
Komatsu IR – DAY 2018

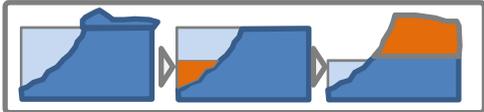
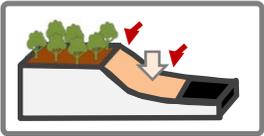
Overview of Underground mining business

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- Mineral resources are generated through several geologic effects.
- Coal is usually categorized as Soft Rock, while other minerals such as Ferrous and Non-Ferrous are called as Hard Rock.

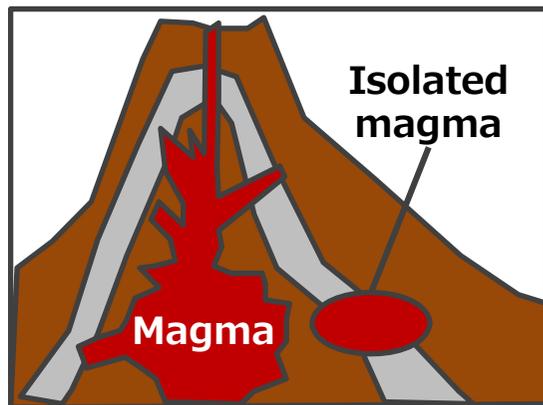
#	Generation of deposits		Major Mineral Resources		
①	Generated from Magma 	Magmatic deposit	Platinum, Chromium, Titanium, Magnetite	Hard Rock	Igneous rock
		Hydrothermal deposit	Gold, Copper, Silver, Lead, Zinc, Tin, Tungsten, Molybdenum, Uranium		
②	Sedimentation/Weathering/Erosion 		Hematite, Nickel, Boxite, Lithium, etc	Soft Rock	Sedimentary rock
③	Geothermal effect/Crustal rising 		Coal		- *1

※1 Coal is not defined as “rock” in geological respect.

- Minerals derived from magma were generated in the depths of underground.
 - 1) In case deposits exist beneath and relatively near from ground level, Open Pit Mining/Strip Mining methods are adopted.
 - 2) In case deposits exist in the depths below geological formations, Underground Mining methods are adopted.
 - 3) Open pit mines might shift to underground methods as they get deeper.

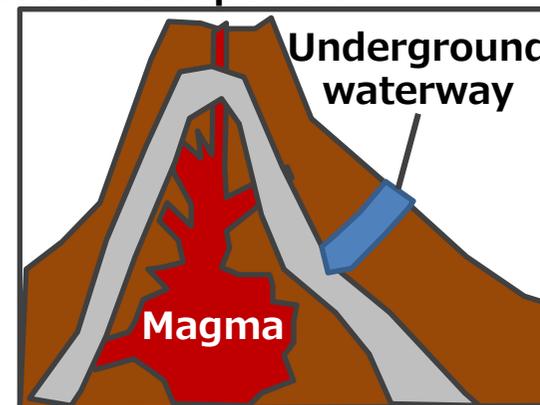
1. Magmatic deposit

- 1) Typical minerals:
Platinum, Chromium, Titanium, Magnetite, etc.
- 2) Generation process
 - In case Magma is slowly cooled, melted metal sulfide (containing Platinum, Chromium, Titanium or others) had been separated and concentrated by specific gravity and generated deposit.



2. Hydrothermal deposit

- 1) Typical minerals:
Gold, Copper, Silver, Lead, Zinc, Tin, Tungsten, Molybdenum, Uranium, etc.
- 2) Generation process
 - Hydrothermal mineral solution (containing metal elements) had been pushed up by high vapor pressure, precipitated and filled chasms in and generated deposits.



- Sedimentary rocks exist widely on the earth, where Open pit / Strip Mining methods are mainly adopted.
- Coal is generated from sediment of plant fossil, which is explored both by Strip Mining and Underground Mining.

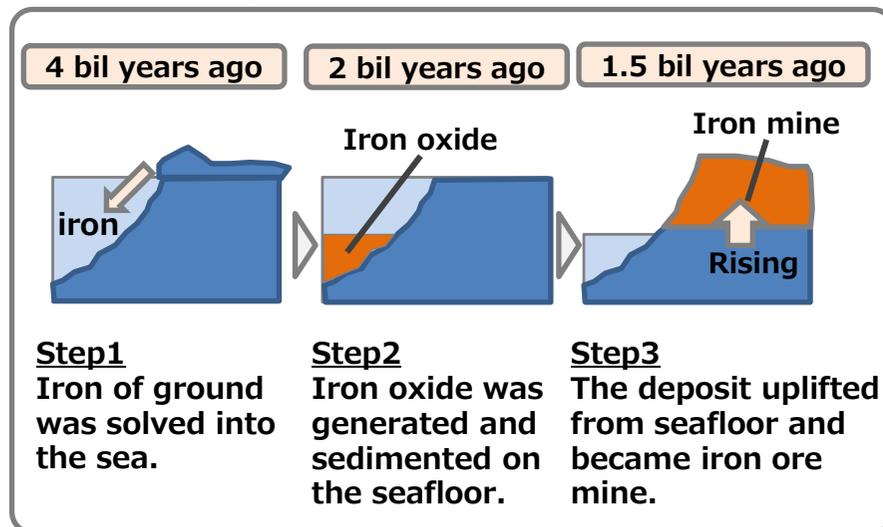
1. Sedimentation/Weathering/Erosion

1) Typical minerals:

Hematite/Nickel/Boxite/Lithium/Phosphate/others

2) Generation of Hematite

•Cyanobacteria had oxidized iron in the sea and made iron rust, which had sedimented in the bottom of the ocean, made deposit of hematite, and then rose up to appear above the ground level.

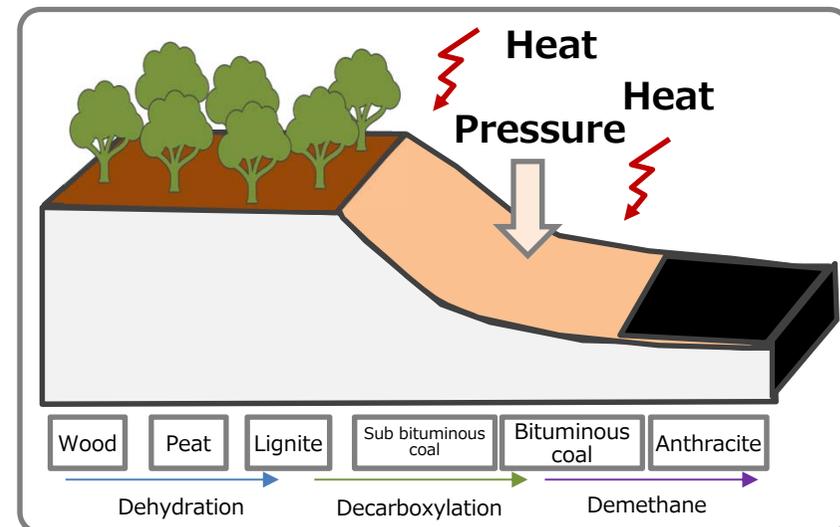


2. Geothermal effect/Crustal rising

1) Typical minerals: Coal

2) Generation of coal

•Fossil of plants sedimented and generated peat. Physical pressure & heat processed dehydration & decarboxylation in the long period, and evolved: peat→lignite→ sub-bituminous coal→bituminous coal→ anthracite, having increased calorie in the above order.



- Komatsu became a full line equipment supplier in IN-PIT operation through the acquisition of KMC in 2017.
- Today, we will explain UG business.



For Surface mining								For Underground mining						
Bulldozer	Motor grader	Dump truck	Hydraulic Excavator	Mechanical Wheel Loader	Elec. Wheel Loader	Rope Shovel	Drill	Drag line	Continuous Miner	Truck	Roof Support	Road header	Shearer	LHD
✓	✓	✓	✓	✓										
					✓	✓	✓	✓	✓	✓	✓	✓	✓	✓

Notes:
 KOMATSU
 KMC (JOYGLOBAL)

- UG Soft Rock methods are consisted of “Longwall” and “Room & Pillar”.
- Room & Pillar is the oldest method. Rooms are dug progressively in a grid and mineral is extracted. For safety purpose, a part of the mineral layer is left to serve as pillars, which supports the roof as the extraction proceeds. It is highly cost efficient (initial investment and maintenance costs). However, the part of the mineral retained in the pillars cannot be mined and will become lost opportunity.

1.Machines

1) Continuous Miner



- Excavate room

2) Mobile Bolter



- Reinforce aisle and pillar

3) Shuttle Car



- Convey excavated coal

4) Feeder Breaker



- Grind excavated coal

5) Flexible Conveyor Train

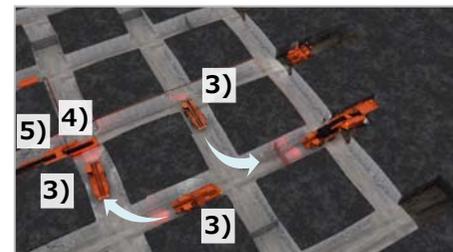


- Haul the coal to outside.

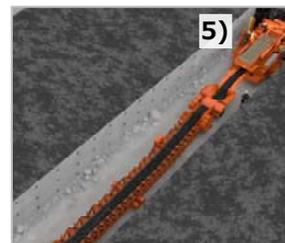
2.Methods (Detailed)



- 1) Continuous Miner will excavate room.
- Room will be reinforced by 2) Mobile Bolter.



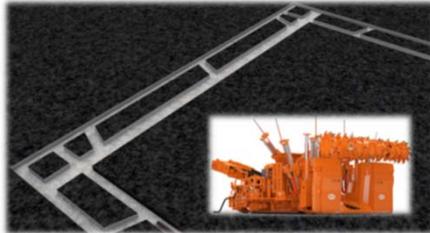
- Coal will be hauled by 3) Shuttle Car to 4) Feeder Breaker and grinded.



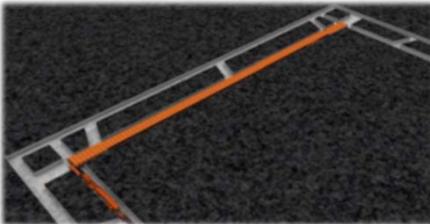
- Excavated coal will be hauled by 5) Flexible Conveyor Train to outside.

- Longwall is one of the development approach for the underground mining and this is basically suitable for soft rock (coal). This approach will prevent rock fall by supporting the ceiling, and to carve the coal line by line, carrying out carved rocks by Conveyor
- Initial cost is higher than Room and Pillar, but it can continuous excavation and it has High productivity.

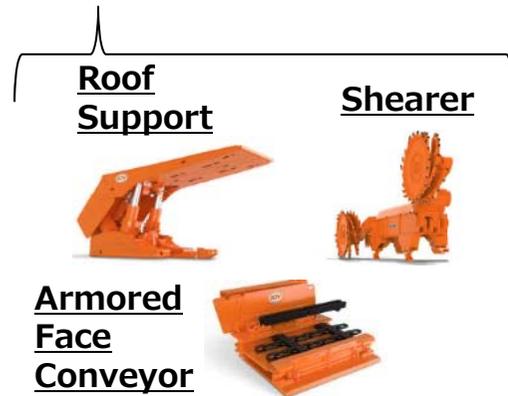
1. Advance preparation



- At first, Entry drivers will excavate entry tunnel.



- After developing aisle, the equipment is set up to excavate and convey coal
- The equipment is composed of 3 parts



- "Roof Support" the machine supporting the ceiling, "Shearer" the one carving the coal layer, and Conveyor which is also called "Armored Face Conveyor" is the one shipping the rock

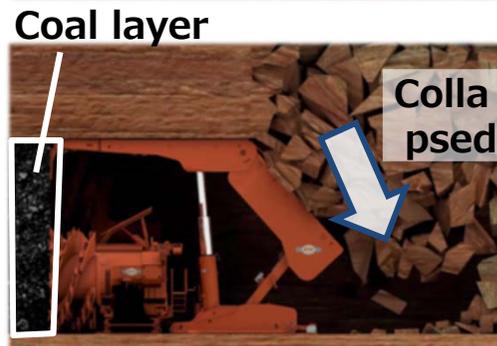
2. Coal excavation



- Shearer will excavate coal layer.
- After that, Armored Face Conveyor will haul excavated coal.



- After excavated one row, the equipment move forward.

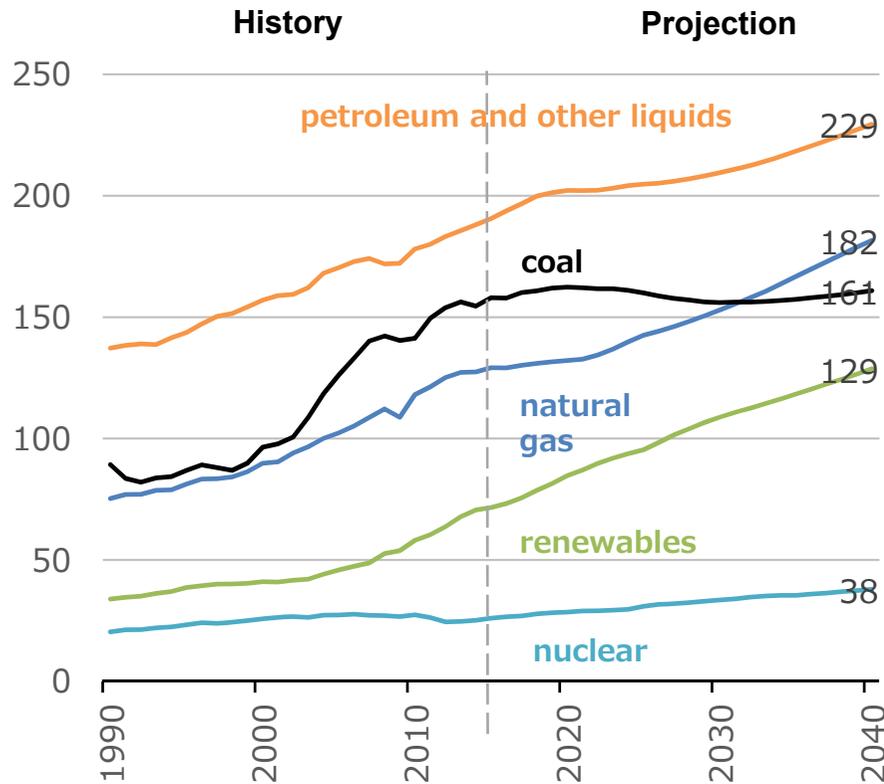


- Collapsed at the back.

- Coal demand for electricity generation is forecasted still stable.
- Komatsu continues to provide for coal customers much higher quality products and services and fulfill social responsibility.

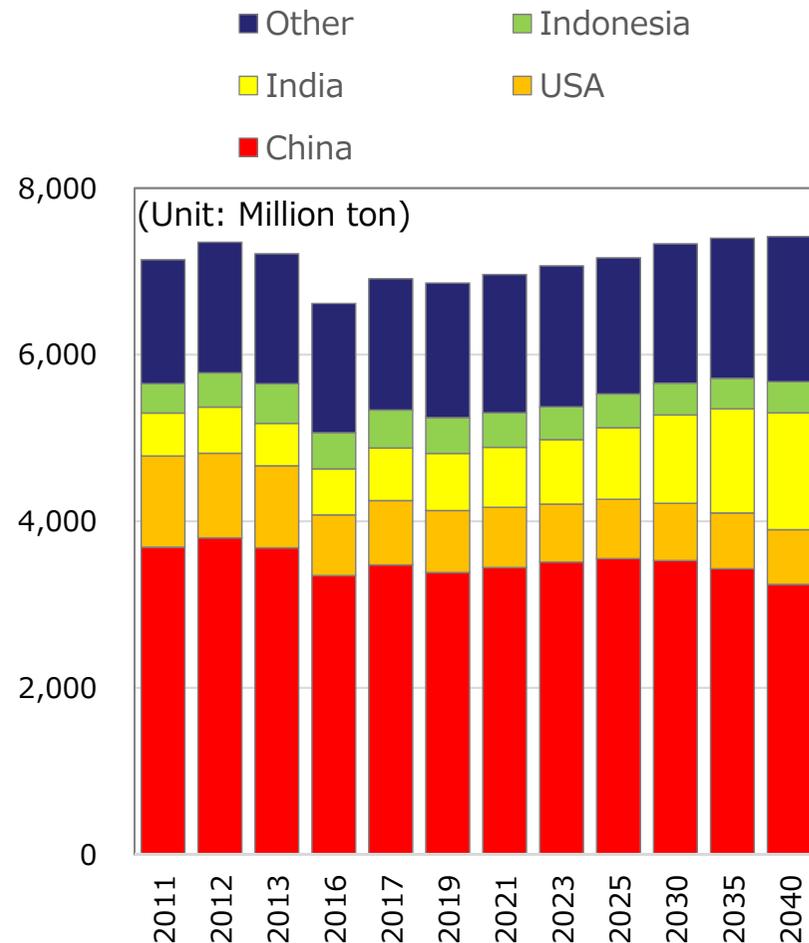
① Primary energy forecast in the world (by minerals)

(Unit: British thermal unit)



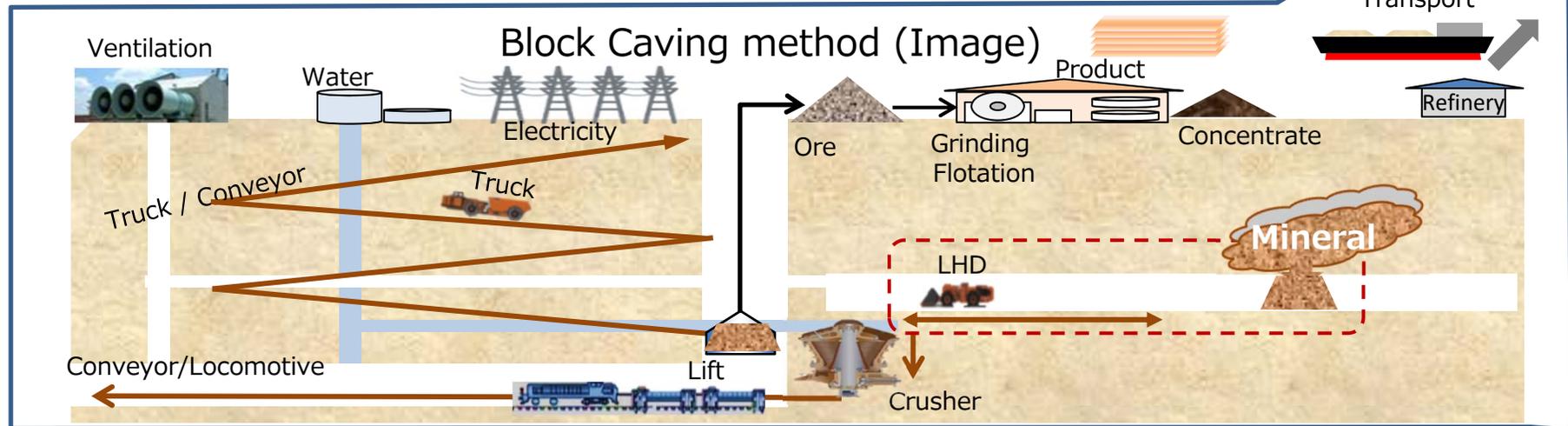
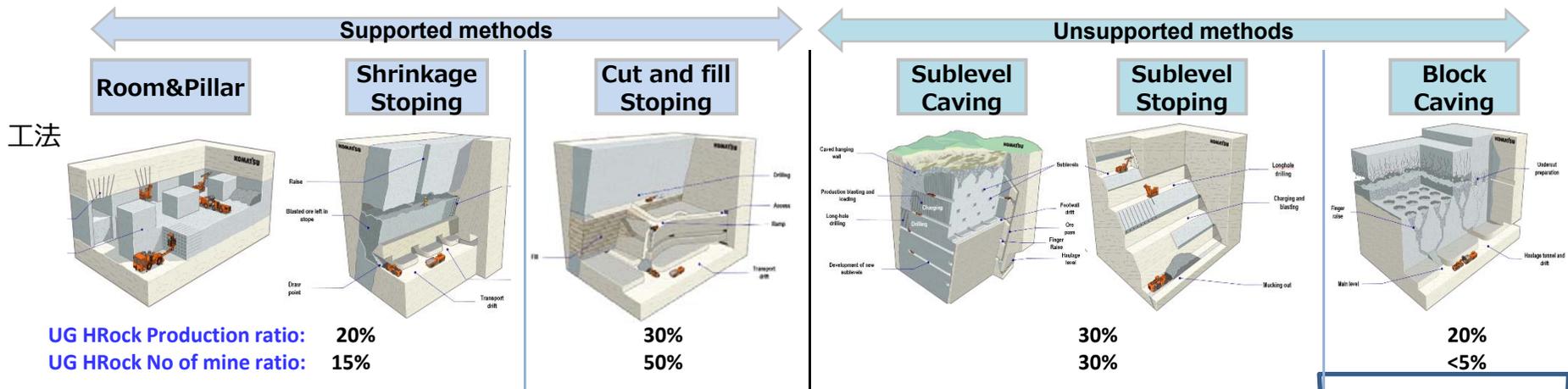
Source: EIA International Energy Outlook 2018 (IEO2018)

② Coal production forecast (by country)



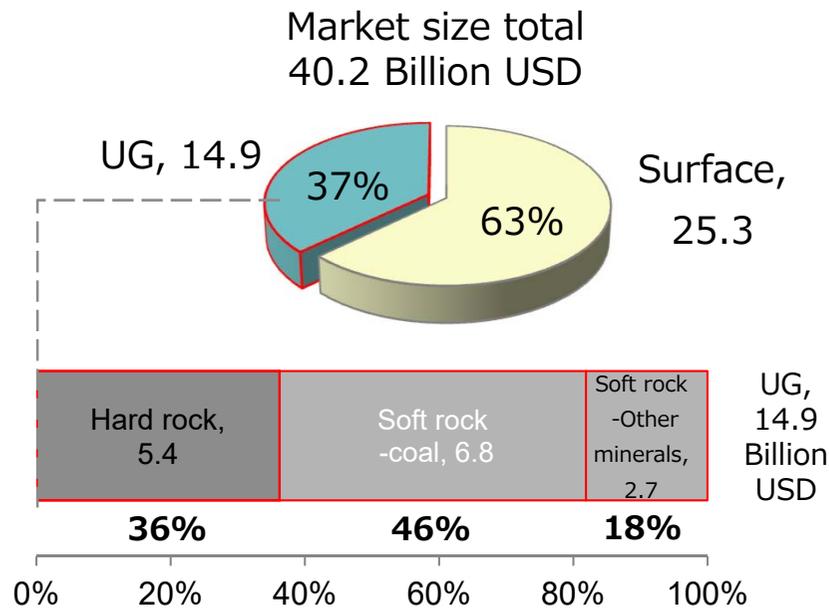
Source: Komatsu estimation

- UG Hard Rock methods are roughly divided into Supported methods and Unsupported methods.
- Block Caving method is for large deposit. After establishing a room under a mineral vein, its roof is dug in an inverted conical shape, and the ore falls into the room under the pressure of its weight. The mineral ore that has fallen through is brought to the surface through the room. Minerals will be hauled through mine tunnels.

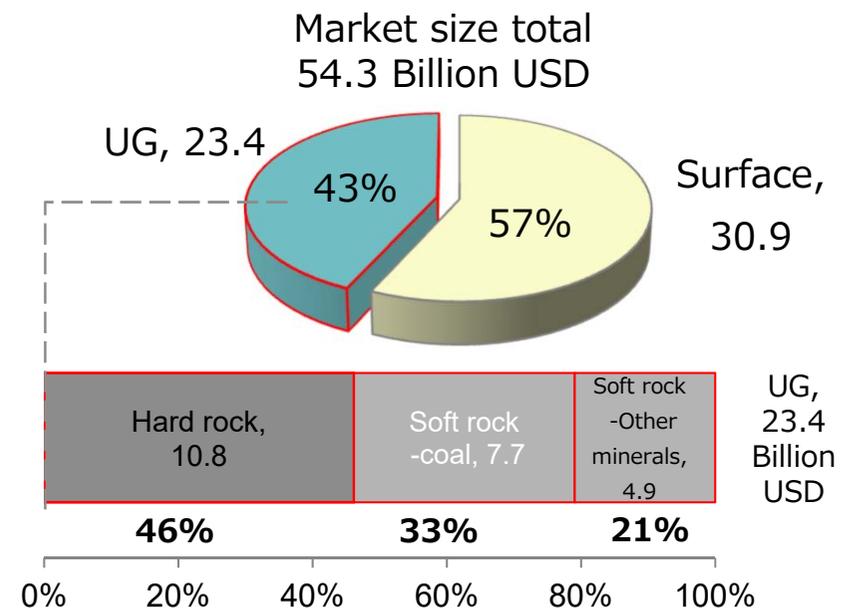


- Market size of mining business is increasing.
- In underground mining, hard rock segment will increase relatively.
- As Open-pit mines are becoming deeper, it is difficult to mine high grade ores, haulage cost of overburden will increase.
- So, some portion of Hard rock mining will shift from Surface to Underground operation.

① Market size(2017)



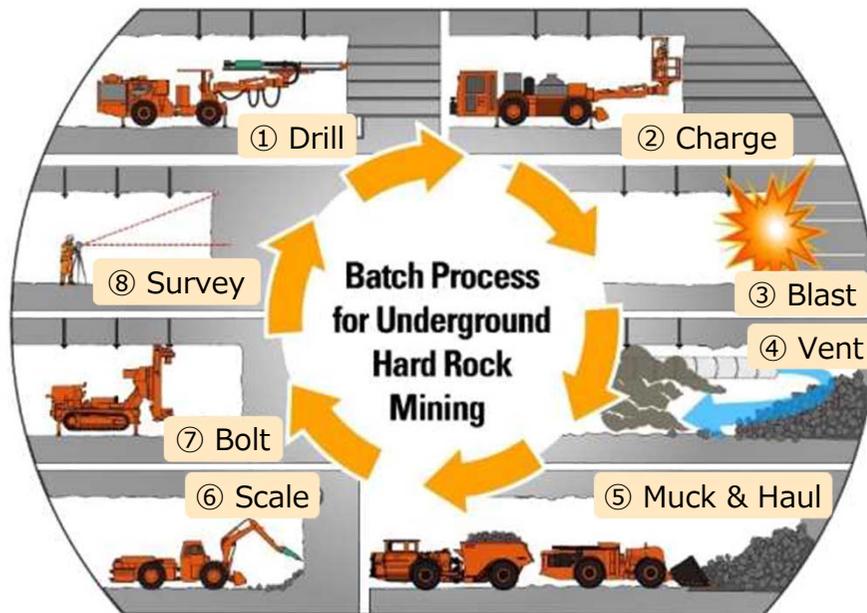
② Market size(2040)



Source: Komatsu estimation

- We aim to develop products which are not existing, but delivering more value to customers “Dantotsu Product” for expanding our market share.
- No Blasting (Safety), No Diesel (Environment), No Batch (Productivity)
⇒ Underground mining automation factory

① Conventional excavation method (Drilling and Blasting : D&B)



② “Dantotsu” UGHR products instead of D&B

No Blasting

- **DynaMiner:** excavated by Dynamic Disc Cutting based on undercutting technology
=> Safety, Reduce support , Flexible tunnel shape, Working environment improvement



No Batch

- **Mining TBM(Tunnel Boring Machine):** excavated by many disc cutters
=> Safety, Rock support reduction, Working environment improvement
Rapid excavation
= early production start



No Diesel

- **Hybrid LHD:**
=>Reduce emissions & temperature raise in tunnel
:Improve health & working environment, Reduce ventilation cost



Key words at “Dantotsu” UGHR products

No Blasting

No Batch

No Diesel

