Towards a U–Pb age map for northern Australia

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SUMMARY

Understanding the geological evolution and resource prospectivity of a region relies heavily on the integration of different geological and geophysical datasets. Geochronology is one key dataset, as it underpins meaningful geological correlations across large regions, and also contributes to reconstruction of past tectonic settings. Using geochronology in combination with other datasets requires the geochronology data to be available in a unified dataset with a consistent format. Northern Australia is a vast and relatively underexplored area that offers enormous potential for the discovery of mineral and energy resources. The area has a long and variably complex tectonic history, which is yet to be fully understood. Numerous geochronology studies have been completed at various scales throughout northern Australia over several decades; however, these data are scattered amongst numerous sources, limiting the ease with which they can be used collectively. The objective of this work is (1) to combine Uranium–Lead (U–Pb) data across north-northeastern Australia into one consistent dataset, and (2) to visualise the temporal and spatial distribution of the U–Pb age data through thematic maps as a tool for better understanding the geological evolution and resource potential of northern Australia.

In this contribution, over 2000 U–Pb ages from the Northern Territory, Queensland, eastern Western Australia and northern South Australia have been compiled into a single, consistent dataset. Data were sourced from Geoscience Australia, State and Territory geological surveys and from academic literature. The compilation presented here includes age data from igneous, metamorphic and sedimentary rocks. Thematic maps of magmatic crystallisation ages, high-grade metamorphic ages and sedimentary maximum depositional ages have been generated using the dataset. These maps enable spatial and temporal trends in the rock record to be visualised up to semi-continental scale and form a component of the 'Isotopic Atlas' of northern Australia currently being compiled by Geoscience Australia.

Key words: geochronology, zircon, northern Australia, compilation

INTRODUCTION

U–Pb geochronological data have been collected in Australia for several decades, leading to an extensive geographic coverage of high-quality data, and the interpreted ages derived from these data underpin current understanding of the geological evolution of the continent. The data and derived ages have been published in a wide variety of academic journal articles and government survey reports of various vintages, and subsets of the data are available in various publicly-accessible databases and datasets. The disparate sources of data, and the variations in reporting style, mean that it is difficult to utilise the data collectively to extract and visualise spatial and temporal patterns.

The compilation in this work includes U–Pb age results from the Northern Territory, Queensland and areas of South Australia and Western Australia. Thematic maps generated from the compilation show the spatial distribution and age brackets for igneous crystallisation, metamorphic and maximum depositional ages. These maps form part of a compilation being undertaken by Geoscience Australia to produce an 'Isotopic Atlas' of northern Australia. The 'Isotopic Atlas' will also include Neodymium (Nd), Hafnium-Oxygen (Hf–O), Lead (Pb) and Argon (Ar) isotopic datasets as important input into 3D modelling and resource potential assessments.

METHOD AND RESULTS

We compiled data from a number of pre-existing datasets, compilations and literature. The datasets and compilations used in this work are: (1) the Arunta Region area U–Pb compilation (McLennan et al., 2015), (2) Geochronological Synthesis and Time-Space plots for Proterozoic Australia (Neumann and Fraser, 2007), (3) Geoscience Australia Geochron Delivery Database, (4) Northern Territory Geological Survey STRIKE Database, (5) Geological Survey of Western Australia GeoVIEW Database, and (6) Geological Survey of Queensland isotopic compilation (Withnall, unpub.).

Age results, including sample information, analytical information and author's age interpretation were combined into a single compilation. Duplicate data and data with no location information were then removed, resulting in over 2000 compiled age results (Figure 1a). Age interpretations were simplified for the purposes of assisting with displaying age data on thematic maps. Here we focus on age data in north-northeastern Australia that has been interpreted as igneous crystallisation ages, maximum depositional ages and metamorphic ages (Fig.1b–d).

At a semi-continental scale, the thematic maps show: (1) data coverage, with areas of sparse data coverage commonly corresponding to areas of cover, (2) coarse scale age trends to ~100 Ma resolution, and (3) identification of regions with protolith ages or metamorphic events within a time-bracket of interest. On a regional, higher resolution scale, U–Pb thematic maps can identify temporal trends in magmatism, volcanism, sedimentation and metamorphism across a region, and can assist with better understanding the tectonic evolution of a region.

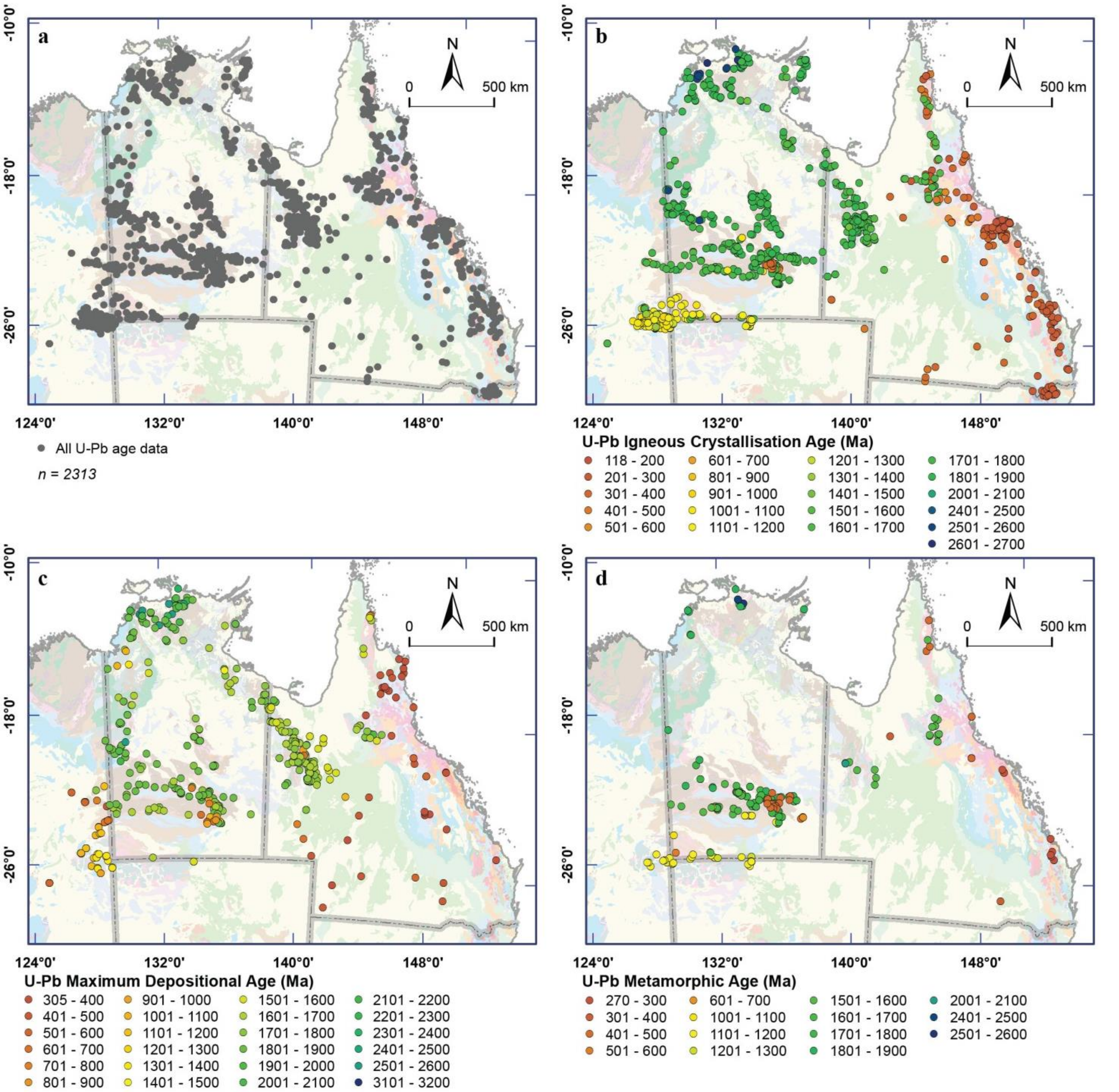

Figure 1.a: Spatial extent of all U–Pb age data included in this compilation, b: overview of U–Pb igneous crystallisation age data, c: U–Pb overview of maximum depositional age data, d: overview of U–Pb metamorphic age data. Note that 1.d does not include age data interpreted to record recrystallisation, isotopic resetting, Pb loss or anatexis. Data is plotted on a basemap of the 1:2.5 M scale Surface Geology of Australia (Raymond et al., 2012).

CONCLUSIONS

This work is a first-pass attempt to display thematic maps of compiled U–Pb age data on a semi-continental scale. The effectiveness of these maps as they currently are displayed, with the U–Pb ages in point form, may depend on the area of interest, data coverage, symbology used, and age data intervals or age range. As a standalone resource, the compilation and maps provide a tool for visualising over 2000 U–Pb age results together. They provide a basis for identifying: (1) spatio-temporal trends in magmatic and high-grade metamorphic events in northern Australia, and (2) gaps in the spatial coverage that could be addressed in future geochronology work. In addition, U–Pb age maps can be used in a GIS environment with other geospatial datasets such as isotopic maps, geological maps and geophysical images as part of a multidisciplinary toolbox approach to resource potential assessments.

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