

# Package ‘mlms’

July 23, 2025

**Title** Multilevel Monitoring System Data for Wells in the USGS INL  
Aquifer Monitoring Network

**Version** 1.0.2

**Description** Analysis-ready datasets detailing the Multilevel Monitoring System (MLMS) wells within the U.S. Geological Survey's (USGS) aquifer-monitoring network at the Idaho National Laboratory (INL) in Idaho, and the data collected within these wells. Supported by the U.S. Department of Energy (DOE), the USGS collected discrete measurements of hydraulic head at various depths from wells in the eastern Snake River Plain (ESRP) aquifer over several years. These measurements were derived from data on fluid pressure, fluid temperature, and atmospheric pressure. Each well was equipped with an MLMS, which included valved measurement ports, packer bladders, casing segments, and couplers. The MLMS facilitated monitoring at multiple hydraulically isolated depth intervals, reaching significant depths below the land surface. Additionally, groundwater samples were collected from these wells over multiple years and analyzed for various chemical and physical parameters.

**Depends** R (>= 4.1)

**Imports** checkmate, graphics, grDevices, jsonlite, plotrix, readxl,  
stats, sf, stringi, tools, utils

**Suggests** connectapi, covr, dm, DiagrammeR, DiagrammeRsvg, fontawesome,  
htmltools, htmlwidgets, inldata, knitr, pkgbuild, pkgdown,  
pkgload, rcmdcheck, reactable, renv, rmarkdown, roxygen2,  
tinytest, V8, webmap

**License** CC0

**Copyright** This software is in the public domain because it contains materials that originally came from the United States Geological Survey (USGS), an agency of the United States Department of Interior. For more information, see the official USGS copyright policy at <https://www.usgs.gov/information-policies-and-instructions/copyrights-and-credits>

**Encoding** UTF-8

**LazyData** true

**LazyDataCompression** xz

**URL** <https://code.usgs.gov/inl/mlms>

**BugReports** <https://code.usgs.gov/inl/mlms/-/issues>

**RoxygenNote** 7.3.2

**NeedsCompilation** no

**Author** Jason C. Fisher [aut, cre] (ORCID:  
    [<https://orcid.org/0000-0001-9032-8912>](https://orcid.org/0000-0001-9032-8912)),  
    Brian V. Twining [aut] (ORCID: [<https://orcid.org/0000-0003-1321-4721>](https://orcid.org/0000-0003-1321-4721))

**Maintainer** Jason C. Fisher <jfisher@usgs.gov>

**Repository** CRAN

**Date/Publication** 2024-11-21 17:30:02 UTC

Contents

calibrations . . . . .	2
get_head_outliers . . . . .	3
get_head_stats . . . . .	5
get_profile . . . . .	6
get_samples . . . . .	7
heads . . . . .	9
plot_profile . . . . .	10
ports . . . . .	11
read_field_json . . . . .	12
read_field_xlsx . . . . .	13
read_mlms_json . . . . .	14
read_sensors_json . . . . .	15
samples . . . . .	15
sensors . . . . .	17
visits . . . . .	18
wells . . . . .	19
xlsx2json . . . . .	20
zones . . . . .	21
<b>Index</b>	<b>22</b>

---

calibrations	<i>Sensor Calibrations</i>
--------------	----------------------------

---

Description

Dataset of electronic sensor calibration measurements in the Multilevel Monitoring System (MLMS) wells of the U.S. Geological Survey (USGS) aquifer-monitoring network, Idaho National Laboratory (INL), Idaho.

**Usage**

```
calibrations
```

**Format**

A data frame with the following variables:

sensor\_id Identifier for the integrated sensor, see [sensors](#) dataset for a description of each sensor.

cal\_dt Calendar date of sensor calibration.

cal\_tp Calibration type.

ref\_temp\_va Reference temperature, in degree Celsius.

ts\_dt Date.

lab\_standard Laboratory standard.

r2 R-squared, coefficient of determination.

p\_value p-value.

**Source**

The dataset originates from the USGS INL Project Office and underwent processing using the [read\\_sensors\\_json](#) function.

**Examples**

```
str(calibrations)
```

---

get_head_outliers	<i>Detect Hydraulic Head Outliers</i>
-------------------	---------------------------------------

---

**Description**

Detect outliers in the fluid pressure data by comparing parameter values against statistical metrics derived from the [heads](#) dataset. This function will employ both the standard score (z-score) and Interquartile Range (IQR) methods for outlier identification.

**Usage**

```
get_head_outliers(
  data = mlms::heads,
  vars = NULL,
  method = c("z-score", "IQR"),
  threshold = 3,
  multiplier = 1.5,
  min_n = 10L,
  quiet = TRUE
)
```

**Arguments**

data	'data.frame' table. Depth-discrete measurements of fluid pressure and temperature, hydraulic head values, and land-surface atmospheric pressure measurements. Defaults to the <a href="#">heads</a> dataset.
vars	'character' vector. One or more variable names for which to compute summary statistics. Choices include: "total_head_va" is the hydraulic head in feet above the North American Vertical Datum of 1988, "temp_va" is the fluid temperature in degree Celsius, "baro_va" is the atmospheric pressure in pounds per square inch absolute (psi), and "press_va" is the absolute fluid pressure in psi. By default, all variables are included.
method	'character' string. Outlier detection method. Specify "z-score" (default) for the standard score method, best suited for normally distributed data, or "IQR" to use the IQR method, which is ideal for skewed distributions.
threshold	'numeric' number. Z-score value used to determine whether a parameter value is considered an outlier or significantly different from the historic mean value.
multiplier	'numeric' number. Multiplier used to determine the threshold for outliers in the IQR method.
min_n	'integer' number. Minimum sample size needed to detect outliers.
quiet	'logical' flag. Whether to suppress printing of outlier information.

**Value**

A data frame with the following variables:

var_ds	Variable description.
var_nm	Variable name as specified in the vars argument.
site_nm	Local site name for a MLMS well.
port_nu	Identifier for the valved measurement port, included only if the by_port argument is set to true (not the default).
press_dt	Time at which measurements were measured outside the multiport casing.
var_va	Parameter value.
z_score	Z-score, a statistical measure that indicates how many standard deviations a parameter value is from the mean.
qu_1st	First quartile (25th percentile) of historical parameter values.
qu_3rd	Third quartile (75th percentile) of historical parameter values.
n	Sample size.

**Author(s)**

J.C. Fisher, U.S. Geological Survey, Idaho Water Science Center

**See Also**

[get\\_head\\_stats](#) function is used to calculate the fluid pressure statistics.

**Examples**

```
d <- get_head_outliers()
str(d)

d <- get_head_outliers(method = "IQR")
str(d)
```

get\_head\_stats

*Calculate Hydraulic Head Statistics***Description**

Calculate summary statistics for multi-level hydraulic head data, categorized by site and port, and summarized over time.

**Usage**

```
get_head_stats(vars = NULL, by_port = FALSE)
```

**Arguments**

vars	'character' vector. One or more variable names for which to compute summary statistics. Choices include: "total_head_va" is the hydraulic head in feet above the North American Vertical Datum of 1988, "temp_va" is the fluid temperature in degree Celsius, "baro_va" is the atmospheric pressure in pounds per square inch absolute (psi), and "press_va" is the absolute fluid pressure in psi. By default, all variables are included.
by_port	'logical' flag. Whether to compute statistics according to a sites monitoring port. Defaults to grouping by site only.

**Value**

A data frame with the following variables:

var\_ds Variable description.

var\_nm Variable name as specified in the vars argument.

site\_nm Local site name for a MLMS well.

port\_nu Identifier for the valved measurement port, included only if the by\_port argument is set to true (not the default).

n Sample size, which is the number of records in a given sample that contain finite values.

nna Number of missing values that were stripped before the statistic was computed.

start\_dt Start date for the period of record.

end\_dt End date for the period of record.

duration Duration of the record period, measured in years.

mean Arithmetic mean of the variable values.  
 sd Standard deviation of the variable values.  
 min Minimum of the variable values.  
 qu\_1st First quartile of the variable values.  
 median Median of the variable values.  
 qu\_3rd Third quartile of the variable values.  
 max Maximum of the variable values.

### Author(s)

J.C. Fisher, U.S. Geological Survey, Idaho Water Science Center

### See Also

[get\\_head\\_outliers](#) function may be used to identify fluid pressure outliers.

### Examples

```
d <- get_head_stats()
str(d)

d <- get_head_stats(vars = "press_va", by_port = TRUE)
str(d)
```

---

get\_profile

*Retrieve Profile Data*

---

### Description

Retrieve pressure, temperature, and water-quality data for site visits.

### Usage

```
get_profile(
  site_nm = NULL,
  stime_dt = NULL,
  poi = NULL,
  time_dt = NULL,
  pcode = NULL,
  strings_as_factors = TRUE
)
```

**Arguments**

**site\_nm** 'character' vector. Local site name for a MLMS well.  
**stime\_dt** 'POSIXct' or 'character' vector. Start time for field visit.  
**poi** 'POSIXct' or 'character' vector of length 2. Start and end limits on the period of interest.  
**time\_dt** 'POSIXct' or 'character' string. Estimated field visit time, the closest time in the vector of field visit start times.  
**pcode** 'character' string. USGS 5-digit parameter code. For example, the parameter code for Tritium is "07000".  
**strings\_as\_factors** 'logical' flag. Whether character vectors should be converted to factor class.

**Value**

A data frame.

**Author(s)**

J.C. Fisher, U.S. Geological Survey, Idaho Water Science Center

**See Also**

[plot\\_profile](#) function to plot multilevel data for a site visit.

**Examples**

```

d <- get_profile(site_nm = "USGS 133", pcode = "07000")
str(d)

d <- get_profile(poi = c("2023-01-01", NA), strings_as_factors = FALSE)
str(d)

```

---

get\_samples

---

*Retrieve Discrete Sample Data*


---

**Description**

Retrieve discrete sample water-quality data from the **inldata** package. See [inldata::samples](#) for a description of the source dataset. Requires that the **inldata** package is available.

**Usage**

```

get_samples(
  site_no = NULL,
  pcode = NULL,
  ports = mlms::ports,
  visits = mlms::visits
)

```

**Arguments**

site_no	'character' vector. USGS site identification number. The site numbers of measurement ports in the Multilevel Monitoring System (MLMS) wells by default.
pcode	'character' vector. USGS 5-digit parameter code. For a list of the parameter codes used by default, refer to the Details section.
ports	'data.frame' table. MLMS measurement port data, see <a href="#">ports</a> dataset for data structure.
visits	'data.frame' table. Field visits, see <a href="#">visits</a> dataset for data structure.

**Details**

The default parameters included are:

00930 Sodium, water, filtered, in milligrams per liter (mg/L).  
 00940 Chloride, water, filtered, in mg/L.  
 00945 Sulfate, water, filtered, in mg/L.  
 00950 Fluoride, water, filtered, in mg/L.  
 01030 Chromium, water, filtered, in micrograms per liter.  
 00618 Nitrate, water, filtered, in mg/L as nitrogen.  
 07000 Tritium, water, unfiltered, in picocuries per liter (pCi/L).  
 13501 Strontium-90, water, unfiltered, in pCi/L.  
 22012 Plutonium-238, water, unfiltered, in pCi/L.  
 28401 Cesium-137, water, unfiltered, in pCi/L.  
 63018 Gross alpha radioactivity, water, unfiltered, Th-230 curve, in pCi/L.  
 80049 Gross beta radioactivity, water, unfiltered, Sr-90/Y-90 curve, in pCi/L.  
 00095 Specific conductance, water, unfiltered, in microsiemens per centimeter at 25 degrees Celsius.

**Value**

A data frame, see [samples](#) dataset for table structure.

**Author(s)**

J.C. Fisher, U.S. Geological Survey, Idaho Water Science Center

**Examples**

```
d <- get_samples(site_no = "433409112570503", pcode = "07000")
```

---

heads	<i>Hydraulic Heads</i>
-------	------------------------

---

### Description

Dataset of depth-discrete measurements of fluid pressure, fluid temperature, atmospheric pressure, and calculated hydraulic head in the Multilevel Monitoring System (MLMS) wells in the U.S. Geological Survey (USGS) aquifer-monitoring network, Idaho National Laboratory (INL), Idaho.

### Usage

heads

### Format

A data frame with the following variables:

site\_nm Local site name for an MLMS well.  
 port\_nu Identifier for the valved measurement port.  
 site\_no USGS site identification number.  
 stime\_dt Start time for field visit.  
 press\_dt Time at which measurements were measured outside the multiport casing.  
 temp\_va Fluid temperature measured inside the multiport casing from the bridge of the pressure transducer, in degree Celsius.  
 baro\_va Atmospheric pressure measured at the time of the port measurement, in pounds per square inch absolute (psi).  
 press\_va Absolute pressure of fluid measured outside the multiport casing, in psi.  
 press\_head\_va Pressure head outside the multiport casing, in feet.  
 total\_head\_va Hydraulic head outside the multiport casing, in feet above the North American Vertical Datum of 1988 (NAVD 88).  
 press\_in\_1\_va Fluid pressure measured inside the multiport casing before the outside pressure measurement was taken, in psi.  
 press\_in\_2\_va Fluid pressure measured inside the multiport casing after the outside pressure measurement was taken, in psi.  
 press\_in\_diff\_va Difference in the fluid pressure measurements taken inside the multiport casing, in psi.  
 replicate\_fl Whether the measurement is a replicate for quality-control purposes.  
 comment\_tx Comments.

### Source

The dataset originates from the USGS INL Project Office and underwent processing using the [read\\_field\\_json](#) function.

Examples

```
str(heads)
```

---

plot_profile	<i>Plot Profile Data</i>
--------------	--------------------------

---

Description

Plot pressure, temperature, or water-quality data for a site visit.

Usage

```
plot_profile(  
  site_nm,  
  time_dt,  
  type = "head",  
  replicates = FALSE,  
  position = NULL,  
  file = NULL,  
  ...  
)
```

Arguments

site_nm	'character' string. Local site name for a MLMS well.
time_dt	'POSIXct' or 'character' string. Estimated field visit time, the closest time in the vector of field visit start times. Note that water-quality samples may be collected up to one week after the site visit for pressure profiling.
type	'character' string. Plot type, choose "head" for hydraulic head, "temp" for fluid temperature, or a USGS 5-digit parameter code (pcode in the <a href="#">samples</a> dataset). Hydraulic head is plotted by default.
replicates	'logical' flag. Whether to include replicate pressure measurements.
position	'character' string. Location used to position the legend. Choose a single key-word from the list "bottomright", "bottom", "bottomleft", "left", "topleft", "top", "topright", "right" and "center".
file	'character' string. PDF file to send plot graphics. Defaults to the active graphics window.
...	Additional arguments to be passed to the <a href="#">pdf</a> function. Only relevant if the file argument is specified.

Value

Invisibly NULL

**Author(s)**

J.C. Fisher, U.S. Geological Survey, Idaho Water Science Center

**See Also**

[get\\_profile](#) function is used to retrieve profile data.

**Examples**

```
site_nm <- "USGS 133"
time_dt <- "2008-08-27"
plot_profile(site_nm, time_dt, position = "topleft")

plot_profile(site_nm, time_dt, type = "temp")

plot_profile(site_nm, time_dt, type = "07000", position = "bottomright")

site_nm <- "USGS 131A"
time_dt <- "2012-10-24"
plot_profile(site_nm, time_dt)

plot_profile(site_nm, time_dt, type = "temp")

plot_profile(site_nm, time_dt, type = "07000")

file <- tempfile("test-profile-", fileext = ".pdf")
plot_profile(site_nm, time_dt, file = file, pointsize = 10)

unlink(file)
```

---

ports

*Measurement Ports*

---

**Description**

Dataset describing the locations of measurement ports within the multilevel completions of wells in the U.S. Geological Survey (USGS) aquifer-monitoring network, Idaho National Laboratory (INL), Idaho. These valved measurement ports enable monitor groundwater outside the multiport casing and within a monitoring zone.

**Usage**

ports

**Format**

A data frame with the following variables:

site\_nm Local site name for a MLMS well.

port\_nu Identifier for the valved measurement port.

site\_no USGS site identification number.

mp\_a\_va Distance between the transducer plane and the bottom of the adjacent upper packer (top of the monitoring zone), in feet, as documented in the system log. A value of not applicable (NA) indicates a optional lower port coupling within the monitoring zone.

wl\_depth\_va Depth to water inside the multiport casing measured using an electric tape (e-tape), in feet below the top of the well casing.

baro\_compl\_va Atmospheric pressure measured at land surface, in pounds per square inch (psi).

temp\_compl\_va Fluid temperature measured inside the multiport casing at the pressure transducer bridge, in degrees Celsius (°C).

press\_compl\_va Absolute pressure of fluid inside the multiport casing, in psi.

tp\_depth\_va Depth to the transducer plane in the measurement port coupling, in feet below land surface.

port\_depth\_va Depth to the measurement port inlet valve of a port coupling, in ft bls.

port\_alt\_va Altitude of the measurement port inlet valve of a port coupling, in feet above the North American Vertical Datum of 1988 (NAVD 88).

zone\_nu Identifier for the depth-discrete monitoring zone, where groundwater in this zone is vertically isolated between upper and lower packers.

npress Number of pressure and temperature measurements collected at the port.

nsamples Number of water-quality samples collected at the port.

**Source**

The dataset originates from the USGS INL Project Office and underwent processing using the [read\\_mlms\\_json](#) function.

**Examples**

```
str(ports)
```

---

read\_field\_json

*Read Field Data in JSON Format*


---

**Description**

Read Multilevel Monitoring System (MLMS) field data in JSON format.

**Usage**

```
read_field_json(
  paths,
  wells = mlms::wells,
  ports = mlms::ports,
  tz = "America/Denver"
)
```

**Arguments**

paths	'character' vector. Paths to the JSON files to read.
wells	'data.frame' table. MLMS well data, see <a href="#">wells</a> dataset for data structure.
ports	'data.frame' table. MLMS measurement port data, see <a href="#">ports</a> dataset for data structure.
tz	'character' string. Time zone specification. Defaults to America/Denver.

**Value**

A list of data frame components. See [visits](#) and [heads](#) datasets for example output.

**Author(s)**

J.C. Fisher, U.S. Geological Survey, Idaho Water Science Center

**See Also**

[write\\_field\\_json](#) function for writing field data to file in JSON format.

**Examples**

```
l <- system.file("extdata/ex-field.json", package = "mlms") |>
  read_field_json()
str(l, max.level = 1)
```

---

read\_field\_xlsx

*Read Field Data in an Excel Workbook*


---

**Description**

Read worksheet(s) of Multilevel Monitoring System (MLMS) field data in an Excel workbook.

**Usage**

```
read_field_xlsx(
  path,
  sheet = NULL,
  pattern = "[0-9]{1,2}-[0-9]{1,2}-[0-9]{2,4}$"
)
```

**Arguments**

path	'character' string. Path to the Excel workbook (xlsx) to read.
sheet	'character' vector. Name of the Excel worksheet(s) to read. Sheet names may also be specified via the pattern argument. If neither argument specifies the sheet, defaults to the first sheet in the workbook.
pattern	'character' string. A pattern (regular expression) used to identify worksheet names in the workbook.

**Value**

A list with data frame components.

**Author(s)**

J.C. Fisher, U.S. Geological Survey, Idaho Water Science Center

**Examples**

```
path <- system.file("extdata/ex-field.xlsx", package = "mlms")
l <- read_field_xlsx(path, sheet = "06-30-2022")
str(l, max.level = 1)
```

---

read\_mlms\_json

*Read MLMS Data in JSON Format*


---

**Description**

Read Multilevel Monitoring System (MLMS) data in JSON format. Requires that the **inldata** package is available.

**Usage**

```
read_mlms_json(path)
```

**Arguments**

path	'character' string. Path to the JSON file to read.
------	--

**Value**

A list of data frame components. See [wells](#), [zones](#), and [ports](#) datasets for example output.

**Author(s)**

J.C. Fisher, U.S. Geological Survey, Idaho Water Science Center

**Examples**

```
l <- system.file("extdata/ex-mlms.json", package = "mlms") |>
  read_mlms_json()
str(l, max.level = 1)
```

---

read_sensors_json	<i>Read Sensor Data in JSON Format</i>
-------------------	--

---

**Description**

Read electronic sensor data in a JSON format.

**Usage**

```
read_sensors_json(path)
```

**Arguments**

path                    'character' string. Path to the JSON file to read.

**Value**

A list of data frame components. See [sensors](#) and [calibrations](#) datasets for example output.

**Author(s)**

J.C. Fisher, U.S. Geological Survey, Idaho Water Science Center

**Examples**

```
l <- system.file("extdata/ex-sensors.json", package = "mlms") |>
  read_sensors_json()
str(l, max.level = 1)
```

---

samples	<i>Water-Quality Samples</i>
---------	------------------------------

---

**Description**

Depth-discrete chemical and physical data for groundwater collected from Multilevel Monitoring System (MLMS) wells in the U.S. Geological Survey (USGS) aquifer-monitoring network, Idaho National Laboratory (INL), Idaho.

**Usage**

```
samples
```

**Format**

A data frame with the following variables:

`site_nm` Local site name for a MLMS well.

`port_nu` Identifier for the valved measurement port.

`site_no` USGS site identification number for a MLMS measurement port.

`stime_dt` Start time for the pressure profiling event.

`sample_dt` Date and time the water-quality sample was collected, in "America/Denver" time zone. Missing values of time were substituted with "12:00".

`parm_short_nm` Parameter short name assigned by the USGS, such as "pH"; followed by 'wu' water, unfiltered or 'wf' water, filtered.

`unit_cd` Units of measurement.

`pcode` USGS 5-digit parameter code. For example, the parameter code for Tritium is "07000".

`remark_cd` Remark code (result level) used to qualify the parameter value. The codes and their meanings are as follows: `NA` (missing value) is a quantified value; "<" is where the actual value is known to be less than the value reported, that is, the measured concentration is below the reporting limit (RL) and represented as a censored (or nondetection) value. For censored values, the value reported is the RL; and "E" is an estimated value, that is, the actual value is greater than the minimum detection limit (MDL) and less than the laboratory reporting level (LRL).

`result_va` Parameter value.

`lab_li_va` Lower confidence interval of the result value based on laboratory analysis.

`lab_ui_va` Upper confidence interval of the result value based on laboratory analysis.

`dqi_cd` Data quality indicator code that indicates the review status of a result. The codes and their meanings are as follows: "R" reviewed and accepted, and "S" provisional (presumed satisfactory).

`sample_type_cd` Sample type code that identifies the quality-assurance (QA) type of a sample. The codes and their meanings are as follows: "2" is a blank sample; "7" is a replicate sample taken from the environment; and "9" is a regular sample taken from the environment.

**Source**

Sample data retrieved from the **inldata** package using the `get_samples` function.

**Examples**

```
str(samples)
```

---

`sensors`*Sensors*

---

**Description**

Dataset of sensors used to make measurements at port couplings in the Multilevel Monitoring System (MLMS) wells of the U.S. Geological Survey (USGS) aquifer-monitoring network, Idaho National Laboratory (INL), Idaho. Sensor calibration measurements are stored in the [calibrations](#) dataset.

**Usage**`sensors`**Format**

A data frame with the following variables:

`sensor_id` Identifier for the integrated sensor.

`sensor_nu` Serial number for the sensor.

`sensor_brand_nm` Brand name.

`sensor_model_cd` Model code.

`press_unit_cd` Pressure unit code.

`temp_unit_cd` Temperature unit code.

`sensor_tp` Integrated sensor types.

`temp_lower_va` Lower temperature range, in degree Celsius.

`temp_upper_va` Upper temperature range, in degree Celsius.

`press_lower_va` Lower fluid pressure range, in pounds per square inch (psi).

`press_upper_va` Upper fluid pressure range, in psi.

`press_res_va` Pressure resolution, in psi.

`press_acc_va` Pressure accuracy, in psi.

`press_repeat_acc_va` Repeated pressure accuracy, in psi.

`press_hyster_acc_va` Hysteresis error of the pressure sensor, in psi.

`response_time_tx` Response time description.

**Source**

The dataset originates from the USGS INL Project Office and underwent processing using the [read\\_sensors\\_json](#) function.

**Examples**

```
str(sensors)
```

visits

*Field Visits***Description**

This dataset provides detailed information about the context and specifics of field visits. It documents field visits to Multilevel Monitoring System (MLMS) wells in the U.S. Geological Survey (USGS) aquifer-monitoring network, Idaho National Laboratory (INL), Idaho. These visits involve measuring fluid pressure at various depths within an MLMS well, typically completed within a few hours.

**Usage**

visits

**Format**

A data frame with the following variables:

site\_nm Local site name for a MLMS well.

stime\_dt Start time for the field visit.

etime\_dt End time for the field visit.

baro\_id Identifier for the barometer used to measure atmospheric pressure.

baro\_start\_va Atmospheric pressure measured at the beginning of the field visit, in pounds per square inch (psi).

baro\_end\_va Atmospheric pressure measured at the visits end, in psi.

sensor\_id Identifier for the pressure sensor.

press\_start\_va Absolute pressure of fluid measured at the beginning of the field visit, in psi.

press\_end\_va Absolute pressure of fluid measured at the visits end, in psi.

temp\_start\_va Temperature of fluid measured at the beginning of the field visit, in degree Celsius.

temp\_end\_va Temperature of fluid measured at the visits end, in degree Celsius.

operators Initials of field operators.

sheet\_version\_tx Version of field sheet.

weather Weather conditions during the field visit.

comment\_tx Comments.

**Source**

The dataset originates from the USGS INL Project Office and underwent processing using the [read\\_field\\_json](#) function.

**Examples**

```
str(visits)
```

wells

*MLMS Wells***Description**

A spatial dataset describing the location of wells equipped with a Multilevel Monitoring System (MLMS) in the U.S. Geological Survey (USGS) aquifer-monitoring network, Idaho National Laboratory (INL), Idaho.

**Usage**

wells

**Format**

A spatial feature data frame with the following variables:

site\_nm Local site name for a MLMS well.

coord\_acy\_va Accuracy of latitude/longitude value, in seconds.

alt\_va Altitude of the land surface reference point (also known as the brass cap), in feet above the North American Vertical Datum of 1988 (NAVD 88).

alt\_acy\_va Accuracy of the altitude value, in feet.

etape\_cf\_va E-tape correction factor determined through calibration, in feet.

deviation\_cf\_va Borehole deviation correction factor, in feet.

stickup\_va Stick-up distance, the height of the well casing that extends above the land surface measurement point, in feet.

mp\_b\_va Distance between the top and bottom of an inflated packer seal, in feet.

mp\_c\_va Distance between the transducer plane and the measurement port inlet valve, in feet.

hole\_depth\_va Total depth to which the hole is drilled, measured as the distance below the land surface reference point, in feet below land surface (ft bls).

well\_depth\_va Depth of the finished well, in ft bls.

construction\_dt Date the well was completed.

install\_dt Date the MLMS was installed.

system\_tp Multiport monitoring system type. Two versions of the Westbay System were utilized in this study: the "MP55" and the "MP38".

nzones Number of depth-discrete monitoring zones.

nports Number of measurement ports.

nvisits Count of field visits for pressure profiling.

geometry Zero-dimensional geometry containing a single point.

**Source**

The dataset originates from the USGS INL Project Office and underwent processing using the [read\\_mlms\\_json](#) function.

Examples

```
str(wells)
```

---

xlsx2json	<i>Convert Field Data from XLSX to JSON</i>
-----------	---

---

Description

Convert the file format of field data from XLSX to JSON.

Usage

```
xlsx2json(path, destdir)
```

Arguments

- path                    'character' string. Either the path to the Excel workbook file (XLSX) to read, or the directory containing XLSX files.
- destdir                'character' string. Destination directory to write JSON file(s). Defaults to the path directory.

Value

File path(s) of the JSON formatted data.

Author(s)

J.C. Fisher, U.S. Geological Survey, Idaho Water Science Center

See Also

- [read\\_field\\_xlsx](#) function for reading field data from a XLSX file.
- [write\\_field\\_json](#) function for writing field data to a JSON file.

Examples

```
path <- system.file("extdata/ex-field.xlsx", package = "mlms") |>
  xlsx2json(destdir = tempdir())

unlink(path)
```

---

 zones

---

*Monitoring Zones*


---

### Description

A dataset describing the locations of depth-discrete monitoring zones within the multilevel completions of wells in the U.S. Geological Survey (USGS) aquifer-monitoring network, Idaho National Laboratory (INL), Idaho. These zones enable precise measurements at various depths, where groundwater is vertically isolated between upper and lower packers within each well.

### Usage

zones

### Format

A data frame with the following variables:

site\_nm Local site name for a MLMS well.

zone\_nu Identifier for the depth-discrete monitoring zone, where groundwater in this zone is vertically isolated between upper and lower packers.

zone\_top\_va Depth to the bottom of the uppermost adjacent packer, in feet below land surface (ft bls).

zone\_bot\_va Depth to the top of the lowermost adjacent packer, in ft bls.

zone\_top\_alt\_va Altitude of the bottom of the uppermost adjacent packer, in feet above the North American Vertical Datum of 1988 (NAVD 88).

zone\_bot\_alt\_va Altitude of the top of the lowermost adjacent packer, in feet above the NAVD 88.

zone\_len\_va Distance between packer seals or zone, length in feet.

nports Number of measurement ports within monitoring zone.

### Source

The dataset originates from the USGS INL Project Office and underwent processing using the [read\\_mlms\\_json](#) function.

### Examples

```
str(zones)
```

# Index

## \* datasets

- calibrations, [2](#)
- heads, [9](#)
- ports, [11](#)
- samples, [15](#)
- sensors, [17](#)
- visits, [18](#)
- wells, [19](#)
- zones, [21](#)

calibrations, [2](#), [15](#), [17](#)

get\_head\_outliers, [3](#), [6](#)  
get\_head\_stats, [4](#), [5](#)  
get\_profile, [6](#), [11](#)  
get\_samples, [7](#), [16](#)

heads, [3](#), [4](#), [9](#), [13](#)

inldata::samples, [7](#)

NA, [16](#)

pdf, [10](#)

plot\_profile, [7](#), [10](#)

ports, [8](#), [11](#), [13](#), [14](#)

read\_field\_json, [9](#), [12](#), [18](#)

read\_field\_xlsx, [13](#), [20](#)

read\_mlms\_json, [12](#), [14](#), [19](#), [21](#)

read\_sensors\_json, [3](#), [15](#), [17](#)

samples, [8](#), [10](#), [15](#)

sensors, [3](#), [15](#), [17](#)

visits, [8](#), [13](#), [18](#)

wells, [13](#), [14](#), [19](#)

write\_field\_json, [13](#), [20](#)

xlsx2json, [20](#)

zones, [14](#), [21](#)