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

LazyData true

RoxygenNote 5.0.1

R topics documented:

concordia.age *Calculate U-Pb concordia ages*

Description

Evaluates the equivalence of multiple ($^{206}Pb/^{238}U$-$^{207}Pb/^{235}U$ or $^{207}Pb/^{206}Pb$-$^{206}Pb/^{238}U$) 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.

Examples

```
data(UPb)
fit <- concordia.age(UPb)
print(paste('age = ',fit$age,'+/-',fit$age.err,'Ma, MSWD = ',fit$mswd))
```

concordia.plot *Concordia diagram*

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 *Get coordinates of error ellipse for plotting*

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.R *Isotopic ratios*

Description

Gets or sets natural isotopic ratios.

Usage

```
I.R(ratio, x = NULL, e = NULL)
```

Arguments

ratio	one of either 'U238U235', 'Ar40Ar36', 'Ar38Ar36', 'Rb85Rb87', 'Sr88Sr86', 'Sr87Sr86', 'Sr84Sr86', 'Re185Re187', 'Os184Os192', 'Os186Os192', 'Os187Os192', 'Os188Os192', 'Os189Os192'
x	new value for ratio
e	new value for its standard error

Value

if x == e == NULL, returns a two-item vector containing the mean value of the requested ratio and its standard error, respectively.

References

Ar: Lee, Jee-Yon, et al. "A redetermination of the isotopic abundances of atmospheric Ar." Geochimica et Cosmochimica Acta 70.17 (2006): 4507-4512.

Rb: Catanzaro, E. J., et al. "Absolute isotopic abundance ratio and atomic weight of terrestrial rubidium." J. Res. Natl. Bur. Stand. A 73 (1969): 511-516.

Sr: Moore, L. J., et al. "Absolute isotopic abundance ratios and atomic weight of a reference sample of strontium." J. Res. Natl.Bur. Stand. 87.1 (1982): 1-8.

Re: Gramlich, John W., et al. "Absolute isotopic abundance ratio and atomic weight of a reference sample of rhenium." J. Res. Natl. Bur. Stand. A 77 (1973): 691-698.

Os: Voelkening, Joachim, Thomas Walczyk, and Klaus G. Heumann. "Osmium isotope ratio determinations by negative thermal ionization mass spectrometry." Int. J. Mass Spect. Ion Proc. 105.2 (1991): 147-159.

U: Hiess, Joe, et al. "238U/235U systematics in terrestrial uranium-bearing minerals." Science 335.6076 (2012): 1610-1614.

Examples

```
# returns the 238U/235U ratio of Hiess et al. (2012):
print(I.R('U238U235'))
# use the 238U/235U ratio of Steiger and Jaeger (1977):
I.R('U238U235',138.88,0)
print(I.R('U238U235'))
```

`lambda` *Decay constants*

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 vector containing the decay constant [in Ma-1] and its standard error, respectively.

Examples

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

`read.data` *Read geochronology data*

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 *Read geochronology data*

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 *Load settings to and from json*

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())
```

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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