DateView: a windows geochronology database

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Abstract

DateView is a freeware desktop database system for the structured storage and retrieval of geochronological information. 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 the data. Available graphs include probability histograms, age versus initial ratio or epsilon, and age versus closure 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.

Keywords: Database; Geochronology; Software; Desktop; Age

1. 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 closure 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.
2. System requirements

The user interface for DateView was developed with Delphi\textsuperscript{(m)} v. 6 and is designed for implementation on Windows\textsuperscript{(m)} 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\textsuperscript{(m)} v. 7 tables arranged to form a relational database with file look-up capabilities. 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\textsuperscript{(n)}, a standard setup program for PC software.

3. Database structure

The software is designed to store a variety of information such as lithostratigraphic unit, date, isotope system, material analysed, analytical technique, simple interpretation of a date and links to the structural domains within which a unit occurs and to the geographic localities of samples. Fig. 1 illustrates the design of the DateView database, in which a ‘core’ table contains the principle geochronological data, supported by a number of ‘lookup’ tables (italicised headings in figure) and of tables for supplementary information e.g. initial composition, statistics, sample details and original isotope data (non-italicised headings). The ‘lookup’ tables ensure consistency in the nomenclature used and preclude typographic errors. A composite primary key on the geochronology data table (bold typeface field names in figure) ensures that the database system rejects duplicate information.

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,

![Fig. 1. Schematic design of DateView database. Numerous tables, some of which are shown here, form a relational design which permits the extraction of specific information. Information in “Geochronology data” table is supported by various lookup tables (italicised headings) and by other tables which store supplementary information (non-italicised headings). Example field values are provided for lookup tables whereas some examples of field names are shown for supporting tables.](image-url)
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 (McIntyre et al., 1966; York, 1966, 1969; Brooks et al., 1972; Ludwig, 1980; Davis, 1982; Wendt, 1984; Kent et al., 1990; Harmer and Eglington, 1991; Zheng, 1992; Eglington and Harmer, 1993; Ludwig and Titterington, 1994; Ludwig, 1998, 2003). 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 $^{238}$U/$^{204}$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 (Eglington 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 GEODEDATE for Windows (Eglington and Harmer, 1999). Alternatively, it is possible to append data by importing data from an Excel(TM) spreadsheet using the DVImport program provided with DateView.

4. Querying the database

Queries of the database are 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.

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 Fig. 2. 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 Fig. 3. Other tabsheets provide access to expanded views of

- samples details (Fig. 4),
- reference details (Fig. 5),
- tectonic and geochemical associations (Fig. 6),
- images (Fig. 7).

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 software built in to the user interface.
5. Graphing the results of queries

Several graphical representations of the data extracted in a query are available. Three types of plot are generally applicable. One illustrates the data in terms of the interpretation associated with each date, the second shows the data as a series of symbols relating to specified age ranges and the third to specified groups of data. In both cases, the user is able to define the values and legend captions to be used via the Graph Options menu. Fig. 8–Fig. 10 illustrate these menu views.

In the case of ‘interpretation’ graphs (Fig. 8), 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 (Fig. 9). A third tab allows the user to specify whether grouped plots should be based on user-specified group, structural province, terrane, chemical association or structural association.

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 (Fig. 11). 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.

- 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 (Fig. 12). The probability curves presented in this plot are normalised to
Fig. 8. Graph options for interpretations to be included in a plot.

Fig. 9. Graph options for dates to be included in a plot.
Fig. 10. Graph options for how data are to be grouped in a plot.

Fig. 11. Interpretation graph of selected data. Vertical lines define uncertainty limits for individual dates.
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 (Fig. 13).

- Plots of initial ratio, epsilon value, gamma value or \(^{238}\text{U}/^{204}\text{Pb}\) (\(\mu\)) 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 (Fig. 14).
- 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 Fig. 15).
- A plot of date versus assumed closure 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 closure temperatures coded for each descriptor.

6. 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® 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. A web-based, client/server version of the database is also being developed so as to facilitate broader sharing of geochronological data.
7. Obtaining copies of the software

The software is provided as a self extracting executable from the IAMG Server which will install the software 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.
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References


Fig. 15. Plot of latitude versus longitude for samples associated with records matching query posted. Symbols used relate to five date intervals previously defined by user. Note that simplified boundaries for various countries have also been provided in this diagram because these areas were included in query definition.


