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BURIAL: A PROGRAM THAT CALCULATES AND PLOTS THE BURIAL HISTORY CURVES AND THERMAL MATURITY HISTORY OF A STRATIGRAPHIC SECTION

Abstract

Burial history diagrams and inferred thermal maturity history calculations of stratigraphic sections are widely used to graphically display burial histories and the timing of hydrocarbon generation.

Unlike most programs, BURIAL uses a data input format that describes depositional and erosional events as geological processes of equal importance in a manner that follows naturally from stratigraphic analysis. This program also allows for the disappearance of stratigraphic units at a distance from the active surface of the model. This enables the program to display subsurface salt dissolution, an important feature of the Western Canada Sedimentary Basin. The burial history computation is very simplified, considering only the decompaction of the clay/shale fraction of lithologies. The program has been designed to allow easy modification should users wish to employ more complex decompaction histories.

The commonly employed Time–Temperature Index is calculated using a steady state, piecewise time-varying conductive heat flux. Calculated values of this index can be plotted on the burial history diagram if the user so wishes. Because of the wide variety of hydrocarbon generation models and the uncertainty of correlation of hydrocarbon generation thresholds to the Time–Temperature Index, the interpretation of those thresholds is left to be performed manually.

Résumé

Les diagrammes d'historique d'enfouissement et les calculs d'historique de maturité thermique de sections stratigraphiques qui en découlent sont largement utilisés pour représenter graphiquement les historiques d'enfouissement et la période de formation des hydrocarbures.

Contrairement à la plupart des programmes, BURIAL utilise un format de données d'entrée qui décrit les phénomènes de vise en place et d'érosion comme des processus géologiques d'égale importance d'une façon qui découle naturellement de l'analyse stratigraphiques. Il tient aussi compte de la disparition d'unités stratigraphiques à une certaine distance de la surface active du modèle, ce qui lui permet d'afficher la dissolution de sel sous la surface, un élément important du bassin sédimentaire de l'Ouest canadien. Le calcul de l'historique d'enfouissement est très simplifié; il n'est basé que sur la décompaction de la fraction argile et schiste argileus des roches. Le programme est conçu de façon à pouvoir être modifié facilement dans le cas où les utilisateurs voudraient obtenir des historiques de décompaction plus complexes.

L'indice temps-température utilisé couramment est calculé à l'aide d'un flux de chaleur de conduction en régime permanent qui varie par morceaux en fonction du temps. Les valeurs calculées de cet indice peuvent être représentées sur le diagramme historique d'enfouissement si l'utilisateur le désire. Étant donnée la grand variété de modèles de formation d'hydrocarbures et l'incertitude de la corrélation des seuils de formation d'hydrocarbures avec l'indice de température en fonction du temps, l'interprétation de ces seuils doit être effectuée à la main.

INTRODUCTION

BURIAL is a FORTRAN 77 computer program that calculates and draws the burial history curves of stratigraphic sections. It calculates inferred thermal maturity for a stratigraphic section over the course of its burial history and can post the value of the associated inferred thermal maturity parameter on the burial history diagram. The data thus represented can then be used in the evaluation of potential petroleum source rocks. Other information provided by this program, such as the decompacted thicknesses of stratigraphic units and the thermal structure of rock sections through time, can be used in paleogeographic analyses and petrological studies, respectively.

Burial history diagrams plot the depth of stratigraphic units, for a single geographic locality, below the active surface of deposition or erosion, as a function of time. Such diagrams have been employed in studies of subsidence (van Hinte, 1978), coalification, and, more recently, in the study of the maturation of potential petroleum source rocks (Waples, 1980). Burial history diagrams are the primitive member of a family of time/position plots that are used in geological analysis. Geohistory diagrams are burial history diagrams in which the elevation of the active surface of deposition is inferred by the addition of the water depth of the depositional environment (van Hinte, 1978). Tectonic subsidence diagrams are used to plot the inferred elevation of a geological basement surface, as if it were unencumbered by sedimentary load, as a function of time (Bond and Kominz, 1984). Numerous discussions relating to the construction of these diagrams (Guidish et al., 1985; van Hinte, 1978), and their application to thermal maturation (Feinstein, 1981; Cercone, 1984; Nunn et al., 1984) and tectonic subsidence models (Bond and Kominz, 1984), appear in the literature.

STRATIGRAPHIC ANALYSIS AND THE BURIAL HISTORY MODEL

A burial history diagram is a simple illustration of the depositional history of a stratigraphic section. A plot of cumulative stratigraphic thickness as a function of geological time constitutes an initial step in the construction of a burial history diagram. Such a diagram would make use of the two most tangible pieces of information available from the stratigraphic section; that is, thickness and geological age. Assignment of absolute values to the geological ages of stratigraphic units and decompaction estimates constitute refinements to the diagram. More important is an understanding of the processes represented by hiatal surfaces in the section and their significance.

Stratigraphic analysis provides information concerning the occurrence of erosional, nondepositional or dissolution events in a given stratigraphic section (Wheeler, 1958). Other techniques, such as organic petrography and clay mineralogy, may assist in estimating the amounts of section removed at degradational vacuities. BURIAL assumes that the process of stratigraphic analysis is complete and that the results of that analysis have been used to formulate a list for the input data file comprising suitable stratigraphic units, their thicknesses, constituent rock types, and geological ages. The burial history model is a simple routine that portrays variations in thickness and depth of stratigraphic units as a function of time.

As units are buried they are compacted. During periods of uplift they essentially retain their thickness and degree of compaction. The present thickness of units reflects their maximum burial depth; units that have never been buried do not change in thickness. The "decompacted" thickness of a lithostratigraphic unit is an estimate of the thickness of a unit at times and depths preceeding maximum burial.

The compaction of sediments is a complex process affected by numerous factors. In a short review of the problem, Bond and Kominz (1984) suggested that the effects of diagenesis so complicated calculations of the porosity history of most rock types that only the mechanical compaction of clay shale fractions could be considered. A similar approach is followed in this program. Bond and Kominz (op. cit.) dealt only with old and compacted rocks. They assumed that the porosity of the clay shale fraction is uniquely a function of depth. Perrier and Quiblier (1974) suggested that mechanical compaction of shale is time dependent whereas Roll (see van Hinte, 1978) suggested that it is also a function of thickness.

Dzevanshir et al. (1986) proposed a porosity law for shales that is a function of depth, age, and proportion of shale. Both the age (A), and proportion of shale (R) terms are calculated in the decay constant of a porosity law that is an exponential function of depth (D). A pre-exponential factor, ϕ_o, is the porosity at zero depth:

$$\phi = \phi_o \exp \{-0.014(13.3 \log A - 83.25 \log R + 2.79) \times 10^{-3} D\} \quad (1)$$

Their porosity law is employed in this program, where the age of the layer is taken as the elapsed time from the age of deposition to the age at which the calculation is performed. The pre-exponential factor for the shale porosity law (shale porosity at zero depth = 0.4192) is taken from a regression line fit to compaction data of A. Roll (see van Hinte, 1978).

These assumptions may not be appropriate for certain stratigraphic sections. In cratonic platform successions, for example, calcium sulphate is commonly deposited as anhydrite in supratidal settings and the assumption of no mechanical compaction is reasonable. In deep subaqueous settings, characteristic of rifted basins, calcium sulphate is commonly deposited as gypsum and the neo-metamorphic dehydration reaction to anhydrite results in a significant reduction in volume (Schwerdtner and Osadetz, 1983). Appropriate compaction laws are considered necessary in such situations, and they are also desirable wherever the diagenetic histories of other rock types are sufficiently well understood.

The decompaction subroutine follows the method described by Bond and Kominz (1984, p. 155, 156) using the shale porosity law of Dzevanshir et al. (1986). A detailed account relating to the derivation of both the compaction coefficient and the decompaction subroutine is given in Appendix 1.

According to this methodology, stratigraphic units should be assigned to standard geological stages, series, and systems according to the specified systematic input format (Appendix 5; Table 2). The ages, epochs, and periods of stages, series, and systems are related to an absolute time scale found in an external data file (Appendix 6). The absolute ages of geological stages are taken from Harland et al. (1982). This file may be replaced by a file considered more appropriate to the regional stratigraphy of the area of investigation, without necessitating a change in the nature of the input data file. It may also be necessary to add ages to the file to accommodate additional geological events, particularly the erosion of several stratigraphic units during a single age.

THERMAL ENVIRONMENT OF BURIAL

The thermal structure of a given stratigraphic section as a function of time must be modelled prior to modelling the thermal maturity of the sediments. Thermal models usually consist of one or more time and depth invariant, geothermal gradients that may or may not be a function of depth (Waples, 1980). This program assumes a conductive steady-state model of heat flux where the flux is either time variant or invariant. Heat flow and surface temperature must be assigned for each geological event. Thermal conductivity of the sediments in each layer may be determined at various stages of compaction, and the geothermal gradient within a layer is the quotient of heat flux and thermal conductivity. Once an appropriate surface temperature is assigned, the variation of temperature with depth in the section is specified for a given time. The thermal conductivity of a stratigraphic layer is described in the model of rock thermal conductivity discussed in Appendix 2. Thermal conductivity is a function of the lithology and porosity of each layer. The porosity of the uncompactable rock fraction commonly controls the thermal conductivity of a layer and strongly affects the calculation of the inferred thermal maturity for the layer.

Further refinement of the thermal model may not provide significant improvement to the model because of the substantial amount of heat transfer accompanying water movement in certain basins (Majorowicz et al., 1985). It is probably more useful to correlate the inferred thermal maturity index by using an independent estimate of thermal maturation, such as vitrinite reflectance.

CALCULATION OF THE INFERRED THERMAL MATURITY OF SEDIMENTS

The Time-Temperature Index (TTI) of Waples (1980) is given in the following formula:

$$\mathrm{TTI} = \sum_{n_{min}}^{n_{max}} (\Delta t_i)\, r^{\,i} \qquad (2)$$

in which n_{max} and n_{min} are the n-values of the highest and lowest temperature intervals encountered (the 100-110° C interval is taken as the base interval with $n = 0$ assigned to it). Δt_i is the time in millions of years during which the sediment is found in a 10° C temperature interval, i, where $n_{min} \leq i \leq n_{max}$. r is an empirically determined factor. Waples (op. cit.) found that $r = 2$ is a reasonable value for most practical petroleum cases (i.e., the reaction rate doubles for every 10° C rise in temperature). This assumption suggests that the onset of significant petroleum generation can be characterized by a pseudo-first-order reaction with an activation energy of 19.69 kcal/mole. This assumption represents a practical geological solution to a difficult problem of chemical kinetics (Snowdon, 1979; Waples, 1983).

McKenzie (1981) suggested the following generalized continuous relation for the TTI:

$$\mathrm{TTI} = \int_{o}^{t} 2^{(T(t)-105)/10}\,dt \qquad (3)$$

The integration of the TTI integral is simplified because of the straight line interpolation of burial rate and heat flow between successive depths of a given stratigraphic unit (Appendix 3). However, the integration results in a singularity if there is no temperature change during a given time interval. There are several instances when this situation can be expected, either during periods of nondeposition or when the amount of erosion accompanying an unconformity is unknown. In such situations, the program employs the expression of Waples (1980). The Time–Temperature Index can be related to levels of coalification/vitrinite reflectance (Waples, 1980), and hence to thresholds of hydrocarbon generation (Powell and Snowdon, 1983). This program calculates both TTI and inferred vitrinite relectance (R_{omax}) values. The correlation of TTI to the logarithm of vitrinite reflectance is taken from Kalkreuth and McMechan's (1984) approximation of Waple's (1980) TTI and reflectance data:

$$\log R_{omax} = -0.4769 + 0.2801\,(\log \mathrm{TTI}) \; - \; 0.007472\,(\log \mathrm{TTI})^2 \qquad (4)$$

Issler (1984) discussed the limitations of this correlation between TTI and vitrinite reflectance. He concluded that inadequacies and errors in both the stratigraphic and heat flow models employed in the calculation influenced the value of the maturation parameter. As discussed below, the lithological model also has a strong influence on the value of the maturation parameter (Table 3).

PROGRAM DESCRIPTION

The source code is written in FORTRAN 77. The program was run on a Hewlett Packard 3000 computer with a MPEXL operating system. Computer drafting routines require a CALCOMP compatible plot library. A program source listing is provided in Appendix 4. A schematic logic flow-diagram is given in Figure 1.

The program is designed to be run interactively. An interactive job listing is provided in Appendix 7, and a sample output log file appears as part of the interactive job listing. A machine-drafted burial history diagram is given in Figure 2. The sample data set used to generate

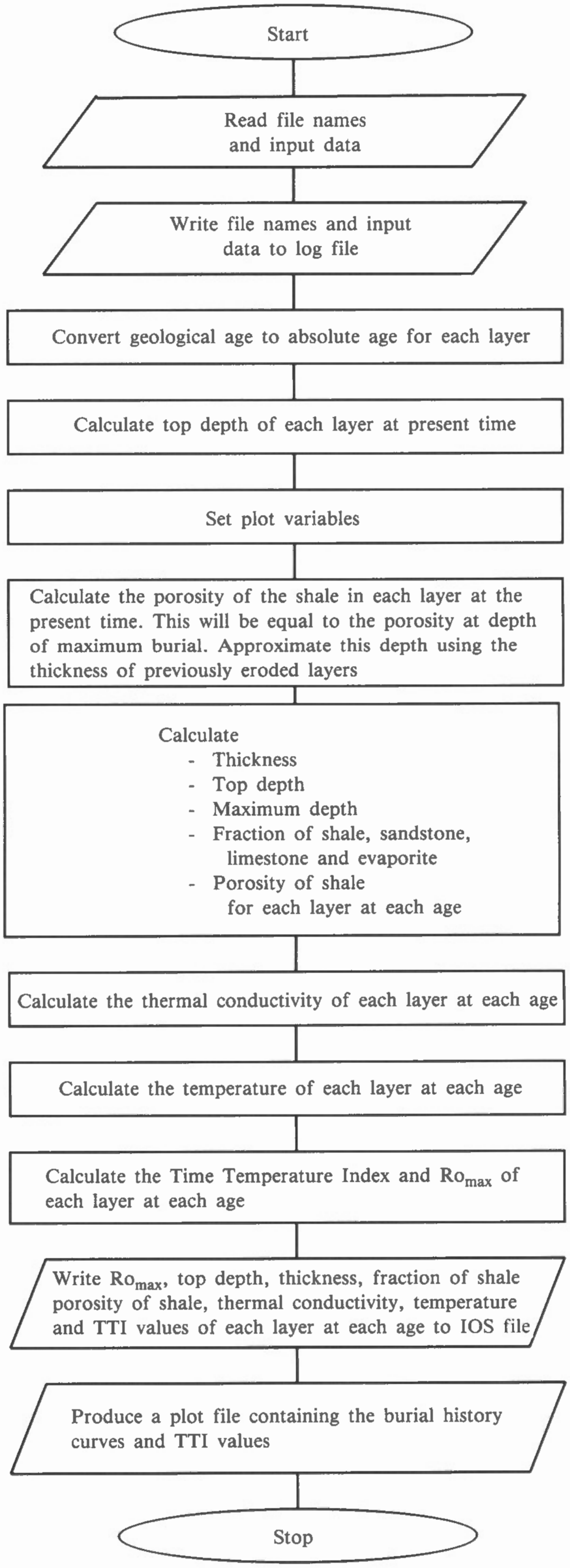

Figure 1. *Logic flow chart.*

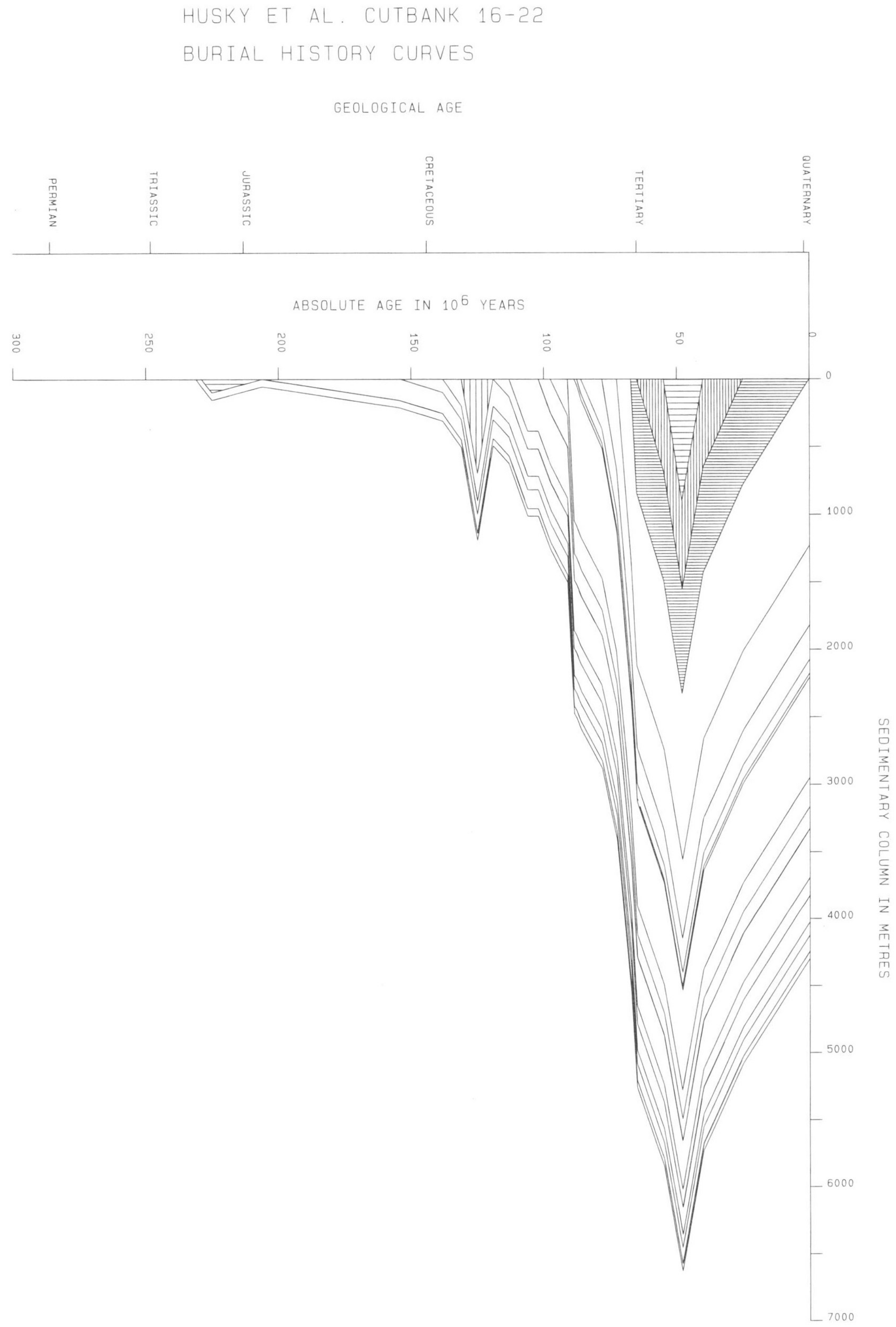

Figure 2. *Burial history diagram for Husky et al. Cutbank 16-22 well.*

Figure 2 is from a west-central Alberta well (Husky et al. Cutbank River, 16-22-63-10W6), described in the 1984 study by Kalkreuth and McMechan. Several additional lines were added to the standard geological age/absolute age assignment file (Appendix 6) in order to approximate the calculations of Kalkreuth and McMechan.

The base of the section, or the oldest stratigraphic intersection in a well, is the first layer in the set of input records. It has zero thickness. Succeeding stratigraphic units and erosional events are input, in order of decreasing geological age, as described below and in Appendix 5.

The program considers units currently observable in the section, as well as those that stratigraphic analysis suggests were present but which have since been eroded. Layers removed by erosion are hatched on the burial history diagram, using a routine modified from Yoeli (1982, section 5.1). The input data file contains a single record for each layer present in, or eroded from, the section. The computer program treats the erosion of a stratigraphic unit as a distinct geological event, requiring a line of input, characterized by zero thickness, specifying the age of the erosional event. It may be necessary, therefore, when building the input file, to divide natural stratigraphic units, such as formations, into those fractions either still present in the sedimentary section or those inferred to have been removed.

The program is sufficiently flexible to allow for the removal of sedimentary layers at any position in the stratigraphic succession, not just at the active surface of deposition or erosion. This capability can be used to display geological processes such as subsurface salt dissolution, an important feature of the Western Canada Sedimentary Basin. Subsurface salt dissolution is modelled in the same way as erosion, following the description below, except that the unit whose thickness changes to zero occurs below the active surface of erosion or deposition.

Layers that have been eroded are input as two records. The first record contains an estimated thickness of the eroded layer while the second, which shows zero thickness, represents the time at which the unit was eroded (see Table 2). An erosional event must be specified for each stratigraphic unit to be removed. Where thickness and lithological constitution of eroded layers are not estimated, the program may be run using only those layers currently comprising the section; however, in such cases, a loss of confidence in the shape of the burial history curve and the results of the maturation calculation is to be expected.

The input file contains two header records and serveral data records. The first header record contains the name of the well, which will be used for the title of the plot. The second header record contains 'M' or 'F' to indicate whether the input data is in metres or feet.

The rest of the file is composed of data records, which represent the stratigraphic layers in the section. There will be one data record for each sedimentary layer and erosion surface currently observable in the section, and two data records for each layer that has been removed by erosion – one representing its deposition and another representing its erosion.

Each data record contains eleven fields. Field one is the present thickness of the layer. Field two is a logical variable, which is true (T) if the geological event (a sedimentary layer or an erosion surface) is present in the section, and false (F) if the geological event (a sedimentary layer removed by erosion) is not currently observable in the section. Field three is a code that indicates the time at which a layer was removed (either by erosion or dissolution) from a section. The value assigned to this code corresponds to the number of a geological event (i.e., code 20 would refer to the 20th geological event in the data file). Layers still present in the section and erosion surfaces will have a code greater than the total number of geological event in the file. Layers removed by erosion will have a code equal to the number of the geological event representing the erosional event that removed the layer. (Note: Failure to correctly specify the value of this field was the main source of aborted program runs.)

Fields four to seven describe the lithological composition of the layer (i.e., the fraction of shale, sandstone, carbonate rock and evaporite). Field eight describes the fractional proportion of porosity in the uncompactable layers. Fields nine and ten contain the boundary conditions of the thermal environment (i.e., the surface heat flux and the surface temperature). Field eleven contains the geological age of the event. The input format for these fields is described in Appendix 5.

Both the input data file and the geological age data file must be built before the program is run. A sample geological age datafile is provided in Appendix 6. Like the input datafile, the absolute age assignment file is in descending order. Where the absolute values of geological ages are equal, the records in the absolute age assignment file should be arranged according to the following hierarchy: Age, Epoch, Period, Era, Eon. The absolute value of a geological age represents the upper limit of the respective Age, Epoch, Period, etc. The subdivision of natural lithostratigraphic units into "portions eroded" and "portions remaining" may necessitate the addition of ages to the geological age data file.

During a run of the program, the program will prompt for the names of: the input data file, the geological age file, a plot file, and an output log file (Appendix 7). The program will display the default values for the burial history diagram plotting routines, and give the user the opportunity to change these parameters. Where complex burial histories and significant amounts of compactible shale are involved, the program may underestimate the maximum depth to which the section extends. Failure to specify an adequate maximum depth on the burial history diagram will result in an error message and termination of the program.

Posting of Time–Temperature Index (TTI) values can be suppressed with the appropriate response at the Time–Temperature Index prompt. Given the fact that inferred thermal maturity of sediments on either side of an unconformity may differ greatly, the program has been designed to plot the TTI of the units above and below an unconformity separately. Because of potential discontinuities in the inferred thermal maturity of sediments across unconformities, the placement of subjective thresholds (i.e., the oil window) is left to be drawn on the burial history diagram by hand.

Both the decompaction subroutine and the thermal structure calculations rely upon assumed values of physical constants. Of particular interest to users are the pre-exponential factor decay constant of the shale porosity law and the rock matrix thermal conductivities. Users of this program may wish to use alternative estimates for the pre-exponential factor in the decompaction subroutine by altering program line 1201. They may also wish to employ their own estimates of rock matrix thermal conductivities by altering program lines 591-595, if these data are available to them.

Details of an interactive program run and the accompanying output log file are in Appendix 7. The output contains two initial fields in each output record that identify the layer and geological event for which the remaining fields are appropriate. The remaining fields describe the following attributes of the layer at the specified time: depth to the top of the layer (in metres), its thickness (in metres), the fraction of the layer's thickness that is shale and the porosity of the shale in the layer, the thermal conductivity of the layer (milliWatts/metre degree), the temperature at the top of the layer (in °C), and the Time–Temperature Index at the top of the layer. The burial history diagram is a machine-drafted drawing of depth to the top of each unit as a function of time, onto which the Time–Temperature Index values may be superimposed (Fig. 2). Units removed by erosion are cross-hatched for easy recognition.

SAMPLE CALCULATION

Accurate construction of the input datafile is essential to the successful execution of the program. The following discussion, though simple, provides a step-by-step description of the sample plot (Fig. 2). Consider the Husky et al. Cutbank River (16-22-63-10W6) well described in the 1984 study by Kalkreuth and McMechan. The stratigraphic section of Late Triassic and younger strata is displayed in Table 1 (M. McMechan, pers. comm., 1986; Anon., 1978, 1981). The section, particularly the Upper Cretaceous succession, is generally conformable. There are several significant unconformities. The ages of erosional intervals are derived from regional stratigraphic analysis (Poulton, 1984; Stott, 1984). Amounts of strata eroded are estimated (M. McMechan, pers. comm., 1986) and are indicated in Table 1. Various combinations of stratigraphic units are then assigned to stages (Caldwell et al., 1978; Poulton, 1984). Following correlation with standard stages, the stratigraphic analysis is complete and the geological events represented in the section can be identified. Suitable descriptions of the lithology for each stage and specification of the surface temperature and heat flow for each age provide sufficient information to establish an input data file (Table 2). In these examples, the lithological models are crude approximations. Two models, using different uncompactable matrix porosities, were used and the inferred Ro values for each model appear in Table 3. Table 3 illustrates the dependence of the inferred thermal maturity model on the suitability of the lithological model. Variations in estimation of heat flow and surface temperature can have similar effects on the inferred thermal maturity calculation.

When estimates of the thickness of strata eroded are available, two input records are required. The first represents the thickness of strata eroded and the time at which deposition was completed. The second input record indicates the time at which the erosion of these

TABLE 1

Stratigraphic section, Husky et al. Cutbank 16-22-63-10W6 well

Unit	Original Thickness (m)	Present Thickness (m)	Age
-- present erosion surface			
Lower Eocene sediments	0900.0	0000.0	Early Eocene
Paleocene sediments	0650.0	0000.0	Paleocene
Upper Wapiti Fm.	2010.0	1230.0	Maastrichtian
Lower Wapiti Fm.	0590.0	0590.0	Campanian and Maastrichtian
Puskwaskau Fm.	0254.5	0254.5	Santonian and Campanian
Badheart Fm.	0104.0	0104.0	Santonian
Muskiki Fm.	0029.6	0029.6	Coniacian
Kaskapau Fm. (includes Cardium Fm. equiv.)	0742.4	0742.4	Cenomanian and Turonian
Dunvegan Fm.	0120.5	0120.5	Cenomanian
Shaftesbury Fm.	0233.5	0233.5	Late Albian and Cenomanian
Paddy Member/Peace River Fm.	0024.0	0024.0	Late Albian
--------------------------- sub-Paddy Member unconformity			
Cadotte Member/Peace River Fm.	0024.0	0024.0	Middle Albian
Harmon Member/Peace River Fm.	0036.0	0036.0	Middle Albian
Spirit River Fm.	0305.0	0305.0	Albian
Bullhead Group	0132.5	0132.5	Barremian to Early Albian
----------------------------- sub-Cadomin Fm. unconformity			
Minnes Group (less Monteith Fm.)	0900.0	0200.0	Neocomian
Monteith Fm.	0100.0	0100.0	Late Jurassic and Neocomian
Upper Fernie Fm.	0103.4	0103.4	Late Middle and Late Jurassic
----------------------------- sub-"Green beds" unconformity			
Lower Fernie Fm.	0017.0	0017.0	Early Jurassic
--------------------------------- sub-Fernie Fm. unconformity			
Whitehorse Member/Spray River Fm.	0154.9	0054.9	Carnian

strata was completed. Estimates of the stratigraphic thickness eroded before deposition of the Nordegg Member, the Bullhead Group, and following the end of molasse sedimentation in the Eocene (estimated by M. McMechan, pers. comm., 1986) have been made. Strata removed by erosion are indicated by the letter "F" in the second field of input records. The third input field contains the number of the input record (i.e., geological event) that produced erosion of the unit. Strata removed by erosion also have matching input records, signifying the erosional events during which they were removed. These erosional events are represented in the input file by imaginary units of zero thickness (Table 2).

Firstly, as an illustration, consider that portion of the Whitehorse Member of the Spray River Formation removed by érosion prior to deposition of the Nordegg Member of the Fernie Formation (Jurassic). Deposition of the Whitehorse Member is inferred to have ended in the Carnian. The age of the top of the Whitehorse Member still present in the well is estimated to be proportional to the ratio of preserved thickness to total thickness of Whitehorse Member that was initially deposited. This information is entered as part of input record 2. The second and third fields of this record are "T" and "27", indicating that the unit is present in the well. The thickness of the strata eroded is entered as input record 3. The second and third fields of this record are "F" and "04", respectively, indicating that the unit was removed by erosion by the end of geological event 4. Input record 4 represents erosion of that portion of the Whitehorse Member deposited at geological event 3, later in the Carnian. One might consider that input record 4 represents the erosion surface at the base of the Jurassic System. This surface has zero thickness and is present in the section today. For this reason, fields 2 and 3 of input record 4 are "T" and "27", respectively. Together, these three input records

TABLE 2

Building the input datafile, Husky et al. Cutbank 16-22-63-10W6 well

Event No.	Description of Event	Thickness (metres)	Contact format and age
1.	Base of the well	0000.0	T27 Middle Triassic
2.	Whitehorse Member deposition (part remaining)	0054.9	T27 Age2290
3.	Whitehorse Member deposition (part eroded)	0100.0	F04 Carnian
4.	Erosion of Whitehorse Member (sub-Fernie unc.)	0000.0	T27 Hettangian
5.	Fernie Fm. deposition	0120.4	T27 Age1540
6.	Monteith Fm. deposition	0100.0	T27 Berriasian
7.	Upper Minnes Group deposition (part remaining)	0200.0	T27 Valangian
8.	Upper Minnes Group deposition (part eroded)	0700.0	F09 Hauterivian
9.	Erosion of Minnes Group (sub-Cadomin Fm. unc.)	0000.0	T27 Barremian
10.	Bullhead Group deposition	0132.5	T27 Aptian
11.	Spirit River Fm. to Cadotte Mbr. deposition	0365.0	T27 Age1060
12.	Sub-Paddy Member unconformity	0000.0	T27 Age1020
13.	Paddy Member to lower Shaftesbury Fm. deposition	0163.0	T27 Albian
14.	Upper Shaftesbury Fm. and Dunvegan Fm. deposition	0215.0	T27 Cenomanian
15.	Kaskapau Fm. deposition	0742.4	T27 Turonian
16.	Muskiki Fm. deposition	0029.6	T27 Coniacian
17.	Badheart Fm. deposition	0104.0	T27 Age0860
18.	Puskwaskau Fm. deposition	0254.5	T27 Age0780
19.	Lower Wapiti Fm. deposition	0590.0	T27 Age0725
20.	Upper Wapiti Fm. deposition (part remaining)	1230.0	T27 Age0672
21.	Upper Wapiti Fm. deposition (part eroded)	0780.0	F26 Cretaceous
22.	Paleocene deposition (entirely eroded)	0650.0	F25 Paleocene
23.	Early Eocene deposition (entirely eroded)	0900.0	F24 Age0480
24.	Erosion of Eocene sediments (time inferred)	0000.0	T27 Age0400
25.	Erosion of Paleocene sediments	0000.0	T27 Age0250
26.	Erosion of Wapiti Fm. (present outcrop)	0000.0	T27 Present

represent the deposition and erosion of the Whitehorse Member. Subsequent burial and uplift of the Spray River Formation is represented by successive geological events in the input file.

Secondly, consider the erosional and non-depositional event that occurred between the Paddy and Cadotte members of the Peace River Formation. No estimate of the amount of strata removed by erosion at this unconformity has been made, although at least one foraminiferal assemblage zone present in strata elsewhere in the basin is missing (Caldwell et al., 1978, Fig. 2). Because no estimate of the amount of strata eroded has been made, no record representing the eroded portion of the Cadotte Member can be input. The erosion surface at the base of the Paddy Member is input, therefore, as a unit of zero thickness.

Finally, consider a situation where the presence of an unconformity is ignored. A considerable lacuna separates the Nordegg Member from the overlying Fernie Formation shales (Poulton, 1984). In the sample data set, this characteristic of the Jurassic System has been ignored and continuous deposition has been assumed. One input record representing the total thickness of Nordegg and Fernie strata is present. This represents a simplification of the stratigraphic model. It may be considered acceptable where eroded strata are thin and contribute little to the overall thermal maturity of the section. Such a simplification does, however, result in decreased reliability of the model. Input records of other units follow the format discussed above. The stratigraphic model used here (Appendix 5) suitably approximates the observed thermal maturity in the well (Kalkreuth and McMechan, 1984, Fig. 8). An improved approximation can be obtained by varying either the lithological or thermal model of the well.

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TABLE 3

Illustration of the dependence of the thermal maturity[i] model on the lithological model

Layer No.	%R_O Model No. 1	%R_O Model No. 2[ii]
1	3.15	1.99
2	3.09	1.95
3	3.09	1.95
4	3.09	1.95
5	2.95	1.86
6	2.81	1.80
7	2.55	1.67
8	2.55	1.67
9	2.55	1.67
10	2.39	1.59
11	2.01	1.38
12	2.01	1.38
13	1.88	1.29
14	1.70	1.19
15	1.23	0.85
16	1.21	0.84
17	1.15	0.80
18	1.02	0.71
19	0.76	0.56
20	0.39	0.32
21	0.25	0.23
22	0.18	0.18
23	0.15	0.15
24	0.14	0.14
25	0.13	0.13
26	0.00	0.00

[i] Inferred values of vitrinite reflectance (%R_O) using equation (2) in the text. Matrix porosity of sandy layers = 0.20. See Appendix 5 for other input variables.

[ii] Inferred values of vitrinite reflectance (%R_O) using equation (2) in the text. Matrix porosity of sandy layers = 0.00. All other input variables are identical to Model 1.

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APPENDIX 1

Compaction coefficient and decompaction subroutine

The compaction coefficient is used to relate the thickness of layer i, at time j, $H_{(i,j)}$, to the thickness of the same layer at the present time, p, $H_{(i,p)}$.

$$H_{(i,j)} = (\text{compaction coefficient})\ H_{(i,p)}$$

The thickness of the i^{th} stratigraphic layer is the sum of the thicknesses of both the uncompactable, $H_{inc(i,j)}$, and compactable (shale), $H_{shale(i,j)}$, lithologies:

$$H_{(i,j)} = H_{inc(i,j)} + H_{shale(i,j)}$$

If $X_{shale(i,j)}$, is the fraction of shale beds in the i^{th} layer at time j, then,

$$H_{shale(i,j)} = H_{(i,j)}(X_{shale(i,j)})$$

$H_{shale(i,j)}$ is composed of a porous fraction, $\Phi_{shale(i,j)}$, and an uncompactable rock matrix fraction, $(1\text{-}\Phi_{shale(i,j)})$. Because compaction is an irreversible process, $\Phi_{shale(i,p)}$ can be estimated using the maximum burial depth of the i^{th} layer. The estimation of $\Phi_{shale(i,p)}$ using compacted thicknesses, as an estimate of maximum burial depth, commonly results in an error less than one per cent of the decompacted thickness. For reference, see the CWLLPHIS Subroutine (program line range 673/765). We assume the thickness of the uncompactable clay matrix will not change through time. Upon substitution,

$$H_{shale(i,j)} = \Phi_{shale(i,j)}(H_{shale(i,j)}) + (1\text{-}\Phi_{shale(i,p)})(H_{shale(i,p)})$$

simplifies to,

$$H_{shale(i,j)} = (H_{shale(i,p)})(1\text{-}\Phi_{shale(i,p)})/(1\text{-}\Phi_{shale(i,j)})$$

Hence,

$$H_{(i,j)} = H_{(i,p)}(1 + X_{shale(i,p)})[(1\text{-}\Phi_{shale(i,p)})/(1\text{-}\Phi_{shale(i,j)})\text{-}1)]$$

which allows for the solution of the thickness of the layer at any time during progressive burial. This relation simplifies to the one used by Bond and Kominz [1984, equation A-7 (from which a set of brackets is missing)], if the present porosity of the shale, $\Phi_{shale(i,p)}$, is zero.

The decompaction subroutine, DELITH (program line range 923/967), follows the method described by Bond and Kominz (1984). The subroutine continues to decompact the shale until the porosity of the shale fraction changes by less than two tenths of one per cent between iterations. The expression that gives the value of the porosity of the shale fraction as a function of depth is:

$$\Phi_{shale(i,j)} = \text{-}\{0.4192/(D_{bottom}\text{-}D_{top})\} - \{e^{\text{-}D_{bottom}} - e^{\text{-}D_{top}}\}$$

where D_{bottom} and D_{top} are the products of the decay constant of the porosity law (Dzevanshir, Buryakovskiy, and Chilingarian, 1986) and the depths of the base and top of the layer, respectively. The pre-exponential factor of the porosity law arising from the data of A. Roll (see van Hinte, 1978) is equal to 0.4192. Users may wish to use their own porosity law by making substitutions to the porosity calculation subroutine, PHICALC (program lines 1189/1208).

APPENDIX 2

Thermal conductivity as a function of lithology

This program determines the thermal conductivity of a layer at a specific time as a function of lithology and porosity using the relationships indicated by Sass et al. (1971). If there are 'n', lithological constituents in a stratigraphic unit, each occupying a volume fraction v_i, and having a thermal conductivity, K_i, then the thermal conductivity of the stratigraphic unit, K_{layer}, will be:

$$K_{layer} = \pi_i K_i^{v_i}$$

and, if each constituent has a porosity Φ_i:

$$K_i = K_{rock\ matrix}^{(1-\Phi_i)} * K_{water}^{(\Phi_i)}$$

We assume that the porosity of the uncompactable rock fraction does not vary with time. The porosity of the shale fraction, as a function of time, is calculated by the decompaction subroutine, DELITH. Evaporites are assumed to have no porosity.

It is necessary to estimate the matrix conductivity of each of the constituent rock types. The determination of matrix thermal conductivity for a given rock type is not a straightforward task (Evans, 1977; Goss et al., 1975). In this program the rock matrix thermal conductivities of both carbonates and shales were determined using the mean values of observed rock porosities and measured thermal conductivities (Marjorowicz et al., 1984). The thermal conductivities of other rock types were determined using the relationship proposed by Evans (1977) and standard rock properties with respect to observed rock thermal conductivities. For reference, see the CTEMPVAR (program line range 596/613).

APPENDIX 3

Solution of the Time–Temperature Integral

From McKenzie (1981) we have:

$$\mathrm{TTI} = \int_{o}^{t} 2^{(T(t)-105)/10} dt$$

Where the temperature, T, is a function of time, t, and:

$$\frac{dT}{dt} = \frac{dT}{dZ} \bullet \frac{dZ}{dt} \text{, where Z is the depth}$$

Now

$$\frac{dT}{dt}\text{, the rate at which the temperature changes with depth}$$

and

$$\frac{dZ}{dt}\text{, the burial rate}$$

are assumed constant between two geological events. Therefore,

$$\int_{T_1}^{T_2} dT = \int_{t_1}^{t_2} \frac{dT}{dZ} \bullet \frac{dz}{dt} dt$$

can be simplified to

$$\int_{T_1}^{T_2} dT = \int_{t_1}^{t_2} \frac{\Delta T}{\Delta t} dt$$

where ΔT is the change in temperature and Δ is the elapsed time between two successive geological events identified in the program's input datafile.
Because they are constant over that interval, we obtain

$$\frac{\Delta t}{\Delta T} \int_{T_1}^{T_2} dT = \int_{t_1}^{t_2} dt$$

which can be substituted into the TTI expression as long as the integration is done piecewise over intervals of constant Δt and ΔT

$$\mathrm{TTI} = \sum_{J=1}^{n} \frac{\Delta tj}{\Delta Tj} \int_{T_{j-1}}^{T_j} 2^{(T-105)/10} \, dT$$

upon integrating

$$\mathrm{TTI} = \sum_{J=1}^{n} \frac{\Delta tj}{\Delta Tj} \left\{ \frac{2^{(T_{j-1}-105)/10}}{\mathrm{In}\ 2^{1/10}} \bullet (2^{(Tj-Tj_{-1})/10}-1) \right\}$$

but $Tj - T_{j-1} = \Delta Tj$ and on simplifying $\mathrm{TTI} = \sum_{J=1}^{n} \frac{2^{(T_{j-1}-105)/10}}{\mathrm{In}\ 2^{\Delta Tj/10(\Delta tj)}} \bullet \left\{ (2^{(\Delta Tj/10}-1) \right\}$

Notice that if ΔT_j or Δt_j is equal to zero power the relationship is undefined and the expression of Waples (1980) must be used.

APPENDIX 4

BURIAL PROGRAM SOURCE LISTING

```
      PROGRAM BURIAL

C
C Burial: A program that calculates and draws burial
C              history curves for a stratigraphic section.
C              Layers that have been eroded are highlighted
C              by shading.
C              In addition, the following values are calculated
C              for each layer at each age: thermal conductivity,
C              temperature, TTI,Romax.
C
C   Written by:  Kathy Mottershead
C          for:  Kirk Osadetz
C         date:  October 1990
C
C    This program requires two input files, a data file and a
C    geological ages file. The data file contains the following
C    fields:
C          wellthck - compacted thickness of each layer (feet or metres)
C           contact - a logical variable which indicates if each layer
C                     is present in the stratigraphic section (true)
C                     or has been removed by erosion (false)
C           removed - the age, in number of geological units (i.e. 1 to
C                     nrec), when each layer in the section was removed
C                     or nrec + 1 for layers presently in the section
C          wellshle - the fraction of shale present in each layer of the
C                     section
C          wellsand - the fraction of sandstone present in each layer
C                     of the section
C          welllime - the fraction of limestone available in each layer
C                     of the section
C          wellevap - the fraction of evaporite present in each layer of
C                     the section
C          phimatrx - the porous fraction of the sandstone and
C                     limestone lithologies in each layer of the section
C             gflow - heat flux in milliwatts / metre**2 at each age
C          surftemp - surface temperature in degrees celsius at each age
C             stage - geological age of layer i of the section
C
C    NOTE: wellshle, wellsand, welllime and wellevap should sum to 1
C
C    The format is (f6.1,1x,11,1x,i2,1x,5 (f5.3,1x), f6.2,1x,f5.2,1x,a8)
C
C    The geological ages file contains the following fields:
C      geological age
C      absolute age in millions of years
C
C    The format is (1x,ai,1x,f5.1)
C
C    The program produces two output files, a file which logs
C    the input and stores the final results, and a plotfile
C    containing the burial history plot in Calcomp compatible form.
C
C    The following internal subroutines are used:
C           Createf - creates a new file
C            Decode - decodes an input value and checks for a null return
C            Delith - decompacts the layers and calculates the
C                     porosity of the shale portion of the layer
C             Hatch - shades the area inside a polygon
C          Inquiref - Returns the record length and file size
C                     for a fully specified file name
C            Phicalc - porosity calculation
C            Pltaxs - plots the axes for the burial history plot
C            Pltbh - plots the burial history curves
C            Pltend - checks that the plotter has maintained its
C                     origin and closes the plot file
C            Pltti - posts the tti values on the plot
C            Pltvar - initializes the plot variables
C
C    The following Calcomp plotting subroutines are used:
C           Newpen - changes pens
C           Number - plots a number
C             Plot - moves the pen in either the up or down position
C            Plots - initializes the plot file
C           Symbol - plots a character string
C
C    The following HP system intrinsics are used:
C              Dateline - returns the current date
C                Fcheck - returns specific details about error
C                         conditions that occurred when a file
C                         system intrinsic returns an error code
C                Fclose - closes a file
C            Flabelinfo - returns information from the file label
C                         of a disk file
C                 Fopen - opens a file and defines the physical
C                         characteristics of the file
C          Hpcicommand - executes a command programmatically
C
C    The following standard Fortran 77 intrinsics are used:
C           Mvbits - moves bits from one variable to another
C
C Parameter iw must be > = the number of corners of the
C                          area to be shaded
C Parameter ix must be > = the number of layers in the section
C Parameter iy must be > = the number of intersections per
C                          hatch line with the area being shaded
C Parameter iz must be > = the number of tti values to be posted
C                          (i.e. 1/2 * ix*ix)
C Parameter usage:    ix - Mainline
C                  iw,iy -Subroutine Hatch
C                     iw - Subroutine Pltbh
C                     iz - Subroutine Plttti
C
        parameter (ix = 50)
C
        system intrinsic hpcicommand
C*****Non-Standard Fortran 77*****
C
        logical contact (ix)
C
        character*1 iunits
        character*8 stage(ix), cmaxage, gstage
        character*32 wellname
        character*36 filename, gfilenam, pfilenam, outfile
        character*51 cmdplot
C
        integer*2 jerr, jparm
        integer removed(ix), iwellnam(15), octal15
C
        real wellthck(ix), wellshle(ix), wellsands(ix),
     &      welllime(ix), wellevap(ix), phimatrx(ix),
     &      age(ix), welltop(ix), wellphis(ix),
     &      topdepth(ix,ix), thick(ix,ix), maxdepth(ix,ix),
     &      phishle(ix,ix), fracshle(ix,ix),
     &      fracsand(ix,ix), fraclime(ix,ix),;
     &      fracevap(ix,ix),
     &      thermk(ix,ix), temp(ix,ix), tti(ix,ix),
     &      yypos(ix), ro(ix),
     &      maxdpth,
     &      qflow(ix), surftemp(ix)
C
        equivalence (wellname, iwellnam(1))
C
      common /plotvar/ xorg, yorg, xwdt, ylinwdt, ylogwdt, ixinc, ixlbl,
     &      ixmax, iylinmax, iylogmax, iup, idown,
     &      charlrg, charmed, charsm1, ittiflag
      common/ maxvar/ cmaxage, maxdpth
C
C            ‘nbytes’ and ‘nrec’ are the record size and number of
C            records for the output file
C
            data nbytes, nrec /80, 4000/
            nx = ix
C
C           Read Input Filename
C
            write (*,*) ‘Data Filename? ’
            read (5,5) filename
    5       format (a36)
            open (10,file=filename,status=‘old’,form=‘formatted’, iostat=ierr)
            if (ierr.ne.0) then
               write (*,*) ‘Could not open data file-ERROR:’,ierr
               stop
            end if
C
C       Read Geological Age Filename
C
        write (*,*) ‘Geological Age Filename? ’
        read (5,5) gfilenam
        open (11,file=gfilenam,status=‘old’,form=‘formatted’,
     &      iostat = ierr)
        if (ierr.ne.o) then
            write (*,*) ‘Could not open geological age file-ERROR:’, ierr
            stop
        end if
C
C       Read Plot Filename (Required by the ISPG Plot Library)
C
C       Specific to HP MPE/XL implementation
C       Form of command: File plotfile = user-specified filename
```

```
C
        write (*,*) ‘Plot Filename (new file) ? ’
        read (5,5) pfilenam
        cmdplot = ‘file plotfile=’//pfilenam//char(13)
C       char(13) = carriage return
C
        call hpcicommand (cmdplot, jerr, jparm)
C*****Non-Standard Fortran 77*****
C
        if (jerr.ne.0) then
            write (8,*) ‘Could not open plot file-ERROR:’, jerr
               stop
        end if
C
C       Read Output Filename
C
        write (*,*) ‘Output File (new file) ? ’
        read (5,5) outfile
C
C       Specific to HP MPE/XL implementation
C
        call createf (outfile, ‘a’, ‘f’, -nbytes, nrec, ierr)
        if (ierr.ne.0) then
               write (*,*) ‘Output File Create Error - ’,ierr
               stop
            end if
            open (12,file=outfile,status=‘old’,form=‘formatted’,iostat=ierr)
            if (ierr.ne.0) then
               write (*,*) ‘Output File Open Error = ’,ierr
               stop
        end if
C
C       Write file names to log file
C
        write (12,10) filename
   10   format (‘ Data Filename - ’,a36)
        write (12,11) gfilenam
   11   format (‘ Geological Age Filename - ’,a36)
        write (12,12) pfilenam
   12   format (‘ Plot Filename - ’,a36)
C
C       Read Well Name from data file
C
        read (10,15) wellname
   15   format (a32)
C
C       Data input as feet or metres?
C
        read (10,25) iunits
   25   format (a1)
        convfctr = 1.0
        if (iunits.eq.‘f’ .or. iunits.eq.‘F’) convfctr = 0.3048
C
C       Read input data
C
C       wellthck(i)     =compacted thickness of layer i (feet or metres)
C       contact(i)      =a logical variable which indicates if layer i
C                         is present in the stratigraphic section (true)
C                         or has been removed by erosion (false)
C       remfoved(i)     =the age, in number of geological units (i.e. 1 to
C                         nrec), when layer i was removed or
C                       =nrec + 1 for layers presently in the section
C       wellshle(i),wellsand(i),welllime(i),wellevap(i)
C                       =the fractions of shale, sandstone, limestone and
C                         evaporites present in layer i (should sum to 1)
C       phimatrx(i)     =the porous fraction of the sandstone and
C                         limestone lithologies in layer i
C       gflow(j)        =heat flux in milliwatts / metre**2 at age j
C       surftemp(j)     =surface temperature in degrees celsius at age j
C       stage(i)        =geological age of layer i
C
C       Convert thickness to metres if necessary
C
        nrec = 1
        do while (nrec.le.ix)
                read (10,45,end=52) wellthck(nrec), contact (nrec),
     &                  removed(nrec), wellshle (nrec),
     &                  wellsand(nrec), welllime(nrec),
     &                  wellevap(nrec), phimatrx(nrec),
     &                  gflow(nrec), surftemp(nrec),
     &                  stage(nrec)
            wellthck(nrec) = wellthck(nrec) * convfctr
            nrec = nrec + 1
        end do
        write (*,*) ‘Number of layers in section > array sizes ’,
     &                  ‘i.e. parameter ix = ’,ix
     &stop
   45   format (f6.1,1x,l1,1x,i2,1x,5(f5.3,1x),f6.2,1x,f5.1,1x,a8)
   52   continue
        nrec = nrec - 1
C
C       Write input data to log file
C
        write (12,55)
        write (12,20) wellname
        write (12,30) iunits
        do i=1,nrec
            write (12,50) wellthck(i), contact(i), removed(i),
     &                  wellshle(i), wellsand(i), wellime(i),
     &                  wellevap(i), phimatrx(i),
     &                  gflow(i), surftemp(i), stage(i)
        end do
        write (12,55)
   20   format (1x,a32)
   30   format (1x,a1)
   50   format (1x,f6.1,1x,l1,1x,i2,1x,5(f5.3,1x),f6.2,1x,f5.1,1x,a8)
   55   format (//)
C
C       Assign absolute ages to units
C
        i = 1
        do while (i.le.nrec)
                read (11,60,end = 65) gstage,gage
   60           format (1x,a8,1x,f5.1)
                if (gstage.eq.stage(i)) then
                   age(i) = gage
                   i = i + 1
                end if
        end do
   65   continue
        i = i-1
        if (i.lt.nrec) then
                write (*,*) ‘ERROR - Invalid Age:’, stage(i+1)
                stop
        end if
C
C       Calculate the top depth of each unit in the well
C
        welltop(nrec) = 0.0
        oldthck = 0.0
        if (contact(nrec)) oldthck = wellthck(nrec)
        do i = nrec-1,-1
                welltop(i) = welltop(i+1) + oldthck
                if (contact(i)) then
                        oldthck = wellthck(i)
                else
                        oldthck = 0.0
                end if
            end do
C
C       Set plot variables
C       Calculate y plot position (yypos) for each age on input file
C
        cmaxage = stage(1)
        maxage = age(1)
        maxdpth = welltop(1) + wellthck(1)
        call pltvar
        do i = 1,nrec
                if (age(i).le.iylinmax) then
                   yypos(i) = ylinpos(age(i))
                else
                   yypos(i) = ylogpos(age(I))
                end if
        end do
C
C       Calculate the porosity of the shale of each unit in the well.
C
        call cwllphis (nrec, nx, contact, wellthck, removed,
     &                  wellshle, welltop, wellphis)
C
C       For each layer at each age, calculate:
C               topdepth
C               thickness
C               maxdepth
C               fraction of shale,sand,lime and evap
C               porosity of shale
C
        depthmax=ixmax
        call dcompact (nrec, nx, depthmax, wellthck, removed,
     &                  wellshle, wllsand, welllime, wellevap,
     &                  wellphis,
     &                  topdepth, thick, maxdepth, phishle,
     &                  fracshle, fracsand, fraclime, fracevap)
C
C       For each layer at each age, calculate:
C               thermal conductivity
C               temperature
C               time temperature index
C               ROmax
C
        call ctempvar (nrec, nx, phimatrx, surftemp, gflow,
     &                  age, thick, phishle,
     &                  fracshle, fracsand, fraclime, fracevap,
     &                  thermk, temp, tti, ro)
C
C       Write results to log file
```

```
C
       write (12,72)
       do i = 1,nrec
           write (12,73) i,ro(i)
       end do
       write (12,74)
       do i = 1,nrec
           write (12,70)
           write (12,75)
           do j = 1,nrec
               write (12,80)i,j,topdepth(i,j),thick(i,j),fracshle(i,j),
     &                 phishle(imj),thermk(imj),temp(i,j),
     &                 tti(imj)
           end do
           write (12,74)
       end do
   72  format (‘LAYER’,1x, ‘ROMAX’,//)
   73  format (2x,i3,3x,f4.2)
   74  format (/////)
   70  format (‘LYR AGE TOP-DEPTH THICKNESS SHALE’,5x,
     &          ‘THERMK’,7x,‘TEMP TTI’)
   75  format (10x,‘(METRES) (METRES) frac phi (W/M-DEG) ’,
     &          2x,‘(DEG-C)’,//)
   80  format (1x,i3,1x,i3,2(2x,f8.2),2(1x,f4.2),1x,f8.2,4x,
     &          f8.2,1x,f9.2)
C
C      Initialize plot file and plot axes
C
       call pltaxs (iwellnam)
C
C      Plot burial history curves
C
       call pltbh (nrec, nx, topdepth, yypos, contact, removed)
C
C      Post tti
C
       if (ittiflag.eq.1) call pltti (nrec, nx, topdepth, yypos, tti)
C
C      Complete plot and close plot file
C
       call pltend
       stop
       end

C******************************************************************************
C
C                     CREATEF SUBROUTINE
C
       Subroutine createf (name, code, format, recsize, recs,ierr)
C
C      This routine creates a file with specified characteristics
C      (HP MPE-XL dependent).
C
C      Input:
C               name - Up to 36 character name, allowing full file spec.
C                      with group, account and lockword. Must terminate
C                      with a non-alphanumeric other than a . or /
C
C               code - "a", ascii format
C                      "b", binary format
C
C             format - "f", fixed record length
C                      "v", variable
C                      "u", undefined
C
C            recsize - If negative, size is in bytes
C
C               recs - Number of records to assign to file
C
C      Output:
C          ierr -  Error status
C                  = 0, no error. file assigned
C                  < 0, the file exists. file not created
C                  > 0, file did not exist, but cannot be created
C                     reason is unknown
C
C          New calc for optimal blocking factor based on min i/o
C          Max ideal b.f. = 8192 / rl (bytes) ..truncate
C
C          Min i / 0 = (nrec to eof / max ideal b.f.) + 1 ..round up
C
C          Opt b.f. = (nrec to eof / minio ) + 1 ..round up
C
             system intrinsic fopen, fcheck, fclose
C*****Non-Standard Fortran 77******
C            (HP MPE-XL dependent)
C
             character*1 code, format
             character*36 name, lname
             logical*2 fop, aop
             equivalence (aop, iaop), (fop, ifop)
             integer*2 bf, iaop, ifop, num, maxextents
             integer*4 recs, nrecs, reof, lu, recsize, ierr
             integer*2 sz, lerr
             integer*4 lrecsz, lnrecs
C
             lname = name
             sz = recsize
             nrecs = recs
             lrecsz = recsize
             lnrecs = recs
             ifop = 0
             iaop = 0
             call mvbits (5i, 0i, 3i,iaop, 0i) ! iaop (12:4) = 5b
             ierr = 0
C
C          Check if request file already exists
C
               call inquiref (name, lrecsz, lnrecs, ierr)
               if (ierr .eq. 0) then !c file exists
                  ierr = -1 !c set ierr negative per calling rules
                  go to 999 !c for this routine and return
               endif


C
C      Request new file
C
             ifop = ibclr(ifop,0) ! ifop(14:2) = 0
             if(code.eq.‘a’) ifop = ibset(ifop,2) ! ifop(13:1) = 1
             if(code.eq.‘b’) ifop = ibclr(ifop,2) ! ifop(13:1) = 0
             call mvbits (0i, 0i, 3i, ifop, 3i) ! ifop (10:3) = 0
          if(format.eq.‘f’) call mvbits (0i, 0i, 2i, ifop, 6i) ! ifop(8:2) =0
          if(format.eq.‘v’) call mvbits (li, 0i, 2i, ifop, 6i) ! ifop(8:2) =1
          if(format.eq.‘u’) call mvbits(2i, 0i, 2i, ifop, 6i) ! ifop(8:2) =2b
             if(recsize .le. 0)length = -recsize
             if(recsize .gt. 0)length = 2. * recsize
             eof = recs
             maxextents = float(length) * eof / 8192.0
             if(maxextents.lt.1) maxextents = 1
             if(maxextents.gt.16)maxextents = 16
C
C            Compute a blocking factor between 1 and 16
C
               do 15 i = 1, 30
               blocklen = float(length - * float(i)
               if (blocklen.gt.3840.0 .and. i.ne.1) go to 16
               sectorblock = ceilf77(blocklen / 256.0)
               blocknum = ceilf77(eof / float(i)) + 1.0
               sectornew = blocknum * sectorblock
               extentsectors = sectornew / float(maxextents)
             extentsectors = ceilf77(extentsectors / sectorblock) * sectorblock
               secalloc = ceilf77 (sectornew / extentsectors) * extentsectors
               if(i.eq.1) go to 14
               if (secalloc .ge. sectors) go to 15
          14 blocknew = i
             sectors = secalloc
          15 continue
C
C         Calculate values for disc used
C
          16 bf = blocknew
C
          num = fopen(lname,fop,aop,sz,,,,bf,,nrecs,maxextents)
          if(ccode( ) .ne. 0) then !c open failed, so
               call fcheck (o, lerr) !c set error in ierr
C*****Non-Standard Fortran 77 (previous 3 lines)******
C
                  ierr = lerr
                  go to 999
               endif
C
               call fclose (num, 1, 0) !c close the file and return ierr = 0
               if(ccode( ) .ne. 0) then !c unless close fails
                    call fcheck (0, lerr)
C*****Non-Standard Fortran 77 (previous 3 lines)******
C
                  ierr = lerr
                  go to 999
               endif
               ierr = 0 ! normal return
          999 return
               end

C******************************************************************************
C
C                  CEILF77
C
      Function ceilf77 (arg)
      i = O
      b = aint(arg)
      if (arg .ne. b) then
          i = 1
      endif
          ceilf77 = b + i
      return
      end
```

```

C***************************************************************************
C
C                    CTEMPVAR SUBROUTINE
C
            Subroutine ctempvar (nrec, nx, phimatrx, surftemp, gflow,
     &                    age, thick, phishle,
     &                    fracshle, fracsand, fraclime, fracevap,
     &                    thermk, temp, tti, ro)
C
C       This subroutine calculates the following variables
C       for each layer(i) at each age(j):
C               thermal conductivity
C               temperature
C               time temperature index
C               ROmax
C
C       Input:
C                   nrec - the number of layers in the section
C                     nx - dimension of the input arrays (parameter ix)
C               phimatrx - the porous fraction of the sandstone and
C                          limestone lithologies in each layer of the section
C               surftemp - surface temperature in degrees celsius at each age
C                  gflow - heat flux in milliwatts / mteres**2 at each age
C                    age - absolute age of each layer in the section
C                  thick - thickness of each layer at each age
C                phishle - porosity of the shale of each layer at each age
C                fracshle - fraction of shale of each layer at each age
C               fracsand - fraction of sandstone of each layer at each age
C               fraclime - fraction of limestone of each layer of each age
C               fracevap - fraction of evaporite of each layer at each age
C
C       Output:
C            thermk  -  thermal conductivity of each layer at each age
C              temp  -  temperature of each layer at each age
C                tti  -  time temperature index of each layer at each age
C                 ro  -  ROmax of each layer at each age
C
        real phimatrx(1), surftemp(1), gflow(1), age(1),
     &          thick (nx,nx), phishle (nx,nx), fracshle(nx,nx),
     &          fracsand(nx,nx), fraclime(nx,nx), fracevap(nx,nx),
     &          thermk(nx,nx), temp(nx,nx), tti(nx,nx), ro(1),
     &          kksand(nx),kklime(nx),kkshale(nx,nx),
     &          ksand, klime, kevap, kwater, kshale
C
C       'ksand', 'klime', 'kevap', 'kwater', 'kshale' are the rock
C       matrix thermal conductivities in milliwatts / metre=kelvin
C
        ksand  =  3200.0
        klime  =  3326.0
        kevap  =  5430.0
        kwater  =  670.0
        kshale  =  3265.0
C
C       Thermal Conductivity Calculation
C
        do i  =  1,nrec
                kksand(i)  =  ksand * (kwater / ksand)**phimatrx(i)
                kklime(i)  =  klime * (kwater / klime)**phimatrx(i)
                do j  =  1,nrec
                    if (thick(i,j).gt.o.o) then
                        kkshale(i,j)  =  kshale * (kwater / kshale) ** phishle(i,j)
                          thermk(i,j)  =  kksand(i)**fracsand(i,j) *
     &                              kksand(i)**fraclime(i,j) *
     &                              kevap**fracevap(i,j) *
     &                              kkshale(i,j)**fracshle(i,j)
     &              else
                        thermk(i,j)  =  0.0
                    end if
                end do
        end do
C
C
C       Temperature Assignment Section
C
        do j  =  1,nrec
                do i  =  j,nrec
                        temp(i,j)  =  surftem(j)
                end do
        end do
        do j  =  2,nrec
                do i  =  j-1,1,-1
                    if (thick(i+1,j).gt.0.0) then
                        temprise  =  gflow(j) / thermk(i+1,j)
                    else
                        temprise  =  0.0
                    end if
                    temp(i,j)  =  temp(i+1,j)  +  (temprise * thick(i+1,j))
                end do
        end do
C
C       Time Temperature Index Calculation
C
        do i  =  1,nrec
                do j  =  1,nrec
                    if (i.lt.j) then
                        agej  =  age(1) - age(j)
                        agejm1  =  age(1) - age(j-1)
                        elapse  =  agej - agejm1
                        tempchan  =  temp(i,j) - temp(i,j-1)
                        if (abs(tempchan).gt.0.001) then
                              alpha  =  2**((temp(i,j-1) - 105.0) / 10.0)
                              bravo  =  2**(tempchan / 10.0) - 1.0
                              charlien  =  2.0**(tempchan / (10.0 * elapse))
                              tti(i,j)  =  tti(i,j-1)  +
     &                           (alpha * bravo / alog(charlie))
                    else
                            alpha  =  2**((temp(i,j) - 105.0) / 10.0)
                            tti(i,j)  =  tti(i,j-1)  +  elapse * (alpha)
                    end if
                else
                    tti(i,j)  =  0.0
                end if
            end do
        end do
C
C       Romax Calculation
C
        do i  =  1,nrec
            ro(i)  =  0.0
            if (tti(i,nrec).gt.0.0) then
                    xlogtti  =  alog10(tti(i,nrec))
                    xlogro  =  -0.4769  +  (0.2801 * xlogtti) -
     &                        (o.007472 * xlogtti**2)
                    ro(i)  =  10.0**xlogro
                end if
        end do
        return
        end

C***************************************************************************
C
C                    CWLLPHIS SUBROUTINE
C
        Subroutine cwllphis (nrec, nx, contact, wellthck, removed,
     &                        wellshle, welltop, wellphis)
C
C       This subroutine calculates the porosity of the shale of each
C       unit in the well.
C       This will be equal to the porosity at maximum burial. In order
C       to approximate this depth a correction factor is calculated
C       for each layer.
C       dpthcorr  =  (combined thickness of previously eroded layers
C                       at the age of maximum burial) - depth of final
C                       burial)
C       If dpthcorr  >  0 it is added to the dept of the layer
C       in the well.
C
C       Input:
C                   nrec - the number of layers in the section
C                     nx - dimension of the input arrays (parameter ix)
C                contact - a logical variable which indicates if layer i
C                          is present in the section (true) or has been
C                          removed by erosion (false)
C               wellthck - the compacted thickness of each layer in the section
C                removed - the age, in number of geological units (i.e. 1 to
                           nrec), when each layer in the section was removed
C                          or nrec +1 for layers presently in the section
C               wellshle - the fraction of shale in each layer in the section
C                welltop - top depth of each layer in the section
C
C       Output:
C               wellphis - porosity of shale of each layer in the section
C
        logical contact(1)
        integer removed(1), agefalse (nx)
        real wellthck(1), wellphis(1), wellshle(1), welltop(1),
     &              totfalse(nx), dpthcorr(nx)
C
        finalbur  =  0.0
        i  =  nrec
        do while (contact(i) .and.i.gt.0)
            finalbur  =  finalbur  +  wellthck(i)
            i  =  i-1
        end do
        istop  =  1
        k  =  0
        do i  =  1,nrec
            totfalse(i)  =  0.0
        end do
        do i  =  nrec,1,-1
            if (.not.contact(i)) then
                    if (istop.eq.1) then
                    k  =  k  +  1
                    istop  =  0
                    end if
```

```
                    totfalse(k) = totfalse(k) + wellthck(i)
                    agefalse(k) = removed(i)
              else
                    if (istop.we.0) istop = 1
                end if
        end do
        numfalse = k
        if (numfalse.gt.0) then
                do i = 1,nrec
                  dpthcorr(i) = 0.0
                  if (contact(i)) then
                    do K = 1,numfalse
                      if (i.lt.agefalse(k).and.totfalse(k).gt.dpthcorr(i))
     &                     dpthcorr(i) = totfalse(k)
                    end do
                    dpthcorr(i) = dpthcorr(i) - finalbur
                    if (dpthcorr(i).lt.0.0) dpthcorr(i) = 0.0
                    else
                      do j = i+1,nrec
                      if (.not.contact(j))
     &                       dpthcorr(i) = dpthcorr(i) + wellthck(j)
                    end do
                end if
            end do
        end if
        do i = 1,nrec
                if (wellshlw(i).gt.0.0 .and. wellthck(i).gt.0.0) then
                   top = welltop(i) + dpthcorr(i)
                   bottom = top + wellthck(i)
                   callphicalc (top, bottom, wellphis (i))
                else
                   wellphis(i) = 0.0
                end if
        end do
        return
        end

C***************************************************************************
C
                        DCOMPACT SUBROUTINE
C
        Subroutine dcompact (nrec, nx, depthmax, wellthck, removed,
     &                       wellshle, wellsand, welllime, wellevap,
     &                       wellphis,
     &                       topdepth, thick, maxdepth, phishle,
     &                       fracshle, fracsand, fraclime, fracevap)
C
C       This subroutine calculates the following variables
C       for each layer (i) at age age(j):
C                   topdepth
C                   thickness
C                   maxdepth
C                   fraction of shale, sand, lime and evap
C                   porosity of shale
C
        Input:
C                  nrec - the number of layers in the section
C                    nx - dimension of the input arrays (parameter ix)
C            depthmax - maximum value of depth axis
C              removed - the age, in number of geological units (i.e. 1 to
C                        nrec), when each layer in the section was removed
C                        or nrec + 1 for layers presently in the section
C             wellshle - fraction of shale in each layer of the section
C             wellsand - fraction of sandstone in each layer of the section
C             welllime - fraction of limestone in each layer of the section
C             wellevap - fraction of evaporite in each layer of the section
C             wellphis - porosity of the shale in each layer of the section
C
C       Output:
C            topdepth - top depth of each layer at each age
C                thick - thickness of each layer at each age
C            maxdepth - maximum depth of each layer at each age
C              phishle - porosity of the shale at each layer at each age
C             fracshle - fraction of shale at each layer at each age
C             fracsand - fraction of sandstone at each layer at each age
C             fraclime - fraction of limestone at each layer of each age
C             fracevap - fraction of evaporite at each layer at each age
C
        integer removed(1)
        real wellthck(1), wellshle(1), wellsand(1), welllime(1),
     &          wellevap(1), wellphis(1), topdepth(nx,nx), thick(nx,nx),
     &          maxdepth(nx,nx), phishle(nx,nx), fracshle(nx,nx),
     &          fracsand(nx,nx), fraclime(nx,nx); fracevap(nx,nx)
C
C       Check that the depth does not exceed the maximum plot limits
C
        do i = 1,nrec
                do j = 1,nrec
                   topdepth(i,j) = 0.0.
                   thick(i,j) = 0.0
                   maxdepth (i,j) - 0.0
                   fracshle(i,j) = 0.0
                   fracsand(i,j) = 0.0
                   fraclime(i,j) = 0.0.
                   fracevap(i,j) = 0.0
                   phishle(i,j) = 0.0
                end do
        end do
        testdpth = 0.0
        do j = 2,nrec
             do i = j,1,-1
                   topdepth(i,j) = topdepth(i+1,j) + thick(i+1,j)
                if (topdepth(i,j) .gt. testdpth) testdpth = topdepth(i,j)
C
                if (topdepth(i,j).le.maxdepth(i,j-1)) then
                  maxdepth(i,j) = maxdepth(i,j-1)
             else
                maxdepth(i,j) = topdepth(i,j)
             end if
C
             if (removed(i).le.j .or. wellthck(i).le.0.001) then
C
C               Layer has disappeared at an earlier age or layer has zero
C                 thickness (i.e. it represents the disappearance of an
C                 earlier layer or the bottom of the well).
C
                   thick(i,j) =0.0
                   phishle(i,j) = 0.0
C
                else if (removed(i).eq.i+1) then
C
C               Layer was removed at next age.  It was never buried
C               and thus never compacted.
C
                thick(i,j) = wellthck(i)
                top = 0.0
                bottom = wellthck(i)
                call phicalc (top, bottom, phishle (i, j))
C
             else if (maxdepth(i,j-1).gt.topdepth(i,j)) then
C
C                 Depth of layer at age j is less than depth of layer
C                 at a previous age.
C
                   thick(i,j) = thick(i,j-1)
                   phishle(i,j) = phishle(i,j-1)
C
                else
C
C                  Decompact layer
C
                   if (wellshle(i).gt.0.0) then
                      call delith (wellshle (i),wellphis (i),
     &                   wellthck(i),topdepth(i,j),
     &                   phishle(i,j),thick(i,j)
                   else
                      phishle(i,j) = 0.0
                      thick(i,j) = wellthck(i)
                   end if
C
                end if
                if (thick(i,j) .gt. 0.0) then
                   fracsand(i,j) = (wellsand(i) * wllthck(i)) / thick(i,j)
                   fraclime(i,j) = (welllime(i) * wellthck(i)) / thick(i,j)
                   fracevap(i,j) = (wellevap(i) * wellthck(i)) / thick(i,j)
                   fracshle(i,j) = 1.0 - fracsand(i,j) - fraclime(i,j)
     &                      -fracevap(i,j)
                   end if
             end do
        end do
        if (textdpth .gt. depthmax) then
             write (*,*) 'Maximum depth of input data', testdpth,' > ',
     &                   'Maximum of depth axis',depthmax
             stop
        end if
        return
        end

C***************************************************************************
C
C               DECODE SUBROUTINE
C
        Subroutine decode (rdum)
C
C       This subroutine decodes an input value and checks
C       for a null return
C
C       Output: rnum - value entered by the user
C
        character*1 card(20)
        character*20 ccard
C
        equivalence (card, ccard)
C
        read (5,900) ccard
 900    format (a20)
```

```
      if (card(1).eq.' ') then
              rdum = -1.0e30
      else
              rdum = rnum(ccard)
      end if
      return
      end

C***************************************************************************
C
C                   DECOMPACTION SUBROUTINE
C
      Subroutine delith (wllshle, wllphis, wllthck,
     &                    tpdepth,phshle,thck)
C
C     This subroutine decompacts layer i at age j and
C     calculates the porosity of the shale portion of
C     the layer
C
C         Input:wllshle - fraction of shale in each layer of the section
C               wllphis - porosity of shale fraction of each layer in the
C                         section
C               wllthck - thickness of each layer in the section
C               tpdepth - top depth of each layer at each age
C
C        Output:phshle - porosity of shale of each layer at each age
C                  thck - thickness of each layer at each age
C
      toler = 1.0
      top = tpdepth
      bottom = tpdepth + wllthck
      phiold = wllphis
C
C     Loop until porosity of the shale changes less than 0.01
C
      k = 0
      do while(abs(toler).gt.0.01
          call phicalc (top, bottom, phinew)
          if (abs(phinew-wllphis).le.0.01) then
             compcor = 1.0
          else
             compcor = 1.0 + wllshle * ( (phinew-wllphis) / (1.0-phinew))
          end if
          thicknew = wllthck * compcor
          bottom = tpdepth + thicknew
          toler = phinew - phiold
          phiold = phinew
      end do
      thck = thicknew
      phshle = phinew
      return
      end

C***************************************************************************
C
C                   HATCHING SUBROUTINE
C
      Subroutine hatch (xpoly, ypoly, ncorner, npat)
C
C     This subroutine shades the area inside a polygon by
C     drawing hatch lines
C
C     Input: xpoly, ypoly - arrays containing the polygon's
C                           coordinates
C                           these arrays must be dimensioned >=
C                           ncorner
C            ncorner  -  number of corners in polygon
C                        (# of sides + 1)
C               npat  -  pattern # for hatching (will be reduced to
C                        one of four possible patterns)
C
C     Parameter iw must be >= number of corners in polygon
C     Parameter iy must be >= number of intersections per
C                           hatch line with the polygon
C
      parameter (iw = 100, iy - 20)
      real xpoly(1), ypoly(1), xint(iy), yint(iy), tang(iw), const(iw)
    common /plotvar/ xorg, yorg, xwdt, ylinwdt, ylogwdt, ixinc, ixlbl,
     &                 ixmax, iylinmax, iylogmax, iup, idown,
     &                 charlrg, charmed, charsm1, ittiflag
C
      if (ncorner.gt.iw) then
          write (*,*) 'Polygon to be shaded has ',ncorner,
     &                 'corners and arrays are dimensioned ',iw
          stop
      end if
      nnpat = npat - ((npat / 4) * 4)
      if (nnpat.eq.1) then
          spacing = 0.25
          slope = 1.570795
      end if
      if (nnpat.eq.1) then
          spacing = 0.25
          slope = 0.0
      end if
      if (nnpat.eq.3) then
          spacing = 0.125
          slope = 1.570795
      end if
      if (nnpat.eq.0) then
          spacing = 0.125
          slope = 0.0
      end if
C
C     Rotate coordinate system by angle 'slope' and redefine xpoly
C     and ypoly in rotated system
C
      coslo = cos(slope)
      sinslo = sin(slope)
      do i = 1,ncorner
              xx = abs(xpoly(i))
              yy = abs(ypoly(i))
              xpoly(i) = xx * coslo + yy * sinslo
              ypoly(i) = -xx * sinslo + yy * coslo
      end do
C
C     Find ymin and ymax in rotated system
C
      ymin = ypoly(1)
      ymax = ypoly(1)
      do i = 2,ncorner
              if (ypoly(i).gt.ymax) ymax = ypoly(i)
              if (ypoly(i).lt.ymin) ymin = ypoly(i)
      end do
C
C     Compute coefficients of polygon side equations and store
C
      do i = 1,ncorner-1
              deltax = xpoly(i+1) - xpoly(i)
              if (abs(deltax).lt.0.0001) deltax = 0.0001
              deltay = ypoly(i+1) - ypoly(i)
              if (abs(deltay).lt.0.0001) deltay = 0.0001
              tang(i) = deltay / deltax
              const(i) = ypoly(i) = tang(i) * xpoly(i)
      end do
C
C     Find position of first hatch line (dely1) and the
C     number of hatch (nhatch)
C
      dely1 = ymin + spacing / 2.0
      nhatch + (ymax - dely1) / spacing + 1
C
C     Check if any hatch line passes through a polygon point
C
      do i = 1,nhatch
              ydash = dely1 + spacing * (i-1)
              do j = 1,ncorner
                 if (abs(ypoly(j)-ydash).lt.o.001)
     &                ypoly(j) = ypoly(j) + 0.001
              end do
      end do
C
C     Intersect hatch lines with polygon sides
C
          do i = 1,nhatch
              nintr = 0
              ydash = dely1 + spacing * (i-1)
              do j = 1,ncorner-1
C
C                Check if intersection occurs on a polygon side
C
                 if ((ydash.gt.ypoly(j).and.ydash.lt.ypoly(j+1)) .or.
     &        (ydash.lt.ypoly(j).and.ydash.gt.ypoly(j+1)) then
                     a = tang(j)
                     b = const(j)
                     xdash = (ydash - b) / a
                     nintr = nintr + 1
                     if (nintre.gt.iy) then
                          write (*,*) 'Number of intersections of hatch ',
     &                           'line with polygon exceeds ',
     &                           'dimension of arrays'
                          stop
                 end if
                     xint(nintr) = xdash
                     yint(nintr) = ydash
          end if
      end do
C
C     Order intersection points in ascending order to xdash and
C     rotate their coordinates into old system
C
      if (nintr.gt.0) then
              do k = nintr-1,1,-1
                     do j = nintr,k+1,-1
                        if (xint(k).gt.xint(j)) then
                             savex = xint(k)
```

```
                              savey = yint(k)
                              xint(k) = xint(j)
                              yint(k) = yint(j)
                              xint(j) = savex
                            yint(j) = savey
                          end if
                        end do
                      end do
                      do j = 1,nintr
                        xx = xint(j)
                        xint(j) = xifnt(j) * coslo - yint(j) * sinslo
                        yint(j) = xx * sinslo + yint(j) * coslo
                      end do
C
C                     Draw hatch line
C
                      do m = 1,nintr-1,2
                        call plot (xint (m), yint (m), iup)
                        call plot (xint (m+1), yint (m+1), idown)
                      end do
                end if
            end do
            return
            end

C***************************************************************************
C
C               Inquiref - flabelinfo version
C                           87/10/19
C
C               Takes a fully specified file name and returns
C               the record length and the file size
C               The error info from flabelinfo for the
C               individual parameters returned is not
C               used. Anfser if it occurs is returned
C               as a positive value in ierr.
C               (HP MPE-XL dependent)
C
C***************************************************************************

            SUBROUTINE INQUIREF(NAME,RECSIZE,RECS,IERR)
C
C           Input:
C                   name - Up to 36 character name, allowing fullfile spec.
C                          with group, account and lockword. Must terminate
C                          with a non-alphanumeric other then a . or /
C
C                 recsize - If negative, size is in bytes
C
C                   recs - Number of records to assign to file
C
C           Output:
C                   ierr - FSERR error code (HP specific)
C
            integer*4 recs, recsize, locrecs
            integer*2 items(3)
            integer*2 locrecsize

            equivalence (items(3), locrecsize), (items(1), locrecs)

            integer*4 ierr
            character*36 name, lname
            integer*2 itemnums(3), itemerrors(2), lerr

            system intrinsic flabelinfo
C*****Non-Standard Fortran 77*****
C           (HP MPE-XL dependent)

            ierr = 0
            recsize = 0
            recs = 0
            lerr = 0
            itemnums(1) = 19 !c specifies record length
            itemnums(2) = 14 !c specifies number of records
            itemnums(3) = 0 !c terminates request list knn 1/18/88
            lname = name
            lc = ibscan(lname, 36)
            lname(lc+1:lc+1) = ';'
C                           terminates filename with required ';'
            call flabelinfo(lname, 0, lerr, itemnums, items, itemerrors)
C*****Non-Standard Fortran 77*****
            recsize = locrecsize
            recs = locrecs
            ierr = lerr

            return
            end

C***************************************************************************
C
C           POROSITY CALCULATION SUBROUTINE
C
            Subroutine phicalc (top, bottom, phi)
C
C               Input: top - top depth of layer i at age j
C                          bottom - bottom depth of layer i at age j
C
C           Output: phi - porosity of shale fraction of layer i
C                                 at age j
C
            phiinit = 0.4192
            decay = 0.4639e - 3
            dtop = decay * top
            dbottom = decay * bottom
          phi = (exp(-dbottom) - exp(-dtop)) * (-phiinit) / (dbottom-dtop)
            return
            end

C***************************************************************************
C
C           AXES PLOT SUBROUTINE
C
            Subroutine pltaxs (iwellnam)
C
C           Input: Iwellname - integer representation of the well name
C
            character*13 agename(14), agename1
            character*27 date
C
            integer idate(7), title2(6), title3(6),
     &              title(5), title5, title6(2), title7(3), title8(7),
     &              agenamei(4), iwellnam(1)
C
            real agetime(14)
C
            equivalence (date,idate), (agename1, agenamei(1))
C
            system intrinsic dateline
C*****Non-Standard Fortran 77*****
C
            common /plotvar/ xorg, yorg, xwdt, ylinwdt, ylogwdt, ixinc, ixlbl,
     &                    ixmax, iylinmax, iylogmax, iup, idown,
     &                    charlrg, charmed, charsm1, ittiflag
C
            data agename/ ' QUATERNARY',        ' TERTIARY',    ' CRETACEOUS',
     &                    ' JURASSIC',          ' TRIASSIC',    ' PERMIAN',
     &                    ' CARBONIFEROUS',     ' DEVONIAN',    ' SILURIAN',
     &                    ' ORDOVICIAN',        ' CAMBRIAN',    ' VENDIAN',
     &                    ' STURTIAN',          ' RIPLIEAN'/
            data agetime/2.0, 65.0, 144.0, 213.0, 248.0, 286.0,
     &                360.0, 408.0, 438.0, 505.0, 590.0, 670.0,
     &                800.0, 1650.0/
                data title2/'BURI', 'AL H', 'ISTO', 'RY C', 'URVE', 'S '/
                data title3/'TIME', 'TEM', 'PERA', 'TURE', 'IND', 'EX '/
                data title4/'ABSO', 'LUTE', 'AGE', ' IN ', '10 '/
                data title5/'6 '/
                data title6/'YEAR', 'S '/
                data title7/'GEOL', 'OGIC', ' AGE'/
                data title8/'SEDI', 'MENT', 'ARY ', 'COLU', 'MN I', 'N ME',
     &                  'TRES'/
C
                xposmax = xorg + xwdt
                yposmax = yorg + ylinwdt + ylogwdt
                yaxisl = xorg - (0.75 + (4 * charsm1) + 1.0 + charmed + 2.0)
                yaxis2 = xorg
C
            call plots (0, 0, 0)
C*****Non-Standard Fortran 77*****
C
            call newpen (1)
C
C           Plot a cross for accuracy check
C
            call plot (0.25, 0.0, iup)
            call plot (0.25, 0.5, idown)
            call plot (0.0, 0.25, iup)
            call plot (0.5, 0.25, idown)
C
C           Write out date and time
C
            call dateline (date)
C*****Non=Standard Fortran 77*****
C
            call symbol (0.5, 0.75, 0.1, idate, 90.0, 28)
C
C           Write well name and titles
C
            xpos = 0.5 + 2 * charlrg
            ypos = yorg + (ylogwdt + ylinwdt - (32 * charlrg)) / 2.0
C
C           Check if title will fit on plot - if not, temporarily
C           change the size of charlrg
C
            chartemp = charlrg
            if (ypos.lt.yorg) then
                ypos = yorg
```

```
         charlrg = (ylogwdt + ylinwdt) / 32.0
      end if
      call symbol (xpos, ypos, charlrg, iwellnam, 90.0, 32)
      xpos = xpos + 1.0 + charlrg
      call symbol (xpos, ypos, charlrg, title2, 90.0 21)
      if (ittiflag.ew.1) then
         call newpen (2)
         xpos = xpos + 0.5 + charlrg
         call symbol (xpos, ypos, charlrg, title3, 90.0, 22)
         call newpen (1)
      end if
      charlrg = chartemp
C
C     Draw and label y axis (i.e. age)
C
      call plot (yaxis1, yorg, iup)
      call plot (yaxis1, yposmax, idown)
      call plot (yaxis2, yorg, iup)
      call plot (yaxis2, yposmax, idown)
      xpos = yorg - (0.75 + (4 * charsm1) + 1.0
      ypos = yorg + (ylogwdt + ylinwdt - (25 * charmed)) / 2.0
C
C     Check if y axis title will fit on plot - if not, temporarily
C     change the size of charmed
C
      chartemp = charmed
      if (ypos.lt.yorg) then
         ypos = yorg
         charmed = (ylogwdt + ylinwdt) / 25.0
      end if
      call symbol (xpos, ypos, charmed, title4, 90.0 18)
      xpos = xpos - (charmed / 2.0)
      ypos = ypos + (18 * charmed)
      call symbol (xpos, ypos, charmed title5, 90.0 2)
      xpos = xpos + charmed / 2.0)
      ypos = ypos + (2 * charmed)
      call symbol (xpos, ypos, charmed, title6, 90.0, 5)
      xpos1 = xorg - 0.5
      xpos2 = xorg
      xpos3 = xorg - (0.75 + (4 * charsm1))
      nlabel = iylinmax / 50 + 1
      do i = 1,nlabel
            ysymb = (i-1) * 50.0
            ypos = ylinpos(ysymb)
            call plot (xpos1, ypos, iup)
            call plot (xpos2, ypos, idown)
            call number (xpos3, ypos, charsm1, ysymb, 0.0, -1)
      end do
      if (iylogmax.gt.iylinmax) then
            nlabel = (iylogmax - iylinmax) / 200
            do i = 1,nlabel
            ysymb = iylinmax + (i * 200.0)
            ypos = ylogpos(ysymb)
            call plot (xpos1, ypos, iup)
            call plot (xpos2, ypos, idown)
            call number (xpos3, ypos, charsm1, ysymb, 0.0, -1)
         end do
      end if
C
      xpos = yaxis1 = (0.75 + (14 * charsm1) + 1.0
      ypos = yorg + (ylogwdt + ylinwdt - (12 * charmed)) / 2.0
      call symbol (xpos, ypos, charmed, title7, 90.0 12)
      xpos1 = yaxis1 = 0.5
      xpos2 = yaxis1
      xpos3 = yaxis1 - (0.75 + (14 * charsm1))
      i = 1
      do while(agetime(i).le.iylogmax.and.i.le.14)
         if (agetime(i).le.iylinmax) then
               ypos = ylinpos(agetime(i))
         else
               ypos = ylogpos(agetime(i))
         end if
         call plot (xpos1, ypos, iup)
         call plot (xpos2, ypos, idown)
         agename1 = agename(i)
         call symbol (xpos3, ypos, charsm1, agenamei, 0.0 13)
         i = i + 1
      end do
      charmed = chartemp
C
C     Draw and label x axis (i.e. depth)
C
      call plot (yaxis1, yposmax, iup)
      call plot (xposmax, yposmax, idown)
      xpos = xorg + (xwdt - (28 * charmed)) / 2.0
C
C     Check if x axis label will fit on plot - if not, temporarily
C     change the size of charmed
C
      chartemp = charmed
      if (xpos.lt.xorg) then
            xpos = xorg
            charmed = xwdt / 28.0
      end if
      ypos = yposmax + 0.75 + (4 * charsm1) + 1.0
      call symbol (xpos, ypos, charmed,t itle8 0.0, 28)
      charmed = chartemp
      ypos1 = yposmax + 0.5
      ypos2 = yposmax
      ypos3 = yposmax + 0.75
      xscl = xwdt / (ixmax / ixinc)
      ntick = ixmax / ixinc + 1
      do i = 1,ntick
            xpos = xorg + (i-1) * xscl
            call plot (xpos, ypos1, iup)
            call plot (xpos, ypos2, idown)
            idiff = mod((i-1),ixlbl)
            if (idiff.eq.0) then
               xsymb = (i-1) * ixinc
               call number (xpos, ypos3, charsm1, xsymb, 90.0, -1)
         end if
      end do
C
      return
      end

C***********************************************************************
C
C     BURIAL HISTORY PLOT SUBROUTINE
C
      Subroutine pltbh (nrec, nx, topdepth, yypos, contact, removed)
C
C     This subroutine plots the burial history curves and calculates
C     the coordinates of the polygons to be shaded
C
C
C          Input: nrec - the number of layers in section
C                   nx - dimension of input arrays (parameter ix)
C            topdepth - array containing the top depth of
C                       all layers at all ages
C               yypos - array containing the y plot position
C                       for ages 1 to j
C             contact - array indicating whether layer i is
C                       currently present in the section (true) or
C                       has been eroded (false)
C             removed - array indicating at what age the bottom
C                       of layer i disappeared
C
C     Parameter iw must by > = the number of corners of the ploygon
C
      parameter (iw = 100)
      logical contact(nx)
      integer removed(nx)
      real topdepth(nx,nx), yypos(nx), xpoly(iw), ypoly(iw)
      real xplot(nx,nx), yplot(nx,nx)
C
      common /plotvar/ xorg, yorg, xwdt, ylinwdt, ylogwdt, ixinc, ixlbl,
     &              ixmax, iylinmax, iylogmax, iup, idown,
     &              charlrg, charmed, charms1, ittiflag
C
      if (nrec.gt.nx) then
            write (*,*) 'Number of layers in section = ',nrec,
     &                  ' and array sizes = ',nx
            stop
      end if
      xscl = xwdt / ixmax
      do i = 1,nrec
         istart = 0
         istop = 0
         xplot(i,1) = xorg
         ypolot(i,1) = yypos(1)
         do j = 2,nrec
               xpos = xorg + (topdepth(i,j) * xscl)
               xplot(i,j) = xpos
               yplot(i,j) = yypos(j)
               if (istop.eq.0) then
                    if (istart.eq.0) then
                      if (topdepth(i,j).gt.0.0) then
                        call plot (xorg, yypos (j-1), iup)
                        call plot (xpos, yypos (j), idown)
                        istart = 1
                      end if
                    else
                      call plot (xpos, yypos (j), idown)
                      if (topdepth(i,j).le.0.0) istop = 1
                  end if
               end if
            end do
      end do
      npat = 1
      do i = 1,nrec
         if (.not.contact(i)) then
C
C           Determine coordinates of polygon to be hatched
C
            ncorner = 0
```

```
            do j = i-1,removed(i)
               ncorner = ncorner + 1
               if (ncorner.gt.iw) then
                  write (*,*) ‘Number of corners in polygon to ’,
     &                        ‘be shaded exceeds dimension of arrays’
                  stop
               end if
               xpoly(ncorner) = xplot(i-1,j)
               ypoly(ncorner) = yplot(i-1,j)
            end do
            do j = removed(i)-1,i,-1
               ncorner = ncroner + 1
               if (ncorner.gt.iw) then
                  write (*,*) ‘Number of corners in polygon to ’
     &                       ‘be shaded exceeds dimension of arrays’
                  stop
               end if
               xpoly(ncorner) = xplotl(i,j)
               ypoly(ncorner) = yplot(i,j)
            end do
            ncorner = ncorner + 1
            if (ncorner.gt.iw) then
               write (*,*) ‘Number of corners in polygon to ’,
     &                    ‘be shaded exceeds dimension of arrays’
               stop
            end if
            xpoly(ncorner) = xploy(1)
            ypoly(ncorner) = ypoly(1)
C
C           Hatch polygon
C
               call hatch (xpoly, ypoly, ncorner, npat)
               npat = npat + 1
         end if
      end do
C
      return
      end

C***************************************************************************
C
C     PLOT TERMINATION SUBROUTINE
C
      Subroutine pltend
C
C     Plot 2nd half of cross for accuracy check and close plot file
C
      common /plotvar/ xorg, yorg, xwdt, ylinwdt, ylogwdt, ixinc, ixlbl,
     &                 ixmax, iylinmax, iylogmax, iup, idown,
     &                 charlrg, charmed, charsml, ittiflag
C
      call plot (0.0, 0.0, iup)
      call plot (0.5, 0.5, idown)
      call plot (0.0, 0.5, iup)
      call plot (0.5, 0.0, idown)
      nchar = 999
      call plot (0.0, 0.0, nchar)
C
      return
      end

C***************************************************************************
C
C         TTI POSTING SUBROUTINE
C
      Subroutine plttti (nrec, nx, topdepth, yypos, tti)
C
C           Input: nrec - the number of layers in section
C                    nx - dimension of input arrays (parameter ix)
C              topdepth - array containing the top depths of
C                         all layers at all ages
C                 yypos - array containing the y plot position
C                         for ages 1 to j
C                   tti - array containing the tti values for all
C                         layers at all ages
C
C     Parameter iz must be >= the number of tti values to be posted
C                       (i.e. 1/2 * ix*ix where ix = the number
C                       of layers in the section)
C
      parameter (iz = 450)
      real topdepth(nx,nx), yypos(nx), tti(nx,nx)
      real posssstx(iz), posty(iz), postz(iz), postminz(iz)
C
      common /plotvar/ xorg, yorg, xwdt, ylinwdt, ylogwdt, ixinc, ixlbl,
     &                      ixmax, iylinmax, iylogmax, iup, idown,
     &                      charlrg, charmed, charsml, ittiflag
C
      xscl = xwdt / ixmax
      i = 0
      do iage = 1,nrec
         i = i + 1
         postx(i) = topdepth(1,iage)
         posty(i) = yypos(iage)
         postz(i) = tti(1,iage)
         postminz(i) = -1.0
         do ilayer = 2,iage
            test = abs(topdepth(ilayer,iage) - topdepth(ilayer-1,iage))
               if (test.gt.0.01) then
                  i = i + 1
                  postx(i) = topdepth(ilayer,iage)
                  posty(i) = yypos(iage)
                  postz(i) = tti(ilayer,iage)
                  postminz(i) = -1.0
               else
                  postminz(i) = tti(ilayer,iage)
               end if
            end do
      end do
      call newpen(2)
      npostrc = i
      do i = 1,npostrcC
         xpos1 = xorg + (postx(i) * xscl)
         xpos2 = xpos1 + (2 * charsml)
         xpos3 = xpos2 + (2 * charsml)
         ypos = posty(i)
         call symbol (xpos1, ypos, charsml, 3, 0.0, -1)
         if (postminz(i).le.-1.0) then
            call number (xpos2, ypos, charsml, postz (i), 90.0, 2)
         else
            call number (xpos2, ypos, charsml, postminz (i), 90.0, 2)
            call number (xpos3, ypos, charsml, postz (i), 90.0, 2)
         end if
      end do
      return
      end

C***************************************************************************
C
C     PLOT VARIABLES INITIALIZATION SUBROUTINE
C
      Subroutine pltvar
C
      character*1 janswer,kanswer
      character*8 cmaxage
      character*20 card
      real maxdpth
C
     common /plotvar/ xorg, yorg, xwdt, ylinwdt, ylogwdt, ixinc, ixlbl,
     &                ixmax, iylinmax, iylogmax, iup, idown,
     &                charlrg, charmed, charsml, ittiflag
      common /maxvar/ cmaxage, maxage, maxdpth
C
      xwdt = 75.0
      ixinc = 100
      ixlbl = 1
      ylinwdt = 50.0
      ylogwdt = 0.0
      iup = 3
      idown = 2
      charlrg = 0.5
      charmed = 0.4
      charsml = 0.25
      ittiflage = 0
C
      write (*,900) cmaxage, maxage
  900 format (1x, ‘Oldest age on data file is ’,a8,‘ - ’,fff6.1,
     &            ‘million years’)
      write (*,901) maxdpth
  901 format (1x,‘Maximum depth of data in wells is ‘,f8.2,’ metres’)
      write (*,902)
  902 format (//)
      imaxdpth = maxdpth + 0.5
      idiff = mod(imaxdpth,ixinc)
      if (idiff.eq.0) then
         ixmax = imaxdpth
      else
         ixmax = imaxdpth - idiff + ixinc
      end if
      imaxage = maxage + 0.5
      idiff = mod(imaxage,100)
      if (idiff.eq.0) then
         iylinmax = imaxage
      else
         iylinmax = imaxage - idiff + 100
      end if
      iylogmax = iylinmax
C
   10 continue
C
      write (*,*) ‘The plot variables are:’
      write (*,*) ‘ char. size for title = ‘,charlrg,’ cm’
      write (*,*) ‘ char.size for axes titles = ‘,charmed,’ cm’
      write (*,*) ‘ char.size for axes labels = ‘,charsml,’ cm’
      write (*,*) ‘ ’
      write (*,*) ‘ max depth = ‘,ixmax,’ metres’
```

```
      write (*,*) ‘ length of depth axis = ‘,xwdt,’ cm’
      write (*,*) ‘ increment for depth tics = ‘,ixinc,’ metres’
      write (*,*) ‘ frequency of depth tic labels = ’,ixlbl
      write (*,*) ‘ ’
      write (*,*) ‘ max linear age = ‘,iylinmax,’ million years’
      write (*,*) ‘ max logarithmic age = ‘,iylogmax,’ million years’
      write (*,*) ‘ length of linear portion = ‘ylinwdt,,’ cm’
      write (*,*) ‘ length of logarithmic portion = ‘,ylogwdt,’ cm’
      write (*,*) ‘ ’
      write (*,*) ‘Caution: If at any time the maximum depth of the’
      write (*,*) ‘ section exceeds the well depth, the ’
      write (*,*) ‘ max depth value may not be large enough’
      write (*,*) ‘ ’
      write (*,*) ‘Do you want to overwrite any of the variables-y/n’
      read (5,15) janswer
   15 format (a1)
      if (janswer.ne.‘y’ .and. janswer.ne.‘Y’) go to 140
C
      write (*,*) ‘Enter char. size for title in cm ’
      call decode (rdum)
      if (rdum.gt.-1.0e30) charlrg = rdum
C
      write (*,*) ‘Enter char. size for axes titles in cm ’
      call decode (rdum)
      if (rdum.gt.-10e30) charmed = rdum
C
      write (*,*) ‘Enter char. size for axes labels in cm ’
      call decode (rdum)
      if (rdum.gt.-1.0e30) charsm1 = rdum
C
      write (*,*) ‘Enter max depth in metres ’
      call decode (rdum)
      if (rdum.gt.-1.0e30) ixmax = rdum + 0.5
C
      write (*,*) ‘Enter length of depth axis in cm ’
      call decode (rdum)
      if (rdum.gt.-1.0e30) xwdt = rdum
C
      write (*,*) ‘Enter increment for depth tics in metres ’
      call decode (rdum)
      if (rdum.gt.-10e30) ixinc = rdum + 0.5
      idiff = mod(ixmax,ixinc)
      if (idiff.gt.0) ixmax = ixmax - idiff + ixinc
C
      write (*,*) ‘Enter frequency of tic labelling ’
      call decode (rdum)
      if (rdum.gt.-1.0e30) ixlbl = rdum + 0.5
C
      write (*,*) ‘Enter max age for linear portion of plot ’,
     &            ‘in millions of years ’
      call decode (rdum)
      if (rdum.gt.-1.0e30) then
          iylinmax = rdum + 0.5
          idiff = mod(iylinmax,100)
          if (idiff.gt.0) iylinmax = iylimax = idiff + 100
      end if
C
      write (*,*) ‘Enter max age for logarithmic portion of plot ’,
     &            ‘in millions of years ’
      call decode (rdum)
      if (rdum.gt.-1.0e30) then
          iylogmax = rdum + 0.5
          idiff = mod(iylogmax,200)
          if (idiff.gt.0) iylogmax = iylogmax - idiff + 200
      end if
C
      if ((iylogmax - iylinmax).lt.100) iylogmax = iylinmax
C
      write (*,*) ‘Enter length of linear portion of age axis in cm ’
      call decode (rdum)
      if (rdum.gt.-1.0e30) ylinwdt = rdum
C
      write (*,*) ‘Enter length of log. portion of age axis in cm ’
      call decode (rdum)
      if (rdum.gt.-1.0e30) ylogwdt = rdum
C
      if (iylogmax.eq.iylinmax.and.ylogwdt.gt.0.0) then
          write (*,*) ‘Length of log. portion of age axis must be 0’
          write (*,*) ‘since max age for log portion of plot = max age’
          write (*,*) ‘of linear portion’
          ylogwdt = 0.0
      end if
C
      go to 10
C
  140 continue
      xorg = 0.5 + 2 * charlrg + 1.0 + charlrg + 0.5 + charlrg + 1.0
     &         + charmed + 1.0 + (13 * charsm1) + 0.75 + 2.0
     &         + charmed + 1.0 + (1 * charsm1) + 0.75
      yorg = 0.0
      totlywdt = yorg + ylogwdt + ylinwdt + 0.75 + (4 * charsm1)
     &             + 1.0 + charmed
      if (titlywdt.gt.86.0) then
          write (*,*) ‘Width of age axis + depth labels exceeds ’,
     &            ‘maximum plotter width of 86 cm’
          stop
      end if
C
C     post tti values?
C
      write (*,*) ‘Do you want to post the tti values = y/n ’
      read (5,15) kanswer
      if (kanswer.eq.‘y’ .or. kanswer.eq.‘Y’) ittiflag = 1
      write (*,902)
C
      if (ittiflag.eq.1) write (*,*) ‘ TTI values will be posted’
      write (*,902)
C
      return
      end

C***********************************************************************
C
CFUNCTION TO CALCULATE POSITION ON LINEAR PORTION OF AGE AXIS
C
      Function ylinpos (age)
C
      common /plovar/ xorg, yorg, xwdt, ylinwdt, ylogwdt, ixinc, ixlbl,
     &             ixmax, iylinmax, iyligmax, iup, idown,
     &             charlrg, charmed, charsm1, ittflag
C
      ylinpos = xorg + ylogwdt + ((iylinmax - age) / iylinmax)
     &             * ylinwdt
      return
      end

C***********************************************************************
C
CFUNCTION TO CALCULATE POSITION ON LOG. PORTION OF AGE AXIS
C
      Function ylogpos (age)
C
      common /plotvar/ xorg, yorg, xwdt, ylinwdt, ylogwdt, ixinc, ixlbl,
     &             ixmax, iylinmax, iylogmax, iup, idown,
     &             charlrg, charmed, charsm1, ittiflag
C
      dum1 = iylogmax
      dum2 = iylinmax
      ylogpos = yorg + (alog10(dum1/age) / alog10(dum1/dum2))
     &             * ylogwdt
      return
      end
```

APPENDIX 5

Sample datafile – Husky et al. Cutbank River 16-22 well

```
HUSKY ET AL. CUTBANK 16-22
M
0000.0  T  27  0.000  1.000  0.000  0.000  0.000  072.00  010.0  MIDTRIAS
0054.9  T  27  0.000  0.000  1.000  0.000  0.000  072.00  010.0  AGE2290
0100.0  F  04  0.000  0.000  1.000  0.000  0.000  072.00  010.0  CARNIAN
0000.0  T  27  1.000  0.000  0.000  0.000  0.000  072.00  010.0  HETTANGI
0120.4  T  27  0.500  0.500  0.000  0.000  0.000  072.00  010.0  AGE1540
0100.0  T  27  0.000  1.000  0.000  0.000  0.000  072.00  010.0  BERRIASI
0200.0  T  27  0.000  1.000  0.000  0.000  0.000  072.00  010.0  VALANGIN
0700.0  F  09  0.000  1.000  0.000  0.000  0.000  072.00  010.0  HAUTERIV
0000.0  T  27  0.000  1.000  0.000  0.000  0.000  072.00  010.0  BARREMIA
0132.5  T  27  0.000  1.000  0.000  0.000  0.000  072.00  010.0  APTIAN
0365.0  T  27  0.100  0.900  0.000  0.000  0.000  072.00  010.0  AGE1060
0000.0  T  27  0.000  1.000  0.000  0.000  0.000  072.00  010.0  AGE1020
0163.0  T  27  0.850  0.150  0.000  0.000  0.000  072.00  010.0  ALBIAN
0215.0  T  27  0.440  0.660  0.000  0.000  0.000  072.00  010.0  CENOMANI
0742.4  T  27  0.956  0.044  0.000  0.000  0.000  072.00  010.0  TURONIAN
0029.6  T  27  1.000  0.000  0.000  0.000  0.000  072.00  010.0  CONIACIA
0104.0  T  27  0.000  1.000  0.000  0.000  0.000  072.00  010.0  AGE0860
0254.5  T  27  0.862  0.138  0.000  0.000  0.000  072.00  010.0  AGE0780
0590.0  T  27  0.300  0.700  0.000  0.000  0.000  072.00  010.0  AGE0725
1230.0  T  27  0.300  0.700  0.000  0.000  0.000  072.00  010.0  AGE0672
0780.0  F  26  0.300  0.700  0.000  0.000  0.000  072.00  010.0  CRETACEO
0650.0  F  25  0.300  0.700  0.000  0.000  0.000  072.00  010.0  PALEOCEN
0900.0  F  24  0.300  0.700  0.000  0.000  0.000  072.00  010.0  AGE0480
0000.0  T  27  1.000  0.000  0.000  0.000  0.000  072.00  010.0  AGE0400
0000.0  T  27  1.000  0.000  0.000  0.000  0.000  072.00  010.0  AGE0250
0000.0  T  27  1.000  0.000  0.000  0.000  0.000  072.00  010.0  PRESENT
```

The input datafile contains three types of records. The first, with a format (A32), is the name of the well or suitable description of the section being analysed. The second record, with a format (A1), indicates whether the input data are in feet, "F", or metres, "M". Succeeding records, are the geological events to be portrayed by the burial history analysis.[1] The format of these events is (F6.1, 1X, L1, 1X, I2, 1X, 5(F5.3, 1X), F6.2, 1X, F5.1, 1X, A8). The fields represented are: thickness of the layer (zero for unconformities); a logical variable which is true (T) of the geological event is currently observable in the stratigraphic section and false (F) if the event is not currently observable in the section (sedimentary layers removed by erosion); the number of geological events (input records), when the layer is removed from the section by erosion (layers still present in the section and erosion surfaces have values greater than the total number of events); four fields describing the fractional proportion of shale, sandstone, carbonate rock and evaporite in each layer; a field describing the fractional proportion of porosity in the uncompactable layers; the surface heat flux (mW/m^2) at the time associated with this event; the surface temperature (°C) at the same time; and the code for the appropriate geological age when this event occurs.

---

[1] Currently the number of events is limited to 50. This may be changed by altering the parameter statement in program line 104.

APPENDIX 6

Sample age assignment file

In the file listed below the format of records is (1X, A8, 1X, F5.1). Additional text is for illustration purposes only. The first field contains the abbreviated geological age that appears in the input file, the second field contains the absolute age assigned in the program, and the additional text is the full geological age name for reference purposes. The assigned absolute ages indicate the upper limit of ages following the time scale of Harland et al. (1982).

```
PRECAMBR        590.00      PRECAMBRIAN
CAERFAI         540.00          Caerfaian
ST. DAVID       525.00          St. David's
MERIONET        505.00          Merioneth
CAMBRIAN        505.00      CAMBRIAN
TREMADOC        488.00          Tremadoc
ARENIG          478.00          Arenig
LLANVIRN        468.00          Llanvirn
LLANDEIL        458.00          Llandeilo
CARODOC         448.00          Carodoc
ASHGILLI        438.00          Ashgill
ORDOVICI        438.00      ORDOVICIAN
LLANDOVE        428.00          Llandovery
WENLOCK         421.00          Wenlock
LUDLOW          414.00          Ludlow
PRIDOLI         408.00          Pridoli
SILURIAN        408.00      SILURIAN
GEDINNIA        401.00              Gedinnian
SIEGENIA        394.00              Siegenian
EMSIAN          387.00              Emsian
EARLYDEV        387.00          Early Devonian
EIFELIAN        380.00              Eifelian
GIVETIAN        374.00              Givetian
MIDDEVON        374.00          Middle Devonian
FRASNIAN        367.00              Frasnian
FAMENNIA        360.00              Famennian
LATEDEVO        360.00          Late Devonian
DEVONIAN        360.00      DEVONIAN
TOURNAIS        352.00              Tournaisian
VISEAN          333.00              Visean
DINANTIA        333.00          Dinantian
SERPUKHO        320.00              Serpukhovian
MISSISSI        320.00      MISSISSIPIAN
NAMURIAN        315.00              Namurian
WESTPHAL        296.00              Westphalian
STEPHANI        286.00              Stephanian
SILESIAN        286.00          Silesian
PENNSYLV        286.00      PENNSYLVANIAN
CARBONIF        286.00      CARBONIFEROUS
SAKMARIA        268.00              Sakmarian
ARTINSKI        263.00              Artinskian
KUNGURIA        258.00              Kungurian
EARLYPER        258.00          Early Permian
KAZANIAN        253.00              Kazanian
TATARIAN        248.00              Tatarian
LATEPERM        248.00          Late Permian
```

PERMIAN	248.00	PERMIAN
PALEOZOI	248.00	PALEOZOIC
SCYTHIAN	243.00	Scythian
ANISIAN	238.00	Anisian
LADINIAN	231.00	Ladinian
MIDTRIAS	231.00	Middle Triassic
AGE2290	229.00	Age for example plot
CARIAN	225.00	Carnian
NORIAN	219.00	Norian
RHAETIAN	213.00	Rhaetian
LATETRIA	213.00	Late Triassic
TRIASSIC	213.00	TRIASSIC
HETTANGI	206.00	Hettangian
SINEMURI	200.00	Sinemurian
PLIENSBA	194.00	Pliensbachian
TOARCIAN	188.00	Toarcian
LIAS	188.00	Lias
AALENIAN	181.00	Aalenian
BAJOCIAN	175.00	Bojocian
BATHONIA	169.00	Bathonian
CALLOVIA	163.00	Callovian
DOGGER	163.00	Dogger
OXFORDIA	156.00	Oxfordian
AGE1540	154.00	Age for example plot (early Kimmeridgian)
KIMMERID	150.00	Kimmeridgian
TITHONIA	144.00	Tithonian
MALM	144.00	Malm
JURASSIC	144.00	JURASSIC
BERRIASI	138.00	Berriasian
VALANGIN	131.00	Valanginian
HAUTERIV	125.00	Hauterivian
NEOCOMIA	125.00	Neocomian
AGE1220	122.00	Age for example plot (middle Barremian)
BARREMIA	119.00	Barremian
APTIAN	113.00	Aptian
AGE1060	106.00	Age for example plot (middle Albian)
AGE1020	102.00	Age for example plot (middle Albian)
ALBIAN	097.50	Albian
EARLYCRE	097.50	Early Cretaceous
CENOMANI	091.00	Cenomanian
TURONIAN	088.50	Turonian
CONIACIA	087.50	Coniacian
AGE0860	086.00	Age for example plot (early Santonian)
SANTONIA	083.00	Santonian
AGE0780	078.00	Age for example plot (middle Campanian)
CAMPANIA	073.00	Campanian
AGE0725	072.50	Age for example plot (early Maastrichtian)
AGE0672	067.20	Age for example plot (middle Maastrichtian)
MAASTRIC	065.00	Maastrichtian
SENONIAN	065.00	Senonian
LATECRET	065.00	Late Cretaceous
CRETACEO	065.00	CRETACEOUS
MESOZOIC	065.00	MESOZOIC
AGE0630	063.00	Age for example plot (early Danian)
DANIAN	060.20	Danian

AGE0570	057.00	Age for example plot (early Thanetian)
THANETIA	054.90	Thanetian
PALEOCEN	054.90	Paleocene
YPRESIAN	050.50	Ypresian
AGE0480	048.00	Age for example plot (early Middle Eocene)
MIDEOCE	042.00	Middle Eocene
AGE0400	040.00	Age for example plot (early Priabonian)
PRIABONI	038.00	Priabonian
EOCENE	038.00	Eocene
RUPELIAN	032.80	Rupelian
AGE0250	025.00	Age for example plot (early Chattian)
CHATTIAN	024.60	Chattian
OLIGOCEN	024.60	Oligocene
PALEOGEN	024.60	PALEOGENE
EARLYMIO	014.40	Early Miocene
MIDMIOCE	011.30	Middle Miocene
LATEMIOC	005.10	Late Miocene
MIOCENE	005.10	Miocene
PLIOCENE	002.00	Pliocene
NEOGENE	002.00	NEOGENE
TERTIARY	002.00	TERTIARY
PLEISTOC	000.01	Pleistocene
HOLOCENE	000.00	Holocene
QUATERNA	000.00	QUATERNARY
CENOZOIC	000.00	CENOZOIC
PRESENT	000.00	PRESENT

APPENDIX 7

Sample interactive program run and output log file

Responses to program prompts are in upper case letters. Program prompts and responses are in lower case letters. The input data file and geological age file are, datafile and ages, respectively. The : prompt is a HP MPE-XL feature and BURIAL is a compiled and prepared version of the Fortran 77 source code found in Appendix 4.

Sample Interactive Program Run

```
:run burial

Data Filename? datafile

Geological Age Filename? ages

Plot Filename (new file) ? plotfile

Output Filename (new file) ? outfile

Oldest age on data file is MIDTRIAS - 231.0 million years
Maximum depth of data in well is 4301.30 metres

The plot variables are:
  char. size for title =   .5 cm
  char. size for axes titles =   .4 cm
  char. size for axes labels =   .25 cm

  max depth =   4400 metres
  length of depth axis =   75.0 cm
  increment for depth tics = 100 metres
  frequency of depth tic labels =   1

  max linear age =   300 milion years
  max logarithmic age =   300 million years
  length of linear portion =   50.0 cm
  length of logarithmic portion =   .0 cm

Caution:  If at any time the maxium depth of the
          section exceeds the well depth, the
          value for max depth may not be large enough

Do you want to overwrite any of these variables-y/n y

Enter char. size for title in cm

Enter char. size for axes titles in cm

Enter char. size for axes labels in cm

Enter max depth in metres 7000

Enter length of depth axis in cm
```

```
Enter increment for depth tics in metres

Enter frequency of tic labelling 5

Enter max age for linear portion of plot in millions of years

Enter max age for logarithmic portion of plot in million of years

Enter length of linear portion of age axis in cm

Enter length of log. portion of age axis in cm

The plot variables are:
  char. size for title =    0.5 cm
  char. size for axes titles =  0.4 cm
  char. size for axes labels -  0.25 cm

  max depth = 7000 metres
  length of depth axis =  75.0 cm
  increments for depth tics =  100 metres
  frequency of depth tic labels =  5

  max linear age =  300 million years
  max logarithmic age =  300 million years
  length of linear portion =  50.0 cm
  length of logarithmic portion =  0.0 cm

Caution:  If at any time the maximum depth of the
          section exceeds the well depth, the
          value for max depth may not be large enough

Do you want to overwrite any of these variables-y/n n

Do you want to post the tti values - y/n n




END OF PROGRAM
```

Output Log File

```
  Data Filename - datafile
  Geological Age Filename - ages
  Plot Filename - plotfile

HUSKY ET AL. CUTBANK 16-22
M
    .0    T  27     .000    1.000     .000     .000     .000    72.00    10.0    MIDTRIAS
  54.9    T  27     .000     .000    1.000     .000     .000    72.00    10.0    AGE2290
 100.0    F  04     .000    1.000     .000     .000     .000    72.00    10.0    CARNIAN
    .0    T  27    1.000     .000     .000     .000     .000    72.00    10.0    HETTANGI
 120.4    T  27     .500     .500     .000     .000     .000    72.00    10.0    AGE1540
 100.0    T  27     .000    1.000     .000     .000     .000    72.00    10.0    BERRIASI
 200.0    T  27     .000    1.000     .000     .000     .000    72.00    10.0    VALANGIN
 700.0    F  09     .000    1.000     .000     .000     .000    72.00    10.0    HAUTERIV
    .0    T  27     .000    1.000     .000     .000     .000    72.00    10.0    BARREMIA
 132.5    T  27     .000    1.000     .000     .000     .000    72.00    10.0    APTIAN
 365.0    T  27     .100     .900     .000     .000     .000    72.00    10.0    AGE1060
    .0    T  27     .000    1.000     .000     .000     .000    72.00    10.0    AGE1020
 163.0    T  27     .850     .150     .000     .000     .000    72.00    10.0    ALBIAN
 215.0    T  27     .440     .660     .000     .000     .000    72.00    10.0    CENOMANI
 742.4    T  27     .956     .044     .000     .000     .000    72.00    10.0    TURONIAN
  29.6    T  27    1.000     .000     .000     .000     .000    72.00    10.0    CONIACIA
 104.0    T  27     .000    1.000     .000     .000     .000    72.00    10.0    AGE0860
 254.5    T  27     .862     .138     .000     .000     .000    72.00    10.0    AGE0780
 590.0    T  27     .300     .700     .000     .000     .000    72.00    10.0    AGE0725
1230.0    T  27     .300     .700     .000     .000     .000    72.00    10.0    AGE0672
 780.0    F  26     .300     .700     .000     .000     .000    72.00    10.0    CRETACEO
 650.0    F  25     .300     .700     .000     .000     .000    72.00    10.0    PALEOCEN
 900.0    F  24     .300     .700     .000     .000     .000    72.00    10.0    AGE0480
    .0    T  27    1.000     .000     .000     .000     .000    72.00    10.0    AGE0400
    .0    T  27    1.000     .000     .000     .000     .000    72.00    10.0    AGE0250
    .0    T  27    1.000     .000     .000     .000     .000    72.00    10.0    PRESENT
```

LAYER	$R_o$max
1	2.02
2	1.98
3	1.98
4	1.98
5	1.89
6	1.82
7	1.69
8	1.69
9	1.69
10	1.61
11	1.40
12	1.40
13	1.31
14	1.21
15	.88
16	.87
17	.84
18	.75
19	.58
20	.33
21	.23
22	.18
23	.15
24	.14
25	.13
26	.00

LAYER	AGE	TOP-DEPTH (METRES)	THICKNESS (METRES)	SHALE		THERMK (mW/M-DEG)	TEMP (DEG-C)	TTI
				FRAC	PHI			
1	1	.00	.00	.00	.00	.00	10.00	.00
1	2	54.90	.00	.00	.00	.00	11.19	.00
1	3	154.90	.00	.00	.00	.00	13.44	.01
1	4	54.90	.00	.00	.00	.00	11.19	.04
1	5	214.05	.00	.00	.00	.00	16.45	.13
1	6	311.14	.00	.00	.00	.00	18.49	.17
1	7	506.14	.00	.00	.00	.00	22.64	.19
1	8	1194.28	.00	.00	.00	.00	37.59	.23
1	9	494.28	.00	.00	.00	.00	21.84	.26
1	10	626.78	.00	.00	.00	.00	24.82	.28
1	11	1012.86	.00	.00	.00	.00	34.30	.32
1	12	1012.86	.00	.00	.00	.00	34.30	.35
1	13	1255.05	.00	.00	.00	.00	43.62	.40
1	14	1504.89	.00	.00	.00	.00	50.20	.51
1	15	2475.88	.00	.00	.00	.00	83.57	.73
1	16	2511.97	.00	.00	.00	.00	84.74	.97
1	17	2590.36	.00	.00	.00	.00	85.19	1.34
1	18	2883.67	.00	.00	.00	.00	93.82	4.12
1	19	3411.12	.00	.00	.00	.00	102.34	7.57
1	20	4543.85	.00	.00	.00	.00	124.59	18.08
1	21	5261.75	.00	.00	.00	.00	139.68	33.17
1	22	5848.14	.00	.00	.00	.00	152.12	210.53
1	23	6631.30	.00	.00	.00	.00	168.66	549.22
1	24	5731.30	.00	.00	.00	.00	144.97	873.34
1	25	5081.30	.00	.00	.00	.00	128.69	1016.96
1	26	4301.30	.00	.00	.00	.00	109.77	1088.92
2	1	.00	.00	.00	.00	.00	10.00	.00
2	2	.00	54.90	.00	.00	3326.00	10.00	.00
2	3	100.00	54.90	.00	.00	3326.00	12.25	.01
2	4	.00	54.90	.00	.00	3326.00	10.00	.03
2	5	159.15	54.90	.00	.00	3326.00	15.26	.12
2	6	256.24	54.90	.00	.00	3326.00	17.31	.16
2	7	451.24	54.90	.00	.00	3326.00	21.45	.17
2	8	1139.38	54.90	.00	.00	3326.00	36.40	.21
2	9	439.38	54.90	.00	.00	3326.00	20.63	.24
2	10	571.88	54.90	.00	.00	3326.00	23.63	.26
2	11	957.96	54.90	.00	.00	3326.00	33.11	.29
2	12	957.96	54.90	.00	.00	3326.00	33.11	.32
2	13	1200.15	54.90	.00	.00	3326.00	42.43	.36
2	14	1449.99	54.90	.00	.00	3326.00	49.01	.47
2	15	2420.98	54.90	.00	.00	3326.00	82.39	.67
2	16	2457.07	54.90	.00	.00	3326.00	83.55	.89
2	17	2535.46	54.90	.00	.00	3326.00	84.00	1.24
2	18	2828.77	54.90	.00	.00	3326.00	92.64	3.79
2	19	3356.22	54.90	.00	.00	3326.00	101.15	6.97
2	20	4488.95	54.90	.00	.00	3326.00	123.40	16.64
2	21	5206.85	54.90	.00	.00	3326.00	138.49	30.55
2	22	5793.24	54.90	.00	.00	3326.00	150.93	193.88
2	23	6576.40	54.90	.00	.00	3326.00	167.47	505.79
2	24	5676.40	54.90	.00	.00	3326.00	143.79	804.28
2	25	5026.40	54.90	.00	.00	3326.00	127.51	936.54
2	26	4246.40	54.90	.00	.00	3326.00	108.58	1002.81

LAYER	AGE	TOP-DEPTH (METRES)	THICKNESS (METRES)	SHALE		THERMK (mW/M-DEG)	TEMP (DEG-C)	TTI
				FRAC	PHI			
3	1	.00	.00	.00	.00	.00	10.00	.00
3	2	.00	.00	.00	.00	.00	10.00	.00
3	3	.00	100.00	.00	.41	3200.00	10.00	.00
3	4	.00	.00	.00	.00	.00	10.00	.03
3	5	159.15	.00	.00	.00	.00	15.26	.11
3	6	256.24	.00	.00	.00	.00	17.31	.15
3	7	451.24	.00	.00	.00	.00	21.45	.17
3	8	1139.38	.00	.00	.00	.00	36.40	.20
3	9	439.38	.00	.00	.00	.00	20.65	.23
3	10	571.88	.00	.00	.00	.00	23.63	.25
3	11	957.96	.00	.00	.00	.00	33.11	.28
3	12	957.96	.00	.00	.00	.00	33.11	.31
3	13	1200.15	.00	.00	.00	.00	42.43	.35
3	14	1449.99	.00	.00	.00	.00	49.01	.46
3	15	2420.98	.00	.00	.00	.00	82.39	.67
3	16	2457.07	.00	.00	.00	.00	83.55	.88
3	17	2535.46	.00	.00	.00	.00	84.00	1.23
3	18	2828.77	.00	.00	.00	.00	92.64	3.78
3	19	3356.22	.00	.00	.00	.00	101.15	6.96
3	20	4488.95	.00	.00	.00	.00	123.40	16.64
3	21	5206.85	.00	.00	.00	.00	138.49	30.54
3	22	5793.24	.00	.00	.00	.00	150.93	193.87
3	23	6576.40	.00	.00	.00	.00	167.47	505.78
3	24	5676.40	.00	.00	.00	.00	143.79	804.27
3	25	5026.40	.00	.00	.00	.00	127.51	936.53
3	26	4246.40	.00	.00	.00	.00	108.58	1002.80
4	1	.00	.00	.00	.00	.00	10.00	.00
4	2	.00	.00	.00	.00	.00	10.00	.00
4	3	.00	.00	.00	.00	.00	10.00	.00
4	4	.00	.00	.00	.00	.00	10.00	.00
4	5	159.15	.00	.00	.00	.00	15.26	.09
4	6	256.24	.00	.00	.00	.00	17.31	.12
4	7	451.24	.00	.00	.00	.00	21.45	.14
4	8	1139.38	.00	.00	.00	.00	36.40	1.7
4	9	439.38	.00	.00	.00	.00	20.65	.20
4	10	571.88	.00	.00	.00	.00	23.63	.22
4	11	957.96	.00	.00	.00	.00	33.11	.26
4	12	957.96	.00	.00	.00	.00	33.11	.28
4	13	1200.15	.00	.00	.00	.00	42.43	.33
4	14	1449.99	.00	.00	.00	.00	49.01	.44
4	15	2420.98	.00	.00	.00	.00	82.39	.64
4	16	2457.07	.00	.00	.00	.00	83.55	.86
4	17	2535.46	.00	.00	.00	.00	84.00	1.20
4	18	2828.77	.00	.00	.00	.00	92.64	3.76
4	19	3356.22	.00	.00	.00	.00	101.15	6.94
4	20	4488.95	.00	.00	.00	.00	123.40	16.61
4	21	5206.85	.00	.00	.00	.00	138.49	30.51
4	22	5793.24	.00	.00	.00	.00	150.93	193.85
4	23	6576.40	.00	.00	.00	.00	167.47	505.75
4	24	5676.40	.00	.00	.00	.00	143.79	804.25
4	25	5026.40	.00	.00	.00	.00	127.51	936.51
4	26	4246.40	.00	.00	.00	.00	108.58	1002.77

LAYER	AGE	TOP-DEPTH (METRES)	THICKNESS (METRES)	SHALE		THERMK (mW/M-DEG)	TEMP (DEG-C)	TTI
				FRAC	PHI			
5	1	.00	.00	.00	.00	.00	10.00	.00
5	2	.00	.00	.00	.00	.00	10.00	.00
5	3	.00	.00	.00	.00	.00	10.00	.00
5	4	.00	.00	.00	.00	.00	10.00	.00
5	5	.00	159.15	.62	.40	2176.68	10.00	.00
5	6	100.00	156.24	.61	.39	2224.95	12.25	.02
5	7	300.00	151.24	.60	.35	2315.18	16.75	.04
5	8	1000.00	139.38	.57	.26	2572.60	32.50	.06
5	9	300.00	139.38	.57	.26	2572.60	16.75	.09
5	10	432.50	139.38	.57	.26	2572.60	19.73	.10
5	11	818.58	139.38	.57	.26	2572.60	29.21	.13
5	12	818.58	139.38	.57	.26	2572.60	29.21	.15
5	13	1061.52	138.63	.57	.25	2591.43	38.58	.18
5	14	1314.10	135.88	.56	.22	2663.29	45.33	.26
5	15	2292.17	128.81	.53	.14	2872.92	79.16	.42
5	16	2328.45	128.63	.53	.14	2878.98	80.33	.60
5	17	2407.23	128.24	.53	.13	2891.79	80.81	.87
5	18	2701.84	126.93	.53	.12	2935.68	89.52	2.93
5	19	3231.15	125.07	.52	.09	3000.72	98.15	5.50
5	20	4366.43	122.52	.51	.05	3095.88	120.55	13.41
5	21	5085.32	121.53	.50	.04	3134.63	135.70	24.85
5	22	5672.84	120.40	.50	.03	3158.11	148.19	159.70
5	23	6456.00	120.40	.50	.02	3180.54	164.75	417.77
5	24	5556.00	120.40	.50	.02	3180.54	141.06	664.88
5	25	4906.00	120.40	.50	.02	3180.54	124.78	774.37
5	26	4126.00	120.40	.50	.02	3180.54	105.86	829.23
6	1	.00	.00	.00	.00	.00	10.00	.00
6	2	.00	.00	.00	.00	.00	10.00	.00
6	3	.00	.00	.00	.00	.00	10.00	.00
6	4	.00	.00	.00	.00	.00	10.00	.00
6	5	.00	.00	.00	.00	.00	10.00	.00
6	6	.00	100.00	.00	.00	3200.00	10.00	.00
6	7	200.00	100.00	.00	.00	3200.00	14.50	.01
6	8	900.00	100.00	.00	.00	3200.00	30.25	.03
6	9	200.00	100.00	.00	.00	3200.00	14.50	.05
6	10	332.50	100.00	.00	.00	3200.00	17.48	.06
6	11	718.58	100.00	.00	.00	3200.00	26.96	.09
6	12	718.58	100.00	.00	.00	3200.00	26.96	.11
6	13	961.52	100.00	.00	.00	3200.00	36.33	.13
6	14	1214.10	100.00	.00	.00	3200.00	43.08	.21
6	15	2192.17	100.00	.00	.00	3200.00	76.91	.34
6	16	2228.45	100.00	.00	.00	3200.00	78.08	.49
6	17	2307.23	100.00	.00	.00	3200.00	78.56	.73
6	18	2601.84	100.00	.00	.00	3200.00	87.27	2.48
6	19	3131.15	100.00	.00	.00	3200.00	95.90	4.69
6	20	4266.43	100.00	.00	.00	3200.00	118.30	11.45
6	21	4985.32	100.00	.00	.00	3200.00	133.45	21.24
6	22	5572.84	100.00	.00	.00	3200.00	145.94	136.61
6	23	6356.00	100.00	.00	.00	3200.00	162.50	357.42
6	24	5456.00	100.00	.00	.00	3200.00	138.81	568.84
6	25	4806.00	100.00	.00	.00	3200.00	122.53	662.52
6	26	4026.00	100.00	.00	.00	3200.00	103.61	709.46

LAYER	AGE	TOP-DEPTH (METRES)	THICKNESS (METRES)	SHALE		THERMK (mW/M-DEG)	TEMP (DEG-C)	TTI
				FRAC	PHI			
7	1	.00	.00	.00	.00	.00	10.00	.00
7	2	.00	.00	.00	.00	.00	10.00	.00
7	3	.00	.00	.00	.00	.00	10.00	.00
7	4	.00	.00	.00	.00	.00	10.00	.00
7	5	.00	.00	.00	.00	.00	10.00	.00
7	6	.00	.00	.00	.00	.00	10.00	.00
7	7	.00	200.00	.00	.00	3200.00	10.00	.00
7	8	700.00	200.00	.00	.00	3200.00	25.75	.02
7	9	.00	200.00	.00	.00	3200.00	10.00	.03
7	10	132.50	200.00	.00	.00	3200.00	12.98	.04
7	11	518.58	200.00	.00	.00	3200.00	22.46	.06
7	12	518.58	200.00	.00	.00	3200.00	22.46	.07
7	13	761.52	200.00	.00	.00	3200.00	31.83	.09
7	14	1014.10	200.00	.00	.00	3200.00	38.58	.14
7	15	1992.17	200.00	.00	.00	3200.00	72.41	.24
7	16	2028.45	200.00	.00	.00	3200.00	73.58	.35
7	17	2107.23	200.00	.00	.00	3200.00	74.06	.52
7	18	2401.84	200.00	.00	.00	3200.00	82.77	1.81
7	19	2931.15	200.00	.00	.00	3200.00	91.40	3.42
7	20	4066.43	200.00	.00	.00	3200.00	113.80	8.38
7	21	4785.32	200.00	.00	.00	3200.00	128.95	15.54
7	22	5372.84	200.00	.00	.00	3200.00	141.44	100.00
7	23	6156.00	200.00	.00	.00	3200.00	158.00	261.64
7	24	5256.00	200.00	.00	.00	3200.00	134.31	416.41
7	25	4606.00	200.00	.00	.00	3200.00	118.03	484.99
7	26	3826.00	200.00	.00	.00	3200.00	99.11	519.35
8	1	.00	.00	.00	.00	.00	10.00	.00
8	2	.00	.00	.00	.00	.00	10.00	.00
8	3	.00	.00	.00	.00	.00	10.00	.00
8	4	.00	.00	.00	.00	.00	10.00	.00
8	5	.00	.00	.00	.00	.00	10.00	.00
8	6	.00	.00	.00	.00	.00	10.00	.00
8	7	.00	.00	.00	.00	.00	10.00	.00
8	8	.00	700.00	.00	.36	3200.00	10.00	.00
8	9	.00	.00	.00	.00	.00	10.00	.01
8	10	132.50	.00	.00	.00	.00	12.98	.02
8	11	518.58	.00	.00	.00	.00	22.46	.03
8	12	518.58	.00	.00	.00	.00	22.46	.05
8	13	761.52	.00	.00	.00	.00	31.83	.07
8	14	1014.10	.00	.00	.00	.00	38.58	.12
8	15	1992.17	.00	.00	.00	.00	72.41	.22
8	16	2028.45	.00	.00	.00	.00	73.58	.33
8	17	2107.23	.00	.00	.00	.00	74.06	.50
8	18	2401.84	.00	.00	.00	.00	82.77	1.79
8	19	2931.15	.00	.00	.00	.00	91.40	3.40
8	20	4066.43	.00	.00	.00	.00	113.80	8.35
8	21	4785.32	.00	.00	.00	.00	128.95	15.52
8	22	5372.84	.00	.00	.00	.00	141.44	99.98
8	23	6156.00	.00	.00	.00	.00	158.00	261.62
8	24	5256.00	.00	.00	.00	.00	134.31	416.39
8	25	4606.00	.00	.00	.00	.00	118.03	484.97
8	26	3826.00	.00	.00	.00	.00	99.11	519.33

LAYER	AGE	TOP-DEPTH (METRES)	THICKNESS (METRES)	SHALE		THERMK (mW/M-DEG)	TEMP (DEG-C)	TTI
				FRAC	PHI			
9	1	.00	.00	.00	.00	.00	10.00	.00
9	2	.00	.00	.00	.00	.00	10.00	.00
9	3	.00	.00	.00	.00	.00	10.00	.00
9	4	.00	.00	.00	.00	.00	10.00	.00
9	5	.00	.00	.00	.00	.00	10.00	.00
9	6	.00	.00	.00	.00	.00	10.00	.00
9	7	.00	.00	.00	.00	.00	10.00	.00
9	8	.00	.00	.00	.00	.00	10.00	.00
9	9	.00	.00	.00	.00	.00	10.00	.00
9	10	132.50	.00	.00	.00	.00	12.98	.01
9	11	518.58	.00	.00	.00	.00	22.46	.03
9	12	518.58	.00	.00	.00	.00	22.46	.04
9	13	761.52	.00	.00	.00	.00	31.83	.06
9	14	1014.10	.00	.00	.00	.00	38.58	.11
9	15	1992.17	.00	.00	.00	.00	72.41	.21
9	16	2028.45	.00	.00	.00	.00	73.58	.32
9	17	2107.23	.00	.00	.00	.00	74.06	.49
9	18	2401.84	.00	.00	.00	.00	82.77	1.78
9	19	2931.15	.00	.00	.00	.00	91.40	3.39
9	20	4066.43	.00	.00	.00	.00	113.80	8.35
9	21	4785.32	.00	.00	.00	.00	128.95	15.51
9	22	5372.84	.00	.00	.00	.00	141.44	99.97
9	23	6156.00	.00	.00	.00	.00	158.00	261.61
9	24	5256.00	.00	.00	.00	.00	134.31	416.38
9	25	4606.00	.00	.00	.00	.00	118.03	484.96
9	26	3826.00	.00	.00	.00	.00	99.11	519.32
10	1	.00	.00	.00	.00	.00	10.00	.00
10	2	.00	.00	.00	.00	.00	10.00	.00
10	3	.00	.00	.00	.00	.00	10.00	.00
10	4	.00	.00	.00	.00	.00	10.00	.00
10	5	.00	.00	.00	.00	.00	10.00	.00
10	6	.00	.00	.00	.00	.00	10.00	.00
10	7	.00	.00	.00	.00	.00	10.00	.00
10	8	.00	.00	.00	.00	.00	10.00	.00
10	9	.00	.00	.00	.00	.00	10.00	.00
10	10	.00	132.50	.00	.00	3200.00	10.00	.00
10	11	386.08	132.50	.00	.00	3200.00	19.48	.01
10	12	386.08	132.50	.00	.00	3200.00	19.48	.02
10	13	629.02	132.50	.00	.00	3200.00	28.85	.04
10	14	881.60	132.50	.00	.00	3200.00	35.60	.08
10	15	1859.67	132.50	.00	.00	3200.00	69.43	.17
10	16	1895.95	132.50	.00	.00	3200.00	70.60	.25
10	17	1974.73	132.50	.00	.00	3200.00	71.07	.39
10	18	2269.34	132.50	.00	.00	3200.00	79.79	1.44
10	19	2798.65	132.50	.00	.00	3200.00	88.42	2.75
10	20	3933.93	132.50	.00	.00	3200.00	110.82	6.78
10	21	4652.82	132.50	.00	.00	3200.00	125.97	12.61
10	22	5240.34	132.50	.00	.00	3200.00	138.45	81.30
10	23	6023.50	132.50	.00	.00	3200.00	155.02	212.76
10	24	5123.50	132.50	.00	.00	3200.00	131.33	338.64
10	25	4473.50	132.50	.00	.00	3200.00	115.05	394.41
10	26	3693.50	132.50	.00	.00	3200.00	96.12	422.36

LAYER	AGE	TOP-DEPTH (METRES)	THICKNESS (METRES)	SHALE		THERMK (mW/M-DEG)	TEMP (DEG-C)	TTI
				FRAC	PHI			
11	1	.00	.00	.00	.00	.00	10.00	.00
11	2	.00	.00	.00	.00	.00	10.00	.00
11	3	.00	.00	.00	.00	.00	10.00	.00
11	4	.00	.00	.00	.00	.00	10.00	.00
11	5	.00	.00	.00	.00	.00	10.00	.00
11	6	.00	.00	.00	.00	.00	10.00	.00
11	7	.00	.00	.00	.00	.00	10.00	.00
11	8	.00	.00	.00	.00	.00	10.00	.00
11	9	.00	.00	.00	.00	.00	10.00	.00
11	10	.00	.00	.00	.00	.00	10.00	.00
11	11	.00	386.08	.15	.38	2931.46	10.00	.00
11	12	.00	386.08	.15	.38	2931.46	10.00	.01
11	13	246.55	382.47	.14	.34	2972.56	19.58	.01
11	14	502.09	379.51	.13	.30	3007.26	26.52	.04
11	15	1487.20	372.47	.12	.19	3093.86	60.76	.08
11	16	1523.65	372.30	.12	.19	3096.09	61.94	.13
11	17	1602.80	371.93	.12	.18	3100.76	62.44	.21
11	18	1898.62	370.72	.11	.16	3116.31	71.23	.78
11	19	2429.61	369.04	.11	.12	3138.18	79.95	1.51
11	20	3567.13	336.80	.10	.07	3167.89	102.48	3.76
11	21	4286.86	365.96	.10	.05	3179.28	117.68	7.04
11	22	4874.88	365.47	.10	.04	3185.94	130.19	45.76
11	23	5658.50	365.00	.10	.03	3192.29	146.78	120.00
11	24	4758.50	365.00	.10	.03	3192.29	123.10	191.14
11	25	4108.50	365.00	.10	.03	3192.29	106.82	222.66
11	26	3328.50	365.00	.10	.03	3192.29	87.89	238.46
12	1	.00	.00	.00	.00	.00	10.00	.00
12	2	.00	.00	.00	.00	.00	10.00	.00
12	3	.00	.00	.00	.00	.00	10.00	.00
12	4	.00	.00	.00	.00	.00	10.00	.00
12	5	.00	.00	.00	.00	.00	10.00	.00
12	6	.00	.00	.00	.00	.00	10.00	.00
12	7	.00	.00	.00	.00	.00	10.00	.00
12	8	.00	.00	.00	.00	.00	10.00	.00
12	9	.00	.00	.00	.00	.00	10.00	.00
12	10	.00	.00	.00	.00	.00	10.00	.00
12	11	.00	.00	.00	.00	.00	10.00	.00
12	12	.00	.00	.00	.00	.00	10.00	.00
12	13	246.55	.00	.00	.00	.00	19.58	.01
12	14	502.09	.00	.00	.00	.00	26.52	.03
12	15	1487.20	.00	.00	.00	.00	60.76	.08
12	16	1523.65	.00	.00	.00	.00	61.94	.12
12	17	1602.80	.00	.00	.00	.00	62.44	.20
12	18	1898.62	.00	.00	.00	.00	71.23	.78
12	19	2429.61	.00	.00	.00	.00	79.95	1.51
12	20	3567.13	.00	.00	.00	.00	102.48	3.76
12	21	4286.86	.00	.00	.00	.00	117.68	7.03
12	22	4874.88	.00	.00	.00	.00	130.19	45.75
12	23	5658.50	.00	.00	.00	.00	146.78	119.99
12	24	4758.50	.00	.00	.00	.00	123.10	191.14
12	25	4108.50	.00	.00	.00	.00	106.82	222.66
12	26	3328.50	.00	.00	.00	.00	87.89	238.45

LAYER	AGE	TOP-DEPTH (METRES)	THICKNESS (METRES)	SHALE		THERMK (mW/M-DEG)	TEMP (DEG-C)	TTI
				FRAC	PHI			
13	1	.00	.00	.00	.00	.00	10.00	.00
13	2	.00	.00	.00	.00	.00	10.00	.00
13	3	.00	.00	.00	.00	.00	10.00	.00
13	4	.00	.00	.00	.00	.00	10.00	.00
13	5	.00	.00	.00	.00	.00	10.00	.00
13	6	.00	.00	.00	.00	.00	10.00	.00
13	7	.00	.00	.00	.00	.00	10.00	.00
13	8	.00	.00	.00	.00	.00	10.00	.00
13	9	.00	.00	.00	.00	.00	10.00	.00
13	10	.00	.00	.00	.00	.00	10.00	.00
13	11	.00	.00	.00	.00	.00	10.00	.00
13	12	.00	.00	.00	.00	.00	10.00	.00
13	13	.00	246.55	.90	.40	1852.46	10.00	.00
13	14	271.08	231.01	.89	.35	1983.62	18.13	.01
13	15	1290.69	196.51	.88	.22	2400.05	54.86	.04
13	16	1327.96	195.69	.88	.22	2412.91	56.10	.07
13	17	1408.82	193.98	.87	.21	2440.25	56.71	.12
13	18	1710.23	188.39	.87	.18	2535.61	65.88	.52
13	19	2248.83	180.77	.86	.14	2681.90	75.10	1.03
13	20	3396.29	170.84	.86	.08	2907.30	98.25	2.68
13	21	4119.72	167.14	.85	.06	3003.12	113.67	5.15
13	22	4709.86	165.01	.85	.05	3061.91	126.31	34.62
13	23	5495.50	163.00	.85	.03	3119.83	143.02	91.64
13	24	4595.50	163.00	.85	.03	3119.83	119.34	146.45
13	25	3945.50	163.00	.85	.03	3119.83	103.05	170.74
13	26	3165.50	163.00	.85	.03	3119.83	84.13	182.91
14	1	.00	.00	.00	.00	.00	10.00	.00
14	2	.00	.00	.00	.00	.00	10.00	.00
14	3	.00	.00	.00	.00	.00	10.00	.00
14	4	.00	.00	.00	.00	.00	10.00	.00
14	5	.00	.00	.00	.00	.00	10.00	.00
14	6	.00	.00	.00	.00	.00	10.00	.00
14	7	.00	.00	.00	.00	.00	10.00	.00
14	8	.00	.00	.00	.00	.00	10.00	.00
14	9	.00	.00	.00	.00	.00	10.00	.00
14	10	.00	.00	.00	.00	.00	10.00	.00
14	11	.00	.00	.00	.00	.00	10.00	.00
14	12	.00	.00	.00	.00	.00	10.00	.00
14	13	.00	.00	.00	.00	.00	10.00	.00
14	14	.00	271.08	.48	.39	2400.15	10.00	.00
14	15	1049.51	241.18	.41	.24	2752.59	48.55	.02
14	16	1087.45	240.51	.41	.24	2761.79	49.83	.04
14	17	1169.70	239.12	.41	.23	2781.07	50.52	.07
14	18	1475.61	234.62	.40	.20	2845.47	59.94	.33
14	19	2020.23	228.60	.38	.16	2936.43	69.49	.67
14	20	3175.37	220.92	.36	.09	3060.58	93.06	1.81
14	21	3901.60	218.12	.35	.07	3108.27	108.62	3.54
14	22	4493.36	216.51	.34	.05	3136.19	121.34	24.38
14	23	5280.50	215.00	.34	.03	3162.75	138.13	64.90
14	24	4380.50	215.00	.34	.03	3162.75	114.44	103.95
14	25	3730.50	215.00	.34	.03	3162.75	98.16	121.25
14	26	2950.50	215.00	.34	.03	3162.75	79.24	129.91

LAYER	AGE	TOP-DEPTH (METRES)	THICKNESS (METRES)	SHALE		THERMK (mW/M-DEG)	TEMP (DEG-C)	TTI
				FRAC	PHI			
15	1	.00	.00	.00	.00	.00	10.00	.00
15	2	.00	.00	.00	.00	.00	10.00	.00
15	3	.00	.00	.00	.00	.00	10.00	.00
15	4	.00	.00	.00	.00	.00	10.00	.00
15	5	.00	.00	.00	.00	.00	10.00	.00
15	6	.00	.00	.00	.00	.00	10.00	.00
15	7	.00	.00	.00	.00	.00	10.00	.00
15	8	.00	.00	.00	.00	.00	10.00	.00
15	9	.00	.00	.00	.00	.00	10.00	.00
15	10	.00	.00	.00	.00	.00	10.00	.00
15	11	.00	.00	.00	.00	.00	10.00	.00
15	12	.00	.00	.00	.00	.00	10.00	.00
15	13	.00	.00	.00	.00	.00	10.00	.00
15	14	.00	.00	.00	.00	.00	10.00	.00
15	15	.00	1049.51	.97	.33	1959.96	10.00	.00
15	16	47.96	1039.49	.97	.33	1980.35	12.04	.00
15	17	150.42	1019.27	.97	.31	2023.38	14.25	.00
15	18	517.42	958.19	.97	.27	2171.09	28.16	.03
15	19	1135.85	884.39	.96	.20	2394.91	42.91	.08
15	20	2374.22	801.15	.96	.12	2733.79	71.96	.31
15	21	3128.80	772.81	.96	.08	2878.48	89.29	.74
15	22	3736.37	756.98	.96	.06	2967.55	102.98	6.41
15	23	4538.10	742.40	.96	.04	3055.57	120.63	18.17
15	24	3638.10	742.40	.96	.04	3055.57	96.95	29.78
15	25	2988.10	742.40	.96	.04	3055.57	80.67	34.93
15	26	2208.10	742.40	.96	.04	3055.57	61.74	37.51
16	1	.00	.00	.00	.00	.00	10.00	.00
16	2	.00	.00	.00	.00	.00	10.00	.00
16	3	.00	.00	.00	.00	.00	10.00	.00
16	4	.00	.00	.00	.00	.00	10.00	.00
16	5	.00	.00	.00	.00	.00	10.00	.00
16	6	.00	.00	.00	.00	.00	10.00	.00
16	7	.00	.00	.00	.00	.00	10.00	.00
16	8	.00	.00	.00	.00	.00	10.00	.00
16	9	.00	.00	.00	.00	.00	10.00	.00
16	10	.00	.00	.00	.00	.00	10.00	.00
16	11	.00	.00	.00	.00	.00	10.00	.00
16	12	.00	.00	.00	.00	.00	10.00	.00
16	13	.00	.00	.00	.00	.00	10.00	.00
16	14	.00	.00	.00	.00	.00	10.00	.00
16	15	.00	.00	.00	.00	.00	10.00	.00
16	16	.00	47.96	1.00	.41	1693.35	10.00	.00
16	17	104.00	46.42	1.00	.40	1746.14	12.34	.00
16	18	475.32	42.09	1.00	.33	1926.89	26.59	.02
16	19	1098.43	37.42	1.00	.25	2198.68	41.68	.07
16	20	2341.56	32.66	1.00	.14	2614.04	71.06	.28
16	21	3097.64	31.16	1.00	.10	2791.63	88.49	.69
16	22	3706.03	30.34	1.00	.07	2901.19	102.22	6.06
16	23	4508.50	29.60	1.00	.05	3009.66	119.93	17.25
16	24	3608.50	29.60	1.00	.05	3009.66	96.24	28.30
16	25	2958.50	29.60	1.00	.05	3009.66	79.96	33.20
16	26	2178.50	29.60	1.00	.05	3009.66	61.03	35.66

LAYER	AGE	TOP-DEPTH (METRES)	THICKNESS (METRES)	SHALE		THERMK (mW/M-DEG)	TEMP (DEG-C)	TTI
				FRAC	PHI			
17	1	.00	.00	.00	.00	.00	10.00	.00
17	2	.00	.00	.00	.00	.00	10.00	.00
17	3	.00	.00	.00	.00	.00	10.00	.00
17	4	.00	.00	.00	.00	.00	10.00	.00
17	5	.00	.00	.00	.00	.00	10.00	.00
17	6	.00	.00	.00	.00	.00	10.00	.00
17	7	.00	.00	.00	.00	.00	10.00	.00
17	8	.00	.00	.00	.00	.00	10.00	.00
17	9	.00	.00	.00	.00	.00	10.00	.00
17	10	.00	.00	.00	.00	.00	10.00	.00
17	11	.00	.00	.00	.00	.00	10.00	.00
17	12	.00	.00	.00	.00	.00	10.00	.00
17	13	.00	.00	.00	.00	.00	10.00	.00
17	14	.00	.00	.00	.00	.00	10.00	.00
17	15	.00	.00	.00	.00	.00	10.00	.00
17	16	.00	.00	.00	.00	.00	10.00	.00
17	17	.00	104.00	.00	.00	3200.00	10.00	.00
17	18	371.32	104.00	.00	.00	3200.00	24.25	.02
17	19	994.43	104.00	.00	.00	3200.00	39.34	.05
17	20	2237.56	104.00	.00	.00	3200.00	68.72	.24
17	21	2993.64	104.00	.00	.00	3200.00	86.15	.58
17	22	3602.03	104.00	.00	.00	3200.00	99.88	5.15
17	23	4404.50	104.00	.00	.00	3200.00	117.59	14.66
17	24	3504.50	104.00	.00	.00	3200.00	93.90	24.06
17	25	2854.50	104.00	.00	.00	3200.00	77.62	28.23
17	26	2074.50	104.00	.00	.00	3200.00	58.69	30.32
18	1	.00	.00	.00	.00	.00	10.00	.00
18	2	.00	.00	.00	.00	.00	10.00	.00
18	3	.00	.00	.00	.00	.00	10.00	.00
18	4	.00	.00	.00	.00	.00	10.00	.00
18	5	.00	.00	.00	.00	.00	10.00	.00
18	6	.00	.00	.00	.00	.00	10.00	.00
18	7	.00	.00	.00	.00	.00	10.00	.00
18	8	.00	.00	.00	.00	.00	10.00	.00
18	9	.00	.00	.00	.00	.00	10.00	.00
18	10	.00	.00	.00	.00	.00	10.00	.00
18	11	.00	.00	.00	.00	.00	10.00	.00
18	12	.00	.00	.00	.00	.00	10.00	.00
18	13	.00	.00	.00	.00	.00	10.00	.00
18	14	.00	.00	.00	.00	.00	10.00	.00
18	15	.00	.00	.00	.00	.00	10.00	.00
18	16	.00	.00	.00	.00	.00	10.00	.00
18	17	.00	.00	.00	.00	.00	10.00	.00
18	18	.00	371.32	.91	.39	1875.99	10.00	.00
18	19	670.15	324.28	.89	.29	2178.18	28.62	.02
18	20	1956.75	280.80	.87	.16	2614.41	60.98	.12
18	21	2725.89	267.74	.87	.11	2793.96	79.25	.32
18	22	3341.28	260.76	.87	.08	2902.89	93.42	3.21
18	23	4150.00	254.50	.86	.06	3009.45	111.50	9.38
18	24	3250.00	254.50	.86	.06	3009.45	87.81	15.54
18	25	2600.00	254.50	.86	.06	3009.45	71.53	18.27
18	26	1820.00	254.50	.86	.06	3009.45	52.61	19.64

LAYER	AGE	TOP-DEPTH (METRES)	THICKNESS (METRES)	SHALE		THERMK (mW/M-DEG)	TEMP (DEG-C)	TTI
				FRAC	PHI			
19	1	.00	.00	.00	.00	.00	10.00	.00
19	2	.00	.00	.00	.00	.00	10.00	.00
19	3	.00	.00	.00	.00	.00	10.00	.00
19	4	.00	.00	.00	.00	.00	10.00	.00
19	5	.00	.00	.00	.00	.00	10.00	.00
19	6	.00	.00	.00	.00	.00	10.00	.00
19	7	.00	.00	.00	.00	.00	10.00	.00
19	8	.00	.00	.00	.00	.00	10.00	.00
19	9	.00	.00	.00	.00	.00	10.00	.00
19	10	.00	.00	.00	.00	.00	10.00	.00
19	11	.00	.00	.00	.00	.00	10.00	.00
19	12	.00	.00	.00	.00	.00	10.00	.00
19	13	.00	.00	.00	.00	.00	10.00	.00
19	14	.00	.00	.00	.00	.00	10.00	.00
19	15	.00	.00	.00	.00	.00	10.00	.00
19	16	.00	.00	.00	.00	.00	10.00	.00
19	17	.00	.00	.00	.00	.00	10.00	.00
19	18	.00	.00	.00	.00	.00	10.00	.00
19	19	.00	670.15	.38	.36	2590.99	10.00	.00
19	20	1339.13	617.62	.33	.20	2906.83	45.68	.03
19	21	2122.31	603.59	.32	.14	3007.74	64.80	.11
19	22	2744.93	596.34	.31	.10	3063.09	79.40	1.18
19	23	3560.00	590.00	.30	.07	3113.57	97.85	3.56
19	24	2660.00	590.00	.30	.07	3113.57	74.17	5.95
19	25	2010.00	590.00	.30	.07	3113.57	57.89	7.01
19	26	1230.00	590.00	.30	.07	3113.57	38.96	7.54
20	1	.00	.00	.00	.00	.00	10.00	.00
20	2	.00	.00	.00	.00	.00	10.00	.00
20	3	.00	.00	.00	.00	.00	10.00	.00
20	4	.00	.00	.00	.00	.00	10.00	.00
20	5	.00	.00	.00	.00	.00	10.00	.00
20	6	.00	.00	.00	.00	.00	10.00	.00
20	7	.00	.00	.00	.00	.00	10.00	.00
20	8	.00	.00	.00	.00	.00	10.00	.00
20	9	.00	.00	.00	.00	.00	10.00	.00
20	10	.00	.00	.00	.00	.00	10.00	.00
20	11	.00	.00	.00	.00	.00	10.00	.00
20	12	.00	.00	.00	.00	.00	10.00	.00
20	13	.00	.00	.00	.00	.00	10.00	.00
20	14	.00	.00	.00	.00	.00	10.00	.00
20	15	.00	.00	.00	.00	.00	10.00	.00
20	16	.00	.00	.00	.00	.00	10.00	.00
20	17	.00	.00	.00	.00	.00	10.00	.00
20	18	.00	.00	.00	.00	.00	10.00	.00
20	19	.00	.00	.00	.00	.00	10.00	.00
20	20	.00	1339.13	.36	.31	2701.93	10.00	.00
20	21	842.84	1279.47	.33	.21	2883.46	32.85	.01
20	22	1492.69	1252.24	.31	.16	2976.42	49.11	.13
20	23	2330.00	1230.00	.30	.11	3057.77	68.89	.44
20	24	1430.00	1230.00	.30	.11	3057.77	45.20	.76
20	25	780.00	1230.00	.30	.11	3057.77	28.92	.90
20	26	.00	1230.00	.30	.11	3057.77	10.00	.98

LAYER	AGE	TOP-DEPTH (METRES)	THICKNESS (METRES)	SHALE		THERMK (mW/M-DEG)	TEMP (DEG-C)	TTI
				FRAC	PHI			
21	1	.00	.00	.00	.00	.00	10.00	.00
21	2	.00	.00	.00	.00	.00	10.00	.00
21	3	.00	.00	.00	.00	.00	10.00	.00
21	4	.00	.00	.00	.00	.00	10.00	.00
21	5	.00	.00	.00	.00	.00	10.00	.00
21	6	.00	.00	.00	.00	.00	10.00	.00
21	7	.00	.00	.00	.00	.00	10.00	.00
21	8	.00	.00	.00	.00	.00	10.00	.00
21	9	.00	.00	.00	.00	.00	10.00	.00
21	10	.00	.00	.00	.00	.00	10.00	.00
21	11	.00	.00	.00	.00	.00	10.00	.00
21	12	.00	.00	.00	.00	.00	10.00	.00
21	13	.00	.00	.00	.00	.00	10.00	.00
21	14	.00	.00	.00	.00	.00	10.00	.00
21	15	.00	.00	.00	.00	.00	10.00	.00
21	16	.00	.00	.00	.00	.00	10.00	.00
21	17	.00	.00	.00	.00	.00	10.00	.00
21	18	.00	.00	.00	.00	.00	10.00	.00
21	19	.00	.00	.00	.00	.00	10.00	.00
21	20	.00	.00	.00	.00	.00	10.00	.00
21	21	.00	842.84	.35	.35	2655.94	10.00	.00
21	22	686.66	806.03	.32	.25	2828.39	28.59	.03
21	23	1550.00	780.00	.30	.17	2967.62	49.97	.11
21	24	650.00	780.00	.30	.17	2967.62	26.28	.19
21	25	.00	780.00	.30	.17	2967.62	10.00	.23
21	26	.00	.00	.00	.00	.00	10.00	.27
22	1	.00	.00	.00	.00	.00	10.00	.00
22	2	.00	.00	.00	.00	.00	10.00	.00
22	3	.00	.00	.00	.00	.00	10.00	.00
22	4	.00	.00	.00	.00	.00	10.00	.00
22	5	.00	.00	.00	.00	.00	10.00	.00
22	6	.00	.00	.00	.00	.00	10.00	.00
22	7	.00	.00	.00	.00	.00	10.00	.00
22	8	.00	.00	.00	.00	.00	10.00	.00
22	9	.00	.00	.00	.00	.00	10.00	.00
22	10	.00	.00	.00	.00	.00	10.00	.00
22	11	.00	.00	.00	.00	.00	10.00	.00
22	12	.00	.00	.00	.00	.00	10.00	.00
22	13	.00	.00	.00	.00	.00	10.00	.00
22	14	.00	.00	.00	.00	.00	10.00	.00
22	15	.00	.00	.00	.00	.00	10.00	.00
22	16	.00	.00	.00	.00	.00	10.00	.00
22	17	.00	.00	.00	.00	.00	10.00	.00
22	18	.00	.00	.00	.00	.00	10.00	.00
22	19	.00	.00	.00	.00	.00	10.00	.00
22	20	.00	.00	.00	.00	.00	10.00	.00
22	21	.00	.00	.00	.00	.00	10.00	.00
22	22	.00	686.66	.34	.36	2659.58	10.00	.00
22	23	900.00	650.00	.30	.24	2874.63	33.69	.02
22	24	.00	650.00	.30	.24	2874.63	10.00	.05
22	25	.00	.00	.00	.00	.00	10.00	.07
22	26	.00	.00	.00	.00	.00	10.00	.11

LAYER	AGE	TOP-DEPTH (METRES)	THICKNESS (METRES)	SHALE FRAC	SHALE PHI	THERMK (mW/M-DEG)	TEMP (DEG-C)	TTI
23	1	.00	.00	.00	.00	.00	10.00	.00
23	2	.00	.00	.00	.00	.00	10.00	.00
23	3	.00	.00	.00	.00	.00	10.00	.00
23	4	.00	.00	.00	.00	.00	10.00	.00
23	5	.00	.00	.00	.00	.00	10.00	.00
23	6	.00	.00	.00	.00	.00	10.00	.00
23	7	.00	.00	.00	.00	.00	10.00	.00
23	8	.00	.00	.00	.00	.00	10.00	.00
23	9	.00	.00	.00	.00	.00	10.00	.00
23	10	.00	.00	.00	.00	.00	10.00	.00
23	11	.00	.00	.00	.00	.00	10.00	.00
23	12	.00	.00	.00	.00	.00	10.00	.00
23	13	.00	.00	.00	.00	.00	10.00	.00
23	14	.00	.00	.00	.00	.00	10.00	.00
23	15	.00	.00	.00	.00	.00	10.00	.00
23	16	.00	.00	.00	.00	.00	10.00	.00
23	17	.00	.00	.00	.00	.00	10.00	.00
23	18	.00	.00	.00	.00	.00	10.00	.00
23	19	.00	.00	.00	.00	.00	10.00	.00
23	20	.00	.00	.00	.00	.00	10.00	.00
23	21	.00	.00	.00	.00	.00	10.00	.00
23	22	.00	.00	.00	.00	.00	10.00	.00
23	23	.00	900.00	.30	.34	2735.63	10.00	.00
23	24	.00	.00	.00	.00	.00	10.00	.01
23	25	.00	.00	.00	.00	.00	10.00	.03
23	26	.00	.00	.00	.00	.00	10.00	.07
24	1	.00	.00	.00	.00	.00	10.00	.00
24	2	.00	.00	.00	.00	.00	10.00	.00
24	3	.00	.00	.00	.00	.00	10.00	.00
24	4	.00	.00	.00	.00	.00	10.00	.00
24	5	.00	.00	.00	.00	.00	10.00	.00
24	6	.00	.00	.00	.00	.00	10.00	.00
24	7	.00	.00	.00	.00	.00	10.00	.00
24	8	.00	.00	.00	.00	.00	10.00	.00
24	9	.00	.00	.00	.00	.00	10.00	.00
24	10	.00	.00	.00	.00	.00	10.00	.00
24	11	.00	.00	.00	.00	.00	10.00	.00
24	12	.00	.00	.00	.00	.00	10.00	.00
24	13	.00	.00	.00	.00	.00	10.00	.00
24	14	.00	.00	.00	.00	.00	10.00	.00
24	15	.00	.00	.00	.00	.00	10.00	.00
24	16	.00	.00	.00	.00	.00	10.00	.00
24	17	.00	.00	.00	.00	.00	10.00	.00
24	18	.00	.00	.00	.00	.00	10.00	.00
24	19	.00	.00	.00	.00	.00	10.00	.00
24	20	.00	.00	.00	.00	.00	10.00	.00
24	21	.00	.00	.00	.00	.00	10.00	.00
24	22	.00	.00	.00	.00	.00	10.00	.00
24	23	.00	.00	.00	.00	.00	10.00	.00
24	24	.00	.00	.00	.00	.00	10.00	.00
24	25	.00	.00	.00	.00	.00	10.00	.02
24	26	.00	.00	.00	.00	.00	10.00	.06

LAYER	AGE	TOP-DEPTH (METRES)	THICKNESS (METRES)	SHALE		THERMK (mW/M-DEG)	TEMP (DEG-C)	TTI
				FRAC	PHI			
25	1	.00	.00	.00	.00	.00	10.00	.00
25	2	.00	.00	.00	.00	.00	10.00	.00
25	3	.00	.00	.00	.00	.00	10.00	.00
25	4	.00	.00	.00	.00	.00	10.00	.00
25	5	.00	.00	.00	.00	.00	10.00	.00
25	6	.00	.00	.00	.00	.00	10.00	.00
25	7	.00	.00	.00	.00	.00	10.00	.00
25	8	.00	.00	.00	.00	.00	10.00	.00
25	9	.00	.00	.00	.00	.00	10.00	.00
25	10	.00	.00	.00	.00	.00	10.00	.00
25	11	.00	.00	.00	.00	.00	10.00	.00
25	12	.00	.00	.00	.00	.00	10.00	.00
25	13	.00	.00	.00	.00	.00	10.00	.00
25	14	.00	.00	.00	.00	.00	10.00	.00
25	15	.00	.00	.00	.00	.00	10.00	.00
25	16	.00	.00	.00	.00	.00	10.00	.00
25	17	.00	.00	.00	.00	.00	10.00	.00
25	18	.00	.00	.00	.00	.00	10.00	.00
25	19	.00	.00	.00	.00	.00	10.00	.00
25	20	.00	.00	.00	.00	.00	10.00	.00
25	21	.00	.00	.00	.00	.00	10.00	.00
25	22	.00	.00	.00	.00	.00	10.00	.00
25	23	.00	.00	.00	.00	.00	10.00	.00
25	24	.00	.00	.00	.00	.00	10.00	.00
25	25	.00	.00	.00	.00	.00	10.00	.00
25	26	.00	.00	.00	.00	.00	10.00	.03
26	1	.00	.00	.00	.00	.00	10.00	.00
26	2	.00	.00	.00	.00	.00	10.00	.00
26	3	.00	.00	.00	.00	.00	10.00	.00
26	4	.00	.00	.00	.00	.00	10.00	.00
26	5	.00	.00	.00	.00	.00	10.00	.00
26	6	.00	.00	.00	.00	.00	10.00	.00
26	7	.00	.00	.00	.00	.00	10.00	.00
26	8	.00	.00	.00	.00	.00	10.00	.00
26	9	.00	.00	.00	.00	.00	10.00	.00
26	10	.00	.00	.00	.00	.00	10.00	.00
26	11	.00	.00	.00	.00	.00	10.00	.00
26	12	.00	.00	.00	.00	.00	10.00	.00
26	13	.00	.00	.00	.00	.00	10.00	.00
26	14	.00	.00	.00	.00	.00	10.00	.00
26	15	.00	.00	.00	.00	.00	10.00	.00
26	16	.00	.00	.00	.00	.00	10.00	.00
26	17	.00	.00	.00	.00	.00	10.00	.00
26	18	.00	.00	.00	.00	.00	10.00	.00
26	19	.00	.00	.00	.00	.00	10.00	.00
26	20	.00	.00	.00	.00	.00	10.00	.00
26	21	.00	.00	.00	.00	.00	10.00	.00
26	22	.00	.00	.00	.00	.00	10.00	.00
26	23	.00	.00	.00	.00	.00	10.00	.00
26	24	.00	.00	.00	.00	.00	10.00	.00
26	25	.00	.00	.00	.00	.00	10.00	.00
26	26	.00	.00	.00	.00	.00	10.00	.00