

DateView 3.1:

a Windows geochronology database

Bruce M. Eglington

Saskatchewan Isotope Laboratory Publication 1

2003

Contents

| | |
|--|----|
| Abstract | 2 |
| Introduction | 2 |
| System requirements..... | 3 |
| Database structure | 3 |
| Querying the database | 4 |
| Graphing the results of queries | 8 |
| Shared implementations of the database | 14 |
| Obtaining copies of the software | 15 |
| Acknowledgments | 15 |
| References | 15 |

Abstract

DateView is a freeware desktop database system for the structured storage and retrieval of geochronological information. A legal copy of the Borland database Engine is provided with the system so it is not necessary to purchase additional database software. It provides a user-friendly interface for constructing queries based on information in the database so as to extract information on specific units, isotope systems, age interpretations, provinces, terranes, reference sources and many other characteristics which geochronologists and geologists might require. Once a subset of the records in the database has been selected, users may choose from several forms of graph so as to better visualise one's data. Available graphs include probability histograms, age versus initial ratio or epsilon and age versus blocking temperature. Simple locality (latitude vs longitude) graphs are also available. Grouping of data by interpretation or age interval in the graphs is user customizable. The database may also be shared with colleagues on an intranet.

Introduction

Systematic collation, assessment and processing of isotopic and geochronological data is best achieved by means of a structured database which permits appropriate querying to extract relevant data. Typical queries which earth scientists have with respect to isotope data include:

- what is the age of a particular geological unit or event?
- what dates (and associated uncertainties) are available in a specified area?
- how do dates obtained by means of different isotope decay schemes compare with each other in a specified area or for a specified formation?
- what is the geological significance of these dates and how confident is one of the individual values?
- how do dates from one area or geological entity compare with those from other areas?
- how do initial ratios vary with time in some area?
- what is the geographic distribution of dates in some area relative to their geological interpretation?

- is there a systematic variation in age relative to blocking temperature for selected isotope decay schemes amongst a particular group of dates?

DateView is a PC-based package which has been designed with these objectives in mind. It facilitates the compilation of relevant geochronological data by individuals whilst also providing a framework for subsequent sharing of data amongst groups of staff where appropriate.

System requirements

The user interface for DateView was developed with Delphi^(TM) v. 6 and is designed for implementation on Windows^(TM) 95/98/NT/ME/2000/XP computers although it is possible to run the software on Macintosh systems utilising suitable emulation software. The tables used for storage of the data are Paradox^(TM) v. 7 tables arranged to form a relational database with file look-up capabilities and referential integrity. Data are thus easily ported or transferred using standard commercial software in addition to data exchange, import and export options provided by the DateView software. The software and data tables are easily installed using InstallShield^(TM), a standard setup program for PC software.

Database structure

Data are stored in multiple tables linked using a unique record ID value for each record. Lookup and referential master tables are available for all important fields. The data in these lookup tables are user customisable. They ensure that the database does not contain duplicate records as a result of minor typographic errors, etc. Data records in the main data table are arranged such that dates are linked to:

- a specified area e.g. a country,
- a geological unit,
- a selected lithology e.g. granite,
- a specified isotope decay scheme e.g. U-Pb radiogenic
- a specific way of calculating the date within this decay scheme e.g. by regression
- the material analysed e.g. zircon
- technique used for analysis e.g. SHRIMP
- a simple interpretation of the meaning of the date e.g. crystallisation
- and a qualitative measure of the geological confidence in the date and its associated interpretation.

Individual data records also contain fields for more quantitative information as regards the statistical evaluation of the date calculation performed. Each record in the main data table may also be linked to a table containing details of the samples used to derive the values stored in the main table. These details currently comprise sample number, whether the sample was included in the date calculation and the longitude and latitude at which the sample was collected. A convention has been adopted in which latitude south of the equator is expressed as a negative value. All latitude and longitude values are expressed in decimal units. A further table, also linked to each record in the main data table, allows the

user to define groups of records which have some particular relevance. For example, all data associated with a particular orogenic event may be given a name such as "orogenesis 1". The DateView software refers to these values as 'group descriptors'. It is also possible to associate each record with particular structural provinces or terranes, geochemical associations or tectonic settings and to define the reference source from which the data were obtained.

Data fields have been structured to store parameters required to describe the various regression and age calculation techniques described in the literature (York, 1966; York, 1969; McIntyre *et al.*, 1966; Brooks *et al.*, 1972; Ludwig, 1980; Davis, 1982; Wendt, 1984; Kent *et al.*, 1990; Harmer and Eglinton, 1991; Zheng, 1992; Eglinton and Harmer, 1993; Ludwig and Titterton, 1994; Ludwig, 1998) Thus the database also includes fields to describe the statistical validity of the date calculation, the type of weighting applied to augment calculated errors where scatter exceeds that which can be explained by the analytical uncertainties and the model used for specific calculations e.g. in the case of model source $^{238}\text{U}/^{204}\text{Pb}$. In cases where both an upper and lower concordia intercept are relevant and need to be queryable, these should be stored as two separate records according to the specific model adopted to explain the discordia effects (Eglinton and Harmer, 1993). Subsequent plots and data queries are based only on the value stored in the primary date field, not in the field reserved for 'other intercept'. This latter field, and its associated uncertainties, are purely supplementary information.

New data may be added to the DateView database manually from the keyboard or from other software, such as GEODATE for Windows (Eglinton, 1999). Alternatively, it is possible to append data by importing data from an Excel^(TM) spreadsheet.

Querying the database

Queries of the database may be based on combinations of the following fields:

1. area
2. stratigraphic unit
3. lithology
4. isotope system
5. technique used for analysis
6. material analysed
7. data reduction method
8. interpretation
9. group descriptors
10. structural province
11. structural terrane
12. source reference
13. chemical association

14. structural association
15. rank (for the specified interpretation)
16. a range of dates
17. statistical validity of the analysis (based either on MSWD or probability of fit)
18. whether the data records have decay constant uncertainties specified or not

Figure 1. Form used to define a query for use with DateView.

Selecting any of items one to fourteen of this list provides access to a drop-down list of available values which may be selected and added to a compound **and/or** query, as illustrated in Figure 1. Up to eight combinations of values within each parameter may be combined in a logical '**or**' sequence which is '**and**'ed with other variables selected. Once the user is happy with the selections made, the query may be executed and the resultant records may be viewed in a number of ways.

The default view for any query is a 'form' view, as illustrated in Figure 2. Other tabsheets provide access to expanded views of

- samples details (Figure 3)
- reference details (Figure 4)
- tectonic and geochemical associations (Figure 5)
- images (Figure 6).

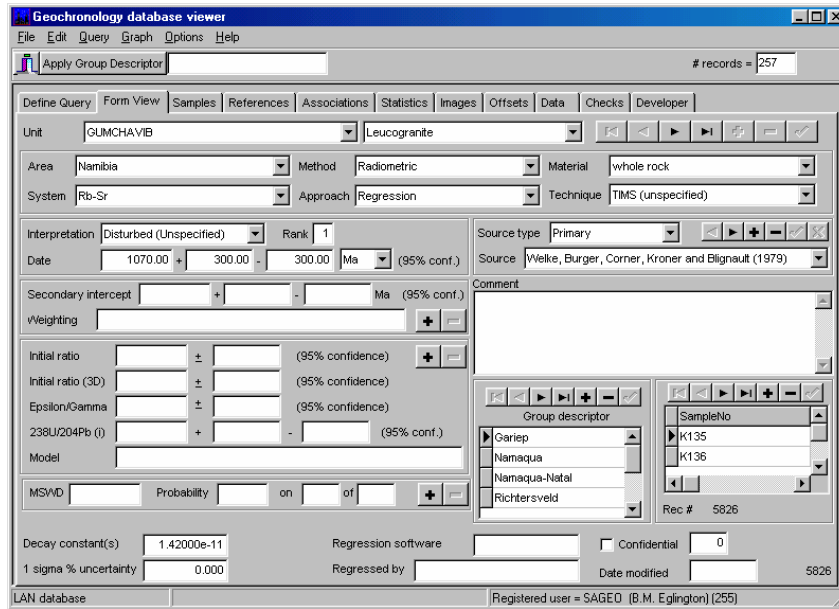


Figure 2. Default form view of the results for one record matching the query posted to the database.

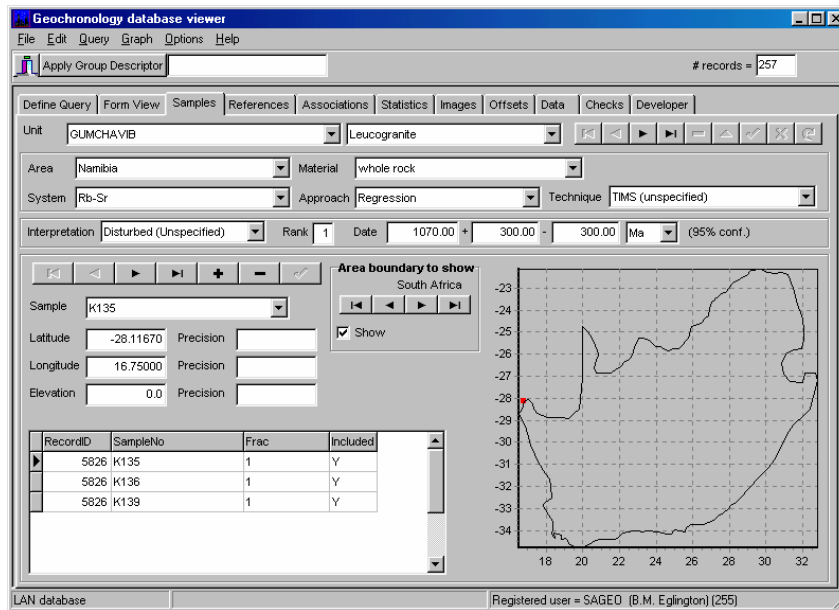


Figure 3. View of sample information for the selected record.

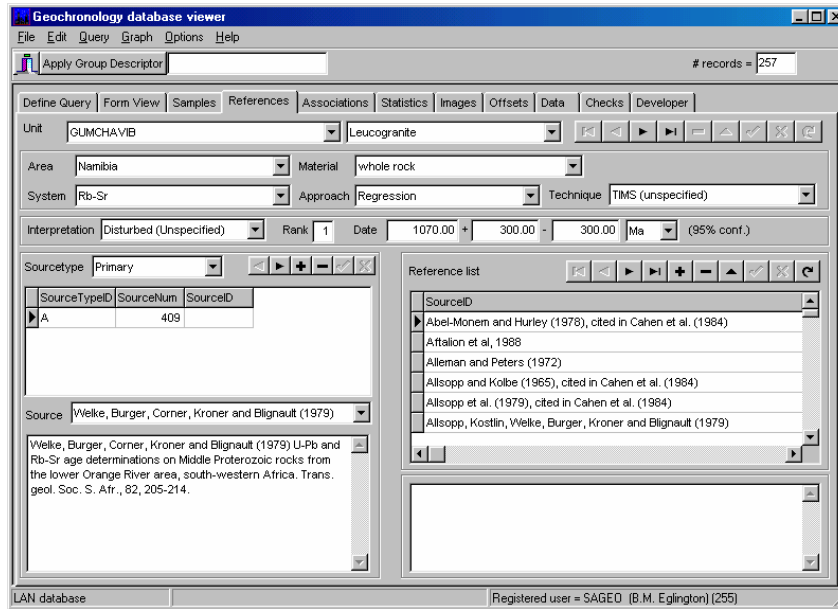


Figure 4. View of reference information for the record selected.

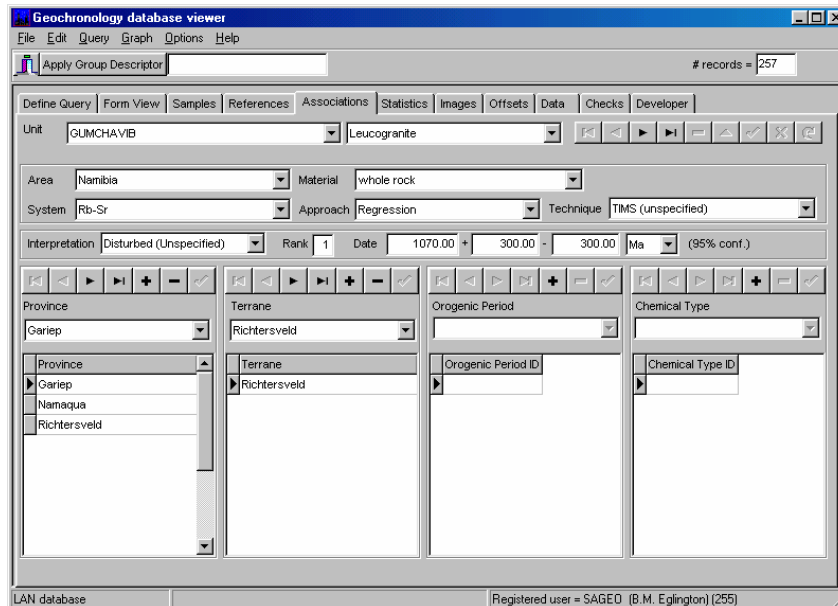


Figure 5. View of structural and geochemical associations for the record selected.

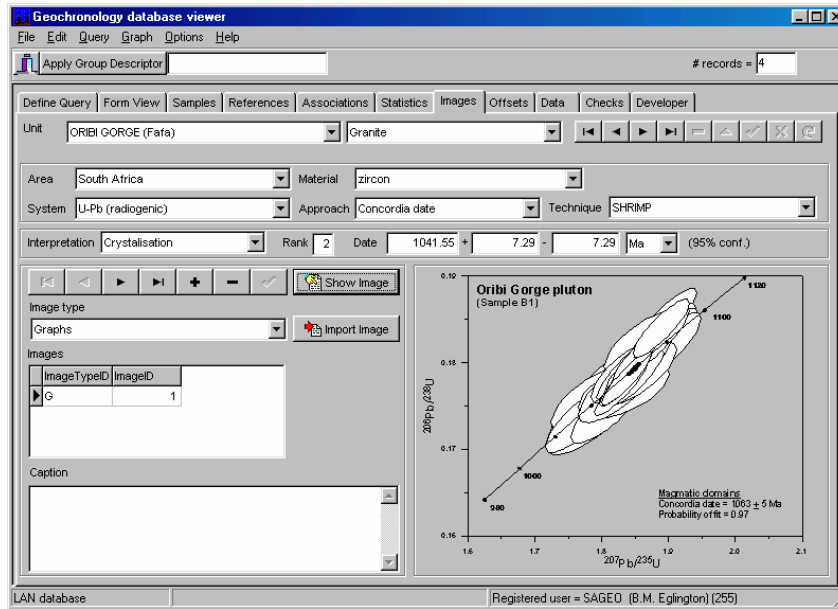


Figure 6. View of images available for the record selected.

It is possible to print the results of a query. These include geochronology, sample locality and reference details at this stage. Reporting is accomplished using the ReportBuilder^(TM) software built in to the user interface.

Graphing the results of queries

Several graphical representations of the data extracted in a query are available. Two types of plot are generally applicable. One illustrates the data in terms of the interpretation associated with each date and the other shows the data as a series of symbols relating to specified age ranges. In both cases, the user is able to define the values and legend captions to be used via the *Graph\Options* menu. Figure 7 to Figure 9 illustrate these menu views.

In the case of 'interpretation' graphs (Figure 7), the user may specify up to five items to be shown in the legend. Each item comprises a combination of up to two specific interpretations which are selected from drop-down lists. For the 'age range' graphs, the user may specify up to five intervals by providing captions for the legend and beginning and ending dates for each interval (Figure 8).

Select plot groupings

Interpretation | Dates | Basis for graphical groups | Other criteria

OK

Group 1
 Title for legend:
 Classification: or

Group 2
 Title for legend:
 Classification: or

Group 3
 Title for legend:
 Classification: or

Group 4
 Title for legend:
 Classification: or

Group 5
 Title for legend:
 Classification: or

Figure 7. Graph options for interpretations to be included in a plot.

Select plot groupings

Interpretation | Dates | Basis for graphical groups | Other criteria

OK

Group 1
 Title for legend: Apply
 Minimum: Maximum:

Group 2
 Title for legend: Apply
 Minimum: Maximum:

Group 3
 Title for legend: Apply
 Minimum: Maximum:

Group 4
 Title for legend: Apply
 Minimum: Maximum:

Group 5
 Title for legend: Apply
 Minimum: Maximum:

Figure 8. Graph options for dates to be included in a plot.

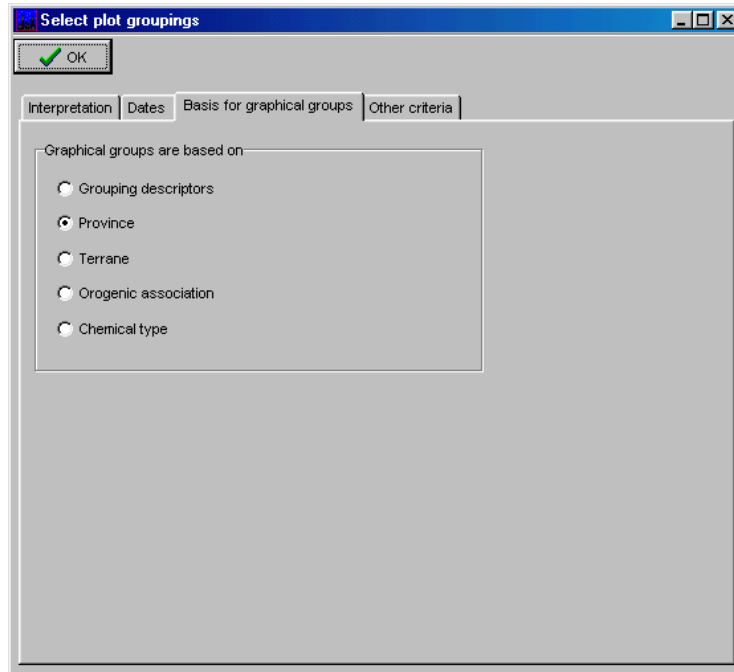


Figure 9. Graph options for how data are to be grouped in a plot.

Specific graphs which are provided in the current version of DateView are:

- sequential plot of date and uncertainty for each of the specified interpretations. This plot provides an overview of the individual data records reported by the query. Data are colour coded according to the interpretation associated with each date (Figure 10). In situations where 'group descriptors' have also been specified in the query, data are also colour coded to reflect the associated descriptor and provided in a separate plot.

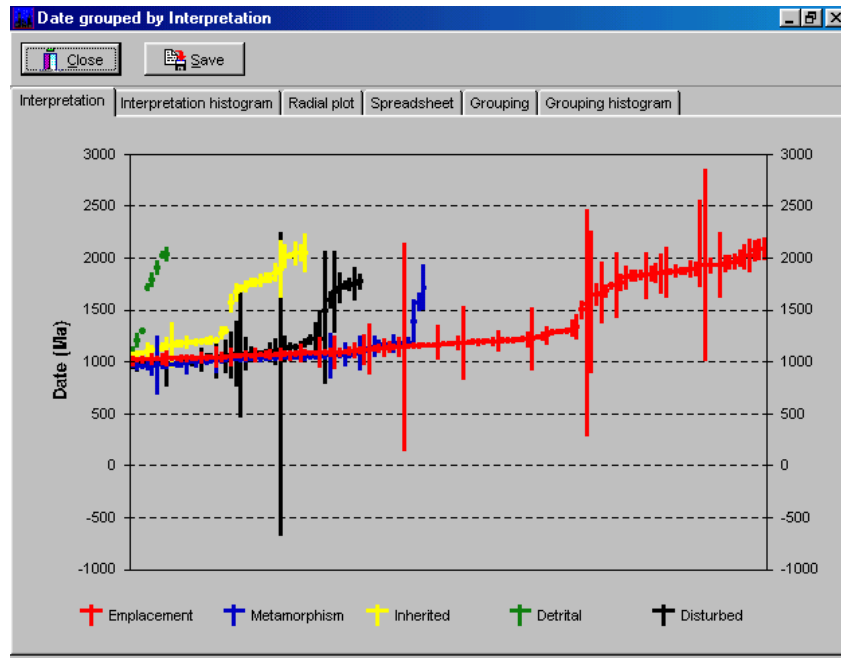


Figure 10. Interpretation graph of selected data. Vertical lines define the uncertainty limits for individual dates.

- a plot of inverse of the 1 sigma uncertainty for each date relative to the deviation of the date from the weighted mean of all dates selected in the query (Galbraith, 1988). Data records are presented with different symbols according to the interpretation associated with each date. This form of diagram is sometimes useful to distinguish between different periods of geological activity and is often used in fission track dating.
- a summed probability distribution of the dates for each interpretation (Figure 11). The probability curves presented in this plot are normalised to 100% for the most intense peak of all the interpretations plotted. This plot also provides a weighted average date of all the records selected, together with an estimate of the statistical validity of this average. The latter is presented as a **Mean Square of Weighted Deviates (MSWD)** value and a **Probability of Fit** value. In situations where 'group descriptors' have also been specified in the query, summed probability curves are also provided for all dates associated with each descriptor in a separate plot (Figure 12).

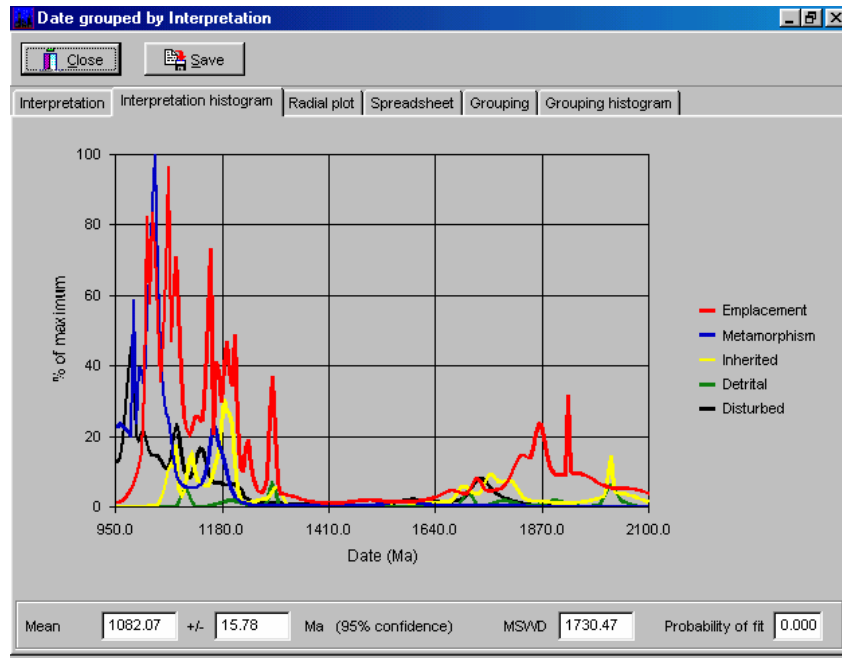


Figure 11. Summed probability histogram of dates for each of up to five selected interpretations.

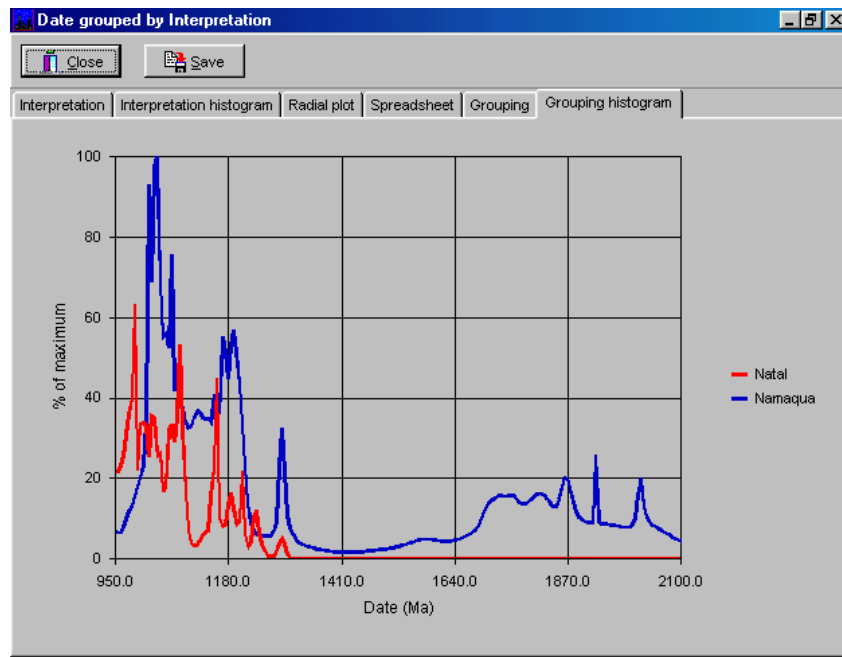


Figure 12. Summed probability histogram of dates for data associated with two groups, in this case the Natal and Namaqua structural provinces of southern Africa.

- plots of initial ratio, epsilon value, gamma value or $^{238}\text{U}/^{204}\text{Pb}$ (μ) relative to date, again with symbols reflecting the interpretation associated with the date. If 'group descriptors' are specified, it is possible to graph these results to reflect the groups concerned (Figure 13).

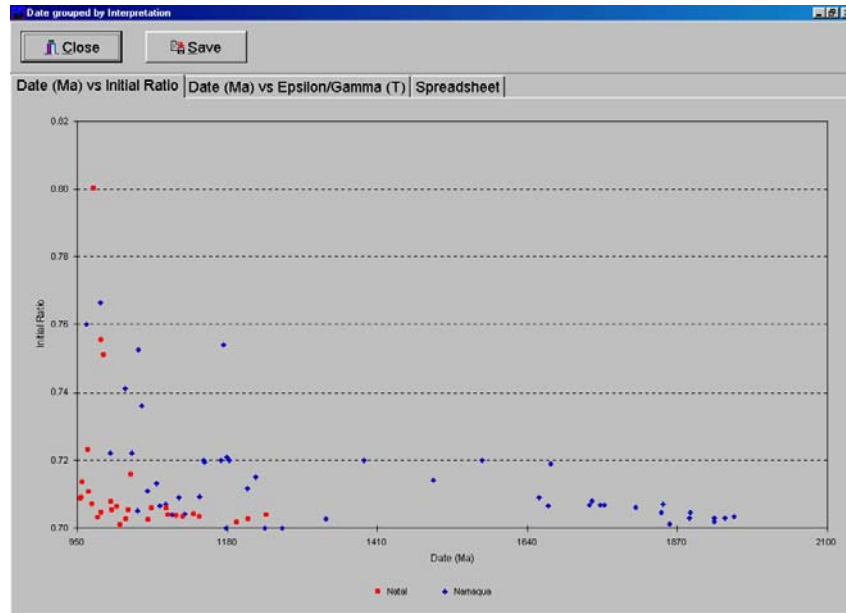


Figure 13. Initial ratio plot for two groups of data. An alternative view allocates symbols according to the interpretations associated with each date.

- an x-y plot of longitude versus latitude with symbols based on interpretation or age band. If areas are specified in the query, the software will also extract data from a supplementary database table, called AreaBound, for data delineating a simplified outline of the area concerned (see Figure 14).

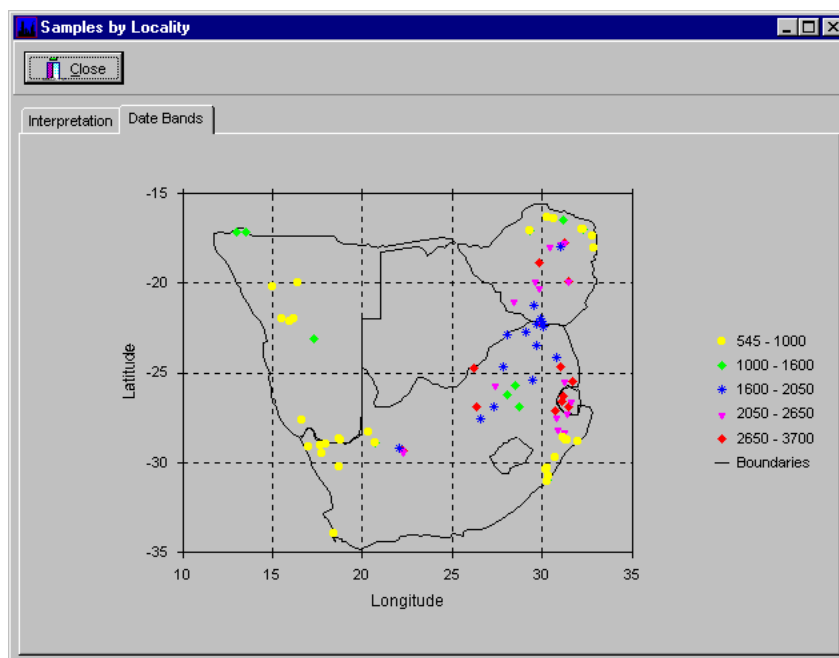


Figure 14. Plot of latitude versus longitude for samples associated with the records matching the query posted. Symbols used relate to five date intervals previously defined by the user. Note that simplified boundaries for various countries have also been provided in this diagram because these areas were included in the query definition.

- a plot of date versus assumed blocking temperature for the specific combination of material analysed, method of analysis and isotope system. Values may be associated with these combinations under *Edit / Lookup tables*. This option requires that one or more 'group descriptors' have been specified in the query and the plot is shown with date and blocking temperatures coded for each descriptor.

Shared implementations of the database

It is also possible to provide shared access to a copy of the database tables across peer-to-peer networks such as those supported by Windows^(TM) 95 and 98. In order to utilise the LAN option, it is necessary to manually modify the DateView.INI file (in the Windows directory) to specify where the shared database is located. In the case of a shared, LAN implementation of the software, various restrictions are implemented as regards access rights for users accessing the shared database. These restrict the extent to which users may modify data, have access to records marked as confidential, import or export data and access certain of the plots. Full details of these restrictions are available from the author for anybody wishing to implement a LAN version of DateView.

Obtaining copies of the software

This software is available as freeware and may be obtained by contacting Bruce Eglington at bruce.eglington@usask.ca or from <http://sil.usask.ca/software.htm>. The software is provided as a self extracting executable which will install the program in an easy, user-friendly way. The installation files currently require about 50 Mb of CD space (mainly to accommodate the Windows installer routines which may not be available in older versions). The software requires about 10 Mb of hard drive space, primarily for the Borland Database Engine.

A copy of this document is available on <http://sil.usask.ca/software.htm>

Acknowledgments

I thank Jock Harmer for discussions around the concepts embodied in this database and software and Toni Balt and Mari Rademeyer for assistance in populating test versions of the database. Frikkie Hartzer provided the initial incentive to develop the software with his compilations of the stratigraphy of South Africa and of the Southern African Development Community (Hartzer, 1998; Hartzer *et al.*, 1998). The Council for Geoscience, South Africa is thanked for its support in the development of the database.

References

- Brooks, C., Hart, S.R. and Wendt, I. (1972). Realistic use of two-error regression treatments as applied to rubidium-strontium data. *Rev. Geophys. Space Phys.*, **10**, 551-577.
- Davis, D.W. (1982). Optimum linear regression and error estimation applied to U-Pb data. *Can. J. Earth Sci.*, **19**, 2141-2149.
- Eglington, B.M. (1999). GEODATE for Windows version 1: Isotope regression and modeling software. *Council for Geoscience Open File Report*, **1999-0206-O**, 1-51.
- Eglington, B.M. and Harmer, R.E. (1993). A review of the statistical principles of geochronometry: II. Additional concepts pertinent to radiogenic U-Pb studies. *S. Afr. J. Geol.*, **96**, 9-21.
- Galbraith, R.F. (1988). Graphical display of estimates having differing standard errors. *Technometrics*, **30**, 271-281.
- Harmer, R.E. and Eglington, B.M. (1991). A review of the statistical principles of geochronometry: towards a more consistent approach for reporting geochronological data. *S. Afr. J. Geol.*, **93**, 845-856.
- Hartzer, F. J. 1998. *A stratigraphic table of the SADC countries*. Pretoria, South Africa: Council for Geoscience.
- Hartzer, F. J., M.R. Johnson, and B.M. Eglington. 1998. *Stratigraphic table of South Africa*. Pretoria, South Africa: Council for Geoscience.
- Kent J. T., G. S. Watson, and T. C. Onstott. 1990. Fitting straight lines and planes with an application to radiometric dating. *Earth Planet.Sci.Lett.* 1-17.

- Ludwig, K.R. (1980). Calculation of uncertainties of U-Pb isotope data. *Earth Planet. Sci. Lett.*, **46**, 212-220.
- Ludwig, K.R. (1998). On the treatment of concordant uranium-lead ages. *Geochim. Cosmochim. Acta*, **62**, 665-676.
- Ludwig, K.R. and Titterton, D.M. (1994). Calculation of $^{230}\text{Th}/\text{U}$ isochrons, ages, and errors. *Geochim. Cosmochim. Acta*, **58**, 5031-5042.
- McIntyre, G.A., Brooks, C., Compston, W. and Turek, A. (1966). The statistical assessment of Rb-Sr isochrons. *J. Geophys. Res.*, **71**, 5459-5468.
- Wendt, I. (1984). A three-dimensional U-Pb discordia plane to evaluate samples with common lead of unknown isotopic composition. *Isotope Geosc.*, **2**, 1-12.
- York, D. (1966). Least-squares fitting of a straight line. *Can. J. Physics*, **44**, 1079-1086.
- York, D. (1969). Least-squares fitting of a straight line with correlated errors. *Earth Planet. Sci. Lett.*, **5**, 320-324.
- Zheng, Y.-F. (1992). The three-dimensional U-Pb method: generalized models and implications for U-Pb two-stage systematics. *Chem. Geology*, **100**, 3-18.