

The 'Midas Touch' for carbon: Turning tax dollars into diamonds with Big Data

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PDAC 2nd March 2020, 14:50

PDAC 2020 Session: The business of diamonds: From rock to ring – Room 716



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THE WORLD'S PREMIER
MINERAL EXPLORATION
& MINING CONVENTION

Agenda

- **The diamond industry now**
- **A look at existing databases**
- **Diamond exploration databases**
 - **What are the costs?**
 - **What are the benefits?**
 - **Cost / benefit balance**

Where is the industry in terms of production?

Greenland

Australia (Northern Territory, Western Australia)

Canada (Manitoba, Northwest Territories)

What do we gain from compiling data?

Levels of sophistication

Costs based on variables – area, samples, reports

Activities (money spent), discoveries (money earned)

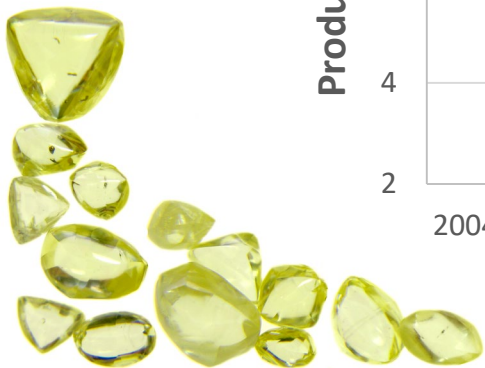
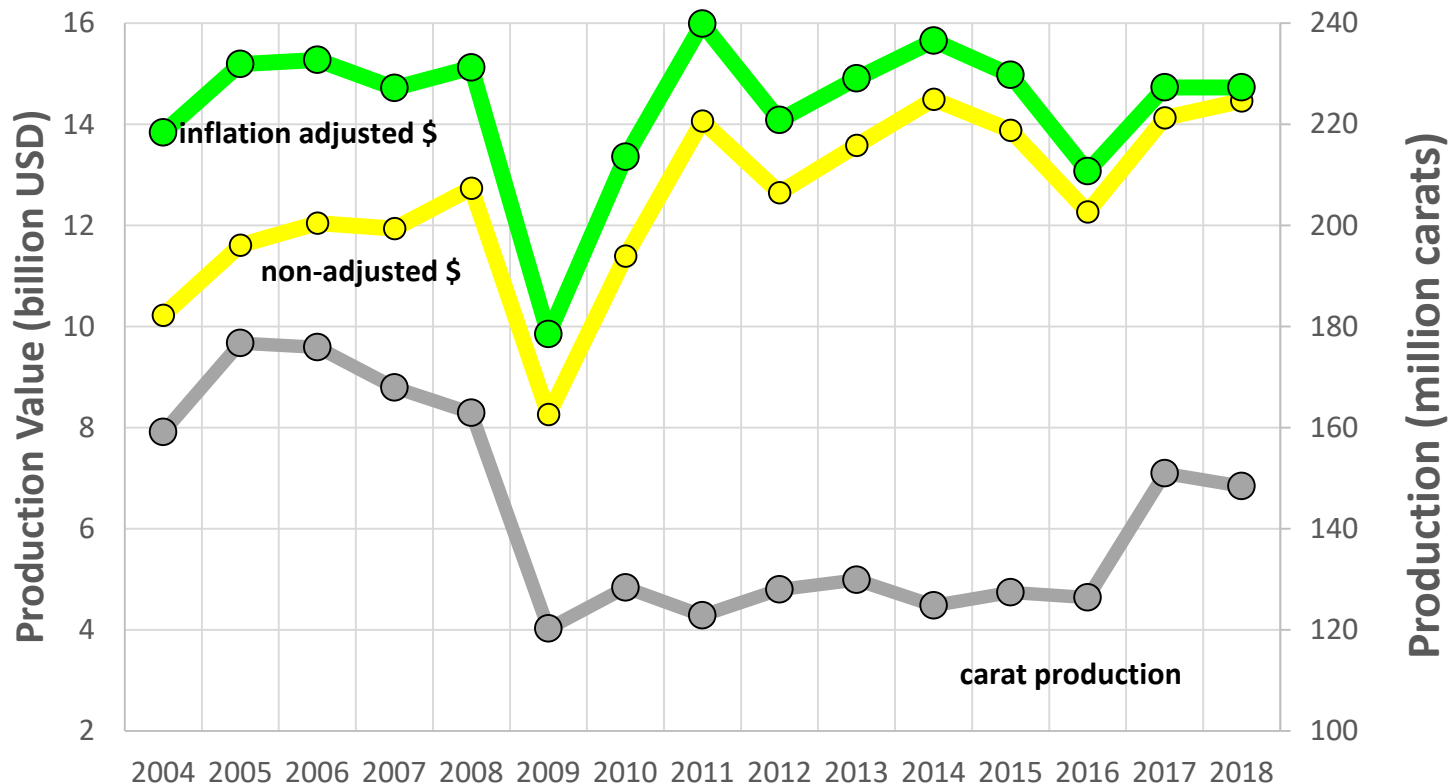
Formal studies

Importance of impact data recording

Who can afford to provide such datasets?

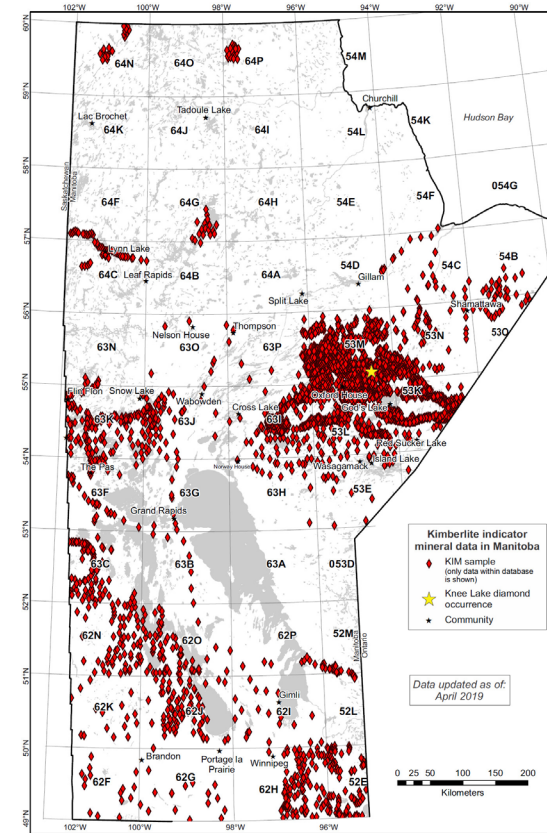


The diamond industry now



- **Title:** Manitoba Kimberlite-indicator Mineral Database
- **Date:** 2003 (v. 1.0), updated May 2019 (v. 3.2)
- **Samples:** 5869
- **Mineral analyses:** 7846
- **Discrete data sources:** 34

<https://www.manitoba.ca/iem/geo/diamonds/index.html>






Northwest Territories Geological Survey (NWT and Nunavut)

- **Title:** Kimberlite indicator and diamond database (KIDD)
- **Date:** 1999, updated 2001, kept current online to 2011 (update underway)
- **Samples:** 189 195 discrete locations (219 770 including subsamples)
- **Mineral analyses:** 145 360
- **Drillholes:** 2232
- **Discrete data sources:** 184



<https://datahub-ntgs.opendata.arcgis.com/datasets/kidd-data-2012>
<http://webapps.nwtgeoscience.ca/WebAppsV2/Searching/DiamondsSearch.aspx>

HOME 

Enter Search Criteria

☒ Must have at least one ☐ Must have all

Separate multiple entries with a semicolon ';'

NTS:

Show/Hide Index

Company:

☐ Has Kimberlite Indicator Mineral Chemistry (KIMC)

Select Additional Fields For Searching

KIDD/KIMC Search Results

Search Results Total: 0 [Show Legend](#) [Hide Legend](#)

☒ Will display the KIDD data and metadata for the KIDD/KIMC sample.

☒ Will download the KIDD data and metadata for the KIDD/KIMC sample into an excel file.

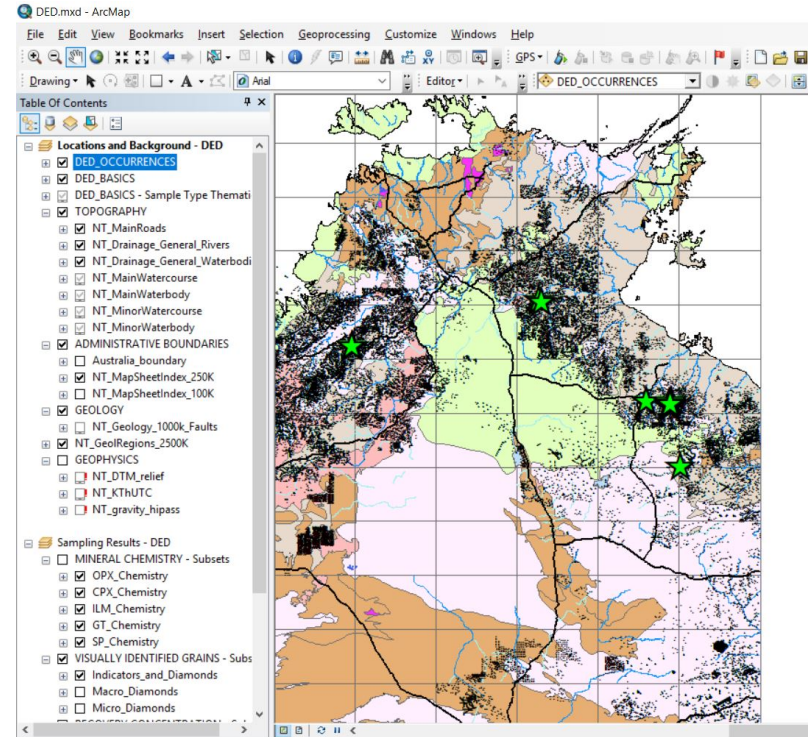
Will download all the KIDD data and metadata for all the KIDD/KIMC records displayed in the results grid into an excel file.

No Diamond Data Found

Northern Territory Geological Survey (Australia)

- **Title:** Northern Territory Diamond Exploration Database
- **Date:** December 2011 (precursor pub. 2003)
- **Samples:** 161 931
- **Mineral analyses:** 15 315
- **In situ occurrences:** 27
- **Discrete data sources:** 716

<https://geoscience.nt.gov.au/gemis/ntgsjspui/handle/1/81750>

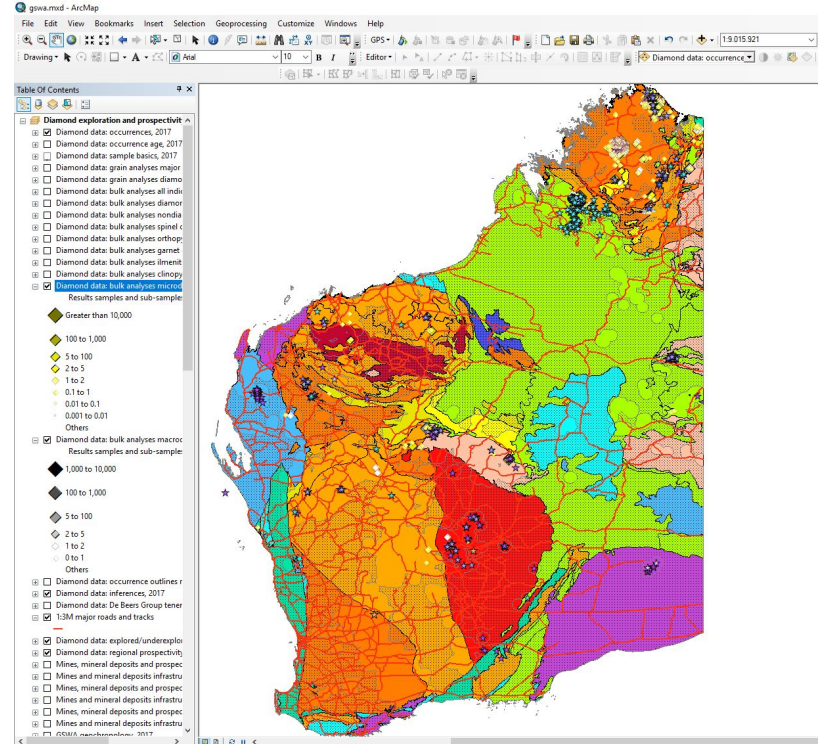
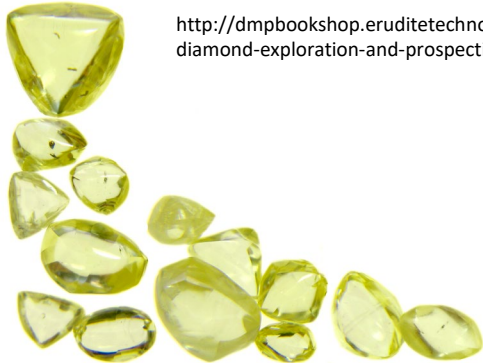




Geological Survey of Western Australia

- **Title:** Diamond exploration and prospectivity of Western Australia
- **Date:** February 2018
- **Samples:** 88 515
- **Mineral analyses:** 33 093
- **In situ occurrences:** 524
- **Discrete data sources:** 989

<http://dmpbookshop.eruditetechnologies.com.au/product/diamond-exploration-and-prospectivity-of-western-australia.do>

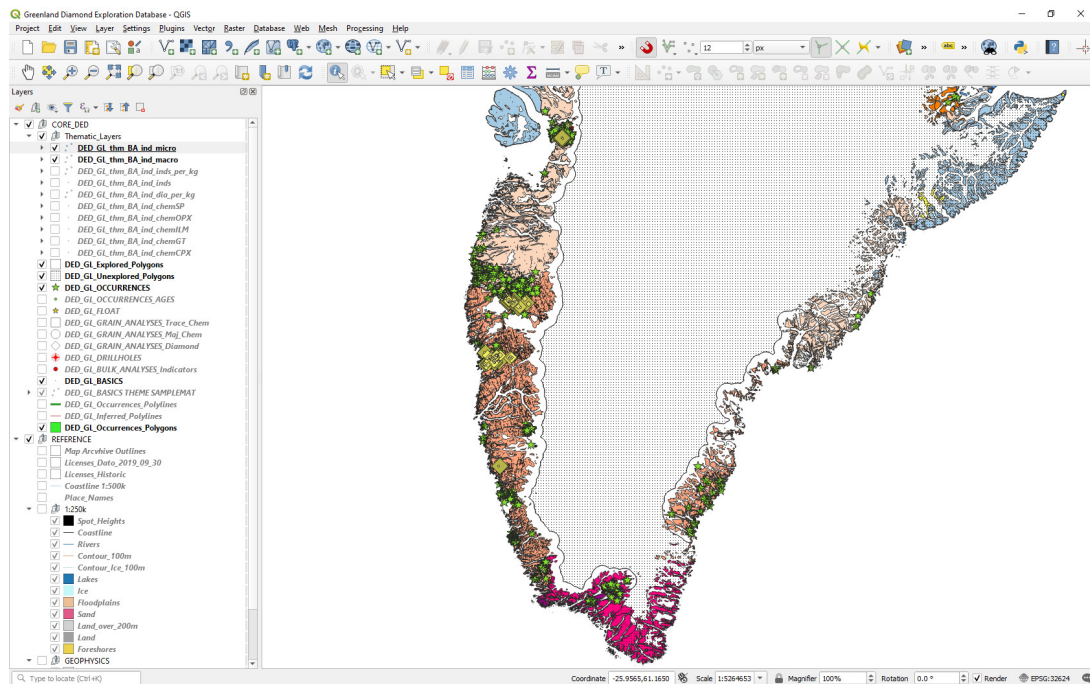




Ministry of Mineral Resources - Govt. of Greenland

- **Title:** Diamond Exploration Package 2020
- **Date:** February 2020 (GEUS precursor 2003, updated 2004)
- **Samples:** 24 996
- **Mineral analyses:** 121 978
- **In situ occurrences:** 3029
- **Drillholes:** 202
- **Discrete data sources:** 135

<https://govmin.gl/2020/01/29/diamond-package-published/>

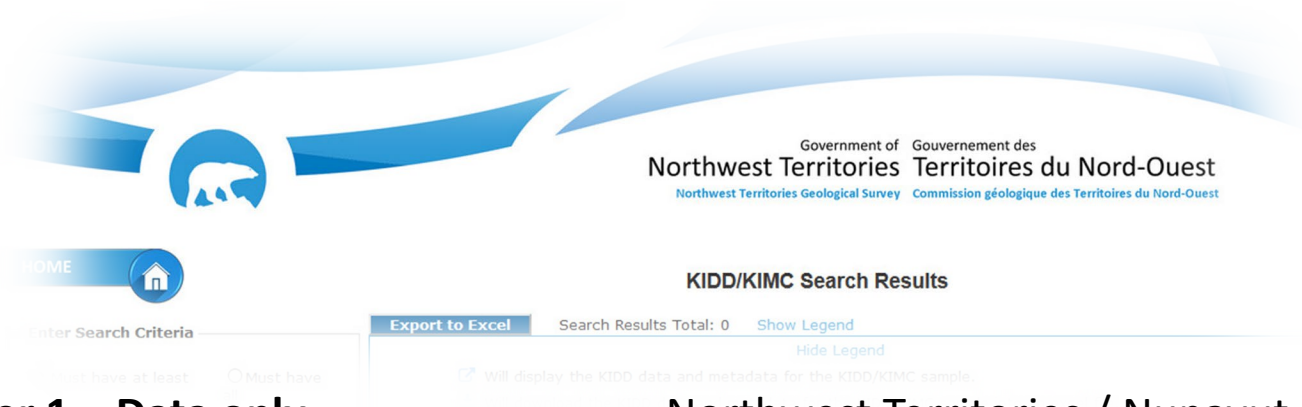


The value of Diamond exploration databases

- Diamond exploration data may be **non-public** – compilation of databases attracts **donation** of large datasets from private resources.
- Data, even when public are almost always **non-standardised** – compilation even at a basic level requires a **quality control** and application of internal consistency.
- Uncompiled data can be more or less inaccessible (scanned documents, unsearchable archives) – compilation puts all data in one place in easy reach of the modern explorer.



The value of Diamond exploration databases



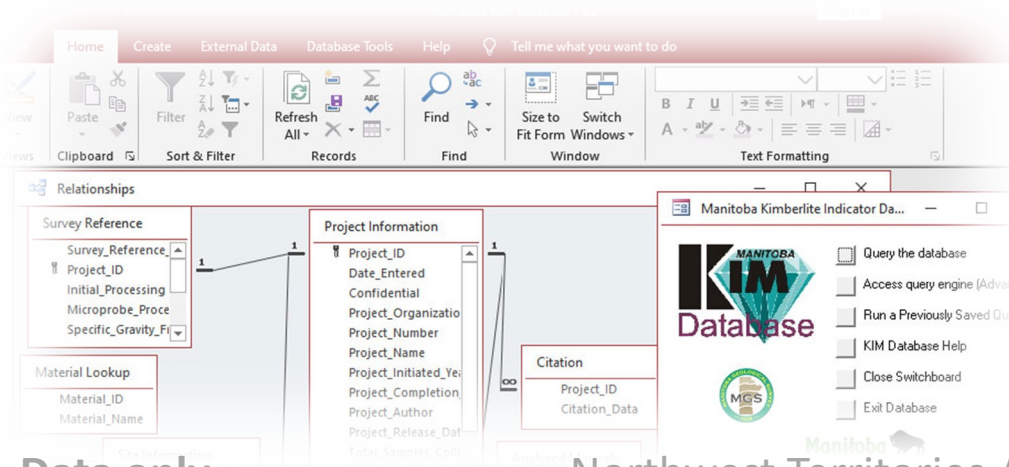
The screenshot shows the official website of the Northwest Territories Geological Survey. The header includes the government logo and the text "Government of Northwest Territories / Gouvernement des Territoires du Nord-Ouest" and "Northwest Territories Geological Survey / Commission géologique des Territoires du Nord-Ouest". A navigation bar has a "HOME" button with a house icon. The main content area is titled "KIDD/KIMC Search Results" and features an "Export to Excel" button, "Search Results Total: 0", and links for "Show Legend" and "Hide Legend". A checkbox is checked, with the label "Will display the KIDD data and metadata for the KIDD/KIMC sample." Below this, a search criteria form is visible with labels "Must have at least" and "Must have".

- **Tier 1 – Data only**

Northwest Territories / Nunavut



The value of Diamond exploration databases

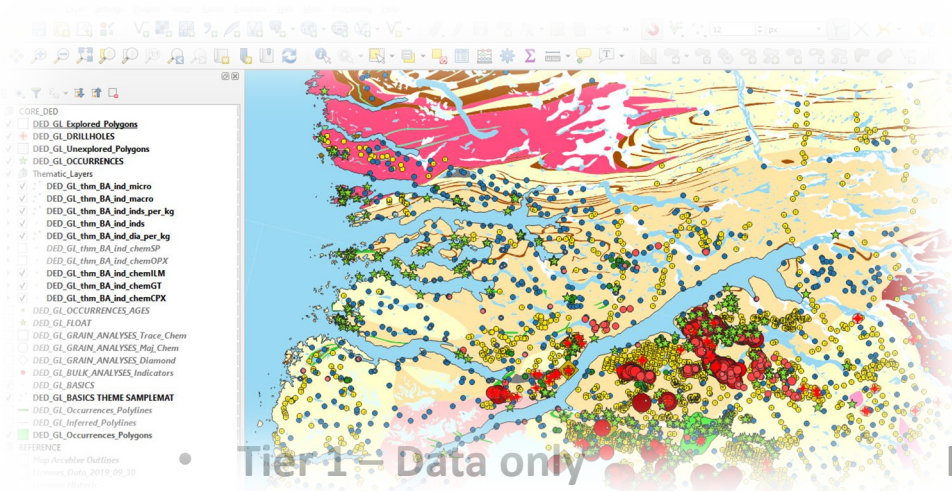


- Tier 1 – Data only
- Tier 2 – Data fully queriable

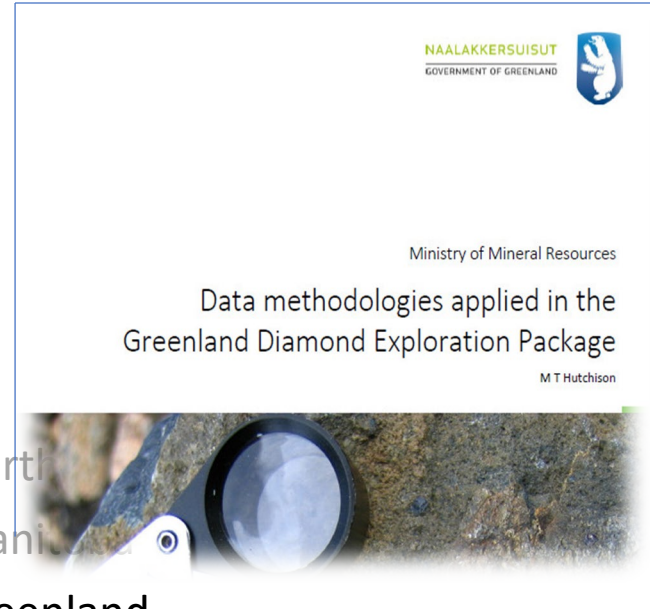
Northwest Territories / Nunavut
Manitoba



The value of Diamond exploration databases

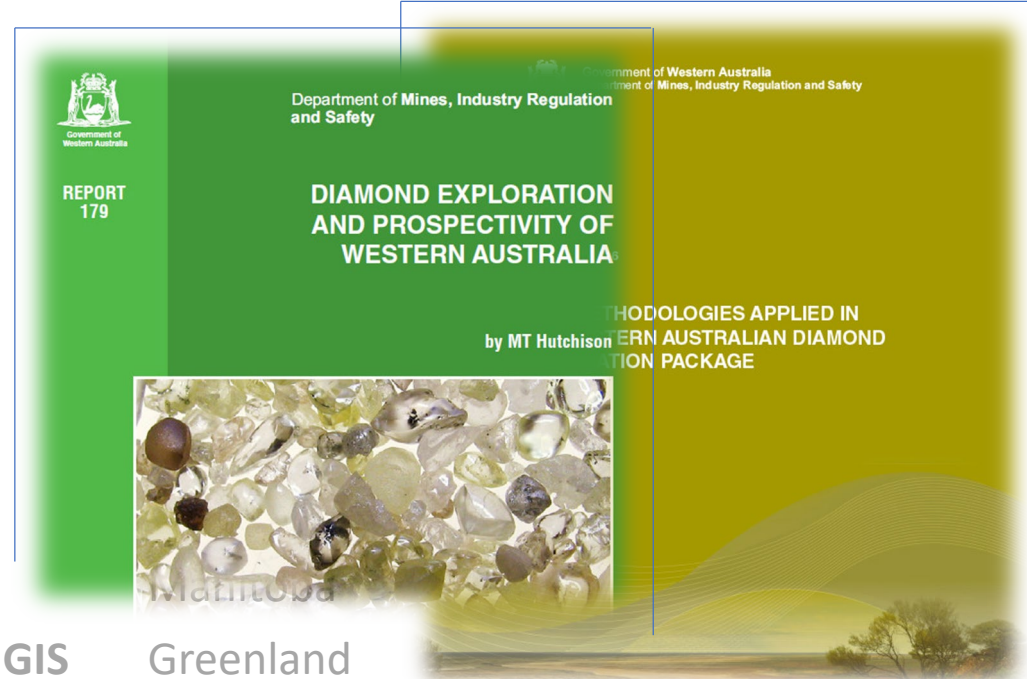
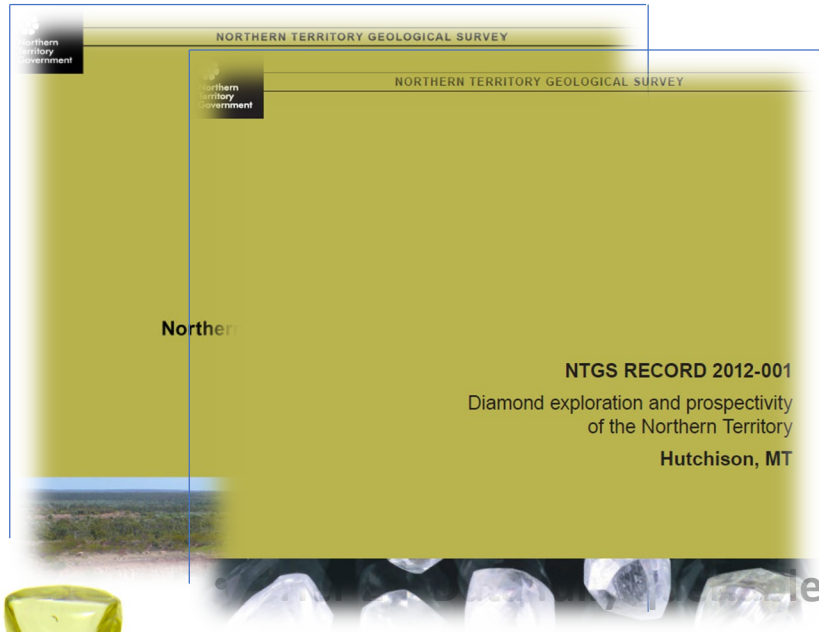


- **Tier 1 – Data only**
- **Tier 2 – Data fully queriable**
- **Tier 3 – Data queriable with GIS**

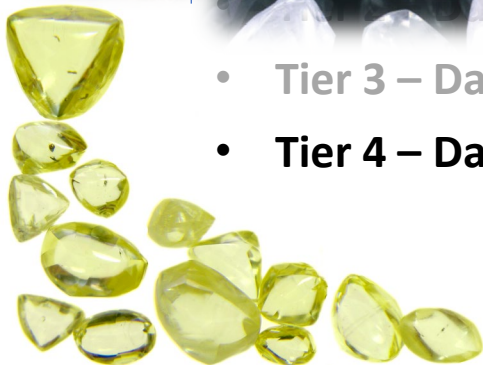


North
Mani
Greenland

The value of Diamond exploration databases



- Tier 3 – Data queriable with GIS Greenland
- Tier 4 – Data queriable with GIS and prospectivity analysis Northern Territory / Western Australia

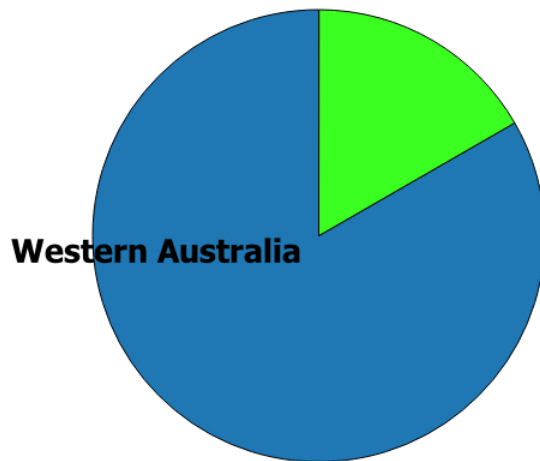


What are the costs?

Project costs - known

Western Australia

AUD \$529,016	TOTAL
AUD \$120,122	ON-COST 20% and 40%
AUD \$649,138	GRAND TOTAL
USD \$514,520	GRAND TOTAL USD – Sep. 2015
USD \$549,146	CORRECTED USD - Feb 2020



KEY



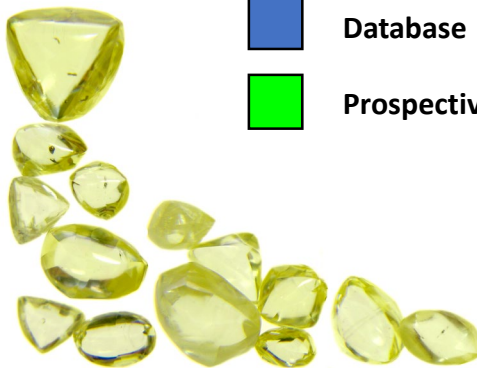
Database



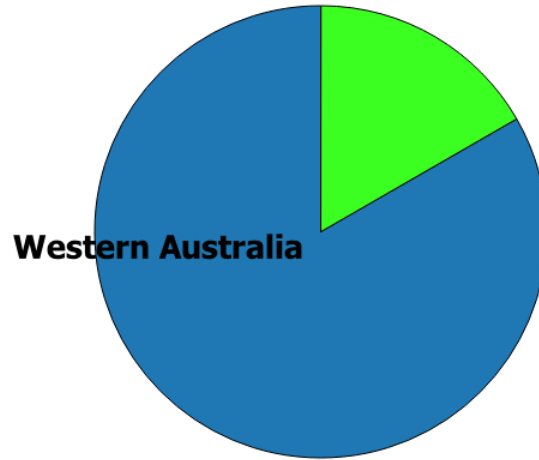
Prospectivity Analysis



Manitoba



Project costs - known



Western Australia

Northern Territory

AUD \$172,615	TOTAL
AUD \$34,523	ON-COST 20%
AUD \$207,138	GRAND TOTAL
USD \$192,007	GRAND TOTAL USD - June 2010
USD \$225,116	CORRECTED USD - Feb 2020



Northern Territory

Manitoba

Greenland

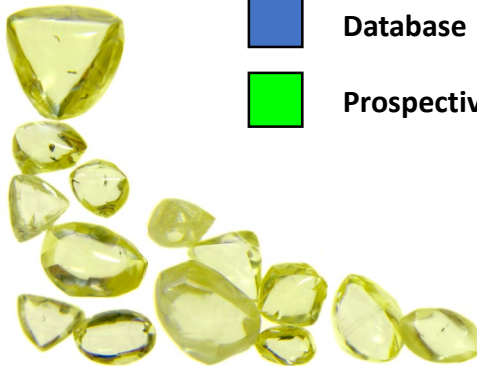
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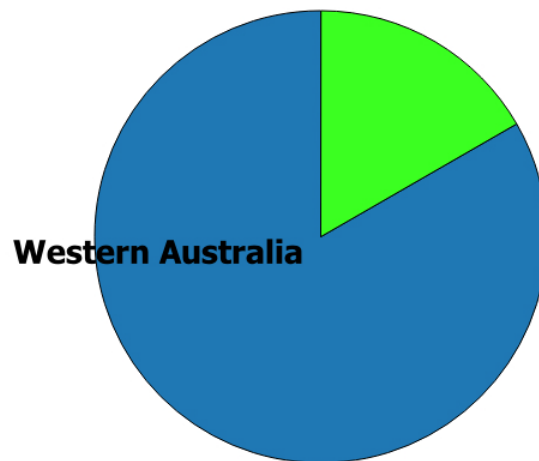
Database



Prospectivity Analysis



Project costs - known



Western Australia

Greenland

DKK 736,250	TOTAL
DKK 147,250	ON-COST 20%
DKK 883,500	GRAND TOTAL
USD \$133,627	GRAND TOTAL USD - June 2019
USD \$136,048	CORRECTED USD - Feb 2020



Northern Territory

Manitoba



Greenland

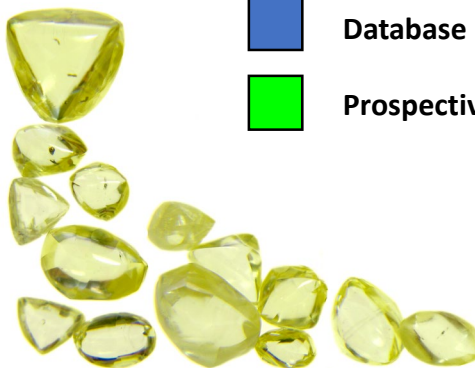
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Database



Prospectivity Analysis



Project costs - known

KEY

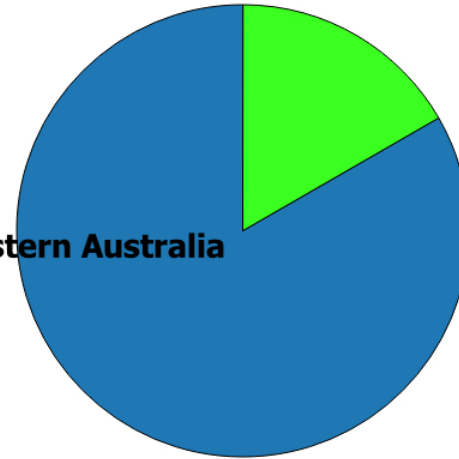


Database



Prospectivity Analysis

Western Australia



Northern Territory



Manitoba



Greenland



Manitoba

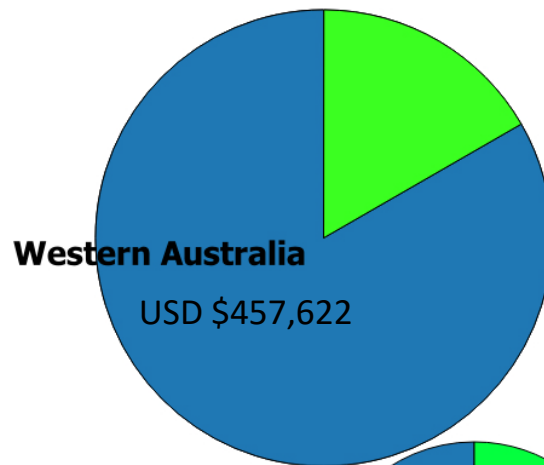
CAD \$20,000 TOTAL
CAD \$4,000 ON-COST 40%
CAD \$24,000 GRAND TOTAL
USD \$23,297 GRAND TOTAL USD – Dec. 2010
USD \$27,314 CORRECTED USD - Feb 2020



Project costs – final estimated

Western Australia

USD \$549,146	COSTED TOTAL
USD \$91,524	PROSPECTIVITY REVIEW
USD \$457,622	DATABASE ONLY COST
	NO PRIOR DATABASE?
USD \$457,622	TOTAL DATABASE COST



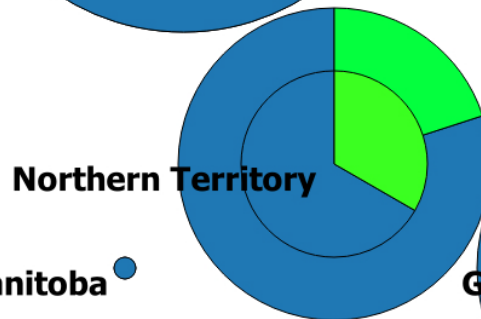
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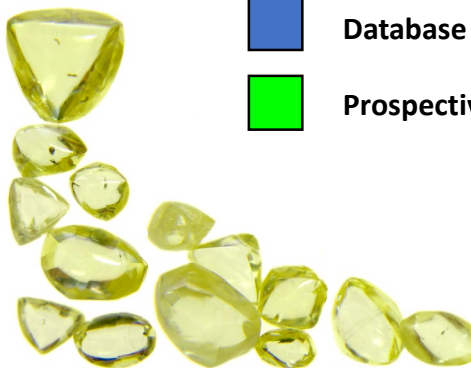
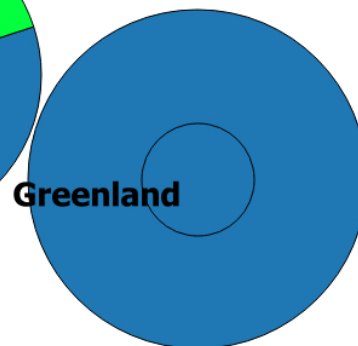
Database



Prospectivity Analysis

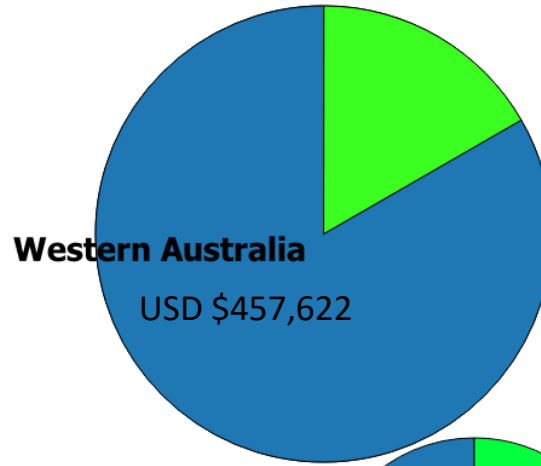


Manitoba



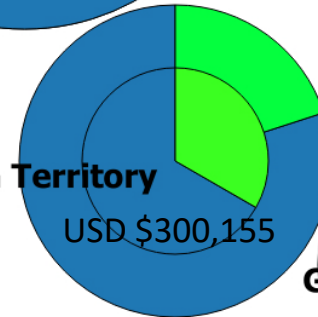
Project costs – final estimated

(GSWA estimate the cost of producing a single 1:100 000 scale geological map to be approx. \$200,000 USD – Then, D. Pers. Commun. Feb-2020)

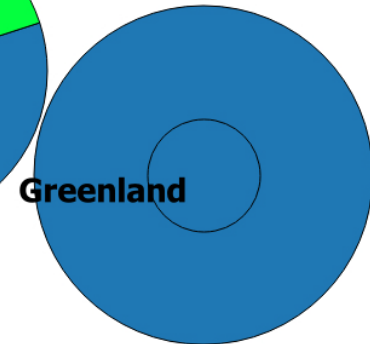


Northern Territory

USD \$225,116	COSTED TOTAL
USD \$75,039	PROSPECTIVITY REVIEW
USD \$150,077	DATABASE ONLY COST
YES (1 man)	PRIOR DATABASE?
USD \$300,155	TOTAL DATABASE COST



Manitoba



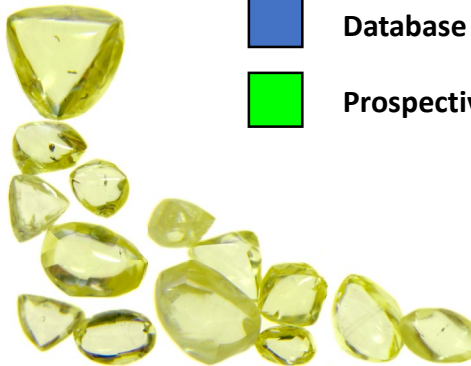
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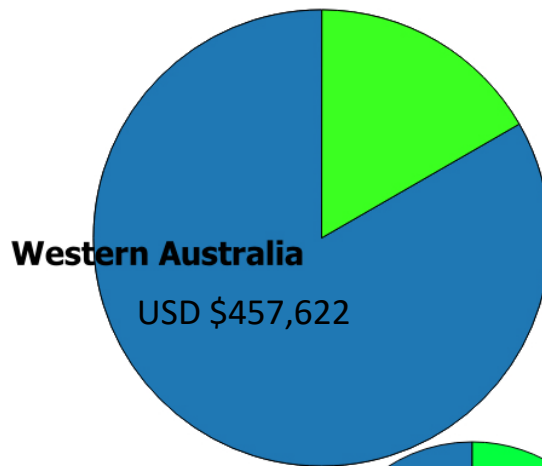
Database



Prospectivity Analysis

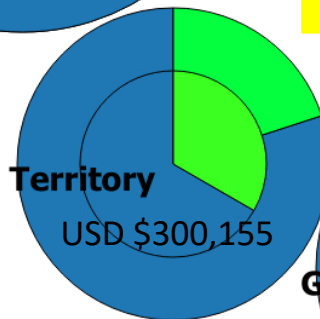


Project costs – final estimated

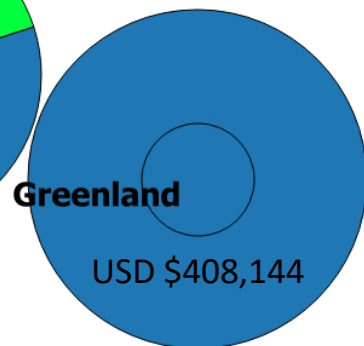


Greenland

USD \$136,048	COSTED TOTAL
USD \$0	PROSPECTIVITY REVIEW
USD \$136,048	DATABASE ONLY COST
YES (2 man)	PRIOR DATABASE?
USD \$408,144	TOTAL DATABASE COST



Manitoba



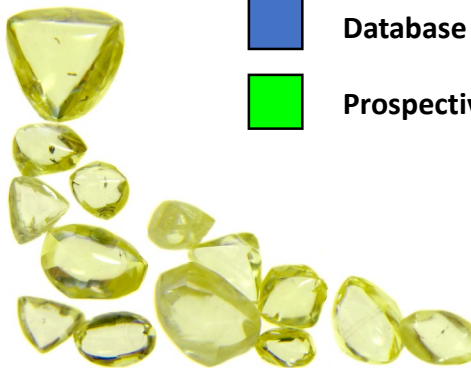
KEY



Database



Prospectivity Analysis



Project costs – final estimated

KEY



Database



Prospectivity Analysis

Western Australia

USD \$457,622

Northern Territory

USD \$300,155

Manitoba

USD \$27,314

Greenland

USD \$408,144

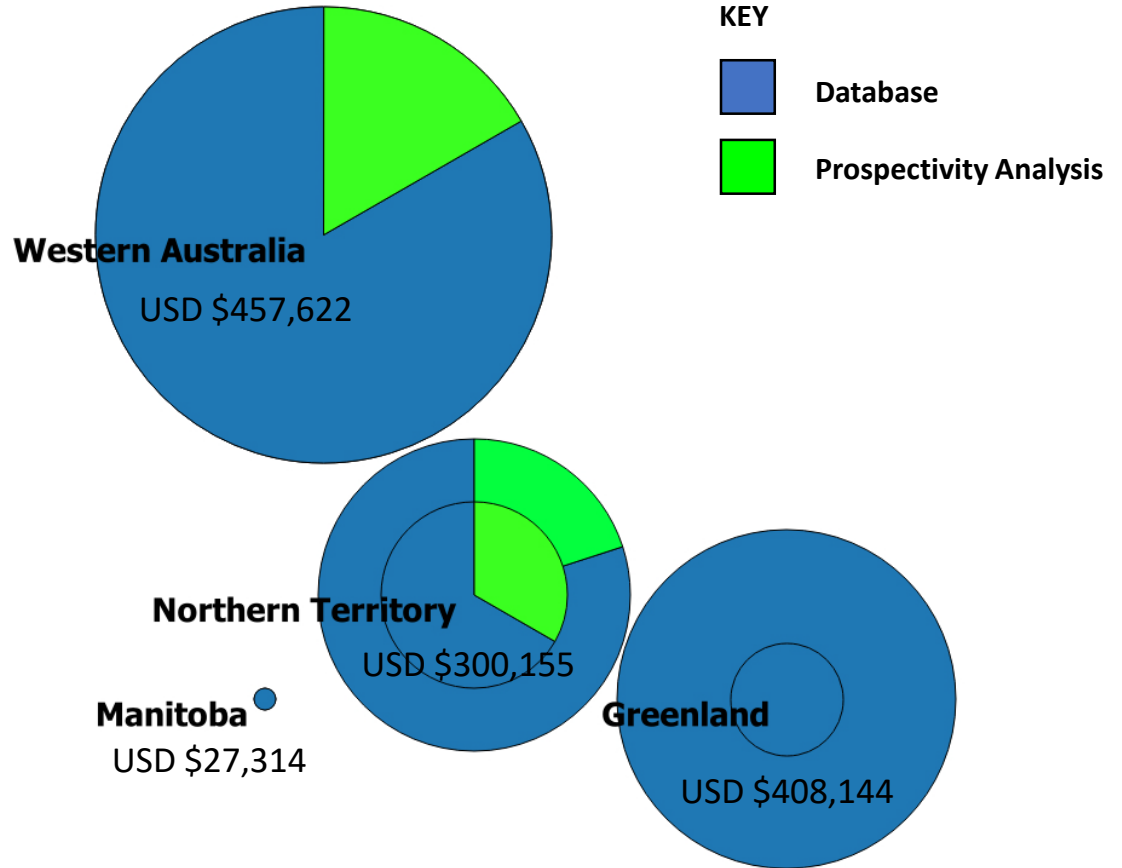
Manitoba

USD \$27,314	COSTED TOTAL
USD \$0	PROSPECTIVITY REVIEW
USD \$27,314	DATABASE ONLY COST
	NO PRIOR DATABASE?
USD \$27,314	TOTAL DATABASE COST



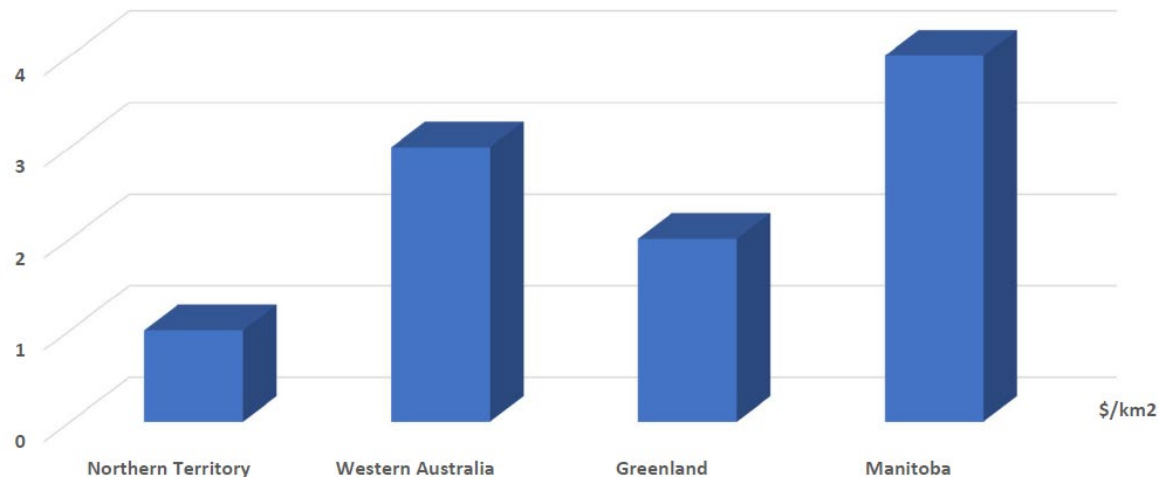
Project costs – final estimated

(Calculated costs of NWT's product unavailable, but their estimate of costs of outsourcing the project and building all of the IT database systems from scratch is \$1.9 to \$2.25 million USD)

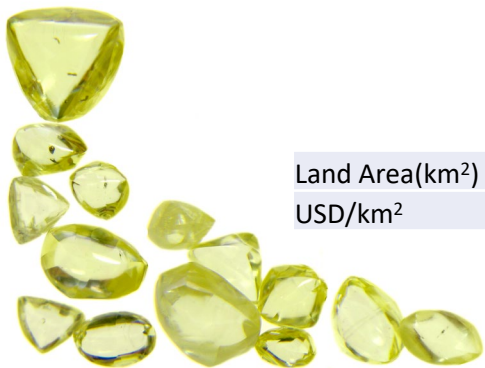


Ranking of costs based on various parameters

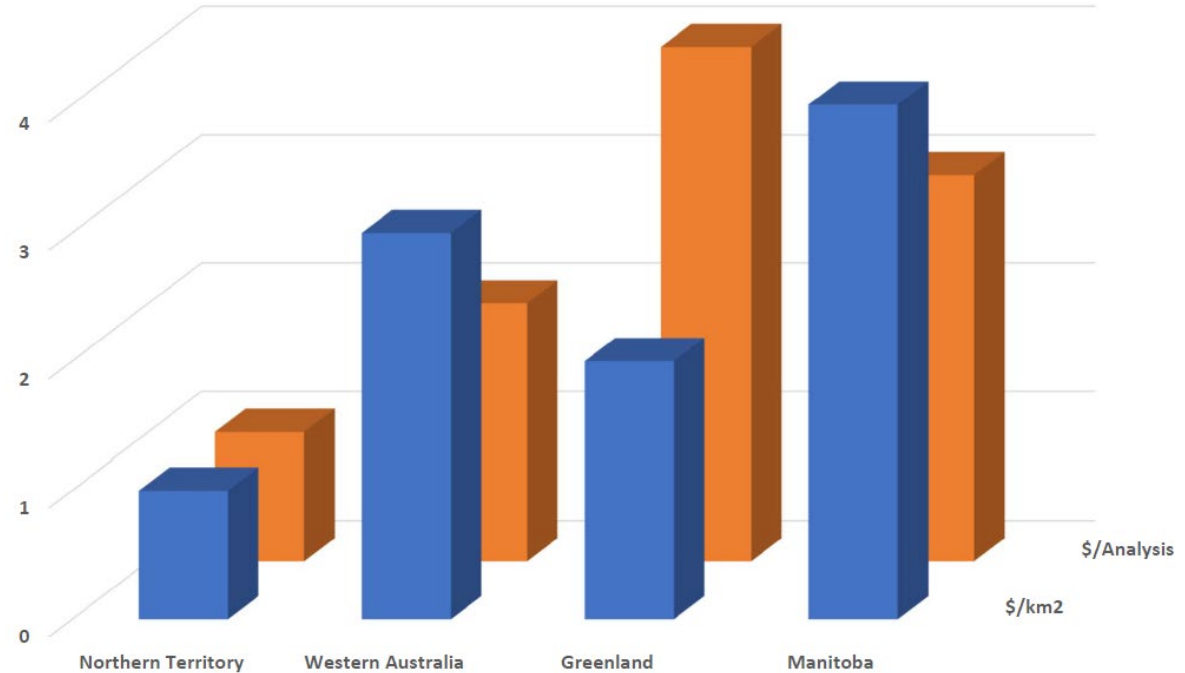
Are the projects
comparable?
Can we predict
from the costs?



Land Area(km²)	1,421,000	2,530,000	2,166,000	648,000
USD/km²	\$0.21	\$0.18	\$0.19	\$0.04



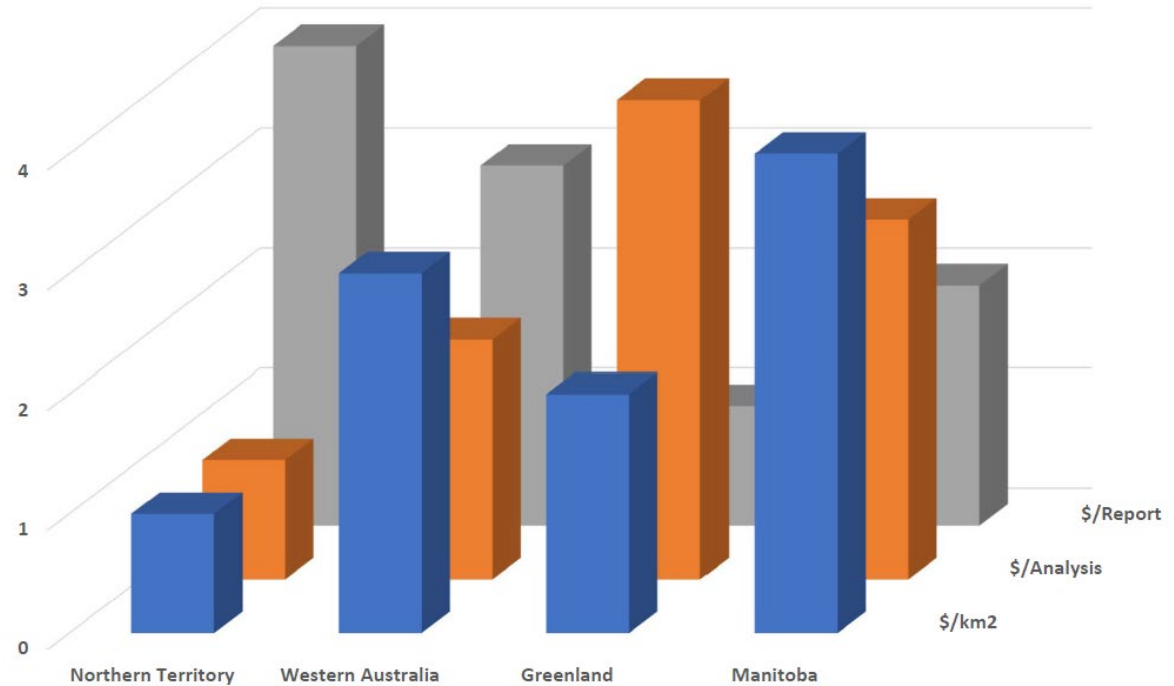
Ranking of costs based on various parameters



15 315	33 093	121 978	7846 Chemical Analyses
\$19.60	\$13.83	\$3.35	\$3.48 USD/Analysis



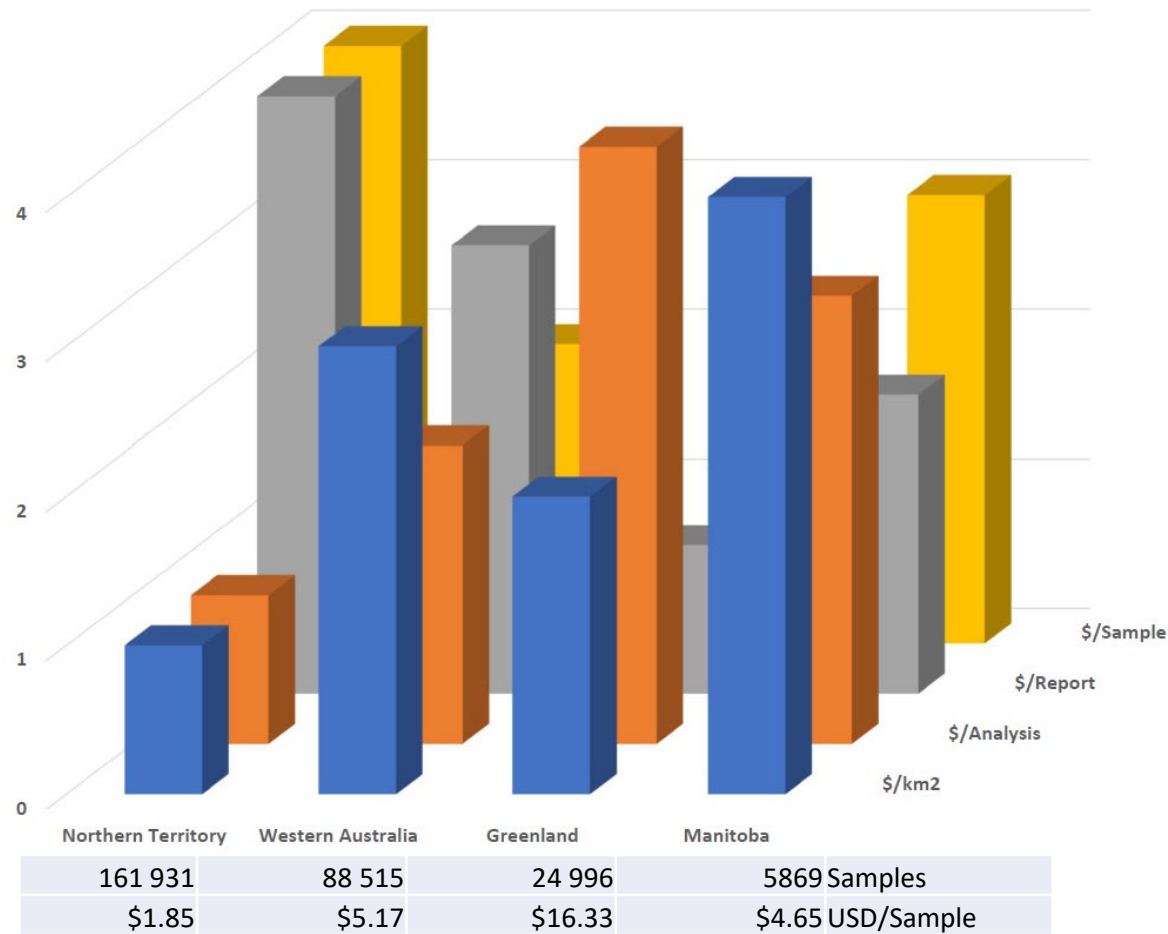
Ranking of costs based on various parameters



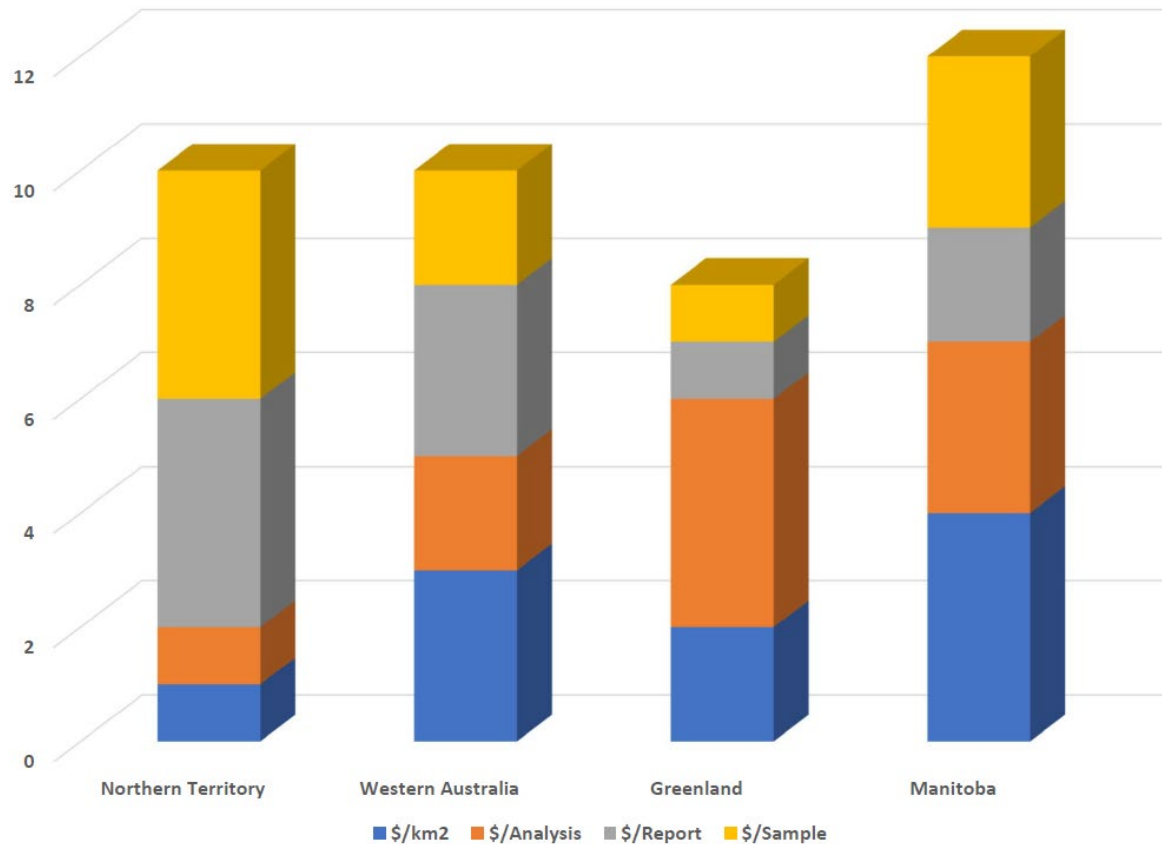
716	989	135	34 Source reports
\$419.21	\$462.71	\$3023.29	\$803.35 USD/Report



Ranking of costs based on various parameters



Summed Rankings



How significant are these costs?

- Totalling all surveys gives a cost of **\$0.18 / km²**

	Land Area (km ²)	Modelled Cost USD	2018 Production	Percentage of 1% of 2018 production
Russia	17,098,246	\$3,077,684	\$3,983,226,836	7.73%
Botswana	581,730	\$104,711	\$3,534,741,705	0.30%
NWT	1,346,106	\$242,299	\$2,097,723,338	1.16%
South Africa	1,221,037	\$219,787	\$1,228,346,438	1.79%
Angola	1,246,700	\$224,406	\$1,223,725,185	1.83%
Namibia	825,615	\$148,611	\$1,125,198,529	1.32%
Lesotho	30,355	\$5,464	\$377,263,476	0.14%
Zimbabwe	390,757	\$70,336	\$209,977,430	3.35%
Sierra Leone	71,740	\$12,913	\$157,063,757	0.82%
DRC	2,344,858	\$422,074	\$136,125,280	31.01%



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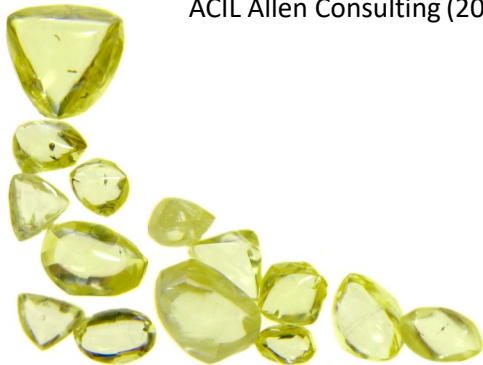
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Benefits to the industry - general

- “..the evidence that the value of mineral deposits discovered through exploration is a multiple many times greater than exploration spending is strong..”
- “.. detailed statistical modelling found that the long run (three year) cumulative effect of \$1M of EIS spending was an increase in exploration expenditure of \$19.8M. This estimate is large, but the estimate is consistent with what might be expected based on a review of other published studies, the targeted nature of the EIS program, and market conditions for the sample period.”
- “The main transmission channel delivering the large private sector exploration response is new geoscience information.”

ACIL Allen Consulting (2015) Exploration Incentive Scheme Economic Impact Study Geological Survey of Western Australia, 78p.



Benefits to the industry - general

- “Economic benefits of the \$56m spent on PACE between 2004-2013: Extra \$700m invested in private mineral exploration (20:1 leverage), extra A\$2400m in State Mining Revenues (a factor of 44x)”

Economics Consulting Services (2014) Report on Evaluation of the Plan for Accelerating Exploration (PACE) for the SA Department of Manufacturing, Innovation, Trade, Resources and Energy

- “The BFD and CORE programs have created a wealth of pre-competitive geoscience information, information systems, and investment opportunities.... Eight exploration successes can be closely linked to the initiatives. Five potential new mining projects can be closely linked to Survey activities”

NTGS (2017) Review of Northern Territory Geological Survey Programs: Bringing Forward Discovery (BFD) Creating Opportunities for Resource Exploration (CORE). Northern Territory Geological Survey, 150p.



Benefits to the industry - specific

- **Manitoba** – Manitoba Geological Survey (MGS) field projects have led to discoveries of diamondiferous rocks. De Beers Canada contributed to the database data and subsequent follow-up by SGS at **Knee Lake** and **Monument Bay** based on the database resulted in discoveries of diamondiferous rocks.
- **Western Australia** – Between 2012 and 2020 a total of 14 **co-funded diamond exploration drilling projects** have been granted between DMP and industry, notably Mad Gap, Webb and Ellendale.

DevEx Resources in their 02 July 2018 press release credited the 2018 GSWA database for their **Oscar** and **Mount Hann** license application.

Ongoing exploration in the **Kimberley** (Lithoquest), **Ellendale** (Lucapa, India Bore and Gibb River Diamonds)

- **Northern Territory** – Kaylan Resources staked ground in **Moroak** in 2012 - drilling work currently planned. Compiled data supported Scriven Exploration work at **Abner Range** and south of **Merlin**.
- **Northwest Territory / Nunavut** – The NWT KIDD was particularly important in the development of the **Coronation Gulf Field**.



Importance of impact data recording

Manitoba don't compile records of expenditures assigned by particular commodity. Only commodity expenditures are Canada-wide, published by NRCan. A large component of the Manitoba Survey's **mandate is to provide** relevant information and data including '**value-added products**' to support and spur mineral exploration, resource development and investment. No qualitative assessments of the **impact** of 'value-added products' specifically for diamonds have been completed (some unpublished studies have been created for precious and base metals).

Similarly for the Northwest Territories / Nunavut, no formally retained knowledge of the cost of generating such products. Published documents have advertised the launch of the database, and how it is expected to be used, but not a follow-up on its **impact**.

The Western Australia Survey have conducted detailed work on the **impact of its Exploration Incentive Scheme** but they are fairly anomalous in this regard and it is not commodity-specific.

The Northern Territory only has started keeping records of **expenditure by commodity** very recently.



Messages to the industry

- **Message to junior explorers** - It's too expensive for you to thoroughly do this work. Lobby your government authorities to do it for you.
- **Message to majors** - You benefit from discoveries by juniors. Share your historical data.
- **Message to Surveys** - These are the costs and benefits so there's a mechanism to lobby your Ministries.
- **Message to Government Ministries** – Even when the resources sector is a cash cow, it still needs to be fed for future growth. Activity generates data but that isn't enough. Support your Agencies to deliver this data. Organised data is what feeds discovery.



Summary

- **The diamond industry now**

The industry has seen, and will likely see a continued fall in production against demand.

- **Gains from compiling data?**

More data, standardisation, accessibility, non-repetition of work, promotion

- **What are the costs?**

Typical compiling costs of between \$150k and \$500k USD for a large province or country with an elaborate product. Expected costs average \$0.12 USD per km² and correlate to 0.3–1.8% of one percent of yearly sales for diamond-producing countries.

- **What are the benefits?**

Activities (money spent), discoveries (money earned). Database-prompted discoveries at Coronation Gulf, Garnet Lake, Knee Lake.

- **Future**

Importance of impact data recording.
Costings provide a mechanism to plan future products.



References

- ACIL Allen Consulting (2015) Exploration Incentive Scheme Economic Impact Study Geological Survey of Western Australia, 78p.
- Armstrong JP (2003) Diamond discovery in the Slave Craton: Compilations of exploration data as tools for future discovery Ext. Abs. 8th Int. Kimberlite Conf., Victoria, BC FLA_0190
- Armstrong JP, Chatman J (2001) Kimberlite indicator and diamond database (KIDD): UPDATE: a compilation of publicly available till sample locations and kimberlite indicator mineral picking results, Slave Craton and environs, Northwest Territories and Nunavut, Canada. DIAND NWT Geology Division, Open report 2001-01, p 5 and CD-ROM
- Armstrong JP, Fitzgerald CE, Kjarsgaard BA, Heaman L, Tappe S (2012) Kimberlites of the Coronation Gulf Field, Northern Slave Craton, Nunavut Canada. Ext. Abs. 10th Int. Kimberlite Conf, Bangalore 10IKC-170
- Duke JM (2010) Government geoscience to support mineral exploration: public policy rationale and impact. Prep. for Prospectors and Developers Assoc. Canada, 72p.
- Economics Consulting Services (2014) Report on Evaluation of the Plan for Accelerating Exploration (PACE) for the SA Department of Manufacturing, Innovation, Trade, Resources and Energy
- Hutchison M.T. (2018) Diamond exploration and regional prospectivity of Western Australia Mineralogy and Petrology 112S2, 737-753 doi.org/10.1007/s00710-018-0579-6 - http://www.trigon-gs.com/Hutchison_18.pdf
- Hutchison M.T. (2018) Diamond exploration and prospectivity of Western Australia. Geological Survey of Western Australia, Report 179, pp70 - <http://dmpbookshop.eruditetechnologies.com.au/product/diamond-exploration-and-prospectivity-of-western-australia-geographical-product-n15bz1.do>
- Hutchison M.T. (2018) Data methodologies applied in the Western Australian diamond exploration package. Geological Survey of Western Australia, Record 2017/16, pp24 - <http://dmpbookshop.eruditetechnologies.com.au/product/data-methodologies-applied-in-the-western-australian-diamond-exploration-package.do>
- Hutchison M.T. (2013) Diamond Exploration and Regional Prospectivity of the Northern Territory of Australia DG Pearson et al. (eds.), Proceedings of 10th International Kimberlite Conference, Volume 2, Spec. Pub. J. Geol. Soc. India 257-280 - http://www.trigon-gs.com/Hutchison_2013.pdf
- Hutchison M.T. (2012) Diamond Exploration and Prospectivity of the Northern Territory. Northern Territory Geological Survey Record 2012-001 pp. 64, vi and 1 map plate - <http://www.geoscience.nt.gov.au/gemis/ntgsjspui/bitstream/1/82456/1/NTGSRec2012-001.zip>
- Hutchison, M.T. (2011) Northern Territory Diamond Exploration Database. Northern Territory Geological Survey Digital Information Package DIP-011, DVD-ROM with Explanatory Notes (vers. December 2011) - <http://www.geoscience.nt.gov.au/gemis/ntgsjspui/handle/1/81750> - Accompanying Explanatory Notes Report 6,068KB .pdf file - http://www.trigon-gs.com/Hutchison_11_DIP011.pdf
- Kimberley Process Statistics (2020) Public Statistics Area https://kimberleyprocessstatistics.org/public_statistics
 - Manitoba Geological Survey (2020) Manitoba Kimberlite-indicator Mineral Database v.3.2 <https://www.manitoba.ca/iem/geo/diamonds/index.html>
 - Northwest Territories Geological Survey (2012) Kimberlite indicator and diamond database (KIDD) <https://datahub-ntgs.opendata.arcgis.com/datasets/kidd-data-2012>
 - NTGS (2017) Review of Northern Territory Geological Survey Programs: Bringing Forward Discovery (BFD) Creating Opportunities for Resource Exploration (CORE). Northern Territory Geological Survey, 150p.

