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A COMPUTER PROGRAMME FOR THE CALCULATION OF THE BARTH MESONORM.

by

W.R. Morgan

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SUMMARY

A computer programme for the calculation of mesonorms of acid, non-peralkaline igneous rocks is presented and briefly described. The programme is written in Fortran, and is designed for use on an I.B.M. 1620 computer. The chemical analyses on which the calculations are made are to be read by the computer from standard Bureau of Mineral Resources silicate analysis punched cards. The results of the calculations are punched on to cards, the format of which fits in with the Bureau's punched card system.

INTRODUCTION

The mesonorm (Barth, 1959 and 1962) is best suited for most plutonic acid igneous rocks because the normative mineralogy more nearly agrees with the modal mineralogy, i.e., normative biotite and hornblende can be calculated, instead of pyroxene, as in the C.I.P.W. norm. Because of this, data from the mesonorms plotted on Qz - Or - Ab and Or - Ab - An diagrams are more realistic than those from C.I.P.W. norms. For the Bureau, the mesonorm is very suitable for the numerous granite samples that have been chemically analysed as part of the age-determination programme.

The programme presented here is written in the Fortran language, and is suitable for an I.B.M. 1620 computer, although with little or no modification it can be used on computers made by other firms. It is designed to calculate the mesonorms of acid, non-peralkaline igneous rocks. Provision is also made in the programme for the calculation of data for Or - Ab - An, Qz - Or - Ab, AFM, AKF, and Solidification Index (Kuno, 1959) variation diagrams, and for Ab - An ratios.

The chemical analyses on which the calculations are made are read by the computer from standard Bureau silicate analysis punched cards (c.f. Fig. 32, Walpole, Haldane, Mather and Morgan, 1964). The results of the calculations are punched by the computer on to cards; the format of these cards has been made to fit in with the age-determination section of the Bureau's punched card system, and will be described later in the section on Output Specifications.

The writer is very grateful to Messrs. M.C. Goldrich and P.R. Wright, of I.B.M. (Australia) Pty., Ltd., Canberra, for much helpful advice during this work. I also wish to thank Dr. A.J.R. White, of the Australian National University, together with Dr. R.R. Harding and Mr. J.M. Rhodes, of the Bureau of Mineral Resources, for discussion and criticism of the manuscript. The use of the computer at the Australian National University for testing the programme is gratefully acknowledged.

EXPLANATION OF THE PROGRAMME

The programme is divided into three parts: the input specifications, the calculations, and the output specifications. Note that in programme statements quoted in the explanation that follows, and in the programme itself, the letter O is printed with an oblique stroke - thus Ø; this serves to distinguish it from the figure zero - 0.

Input Specifications. Statements 1, 2, and DIMENSIØN NØ (5) are specifications to read the chemical analyses from punched cards. The specimen numbers are read from columns 3 to 11. The values for the oxides are punched in fourteen four column fields, starting from column 12, in the following order: SiO_2, TiO_2, Al_2O_3, Fe_2O_3, FeO, MnO, MgO, CaO, Na_2O, K_2O, P_2O_5, H_2O (+), H_2O (-), CO_2. Each oxide is punched as four figures, without the decimal point (c.f. Fig. 32, Walpole, et al, op. cit.).

The statement DIMENSIØN NØ (5) creates an array for the storage of the specimen number. Statement 1 lists the symbols for each of the oxides, and statement 2 gives the format of the specimen numbers and the oxides.

The Calculations. The methods used in the programme are described in detail, but only a general outline of the whole programme is given. The plan of the programme is shown in figures 1A and 1B; on it, the statement numbers are shown adjacent to the relevant boxes. A key to the symbols used is given in Appendix I.

SUM is the sum of the oxides. Statements PS = ØS/6.006 to PCØ = ØCØ/4.401 are the calculations for the molecular proportions. SUM 1 is the sum of the molecular proportions, and is the constant used in the calculation of the cation values in the statements SI = PS/SUM 1 to C = PCØ/SUM 1. The normative minerals are calculated in the statements from PØ = 1.667*P to statement 43. The normative minerals that can be calculated are quartz (qz), orthoclase (or), albite (ab), anorthite (an), corundum (co), biotite (bi), hornblende (hb), hypersthene (hy), wollastonite (wo), magnetite (mt), hematite (he), sphene (sp), ilmenite (il), rutile (ru), apatite (ap), calcite (cc), and water (aq).

Variation diagram data are computed in the statements FEL = (ØR+AB+AN)/100.0 to FF = FE/AKF; these supply information for the following: Or-Ab-An, Qz-Or-Ab, Ab-An, AFM, the Solidification Index, and AKF.

To show the method of forming the normative minerals, the calculation of albite is described in detail as an example. Statement 9, and the two that follow it, read:-

```
9   AB = 5.*ZNA
    AL = AL - ZNA
    SI = SI - ZNA
```

In the mesonorm, albite is formed by adding to the Na cation an equal amount of Al, and three times this amount of Si; in other words, the Na cation can be multiplied by five, which is what happens in statement 9. In the two following statements, Al and Si are reduced by the amounts of these materials necessary to form albite.

IF and COMPUTED GO TO statements form loops in the programme in order to take into account differences in proportions of the chemical components in different rocks. For example, before anorthite (AN) is computed, it is necessary to determine the relative amounts of Al and Ca by the IF statement:-

```
14 IF (AL - 2. * CA) 15, 16, 16
```

If the result of the calculation in statement 14 is positive (i.e., Al is in excess) or zero (i.e., Al equals twice the amount of Ca), the programme is directed to statement 16, where anorthite is computed in terms of Ca, and corundum (CØ) is formed. If, however, Ca is in excess, the calculation proceeds to statement 15, where corundum is given as 0.0, and anorthite is computed in terms of Al.

It will be noted that the expression K = 1 is created at statement 16, and K = 2 at 15. K = 1 indicates that Al excess in terms of Ca, and K = 2 indicates the reverse. The factor K is used in a COMPUTED GO TO statement immediately before statement 26:

```
GØ TØ (26, 25), K
```

If K = 1, the calculation goes to statement 26, where hornblende (HB) is given zero value (i.e., Al is in excess). If K = 2, the programme proceeds to 25, after which, at statements 34 or 35, hornblende is computed. The IF statement at 25 indicates whether or not Ca exceeds the Fe^{++} and Mg (i.e., TMG) constituents.

Silica checks have been inserted as IF statements at 6, 7, 37, 44, and 45. Their purpose is to reject an analysis if it is found that there is insufficient Si to properly complete the calculations. On rejection, the specimen number and the words NO SILICA are punched on to a card at the output, and the computer proceeds to the next analysis.

The alkalinity of specimens is tested by an IF statement just before 8:-

IF (AL - ZNA) 8, 7, 6

If Na (ZNA) is in excess, the programme is directed to 8 and 55, where the specimen is rejected and its number, together with the word PERALKALINE, is punched out.

Many chemical analyses may not contain CO_2. This is catered for by the IF statement immediately before 49:-

IF (C - O.) 48, 48, 49

If CO_2 is not present, the programme is directed to 48, where calcite (CC) is given as 0.0; if CO_2 is present, calcite is computed at 49.

Output Specifications. On the 1620 computer, the results may be printed or put on to punched cards. The writer decided in favour of cards because the process is more rapid, and thus saves computer time. The information can be printed later by a card-listing device, such as the I.B.M. 870 document-writer.

The results are punched on to five cards for each specimen. Each card contains card code (5 in column 1, indicating age-determination), sequence number (8 in column 2, indicating card 8 in the age-determination series), the specimen number in columns 3 to 11, and an identification number (1, 2, 3, 4 or 5) in column 12. The normative minerals are placed on cards 1, 2, and 3; the diagram data on cards 4 and 5. The layout of the cards is shown in Table I. The results are given to two decimal places.

THE PROGRAMME.

```
      DIMENSIØN NØ(5)
   READ 2,(NØ(K),K=1,5),ØS,ØT,ØA,Ø3,Ø2,ØMN,ØMG,ØC,ØN,ØK,ØP,ØHP,ØHM,ØC
     1Ø
    2 FØRMAT(4A2,A1,14F4.0)
      SUM=(ØS+ØT+ØA+Ø3+Ø2+ØMN+ØMG+ØC+ØN+ØK+ØP+ØHP+ØHM+ØCØ)/100.0
      PS=ØS/6.006
      PT=ØT/7.990
      PA=ØA/5.097
      PF3=Ø3/7.984
      PF2=Ø2/7.184
      PMN=ØMN/7.093
      PMG=ØMG/4.032
      PC=ØC/5.608
      PN=ØN/3.0995
      PK=ØK/4.7095
      PP=ØP/7.098
      PCØ=ØCØ/4.401
      SUM1=(PS+PT+PA+PF3+PF2+PMN+PMG+PC+PN+PK+PP)/100.0
      SI=PS/SUM1
      TI=PT/SUM1
      AL=PA/SUM1
      F3=PF3/SUM1
      F2=(PF2+PMN)/SUM1
      FMG=PMG/SUM1
      CA=PC/SUM1
      ZNA=PN/SUM1
      YK=PK/SUM1
      P=PP/SUM1
      C=PCØ/SUM1
      DK=YK
      PØ=1.667*P
      AP=P+PØ
      CA=CA-PØ
      IF(C-0.)48,48,49
   49 CC=C
      CA=CA-C
```

```
      GØ TØ 70
   48 CC=0.0
   70 IF(CA-TI)4,4,3
    4 IF(F2-TI)81,80,80
   80 XIL=TI+TI
      F2=F2-TI
      SP=0.0
      RU=0.0
      GØ TØ 82
   81 XIL=F2+F2
      RU=TI-F2
      SP=0.0
      GØ TØ 82
    3 SP=3.*TI
      CA=CA-TI
      SI=SI-TI
      XIL=0.0
      RU=0.0
   82 ALL=AL-(ZNA+YK+2.*CA)
      PØR=5.*YK
      AL=AL-YK
      SI=SI-3.*YK
      IF(AL-ZNA)8,7,6
    8 PUNCH 55,(NØ(K),K=1,5)
   55 FØRMAT(4A2,A1,3X,11HPERALKALINE)
      GØ TØ 1
```

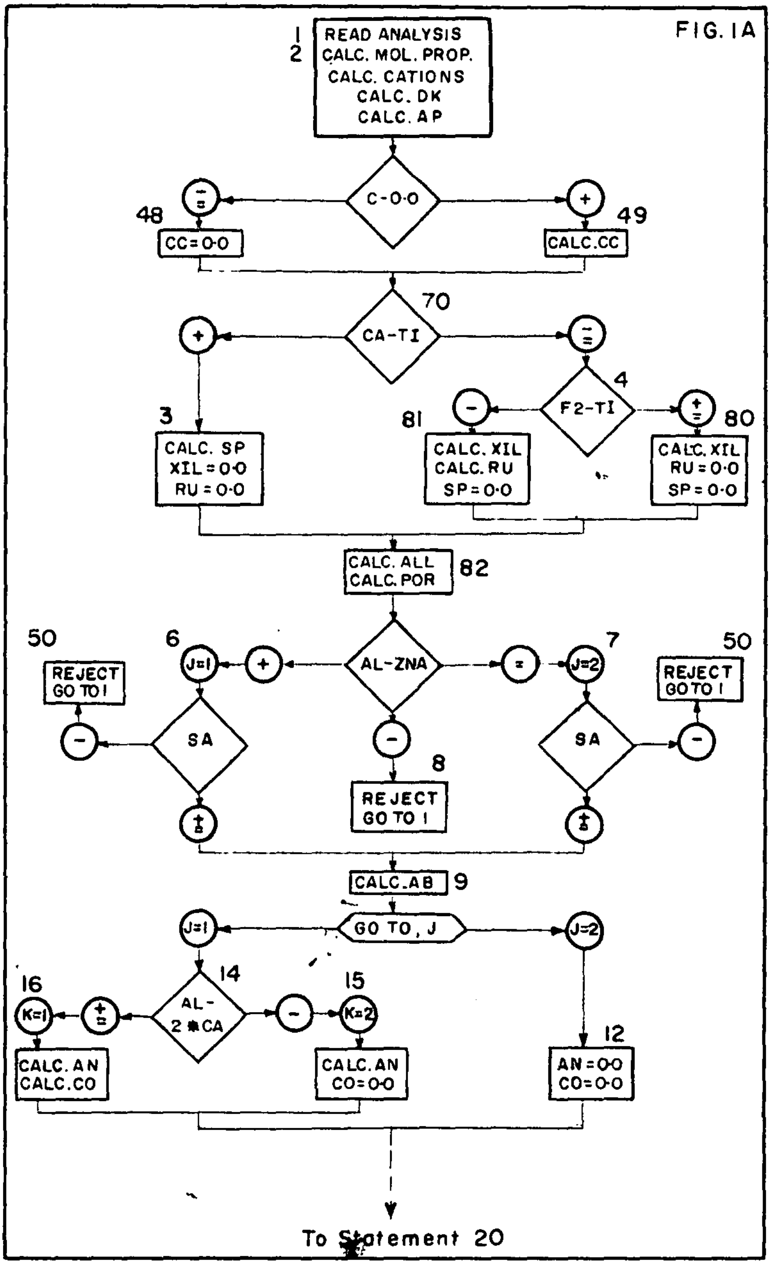
```
 6 J=1
   SA=3.*ZNA+2.*CA
   IF(SI-SA)50,9,9
50 PUNCH 54,(NØ(K),K=1,5)
54 FØRMAT(4A2,A1,3X,9HNØ SILICA)
   GØ TØ 1
 7 J=2
   SB=3.*ZNA
   IF(SI-SB)50,9,9
 9 AB=5.*ZNA
   AL=AL-ZNA
   SI=SI-3.*ZNA
11 GØ TØ(14,12),J
12 AN=0.0
   CØ=0.0
   GØ TØ 20
14 IF(AL-2.*CA)15,16,16
16 K=1
   AN=5.*CA
   CØ=AL-2.*CA
   SI=SI-2.*CA
   GØ TO 2Ø
15 K=2
   AN=2.5*AL
   CA=CA-.5*AL
   SI=SI-AL
   CØ=0.0
20 IF(F2-0.5*F3)21,22,22
21 EMT=3.*F2
   HE=F3-2.*F2
   F2=F2-F2
   GØ TØ 23
22 EMT=1.5*F3
   F2=F2-0.5*F3
```

```
      HE=0.0
   23 TMG=F2+FMG
      FE=TMG
      GØ TØ(26,25),K
   26 HB=0.0
      GØ TØ 27
   25 IF(TMG-2.5*CA)45,44,44
   45 SH=1.6*TMG+(CA-0.4*TMG)
      IF(SI-SH)50,34,34
   34 HB=3.0*TMG
      CA=CA-0.4*TMG
      SI=SI-1.6*TMG
      WØ=CA+CA
      SI=SI-CA
      BI=0.0
      ØR=PØR
      HY=0.0
      GØ TØ 43
   44 SD=4.*CA
      IF(SI-SD)50,35,35
   35 HB=7.5*CA
      TMG=TMG-2.5*CA
      SI=SI-4.0*CA
   27 IF(0.6*POR-TMG)37,36,36
   36 BI=TMG+1.667*TMG
      ØR=PØR-1.667*TMG
      HY=0.0
      WØ=0.0
      GØ TØ 43
```

E 4 D

```
37 BI=PØR+0.6*PØR
   TMG=TMG-0.6*PØR
   IF(SI-TMG)50,42,42
42 WØ=0.0
   ØR=0.0
   HY=TMG+TMG
   SI=SI-TMG
43 QZ=SI
   AQ=(ØHP+ØHM)/100.0
   SUM2=AP+CC+SP+XIL+AB+AN+CØ+EMT+HE+HB+BI+WØ+ØR+HY+QZ+RU
   FEL=(ØR+AB+AN)/100.0
   ØRX=ØR/FEL
   ABX=AB/FEL
   ANX=AN/FEL
   QF=(QZ+AB+ØR)/100.0
   QZF=QZ/QF
   ØRF=ØR/QF
   ABF=AB/QF
   PLG=(AB+AN)/100.0
   ABP=AB/PLG
   ANP=AN/PLG
   FMA=(ØMG+Ø3+Ø2+ØN+ØK)/100.0
   AF=(Ø3+Ø2)/FMA
   AM=ØMG/FMA
   AA=(ØN+ØK)/FMA
   SØI=ØMG/FMA
   AKF=(ALL+DK+FE)/100.0
   AL2=ALL/AKF
```

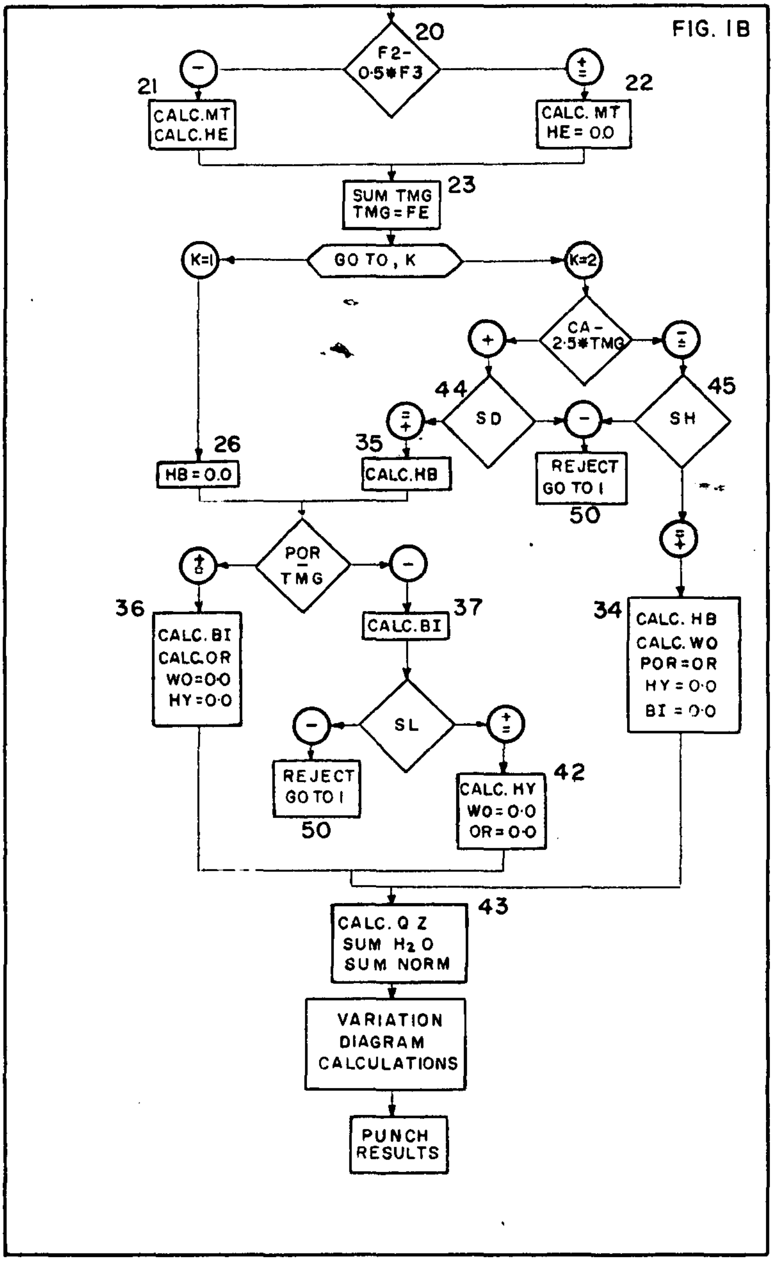
```
      CK=DK/AKF
      FF=FE/AKF
      N6=58
      N1=1
      N2=2
      N3=3
      N4=4
      N5=5
      PUNCH 95,N6,(NØ(K),K=1,5),N1,SUM,SUM2,QZ,ØR,AB,AN,CØ,BI,HB
      PUNCH 95,N6,(NØ(K),K=1,5),N2,HY,WØ,EMT,HE,SP,XIL,RU,AP,CC
      PUNCH 95,N6,(NØ(K),K=1,5),N3,AQ
      PUNCH 95,N6,(NØ(K),K=1,5),N4,ØRX,ABX,ANX,QZF,ØRF,ABF,ABP,ANP,SØI
      PUNCH 95,N6,(NØ(K),K=1,5),N5,AA,AF,AM,AL2,CK,FF
   95 FØRMAT(I2,4A2,A1,I1,(9F7.2))
      GØ TØ 1
      END
```



READ ANALYSIS
CALC. MOL. PROP.
CALC. CATIONS
CALC. DK
CALC. AP
C-0.0
CC=0.0
CALC.CC
CA-TI
F2-TI
CALC. SP
XIL=0.0
RU=0.0
CALC. XIL
CALC. RU
SP=0.0
CALC. XIL
RU=0.0
SP=0.0
CALC. ALL
CALC. POR
AL-ZNA
J=1
J=2
SA
SA
REJECT
GO TO 1
REJECT
GO TO 1
REJECT
GO TO 1
CALC.AB
GO TO, J
J=1
J=2
AL-
2 * CA
K=1
K=2
CALC. AN
CALC. CO
CALC. AN
CO=0.0
AN=0.0
CO=0.0
To Statement 20

FIG. 1A

FIG. 1B


20
F2-
0·5*F3
21
CALC.MT
CALC.HE
22
CALC. MT
HE = 0.0
23
SUM TMG
TMG = FE
K=1
GO TO, K
K=2
CA-
2·5*TMG
44
SD
45
SH
26
HB = 0.0
35
CALC.HB
REJECT
GO TO 1
50
POR
TMG
36
CALC. BI
CALC.OR
WO=0·0
HY=0·0
37
CALC. BI
34
CALC. HB
CALC. WO
POR=OR
HY = 0·0
BI = 0·0
SL
REJECT
GO TO 1
50
42
CALC. HY
WO = 0·0
OR = 0·0
43
CALC. Q Z
SUM H2 O
SUM NORM
VARIATION
DIAGRAM
CALCULATIONS
PUNCH
RESULTS

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<u>TABLE I</u>

LAYOUT OF DATA ON RESULTS CARDS

Col. 1	Col. 2	Columns 3 to 11	Col. 12	Columns 13 to 19	Columns 20 to 26	Columns 27 to 33	Columns 34 to 40	Columns 41 to 47	Columns 48 to 54	Columns 55 to 61	Columns 62 to 68	Columns 69 to 75
5	8	Specimen No.	1	Sum oxide	Sum norm	Quartz	Orthoclase	Albite	Anorthite	Corundum	Biotite	Hornblende
5	8	Specimen No.	2	Hypersthene	Wollastonite	Magnetite	Hematite	Sphene	Ilmenite	Rutile	Apatite	Calcite
5	8	Specimen No.	3	Water								
5	8	Specimen No.	4	Or	Ab	An	Qz	Or	Ab	Ab	An	SI *
5	8	Specimen No.	5	A	F	M	A	K	F			

* Solidification Index

5 in column 1 indicates the age-determination section of the Bureau's data processing system (Card Code, p.17 of Walpole, et al, 1964).

8 in column 2 indicates Sequence Number 8 in the age-determination section of the Bureau system (c.f., page 18 of Walpole, et al, 1964).

APPENDIX I - KEY TO SYMBOLS

Symbol	Meaning
ØS	SiO_2
ØT	TiO_2
ØA	Al_2O_3
Ø3	Fe_2O_3
Ø2	FeO
ØMN	MnO
ØMG	MgO
ØC	CaO
ØN	Na_2O
ØK	K_2O
ØP	P_2O_5
ØHP	$H_2O(+)$
ØHM	$H_2O(-)$
ØCØ	CO_2
SUM	Sum oxides
PS	Si
PT	Ti
PA	Al
PF3	Fe^{+++}
PF2	Fe^{++}
PMN	Mn — Molecular proportions.
PMG	Mg
PC	Ca
PN	Na
PK	K
PP	P
PCØ	C
SUM 1	Sum of molecular proportions.
SI	Si
TI	Ti
AL	Al
F3	Fe^{+++} — cations.
F2	Fe^{++}
FMG	Mg

Symbol	Meaning
CA	Ca
ZNA	Na — cations.
YK	K
P	P
C	C
DK	Potassium for AKF calculation.
AP	Apatite
CC	Calcite
XIL	Ilmenite
SP	Sphene
RU	Rutile
ALL	Al for AKF calculation
PØR	Provisional orthoclase
AB	Albite
AN	Anorthite
CØ	Corundum
EMT	Magnetite
HE	Hematite
TMG	F2 + FMG
FE	F2 + FMG(for AKF)
HB	Hornblende
WØ	Wollastonite
BI	Biotite
ØR	Orthoclase
HY	Hypersthene
QZ	Quartz
AQ	Water
SUM 2	Total of minerals.
FEL	(or + ab+an)/100
ØRX	Or-Ab-An
ABX	diagram
ANX	data.
QF	(qz+or+ab)/100

Symbol	Meaning
QZF	Qz-Or-Ab
ORF	diagram
ABF	data.
PLG	(ab+an)/100
ABP	Plagioclase
ANP	data.
FMA	$(MgO+Fe_2O_3+FeO+Na_2O+K_2O)/100$
AF	FMA
AM	diagram
AA	data.
AKF	(ALL+DK+FE)/100
AL2	AKF
CK	diagram
FF	data.
SØI	Solidification index.

REFERENCES

BARTH, T.F.W., - 1959 - Principles of classification and norm calculations of metamorphic rocks. J.Geol., 67(2), 135-153.

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APPENDIX

by

T. Quinlan

The computer programme for the calculation of the Barth Mesonorm, as described in this Record, has been revised so that it will run on the C.D.C. 3600 computer at the C.S.I.R.O. Computing Research Centre. At the same time the opportunity was taken to change the method of output of the results, from punched cards to output from the line printer. This was done because the cost of printing the results from the C.D.C. 3600 is not significant in comparison to the time required for calculation.

A listing of the revised programme is given on the following pages, and an example of the results for the two data cards (which follow the Run Card, on page 14) is shown on page 15.

```
@JOB, CBDMRCTQ,MESONORM,3                                                   3600
@FTN,!,L,X,*
      PROGRAM MESONORM                                                    MES 001
C     WRITTEN BY W.R. MORGAN ,   REFERENCE,B.M.R. RECORD 1965/117        MES 002
C     TO CALCULATE MESONORMS OF ACID,NON-PERALKALINE IGNEOUS ROCKS        MES 003
C     REFERENCE, BARTH,T.F.W.,1959, J.GEOL 67(2),135-153.                 MES 004
C                BARTH,T.F.W.,1962, J.GEOL 70(4),497-498.                 MES 005
C     REVISED BY T. QUINLAN, B.M.R, FEB 1965 TO RUN ON A CDC 3600.       MES 006
      DIMENSION NO(2),NAME(20),T(15)                                      MES 007
      DATA (NAME=8HGRANITE ,8H        ,8HGNEISS  ,8H        ,8HGRANODIO,MES 008
     *           8HRITE    ,8HADAMELLI,8HTE      ,8HDACITE  ,8H        ,MES 009
     *           8HRHYOLITE,8H        ,8HDOLERITE,8H        ,8H        ,MES 010
     *           8H        ,8H        ,8H        ,8H        ,8H        )MES 011
    2 FORMAT(2X,R8,A1,14F4.0,5X,R5)                                       MES 012
   54 FORMAT(1H-,10X,*SAMPLE NO *,R8,A1,* IS SILICA POOR AND THIS PROGRAMES 013
     *M CANNOT CALCULATE ITS MESONORM*)                                   MES 014
   55 FORMAT(1H-,10X,*SAMPLE NO *,R8,A1,* IS A PERALKALINE ROCK, THIS PRMES 016
     *OGRAM CANNOT CALCULATE ITS MESONORM*)                               MES 017
  155 FORMAT(1H4)                                                         MES 018
  901 FORMAT (1HG,116X,8HPAGE NO.,I6,/,60X,8HPAGE NO.,I6)                 MES 019
  950 FORMAT (1H-, 5X,*MESONORM OF SAMPLE NO. *,R8,A1,*WHICH IS A *,2R8)MES 020
  951 FORMAT (1H-,10X,*SILICATE ANALYSIS*,12X,*MESONORM*,21X,*COORDINATEMES 021
     1S FOR VARIATION DIAGRAMS*)                                          MES 022
  952 FORMAT (1H-,10X,*OXIDE    PERCENT*,13X,*MINERAL*,8X,*PERCENT*,7X,*MES 023
     2FELDSPAR*,/)                                                        MES 024
  953 FORMAT (1H ,10X,*SIO2     *,F6.2,14X,*QUARTZ        *,F6.2,8X,*  MES 025
     *ORTHOCLASE *,F6.1,3X,*QUARTZ     *,F6.1)                            MES 026
  954 FORMAT (1H ,10X,*TIO2     *,F6.2,14X,*ORTHOCLASE    *,F6.2,8X,*  MES 027
     *ALBITE     *,F6.1,3X,*ORTHOCLASE *,F6.1)                            MES 028
  955 FORMAT (1H ,10X,*AL2O3    *,F6.2,14X,*ALBITE        *,F6.2,8X,*  MES 029
     *ANORTHITE  *,F6.1,3X,*ALBITE     *,F6.1)                            MES 030
  956 FORMAT (1H ,10X,*FE2O3    *,F6.2,14X,*ANORTHITE     *,F6.2,8X,*  MES 031
     *           *,F6.1)                                                  MES 032
  957 FORMAT (1H ,10X,*FEO      *,F6.2,14X,*CORUNDUM      *,F6.2,8X,*  MES 033
     *ALBITE     *,F6.1)                                                  MES 034
  958 FORMAT (1H ,10X,*MNO      *,F6.2,14X,*BIOTITE       *,F6.2,8X,*  MES 035
     *ANORTHITE  *,F6.1)                                                  MES 036
  959 FORMAT (1H ,10X,*MGO      *,F6.2,14X,*HORNBLENDE    *,F6.2,8X,*  MES 037
     *           *,F6.1,3X)                                               MES 038
  960 FORMAT (1H ,10X,*CAO      *,F6.2,14X,*HYPERSTHENE   *,F6.2,8X,*AFMES 039
     *M          *,F6.1)                                                  MES 040
  961 FORMAT (1H ,10X,*NA2O     *,F6.2,14X,*WOLLASTONITE  *,F6.2,8X,*  MES 041
     *           *,F6.1)                                                  MES 042
```

```
962  FORMAT (1H ,10X,*K20       *,F6.2,14X,*MAGNETITE       *,F6.2,8X,*  MES 043
    *ALKALI     *,F6.1,3X)                                               MES 044
963  FORMAT (1H ,10X,*P205      *,F6.2,14X,*HEMATITE        *,F6.2,8X,*  MES 045
    *IRON       *,F6.1)                                                  MES 046
964  FORMAT (1H ,10X,*H2O(+)    *,F6.2,14X,*SPHENE          *,F6.2,8X,*  MES 047
    *MAGNESIA   *,F6.1)                                                  MES 048
965  FORMAT (1H ,10X,*H2O(-)    *,F6.2,14X,*ILMENITE        *,F6.2,8X,*  MES 049
    *           *,F6.1)                                                  MES 050
966  FORMAT (1H ,10X,*CO2       *,F6.2,14X,*RUTILE          *,F6.2,8X,*AKMES 051
    *F          *,F6.1)                                                  MES 052
967  FORMAT (1H ,39X,*APATITE   *,F11.2,21X,F6.1)                        MES 053
968  FORMAT (1H ,39X,*CALCITE   *,F11.2,10X,*A*,10X,F6.1)                MES 054
969  FORMAT (1H ,39X,*WATER     *,F11.2,10X,*K*,10X,F6.1)                MES 055
970  FORMAT (1H ,70X,*F*,10X,F6.1)                                       MES 056
971  FORMAT (1H ,10X,*TOTAL     *,F6.2,14X,*TOTAL           *,F6.2,8X,*SOMES 057
    *LIDIFICATION INDEX =*,F6.2)                                         MES 058
     NOB=3                                                               MES 059
     NPAGE=1                                                             MES 060
   1 CONTINUE                                                            MES 061
     READ 2,NO(1),NO(2),OS,OT,OA,O3,O2,OMN,OMG,OC,ON,OK,OP,OHP,OHM,OCO,MES 062
    *NOR                                                                 MES 063
     IF(EOF,60) 999,101                                                  MES 064
101  CONTINUE                                                            MES 065
     T(1)=OS/100.0                                                       MES 066
     T(2)=OT/100.0                                                       MES 067
     T(3)=OA/100.0                                                       MES 068
     T(4)=O3/100.0                                                       MES 069
     T(5)=O2/100.0                                                       MES 070
     T(6)=OMN/100.0                                                      MES 071
     T(7)=OMG/100.0                                                      MES 072
     T(8)=OC/100.0                                                       MES 073
     T(9)=ON/100.0                                                       MES 074
     T(10)=OK/100.0                                                      MES 075
     T(11)=OP/100.0                                                      MES 076
     T(12)=OHP/100.0                                                     MES 077
     T(13)=OHM/100.0                                                     MES 078
     T(14)=OCO/100.0                                                     MES 079
     N=1                                                                 MES 080
     IF(NOR.EQ.2751456360B) GO TO 102   N=N+2                            MES 081
     IF(NOR.EQ.2745626260B) GO TO 102   N=N+2                            MES 082
     IF(NOR.EQ.2751452451B) GO TO 102   N=N+2                            MES 083
```

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      IF(NOR.EQ.2124444343B) GO TO 102   N=N+2                                       MES 084
      IF(NOR.EQ.2423636060B) GO TO 102   N=N+2                                       MES 085
      IF(NOR.EQ.5130704363B) GO TO 102   N=N+2                                       MES 086
      IF(NOR.EQ.2443516360B) GO TO 102   N=N+2                                       MES 087
102   CONTINUE                                                                       MES 088
      IF(NOB.EQ.3) 112,122                                                           MES 089
112   CONTINUE                                                                       MES 090
      PRINT 901,NPAGE,NPAGE                                                          MES 091
      NPAGE=NPAGE+1                                                                  MES 092
      NOB=1                                                                          MES 093
122   CONTINUE                                                                       MES 094
      PRINT 950,NO(1),NO(2),NAME(N),NAME(N+1)                                        MES 095
      SUM=OS+OT+OA+O3+O2+OMN+OMG+OC+ON+OK+OP+OHP+OHM+OCO                             MESONORM
      SUM=SUM/100.
      PS=OS/6.006                                                                    MESONORM
      PT=OT/7.990                                                                    MESONORM
      PA=OA/5.097                                                                    MESONORM
      PF3=O3/7.984                                                                   MESONORM
      PF2=O2/7.184                                                                   MESONORM
      PMN=OMN/7.093                                                                  MESONORM
      PMG=OMG/4.032                                                                  MESONORM
      PC=OC/5.608                                                                    MESONORM
      PN=ON/3.0995                                                                   MESONORM
      PK=OK/4.7095                                                                   MESONORM
      PP=OP/7.098
      PCO=OCO/4.401                                                                  MESONORM
      SUM1=(PS+PT+PA+PF3+PF2+PMN+PMG+PC+PN+PK+PP)/100.0                              MESONORM
      SI=PS/SUM1                                                                     MESONORM
      TI=PT/SUM1                                                                     MESONORM
      AL=PA/SUM1                                                                     MESONORM
      F3=PF3/SUM1                                                                    MESONORM
      F2=(PF2+PMN)/SUM1                                                              MESONORM
      FMG=PMG/SUM1                                                                   MESONORM
      CA=PC/SUM1                                                                     MESONORM
      ZNA=PN/SUM1                                                                    MESONORM
      YK=PK/SUM1                                                                     MESONORM
      P=PP/SUM1                                                                      MESONORM
      C=PCO/SUM1                                                                     MESONORM
      DK=YK
      PO=1.667*P
```

```
      AP=P+PO                                   MESONORM
      CA=CA-PO                                  MESONORM
      IF(C-0.)48,48,49                          MESONORM
   49 CC=C
      CA=CA-C                                   MESONORM
      GO TO 70                                  MESONORM
   48 CC=0.0                                    MESONORM
   70 IF(CA-TI)4,4,3                            MESONORM
    4 IF(F2-TI)81,80,80
   80 XIL=TI+TI
      F2=F2-TI
      SP=0.0
      RU=0.0
      GO TO 82
   81 XIL=F2+F2
      RU=TI-F2
      SP=0.0
      GO TO 82
    3 SP=3.*TI                                  MESONORM
      CA=CA-TI                                  MESONORM
      SI=SI-TI                                  MESONORM
      XIL=0.0                                   MESONORM
      RU=0.0
   82 ALL=AL-(ZNA+YK+2.*CA)
      POR=5.*YK
      AL=AL-YK                                  MESONORM
      SI=SI-3.*YK                               MESONORM
      IF(AL-ZNA)8,7,6                           MESONORM
    8 PRINT 55,NO(1),NO(2)
      PRINT 155
      NOB=NOB+1
      GO TO 1                                   MESONORM
    6 J=1                                       MESONORM
      SA=3.*ZNA+2.*CA                           MESONORM
      IF(SI-SA)50,9,9                           MESONORM
   50 PRINT 54,NO(1),NO(2)
      PRINT 155
      NOB=NOB+1
      GO TO 1                                   MESONORM
    7 J=2                                       MESONORM
      SB=3.*ZNA                                 MESONORM
      IF(SI-SB)50,9,9                           MESONORM
    9 AB=5.*ZNA                                 MESONORM
      AL=AL-ZNA                                 MESONORM
```

```
      SI=SI-3.*ZNA                                                      MESONORM
   11 GO TO(14,12),J                                                    MESONORM
   12 AN=0.0
      CO=0.0                                                            MESONORM
      GO TO 20                                                          MESONORM
   14 IF(AL-2.*CA)15,16,16
   16 K=1                                                               MESONORM
      AN=5.*CA                                                          MESONORM
      CO=AL-2.*CA                                                       MESONORM
      SI=SI-2.*CA                                                       MESONORM
      GO TO 20                                                          MESONORM
   15 K=2                                                               MESONORM
      AN=2.5*AL                                                         MESONORM
      CA=CA-.5*AL                                                       MESONORM
      SI=SI-AL                                                          MESONORM
      CO=0.0                                                            MESONORM
   20 IF(F2-0.5*F3)21,22,22
   21 EMT=3.*F2                                                         MESONORM
      HE=F3-2.*F2                                                       MESONORM
      F2=F2-F2                                                          MESONORM
      GO TO 23                                                          MESONORM
   22 EMT=1.5*F3                                                        MESONORM
      F2=F2-0.5*F3
      HE=0.0                                                            MESONORM
   23 TMG=F2+FMG                                                        MESONORM
      FE=TMG
      GO TO(26,25),K                                                    MESONORM
   26 HB=0.0                                                            MESONORM
      GO TO 27                                                          MESONORM
   25 IF(TMG-2.5*CA)45,44,44
   45 SH=1.6*TMG
      IF(SI-SH)50,34,34                                                 MESONORM
   34 HB=3.0*TMG                                                        MESONORM
      CA=CA-0.4*TMG
      SI=SI-1.6*TMG
      WO=CA+CA

      SI=SI-CA
      BI=0.0                                                            MESONORM
      OR=POR                                                            MESONORM
      HY=0.0                                                            MESONORM
      GO TO 43                                                          MESONORM
   44 SD=4.*CA
```

```
      IF(SI-SD)50,35,35                                             MESONORM
   35 HB=7.5*CA                                                     MESONORM
      TMG=TMG-2.5*CA
      SI=SI-4.0*CA
   27 IF(POR-0.6*TMG)37,36,36
   36 BI=TMG+1.667*TMG
      OR=POR-1.667*TMG
      HY=0.0                                                        MESONORM
      WO=0.0
      GO TO 43                                                      MESONORM
   37 BI=POR+0.6*POR
      TMG=TMG-0.6*POR
      IF(SI-TMG)50,42,42                                            MESONORM
   42 WO=0.0
      OR=0.0                                                        MESONORM
      HY=TMG+TMG                                                    MESONORM
      SI=SI-TMG                                                     MESONORM
   43 QZ=SI                                                         MESONORM
      AQ=(OHP+OHM)/100.0
      SUM2=AP+CC+SP+XIL+AB+AN+CO+EMT+HE+HB+BI+WO+OR+HY+QZ+RU
      FEL=(OR+AB+AN)/100.0                                          MESONORM
      ORX=OR/FEL                                                    MESONORM
      ABX=AB/FEL                                                    MESONORM
      ANX=AN/FEL                                                    MESONORM
      QF=(QZ+AB+OR)/100.0                                           MESONORM
      QZF=QZ/QF                                                     MESONORM
      ORF=OR/QF                                                     MESONORM
      ABF=AB/QF                                                     MESONORM
      PLG=(AB+AN)/100.0                                             MESONORM
      ABP=AB/PLG                                                    MESONORM
      ANP=AN/PLG                                                    MESONORM
      FMA=(OMG+O3+O2+ON+OK)/100.0                                   MESONORM
      AF=(O3+O2)/FMA                                                MESONORM
      AM=OMG/FMA                                                    MESONORM
      AA=(ON+OK)/FMA                                                MESONORM
      SOI=OMG/FMA                                                   MESONORM
      AKF=(ALL+DK+FE)/100.0                                         MES 245
      AL2=ALL/AKF                                                   MES 246
      CK=DK/AKF                                                     MES 247
      FF=FE/AKF                                                     MES 248
      PRINT 951                                                     MES 249
      PRINT 952                                                     MES 250
```

```
      PRINT 953,T( 1), QZ,ORX,QZF                                       MES 251
      PRINT 954,T(2 ),OR,ABX,ORF                                        MES 252
      PRINT 955,T(3 ),AB,ANX,ABF                                        MES 253
      PRINT 956,T(4 ),AN                                                MES 254
      PRINT 957,T(5 ),CO,ABP                                            MES 255
      PRINT 958,T(6 ),BI,ANP                                            MES 256
      PRINT 959,T(7 ),HB                                                MES 257
      PRINT 960,T(8 ),HY                                                MES 258
      PRINT 961,T(9 ),WO                                                MES 259
      PRINT 962,T(10),EMT,AA                                            MES 260
      PRINT 963,T(11),HE,AF                                             MES 261
      PRINT 964,T(12),SP,AM                                             MES 262
      PRINT 965,T(13),XIL                                               MES 263
      PRINT 966,T(14),RU                                                MES 264
      PRINT 967,AP                                                      MES 265
      PRINT 968,CC,AL2                                                  MES 266
      PRINT 969,AQ,CK                                                   MES 267
      PRINT 970,FF                                                      MES 268
      PRINT 971,SUM,SUM2,SOI                                            MES 269
      NOB=NOB+1                                                         MES 270
      GO TO 1                                                           MES 271
  999 CONTINUE                                                          MES 272
      END                                                               MES 273
         SCOPE
@LOAD
@RUN, 3,2000
2666169971 7480000513900013008900020015010102950510001500610007002510010GRNT CE2
2666169972 5980005820600265042000110255007302100440001201650010003409990GRNT CE2
@
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MESONORM OF SAMPLE NO, 66169971 WHICH IS A GRANITE

SILICATE ANALYSIS		MESONORM	
OXIDE	PERCENT	MINERAL	PERCENT
SIO2	74,80	QUARTZ	35,11
TIO2	0,05	ORTHOCLASE	29,28
AL2O3	13,90	ALBITE	27,03
FE2O3	0,13	ANORTHITE	2,32
FEO	0,89	CORUNDUM	3,00
MNO	0,02	BIOTITE	2,36
MGO	0,15	HORNBLENDE	0,00
CAO	1,01	HYPERSTHENE	0,00
NA2O	2,95	WOLLASTONITE	0,00
K2O	5,10	MAGNETITE	0,14
P2O5	0,15	HEMATITE	0,00
H2O(+)	0,61	SPHENE	0,11
H2O(-)	0,07	ILMENITE	0,00
CO2	0,25	RUTILE	0,00
		APATITE	0,32
		CALCITE	0,32
		WATER	0,68
TOTAL	100,08	TOTAL	100,00

COORDINATES FOR VARIATION DIAGRAMS

FELDSPAR

ORTHOCLASE	49,9	QUARTZ	38,4
ALBITE	46,1	ORTHOCLASE	32,0
ANORTHITE	4,0	ALBITE	29,6

ALBITE	92,1
ANORTHITE	7,9

AFM

ALKALI	87,3
IRON	11,1
MAGNESIA	1,6

AKF

A	29,9
K	61,3
F	8,8

SOLIDIFICATION INDEX = 1,63

MESONORM OF SAMPLE NO, 66169972 WHICH IS A GRANITE

SILICATE ANALYSIS		MESONORM	
OXIDE	PERCENT	MINERAL	PERCENT
SIO2	59,80	QUARTZ	29,16
TIO2	0,58	ORTHOCLASE	17,33
AL2O3	20,60	ALBITE	19,48
FE2O3	2,65	ANORTHITE	0,71
FEO	4,20	CORUNDUM	13,68
MNO	0,11	BIOTITE	15,24
MGO	2,55	HORNBLENDE	0,00

COORDINATES FOR VARIATION DIAGRAMS

FELDSPAR

ORTHOCLASE	46,2	QUARTZ	44,2
ALBITE	51,9	ORTHOCLASE	26,3
ANORTHITE	1,9	ALBITE	29,5

ALBITE	96,5
ANORTHITE	3,5