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The Effective Use of Indicator Minerals in India- An Exploration Case Study

Exploration 07- Indicator Mineral Methods in Mineral Exploration Workshop

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, Rio Tinto Exploration Toronto, September 9 2007



Diamonds and Rio Tinto

- Rio Tinto has been involved with diamonds since 1979 with the discovery of Argyle in Australia.
- Other diamond projects include Diavik and the more modest Murowa mine in Zimbabwe.
- Share of the production from these three mines in 2006 \approx 1 US\$ bn.
- Major supplier of diamonds for Indian cutting and polishing industry.
- Global network exploration programs, and leading-edge mineral chemistry analytical facilities. Facilities include mini-DMS plants, caustic fusion for micro-diamonds and macro-diamond recovery using 10 tph DMS plants.



Diamonds and India

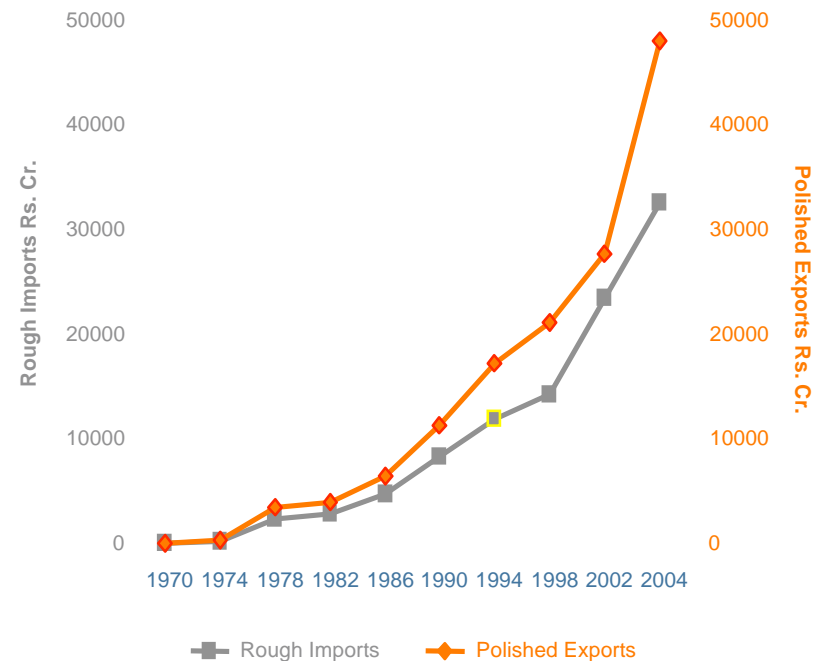
- India has a unique cultural association with diamonds dating back at least 3000 years. Diamonds have significant historical tribute, dowry, religious, and astrological importance and reflect the wealth of Kings and Government.
- Production to 19th Century estimated at 12 million carats.
- Today diamonds are quite commonly found after rains on tilled fields and provide a windfall to poor farmers, but disputes are common...
- Alluvial workings (e.g.: Panna) and India's only primary operating source at Majhgawan (0.12 cpt, US\$96/ct, 85,000 ct annual production)



Diamonds Are Important to Rio Tinto and India

- India imports 55% by value and 80% by volume of the world's rough diamond production. Rio Tinto supplies approximately 30% of these diamonds from its international mines.
- The Indian jewellery industry is the main customer for diamonds produced by Rio Tinto's diamond mines.
- Cut and polished diamonds comprise ~18% of India's exports by value.
- 1 million people are employed by the diamond industry in India (Mumbai, Surat).
- This industry is threatened by tightening world supplies.
- India needs new, local diamond sources.

Diamond Imports / Polished Exports – Significant Growth



Why India? – Ten Good Reasons!

- All discovered in India prior to 19th Century
- All from alluvial or conglomeratic sources, eroded from kimberlite
- *Rio Tinto is targeting undiscovered kimberlite sources of these diamonds*



Orlov 189 ct



Darya-I-Noor
185 ct



Regent
140 ct



Kohinoor
105 ct



Shah
89 ct



Sancy
55 ct



Hope
45 ct



Tereschenko
43 ct



Dresden Green
41ct



Wittelsbach
35 ct

Rio Tinto Exploration In India

- Rio Tinto has had a presence in India since 1985, and have been actively exploring since 1996. Rio Tinto has been exploring for diamonds in India since 2000.
- Rio Tinto has explored over 40,000 km² and in the process discovered over 30 kimberlites, several diamondiferous, 16 within Madhya Pradesh in N Central India.
- Expenditure to date > US\$30M.
- RT considers diamond prospectivity in India as very high.
- Advanced projects include Bunder where LDD and surface bulk sampling continues on a cluster of 8 Argyle age diamondiferous lamproites, the largest of which is 17ha.

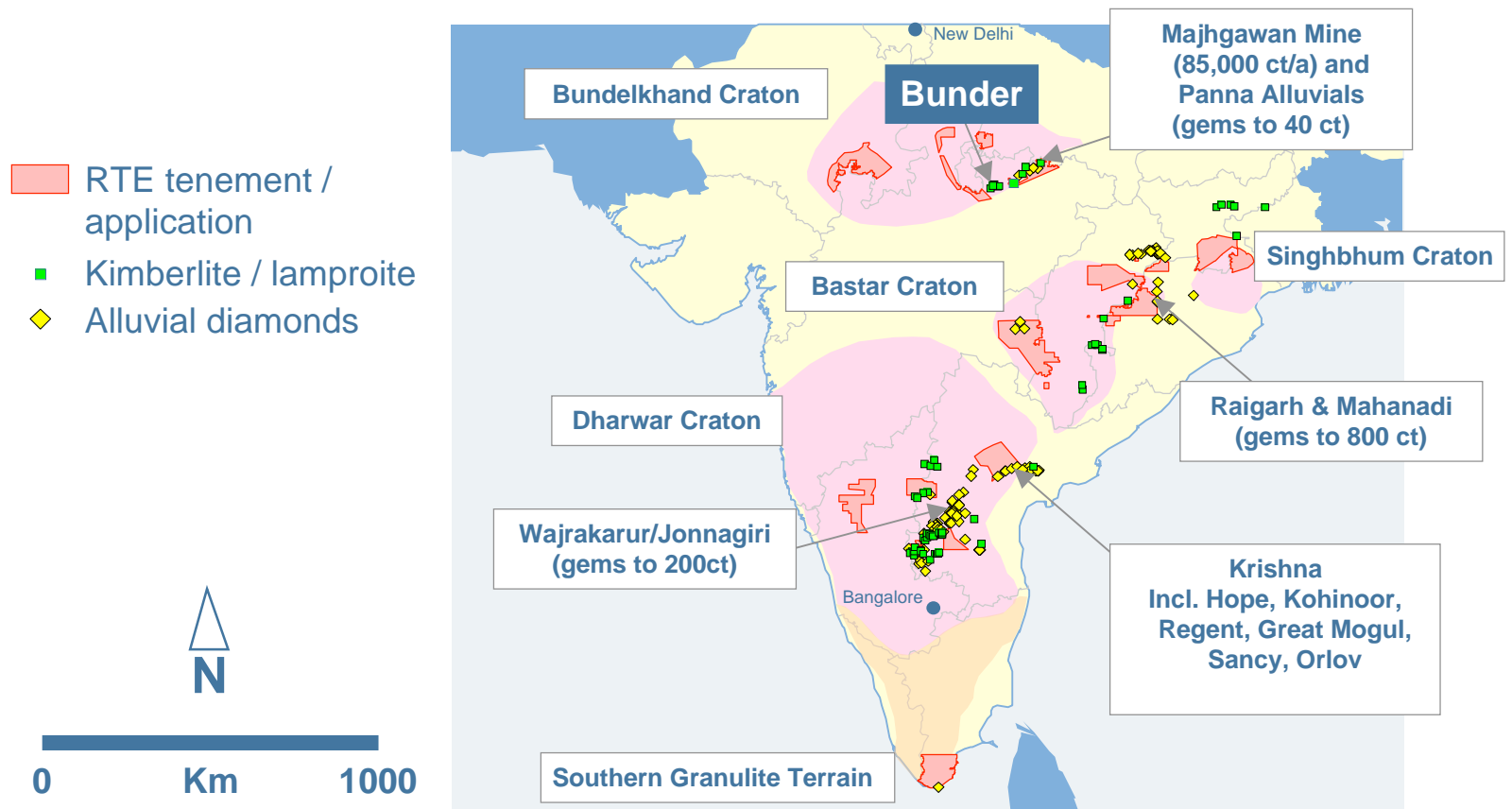


Bunder Discovery Outcrop



Drilling at Bunder

Rio Tinto Diamond Exploration In India



Rio Tinto Diamond Exploration In India- Local Context

- Slow tenement grant (2 to 4+ years), generally only majors exploring.
- Permits limited to 10,000km² per company per state. Must reduce by 50% after 2 years and 99.75% after 3 years. No “open range” exploration.
- Forest access, airborne geophysics and drilling approvals slow/restrictive. Sample export delays from States. Rules poorly administered and inflexible.
- Good road access (poor condition), low operating and capital costs, exploration year round
- Poorly developed drilling industry, air photographs/radiometrics banned.
- People, people, people!!!



Khajuarho (12th century temples)



Rio Tinto Diamond Exploration In India- Strategy

- Secure, explore, advance or drop, then secure additional permits.
- Keep a relatively large team exploring multiple states at once. Maintain supply for labs, but flexibility needed.
- Gravel/KIM sampling to quickly prospect large areas, rapid follow up using soil/loam sampling, ground geophysics, prioritization of drill targets, drill test and sample
- Good lab setup for first pass reconnaissance and rapid, follow up sampling. Modern mini-DMS for small bulk samples. Rapid turnover.



Gravel sampling at Bunder



Ground magnetic survey



Kimberlite logging

Rio Tinto Diamond Exploration In India- Gravel Sampling

- Indicator mineral sampling, largely from gravel samples has been a critical component of the exploration strategy in India.
- Since 2000, RT has collected over 6,000 gravel samples.
- Important Factors;
 - Sample spacing and orientation.
 - Quality sample/trap sites.
 - Quality lab setup for first pass reconnaissance and rapid, follow up sampling.
 - Importance of rigorous prioritization of indicator results and mineral chemistry.
 - Importance of ensuring that HSEC performance and corporate governance is consistent with Rio Tinto standards.



Rio Tinto Diamond Exploration In India- Gravel Sampling

- Indicators are common in Indian gravel samples with ~60% returning positive chromite counts and 12% returning positive pyrope counts
- Background of 5-20 chromites, 1-2 pyropes common, requires prioritization, discrimination.
- 10's – 1000's of chromite and 1's - 10's of pyrope and variable micro-ilmenite are typical of kimberlite associated first pass gravel samples, diamond and chrome diopside are rarely present or preserved, grain size related to proximity



Gravel sampling in India

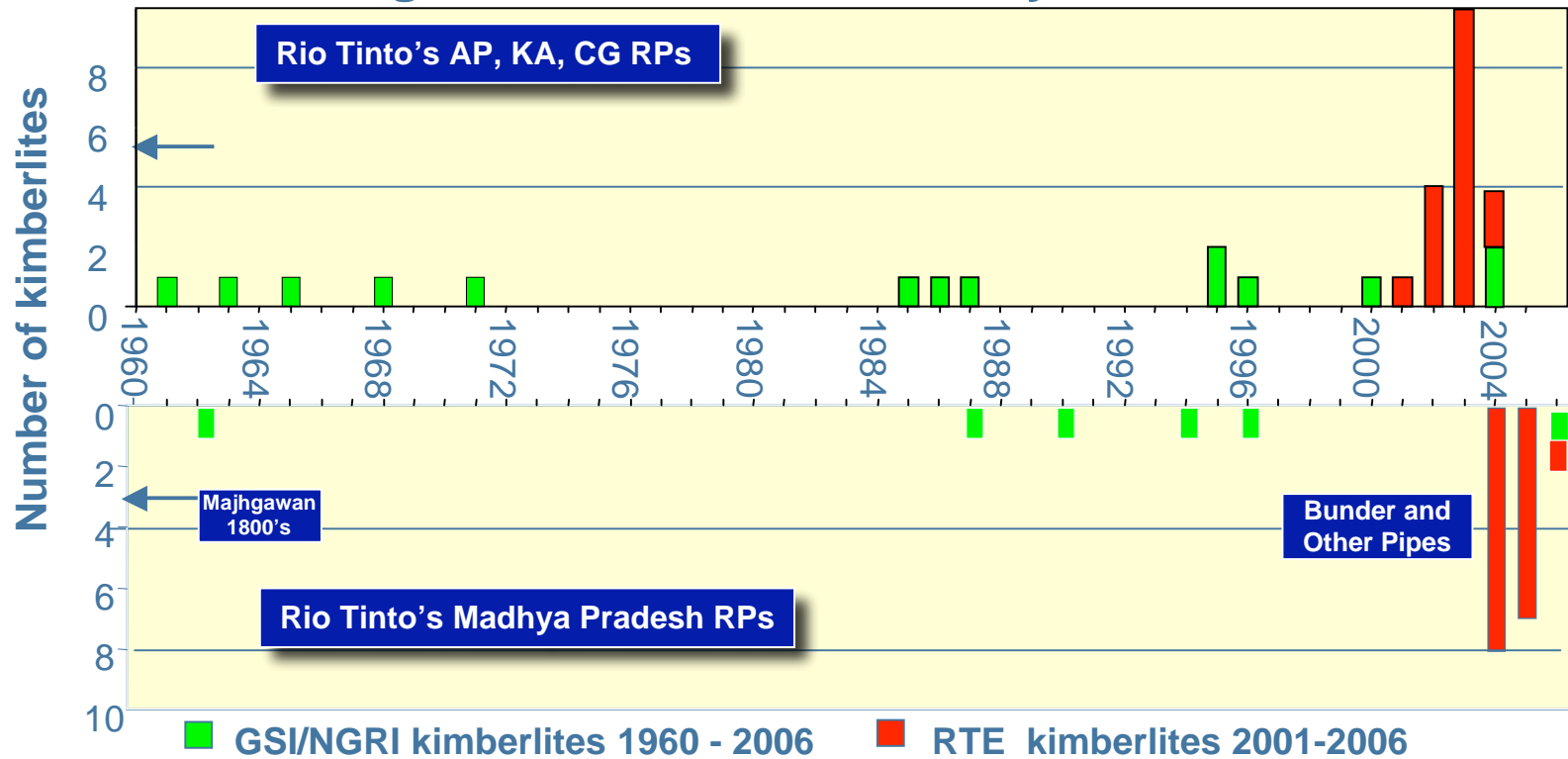
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Rio Tinto Diamond Exploration In India- Bangalore Lab



Accelerating the Kimberlite Discovery Rate in India





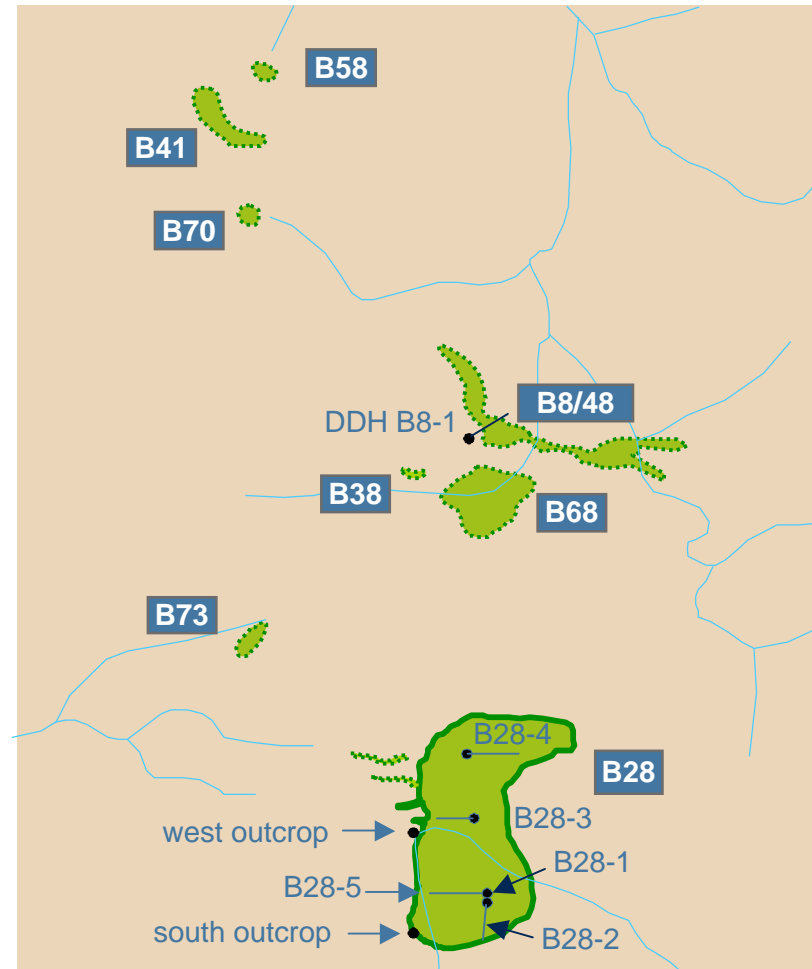
- *Rio Tinto has increased the discovery rate since commencing exploration in India*

Follow-Up Sample Taken 50m from Discovery Outcrop



Bunder Project Lamproites

-  Lamproite
-  Mesoproterozoic sandstone



Bunder Project – Work Completed to Date

- **Reconnaissance gravel sampling to locate traces of kimberlite indicator minerals.** Started. Jan 2003. Bunder Prospect discovered Feb 2004.
- **Soil sampling and ground geophysics to identify kimberlite targets.** Started Jan 2004. Over five thousand samples and several thousand line km ground geophysics completed.
- **Prospecting to locate kimberlite.** Bunder lamproite discovered May 2004. Eight kimberlites found to date at Bunder



Bunder Gravel Sampling



Bunder Discovery Outcrop



Bunder Ground Geophysics

Bunder Project – Work Completed to Date

- **Drilling to delineate and sample lamproites** - six holes (1,300m) drilled at Bunder Prospect Jan-July 2005, no trees cut.
- 2.5 tonnes of drill core and outcrop processed, encouraging diamond counts have been recorded.
- Expenditure exceeded commitments by 300%



Drilling at Bunder



B28-1 Drill Core

Bunder Project – Work Completed to Date Cont'd

- **Bunder PL** granted July 2006, executed Sept 2006, work re-commenced Oct 2006
- Evaluation of Bunder pipes- large diameter drilling and surface bulk sampling in progress
- Detailed **Environmental and Social Studies** ongoing.
- **Good HSEC performance to international standards.** No critical risk HSEC incidents. Extensive training and auditing. Environmental ISO 14001 certification achieved.

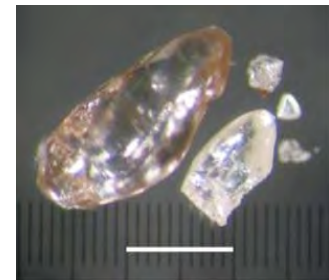
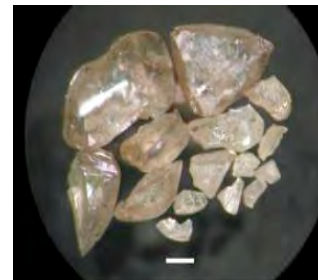
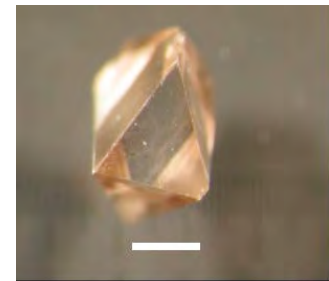
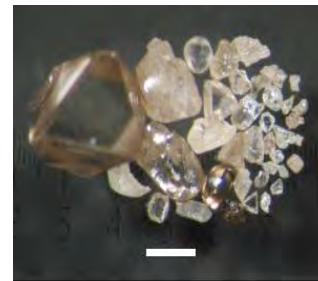


Environmental Baseline Studies



First Aid Accident Scene Management Training

Bunder Project B28 Diamonds



- Largest stone 4.3mm by 2.7mm, 0.177 carats

Summary

- Rio Tinto is a successful, committed and careful exploration company that operates to world class health, safety, environment, community and business integrity standards.
- Rio Tinto has had a presence in India since 1985, and has been exploring for diamonds in India since 2000. Since that time, Rio Tinto has accelerated the kimberlite discovery rate, explored over 40,000 km² and in the process discovered over 30 kimberlites, several diamondiferous.
- Indicator mineral sampling, largely from gravel samples has been a critical component of the exploration strategy in India. Since 2000, over 6,000 gravel samples have been collected and analyzed
- Rio Tinto discovered eight Argyle age diamondiferous lamproites at Bunder in 2004. This discovery was made through the effective use of indicator mineral sampling as a first pass and early follow-up tool, followed by detailed ground geophysics and soil sampling. Pipes are currently being evaluated.
- RT considers diamond prospectivity in India as very high. India has been a challenging place to operate, however seven years of persistence is starting to deliver rewards.