May-16
Jul-16
Sep-16
Nov-16
Jan-17
Time
Gage setting location adjusted 5 feet to accommodate issues with water quality sampling.

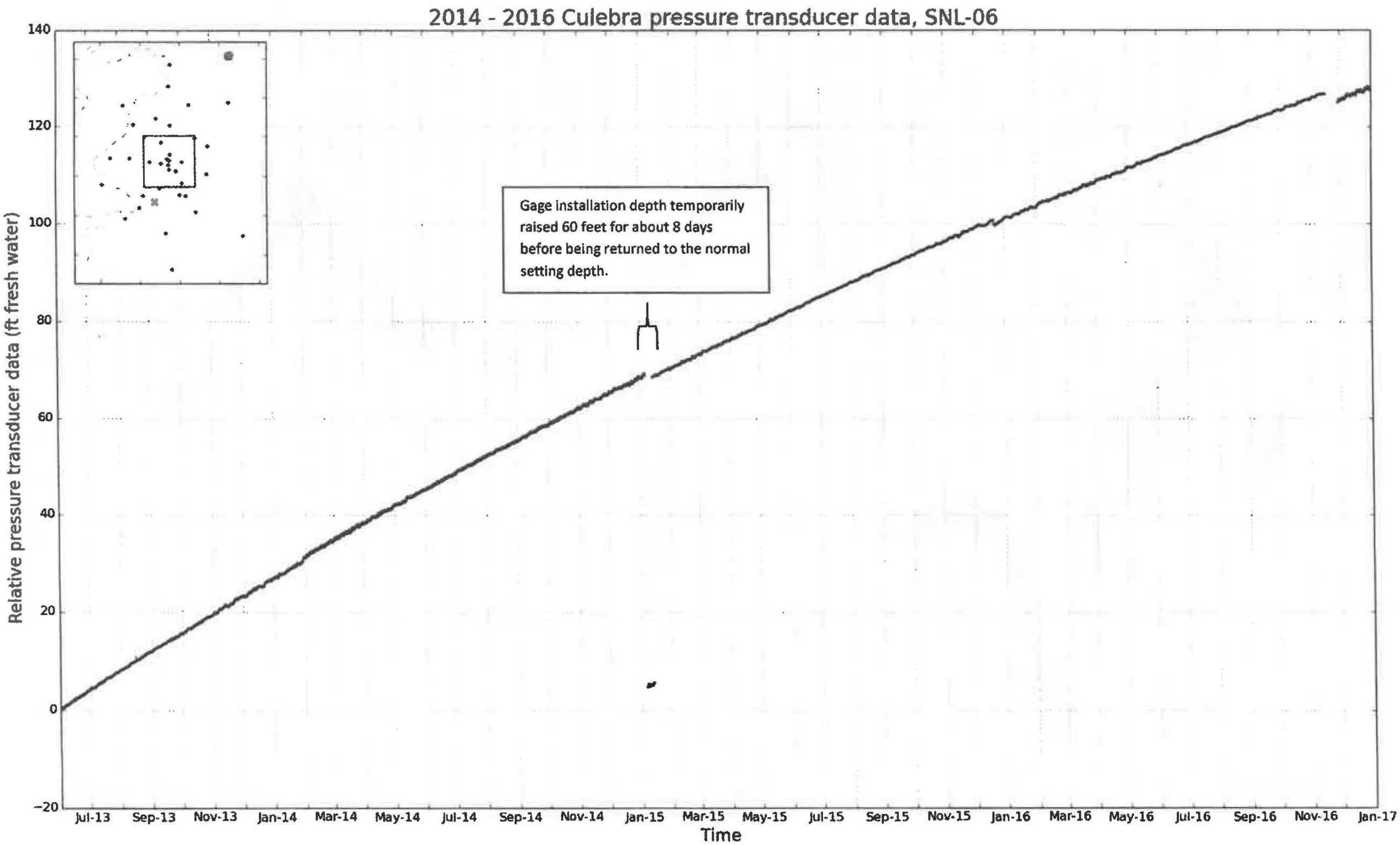

2014 - 2016 Culebra pressure transducer data, SNL-01
Relative pressure transducer data (ft fresh water)
1.0
0.5
0.0
−0.5
−1.0
−1.5
−2.0
−2.5
−3.0
−3.5
Jul-13
Sep-13
Nov-13
Jan-14
Mar-14
May-14
Jul-14
Sep-14
Nov-14
Jan-15
Mar-15
May-15
Jul-15
Sep-15
Nov-15
Jan-16
Mar-16
May-16
Jul-16
Sep-16
Nov-16
Jan-17
Time


2014 - 2016 Culebra pressure transducer data, SNL-02
Relative pressure transducer data (ft fresh water)
3
2
1
0
-1
-2
-3
-4
Jul-13
Sep-13
Nov-13
Jan-14
Mar-14
May-14
Jul-14
Sep-14
Nov-14
Jan-15
Mar-15
May-15
Jul-15
Sep-15
Nov-15
Jan-16
Mar-16
May-16
Jul-16
Sep-16
Nov-16
Jan-17
Time

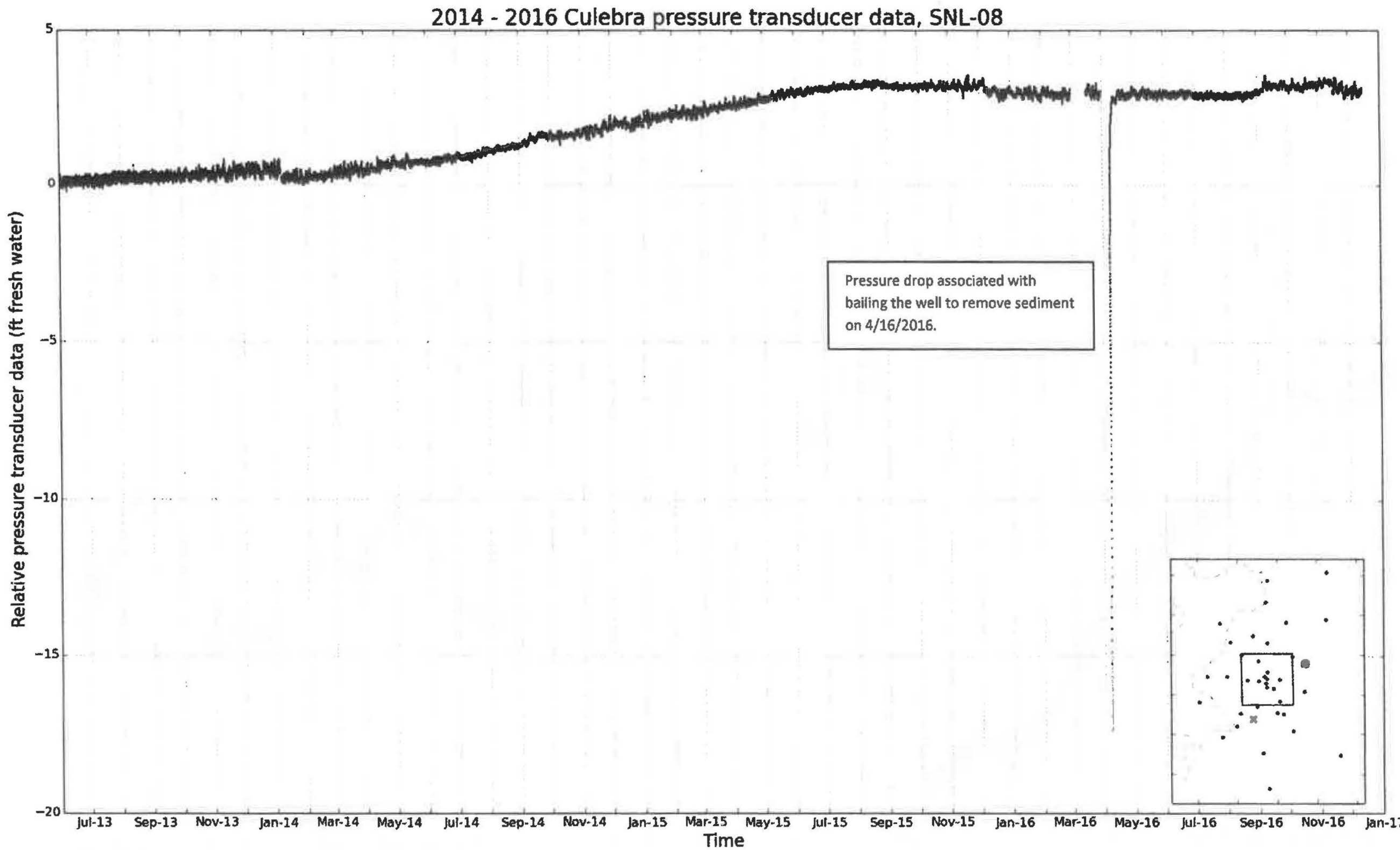

2014 - 2016 Culebra pressure transducer data, SNL-03
Relative pressure transducer data (ft fresh water)
0.5
0.0
−0.5
−1.0
−1.5
−2.0
−2.5
−3.0
Jul-13
Sep-13
Nov-13
Jan-14
Mar-14
May-14
Jul-14
Sep-14
Nov-14
Jan-15
Mar-15
May-15
Jul-15
Sep-15
Nov-15
Jan-16
Mar-16
May-16
Jul-16
Sep-16
Nov-16
Jan-17
Time

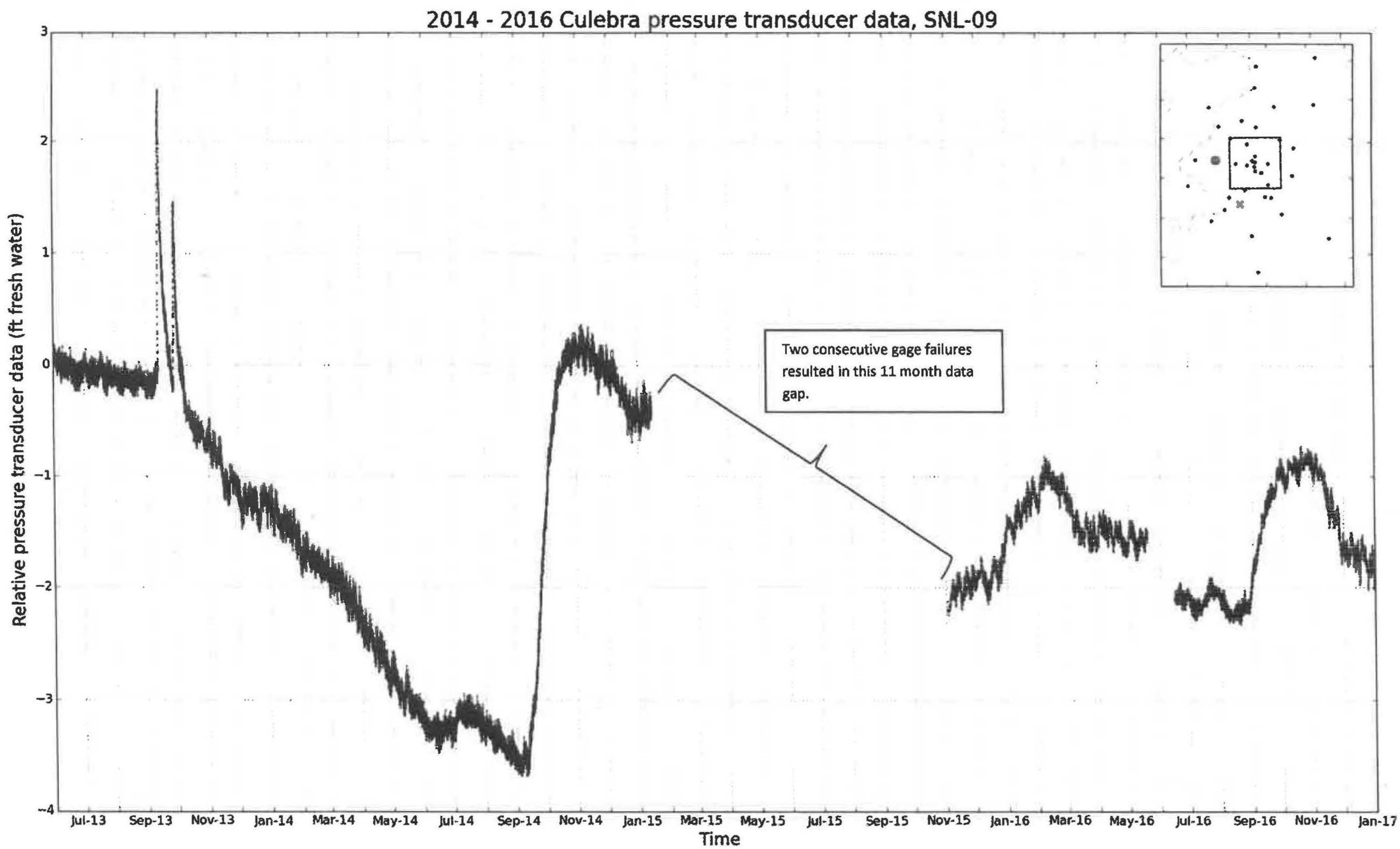


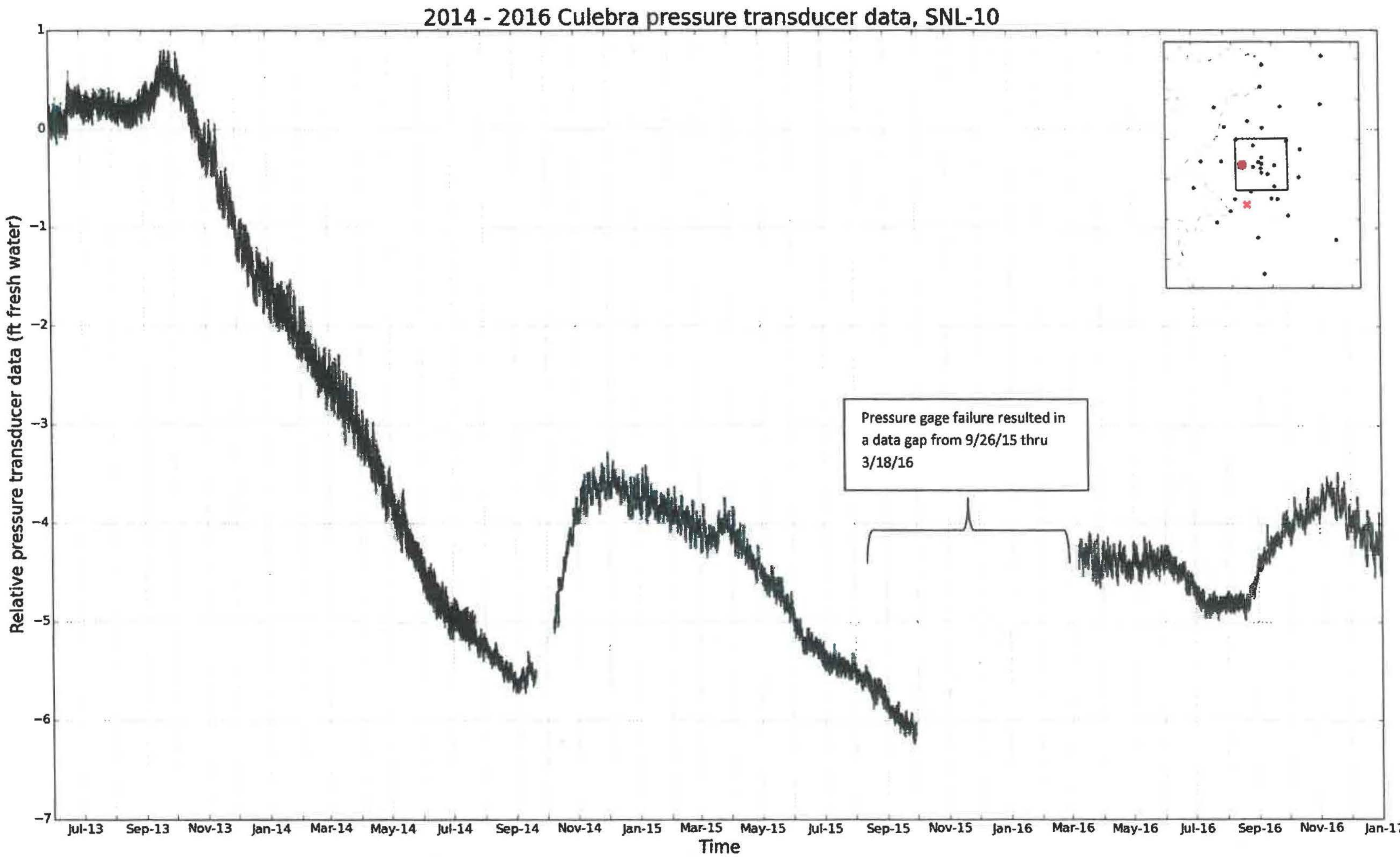
2014 - 2016 Culebra pressure transducer data, SNL-05
Relative pressure transducer data (ft fresh water)
1.5
1.0
0.5
0.0
−0.5
−1.0
−1.5
−2.0
−2.5
−3.0
Jul-13
Sep-13
Nov-13
Jan-14
Mar-14
May-14
Jul-14
Sep-14
Nov-14
Jan-15
Mar-15
May-15
Jul-15
Sep-15
Nov-15
Jan-16
Mar-16
May-16
Jul-16
Sep-16
Nov-16
Jan-17
Time

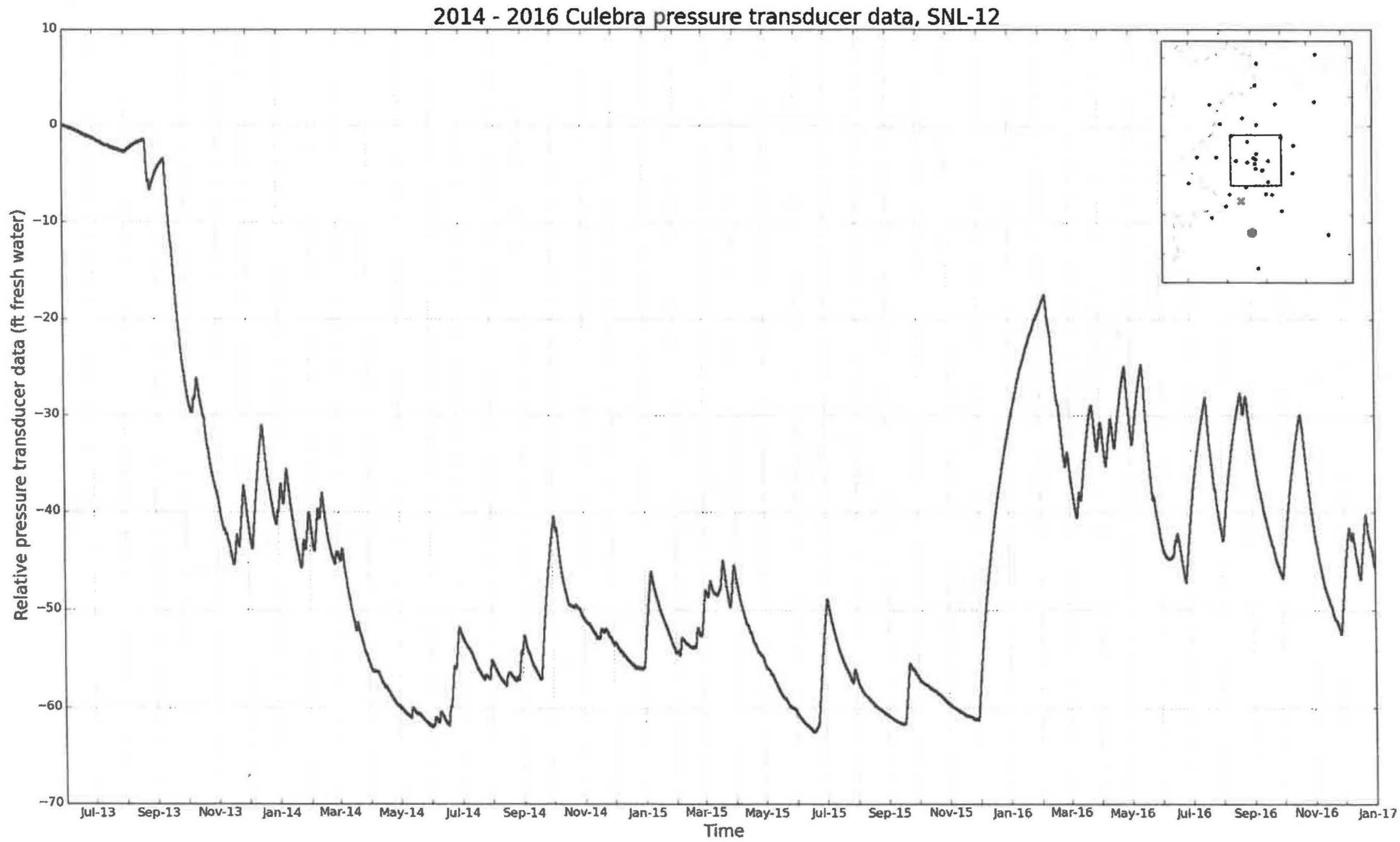


2014 - 2016 Culebra pressure transducer data, SNL-06
Gage installation depth temporarily raised 60 feet for about 8 days before being returned to the normal setting depth.
Relative pressure transducer data (ft fresh water)
140
120
100
80
60
40
20
0
−20
Jul-13
Sep-13
Nov-13
Jan-14
Mar-14
May-14
Jul-14
Sep-14
Nov-14
Jan-15
Mar-15
May-15
Jul-15
Sep-15
Nov-15
Jan-16
Mar-16
May-16
Jul-16
Sep-16
Nov-16
Jan-17
Time

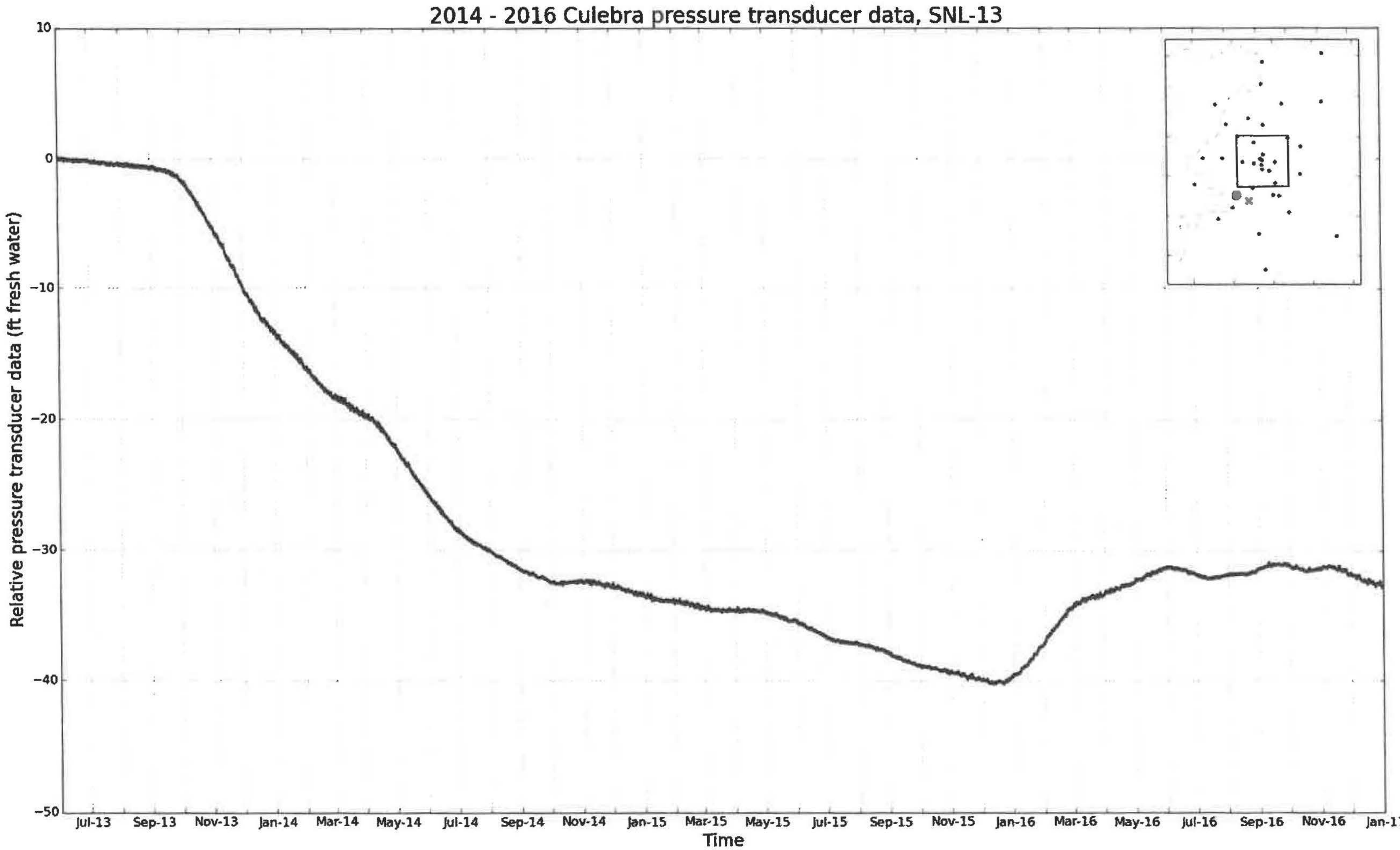

2014 - 2016 Culebra pressure transducer data, SNL-08
Relative pressure transducer data (ft fresh water)
5
0
−5
−10
−15
−20
Pressure drop associated with bailing the well to remove sediment on 4/16/2016.
Jul-13
Sep-13
Nov-13
Jan-14
Mar-14
May-14
Jul-14
Sep-14
Nov-14
Jan-15
Mar-15
May-15
Jul-15
Sep-15
Nov-15
Jan-16
Mar-16
May-16
Jul-16
Sep-16
Nov-16
Jan-17
Time


2014 - 2016 Culebra pressure transducer data, SNL-09
Relative pressure transducer data (ft fresh water)
3
2
1
0
−1
−2
−3
−4
Jul-13
Sep-13
Nov-13
Jan-14
Mar-14
May-14
Jul-14
Sep-14
Nov-14
Jan-15
Mar-15
May-15
Jul-15
Sep-15
Nov-15
Jan-16
Mar-16
May-16
Jul-16
Sep-16
Nov-16
Jan-17
Time
Two consecutive gage failures resulted in this 11 month data gap.

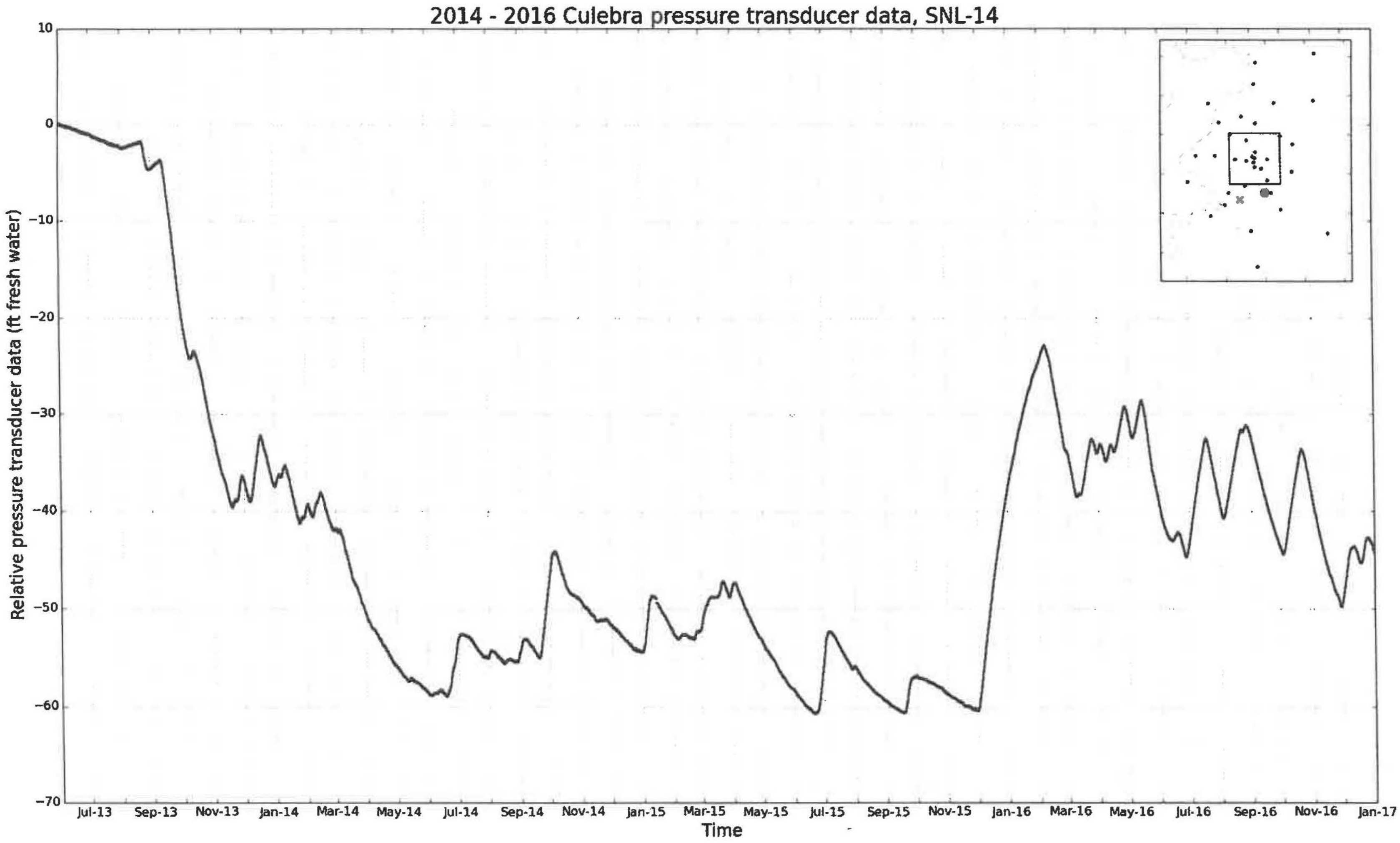

2014 - 2016 Culebra pressure transducer data, SNL-10
Relative pressure transducer data (ft fresh water)
1
0
−1
−2
−3
−4
−5
−6
−7
Pressure gage failure resulted in a data gap from 9/26/15 thru 3/18/16
Jul-13
Sep-13
Nov-13
Jan-14
Mar-14
May-14
Jul-14
Sep-14
Nov-14
Jan-15
Mar-15
May-15
Jul-15
Sep-15
Nov-15
Jan-16
Mar-16
May-16
Jul-16
Sep-16
Nov-16
Jan-17
Time



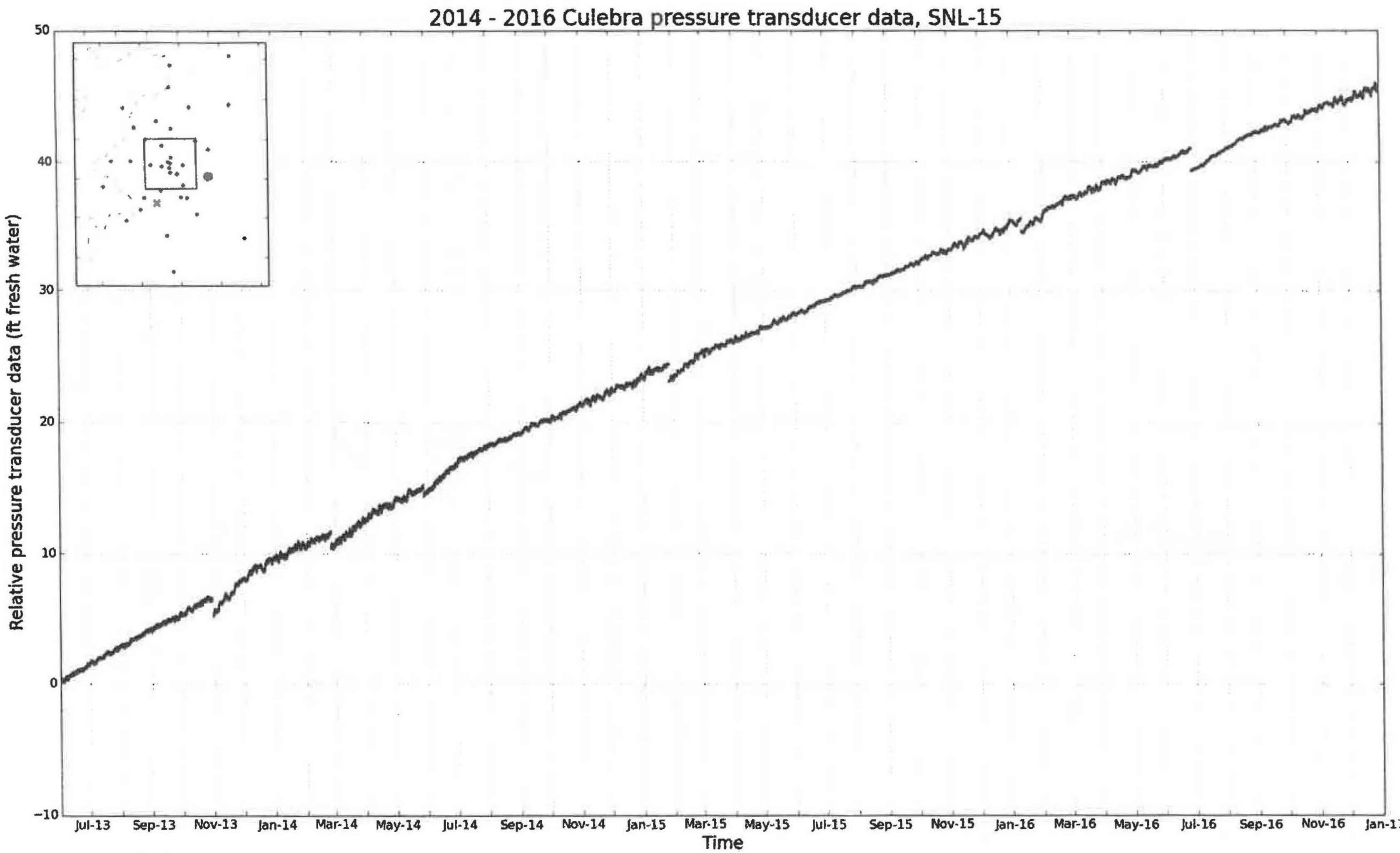
2014 - 2016 Culebra pressure transducer data, SNL-12
Relative pressure transducer data (ft fresh water)
10
0
−10
−20
−30
−40
−50
−60
−70
Jul-13
Sep-13
Nov-13
Jan-14
Mar-14
May-14
Jul-14
Sep-14
Nov-14
Jan-15
Mar-15
May-15
Jul-15
Sep-15
Nov-15
Jan-16
Mar-16
May-16
Jul-16
Sep-16
Nov-16
Jan-17
Time



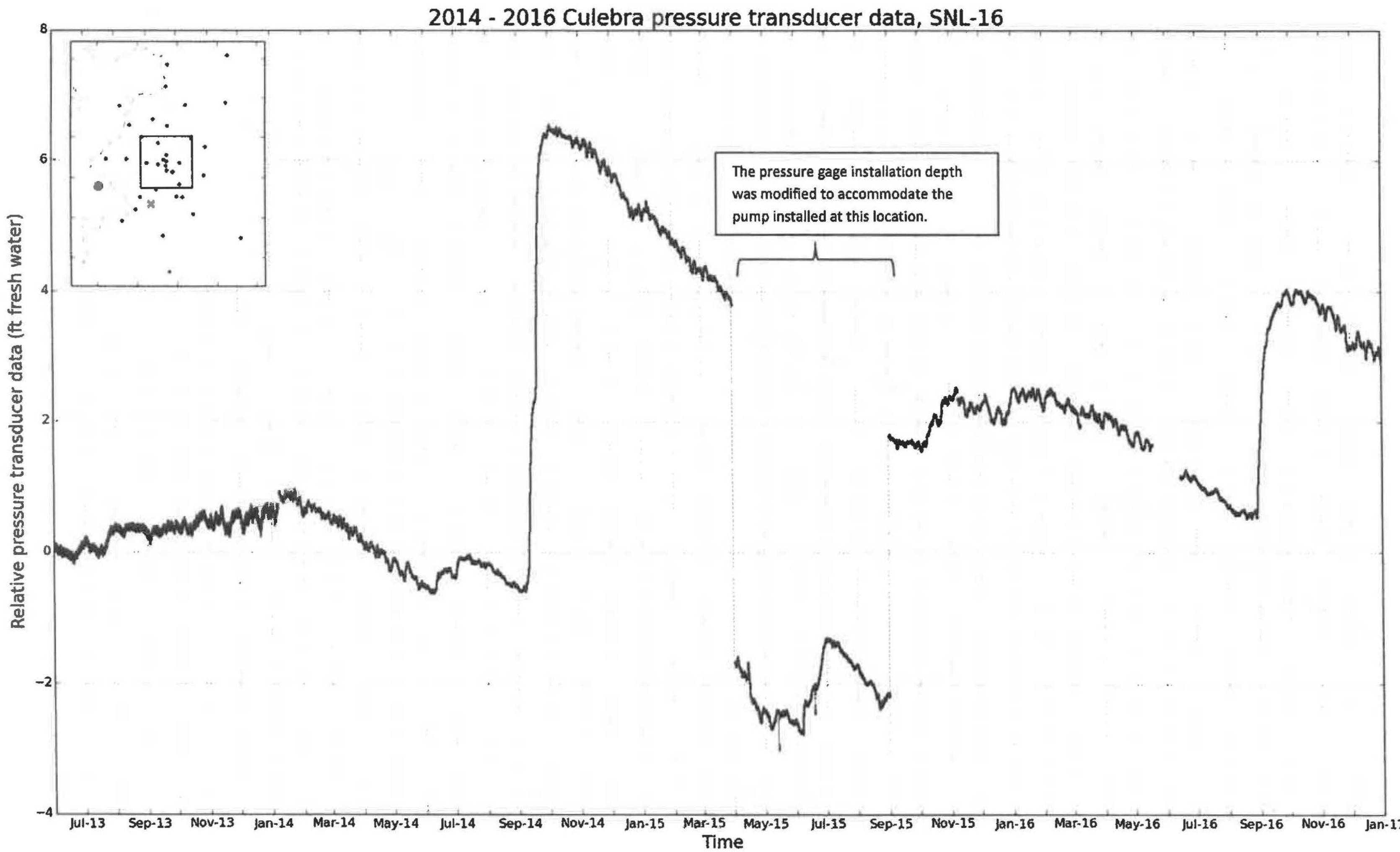
2014 - 2016 Culebra pressure transducer data, SNL-13
Relative pressure transducer data (ft fresh water)
10
0
-10
-20
-30
-40
-50
Jul-13
Sep-13
Nov-13
Jan-14
Mar-14
May-14
Jul-14
Sep-14
Nov-14
Jan-15
Mar-15
May-15
Jul-15
Sep-15
Nov-15
Jan-16
Mar-16
May-16
Jul-16
Sep-16
Nov-16
Jan-17
Time

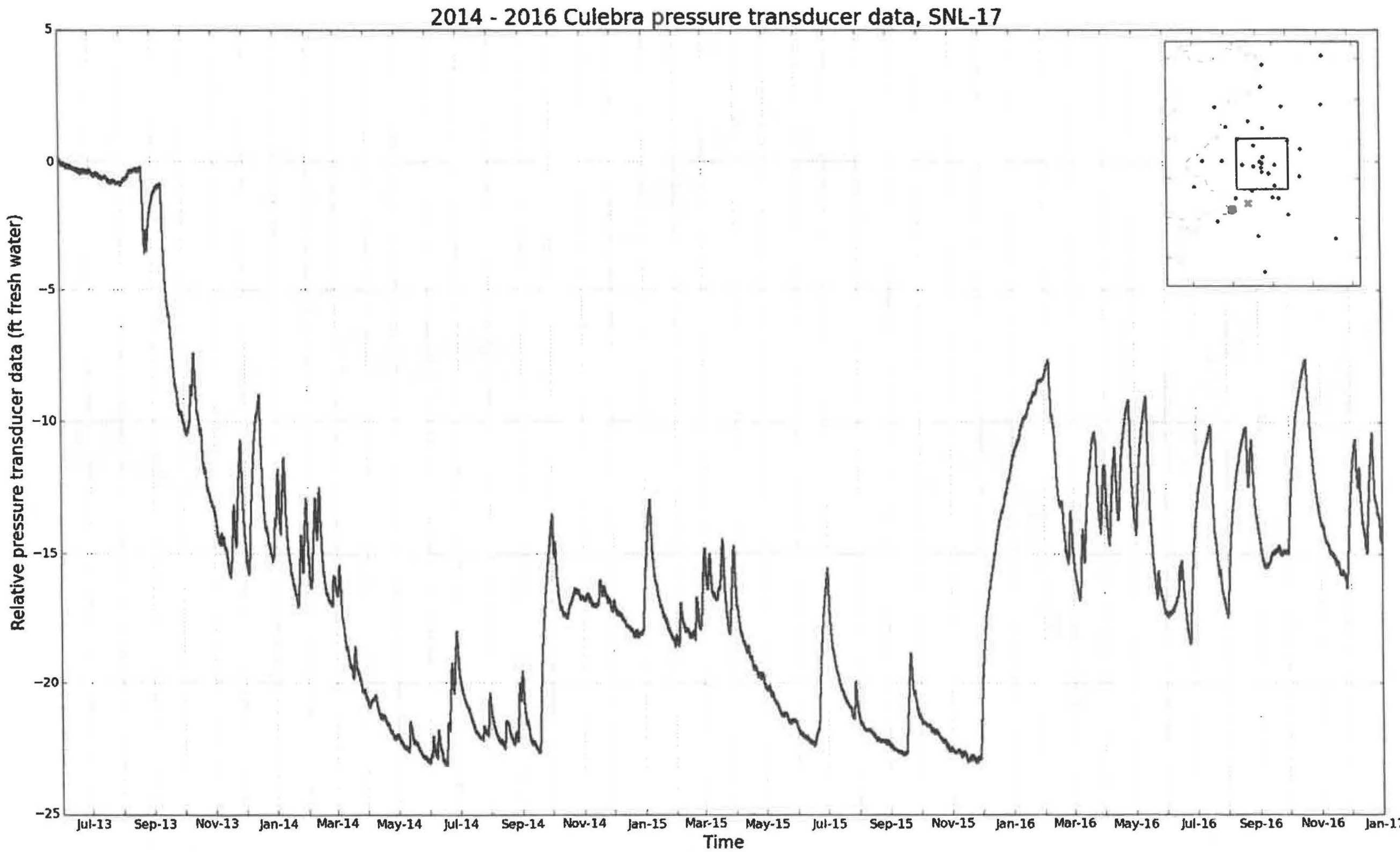


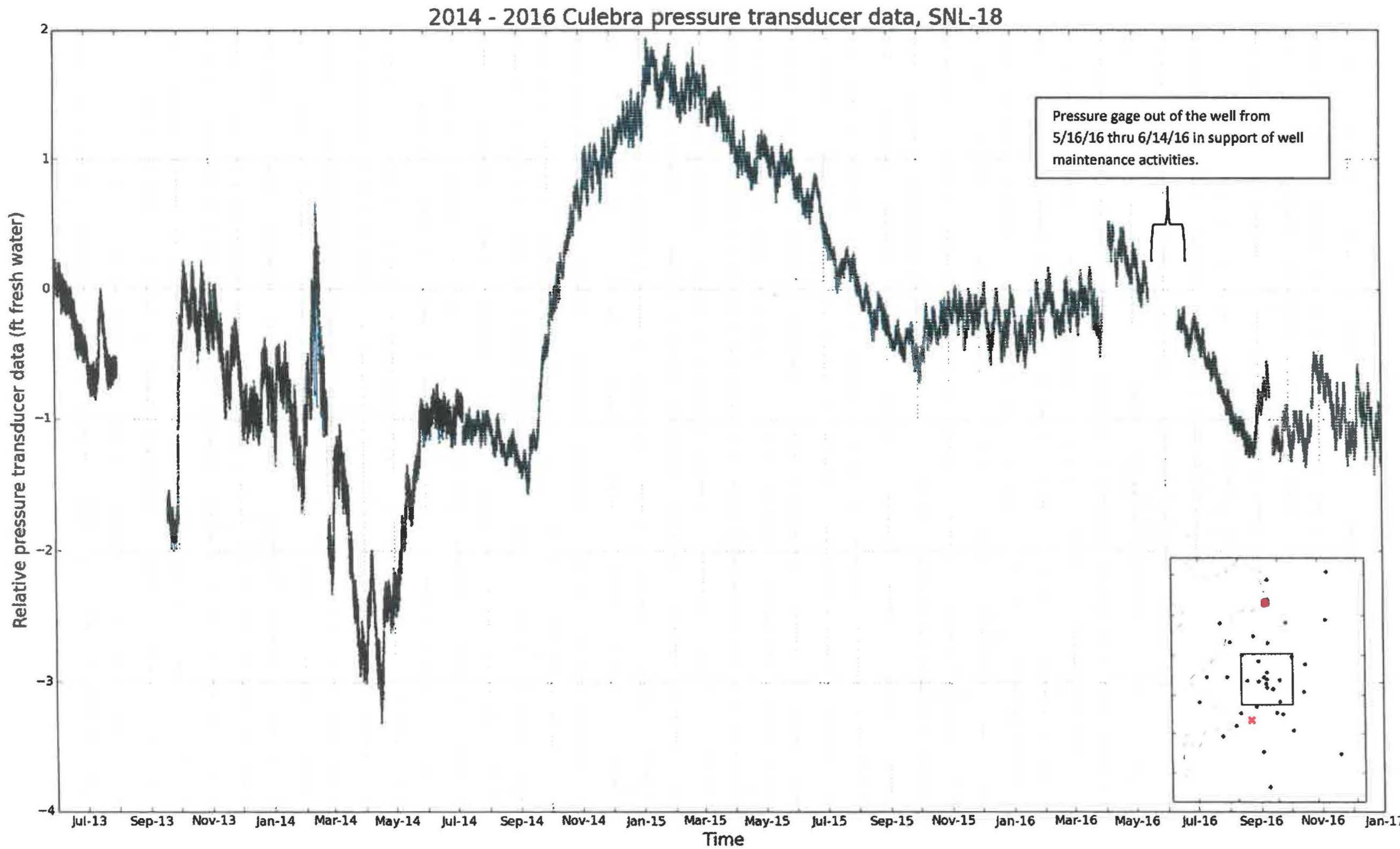
2014 - 2016 Culebra pressure transducer data, SNL-14
Relative pressure transducer data (ft fresh water)
10
0
−10
−20
−30
−40
−50
−60
−70
Jul-13
Sep-13
Nov-13
Jan-14
Mar-14
May-14
Jul-14
Sep-14
Nov-14
Jan-15
Mar-15
May-15
Jul-15
Sep-15
Nov-15
Jan-16
Mar-16
May-16
Jul-16
Sep-16
Nov-16
Jan-17
Time



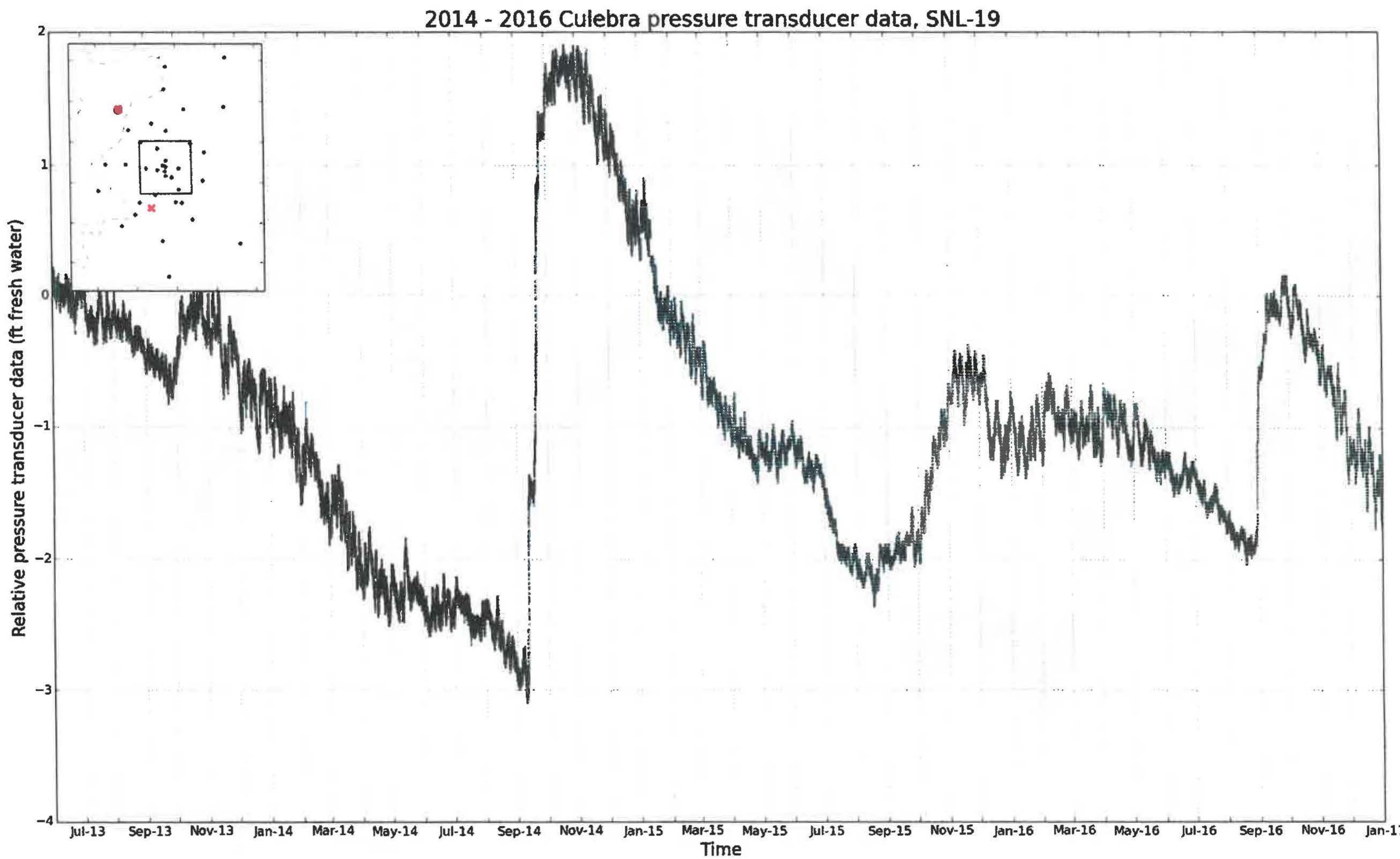
2014 - 2016 Culebra pressure transducer data, SNL-15
Relative pressure transducer data (ft fresh water)
50
40
30
20
10
0
−10
Jul-13
Sep-13
Nov-13
Jan-14
Mar-14
May-14
Jul-14
Sep-14
Nov-14
Jan-15
Mar-15
May-15
Jul-15
Sep-15
Nov-15
Jan-16
Mar-16
May-16
Jul-16
Sep-16
Nov-16
Jan-17
Time

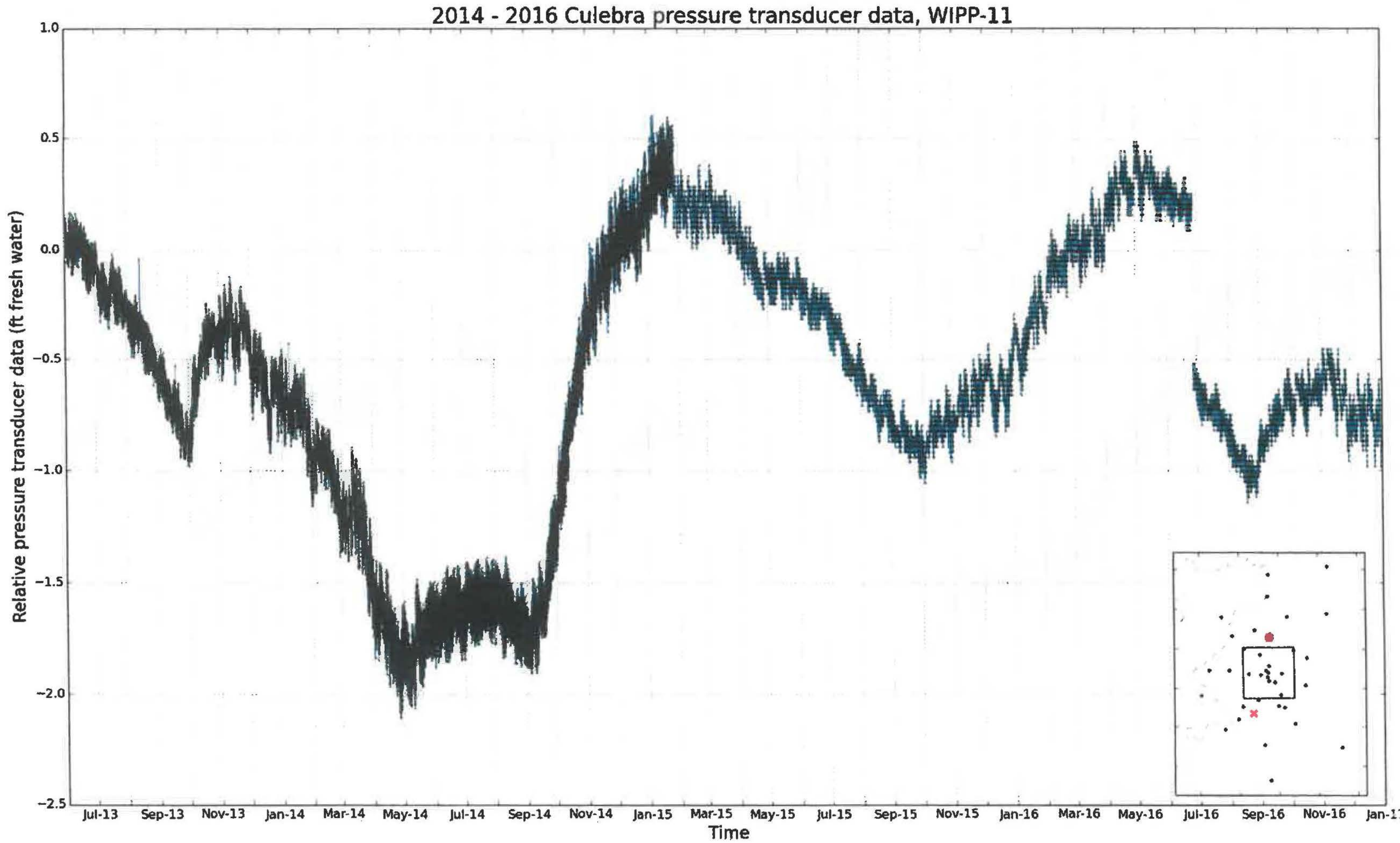

2014 - 2016 Culebra pressure transducer data, SNL-16
Relative pressure transducer data (ft fresh water)
Time
The pressure gage installation depth was modified to accommodate the pump installed at this location.
8
6
4
2
0
−2
−4
Jul-13
Sep-13
Nov-13
Jan-14
Mar-14
May-14
Jul-14
Sep-14
Nov-14
Jan-15
Mar-15
May-15
Jul-15
Sep-15
Nov-15
Jan-16
Mar-16
May-16
Jul-16
Sep-16
Nov-16
Jan-17

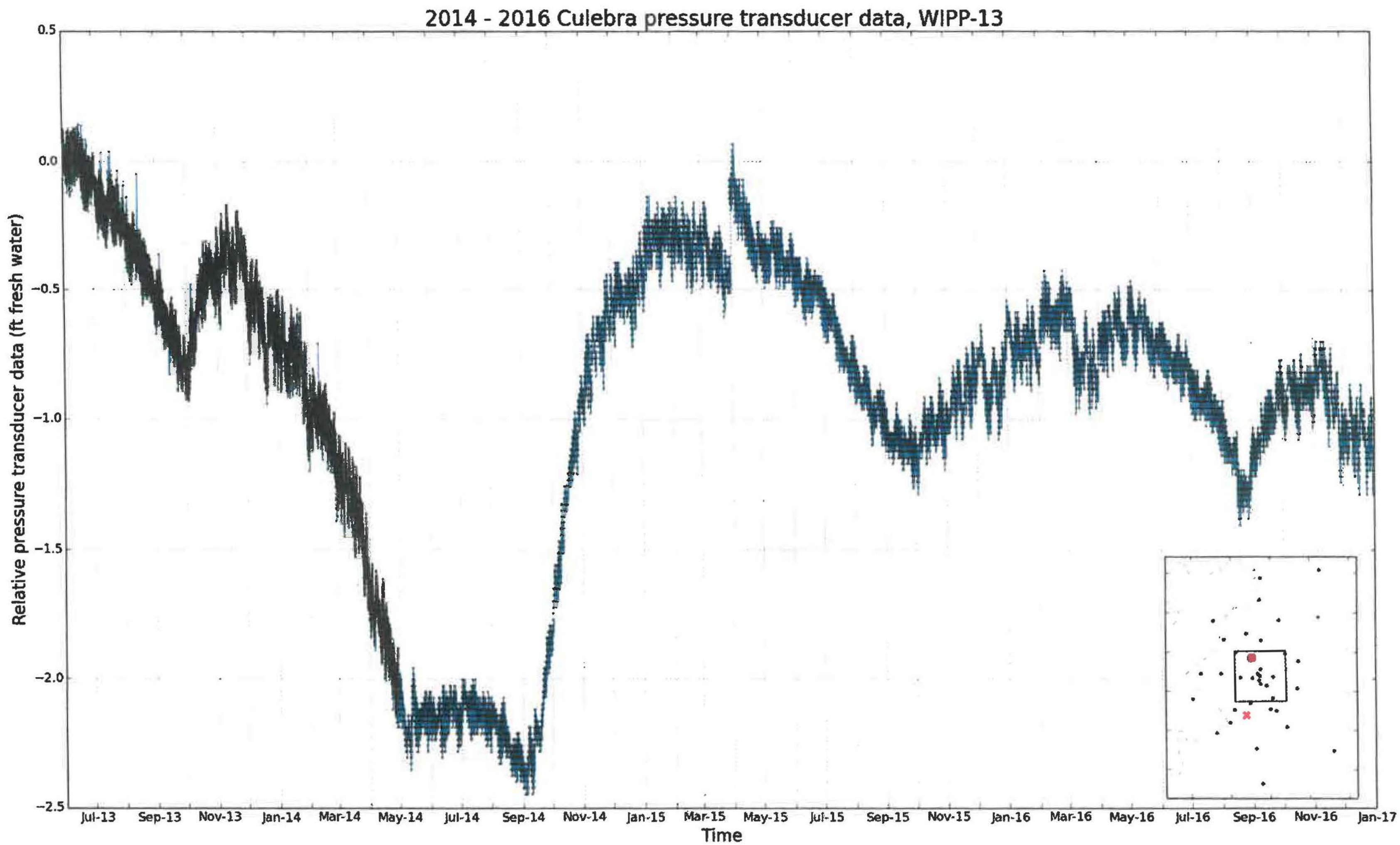

2014 - 2016 Culebra pressure transducer data, SNL-17
Relative pressure transducer data (ft fresh water)
Time
5
0
−5
−10
−15
−20
−25
Jul-13
Sep-13
Nov-13
Jan-14
Mar-14
May-14
Jul-14
Sep-14
Nov-14
Jan-15
Mar-15
May-15
Jul-15
Sep-15
Nov-15
Jan-16
Mar-16
May-16
Jul-16
Sep-16
Nov-16
Jan-17

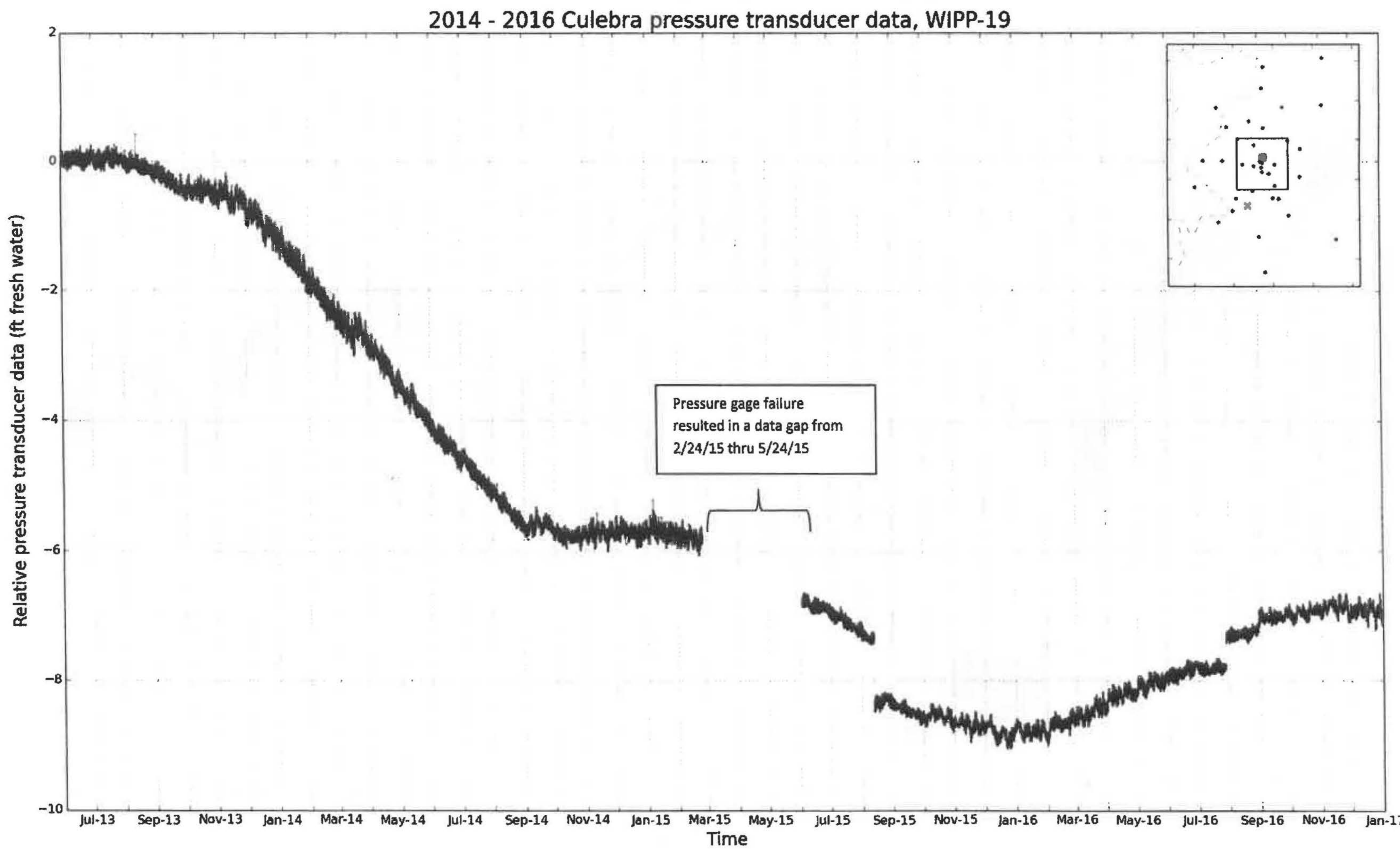


2014 - 2016 Culebra pressure transducer data, SNL-18
Relative pressure transducer data (ft fresh water)
Time
2
1
0
-1
-2
-3
-4
Jul-13
Sep-13
Nov-13
Jan-14
Mar-14
May-14
Jul-14
Sep-14
Nov-14
Jan-15
Mar-15
May-15
Jul-15
Sep-15
Nov-15
Jan-16
Mar-16
May-16
Jul-16
Sep-16
Nov-16
Jan-17
Pressure gage out of the well from 5/16/16 thru 6/14/16 in support of well maintenance activities.


2014 - 2016 Culebra pressure transducer data, SNL-19
Relative pressure transducer data (ft fresh water)
2
1
0
-1
-2
-3
-4
Jul-13
Sep-13
Nov-13
Jan-14
Mar-14
May-14
Jul-14
Sep-14
Nov-14
Jan-15
Mar-15
May-15
Jul-15
Sep-15
Nov-15
Jan-16
Mar-16
May-16
Jul-16
Sep-16
Nov-16
Jan-17
Time


2014 - 2016 Culebra pressure transducer data, WIPP-11
Relative pressure transducer data (ft fresh water)
1.0
0.5
0.0
−0.5
−1.0
−1.5
−2.0
−2.5
Jul-13
Sep-13
Nov-13
Jan-14
Mar-14
May-14
Jul-14
Sep-14
Nov-14
Jan-15
Mar-15
May-15
Jul-15
Sep-15
Nov-15
Jan-16
Mar-16
May-16
Jul-16
Sep-16
Nov-16
Jan-17
Time


2014 - 2016 Culebra pressure transducer data, WIPP-13
Relative pressure transducer data (ft fresh water)
0.5
0.0
−0.5
−1.0
−1.5
−2.0
−2.5
Jul-13 Sep-13 Nov-13 Jan-14 Mar-14 May-14 Jul-14 Sep-14 Nov-14 Jan-15 Mar-15 May-15 Jul-15 Sep-15 Nov-15 Jan-16 Mar-16 May-16 Jul-16 Sep-16 Nov-16 Jan-17
Time


2014 - 2016 Culebra pressure transducer data, WIPP-19
Relative pressure transducer data (ft fresh water)
Time
2
0
-2
-4
-6
-8
-10
Jul-13
Sep-13
Nov-13
Jan-14
Mar-14
May-14
Jul-14
Sep-14
Nov-14
Jan-15
Mar-15
May-15
Jul-15
Sep-15
Nov-15
Jan-16
Mar-16
May-16
Jul-16
Sep-16
Nov-16
Jan-17
Pressure gage failure resulted in a data gap from 2/24/15 thru 5/24/15