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REM (relative element magnitude)

Program Explanation and Computer Program Listing

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Abstract

The REM (relative element magnitude) program is designed as an aid in the characterization of geochemical anomalies. The program ranks the magnitudes of anomalies of individual elements within a multielement geochemical anomaly.

Introduction

The interpretation of a geochemical anomaly, believed to be the product of concealed mineralization, should incorporate two inferences: 1, the type of ore minerals that might be expected at depth, and 2, an estimate of the depth to possible ore-mineral concentration.

Core drilling is the only definitive method of determining these parameters. However, reasonable estimates must and can be made on the basis of existing geologic, geophysical, and geochemical information prior to the expensive drilling stage. Geologic information is essential in determining the type of mineralization that might be expected within a given area. Geologic information in conjunction with geophysical data can provide information as to the depth at which an ore-mineral concentration might be found. Geochemical data, on the other hand, can add very significantly to the determination of both parameters.

Geochemical data represent measurements of quantities directly involved in the mineralization process; they, aside from drill data, therefore constitute the most valid body of information from which estimates as to type of and depth to ore-mineral concentrations might be made.

The type of mineralization can be deduced from the elemental assemblage that has been introduced into the mineralized area, as well as the relative amount of each element within this assemblage. The comparison of these two anomaly traits with those of anomalies associated with orebodies of known composition can provide an indication of the type of minerals that can be expected at depth.

The REM (relative element magnitude) program is intended to aid in the determination of the type of mineralization. It is designed to characterize a geochemical anomaly on the basis of elemental association as well as the relative magnitude of each individual element anomaly within the overall association.

Program explanation

Introduction

The REM program is designed to rank the magnitudes of individual element anomalies within a multi-element geochemical anomaly. Calculations are performed on a cell basis (that is, on all sample locations falling within a defined area) rather than on individual sample locations. Only rectangular cell configurations are permitted by this program. The user determines the cell size, shape and location by defining its corner points in terms of minimum and maximum of latitude and longitude or (x) and (y). In most instances the cell boundaries should barely encompass the anomalous area under study.

The cell should contain a reasonable number of sample sites. The size of the actual population is a function of cell size and the structural and topographic complexity of the area. Sample site distribution within the area should be as uniform as possible. In addition to the geographic parameters of the cell, the element association to be considered and the threshold value for each element within the association must be defined at the start of each program run. The analytical data used must have been derived from the same type of sample.

Mode of calculation

The REM program calculations are performed on the basis of two parameters for each of the elements within the selected elemental suite. The first of these, the intensity factor, is derived by dividing the mean of all anomalous values of a given element within the defined area by its respective threshold value. The second, the area factor, is derived by dividing the number of sample locations within the defined area that contain anomalous levels of this element by the total number of sample locations within this area. These two values are multiplied for each element and the product is the individual element magnitude. All individual element magnitudes are added to give the total anomaly magnitude of the cell. In addition, each individual element magnitude is divided by the anomaly magnitude of the cell and the quotient is expressed in percent. This is the relative element magnitude.

Program execution

The REM program uses a STATPAC data set(s) (VanTrump and Miesch, 1977) as input and prompts the user, interactively, for the required information. The program execution can be divided into three sections:

a. Input.

b. Verification.

c. Output.

Each section will be explained in detail in conjunction with a sample program run.

Input section

This section explains the types of information required to initiate the program. An example of the required input, keyed numerically to the type of information required at each step, is shown below:

INPUT SECTION

```
REM (1.)

ENTER NO. OF INPUT FILES : 1 (2)

ENTER INPUT FILE NAMES : (3)

FILE NO.  1    = LHM1 (a)
DATA SET NAME = LHM1 (b)

ENTER LAT-LONG COL NOS : 1,2 (4)

ENTER LOC VALS (XMIN,XMAX,YMIN,YMAX) : 32.75,32.78,107.76,107.79 (5)

ENTER NO. OF VAR TO BE USED : 4 (6)

ENTER FILE NO, COL NO, & THRESHOLD VAL FOR EACH VAR: (7)
VAR NO  1 : 1,18,150
VAR NO  2 : 1,20,10
VAR NO  3 : 1,23,150
VAR NO  4 : 1,31,2000

DO YOU WANT TO CORRECT ANY VARS ? N
```

1. Lower case REM will initiate the program.
2. The number of STATPAC binary files containing the desired data.
3. a. The name(s) of STATPAC binary file(s) containing the desired STATPAC data set.
   b. The name(s) of the STATPAC data set(s) within the file given in step 3a containing the desired variables.
4. The column numbers in the data set for the latitude (x) and longitude (y). If more than one file is used, the column numbers for latitude and longitude must be the same in all files
5. The location and size of the selected rectangular cell. The mininum and maximum latitude (x) and longitude (y) defining the selected area are entered in decimal form.
6. The number of elements within the selected elemental suite.
7. a. The file number within which each selected element is located.
   b. The column number of each selected element.
   c. The threshold value for each selected element. The program will consider all values $\geq$ to this value.

Verification section

This section of the program shows the input parameters on which the program will make its calculations. An example of this section, keyed numerically to an explanation of the information provided, is shown below:

VERIFICATION SECTION

```
WINDOW AREA:        MINIMUM     MAXIMUM
     LATITUDE       32.7500     32.7800   (1)
    LONGITUDE      107.7600    107.7900

VARIABLES:
    VAR  1 = COL  18, FILE  1 (S-CU    ), THESHOLD VALUE =    150.000
(2) VAR  2 = COL  20, FILE  1 (S-MO    ), THESHOLD VALUE =     10.000
    VAR  3 = COL  23, FILE  1 (S-PB    ), THESHOLD VALUE =    150.000
    VAR  4 = COL  31, FILE  1 (S-ZN    ), THESHOLD VALUE =   2000.000
             (a)      (b)      (c)  (d)                        (e)
```

1. The mininum and maximum latitude (x) and longitude (y) defining the area to be used.
2. A list of the variables on which calculations will be made. The following information is provided for each:
    a. Variable number.
    b. Column number of the variable.
    c. File number within which the variable is located.
    d. Element name of the selected variable.
    e. Threshold value of the selected variable.

Output section

This section of the program gives the results of the program calculations. An example of the output, keyed numerically to an explanation of the type of information provided, is shown below:

OUTPUT SECTION

GENERAL STATS:

VAR ID	TOTAL	ANOM	SUM	MEAN	INTENSITY	AREA (7)	EM (8)	REM (10)
S-ZN	13	12	61000.0	5083.333	2.54	92.31	234.62	47.4
S-MO	13	8	225.0	28.125	2.81	61.54	173.08	35.0
S-PB	13	4	1550.0	387.500	2.58	30.77	79.49	16.1
S-CU	13	1	150.0	150.000	1.00	7.69	7.69	1.6
(1)	(2)	(3)	(4)	(5)	(6)	TOTAL (AM) (9)	494.87	

The following information is provided for each element with n the selected association:

1. Element identification of variable.
2. The total number of sample locations within the cell area.
3. Number of anomalous ($\geq$ threshold) sample locations within the cell area.
4. The sum of all anomalous values occurring within the cell area.
5. The mean anomalous value within the cell area.
6. The mean divided by the threshold value. The quotient is the intensity factor for this element.
7. The number of anomalous sample locations within the cell area divided by the total number of sample locations here. This is called the area factor for this element and is expressed in percent.
8. The product of the intensity and the area factors. This value is termed the element magnitude (EM).
9. The sum of all element magnitudes, termed the anomaly magnitude (AM).
10. The element magnitude divided by the anomaly magnitude and expressed in percent. This value is termed the relative element magnitude. The REM values of the selected variables are ranked in decreasing order. If no anomalous values for a given variable are found within the cell area, the variable is dropped from the calculations and is flagged by a row of stars.

References cited

VanTrump, Jr., George, and Miesch, A. T., 1977, The U.S. Geological Survey RASS-STATPAC System for management and statistical reduction of geochemical data: Computers and Geoscience, v. 3, p. 475-488.

Appendix A

A Computer Listing of the REM Program

```
20          read 130,id(1,i),id(2,i)
21      130 format (2a4)
22          call searches (icd(i),itp(i),id(1,i),n(i),m(i),ivid,$120)
23      140 continue
      c     ------------------------------------------------------------
      c ... Enter geodetic locations to be used.
      c     ------------------------------------------------------------
24          call ioa_$nnl ("^/Enter Lat-Long col nos : ")
25          read 210,iselv(1,1),iselv(2,1)
26          do 150 i=2,50
27          iselv(1,i)=iselv(1,1)
28      150 iselv(2,i)=iselv(2,1)
29          call ioa_$nnl ("^/Enter loc vals (xmin,xmax,ymin,ymax) : ")
30          read 210,xmin,xmax,ymin,ymax
      c     ------------------------------------------------------------
      c ... Enter variables to be used.
      c     ------------------------------------------------------------
31      160 call ioa_$nnl ("^/Enter no. of var to be used : ")
32          read 210,nv
33          print 170
34      170 format (/"Enter File No, col no, & threshold val for each var:")
35          do 200 i=1,nv
36      180 call ioa_$nnl ("Var No ^2i : ",i)
37          read 210,nofl(i),iselv(3,i),values(i)
38          if (nofl(i).le.nf) go to 200
39          print 190,nofl(i)
40      190 format ("Error ... file no.",i3," not defined.  Try again.")
41          go to 180
42      200 continue
43      210 format (v)
      c     ------------------------------------------------------------
      c ... Inquiry about possible corrections to input parameters.
      c     ------------------------------------------------------------
44          call ioa_$nnl ("^/Do you want to correct any vars ? ")
45          read 400,ians
46          if (ians.ne.iyes) go to 270
47      220 print 230
48      230 format (/"Enter var no, file no, col no, & anom val")
49      240 call ioa_$nnl ("Pos : ")
50          read 210,i,j,k,zval
51          if (i.gt.nv) go to 250
52          if (j.gt.nf) go to 250
53          if (k.gt.m(j)) go to 250
54          nofl(i)=j
55          iselv(3,i)=k
56          values(i)=zval
57          call ioa_$nnl ('Another ? ')
58          read 400,ians
59          if (ians.eq.iyes) go to 240
```

Relative Element Magnitude Program

```
c      * * * * Relative Element Magnitude Program (rem) - Statpac * * * *
c                          U.S. Geological Survey
c                     Geologic Division, Denver, Colorado
c                       written by George VanTrump, Jr.
c                              for Henry V. Alminas
c                               on March 14, 1978
c      * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * *
c          This program is designed as an aid in the characterization of
c      geochemical anomalies.  The program ranks individual element
c      anomaly magnitudes within a multi-element geochemical anomaly.
c          The program uses a STATPAC data set as input and prompts the
c      user, interactively, for the required information.
c          The following subroutines, referenced within this program but
c      not listed, perform the following:
c          ioa_$nnl - prompts the user with a character string and holds
c             the cursor at the end of the string so that the reply to
c             the query is on the same line as the question.
c          openf    - attaches and opens a STATPAC binary file.
c          closef   - closes and detaches a STATPAC binary file.
c          searches - finds the required data set in the input STATPAC
c             binary file.
c          getlst   - reads a record(sample) from a STATPAC data set.
c      ------------------------------------------------------------------
c
1          external ioa_$nnl (descriptors), openf (descriptors)
2          character*32 file
3          real mean(50),int(50)
4          dimension irid(4),loc(2),x(199),ia(199),ivid(199,2),values(50),
4         1 sum(50),numan(50),area(50),num(50),nofl(50),iselv(3,50),
4         2 ids(2,50),ierr(50),rfm(50),nos(50),r(50),prod(50),itp(10),
4         3 icd(10),id(2,10),n(10),m(10)
5          data iyes/"y"/,iblk/" "/,ibbb/"B"/
c      ------------------------------------------------------------------
c ...  Enter files to be used.
c      ------------------------------------------------------------------
6          call ioa_$nnl ("^/Enter no. of input files : ")
7          read 210,nf
8          print 100
9        100 format (/"Enter input file names :")
10         do 140 i=1,nf
11         call ioa_$nnl ("^/File No. ^2i    = ",i)
12         read 110,file
13       110 format (a32)
14         icd(i)=0
15         itp(i)=i+9
16         n(i)=0
17         m(i)=0
18         call openf (itp(i),file,"sqi ")
19       120 call ioa_$nnl ("Data Set Name = ")
```

```
      go to 270
  250 print 260,i,j,k
  260 format ("Error ... var no.",i3," or file no.",i3," or col no.",i3,
     1" not defined.  Try again.")
      go to 240
c     ------------------------------------------------------------------
c ... Begin computations.
c     ------------------------------------------------------------------
  270 do 280 i=1,nv
      j=nofl(i)
      itt=itp(j)
      call searches (icd(j),itt,id(1,j),n(j),m(j),ivid,$410)
      sum(i)=0.0
      num(i)=0
      numan(i)=0
      nn=n(j)
      mm=m(j)
      ix=iselv(1,i)
      iy=iselv(2,i)
      iz=iselv(3,i)
      ids(1,i)=ivid(iz,1)
      ids(2,i)=ivid(iz,2)
      zval=values(i)
      do 280 j=1,nn
      call getlst (itt,ir,irid,loc,x,ia,mm,$410)
      if (ia(iz).eq.ibbb) go to 280
      if (x(ix).lt.xmin.or.x(ix).gt.xmax) go to 280
      if (x(iy).lt.ymin.or.x(iy).gt.ymax) go to 280
      num(i)=num(i)+1
      if (ia(iz).ne.iblk) go to 280
      if (x(iz).lt.zval) go to 280
      sum(i)=sum(i)+x(iz)
      numan(i)=numan(i)+1
  280 continue
      denom=0.0
      do 310 i=1,nv
      rfm(i)=1.0e15
      ierr(i)=1
      if (numan(i).ne.0.and.num(i).ne.0) ierr(i)=0
      mean(i)=1.0e15
      int(i)=1.0e15
      area(i)=1.0e15
      prod(i)=1.0e15
      r(i)=1.0e15
      nos(i)=i
      if (numan(i).eq.0) go to 290
      mean(i)=sum(i)/numan(i)
      int(i)=mean(i)/values(i)
  290 if (num(i).eq.0) go to 300
```

```
105         area(i)=100.0*numan(i)/num(i)
106      300 if (ierr(i).eq.0) denom=denom+int(i)*area(i)
107      310 continue
108          sums=0.0
109          do 320 i=1,nv
110          if (ierr(i).ne.0) go to 320
111          prod(i)=int(i)*area(i)
112          sums=sums+prod(i)
113          rfm(i)=100.0*prod(i)/denom
114          r(i)=rfm(i)
115      320 continue
116          ns=nv
117      330 ns=ns-1
118          ichg=0
119          if (ns.lt.0) go to 340
120          do 340 i=1,ns
121          if (r(i).ge.r(i+1)) go to 340
122          rs=r(i)
123          r(i)=r(i+1)
124          r(i+1)=rs
125          nsav=nos(i)
126          nos(i)=nos(i+1)
127          nos(i+1)=nsav
128          ichg=1
129      340 continue
130          if (ichg.ne.0) go to 330
     c       ------------------------------------------------------------------
     c   ... Print results.
     c       ------------------------------------------------------------------
131      350 print 360,xmin,xmax,ymin,ymax,(i,iselv(3,i),nofl(i),ids(1,i),
131         1 ids(2,i),values(i),i=1,nv)
132      360 format (/"Window Area:     Minimum    Maximum"/5x,"Latitude",2f10.4/
132         1 4x,"Longitude",2f10.4//"Variables:"/(4x,"Var ",i2," = Col ",i3,
132         2 ", file ",i2," (",2a4,"), Theshold Value = ",f10.3))
133      370 print 380,(ids(1,nos(i)),ids(2,nos(i)),num(nos(i)),
133         1 numan(nos(i)),sum(nos(i)),mean(nos(i)),int(nos(i)),
133         2 area(nos(i)),prod(nos(i)),rfm(nos(i)),i=1,nv)
134      380 format (/"General Stats:"/1x,"Var ID   Total  Anom",
134         1 t27,"Sum",t35,"Mean",t42,"Intensity",t53,"Area",t63,"EM",
134         2t71,"REM"/(2a4,2i6,f10.1,1x,f9.3,1x,f7.2,2x,f6.2,1x,f9.2,2x,f5.1))
135          print 390,sums
136      390 format (t48,"Total(AM)",f10.2)
     c       ------------------------------------------------------------------
     c   ... Inquiry about changes to existing parameters.
     c       ------------------------------------------------------------------
137          call ioa_$nnl ("^/Do you want to change any cols ? ")
138          read 400,ians
139          if (ians.eq.iyes) go to 220
140          call ioa_$nnl ("^/Do you want another set of selected cols ? ")
```

```
      read 400,ians
  400 format (a1)
      if (ians.eq.iyes) go to 160
      call ioa_$nnl ("^/Do you want to change location values ? ")
      read 400,ians
      if (ians.ne.iyes) go to 410
      call ioa_$nnl ("^/Enter new loc vals (xmin,xmax,ymin,ymax) : ")
      read 210,xmin,xmax,ymin,ymax
      go to 270
c     ------------------------------------------------------------
c ... Close files.
c     ------------------------------------------------------------
  410 do 420 i=1,nf
  420 call closef (itp(i))
c
      stop
      end
```