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DEPOR AND BURSUB - TWO FORTRAN 77 COMPUTER PROGRAMS FOR POROSITY AND SUBSIDENCE HISTORY

F.M. Gradstein[1], B. Stam[2], P. Lloyd[3], D. Gillis[4] and A. Jackson[1]

[1] Geological Survey of Canada, Bedford Institute of Oceanography, Dartmouth, N.S. B2Y 4A2
[2] Shell Exploration and Production Laboratories, Rijswijk, Netherlands
[3] Norcen Energy Resources Ltd., Calgary, Alta.
[4] Gilldat Data Analysis Consulting, Dartmouth, N.S.

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Abstract - Burial history is a powerful analytical and predictive tool in basin analysis. The Fortran 77 computer programs DEPOR (Depth and Porosity) and BURSUB (Burial and Subsidence) calculate depth-porosity functions and rates of compacted and decompacted burial and load-corrected subsidence, using both physical and stratigraphic borehole data. DEPOR requires as input, (1) measured porosities as a function of lithology and depth or, (2) lithology and sonic travel time as a function of depth. The porosity versus depth functions for each lithology are input in BURSUB which requires for each stratigraphic increment, (1) age in millions of years, (2) minimum and maximum water depth estimates and if so desired (3) estimates of eustatic sealevel height. The programs present the result in a series of tables, but output can be adapted for attractive graphics display, as demonstrated for two deep boreholes. Both DEPOR and BURSUB programs are listed.

INTRODUCTION

As a result of a better understanding of the fundamental processes that affect vertical motion in basins, the drilling of many deep ocean and continental wells and improved reliability of biostratigraphy, paleobathymetry and linear time scales for the last 200 Ma, (basement) subsidence and sediment burial curves are now easily accessible and powerful analytical and predictive tools in basin analysis.

Subsidence is here defined as the vertical motion at a site induced below the sedimentary cover and not due to sediment loading. In a passive continental margin setting this motion is largely due to rift controlled deep crustal faulting and thermally-induced cooling and shrinking of the sub-sedimentary crust ("basement"). Such motion is generally considered to be downward. Burial is defined as the depth transect or path followed by a particular age level in a well site through time, from its original depth of deposition to its present-day burial depth. It is generally best to work with decompacted or restored thicknesses. It follows that burial history for age points in a well site is calculated and plotted relative to and below the paleo seafloor depth through time. This depth in turn is influenced by the eustatic sealevel height.

This study presents two Fortran 77 programs (listed in Appendix 2) for subsidence and burial history for use on micro computers with or without graphics support.The program DEPOR (Depth and Porosity) calculates the porosity versus depth curve for each discrete lithology, like shale or sand in a borehole, using either a series of measured porosity values as a function of lithology and depth or (logged) sonic travel time as a function of depth. It is also possible to use the depth-sonic travel time log to calculate a generalized porosity versus depth curve per well. The depth-porosity functions for each lithology are input in BURSUB (Burial and Subsidence), together with age in millions of years, paleo waterdepth and eustatic sealevel height for each stratigraphic increment downhole.

BURSUB shows the rate of burial of a geological horizon as a function of basement subsidence, decompacted sediment fill and water loading. When combined with information on the temperature gradient through time, the burial curves reveal how long deposits resided in a potential oil and gas generating window. Restored burial depths, corrected for compaction can be superimposed on basinwide isochrons as an aid in mapping of depocentres and onlap and offlap cycles. Introduction to the subject and its multitude of geological applications are in Van Hinte (1978), Hardenbol _et al._ (1981), Wood (1981) and Gradstein _et al._ (1985). The latter study also analyzes the construction of regional and standard timescales, which together with paleobathymetric estimates control the accuracy of the method in basin analysis.

DEPOR

In order to calculate burial and subsidence depths, it is necessary to decompact the sedimentary units in the columnar stratigraphic sections chosen. Calculation of the original thickness and its successive decrease in thickness and increase in mass and bulk density is generally simplified by assuming a direct relationship between thickness and porosity. Porosity reduction in general is a function of compaction (pore spare loss) and cementation (pore space fill). The result is an increase in mass or in bulk density, although cementation does not necessarily change volume at one particular site. It is beyond the scope of this introduction to reiterate extensive discussions on this subject, for which we refer the interested reader to recent studies, amongst others, by Bond and Kominz (1984) and Magara (1980).

The porosity-depth curves method assumes there is a direct relationship between the decrease in (directly or indirectly measured) porosity and the decrease in volume (compaction). The decrease in thickness of a stratigraphic unit is directly related to the decrease in porosity as a function of increasing depth of burial (below the seafloor).

The program DEPOR calculates the depth-porosity relationship for limestone, shale, siltstone and sandstone. These depth-porosity functions, which may be linear or exponential, are determined by two parameters:

(1) F, which is the porosity of the sediment prior to burial, and

(2) C, which is the amount by which F decreases with each metre of burial.

F and C are used in program BURSUB for decompaction of sediment layers. In case of a linear porosity-depth relation, the porosity is

$$F - C.\ \mathrm{DEPTH} \tag{1}$$

for an exponential depth-porosity relation, the porosity is

$$F.e^{-C.\mathrm{DEPTH}} \tag{2}$$

DEPOR requires two input data files: (1) a file containing depth-lithology information for maximally 80 levels, shown in Table 1, and (2) a file containing either depth-sonic travel time information for maximally 80 levels, shown in Table 2, or depth-porosity information for maximally 80 levels, illustrated in Table 3. The codes used for lithology in Table 1 are the same as those used in BURSUB for decompaction. These codes are:

1 - for shale (exponential depth-porosity relation),

2 - for sand (exponential),

3 - for siltstone (exponential),

4 - for limestone (exponential),

5 - for shale (linear depth-porosity relation),

6 - for sand (linear), and

7 - for siltstone (linear).

8 - for limestone (linear)

In a default mode Bursub can be executed with internally stored F and C values per lithology, approximately valid for the Cenozoic of the North Sea and Labrador Shelf.

When sonic travel time information is used as input, it may be necessary to reduce the thousands of (digitized) downhole data points to a managable, geologically acceptable size. DEPOR accepts 80 sonic-travel-time versus depth points, in which each travel time value is an average of all measured values over a specific depth interval. Since measured sonic travel time (t_{log}; see below) is a function of fluid saturation, it decreases in case of overpressure and thus prevents excess estimates for decompaction when underconsolidation occurs.

Wyllie et al. (1956, 1958) has demonstrated a linear relationship between elastic wave velocities and porosity according to the formula

$$\frac{1}{\bar{v}} = \frac{\phi}{v_f} + \frac{1-\phi}{v_m} \tag{3}$$

in which $\bar{v}$ is the time-average velocity, v_f is the velocity in saturated fluid (5300 ft/sec; Schlumberger, 1979), v_m is the velocity in the medium (rock) and ϕ is the porosity. In terms of sonic travel time (in microsec./ft.) this formula may be written as (Schlumberger, 1972)

$$t_{log} = \phi\, t_f + (1-\phi)t_m \quad \text{or} \tag{4}$$

$$\phi = (t_{log}-t_m)/(t_f-t_m) \tag{5}$$

in which t_{log} is the measured sonic travel time (AU in DEPOR), t_f is the travel time in fluid, and t_m is the travel time in the medium. This formula can also be written as (Magara, 1976)

$$\phi = t_{log}\, A-B \tag{6}$$

in which A and B are constants that are medium (i.e. lithology) dependent. It is in this format that the formula for ϕ is used in DEPOR. The values for A and B (see also Fig. 1) as used in DEPOR are:

for shale, A = 0.466 and B = 31.7 (Magara, 1976)

for sandstone, A = 0.741 and B = 39.6 (Schlumberger, 1979)

for limestone, A = 0.677 and B = 27.6 (Schlumberger, 1979).

No information concerning A and B for siltstone is available, but in DEPOR it is assumed that the constants for siltstone most closely resemble those of sandstone. Then, using depth-lithology and depth-sonic velocity data, DEPOR calculates depth-porosity points for each lithology. In the case that depth-porosity data are used as input file, DEPOR simply links depth-porosity with depth-lithology.

The depth-porosity points for each lithology are plotted on a bivariate graph and a linear and exponential fit through these points are calculated, together with the values for F and C for both fits. Using the least sum of the squared differences, the program calculates which fit is best. The F and C values per lithology belonging to the best fit are used as input in BURSUB. For example, if the best fit for sand is linear, the lithology code for sand in BURSUB is 6 (instead of 2 for exponential) and the F and C values for this category are used.

The porosity-depth curves for the lithologies encountered may not necessarily extrapolate to the best empirical values for porosities at zero depth. The program DEPOR calculates the best fit estimates for the measured or calculated porosities over the borehole interval sampled, which rarely includes the upper section. Typical surface porosities for shale are 62%, for siltstone 55% (Magara 1980), for calcarinite, micrite and limestone undifferentiated as high as 70% and for undifferentiated sandstone as high as 40% (Bond and Kominz 1984). To ~~above~~ avoid overestimation of original thicknesses when the porosity-depth curves extrapolate to irrealistically high surface porosities, it may be useful to use linear instead of exponential fits, even if the residuals analysis suggests the exponential fit to be best.

Finally, the porosity-depth points for all lithologies together are plotted and a linear and an exponential fit calculated, which results in F and C values for the whole stratigraphic section penetrated by the well. These F and C values are then independent of a specific lithology notation per level. Although generally less accurate, it is a quick way of achieving decompaction parameters. Examples of the use of DEPOR are in Appendix 1.

BURSUB

The program BURSUB essentially integrates biostratigraphic and paleobathymetric data into a time-depth framework. In order to obtain burial and tectonic subsidence information, corrections are made for the effects of compaction and sediment loading, changes in paleo water depth and global sealevel changes. Expecially when displayed graphically, burial and subsidence analyses afford rapid insight into (de) compacted burial and tectonic subsidence of sedimentary basins. Examples of input and output files for BURSUB are given in Appendix 1, using Deep Sea Drilling Project (DSDP) Site 398, off Portugal and the Amoco Imperial Murre G-67 well, Grand Banks of Newfoundland. An explanation of the input files is given in the listing of the BURSUB program in Appendix 2. It should be noted that all burial and subsidence calculations are relative to sealevel (=zero burial or subsidence, with thicknesses of water column and sediment column both zero). When, as often is the case, downhole depths are measured from the rotary table then both the height of the rotary table above sealevel and the present-day waterdepth must be specified. These values, either in feet or metres, will be subtracted from all downhole depths, therewith setting the first downhole depth value to zero and all other values relative to zero.

The compacted burial of well sites is simply calculated according to the formula:

$$udb = z + (w_x + w_m)/2 \tag{7}$$

in which udb is the compacted burial depth, z the depth (corrected for rotary table height), w_x the maximum estimate for the paleo waterdepth, and w_m the minimum estimate for the paleo waterdepth.

Decompaction is achieved by means of "backstripping", where sediment packages, starting with the youngest one, are progressively stripped off. Older, underlying units are restored to their original thicknesses during time of deposition by applying a factor found from sliding each lithology unit up its own porosity versus depth curve (Sclater and Christie, 1980, p. 3734, Fig. A4 and A5). These authors make use of the simple porosity-depth relationship of Ruby and Hubbert (1960),

$$F = F_o e^{-cz} \tag{8}$$

where F is the porosity, F_o the porosity at the surface prior to compaction, z is the depth below the surface in km and c is the constant used in DEPOR, (the amount by which porosity decreases with depth). In a sediment unit which is slid up its own porosity-depth curve, the upper level achieves porosity F_o. The original thickness of the unit is found by adding the amount of water needed to fill the porosity F_o, (or rather the average porosity over the measured thickness of the unit). This expansion allows approximation of the original depth of deposition of the lower level of this unit, prior to compaction. Potential compaction from the weight of the overlying (paleo) water column $(w_{min} + w_{max})/2$ is ignored. The decompaction model assumes hydrostatic equilibrium between sediment pore water and the overlying water column between the seafloor and sea surface.

After decompaction of the well column, the decompacted burial depth per unit is calculated by

$$z_t = z_{pl} + (w_x + w_m)/2 \tag{9}$$

in which z_t is the decompacted burial depth and z_{pl} the value for the decompacted depth per unit time. BURSUB calculates z_t for each age level in the input file from its original zero depth of deposition to its present resting place. Care is taken to systematically reduce thickness of each older unit during successively deeper burial.

The final calculation in the reconstruction of burial history involves tectonic or driving force subsidence, which is the rate of "basement" subsidence corrected for sediment and water loading. For this calculation it is necessary to think in terms of weight balancing. With an average sediment density of 2.7 g/cm^3 (at 0% porosity) mantle displacement as a result of sediment loading is often approximately 0.7 x the thickness of the solid sediment column, which means that tectonic subsidence is about 30% of burial depth. Following Watts and Steckler (1981), the unloaded basement depth as calculated in BURSUB is

$$\begin{aligned} yss = {} & z_{pl} \cdot ((\rho_m - \rho_{sm})/(\rho_m - \rho_w)) + (w_x + w_m)/2 + (sl_x + sl_m)/2 \\ & - ((\rho_w/(\rho_m - \rho_w)) ((sl_x + sl_m)/2)) \end{aligned} \tag{10}$$

in which p_m is the density of the mantle, p_w is the density of water, sl_x is a maximum and sl_m a minimum estimate for a change in global sealevel. The parameter yss is the average tectonic subsidence, since it uses the average value between the maximum and minimum paleo waterdepth and sealevel changes. Tectonic subsidence (expressed in depth below sealevel) values are also calculated for the following situations (a) maximum paleo waterdepth and maximum sealevel change (= yxx), (b) minimum paleo waterdepth and maximum sealevel change (= ymx), (c) maximum paleo waterdepth and minimum sealevel (= yxm), and (d) minimum paleo waterdepth and minimum sealevel (ymm). The program input and output in Appendix 1 shows examples.

Technical Requirements for DEPOR and BURSUB

Both BURSUB and DEPOR were compiled and executed on the IBM - PCXT microcomputer with an 8087 math coprocessor, IBM Professional Fortran compiler V1.00 and the IBM linker V2.30 (© IBM Corp. 1984). Versions of the programs also were adapted for use on the Victor 9000 microcomputer with an 8087 math coporcessor, and M-S Fortran (© Microsoft 1983). These programs require a minimum of 192 k RAM and at least 1 350 kb diskette driver. The program BURSUB produces an output file for the Epson-MX printer, but a run time option is available to supress the carriage control characters, which allows the use of an alternative 132 column printer. The actual carriage control characters used are listed in the program. Graphics adaptation is possible on the IBM-PC, using either the IBM Graphics Development Toolkit or through an intermediate data file which utilizes the graphics functions of the IBM Basic language. For the Victor 9000 good use can be made of PLOTS 5 fortran subroutines and the Victor GRAFIX toolkit for higher resolution (399 x 799 data points) graphs.

APPENDIX 1

In order to illustrate the use of DEPOR and BURSUB, two geological examples will be briefly treated. The first deals with the Murre G-67 well, Grand Banks, which penetrated a Cenozoic, Upper Cretaceous and 'complete' Jurassic section, before bottoming in Devonian low-grade metamorphic rocks. The second example uses the cored Cretaceous and Tertiary deep marine section at DSDP Site 398, Vigo Seamount. The Murre well has both lithology and sonic travel time data and DSDP Site 398 has lithology and depth-porosity available for input in DEPOR.

Tables 4 and 5 show the depth-lithology and depth-sonic travel time files for input in DEPOR to calculate F and C in the Murre well. Table 6 gives the calculated values for F and C for shale, sandstone, siltstone and limestone. For each lithology the print-out also produces a statement that the best fit of the depth-porosity data, either per lithology or for all lithologies combined is either linear or exponential. The F and C values corresponding to the best fit(s) and its lithology code (1-8) are then to be used for input in BURSUB. In order to visually judge the depth-porosity data, it is convenient to provide graphics output. This is shown in Figure 2, which displays the depth-porosity scattergrams and its linear and best fits. The exponential fit for limestone suggests an irrealistic (>1) porosity at zero depth, which will lead BURSUB to decompact wrongly. Although mathematically the best fit is exponential, geologically the best fit in linear and this one was adopted. Unless otherwise deemed necessary, users may generally prefer to enter in BURSUB all F and C values rather than the ones for all lithologies combined.

The BURSUB input file for Murre G-67, generated as part of BURSUB output, is shown in Table 7. The unit of stratigraphic and water depths measurement can be either feet (f) or meters (m). In default (d) mode BURSUB will use internally stored F and C values for each lithology, valid for the Cenozoic sections of the Labrador Shelf. In a non-default mode (specified by D or d), the program will ask for the proper F and C values to be entered following reading of the age-depth-etc. input file. In the Murre case all appropriate F and C parameters were entered.

Table 8 shows the numerical output and Figure 3 the corresponding graphical display generated by BURSUB for the Murre G-67 well. It includes:

(1) the burial and subsidence depth for the TD (total depth) level in the well

(2) sedimentation, burial and tectonic subsidence rates

(3) decompacted burial depths for each age level

Note that the estimate for rapid shallowing between 91 and 87.5 Ma lead to negative burial and subsidence rates (Figure 3a and Table 8c).

It turns out that more than 75% of the total decompacted burial and subsidence occurred took place during the first 50 Ma in the Jurassic, after which subsidence almost ceased and burial rates decreased correspondingly during the remainder of the Cretaceous-Tertiary period. Inspection of Table 8 also shows that the decompacted sedimentation rates for the Middle and Upper Jurassic section surpass the decompacted burial rate, which eventually led to the very shallow or non-marine conditions at the end of Jurassic and during the Early Cretaceous. The burial plot (Figure 3a) reveals a long standstill in sedimentation during Early Cretaceous, and possibly reflects erosion on the order of a few hundreds of meters of sediment during Early Cretaceous time. Such an event has also been observed in surrounding Grand Banks wells and is related to effects of an Early Cretaceous regional uplift. Lack of Early Cretaceous data may preclude detection of an isostatically induced uplift of basement in Murre. The increase in paleo waterdepth during the Turonian (≈90 Ma) may be both tectonic and eustatic induced.

On the basis of Figure 3 and Table 8 it is possible to draw some generalized conclusion (Stam, 1986). After correction for the effects of sediment and water loading, and for paleobathymetric and eustatic change in height of sealevel above the seafloor, the tectonic subsidence shows an exponential decrease with time; early rapid subsidence gave way to lesser rates. Such exponential subsidence curves were explained by Watts and Steckler (1981) to be a response to the thermal contraction of the sub-sedimentary lithosphere as it cools following initial rifting. This event in Murre acted during the Early Jurassic. Deep crustal listric faults, the result of crustal thinning during extension, may have accelerated early subsidence, reason why the curve is relatively steep in parts.

The second and brief example in this paper deals with DSDP Site 398, Vigo Seamount, for which no sonic log but depth-porosity measurements (Table 9) are available (Ryan, Sibuet et al., 1979) to run DEPOR. For shale the best fit is linear with F = 0.5377 and C = 0.0001434, for silt-stone the best fit is linear with F = 0.5087 and C = 0.0001584, for limestone the best fit is exponential with F = 0.5542 and C = 0.0008181; there is no sand. BURSUB was executed using these F and C values and the corresponding lithology codes. A print-out of the DSDP Site 398 input data, which is part of the printed output file, is shown in Table 10. A common problem in sites near ocean crust basins, but situated on relatively elevated "blocks" like Vigo seamount, is inference on the paleo waterdepth track. We have assumed approximate adherence to an oceanic back-track curve, working backwards from the present day waterdepth at the site of 3910 m. Well sites, close to the shelf edge or on the slope of the

Canadian eastern seaboard often display a rapid deepening in the latest Cretaceous or early Tertiary (e.g. Gradstein and Srivastava, 1980), a trend related to the tensional pull during the Laramide tectonic event, when significant opening took place in the southern Labrador Sea and the North Sea accelerated subsidence. Based on this reasoning, accelerated deepening has also been invoked for the Vigo Site. Working further backwards, initial water depth may have been around 2 km. Compacted and decompacted burial history (Figure 4) show an accelerated early downward trend, probably in response to relatively rapid sedimentation (≈ 5 cm/10^3y) when seafloor spreading between Iberia and Grand Banks started. The decompacted sedimentation rate of over 6 cm/10^3y around 115 Ma (Aptian) is later repeated in latest Miocene to Pliocene time (≈ 5 Ma ago). The latter may be a response to the Messinian sealevel drop which created (further) canyon cutting and downlap along margins. The histogram which displays decompacted sedimentation rates (Figure 4), particularly when used for a number of sites in a particular basin provides rapid insight in the stratigraphic distribution of hiatuses and sedimentation.

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LIST OF FIGURES

List of Tables

Table 9. Depth-porosity file for input in DEPOR to calculate F and C in DSDP Site 398; depth in m and porosity in percent per volume unit.

Table 10. Print-out of the DSDP Site 398 input data for BURSUB.

APPENDIX 2

Listing of Fortran 77 programs DEPOR and BURSUB.

```
      PROGRAM DEPOR
C
C     DEPOR (FOR DEPTH-POROSITY ANALYSIS ) IS A FORTRAN 77 PROGRAM
C     DISCUSSED IN STAM ET.AL. 1986, ALGORITHMS FOR BURIAL AND SUBSIDEN
C     HISTORY, COMPUTER AND GEOSCIENCES, VOL.___, NO.__, P.___.
C
C     DEPOR WAS WRITTEN TO RUN ON THE IBM-PCXT WITH NUMERICAL COPROCESS
C     USING IBM PROFESSIONAL FORTRAN V1.00 AND IBM LINKER V2.30.
C
C     DEPOR CALCULATES THE RELATIONSHIP BETWEEN DEPTH AND POROSITY FOR
C     DIFFERENT LITHOLOGIES USING DEPTH-LITHOLOGY AND DEPTH-POROSITY OR
C     DEPTH-SONIC LOG DATA.
C
C     MAXIMUM NUMBER OF WELL DEPTHS IS 80
C
      REAL*4      DEP(80),DSH(80),DSS(80),DSN(80),DLM(80),PSH(80),
     +            PSS(80),PSN(80),PLM(80),LPSH(80),LPSS(80),LPSN(80),
     +            LPLM(80),LF1E,LF2E,LF3E,LF42,LFTE
      INTEGER*2     CORI,LITH(80),TFIT
      character*1  UNI
      character*30 title
      character*10 tp1,tp2,outfil
      LF1E=0.0
      LF2E=0.0
      LF3E=0.0
      LF4E=0.0
      OPEN (3,FILE='PLT.ERR',STATUS='UNKNOWN')
      CALL CREDITS (6)
      WRITE(*,*) 'CHOOSE ONE OF THE FOLLOWING'
      WRITE(*,*) '1.  CALCULATE POROSITY VALUES FROM SONIC LOGS.'
      WRITE(*,*) '2.  INPUT POROSITY-DEPTH VALUES DIRECTLY.'
      WRITE(*,*) '  '
      WRITE(*,*) '    CHOICE: '
      READ(*,*) CORI
C
C       READ THE LITHOLOGIC TYPES AND THEIR DEPTH FROM DISK.
C       THESE TYPES SHOULD BE THE SAME AS THOSE USED IN THE
C       DECOMPACTION PROGRAM.
C       THE FIRST LINE OF LITHOLOGY DATA CONTAINS THE FEET (F) OR
C       METERS (M) CODE. THE SECOND LINE SHOWS THE DEPTH OF THE
C       TOP OF THE FIRST LAYER. SUBSEQUENT LINES CONTAIN THE DEPTH
C       TO THE BOTTOM OF A LAYER AND THE LITHOLOGIC TYPE FOR THAT
C       LAYER (FREE FORMAT), 1 FOR shale, 2 FOR sandstone,
C       3 FOR siltstone, and 4 FOR limestone.
C
      write(*,*) 'Enter the name of the file containing'
      write(*,*) 'lithology data.'
      WRITE(*,*) '  '
      WRITE(*,*) '                 FILENAME: '
      read(*,'(a10)') tp2
      open(2,file=tp2)
      READ(2,'(A1)') UNI
      READ(2,*,END=20,ERR=20) DEP(1)
      IF (UNI.EQ.'F'.OR.UNI.EQ.'f') DEP(1)=DEP(1)*.3048
      DO 10,I=1,80
```

```
      READ(2,*,END=20,ERR=20) DE,LITH(I)
      IF (UNI.EQ.'F'.OR.UNI.EQ.'f') DE=DE*.3048
      DEP(I+1)=DE
      NUML=I
10    CONTINUE
20    CONTINUE
C
C        OPTION 1: CALCULATE POROSITIES FROM SONIC LOGS.
C
      IF(CORI.EQ.1) THEN
      WRITE(*,*)
      WRITE(*,*)'*****************************************************'
      WRITE(*,*) 'SONIC TRAVELTIMES AND DEPTHS (OUTPUT FROM PROGRAMME'
      WRITE(*,*) 'PLGRAU) MUST BE ON A FILE , WITH'
      WRITE(*,*) 'DEPTH IN FEET, TRAVELTIME IN MICROSECONDS PER FOOT.'
      WRITE(*,*) '*****************************************************'
      write(*,*)
      write(*,*) 'Enter the name of the file containing'
      write(*,*) 'sonic velocity data.'
      write(*,*) ' '
      write(*,*) '                    FILENAME: '
      read(*,'(a10)') tp1
      open(1,file=tp1)
C
C        CALCULATE POROSITIES USING MAGARA'S FORMULA. POROSITY VALUES
C        ARE STORED IN ARRAYS PSH,PSS,PSN OR PLM AND DEPTHS IN DSH,DSS,
C        OR DLM ACCORDING TO WHETHER THE DEPTH LIES IN THE RANGE OF
C        shale, sandstone, siltstone OR limestone.
C        J=NUMBER OF POINTS IN shale, K=NUMBER IN sandstone,
C        L=NUMBER IN siltstone, M=NUMBER IN limestone.
      J=0
      K=0
      L=0
      M=0
      dmax=0.
      READ(1,'(a30)') title
30    READ(1,*,END=35,ERR=35) DEPTH,AU
      DEPTH=DEPTH/3.28
      if(depth.gt.dmax) dmax=depth
      POR=(0.466*AU-31.7)/100.
C
C        CALL SUBROUTINE LTYPE TO DETERMINE THE LITHOLOGY,
C        CALCULATE POROSITY AND
C        ASSIGN POROSITY VALUE TO THE APPROPRIATE ARRAY.
C
      CALL LTYPE(AU,CORI,DEP,DEPTH,DSH,DSN,DSS,DLM,J,K,L,M,LITH,
     &NUML,POR,PSH,PSN,PSS,PLM)
      GO TO 30
      ENDIF
C        OPTION 2: INPUT POROSITY-DEPTH VALUES DIRECTLY
C
35    IF(CORI.EQ.2) THEN
      dmax=0.
      WRITE(*,*)
      write(*,*) '*****************************************************'
```

```
      WRITE(*,*) 'DEPTH AND POROSITY VALUES MUST BE ON A FILE ,'
      WRITE(*,*) 'ONE PAIR PER LINE. FREE FORMAT.'
      WRITE(*,*) 'DEPTH MUST BE IN METERS, POROSITY IN PERCENT.'
      write(*,*) '************************************************'
      WRITE(*,*) ' '
      write(*,*) 'Enter the name of the file containing'
      write(*,*) 'porosity-depth data.'
      WRITE(*,*) ' '
      WRITE(*,*) '               FILENAME: '
      read(*,'(a10)') tp1
      open(1,file=tp1)
      read(1,'(a30)') title
40    READ(1,*,END=50,ERR=50) DEPTH,POR
      if(depth.gt.dmax) dmax=depth
      por=por/100.
C
C        CALL LTYPE TO DETERMINE LITHOLOGY AND ASSIGN DEPTH
C        AND POROSITY VALUES TO THE APPROPRIATE ARRAY.
C
      CALL LTYPE(AU,CORI,DEP,DEPTH,DSH,DSN,DSS,DLM,J,K,L,M,LITH,
     &NUML,POR,PSH,PSN,PSS,PLM)
      GO TO 40
      ENDIF
50    CONTINUE
C
C        FIT LINEAR AND/OR EXPONENTIAL TRENDS TO POROSITY-DEPTH DATA.
C
      WRITE(*,*)
      WRITE(*,*) 'CHOOSE ONE OF THE FOLLOWING:'
      WRITE(*,*) '1. FIT A LINEAR FUNCTION TO THE POROSITY-DEPTH.'
      WRITE(*,*) '2. FIT AN EXPONENTIAL FUNCTION TO THE DATA.'
      WRITE(*,*) '3. TRY BOTH LINEAR AND EXPONENTIAL FITS AND LET TH-
      WRITE(*,*) '   PROGRAMME DECIDE WHICH IS BEST.'
      WRITE(*,*) ' '
      WRITE(*,*) '   CHOICE: '
      READ(*,*) TFIT
C            FOR LINEAR FIT
      IF(TFIT.EQ.1.OR.TFIT.EQ.3) THEN
C                  FOR shale
      IF (J.NE.0) CALL FITONE(F1L,C1L,J,TFIT,DSH,PSH)
C                  FOR sandstone
      IF (K.NE.0) CALL FITONE(F2L,C2L,K,TFIT,DSS,PSS)
C                  FOR siltstone
      IF (L.NE.0) CALL FITONE(F3L,C3L,L,TFIT,DSN,PSN)
C                  FOR limestone
      IF (M.NE.0) CALL FITONE(F4L,C4L,M,TFIT,DLM,PLM)
C                  FOR ALL POINTS
      CALL FITALL(FTL,CTL,J,K,L,M,TFIT,DSH,DSS,DSN,DLM,PSH,PSS,
     &PSN,PLM)
      ENDIF
C            FOR EXPONENTIAL FIT
      IF(TFIT.EQ.2.OR.TFIT.EQ.3) THEN
C                  TAKE LOGS OF POROSITY VALUES
      DO 60,I=1,J
60    LPSH(I)=ALOG(PSH(I))
```

```
      DO 70,I=1,K
70    LPSS(I)=ALOG(PSS(I))
      DO 80,I=1,L
80    LPSN(I)=ALOG(PSN(I))
      DO 81 I=1,M
81    LPLM(I)=ALOG(PLM(I))
C                 FOR shale
      IF (J.NE.0) CALL FITONE(LF1E,C1E,J,TFIT,DSH,LPSH)
      F1E=EXP(LF1E)
C                 FOR sandstone
      IF (K.NE.0) CALL FITONE(LF2E,C2E,K,TFIT,DSS,LPSS)
      F2E=EXP(LF2E)
C                 FOR siltstone
      IF (L.NE.0) CALL FITONE(LF3E,C3E,L,TFIT,DSN,LPSN)
      F3E=EXP(LF3E)
c                 FOR limestone
      IF (M.NE.0) CALL FITONE(LF4E,C4E,M,TFIT,DLM,LPLM)
      F4E=EXP(LF4E)
C                 FOR ALL POINTS
      CALL FITALL(LFTE,CTE,J,K,L,M,TFIT,DSH,DSS,DSN,DLM,
     &LPSH,LPSS,LPSN,LPLM)
      FTE=EXP(LFTE)
      ENDIF
C             CALCULATE SUMS OF SQUARED DIFFERENCES
      IF(TFIT.EQ.3)THEN
      SQ1L=SSQ(1,F1L,C1L,J,DSH,PSH)
      SQ2L=SSQ(1,F2L,C2L,K,DSS,PSS)
      SQ3L=SSQ(1,F3L,C3L,L,DSN,PSN)
      SQ4L=SSQ(1,F4L,C4L,M,DLM,PLM)
      SQTL=SSQ(1,FTL,CTL,J,DSH,PSH)
      SQTL=SQTL+SSQ(1,FTL,CTL,K,DSS,PSS)
      SQTL=SQTL+SSQ(1,FTL,CTL,L,DSN,PSN)
      SQTL=SQTL+SSQ(1,FTL,CTL,M,DLM,PLM)
      SQ1E=SSQ(2,F1E,C1E,J,DSH,PSH)
      SQ2E=SSQ(2,F2E,C2E,K,DSS,PSS)
      SQ3E=SSQ(2,F3E,C3E,L,DSN,PSN)
      SQ4E=SSQ(2,F4E,C4E,M,DLM,PLM)
      SQTE=SSQ(2,FTE,CTE,J,DSH,PSH)
      SQTE=SQTE+SSQ(2,FTE,CTE,K,DSS,PSS)
      SQTE=SQTE+SSQ(2,FTE,CTE,L,DSN,PSN)
      SQTE=SQTE+SSQ(2,FTE,CTE,M,DLM,PLM)
      ENDIF
C
C     OUTPUT RESULTS
C
      WRITE (*,*) 'ENTER OUTPUT FILENAME: '
      READ(*,'(A10)') OUTFIL
      open(10,file=OUTFIL,STATUS='UNKNOWN',ACCESS='SEQUENTIAL')
      CALL CREDITS (10)
      write(10,'(1x,a30,/)') title
      if(j.ne.0) then
      WRITE(10,*)'shale'
      WRITE(10,*)
      IF(TFIT.EQ.1.OR.TFIT.EQ.3) WRITE(10,90) F1L,-C1L
90    FORMAT(6X,'LINEAR:',7X,'F=',E10.4,' C=',E10.4)
```

```
      IF(TFIT.EQ.2.OR.TFIT.EQ.3) WRITE(10,100) F1E,-C1E
100   FORMAT(6X,'EXPONENTIAL:',2X,'F=',E10.4,' C=',E10.4)
      IF(TFIT.EQ.3) THEN
      IF(SQ1L.LT.SQ1E) WRITE(10,*) 'THE BEST FIT IS LINEAR.'
      IF(SQ1E.LT.SQ1L) WRITE(10,*) 'THE BEST FIT IS EXPONENTIAL.'
      IF(SQ1L.EQ.SQ1E) WRITE(10,*) 'BOTH FITS ARE EQUALLY GOOD.'
      ENDIF
      endif
      if(k.ne.0) then
      WRITE(10,*)
      WRITE(10,*)
      WRITE(10,*) 'sandstone'
      WRITE(10,*)
      IF(TFIT.EQ.1.OR.TFIT.EQ.3) WRITE(10,90) F2L,-C2L
      IF(TFIT.EQ.2.OR.TFIT.EQ.3) WRITE(10,100) F2E,-C2E
      IF(TFIT.EQ.3) THEN
      IF(SQ2L.LT.SQ2E) WRITE(10,*) 'THE BEST FIT IS LINEAR.'
      IF(SQ2E.LT.SQ2L) WRITE(10,*) 'THE BEST FIT IS EXPONENTIAL.'
      IF(SQ2E.EQ.SQ2L) WRITE(10,*) 'BOTH FITS ARE EQUALLY GOOD.'
      ENDIF
      endif
      if(l.ne.0) then
      WRITE(10,*)
      WRITE(10,*)
      WRITE(10,*) 'siltstone'
      WRITE(10,*)
      IF(TFIT.EQ.1.OR.TFIT.EQ.3) WRITE(10,90) F3L,-C3L
      IF(TFIT.EQ.2.OR.TFIT.EQ.3) WRITE(10,100) F3E,-C3E
      IF(TFIT.EQ.3) THEN
      IF(SQ3L.LT.SQ3E) WRITE(10,*) 'THE BEST FIT IS LINEAR.'
      IF(SQ3E.LT.SQ3L) WRITE(10,*) 'THE BEST FIT IS EXPONENTIAL.'
      IF(SQ3E.EQ.SQ3L) WRITE(10,*) 'BOTH FITS ARE EQUALLY GOOD.'
      ENDIF
      endif
      if(m.ne.0) then
      WRITE(10,*)
      WRITE(10,*)
      WRITE(10,*) 'limestone'
      WRITE(10,*)
      IF(TFIT.EQ.1.OR.TFIT.EQ.3) WRITE(10,90) F4L,-C4L
      IF(TFIT.EQ.2.OR.TFIT.EQ.3) WRITE(10,100) F4E,-C4E
      IF(TFIT.EQ.3) THEN
      IF(SQ4L.LT.SQ4E) WRITE(10,*) 'THE BEST FIT IS LINEAR.'
      IF(SQ4E.LT.SQ4L) WRITE(10,*) 'THE BEST FIT IS EXPONENTIAL.'
      IF(SQ4E.EQ.SQ4L) WRITE(10,*) 'BOTH FITS ARE EQUALLY GOOD.'
      ENDIF
      endif
      WRITE(10,*)
      WRITE(10,*)
      WRITE(10,*) 'all lithologies'
      WRITE(10,*)
      IF(TFIT.EQ.1.OR.TFIT.EQ.3) WRITE(10,90) FTL,-CTL
      IF(TFIT.EQ.2.OR.TFIT.EQ.3) WRITE(10,100) FTE,-CTE
      write(10,*) ' '
      write(10,*) ' '
```

```
      IF(TFIT.EQ.3) THEN
      IF(SQTL.LT.SQTE) WRITE(10,*) 'THE BEST FIT IS LINEAR.'
      IF(SQTE.LT.SQTL) WRITE(10,*) 'THE BEST FIT IS EXPONENTIAL.'
      IF(SQTE.EQ.SQTL) WRITE(10,*) 'BOTH FITS ARE EQUALLY GOOD.'
      write (10,*) ' '
      write (10,*) ' '
      ENDIF
      WRITE(*,*) '    '
      WRITE(*,*) 'OUTPUT AVAILABLE IN FILE: ',OUTFIL
      WRITE (*,*)'    '
      END
C
C
C
      SUBROUTINE LTYPE(AU,CORI,DEP,DEPTH,DSH,DSN,DSS,DLM,J,K,L,M,
     &LITH,NUML,POR,PSH,PSN,PSS,PLM)
C
      REAL DEP(20),DSH(80),DSS(80),DSN(80),DLM(80),PSH(80),PSS(80),
     &PSN(80),PLM(80),LPSH(80),LPSN(80),LPLM(80),DEPTH,POR
      INTEGER LITH(20),J,K,L,M,TLITH,CORI
C
C       DETERMINE LITHOLOGIC TYPE AT A PARTICULAR DEPTH AND
C       ASSIGN DEPTH AND porosity VALUES TO APPROPRIATE ARRAYS
C
      TLITH=0
      DO 10,I=1,NUML
        IF(DEPTH.GE.DEP(I).AND.DEPTH.LT.DEP(I+1)) TLITH=LITH(I)
 10   CONTINUE
C
C       CALCULATE POROSITIES AND
C       ASSIGN DEPTHS AND POROSITIES TO APPROPRIATE ARRAYS
C
C            FOR shale
C            POROSITIES GREATER THAN 62% ARE EXCLUDED
C
      IF(TLITH.EQ.1.or.tlith.eq.5) then
        IF(CORI.EQ.1) POR=(0.466*AU-31.7)/100.
        IF(POR.GE.0.62)RETURN
        IF(POR.LT.0.) RETURN
        J=J+1
        DSH(J)=DEPTH
        PSH(J)=POR
      ENDIF
C
C            FOR sandstone
C            POROSITIES GREATER THAN 60% ARE EXCLUDED
C
      IF(TLITH.EQ.2.or.tlith.eq.6)then
        IF(CORI.EQ.1) POR=(0.741*AU-39.6)/100.
        IF(POR.GT.0.60) RETURN
        IF(POR.LT.0.) RETURN
        K=K+1
        DSS(K)=DEPTH
        PSS(K)=POR
      ENDIF
```

```
C
C             FOR siltstone
C             POROSITIES GREATER THAN 55% ARE EXCLUDED
C
      IF(TLITH.EQ.3.or.tlith.eq.7) THEN
        IF(CORI.EQ.1) POR=(0.466*AU-31.7)/100.
        IF(POR.GE.0.55)RETURN
        IF(POR.LT.0.) RETURN
        L=L+1
        DSN(L)=DEPTH
        PSN(L)=POR
      ENDIF
C
C             FOR limestone
C             POROSITIES GREATER THAN 70% ARE EXCLUDED
C
      IF(TLITH.EQ.4.or.tlith.eq.8) then
        IF(CORI.EQ.1) POR=(0.677*AU-27.6)/100.
        IF(POR.GT.0.70) RETURN
        IF(POR.LT.0.) RETURN
        M=M+1
        DLM(M)=DEPTH
        PLM(M)=POR
      ENDIF
      RETURN
      END
C
C
      SUBROUTINE FITONE(A,B,N,TFIT,X,Y)
C
C       CALCULATES INTERCEPT "A" AND SLOPE "B" FOR A LEAST SQUARES
C       LINEAR FIT TO POINTS WITH COORDINATES X AND Y,
C       FOR A SINGLE LITHOLOGIC TYPE.
C
      INTEGER N,TFIT
      REAL X(80),Y(80)
C             FIND MEAN OF X AND Y
      XTOT=0.
      YTOT=0.
      DO 10 I=1,N
        XTOT=XTOT+X(I)
        YTOT=YTOT+Y(I)
10    CONTINUE
      XAVG=XTOT/N
      YAVG=YTOT/N
C             FIND THE COVARIANCE AND THE VARIANCE OF X
      SV=0.
      SCV=0.
      DO 20,J=1,N
        SCV=SCV+(X(J)-XAVG)*(Y(J)-YAVG)
        SV=SV+(X(J)-XAVG)**2
20    CONTINUE
      SXY=SCV/(N-1)
      S1=SV/(N-1)
C             CALCULATE A AND B
```

```
      B=SXY/S1
      A=YAVG-B*XAVG
      END
C
C
      SUBROUTINE FITALL(A,B,J,K,L,M,TFIT,X1,X2,X3,X4,Y1,Y2,Y3,Y4)
C
C       CALCULATES INTERCEPT "A" AND SLOPE "B" FOR A LEAST SQUARES
C       LINEAR FIT TO THE ENTIRE SET OF porosity-DEPTH POINTS,
C       REGARDLESS OF LITHOLOGY.
C       J,K,L,M; 1,2,3,4, shale,sandstone,siltstone,limestone
C
      INTEGER J,K,L,M
      REAL X1(80),X2(80),X3(80),X4(80),Y1(80),Y2(80),Y3(80),Y4(80)
      N=J+K+L+M
C           FIND THE MEAN OF X AND Y
      XTOT=0.
      YTOT=0.
      DO 10  I=1,J
        XTOT=XTOT+X1(I)
        YTOT=YTOT+Y1(I)
10    CONTINUE
      DO 20 I=1,K
        XTOT=XTOT+X2(I)
        YTOT=YTOT+Y2(I)
20    CONTINUE
      DO 30 I=1,L
        XTOT=XTOT+X3(I)
        YTOT=YTOT+Y3(I)
30    CONTINUE
      DO 31 I=1,M
        XTOT=XTOT+X4(I)
        YTOT=YTOT+Y4(I)
31    CONTINUE
      XAVG=XTOT/N
      YAVG=YTOT/N
C           FIND THE COVARIANCE AND THE VARIANCE OF X
      SV=0.
      SCV=0.
      DO 40 I=1,J
        SCV=SCV+(X1(I)-XAVG)*(Y1(I)-YAVG)
        SV=SV+(X1(I)-XAVG)**2
40    CONTINUE
      DO 50 I=1,K
        SCV=SCV+(X2(I)-XAVG)*(Y2(I)-YAVG)
        SV=SV+(X2(I)-XAVG)**2
50    CONTINUE
      DO 60 I=1,L
        SCV=SCV+(X3(I)-XAVG)*(Y3(I)-YAVG)
        SV=SV+(X3(I)-XAVG)**2
60    CONTINUE
      DO 61 I=1,M
        SCV=SCV+(X4(I)-XAVG)*(Y4(I)-YAVG)
        SV=SV+(X4(I)-XAVG)**2
61    CONTINUE
```

```
C
C         CALCULATE A AND B
C
      SXY=SCV/(N-1)
      S1=SV/(N-1)
      B=SXY/S1
      A=YAVG-B*XAVG
      END
C
C
      FUNCTION SSQ(LE,A,B,N,X,Y)
      REAL X(80),Y(80)
C
C         CALCULATE SUM OF SQUARED DIFFERENCES BETWEEN THE DATA
C         POINTS AND THE LINEAR OR EXPONENTIAL FIT.
C               FOR LINEAR FIT
      SSQ=0.
      IF(LE.EQ.1) THEN
        DO 10 I=1,N
          SSQ=SSQ+(Y(I)-(A+B*X(I)))**2
10      CONTINUE
      ENDIF
C               FOR EXPONENTIAL FIT
      IF(LE.EQ.2) THEN
        DO 20 I=1,N
          SSQ=SSQ+(Y(I)-A*EXP(B*X(I)))**2
20      CONTINUE
      ENDIF
      END
C
      SUBROUTINE CREDITS (UNIT)
      INTEGER   UNIT
      WRITE (UNIT,*) ' **** CALCULATION OF DEPTH-POROSITY FUNCTION ****
      WRITE (UNIT,*) '                                                '
      WRITE (UNIT,*) ' PROGRAM PREPARED BY F.LLOYD,B.STAM,'
      WRITE (UNIT,*) ' F.GRADSTEIN AND D.GILLIS,'
      WRITE (UNIT,*) ' JANUARY, 1986, '
      WRITE (UNIT,*) ' ATLANTIC GEOSCIENCE CENTER,'
      WRITE (UNIT,*) ' BEDFORD INSTITUTE OF OCEANOGRAPHY,'
      WRITE (UNIT,*) ' DARTMOUTH, N.S., B2Y 4A2'
      WRITE (UNIT,*) ' CANADA'
      WRITE (UNIT,*) '          '
      WRITE (UNIT,*) '          '
      RETURN
      END
```

```
      PROGRAM BURSUB
C
C     BURSUB (for burial and subsidence analysis) is a Fortran 77 program
C     discussed in Stam. et.al. (1986), Algorithms for Burial and Subsidence
C     History. Computers and Geosciences, vol ___, no.__, p.___. This is a
C     modified and expanded version of an original program by D. Issler.
C     Dept. of Oceanography, Dalhousie University, Halifax, N.S., using a
C     listing by R. Wood (Ph.D. Thesis, Geology Department, Cambridge
C     University, U.K.).
C
C     BURSUB was written to run on an IBM-PCXT with numerical coprocessor
C     using IBM Professional Fortran V1.00 and IBM Linker V2.30.
C
C     A = age of sediments
C     D = depth of sediments
C     L = lithology
C     WM = minimum waterdepth
C     WX = maximum waterdepth
C     SLM = minimum height of sealevel relative to present
C           sealevel
C     SLX = maximum height of sealevel relative to present
C           sealevel
C     TZ = array containing decompaction corrected depths for
C          each layer
C     UDB = uncorrected burial depth
C     ZT = decompaction corrected burial depth
C     Y = water-filled subsidence with sediment load correction
C     YXX = Y + WX + SLX
C     YMX = Y + WM + SLX
C     YXM = Y + WX + SLM
C     YMM = Y + WM + SLM
C     YSS = average subsidence depth
C     TTL = well name
C     N = number of age-depth points
C     N1 = number of lithological units (= N-1)
C     Z1,Z2 = initial depths used in decompacting units per time
C             step
C     ZP1,ZP2 = decompacted layer depths per unit time
C     FM = mean porosity
C     PSM = mean sediment density
C     PSA = mean density of individual decompacted layers
C     PA = mean density of summed decompacted layers
C     PW = density of water (= 1030)
C     PM = density of mantle (= 3330)
C     DSET - data file title
C     TSED,ASED - thickness and age of decompacted sediment
C                 units (self compacted sediment thicknesses)
C     SRATE - decompated sedimentation rate
C     SM - sediments mass (fully compacted) in each time interval
C     MRATE - sediment mass accumulation
C
C
C             FORMAT OF INPUT DATA
C
C     Description                                 Example
```

```
c   Card 1: a comment (DSET)              Shell
c   Card 2: number of data points (N)     13
c   Card 3: title (TTL)                   Shell North sea burial
c   Card 4: input f: all depth            m
c           points will be con-
c           verted from feet to
c           metres, any other
c           character (m for
c           example): no conver
c           sion.
c   Card 5: height of rotary table above     25.  175.
c           sealevel and present-day water-
c           depth, either in feet or metres.
c           These values will be subtracted
c           from all down-hole depth (D) mea-
c           surements.
c   Card 6: entering d or D: the program
c           will use the default values for F
c           and C as specified below. Any
c           other character: you will be
c           prompted to enter values for
c           F and C for ALL eight litho-
c           logies. F= porosity with no
c           burial. C= the amount by
c           which F decreases with each
c           metre burial.
c   Card 7-7+N: input data free          age depth WM WX SLM SLX
c               format.                  65.  400. 5. 25.  0. 50.
c   Card 7+N+1: lithology codes free      1 6 8 2 6 1 1 3 3 3 3 2
c               format.
c
c
c
c lithology codes: 1= Shale      (exponential)
c                  2= Sand       (exponential)
c                  3= Siltstone  (exponential)
c                  4= Limestone  (exponential)
c                  5= Shale      (linear)
c                  6= Sand       (linear)
c                  7= Siltstone  (linear)
c                  8= Limestone  (linear)
c
c  Default F & C values are based on Labrador Shelf
C  or North Sea porosity-depth curves.
c
C     SET MAXIUM NUMBER OF WELL DEPTHS IN VARIABLE DIM
C
      INTEGER*2 DIM
      PARAMETER (DIM=30)
C
      REAL*4     A(DIM),D(DIM),WM(DIM),WX(DIM),SLM(DIM),SLX(DIM),
     *           TZ(DIM,DIM),ZT(DIM),UDB(DIM),Y(DIM),
     *           YXX(DIM),YMX(DIM),YXM(DIM),YMM(DIM),
     +           DC(DIM),PSM(DIM),PSA(DIM,DIM),DEBUR(DIM),
     *           PA(DIM,DIM),WA(DIM),YSS(DIM),DEPTH(DIM),C(8),F(8),PSG(8)
```

```
      REAL*4     MRATE(DIM)
      INTEGER*2 L(DIM),FLG,FMT
      character * 72  dset, ttl*80, OUTFIL*64
      character * 1 MF,DEFALT,OTP,IOPT,JOPT
      CHARACTER *32 LIC(9)
c
c     Values for grain densities
c
      data PSG /2700.,2650.,2680.,2710.,2700.,2650.,2680.,2710./
c
c
c     Default values for lithological parameters F and C
c
      data F /.473,.547,.503,.70,.456,.465,.467,.601/
      data C /1.6518e-4,3.5320e-4,2.3925e-4,.00071,
     &          5.5824e-5,9.8836e-5,7.3556e-5,.2181e-3/
C
      LIC(1)='                                '
      LIC(2)='(1)-SHALE     EXPONENTIAL       '
      LIC(3)='(2)-SAND      EXPONENTIAL       '
      LIC(4)='(3)-SILTSTONE EXPONENTIAL       '
      LIC(5)='(4)-LIMESTONE EXPONENTIAL       '
      LIC(6)='(5)-SHALE     LINEAR            '
      LIC(7)='(6)-SAND      LINEAR            '
      LIC(8)='(7)-SILTSTONE LINEAR            '
      LIC(9)='(8)-LIMESTONE LINEAR            '
c
      CALL CREDITS (6)
      CALL DSKMAN (OTP,OUTFIL)
c
      PM = 3330.
      PW = 1030.
      PR = PM/(PM-PW)
      READ (30,97) DSET
      READ (30,98) N
      READ (30,99) TTL
      READ (30,190) mf
  190 format (a1)
      read (30,*) rohite,wdep
      read (30,190) defalt
      WRITE (7,'(//,54X,A22,///)') '***** INPUT DATA *****'
      WRITE (7,96) DSET
      WRITE (7,100) TTL
      WRITE (7,101) N
      write (7,200) mf
  200 FORMAT (20X,'INPUT DEPTH MEASUREMENT IN ',A1)
      WRITE (7,205) 'UNIT OF MEASUREMENT FOR TABLE IS METERS'
  205 FORMAT (20X,A39)
      IF (MF.EQ.'F'.OR.MF.EQ.'f') THEN
        ROHITE=ROHITE/3.2809
        WDEP=WDEP/3.2809
      ENDIF
      write (7,210) rohite,wdep
  210 FORMAT (20X,'ROTARY TABLE HEIGHT =',f8.3,7x,'WATER DEPTH =',f8.3)
      WRITE (7,*) ' '
```

```
      WRITE (7,102)
      do 1 i=1,n
        READ (30,*) A(I),D(I),WM(I),WX(I),SLM(I),SLX(I)
        IF (MF.EQ.'F'.OR.MF.EQ.'f') D(I)=D(I)/3.2809
        IF (I.LE.9) THEN
          WRITE (7,201) A(I),D(I),WM(I),WX(I),SLM(I),SLX(I),LIC(I)
        ELSE
          WRITE (7,104) A(I),D(I),WM(I),WX(I),SLM(I),SLX(I)
        ENDIF
    1 CONTINUE
      do 560 j=1,n
         d(j) = d(j) - rohite - wdep
         DEPTH(J)=D(J)
  560 continue
      IF (A(N).LE.100) THEN
        SCALE=0
      ELSE
        SCALE=1
      ENDIF
      N1 = N - 1
      READ (30,*) (L(J),J=1,N1)
      WRITE (7,*) ' '
      WRITE (7,106) N1,(L(J),J=1,N1)
c
c     In case that the Labrador/North Sea values for F and C
c     are not being used, these values have to be specified
c     by the user; for ALL eight lithologies.
c
      FLG=0
   30 IF ((DEFALT.NE.'D'.and. defalt .ne. 'd').OR.FLG.NE.0) then
        CALL INTEXT1
        READ (*,'(A1)') IOPT
        IF (IOPT.EQ.'y') IOPT='Y'
        IF (IOPT.EQ.'Y') THEN
          WRITE (6,*) 'DO YOU WISH TO USE AN EXPONENTIAL FIT?'
          WRITE (6,*) '(DEFAULT FIT IS LINEAR) (Y/N): '
          READ (*,'(A1)') JOPT
          IF (JOPT.EQ.'y') JOPT='Y'
          IF (JOPT.EQ.'Y') THEN
            DO 601 I=1,N1,1
              L(I)=1
  601       CONTINUE
          ELSE
           DO 602 I=1,N1,1
              L(I)=7
  602      CONTINUE
          ENDIF
          WRITE (6,*) 'ENTER THE SINGLE F & C VALUES FOR THE'
          IF (JOPT.EQ.'Y') THEN
            WRITE (6,*) 'EXPONENTIAL MODEL IN FREE FORMAT: '
            READ (*,*) F(1),C(1)
          ELSE
            WRITE (6,*) 'LINEAR MODEL IN FREE FORMAT: '
            READ (*,*) F(7),C(7)
          ENDIF
```

```
        ELSE
          CALL LITHCODE
          do 9988 i=1,8
            WRITE (*,1110) LIC(I+1)
1110        format (1x,'For lithology code ',A32)
            write (*,1111)
1111        format (1x,'Please type F and C, free format: ')
            READ (*,*) F(I),C(I)
9988      continue
        ENDIF
      ENDIF
      CALL QUERY1 (LIC,F,C,IOPT,JOPT,DEFALT,FLG)
      IF (FLG.EQ.1) GOTO 30
C
C  UNCORRECTED BURIAL CALCULATED FROM THE TOP OF THE SEDIMENTS DOWNWARD
C
      DO 2 I=1,N
        WA(I) = (WX(I) + WM(I))/2.
        UDB(I) = D(N) - D(I) + WA(I)
    2 CONTINUE
C
C  CALCULATE THE LOAD OF THE PRESENT DAY SEDIMENT COLUMN
C
      J = 1
      P = 0.
      PA(1,1) = 0.
      DO 3 KJ=1,N1
        IF (D(KJ+1).EQ.D(KJ)) GO TO 17
        IF (L(J).GT.6) GO TO 4
c       FM = F/C * (EXP(-C * D(KJ)) - EXP(-C * D(KJ+1)))/(D(KJ+1)-D(KJ
        FM = F(L(J))/C(L(J)) * (EXP(-C(L(J)) * D(KJ)) - EXP(-C(L(J)) *
     &  D(KJ+1)))/(D(KJ+1)-D(KJ))
        GO TO 5
   17   PSA(KJ,1) = 0.
        GO TO 6
    4   FM = F(L(J)) - (1./2. * C(L(J)) * (D(KJ+1) + D(KJ)))
    5   PSA(KJ,1) = FM * PW + (1. - FM) * PSG(L(J))
    6   PS = PSA(KJ,1) * (D(KJ+1) - D(KJ))
        J = J + 1
        P = P + PS
    3 PA(KJ+1,1) = P/D(KJ+1)
C
C  STORE LAYERS
C
      M = 1
      DO 7 JJ=1,N
    7   TZ(JJ,M) = D(JJ)
      ZP1 = D(N)
      IF (OTP.EQ.'Y') THEN
        WRITE (7,*) CHAR(12)
      ELSE
        WRITE (7,'(///////)')
      ENDIF
      WRITE (7,'(///)')
      WRITE (7,'(40X,A36,A13)') '***** BURIAL AND TECTONIC SUBSIDENCE'
```

```
     +                                    '  DEPTHS *****'
      WRITE (7,'(46X,A26,///)') '          (IN METERS)      '
      WRITE (7,113)
      GO TO 8
    9 M = M + 1
      j=m
      CALL DECOMP (L,P,J,PW,D,N1,ZP1,DC,M,PSA,PA,F,C,PSG,DIM)
    8 IF (ZP1.NE.0.) PSM(M) = P/ZP1
      IF (ZP1.EQ.0.) PSM(M) = 0.
      Y(M) = ZP1 * ((PM - PSM(M))/(PM - PW))
      YXX(M) = Y(M) + (WX(M) + SLX(M)) - (SLX(M) * PR)
      YXM(M) = Y(M) + (WX(M) + SLM(M)) - (SLM(M) * PR)
      YMX(M) = Y(M) + (WM(M) + SLX(M)) - (SLX(M) * PR)
      YMM(M) = Y(M) + (WM(M) + SLM(M)) - (SLM(M) * PR)
      YSS(M) = (Y(M) + ((WX(M) + WM(M))/2)) - (((SLX(M) +
     *         SLM(M))/2) * PR) + ((SLX(M) + SLM(M))/2)
      ZT(M) = ZP1 + ((WX(M) + WM(M))/2.)
      WRITE (7,114) A(M),UDB(M),ZT(M),Y(M),YXX(M),YXM(M),
     *              YMX(M),YMM(M),YSS(M),
     *              PSM(M)
      IF (M.EQ.1) GO TO 9
      IF (M.GT.N1) GO TO 12
C
C     RESET DEPTH LEVEL AND STORE DECOMPACTED LAYERS
C
      D(M)=0.
      TZ(M,M)=0.
      INC=M+1
      DO 10 KL=INC,N
        TZ(KL,M)=DC(KL)
   10 D(KL)=DC(KL)
      GOTO 9
   12 WRITE (7,*) ' '
      TZ(M,M)=0.
      PA(M,M)=0.
      WRITE (7,'(//)')
      WRITE (7,300) 'LEGEND: A   = AGE OF SEDIMENTS               '
      WRITE (7,300) '        UDB = UNCORRECTED BURIAL DEPTH '
      WRITE (7,300) '        ZT  = DECOMPACTED BURIAL DEPTH '
      WRITE (7,310) '        Y   = SUBSIDENCE WITH SEDIMENT ',
     +'LOAD CORRECTION (WATER-FILLED)                      '
      WRITE (7,310) '        YXX = SUBSIDENCE CORRECTED FOR ',
     +'SEDIMENT LOAD, MAXIMUM WATER DEPTH AND MAXIMUM SEALEVEL'
      WRITE (7,310) '        YXM = SUBSIDENCE CORRECTED FOR ',
     +'SEDIMENT LOAD, MAXIMUM WATER DEPTH AND MINIMUM SEALEVEL'
      WRITE (7,310) '        YMX = SUBSIDENCE CORRECTED FOR ',
     +'SEDIMENT LOAD, MINIMUM WATER DEPTH AND MAXIMUM SEALEVEL'
      WRITE (7,310) '        YMM = SUBSIDENCE CORRECTED FOR ',
     +'SEDIMENT LOAD, MINIMUM WATER DEPTH AND MINIMUM SEALEVEL'
      WRITE (7,310) '        YSS = AVERAGE SUBSIDENCE (AVERA',
     +'GE WATER DEPTH, AVERAGE SEALEVEL)                    '
      WRITE (7,310) '        PSM = MEAN SEDIMENT DENSITY (IN',
     +' KG/M**3)                                            '
C
C
```

```
C   CALCULATE THE SEDIMENTATION RATE AND THE SEDIMENT MASS ACCUMULATION RAT
C   (FULLY COMPACTED MASS) FOR EACH AGE UNIT FOR TIME SINCE RIFTING
C
      IF (OTP.EQ.'Y') THEN
        WRITE (7,*) CHAR(12)
      ELSE
        WRITE (7,'(////////)')
      ENDIF
      WRITE (7,'(39X,A29,A32)') '***** SEDIMENTATION, BURIAL &',
     +                          ' TECTONIC SUBSIDENCE RATES *****'
      WRITE (7,'(////)')
      WRITE (7,115)
      DO 13 J=1,N1
        TSED = TZ(J+1,J) - TZ(J,J)
        ASED = A(J+1) - A(J)
        S=DEPTH(J+1)-DEPTH(J)
        RS=TSED
        RSR=TSED/(ASED*10.)
        UDBR=(UDB(J)-UDB(J+1))*.1/ASED
        USR=(DEPTH(J+1)-DEPTH(J))/(ASED*10.)
        ZTR=(ZT(J)-ZT(J+1))*.1/ASED
        YSSR=(YSS(J)-YSS(J+1))*.1/ASED
        SRATE = (TSED/ASED)/10.
        MRATE(J) = SRATE
        WRITE (7,116) A(J),A(J+1),S,RS,USR,RSR,UDBR,ZTR,YSSR
   13 CONTINUE
      CALL INTEXT2
      IF (OTP.EQ.'Y') THEN
        WRITE (7,*) CHAR(12)
      ELSE
        WRITE (7,'(////////)')
      ENDIF
      WRITE (7,'(38X,A30,1X,A37)') '***** DECOMPACTED BURIAL DEPTH'.
     +'(IN METERS) FOR EACH AGE LEVEL *****'
      WRITE (7,'(///)')
      DO 600 K=N,1,-14
        IF (K.GE.14) THEN
          IK=14
          JK=K-13
          WRITE (7,240) (A(I),I=K,JK,-1)
        ELSE
          IK=K
          JK=1
          WRITE (7,240) (A(I),I=K,1,-1)
        ENDIF
        WRITE (7,*)  'LEVEL ------------------------------------------
     +-----------------------------------------------------------------
     +-----------------'
        DO 605 I=N,1,-1
          DO 610 J=I,JK,-1
            DEBUR(J)=(TZ(I,J)/1.0)+WA(J)
  610     CONTINUE
          IC=I-JK+1
          IF (K.LT.14) IC=IC+14-K
          IF (IC.EQ.1) THEN
```

```
            WRITE (7,221) A(I),(DEBUR(J),J=I,JK,-1)
          ELSE IF (IC.EQ.2) THEN
            WRITE (7,222) A(I),(DEBUR(J),J=I,JK,-1)
          ELSE IF (IC.EQ.3) THEN
            WRITE (7,223) A(I),(DEBUR(J),J=I,JK,-1)
          ELSE IF (IC.EQ.4) THEN
            WRITE (7,224) A(I),(DEBUR(J),J=I,JK,-1)
          ELSE IF (IC.EQ.5) THEN
            WRITE (7,225) A(I),(DEBUR(J),J=I,JK,-1)
          ELSE IF (IC.EQ.6) THEN
            WRITE (7,226) A(I),(DEBUR(J),J=I,JK,-1)
          ELSE IF (IC.EQ.7) THEN
            WRITE (7,227) A(I),(DEBUR(J),J=I,JK,-1)
          ELSE IF (IC.EQ.8) THEN
            WRITE (7,228) A(I),(DEBUR(J),J=I,JK,-1)
          ELSE IF (IC.EQ.9) THEN
            WRITE (7,229) A(I),(DEBUR(J),J=I,JK,-1)
          ELSE IF (IC.EQ.10) THEN
            WRITE (7,230) A(I),(DEBUR(J),J=I,JK,-1)
          ELSE IF (IC.EQ.11) THEN
            WRITE (7,231) A(I), (DEBUR(J),J=I,JK,-1)
          ELSE IF (IC.EQ.12) THEN
            WRITE (7,232) A(I),(DEBUR(J),J=I,JK,-1)
          ELSE IF (IC.EQ.13) THEN
            WRITE (7,233) A(I),(DEBUR(J),J=I,JK,-1)
          ELSE IF (IC.EQ.14) THEN
            WRITE (7,234) A(I),(DEBUR(J),J=I,JK,-1)
          ELSE IF (IC.GT.14) THEN
            II=JK+IK-1
            WRITE (7,234) A(I),(DEBUR(J),J=II,JK,-1)
          ENDIF
605     CONTINUE
        WRITE (7,*) '===================================================
     +===================================================================
     +=================='
600   CONTINUE
      IF (OTP.EQ.'Y') WRITE (7,*) CHAR(18)
      WRITE (*,'(//)')
      WRITE (6,*) ' OUTPUT IS READY FOR PRINTING FROM FILE: ',OUTFIL
9950  STOP
 221  FORMAT (1X,F5.1,1X,'|',1X,13(9X),F9.1)
 222  FORMAT (1X,F5.1,1X,'|',1X,12(9X),2F9.1)
 223  FORMAT (1X,F5.1,1X,'|',1X,11(9X),3F9.1)
 224  FORMAT (1X,F5.1,1X,'|',1X,10(9X),4F9.1)
 225  FORMAT (1X,F5.1,1X,'|',1X,9(9X),5F9.1)
 226  FORMAT (1X,F5.1,1X,'|',1X,8(9X),6F9.1)
 227  FORMAT (1X,F5.1,1X,'|',1X,7(9X),7F9.1)
 228  FORMAT (1X,F5.1,1X,'|',1X,6(9X),8F9.1)
 229  FORMAT (1X,F5.1,1X,'|',1X,5(9X),9F9.1)
 230  FORMAT (1X,F5.1,1X,'|',1X,4(9X),10F9.1)
 231  FORMAT (1X,F5.1,1X,'|',1X,3(9X),11F9.1)
 232  FORMAT (1X,F5.1,1X,'|',1X,2(9X),12F9.1)
 233  FORMAT (1X,F5.1,1X,'|',1X,9X,13F9.1)
 234  FORMAT (1X,F5.1,1X,'|',1X,14F9.1)
 240  FORMAT (2X,'AGE',4X,15(3X,F5.1,1X))
```

```
 96 FORMAT (20X,'FILE NAME - ',A72)
 97 FORMAT (A72)
 98 FORMAT (I2)
 99 FORMAT (A80)
100 FORMAT (20X,'WELL NAME - ',A80)
101 FORMAT (20X,'NUMBER OF AGE DEPTH POINTS. N = ',I2)
102 FORMAT (20X,' AGE ',6X,'DEPTH',2X,' WMIN',1X,' WMAX',2X,'SLMIN',
   *        2X,'SLMAX',12X,'LITHOLOGY CODES')
104 FORMAT (20X,F5.1,5X,F6.0,2X,F5.0,1X,F5.0,2X,F5.0,2X,F5.0)
106 FORMAT (20X,I2,1X,'LITHOLOGICAL UNITS - ',30I2)
113 FORMAT (20X,'   A   ',5X,' UDB ',4X,' ZT  ',4X,'   Y   ',4X,
   *        ' YXX       YXM       YMX       YMM       YSS     ',
   *        '  PSM')
114 FORMAT (20X,F5.1,3X,9(F7.1,2X))
115 FORMAT (25X,'     T               S              RS           USR   ',
   *        '          RSR             UDBR            ZTR            YSSR')
116 FORMAT (25X,F5.1,' - ',F5.1,3X,F6.1,6(2X,F10.2))
201 FORMAT (20X,F5.1,5X,F6.0,2X,F5.0,1X,F5.0,2X,F5.0,2X,F5.0,
   +12X,A32,A16)
300 FORMAT (25X,A39)
310 FORMAT (25X,A39,A55)
    END
C
C     ******************************************************************
C
      SUBROUTINE DECOMP (L,P,J,PW,D,N1,ZP1,DC,M,PSA,PA,F,C,PSG,DIM)
C
C  CALCULATES THE SEDIMENT LOAD AFTER BACKSTRIPPING AND DECOMPACTION.
C
      INTEGER*2 DIM
      INTEGER*2 L(DIM)
      REAL*4    D(DIM),DC(DIM),PSA(DIM,DIM),PA(DIM,DIM)
      REAL*4    F(9),C(9),PSG(9)
      P = 0.
      PA(J,M) = 0.
      ZP1 = 0.
      IF (M.GT.N1) GO TO 6
C
C  BACKSTRIP A SEDIMENTARY UNIT
C
      DO 1 JL=J,N1
      Z1 = D(J)
      Z2 = D(J+1)
      IF (Z1.EQ.Z2) GO TO 7
C
C  SOLVE FOR ZP2 USING NEWTON'S METHOD AND AN EXPONENTIAL DEPTH-POROSITY
C  RELATION.
C
      K = 1
      Z = 5.
      IF (L(J).GT.6) GO TO 3
    2 X = (Z-ZP1) - (Z2-Z1) + ((F(L(J))/C(L(J))) * (EXP(-C(L(J))*Z1) -
     &EXP(-C(L(J))*Z2)) - ((F(L(J))/C(L(J))) * (EXP(-C(L(J))*ZP1) -
     &EXP(-C(L(J))*Z)))
      DX = 1. - F(L(J)) * EXP(-C(L(J)) * Z)
```

```
      R = ABS(X/DX)
      ZP2 = Z - X/DX
      E = ZP2 * 1.E-4
      K = K + 1
      IF (R.LT.E) GO TO 4
      IF (R.GT.E) Z = ZP2
      IF (K.LE.100) GO TO 2
      WRITE (7,112) Z,R,E
      GO TO 4
C
C  SOLVE FOR ZP2 BY FINDING THE ROOTS OF THE QUAD EQUATION ASSUMING
C  LINEAR DEPTH-POROSITY RELATION.
C
    3 B = 1. - F(L(J))
      CC = -((1./2.)*C(L(J))*(ZP1**2.)) + (ZP1 * (F(L(J))-1.)) -
     &((Z2-Z1) * (1.-F(L(J)) + (1./2.*C(L(J))*(Z2+Z1))))
      A = 1./2. * C(L(J))
      ZP2 = (-B + SQRT(B**2. - (4 * A * CC)))/(2. * A)
      GO TO 5
C
C CALCULATE THE MEAN DENSITY OF THE SEDIMENTARY LAYER ASSUMING AN EXPONENT
C POROSITY-DEPTH FUNCTION.
C
    4 FM = F(L(J))/C(L(J)) * (EXP(-C(L(J)) * ZP1) -EXP(-C(L(J)) *
     &ZP2))/(ZP2 - ZP1)
      GO TO 8
    7 ZP2 = ZP1
      PSA(J,M) = 0.
      GO TO 9
C
C  CALCULATE THE MEAN SEDIMENT DENSITY USING A LINEAR POROSITY-DEPTH FUNC
C
    5 FM = F(L(J)) - (1./2. * C(L(J)) * (ZP2 + ZP1))
    8 PSA(J,M) = (FM * PW + (1. - FM) * PSG(L(J)))
    9 PS = PSA(J,M) * (ZP2 - ZP1)
      P = P + PS
      PA(J+1,M) = P/ZP2
      ZP1 = ZP2
      DC(J+1) = ZP2
      J = J + 1
    1 CONTINUE
    6 RETURN
  112 FORMAT ('100 ITERATIONS',2X,'Z = ',F6.1,1X,'R = ',E10.5,1X,'E = ',
     -        E10.5)
      END
C
      SUBROUTINE CREDITS (UNIT)
      INTEGER*2 UNIT
      IF (UNIT.EQ.6) THEN
        WRITE (6,1000) ' ***** BURIAL AND SUBSIDENCE ANALYSIS *****'
        WRITE (6,1000) '                                            '
        WRITE (6,1000) ' PROGRAM PREPARED BY B.STAM,F.GRADSTEIN     '
        WRITE (6,1000) ' AND D.GILLIS,                              '
        WRITE (6,1000) ' JANUARY, 1986,                             '
        WRITE (6,1000) ' ATLANTIC GEOSCIENCE CENTER,                '
```

```
        WRITE (6,1000) ' BEDFORD INSTITUTE OF OCEANOGRAPHY,         '
        WRITE (6,1000) ' DARTMOUTH, N.S., B2Y 4A2,                  '
        WRITE (6,1000) ' CANADA                                     '
        WRITE (6,1000) '                                            '
        WRITE (6,1000) '                                            '
      ELSE IF (UNIT.EQ.7) THEN
        WRITE (7,1010) ' ***** BURIAL AND SUBSIDENCE ANALYSIS *****'
        WRITE (7,1010) '                                            '
        WRITE (7,1010) ' PROGRAM PREPARED BY B.STAM,F.GRADSTEIN     '
        WRITE (7,1010) ' AND D.GILLIS,                              '
        WRITE (7,1010) ' JANUARY, 1986,                             '
        WRITE (7,1010) ' ATLANTIC GEOSCIENCE CENTER,                '
        WRITE (7,1010) ' BEDFORD INSTITUTE OF OCEANOGRAPHY,         '
        WRITE (7,1010) ' DARTMOUTH, N.S., B2Y 4A2,                  '
        WRITE (7,1010) ' CANADA                                     '
        WRITE (7,1010) '                                            '
        WRITE (7,1010) '                                            '
      ENDIF
1000  FORMAT (A43)
1010  FORMAT (20X,A43)
      RETURN
      END
C
      SUBROUTINE LITHCODE
      write (6,*) '*************************************'
      write (6,*) '* You must specify both the         *'
      write (6,*) '* F and C values for all eight      *'
      write (6,*) '* lithologies (not necesary ob-     *'
      write (6,*) '* served in the well or section, in*'
      write (6,*) '* which case you can enter any      *'
      write (6,*) '* value).                           *'
      write (6,*) '* First F and then C have to be     *'
      write (6,*) '* typed in the following order:     *'
      write (6,*) '*                                   *'
      write (6,*) '* (1)-SHALE     EXPONENTIAL         *'
      write (6,*) '* (2)-SAND      EXPONENTIAL         *'
      write (6,*) '* (3)-SILTSTONE EXPONENTIAL         *'
      write (6,*) '* (4)-LIMESTONE EXPONENTIAL         *'
      write (6,*) '* (5)-SHALE     LINEAR              *'
      write (6,*) '* (6)-SAND      LINEAR              *'
      write (6,*) '* (7)-SILTSTONE LINEAR              *'
      write (6,*) '* (8)-LIMESTONE LINEAR              *'
      write (6,*) '*************************************'
      RETURN
      END
C
      SUBROUTINE DSKMAN (SOTP,OUTFN)
      CHARACTER*1 SOTP,SIOPT
      CHARACTER*64 INFILE,OUTFN
C
c  disc-file management
c
c Prompt to the screen by writing to *.
      write (*,2000)
 2000 format (1x,'Please type file-name for input: ')
```

```
      read (*,2010) infile
 2010 format (a64)
      OPEN (3,FILE='FLT.ERR'.STATUS='UNKNOWN',ACCESS='SEQUENTIAL')
      open (30, file=infile, status='old', form='formatted')
      write (*,2020)
 2020 format (1x,'             File name for output: ')
      read (*,2010) OUTFN
      open (7, file=OUTFN, status='unknown', access='sequential')
      WRITE (*,2025)
      CALL CREDITS (7)
2025  FORMAT (1X,'ARE YOU USING AN EPSON MX PRINTER? (Y/N): ')
      READ (*,'(A1)') SOTP
      IF (SOTP.EQ.'y') SOTP='Y'
      IF (SOTP.NE.'Y') THEN
        WRITE (6,*) ' 132 COLUMN PAPER IS REQUIRED FOR OUTPUT'
      ELSE
        WRITE (6,*) 'THE OUTPUT FILE WILL PRINT 132 COLUMNS ON',
     +  ' 80 COLUMN PAPER'
      ENDIF
      WRITE (*,'(//)')
      IF (SOTP.EQ.'Y') WRITE (7,*) CHAR(15)
      write (*,2200)
 2200 format (//5x, 'If for any reason you wish to abort ',
     +  'execution,' /9x,'you may type   CTRL-C'/)
      RETURN
      END
C
      SUBROUTINE INTEXT1
      WRITE (6,*) ' '
      WRITE (6,*) ' '
      WRITE (6,*) 'FOR THIS FILE F & C VALUES MUST BE ENTERED FOR'
      WRITE (6,*) 'THE LITHOLOGIES (DEFAULTS DO NOT APPLY).'
      WRITE (6,*) '        '
      WRITE (6,*) 'DO YOU WISH TO ENTER ONLY'
      WRITE (6,*) 'ONE F & C FOR ALL LITHOLOGIES? (Y/N): '
      RETURN
      END
C
      SUBROUTINE QUERY1  (SLIC,SF,SC,SIOPT,SJOPT,SDFLT,SFLG)
      REAL SF(8),SC(8)
      CHARACTER *32 SLIC(9).SOPT*1,SIOPT*1,SJOPT*1,QES*1,SDFLT*1
      INTEGER SFLG
      SFLG=0
      WRITE (*,*) '         LITHOLOGY PARAMETERS ENTERED'
      WRITE (*,*) '         =============================='
      WRITE (*,*) ' '
      IF (SIOPT.EQ.'Y') THEN
        WRITE (*,*) 'ONE PAIR OF F & C VALUES WERE ENTERED FOR ALL ',
     +              'LITHOLOGIES,'
        IF (SJOPT.EQ.'Y') THEN
          WRITE (*,*) 'USING AN EXPONENTIAL MODEL.'
          WRITE (*,*) ' '
          WRITE (*,1010) SF(1),SC(1)
        ENDIF
        IF (SJOPT.NE.'Y') THEN
```

```
          WRITE (*,*) 'USING A LINEAR MODEL.'
          WRITE (*,*) ' '
          WRITE (*,1010) SF(7),SC(7)
        ENDIF
      ELSE
        IF ((SDFLT.EQ.'D'.OR.SDFLT.EQ.'d').AND.SFLG.EQ.0) THEN
          WRITE (*,*) '      (PROGRAM DEFAULT VALUES WERE USED)'
          WRITE (*,*) ' '
          DO 100 I=1,8
            WRITE (*,1015) SLIC(I+1),SF(I),SC(I)
 100      CONTINUE
        ELSE
          DO 110 I=1,8
            WRITE (*,1000) SLIC(I+1),SF(I),SC(I)
 110      CONTINUE
        ENDIF
      ENDIF
      WRITE (*,*) ' '
      WRITE (*,*) 'DO YOU WISH TO ENTER F & C VALUES AGAIN ? (Y/N): '
      READ (*,'(A1)') QES
      IF (QES.EQ.'y'.OR.QES.EQ.'Y') SFLG=1
      RETURN
 1000 FORMAT (1X,A32,' F=',E9.4,' C=',E9.4)
 1010 FORMAT (1X,'F=',E9.4,'       C=',E9.4)
 1015 FORMAT (1X,A32,1X,'F=',E9.4,' C=',E9.4)
      END
C
      SUBROUTINE INTEXT2
      WRITE (7,'(////)')
      WRITE (7,1000)'LEGEND: T    = TIME IN MA BEFORE PRESENT     '
      WRITE (7,1010)'         S    = SEDIMENT THICKNESS (OBSERVED) ',
     +              'IN METERS    '
      WRITE (7,1010)'         RS   = RESTORED SEDIMENT THICKNESS IN',
     +              ' METERS      '
      WRITE (7,1010)'         USR  = UNCORRECTED SEDIMENTATION RATE',
     +              ' IN CM/1000 Y'
      WRITE (7,1010)'         RSR  = RESTORED SEDIMENTATION RATE IN',
     +              ' CM/1000 Y   '
      WRITE (7,1010)'         UDBR = UNCORRECTED BURIAL RATE IN CM/',
     +              '1000 Y       '
      WRITE (7,1010)'         ZTR  = DECOMPACTED BURIAL RATE IN CM/',
     +              '1000 Y       '
      WRITE (7,1010)'         YSSR = AVERAGE SUBSIDENCE RATE IN CM/',
     +              '1000 Y       '
 1000 FORMAT (25X,A45)
 1010 FORMAT (25X,A45,A13)
      RETURN
      END
```

Table 1

Depth	Lithology Code
100	
250	1
350	1
610	1
611	6
731	6
831	3
906	8
1006	8
1007	8
1327	8
1467	6

Table 2

Depth	Sonic Travel Time
873.250	197.967
948.250	189.827
1023.250	178.250
1098.250	163.883
1173.250	163.197
1248.250	186.529
1323.250	176.106

Table 3

Depth	Porosity
50.0	55
75.0	55
100.0	55
125.0	52
150.0	48
175.0	42
200.0	48
225.0	50
250.0	52
275.0	57

f		3020	4	4680	4
865		3390	4	4930	1
910	2	3430	4	4940	4
1720	1	3540	2	5110	1
1810	2	3620	2	5130	4
2010	1	3710	4	5200	1
2500	2	3780	3	5220	4
2560	1	3860	4	5320	2
2580	3	3990	1	6550	4
2640	1	4010	2	7750	1
2650	3	4090	4	7790	2
2740	1	4140	3	7850	1
2760	3	4180	4	7940	2
2940	1	4420	1	8400	1
2980	1	4460	4	9600	4
2990	4	4660	1	10400	1
3010	2				

Table 4.

AMOCO IOE MURRE G67 FT

Depth	Sonic Travel Time	Depth	Sonic Travel Time	Depth	Sonic Travel Time
873.250	197.967	4098.250	116.677	7323.250	86.389
948.250	189.827	4173.250	125.433	7398.250	84.915
1023.250	178.250	4248.250	119.559	7473.250	77.205
1098.250	163.883	4323.250	119.600	7548.250	78.634
1173.250	163.197	4398.250	107.334	7623.250	83.281
1248.250	186.529	4473.250	106.211	7698.250	81.771
1323.250	176.106	4548.250	110.757	7773.250	80.093
1398.250	155.055	4623.250	115.267	7848.250	85.066
1473.250	151.194	4698.250	111.996	7923.250	85.362
1548.250	147.910	4773.250	110.386	7998.250	78.896
1623.250	159.577	4848.250	106.884	8073.250	78.569
1698.250	150.866	4923.250	104.036	8148.250	78.229
1773.250	149.866	4998.250	103.545	8223.250	73.343
1848.250	153.720	5073.250	100.136	8298.250	72.474
1923.250	147.721	5148.250	97.600	8373.250	70.307
1998.250	133.686	5223.250	94.101	8448.250	69.790
2073.250	141.489	5298.250	85.374	8523.250	56.281
2148.250	131.846	5373.250	89.728	8598.250	54.225
2223.250	123.264	5448.250	83.390	8673.250	54.966
2298.250	134.046	5523.250	80.897	8748.250	54.505
2373.250	131.368	5598.250	89.308	8823.250	55.982
2448.250	117.513	5673.250	88.059	8898.250	52.089
2523.250	113.978	5748.250	86.430	8973.250	51.159
2598.250	115.885	5823.250	80.067	9048.250	53.028
2673.250	116.093	5898.250	84.395	9123.250	50.812
2748.250	126.572	5973.250	79.348	9198.250	55.438
2823.250	113.597	6048.250	74.455	9273.250	59.127
2898.250	146.445	6123.250	83.153	9348.250	52.180
2973.250	147.792	6198.250	84.765	9423.250	53.548
3048.250	153.339	6273.250	63.896	9498.250	55.393
3123.250	113.047	6348.250	66.641	9573.250	67.981
3198.250	124.181	6423.250	86.531	9648.250	80.286
3273.250	144.803	6498.250	60.639	9723.250	81.682
3348.250	114.131	6573.250	74.952	9798.250	73.399
3423.250	83.146	6648.250	92.042	9873.250	89.975
3498.250	111.930	6723.250	91.808	9948.250	68.657
3573.250	103.929	6798.250	93.091	10023.250	69.103
3648.250	107.148	6873.250	93.785	10098.250	69.079
3723.250	111.232	6948.250	93.246	10173.250	68.989
3798.250	126.339	7023.250	91.498	10248.250	67.842
3873.250	112.330	7098.250	89.699	10323.250	61.726
3948.250	107.007	7173.250	90.472	10398.250	53.685
4023.250	112.467	7248.250	84.809		

Table 5.

AMOCO IOE MURRE G67 FT

shale

```
     LINEAR:         F=0.4552E+00 C=0.1618E-03
     EXPONENTIAL:    F=0.8706E+00 C=0.1231E-02
THE BEST FIT IS EXPONENTIAL.
```

sandstone

```
     LINEAR:         F=0.6601E+00 C=0.1969E-03
     EXPONENTIAL:    F=0.7649E+00 C=0.5466E-03
THE BEST FIT IS EXPONENTIAL.
```

siltstone

```
     LINEAR:         F=0.3817E+00 C=0.1378E-03
     EXPONENTIAL:    F=0.4252E+00 C=0.5647E-03
THE BEST FIT IS EXPONENTIAL.
```

limestone

```
     LINEAR:         F=0.6913E+00 C=0.2181E-03
     EXPONENTIAL:    F=0.1423E+01 C=0.9639E-03
THE BEST FIT IS EXPONENTIAL.
```

all lithologies

```
     LINEAR:         F=0.5153E+00 C=0.1647E-03
     EXPONENTIAL:    F=0.9047E+00 C=0.1007E-02
```

THE BEST FIT IS LINEAR.

Table 6.

***** INPUT DATA *****

FILE NAME - Murre.sub
WELL NAME - Murre G-67
NUMBER OF AGE DEPTH POINTS, N = 20
INPUT DEPTH MEASUREMENT IN m
UNIT OF MEASUREMENT FOR TABLE IS METERS
ROTARY TABLE HEIGHT = 30.000   WATER DEPTH = 67.000

AGE	DEPTH	WMIN	WMAX	SLMIN	SLMAX
0.0	97.	67.	67.	0.	0.
23.5	250.	75.	100.	0.	30.
36.5	350.	50.	75.	0.	45.
52.0	610.	10.	50.	0.	65.
84.0	611.	0.	0.	0.	100.
88.5	731.	50.	100.	0.	100.
91.0	831.	200.	500.	0.	100.
97.5	906.	50.	50.	0.	95.
100.0	1006.	0.	10.	0.	90.
148.0	1007.	0.	0.	0.	50.
156.0	1327.	0.	25.	0.	60.
163.0	1467.	50.	50.	0.	60.
169.0	1687.	100.	200.	0.	50.
176.0	1887.	50.	50.	0.	35.
183.0	2007.	25.	25.	0.	30.
187.0	2127.	100.	200.	0.	20.
193.0	2277.	100.	200.	0.	20.
196.0	2590.	75.	150.	0.	10.
198.0	2727.	50.	100.	0.	0.
208.0	2967.	0.	10.	0.	0.

LITHOLOGY CODES

(1)-SHALE EXPONENTIAL
(2)-SAND EXPONENTIAL
(3)-SILTSTONE EXPONENTIAL
(4)-LIMESTONE EXPONENTIAL
(5)-SHALE LINEAR
(6)-SAND LINEAR
(7)-SILTSTONE LINEAR
(8)-LIMESTONE LINEAR

19 LITHOLOGICAL UNITS - 2 1 1 1 2 3 3 2 8 3 8 1 8 8 1 1 1 8 8

Table 7.

SEDIMENTATION, BURIAL & TECTONIC SUBSIDENCE RATES

T	S	RS	USR	RSR	UDBR	ZTR	YSSR
0.0 - 23.5	153.0	153.00	0.65	0.65	0.56	0.06	-0.04
23.5 - 36.5	100.0	154.99	0.77	1.19	0.96	0.47	0.32
36.5 - 52.0	260.0	385.17	1.68	2.48	1.89	1.35	0.82
52.0 - 84.0	1.0	4.08	0.00	0.01	0.10	0.10	0.12
84.0 - 88.5	120.0	193.08	2.67	4.29	1.00	0.34	-0.49
88.5 - 91.0	100.0	120.72	4.00	4.83	-7.00	-8.92	-10.96
91.0 - 97.5	75.0	92.82	1.15	1.43	5.77	5.19	4.57
97.5 - 100.0	100.0	190.66	4.00	7.63	5.80	5.37	3.85
100.0 - 148.0	1.0	1.64	0.00	0.00	0.01	0.01	-0.01
148.0 - 156.0	320.0	396.64	4.00	4.96	3.84	1.89	-0.29
156.0 - 163.0	140.0	247.03	2.00	3.53	1.46	0.39	-0.48
163.0 - 169.0	220.0	526.66	3.67	8.77	2.00	2.76	0.43
169.0 - 176.0	200.0	386.13	2.86	5.52	4.29	3.80	2.34
176.0 - 183.0	120.0	254.05	1.71	3.63	2.07	1.32	0.42
183.0 - 187.0	120.0	368.86	3.00	9.22	-0.12	-0.11	-2.18
187.0 - 193.0	150.0	431.79	2.50	7.20	2.50	2.70	1.00
193.0 - 196.0	313.0	709.48	10.43	23.65	11.68	17.95	10.67
196.0 - 198.0	137.0	343.30	6.85	17.16	8.72	14.67	10.22
198.0 - 208.0	240.0	585.29	2.40	5.85	3.10	6.55	4.96

LEGEND: T = TIME IN MA BEFORE PRESENT
S = SEDIMENT THICKNESS (OBSERVED) IN METERS
RS = RESTORED SEDIMENT THICKNESS IN METERS
USR = UNCORRECTED SEDIMENTATION RATE IN CM/1000 Y
RSR = RESTORED SEDIMENTATION RATE IN CM/1000 Y
UDBR = UNCORRECTED BURIAL RATE IN CM/1000 Y
ZTR = DECOMPACTED BURIAL RATE IN CM/1000 Y
YSSR = AVERAGE SUBSIDENCE RATE IN CM/1000 Y

Table 8a.

BURIAL AND TECTONIC SUBSIDENCE DEPTHS
(IN METERS)

A	UDB	ZT	Y	YXX	YXN	YNX	YNN	YSS	PSM
0.0	2937.0	2937.0	1387.9	1454.8	1454.8	1454.8	1454.8	1454.8	2217.8
23.5	2804.5	2923.4	1382.4	1469.0	1482.4	1444.0	1457.4	1463.2	2208.8
36.5	2679.5	2862.1	1369.5	1424.4	1444.5	1399.4	1419.5	1421.9	2204.9
52.0	2387.0	2653.3	1278.9	1239.8	1328.9	1239.8	1288.9	1294.3	2208.7
84.0	2356.0	2621.7	1277.7	1233.0	1277.7	1233.0	1277.7	1255.4	2209.0
88.5	2311.0	2606.4	1224.7	1279.9	1324.7	1229.9	1274.7	1277.3	2217.3
91.0	2466.0	2829.3	1323.6	1678.9	1723.6	1378.9	1423.6	1551.3	2194.9
97.5	2111.0	2492.2	1225.5	1233.0	1275.5	1233.0	1275.5	1254.3	2175.8
100.0	1966.0	2358.1	1173.1	1142.8	1183.1	1132.8	1173.1	1158.0	2183.3
148.0	1960.0	2352.4	1172.8	1150.4	1172.8	1150.4	1172.8	1161.6	2183.3
156.0	1652.5	2201.3	1165.4	1183.5	1210.4	1158.5	1185.4	1184.4	2084.4
163.0	1550.0	2174.2	1191.3	1204.5	1231.3	1204.5	1231.3	1217.9	2050.9
169.0	1430.0	2008.7	1053.0	1220.6	1253.0	1130.6	1153.0	1191.8	2027.0
176.0	1130.0	1742.4	985.6	1020.0	1035.6	1020.0	1035.6	1027.8	1990.5
183.0	985.0	1649.7	980.4	991.9	1005.4	991.9	1005.4	998.6	1942.1
187.0	990.0	1634.2	940.3	1131.4	1140.3	1031.4	1040.3	1085.9	1892.2
193.0	840.0	1492.2	880.1	1071.1	1080.1	971.1	980.1	1025.6	1821.9
196.0	489.5	953.7	595.2	740.7	745.2	665.7	670.2	705.4	1702.7
198.0	315.0	660.3	426.0	526.0	526.0	476.0	476.0	501.0	1655.8
208.0	5.0	5.0	0.0	10.0	10.0	0.0	0.0	5.0	0.0

LEGEND: A = AGE OF SEDIMENTS
UDB = UNCORRECTED BURIAL DEPTH
ZT = DECOMPACTED BURIAL DEPTH
Y = SUBSIDENCE WITH SEDIMENT LOAD CORRECTION (WATER-FILLED)
YXX = SUBSIDENCE CORRECTED FOR SEDIMENT LOAD, MAXIMUM WATER DEPTH AND MAXIMUM SEALEVEL
YXN = SUBSIDENCE CORRECTED FOR SEDIMENT LOAD, MAXIMUM WATER DEPTH AND MINIMUM SEALEVEL
YNX = SUBSIDENCE CORRECTED FOR SEDIMENT LOAD, MINIMUM WATER DEPTH AND MAXIMUM SEALEVEL
YNN = SUBSIGENCE CORRECTED FOR SEDIMENT LOAD, MINIMUM WATER DEPTH AND MINIMUM SEALEVEL
YSS = AVERAGE SUBSIDENCE (AVERAGE WATER DEPTH, AVERAGE SEALEVEL)
PSM = MEAN SEDIMENT DENSITY (IN KG/M**3)

Table 8b.

DECOMPACTED BURIAL DEPTH (IN METERS) FOR EACH AGE LEVEL

AGE LEVEL	208.0	198.0	196.0	193.0	187.0	183.0	176.0	169.0	163.0	156.0	148.0	100.0	97.5	91.0
208.0	5.0	660.3	953.7	1492.2	1634.2	1649.7	1742.4	2008.7	2174.2	2201.3	2352.4	2358.1	2492.2	2829.3
198.0		75.0	455.8	1102.0	1289.0	1308.8	1402.1	1607.6	1879.5	1912.3	2077.0	2082.7	2223.7	2563.6
196.0			112.5	859.5	1066.0	1090.1	1197.7	1497.0	1707.0	1743.7	1917.3	1923.1	2068.6	2410.2
193.0				150.0	581.8	659.2	786.7	1119.8	1360.5	1402.3	1586.2	1592.0	1741.8	2085.1
187.0					150.0	393.9	549.9	919.7	1186.7	1232.4	1423.7	1429.6	1582.5	1926.9
183.0						25.0	334.0	741.9	1041.9	1091.9	1291.3	1297.2	1453.3	1798.9
176.0							50.0	536.1	873.2	929.5	1142.4	1148.4	1310.7	1659.6
169.0								150.0	576.1	646.0	886.8	892.9	1067.6	1420.2
163.0									50.0	259.5	595.3	601.8	799.7	1159.6
156.0										12.5	396.6	403.1	616.3	981.7
148.0											0.0	6.6	242.1	614.8
100.0												5.0	240.7	613.4
97.5													50.0	442.8
91.0														250.0

AGE LEVEL	88.5	84.0	52.0	36.5	23.5	0.0
208.0	2606.4	2621.7	2653.3	2862.1	2923.4	2937.0
198.0	2344.4	2366.0	2397.6	2617.9	2601.4	2697.0
196.0	2193.4	2219.1	2250.8	2478.2	2543.1	2560.0
193.0	1870.4	1899.3	1931.1	2163.6	2229.3	2247.0
187.0	1713.7	1744.8	1776.6	2012.5	2078.8	2097.0
183.0	1587.1	1620.4	1652.2	1891.4	1958.3	1977.0
176.0	1450.0	1488.4	1520.4	1768.3	1836.8	1857.0
169.0	1217.8	1266.0	1298.1	1562.5	1634.1	1657.0
163.0	965.9	1025.9	1058.2	1338.1	1412.0	1437.0
156.0	794.7	864.9	897.3	1192.9	1269.6	1297.0
148.0	456.9	520.0	552.6	867.0	946.8	977.0
100.0	453.6	518.8	551.4	866.0	945.8	976.0
97.5	284.5	389.4	422.3	760.0	843.1	876.0
91.0	195.7	305.8	338.8	683.1	767.2	801.0
88.5	75.0	193.1	226.2	580.3	665.9	701.0
84.0		3.0	34.1	448.8	540.7	581.0
52.0			30.0	447.7	539.7	580.0
36.5				62.5	242.3	320.0
23.5					87.5	270.0
0.0						67.0

Table 8c.

Vigo Seamount DSDP-398

Depth	Porosity	Depth	Porosity
50.0	55	925.0	40
75.0	55	950.0	40
100.0	55	975.0	30
125.0	52	1000.0	32
150.0	48	1025.0	40
175.0	42	1050.0	42
200.0	48	1075.0	39
225.0	50	1100.0	41
250.0	52	1125.0	40
275.0	57	1150.0	42
300.0	50	1175.0	40
325.0	45	1200.0	38
350.0	50	1225.0	40
375.0	45	1250.0	30
400.0	40	1275.0	33
425.0	40	1300.0	40
450.0	30	1325.0	35
500.0	35	1350.0	30
525.0	30	1375.0	33
550.0	25	1400.0	30
600.0	40	1425.0	20
625.0	40	1450.0	30
650.0	50	1475.0	20
675.0	35	1500.0	30
700.0	30	1525.0	35
725.0	30	1550.0	30
750.0	40	1575.0	25
775.0	40	1600.0	25
800.0	30	1625.0	25
825.0	28	1650.0	30
850.0	30	1675.0	20
875.0	35	1700.0	20
900.0	50		

Table 9.

***** INPUT DATA *****

FILE NAME - VIGO.SUB
WELL NAME - site 398
NUMBER OF AGE DEPTH POINTS, N = 24
INPUT DEPTH MEASUREMENT IN m
UNIT OF MEASUREMENT FOR TABLE IS METERS
ROTARY TABLE HEIGHT = 0.000 WATER DEPTH = 0.000

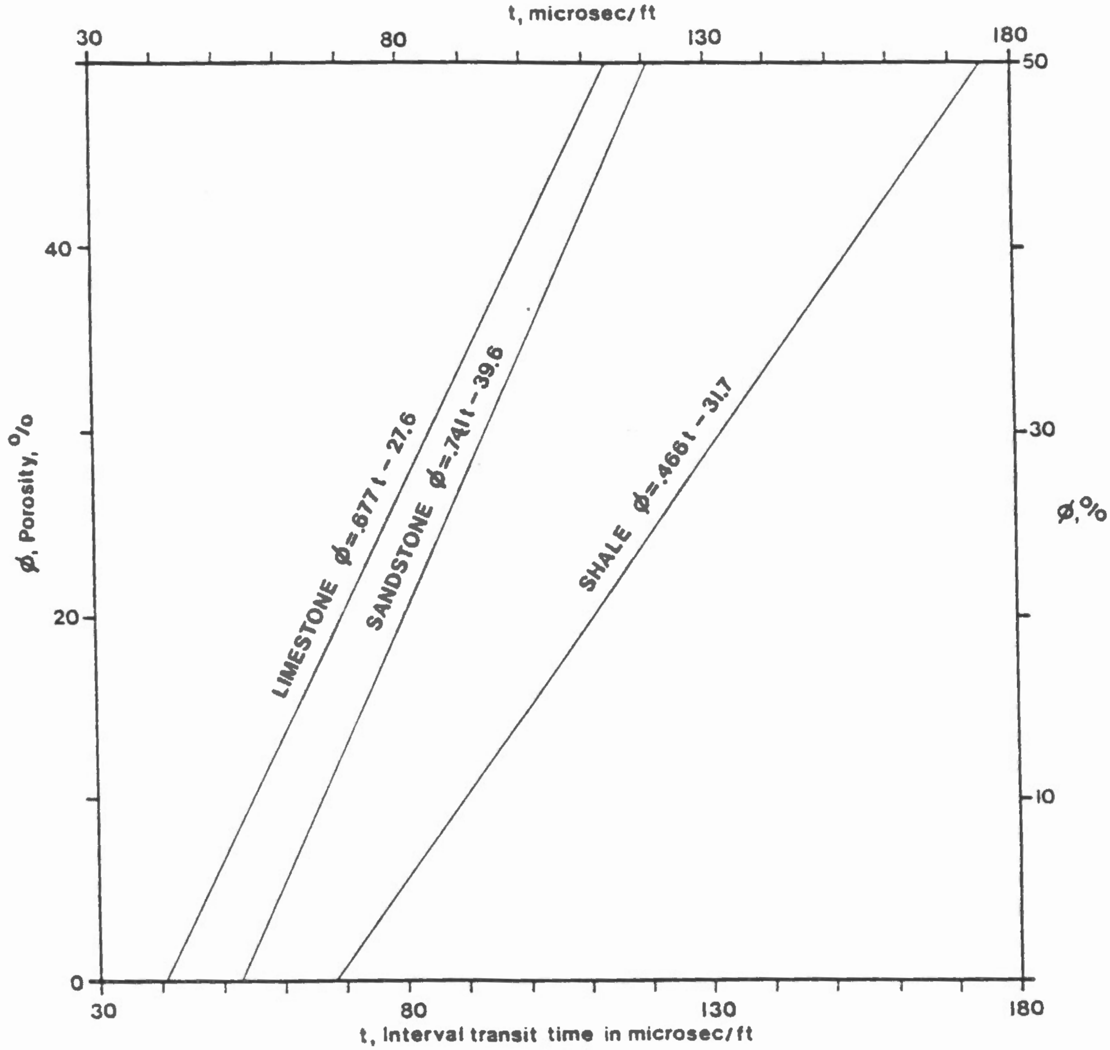
AGE	DEPTH	WMIN	WMAX	SLMIN	SLMAX
0.0	0.	3910.	3910.	0.	0.
1.6	40.	3850.	3850.	0.	2.
3.4	175.	3800.	3800.	0.	5.
5.3	280.	3750.	3750.	0.	5.
11.2	380.	3700.	3700.	0.	10.
15.1	430.	3650.	3650.	0.	15.
23.7	520.	3600.	3600.	0.	30.
30.0	560.	3500.	3500.	0.	40.
43.6	600.	3450.	3450.	0.	50.
52.0	720.	3300.	3400.	0.	65.
57.8	740.	3200.	3300.	0.	70.
62.0	760.	3100.	3100.	0.	75.
63.5	780.	3000.	3000.	0.	75.
66.4	800.	2900.	2900.	0.	85.
74.5	850.	2800.	2800.	0.	90.
84.0	920.	2700.	2700.	0.	100.
91.0	950.	2600.	2600.	0.	100.
97.5	1000.	2500.	2500.	0.	95.
102.0	1070.	2400.	2400.	0.	85.
109.0	1300.	2300.	2300.	0.	80.
113.0	1410.	2200.	2200.	0.	75.
116.0	1550.	2100.	2100.	0.	45.
119.0	1640.	2050.	2050.	0.	40.
124.0	1700.	2000.	2000.	0.	40.

LITHOLOGY CODES

(1)-SHALE EXPONENTIAL
(2)-SAND EXPONENTIAL
(3)-SILTSTONE EXPONENTIAL
(4)-LIMESTONE EXPONENTIAL
(5)-SHALE LINEAR
(6)-SAND LINEAR
(7)-SILTSTONE LINEAR
(8)-LIMESTONE LINEAR

23 LITHOLOGICAL UNITS - 3 3 3 4 4 4 4 4 3 4 5 4 4 4 3 5 3 5 5 5 3 3 3

Table 10.



t, microsec/ft
30
80
130
180
50
40
30
20
10
0
ϕ, Porosity, %
ϕ,%
LIMESTONE ϕ=.677 t - 27.6
SANDSTONE ϕ=.741 t - 39.6
SHALE ϕ=.466 t - 31.7
t, Interval transit time in microsec/ft

Fig. 1.

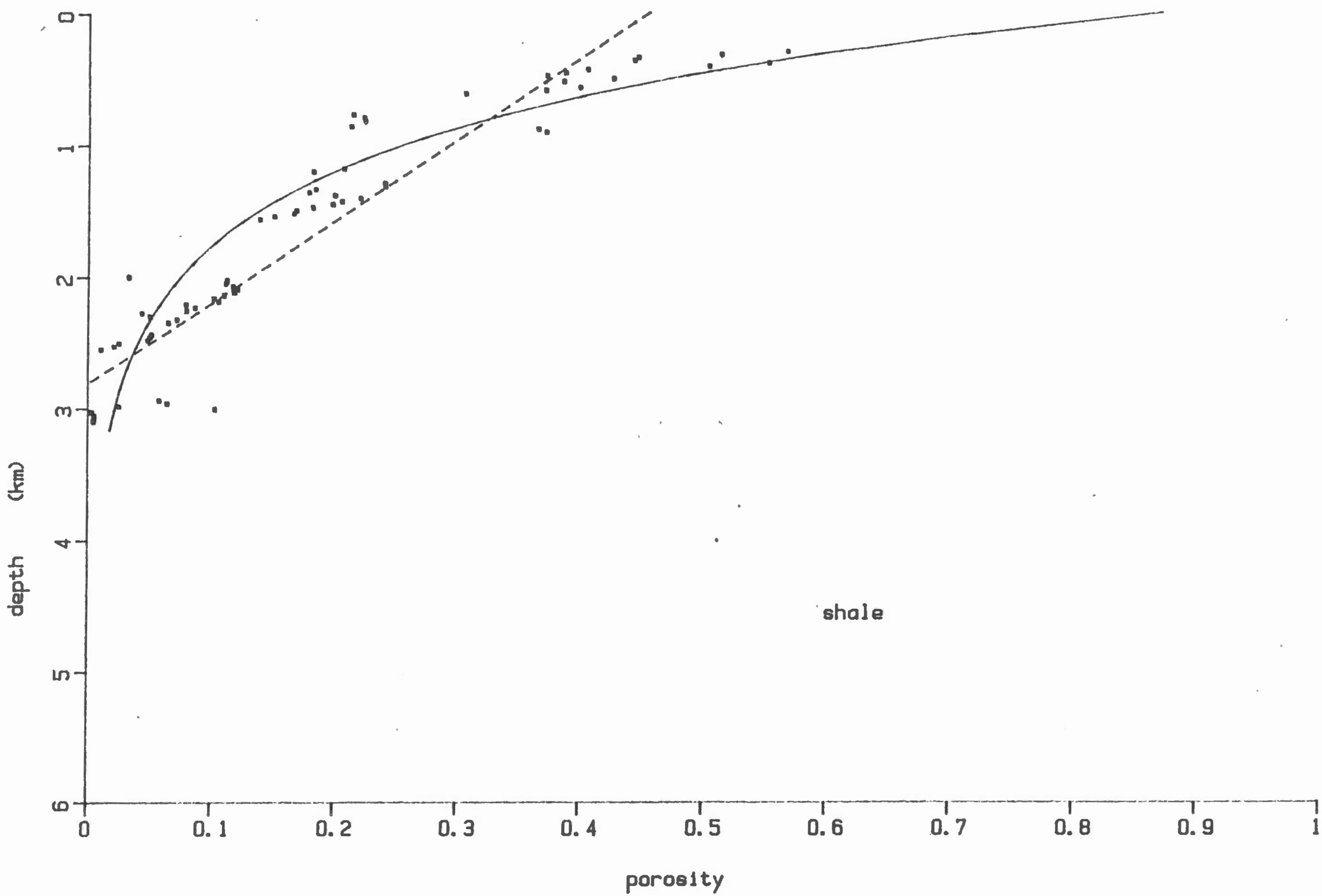
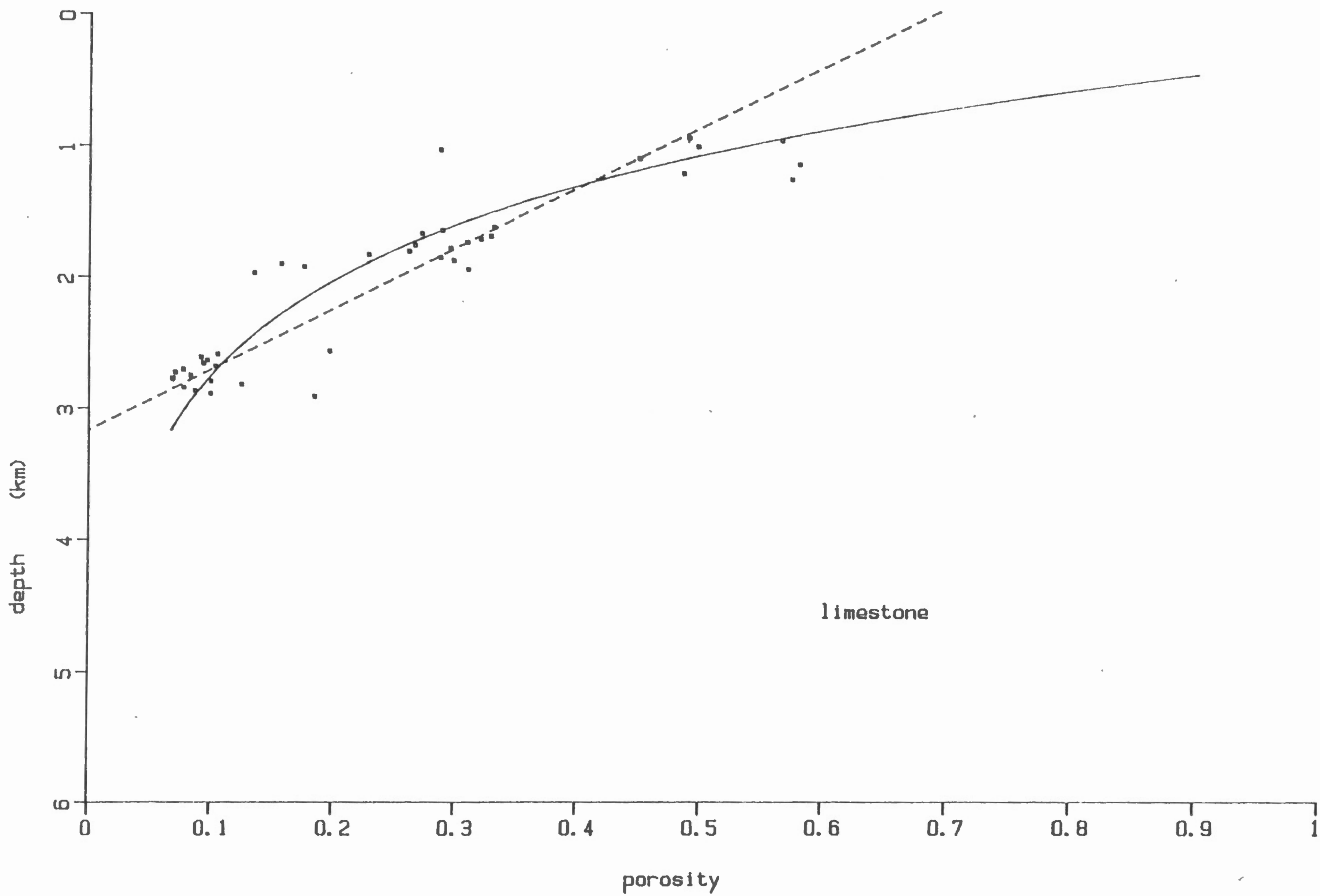
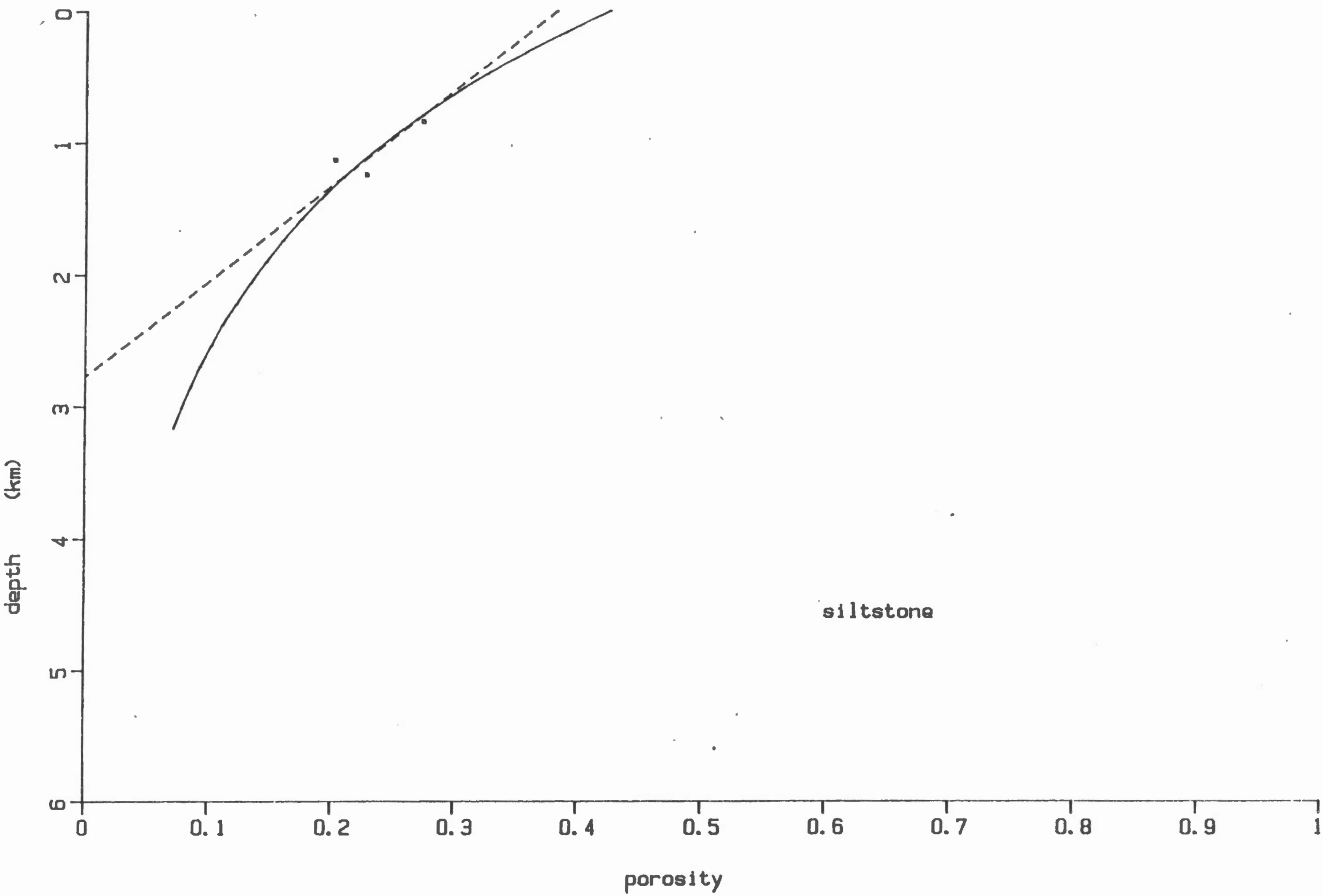


Fig. 2a.


0
1
2
3
4
5
6
depth (km)
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
porosity
limestone



depth (km)
0
1
2
3
4
5
6
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
porosity
siltstone

Fig. 2c.

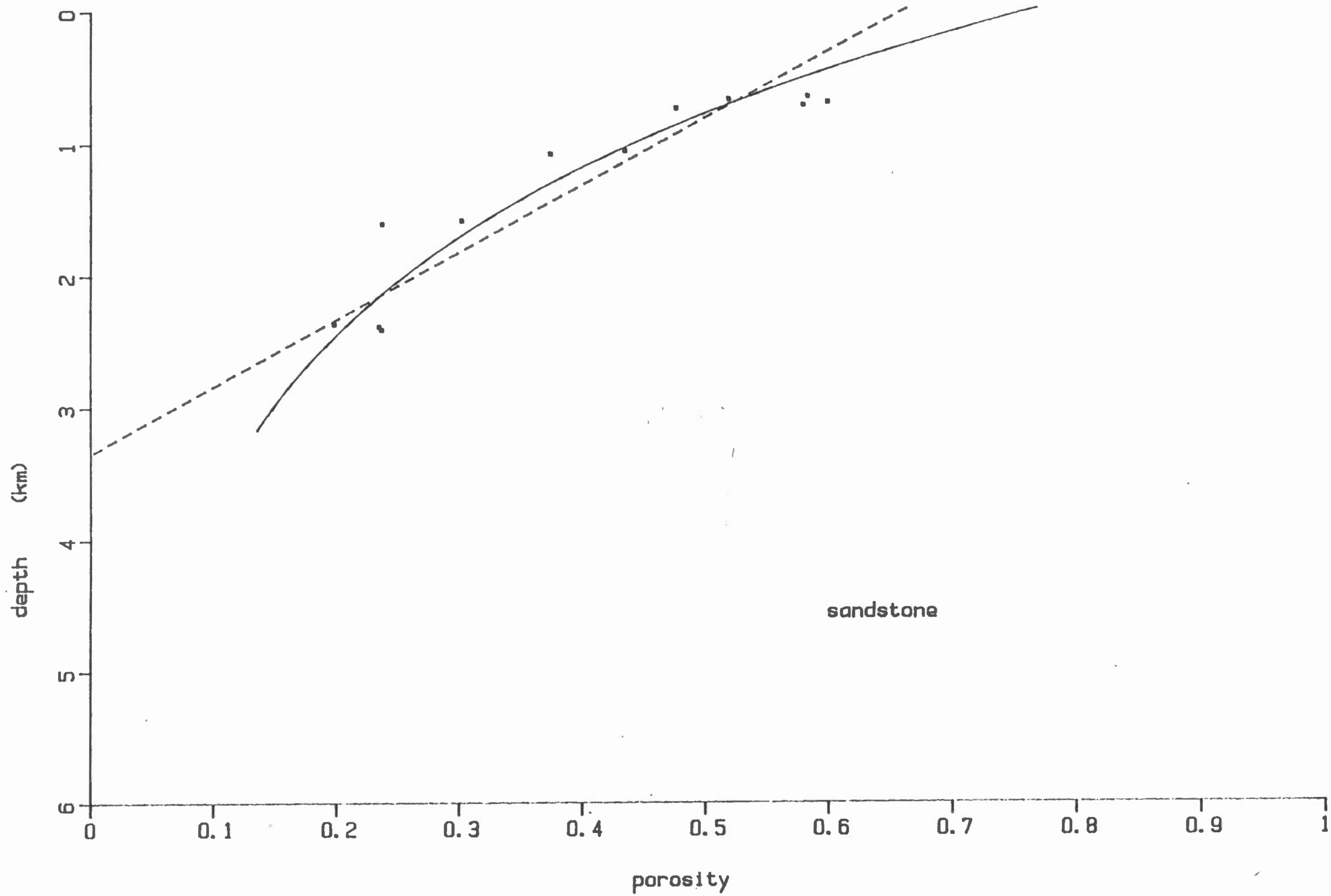
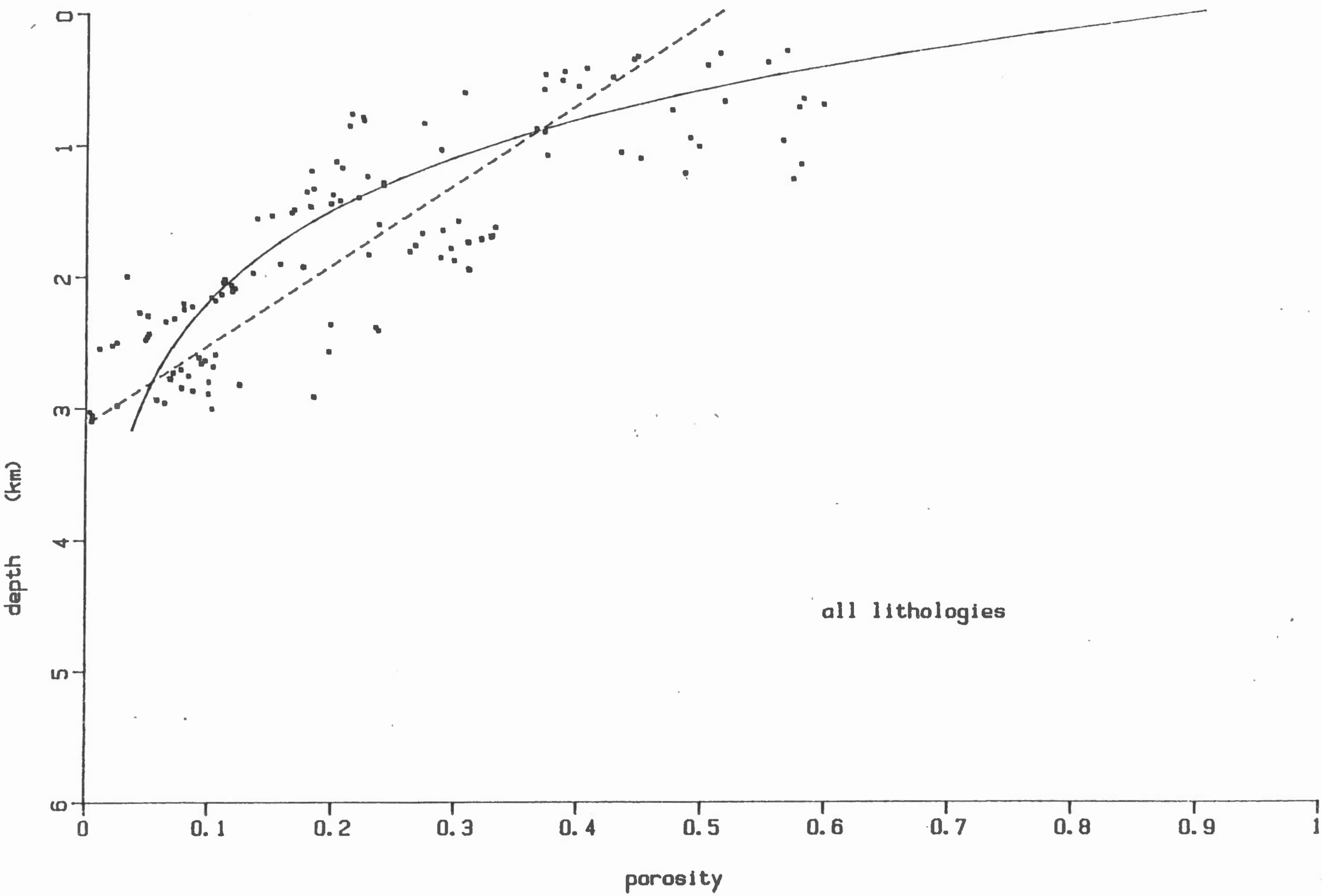
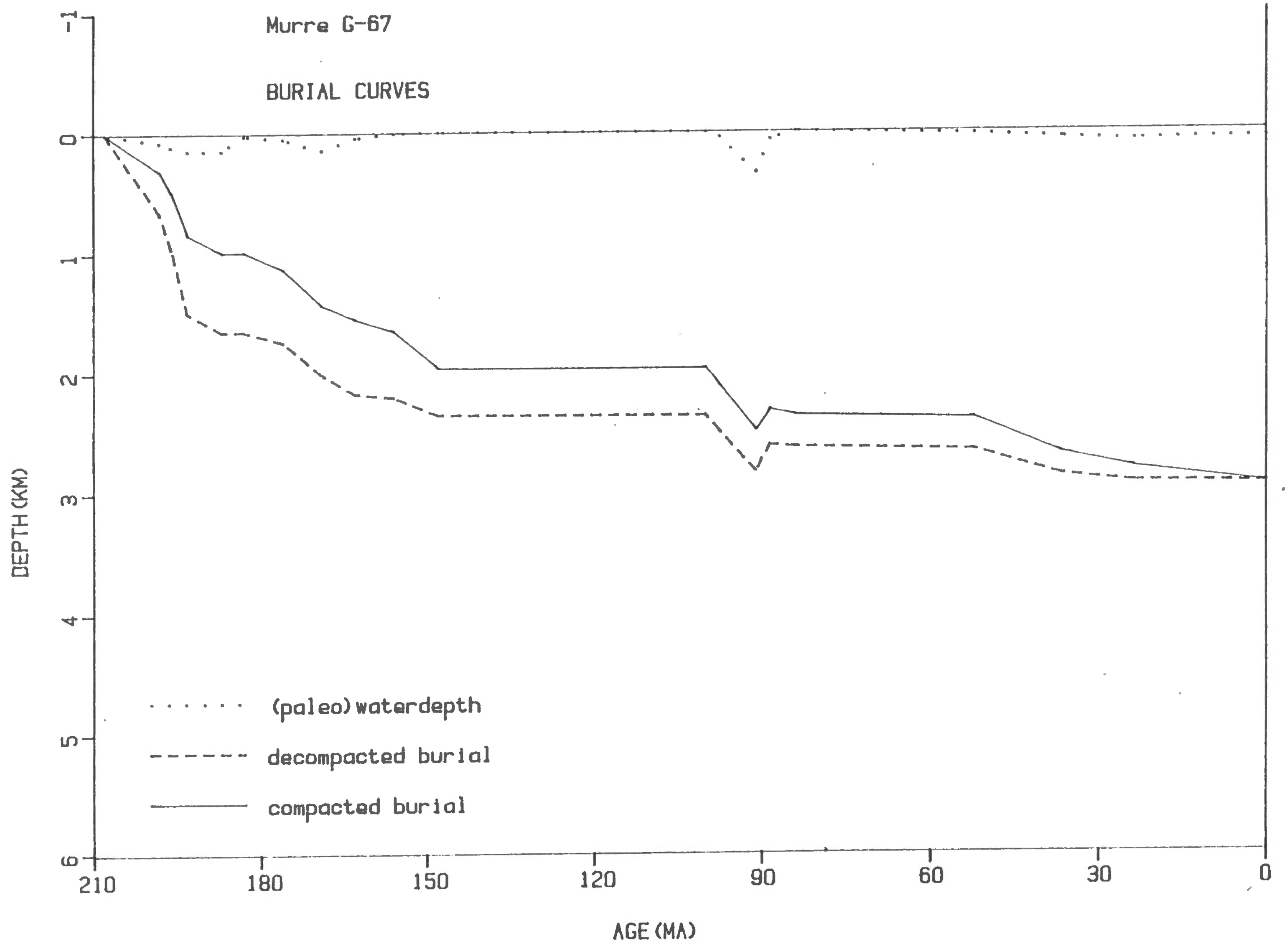

depth (km)
0
1
2
3
4
5
6
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
porosity
sandstone

Fig. 2d.



depth (km)
0
1
2
3
4
5
6
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
porosity
all lithologies

Fig. 2e.



Murre G-67
BURIAL CURVES
-1
0
1
2
3
4
5
6
DEPTH (KM)
210
180
150
120
90
60
30
0
AGE (MA)
(paleo) waterdepth
decompacted burial
compacted burial

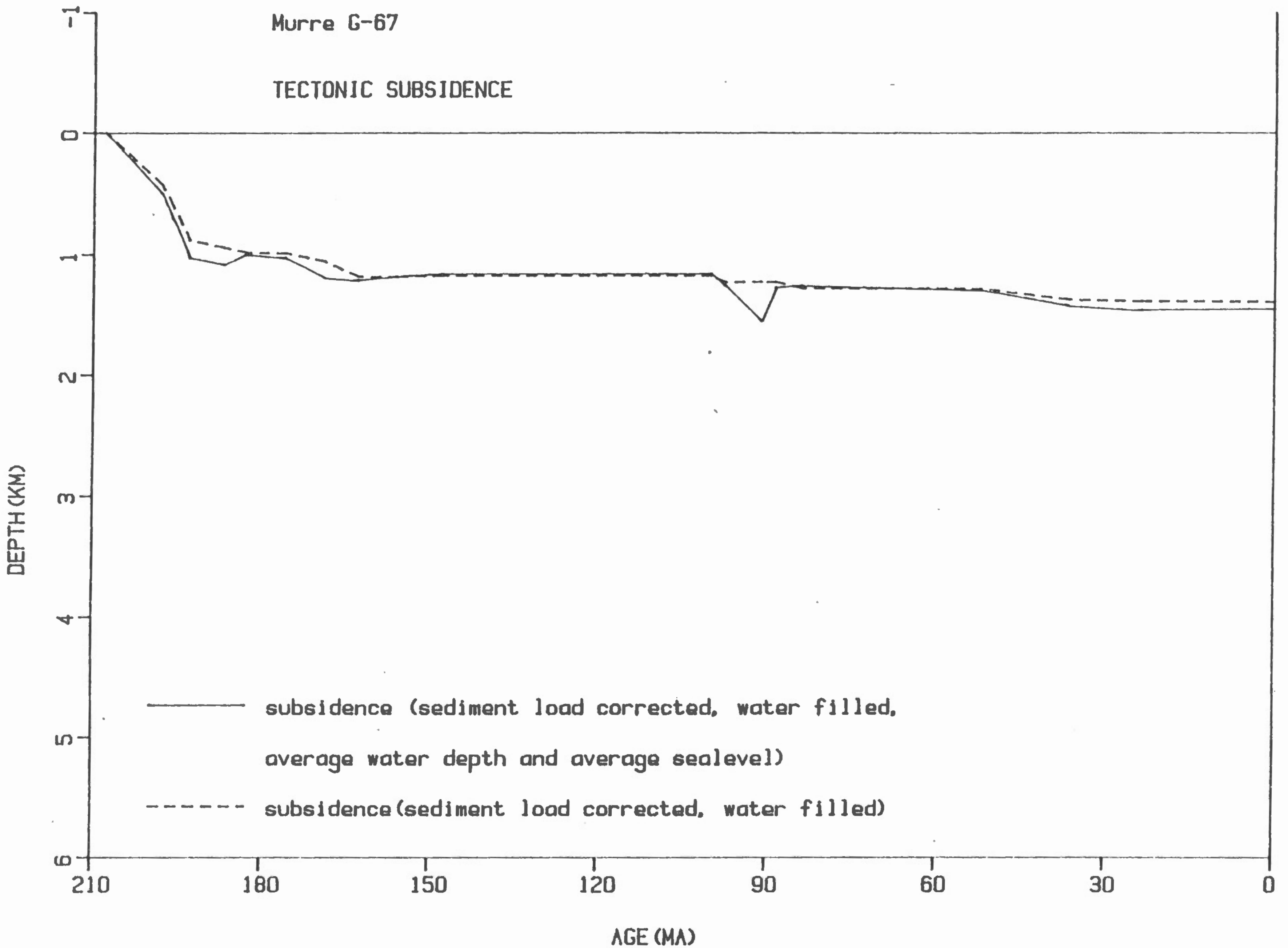

Murre G-67
TECTONIC SUBSIDENCE
DEPTH (KM)
-1
0
1
2
3
4
5
6
210
180
150
120
90
60
30
0
AGE (MA)
subsidence (sediment load corrected, water filled, average water depth and average sealevel)
subsidence (sediment load corrected, water filled)

Fig. 3b.

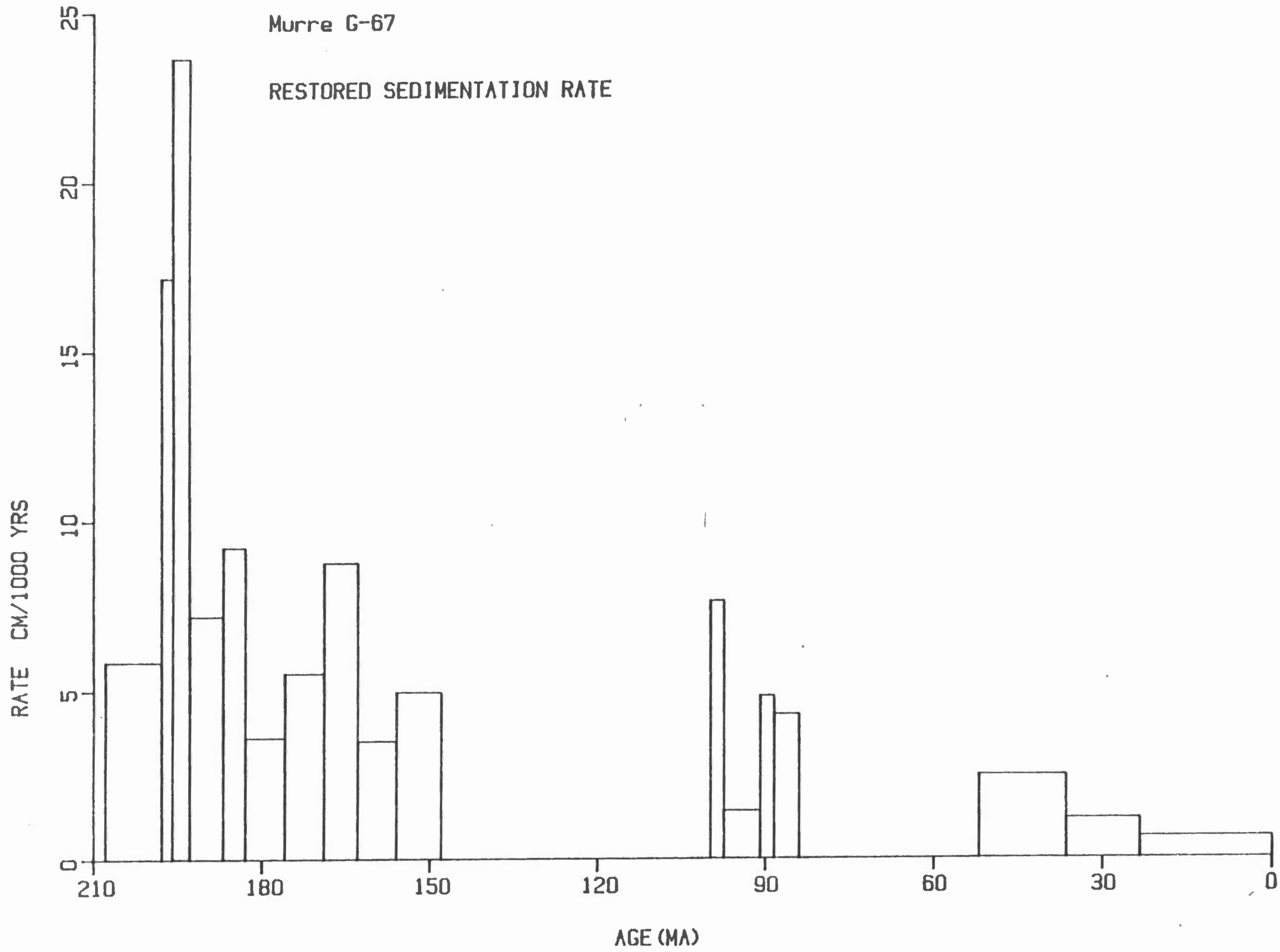
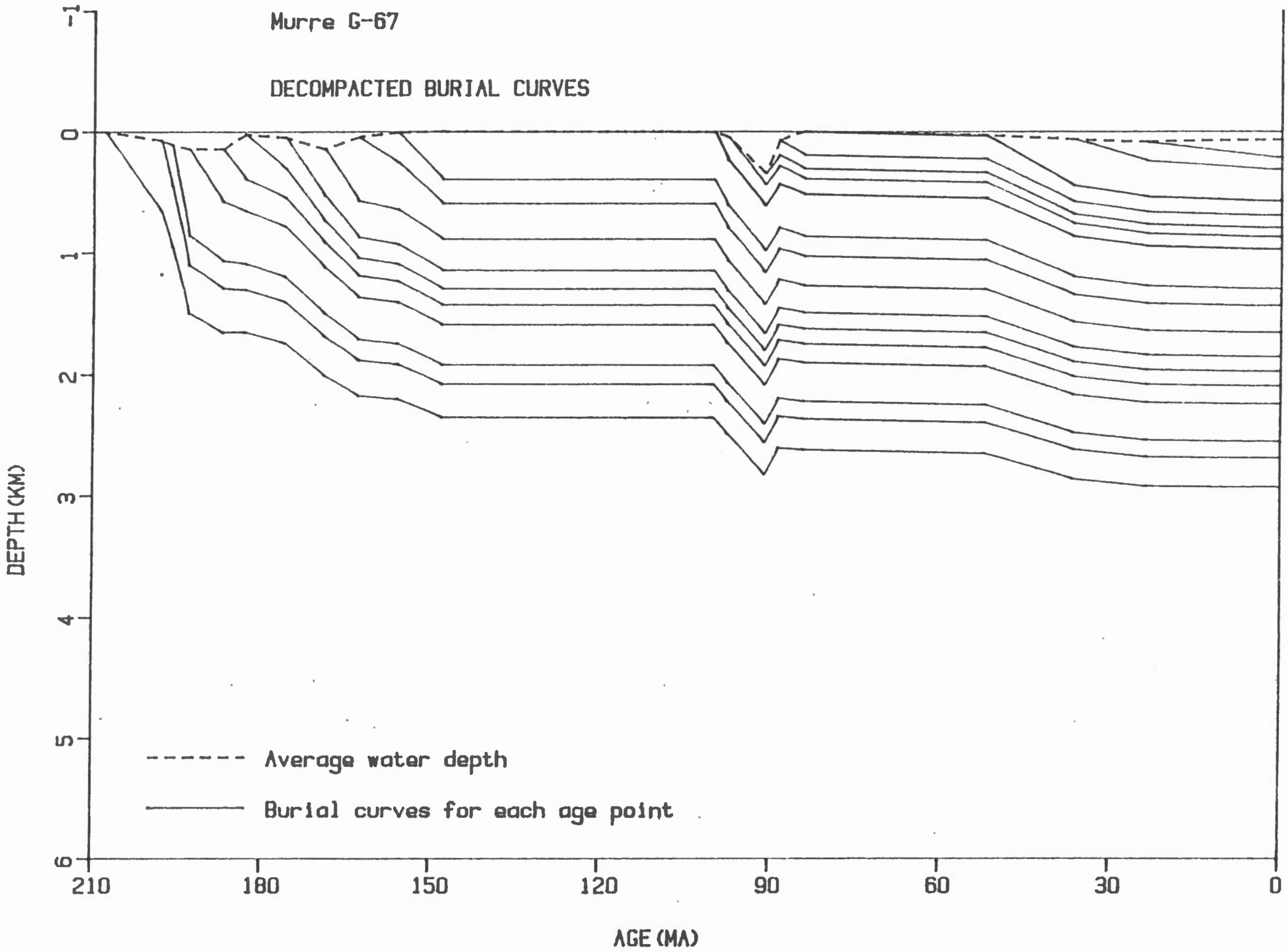
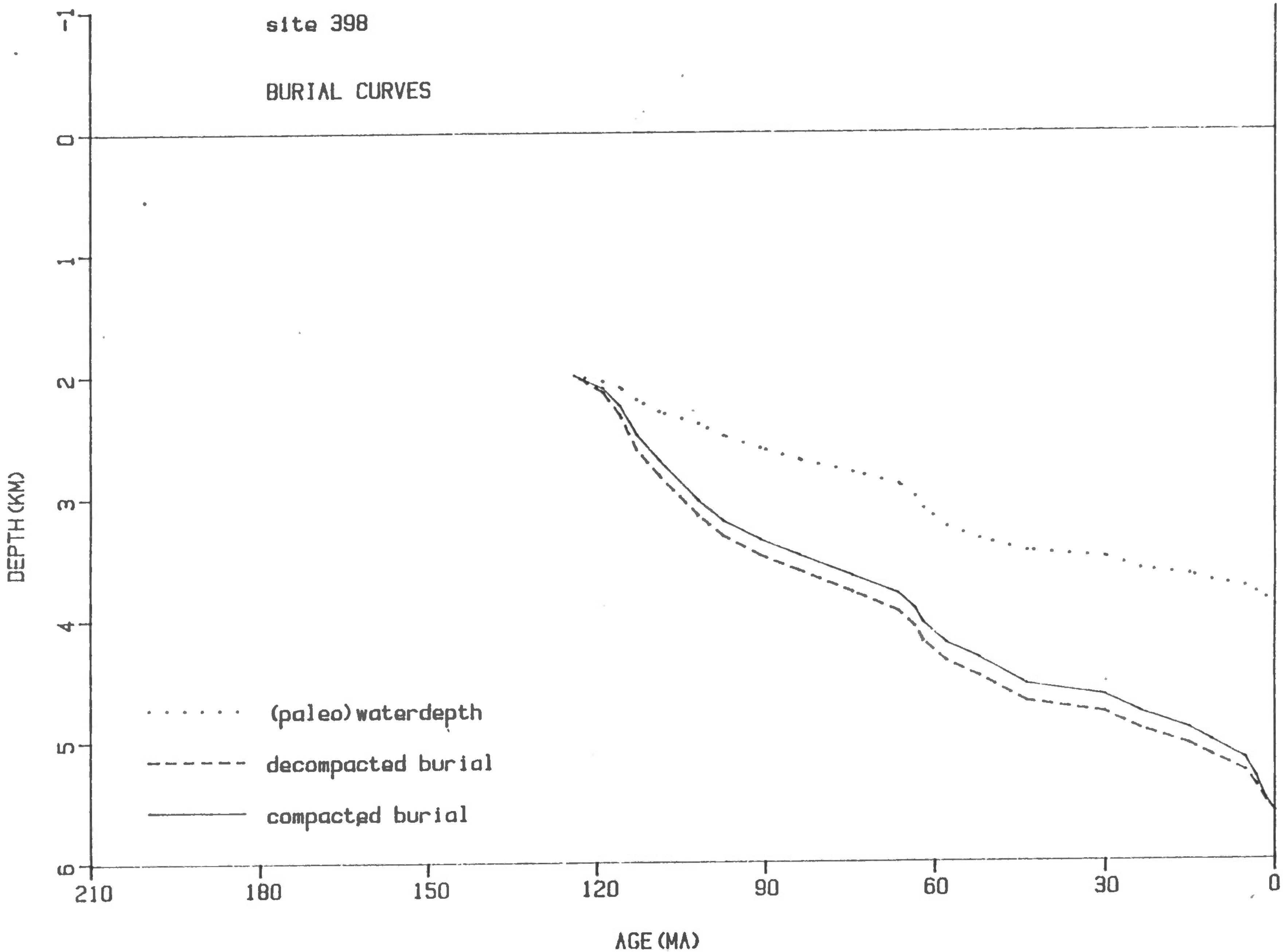

Murre G-67
RESTORED SEDIMENTATION RATE
RATE CM/1000 YRS
0
5
10
15
20
25
210
180
150
120
90
60
30
0
AGE (MA)

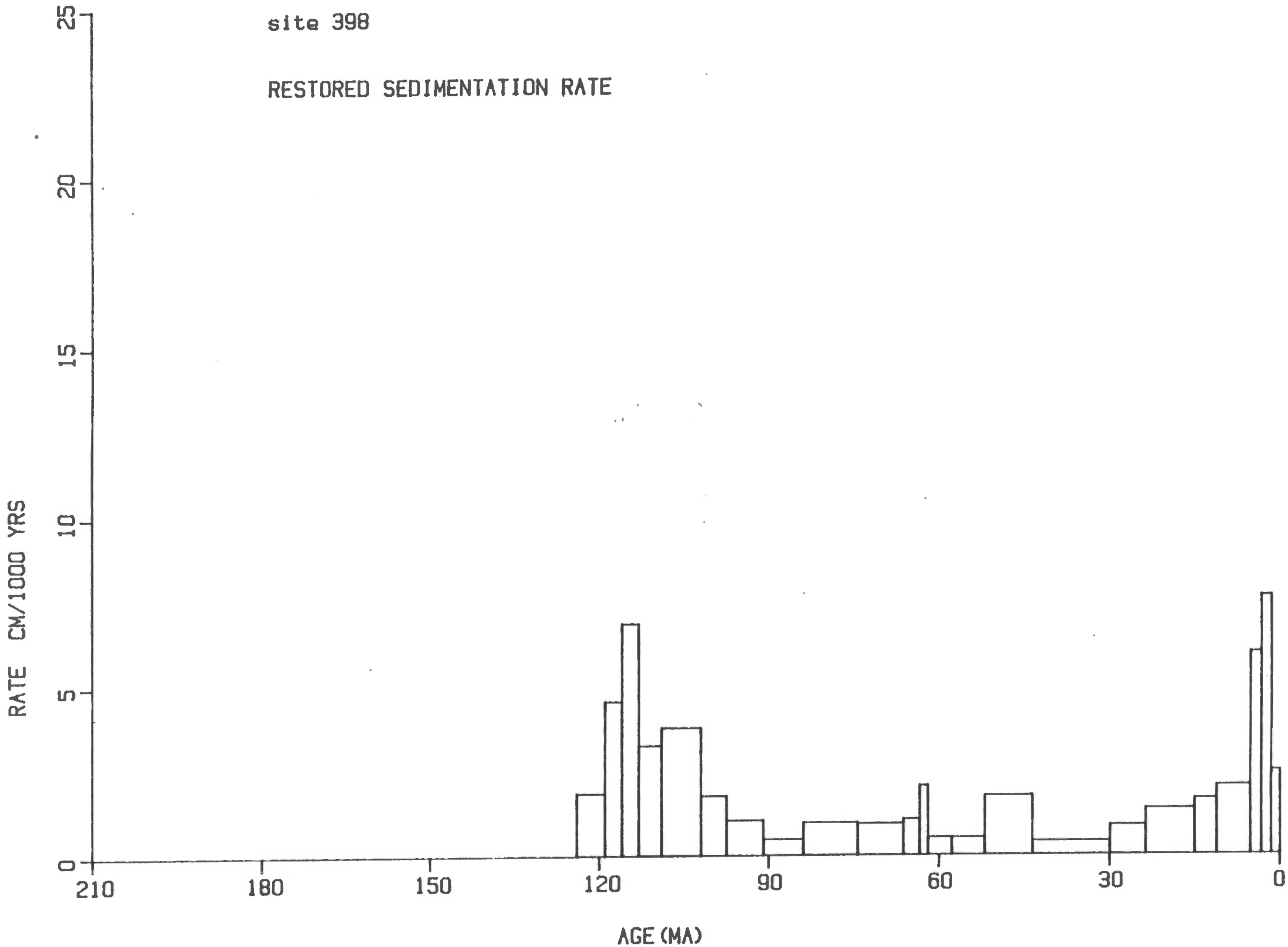
Fig. 3c.


Murre G-67
DECOMPACTED BURIAL CURVES
-1
0
1
2
3
4
5
6
DEPTH (KM)
210
180
150
120
90
60
30
0
AGE (MA)
Average water depth
Burial curves for each age point
Fig. 3d.



site 398
BURIAL CURVES
DEPTH (KM)
-1
0
1
2
3
4
5
6
(paleo) waterdepth
decompacted burial
compacted burial
210
180
150
120
90
60
30
0
AGE (MA)

Fig. 4a.



site 398
RESTORED SEDIMENTATION RATE
RATE CM/1000 YRS
0
5
10
15
20
25
210
180
150
120
90
60
30
0
AGE (MA)

Fig. 4b.