

Recent trends in gold discovery - are we finding enough?

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Overview

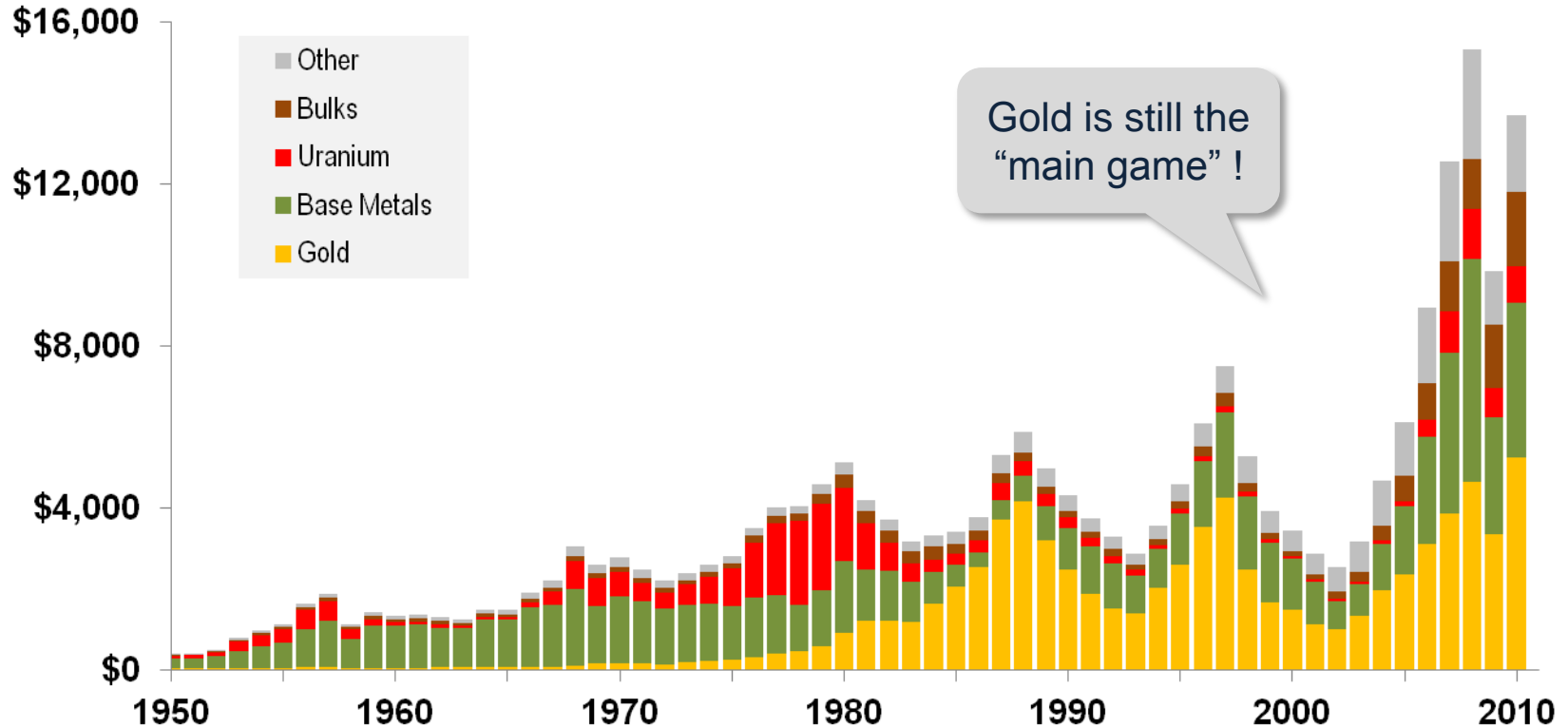
- Trends in exploration expenditures
- Trends in Discovery – *How much metal found, average deposit size and grade, depth of cover, project quality.*
- Current “Hot Spots” for exploration – *Where are they?*
- Trends in discovery costs – *Trend in \$/oz over time. Unit discovery costs for greenfield & brownfield exploration. Which regions are best for finding multi-million ounce deposits*
- How resources grow over time - *data on the “blue sky” potential of a new discovery. Impact of changes in cut-off grade on resources*
- Trends in conversion rates (from Discovery > Development) - *Not all discoveries get mined, and those that do may take many years*
- Time lag between discovery and development
- Are we finding enough gold? - *Strategic implications for the industry and long term price of gold*
- Conclusions

Spending on gold exploration over the last 60 years

TRENDS IN EXPLORATION EXPENDITURES

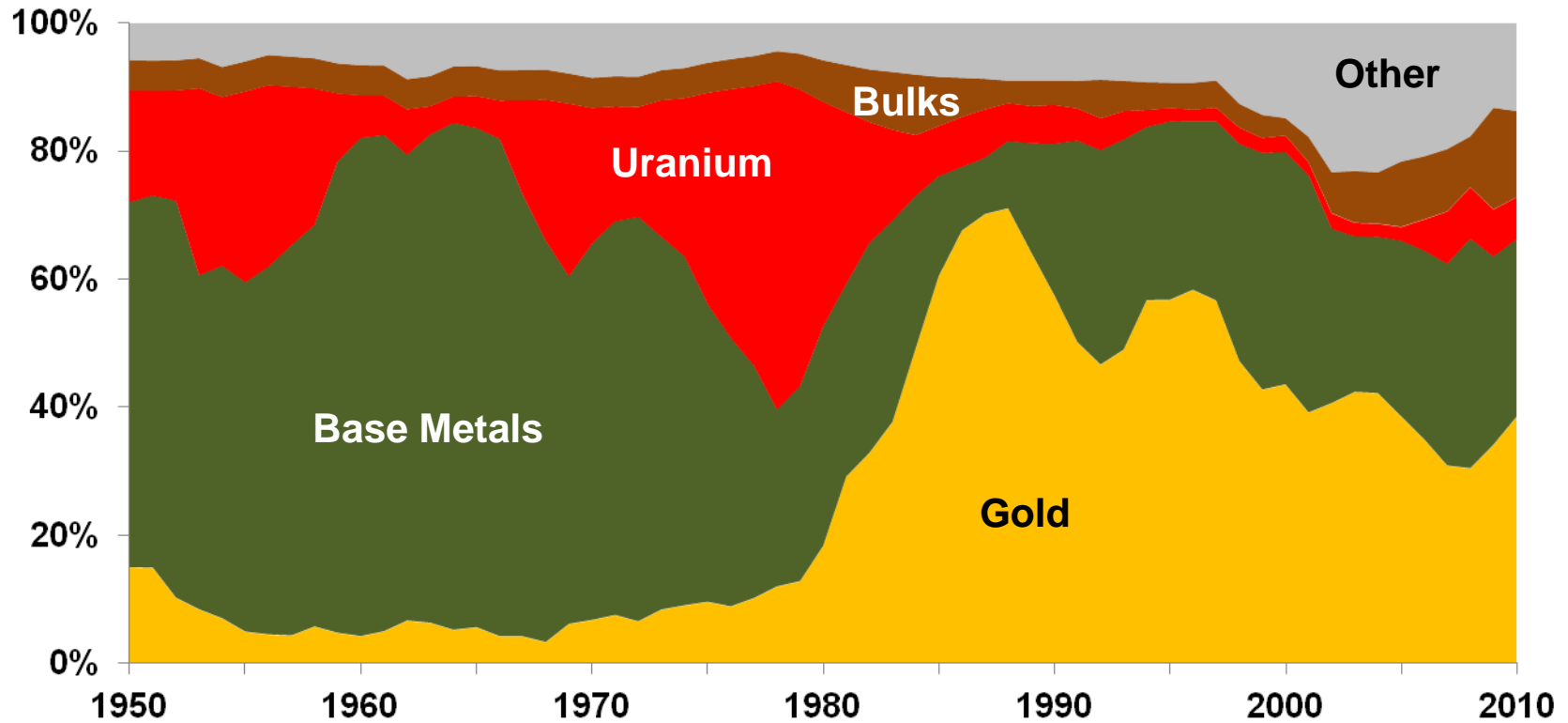
Exploration Expenditures: Western World

June 2011 US\$m



Sources: MinEx Consulting estimates, based on data from ABS, NRCan, Tilton (1988), Wallace (1992,93) and Metal Economics Group © 2010

Exploration Expenditures: Western World

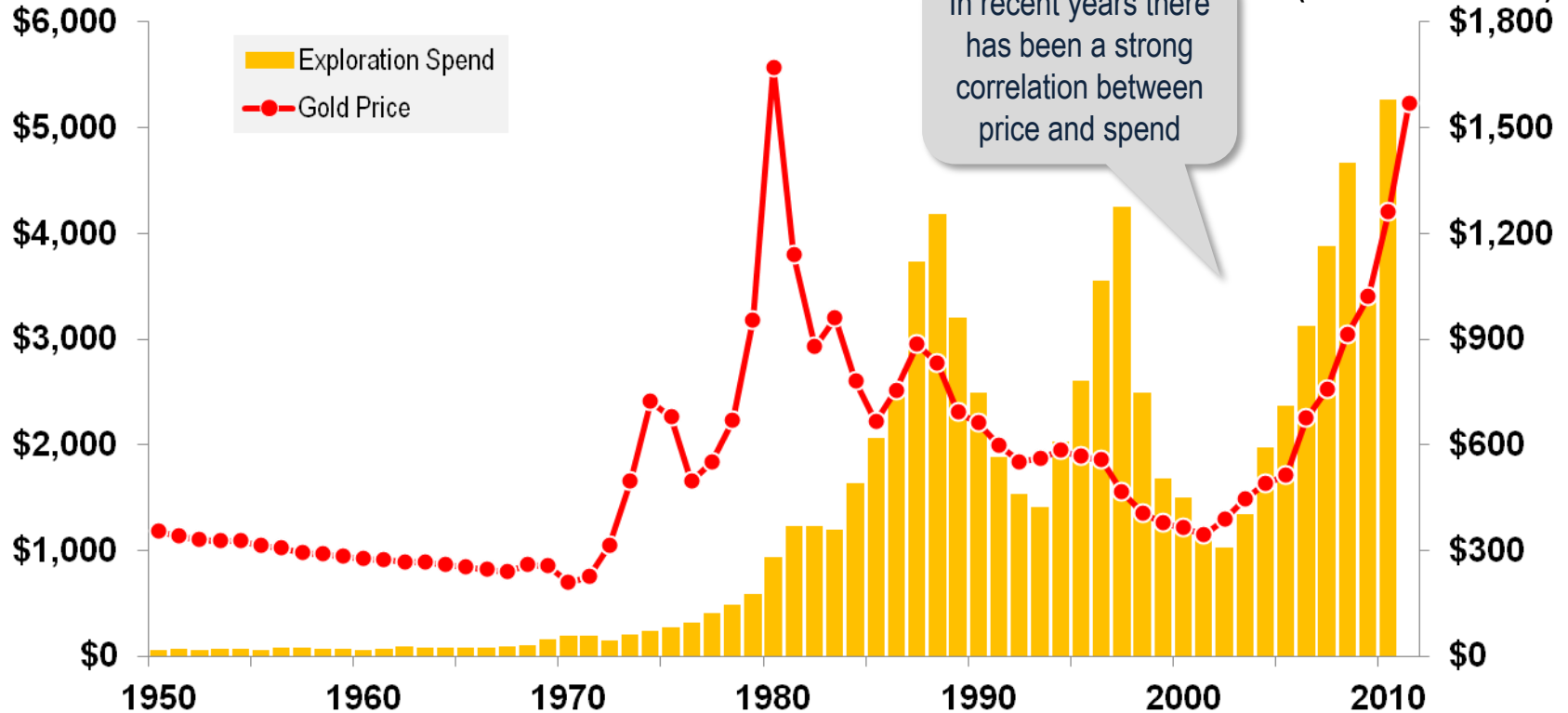


Sources: MinEx Consulting estimates, based on data from ABS, NRCan, Tilton (1988), Wallace (1992,93) and Metal Economics Group © 2010

Exploration expenditures are driven by commodity prices

Gold price versus exploration on gold in the Western World : 1950-2010

Exploration Expenditures
(June 2011 US\$m)

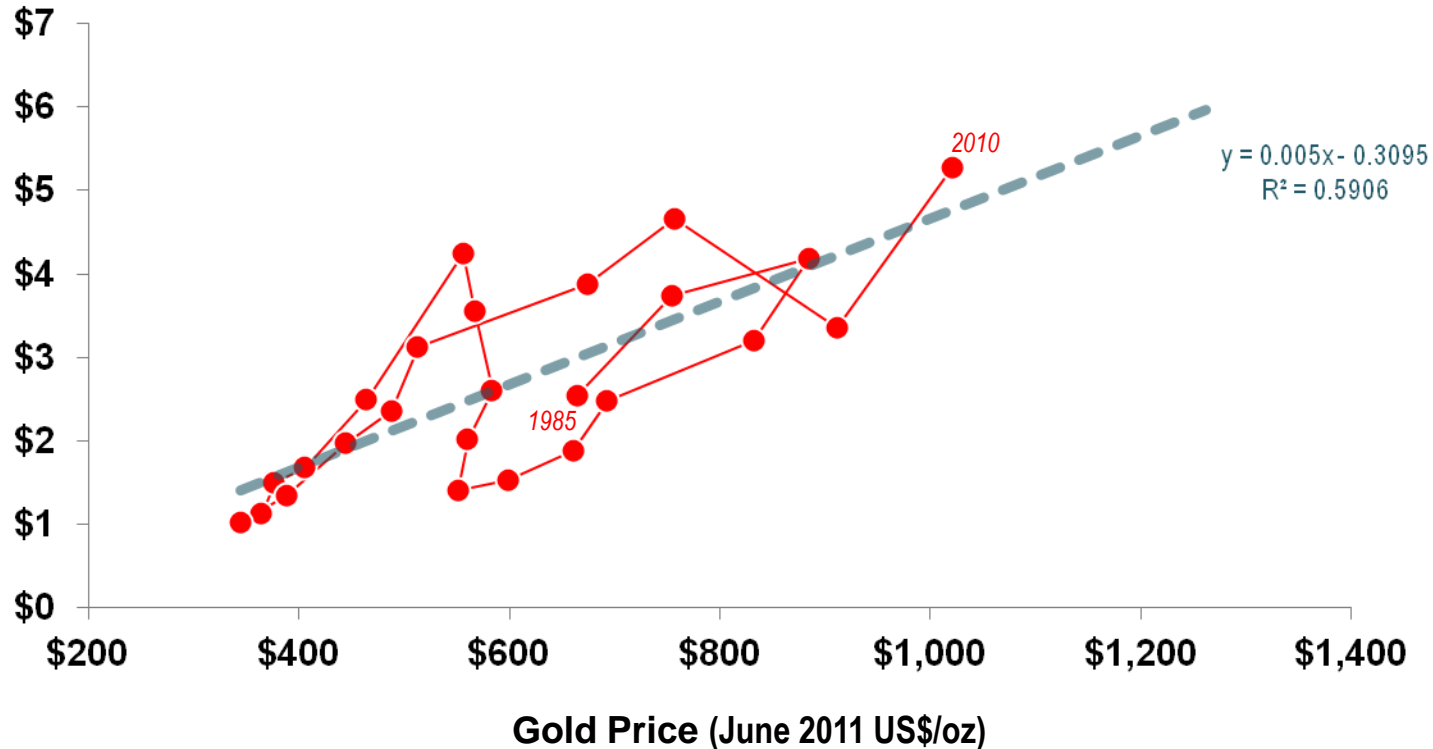


Sources: MinEx Consulting estimates. Post 1992 expenditure data from Metal Economics Group © 2010

Exploration expenditures versus gold price

Western World: 1985-2010 with one year lag for spend

Exploration Expenditures in following year
(June 2011 US\$m)



Sources: MinEx Consulting estimates. Post 1992 expenditure data from Metal Economics Group © 2010

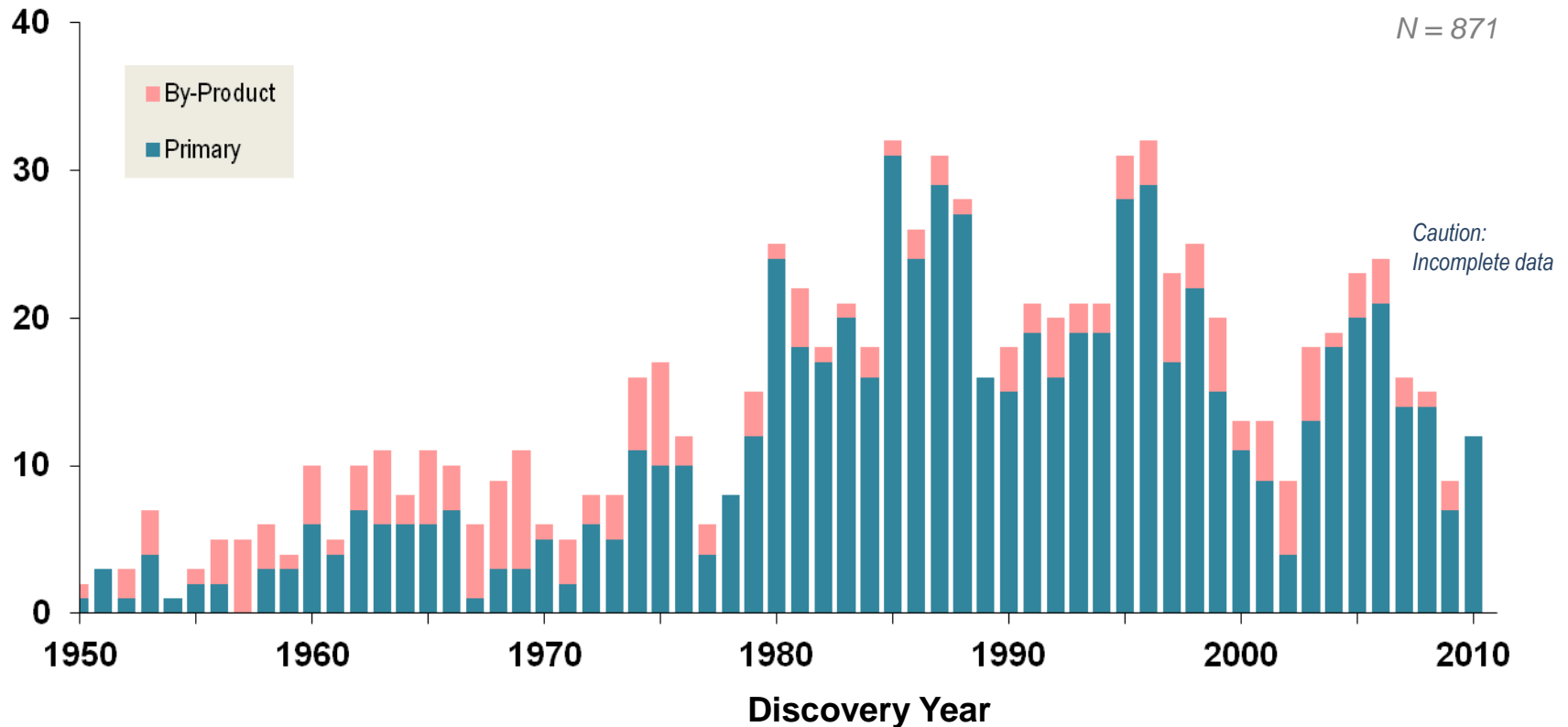
Is there a change in the types of gold deposits being found?

TRENDS IN THE NUMBER, SIZE AND TYPE OF GOLD DISCOVERIES

Total number of gold discoveries

Gold deposits >1 Moz found in World: 1950-2010

Number of Discoveries

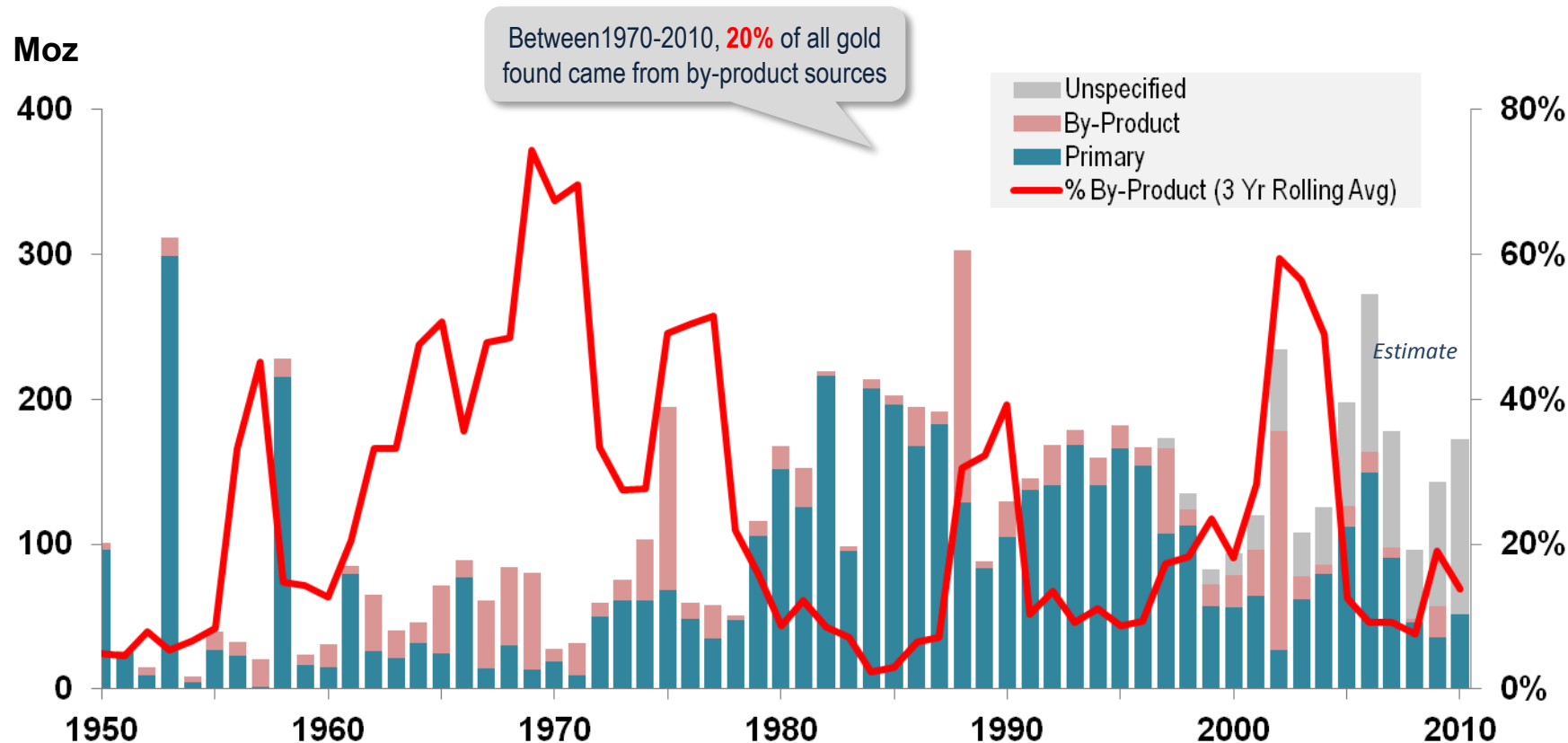


Caution: Chart excludes adjustment or missing deposits or resource growth over time

Source: MinEx Consulting © November 2011

Total amount of gold found by type

Total World Gold : Primary & By-Product: 1950-2010

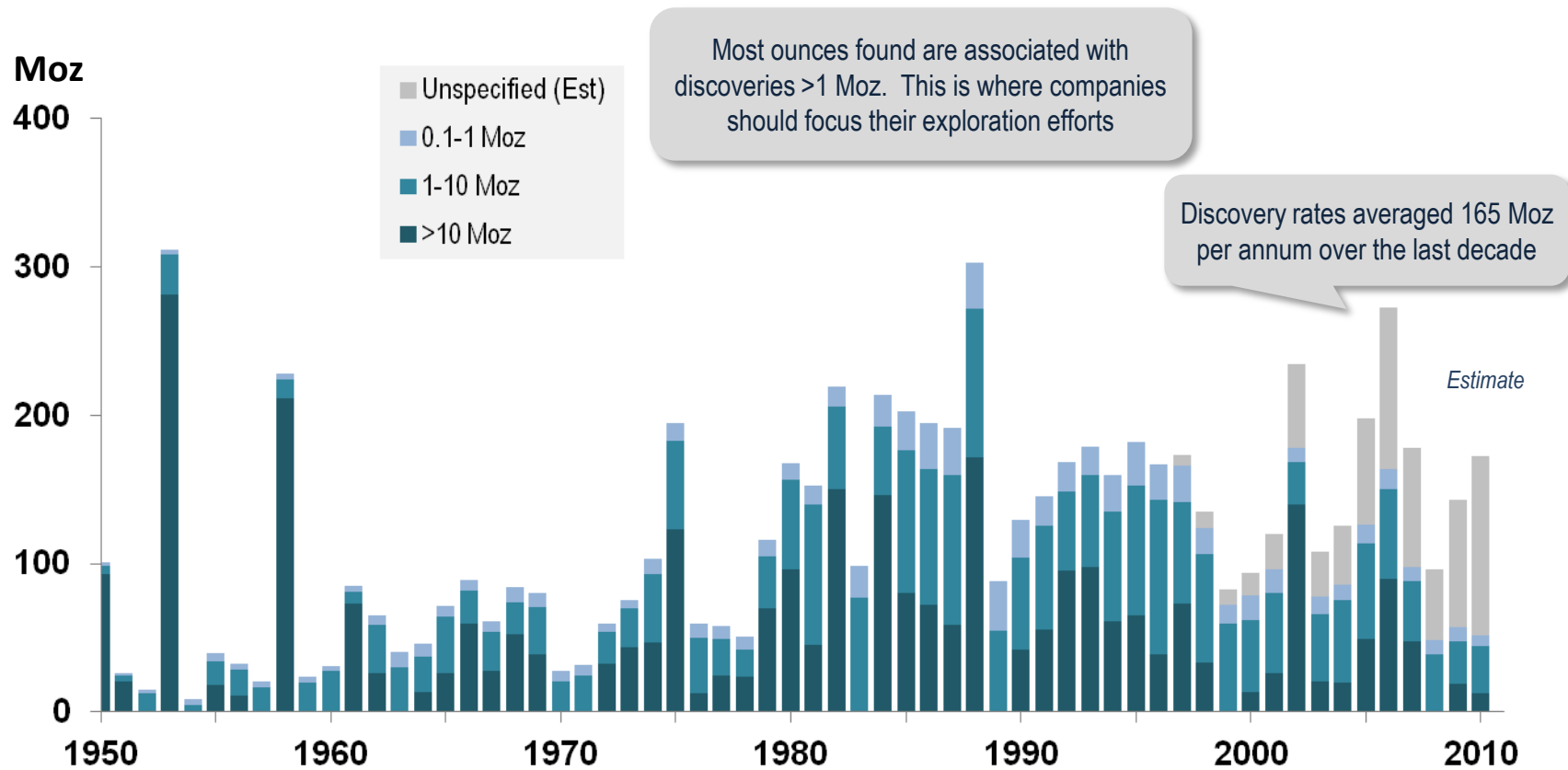


Note: Annual figures have been increased by 15% to reflect deposits not in the database (as inferred from the cumulative frequency curve) or those deposits with no reported discovery date

Source: MinEx Consulting © November 2011

Total amount of gold found by size

Total World including by-product gold: 1950-2010

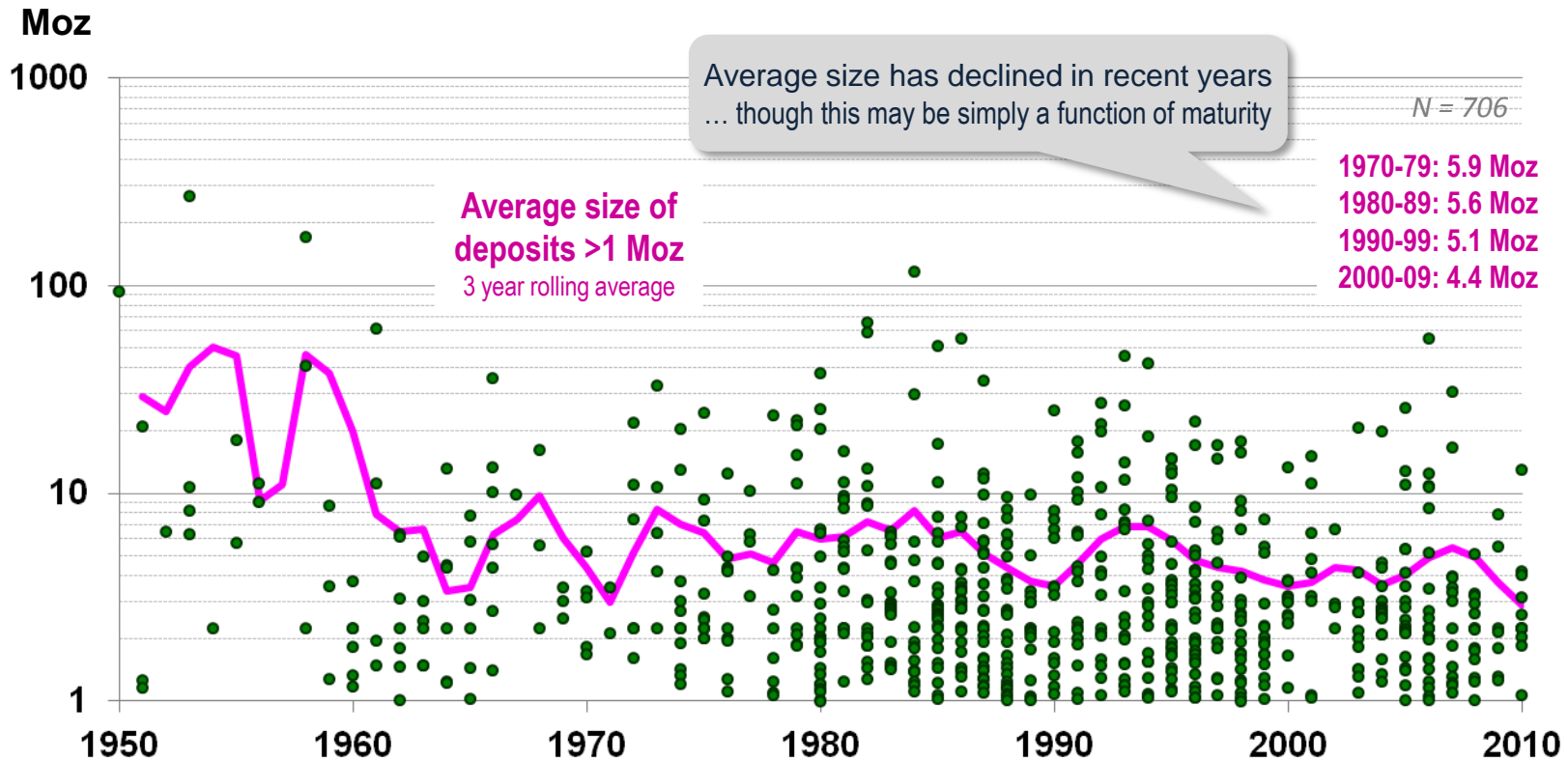


Note: Annual figures have been increased by 15% to reflect deposits not in the database (as inferred from the cumulative frequency curve) or those deposits with no reported discovery date

Source: MinEx Consulting November 2011

Trend in the average size of gold deposit discovered

All primary gold discoveries >1 Moz in the World: 1950-2010

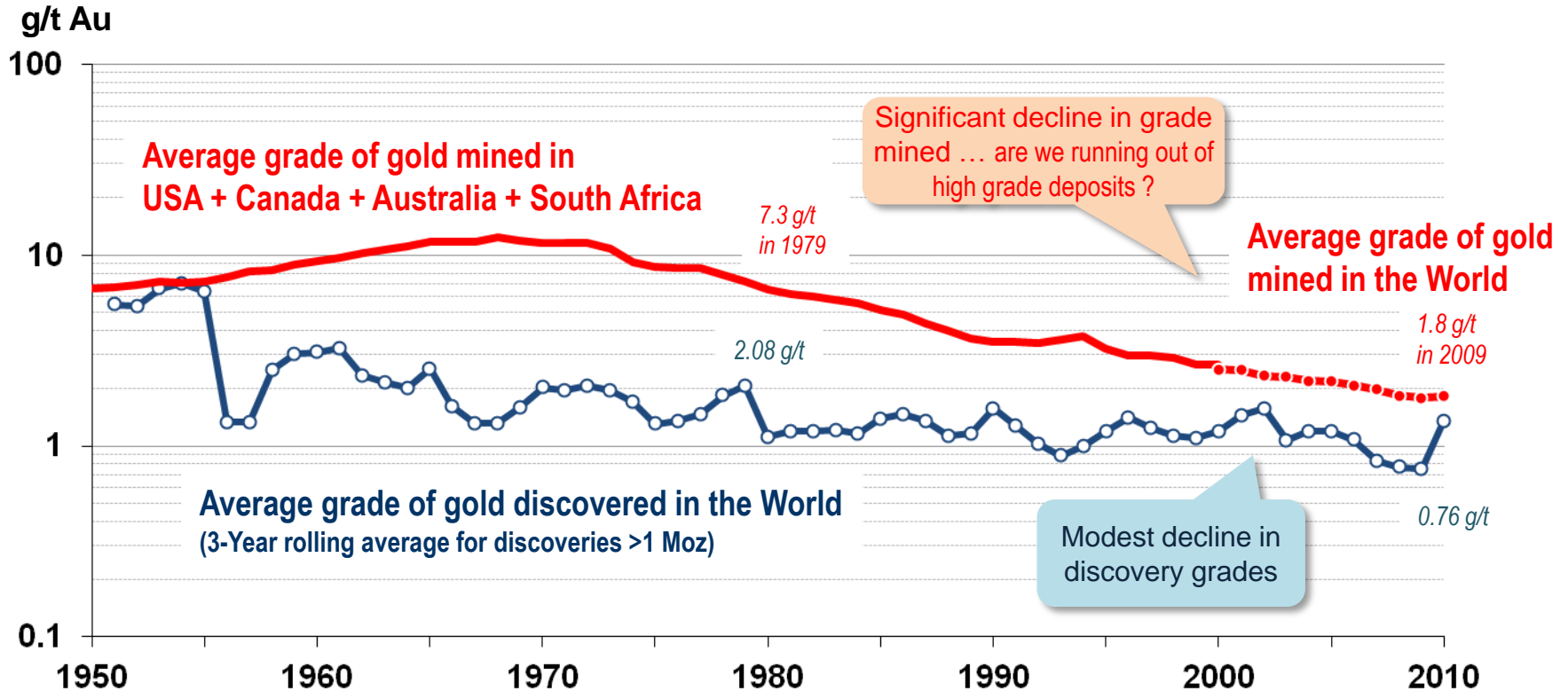


Note: Excludes deposits where gold is a by-product.
No adjustment made for growth in recent discoveries

Source: MinEx Consulting November 2011

Trend in average ore grades

Average ore grade for all primary gold discoveries >1 Moz in the World versus average head grade of ore mined



Note: Excludes deposits where gold is a by-product

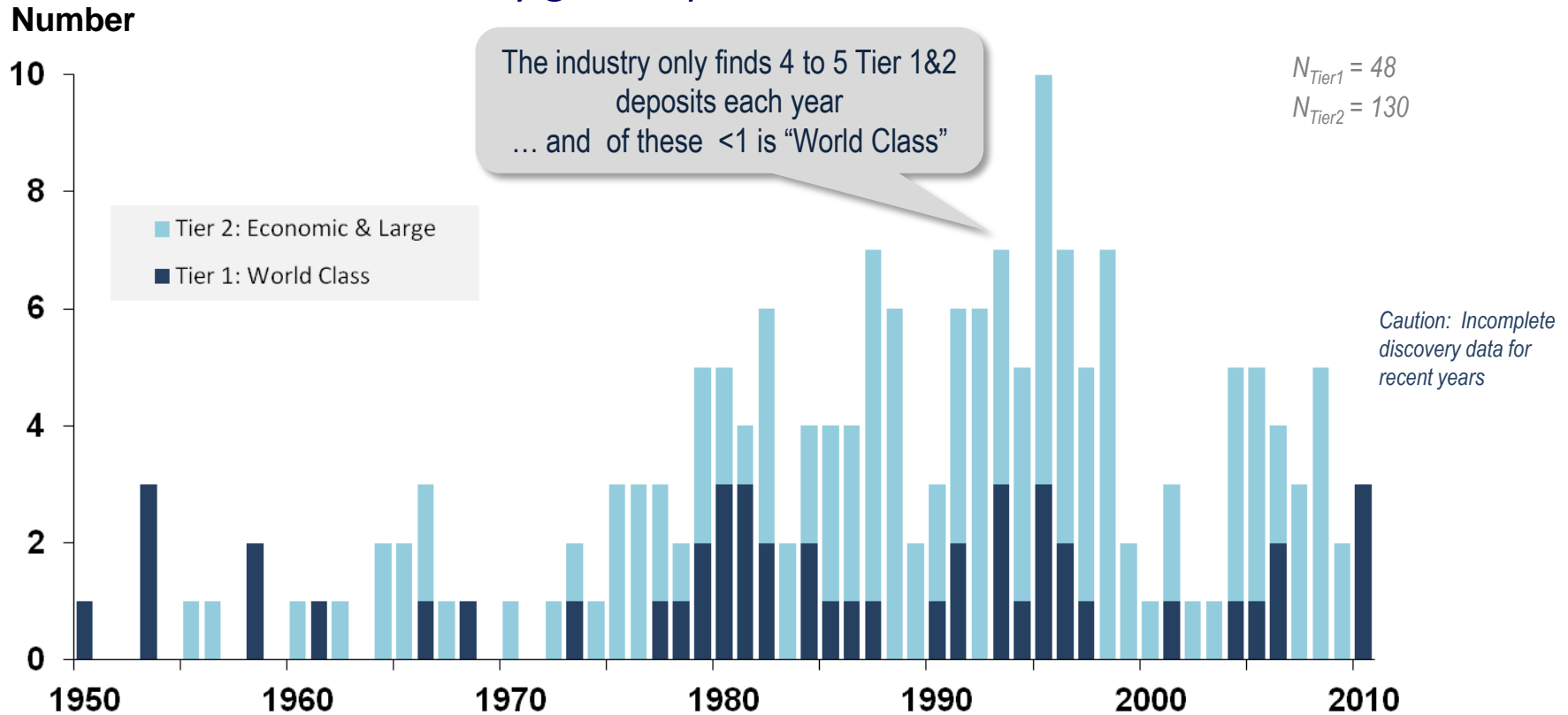
Sources: MinEx Consulting November 2011
Mudd (2010), Fellows (2010)

Focus is on finding World Class Deposits

TRENDS IN THE QUALITY OF GOLD DISCOVERIES

Only a handful of the discoveries made each year are “Company-Makers”

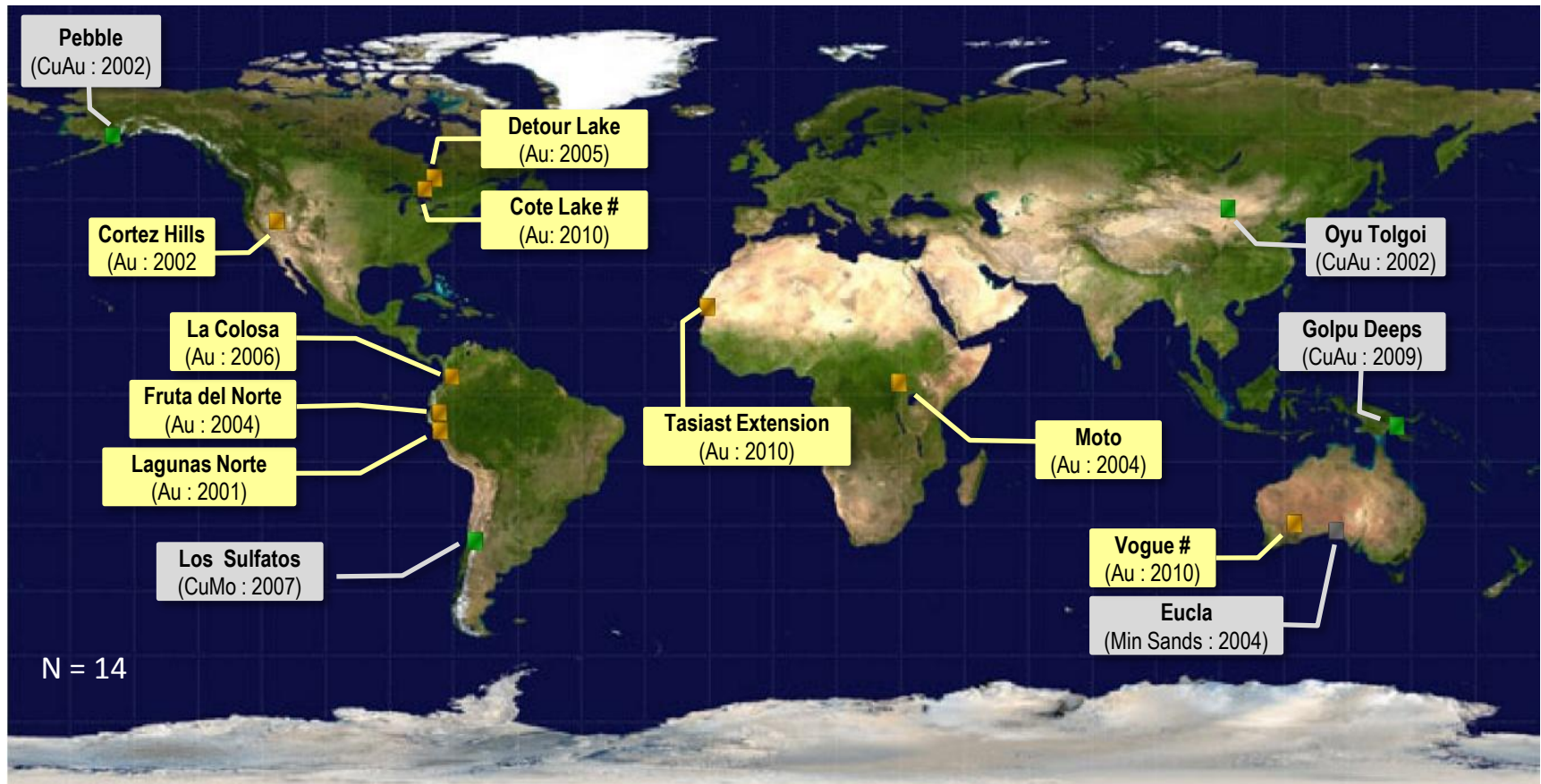
All Tier 1 & 2 Primary gold deposits found in the World: 1950-2010



Note: Primary gold deposits only

Source: MinEx Consulting © November 2011

Tier 1 deposits discovered since 2000 : All Metals



#: Provisional estimate. Assumes resource will grow over time

Note: Excludes Bulk Mineral deposits

Source: MinEx Consulting © November 2011

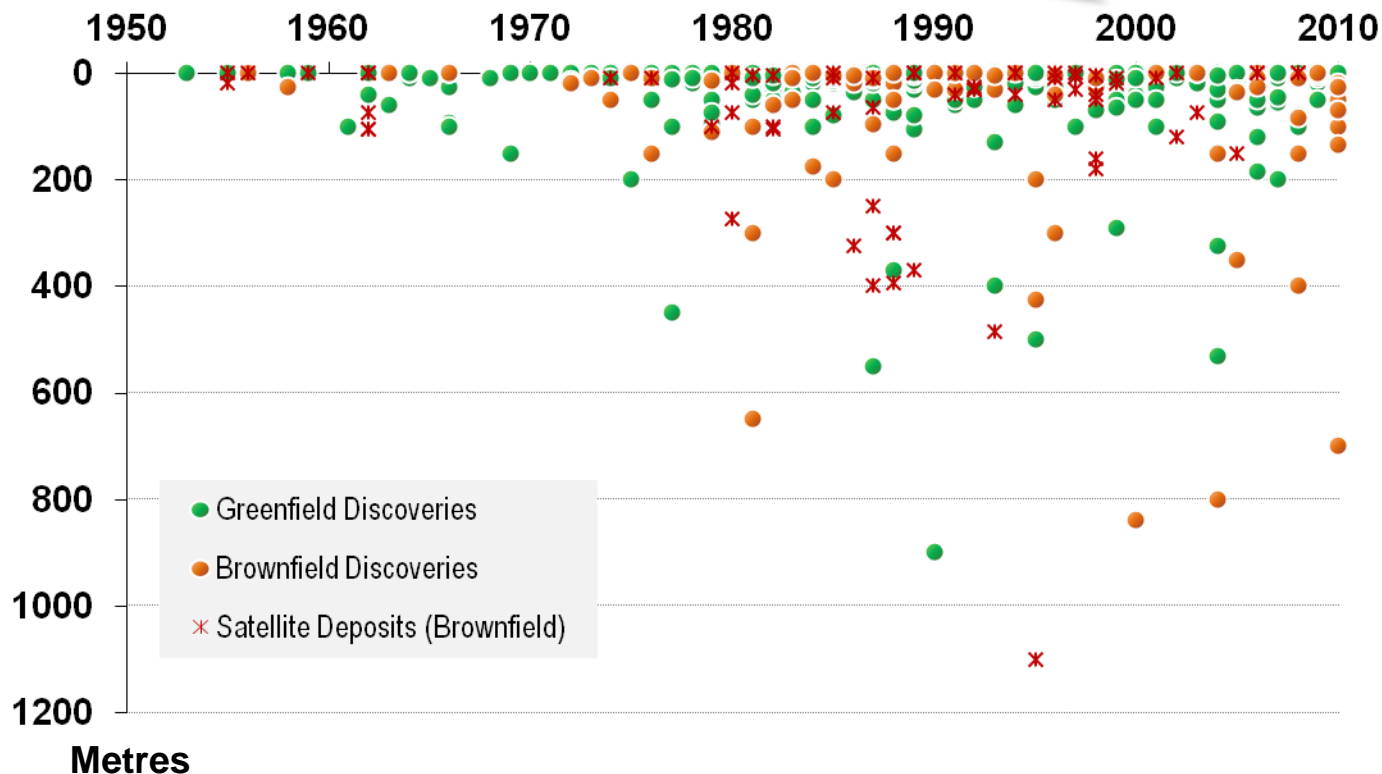
The industry continues to focus on outcropping deposits

TRENDS IN THE DEPTH OF COVER FOR GOLD DISCOVERIES

Depth of Cover on gold discoveries

Primary gold deposits >1 Moz found in World#: 1950-2010

We still continue to explore at shallow depths
– the concern is that are we depleting this search-space?



Note: Analysis excludes South Africa

Source: MinEx Consulting © November 2011

Average depth of cover

Primary gold deposits found in World[#]

Nearly half of all greenfield discoveries are at surface
... many of these are in new regions

	1950-59	1960-69	1970-79	1980-89	1990-99	2000-10
Greenfield Discoveries						
- % Outcropping	100%	47%	48%	42%	45%	45%
- Average Depth (metres)	0	31	38	21	29	29
Brownfield Discoveries						
- % Outcropping	-	-	10%	21%	35%	26%
- Average Depth (metres)	-	-	47	70	135	171

Note: Analysis excludes South Africa

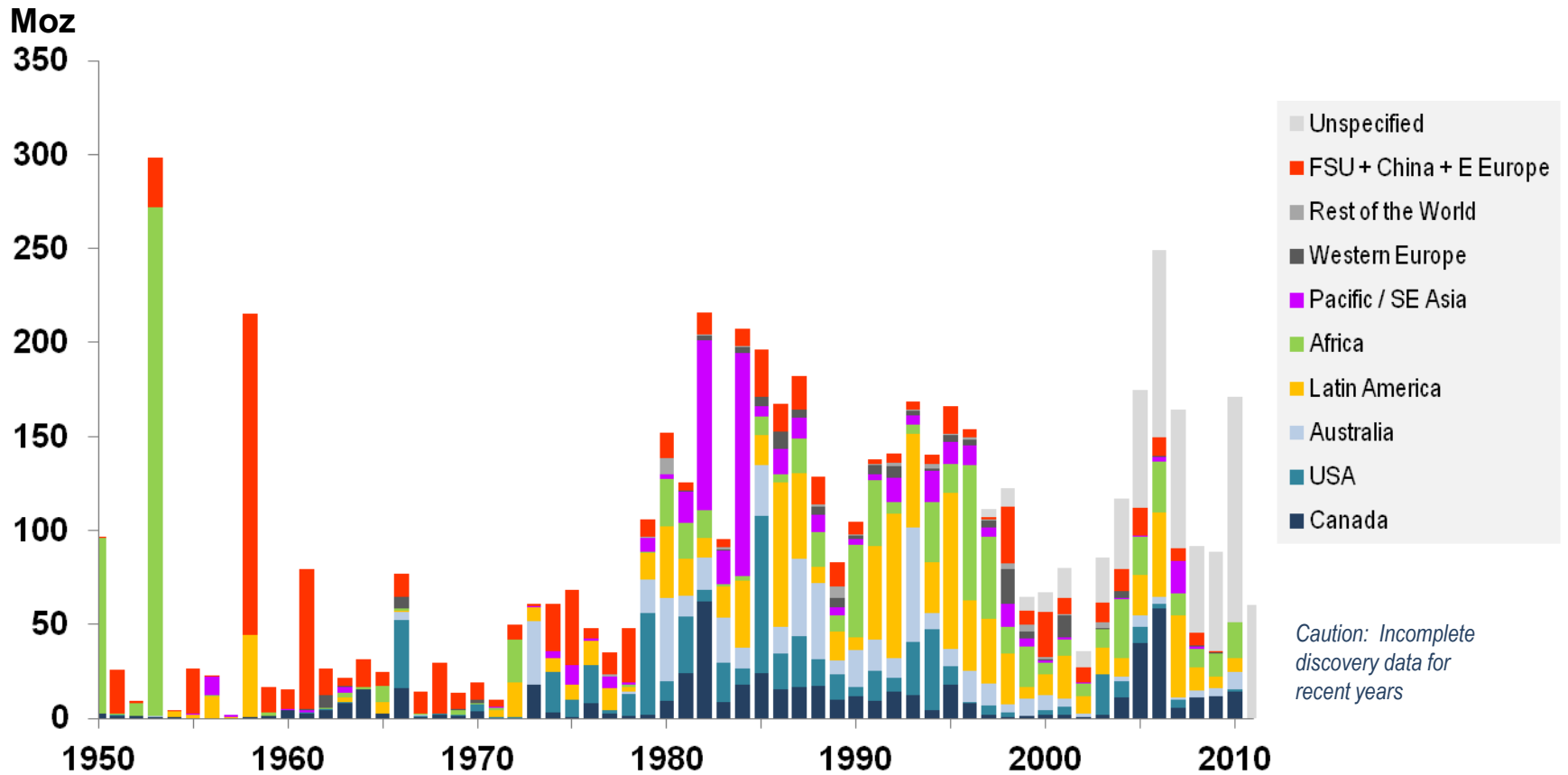
Source: MinEx Consulting © November 2011

Current “Hot Spots” for gold exploration

TRENDS IN THE LOCATION OF GOLD DISCOVERIES

Ounces discovered by Region

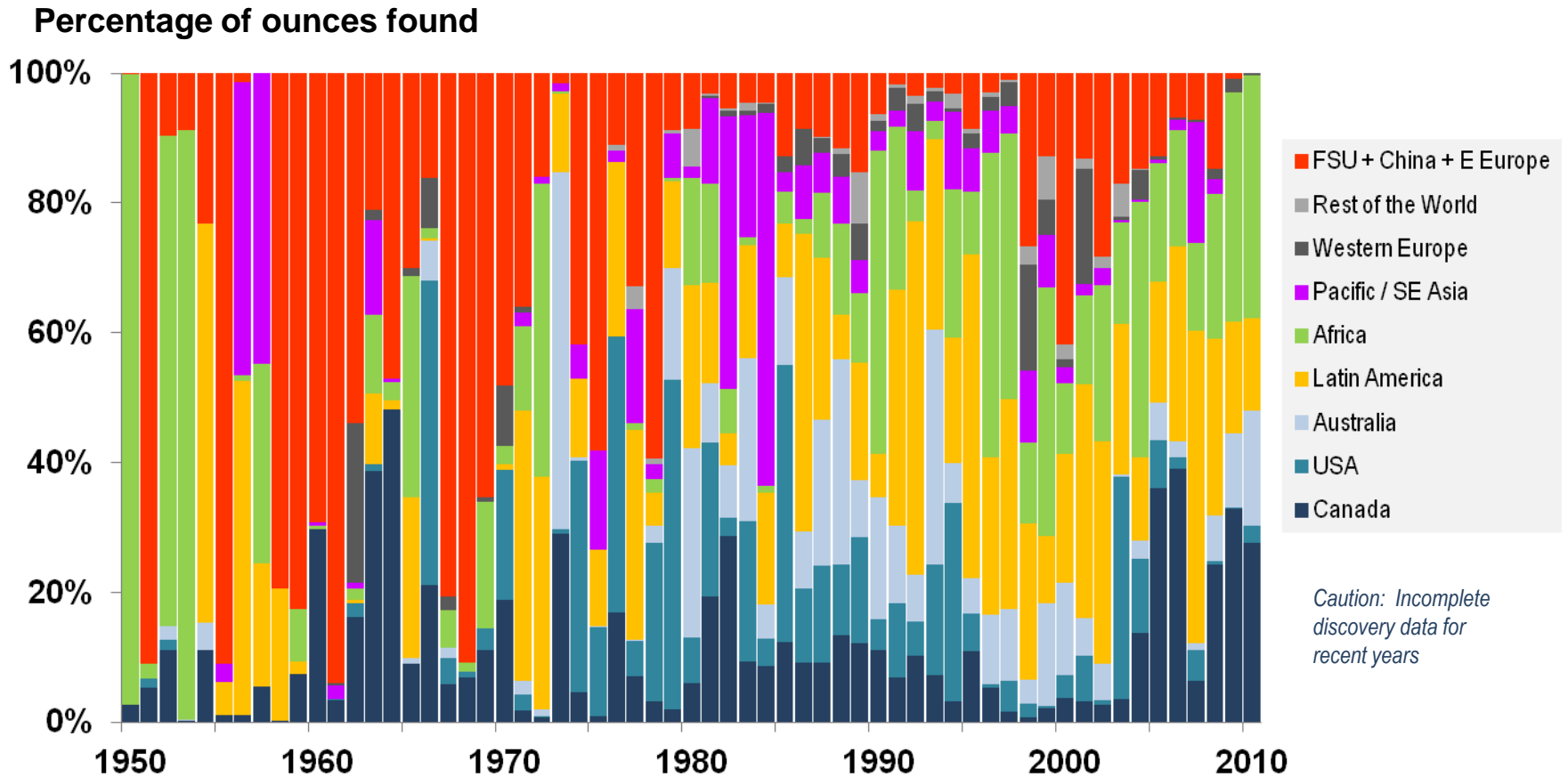
Primary Gold deposits found : 1950-2010



Source: MinEx Consulting © November 2011

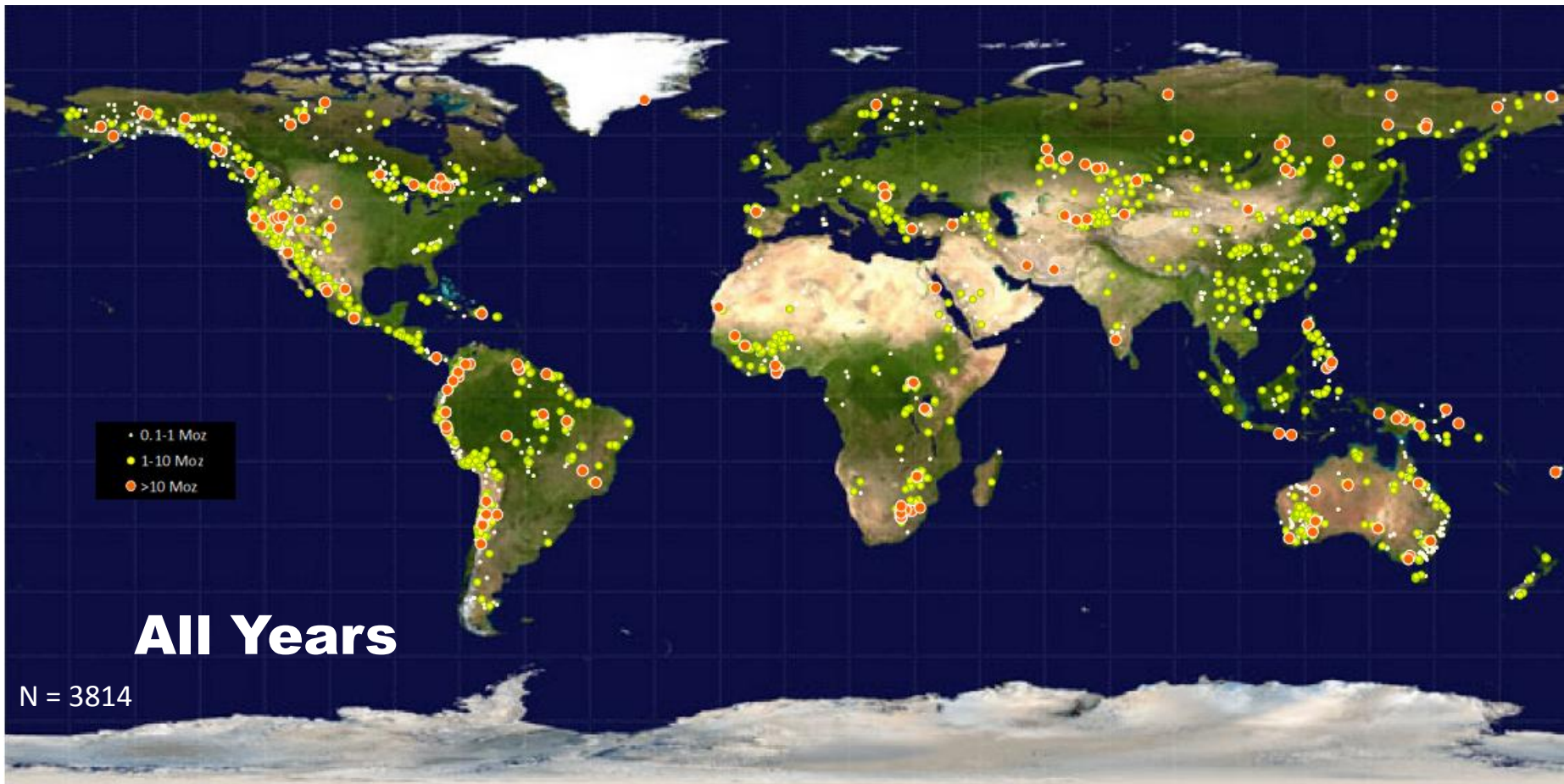
Ounces discovered by Region

Primary Gold deposits found: 1950-2010



Source: MinEx Consulting © November 2011

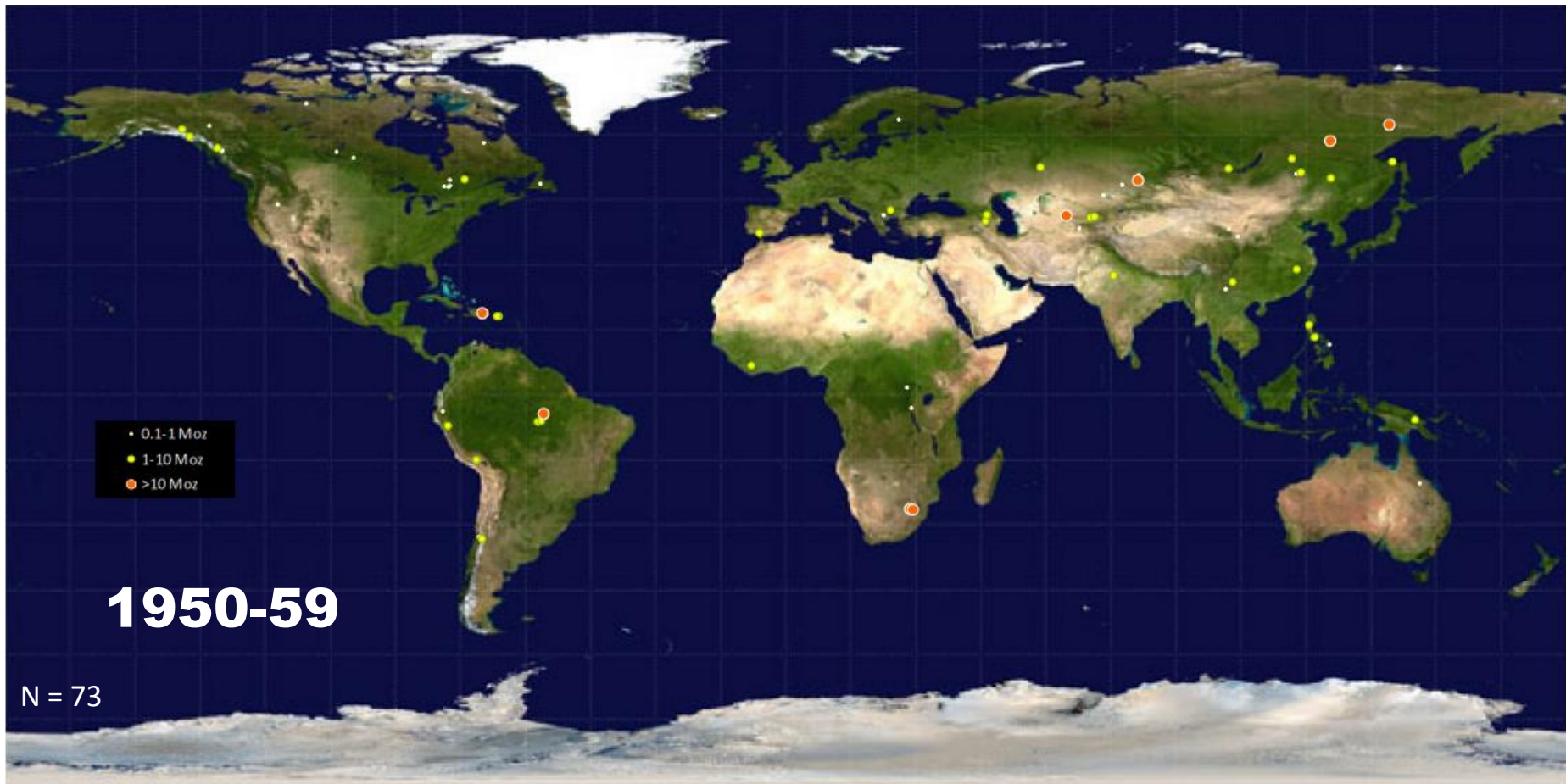
Gold Discoveries in the World : All Years



Note: All deposits > 01 Moz Au including by-product gold

Source: MinEx Consulting © November 2011

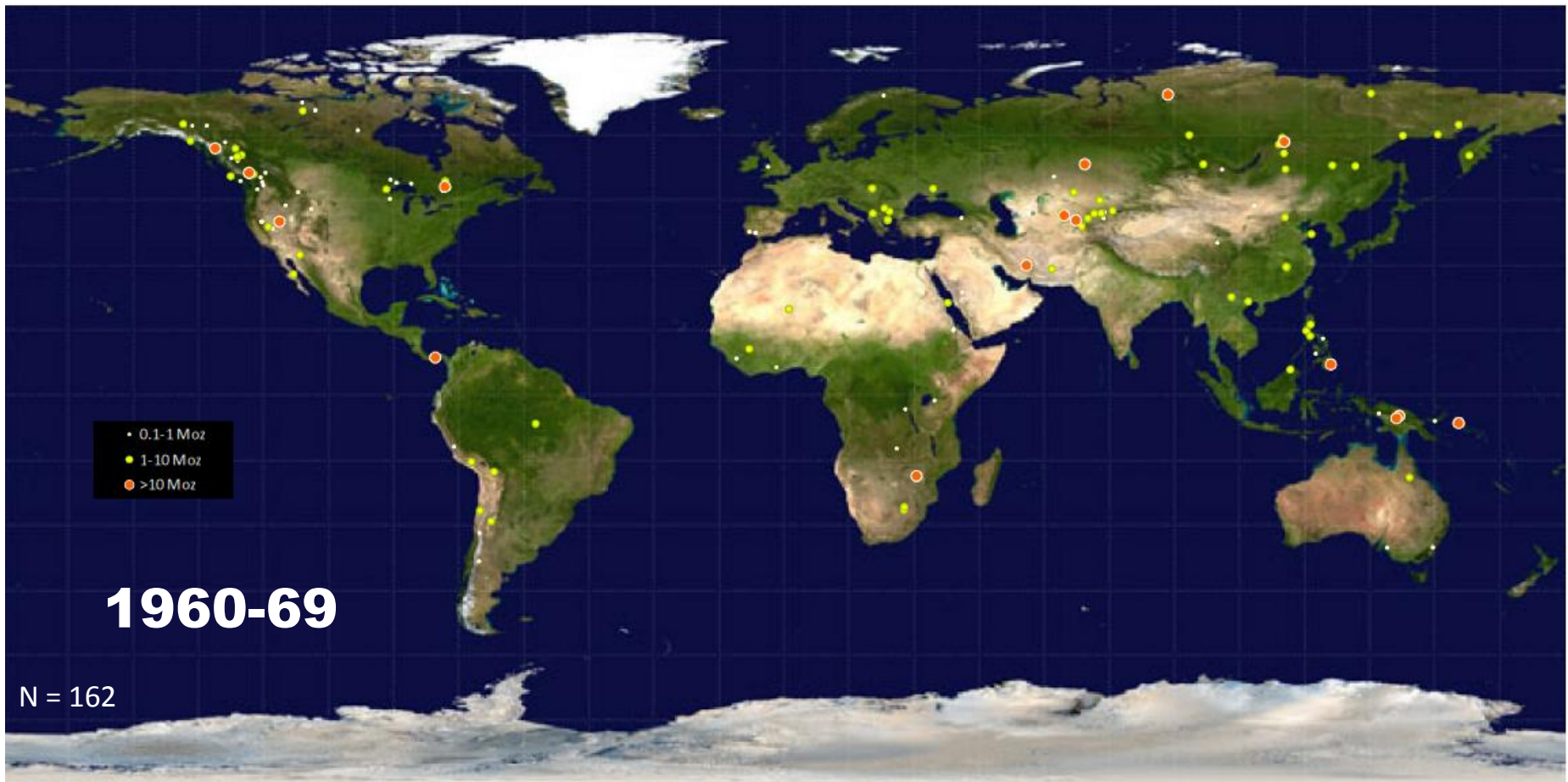
Gold deposits discovered in the 1950s



Note: All deposits > 01 Moz Au including by-product gold

Source: MinEx Consulting © November 2011

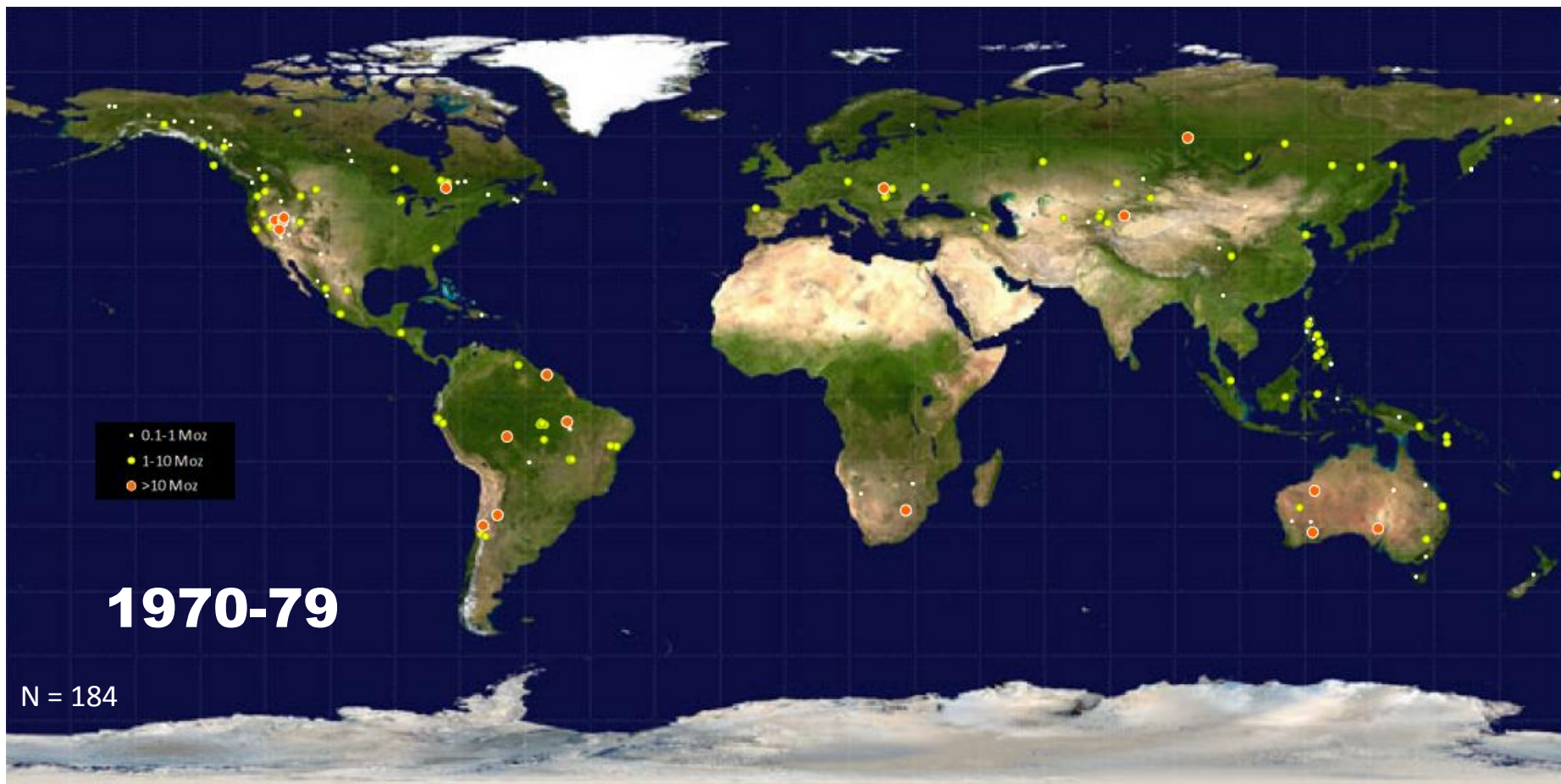
Gold deposits discovered in the 1960s



Note: All deposits > 01 Moz Au including by-product gold

Source: MinEx Consulting © November 2011

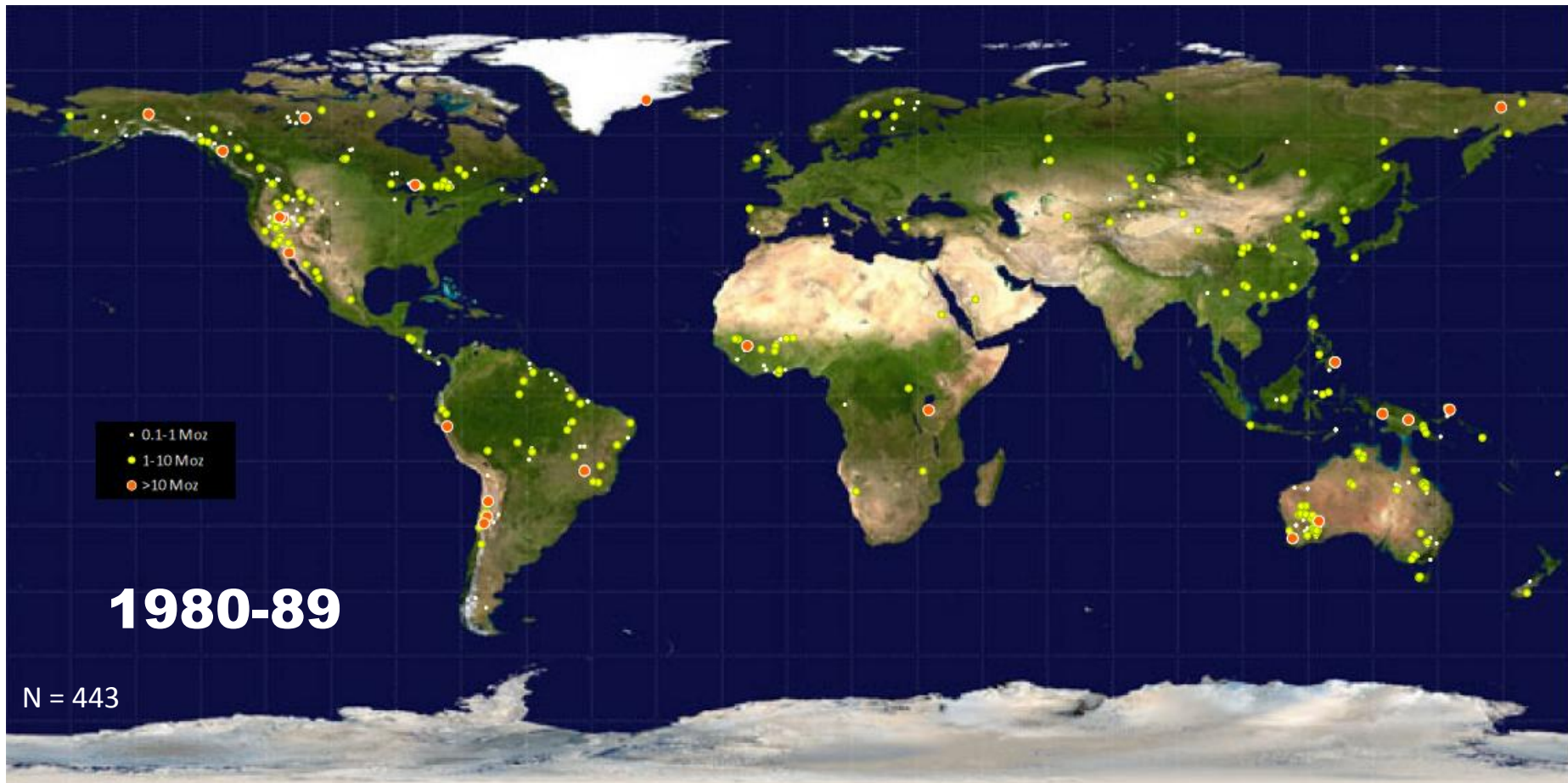
Gold deposits discovered in the 1970s



Note: All deposits > 01 Moz Au including by-product gold

Source: MinEx Consulting © November 2011

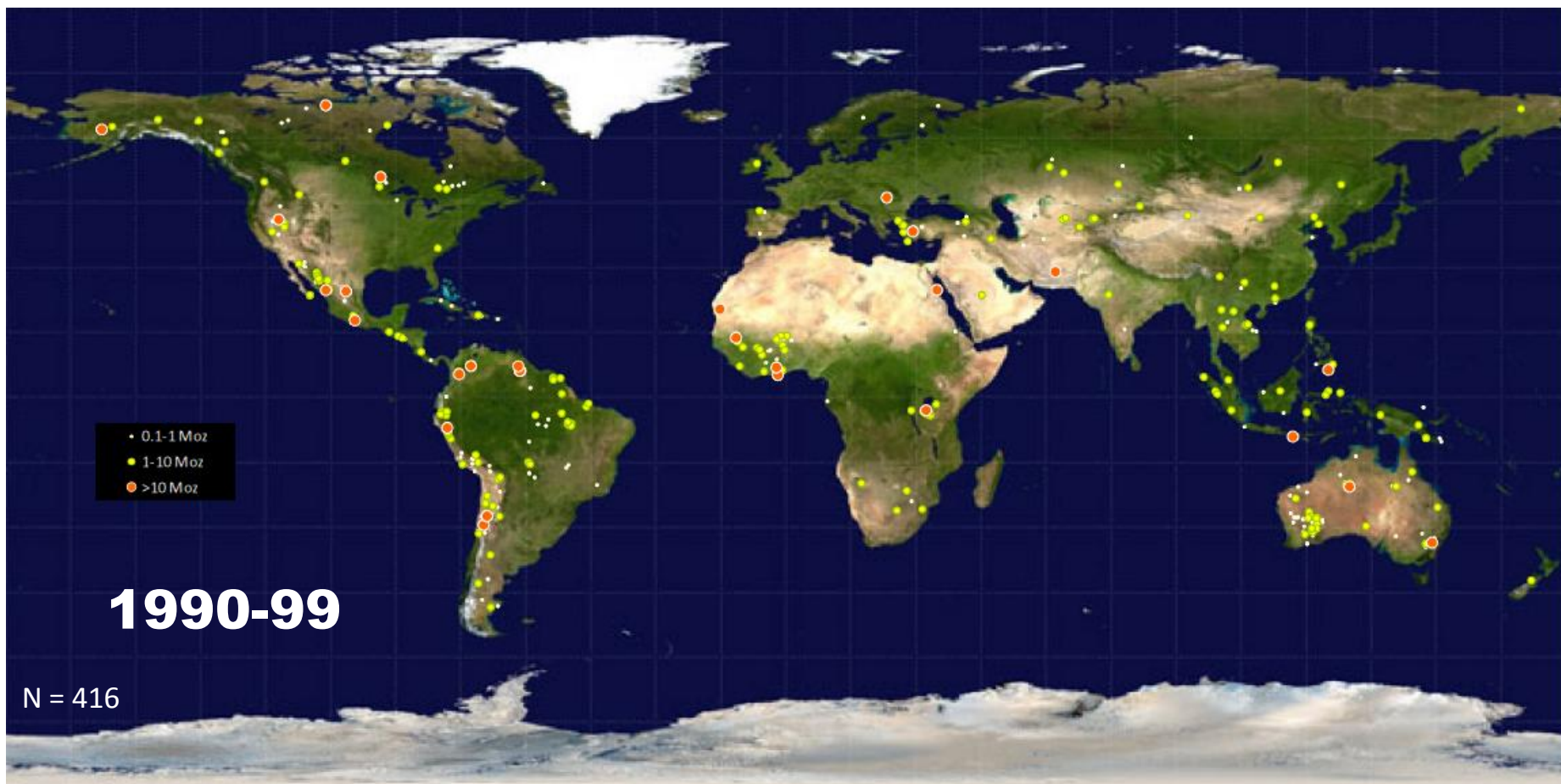
Gold deposits discovered in the 1980s



Note: All deposits > 01 Moz Au including by-product gold

Source: MinEx Consulting © November 2011

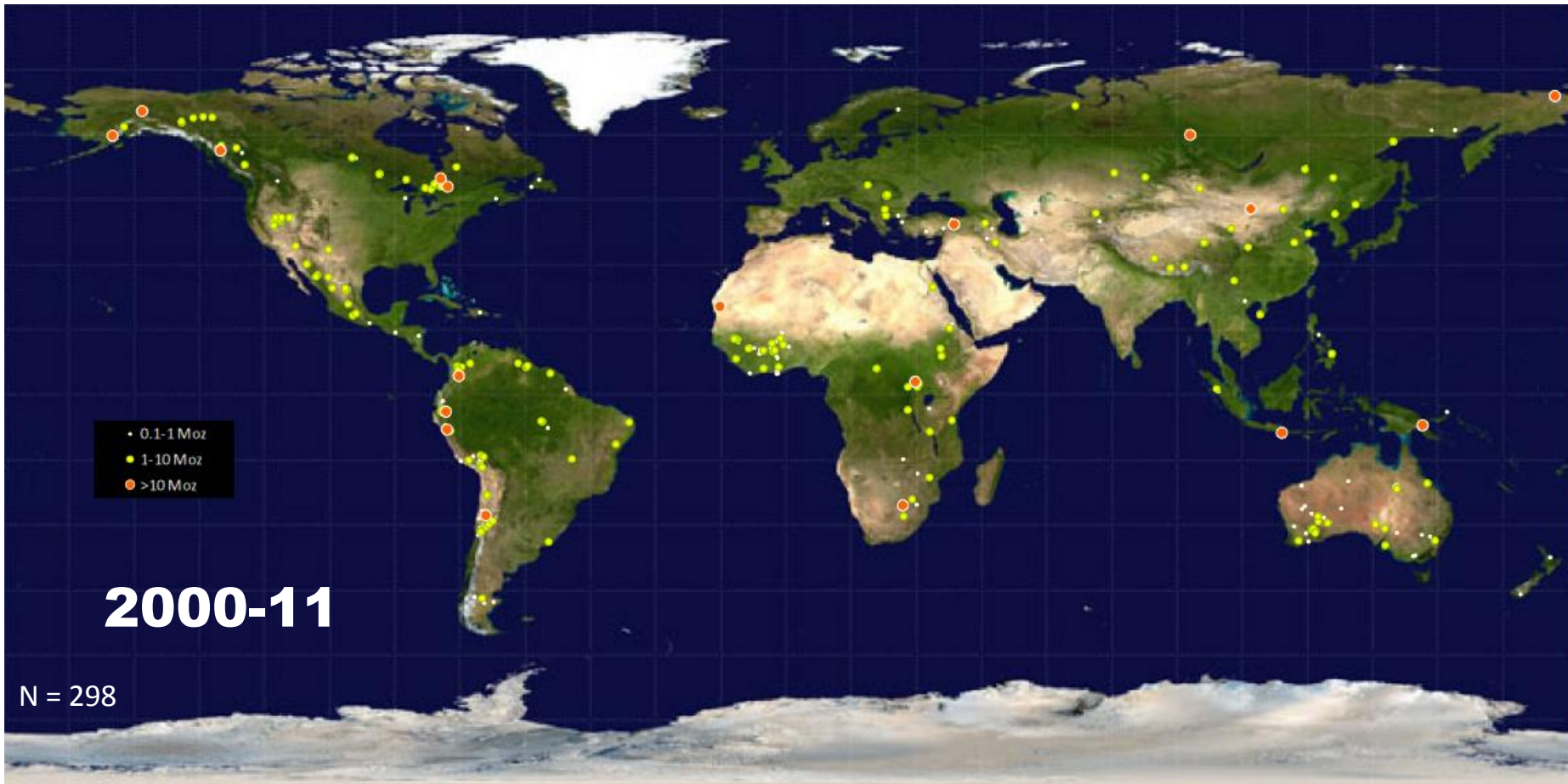
Gold deposits discovered in the 1990s



Note: All deposits > 01 Moz Au including by-product gold

Source: MinEx Consulting © November 2011

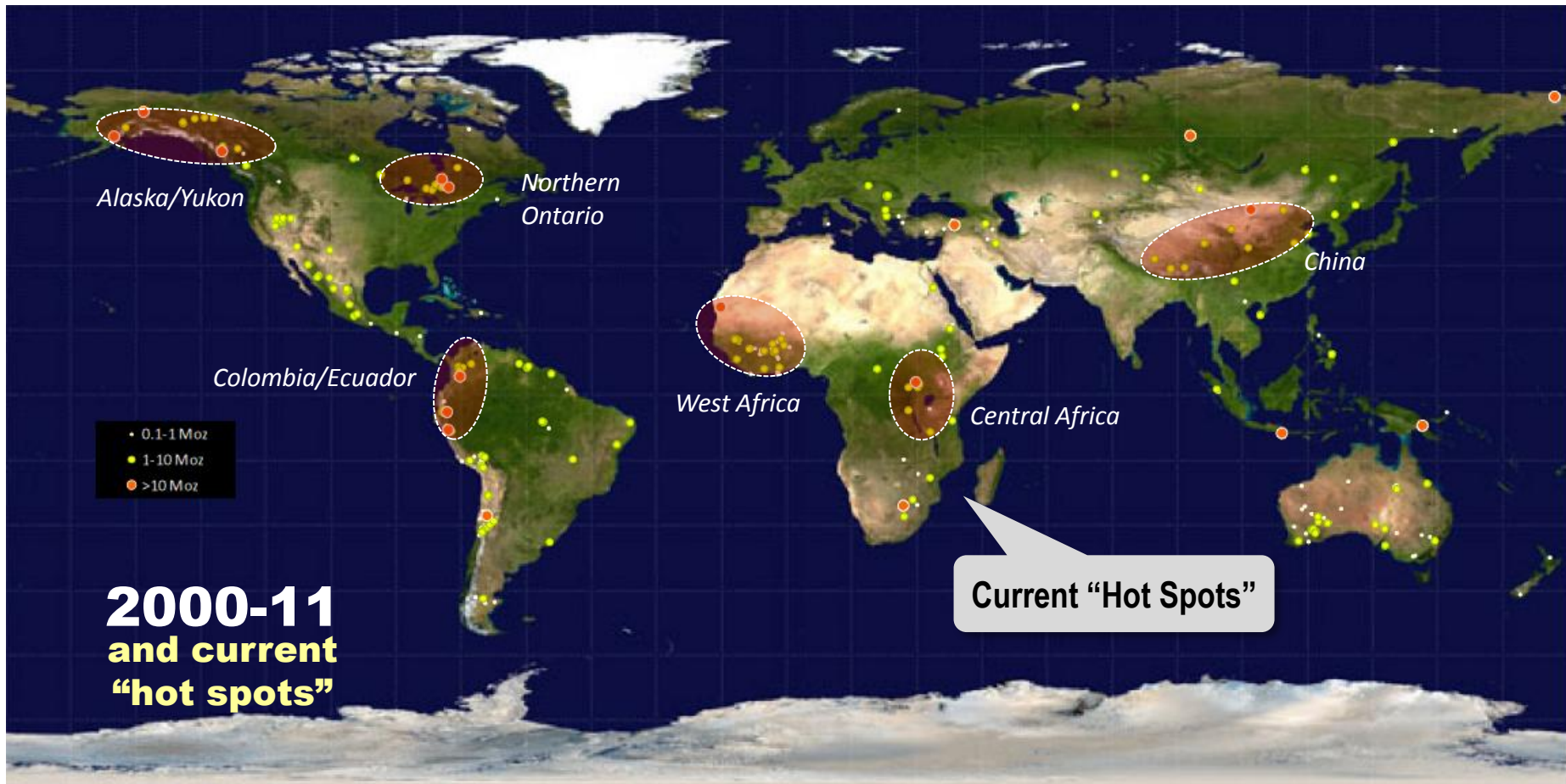
Gold deposits discovered in the 2000s



Note: All deposits > 01 Moz Au including by-product gold

Source: MinEx Consulting © November 2011

Gold deposits discovered since 2000 and current hot spots of activity



Note: All deposits > 01 Moz Au including by-product gold

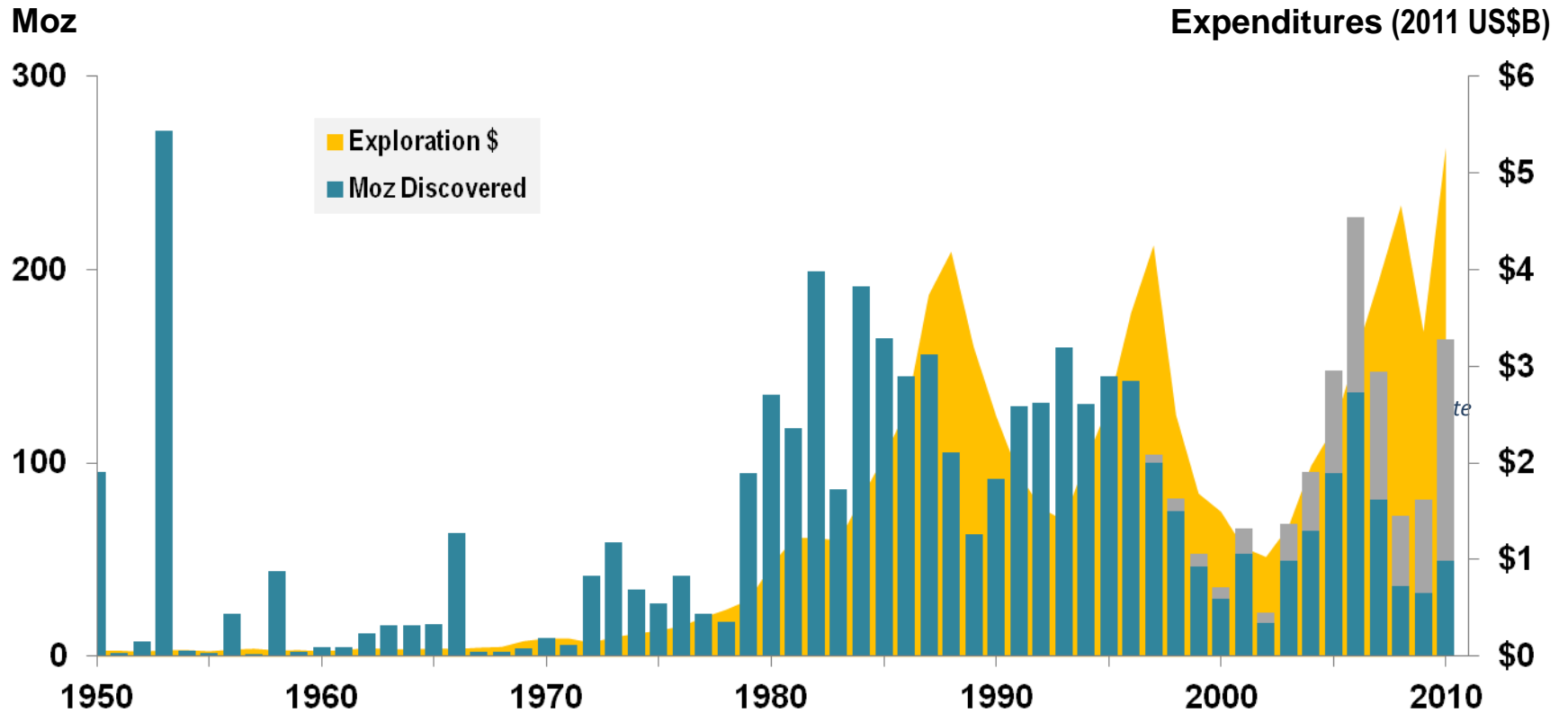
Source: MinEx Consulting © November 2011

Estimated unit finding costs for gold

TRENDS IN DISCOVERY COSTS

Gold Exploration expenditures and ounces found

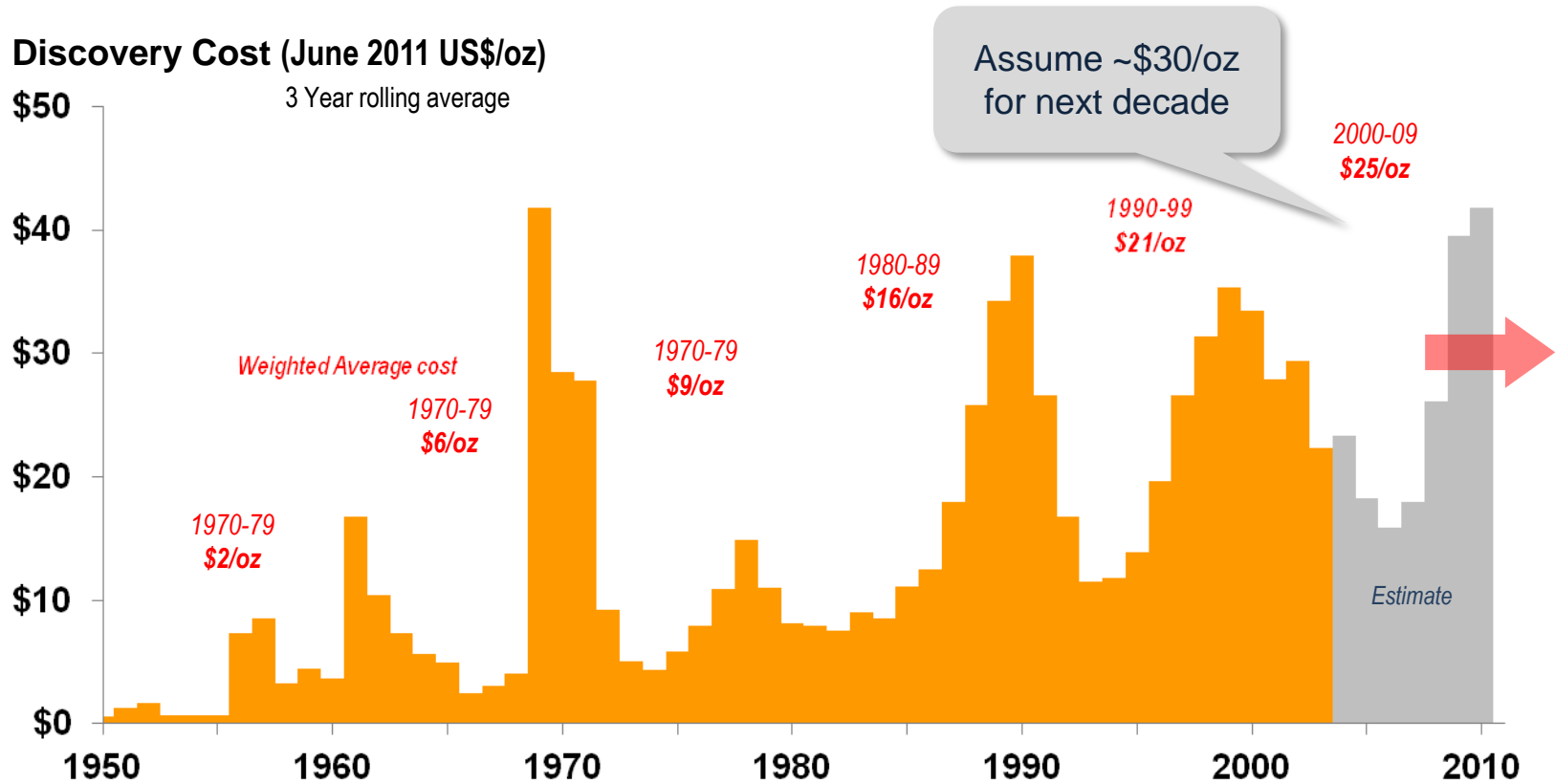
Primary gold found in Western World: 1950-2010



Sources: MinEx Consulting estimates. Post 1992 expenditure data from Metal Economics Group © 2010

Discovery costs for gold are rising

Primary gold in Western World: 1950-2010



Source: MinEx Consulting © Nov 2011

Average discovery costs: 2001-2010

(June 2011 US\$/oz)

	Greenfield	Brownfield	Total
Canada	\$35	\$6	\$20
USA	\$50	\$29	\$42
Australia	\$76	\$41	\$60
Latin America	\$22	\$25	\$23
Africa	\$23	\$9	\$16
Pacific/ SE Asia	\$34	\$162	\$44
Europe	\$34	\$42	\$35
EE + FSU + China	\$27	\$46	\$31
Rest of World	\$46	\$17	\$45
World	\$31	\$17	\$26

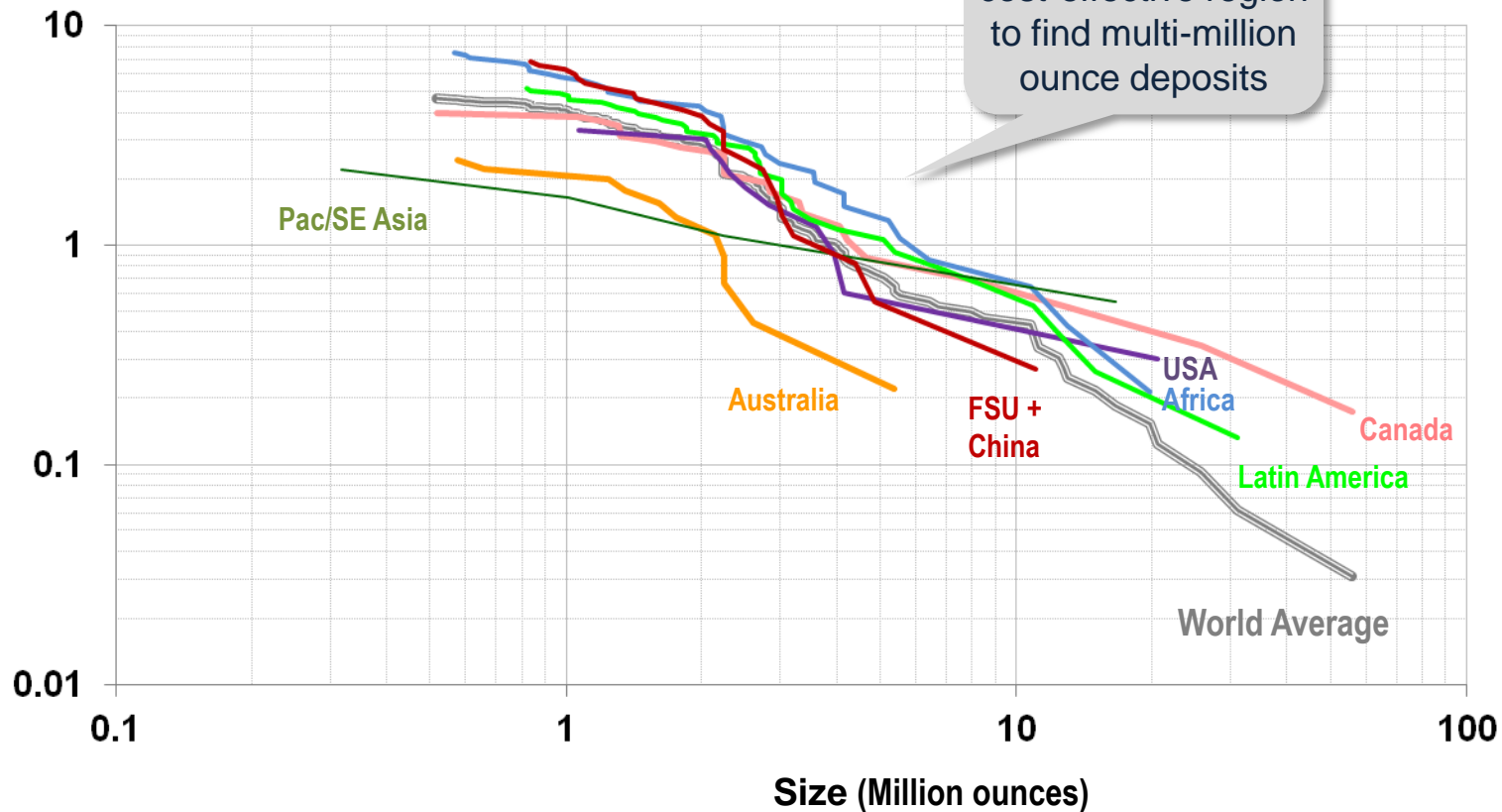
Note: Primary gold discoveries only.
Costs can vary significantly within a given Region

Source: MinEx Consulting © November 2011

The ability to find giant deposits varies by region

Size-Frequency distribution of primary gold deposits found: 2001-10

Cumulative Number of Deposits found per \$1 billion (in June 2011 US\$)



Based on Primary Greenfield and Brownfield gold deposits
Excludes Satellite Deposits

Source: MinEx Consulting © November 2011

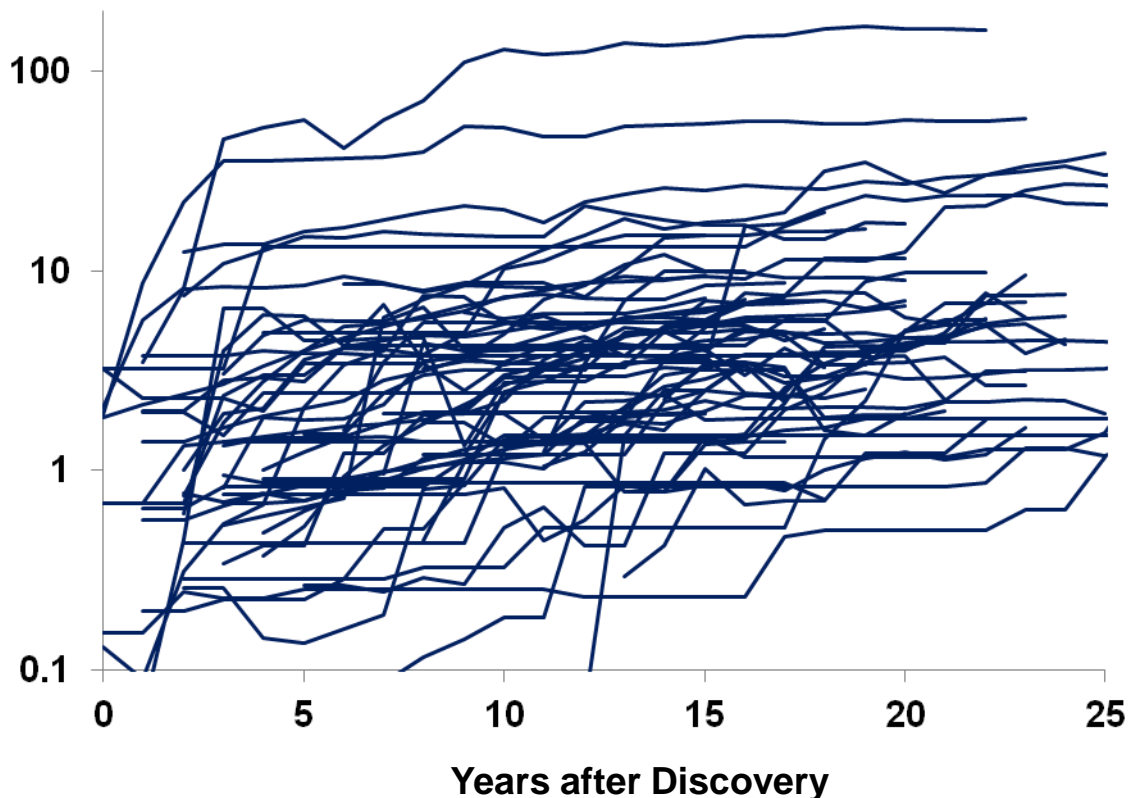
Gold deposits do grow over time

GROWTH TRENDS FOR RECENT DISCOVERIES

Observation 1 : Deposits tend to grow over time

60 Major Gold deposits found between 1980-1996

Resource (Moz)



Study based on a detailed analysis of the year-by-year reported resources for 60 major gold deposits, made up of:

- 20 Orogenic Mesothermal
- 21 Epithermal-style
- 9 Carlin-style
- 10 Porphyry-style

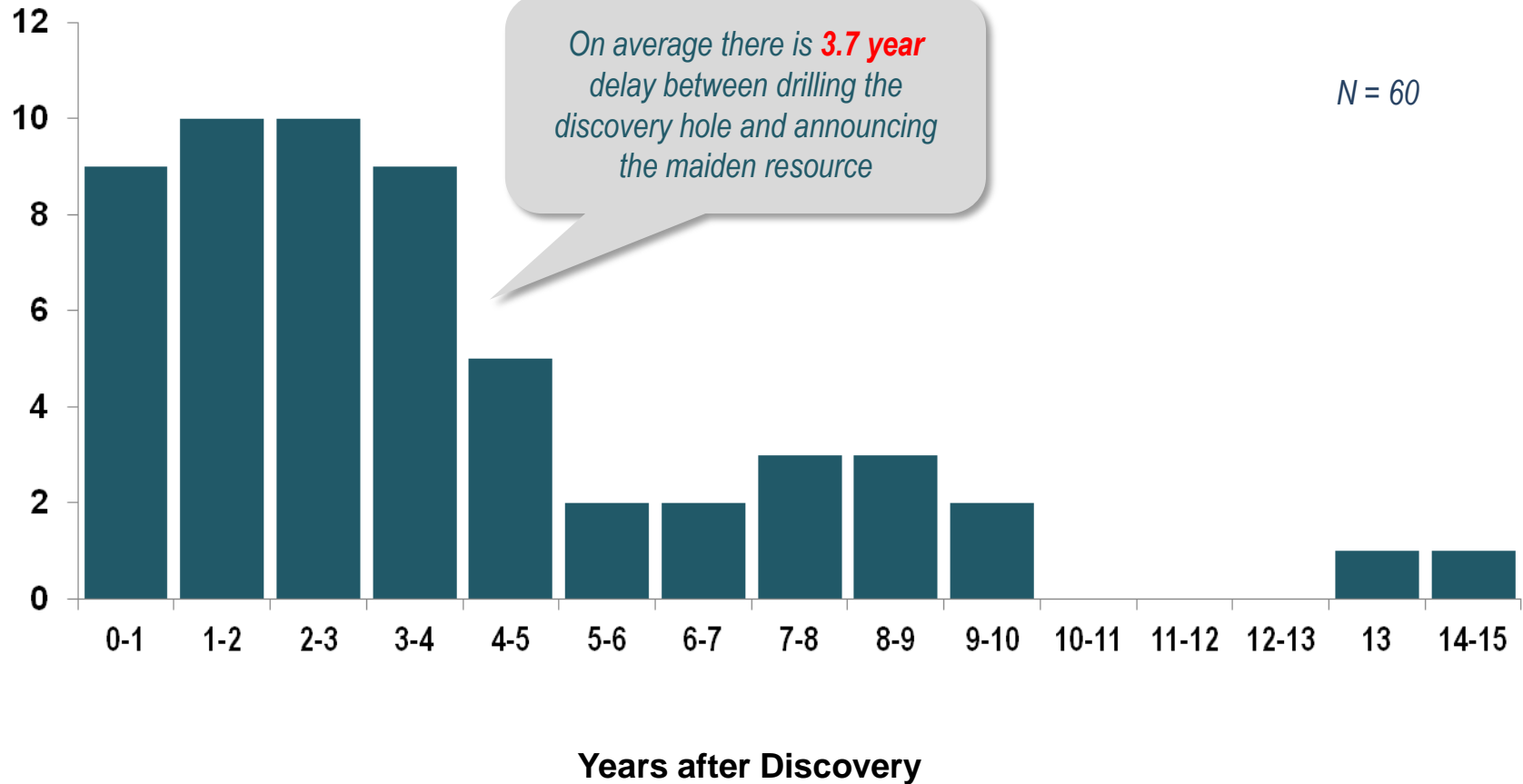
Most of the deposits grew over time

Source: MinEx Consulting © November 2011

Observation 2: It takes time to report a discovery

Years delay between discovery and first resource announcement

Number of Deposits

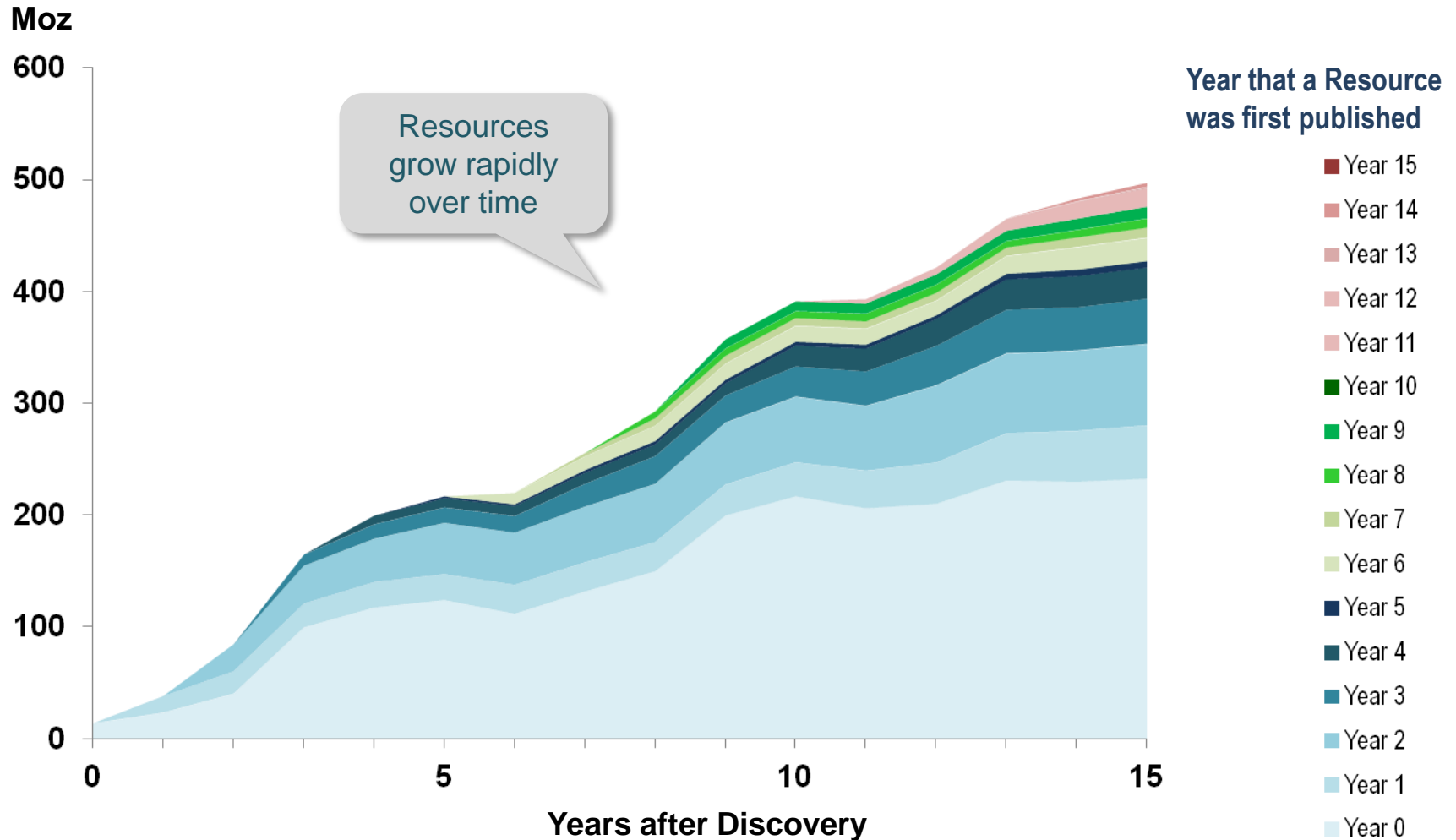


Analysis based on 60 significant (ie >1 Moz) gold discoveries made between 1980-96 in the world

Source: MinEx Consulting © November 2011

Observation 3: Even after adjusting for delays in reporting, deposits do grow over time

reported resource for deposits with same initial resource year

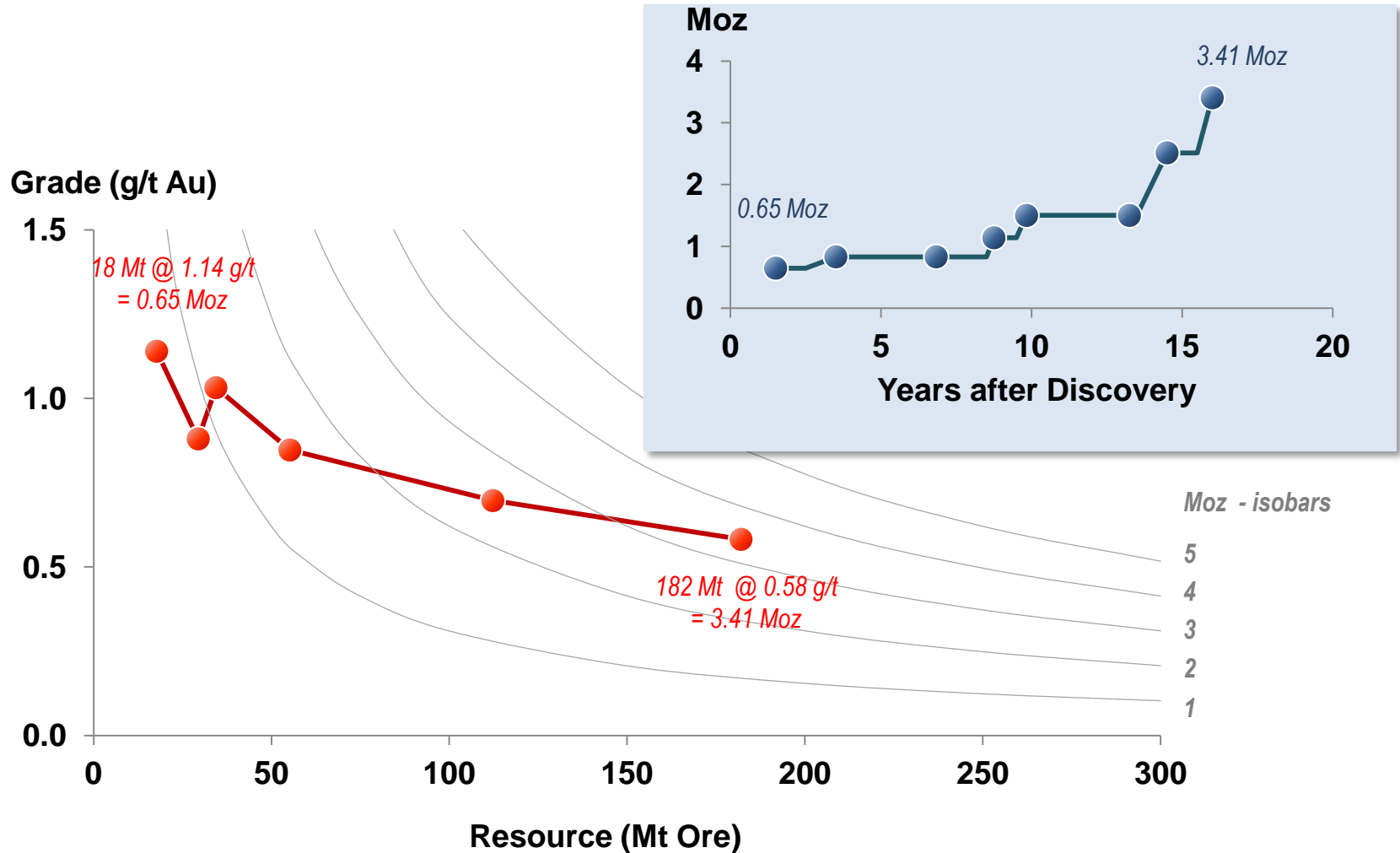


Data: Company Reports

Source: MinEx Consulting © November 2011

Observation 4: Part of the growth is due to using a lower cut-off grade

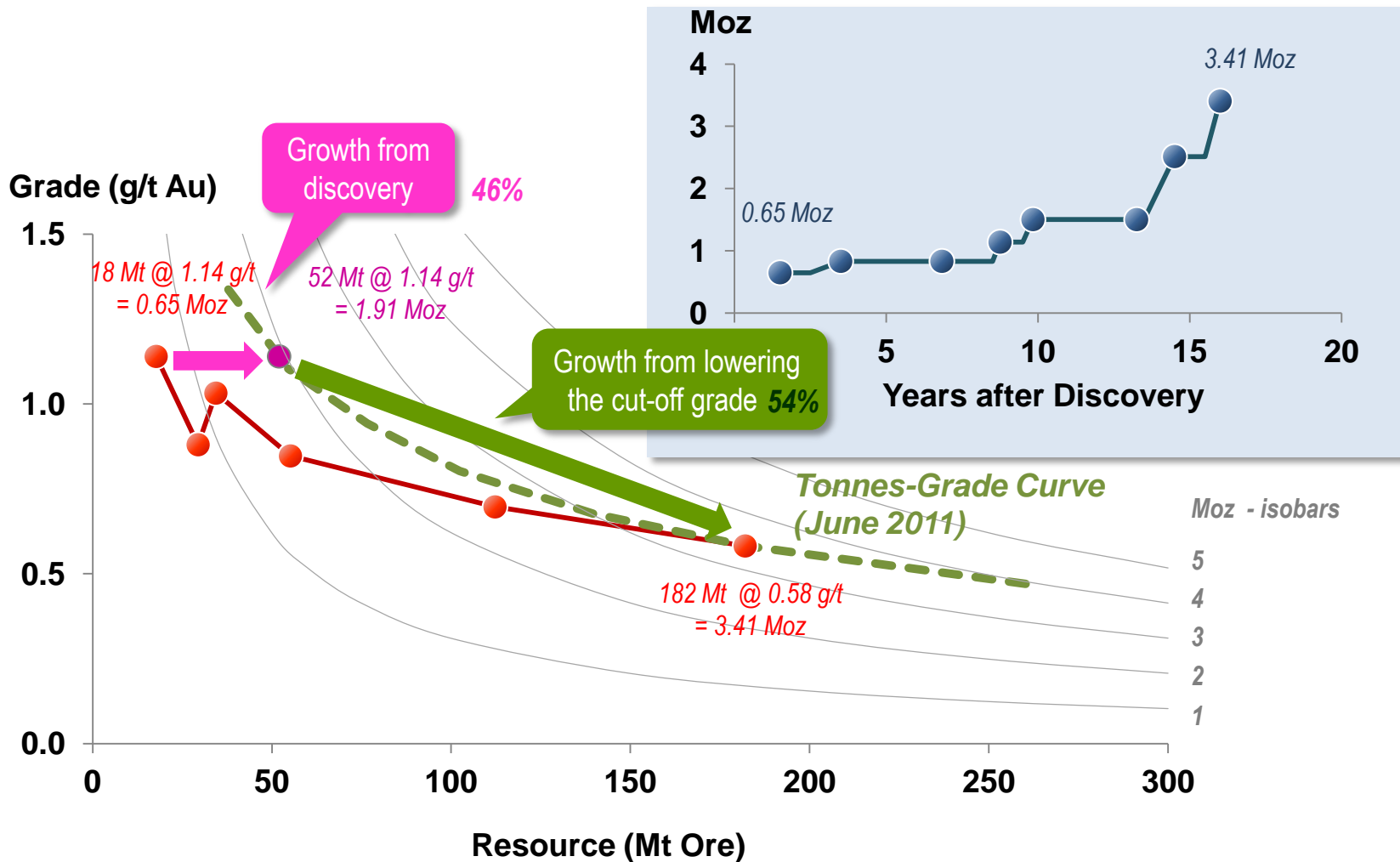
Shahuindo Gold Deposit: Discovered in 1995



Data: Company Reports

Observation 4: Part of the growth is due to using a lower cut-off grade

Shahuindo Gold Deposit: Discovered in 1995



Data: Company Reports

Changing the cut-off grade has a major impact on the size and quality of the resources available for mining

- Most deposits have a “halo” of low grade ore surrounding a high-grade core
- The reported size of the deposit will depend on the cut-off grade used
 - As a rule of thumb, lowering the cut-off grade by 50%, increases the ore tonnes by 4-8x and the contained metal by 2-4x



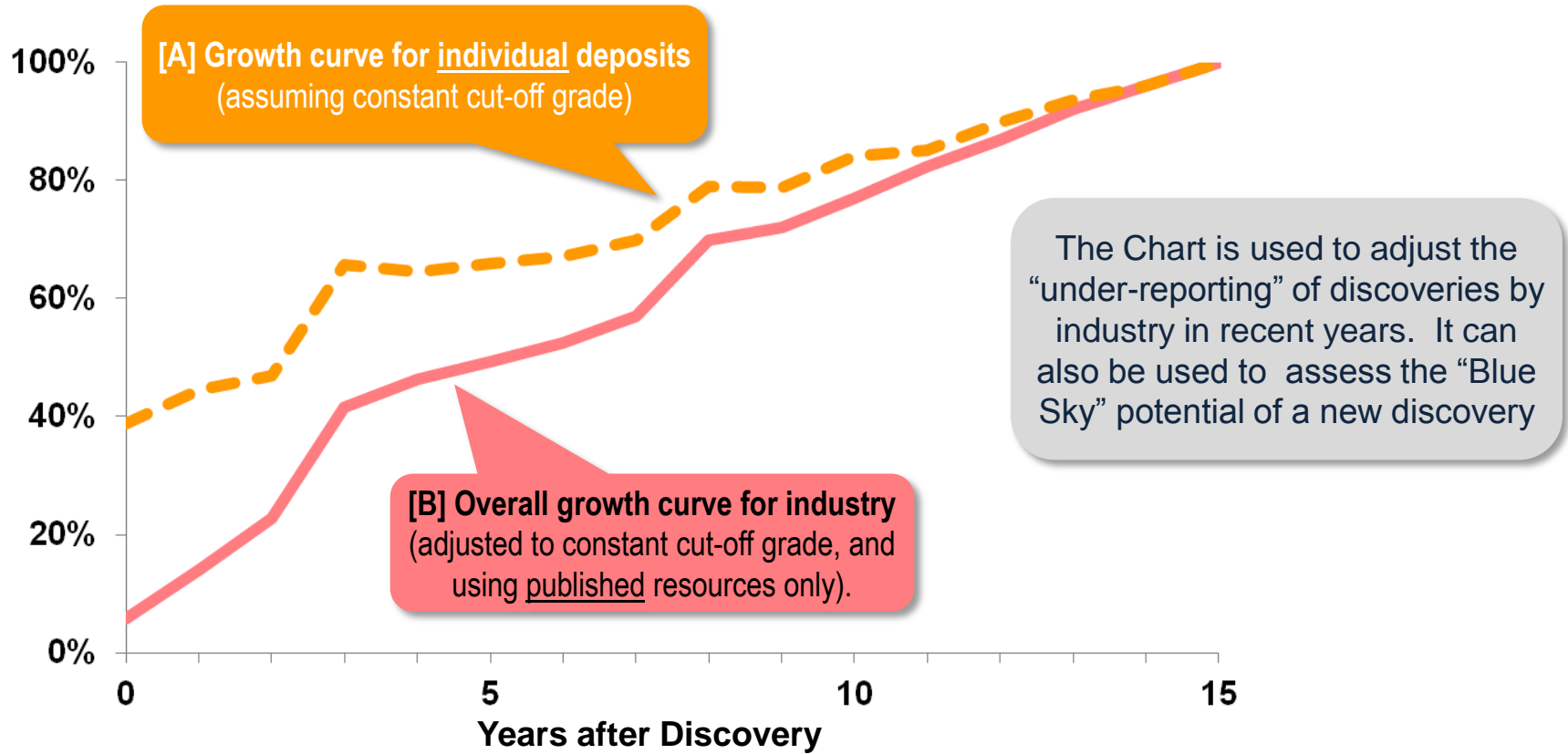
The ratio varies with the type of deposit

- The cut-off grade is driven by economics which, in turn, are driven by commodity prices, costs and level of business risk

Costs are influenced, energy & labour-intensity, innovations in mining and processing methods and economies of scale

RESULTS : Estimated Growth Curves for a portfolio of gold projects and individual gold deposits

Relative Size (Year 15= 100%)



Note : Percentage figures are based on the growth profiles of each deposit. Results give equal-weighting to all 60 deposits.

Source: MinEx Consulting © November 2011

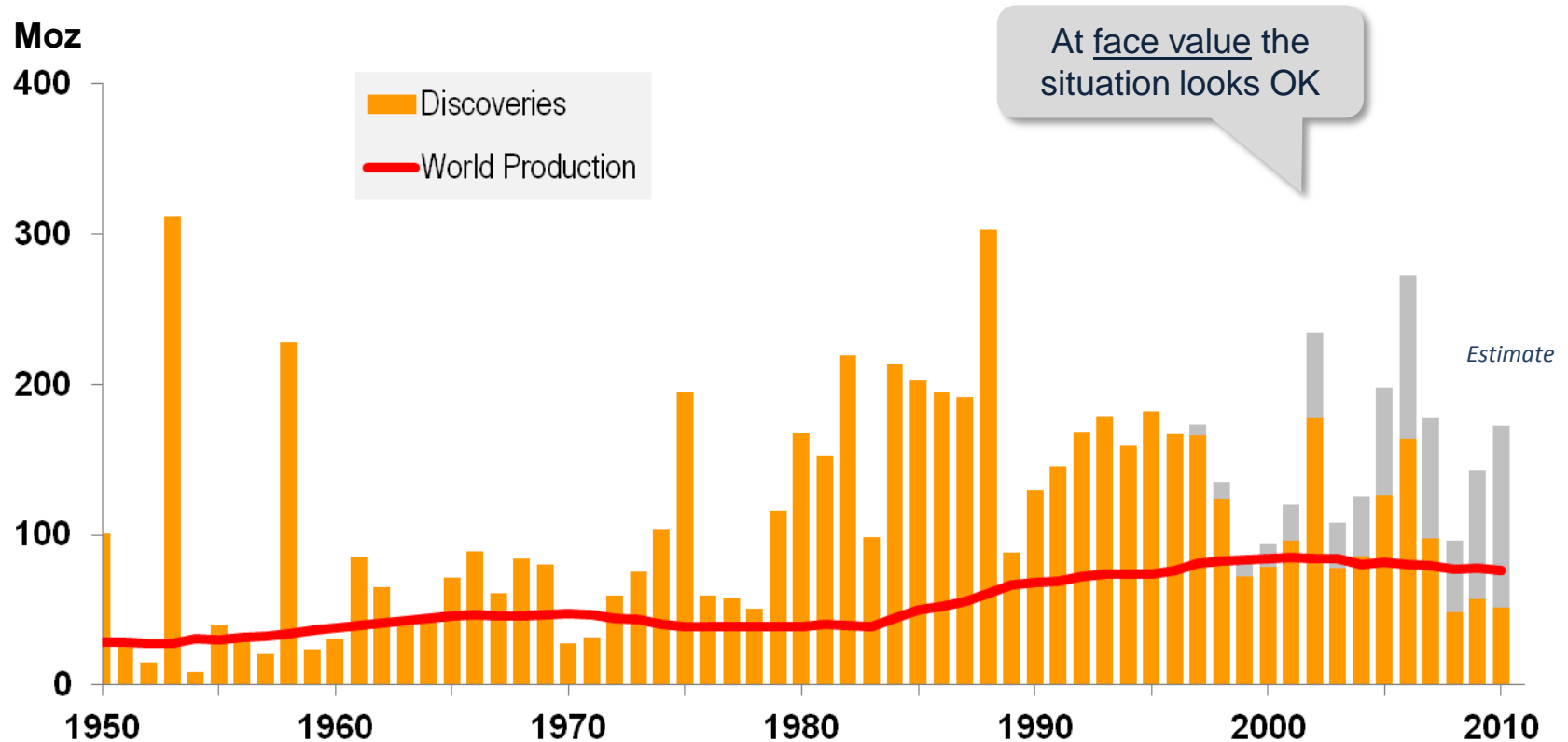
ARE WE FINDING ENOUGH GOLD?

Are we finding enough gold?

- Key drivers
 - Current discovery rates
 - Conversion rates (from discovery to operating mine)
 - Lag between discovery and development
 - Likely losses on mining
 - Current and (more importantly) future mining rates
- Modifying factors
 - Current inventory of undeveloped projects (and their quality)
 - Ability to increase resources through lowering the cut-off grade
 - Long term costs
 - Impact of environmental and social factors
 - Long term prices

Mining & discovery rates for gold

Amount of gold found and mined in the World: 1950-2010

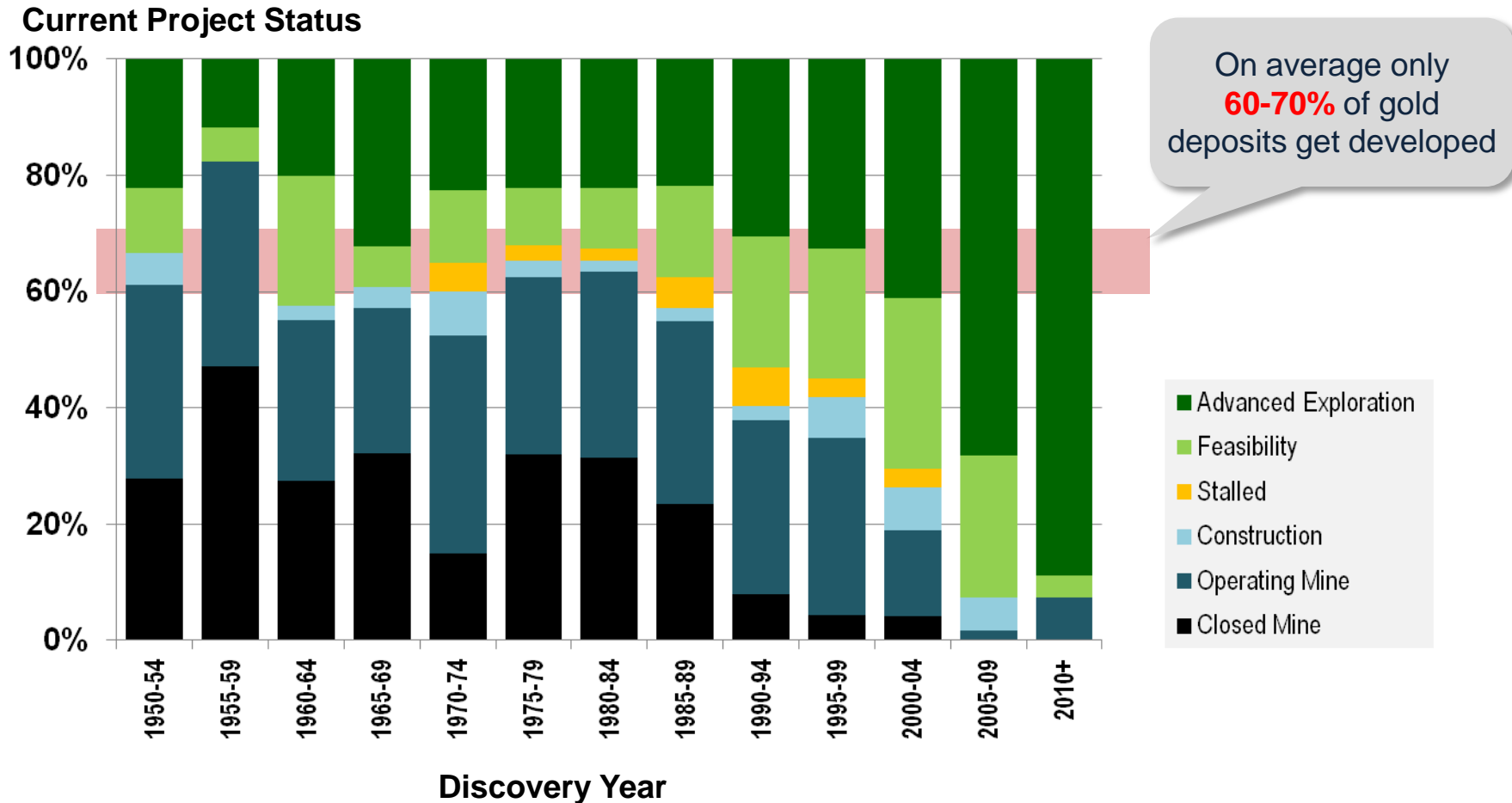


Note: Chart include minor adjustment for deposits missing from the database
Is based on discoveries > 0.1 Moz

Sources: MinEx Consulting Nov 2011.
Production data from USGS

Conversion rates for gold discoveries

Current status of primary gold deposits found in the World: 1950-2011



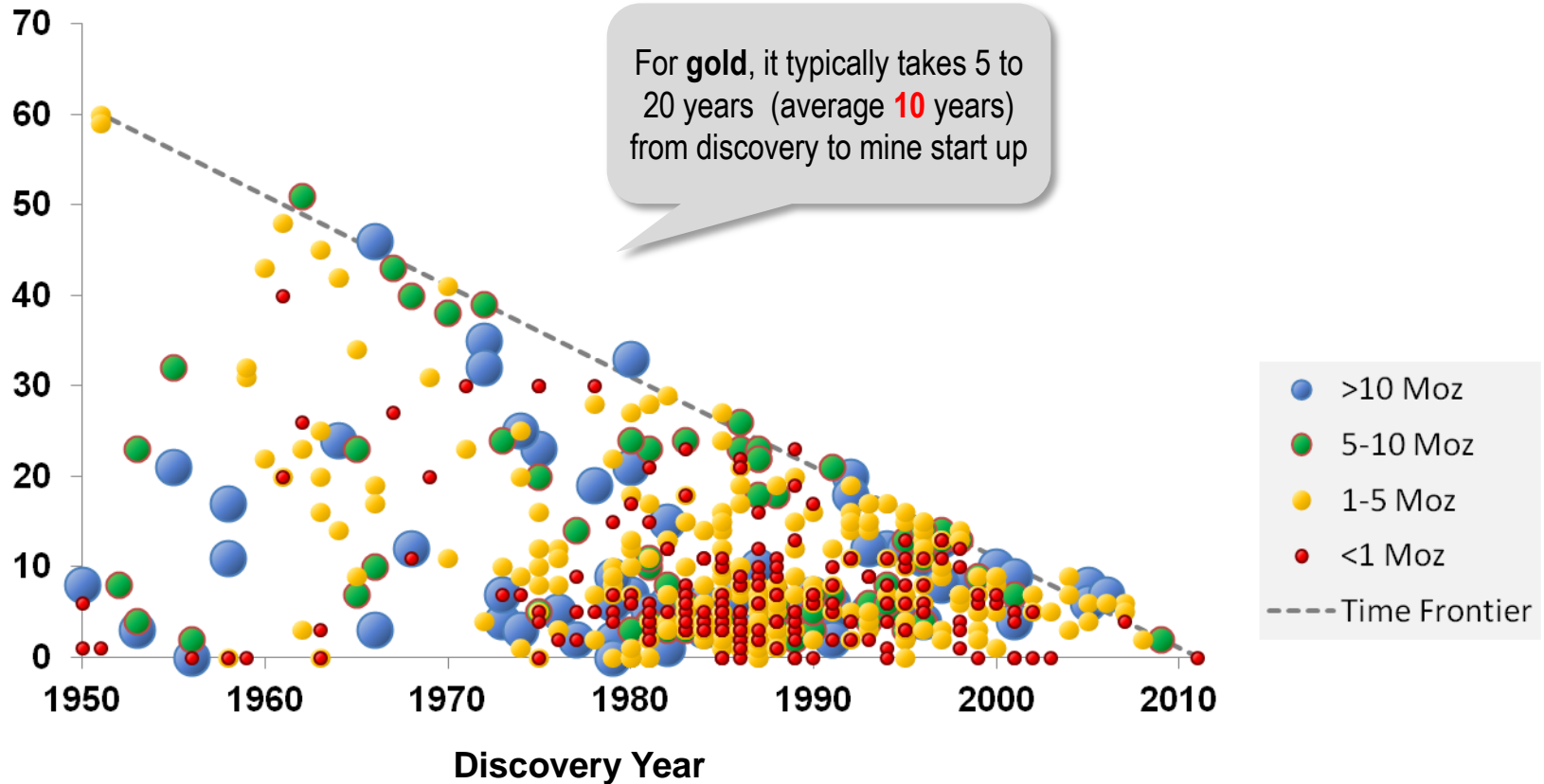
Analysis based on 1209 Primary gold deposits >0.1 Moz

Source: MinEx Consulting © Oct 2011

Development time for successful gold projects

Primary gold projects in the World: 1950-2011

Time Discovery and Development (Years)



Analysis based on 571 Primary gold deposits >0.1 Moz

Source: MinEx Consulting © Nov 2011

Are we finding enough gold?

- Key drivers

- Current discovery rates ... *is slowing down*
- Conversion rates (from discovery to operating mine) ... *only 60-80%*
- Conversion rates (Resources into Reserves) ... *<100%*
- Lag between discovery and development ... *typically 5-15 years*
- Likely losses on mining ... *typically 5-10%*
- Current and (more importantly) future mining rates

Given the long delays to convert a discovery into a mine, need to consider size of market at that time

- Modifying factors

- Current inventory of undeveloped projects (and their quality)
- Ability to increase resources through lowering the cut-off grade
- Long term costs
- Impact of environmental and social factors)
- Long term prices

Given the feedback loops, is this an input or an output ??

How much metal do we need to find ?

To ensure no supply interruptions in the longer term the industry needs to be finding 2x as much gold as it mines

Actual Factor is between 1.9x to 2.6x based on 60-70% of all deposits being developed as mines, 60-80% conversion of resources into reserves and 90-95% of recovery of metal on mining/processing. Ignores benefit of resource growth over time.

Estimated Discovery/Production ratio for gold

	Average Exploration spend for 2001-10	Exploration Spend in 2010
World exploration spend rate (2011 US\$m pa)	\$2800m	\$5300m
Unit discovery costs	~\$30/oz	~\$30/oz
Expected amount of metal to be found	93 Moz	177 Moz
Gold Production in 2010 & 2020	78 & 90 Moz	78 & 90 Moz
Discovery/Production Ratios		
- At 2010 Production Rate	1.2x	2.3x
- At 2020 Production Rate	1.0x	2.0x

Target is >2x

Source: MinEx Consulting © Nov 2011

Implications for the future

- To deliver a sufficient pipeline of new gold mines, industry needs to:
 - Maintain exploration spending at current high levels
(ie >US\$6b pa ... it can't revert back to the 10 year historic average)
 - Develop ways to be more efficient/effective at exploration
(i.e. achieve discovery costs <\$30/oz)
 - Shorten the time from discovery to development
 - Develop better mining & processing methods, to make marginal projects work *(i.e. improve the conversion rate)*

Any remaining shortfall will have to be filled through higher prices
– as this will increase the available resources (through lower cut-off grades), improve the economics of marginal prices and stimulate additional exploration

The dynamic nature of the market means that it can take several years before higher prices translate into extra production

The future for Exploration

SUMMARY/CONCLUSIONS

Summary / Conclusions (1/3)

- Exploration Expenditures are cyclical

Industry is currently spending US\$5-6 billion, up from \$2.8b pa over the last decade

- Discovery costs are rising for gold

Costs have nearly doubled in the last 2 decades to over \$25/oz – made up of Greenfield at \$31/oz and \$17/oz for Brownfield exploration. Current costs are running at \$30-40/oz. Individual countries will be better/worse than average

- The current hot spots for exploration success are Columbia/Ecuador, Yukon/Alaska, Northern Ontario, West Africa, East Africa and China

Cheapest regions to make large greenfield discoveries are Latin America and Africa

- The industry only finds four to five Tier 1&2 deposits each year

... and of these at best only one is “World Class”

- Not all discoveries turn into mines

Conversion rates are only 60-70%, depending on the size, quality and location

- For the successful projects, there is a lag of 5-15 years between discovery and development

- Recognise that discoveries do grow over time

On average, two years after discovery, the resource will be 50% of that at Year 15

Summary / Conclusions (2/3)

- Even at current (high) exploration expenditure rates, the industry will struggle to find enough to meet out future needs
- In the longer term the market will “balance itself” through the complex interplay between:
 - *Level of exploration spending*
 - *Efficiency and effectiveness of exploration activities*
 - *Speed of converting discoveries into mines*
 - *The current inventory of undeveloped projects (quality & number)*
 - *Proportion of new projects that are economically viable*
 - *Innovations in technology (that make marginal projects viable)*
 - *Changes in mining costs and business risk*
 - *Change in cut-off grades (which can increase/decrease available resources)*
 - *Growth in primary metal demand, and*
 - **Commodity Prices**
- Given the long delays between discovery and development, there is a real risk that the gold industry could face supply constraints in the short term

**This is both a challenge
and an opportunity !**

Summary / Conclusions (2/3)

In conclusion ...

The gold industry is facing several challenges and opportunities.

Persistence, good science and the ability to operate in new frontiers (and new countries) are the keys to finding, growing and developing the next generation of high quality mines

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