Calcul statistique sur les composantes magnétiques avec le package ArMag

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2020-06-22

Introduction

This package is an extraction of the functions of the calculation software on magnetic components developed at the Rennes Archaeomagnetism Laboratory, hosted at the Geosciences-Rennes laboratory.

Installing ArMag

ArMag will run in Windows, Mac OS X or Linux. To install ArMAg you first need to install R. I would also recommend installing Rstudio as a nice desktop environment for using R. Once in R you can type:

```
# install.packages('ArMag')
```

at the R command prompt to install ArMag. If you then type:

```
# library(ArMag)
```

Installing ArMag via GitHub

```
if (!require(devtools))

 {install.packages("devtools")}

#> Loading required package: devtools

#> Loading required package: usethis


devtools::install_github("chrono35/ArMag", force = TRUE)

#> Downloading GitHub repo chrono35/ArMag@master

#>

   checking for file
‘/private/var/folders/ms/3r6m3pqn4jq1hk94t646qdd00000gn/T/Rtmplfwoyd/
remotes7af451385dc9/chrono35-ArMag-933685d/DESCRIPTION’ ...


✓  checking for file
```

```
‘/private/var/folders/ms/3r6m3pqn4jq1hk94t646qdd00000gn/T/Rtmplfwoyd/
remotes7af451385dc9/chrono35-ArMag-933685d/DESCRIPTION’

#>


─  preparing ‘ArMag’:

#>


   checking DESCRIPTION meta-information ...


✓  checking DESCRIPTION meta-information

#>


─  checking for LF line-endings in source and make files and shell scripts

#>


─  checking for empty or unneeded directories

#>


─  building ‘ArMag_0.0.1.0001.tar.gz’

#>



#>

library("ArMag") #,
lib.loc="/Library/Frameworks/R.framework/Versions/3.5/Resources/library")
```

it will load in all the ArMag functions.

Loading Rennes’ AM file

You need two functions, the first one reads the information, corresponding to the headers of each sample, the second one reads the measurements of each sample.

```
file.AM <- "../examples/14039C.AMP"


mes <- NULL

mes.info <- read.AM.info (file.AM)

mes <- read.AM.mesures(file.AM)
```

Empty file generation

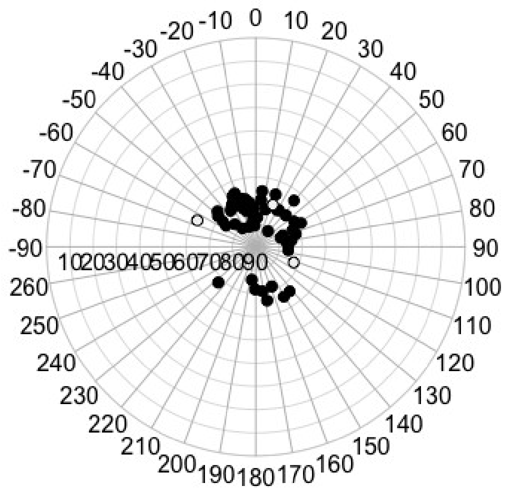
Function used before making the measurements. Warning, this function overwrites the existing file

```
file.AM <- "../examples/test.txt"

list.ech <- c("1T",  "17T",  "35T",  "47T",  "50T",  "59T",  "83T",  "87T",  "89T",
"94T",  "100T", "102T", "103T" )

genere.AMD(file.AM, list.ech)
```

Plot of NRN values

A simple, R command allows to select the steps with the value 0, corresponding to step 0N0

```
select <- NULL

# select$I <- mes$I[mes$step.value== 0]

# select$D <- mes$I[mes$step.value== 0]

select <- mes[mes$step.value== 0,]

lambert(select, inc.lim = c(0,90))
```



mcFadden statistic on NRN value

Example of the calculation of the mcFadden statistic on the selected samples

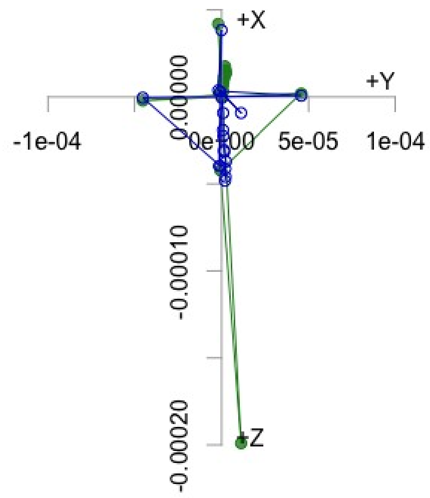
```
stat.mcFadden(select)

#>    n imoy.McFadden imoy.McElhinny a95.mcFad a95.eqFish      Kb     Kssb   imin

#> 1 57      71.86602       72.43625  1.344392    1.47212 159.221 156.4276 62.308

#>       imax      Dmin     Dmax

#> 1 81.46792 -65.50389 226.8085
```

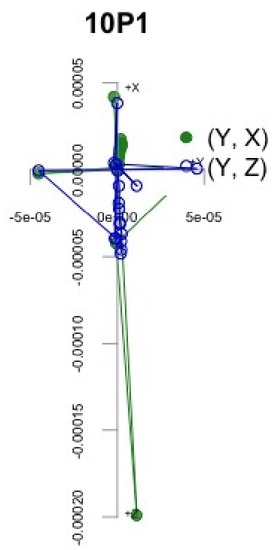
Extraction of measurements corresponding to a sample using its name

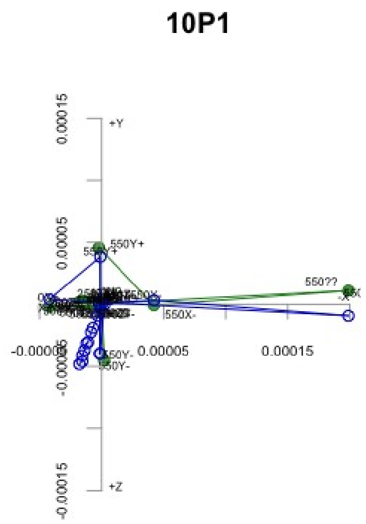
```
mes.ech <- NULL

mes.ech <- extract.mesures.specimen.name("10P1", mes)
```

Zijderveld plot

```
par(pty="s") # force une figure carré

zijderveld1(mes.ech$X, mes.ech$Y, mes.ech$Z)

par(mfrow = c(1,2), pty="m", cex.lab = 0.5, cex.axis = 0.6) # separated into 2
columns and restored a maximum size figure

# cex.lab set the text size of the steps

zijderveld1(mes.ech, legend.pos = "topright")

zijderveld2(mes.ech, pt.names = NULL)
```





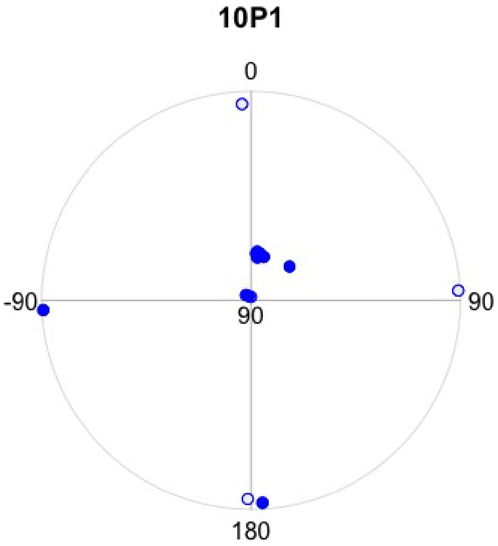


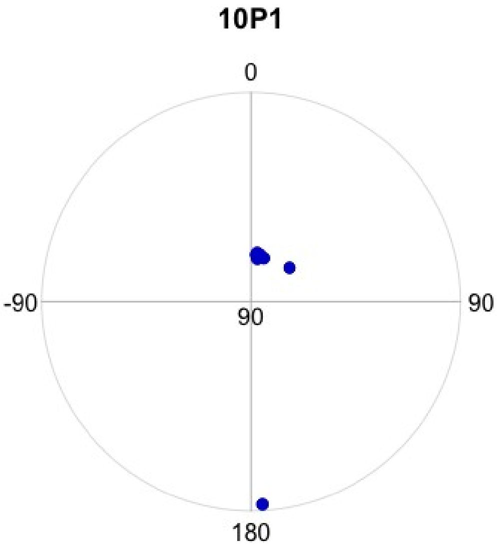
Plot the schmitt-Lambert projection

Each function using different parameters

```
lambert.XYZ.specimen(mes.ech)

# remove anisotropîe step
```

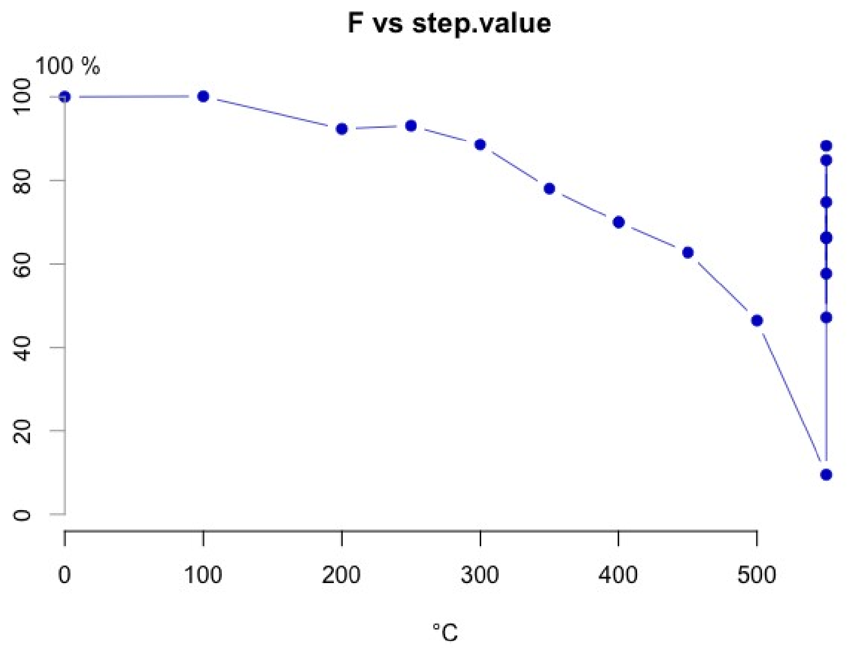
```
mes.ech.ssAni<-remove.step(mes.ech)

#> [1] "550Z+" "550Z-" "550X+" "550X-" "550Y+" "550Y-" "550ZB"

lambert.ID.specimen(mes.ech.ssAni)
```

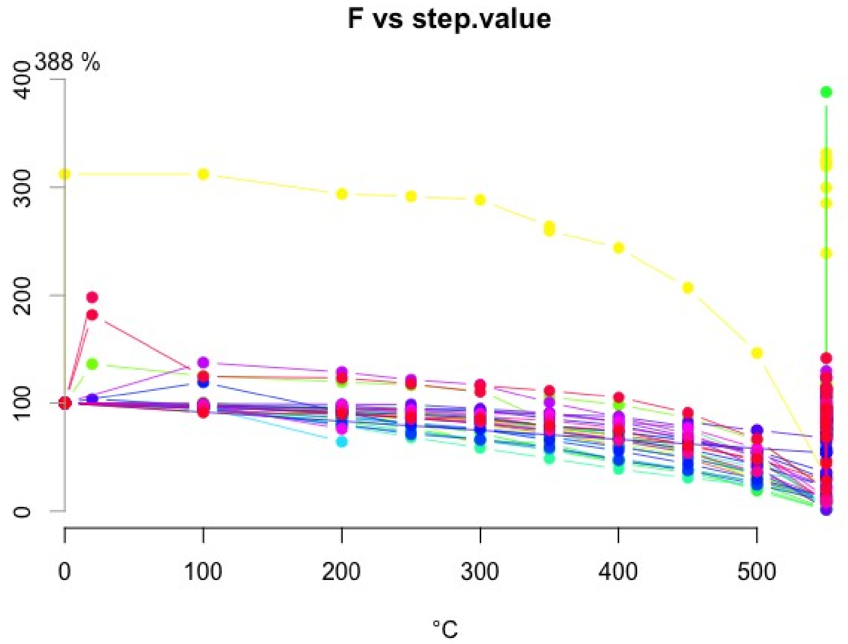


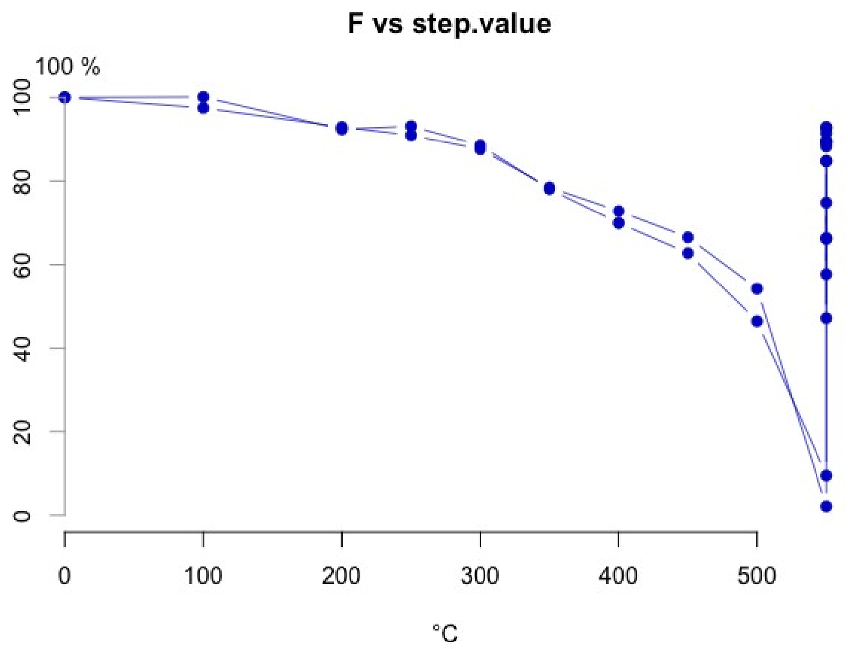


demagnetizing and partial component

```
mes.sel2 <- extract.mesures.specimen.name("1P1", mes)

mes.sel3 <- extract.mesures.specimen.name("16P1", mes)

demag(mes.sel2, step.J0 = NULL)

demag(mes, step.J0 = 0, pt.col = rainbow(length(mes.info$name)))

demag(rbind(mes.sel2, mes.sel3), normalize = TRUE)


partial.component(mes.sel2$X, mes.sel2$Y, mes.sel2$Z)

#>           X           Y         Z        I         D F         Sl      MAD

#> 1 0.2726137 -0.02949615 0.9616713 74.08537 -6.175245 1 0.03145648 34.52748

#>        DANG

#> 1 0.5730495
```





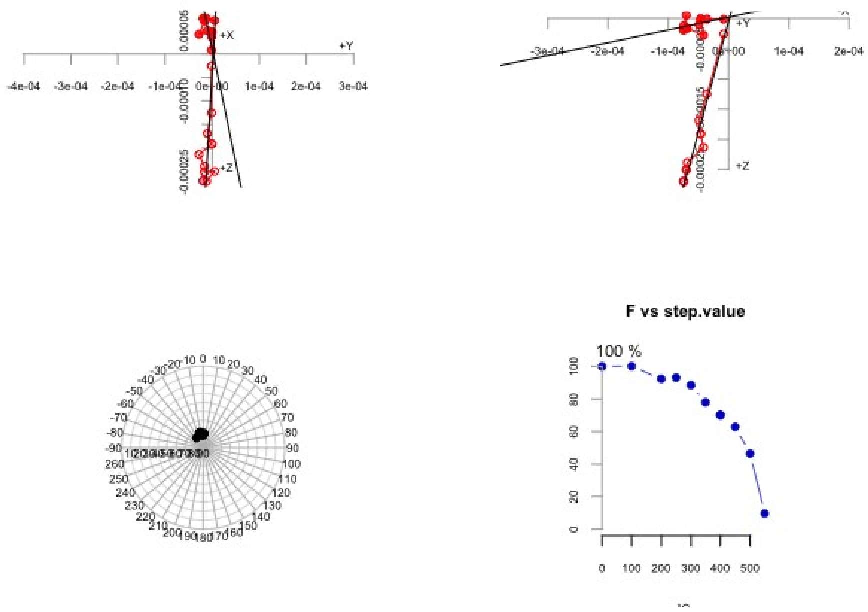


Synthetic view of a sample

The zijderveld1.T1T2 and zijderveld2.T1T2 functions remove the anisotropy steps by default

```
par(mfrow = c(2, 2), cex.lab = 0.7, cex.axis = .7, cex = 0.7, cex.main = 1, cex.sub =
0.1,
```

```
    mai = c(0.5, 0.5, 0.7, 0.3), oma = c(0, 1, 1, 1))#, pty ="s" )
zijderveld1.T1T2(mes.sel2)
#> [1] "550Z+" "550Z-" "550X+" "550X-" "550Y+" "550Y-" "550ZB"
zijderveld2.T1T2(mes.sel2)
#> [1] "550Z+" "550Z-" "550X+" "550X-" "550Y+" "550Y-" "550ZB"

# removal of anisotropy steps
mes.sel2 <- remove.step(mes.sel2, verbose = FALSE)
lambert(mes.sel2, inc.lim = c(0, 90))
demag(mes.sel2, step.J0 = NULL)
```



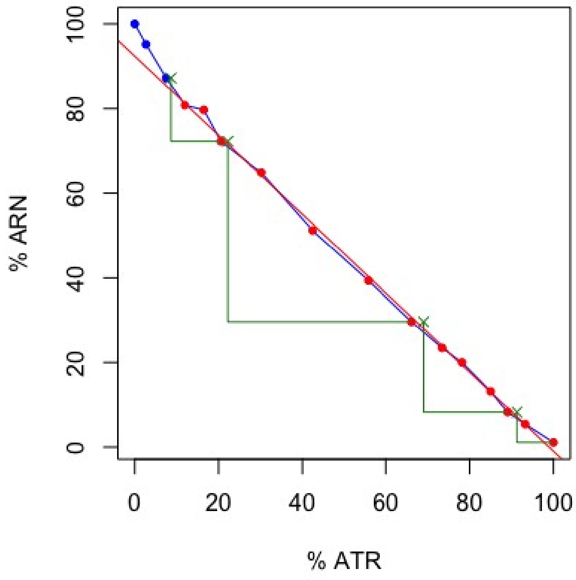
Synthetic view

Arai - intensity plot

```
file.INT <- "../examples/INT_example.AMD"

mesINT <- NULL
mesINT <- read.AM.mesures(file.INT)
mesINT.info <- read.AM.info (file.INT)
mes.sel<- extract.mesures.specimen.name("40001B_11B1", mesINT)
```

```
# reference

# Coe 1978 : DOI: 10.1029/JB083iB04p01740

# Prévost et Al. 1985 DOI: 10.1029/JB090iB12p10417

par(pty="s", "xaxp")

relative = FALSE

verbose = TRUE

show.plot = TRUE

vol=10.8

TH = 60

aim.coef = 1E-10*1E6/vol #1E6

show.step.value = FALSE

R.mark = 'R'  # Positive pTRM

V.mark = 'V'  # Negative pTRM

P.mark = 'P'  # pTRM check

L.mark = "L"  # sLow cooling

Q.mark = "Q"  # Quick cooling

pt.col = "blue"

loop.col = "forestgreen"

step.J0 = "20N0" # ou NULL


begin.step.value = 0

end.step.value = 700
```

```
par(pty="s", "xaxp")

arai(mes.sel, begin.step.value = 250, end.step.value = 700, aim.coef = 1E-10*1E6/vol)
```




```
#> [1] "Coef. Corr. lin. R= -0.999 pour 13 points"
#> [2] " Sigmab ( Coe 1978) = 0.0123"
#> [3] "with lab field : 60 µT => Fe= 56 ± 0.737 µT (Coe et Al. 1978)"
#> [4] "f = 87.62% (Coe et Al. 1978)"
#> [5] "q = 59.9"
#> [6] "g  = 0.899"
#> [7] "Crm  = 7.216e-11 (Coe 1984)"
#> [8] "q (Prévost 85) = 64.1"
#> [9] "sigma (Prévost 85) = 0.0131"
#> [1] "Speed Rate with slow step: -0.6727 %"
#> [2] "Derive speed Rate with quick step: -0.1607 %"
#> [3] "Fe Lent= 56.4 ± 0.742 µT"
#> $ARN
#>                X             Y             Z         I        D            F
#> 1  -3.226852e-10 -1.258333e-09 -1.208333e-09 -42.92797 255.6171 1.774147e-09
#> 2  -3.387500e-10 -1.218519e-09 -1.119444e-09 -41.51288 254.4640 1.688992e-09
#> 3  -2.662500e-10 -1.159722e-09 -9.905556e-10 -39.77652 257.0700 1.548239e-09
#> 4  -2.667593e-10 -1.056481e-09 -9.316204e-10 -40.52980 255.8291 1.433607e-09
#> 5  -2.757407e-10 -1.062963e-09 -8.903241e-10 -39.03350 255.4576 1.413719e-09
```

```
#> 6  -2.479630e-10 -9.574074e-10 -8.167130e-10 -39.54988 255.4798 1.282628e-09
#> 7  -2.236111e-10 -8.601389e-10 -7.302778e-10 -39.41027 255.4273 1.150281e-09
#> 8  -1.836574e-10 -6.969444e-10 -5.526852e-10 -37.48220 255.2371 9.082525e-10
#> 9  -1.493056e-10 -5.271759e-10 -4.332870e-10 -38.33688 254.1869 6.985301e-10
#> 10 -1.102778e-10 -4.035648e-10 -3.180556e-10 -37.24363 254.7165 5.255331e-10
#> 11 -8.549074e-11 -3.224537e-10 -2.481481e-10 -36.64417 255.1510 4.157674e-10
#> 12 -6.451852e-11 -2.784259e-10 -2.106481e-10 -36.39164 256.9533 3.550441e-10
#> 13 -3.353704e-11 -1.873611e-10 -1.361111e-10 -35.56850 259.8517 2.339982e-10
#> 14 -3.350000e-11 -1.134722e-10 -8.518519e-11 -35.75361 253.5520 1.457900e-10
#> 15 -1.508333e-11 -7.982407e-11 -5.046296e-11 -31.84792 259.2997 9.563420e-11
#> 16 -1.262500e-11 -8.928241e-12 -1.203704e-11 -37.89868 215.2675 1.959577e-11
#>    step.value step.name
#> 1          20         0
#> 2         100         A
#> 3         200         B
#> 4         250         C
#> 5         275         D
#> 6         300         E
#> 7         325         F
#> 8         350         G
#> 9         375         H
#> 10        400         I
#> 11        425         J
#> 12        450         K
#> 13        475         L
#> 14        500         M
#> 15        525         N
#> 16        550         O
#>
#> $ATR
```

```
#>                X              Y            Z        I         D            F
#> 1   0.000000e+00  0.000000e+00 0.000000e+00  0.00000   0.00000 0.000000e+00
#> 2   1.754630e-11 -2.037037e-11 4.074074e-11 56.57861 -49.25959 4.881222e-11
#> 3  -4.629630e-14  6.944444e-12 1.362963e-10 87.08318  90.38197 1.364731e-10
#> 4  -2.592593e-12  2.129630e-11 2.174537e-10 84.36555  96.94098 2.185094e-10
#> 5  -1.388889e-11  3.240741e-11 2.994907e-10 83.28563 113.19859 3.015590e-10
#> 6  -1.277778e-11 -1.851852e-11 3.749537e-10 86.56609 235.39432 3.756281e-10
#> 7  -1.212963e-11  1.342593e-12 5.530556e-10 88.73592 173.68381 5.531902e-10
#> 8   6.064815e-12  3.148148e-12 7.760185e-10 89.49550  27.43310 7.760486e-10
#> 9  -2.856481e-11  4.027778e-12 1.019491e-09 88.37920 171.97393 1.019899e-09
#> 10 -1.601852e-11 -4.398148e-12 1.207870e-09 89.21208 195.35316 1.207985e-09
#> 11 -1.876852e-11 -8.379630e-12 1.340741e-09 89.12170 204.05945 1.340898e-09
#> 12 -3.409259e-11 -4.537037e-12 1.429167e-09 88.62143 187.58037 1.429580e-09
#> 13 -1.462963e-11  1.527778e-12 1.553704e-09 89.45759 174.03819 1.553773e-09
#> 14 -1.623148e-11 -1.439815e-11 1.626852e-09 89.23590 221.57465 1.626997e-09
#> 15 -2.579630e-11 -3.037037e-12 1.705093e-09 89.12725 186.71461 1.705290e-09
#> 16 -2.670833e-11 -1.193287e-11 1.827778e-09 89.08308 204.07435 1.828012e-09
#>    step.value step.name
#> 1          20         0
#> 2         100         A
#> 3         200         B
#> 4         250         C
#> 5         275         D
#> 6         300         E
#> 7         325         F
#> 8         350         G
#> 9         375         H
#> 10        400         I
#> 11        425         J
#> 12        450         K
```

```
#> 13        475         L
#> 14        500         M
#> 15        525         N
#> 16        550         O
#>
#> $ATP
#>                X             Y            Z        I         D            F
#> 1 -7.962963e-12 -1.527778e-11 1.560185e-10 83.69861 242.47093 1.569669e-10
#> 2  5.106481e-12 -7.824074e-12 4.057407e-10 88.68088 -56.86901 4.058483e-10
#> 3 -8.398148e-12 -9.861111e-12 1.260926e-09 89.41146 229.58085 1.260992e-09
#> 4 -2.220370e-11 -1.259259e-13 1.668981e-09 89.23778 180.32494 1.669129e-09
#>   step.value step.name
#> 1        200         E
#> 2        300         I
#> 3        400         M
#> 4        500         O
#>
#> $stat
#>         Fe     SigFe      FeL    SigFeL        rateL        rateQ   sigmaCoe
#> 1 56.03441 0.7368077 56.41135 0.7417642 -0.006726996 -0.001606999 0.01228013
#>           JTRM    fCoe78   qCoe78         g      CrmMax qPrevost85
#> 1 1.790584e-09 0.8762355 59.88656 0.8986857 7.21559e-11   64.12476
#>   sigmaPrevost85
#> 1      0.0131492
```

Sun azimuth

```
sun.azimuth (10, 11, 2019, 11, 19, seconde=0, 48, longmin=0, longsec=0, 45, latmin=0,
latsec=0)
#> [1] 221.8943
```

igrf13syn

This is a synthesis routine for the 13th generation IGRF as agreed in December 2019 by IAGA Working Group V-MOD. It is valid 1900.0 to 2025.0 inclusive. Values for dates from 1945.0 to 2015.0 inclusive are definitive, otherwise they are non-definitive. Reference:

Thébault, E., Finlay, C.C., Beggan, C.D. et al. International Geomagnetic Reference Field: the 12th generation. Earth Planet Sp 67, 79 (2015). https://doi.org/10.1186/s40623-015-0228-9

```
isv <- 1

date <- 2000

itype <- 1

alt <- 50

colat <- 90 - 45

elong <- 10


igrf13syn(isv=isv, date=date, itype=itype , alt=alt, colat= colat, elong=elong)

#> $x

#> [1] 8.357313

#>

#> $y

#> [1] 37.63232

#>

#> $z

#> [1] 31.11141

#>

#> $f

#> [1] 49.53742

#>

#> $type

#> [1] "Secular Variation"

#>

#> $dec

#> [1] 77.47906
```

```
#>
#> $inc
#> [1] 38.90556
#>
#> $hoz
#> [1] 38.54914
```