

Technology Development for *Arsenic* Treatment in JX Nippon Mining & Metals Group

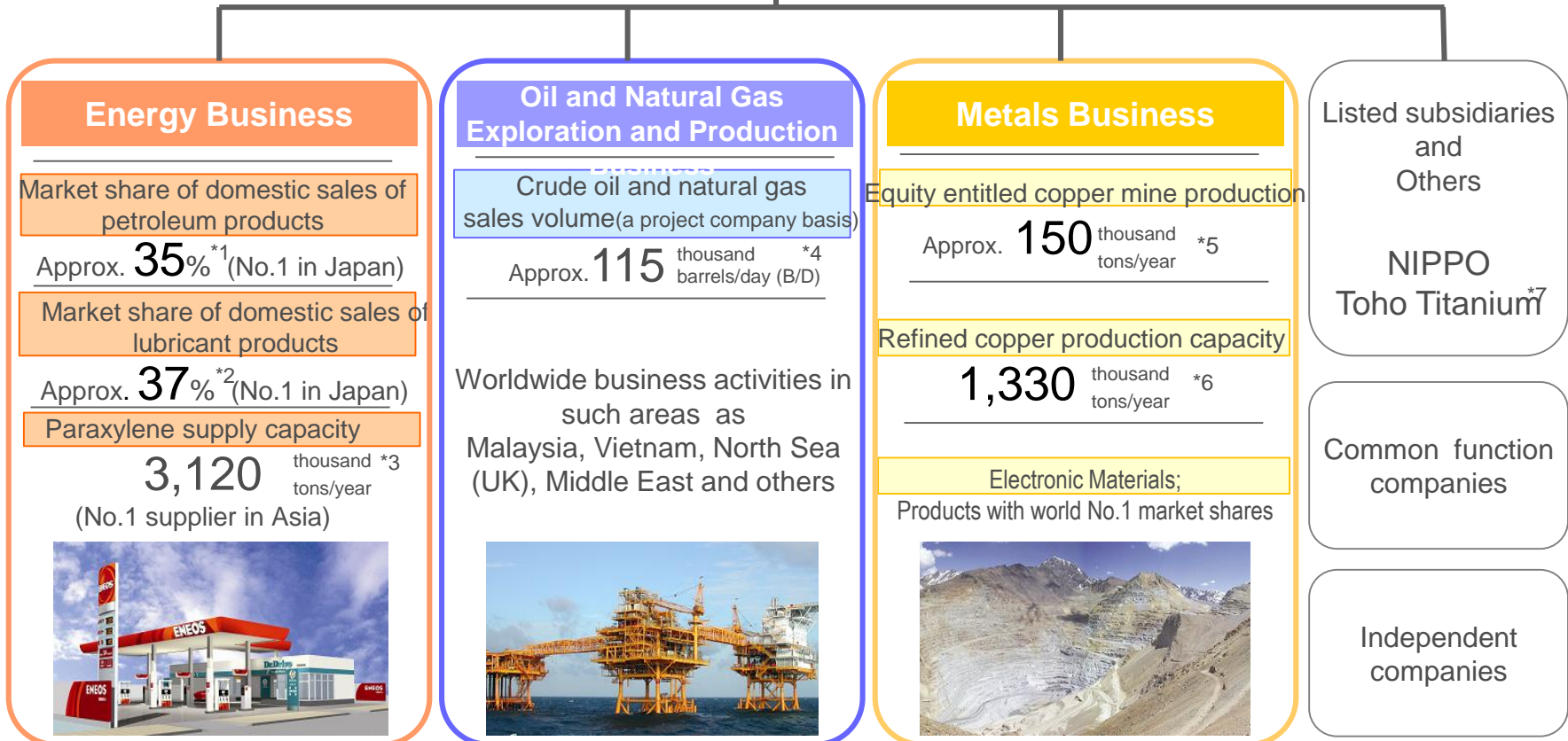
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 - *Arsenic* immobilization
 - *Arsenic* sulfide
 - Biological Scorodite

Introduction

- Summary of JX Group's Businesses



*1 FY2014 actual *2 FY2014 actual *3 As of Mar. 2015
 *4 Crude oil equivalent (average daily production from Jan. to Dec. 2014 actual)
 *5 Equity entitled copper production contained in copper concentrate (CY2014 actual)
 *6 Pan Pacific Copper (67.6% equity stake) ; 650 thousand tons/year + LS-Nikko Copper (39.9% equity stake) ;680 thousand tons/year (As of Mar. 2015)
 *7 Profit and loss of Toho Titanium is included in the Metals Business.

Introduction

- Business Overviews of JX Nippon Mining & Metals



Introduction

- Smelting Business

No.1 copper producer in Japan



Operation site	Capacity ^{*1}	JX NMM's share
Saganoseki (Oita, Japan)	450 kt ^{*2}	66%
Tamano (Okayama, Japan)	200 kt ^{*3}	41.9%
LS-Nikko Copper (Onsan, South Korea)	680 kt	39.9%
Total	1,330 kt	

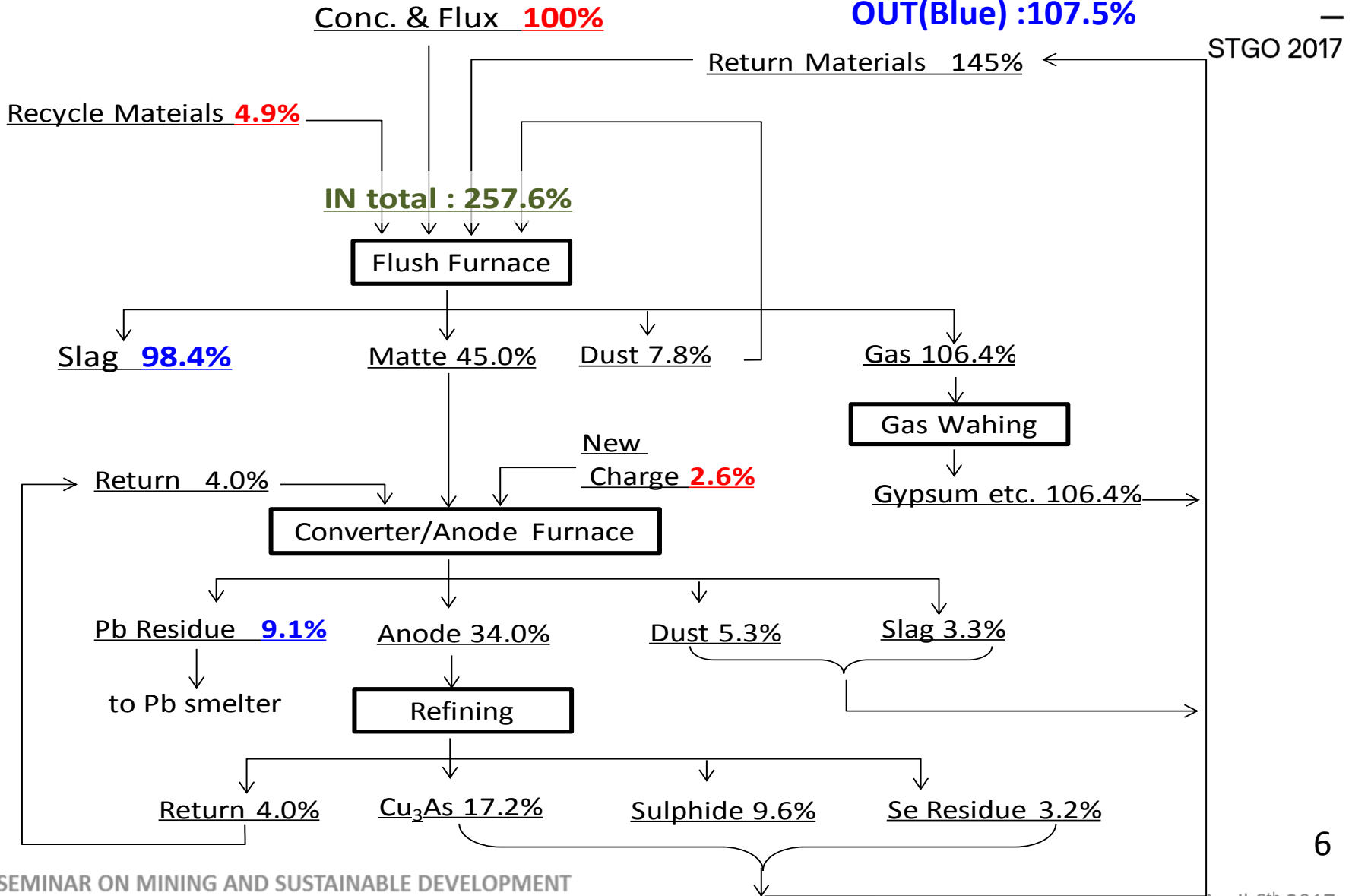
*1 Annual production capacity of refined copper

*2 Including refining process at Hitachi Works

*3 Pro-rata share of capital participation

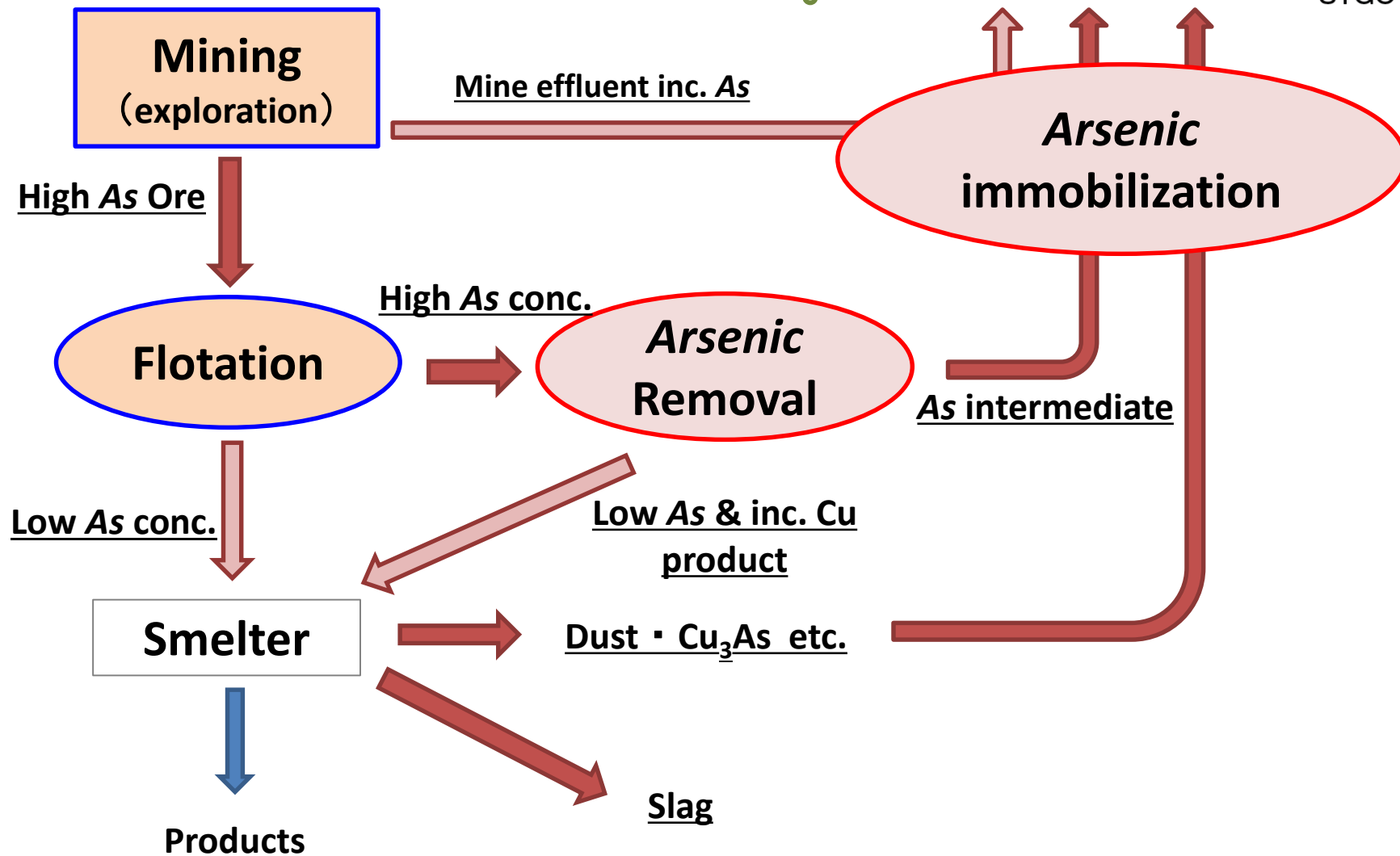
As distribution in smelter

IN(Red) :107.5%
OUT(Blue) :107.5%

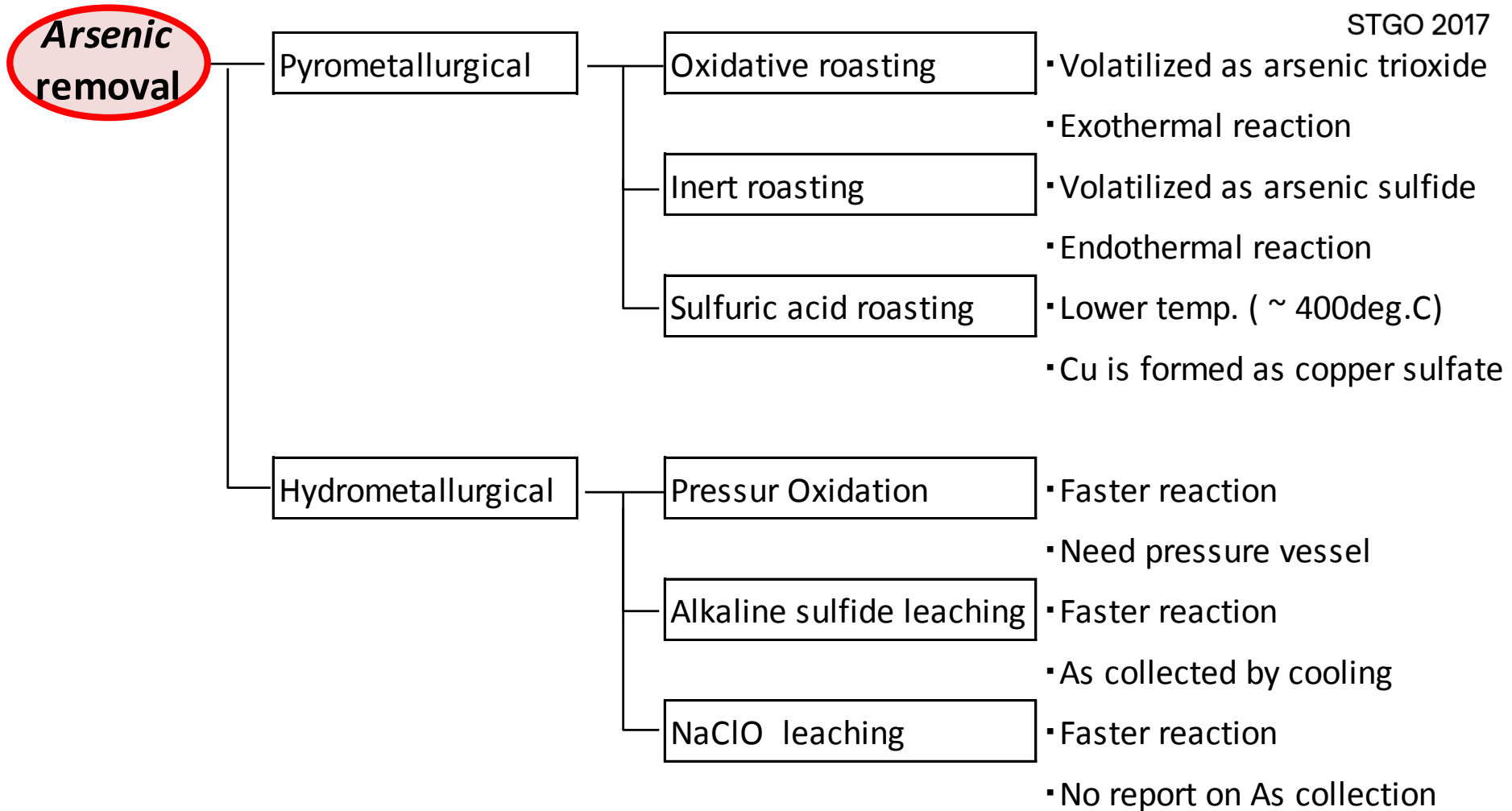


Measures for High *Arsenic* Ore

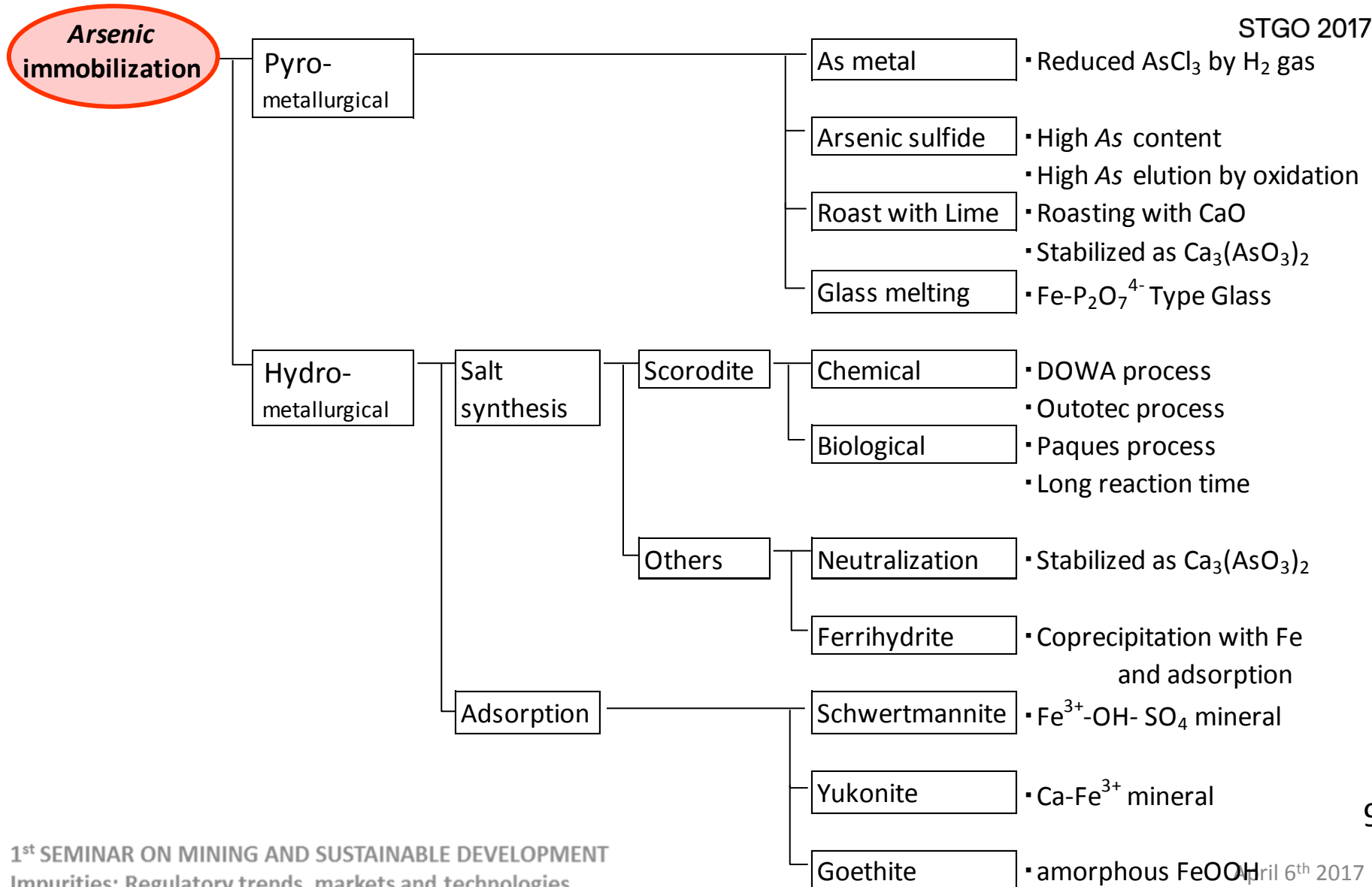
As storage - custody



Arsenic removal



Arsenic immobilization



Premise

Selected Technology

Arsenic removal

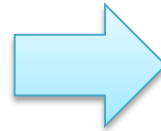
- Collected copper as sulfide
- Low As in collected material
- Low cost



- Inert roasting
Copper : CuS_2 , Arsenic : As_2S_3
- Alkaline sulfide leaching
Copper : Cu_2S , Arsenic : Na_3AsS_4

Arsenic immobilization

- Low cost
- High As density in material
- Lower elution



- *Arsenic sulfide*
For collected As
from inert roasting
- Biological scorodite

Arsenic removal

- Inert Roasting
- Alkaline Sulfide leaching

➤ Inert Roasting

(Technical overview)

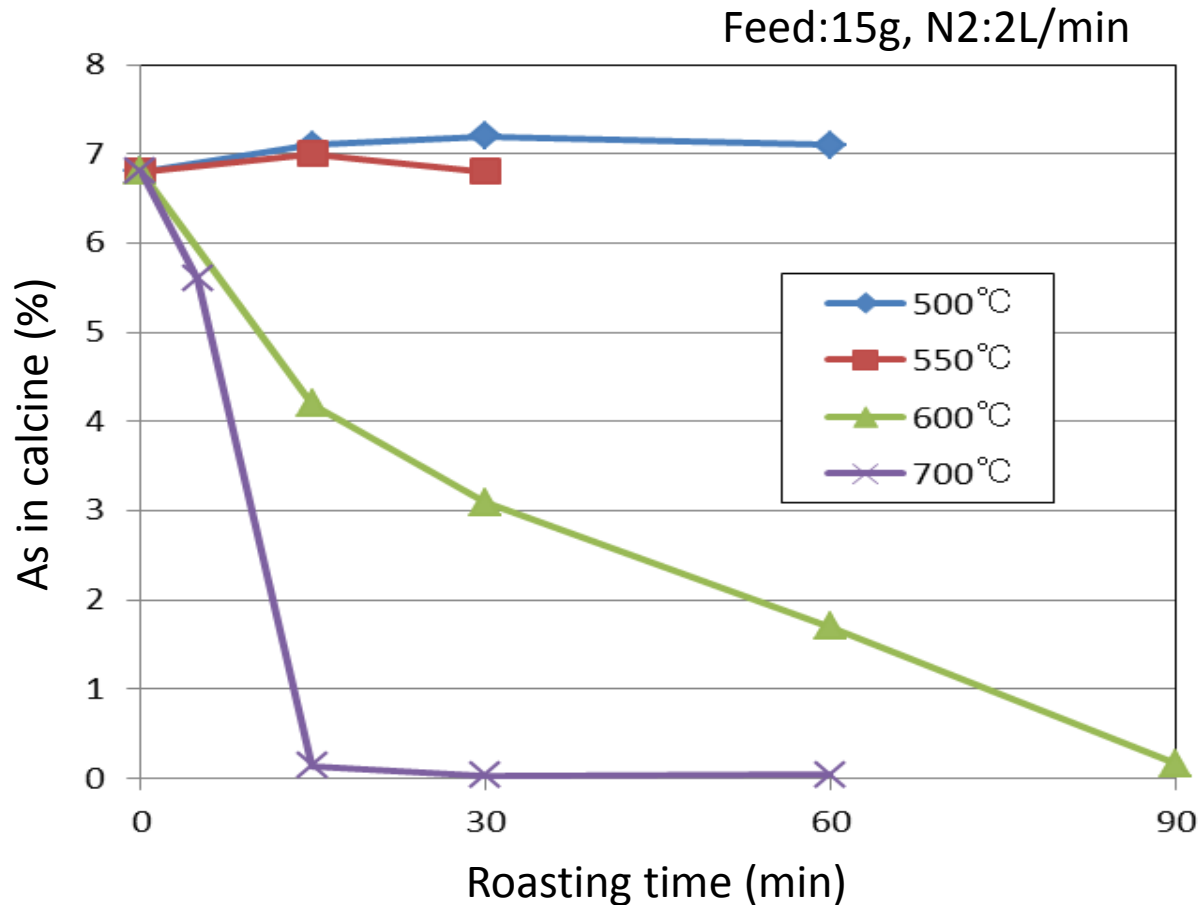
- Thermal decomposition under N_2 atmosphere.
- Arsenic is separated as As_2S_3
- Collected excess sulfur as S_2 gas.

(Achievements)

- As content of calcine reached under 0.1%
Temp. is over $700^\circ C$,
Reaction time is 15~30min
- Collected As is mixture of amorphous As sulfide and S^0
- Cu is collected as sulfide

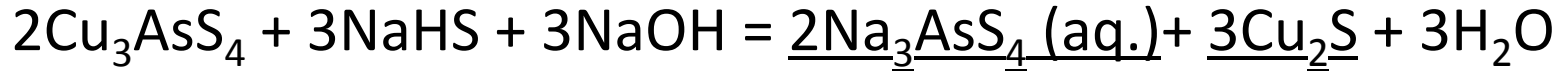
➤ Inert Roasting

- Effect of temp. and time -



➤ Alkaline Sulfide leaching

(Technical overview)

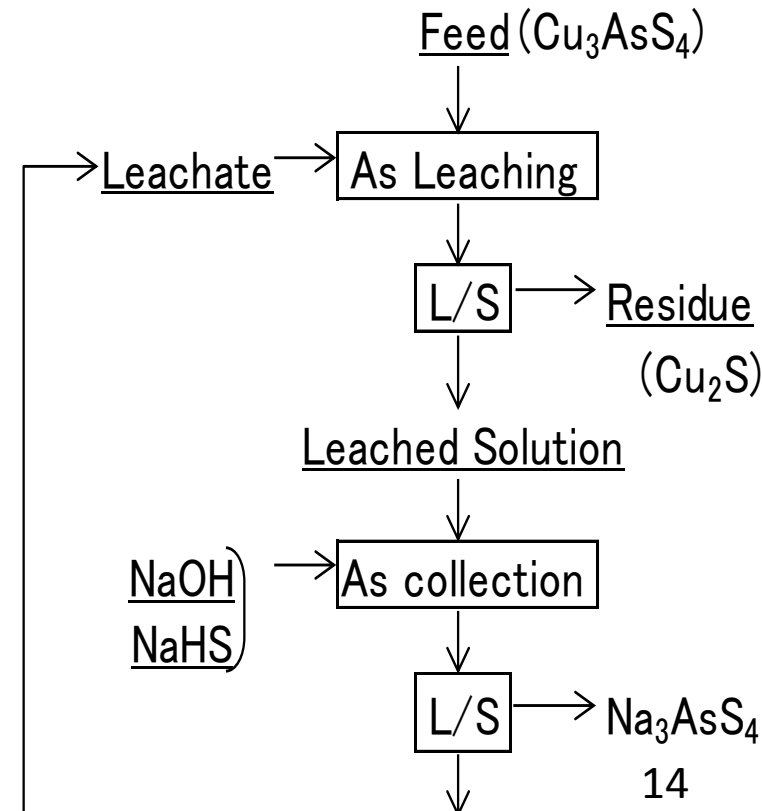


- Arsenic is dissolved and copper is precipitated as sulfide
- Cooling of solution in order to collect As compound

Temp. : leaching 80°C
collection 20°C

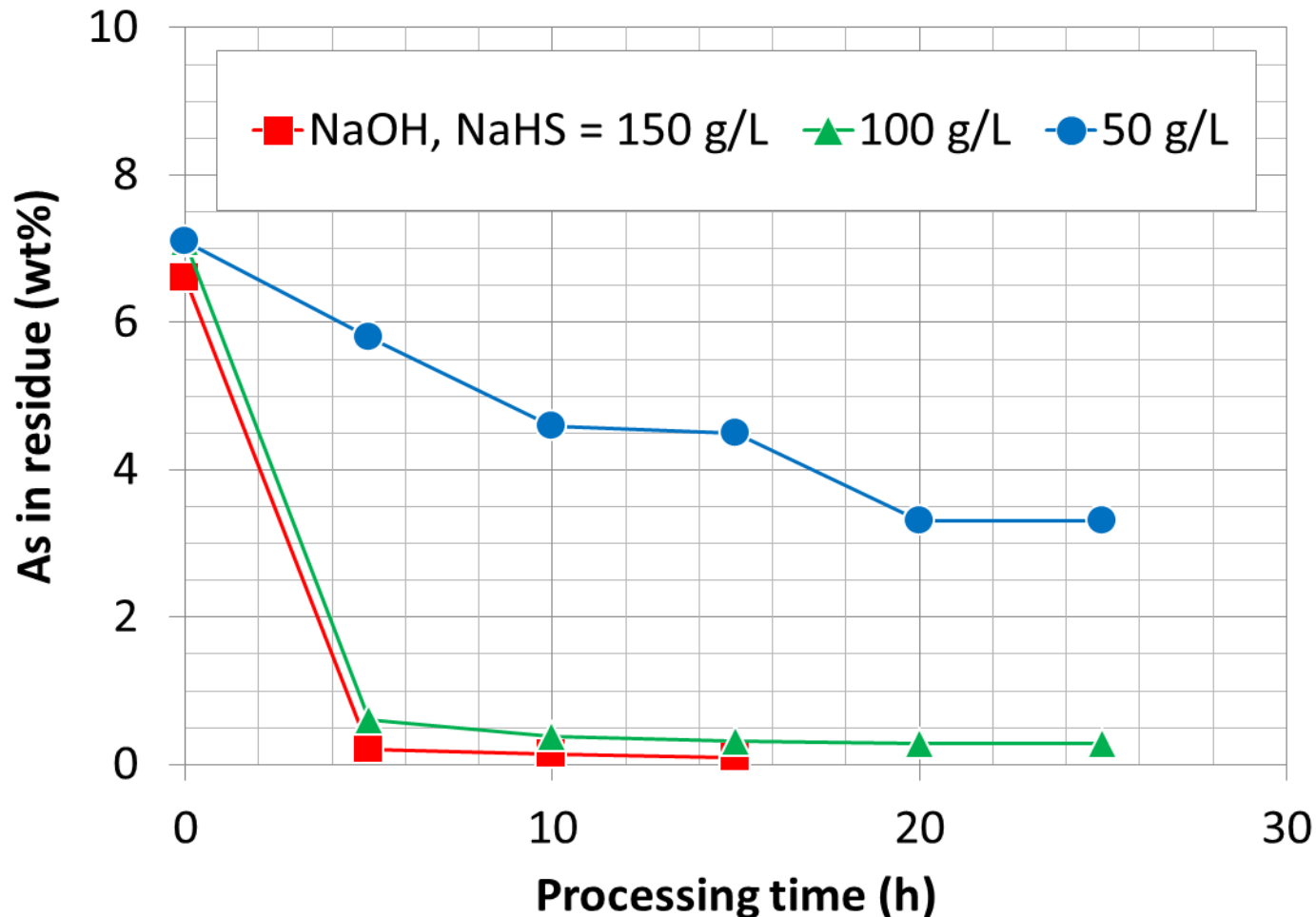
(Achievements)

- As content in residue reached to 0.2%
- Confirmed circulation using of solution



➤ Alkaline Sulfide leaching

- Effect of NaHS and NaOH concentration



Arsenic immobilization

- *Arsenic* sulfide
- Biological scorodite

➤ Arsenic Sulfide

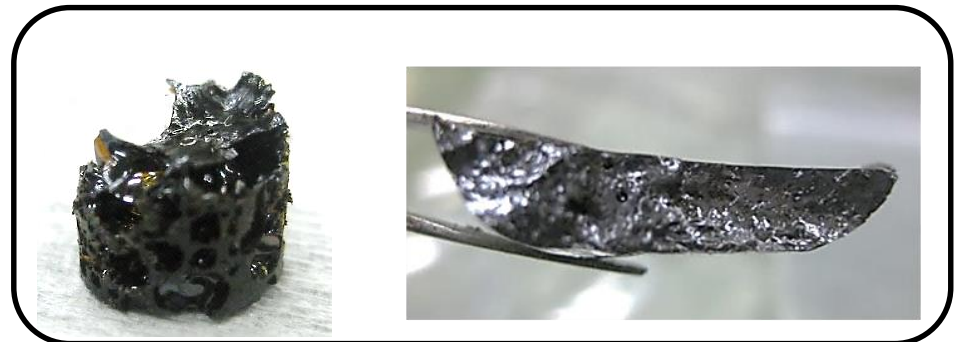
(Technical overview)

- For storage of collected As from inert roasting
- Heating over 250°C to melt
- Melting provides less volume and lower elute concentration.
- Adjusting S/As ratio to reduce As eluting
 - TCLP test results reach As 0.2 mg/L

**As-S mixture collected
from inert roasting**



After melting



➤ Biological scorodite

(Technical overview)

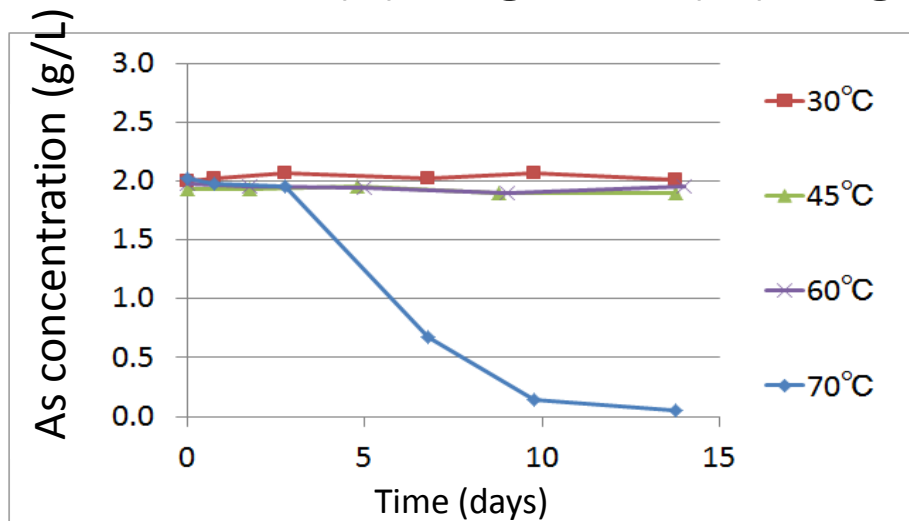
- Fe(II) and As(III) are oxidized by bacteria work
to produce scorodite ($\text{FeAsO}_4 \cdot 2\text{H}_2\text{O}$)

- Conditions

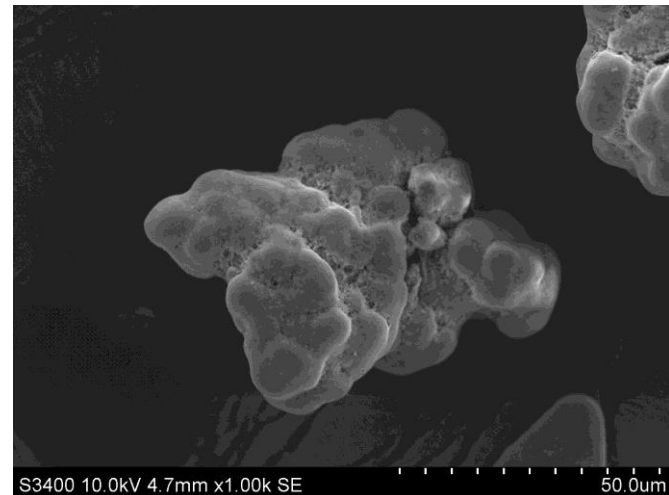
Bacteria: *Acidianus brierleyi*

Optimum temp. : 70°C

Fe(II) = 2g/L , As(III) = 2g/L, pH = 1.5



Effect of Temp.



Biological scorodite

Summary

- JX-Nippon Mining & Metals is developing technology for *arsenic* removal and *arsenic* immobilization.
 - Inert roasting
 - Alkaline sulfide leaching
 - *Arsenic* sulfide
 - Biological scorodite

- There are several technologies for *arsenic* treatment. These can be combined and optimized for each cases.

- We believe that we can select better process by proceeding with development in cooperation with mining side.

Thank you for your attention