DIGITAL COMPILATION OF ISOTOPIC AGES FOR BRITISH COLUMBIA: BCAGE 2003 RELEASED AS MS-ACCESS OPEN-FILE CD

By Katrin Breitsprecher and James K. Mortensen, University of British Columbia

KEYWORDS: Ar-Ar, database, geochronology, fission-track, isotopic age, K-Ar, Rb-Sr, Re-Os, Sm-Nd, U-Pb, (U-Th)-He

INTRODUCTION

Isotopic age determinations form a critical part of the geoscientific knowledge base for British Columbia. Isotopic ages were first reported for rock units in British Columbia in 1960, with the advent of the potassium-argon (K-Ar) method of dating. Subsequent decades witnessed the widespread application of additional dating methods, such as the Rb-Sr method in the mid-1970's, the U-Pb and fission-track methods in the mid-1980's, and the $^{40}Ar/^{39}Ar$ and Nd-Sm methods in the late 1990's. More recently, age determinations utilizing the Lu-Hf, Re-Os or (U-Th)-He systems are increasingly being reported as these dating methods are refined. Isotopic dating has been widely used in British Columbia for more than four decades, and the number of isotopic ages which have been generated from rock units within British Columbia is very large. However, because all of the data was never collated into a single database, accessing and utilizing these age determinations for geologic study has been difficult. Firstly, while it is generally known that some older age determinations are not reliable due to either revision to applicable decay constants, outdated systematics and/or analytical techniques, most users do not have the technical background required to evaluate the reliability of a reported age. Secondly, not all reported dates are properly indexed or keyworded such that they can be found by an indexing engine such as GeoRef. Finally, a great many isotopic ages are reported in "grey literature" such as unpublished theses, which are difficult and in some cases expensive to obtain, and are commonly only available in a cumbersome format such as microfiche. Theses are also usually not consistently indexed on any search engine, and contained age data must be laboriously extracted by searching each university's individual library catalogue.

BCAge 2003 was released in December of 2003, as a Micosoft-Access–based database which includes all currently available isotopic age determinations for rock units within British Columbia. The database contains almost 7,000 ages from over 4,750 different rock units in British Columbia, reported in more than 600 individual sources. The database is available as a BC Geological Survey Branch Open File in CD format. We have chosen to provide the database in Microsoft Access format because this is a very widely available and reasonably user-friendly software package, that loads easily even on lower-end personal computers. BCAge 2003 compliments its northern counterpart, YukonAge 2002, which was released in 2002. In addition to providing the public with a single queriable source for geochronologic data, BCAge provides several unique additional features which enhance the utility of the data. Firstly, a *'reliability rating'* has been assigned to each age determination in the compilation. This feature allows a user to quickly evaluate which ages returned by a query would be considered to be reliable by present-day geochronologic standards. Secondly, wherever possible, older ages have been recalculated to current (IUGS) decay constants. Many older dates, particularly in the K-Ar system, were considered unreliable because they had been calculated with since-revised (obsolete) decay constants. Thirdly, many earlier K-Ar ages were reported with 1-sigma errors; these have been standardized in the data-base to the current standard of reporting errors for age determinations at the 2-sigma level; thus reported ages and errors are comparable throughout the entire data set. Finally, a number of previously unpublished isotopic ages generated at the University of British Columbia Geochron Lab during the 1970's and 1980's have been included in BCAge.

SYSTEM REQUIREMENTS

The database is designed for use on newer PC (Windows-based) systems, using Microsoft Access 2000 or above. The database has been rigorously tested on Windows 2000, ME and XP. The product is expected to work on Mac systems running MS-Access 2000 or above, although this has not yet been tested. The database is *not* a stand-alone module; Microsoft Access must be installed before the data-base can be opened. BCAge should run on any PC which runs Microsoft Access 2000 or better; however, because of the large size of the database (over 30 Meg), it runs slowly on PII, and poorly (inoperably slowly) on Pentium-I systems.

INCLUSION CRITERIA

Post-1987 reports containing isotopic ages were identified using a 'ground-up' approach. Georef was queried for *absolute-age*, *geochronology*, *dating*, *Ar-Ar*,

K-Ar, *Rb-Sr*, *U-Pb*, *Sm-Nd*, and *fission-track.* Each returned source was checked to see whether it reported age determinations. All BCGS Fieldwork and GSC Current Research articles, which are not fully indexed, were checked visually for isotopic age content. GSC Paper-2 series on radiogenic ages "Silverbook reports" and GSC "Summary of K-Ar and Ar-Ar Age Determination" reports were similarly checked for data pertaining to the British Columbian jurisdiction. An exhaustive thesis search was conducted, beginning with those generated at UBC, then searching library catalogues of each Canadian university with a geology department, and finally searching U.S. universities with in-house geochron facilities, or those known to have faculty involved in Cordilleran studies. All hard-rock theses were obtained for verification of geochronological content. Soft-rock studies were only obtained if it was apparent from the title or other indicators that the study included detrital mineral dating.

Some levels of reporting are considered too preliminary for inclusion in the BCAge compilation. These include: ages cited as "personal communication"; ages in abstracts which are not accompanied by either analytical data (or visual representation of data), or adequate sample information (including location); ages which are reported as a point locations on a map without supporting data or written documentation (e.g. preliminary dates plotted on open-file maps).

CONTENT

BCAge contains nearly 7,000 geo-referenced age determinations. The dataset incorporates an older data compilation (the R.L. Armstrong age database at UBC), which included ages reported to about 1987, and all ages subsequently published, including those indexed by Georef up to June 2003. Also, the database contains a number of age determinations from older theses from universities in eastern Canada and the United States, which were not in the original Armstrong database. In some cases, more than one age is available for a sample. In the case of clastic rocks for which ages of detrital minerals are reported, each grain analyzed represents a unique age determination. Over 4,750 different samples are represented by the age determinations in BCAge 2003. In the interest of maintaining a high level of data utility and flexibility, neither the BCAge interface nor the data has been encrypted.

The data-base consists of 3 linked tables: 1) a rock table, which contains one record for each sample dated; 2) an age table, containing one record for each age determination reported; and 3) a sources table, containing one record for each report containing ages. The relational nature of the database ensures that multiple age determinations from a single sample (e.g. either as replicate analysis, as ages determined using different isotopic systems, or as multiple, multi-sourced grains in a clastic sedimentary rock), are linked to that single sample, and display as such to the user. Furthermore, this structure allows for ages from a single sample which appeared in different reports (e.g. Ar-Ar ages in one publication and U-Pb ages in another) to appear simultaneously to the user, because they are linked to a single record in the "rock" table.

Data compiled in BCAge remains the ownership of the authors who produced or reported that information. All ages returned by BCAge queries are linked to a complete listing of the original source of the data and should be cited to that original report. Users who wish to cite the results of a query, however, such as "Previously reported ages for Unit X range from 85 to 115 Ma", or who wish to cite the relative reliability of individual ages, should cite the BCAge compilation as the source of that information.

Accuracy of the data returned by BCAge should be verified by the user from the original source(s). BCAge is intended as a search engine to locate reports containing original isotopic age data; the level of funding for the project did not allow for double-checking of data after input. Further, in many cases, accuracy is limited by the quality of the original reports. Of particular note is significant errors in sample locations in some original reports, which have been noted during the process of data entry. Problems include locations drawn on sketch maps with erroneous coordinates, UTM coordinates reported one digit short of a proper coordinate, and loosely constrained sample locations (the latter is particularly true for older reports, which commonly constrain locations only to the nearest 5 minutes). Where noted and where possible, such errors in original reporting have been corrected during compilation. As GIS-based mapping is becoming the new norm, even a small amount of rounding in the reported coordinates can place a sample in the wrong polygon for its lithologic type. The Geological Survey of Canada has provided extra funding on this project to conduct a comprehensive verification of data coordinates to the latest GIS map products for the 82L and 82K mapsheets in southern British Columbia. A field exists in the 'rocks' table called "checked to GIS" which, if empty (presently, all records except those on the 2 mapsheets noted above), indicates to the user that the location has not been verified to a current map. It is hoped that as new mapping projects proceed, similar verification of this data will be undertaken as part of the mapping function.

USAGE NOTES

Data may be queried using the interface provided on the basis of AGE (query the 'ages' table), LOCATION (query the 'rock' table) or SOURCE (query the 'refs' table). Each of these queries will return records meeting input criteria which the user is prompted for, in addition to linking essential information to that record from each

of the other two tables. Hotlinked buttons will take the user to additional details on rock/source. Using the "search by age" function permits the user to easily export the query results in the form of an Excel (or other format) table, which can then be modified as desired by the user for insertion into a report. Alternatively, because each age is geo-referenced, the user may wish to link the exported Excel table to a spatial format (GIS) so that records are plotted graphically. Secondary filters may be applied to returned criteria. For example, a user may start by asking for all records between 85 and 115 Ma in age. This will return all records from throughout B.C. in this age range. The user may wish to see only those records occurring on a particular mapsheet: right-click on the "mapsheet" field of the records dialogue box, enter your mapsheet ID (e.g. 104B) in the "filter for" field, hit "enter" and all other records will be screened out. These types of filters may be applied to any field visible on the age-records dialogue box, and may be made repetitively, such that the query is continually refined in a series of steps (i.e. filter by lithology, then reliability rating, dating method etc.). Note that filtering is not 100% Boolean; wild-carding (*) is necessary the user wishes to short-cut the filter criteria.

Querying "by location" returns all rocks (samples) that meet the search criteria, with age(s) tied to each sample in a cascading screen. This function permits the user to easily identify cases in which more than one age has been determined from the same sample (e.g., using different isotopic methods). This is particularly useful for those many cases where such determinations are published in different reports, as is often the case due to variability in turn-around time at different labs, and for different systems of dating. Additional usage notes are provided as "read me" files on the CD.

PLANNED UPDATES

It is anticipated that BCAge will be updated on an annual basis to reflect new ages reported during the previous year.

FUTURE APPLICATIONS

In addition to regular updates of BCAge in its present format, at least 3 other applications/enhancements are planned at the time of writing. The first is the pending integration of BCAge data with MapPlace. This will permit MapPlace users to see the BCAge data plotted graphically with respect to geology, geochemistry and any other MapPlace dataset. The second application will be to integrate reliable age determinations into the North America Data Model (NADM); this is being done under the direction of M.E. Villeneuve at the Geological Survey of Canada. NADM is an Oracle-based engine which is envisioned to hold data pertaining to all aspects of geology for the entire North American continent. This project, which was initiated by the US Geological Survey and is now being carried out in conjunction with the Geological Survey of Canada, will ultimately incorporate isotopic age data from throughout the US and Canada. The Geological Survey of Canada will import portions of BCAge data which are relevant to the NADM project (e.g. exclude unreliable ages) in its own open-file for the purpose of facilitating internal data management for that project. The interested reader should note that BCAge is the product intended for use by scientists conducting local or regional Cordilleran studies, whereas the pending GSC version open-file is intended to facilitate data management, modeling and geologic study at a much larger (national to continental) scale.

The third planned application of the dataset is to create a cross-jurisdictional database. YukonAge 2002 contains approximately 1,500 ages from the Yukon Territory and is in the same format at BCAge. In addition, the US Geological Survey (Anchorage) hopes to release a geochronological compilation for Alaska at some point in the future (P. Haeussler and D.W. Bradley, personal communication, 2003). In the case of the Canadian Cordilleran (B.C. and Yukon) jurisdictions, the database products were designed at the outset for easy integration in the future. The viability of fusing with the Alaskan database is presently uncertain from a logistical perspective; there is general agreement however from all involved jurisdictions that a complete isotopic age compilation for the entire northern Cordilleran would be very desirable. Preparation of a Canadian Cordillera product (fusion of YukonAge and BCAge) will proceed imminently, and is expected to be released sometime in 2004. This product will contain updates for 2004 (newly reported ages) for both jurisdictions. Some interface improvements are also planned, including a "search by terrane" function. Finally, the authors are considering, at a conceptual level, the possibility of generating a 4D graphical product from the data as a spin-off product of the database.

ACKNOWLEDGMENTS

Thompson from the Geological Survey of Canada for their on-going support for the project.