Presentation Outline

- Safety share
- Introduction
  - Global copper reserves/resources
  - Phelps Dodge production & reserves profile
- Commercial drivers for copper concentrate leaching
- The copper concentrate market and TC/RCs
- Phelps Dodge copper pressure leaching developments
  - High temperature
  - Medium temperature
- Critical success factors for commercialization
- Conclusions
Safety Share - Bagdad Concentrate Leach Project

◆ Construction Safety Record (total project)

- Total man hours: 330,000
- Lost time injuries: 0
- Recordable injuries: 3
- First aid treatment: 9
- Near miss incidents: 7
- Recordable Injury Frequency Rate = 1.86 (per 200,000 man hours)

◆ Operations & Maintenance (project to date)

- Lost time injuries: 0
- Recordable injuries: 0
- First aid treatment: 2
- Near miss incidents: 18 (2004 YTD)
- Recordable Injury Frequency Rate = 0
- 651 Zero days since project start
Global Copper Industry by Process Type

2003 Production (Est.)

- Mill, Smelt (cpy/cc): 80%
- Leach, SX/EW (cc): 10%
- Leach, SX/EW (ox): 10%

Remaining Reserves (Est.)

- Mill, Smelt or Con Leach (cpy/cc): 80%
- Leach, SX/EW (cc): 9%
- Leach, SX/EW (ox): 11%
Potential Phelps Dodge Production Profile by Process Type

2004 Production

- Mill, Con Leach (cpy/cc): 20%
- Mill, Smelt (cpy/cc): 2%
- Leach, SX/EW (cc): 34%
- Leach, SX/EW (ox): 44%

2010 Production

- Mill, Con Leach (cpy/cc): 22%
- Mill, Smelt (cpy/cc): 18%
- Leach, SX/EW (cc): 22%
- Leach, SX/EW (ox): 36%
Phelps Dodge Mineral Reserves Profile by Process Type

- Mill, Con Leach or Smelt (cpy/cc) - 59%
- Leach, SX/EW (cc) - 24%
- Leach, SX/EW (ox) - 17%
Drivers for Concentrate Leaching

- Cost effective alternative to conventional smelting & refining
- Capital cost versus greenfield smelter/refinery projects
  - $1,000-2,000 versus $3,000-6,000/annual tonne
  - Ability to utilize existing SX capacity ($300-400/annual mt)
  - Ability to utilize spare EW capacity ($500-600/annual mt)
  - Ability to utilize existing infrastructure
- TC/RCs – Commercial third party smelting & refining rates
- Operating cost
  - Oxygen requirements & cost
    - Altitude
  - Acid balance
  - Freight rates, distances, handling
- Copper recovery
- By-products (Au, Ag, other)
- Smelter penalty elements (As, Sb, Bi, other)
Chalcopyrite Concentrate Pressure Leaching Options

- Atmospheric sulfate media
  - Attrition grind & ferric leach
  - Silver-catalyzed ferric leach
  - Biological ferric leach

- Pressure sulfate
  - High temperature (>200°C)
  - Medium temperature (>100°C <200°C)
  - Chloride-assisted

- Halide system
  - Chloride
  - Chloride-bromide

- Ammonia
Factors Affecting Process Selection

- Deposit characteristics
- Concentrate mineralogy
- Concentrate grade
- Location
  - Stand-alone versus integrated at mine site
- Site acid requirements
- Regional acid market
  - Availability and cost
- Acid neutralizing material
  - Availability and cost
The Copper Processing Technology Today

- Mine
- Primary Crushing
- Sec/Tert Crushing
- Milling (Chalcocite) (Chalcopyrite)
- Solution Extraction
- Smelting
- Electro-Refining
- Electro-Winning
- Customers

Flowchart:
- Stockpile Leaching (Oxide) (Chalcocite)
- Acid

Steps:
1. Mine
2. Primary Crushing
3. Sec/Tert Crushing
4. Milling (Chalcocite) (Chalcopyrite)
5. Solution Extraction
6. Smelting
7. Electro-Refining
8. Electro-Winning
9. Customers

Inventory:
- Stockpile Leaching (Oxide) (Chalcocite)
- Acid
Real TC/RCs and Copper Prices ($2002)

Copper Prices (¢/lb)  | Japanese TC/RCs  | TC/RCs (¢/lb)

- Copper Prices
- TC/RCs
- Linear (Copper Prices)
- Linear (TC/RCs)
TC/RCs versus Price


\[ y = 0.1401x + 10.415 \]

\[ R^2 = 0.7257 \]

Copper Price - ¢/lb (Constant 2002$)

TC/RC - ¢/lb (Constant 2002$)
Forecast Real TC/RCs as a Percentage of Copper Price

Source: Brook Hunt

(Cu kmt)

- Others (9%)
- Indonesia (21%)
- India (21%)
- China (49%)

Source: Brook Hunt
Near-Term Shortfall in Copper Supply

Source: Brook Hunt

- Shortfall in mine production expected to be filled by concentrate production
- Existing concentrate production w/ majority of restarts & all financed projects

Scrap/Other
SX/EW Production
Copper Consumption
Concentrate Production
SX/EW New Production
Primary Smelter Capacity vs. Mine Production

(Cu kmt)

- Smelter Capacity
- Smelter Production
- Mine Production

Source: Brook Hunt

82% 84% 86%
Phelps Dodge Copper Pressure Leaching Developments

Phelps Dodge (& Placer Dome) have developed a suite of proprietary processes, including:

- **High temperature process (HT)**
  - Converts essentially all sulfide sulfur to acid
  - Maximizes acid production
  - Suitable for locations where dilute acid can be used beneficially

- **Medium temperature process (MT)**
  - Converts a significant portion of sulfide sulfur to elemental sulfur
  - Lower oxygen costs
  - Minimizes acid production
  - Suitable for locations where dilute acid cannot be used beneficially
Phelps Dodge Concentrate Leaching Milestones

- **2Q 1998**: Sulfate-based concentrate leaching development started
- **1999-2000**: Batch testwork at Hazen Research, Dawson and Phelps Dodge Process Technology Center
- **2000-2001**: Continuous Pilot Plant Testing
- **3Q 2001**: Technology Development Agreement executed with Placer Dome
- **Nov 2001**: Bagdad HT Project approved
- **Nov 2001**: Engineering awarded to Kvaerner
- **Mar 25, 02**: Construction started by KIC
- **Mar 6, 03**: Wet commissioning begun
- **Mar 20, 03**: Start-up: First concentrate feed
- **July 2003**: All design parameters met, steady state operation

Four years from first testing to commercial demonstration
Phelps Dodge Concentrate Leaching Milestones (cont.)

- April 2004 Bagdad MT-DEW Conversion approved
- July 2004 Construction of MT-DEW started
- 1Q05 Commissioning of MT-DEW scheduled
Concentrate Leaching – Alternative to Smelting & Refining

Offers full cost benefit of $0.05-0.10/lb over smelting & refining
Bagdad Concentrate Leach Plant

August, 2003
Concentrate Leach – Performance Summary

- Operated since March 2003
  - 18 months continuous operation

- All key design criteria achieved
  - Above design throughput
  - Above design availability
  - Above design copper extraction
  - Operating costs in line with expectations

- Demonstrated technical and economic viability of high temperature process in the appropriate application, where the dilute acid can be used beneficially
Bagdad Concentrate Leach - Copper Production

Production (tonnes)

Production (metric tons) Design Basis Production
Start-up Data (adapted from McNulty, 1998)

% of Design Capacity

Months Since Commissioning

Bagdad: 
BCLP 3 Mo. Avg.: 
Category 1: 
Category 2: 
Category 3: 
Category 4:
Potential to provide additional full cost benefits of up to $0.05/lb copper over high temperature process (i.e. $0.10-0.15/lb total benefit)
Concentrate Leach - MT-DEW-SX Process

Concentrate

Super-fine grind

Pressure Leach

Tails

DEW

SX

EW

PLS from stockpile leach

Stockpile Leach

Cathode Cu
Concentrate Leach – The Path Forward

- Conversion of Bagdad to medium-temperature and direct electrowinning mode of operation under consideration
  - Construction started in 3Q04
  - Start up scheduled in 1Q05
  - Commercial demonstration complete by 4Q05
Phelps Dodge Concentrate Leaching Developments

- High temperature (>200ºC) and medium temperature (140-180ºC) pressure leaching in sulfate media
- Low cash cost alternative to smelting and refining
- Safe, environmentally-sound
- Acid balance is a critical cost driver
- Concentrate, cathode and acid freight considerations
- Ability to utilize existing SX and EW capacity
- Utilize existing infrastructure
Production Decisions Impacted by Concentrate/Acid Balance

North American Concentrate
- Bagdad
- Sierrita
- Chino (partial capacity)
- Cobre
- Morenci (off line)

North American Leach
- Morenci
- Bagdad
- Sierrita
- Chino
- Tyrone (partial capacity)
- Miami (partial capacity)

External concentrate source

Chino Smelter
650,000 tpy capacity (off line)

External acid source

Miami Smelter
750,000 tpy capacity (operating)

External acid consumer

Candelaria concentrate

External concentrate source

Candelaria
concentrate

October 25th, 2004
Concentrate Leach – Potential Applications

- **Morenci**
  - Preliminary feasibility study in progress
  - Scheduled for completion 4Q04

- **Cerro Verde primary sulfides**
  - Preliminary feasibility study scheduled for 1Q05

- **El Abra primary sulfides**

- **Other**
Copper Pressure Leaching – Critical Success Factors

- TC/RC market conditions
  - Long term view?
- Ability to understand and exploit acid balance at site(s)
- Materials of construction
- Operating control
  - Mineralogy
- Competitive advantage
  - Speed of implementation
  - Scale of implementation
  - Ability to apply to greater proportion of production
- Other technical developments
  - Improve capital and operating costs
- Environmental permitting
- Intellectual property
  - A complex environment