Package 'gravmagsubs'

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Type Package

Title Gravitational and Magnetic Attraction of 3-D Vertical Rectangular Prisms

Version 1.0.1

Description Computes the gravitational and magnetic anomalies generated by 3-D vertical rectangular prisms at specific observation points using the method of Plouff (1976) <doi:10.1190/1.1440645>.

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URL https://code.usgs.gov/gmegsc/gravmagsubs

Imports Rcpp (>= 1.0.5)

LinkingTo Rcpp

SystemRequirements GNU make

Suggests knitr, rmarkdown, fields, ggplot2, gridExtra, scales, scatterplot3d

VignetteBuilder knitr

NeedsCompilation yes

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`gravmagsubs-package` *Gravitational and magnetic attraction of 3-D vertical rectangular prisms*

Description

The package `gravmagsubs` provides tools for computing the gravitational and magnetic anomalies generated by 3-D vertical rectangular prisms at specific observation points. The package consists of two functions:

- `rectprismgrav` : Computes the gravitational attraction of 3-D right rectangular prisms.
- `rectprismmag` : Computes the magnetic effect of 3-D right rectangular prisms.

Each function can compute the total anomaly of a series of `N` prisms at `M` observation points.

Each function also has a logical flag `bycell` (default `FALSE`). If `bycell=TRUE`, the function returns the contribution from each individual prism.

References

- Plouff, D., 1976, Gravity and magnetic fields of polygonal prisms and application to magnetic terrain corrections, Geophysics, v. 41, pp. 727–741, doi:10.1190/1.1440645.

`rectprismgrav` *rectprismgrav*

Description

Calculates the graviational attraction of 3-D rectangular prisms. Calculates anomalies of `N` prisms at `M` observation stations.

Stations cannot be positioned on the edge of a prism.

Coordinates of stations and prisms are assumed to share a common coordinate system.

Usage

```
rectprismgrav(xstation, ystation, zstation, xmin, xmax, ymin, ymax,
                        zdeep, zshallow, deltarho, bycell=FALSE)
```

Arguments

`xstation`	vector of length `M` with the x-coordinates of each station, in km, positive east;
`ystation`	vector of length `M` with the y-coordinates of each station, in km, positive north;
`zstation`	vector of length `M` with the z-coordinates of each station, in km, positive up;
`xmin`	vector of length `N` with the minimum x-coordinates of each prism, in km, positive east;

xmax	vector of length N with the maximum x-coordinates of each prism, in km, positive east;
ymin	vector of length N with the minimum y-coordinates of each prism, in km, positive north;
ymax	vector of length N with the maximum y-coordinates of each prism, in km, positive north;
zdeep	vector of length N with the bottom z-coordinates of each prism, in km, positive up;
zshallow	vector of length N with the top z-coordinates of each prism, in km, positive up;
deltarho	vector of length N with the density contrast of each prism, in grams per cubic centimeter (g/cc);
bycell	returns M-by-N matrix with anomaly values generated by individual prisms (default FALSE).

Value

Returns a matrix of length M rows.

If bycell=FALSE, there will be M rows and 1 column, and the element in the i-th row represents the total gravity anomaly generated by all N prisms as observed at the i-th station.

If bycell=TRUE, the matrix will have M rows and N columns, with the element [i,j] representing the anomaly value generated by the j-th prism as observed at the i-th station.

References

- Plouff, D., 1975, Derivation of formulas and FORTRAN programs to compute gravity anomalies of prisms, National Technical Information Service No. PB-243-526, U.S. Department of Commerce, Springfield, VA. https://ntrl.ntis.gov/NTRL/dashboard/searchResults/titleDetail/PB243526.xhtml.

See Also

rectprismmag, gravmagsubs.

Examples

```
#########################################################
## gravity anomaly of a single prism at a single point ##

# location of the point where the gravity anomaly will be calculated
gravstation <- data.frame(x=0, y=0, z=0)

# the rectangular prism is defined by its six edges
prism1 <- data.frame(xmin=-5, xmax=5,
                     ymin=-5, ymax=5,
                     zmin=-10, zmax=-5)

# density contrast in g/cc
```

```
drho <- 0.3

gravanom <- rectprismgrav(gravstation$x, gravstation$y, gravstation$z,
                          prism1$xmin, prism1$xmax,
                          prism1$ymin, prism1$ymax,
                          prism1$zmin, prism1$zmax, drho)

#########################################################
```

`rectprismmag` *rectprismmag*

Description

Calculates the magnetic effect of 3-D rectangular prisms. Calculates anomalies of `N` prisms at `M` observation stations.

Stations cannot be positioned inside a prism, or on its edges or faces. Stations cannot be positioned directly below the corners of a prism.

Coordinates of stations and prisms are assumed to share a common coordinate system.

Returns total field magnetic anomaly in nanoteslas (nT).

N.B. Demagnetization effects are ignored in this subroutine.

Usage

```
rectprismmag(xstation, ystation, zstation, xmin, xmax, ymin, ymax,
             zdeep, zshallow, suscvolsi, nrmstr, nrmincl, nrmdecl,
             fieldtotal, fieldincl, fielddecl, bycell=FALSE)
```

Arguments

`xstation`	vector of length `M` with the x-coordinates of each station, in km, positive east;
`ystation`	vector of length `M` with the y-coordinates of each station, in km, positive north;
`zstation`	vector of length `M` with the z-coordinates of each station, in km, positive up;
`xmin`	vector of length `N` with the minimum x-coordinates of each prism, in km, positive east;
`xmax`	vector of length `N` with the maximum x-coordinates of each prism, in km, positive east;
`ymin`	vector of length `N` with the minimum y-coordinates of each prism, in km, positive north;
`ymax`	vector of length `N` with the maximum y-coordinates of each prism, in km, positive north;
`zdeep`	vector of length `N` with the bottom z-coordinates of each prism, in km, positive up;

zshallow	vector of length N with the top z-coordinates of each prism, in km, positive up;
suscvolsi	vector of length N with the volume susceptibility (unitless);
nrmstr	vector of length N with the remanent magnetization of each prism, in Amperes per meter (A/m);
nrmincl	vector of length N with the inclination angle of the remanent magnetization for each prism, in degrees, positive below horizontal;
nrmdecl	vector of length N with the declination angle of the remanent magnetization for each prism, in degrees, positive east of true north;
fieldtotal	vector of length N with the Earth's field intensity at each prism, in nanoteslas (nT);
fieldincl	vector of length N with the Earth's field inclination at each prism, in degrees, positive below horizontal;
fielddecl	vector of length N with the Earth's field declination at each prism, in degrees, positive east of true north;
bycell	returns M-by-N matrix with anomaly values generated by individual prisms (default FALSE).

Value

Returns a matrix of length M rows.

If bycell=FALSE, there will be M rows and 1 column, and the element in the i-th row represents the total magnetic anomaly generated by all N prisms as observed at the i-th station.

If bycell=TRUE, the matrix will have M rows and N columns, with the element [i,j] representing the anomaly value generated by the j-th prism as observed at the i-th station.

References

- Plouff, D., 1975, Derivation of formulas and FORTRAN programs to compute magnetic anomalies of prisms, National Technical Information Service No. PB-243-525, U.S. Department of Commerce, Springfield, VA. https://ntrl.ntis.gov/NTRL/dashboard/searchResults/titleDetail/PB243525.xhtml.

See Also

rectprismgrav, gravmagsubs.

Examples

```
#########################################################
## magnetic anomaly of single prism at a single point  ##

# location of the point where the magnetic anomaly will be calculated
magstation <- data.frame(x=0, y=0, z=0)

# the rectangular prism is defined by its six edges
prism1 <- data.frame(xmin=-5, xmax=5,
```

```
                    ymin=-5, ymax=5,
                    zmin=-10, zmax=-5)

susc <- 5       # susceptiblity (SI)
mstr <- 0       # remanent magnetization (A/m)
mincl <- 0      # remanent inclination (deg)
mdecl <- 0      # remanent declination (deg)
ftotal <- 48800 # Earth's field intensity (nT)
fincl <- 60     # field inclination (deg)
fdecl <- 12     # field declination (deg)

maganom <- rectprismmag(magstation$x, magstation$y, magstation$z,
                        prism1$xmin, prism1$xmax,
                        prism1$ymin, prism1$ymax,
                        prism1$zmin, prism1$zmax, susc,
                        mstr, mincl, mdecl,
                        ftotal, fincl, fdecl)

############################################################
```

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