

Package ‘IsoplotR’

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Title Statistical Toolbox for Radiometric Geochronology

Version 0.3

Description An R implementation of Ken Ludwig's popular Isoplot add-in to Microsoft Excel. Currently plots U-Pb data on Wetherill and Tera-Wasserburg concordia diagrams, taking into account error correlations. Future versions will include functionality for the Ar-Ar, Rb-Sr, Sm-Nd, Re-Os, U-Th-He, fission track and cosmogenic nuclide methods, including isochrons, age spectra, ternary diagrams, kernel density estimates, radial plots, banana diagrams and multidimensional scaling plots. A graphical user interface is provided as an RStudio Shiny app.

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Depends R (>= 3.0.0)

Imports methods

License GPL-2

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concordia.age	<i>Calculate U-Pb concordia ages</i>
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Description

Evaluates the equivalence of multiple ($^{206}\text{Pb}/^{238}\text{U}$ - $^{207}\text{Pb}/^{235}\text{U}$ or $^{207}\text{Pb}/^{206}\text{Pb}$ - $^{206}\text{Pb}/^{238}\text{U}$) compositions, computes the weighted mean isotopic composition and the corresponding concordia age using the method of maximum likelihood, computes the mswd of equivalence and concordance and their respective Chi-squared p-values.

Usage

```
concordia.age(x, wetherill = TRUE)
```

Arguments

x	an object of class UPb
wetherill	boolean flag to indicate whether the data should be evaluated in Wetherill (TRUE) or Tera-Wasserburg (FALSE) space

Value

a list with the following items:

- x: a named vector with the weighted mean U-Pb composition
- x.cov: the covariance matrix of the mean U-Pb composition
- age: the concordia age (in Ma)
- age.err: the standard error of the concordia age
- mswd: a list with two items (equivalence and concordance) containing the MSWD (Mean of the Squared Weighted Deviates, a.k.a the reduced Chi-squared statistic outside of geochronology) of isotopic equivalence and age concordance, respectively.
- p.value: a list with two items (equivalence and concordance) containing the p-value of the Chi-square test for isotopic equivalence and age concordance, respectively.

concordia.plot	<i>Concordia diagram</i>
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Description

Wetherill and Tera-Wasserburg concordia diagrams

Usage

```
concordia.plot(x, limits = NULL, alpha = 0.05, wetherill = TRUE,
  show.numbers = FALSE, ellipse.col = rgb(0, 1, 0, 0.5),
  concordia.col = "darksalmon", dcu = TRUE, show.age = 0)
```

Arguments

x	an object of class UPb
limits	age limits of the concordia line
alpha	confidence cutoff for the error ellipses
wetherill	boolean flag (FALSE for Tera-Wasserburg)
show.numbers	boolean flag (TRUE to show grain numbers)
ellipse.col	background colour of the error ellipses
concordia.col	colour of the concordia line
dcu	show decay constant uncertainty?
show.age	one of either 0: don't show the age 1: calculate the concordia age (2: fit a discordia line - not implemented yet)

Examples

```
data(UPb)
concordia.plot(UPb)
```

ellipse	<i>Get coordinates of error ellipse for plotting</i>
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Description

Construct an error ellipse age a given confidence level from its centre and covariance matrix

Usage

```
ellipse(x, y, covmat, alpha = 0.05)
```

Arguments

x	x-coordinate (scalar) for the centre of the ellipse
y	y-coordinate (scalar) for the centre of the ellipse
covmat	covariance matrix of the x-y coordinates
alpha	the probability cutoff for the error ellipses

Value

a [50x2] matrix of plot coordinates

Examples

```
x = 99; y = 101;
covmat <- matrix(c(1,0.9,0.9,1),nrow=2)
ell <- ellipse(x,y,covmat)
plot(c(90,110),c(90,110),type='l')
polygon(ell,col=rgb(0,1,0,0.5))
points(x,y,pch=21,bg='black')
```

I.A

Isotope abundance

Description

Gets or sets the natural abundance of isotopes

Usage

```
I.A(nuclide, x = NULL, e = NULL)
```

Arguments

nuclide	one of either 'U', 'U238', 'U235', or 'Th232'
x	new value for the isotope abundance
e	new value for the standard error of the abundance

Value

if `x == e == NULL`, returns a two element list containing:

`x`: a number or a vector of numbers between 0 (absent) and 1 (dominant)

and

`e`: the standard error or covariance matrix of `x`

or, if `nuclide = 'U'`:

`cov`: the covariance matrix of all naturally occurring isotopes

Examples

```
print(I.A('U238')$x)
# use the 238U/235U ratio of Steiger and Jaeger (1977)
U238U235(138.88,0)
print(I.A('U238')$x)
```

lambda	<i>Decay constants</i>
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Description

Gets or sets the decay constants of radioactive istopes

Usage

```
lambda(nuclide, x = NULL, e = NULL)
```

Arguments

nuclide	the nuclide name
x	new value for the decay constant
e	new value for the decay constant uncertainty

Value

if `x == e == NULL`, returns a two-item list containing:

x: the decay constant [in Ma-1]

e: the standard error of the decay constant [in Ma-1]

Examples

```
print(lambda('U238')$x)
# use the decay constant of Kovarik and Adams (1932)
lambda('U238',0.0001537,0.0000068)
print(lambda('U238')$x)
```

read.data	<i>Read geochronology data</i>
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Description

Cast a .csv file into one of IsoplotR's data classes

Usage

```
read.data(fname, method = "U-Pb", format = 1, ...)
```

Arguments

fname	file name (.csv format)
method	one of 'U-Pb', 'Ar-Ar', 'Rb-Sr', 'Sm-Nd', 'Re-Os', 'U-Th-He', 'fission tracks', 'cosmogenic nuclides' or 'other'
format	formatting option, depends on the value of method. If method = 'U-Pb', then format is one of either: 1: 7/6, s[7/6], 6/8, s[6/8], 7/5, s[7/5]
...	optional arguments to the read.csv function

Value

an object of class 'UPb', 'ArAr', 'RbSr', 'SmNd', 'ReOs', 'UThHe', 'fission', 'cosmogenics', or 'other'

Examples

```
# load one of the built-in .csv files:
fname <- system.file("UPb.csv",package="IsoplotR")
UPb <- read.data(fname,'U-Pb')
concordia.plot(UPb)
```

read.matrix	<i>Read geochronology data</i>
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Description

Cast a matrix into one of IsoplotR's data classes

Usage

```
read.matrix(x, method = "U-Pb", format = 1)
```

Arguments

x	a matrix
method	see read.data for details
format	see read.data for details

Value

see read.data for details

Examples

```
# load one of the built-in .csv files:
fname <- system.file("UPb.csv",package="IsoplotR")
dat <- read.csv(fname,header=TRUE)
UPb <- read.matrix(dat,method='U-Pb',format=1)
concordia.plot(UPb)
```

settings	<i>Load settings to and from json</i>
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Description

Get and set preferred values for decay constants and isotopic abundances from and to a .json file format

Usage

```
settings(fname = NULL)
```

Arguments

fname the path of a .json file

Value

if fname==NULL, returns a .json string

Examples

```
json <- system.file("defaults.json",package="IsoplotR")
settings(json)
print(settings())
```

U238U235	<i>238U/235 ratio</i>
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Description

Gets or sets the natural 238U/235 ratio. The default value of 137.818 is taken from Hiess et al. (2012)

Usage

```
U238U235(x = NULL, e = NULL)
```

Arguments

x new value for $^{238}\text{U}/^{235}\text{U}$ ratio
 e new value for its standard error

Value

if `x == e == NULL`, returns a two-item list containing:
 x: the $^{238}\text{U}/^{235}\text{U}$ ratio
 e: the standard error of the $^{238}\text{U}/^{235}\text{U}$ ratio

Examples

```
print(U238U235())$x)
# use the  $^{238}\text{U}/^{235}\text{U}$  ratio of Steiger and Jaeger (1977)
U238U235(138.88,0)
print(U238U235())$x)
```

UPb

An example U-Pb dataset

Description

An example U-Pb dataset provided with Ludwig's Isoplot add-in

Details

UPb is an object of class UPb, i.e. a list with two items
 x: a matrix formatted according to format
 format: an integer defining the format of x. Options are:
 1: 7/6, s[7/6], 6/8, s[6/8], 7/5, s[7/5]

Author(s)

Ken Ludwig and Pieter Vermeesch

Examples

```
data(UPb)
concordia.plot(UPb)
```


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