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Isotopic Atlas of Australia: Geochronology compilation for Tasmania

Version 1.0

S.L. Jones, K. Waltenberg, R. Ramesh, G. Cumming, J.L. Everard, M.J. Vicary, S. Bodorkos, R.S. Bottrill, K. Knight, A.W. McNeill, and S. Meffre.

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Contents

Executive Summary

This Record documents the efforts of Mineral Resources Tasmania (MRT) and Geoscience Australia (GA) in compiling a geochronology (age) compilation for Tasmania, describing both the dataset itself and the process by which it is incorporated into the continental-scale Isotopic Atlas of Australia. The Isotopic Atlas draws together age and isotopic data from across the country and provides visualisations and tools to enable users to extract maximum value from these datasets. Data is added to the Isotopic Atlas in a staged approach with priorities determined by GA- and partner-driven focus regions and research questions. The Tasmanian dataset represents the second in a series of compilation publications (Records and Datasets) for the southern states of Australia, produced during the second phase of the Exploring for the Future (EFTF) initiative over 2020–2024.

This initial release (version 1.0) of the Tasmanian geochronology compilation comprises a total of 878 ages, chronicling the evolution of onshore Tasmania from Mesoproterozoic deposition of sedimentary successions in western King Island through to Neogene basaltic volcanism in Bass Strait and its margins. Most ages in this compilation document the evolution of the Delamerian Orogen and Lachlan Orogen in the interval 520–350 Ma, and these Paleozoic ages were predominantly determined using the Rb–Sr, K–Ar, and U–Pb isotopic systems. Ages younger than 320 Ma largely comprise K–Ar and Ar–Ar analyses documenting Mesozoic post-orogenic uplift and cooling, and Mesozoic to Cenozoic basaltic volcanism.

The compilation was assembled primarily from data, reports, journal articles and theses provided to GA by MRT. The accompanying data compilation to this Record contains a ‘snapshot in time’ of the data coverage. The most up-to-date dataset can be downloaded from GA’s EFTF Geochronology and Isotopes Data Portal and MRT’s LISTmap.

1 Introduction

The continental-scale Isotopic Atlas of Australia (Fraser et al., 2020) is one of the flagship datasets of Geoscience Australia's (GA's) Exploring for the Future (EFTF) Program. The Isotopic Atlas compiles and integrates radiometric age and isotopic data from across Australia, and makes the dataset publicly accessible and useable through the EFTF Portal. Data compilation efforts during the first phase of EFTF (2016–2020) focused on northern Australia (Anderson et al., 2017; Jones et al., 2018; Fraser et al., 2020). The second phase of the EFTF Program (2020–2024) has extended this coverage into southern Australia. The publication of this Record and dataset for Tasmania represents the second of several isotopic data releases envisaged for the Isotopic Atlas over this second phase, with the first of these, the Victorian compilation, released in 2021 (Waltenberg et al., 2021).

This Tasmanian compilation (Figure 1.1) gathers all numerical rock-age information discoverable through published (and some unpublished) sources. As part of this project, GA and Mineral Resources Tasmania (MRT) have compiled existing geochronology data across Tasmania into a standardised format. The dataset sources are from journal articles, books, technical reports and theses. Some unpublished data is also included where sufficient context is available. The dataset (Appendix A.2) includes all discoverable age data compiled by MRT and GA as of June 2022, but is not necessarily exhaustive. Note that Appendix A.2 is a 'snapshot in time' and updates to the compilation can be downloaded from the EFTF Portal or MRT's LISTmap. This Record provides an overview of the data compiled as part of this process.

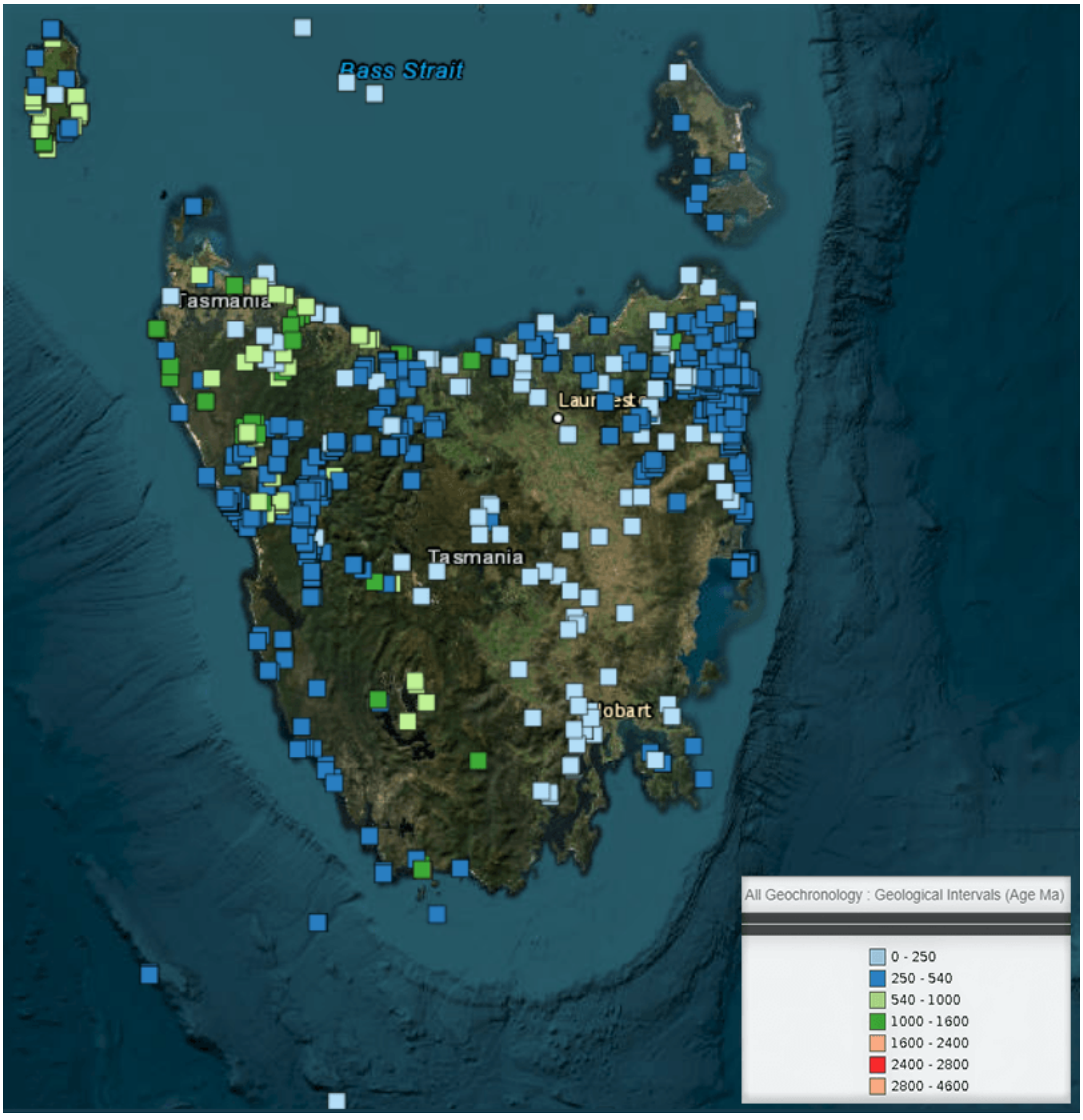

Figure 1.1 Map of Tasmania (from GA's EFTF Portal) showing locations of dated samples included in this Tasmanian compilation. Note: 15 samples from this compilation located further south of the map are not showing.

2 Compilation approach

The Tasmanian dataset (Appendix A.2) includes discoverable age data compiled by MRT and GA, but is not necessarily exhaustive. MRT provided the majority of the age information through Microsoft® Excel workbooks and Access databases, published and unpublished department technical reports, journal articles and university theses. Some additional data were sourced from a general online search of published journal articles not included with the MRT information, and from existing samples already in GA's databases. These disparate forms of information were consolidated at GA into a single spreadsheet, designed for upload into GA's Interpreted Ages database. The data, including any future updates, are publicly available and downloadable via GA's EFTF Portal and MRT's LISTmap. A table of column header descriptors used in the consolidated spreadsheet is available in Appendix A.1.

The compilation focus is on numerical (absolute) rock ages that characterise the deep-time geological record, and mainly comprise ages of rock samples derived by measuring the radioactive decay of a parent isotope to a daughter isotope. This compilation only contains numerical ages from quantitative analytical techniques. It does not currently include non-radiogenic isotope ages (except fission-track), ages from soil, water, air, or biological material, exposure dating (e.g. cosmogenic isotopes), isotope geochemistry model ages (e.g. Pb–Pb, Sm–Nd, Lu–Hf), or any other geochemistry including stable isotopes. It is envisaged that this dataset will be continuously updated as new data are generated, and as additional detail becomes available for previously-captured ages.

2.1 Quality control procedures

We defined the following six criteria as minimum requirements for including age data in the compilation:

1. The age is specified as a single numerical value (rather than an age range).
2. The age can reasonably be interpreted in terms of a geological event affecting the rock.
3. The method (isotopic system) used to measure the age is known.
4. The nature of the material analysed to measure the age is known.
5. The sample location is directly specified, or can reasonably be inferred.
6. The primary bibliographic source of the data is known, as far as possible.

2.2 Quality of geochronology information

2.2.1 Rock-event ages and uncertainties

The requirement for an age-result to be a single value means this compilation does not include data described in terms of age-ranges, such as detrital provenance age spectra in sedimentary rocks. In general, such spectra are summarised solely in terms of a *maximum* age for deposition of the host sedimentary rock, defined by the youngest individual (or cluster of) detrital grain(s).

In the case of microanalytical techniques (such as secondary ion mass spectrometry (SIMS) or laser ablation-inductively coupled plasma mass spectrometry (LA-ICPMS) methods), single analyses are not compiled because rock-event ages determined from these measurements are typically derived from statistical groupings of multiple analyses. However, in cases where a single microanalysis is interpreted as entirely representative of a rock-event age (e.g. a maximum depositional age which is defined by a single analysis at the young end of a provenance age spectrum), that single-grain age is recorded in the compilation.

The compilation includes some ages without uncertainties. These should be treated with caution, as the absence of a quoted uncertainty can reflect compromising factors such as poor analytical conditions, or geologically unexplained results. Where an age is reported with asymmetric errors (e.g. +10/-8 Ma), the uncertainty field in the compilation provides the arithmetic average of the two values, and the asymmetric uncertainties reported by the original source are supplied as a free-text comment.

2.2.2 Interpretation of dated geological events

Where possible, we document the geological event attributed to an age as described by the primary bibliographic source. In cases where the primary source did not explicitly link the measured age to an interpreted geological event, we applied our best interpretation of the age, based on factors such as rock type and the isotopic system used for dating. We then applied a simplified categorisation of geological event-types to aid synthesis (section 3.3).

In general, isotopic analyses interpreted to have been affected by open-system behaviour (resulting in partial loss or gain of parent or daughter isotopes), fall into two categories: (1) those preserving information defining the age of the resetting event, in which case the “isotopic resetting” event is captured in this compilation, and (2) those affected by isotopic disturbance of indeterminate age, which are excluded from the compilation.

Ages interpreted by the primary source to represent some non-geological phenomenon (e.g. analytical instrumentation-related effects) are excluded from this compilation.

2.2.3 Other considerations

Age results are linked to their primary bibliographic source(s) to the maximum extent possible, as a basic data quality control measure, and to ensure that interested users can pursue additional result-specific information not captured by our compilation, if desired. A small number (fewer than 20) of the compiled ages are not directly attributable to a primary reference, instead originating from legacy MRT data compilations. These records are labelled accordingly, and will be updated in the live version of the compilation (section 4) if future work reveals the primary sources for these ages.

Additional considerations specific to the Rb–Sr and K–Ar isotopic systems are outlined in section 3.1.1 and section 3.1.2 respectively.

2.3 Quality of location information

Location information is captured using the horizontal datum and co-ordinate systems employed by the primary source as far as possible, for quality assurance and transparency. These disparate “original geometries” are transformed and unified by GA (using Oracle® Spatial Data Objects) for delivery in this compilation as decimal degrees latitude and longitude, referred to the Geocentric Datum of Australia 1994 (GDA94).

The quality and completeness of location information as provided by original sources is variable, and some estimates of location are likely to be inaccurate. Issues that affect the quality of location information include:

- Some publications do not provide numerical coordinate data for sample locations. In these cases, we have used location maps (of variable accuracy) in conjunction with satellite data (e.g. Google Earth) to approximate sample locations;
- Many sample locations collected by GPS prior to the early 2000s were subject to Selective Availability, where the satellite signal was purposely scrambled. This results in inaccuracies of up to 100 m (GPS.GOV, accessed 2022);
- Some publications report location coordinates (e.g. latitude and longitude, or easting and northing) without specifying their horizontal datum (e.g. GDA94, Australian Geodetic Datum 1966 (AGD66), etc.). In many cases, the horizontal datum can be accurately inferred, but where this is not possible, systematic offsets of up to 200 m can arise as a consequence of a misattribution.

In light of these considerations, the compilation includes a column (ACCURACY_M), which defines a radius (in metres, centred on the compiled sample coordinates), within which the true sample collection site is likely to lie. A large ACCURACY_M value reflects a low degree of confidence in the location data captured from the primary referenced source. In addition, wherever possible a free-text description of the location (LOCATION_DESC), has been captured in the dataset to aid in locating sample collection sites.

3 Description of dataset

3.1 Isotopic system

This geochronology compilation of Tasmania includes 878 ages spanning seven isotopic systems (Figure 3.1). Six of these are based on the radioactive decay of a parent isotope to a daughter nuclide, measuring the proportions of the parent isotope and daughter isotope, and calculating an age based on the radioactive decay rate (e.g. Faure and Mensing, 2015, and references therein). The seventh is the fission-track method, which also relies on radioactive decay of uranium: however, instead of measuring the daughter isotope, it measures the characteristics of linear radiation damage tracks left in the mineral structure to derive an age (Faure and Mensing, 2015, and references therein).

Most ages in this compilation are derived from the U–Pb, K–Ar and Rb–Sr systems, with fewer from the Ar–Ar, Re–Os and Sm–Nd systems, and fission track (Figure 3.1). The total span of interpreted ages range from Neoarchean (measured in a dredge sample collected from the offshore East Tasman Rise) to Neogene, with the largest proportion chronicling the evolution of the Paleozoic Lachlan Orogen in the interval 520–380 Ma (Figure 3.2). Most of these Paleozoic ages were determined using the Rb–Sr, K–Ar, and U-Pb isotopic systems. Ages younger than 320 Ma largely comprise K–Ar analyses documenting Mesozoic post-orogenic uplift and cooling, and K–Ar and Ar–Ar dates constraining Mesozoic and Cenozoic basaltic volcanism.

In the following sections, we include detail on some of the isotopic systems where the data benefit from further explanation – namely Rb–Sr and K–Ar.

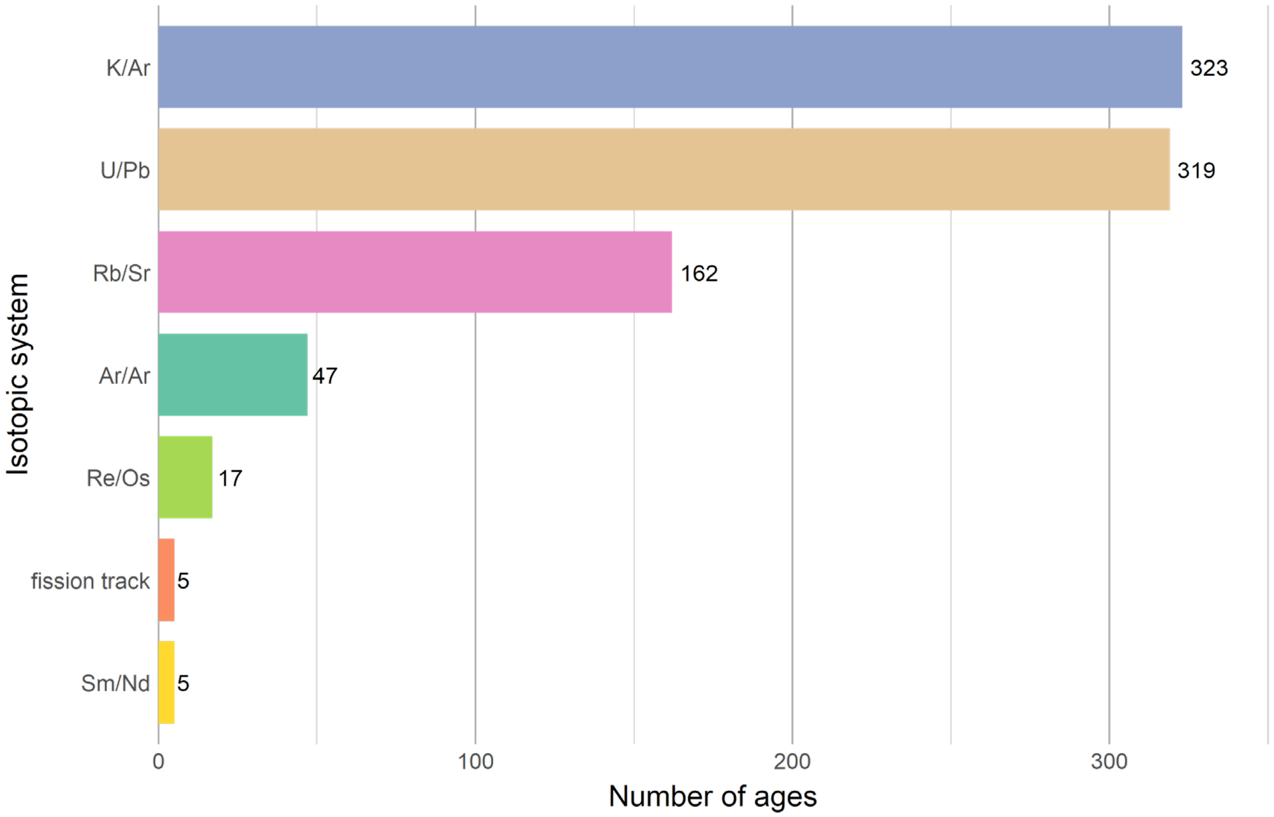

Figure 3.1 Number of ages in this compilation, grouped by isotopic system. Total number of ages = 878. Counts of each isotopic system are at the end of each bar.

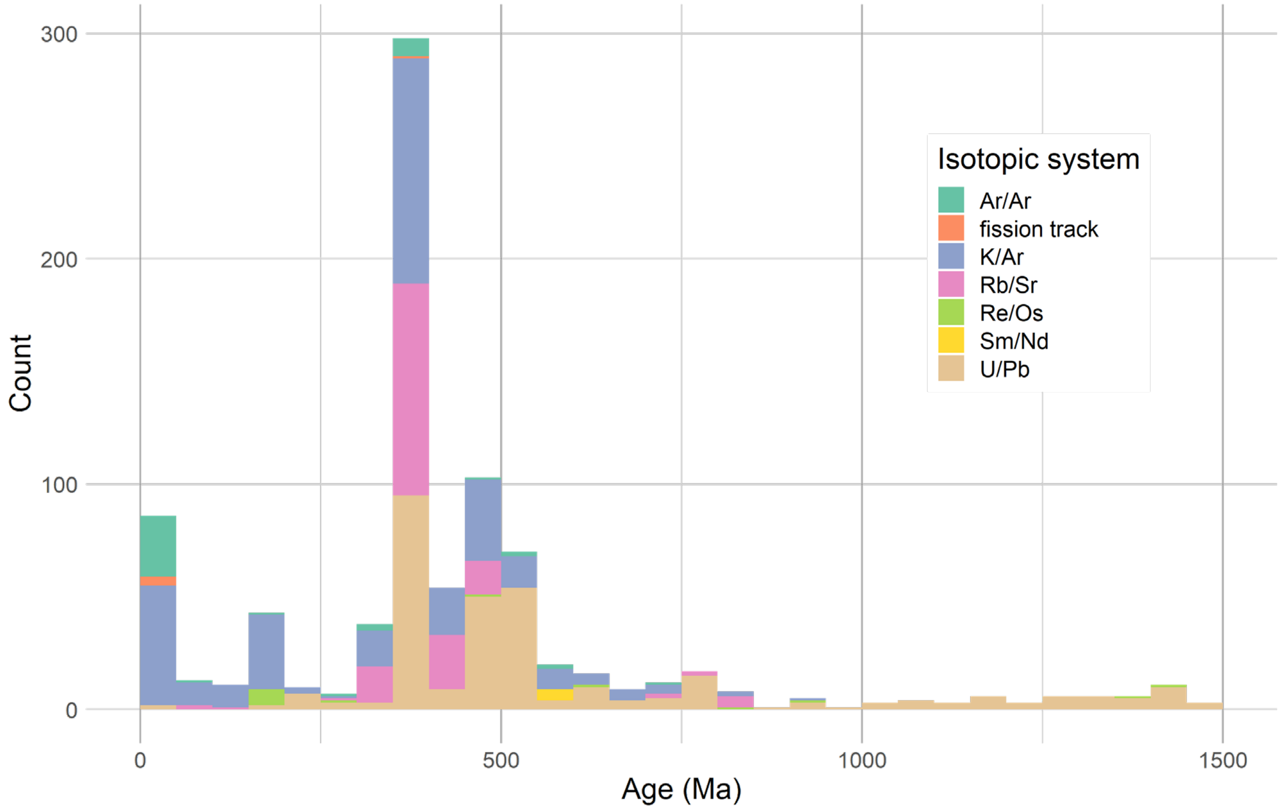

Figure 3.2 Distribution of ages in the compilation, coloured by isotopic system used for age determination. Events older than 1500 Ma (n = 5) are not shown. Bin width is 50 Ma.

3.1.1 Rb–Sr ages

Historically, Rb–Sr dating commonly analysed the isotopic composition of several samples that were assumed to share a common geological history. Data from these samples were pooled (by regressing a line through multiple analyses), to calculate an isochron age for the set of samples (e.g. McDougall and Leggo, 1965; Brooks and Compston, 1965). In this way, a single age is applied to multiple samples, sometimes geographically separated by significant distances. Ages obtained in this fashion are noted in the column AGE_REMARK_FROM_SOURCE as: "*isochron age derived from multiple samples, including* [list of age identifiers included in isochron calculation]". This is to emphasise to co-dependent nature of the individual samples included in such multi-sample isochron ages, and to guard against misinterpretation of the included samples as a fortuitous set of identical independent results. More specific details on the methods applied to a set of 'same-aged' samples can be further explored in the individual references provided in the Tasmanian compilation dataset (Appendix A.2).

Not all Rb–Sr isochron ages are calculated by incorporating multiple samples; another approach is to analyse different mineral fractions from the same rock (e.g., whole rock, K-feldspar and biotite). Where this has been done the various components are listed in the MINERAL column in the compilation.

A significant limitation of the Rb–Sr isotope system is the relative mobility of these isotopes, particularly in hydrothermal fluids (Faure and Mensing, 2005). For this reason, it is common for Rb–Sr ages to be significantly different to ages derived from different isotopic systems such as U–Pb. Determining the significance of a Rb–Sr age is thus complex and relies on an understanding of the metasomatic and thermal history of a rock. Because of these difficulties, and because many dates obtained by Rb–Sr do not provide sufficient detail to make this assessment, Rb–Sr ages in this compilation with uncertain geological attribution have been assigned to the "cooling" geological event. This "cooling" attribution is intended to represent the time at which the rock has cooled sufficiently after emplacement or metamorphism for hydrothermal fluids to cease circulating, and for Rb and Sr isotopes to become immobile.

3.1.2 K–Ar ages

The K–Ar dating method is generally capable of providing reliable crystallisation ages for rapidly-cooled rocks; however, it is less effective at capturing the crystallisation age of slowly-cooled rocks, because Ar can be lost from rocks and minerals by diffusion at temperatures below that at which the rock crystallises (section 3.3; McDougall and Harrison, 1999). In this compilation, where the geological event attributed to the age is unclear in the primary bibliographic source, we assign K–Ar ages from volcanic rocks as igneous crystallisation ages, and ages from intrusive rocks as cooling ages.

3.2 Analysed material

A range of geological materials are analysed for geochronology, and the type of material analysed depends heavily on the isotopic system used to date the sample. Figure 3.3 displays a visual representation of the material analysed by isotopic method. In this compilation, whole rocks are the most common analyte, driven mainly by the dominance of Rb–Sr and K–Ar dating methods in Tasmania. This is followed by zircon, mainly by U–Pb methods, and micas (biotite and white micas) by Rb–Sr and K–Ar methods. Minor analyte materials include monazite, amphiboles, feldspars, and cassiterite. Many other minerals are analysed in minor amounts.

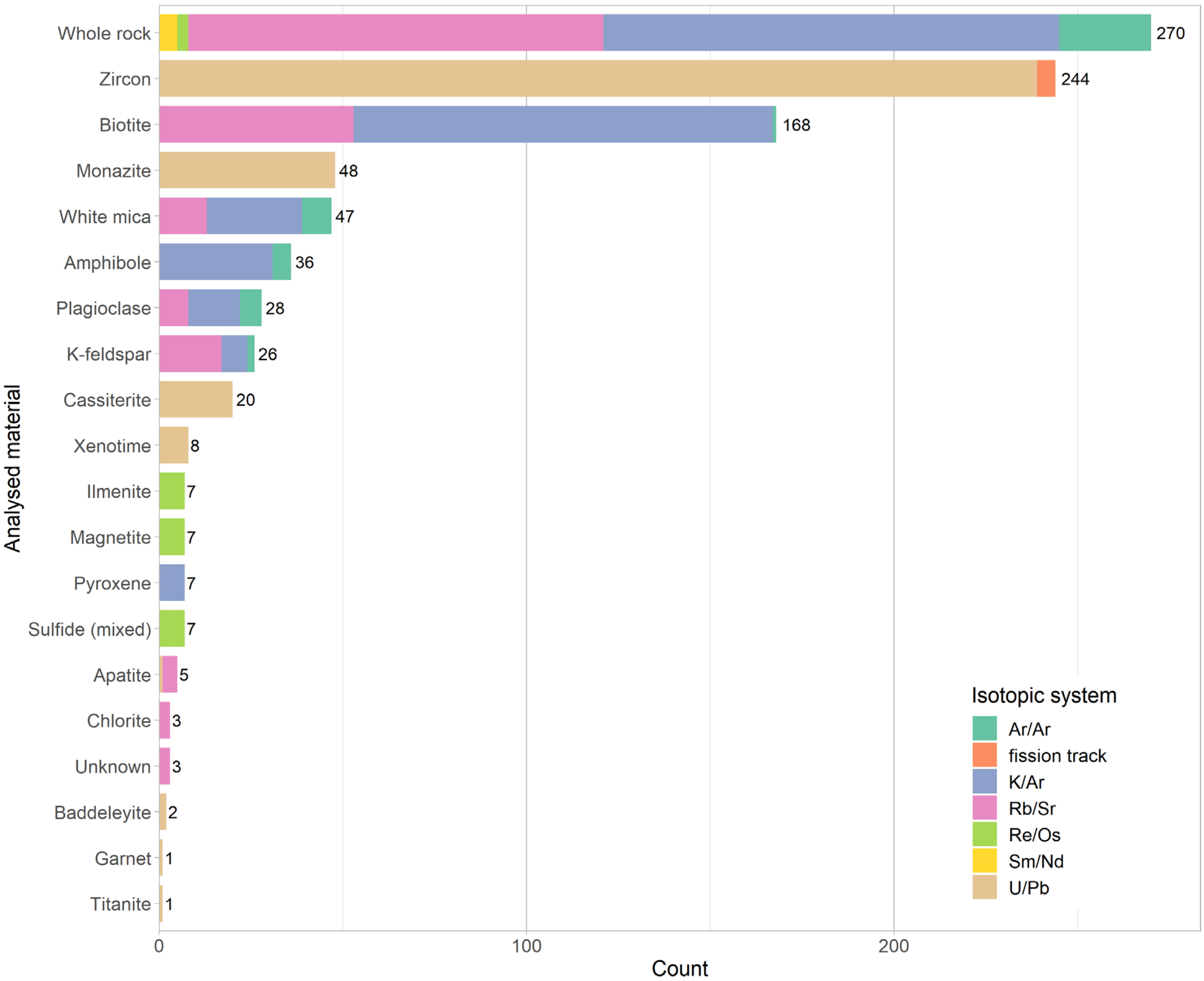

Figure 3.3 The various materials analysed as part of the compilation, coloured by isotopic system. Counts of each material are at the end of each bar. This diagram combines some sets of MINERAL values in the compilation: 'White mica' combines muscovite, sericite and zinnwaldite, 'Amphibole' includes hornblende, 'Pyroxene' includes orthopyroxene, and 'K-feldspar' includes sanidine. Total number of materials analysed = 938, which exceeds the total number of ages (878) owing to the presence of multi-mineral Rb–Sr isochron ages as described in section 3.1.1.

3.3 Geological events

Radiometric dates most commonly reflect the time the isotopic system of interest became closed to the exchange of parent and daughter products. Examples of isotopic 'closure' include crystallisation of the material targeted for analysis or cooling of the material to a temperature below which the decay product is captured within the rock. Linking these physical processes to geological events is a matter of subjective interpretation.

The types of 'rock-scale' geological events and processes dated isotopically include igneous crystallisation, sedimentation, metamorphism, cooling, deformation, alteration and mineralisation. Each age in this compilation includes an interpretation of the type of geological event or process dated. We have done this in two ways: we have preserved the interpretations applied by the original authors in a free-text field, but we have also applied simplified geological event categories to assist with organising, filtering and visualising the data.

Table 3.1 describes the simplified geological events used in this Tasmanian compilation. Figure 3.4 summarises age data by simplified geological event and isotopic system. The most common geological event type in this compilation is cooling, followed by igneous crystallisation. Figure 3.5 shows the distribution of geological events over time.

Table 3.1 Descriptions of simplified geological events used in this compilation.

Simplified Geological Event	Description
cooling	Cooling through a sample-specific closure temperature, above which the isotopic system is open, and below which the system is considered isotopically closed.
igneous crystallisation	Crystallisation of an igneous rock.
maximum age of deposition	The maximum age constraint for deposition of a sedimentary rock, defined by the youngest components within the sediment.
metamorphism	Modification of a rock or material in response to temperature and/or pressure changes.
deformation	A measurement interpreted to estimate the timing of strain and/or formation of a structural fabric.
hydrothermal alteration	Modification of a rock or material through interaction with high-temperature fluids.
isotopic resetting	Any event that leads to open-system behaviour of the isotopic system, not covered by any other geological event attribution, or for which the event is unclear.
deposition	Sedimentary deposition as measured in material formed during deposition and/or diagenesis (e.g. cements). These are separate and distinct from *maximum* depositional ages (which are defined by detrital minerals).
recrystallisation	Modification of a rock or material through dissolution and reprecipitation.
significance unknown	The geological event represented by the data is unknown or unclear.

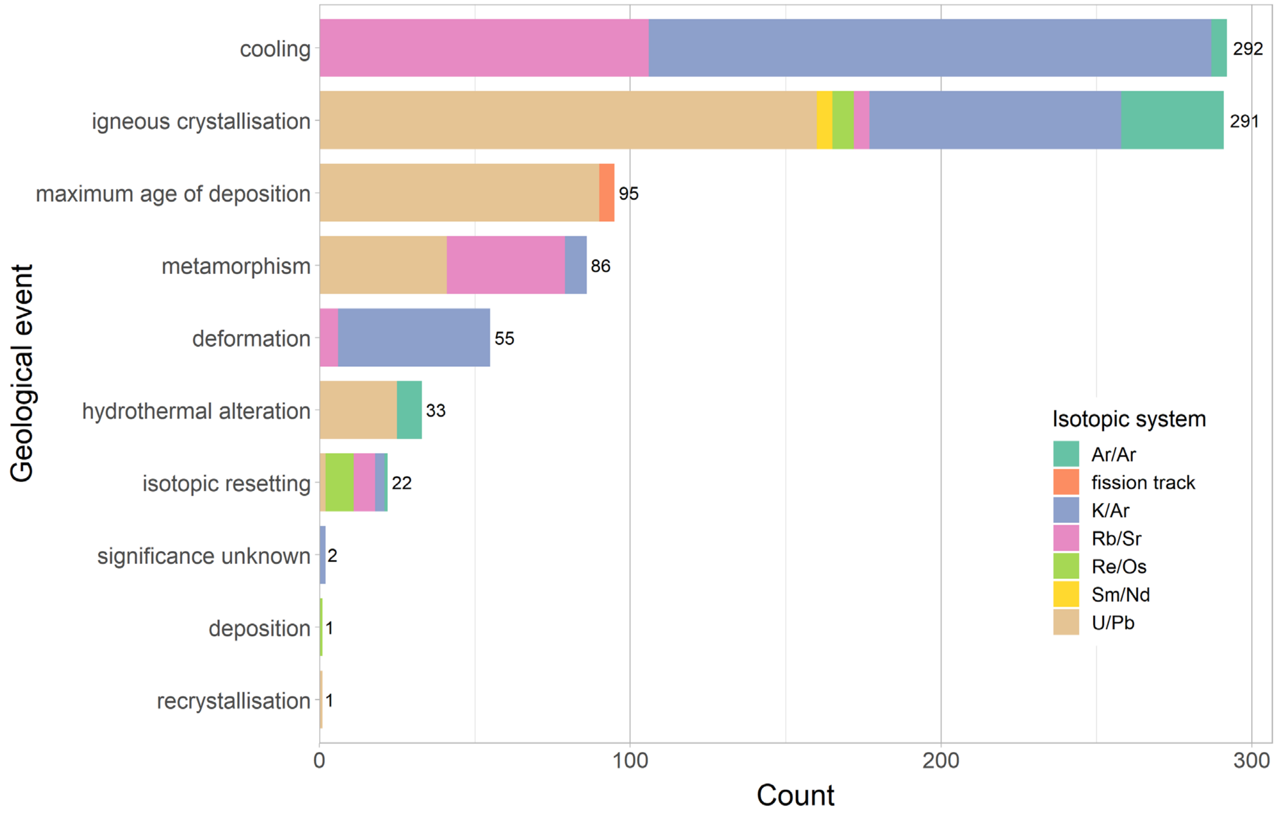

Figure 3.4 Number of ages classified into each type of simplified geological event, coloured by isotopic system. Counts of each geological event are at the end of each bar.

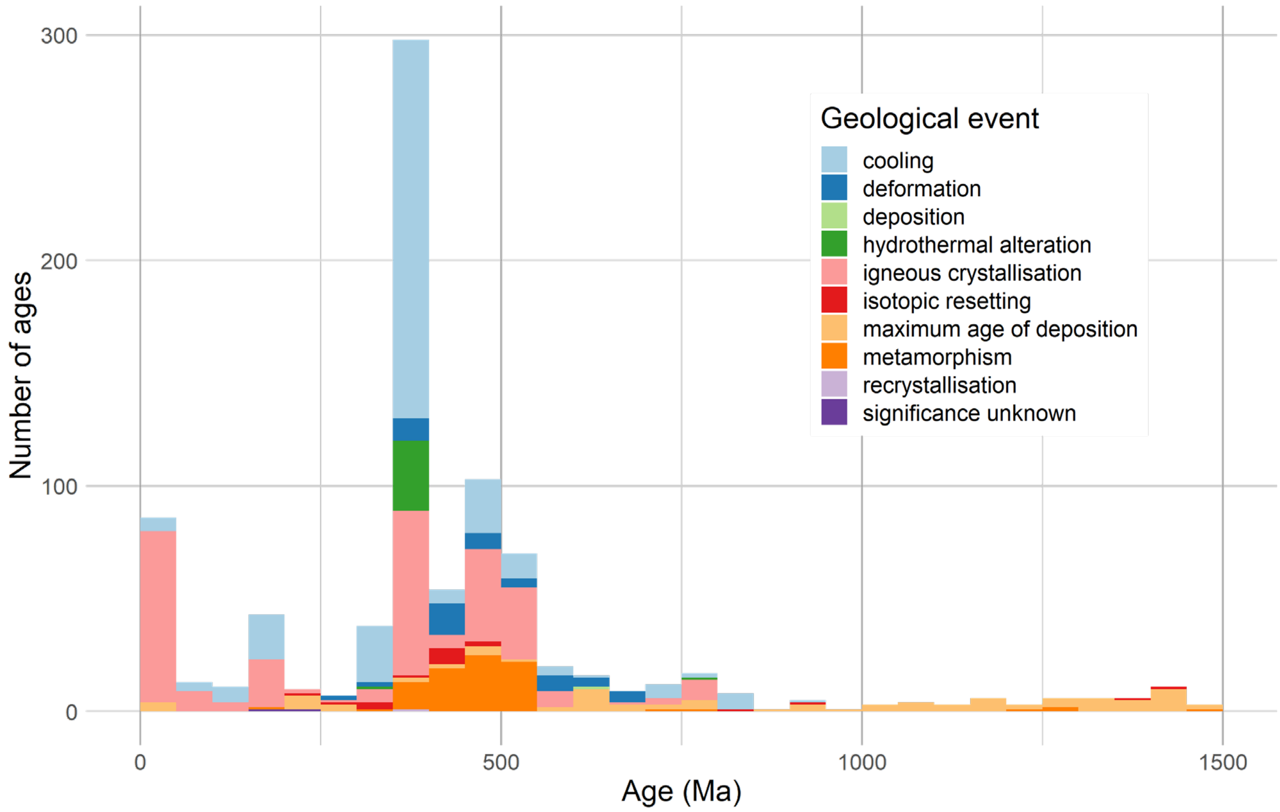

Figure 3.5 Age (Ma) histogram, coloured by simplified geological event. Events older than 1500 Ma (n = 5) are not shown. Bin width is 50 Ma.

3.4 Contoured age maps

An age-interpolated thematic map was produced through spatial analysis of 459 age data points (AGE_MA column) using igneous crystallisation and cooling geological events from U–Pb, Ar–Ar and K–Ar isotopic systems of the Tasmanian compilation (Figure 3.6). The map was generated by importing this subset compilation spreadsheet into ArcGIS Pro v.2.9, to produce location point data (yellow circles, Figure 3.6). A 'Natural Neighbor' interpolation with a 10-class 'Natural Jenks' break was produced from the age point data, and the contours were clipped to the Tasmanian region landmasses. The final map is a 'Percent Clip' stretched image of the interpolated age contours using the 'Viridis' colour scheme, which was passed through Coblis, a free online colour blindness simulator, for colour-blind compatibility (Colblindor, 2022).

This type of thematic map is useful for showing the spatial distribution coverage of age sampling sites and demonstrates the type of spatial information that may be obtained from visualising geological age data and age trends across the Tasmanian region.

The magmatic and cooling age-interpolated contoured map (Figure 3.6) broadly resembles the Geological Elements map (Figure 3.7) published by Seymour and Calver (1995). These Geological Elements represent eight regions with different geological histories: the Tasmania Basin, Northeast Tasmania Element, Sheffield Element, Dundas Element, Adamsfield–Jubilee Element, Rocky Cape Element, Tyennan Element and King Island (Seymour and Calver, 1995). At Tasmania-scale, the contoured map (Figure 3.6) illustrates some broad trends, highlighting age differences between western and eastern Tasmania:

- The western portion of Tasmania, including King Island, shows areas that are distinctly older than eastern Tasmania, especially in the Tyennan Element in the southwest.
- The central-eastern region (Tasmania Basin) is younger, inferred by Seymour and Calver (1995) to cover older rocks.
- The northeast tip (Northeast Tasmania Element) is older than the area around the Tamar Fracture System (a north–south trending fault system), but it is not as old as the western Tasmania region.

Figure 3.8 illustrates the number of ages from each of Tasmania's Geological Elements, and the isotopic systems used to derive the ages in each geological element. Unsurprisingly, the greatest data density is in the major mining areas of Tasmania, encompassing the Northeast Tasmania Element and the Dundas Element.

It is important to note that the data in these Figures are purely indicative for Tasmania as a whole, and it is necessary to integrate this dataset with other relevant geological and geophysical datasets in order to draw valid inferences about the geological evolution of southeastern Australia. The proportion of each event-type and age-bracket is likely to be influenced (and/or biased) by sample availability, focus areas of historical research projects, and the availability and/or discoverability of age data.

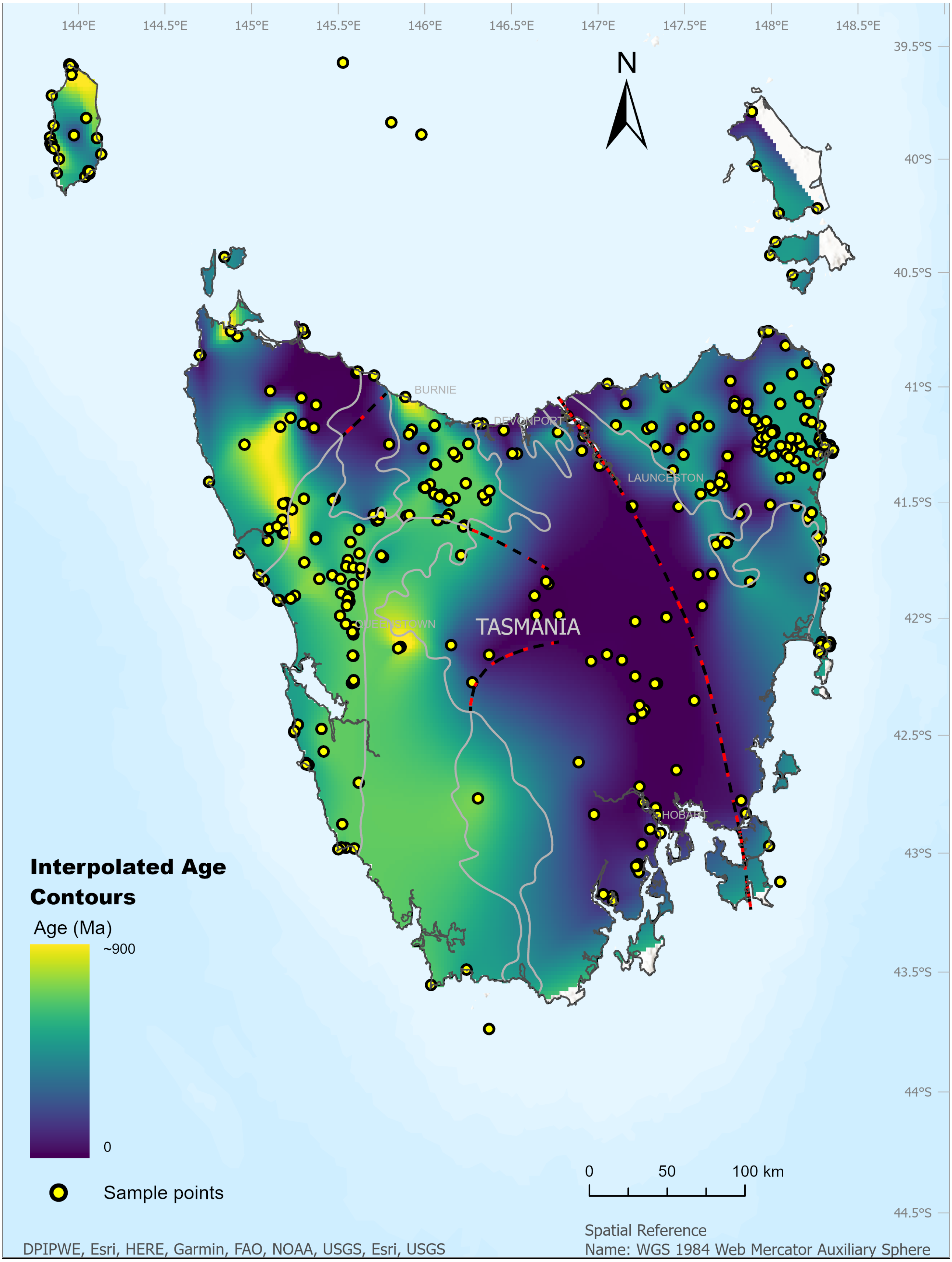

Figure 3.6 Contoured age map, interpolated from 459 data-points corresponding to U–Pb, Ar–Ar and K–Ar magmatic and cooling ages. Yellow circles denote sample locations used in the contour-interpolation; solid light grey lines denote Element boundaries as defined by Seymour and Calver (1995; see also Figure 3.7). Red/black dashed lines represent major interpreted faults. The Tamar Fracture system is the north–south trending dashed line transecting eastern Tasmania.

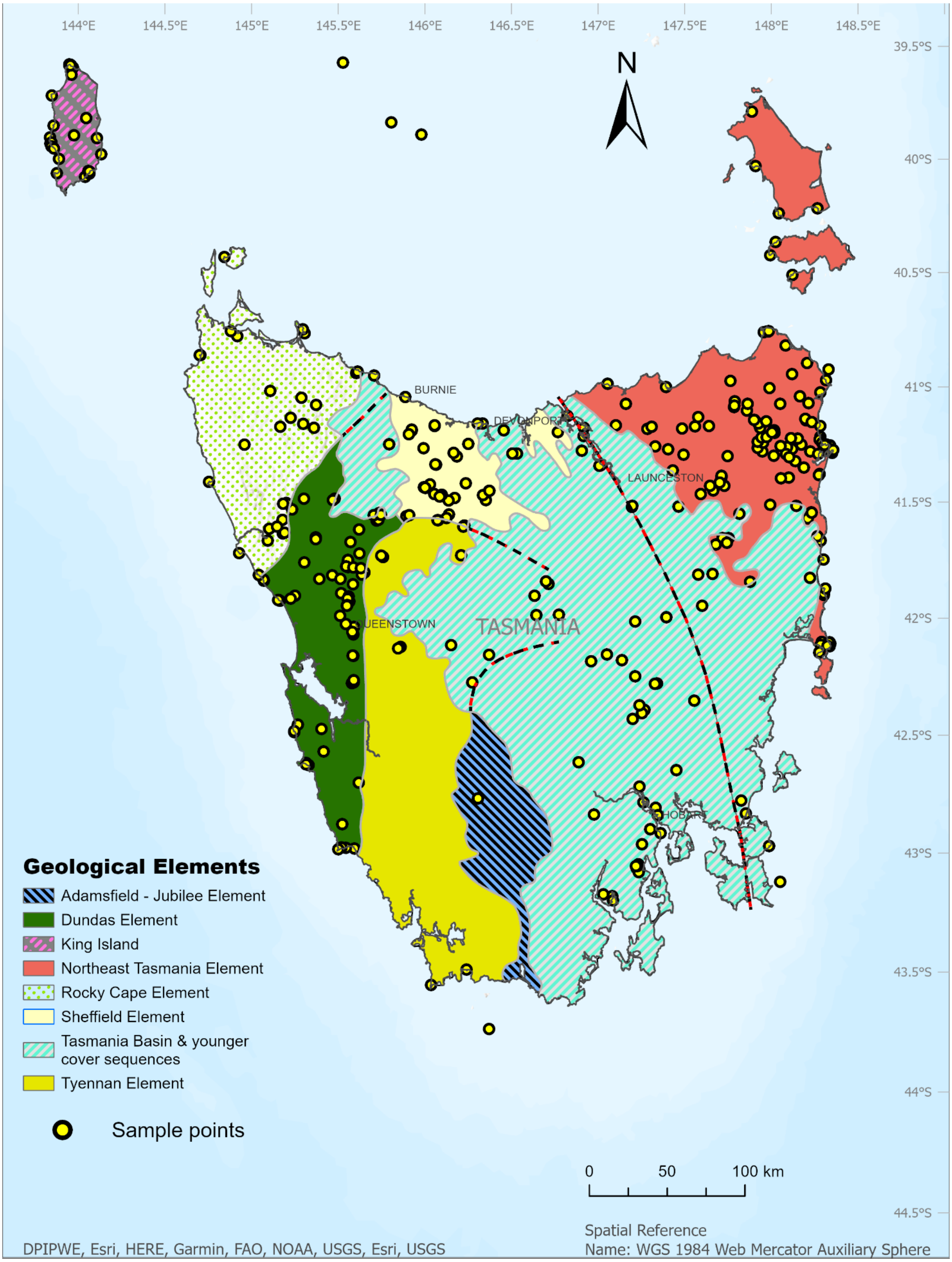

Figure 3.7 Map of the eight Geological Elements of Tasmania, reproduced from Seymour and Calver (1995). Red/black dashed lines represent major interpreted faults. The Tamar Fracture system is the north–south trending dashed line transecting eastern Tasmania.

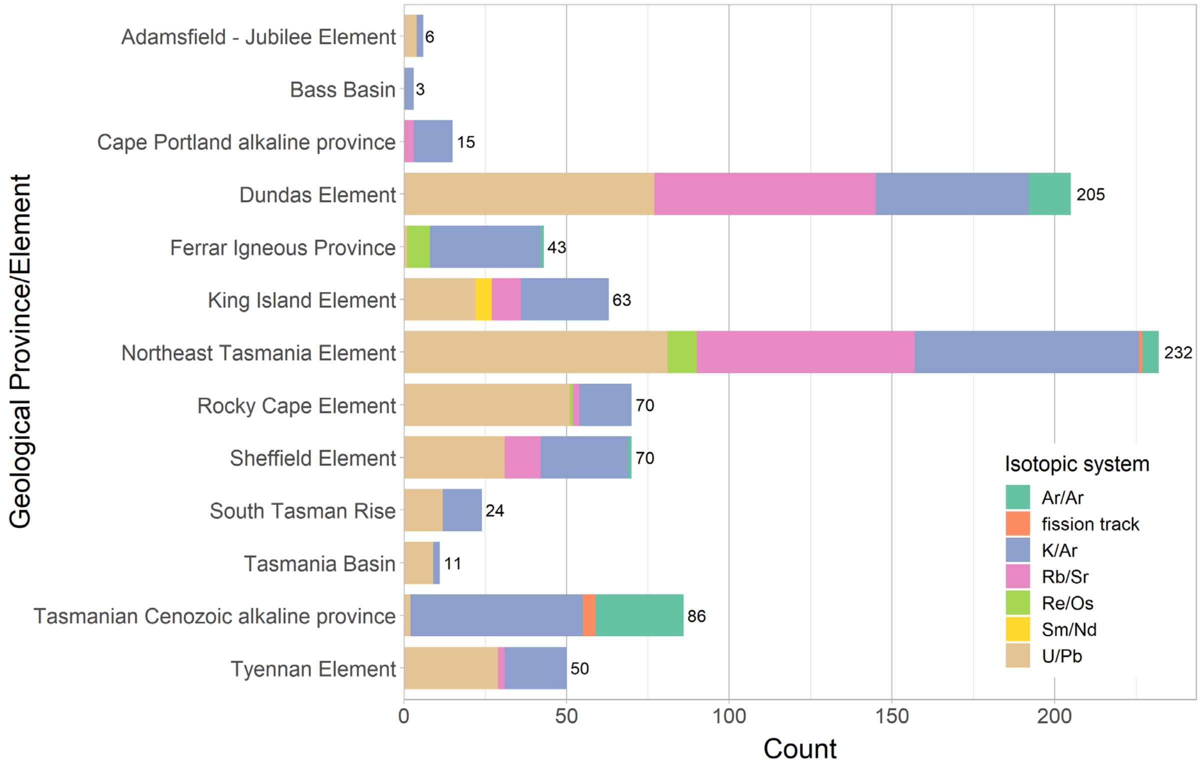

Figure 3.8 Tasmania's geological elements (as defined by Seymour and Calver, 1995), plus post-Triassic igneous provinces, by isotopic system. Counts of each geological province/element are at the end of each bar.

4 Accessing the data compilation

The data compilation can be accessed, downloaded and interrogated in several ways:

1. A snapshot of the data compilation as it stood at the time of writing is available as an electronic file associated with this Record (https://doi.org/10.11636/Record.2022.044);
2. The living data compilation is incorporated into the Geochronology layers of the Isotopic Atlas of Australia, which can be accessed through the EFTF Portal. A guide on how to use the Portal is found under the 'About' tab. The data can be visualised and interrogated, and datasets are available for download in the individual layers in CSV, JSON, KML and Shapefile format. The default settings will provide a download of the nationwide geochronology compilation in its entirety. Data specific to Tasmania (and nearby offshore areas) can be downloaded using the Filter tools, by setting 'State' = 'TAS'.
3. The living data for Tasmania is also available via Mineral Resources Tasmania's LISTmap. A guide and video on using this tool is found under the 'Help' button at the top of the map.
4. The WMS link (https://services.ga.gov.au/gis/geochronology-isotopes/wms) for the Isotopic Atlas can be imported into other portal or GIS systems.

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Appendix

A.1 Column descriptions for the geochronology compilation

Column name	Column description
AGE_NO	GA unique, persistent identifier for the age record.
SAMPLE_PID	Persistent identifier (PID) hyperlink for the sample metadata.
IGSN	International GeoSample Number. Unique alphanumeric identifier assigned under the IGSN scheme.
SAMPLENO	GA unique identifier for the sample.
SAMPLE_ID	Sample identifier as it appears in the source or original reference, as per the first source catalogued into the GA database (additional sources may use different identifiers).
AGE_MA	Age in millions of years.
AGE_MA_UNCERTAINTY	Absolute uncertainty of the age, in millions of years. In cases of asymmetric uncertainties, is approximated as the arithmetic mean of the two asymmetric values.
AGE_CONFIDENCE_LEVEL	Confidence level of the uncertainty on the age.
AGE_MSWD	Mean Square of Weighted Deviates (MSWD). For a population of analyses defining an age, MSWD is a numeric measure of the extent to which the observed scatter in the population (relative to the best-fit line) can be explained by the assigned errors and error-correlations measured for each analysis in the population. If the assigned errors are the only cause of scatter, this will tend to be near unity (1). Values much greater than unity generally indicate either underestimated analytical errors, or the presence of non-analytical scatter (i.e. data dispersion attributable to the geological history of the sample). Values much less than unity generally indicate either overestimated analytical errors, or unrecognised error-correlations.
NUMBER_OF_ANALYSES	Count of the analyses within the population, or the number of heating steps used to define the age.
CALCULATION_TYPE	Statistical process used to generate the age data.
GEOLOGICAL_EVENT	Type of geological event associated with the age data.
ISOTOPIC_SYSTEM	Name of isotopic system used to generate the age.

Column name	Column description
ISOTOPIC_RATIO	Name of the specific isotopic ratio(s) used to generate the age.
MINERAL	List of material(s) analysed.
MOUNT_ID	Identifier of an epoxy mount hosting the analysed target material.
ANALYTICAL_EXTRACTION_SYSTEM	Instrumentation used to extract isotopes or otherwise prepare material for age analysis.
ANALYTICAL_COLLECTION_SYSTEM	Instrumentation used to measure the age data.
LABORATORY_NAME	Name of institution or laboratory where analyses were carried out.
AGE_INTERPRETED_FROM_SOURCE	The geological event that the age is interpreted to represent, as reported by the original source.
OTHER_AGE_INTERPRETED_FROM_SOURCE	Secondary geological event represented by the age, as interpreted by the original source.
AGE_REMARK_FROM_SOURCE	Additional information about the age, as described by the original source.
AGE_SOURCE	Data compilation or database from which the age information was reported.
PROJECT	The name of the project or field survey that is associated with the collection of the isotopic data.
STRATNO	GA unique identifier of the stratigraphic unit to which the sample belongs, from the Australian Stratigraphic Units Database (Geoscience Australia and Australian Stratigraphy Commission, 2017).
STRAT_UNIT_PID	Persistent identifier (PID) for the stratigraphic unit.
STRAT_UNIT_NAME	Name of the stratigraphic unit to which the sample belongs, from the Australian Stratigraphic Units Database (Geoscience Australia and Australian Stratigraphy Commission, 2017).
INFORMAL_UNIT_NAME	An informal or company-reported unit name used to identify the stratigraphic unit. This may be a name used in a company report or field notes, or a temporary name used before a formal name has defined in the Australian Stratigraphic Units Database.
UNIT_NAME_SOURCE	Geological unit to which the age is attributed, as described by the original source.
MATERIAL_TYPE	Type of material the sample comprises (e.g. rock, sediment, water).
LITHOLOGY_GROUP	Code for a broad classification of the rock type or unconsolidated earth material.

Column name	Column description
LITHOLOGY	Lithology type name of the rock or regolith material. Names may be formally defined by internationally agreed classification (e.g. IUGS igneous rocks scheme) or otherwise commonly used rock names based on compositional, genetic, and grainsize parameters.
MODE_OF_OCCURRENCE	The mode of occurrence of the earth material, its morphology, or relationship to adjacent material (e.g. dyke, clast, matrix, phenocryst).
SAMPLE_TYPE	Description of the type, or physical form, of the specimen or observation (e.g. core, hand specimen, thin section).
SAMPLE_DESC	A free text description of the sample.
SAMPLING_FEATURE_NAME	The name of the entity from which the sample was obtained.
SAMPLING_FEATURE_TYPE	Type of sampling feature (e.g. marine survey, borehole, fieldsite).
SAMPLING_FEATURE_PID	Persistent identifier (PID) hyperlink to the sampling feature (borehole or fieldsite) metadata.
SAMPLING_FEATURE_LOCATION	2D Geometry capturing the GDA94 latitude and longitude coordinates of the point at which the borehole enters the solid Earth or the sample was taken.
BOREHOLE_TOP_DEPTH_M	Uppermost depth (in metres) of the borehole interval from which the sample was obtained.
BOREHOLE_BASE_DEPTH_M	Lowermost depth (in metres) of the borehole interval from which the sample was obtained.
GEOLOGICAL_PROVINCE	List of geological provinces associated with the sample.
GEOLOGICAL_REGION_NAME	Name given to the surface geological region from which the fieldsite sample was collected.
REGION_NAME_SOURCE	Geological region and/or province (not necessarily GA-recognised or approved) to which the age is attributed, as described by the original source.
STATE	Australian jurisdiction from which the sample was collected.
COUNTRY	Country in which the sample was collected.
LAT_GDA94	Latitude in decimal degrees for GDA94 Datum, expressed as a negative for southern hemisphere, for the sample collection site.
LONG_GDA94	Longitude in decimal degrees for GDA94 Datum, expressed as a positive for eastern hemisphere, for the sample collection site.

Column name	Column description
ELEV_M_AHD	Elevation of the collection location for the sample relative to the Australian Height Datum, in metres.
ACCURACY_M	Limit of the accuracy of the horizontal sample location coordinates, in metres.
LOCATION_METHOD	Method used to determine the position of the observation or measurement.
LOCATION_DESC	Description of the sample location.
SAMPLE_ACQUISITION_DATE	The date the sample was acquired, or alternatively the date the fieldsite was visited or observed.
SAMPLE_ORIGINATOR	Name of person who collected the sample, or was responsible for entering sample information into the database.
SAMPLE_PHOTO	Boolean (Y/N) identifying whether there is a sample photo stored in the GA database.
FIELDSITE_PHOTO	Boolean (Y/N) indicating whether there is a fieldsite photo stored in the GA database.
AGE_REF_ID	List of unique GA identifiers for the original sources of the age data.
AGE_REF	List of bibliographic references for age data, identifying the original publications/data sources.
AGE_PUBLICATION_LINKS	List of URLs for the bibliographic references that are the original sources of the age data.

A.2 Accompanying dataset

A snapshot of the data compilation as it stood at the time of writing is available as an electronic file associated with this Record (https://doi.org/10.11636/Record.2022.044).