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OPEN FILE 7932 (revised)

The Tri-Territorial Bedrock Knowledge Entry Tool (KET)

D. Paul, B. Brodaric, M.R. St-Onge, J.C. Harrison, S. Tella, H.P. Julien, and P. Zhao

2016

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Abstract

The Tri-Territorial (Tri-T) Bedrock Knowledge Entry Tool (KET) is a data entry tool that comprises the first step in a workflow to capture, validate and populate the Tri-Territorial Bedrock Database, a repository of geological map information for the Canadian Arctic, north of 60 degrees. As an XML based form, the KET was developed to provide a comprehensive, user-friendly tool for parsing complex geological relationships and concepts from published geological maps and supplementary geoscience publications. To maintain consistency between the Tri-T database and KET, an integrated and internally consistent science language was developed based on government and international standards. Once loaded into the database, the depth of attribution and hierarchical classification of map units captured through the KET enable complex queries and re-classification of units internal to a specific map and across all maps in the Tri-T Bedrock database. This report describes the design, rationale and functionality of the KET as an important component towards building a new compilation of the geology of the Canadian North.

1 Introduction

The Tri-Territorial (Tri-T) Bedrock Database is a repository for geological information that represents an evolving compilation of the bedrock geology of the Canadian Arctic down to 60 degrees north. Currently the database includes approximately 20 geology maps, ranging in scale from 1:200,000 to 1:5,000,000. These maps, selected as current representations of northern geology at a regional scale, form the basis for a first order synthesis to update previous national compilations such as Wheeler et al. 1996. With the recent addition of 11 Geo-mapping for Energy and Minerals (GEM) maps (1:100,000 to 1:125,000 scale), and as the database expands with the incorporation of new field mapping and published geoscience information under the GEM program, the database is evolving and thus becoming a comprehensive resource of Canadian Northern bedrock geology for a variety of stakeholders including scientists, government, industry and northerners.

One of the strengths of the Tri-T Bedrock database is its depth of geological unit description, including extensive references to published geological maps, journal papers, and government reports. Development and use of a standard science language facilitates detailed interrogation of features within and across maps in the Tri-T database, while constrained pick lists and vocabularies maintain data integrity. Capturing such detailed geological information and complex concepts necessitated the creation of a data entry—parsing—tool that was both flexible and simple to use. The Tri-T Bedrock Knowledge Entry Tool (KET) was developed to enable manual data entry of geological unit attributes, events and relationships, thus bridging scientific knowledge (complex geological relationships and concepts) and technology (complex relational database). The KET provides a straightforward scientific parsing tool that forms the first step in a workflow to capture, validate and populate the Tri-T Bedrock Database.

This report focuses on the design, functionality and scientific rationale behind the KET. The technical design principles and science language of the Tri-T Bedrock Database are described in detail in OF7859 (Brodaric et al. 2015).

2 Tri-Territorial Knowledge Entry Tool

The KET is a menu-driven form for capturing information from published geological maps and supplementary geoscience publications. It features an integrated and internally consistent science language linked to the Tri-T Bedrock database vocabularies (Brodaric et al. 2015). The science language draws from existing standards such as GeoSCiML and Geological Survey of Canada's Geological Map Flow (GMF) vocabularies but varies with substitutions for commonly used terms in Canadian geology (e.g. lithology, minerals). In addition, new vocabularies were assembled for geological setting, unit name hierarchies, morphology and fabric. The geological timescale used within the Tri-T KET tool and Tri-T Bedrock Database is a modified version of the International Commission on Stratigraphy (ICS) September 2010 timescale. It includes revisions for the Mesozoic based on the ICS Subcommission for Stratigraphic Information, and modifications to the Ordovician based on data provided by the GeoWhen database. (Appendix A.1).

The KET design takes into consideration complex geological relationships (e.g. deformation events, hierarchical tectonostratigraphic/lithological parent relationships) while providing the flexibility to populate a minimum of attribute fields. After data capture with KET, and prior to loading the information into the Tri-T Database, the files undergo several iterations of validation processing to ensure data integrity within the forms and with the target fields of the Tri-T Bedrock Database (Appendix A.2). Geometric elements for each map are loaded first into the database, the map unit descriptions are loaded next into the KET, followed by validation and joining of the map unit descriptions to specific geometries. The extensive attribution and hierarchical classification of map units within the database, enables complex queries and re-classification of units internal to a specific map and across all maps in the database. As an achievable goal of the Tri-T Bedrock Database, a new compilation of the geology of the North will be possible through reclassification and generalization queries based on the broad range of source map and value added information captured through the Tri-T KET tool.

2.1 Tool Overview

The KET form consists of two distinct sections: general map publication information followed by several groups of thematic fields to describe/document geological units associated with the map. Figure 1 shows only a subset of the attribute fields as they appear when the unpopulated template is opened.

In general, basic publication and geological unit information is parsed directly from the published map legend, while many other attributes are compiled from multiple published sources. Adding detail about a unit beyond the standard legend (e.g. environment, deformation, setting, age and metamorphic properties) facilitates correlations to similar units within a map and across other maps. All supplementary information is referenced to its source, whether it be the original map publication or another scientific publication (e.g. paper, report).

The layout of the form is such that general information pertaining to map publication, which would be common to all map legend units for a given map, is captured first. This “tombstone data” section is followed by groups of thematic attribute fields (i.e. collections) where increasing levels of attribute detail can be related to a single geological unit and its parts. The unit is described in general terms (e.g.name, colour, morphology, description, etc.) in addition to optional attributes relating to its environment and deformation history by defining lithostratigraphic and deformation parent units. Beyond the general unit description, specific information related to its constituent parts (i.e. major, minor, trace) can be captured in the lithology section of the form, e.g. details on lithologic fabric, structure, type, age and setting, etc. Unit protolith information related to age, setting and metamorphic conditions can also be entered in separate optional sections of the KET.

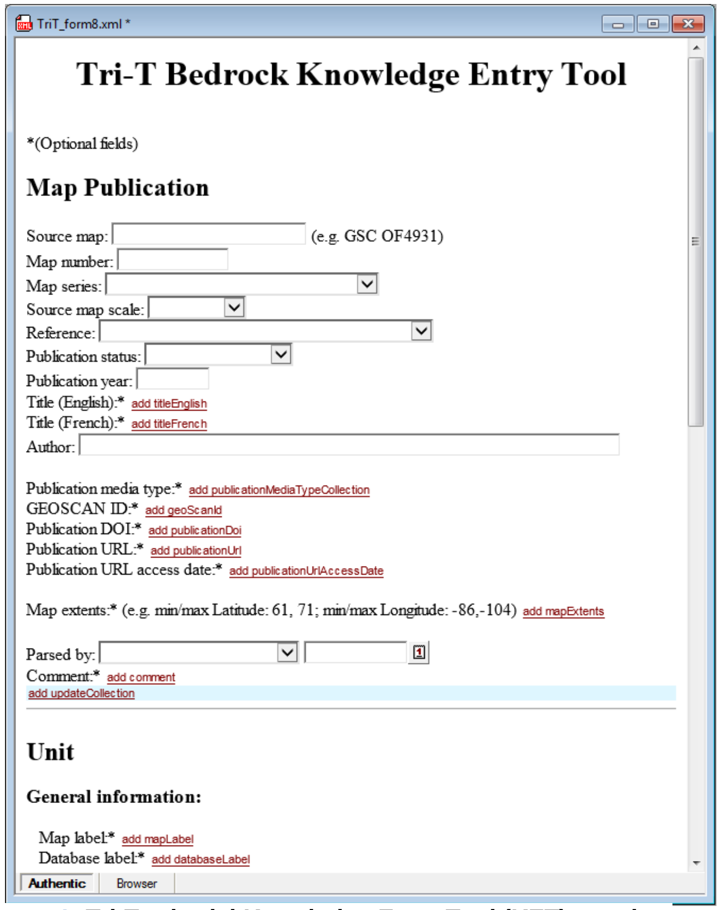


Figure 1: **Tri-Territorial Knowledge Entry Tool (KET) template**

The Tri-T KET form was developed using various Altova® software including StyleVision® and XMLSpy® for the design of the electronic form to be used in Authentic®, an XML content authoring tool. Each geological map unit is parsed individually and stored as a separate XML file within a directory specific to a given map. The unit files are organized within a single map publication directory, as shown in Figure 2, in order that validation and loading scripts process the entire group of unit files for a given map.

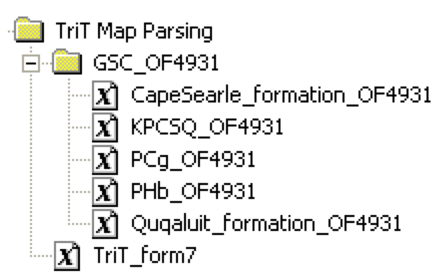


Figure 2: **Data structure example of XML files within a single map publication**

In each section, information is entered into individual fields or within thematic 'collections' that group related attributes. This organization allows expanding only those fields relevant for a given unit. The following examples of attribute collections and graphic elements relate to lithology, but this formatting can apply to any theme within the KET form. Figure 3 shows a typical example where selecting add lithologyCollection, expands the Lithology collection to expose multiple fields (Figure 4) relevant to a unit lithology. Within the form, dashed and dotted boxes are used to visually group related information, e.g. major, minor and trace lithology within the Lithology collection. Sections or individual fields that can be repeated have a light blue background. For example, in Figure 4, the Major lithology section can be repeated to capture multiple major lithologies in a unit, while the Particle type section allows multiple particle type entries per lithology.

There are three types of fields within the KET: mandatory, required and optional. Mandatory fields appear open in the empty form template indicating the need to be populated. Required fields are similar in function to mandatory fields, but only become visible within a collection that is expanded. Optional fields and collections are non-compulsory and are therefore expanded and populated only if relevant information is available. In Figure 1, the Source map and Map number fields are examples of mandatory fields because they are visible when the empty form template is opened and therefore must be populated. Most fields within the Map Publication section and several within the Unit section are mandatory to allow for identification of individual map publications and enable queries by unit name and other criteria within the Tri-T Bedrock Database. In Figure 4, when the optional Lithology collection is expanded, Abundance is a required field of the Major lithology, Minor lithology and Trace lithology sections. In the same figure, all optional fields are followed by an asterisk (*) and underlined brown text, e.g. add lithColour.

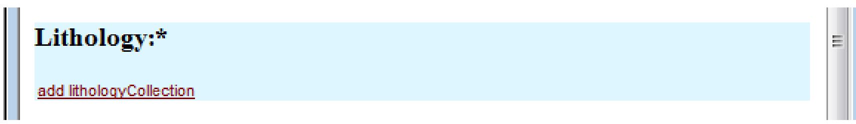


Figure 3: Collection example: Lithology

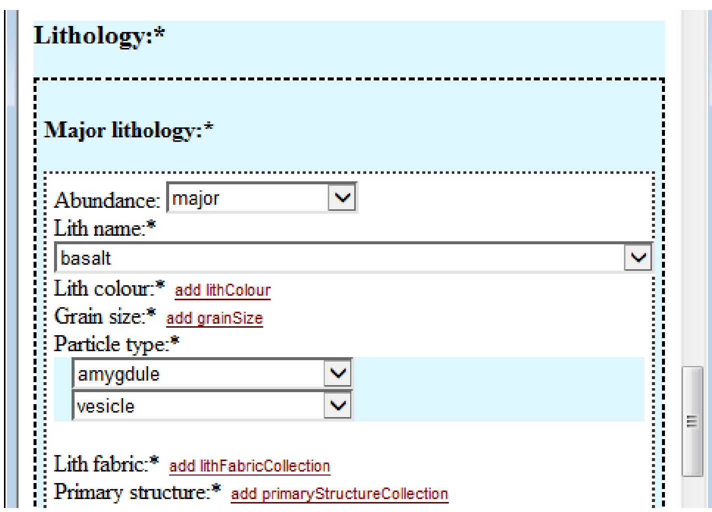
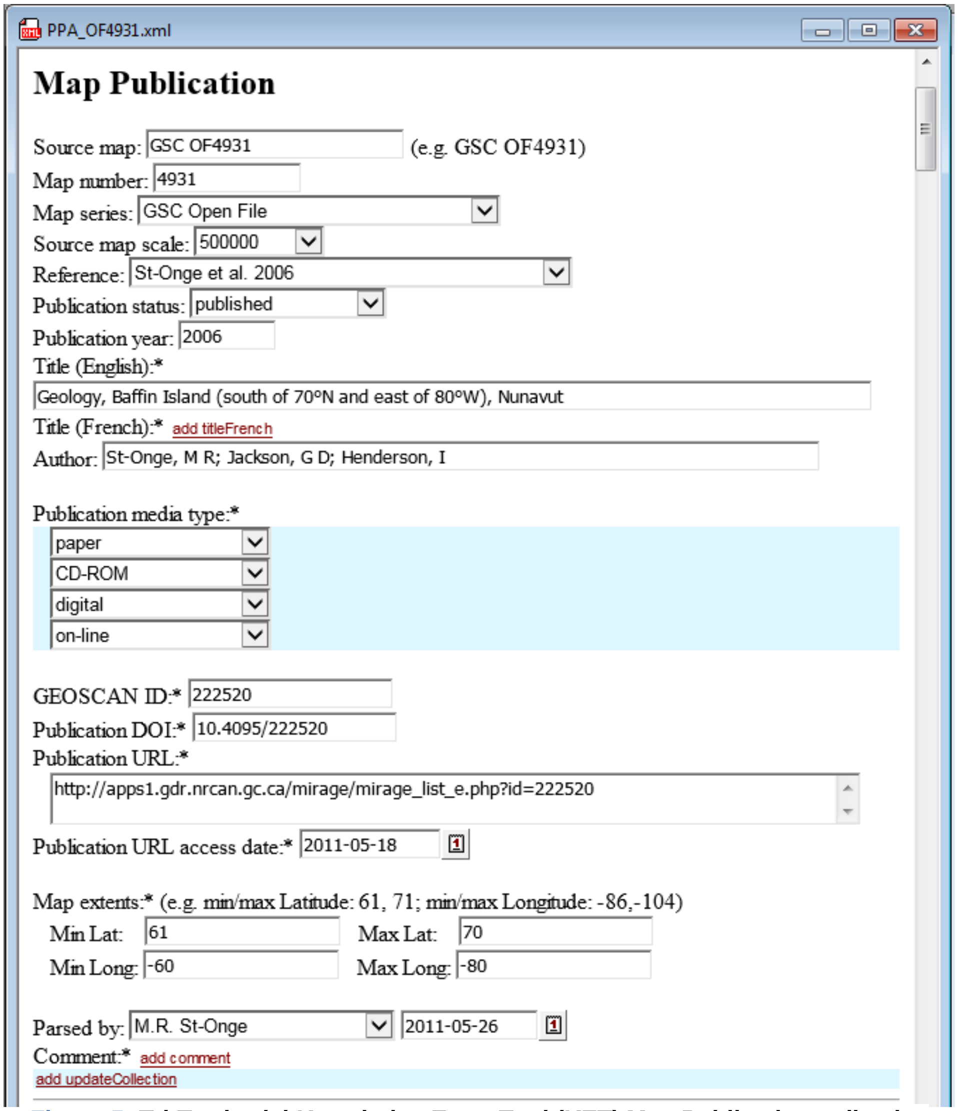


Figure 4: Required and optional fields

2.2 Map Publication

The first section of the KET captures the general information about the map and its publication. These data are common to all units of a given map (Figure 5) and therefore, this section only needs to be populated once and saved as a template for use with all other units of a specific map. Most fields within the Map Publication section are mandatory to properly identify the data source for database loading and queries.


PPA_OF4931.xml

Map Publication

Source map: GSC OF4931 (e.g. GSC OF4931)
Map number: 4931
Map series: GSC Open File
Source map scale: 500000
Reference: St-Onge et al. 2006
Publication status: published
Publication year: 2006
Title (English):*
Geology, Baffin Island (south of 70°N and east of 80°W), Nunavut
Title (French):* add titleFrench
Author: St-Onge, M R; Jackson, G D; Henderson, I

Publication media type:*
paper
CD-ROM
digital
on-line

GEOSCAN ID:* 222520
Publication DOI:* 10.4095/222520
Publication URL:*
http://apps1.gdr.nrcan.gc.ca/mirage/mirage_list_e.php?id=222520
Publication URL access date:* 2011-05-18

Map extents:* (e.g. min/max Latitude: 61, 71; min/max Longitude: -86,-104)
Min Lat: 61 Max Lat: 70
Min Long: -60 Max Long: -80

Parsed by: M.R. St-Onge 2011-05-26
Comment:* add comment
add updateCollection

Figure 5: **Tri-Territorial Knowledge Entry Tool (KET) Map Publication collection**

The following fields appear as either mandatory or optional fields within the Map Publication section of the form.

Source map (mandatory)**:**
Government agency abbreviation (GSC, YGS, etc.) followed by the unique map number (and edition where appropriate) e.g. “GSC 2505A” or “YGS OF2001-002”.

Map number (mandatory)**:**
The unique map number e.g. “4931” from the source map field.

Map series (mandatory)**:**
Government agency map series type e.g. “GSC Open File”.

Source map scale (mandatory)**:**

A picklist allows users to choose from one of a selection of common source map scales; each of these expressed as the denominator of the actual fractional scale value (e.g. “250000” = “1:250 000” scale).

Reference (mandatory)**:**
An abbreviated source map reference, consisting of the surname of authors, followed by year of publication, e.g. Tella et al. 2008. Where the same author or authors have produced more than one input publication in the given year, the year of publication is suffixed with a letter. Each unique reference is tied to a master citation list.

Publication status (mandatory)**:**
The stage of publication completion, i.e. “unpublished”, “in prep.”, “in press”, “published”.

Publication year (mandatory)**:**
The year the map was published. This field remains blank until the Publication status of the previous field is changed to ‘published’.

Title (English) or Title (French) (optional)**:**
The full title of the publication in either English or French.

Author (mandatory)**:**
Full list of all authors for the publication.

Publication media Type (optional)**:**
Listing of the various format(s) available for a given map publication, e.g. “paper”, “online”, “DVD”, etc.

GEOSCAN ID (optional)**:**
Unique identifier for scientific publications within a bibliographic database developed and maintained by the Earth Sciences Sector (ESS) of Natural Resources Canada.

Publication DOI: (optional)**:**
A digital object identifier (DOI) is a character string used to uniquely identify the digital map publication. It remains the same while the URL may change.

Publication URL (optional)**:**
This field refers to the location/address of the publication on the Internet (usually includes the domain name).

Publication URL access date (optional)**:**
Referring to the previous field, this entry represents the last known valid date for the online address of the publication.

Map extents (optional)**:**
The minimum and maximum latitude and longitude in decimal degrees of the bounding box representing the area covered by the publication.

Parsed by (mandatory)**:**
This field is for capturing the name of the scientific authority responsible for parsing the information for an individual geological unit or cartographic feature.

Comment (optional)**:**
An optional field allowing for free text remarks related to the specific unit or general comments on the publication or parsing.

add updateCollection (optional)**:**
This optional collection can be expanded to add multiple entries for updates to the content of the individual map unit form, (Figure 6). The name of the individual revising the file and date performed are required fields as well as a free text comment field to document the details of the revision.

Figure 6: **Example of multiple update entries**

2.3 Unit collection – General Information

The second section of the KET form relates to information about an individual map unit. Unit descriptions on a map legend vary in detail and in general fail to present all information known about a unit. To address this shortcoming, KET allows content to be compiled from multiple published sources, and not only from the source map legend. Going beyond a standard geology legend and capturing geochronology information or environment and deformation history from supplementary journal papers facilitates correlations to similar units within a map and across other maps.

All information is referenced to its source, whether it is the original map publication or other scientific publications. Although fields can be populated in any order, typically, general information about the unit (colour, morphology, etc.) is captured first (Figure 7). This is followed by optional collections that can be expanded to add information about environment, deformation, lithology, mineral, age and metamorphic properties (described in sections 2.1.3 – 2.1.6)

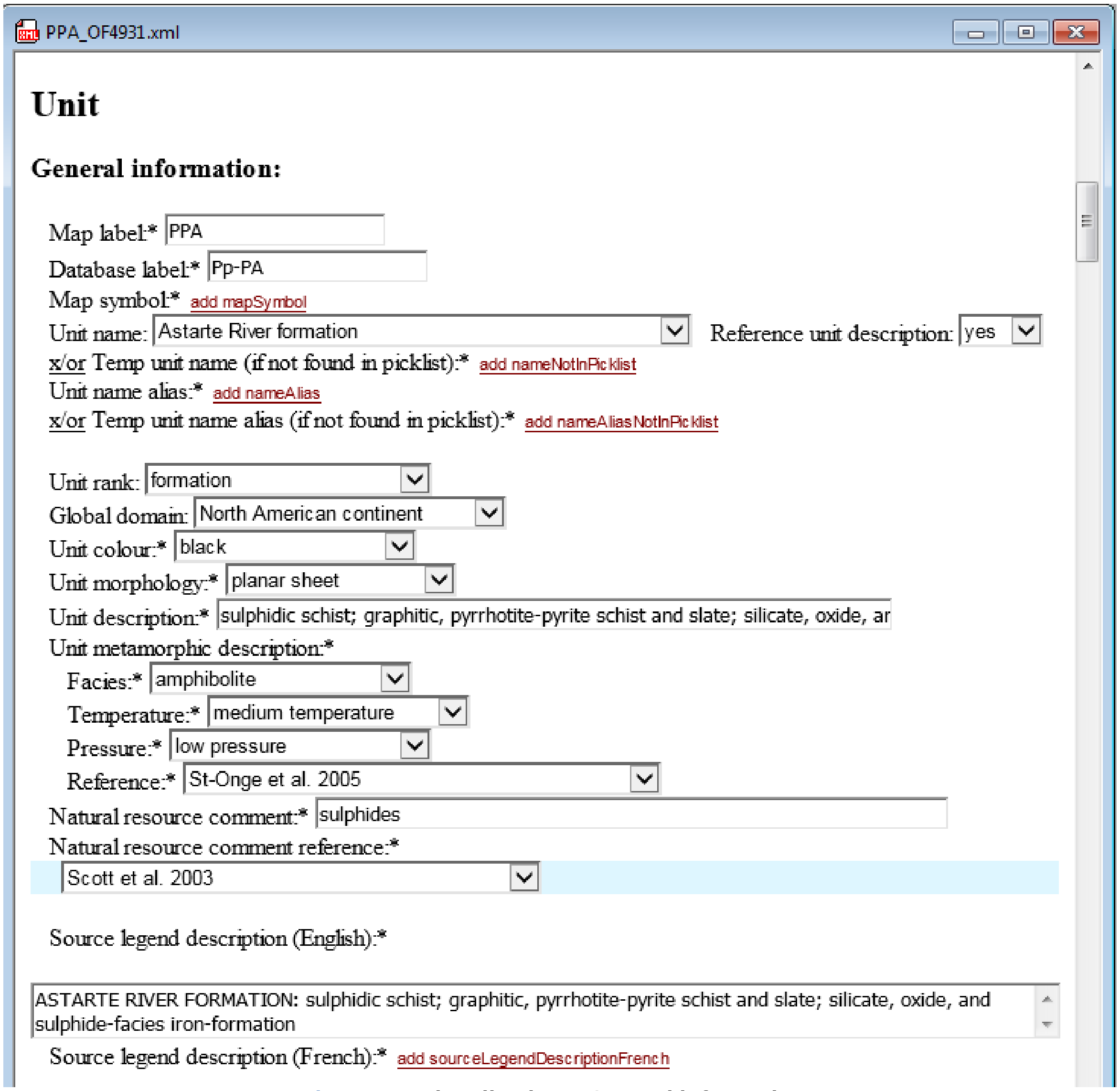


Figure 7: Unit collection – General information

The following fields appear as either mandatory or optional fields within the unit's general information section of the form.

Map Label (optional)**:**
This field contains the geologic unit label appearing on the published map face, e.g. APKz. Labels may be duplicated across different maps, in which case, the unique map publication number is used to differentiate these in the database.

Database Label (optional)**:**
This label may exist within the spatial map file to account for special font characters denoting an age bracket. For example, an Archean/Paleoproterozoic unit may have a database label of Ar-PpKz that displays on the map as APKz. If no database label exists, the map label in the previous field is used to populate this field providing a link between the unit's attributes and spatial file during loading into the Tri-T Bedrock Database.

Map symbol (optional)**:**
This field is an alphanumeric value linked to a style file defining the symbology of a point, line or polygon occurrence of a unit or cartographic feature.

Unit name:
This mandatory field represents the formal or informal name of a geological unit selected from a controlled picklist. If a name is not in the picklist, the “Unit name” is left blank and a new unit name is entered into the optional “Temp unit name (if not found in picklist)” field. This will flag that the master unit name picklist requires updating to include the new name. During validation processing, any new names are vetted by scientific staff and then added to the master unit name list. A processing script updates the xml file to populate the “Unit name” field with the appropriate data, and removes the “Temp unit name”. The “Parent unit name” works in the same manner with a temporary field and shares the same picklist as the “Unit name”.

Reference unit description:
As part of the mandatory input for Unit name, this field must be populated as either “yes” or “no”. It indicates whether the unit entry is an archetypical description or a local description for a specific map or area. By default this field is set to “no”.

Unit rank:
This mandatory field indicates the hierarchical level of a geological unit, e.g. group, formation, or member. This classification is important in establishing a unit’s position within a parent-child hierarchy to facilitate querying and reclassification of units for compilation purposes. For example, “Bravo formation” would generalize to the higher level “Piling group” rank, since a group can be composed of one or more formations.

Global Domain:
This mandatory field represents the largest (i.e. global-scale) geographical domain that contains the map unit. The menu includes examples “North American continent”, and “Arctic ocean”.

Unit colour (optional)**:**
This optional field records a single dominant colour of the unit as a whole.

Unit morphology (optional)**:**
This optional field records the typical shape and form of the unit, for example block, lenticular, or wedge.

Unit description (optional)**:**
This free text field describes general characteristics of the unit. It is an optional field that may include the source legend description and/or other unit specific published content.

Unit metamorphic description (optional)**:**
This optional collection expands to include metamorphic descriptors such as facies, temperature, and pressure fields. This collection of metamorphic attributes is referenced to their sources in the Reference field within this section.

Natural resource comment (optional)**:**
This field is used to note economic resource potential, for example: gas and oil source rock; a gold prospect; a zinc-lead SEDEX host; building stone; etc.

Natural resource comment reference (optional)**:**
One or more references can be provided from a menu to document the source for the natural resource comment field.

Source legend description (English/French) (optional)**:**
This optional field represents the unit description as it appears on the published map in English or French.

2.3.1 Environment, Deformation and Parent Units

The optional section on domain environment, deformation and parent unit collections identify a unit in terms of its lithostratigraphic or deformation parents. The environment and parent unit names represent lithostratigraphic classifications while the deformation names distinguish deformation/orogenic series. A map unit may fall under more than one type of parent unit.

The same reasoning behind establishing the unit rank in the previous section, applies to the relationship of a map unit (child) and its stratigraphic or deformation parent.
A generalized compilation map requires the simplification and grouping of lesser ranked units to regional scale units, e.g. several formations combine to a group rank parent because a unit can be part of another unit. The Unit Rank table in Appendix A.3 represents the hierarchical classification of rank and level where the smaller level numbers coincide with the higher ranks. For example, within lithostratigraphic terms, a rank of supergroup contains lesser ranks of group/sequence/formation, etc.

Within each of these collections, a formal or informal name is required, as well as its associated unit rank chosen from a drop down list.
In the following example, the Paleoproterozoic "Longstaff Bluff formation" is classified in terms of its stratigraphic and deformation parents. In Figure 8, its lithostratigraphic parents are listed where, "Rae craton cover" is a parent of "Piling group" and "Longstaff Bluff formation"; and the "Piling group" is a parent of "Longstaff Bluff formation":

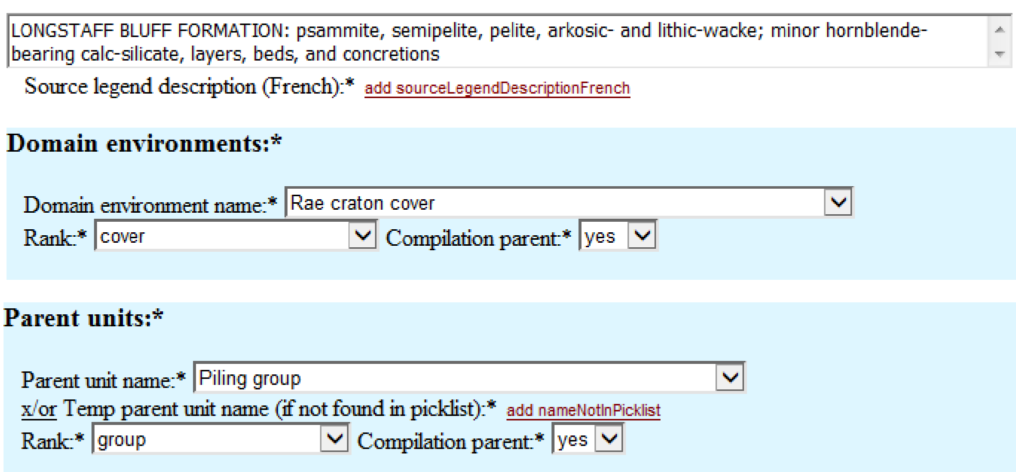


Figure 8: Tectonostratigraphic unit hierarchy example

Similarly, in Figure 9, the "Longstaff Bluff formation" can also be classified according to its deformation history as part of the "Foxe fold belt" and "Trans-Hudson orogen":

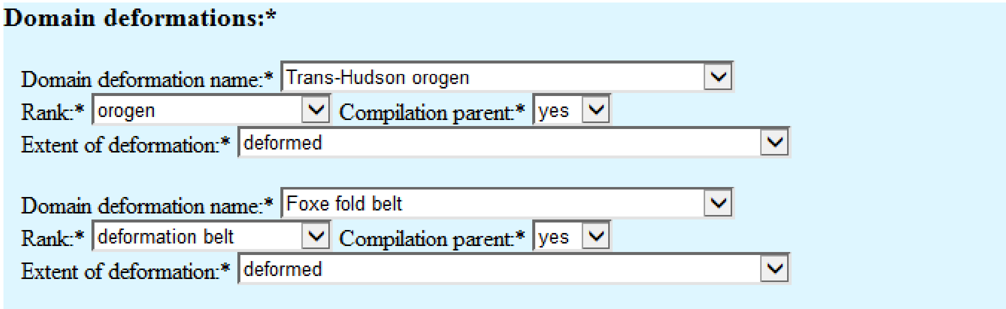


Figure 9: Deformation unit hierarchy example

A 'Compilation parent' field is also required as either "yes" or "no" to indicate the preferred reclassification parent unit. This is particularly important in complex relationships where a unit may belong to more than one parent unit of the same rank. To facilitate generalization and unit simplification in this scenario, the unit can only be generalized to one compilation parent based on a dominant lithology, age or spatial distribution of a unit in relation to its compilation parents. In Section 3.2, examples of this type of complex unit relationship are presented.

2.3.2 Lithology

The next section of the KET form describes unit lithologies in terms of their bedding, colour, particle type, fabric, primary structure, age, and metamorphic properties. A geological unit can be composed of one or more lithologies, each varying in abundance (i.e. major, minor, trace). As a result a unit may contain one or more of each of a major, minor and/or trace lithology collections. The example fields shown in Figures 10 through 13 appear in each of these collections. Only those requiring additional clarification are described below.

Particle type (optional)**:**
This optional field may be populated as multiple entries. The pick list contains mineral particle types appropriate for different rock types; the usage of "grain" is recommended for clastic sedimentary rocks, "phenocryst" for magmatic rocks, "crystal - metamorphic" for non-porphyroblastic metamorphic rocks and "crystal – sedimentary" for carbonate sedimentary rocks precipitated from a water column.

When parsing source legends, it is necessary to distinguish particle types from rock fabrics. For example, volcanic rocks may be described as containing amygdules or particles of glass, in which case 'amygdule' or 'glass' would be listed here within the particle type field.

Lith fabric (optional)**:**
The dominant fabric types for each lithology are recorded in these fields. Multiple fabric types can be recorded for each lithology. While terms such as cryptocrystalline, aphanitic, glassy or megacrystic, imply something about grain size, within the KET, they are considered to primarily describe rock fabric under the major/minor/trace lithology fabric fields.

In contrast to the previous particle type (amygdule or glass) example, volcanic rocks may also be described as having an 'amygdaloidal' or 'glassy' fabric, in which case these would be captured in the major/minor/trace lithology fabric attribute fields.

Primary structure (optional)**:**
Primary depositional or accumulative structures and or features that serve to characterize the environments in which map units or specific lithologies have formed are recorded in this field. Examples include bioherm, columnar joint, mud crack, ripple mark. Pluralized usage in source descriptions are generally reduced to the singular form for this vocabulary.

Bedding pattern (optional)**:**
Features that characterize the primary internal geometry of stratified rocks and their component layers are listed in this field.

Figure 10 shows the lithologic properties for black shale that forms a major component of the Astarte River formation on Baffin Island. This unit is also composed of iron formation as a minor lithology (not show below).

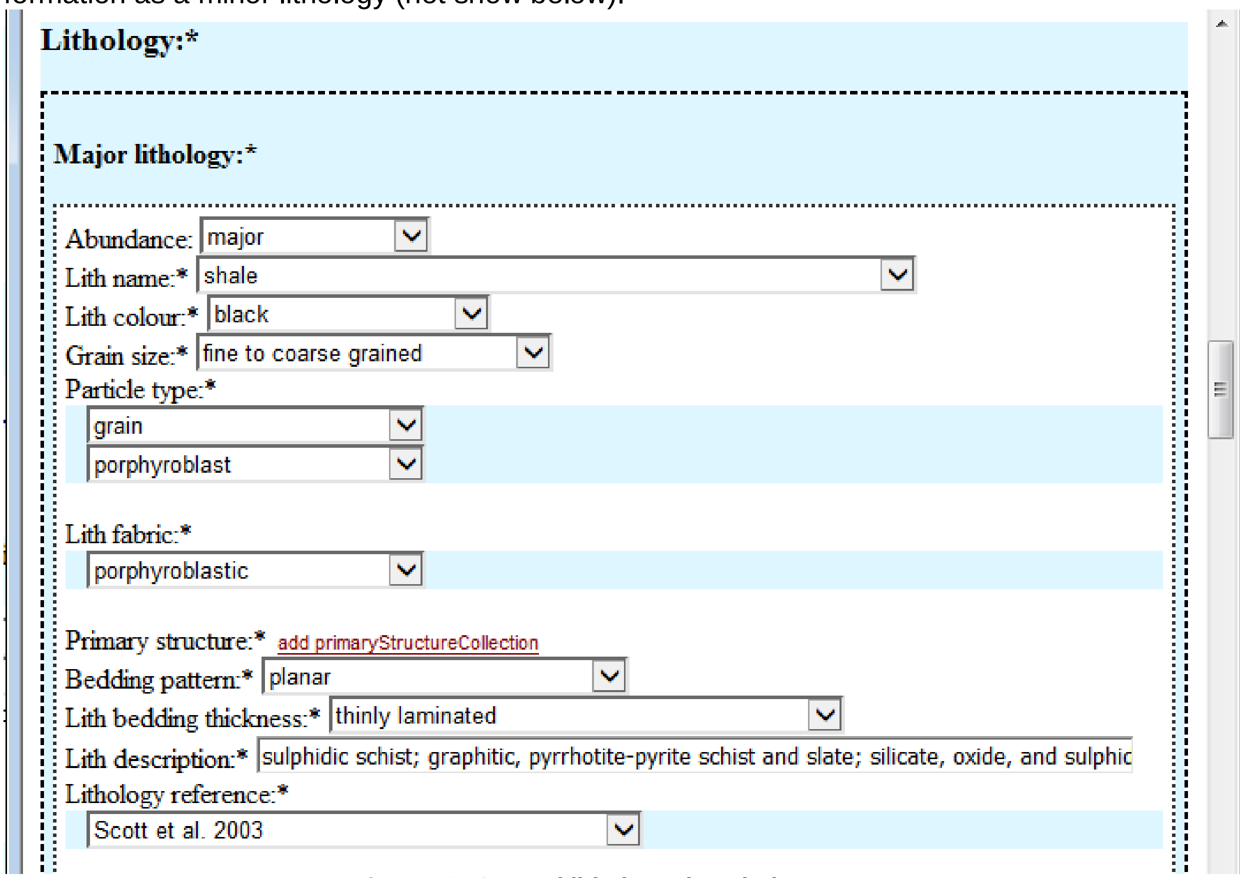


Figure 10: **General lithology description**

The tectonic and depositional environment settings for each component lithology (Figure 11) can be described in terms of local features to regional to broad-scale general geologic processes (e.g. turbidite setting to shelf to sedimentary – carbonate setting). These optional attribute fields apply to each respective major, minor; or trace lithology and/or Protolith attribute fields.

Tectonic settings (optional)**:**

This field captures a single tectonic setting for the unit as a whole, and/or distinct settings based on lithology or relative abundance (major, minor, trace). In cases where the setting evolves through time in a unit, it may be appropriate to discriminate protolith and evolved settings.

Environment settings (optional)**:**
For each attribute field within this collection, a single environment sub-setting for the unit as a whole and/or distinct settings based on lithology or relative abundance (major, minor, trace) is populated. In cases where the setting evolves through time in a unit, it may be appropriate to discriminate protolith and evolved settings.

A paleoclimate setting, or water depth, can be chosen for the unit as a whole as implied by mineralogy, geochemistry, lithology and paleoenvironmental indicators.
A fluid chemistry setting for the unit as a whole, or for component lithologies, can be described as implied by primary mineralogy, geochemistry, lithology and paleoenvironmental indicators.

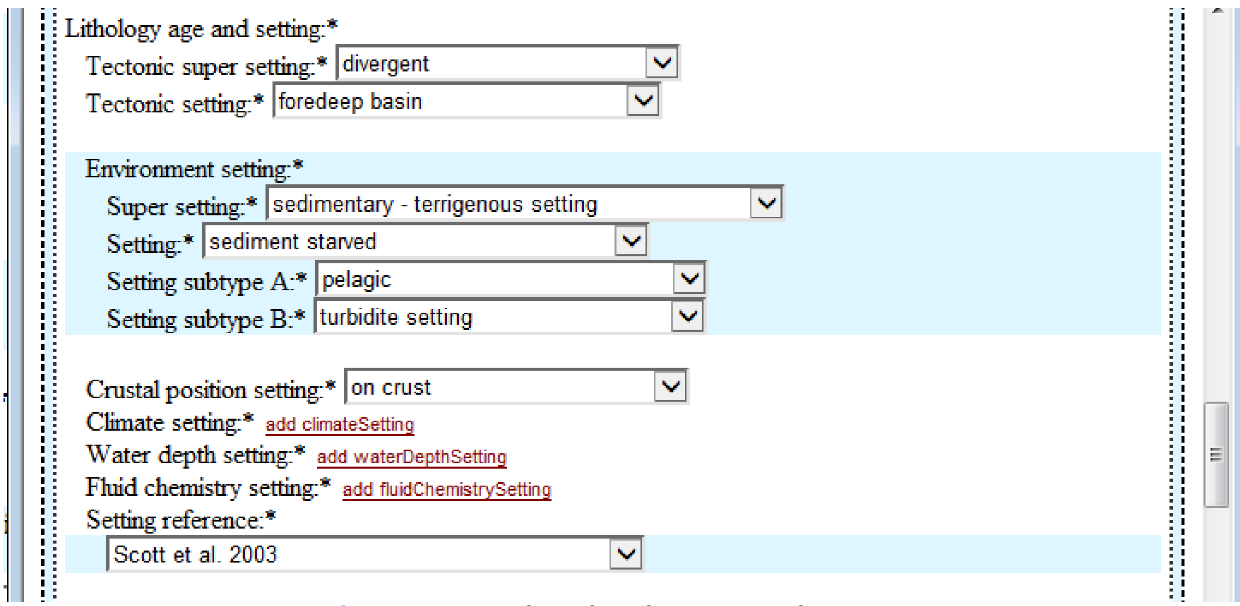


Figure 11: Tectonic and Environment setting

The age of a lithology can be expressed in terms of absolute (chronologic) or relative (chronostratigraphic) age information as shown in Figure 12. In this section of the form, both optional collections include age type, method, material, and interpretation. The age type distinguishes the dating of a protolith from metamorphic events. Absolute maximum and/or minimum age values are recorded in millions of years and may include plus/minus error ranges. Relative ages are usually obtained stratigraphically in relation to other intervals and therefore include an age certainty field.

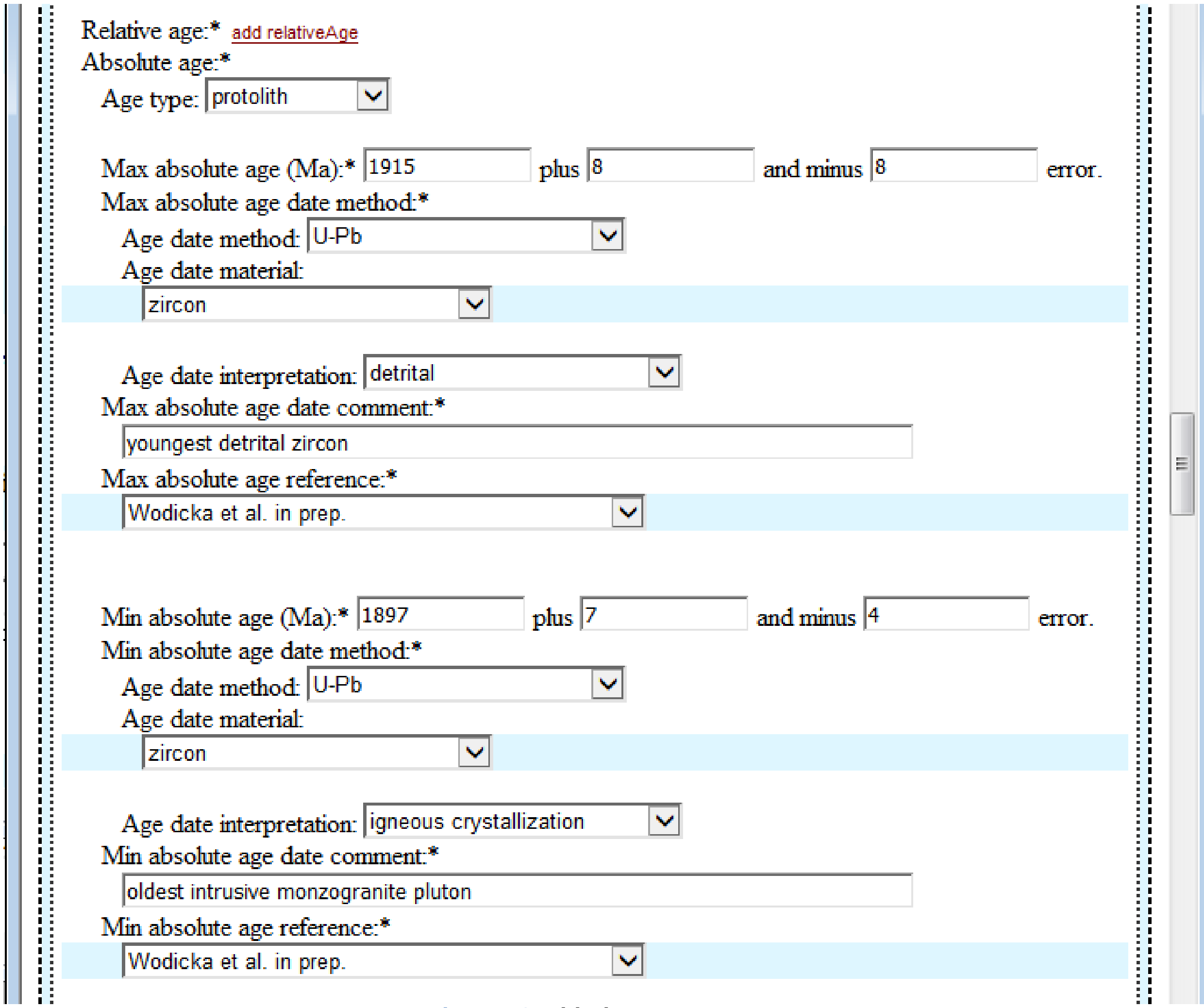


Figure 12: Lithology age

A lithology may contain one or more minerals which are noteworthy for identifying commercial economic significance, metamorphic grade, or determining rock composition. Figure 13, shows multiple economic minerals as well as amphibolite facies metamorphism. The mineral attributes are optional fields but each collection of attributes is referenced to its sources when populated.

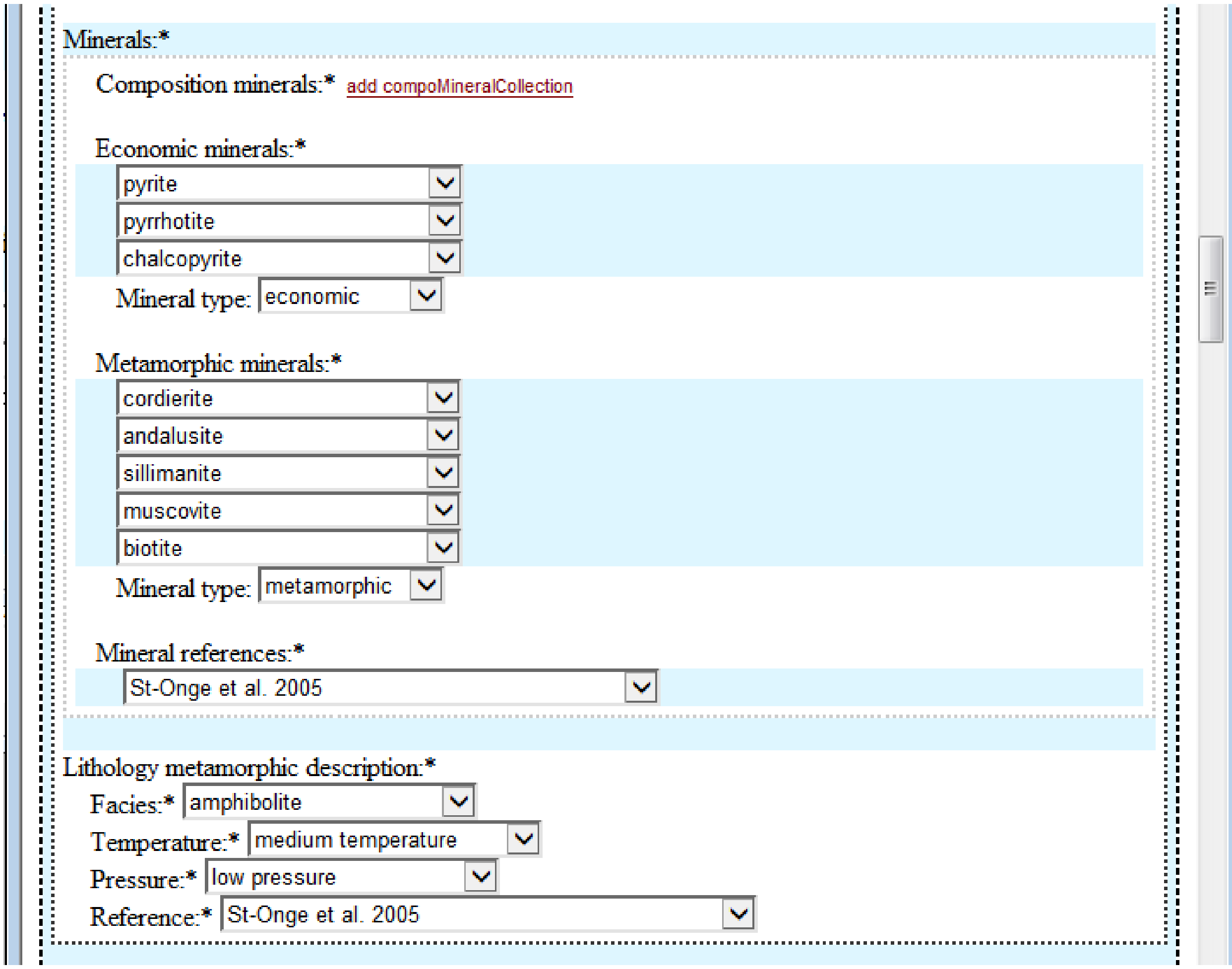


Figure 13: Lithology minerals

2.3.3 Protolith age and setting

The age and setting information related to the protolith are contained within the Protolith age and setting collection, Figure 14. This optional collection consists of the same fields found and described within the lithology section 2.3.2 and figures 11 and 12. The protolith tectonic and environment setting represents general information that includes type of climate or crustal position, and detailed information on multiple local environments.

The protolith age can be expressed in terms of absolute maximum and/or minimum age values and may include plus/minus error range values. Relative ages are usually obtained stratigraphically in relation to other intervals and therefore include an age certainty field. Both collections include age type, method, material, and interpretation. The age type distinguishes the dating of a protolith from metamorphic events. The age information is valuable in placing the unit in terms of geological event history.

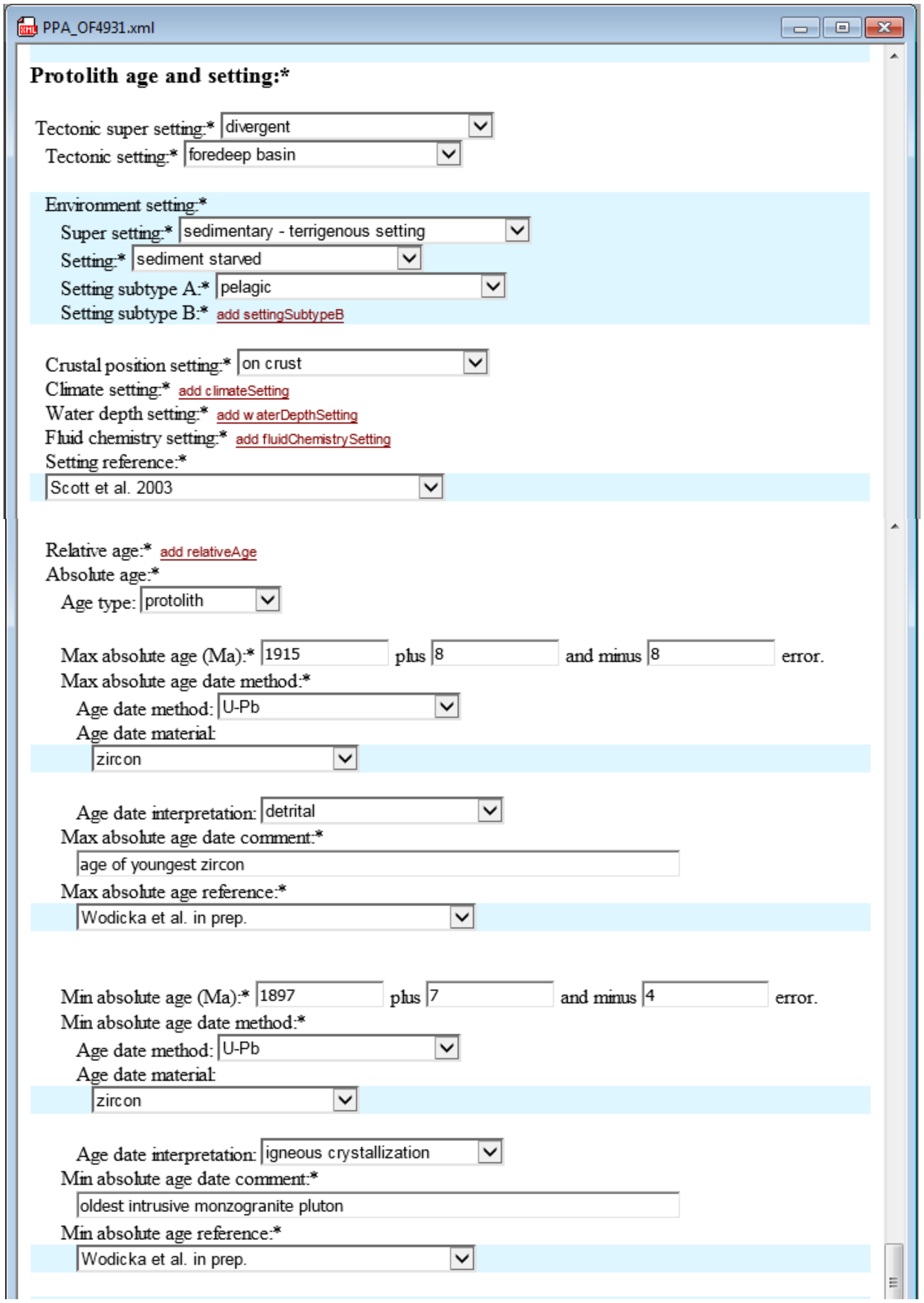


Figure 14: Protolith age and setting collection

2.3.4 Metamorphic age and setting

In this final optional section of the KET form, Figure 15, one or more metamorphic events associated with a geological unit can be described in terms of setting, age type, and chronostratigraphic age (relative) or chronologic age (absolute). The metamorphic setting regime can be defined as either extensional, compressional or strike-slip and setting type describes the nature of the metamorphism (e.g. contact, burial, regional, etc.). The above content is referenced to one or more sources.

The age of a metamorphic event can be expressed in terms of absolute (chronologic) or relative (chronostratigraphic) age information. Both of these collections include age type, method, material, and interpretation. The age type distinguishes the dating of a protolith from metamorphic events. Absolute maximum and/or minimum age values are recorded in millions of years and may include plus/minus error ranges. Relative ages are usually obtained stratigraphically in relation to other intervals and therefore include an age certainty field. As shown in Figure 15, this content is referenced to one or more sources.

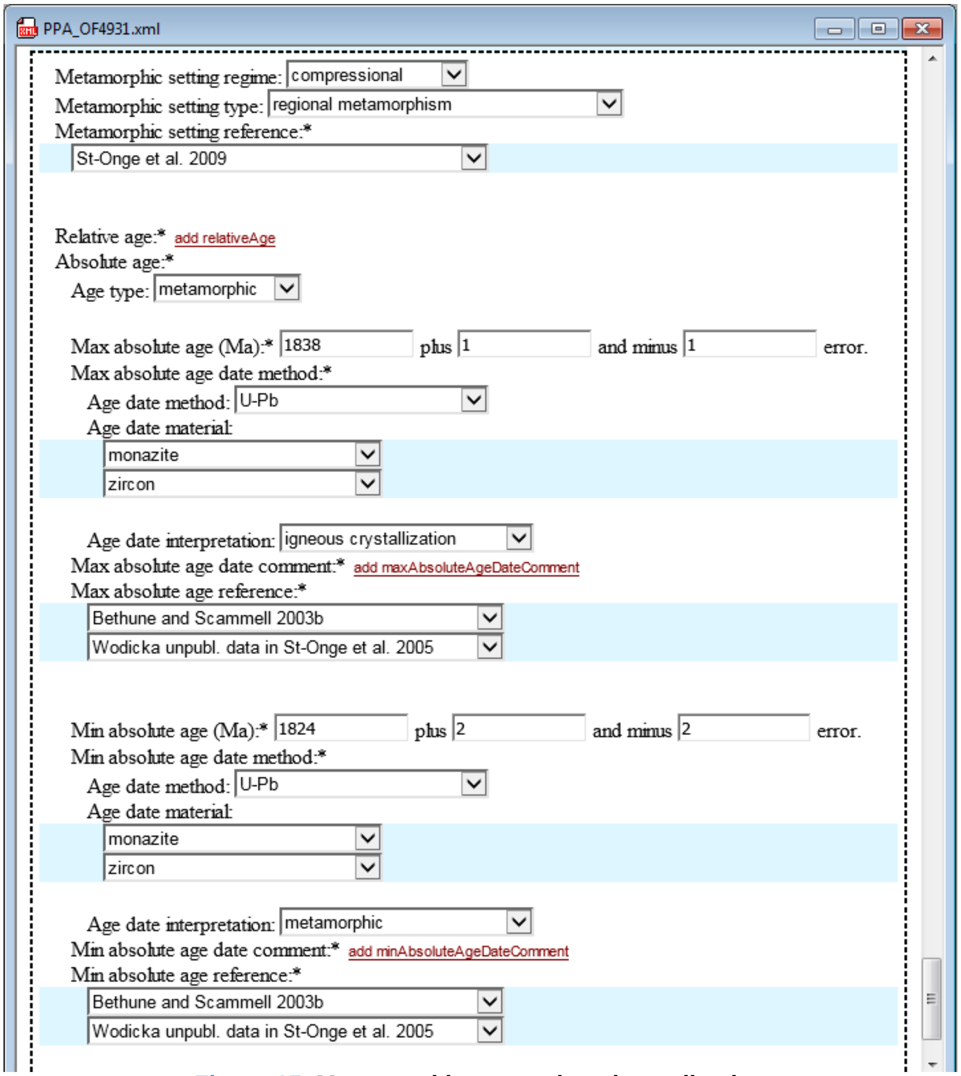


Figure 15: Metamorphic age and setting collection

3 Unit Examples

3.1 Composite unit

Within a map, there are units that exist as a result of the compilation of several formal or informal units. These represent whole-part relationships where the composite unit (parent) is made up of parts (children). When a unit appears in a legend as a composite unit, separate KET forms are completed for the parent unit and its parts (children). In many cases, the composite unit will be unique to a specific map publication because they are based on an author's decision as to what parts constitute the composite unit.

In the following example from GSC Open file 4931 (OF4931), a composite unit, KPCSQ consists of 2 formations: Cape Searle formation and Quqaluit formation (Figure 16). To fully capture this relationship, three KET forms were completed to represent the composite map unit and its two formation parts. The map publication portion of the form is common to all three files and only diverges in the details about lithology, relative ages, minerals, etc.

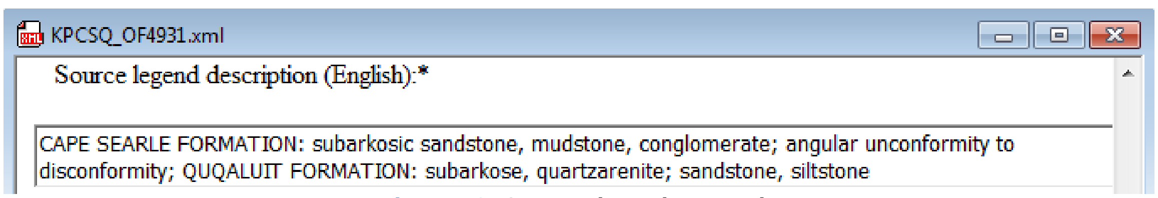


Figure 16: Composite unit example

KPCSQ_ OF4931.xml
The form entry for the composite parent unit "*KPCSQ_OF4931"* represents a generalized description, populated with only as much information as is known about the aggregate unit.
CapeSearle_formation_OF4931.xml
This form describes the Cape Searle formation as it occurs within the published map OF4931. From the source legend description, details about lithologies (i.e. subarkosic sandstone, mudstone, and conglomerate), relative ages, etc. populate the unit fields. As a part (child) of composite unit KPCSQ, its parent unit is recorded as "*KPCSQ_OF4931"* with a unit rank of group.
Quqaluit_formation_OF4931.xml
This form describes the Quqaluit formation as it occurs within OF4931. From the source legend description, details about lithologies (i.e. subarkose, quartzarenite sandstone, and siltstone), relative ages, etc. are populated in the unit section of the form. This unit part (child) has a parent unit of "*KPCSQ_OF4931"* with a unit rank of group.

If a unit occurs on more than one map and varies in its characteristics, the unit will be entered as a second XML file with the new map added as a suffix to the XML file and unit name. Using the example for the occurrence of the Cape Searle formation on OF4933 which varies from that in OF4931, the unit name would be "*Cape Searle formation_OF4933*".

If both occurrences of this unit represent partial descriptions of the Cape Searle formation, another form entry should be made to describe the prototype of the

Cape Searle formation. This would maintain the unit name “Cape Searle formation” as it defines the formation in terms of its typical and necessary characteristics across all variations on different maps.

3.2 Complex unit

There are some instances where a composite unit may have may have multiple parents of the same rank, resulting in complex parent relationships. For compilation purposes, designating a single parent is necessary and the decision as to how one compilation parent is assigned over another may be based on proportion (e.g. dominant lithology), age or spatial distribution.

Phanerozoic units from the Arctic Islands are used to demonstrate this concept in Figure 17. In this example, “Borup Fiord formation” occurs on the map a single unit but also as part of three composite map units (CPEn1, CPEn2 and Cb3), each consisting of Borup Fiord and another formation. Within their respective KET forms, they have been assigned a unit rank of group and a parent at the assemblage level. The composite units CPEn1, CPEn2 and Cb3, as well as the “Borup assemblage”, are valid parent units for the Borup Fiord formation in this map but only “Borup assemblage” was assigned as the preferred Compilation parent because it exists as a straight forward lithostratigraphic parent. Each of the other parents are composite units and contain at least one other formation.

The composite units CPEn1_OF8888, (**Borup Fiord** and Nansen formations) and CPEn2_OF8888, (**Borup Fiord**, Nansen, and van Hauen, Degerbols formations) were assigned a Compilation parent of “Nansen assemblage” because in each of these, the volume of Borup Fiord formation was less than that of Nansen formation.

Only the composite unit Cb3_OF8888, (Emma Fiord and **Borup Fiord** formations) was assigned a Compilation parent of Borup assemblage because the Borup formation was proportionally more significant in terms of thickness than the Emma Fiord formation.

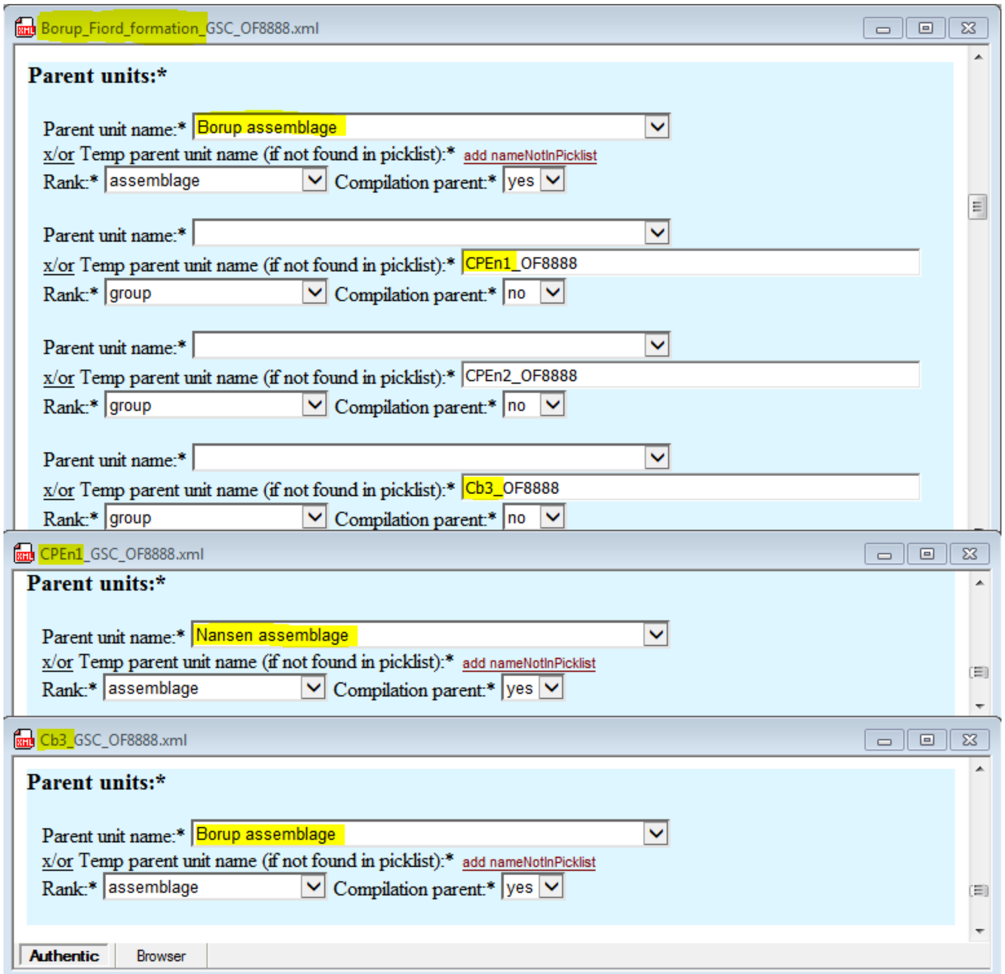


Figure 17: **Complex unit parents**

3.3 Cartographic units

A simplified version of the KET form is used to capture attributes related to cartographic and topographic features where these were exist with the published source geology data. These may include unmapped areas, embedded water, ice, interpreted map or political boundaries. Within the KET, these features are assigned an arbitrary map label which is added to the associated geometries in the source shape file for the purpose of joining attributes during database loading. They are also given a Unit rank of 'cartographic' and a simple Unit description (e.g. unmapped area – no lithology information) which is loaded to the Carto_Feature table within the Tri-Territorial bedrock database.

When ice features geometries are integral with geology units, they are maintained and loaded into the Geol_unit table. They are similarly attributed to the cartographic features described above.

As of the publication date for this document, only those attributes that correspond to polygonal geometries for geological units or cartographic features have been loaded into the Tri-T Bedrock database.

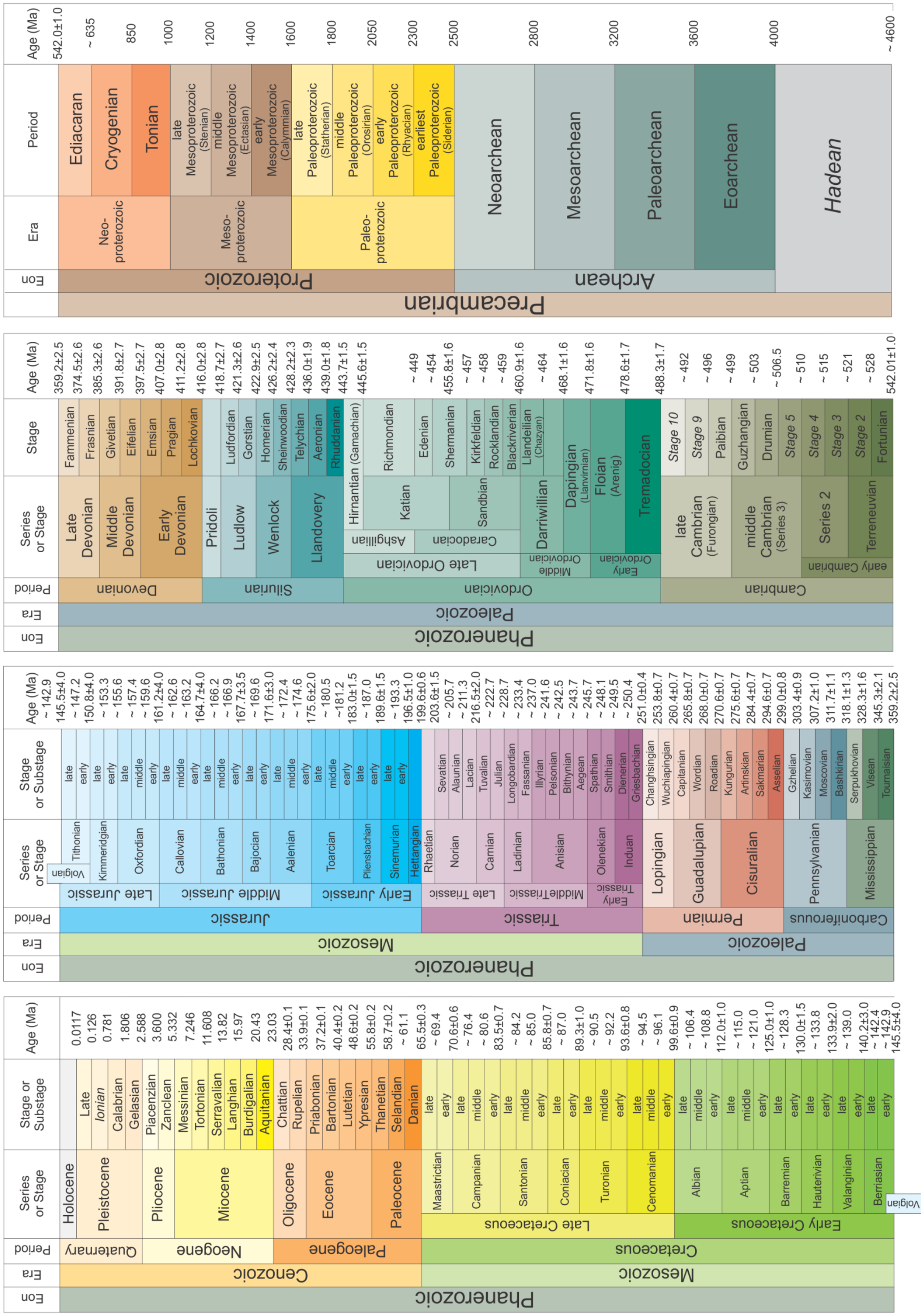
Appendix A

The following section includes representations of the Tri-Territorial Bedrock geological timescale, a table relating the Tri-T Bedrock KET fields to the Tri-T Bedrock Database, and a table of tectonstratigraphic and deformation unit ranks.

A.1 Tri-Territorial Bedrock Timescale

The geological timescale (Figure 18) used within the Tri-T KET tool and Tri-T Bedrock database is a modified version of the International Commission on Stratigraphy (ICS) September 2010 timescale edition. It includes revisions for the Mesozoic based on the ICS Subcommission for Stratigraphic Information, and modifications to the Ordovician based on data provided by the GeoWhen database maintained by R.A. Rohde (University of California at Berkeley). Italicized terms shown in the graphic are informal.
See the References section for additional information.

Figure 18: Tri-T Bedrock Database Timescale



A.2 KET fields mapped to Tri-T Bedrock Database fields

Table 1 relates the Tri-T Bedrock KET attribute fields to corresponding tables and fields within the Tri-T Bedrock Database (Brodaric et al. 2015). Note that database fields without direct correspondence to a KET field are listed as “n/a” in Table 1. However, some of these fields are indirectly derived from the KET. For example, several “ID” fields are populated with numeric IDs found by searching on names from KET. Other such fields represent potential future extensions to the KET form.

Table 1: **KET fields mapped to Tri-T Bedrock database tables and fields**

Tri-T Database Table	Tri-T Database Field	KET Field
Map_Symbol	**symbol_ID**	**Map Symbol**
	symbolFile_URL	n/a
	symbolLabel_EN	**Map Label**
	symbolLabel_FR	n/a
	symbolLabel_DB	**Database Label**
	rotAngle	n/a
Map_Legend	legend_ID	n/a
Map_Legend_Item	legendItem_ID	n/a
	legend_ID	n/a
	mapSymbol_ID	n/a
	legSequence	n/a
	legItemTitle_EN	n/a
	legItemTitle_FR	n/a
	legItemDescription_EN	**Source legend description (EN)**
	legItemDescription_FR	**Source legend description (FR)**
	legItemUnit_ID	n/a
	legItemStructure_ID	n/a
	legItemCarto_ID	n/a
n/a	n/a	**Source map**
Publication	pub_ID	n/a
	pubNumber	**Map number**
	pubSeries	**Map series**
	pubScale	**Source map scale**
	pubAlias	**Reference**
	pubAuthor	**Author**
	pubTitle_EN	**Title (English)**
	pubTitle_FR	**Title (French)**
	pubStatus	**Publication status**
	pubYear	**Publication year**
	pubMediaType1	**Publication MediaType**
	pubMediaType2	**Publication MediaType**
	pubMediaType3	**Publication MediaType**
	pubMediaType4	**Publication MediaType**
	pubMediaType5	**Publication MediaType**
	pubExtentsNTS	n/a
	pubExtentsMinLat	**Map extents Min Lat**
	pubExtentsMinLong	**Map extents MinLong**
	pubExtentsMaxLat	**Map extents MaxLat**
	pubExtentsMaxLong	**Map extents MaxLong**
	publisher	n/a

	pubDescription_EN	n/a
	pubDescription_FR	n/a
	pubGeoSCAN_ID	**GeoSCAN ID**
	pubDOI	**Publication DOI**
	pubURL	**Publication URL**
	pubURLAccessDate	**Publication URL Access Date**
Published_Item	geoPub_ID	n/a
	pub_ID	n/a
	map_ID	n/a
	legend_ID	n/a
	structure_ID	n/a
	unit_ID	n/a
	unitMetamorphic_ID	n/a
	eventSetting_ID	n/a
	lithology_ID	n/a
	lithMineral_ID	n/a
	mineral_ID	n/a
	ageDate_ID	n/a
	stratAge_ID	n/a
	timeScale_ID	n/a
	vocab_ID	n/a
	concept_ID	n/a
Edit	edit_ID	n/a
	editAuthor	**Parsed by/Updated by**
	editDate	**Parsed by date/Updated By date**
	editDescription	**Parsed by Comment/Updated By Comment**
	map_ID	n/a
	legend_ID	n/a
	legenditem_ID	n/a
	stratAge_ID	n/a
	ageDate_ID	n/a
	timeScale_ID	n/a
	event_ID	n/a
	mineral_ID	n/a
	lithology_ID	n/a
	unit_ID	n/a
	structure_ID	n/a
	vocab_ID	n/a
	concept_ID	n/a
Geol_Feature	geolFeature_ID	n/a
	unitClassifier_ID	n/a
	structureClassifier_ID	n/a
	cartoClassifier_ID	n/a
	classifierAccuracy	n/a
	unitDescription_ID	n/a
	structureDescription_ID	n/a
	cartoDescription_ID	n/a
	geoFile_ID	n/a
	geoPoly_ID	n/a
	geoLine_ID	n/a

	geoPoint_ID	n/a
	geoPositionReason	n/a
	geoPositionAccuracy	n/a
Geol_Unit	**unit_ID**	n/a
	purpose	n/a
	unitType	n/a
	unitName	**unitName/ *DomEnviroName/ DomDefName***
	unitNameAlias	**Unit name alias**
	referenceUnitDescription	**Reference unit description**
	unitRank	**unitName Rank *⁄DomEnviroName Rank ⁄DomDefName Rank***
	unitGlobalDomain	**Global domain**
	unitColour	**Unit colour**
	unitMorphology	**Unit morphology**
	unitDescription	**Unit description**
	unitDeformationExtent	**Extent of deformation**
	unitMetamorphicFacies	**(Unit metamorphic description) Facies**
	unitMetamorphicTemperature	**(Unit metamorphic description) Temperature**
	unitMetamorphicPressure	**(Unit metamorphic description) Pressure**
	unitNaturalResourceComment	**Natural resource comment**
	unitLexicon_URL	n/a
	unitChemicalComposition	n/a
	unitPetrographicComposition	n/a
	unitThickness	n/a
Geol_Unit_Part	**unitParent_ID**	n/a
	unitPart_ID	n/a
	unitReclassifier	**Compilation parent**
	unitAbundance	n/a
	unitProportion	n/a
Geol_Unit_Lithology	unit_ID	n/a
	lithology_ID	n/a
	lithAbundance	**Abundance (Major/Minor/Trace Unit)**
	lithProportion	n/a
Geol_Lithology	lithology_ID	n/a
	lithName	**Lith name**
	lithBeddingPattern	**Bedding pattern**
	lithBeddingThickness	**Lith bedding thickness**
	lithColour	**Lith colour**
	lithParticleSize	**Grain size**
	lithParticleType1	**Particle type**
	lithParticleType2	**Particle type**
	lithParticleType3	**Particle type**
	lithParticleType4	**Particle type**
	lithFabric1	**Lith fabric**
	lithFabric2	**Lith fabric**
	lithFabric3	**Lith fabric**

	lithDescription	**Lith Description**
	lithPrimaryStructure1	**Primary structure**
	lithPrimaryStructure2	**Primary structure**
	lithPrimaryStructure3	**Primary structure**
	lithMetamorphicFacies	**(Lithology metamorphic description) Facies**
	lithMetamorphicTemperature	**(Lithology metamorphic description) Temperature**
	lithMetamorphicPressure	**(Lithology metamorphic description) Pressure**
	lithParticleShape	n/a
	lithConsolidationDegree	n/a
	lithChemicalComposition	n/a
	lithPetrographicComposition	n/a
Geol_Lithology_Part	lithParent_ID	n/a
	lithPart_ID	n/a
	lithAbundance	**Abundance (Major/Minor/Trace Lithology)**
	lithProportion	n/a
	lithRole	n/a
Geol_Event	event_ID	n/a
	unit_ID	n/a
	lithology_ID	n/a
	structure_ID	n/a
	age_Type	**Age type (Lithology/Unit Protolith/Metam Age)**
	settingTectonicSuper	**Tectonic super setting (Lithology/Unit Protolith/Metamorphic Age)**
	settingTectonic	**Tectonic setting (Lithology/Unit Protolith/Metamorphic Age)**
	settingCrustalPosition	**Crustal position setting (Lithology/Unit Protolith/Metamorphic Age)**
	settingClimate	**Climate setting (Lithology/Unit Protolith/Metamorphic Age)**
	settingWaterDepth	**Water depth setting (Lithology/Unit Protolith/Metamorphic Age)**
	settingFluidChemistry	**Fluid chemistry setting (Lithology/Unit Protolith/Metamorphic Age)**
	settingMetamorphicRegime	**Setting Regime (Lithology/Unit Protolith/Metamorphic Age)**
	settingMetamorphicType	**Setting Type (Lithology/Unit Protolith/Metamorphic Age)**
	activeStatus	n/a
	minStratAge_ID	n/a
	minStrateAgeCertainty	**Min relative age certainty (Lithology/Unit Protolith/Metamorphic Age)**
	minStratAgeMethod_ID	n/a

	minStratAgeComment	**Min relative age date comment (Lithology/Unit Protolith/Metamorphic Age)**
	maxStratAge_ID	n/a
	maxStratAgeCertainty	**Max relative age certainty (Lithology/Unit Protolith/Metamorphic Age)**
	MaxStratAgeMethod_ID	n/a
	maxStratAgeComment	**Max relative age date comment (Lithology/Unit Protolith/Metamorphic Age)**
	minAgeDate_ID	n/a
	minAgeDateMethod_ID	n/a
	minAgeDateComment	**Min age date comment (Lithology/Unit Protolith/Metamorphic Age)**
	maxAgeDate_ID	n/a
	maxAgeDateMethod_ID	n/a
	maxAgeDateComment	**Max age date comment (Lithology/Unit Protolith/Metamorphic Age)**
Geol_Event_Sequence	preEvent_ID	n/a
	nextEvent_ID	n/a
Geol_Setting	setting_ID	n/a
	event_ID	n/a
	settingEnvironmentSuper	**(Environment) Super setting**
	settingEnvironment	**(Environment) Setting**
	settingEnvironmentSubA	**(Environment) Setting subtype A**
	settingEnvironmentSubB	**(Environment) Setting subtype B**
Geol_AgeMethod	**method_id**	n/a
	methodType	**Age method type (Lithology/Unit Protolith/Metam Age)**
	methodMaterial1	**Age date material1 (Lithology/Unit Protolith/Metam Age)**
	methodMaterial2	**Age date material2 (Lithology/Unit Protolith/Metam Age)**
	methodInterpretation	**Age Date Interpretation**
Geol_Age_Date	ageDate_ID	n/a
	ageDate	**Max/Min Absolute or Relative Age**
	ageDateErrorPlus	**Max/Min Absolute or Relative AgeErrorPlus**
	ageDateErrorMinus	**Max/Min Absolute or Relative AgeErrorMinus**
	minDate	n/a
	maxDate	n/a
	minDateErrorPlus	n/a
	minDateErrorMinus	n/a
	maxDateErrorPlus	n/a

	maxDateErrorMinus	n/a
	ageDateComment	**(Max/Min Age Absolute or Relative) Comment**
	ageAccuracy	n/a
Geol_Age_Strat	stratAge_ID	n/a
	timeScale_ID	n/a
	stratAgeName	Relative Age: Max/Min
	stratAgeNameAlias	n/a
	minStratAgeDate_ID	n/a
	maxStratAgeDate_ID	n/a
Geol_Age_Strat_Part	stratAgeParent_ID	n/a
	stratAgePart_ID	n/a
Geol_Time_Scale	timeScale_ID	n/a
Geo_Mineral	mineral_ID	n/a
	lithology_ID	n/a
	minName	**Minerals (under each of Composition; Economic; Metamorphic)**
	minPurpose	**Mineral Type (under each of Composition; Economic; Metamorphic)**
	minAbundance	n/a
	minProportion	n/a
Geol_Structure	structure_ID	n/a
	purpose	n/a
	structureType	n/a
	contactCharacter	n/a
	foldProfile	n/a
	generation	n/a
	planePolarity	n/a
	hangingWallDirection	n/a
	movementSense	n/a
	movementType	n/a
	azimuth_trend	n/a
	dip_plunge	n/a
	measurementDirection	n/a
	measurementConvention	n/a
	structureDescription	n/a
	structureParent_ID	n/a
	structurePart_ID	n/a
Carto_Feature	carto_ID	n/a
	purpose	n/a
	cartoType	**unitName**
	cartoDescription	**Source legend description**

A.3 Unit rank and level

Table 2 represents the geological unit rank in a tectonstratigraphic and deformation hierarchy. Ranks with larger level numbers represent a finer resolution rank type. This classification is important in establishing a unit's position within a parent-child hierarchy to facilitate querying and reclassification of units for compilation purposes. For example, at a very broad, regional scale, a unit may be classified at the craton level, but may also be categorized at the intrusion level when a more detailed resolution of compilation is required. While a map unit may fall under more than one type of parent unit rank, it can only be reclassified within permissible parent/child relationships such that the deformation/orogenic and stratigraphic/environment rank series cannot be mixed. For example, deformation/orogenic units can only be simplified within this rank series:

Deformation > orogen > deformation belt > deformation complex/zone/block

Similarly, stratigraphic and environment parent unit ranks can only be reclassified within the tectonostratigraphic series:

Global > continent/ocean

Environment > craton/cover/terrane/stitching assemblage > basin/platform/rift/shelf/subterrane/trough/uplift/arch/uplift cover/uplift stitching assemblage > facies belt/graben/ridge/barrier/embayment/slope/astrobleme

Stratigraphic > supergroup/arc/succession > assemblage/plutonic assemblage > batholith/plutonic complex/group/volcanic chain > sequence/subgroup/subcomplex > formation/suite/swarm/volcanic centre > member/pluton/dyke/sill/ facies/intrusion/part/stock > bed/flow/unit/tongue

Table 2: Unit rank and level

RANK	LEVEL
GLOBAL	
continent/ocean	200
ENVIRONMENT	
craton/cover/terrane/stitching assemblage	300
basin/platform/rift/shelf/subterrane/trough/uplift/arch/uplift cover/uplift stitching assemblage	310
facies belt/graben/ridge/barrier/embayment/slope/astrobleme	320
DEFORMATION	
orogen	400
deformation belt	410
deformation complex/zone/block	420
STRATIGRAPHIC	
supergroup/arc/succession	500
assemblage/plutonic assemblage	510
batholith/plutonic complex/group/volcanic chain	520
sequence/subgroup/subcomplex	530

formation/suite/swarm/volcanic centre	540
member/pluton/dyke/ sill/ facies/intrusion/part/stock	550
bed/flow/unit/tongue	560

References

Brodaric, B., Paul, D., St-Onge, M.R., and Harrison, J.C., 2015. The Tri-territorial (TriT) Bedrock Database Design and Science Language; Geological Survey of Canada, Open File 7859, 200 pp. doi: 10.4095/296669.

Tri-Territorial Bedrock Timescale (Appendix A.1, Figure 18):

Modified after the International Commission on Stratigraphy (ICS) 2009/2010 time scale from an illustration made available through a website maintained by the Subcommission for Stratigraphic Information: https://engineering.purdue.edu/Stratigraphy/charts/chart.html.

This chart has been modified based on detailed charts for the Mesozoic provided by the ICS Subcommission for Stratigraphic Information: https://engineering.purdue.edu/Stratigraphy/charts/educational.html.

Modifications to the Ordovician is based on data provided by the GeoWhen Database maintained by R.A. Rohde (University of California at Berkeley); http://www.stratigraphy.org/bak/geowhen/index.html).

Gradstein, F.M., Ogg, J.G., Schmitz, M.D., Ogg, G.M., 2012. The Geologic Time Scale 2012; Elsevier, 1176 pp.