Appendix K: FORTRAN Program to Convert NUTS's Binary Output to a Readable Format

NUTS_BIN_READ Procedure:

A FORTRAN listing for the procedures that can be used to read the binary files from NUclide Transport System (NUTS) is provided in this appendix. A discription of the variables and a descriptive line before the main functions of the procedure are also included to increase the readability of the subroutines.

```
C
C****************** START SUBROUTINE NUTS_BIN_READ ******************
C
                      SUBROUTINE NUTS_BIN_READ
C
C-----------------------------------------------------------------------
C
C                           NUTS_BIN_READ
C
C       Purpose:
C       --------
C       This subroutine reads NUTS output binary file
C
C       Author:          Ali A. Shinta
C       -------
C
C       Call:  BRE33D, BRE23D
C
C       Arguments:
C       ----------
C DXGRID              Grid block length in x-direction
C DYGRID              Grid block length in y-direction
C DZGRID              Grid block length in z-direction
C ZTIME               Total time
C IFLAGTIME           Flag = 0 for time = 0 and 1 otherwise
C NO_TIMESTEP Time step no.
C SDATE               Date of the run
C STIME               Time of the run
C NPNAME              Program name
C NVRSION             Program version no.
C NREVDATE            Revision date
C NCPUNAME            Name of the machine on which the run is conducted
C ANSWERTEST  Flag to tell if the input is from BRAGFLO or stand alone file
C FINFILETYPE Output files type
C COMBTITLE           A combination of NUTS title and BRAGFLO or TEST run title
C INTITLE             BRAGFLO or TEST run title
C NUTS_TITLE          NUTS title
C IDIMENSION          No. of dimensions
C RADINPUT            Nuts input file name
C FILE_NAME           BRAGFLO or test run input file name
C RADOUTDBG   NUTS ASCII debug output file name
C RADOUTPUT   NUTS output file name
C RADOUTBIN   Output Binary name
C RADOUTASC   Output ASCII file name
C MEDIUM              Type of the porous medium (fracture, matrix, etc..)
C FRACTUR              Logical flag to identify fracture continuum
C MATRIX              Logical flag to identify matrix continuum
C SINGLE_POROSITY      Logical flag to identify single-porosity system
C DUAL_POROSITY        Logical flag to identify dual-porosity
C DUAL_PERMEABILITY Logical flag to identify dual-permeability system
C NBLOCK              Total number of grid blocks
C NX OR IMAX          No. of grid blocks in x-direction
C NY OR JMAX          No. of grid blocks in y-direction
C NZ OR KMAX  No. of grid blocks in z-direction
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C NOCONTINUM  No. of continum
C NO_PHASES          Number of phases
C X                  Grid block x-coordinate
C Y                  Grid block x-coordinate
C Z                  Grid block x-coordinate
C AXGRID             Interblock area in x-direction (I,I-1)
C AYGRID             Interblock area in y-direction (J,J-1)
C AZGRID             Interblock area in z-direction (K,K-1)
C VRGRID             Grid volume
C PHREQ              Flag to identify pH dependency (Y/N)
C PHGRID             Grid block ground water pH
C NSITES             No. of radioactive sites
C NUCLIDE            Total number of radionuclide
C SITE_NAME          Name of the disposal site
C COMPONENT_NAME Component name
C NAME         Component name
C Daughter_NAME      Component daughter name
C ELEMENT_NAME       Element name
C GROUP_NAME  Group under which the isotope is classified, i.e: U for
U235,238,.....etc.
C PARENT_NAME Component parent name
C NCOMPONENT  No. of the components in each site
C WASTEVOL           Site's waste vol in M3.
C COMPINT            Initial inventory of the component in Kg.
C XMOLWT             Molecular weight
C XLAMDA             Decay constant of the component in 1/s.
C RAD                Character to identify the component radioactivity (radioactive and
not_radioactive)
C NOELEMENT   No. of the input elements
C ELSOLB_LIMIT_COR Element solubility limit (Kg/M3) of block I
C ELTEMP_SOLB Logical variable to identify if the element solubility is temperature
dependent
C ELEMNT_SOLB_LIMIT  Element solubility limit
C C0-5               Solubility parameters for temperature dependency correlation
C PHASETYPE          Phase type to be transported (liquid or gas)
C EQCI               Intercept of the equilibrium line for gas solubility in the ground
water
C EQCS         Slope of the equilibrium line for gas solubility in the ground water
C IWASTE             Waste matrix, 1=waste node, 0=no-waste node.
C ADSTYPEM or F      Flag to identify whether sorption is considered (Y/N)
C MAT_ISOTHERM       Type of the adsorp. isotherm in the matrix
C                    L/l=Linear,F/f=Freundlich,LA/La/la=Langumir
C FRAC_ISOTHERM      Type of the adsorp. isotherm in the fracture
C                    L/l=Linear,F/f=Freundlich,LA/La/la=Langumir
C MSORPTION          Flag to identify whether the component is
C                    sorbable in the matrix (ADSORP/NON_ADSORP)
C MADSTEMPDEP Logical flag to identify whether the component sorption is temp.
dependent
C FSORPTION          Flag to identify whether the component is
C                    sorbable in the matrix (ADSORP/NON_ADSORP)
C FADSTEMPDEP Logical flag to identify whether the component sorption is temp.
dependent



C XLMGRID            Linear sorption coefficient in the matrix ({M3 fluid}/{Kg solid})
C XLFGRID            Linear sorption coefficient in the fracture ({M3 fluid}/{Kg
solid})
C XFCMGRID           Freundlich coefficient in the matrix (dimensionless).
C XFDCMGRID          Freundlich distribution coefficient in the matrix ({M3 fluid}/{Kg
solid}).
C XLCMGRID           Langumir coefficient in the matrix (dimensionless).
C XLDCMGRID          Langumir distribution coefficient in the matrix
C XFCFGRID           Freundlich coefficient in the fracture (dimensionless).
C XFDCFGRID          Freundlich distribution coefficient in the fracture ({M3
fluid}/{Kg solid}).
C XLCFGRID           Langumir coefficient in the fracture (dimensionless).
C XLDCFGRID          Langumir distribution coefficient in the fracture
C REFTEMPKD          Reference temperature of Kd measurment
C ADSEXPCOEFF Coefficient to adjust sorption at new temperature
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C RHOGRID            Grid block rock density (kg/m3)
C MDISPREQ           Flag to identify whether there is dispersion in the matrix (Y/N)
C FDISPREQ           Flag to identify whether there is dispersion in the matrix (Y/N)
C MFDISPREQ          Flag to identify whether there is dispersion between matrix and
fracture (Y/N)
C ALLMGRID           Longitudinal matrix dispersivity
C ALLFGRID           Longitudinal fracture dispersivity
C ALTMGRID           Transverse matrix dispersivity
C ALTFGRID           Transverse fracture dispersivity
C TORMGRID           Matrix tortousity
C TORFGRID           Matrix tortousity
C DMOL         Molecular diffusion at reference temperature (M2/s.)
C DMOLTEMDEP Logical flag to identify whether the molecular diffusion
C                    is temperature dependent (.T./.F.)
C TREF         Reference temperature (K)
C VISREF             Viscocity at reference temperature TREF (Pa/s)
C FSTATUSINJ         Flag to identify whether there is injection in the fracture (Y/N)
C MSTATUSINJ Flag to identify whether there is injection in the matrix (Y/N)
C STOCKMAN           Logical flag to identify whether NUTS interfaces with actinide
source submodel
C TIMEMSTRT          Starting time of injection/production in the matrix (s)
C TIMEMEND           Ending time of injection/production in the matrix (s)
C TIMEFSTRT          Starting time of injection/production in the fracture (s)
C TIMEFEND           Ending time of injection/production in the fracture (s)
C CONCINJMGRID       Concentration of the injected component j in grid i of the matrix
(kg/m3)
C CONCINJFGRID       Concentration of the injected component j in grid i of the
fracture (kg/m3)
C FDIRICHLET         Flag to identify whether dirichlet B.C. is available in the
fracture (T/F)
C MDIRICHLET Flag to identify whether dirichlet B.C. is available in the matrix (T/F)
C CONCDIRMGRID       Specified concentration for D.B.C. in the matrix block (kg/m3)
C CONCDIRFGRID       Specified concentration for D.B.C. in the matrix block (kg/m3)
C IPRFRQA            Frequency of print in ASCII file (ex:5=each 5 timesteps)
C IPRFRQB            Frequency of print in BINARY file
C IPRNTFA            Flag to print the fracture variable in ASCII file
C IPRNTFB            Flag to print the fracture variable in BINARY file
C IPRNTMA            Flag to print the matrix variable in ASCII file
C IPRNTMB            Flag to print the matrix variable in BINARY file
C IPRNTMc            Flag to print the matrix variable in CDB file
C VAR                Printed variable name
C DEBUG              Logical flag to generate debug file and variables
C SWMOLDGRID Matrix saturation at time level n
C PORMOLDGRID Matrix porosity at time level n
C SWFOLDGRID Fracture saturation at time level n
C PORFOLDGRID Fracture porosity  at time level n
C BRVOLGRID          Brine volume in each matrix grid (m3)
C SUMM_DISGRID       Matrix total mass per grid block of the dissolved isotopes
C SUMF_DISGRID       Fracture total mass per grid block of the dissolved isotopes
C SUMM_PRECIPGRID  Matrix total mass per grid block of the precipitated isotopes
C SUMF_PRECIPGRID    Fracture total mass per grid block of th eprecipitated isotopes
C SUMM_TOTALGRID  Matrix total mass per grid block of the dissolved,
C                    precipitated, and sorbed isotopes
C SUMF_TOTALGRID     Fracture total mass per grid block of the dissolved,
C                    precipitated, and sorbed isotopes
C CSUMM_DISGRID      Matrix total curies per grid block of the dissolved isotopes
C CSUMF_DISGRID      Fracture total curies per grid block of the dissolved isotopes
C CSUMM_PRECIPGRID  Matrix total curies per grid block of the precipitated isotopes
C CSUMF_PRECIPGRID   Fracture total curies per grid block of th eprecipitated isotopes
C CSUMM_TOTALGRID  Matrix total curies per grid block of the dissolved,
C                     precipitated, and sorbed isotopes
C CSUMF_TOTALGRID    Fracture total curies per grid block of the dissolved,
C                       precipitated, and sorbed isotopes
C CM                 Concentration of the isotope in the matrix at time level n+1
C CMOLD              Concentration of the isotope in the matrix at time level n
C CF                 Concentration of the isotope in the fracture  at time level n+1
C CFOLD              Concentration of the isotope in the fracture  at time level n
C BLOCF_DIS_MASSGRID       Fracture mass of dissolved isotope per grid volume Kg/(M3
rock).
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C BLOCM_DIS_MASSGRID       Matrix mass of dissolved isotope per grid volume in Kg/(M3
rock).
C BLOCF_PRC_MASSGRID       Fracture mass of precipitated isotope per grid volume Kg/(M3
rock).
C BLOCM_PRC_MASSGRID  Matrix mass of precipitated isotope per grid volume Kg/(M3
rock).
C ADPRCONM_TOTAL_MASSGRID  Total mass resulted from dissolved, precipitated and
C                          sorbed isotopes in the matrix
C ADPRCONF_TOTAL_MASSGRID  Total mass resulted from dissolved, precipitated and
C                          sorbed isotopes in the fracture
C VOLM_CONC_CURIESGRID     Equivalent curies of the volumetric concentration in the
matrix
C VOLF_CONC_CURIESGRID     Equivalent curies of the volumetric concentration in
thefracture
C DISM_MASS_CURIESGRID     Curies of the dissolved mass per grid block in the matrix
C DISF_MASS_CURIESGRID     Curies of the dissolved mass per grid block in the fracture
C PRCIPM_MASS_CURIESGRID   Curies of the precipitated mass per grid block in the matrix
C PRCIPF_MASS_CURIESGRID         Curies of the precipitated mass per grid block in the
matrix
C TOTALM_MASS_CURIESGRID   Curies of the total mass (dissolved + sorbed + Precipitate)
                           per grid block in the matrix
C TOTALF_MASS_CURIESGRID   Curies of the total mass (dissolved + sorbed + Precipitate)
                           per grid block in the fracture
C FLUXJM1MGRID             Fluxes crossing grid block lower interface in y-direction in
the matrix (kg/s)
C FLUXJF1MGRID             Fluxes crossing grid block lower interface in y-direction in
the fracture (kg/s)
C FLUXIM1MGRID             Fluxes crossing grid block left interface in x-direction in
the matrix (kg/s)
C FLUXIF1MGRID             Fluxes crossing grid block left interface in x-direction in
the fracture (kg/s)
C CONDMMASSGRID            Gas mass that dissolve in the grid block brine of the matrix
(kg)
C CONDFMASSGRID            Gas mass that dissolve in the grid block brine of the matrix
(kg)
C QWXF_GRID                Water interblock rate in x-direction in the fracture (m3/s)
C QWYF_GRID                Water interblock rate in y-direction in the fracture (m3/s)
C QWZF_GRID                Water interblock rate in z-direction in the fracture (m3/s)
C QWXM_GRID          Water interblock rate in x-direction in the matrix (m3/s)
C QWYM_GRID          Water interblock rate in y-direction in the matrix (m3/s)
C QWZM_GRID          Water interblock rate in z-direction in the matrix (m3/s)
C QPRMGRID                 Matrix production rate (M3 /s)
C QINMGRID                 Matrix injection rate (M3 /s)
C BLOCKMBMMAX        Maximum residual among matrix blocks
C CMBIM                    Isotope material balance error for the time step in the
matrix
C CMBTM                    Cumulative isotope material balance error in the matrix
C SUMRTM                   Cumulative residuals in the matrix
C SUMQTM                   Cumulative sources in the matrix
C BLOCKMBFMAX        Maximum residual among fracture blocks
C CMBIF                    Isotope material balance error for the time step in the
fracture
C CMBTF                    Cumulative isotope material balance error in the fracture
C SUMRTF                   Cumulative residuals in the fracture
C SUMQTF                   Cumulative sources in the fracture
C JBIN                     NUTS binary output file unit number
C
C*******************************************************************************
C*******************************************************************************


C-------------------------------------------------------------------
C
      INCLUDE 'PARAMBR.INC'
      INCLUDE 'BINRHEAD.INC'
      COMMON/D3SIZE/NX,NY,NZ
      INTEGER NX,NY,NZ,I,J,KK
C
C------------------------ READ TIME INFORMATION -------------------------
C
```

```
      READ(JBIN)ZTIME,IFLAGTIME,NO_TIMESTEP
C
C!!!!!!!!!!!!!!!!!!!!!! START READING INITIAL VARIABLES !!!!!!!!!!!!!!!!!!!!!!
C
      IF(IFLAGTIME .EQ. 0) THEN
C
C------------------------ READ PROGRAM HEADINGS (QA INFORMATION)
------------------------
C
      READ (JBIN) SDATE
      READ (JBIN) STIME
      READ (JBIN) NPNAME
      READ (JBIN) NVRSION
      READ (JBIN) NREVDATE
      READ (JBIN) NCPUNAME
C
C------------------------ READ THE RUN TITLES AND FILES' TYPE ----------------------
----------
C
      READ(JBIN) ANSWERTEST,FINFILETYPE
      READ(JBIN) COMBTITLE,INTITLE,NUTS_TITLE
C
C---------------------- READ THE FILES' NAMES ----------------------
C
      READ(JBIN) RADINPUT,FILE_NAME,RADOUTPUT
      IF(FINFILETYPE .EQ. 'ASC' .OR. FINFILETYPE .EQ. 'ASC-BIN'
     1 .OR. FINFILETYPE .EQ. 'ASC-CDB' .OR. FINFILETYPE .EQ.
     2 'ASC-BIN-CDB' .OR. DEBUG)
     3 READ(JBIN) RADOUTASC
      IF(FINFILETYPE .EQ. 'BIN' .OR. FINFILETYPE .EQ. 'ASC-BIN'
     1 .OR. FINFILETYPE .EQ. 'BIN-CDB' .OR. FINFILETYPE .EQ.
     2 'ASC-BIN-CDB')
     3 READ(JBIN) RADOUTBIN
      IF(FINFILETYPE .EQ. 'CDB' .OR. FINFILETYPE .EQ. 'ASC-CDB'
     1 .OR. FINFILETYPE .EQ. 'BIN-CDB' .OR. FINFILETYPE .EQ.
     2 'ASC-BIN-CDB')
     3 READ(JBIN) RADOUTCDB

C
C--------------- READ MEDIA TYPE AND LOGICAL CONTROLS ----------------
C
      READ(JBIN) MEDIUM,FRACTURE,MATRIX,SINGLE_POROSITY,
     & DUAL_POROSITY,DUAL_PERMEABILITY
C
C----------------- READ THE TOTAL NUMBER OF GRID BLOCKS --------------
C
      READ(JBIN) NBLOCK
C
C-------------------- READ DIMENSIONS OUTPUT ----------------------
C
      READ(JBIN) IDIMENSION,NX,NY,NZ,DIRECTION
      READ(JBIN) NOCONTINUM,NO_PHASES
C
C--------------- Grid Grid Block Length (x-direction)
C
      CALL BRE33D(DXGRID,JBIN)
C
C---------------- Grid Grid Block Width (y-direction)
C
      CALL BRE33D(DYGRID,JBIN)
C
C---------------- Grid Grid Block Hight (z-direction)
C
      CALL BRE33D(DZGRID,JBIN)
C
C--------------- READ Grid Block X,Y,Z COORDINATE
C
      CALL BRE33D(X,JBIN)
      CALL BRE33D(Y,JBIN)
      CALL BRE33D(Z,JBIN)
```

```
C
C------------------------ Read Grid Block Volume ---------------------
C
      CALL BRE33D(VRGRID,JBIN)
C
C------------------- Read Interface Area in x-direction ---------------
C
      CALL BRE33D(AXGRID,JBIN)
C
C------------------- Read Interface Area in y-direction ---------------
C
      CALL BRE33D(AYGRID,JBIN)
C
C------------------- Read Interface Area in z-direction ---------------
C
      CALL BRE33D(AZGRID,JBIN)
C
C------------------------ Read Ground Water pH -------------------------
C
      READ(JBIN) PHREQ
      IF(PHREQ .EQ. 'Y' .OR. PHREQ .EQ. 'y') CALL BRE33D(PHGRID,JBIN)
C
C------------------------ WASTE INFORMATION ----------------------
C
      READ(JBIN) NUCLIDE, NSITES
C
C----------------------- SITE INFORMATION
C
      READ(JBIN) (SITE_NAME(I), NCOMPONENT(I),WASTEVOL(I),
     & I=1,NSITES)
      READ(JBIN) (NAME(I),DAUGHTER_NAME(I),PARENT_NAME(I),
     & GROUP_NAME(I), I=1,NUCLIDE)
C
      READ(JBIN)(XMOLWT(I),RAD(I),XLAMDA(I),COMPINT(I),I=1,NUCLIDE)
C
C---------------SOLUBILITY DATA
C
      READ(JBIN) NOELEMENT
      READ(JBIN) (ELTEMP_SOLB(I), I = 1,NOELEMENT)
      DO I = 1, NOELEMENT
          IF(.NOT. ELTEMP_SOLB(I)) THEN
C
C<><><><><><> ELEMENT NAME,TEMP. DEPENDENCY,SOLUBILITY LIMIT
C
      READ(JBIN) ELEMENT_NAME(I),ELEMNT_SOLB_LIMIT(I)
          ELSE
C
C<><><><><><> ELEMENT NAME,TEMP. DEPENDENCY,CORRELATION PARAMETERS
C
      READ(JBIN) ELEMENT_NAME(I),C0(I),C1(I),C2(I),
     & C3(I),C4(I),C5(I)
      ENDIF
      END DO
C
C------------------ GAS EQUILIBRIUM LINE CONSTANTS ---------------------
C
      IF(PHASETYPE .EQ. 'G')
     & READ(JBIN) (EQCI(I),EQCS(I), I = 1,NUCLIDE)
C
C------------------- WASTE MATRIX
C
      READ(JBIN)((IWASTE(I,J),I=1,NBLOCK),J=1,NUCLIDE)
C
C-------------------------- SORPTION INPUT INFORMATION -------------
C
C************** MATRIX SORPTION
C
                  IF(MATRIX) THEN
      READ(JBIN) ADSTYPEM
      IF(ADSTYPEM .EQ. 'N' .OR. ADSTYPEM .EQ. 'n') GO TO 100
```

```
      READ(JBIN) MAT_ISOTHERM
      READ(JBIN)(NAME(J),MSORPTION(J),MADSTEMPDEP(J),J=1,NUCLIDE)
C
C-------------- LINEAR DISTRIBUTION COEFFICIENTS ------------
C
      IF(MAT_ISOTHERM .EQ. 'L' .OR. MAT_ISOTHERM .EQ. 'l') THEN
      DO 10 J = 1, NUCLIDE
      CALL BRE23D(XLMGRID,JBIN,J)
 10   CONTINUE
      ENDIF
C
C------------- FREUNDLICH DISTRIBUTION COEFFICIENTS -------------
C
      IF(MAT_ISOTHERM .EQ. 'F' .OR. MAT_ISOTHERM .EQ. 'f') THEN
      DO 20 J = 1, NUCLIDE
      CALL BRE23D(XFDCMGRID,JBIN,J)
 20   CONTINUE
      DO 30 J = 1, NUCLIDE
      CALL BRE23D(XFCMGRID,JBIN,J)
 30   CONTINUE
      ENDIF
C
C-------------- LANGUMIR DISTRIBUTION COEFFICIENTS -------------
C
      IF(MAT_ISOTHERM .EQ. 'LA' .OR. MAT_ISOTHERM .EQ. 'La'
     &     .OR. MAT_ISOTHERM .EQ. 'la') THEN
      DO 40 J = 1, NUCLIDE
      CALL BRE23D(XLDCMGRID,JBIN,J)
 40   CONTINUE
      DO 50 J = 1, NUCLIDE
      CALL BRE23D(XLCMGRID,JBIN,J)
 50   CONTINUE
      ENDIF
 100  CONTINUE
                  ENDIF
C
C*************** FRACTURE SORPTION
C
                  IF(FRACTURE) THEN
      READ(JBIN) ADSTYPEF
      IF(ADSTYPEF .EQ. 'N' .OR. ADSTYPEF .EQ. 'n') GO TO 200
      READ(JBIN) FRAC_ISOTHERM
      READ(JBIN)(NAME(J),FSORPTION(J),FADSTEMPDEP(J),J=1,NUCLIDE)
C
C-------------- LINEAR DISTRIBUTION COEFFICIENTS ------------
C
      IF(FRAC_ISOTHERM .EQ. 'L' .OR. FRAC_ISOTHERM .EQ. 'l') THEN
      DO 110 J = 1, NUCLIDE
      CALL BRE23D(XLFGRID,JBIN,J)
 110  CONTINUE
      ENDIF
C
C------------- FREUNDLICH DISTRIBUTION COEFFICIENTS -------------
C
      IF(FRAC_ISOTHERM .EQ. 'F' .OR. FRAC_ISOTHERM .EQ. 'f') THEN
      DO 120 J = 1, NUCLIDE
      CALL BRE23D(XFDCFGRID,JBIN,J)
 120  CONTINUE
      DO 130 J = 1, NUCLIDE
      CALL BRE23D(XFCFGRID,JBIN,J)
 130  CONTINUE
      ENDIF
C
C-------------- LANGUMIR DISTRIBUTION COEFFICIENTS -------------
C
      IF(FRAC_ISOTHERM .EQ. 'LA' .OR. FRAC_ISOTHERM .EQ. 'La'
     &     .OR. FRAC_ISOTHERM .EQ. 'la') THEN
      DO 140 J = 1, NUCLIDE
      CALL BRE23D(XLDCFGRID,JBIN,J)
 140  CONTINUE
```

```
      DO 150 J = 1, NUCLIDE
      CALL BRE23D(XLCFGRID,JBIN,J)
 150  CONTINUE
      ENDIF
 200   CONTINUE
                  ENDIF
C
C-------------- REFERENCE TEMP. AND SORPTION EXPONENT -------------
C
      IF((ADSTYPEF .EQ. 'Y' .OR. ADSTYPEF .EQ. 'y') .OR.
     & (ADSTYPEM .EQ. 'Y' .OR. ADSTYPEM .EQ. 'Y')) THEN
       DO I = 1, NUCLIDE
      IF(FADSTEMPDEP(I) .OR. MADSTEMPDEP(I))
     & READ(JBIN)NAME(J),REFTEMPKD(J),ADSEXPCOEFF(J)
       END DO
       ENDIF
C
C---------------------- ROCK DENSITY OUTPUT ----------------------
C
      IF(ADSTYPEM .EQ. 'N' .OR. ADSTYPEM .EQ. 'n' .AND.
     &  ADSTYPEF .EQ. 'N' .OR. ADSTYPEF .EQ. 'n') GO TO 300
      CALL BRE33D(RHOGRID,JBIN)
C
 300   CONTINUE
C
C---------------------------- DISPERSION ----------------------------
C
      IF(SINGLE_POROSITY .AND. FRACTURE) READ(JBIN) FDISPREQ
      IF(SINGLE_POROSITY .AND. MATRIX) READ(JBIN) MDISPREQ
      IF(DUAL_POROSITY .OR. DUAL_PERMEABILITY)
     & READ(JBIN) MDISPREQ,MFDISPREQ,FDISPREQ
C
C*********************** MATRIX
C
                  IF(MATRIX) THEN
      IF(MDISPREQ .EQ. 'N' .OR. MDISPREQ .EQ. 'n') GO TO 400
C
C---------------------- MATRIX LONGITUDINAL DISPERSIVITY -------------
C
      CALL BRE33D(ALLMGRID,JBIN)
C
C---------------------- ROCK TRANSVERSE DISPERSIVITY -------------
C
      CALL BRE33D(ALTMGRID,JBIN)
C
C---------------------- ROCK TORTOUSITY DATA -------------
C
      CALL BRE33D(TORMGRID,JBIN)
C
 400   CONTINUE
                  ENDIF
C
C*********************** FRACTURE
C
                  IF(FRACTURE) THEN
      IF(FDISPREQ .EQ. 'N' .OR. FDISPREQ .EQ. 'n') GO TO 500
C
C------------------ FRACTURE LONGITUDINAL DISPERSIVITY -------------
C
      CALL BRE33D(ALLFGRID,JBIN)
C
C---------------------- FRACTURE TRANSVERSE DISPERSIVITY -------------
C
      CALL BRE33D(ALTFGRID,JBIN)
C
C---------------------- FRACTURE TORTOUSITY DATA -------------
C
      CALL BRE33D(TORFGRID,JBIN)
 500   CONTINUE
```

```
                    ENDIF
C
C----------------------MOLECULAR DIFFUSION DATA -------------
C
      IF((MDISPREQ .EQ. 'Y' .OR. MDISPREQ .EQ. 'y') .OR.
     & (FDISPREQ .EQ. 'Y' .OR. MDISPREQ .EQ. 'y')) THEN
      READ(JBIN) (DMOLTEMDEP(I), I = 1, NUCLIDE)
      DO I = 1, NUCLIDE
      IF(.NOT. DMOLTEMDEP(I)) THEN
C
C<><><><><> MOLECULAR DIFFUSION,TEMP. DEPENDENCY
C
      READ(JBIN) DMOL(I)
      ENDIF
      IF(DMOLTEMDEP(I)) THEN
C
C<><><><> MOLECULAR DIFFUSION,TEMP. DEPENDENCY,REF. TEMP & VISCOSITY
C
      READ(JBIN) DMOL(I),TREF(I),VISREF(I)
      ENDIF
      END DO
      ENDIF
C
C--------------------- INJECTION HISTORY ----------------------
C
      IF(SINGLE_POROSITY .AND. FRACTURE)
     & READ(JBIN) FSTATUSINJ,STOCKMAN
C
      IF(SINGLE_POROSITY .AND. MATRIX)
     & READ(JBIN) MSTATUSINJ,STOCKMAN
C
      IF(DUAL_POROSITY .OR. DUAL_PERMEABILITY)
     & READ(JBIN) MSTATUSINJ,FSTATUSINJ,STOCKMAN
C
      IF(STOCKMAN) GO TO 901
C
C****************** MATRIX
C
                    IF(MATRIX) THEN
      IF(MSTATUSINJ .EQ. 'N' .OR. MSTATUSINJ .EQ. 'n') GO TO 700
      READ(JBIN) TIMEMSTRT, TIMEMEND
      DO 600 J = 1,NUCLIDE
      CALL BRE23D(CONCINJMGRID,JBIN,J)
 600   CONTINUE
 700   CONTINUE
                    ENDIF
C
C******************** FRACTURE
C
                    IF(FRACTURE) THEN
      IF(FSTATUSINJ .EQ. 'N' .OR. FSTATUSINJ .EQ. 'n') GO TO 900
      READ(JBIN) TIMEFSTRT, TIMEFEND
      DO 800 J = 1,NUCLIDE
      CALL BRE23D(CONCINJFGRID,JBIN,J)
 800   CONTINUE
 900   CONTINUE
                    ENDIF
 901  CONTINUE
C
C-------------- SPECIFY DIRICHLET B.C. IF ANY ----------------------
C
      IF(SINGLE_POROSITY .AND. FRACTURE) READ(JBIN) FDIRICHLET
      IF(SINGLE_POROSITY .AND. MATRIX) READ(JBIN) MDIRICHLET
      IF(DUAL_POROSITY .OR. DUAL_PERMEABILITY)
     & READ(JBIN) MDIRICHLET,FDIRICHLET
C
C******************** MATRIX
C
            IF(MATRIX) THEN
      IF(MDIRICHLET) THEN
```

```
      DO 902 J = 1,NUCLIDE
      CALL BRE23D(CONCDIRMGRID,JBIN,J)
 902   CONTINUE
      ENDIF
            ENDIF
C
C******************** FRACTURE
C
                  IF(FRACTURE) THEN
      IF(FDIRICHLET) THEN
      DO 904 J = 1,NUCLIDE
      CALL BRE23D(CONCDIRFGRID,JBIN,J)
 904   CONTINUE
      ENDIF
                  ENDIF
C----------------- READ PRINT FLAGS OF THE BINARY FILE -----------------
C------------ SPECIFY NUMBER OF OUTPUT ARRAYS AND THEIR TITLES --------
C
      IF(FINFILETYPE .EQ. 'BIN' .OR. FINFILETYPE .EQ. 'ASC-BIN'
     1 .OR. FINFILETYPE .EQ. 'BIN-CDB' .OR. FINFILETYPE .EQ.
     2 'ASC-BIN-CDB'.OR. DEBUG) THEN
C
C************ MATRIX
C
            IF(MATRIX) THEN
      READ(JBIN) (IPRNTMB(I), I = 1, NMVARB)
      DO 910 I = 1, NVARTIT/2
      IF(IPRNTMB(I) .GT. 0) READ(JBIN) VAR(I)
 910  CONTINUE
            ENDIF
C
C************ FRACTURE
C
            IF (FRACTURE) THEN
      READ(JBIN) (IPRNTFB(I), I = 1, NFVARB)
      KK = 0
      DO 920 I = NVARTIT/2+1, NVARTIT
      KK = KK + 1
      IF(IPRNTFB(KK) .GT. 0) READ(JBIN) VAR(I)
 920  CONTINUE
            ENDIF
                  ENDIF
C
C********************* READ PRINT FLAGS OF ASCII FILES
C
      IF(FINFILETYPE .EQ. 'ASC' .OR. FINFILETYPE .EQ. 'ASC-BIN'
     1 .OR. FINFILETYPE .EQ. 'ASC-CDB' .OR. FINFILETYPE .EQ.
     2 'ASC-BIN-CDB'.OR. DEBUG) THEN
C
C+++++++++++++++++++ FRACTURE OUTPUT FLAGS
C
      IF(FRACTURE) READ(JBIN) (IPRNTFA(I), I = 1, NFVARA)
C
C+++++++++++++++++++ MATRIX OUTPUT FLAGS
C
      IF(MATRIX) READ(JBIN) (IPRNTMA(I), I = 1, NMVARA)
                  ENDIF
C
C******************** READ PRINT FLAGS OF CDB FILES
C
      IF(FINFILETYPE .EQ. 'CDB' .OR. FINFILETYPE .EQ. 'ASC-CDB'
     1 .OR. FINFILETYPE .EQ. 'BIN-CDB' .OR. FINFILETYPE .EQ.
     2 'ASC-BIN-CDB'.OR. DEBUG) THEN
C
C+++++++++++++++++++ FRACTURE OUTPUT FLAGS
C
      IF(FRACTURE) READ(JBIN) (IPRNTFC(I), I = 1, NFVARC)
C
C+++++++++++++++++++ MATRIX OUTPUT FLAGS
C
```

```
      IF(MATRIX) READ(JBIN) (IPRNTMC(I), I = 1, NMVARC)
                 ENDIF
C
C==================== START MATRIX INITIALIZATION ====================
C
C------------------- Matrix Porosity Initialization -----------------
C
                   IF(MATRIX) THEN
      CALL BRE33D(PORMOLDGRID,JBIN)
C
C------------------ Matrix Saturation Initialization ---------------
C
      CALL BRE33D(SWMOLDGRID,JBIN)
C
C------------------- BRINE VOLUME Initialization ---------------
C
      CALL BRE33D(BRVOLGRID,JBIN)
C
C------------------- TOTAL DISSOLVED MASS PER GRID BLOCK -----------------
C
      IF(IPRNTMB(1) .GT. 0) CALL BRE33D (SUMM_DISGRID,JBIN)
C
C-----------------TOTAL PRECIPITATED MASS PER GRID BLOCK ----------------
C
      IF(IPRNTMB(2) .GT. 0) CALL BRE33D (SUMM_PRECIPGRID,JBIN)
C
C------------------ THE TOTAL OF DISSOLVED, PRECIPITATED, ----------------
C---------------------- AND SORBED MASS PER GRID BLOCK -----------------
C
      IF(IPRNTMB(3) .GT. 0) CALL BRE33D (SUMM_TOTALGRID,JBIN)
C
C---------------- TOTAL DISSOLVED CURIES PER GRID BLOCK -----------------
C
      IF(IPRNTMB(4) .GT. 0) CALL BRE33D (CSUMM_DISGRID,JBIN)
C
C---------------- TOTAL PRECIPITATED CURIES PER GRID BLOCK ---------------
C
      IF(IPRNTMB(5) .GT. 0) CALL BRE33D (CSUMM_PRECIPGRID,JBIN)
C
C------------------ THE TOTAL OF DISSOLVED, PRECIPITATED, ----------------
C-------------------- AND SORBED CURIES PER GRID BLOCK -----------------
C
      IF(IPRNTMB(6) .GT. 0) CALL BRE33D (CSUMM_TOTALGRID,JBIN)
C
      DO 1000 J = 1, NUCLIDE
      READ(JBIN) NAME(J)
C
C------------------- INITIAL VOLUMETRIC CONCENTRATION -----------------
C
      IF(IPRNTMB(7) .GT. 0) CALL BRE23D(CMOLDGRID,JBIN,J)
C
C----------------------- INITIAL DISSOLVED MASS ---------------------
C
      IF(IPRNTMB(8) .GT. 0) CALL BRE23D(BLOCM_DIS_MASSGRID,JBIN,J)
C
C------------------ INITIAL MASS OF THE PRECIPITATE ------------------
C
      IF(IPRNTMB(9) .GT. 0) CALL BRE23D(BLOCM_PRC_MASSGRID,JBIN,J)
C
C------------------ INITIAL TOTAL MASS ON SOIL BASIS -----------------
C
      IF(IPRNTMB(10) .GT. 0)
     & CALL BRE23D(ADPRCONM_TOTAL_MASSGRID,JBIN,J)
C
C------------------ INITIAL CURIES OF VOLUMETRIC CONCENTRATION ----------
C
      IF(IPRNTMB(11) .GT. 0)
     & CALL BRE23D(VOLM_CONC_CURIESGRID,JBIN,J)
C
C------------------ INITIAL CURIES OF DISSOLVED NUCLIDES -------------
```

```
C
      IF(IPRNTMB(12) .GT. 0)
     & CALL BRE23D(DISM_MASS_CURIESGRID,JBIN,J)
C
C----------------- INITIAL CURIES OF THE PRECIPITATE ------------
C
      IF(IPRNTMB(13) .GT. 0)
     & CALL BRE23D(PRCIPM_MASS_CURIESGRID,JBIN,J)
C
C------------------- INITIAL CURIES OF TOTAL MASS ----------------
C
      IF(IPRNTMB(14) .GT. 0)
     & CALL BRE23D(TOTALM_MASS_CURIESGRID,JBIN,J)
 1000 CONTINUE
                    ENDIF
C
C=================== START FRACTURE INITIALIZATION ===================
C
C-------------------- Fracture Porosity Initialization --------------
C
            IF(FRACTURE) THEN
      CALL BRE33D(PORFOLDGRID,JBIN)
C
C------------------- Fracture Saturation Initialization --------------
C
      CALL BRE33D(SWFOLDGRID,JBIN)
C
C------------------ TOTAL DISSOLVED MASS PER GRID BLOCK ----------------
C
      IF(IPRNTFB(1) .GT. 0) CALL BRE33D (SUMF_DISGRID,JBIN)
C
C----------------TOTAL PRECIPITATED MASS PER GRID BLOCK ---------------
C
      IF(IPRNTFB(2) .GT. 0) CALL BRE33D (SUMF_PRECIPGRID,JBIN)
C
C----------------- THE TOTAL OF DISSOLVED, PRECIPITATED, ----------------
C--------------------- AND SORBED MASS PER GRID BLOCK ----------------
C
      IF(IPRNTFB(3) .GT. 0) CALL BRE33D (SUMF_TOTALGRID,JBIN)
C
C---------------- TOTAL DISSOLVED CURIES PER GRID BLOCK ----------------
C
      IF(IPRNTFB(4) .GT. 0) CALL BRE33D (CSUMF_DISGRID,JBIN)
C
C--------------- TOTAL PRECIPITATED CURIES PER GRID BLOCK ---------------
C
      IF(IPRNTFB(5) .GT. 0)CALL BRE33D (CSUMF_PRECIPGRID,JBIN)
C
C----------------- THE TOTAL OF DISSOLVED, PRECIPITATED, ----------------
C------------------- AND SORBED CURIES PER GRID BLOCK ----------------
C
      IF(IPRNTFB(6) .GT. 0)CALL BRE33D (CSUMF_TOTALGRID,JBIN)
C
      DO 2000 J = 1, NUCLIDE
      READ(JBIN) NAME(J)
C
C------------------ INITIAL VOLUMETRIC CONCENTRATION ----------------
C
      IF(IPRNTFB(7) .GT. 0)CALL BRE23D(CFOLDGRID,JBIN,J)
C
C---------------------- INITIAL DISSOLVED MASS --------------------
C
      IF(IPRNTFB(8) .GT. 0)CALL BRE23D(BLOCF_DIS_MASSGRID,JBIN,J)
C
C----------------- INITIAL MASS OF THE PRECIPITATE -----------------
C
      IF(IPRNTFB(9) .GT. 0)CALL BRE23D(BLOCF_PRC_MASSGRID,JBIN,J)
C
C-------------------- TOTAL MASS ON SOIL BASIS ---------------------
C
```

```
      IF(IPRNTFB(10) .GT. 0)
     & CALL BRE23D(ADPRCONF_TOTAL_MASSGRID,JBIN,J)
C
C----------------- INITIAL CURIES OF VOLUMETRIC CONCENTRATION ----------
C
      IF(IPRNTFB(11) .GT. 0)
     & CALL BRE23D(VOLF_CONC_CURIESGRID,JBIN,J)
C
C----------------- INITIAL CURIES OF DISSOLVED NUCLIDES -------------
C
      IF(IPRNTFB(12) .GT. 0)
     & CALL BRE23D(DISF_MASS_CURIESGRID,JBIN,J)
C
C----------------- INITIAL CURIES OF THE PRECIPITATE ----------
C
      IF(IPRNTFB(13) .GT. 0)
     & CALL BRE23D(PRCIPF_MASS_CURIESGRID,JBIN,J)
C
C------------------- INITIAL CURIES OF TOTAL MASS -----------------
C
      IF(IPRNTFB(14) .GT. 0)
     & CALL BRE23D(TOTALF_MASS_CURIESGRID,JBIN,J)
 2000 CONTINUE
C
                           ENDIF
                                 RETURN
                                       ENDIF
C
C!!!!!!!!!!!!!!!!!!!!!!!!!! END OF INTIALIZATION AND INPUT ECHO
!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!
C
C
C!!!!!!!!!!!!!!!!!! OUTPUT TIME DEPENDENT VARIABLES !!!!!!!!!!!!!!!!!!
C
C%%%%%%%%%%  SPECIAL INTEREST VARIABLES OUTPUT %%%%%%%%%%
C
C----------------- MASS FLUXES CROSSING J-1 AND I-1 BOUNDARIES ----------------
C************ MATRIX
C
      IF(SINGLE_POROSITY .AND. MATRIX) THEN
      DO 2500 J = 1, NUCLIDE
      READ(JBIN) NAME(J)
      CALL BRE23D(FLUXJM1MGRID,JBIN,J)
      CALL BRE23D(FLUXIM1MGRID,JBIN,J)
 2500 CONTINUE
      ENDIF
C
C************** FRACTURE
C
      IF(SINGLE_POROSITY .AND. FRACTURE) THEN
      DO 2600 J = 1, NUCLIDE
      READ(JBIN) NAME(J)
      CALL BRE23D(FLUXJM1FGRID,JBIN,J)
       CALL BRE23D(FLUXIM1FGRID,JBIN,J)
 2600 CONTINUE
      ENDIF
C
C************** DUAL-POROSITY OR DUAL-PERMEABILITY
C
      IF(DUAL_POROSITY .OR. DUAL_PERMEABILITY) THEN
      DO 2700 J = 1, NUCLIDE
      READ(JBIN) NAME(J)
      CALL BRE23D(FLUXJM1TGRID,JBIN,J)
      CALL BRE23D(FLUXIM1TGRID,JBIN,J)
 2700 CONTINUE
      ENDIF
C
C---------------------- MASS DISSOLVED IN THE BRINE  FROM GAS PHASE ----------------
C
                  IF(PHASETYPE .EQ. 'G') THEN
```

```
C
C********************* MATRIX
C
        IF(SINGLE_POROSITY .AND. MATRIX) THEN
        DO 2710 J = 1, NUCLIDE
        READ(JBIN) NAME(J)
        CALL BRE23D(CONDMMASSGRID,JBIN,J)
 2710   CONTINUE
        ENDIF
C
C********************* FARCTURE
C
       IF(SINGLE_POROSITY .AND. FRACTURE) THEN
        DO 2720 J = 1, NUCLIDE
        READ(JBIN) NAME(J)
        CALL BRE23D(CONDFMASSGRID,JBIN,J)
 2720   CONTINUE
        ENDIF
C
C************* DUAL POROSITY OR DUAL PERMEABILITY
C
       IF(DUAL_POROSITY .OR. DUAL_PERMEABILITY) THEN
       DO 2730 J = 1, NUCLIDE
       READ(JBIN) NUCLIDE
        CALL BRE23D(CONDMMASSGRID,JBIN,J)
        CALL BRE23D(CONDFMASSGRID,JBIN,J)
 2730  CONTINUE
             ENDIF
                          ENDIF
C
C------------------ SOURCE FROM THE ACTINIDE SOURCE SUBMODEL ---------------
C Note that the source is in kg/s and injected only in the fracture
C
             IF(STOCKMAN) THEN
       DO 2740 J = 1,NUCLIDE
       READ(JBIN) NUCLIDE
       CALL BRE23D(CONCINJFGRID,JBIN,J)
 2740   CONTINUE
             ENDIF
C
C-------------------- BRINE INTERFACES VOLUMETRIC FLUXES (M3/S) ----------------------
C*************** FRACURE
C
        IF(SINGLE_POROSITY .AND. FRACTURE) THEN
       CALL BRE33D (QWXF_GRID,JBIN)
       CALL BRE33D (QWYF_GRID,JBIN)
       ENDIF
C
C*************** MATRIX
C
        IF(SINGLE_POROSITY .AND. MATRIX) THEN
       CALL BRE33D (QWXM_GRID,JBIN)
       CALL BRE33D (QWYM_GRID,JBIN)
       ENDIF
C
C***************** DUAL-PERMEABILITY OR POROSITY
C
        IF(DUAL_POROSITY .OR. DUAL_PERMEABILITY) THEN
       CALL BRE33D (QWXF_GRID,JTEMP)
       CALL BRE33D (QWYF_GRID,JTEMP)
       CALL BRE33D (QWXM_GRID,JTEMP)
       CALL BRE33D (QWYM_GRID,JTEMP)
       ENDIF
CI
CI=============================================================================I
CI                                MATRIX                                     I
CI=============================================================================I
C
             IF(MATRIX) THEN
C
```

```
C---------------------- PRODUCTION RATE OF EACH BLOCK ---------------------
C
      CALL BRE33D (QPRMGRID,JBIN)
C
C---------------------- INJECTION RATE OF EACH BLOCK ---------------------
C
      CALL BRE33D (QINMGRID,JBIN)
C
C------------------- BRINE VOLUME IN EACH GRID BLOCK---------------
C
      CALL BRE33D(BRVOLGRID,JBIN)
C
C%%%%%%%%%%  USER SPECIFIED VARIABLES OUTPUT %%%%%%%%%%%
C
C
C------------------- TOTAL DISSOLVED MASS PER GRID BLOCK ----------------
C
      IF(IPRNTMB(1) .GT. 0) CALL BRE33D (SUMM_DISGRID,JBIN)
C
C----------------TOTAL PRECIPITATED MASS PER GRID BLOCK ---------------
C
      IF(IPRNTMB(2) .GT. 0) CALL BRE33D (SUMM_PRECIPGRID,JBIN)
C
C----------------- THE TOTAL OF DISSOLVED, PRECIPITATED, ---------------
C---------------------- AND SORBED MASS PER GRID BLOCK -----------------
C
      IF(IPRNTMB(3) .GT. 0) CALL BRE33D (SUMM_TOTALGRID,JBIN)
C
C---------------- TOTAL DISSOLVED CURIES PER GRID BLOCK ----------------
C
      IF(IPRNTMB(4) .GT. 0) CALL BRE33D (CSUMM_DISGRID,JBIN)
C
C--------------- TOTAL PRECIPITATED CURIES PER GRID BLOCK ---------------
C
      IF(IPRNTMB(5) .GT. 0) CALL BRE33D (CSUMM_PRECIPGRID,JBIN)
C
C----------------- THE TOTAL OF DISSOLVED, PRECIPITATED, ----------------
C------------------- AND SORBED CURIES PER GRID BLOCK -----------------
C
      IF(IPRNTMB(6) .GT. 0) CALL BRE33D (CSUMM_TOTALGRID,JBIN)
C
      DO 3000 J = 1, NUCLIDE
      READ(JBIN) NAME(J)
C
C======================== VOLUMETRIC CONCENTRATION ========================
C
      IF(IPRNTMB(7) .GT. 0) CALL BRE23D(CMGRID,JBIN,J)
C
C============================ DISSOLVED MASS ============================
C
      IF(IPRNTMB(8) .GT. 0) CALL BRE23D(BLOCM_DIS_MASSGRID,JBIN,J)
C
C======================== MASS OF THE PRECIPITATE ========================
C
      IF(IPRNTMB(9) .GT. 0) CALL BRE23D(BLOCM_PRC_MASSGRID,JBIN,J)
C
C======================== TOTAL MASS ON SOIL BASIS ========================
C
      IF(IPRNTMB(10) .GT. 0)
     & CALL BRE23D(ADPRCONM_TOTAL_MASSGRID,JBIN,J)
C
C=================== CURIES OF VOLUMETRIC CONCENTRATION ===================
C
      IF(IPRNTMB(11) .GT. 0)
     & CALL BRE23D(VOLM_CONC_CURIESGRID,JBIN,J)
C
C===================== CURIES OF DISSOLVED NUCLIDES =====================
C
      IF(IPRNTMB(12) .GT. 0)
     & CALL BRE23D(DISM_MASS_CURIESGRID,JBIN,J)
```

```
C
C======================= CURIES OF THE PRECIPITATE ======================
C
      IF(IPRNTMB(13) .GT. 0)
     & CALL BRE23D(PRCIPM_MASS_CURIESGRID,JBIN,J)
C
C========================= CURIES OF TOTAL MASS =========================
C
      IF(IPRNTMB(14) .GT. 0)
     & CALL BRE23D(TOTALM_MASS_CURIESGRID,JBIN,J)
C
C------------------- MATRIX MATERIAL BALANCE ERROR --------------------
C
      READ(JBIN)NAME(J),BLOCKMBMMAX(J),CMBIM(J),CMBTM(J),
     & SUMRTM(J),SUMQTM(J)
 3000 CONTINUE
                          ENDIF
C
CI=================================================================I
CI                              FRACTURE                           I
CI=================================================================I
C
            IF(FRACTURE) THEN
C
C---------------------- PRODUCTION RATE OF EACH BLOCK ---------------------
C
      CALL BRE33D (QPRFGRID,JBIN)
C
C----------------------- INJECTION RATE OF EACH BLOCK ---------------------
C
      CALL BRE33D (QINFGRID,JBIN)
C
C%%%%%%%%%%  USER SPECIFIED VARIABLES OUTPUT %%%%%%%%%%
C
C
C------------------- TOTAL DISSOLVED MASS PER GRID BLOCK -----------------
C
      IF(IPRNTFB(1) .GT. 0) CALL BRE33D (SUMF_DISGRID,JBIN)
C
C-----------------TOTAL PRECIPITATED MASS PER GRID BLOCK ----------------
C
      IF(IPRNTFB(2) .GT. 0) CALL BRE33D (SUMF_PRECIPGRID,JBIN)
C
C------------------ THE TOTAL OF DISSOLVED, PRECIPITATED, ----------------
C---------------------- AND SORBED MASS PER GRID BLOCK -----------------
C
      IF(IPRNTFB(3) .GT. 0) CALL BRE33D (SUMF_TOTALGRID,JBIN)
C
C---------------- TOTAL DISSOLVED CURIES PER GRID BLOCK -----------------
C
      IF(IPRNTFB(4) .GT. 0) CALL BRE33D (CSUMF_DISGRID,JBIN)
C
C--------------- TOTAL PRECIPITATED CURIES PER GRID BLOCK ---------------
C
      IF(IPRNTFB(5) .GT. 0) CALL BRE33D (CSUMF_PRECIPGRID,JBIN)
C
C------------------ THE TOTAL OF DISSOLVED, PRECIPITATED, ----------------
C-------------------- AND SORBED CURIES PER GRID BLOCK -----------------
C
      IF(IPRNTFB(6) .GT. 0) CALL BRE33D (CSUMF_TOTALGRID,JBIN)
      DO 4000 J = 1, NUCLIDE
      READ(JBIN) NAME(J)
C
C======================== VOLUMETRIC CONCENTRATION ======================
C
      IF(IPRNTFB(7) .GT. 0) CALL BRE23D(CFGRID,JBIN,J)
C
C============================ DISSOLVED MASS ============================
C
      IF(IPRNTFB(8) .GT. 0) CALL BRE23D(BLOCF_DIS_MASSGRID,JBIN,J)
```

```
C
C======================== MASS OF THE PRECIPITATE ========================
C
      IF(IPRNTFB(9) .GT. 0) CALL BRE23D(BLOCF_PRC_MASSGRID,JBIN,J)
C
C======================== TOTAL MASS ON SOIL BASIS ========================
C
      IF(IPRNTFB(10) .GT. 0)
     & CALL BRE23D(ADPRCONF_TOTAL_MASSGRID,JBIN,J)
C
C==================== CURIES OF VOLUMETRIC CONCENTRATION ==================
C
      IF(IPRNTFB(11) .GT. 0)
     & CALL BRE23D(VOLF_CONC_CURIESGRID,JBIN,J)
C
C===================== CURIES OF DISSOLVED NUCLIDES =======================
C
      IF(IPRNTFB(12) .GT. 0)
     & CALL BRE23D(DISF_MASS_CURIESGRID,JBIN,J)
C
C======================== CURIES OF THE PRECIPITATE =======================
C
      IF(IPRNTFB(13) .GT. 0)
     & CALL BRE23D(PRCIPF_MASS_CURIESGRID,JBIN,J)
C
C========================== CURIES OF TOTAL MASS ==========================
C
      IF(IPRNTFB(14) .GT. 0)
     & CALL BRE23D(TOTALF_MASS_CURIESGRID,JBIN,J)
C
C-------------------- FRACTURE MATERIAL BALANCE ERROR ---------------------
C
      READ(JBIN)NAME(J),BLOCKMBFMAX(J),CMBIF(J),CMBTF(J),
     & SUMRTF(J),SUMQTF(J)
 4000 CONTINUE
                          ENDIF

C
C**********************************************************************
C
      RETURN
C
C%%%%%%%%%%%%%% END OF SUBROUTINE NUTS_BIN_READ %%%%%%%%%%%%%%%%%%
C
      END
C
C%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
C
C******************** START SUBROUTINE BRE33D **********************
C
      SUBROUTINE BRE33D(ARRAY,JTEMP)
C
C----------------------------------------------------------------------
C
C                              BRE33D
C
C       Purpose:
C       --------
C      This subroutine read 3D variable from a binary file in a single
C      precision format
C
C       Author:          Ali A. Shinta
C       -------
C
C      Call:  NONE
C      Called by: NUTS_BIN_READ
C       Arguments:
C       ----------
C      ARRAY  Single precision 3D variable
C      JTEMP  Input file unit number
```

```
C
C-----------------------------------------------------------------------
C
      INCLUDE 'PARAMBR.INC'
      IMPLICIT NONE
      COMMON/D3SIZE/NX,NY,NZ
      INTEGER NX,NY,NZ,I,J,K,JTEMP
      DIMENSION ARRAY(MX,MY,MZ)
      REAL ARRAY
      DO 10 K = 1, NZ
      DO 10 J = 1, NY
      DO 10 I = 1, NX
      ARRAY(I,J,K) = 0.0
 10   CONTINUE
C
      READ(JTEMP)(((ARRAY(I,J,K),I=1,NX),J=1,NY),K=1,NZ)
C
      RETURN
C
C%%%%%%%%%%%%%%%%%%%%% END OF SUBROUTINE BRE33D %%%%%%%%%%%%%%%%
C
      END
C
C%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
C
C%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
C
C******************** START SUBROUTINE BRE23D ********************
C
      SUBROUTINE BRE23D(VAROUTPUT,JTEMP,ICOUNT)
C
C-----------------------------------------------------------------------
C
C                              BRE23D
C
C       Purpose:
C       --------
C      This subroutine read a single precision 3D variable from BINARY
C      file an return it as 4D.
C
C       Author:          Ali A. Shinta
C       -------
C
C      Call:  None
C      Called by: NUTS_BIN_READ
C       Arguments:
C       ----------
C      VAROUTPUT            4D single precision variable
C      ARRAY         Single precision 3D variable
C
C-----------------------------------------------------------------------
C
      INCLUDE 'PARAMBR.INC'
      IMPLICIT NONE
      COMMON/D3SIZE/NX,NY,NZ
      INTEGER NX,NY,NZ,I,J,K,JTEMP,ICOUNT
      DIMENSION ARRAY(MX,MY,MZ),VAROUTPUT(MX,MY,MZ,NC)
      REAL ARRAY,VAROUTPUT
C
      DO 10 K = 1, NZ
      DO 10 J = 1, NY
      DO 10 I = 1, NX
      ARRAY(I,J,K) = 0.0
 10   CONTINUE
C
      READ(JTEMP)(((ARRAY(I,J,K),I=1,NX),J=1,NY),K=1,NZ)
C
      DO 20 K = 1, NZ
      DO 20 J = 1, NY
      DO 20 I = 1, NX
```

```
      VAROUTPUT(I,J,K,ICOUNT) = 0.0
      VAROUTPUT(I,J,K,ICOUNT) = ARRAY(I,J,K)
 20   CONTINUE

C
      RETURN
C
C%%%%%%%%%%%%% END OF SUBROUTINE  BRE23D %%%%%%%%%%%%%%%%
C
      END
C%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
C


C*********************************************************************
C---------------------- BINRHEAD.INC -------------------------------
C*********************************************************************
C
C-----------------------------------------------------------------
C
C                          BINRHEAD.INC
C
C       Purpose:
C       --------
C      This include file has the common blocks and the declarations
C      required for NUTS_BIN_READ.
C
C       Author:          Ali A. Shinta
C       -------
C
C       Call: NONE
C      Called By: NUTS_BIN_READ
C
C       Arguments:
C       ----------
C       AS DEFINED PREVIOUSLY
C-----------------------------------------------------------------
C
       IMPLICIT NONE
C
C-----------------------------------------------------------------
      COMMON/DIMENSION/DXGRID(MX,MY,MZ),DYGRID(MX,MY,MZ),
     & DZGRID(MX,MY,MZ),VRGRID(MX,MY,MZ),AXGRID(MX,MY,MZ),
     & AYGRID(MX,MY,MZ),AZGRID(MX,MY,MZ),X(MX,MY,MZ),
     & Y(MX,MY,MZ),Z(MX,MY,MZ),NBLOCK,IDIMENSION,
     & DIRECTION
C
      REAL DXGRID,DYGRID,DZGRID,VRGRID,AXGRID,AYGRID,AZGRID,X,Y,Z
C
      INTEGER NBLOCK,IDIMENSION
C
      CHARACTER*10 DIRECTION
C-----------------------------------------------------------------
      COMMON/PROPERTIES/RHOGRID(MX,MY,MZ),QPRMGRID(MX,MY,MZ),
     & QPRFGRID(MX,MY,MZ),QINMGRID(MX,MY,MZ),QINFGRID(MX,MY,MZ),
     & PHGRID(MX,MY,MZ),PORFOLDGRID(MX,MY,MZ),PORMOLDGRID(MX,MY,MZ),
     & SWFOLDGRID(MX,MY,MZ),SWMOLDGRID(MX,MY,MZ),PHREQ
C
      REAL RHOGRID,QPRMGRID,QPRFGRID,QINMGRID,QINFGRID,PHGRID,
     & PORFOLDGRID,PORMOLDGRID,SWFOLDGRID,SWMOLDGRID
C
      CHARACTER*20 PHREQ
C-----------------------------------------------------------------
      COMMON/MISCELL/ZTIME,IFLAGTIME,NUCLIDE,NO_PHASES,NOCONTINUM,
     &  NO_TIMESTEP
C
      REAL ZTIME
C
      INTEGER IFLAGTIME,NUCLIDE,NO_PHASES,NOCONTINUM,NO_TIMESTEP
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C-----------------------------------------------------------------------
      COMMON/UFNAMETITLES/JBIN,FINFILETYPE,ANSWERTEST,RADINPUT,
     & RADOUTPUT,RADOUTBIN,RADOUTASC,RADOUTCDB,VAR(NVARTIT),
     & NUTS_TITLE,INTITLE,COMBTITLE,FILE_NAME,DEBUG
C
      INTEGER JBIN
C
      CHARACTER*20 FINFILETYPE,ANSWERTEST
      CHARACTER*35 VAR
      CHARACTER*80 RADINPUT,RADOUTPUT,RADOUTBIN,RADOUTASC,
     & FILE_NAME,RADOUTCDB
      CHARACTER*100 NUTS_TITLE,INTITLE
      CHARACTER*132 COMBTITLE
C
      LOGICAL DEBUG
C-----------------------------------------------------------------------
      COMMON/FMMASSES/ADPRCONF_TOTAL_MASSGRID(MX,MY,MZ,NC),
     & ADPRCONM_TOTAL_MASSGRID(MX,MY,MZ,NC),
     & BLOCF_DIS_MASSGRID(MX,MY,MZ,NC),
     & BLOCM_DIS_MASSGRID(MX,MY,MZ,NC),
     & BLOCF_PRC_MASSGRID(MX,MY,MZ,NC),
     & BLOCM_PRC_MASSGRID(MX,MY,MZ,NC),
     & SUMF_DISGRID(MX,MY,MZ),
     & SUMF_PRECIPGRID(MX,MY,MZ),
     & SUMF_TOTALGRID(MX,MY,MZ),
     & SUMM_DISGRID(MX,MY,MZ),
     & SUMM_PRECIPGRID(MX,MY,MZ),
     & SUMM_TOTALGRID(MX,MY,MZ)
C
      REAL ADPRCONF_TOTAL_MASSGRID,ADPRCONM_TOTAL_MASSGRID,
     & BLOCF_DIS_MASSGRID,BLOCM_DIS_MASSGRID,BLOCF_PRC_MASSGRID,
     & BLOCM_PRC_MASSGRID,SUMF_DISGRID,SUMF_PRECIPGRID,
     & SUMF_TOTALGRID,SUMM_DISGRID,SUMM_PRECIPGRID,
     & SUMM_TOTALGRID
C-----------------------------------------------------------------------
      COMMON/FMCURIES/VOLM_CONC_CURIESGRID(MX,MY,MZ,NC),
     & DISM_MASS_CURIESGRID(MX,MY,MZ,NC),
     & PRCIPM_MASS_CURIESGRID(MX,MY,MZ,NC),
     & TOTALM_MASS_CURIESGRID(MX,MY,MZ,NC),
     & VOLF_CONC_CURIESGRID(MX,MY,MZ,NC),
     & DISF_MASS_CURIESGRID(MX,MY,MZ,NC),
     & PRCIPF_MASS_CURIESGRID(MX,MY,MZ,NC),
     & TOTALF_MASS_CURIESGRID(MX,MY,MZ,NC),
     & CSUMF_DISGRID(MX,MY,MZ),CSUMF_PRECIPGRID(MX,MY,MZ),
     & CSUMF_TOTALGRID(MX,MY,MZ),CSUMM_DISGRID(MX,MY,MZ),
     & CSUMM_PRECIPGRID(MX,MY,MZ),CSUMM_TOTALGRID(MX,MY,MZ)
C
      REAL VOLM_CONC_CURIESGRID,DISM_MASS_CURIESGRID,
     & PRCIPM_MASS_CURIESGRID,TOTALM_MASS_CURIESGRID,
     & VOLF_CONC_CURIESGRID,DISF_MASS_CURIESGRID,
     & PRCIPF_MASS_CURIESGRID,TOTALF_MASS_CURIESGRID,
     & CSUMF_DISGRID,CSUMF_PRECIPGRID,
     & CSUMF_TOTALGRID,CSUMM_DISGRID,
     & CSUMM_PRECIPGRID,CSUMM_TOTALGRID
C-----------------------------------------------------------------------
      COMMON/BACPRINTFLAGS/IPRNTFB(NFVARB),IPRNTMB(NMVARB),
     & IPRNTFA(NFVARA),IPRNTMA(NMVARA),
     & IPRNTFC(NFVARC),IPRNTMC(NMVARC)
C
      INTEGER IPRNTFB,IPRNTMB,IPRNTFA,IPRNTMA,IPRNTFC,IPRNTMC
C-----------------------------------------------------------------------
      COMMON/FMCONCMATBERR/CMBIF(NC),CMBTF(NC),SUMRTF(NC),
     & SUMQTF(NC),BLOCKMBFMAX(NC),CMBIM(NC),CMBTM(NC),
     & SUMRTM(NC),SUMQTM(NC),BLOCKMBMMAX(NC)
C
      REAL CMBIF,CMBTF,SUMRTF,SUMQTF,BLOCKMBFMAX,CMBIM,CMBTM,
     & SUMRTM,SUMQTM,BLOCKMBMMAX

C-----------------------------------------------------------------------
      COMMON/RADSITE/ELEMNT_SOLB_LIMIT(NC),C0(NC),C1(NC),C2(NC),
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     & C3(NC),C4(NC),C5(NC),XMOLWT(NC),COMPINT(NC),WASTEVOL(NS),
     & XLAMDA(NC),IWASTE(NB,NC),NCOMPONENT(NS),NSITES,NOELEMENT,
     &   RAD(NC),ELTEMP_SOLB(NC)
C
      REAL ELEMNT_SOLB_LIMIT,C0,C1,C2,C3,C4,C5,XMOLWT,COMPINT,
     & WASTEVOL,XLAMDA
C
      INTEGER IWASTE,NCOMPONENT,NSITES,NOELEMENT
C
      CHARACTER*20 RAD
C
      LOGICAL ELTEMP_SOLB
C-----------------------------------------------------------------------
      COMMON/NAMES/PARENT_NAME(NC),NAME(NC),
     & DAUGHTER_NAME(NC),ELEMENT_NAME(NC),
     & GROUP_NAME(NC),SITE_NAME(NS)
C
      CHARACTER*20 PARENT_NAME,NAME,DAUGHTER_NAME,ELEMENT_NAME,
     & GROUP_NAME,SITE_NAME
C-----------------------------------------------------------------------
      COMMON/ADSORPPROP/XLFGRID(MX,MY,MZ,NC),XLMGRID(MX,MY,MZ,NC),
     & XFDCFGRID(MX,MY,MZ,NC),XFDCMGRID(MX,MY,MZ,NC),
     & XFCFGRID(MX,MY,MZ,NC),XFCMGRID(MX,MY,MZ,NC),
     & XLDCMGRID(MX,MY,MZ,NC),XLDCFGRID(MX,MY,MZ,NC),
     & XLCMGRID(MX,MY,MZ,NC),XLCFGRID(MX,MY,MZ,NC),
     & REFTEMPKD(NC),ADSEXPCOEFF(NC),
     & FSORPTION(NC),MSORPTION(NC),ADSTYPEF,
     & ADSTYPEM,MAT_ISOTHERM,FRAC_ISOTHERM,
     & MADSTEMPDEP(NC),FADSTEMPDEP(NC)
C
      REAL XLFGRID,XLMGRID,XFDCFGRID,XFDCMGRID,XFCFGRID,XFCMGRID,
     & XLDCMGRID,XLDCFGRID,XLCMGRID,XLCFGRID,REFTEMPKD,ADSEXPCOEFF
C
      CHARACTER*20 FSORPTION,MSORPTION,ADSTYPEF,ADSTYPEM,
     & MAT_ISOTHERM,FRAC_ISOTHERM
C
      LOGICAL MADSTEMPDEP,FADSTEMPDEP
C-----------------------------------------------------------------------
      COMMON/DISPPROP/ALLFGRID(MX,MY,MZ),ALTFGRID(MX,MY,MZ),
     & TORFGRID(MX,MY,MZ),ALLMGRID(MX,MY,MZ),ALTMGRID(MX,MY,MZ),
     & TORMGRID(MX,MY,MZ),DMOL(NC),VISREF(NC),TREF(NC),MDISPREQ,
     & FDISPREQ,MFDISPREQ,DMOLTEMDEP(NC)
C
      REAL ALLFGRID,ALTFGRID,TORFGRID,ALLMGRID,ALTMGRID,
     & TORMGRID,DMOL,VISREF,TREF
C
      CHARACTER*20 MDISPREQ,FDISPREQ,MFDISPREQ
C
      LOGICAL DMOLTEMDEP
C-----------------------------------------------------------------------
      COMMON/CONCFM/CFGRID(MX,MY,MZ,NC),CMGRID(MX,MY,MZ,NC),
     & CFOLDGRID(MX,MY,MZ,NC),CMOLDGRID(MX,MY,MZ,NC)
C
      REAL CFGRID,CMGRID,CFOLDGRID,CMOLDGRID
C-----------------------------------------------------------------------
      COMMON/CONCSOURCE/CONCINJFGRID(MX,MY,MZ,NC),
     & CONCDIRMGRID(MX,MY,MZ,NC),CONCDIRFGRID(MX,MY,MZ,NC),
     & CONCINJMGRID(MX,MY,MZ,NC),TIMEMSTRT,TIMEMEND,TIMEFSTRT,
     & TIMEFEND,MDIRICHLET,FDIRICHLET,MSTATUSINJ,FSTATUSINJ,STOCKMAN
C
      REAL CONCINJFGRID,CONCDIRMGRID,CONCDIRFGRID,CONCINJMGRID,
     & TIMEMSTRT,TIMEMEND,TIMEFSTRT,TIMEFEND
C
      CHARACTER*20 MSTATUSINJ,FSTATUSINJ
C
      LOGICAL MDIRICHLET,FDIRICHLET,STOCKMAN
C-----------------------------------------------------------------------
      COMMON/PORMEDIA/MEDIUM,FRACTURE,MATRIX,SINGLE_POROSITY,
     & DUAL_POROSITY,DUAL_PERMEABILITY
C
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      CHARACTER*24 MEDIUM
C
      LOGICAL FRACTURE,MATRIX,SINGLE_POROSITY,DUAL_POROSITY,
     & DUAL_PERMEABILITY
C-----------------------------------------------------------------------
      COMMON/HEADINGS/NPNAME,NVRSION,NREVDATE,NCPUNAME,SDATE,STIME
C
       CHARACTER SDATE*9,STIME*8,NCPUNAME*32
      CHARACTER*8 NPNAME, NVRSION,NREVDATE
C-----------------------------------------------------------------------
      COMMON/INTERFLUXES/FLUXJM1MGRID(MX,MY,MZ,NC),
     & FLUXJM1FGRID(MX,MY,MZ,NC),FLUXJM1TGRID(MX,MY,MZ,NC),
     & FLUXIM1MGRID(MX,MY,MZ,NC),FLUXIM1FGRID(MX,MY,MZ,NC),
     & FLUXIM1TGRID(MX,MY,MZ,NC)
C
      REAL FLUXJM1MGRID,FLUXJM1FGRID,FLUXJM1TGRID,
     & FLUXIM1MGRID,FLUXIM1FGRID,FLUXIM1TGRID
C-----------------------------------------------------------------------
       COMMON/BCONDMAS/CONDMMASSGRID(MX,MY,MZ,NC),
     & CONDFMASSGRID(MX,MY,MZ,NC),EQCI(NC),EQCS(NC),
     & PHASETYPE
C
      REAL CONDMMASSGRID,CONDFMASSGRID,EQCI,EQCS
C
      CHARACTER PHASETYPE*10
C-----------------------------------------------------------------------
      COMMON/BRVOLGRID/BRVOLGRID(MX,MY,MZ)
      REAL*4 BRVOLGRID
C-----------------------------------------------------------------------
      COMMON/BRINERATES/QWXF_GRID(MX,MY,MZ),QWYF_GRID(MX,MY,MZ),
     & QWXM_GRID(MX,MY,MZ),QWYM_GRID(MX,MY,MZ)
      REAL*4 QWXF_GRID,QWYF_GRID,QWXM_GRID,QWYM_GRID
C
C%%%%%%%%%%%%%%%%%%% END OF BINRHEAD.INC   %%%%%%%%%%%%%%%%%%
C
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