MINING MARKET CYCLES AND TAILINGS DAM INCIDENTS

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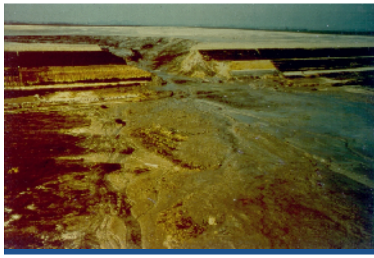
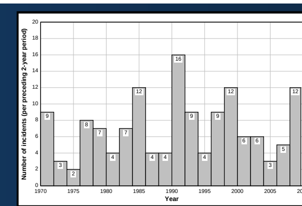
Introduction

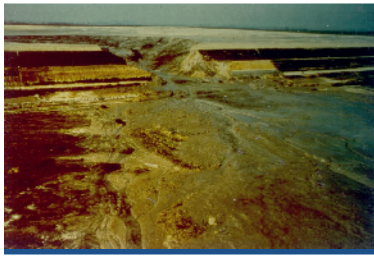
- The Mining Industry is driven by cyclical global economic conditions.
- The most recent boom cycle started gathering some modest signs of life in 2003 through 2005 but took off in early 2006 to what eventually became many unprecedented highs in commodity prices.
- Though this most recent 2006-2008 boom was exceptional in terms of its height and the rapid and severe nature of its contraction, it is far from the first cycle the mining industry has seen

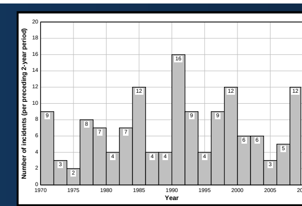




Introductions cont…

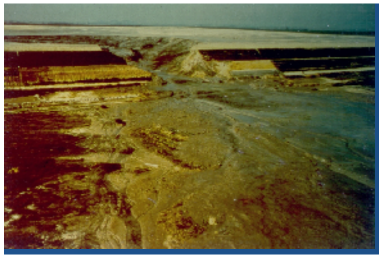
- From the comparisons made, trends appear that should create some sense of urgency in the Mining Industry for enhanced tailings dam stewardship in the near future.
- The paper includes some anecdotes from projects completed in this most recent boom to illustrate some of the reasons why the trends noted may exist.
- Further, the paper will provide some thoughts on how to prevent this trend reappearing during the inevitable next cycle in the Mining Industry.





Tailings Dam Failure Database

- There is a reasonably good database of tailings dam failure incidents going back to 1968
- Author's database uses readily available literature and less available accounts via review assignments and similar
- December 1968 through to August 2009, there were 143 tailings dam incidents
- The data, compiled on two-year cumulative bases, shows five distinct "peaks" in activity over the ~40 years



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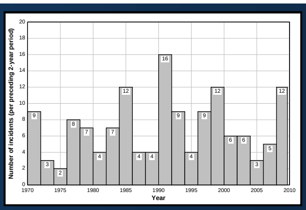

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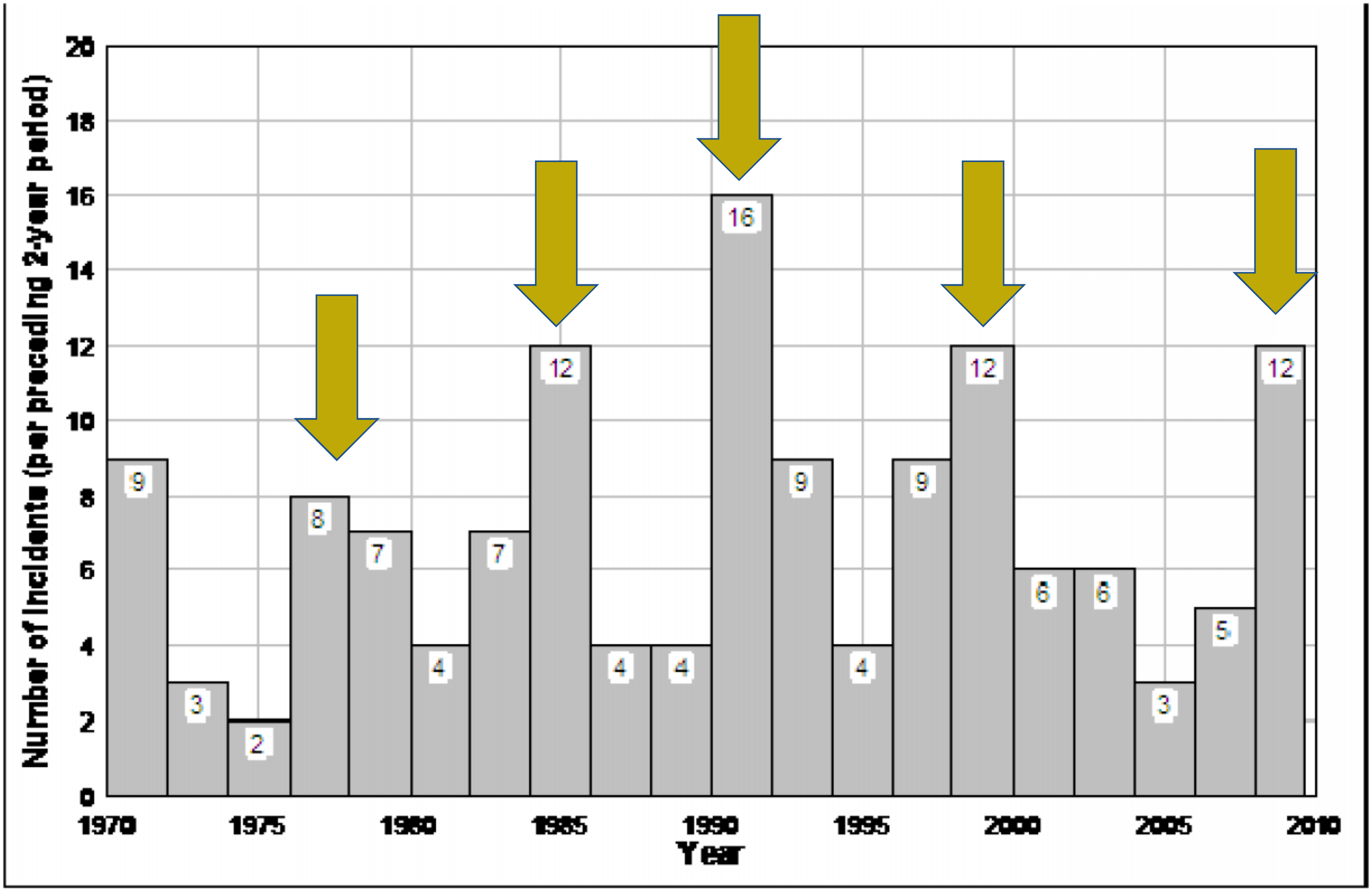

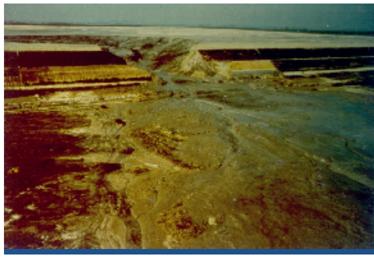

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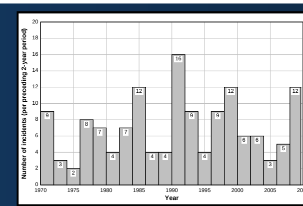

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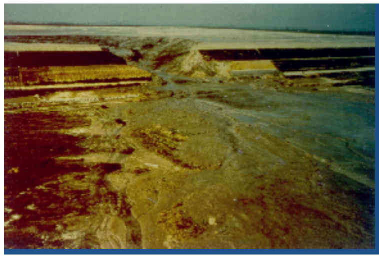
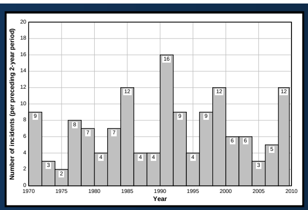
Start of Two-Year Period	Number of Tailings Dam Incidents
January 1976	8
January 1984	12
March 1990	16
February 1998	12
Early to Mid 2009 (?)	>12

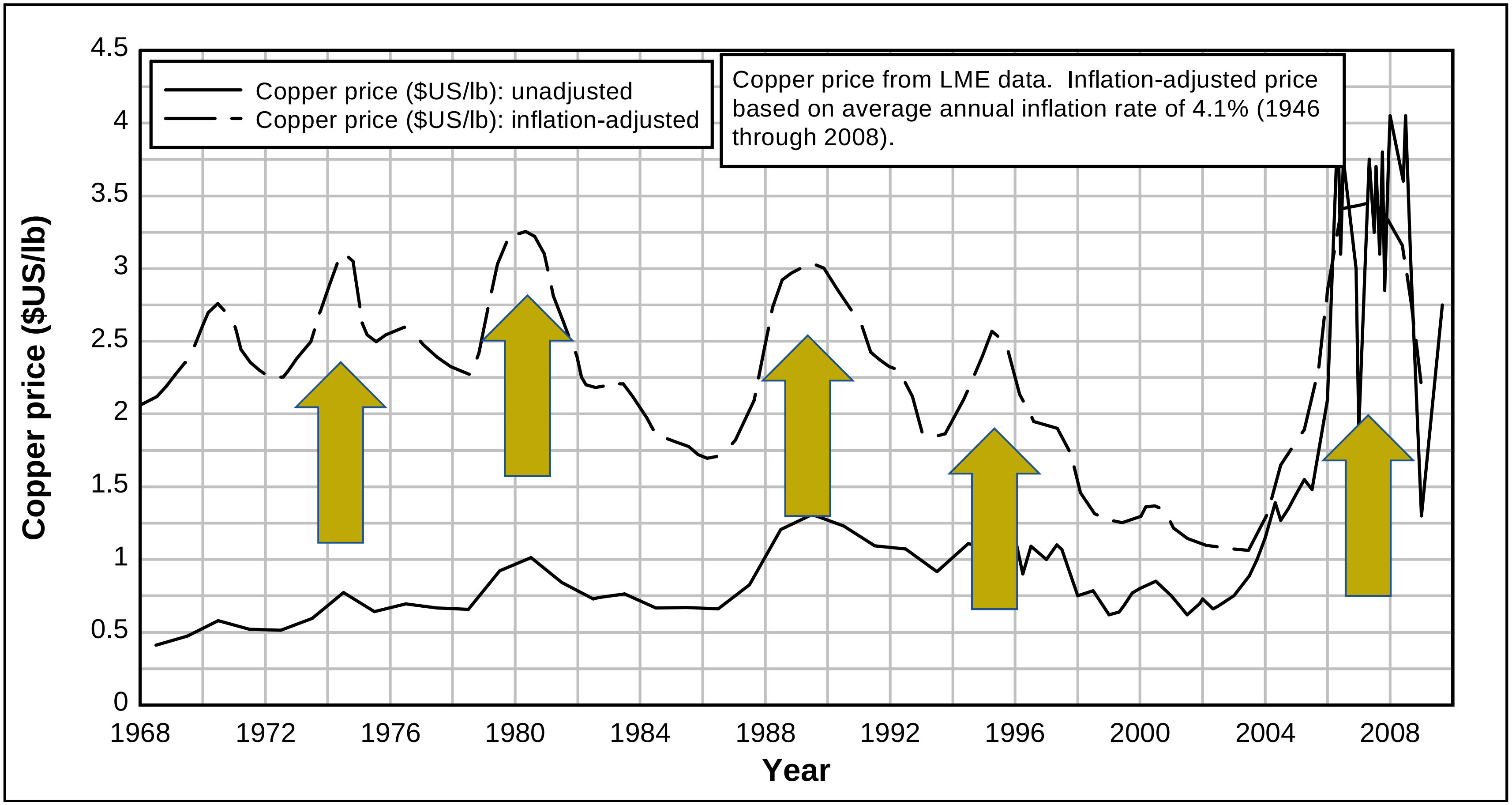
Copper Price

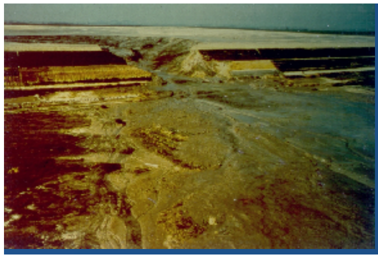
- Copper has a history of use that is at least 10,000 years old
- More than 95% of the copper supply has been developed since 1900
- One of the most used and re-used metals
- Typically, copper price as seen as bellwether for the health of the mining industry
- The copper price has shown a number of peaks since 1968 (though more subtle)

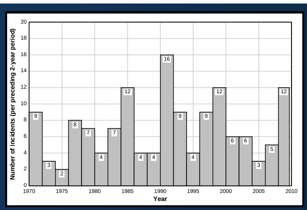




Copper Price – 1968 to 2009



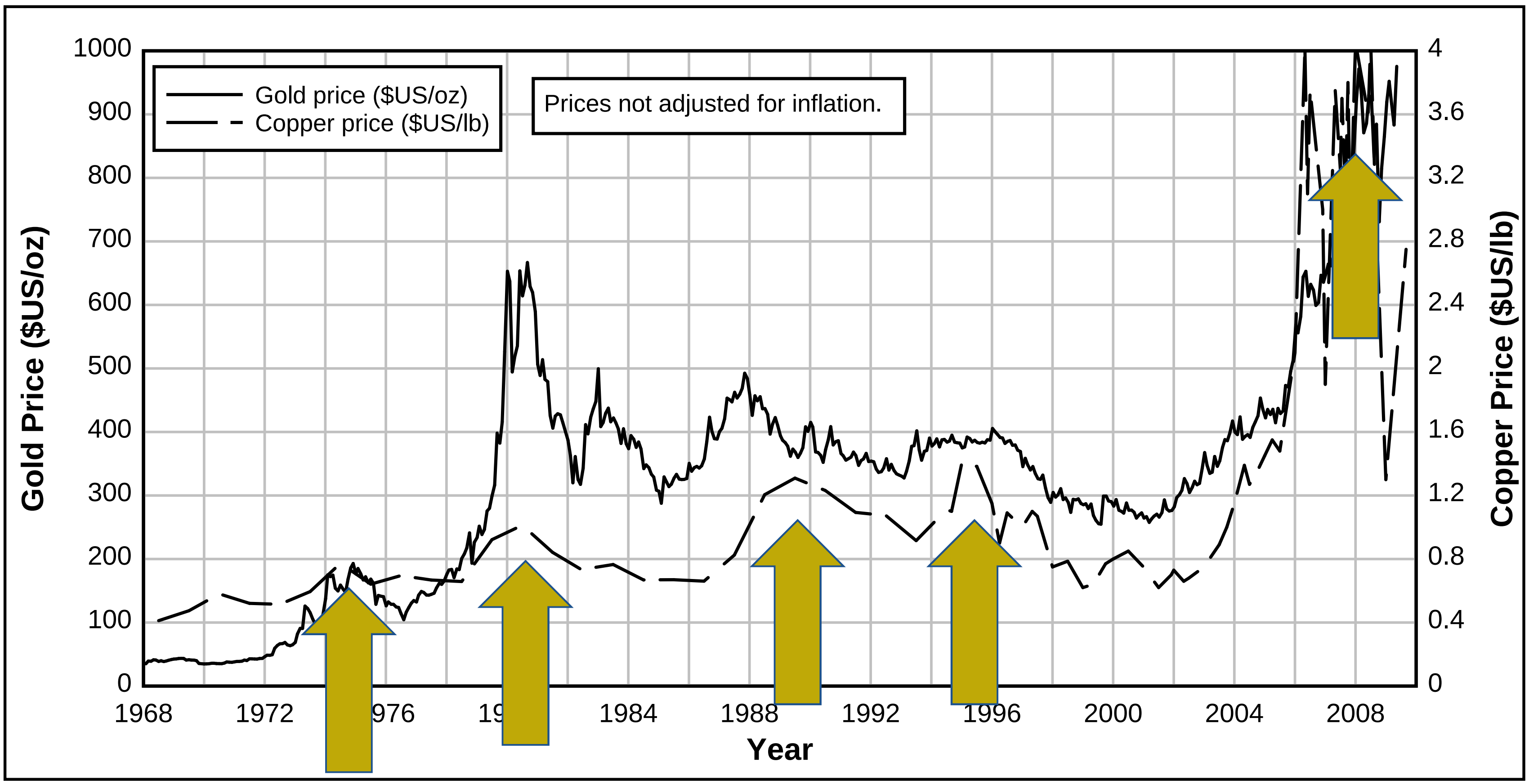


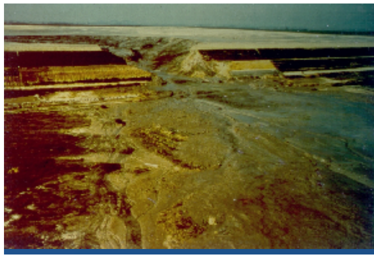


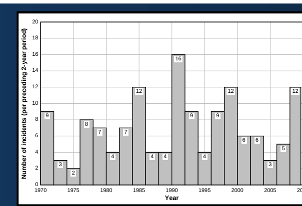
Gold Price

- Mined since “Roman” times
- Actually, very little gold mined:
  - To the end of 2006, *all* the gold ever mined totaled 158,000 tonnes
  - This is equivalent to a cube with an edge length of just 20.2 meters
- Still is, however, a very emotive barometer for the mining industry
- Per copper, gold price shown a number of cycles since 1968

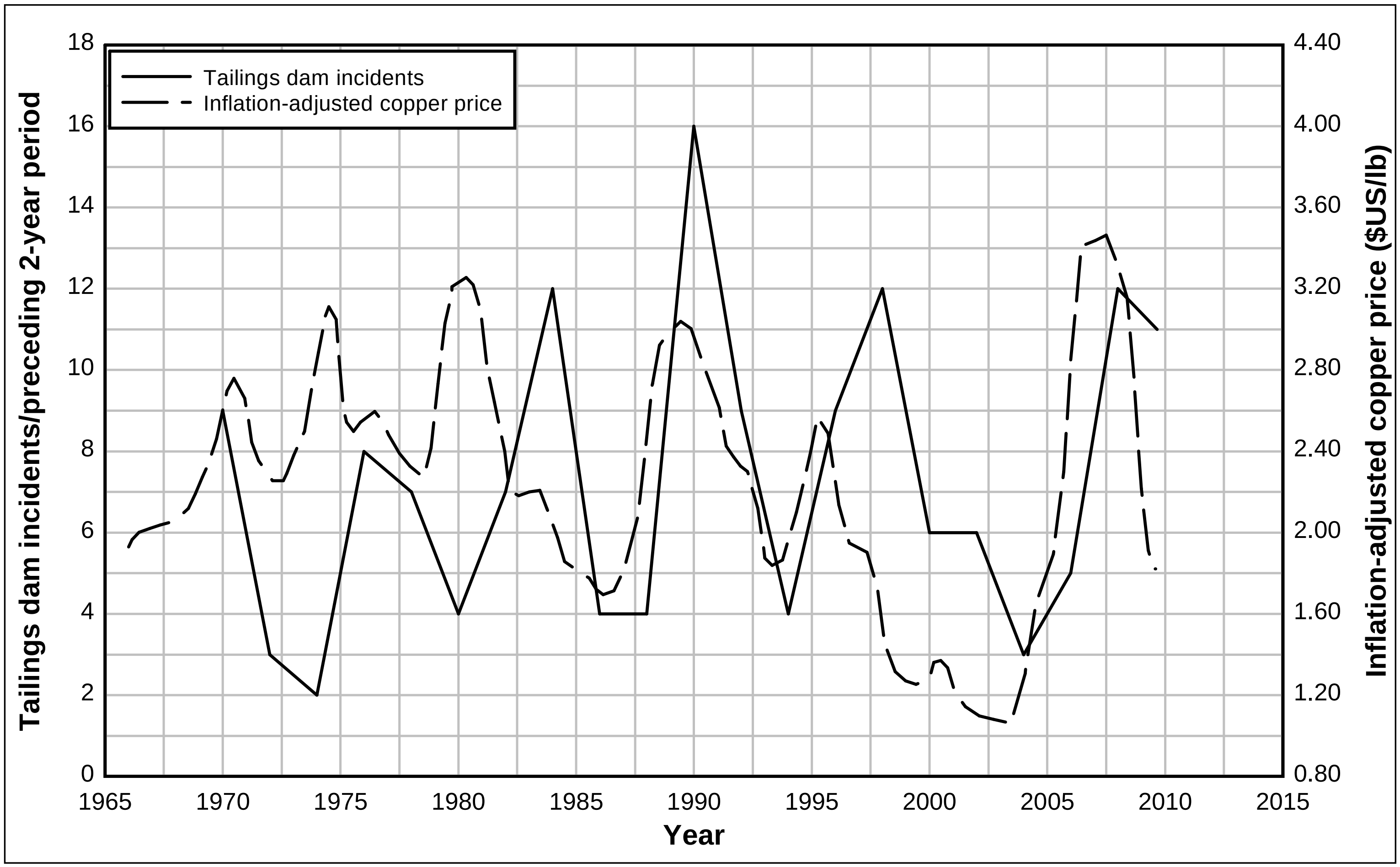
Copper and Gold Price – 1968 to 2009

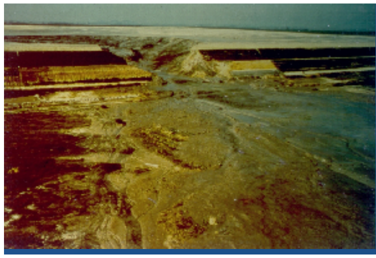






Tailings Incidents – Copper Price Relationship





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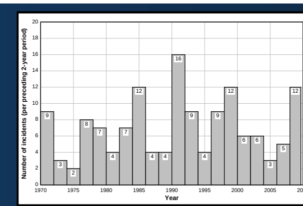
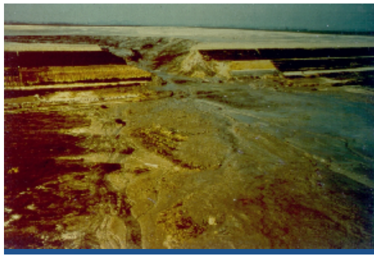


Start of Two Year Period of Increased Tailings Dam Incidents	Peak of Copper Price	Peak of Gold Price
January 1976	January 1974	January 1974
January 1984	September 1980	September 1980
March 1990	June 1989	December 1987
February 1998	September 1995	January 1996
Q1-Q2 2009 (?)	February 2008	February 2008



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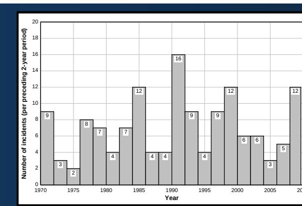
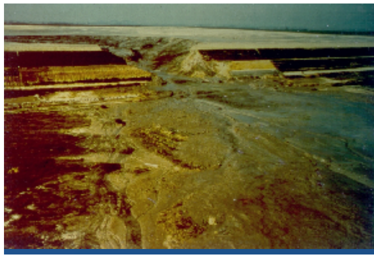
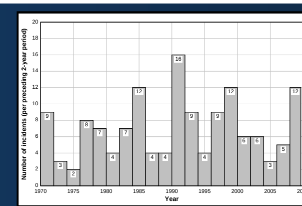


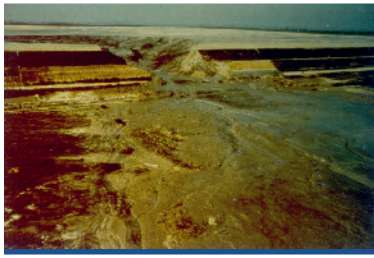
Time Lag from Peak of Copper Price to Peak in Tailings Dam Incidents	Time Lag from Peak of Gold Price to Peak in Tailings Dam Incidents
24 months	24 months
39 months	39 months
9 months	27 months
28 months	25 months

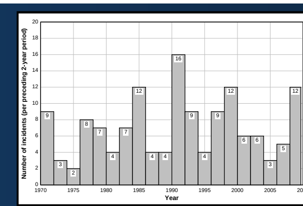




Summary of Comparisons

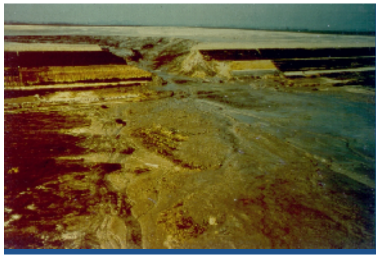
- Average time lag from the four peaks prior to 2008 peak to peak in “two-year” tailings dam incidents:
  - – Copper 25 months
  - – Gold 29 months
- Actual time lag may range between 18 and 36 months post peak price versus a set period as implied by the simplistic average used





If we accept there is a trend, then why?

- Permit haste:
  - use of fashionable but project-inappropriate tailings technologies
  - unprecedented design/operation to satisfy non-realistic regulatory preference
  - defaulting to flooding for potential ARD despite dam safety risks
  - acceptance of sites that are pleasing to regulators but not to geotechnical reality
  - over-taxed regulatory capacity.
- Fast tracking of investigation, design and construction to take advantage of the price cycle



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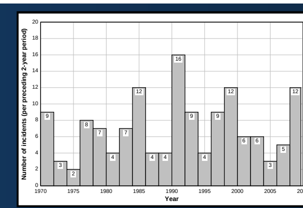

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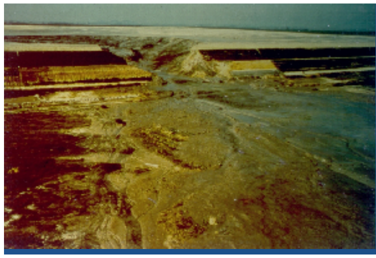
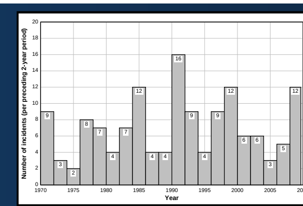
Continued…

- Rapid turnover of key mine management and operating personnel as new opportunities abound during the boom times
- Disconnect between design expectations and operational realities
- Development of long-known deposits that have been left undeveloped for good reasons
- Pressures to cut costs for once mines constructed on the basis of rising commodity prices are forced to operate with the reality of lower commodity prices
- “Cookie cutter” designs having attributes well and good in, for example, South Africa, but being used for a project in a high rainfall, high seismic environment.





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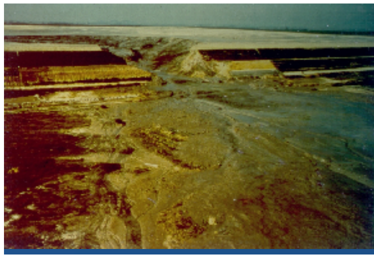
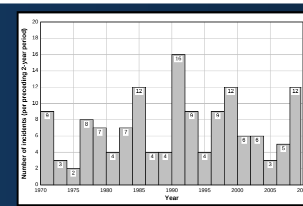
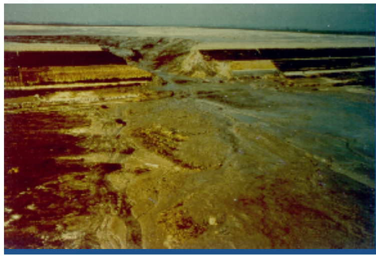
- Inexperienced (but overconfident) designers
- Experienced (but overly-subscribed) designers
- Lack of independent, third party review
- Inadequate appreciation of capital and operating costs associated with designs based more on rapid permit procurement than technical and economic realities
- Rapid cost escalation during project construction due to boom times, necessitating cost cutting

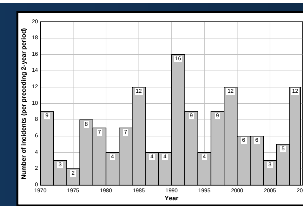




Conclusion

- Is there really a correlation between tailings dam incidents and mining cycle booms? Empirically, such a case can be made.
- This evaluation was admittedly not a rigorous scientific evaluation
- However, if the trends suggested by the data over the booms of the period since 1968 provide some guide to the future, the implications to the mining industry in the near future are clear
- The recent boom that ended so abruptly in 2008 was unprecedented in terms of copper price
- The increase in tailings dam incidents of the past year or so may only be a precursor to a peak coming in the next 12 to 30 months???





HOWEVER…….

- What about the Oil Sands industry?
  – Some of the largest tailings impoundments in the world
  – Subjected to the same market cycles over its now 40+ year history
- YET:
  – Incidents record is enviable; significantly better than world-wide database; no physical failures to date
- SOMETHING TO BE PROUD OF…….
  – The Oil Sands Industry should get a much deserved “Pat-On-The-Back”