Urban mining

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U.M. was defined by Prof. Nanjo, Tohoku univ. at 1988.

- “Urban Mining; orientation of recycling from comprehensive view of resource” Bulletin of Research Inst. of Mining, Dressing & Metallurgy, Tohoku Univ. 43(1988)239-251
- He considered the manufactured product accumulated on the ground to be a resource, and named the accumulated places Urban Mine.

exploration: generation after use can beprehensible

grade: higher than ore because of intensive use

energy: possibility of saving energy for reduction

environment: prevention of diffusion of hazardous element and damaging landscape
電子機器内の基板（都市鉱石）には様々な部品が存在します。それぞれの部品の中には、希少、有価な金属が含有しています。一例として携帯電話の基板を示します。
**Urban mine**

Country’s accumulation can be estimated by considering metals which transported in products.
わが国の都市鉱山蓄積は、
世界の年間消費を地球何個分まかなえるか

日本の都市鉱山蓄積量 / 世界の年間消費量

Au  6.8kt
Ag  60kt
Cu  38Mt
Fe  1.2Gt
Pb  5.6Mt
Sn  660kt
Co  130kt
PGM 2.5kt
V  140kt
Li  4.4kt
Ta  1.7kt
In
Japan has great possibility of urban mining because Japan has developed with integrating resources from all over the world.
Colaboration team since 2008

From viewpoint of resource
Recycling material is “goods”

From viewpoint of waste management
Recycling material is “bads”

Local government

- Collection measure
- Recycling technology
- Hazardous management
- System construction

- METI
- MOE

Akita Ibaraki Fukupka
Tokyo Osaka Kyoto Nagoya

collector Dis-assembler separator smelter
センター持ち込み

目的の前で破解（物材機構の技術）

基板（緑と銅色）

磁石

モータ

まとめて粗選別（簡単、雇用対策）

国環研or筑波大

効果評価

物材機構

技術指導

買い物取り

本選別

貴金属再生へ

他金属再生へ

物材機構新技術

タングステン回収

その他 不燃物

NIMS

物材機構

技術指導
リサイクルの二つの側面
リサイクルにはgoodsとbadsの2側面があり、循環型社会形成基本計画などではbads対策の側面が強く表に出ている。

製品（goods）

bads

天然資源採取の削減

goods

資源の再利用

最終処分の減量
有害物質の管理
As the climate change is getting important, therefore, we need to take care of other risks. Catastrophe comes from neighboring risks.
Causes of resource risk

- Pursue of wealth of 80% people in the world
- Demand from new technologies of eco-innovation
Fe-type: weakly de-coupled
Al, Ni, Mo, Ag, Sb

Zn-type: de-coupled
Cu, Sn, Pb, W, Cr, Mn, Au

Si-type: still coupling    Pt, Co

R.E.-type: further coupling    Li, In, Ga

Four types of the two step line model of metal consumption v.s. GDP per capita
Several times amount of reserves will be required by 2050.

It will be close to the amount of reserve by 2050: Fe, Mo, W, Co, Pt, Pd

It will require several times amount of reserve by 2050: Ni, Mn, Li, In, Ga

It will run over the amount of reserve base by 2050: Cu, Pb, Zn, Au, Ag, Sn

Eco-innovation requires new demand of rare materials.
Mined material (resource view)

Top of mount Fuji
10Gton

mount Fuji
100Gton

two mount Fijis
215Gton

Extracted metal (consumer view)

A 25m pool
Pt

An Olympic pool
Au

1500 Pentagons
Fe
20 Giga tons/year are mined at the resource end. Increasing at the rate of 560 million tons per year.

1.5 times serious than in 1960-70s
\[ y = 441x + 6,921,315 \]
\[ y = 1406.1x \]
\[ y = 17,967,817 \]
Lifestyle change into “Factor8” is required!
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石垣島宣言

材料はこれまで人類社会の発展に貢献してきました。しかし、その一方で大量生産・消費・廃棄を通じて環境負荷を増やしてきたことも指摘されています。
現在、人類活動の更なる発展を求めて材料への要求が一層高まってきています。そのために、材料に係わる資源リスク*も急速に増大しようとしています。
そこで、材料を持続可能な社会の構築に役立てることを目指す私たちは、資源利用に関する以下の3原則の重要性を再確認します。

資源利用の3つの原則

資源を枯渇させない
環境リスクを増やさない
地域的世代的公正に配慮する

また私たちは、材料を利用し使用する全ての人々に、この原則に則った以下の4つの実践を呼びかけ、私たち自身も、これらを具現化する材料技術を開発していく決意を表明します。

資源利用の4つの実践

使わずにすむものは使わない（Reduce）
丁寧に使う（Reuse）
何度も使う（Recycle）
ありふれたものを使う（リプレイス）

Http://www.nims.go.jp/ecomaterial/hal/MR/
DECLARATION OF ISSEM 2007 at ISHIGAKIJMA

While materials play an essential role in the development of human society, their negative aspects of environmental burden through the massive production, consumption, and disposal have been pointed out. The demand for materials is now expanding further in order to satisfy growing human needs. It may cause a rapid increase in the resource risk. We, who aim to utilize materials to construct a sustainable society, reconfirm the importance of the following three principles.

Three principles in the area of resource use
- Resource Conservation
- Environmental Protection
- Regional and Generational Equity

Based on these principles, we ask you, consumers of materials, to observe the following four practices. We also pledge ourselves to advance technologies which realize these four practices in material research.

Four practices in the area of resource use
- Use minimum quantity
- Use completely
- Circulate as many times as possible
- Use abundant resources

International Symposium of Sustainable Energy and Material was held at 2007 at Ishigaki Island, Japan to discuss the contribution of materials science and engineering to sustainable use of energy and resource.
Some metal has more on-surface stock than underground stock

Secondary Stock
On surface stock

Primary Stock
underground stock (reserve)

Au (t) : 69%

Ag (kt) : 70%

Cu (Mt) : 48%
Annual products 26 million

In use 100 million

New 5 million

Replaced 21 million

In-use stock

About 7 mg Gold is contained 700 kg Au is in use.

6.5 million phones are recycled.

50 kg

We have not yet explored the vein of urban mine.

Recovered from Used stock

50 kg

Major part of urban mine is dissipated stock.

6.5 million phones are recycled.

100 kg

But, at the current status,

We have a lot of things to do!!
Challenge of urban mining

Challenge to mass: dilutely distributed
- Natural mine is the result of many years concentration

Challenge to grade: problem of waste from U.M.
- As, Br, Cd etc. are contained

Challenge to cost: disassembling and pretreatment
- Requirement of cheap process superior to human’s discrimination
| Metals per unit are not so expensive |
|------------------------------|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Camcoder | audio | camera | MD Player | CD Player | LCD TV | DVD player | Table Telephone | car navigation | mobile game | Smart Audio | Cell phone | |
| ¥/unit | 150 | 372 | 110 | 108 | 67 | 70 | 32 | 10 | 21 | 66 | 43 | 119 |
| Co | 0.04 | 0.16 | 0.04 | 0.04 | 0.02 | 0.01 | 0.02 | 0.04 | 0.01 | 0.45 |
| Ni | 1.90 | 6.99 | 2.86 | 1.54 | 1.15 | 0.60 | 0.43 | 0.18 | 0.79 | 2.80 | 0.38 | 2.34 |
| Cu | 4.21 | 28.97 | 12.75 | 6.15 | 3.74 | 10.88 | 4.17 | 0.71 | 6.90 | 8.32 | 1.50 | 5.01 |
| Zn | 0.07 | 0.52 | 0.25 | 0.06 | 0.10 | 0.48 | 0.04 | 0.03 | 0.08 | 0.13 | 0.01 | 0.09 |
| Mo | 0.12 | 0.01 | | | | | | | | | | |
| Pd | 40.07 | 12.33 | 3.08 | | | | | | | | | |
| Ag | 7.12 | 32.74 | 10.61 | 6.21 | 6.37 | 3.18 | 2.43 | 1.58 | 3.18 | 2.73 | 1.70 | 5.62 |
| Sn | 1.27 | 8.47 | 2.11 | 2.01 | 2.32 | 3.16 | 0.85 | 0.51 | 0.95 | 2.12 | 0.28 | 0.93 |
| Ta | 2.82 | 6.26 | 0.94 | 0.31 | 0.63 | | | | | | | |
| W | 0.01 | 0.07 | 0.01 | | | | | | | | | |
| Au | 77.32 | 274.90 | 51.54 | 85.91 | 51.54 | 25.77 | 17.18 | 3.44 | 8.59 | 34.36 | 37.80 | 96.21 |
| Pb | 14.87 | 7.48 | 16.24 | 1.97 | 0.79 | 23.48 | 5.91 | 3.47 | 0.25 | 14.87 | 0.8 | 3.96 |
| Bi | 0.08 | 0.04 | 0.04 | 0.01 | 0.01 | 0.02 | 0.01 | 0.01 | 0.04 | | | |
1) material flow in the era of mass production

- Large scale waste
- Product materialize
- Request materialize
- Materialization of property
- Accumulation of consumer of materialized product
- Select many variety of requests
- Service materialize
- The request materialize
- Many variety of request
- Large scale production

2) material flow in the era of dematerialization

- Less resources, circulation of materials
- Materialize the request
- Customize appropriate presentation of request
- Less waste
- Consumer or prosumer of service
- Satisfaction and content
- Production
summary

• Resource risk is near at hand

• We are at the entrance where secondary resource is more than underground resource.

• For effective urban mining, recyclable design is the master card

• Circulation chain (material leasing system) should be constructed.