

A diamond exploration database for the Northern Territory

Mark T Hutchison¹

Introduction

Australia is estimated to have produced approximately 12% of global rough diamond production by weight in 2010. All currently producing Australian mines are associated with Proterozoic mobile belts surrounding the Kimberley Basin in Western Australia and diamondiferous kimberlites are also known from locations within the basin itself. The Kimberley Basin is understood to be underlain by Archaean lithospheric mantle (Graham *et al* 1999): old, cold and thick cratonic roots provide the most abundant source of diamonds exploited worldwide.

The Northern Territory hosts some 2200 km² of exposed Archaean rocks and over half a million km² of Palaeoproterozoic rocks, comprising around 40% of the area of the Territory. Most notable of the Palaeoproterozoic terranes are the Pine Creek Orogen (Worden *et al* 2008), McArthur Basin (Rawlings 1999) and Aileron Province (Scrimgeour 2003). Similarly to Western Australia, much of the Northern Territory's orogenic belts and sedimentary basins are also believed to be underlain by thick Archaean lithospheric mantle (eg Hollis *et al* 2011) and Archaean outcrops, such as the Kukulak Gneiss in the Caramal Inlier, West Arnhem Land (Hollis *et al* 2009), continue to be discovered. Most exposed solid geology is of a sufficient age for one to expect that diamondiferous intrusives would have penetrated them in places. Indeed the Northern Territory hosted the only mined primary diamond deposit outside of Western Australia at Merlin until its closure in 2003 and diamondiferous kimberlites as young as 179 Ma are known from the Territory (Belousova *et al* 2001). The Merlin field is currently undergoing re-development and the kimberlites in this field are examples of diamond-bearing rocks penetrating a sedimentary succession (in this case the Cambrian? Bukalara Sandstone) and yet, having a depth of origin of approximately 120 km (from calculations based on data in Reddcliffe 1999, following the methodology of Brey and Köhler 1990). This depth of origin is well within the diamond stability field within thickened crystalline lithospheric mantle. In addition to Merlin, numerous other diamond deposits are known.

Both theory and precedent therefore exist in support of future economic diamond discoveries in the Northern Territory.

Diamond exploration is a timely endeavour, as even before the commencement of recent depressions in mineral exploration worldwide, projected diamond production was expected to fall short of demand in 2006 (Calderon *et al* 2007). Hiatuses in production, premature permanent closure of mines and a significant break in exploration activity due to financial considerations, have exacerbated the problem. Globally, recovering demand for gem diamonds accompanies a need for new World-class diamond mines to commence production.

Few recent discoveries are undergoing development at a sufficient scale to meet demand in the short term. Hence, the Northern Territory is as well placed on the World stage for diamond exploration as is any region, as it has a combination of appropriate geology and the advantages of developed infrastructure and robust and transparent mining regulations. The Northern Territory Geological Survey (NTGS) aims to stimulate diamond exploration by launching an up-to-date database of appropriate historical exploration data.

Database structure

The Northern Territory benefits from having experienced continuous diamond exploration since the early 1970s, generating in excess of 700 relevant company reports. In 2005, a compilation of sample locations and diamond and indicator mineral recovery was published by NTGS, focusing on indicator minerals. This database has been considerably expanded upon to bring diamond exploration up to date, to incorporate newly released data on strategically important locations such as Timber Creek, the Packsaddle kimberlites and the Merlin Field, and to incorporate valuable data from sources other than government-filed reports (Figure 1). A considerably larger number of data fields have been populated. These include original datum information, sampling screen sizes and concentrate weights, and information on associated mineral phases recovered, which is useful for prospecting for other commodities. A detailed breakdown of mineral phase sub-types is included, using mineral chemistry in conjunction with the most up-to-date kimberlite and mantle mineral classification schemes, such as Grütter *et al* (2004) and Wyatt *et al* (2004). Locations of samples taken for bulk chemical analysis, trace element mineral chemical data and full diamond descriptions complement the primary indicator mineral data.

A significant development is the immediate current availability of the data online at STRIKE (<http://apps.minerals.nt.gov.au/strike>), as an accompaniment to the DVD data release with accompanying notes, which is forthcoming. The online database will be updated periodically, as new diamond exploration results become open-filed.

Highlights

The NTGS diamond exploration database incorporates the locations of over 75 000 diamond exploration samples, the overwhelming majority being samples taken for separation of diamonds and diamond indicator minerals. Associated with these samples are over 14 500 chemical analyses of mineral separate grains, acquired during the course of diamond exploration.

Amongst the highlights of the updated database, data associated with the Merlin kimberlite field stand out. The Merlin field is the most significant field of primary diamond-bearing rocks within the Northern Territory; however, scant mention of the field was made in the 2005 compilation. Although much of the Merlin data remains confidential, large

¹ C/o Northern Territory Geological Survey, PO Box 3000, Darwin, NT 0801, Australia. Email: mth@trigon-gs.com / mark.hutchison@nt.gov.au.

quantities of publicly-available data have been integrated into the current database, primarily from Reddcliffe (1999). The dataset incorporates information acquired from regional and local exploration, as well as from samples recovered from kimberlites. This expansion on the NTGS diamond database therefore provides valuable insights into a successful exploration methodology and a detailed picture of the type locality of Northern Territory diamondiferous rocks. The Merlin data comprise over 1500 loam sample locations, with

accompanying diamond and indicator mineral recovery data, as well as data from numerous regional and bulk stream sediments and large-diameter drilling sites. Descriptions of representative diamonds are included, in addition to over 1600 mineral chemical analysis of indicator minerals.

Detailed reconnaissance and mineral sampling data are now also available for the second most prolific source of diamonds in the Northern Territory, other than the Merlin field. The Timber Creek kimberlite pipes lie at the opposite,

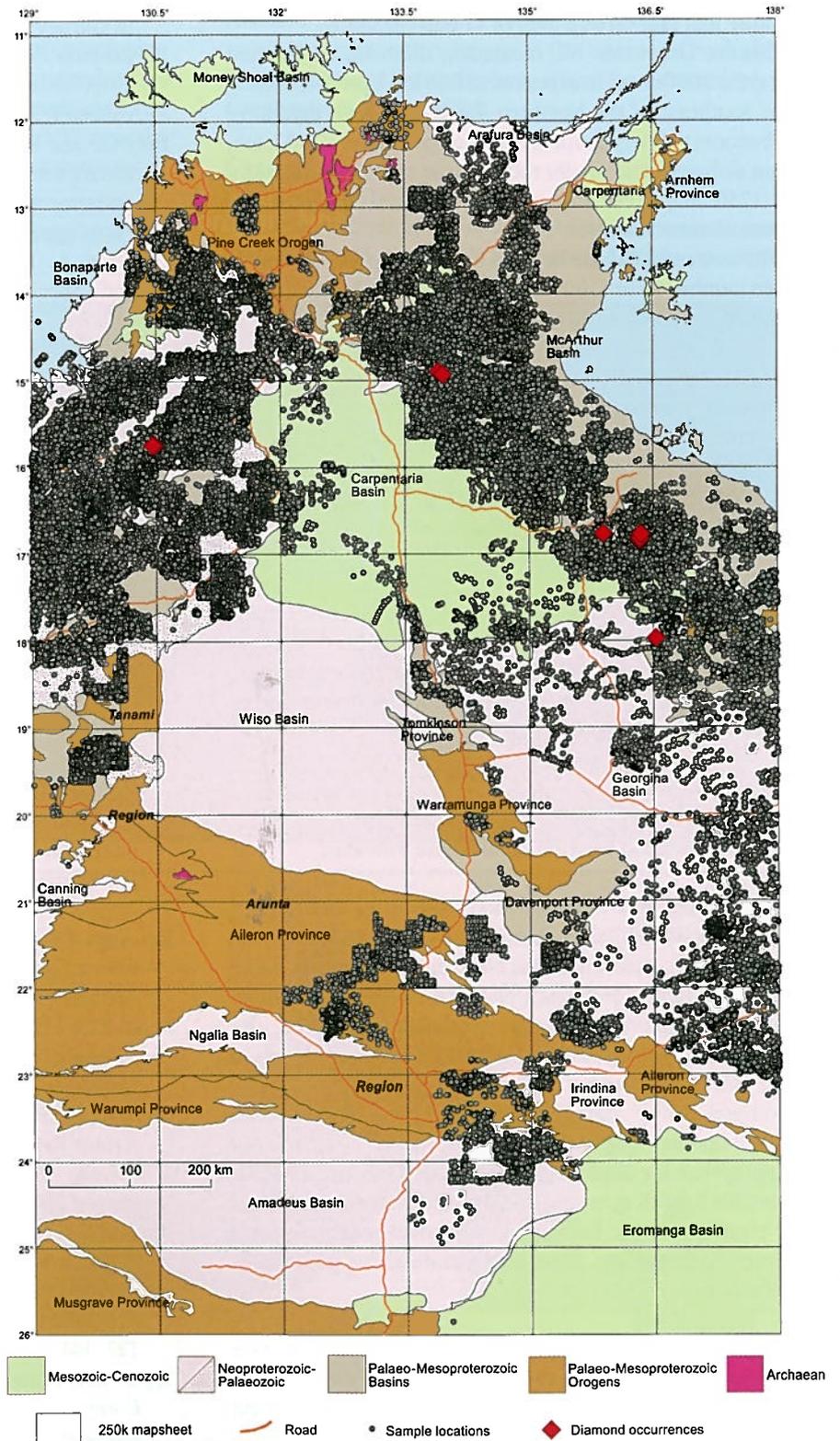


Figure 1. Locations of sites of indicator mineral and bulk chemistry samples taken with regards to diamond exploration in the Northern Territory. Grey dots – sample locations; red diamonds – locations of principal diamond occurrences; black squares – boundaries of 1:250 000 geological mapsheets; annotated polygons – geological regions.

western edge of the Territory from the Merlin field and are emplaced into Palaeo- to Mesoproterozoic limestones (Berryman *et al* 1999) that show similarities with the host rocks of Australia's largest diamond mine, Argyle. The Argyle pipes are located nearby to Timber Creek, being 250 km southwest across the border into Western Australia. Tawana Resources NL reported that 17 387 macrodiamonds were recovered from the TC-01 pipe and the updated database includes descriptions of some of these diamonds, in addition to locations for bulk chemical and indicator mineral sampling that recovered a total of 11 636 chromites.

Elkedra Diamonds NL conducted diamond exploration during the 2000s over in excess of 15 000 km², predominantly in the southeast of the Northern Territory. These data have now become publicly available and comprise over 4300 loam, stream sediment and *in situ* rock sample sites, incorporating over 1250 major element mineral chemical analyses and 98 trace element analyses.

The current database benefits from the incorporation of a large number (over 1100 records) of previously uncaptured Stockdale Prospecting Ltd exploration data, predominantly covering large areas of Arnhem Land. These data are of particular interest, due to the recovery of prospective picrolimenite and garnet grains and given the recent discoveries of Archaean inliers in the region (Hollis *et al* 2009), supporting the concept of an underlying, old, thick mantle lithosphere.

In the modernised and more up-to-date diamond database, both locations of immediate exploration interest (Merlin and Timber Creek) are apparent, in addition to considerable large gaps in exploration coverage within areas of diamond potential. Notable unreconnoitered prospective areas include most of the Archaean inliers, the Aileron, Warumpi, Davenport and Warramunga provinces, the Tanami Region, and parts of the Pine Creek Orogen and McArthur Basin, particularly within Arnhem Land.

Conclusions

The NTGS diamond exploration database provides:

- a detailed picture of the methods, successes and failures of publicly available diamond exploration programs conducted to date within the Northern Territory. In doing so, the database provides a platform for the development of future exploration programs suitable to the particular geological, geophysical and climatic conditions extant in the Northern Territory
- comprehensive data that have been treated with contemporary phase discrimination techniques appropriate for target identification, and that use a format suitable for full querying and detailed statistical analysis
- a clear picture of the gaps in historical reconnaissance sampling programs, appropriate to directing greenfields exploration.

It is expected that the diamond exploration database will provide a highly relevant springboard for continuing advances on the status of the Northern Territory as a diamond producer.

References

- Belousova EA, Griffin WL, Shee SR, Jackson SE and O'Reilly SY, 2001. Two age populations of zircons from the Timber Creek kimberlites, Northern Territory, as determined by laser ablation, ICP-MS analysis: *Australian Journal of Earth Sciences* 48, 757–765.
- Berryman AK, Stiefenhofer J, Shee SR, Wyatt BA and Belousova EA, 1999. The discovery and geology of the Timber Creek kimberlites, Northern Territory, Australia: in Gurney JJ, Gurney JL, Pascoe MD and Richardson SH (editors) *Proceedings of the VIIth International Kimberlite Conference, Rondebosch, South Africa, April 11–17 1988, volume 1*, 30–39.
- Brey GP and Köhler T, 1990. Geothermobarometry in 4-phase lherzolites: II, New thermobarometers, and practical assessment of existing thermobarometers. *Journal of Petrology* 31, 1353–1378.
- Calderon A, Liebenberg A and Ryder C, 2007. Diamonds and Specialty Products CSG Briefing: BHP Billiton Content Repository. <http://www.bhpbilliton.com/bbContentRepository/dspcsbriefingsydney.pdf> (accessed February 2011).
- Graham S, Lambert DD, Shee SR, Smith CB and Reeves S, 1999. Re-Os isotopic evidence for Archean lithospheric mantle beneath the Kimberley block, Western Australia. *Geology* 27, 431–434.
- Grütter HS, Gurney, JJ, Menzies AH and Winter F, 2004. An updated classification scheme for mantle-derived garnet, for use by diamond explorers: *Lithos* 77, 841–857.
- Hollis JA, Carson CJ and Glass LM, 2009. Extensive exposed neo-Archaean crust in Arnhem Land, Pine Creek Orogen: U-Pb zircon SHRIMP geochronology: in 'Annual Geoscience Exploration Seminar (AGES) 2011. Record of abstracts.' *Northern Territory Geological Survey, Record 2009-002*.
- Hollis JA, Glass LM, Carson CJ, Armstrong R, Yaxley G, Kemp AIS, Scherstén A and Phillips D, 2011. The geological evolution of the Pine Creek Orogen: new pieces in the puzzle on Orogen and Craton scale: in 'Annual Geoscience Exploration Seminar (AGES) 2011. Record of abstracts.' *Northern Territory Geological Survey, Record 2011-001*.
- Rawlings DJ 1999. Stratigraphic resolution of a multiphase intracratonic basin system: the McArthur Basin, northern Australia. *Australian Journal of Earth Sciences* 46, 703–723.
- Reddicliffe TH, 1999. *Merlin Kimberlite Field, Batten Province, Northern Territory*. MSc thesis, Department of Geology, University of Western Australia, Perth.
- Scrimgeour IR, 2003. Developing a revised framework for the Arunta Region: in 'Annual Geoscience Exploration Seminar (AGES) 2003'. *Northern Territory Geological Survey, Record 2003-001*.
- Worden KE, Carson CJ, Scrimgeour IR, Lally J and Doyle N, 2008. A revised Palaeoproterozoic chronostratigraphy for the Pine Creek Orogen, northern Australia: Evidence from SHRIMP U-Pb geochronology. *Precambrian Research* 166, 122–144.
- Wyatt BA, Baumgartner M, Anckar E and Grütter H, 2004. Compositional classification of "kimberlitic" and "non-kimberlitic" ilmenite. *Lithos* 77, 819–840.