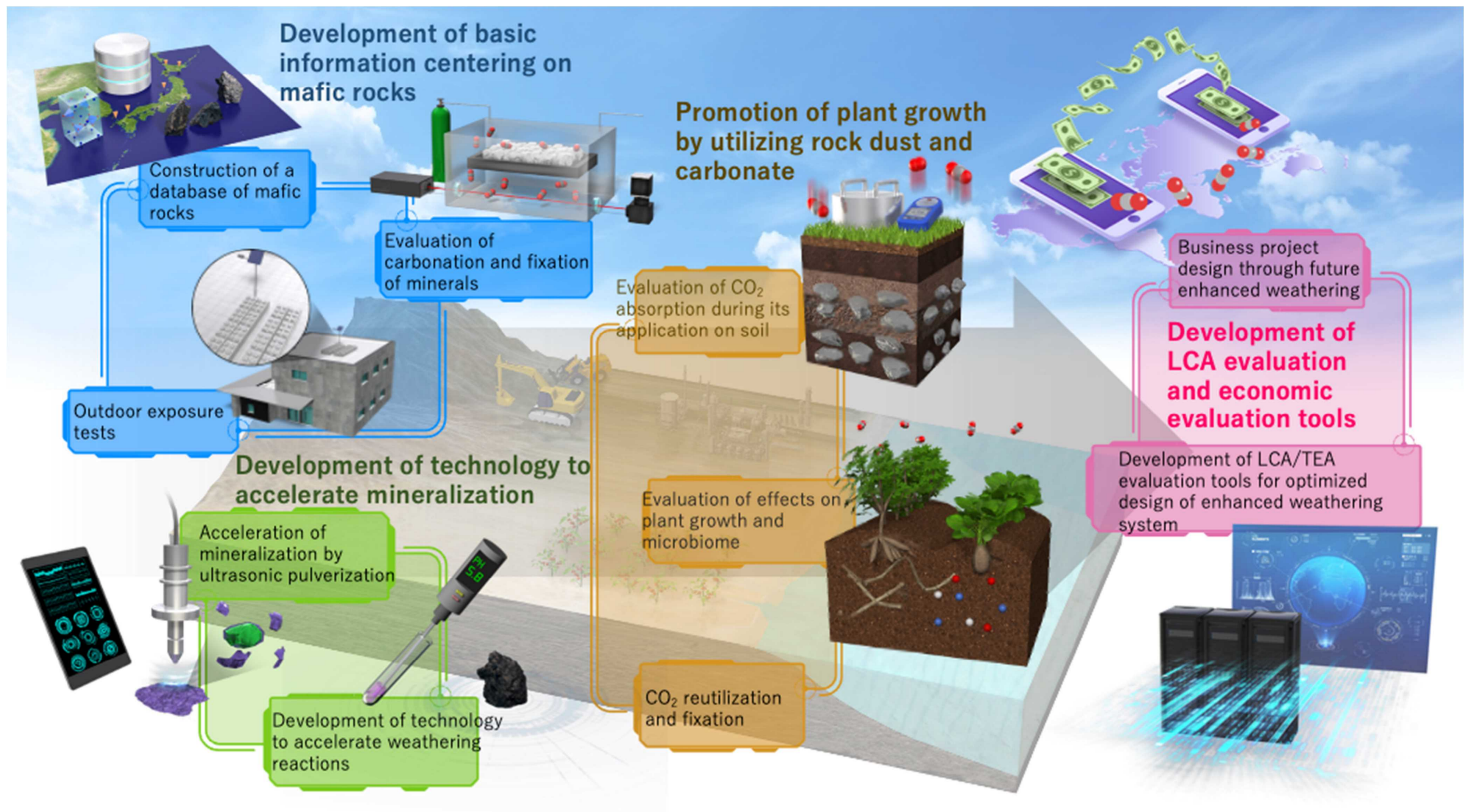


We will develop the CO₂ accounting methods of enhanced mineralization through a mafic rocks database and CO₂ fixation measurement technology. We will also build an LCA/TEA assessment tool for complete system design by realizing faster carbonation technology and optimizing utilization of rock dust and carbonate to enhance plant growth.



CO₂ Accounting

- Development of the mafic rocks database in Japan, including **chemical and mineral compositions**, **mining site information**, etc.
- Measurement of CO₂ absorption under various control conditions, such as laboratory, **long-term outdoor exposure conditions**, and **soil conditions**.

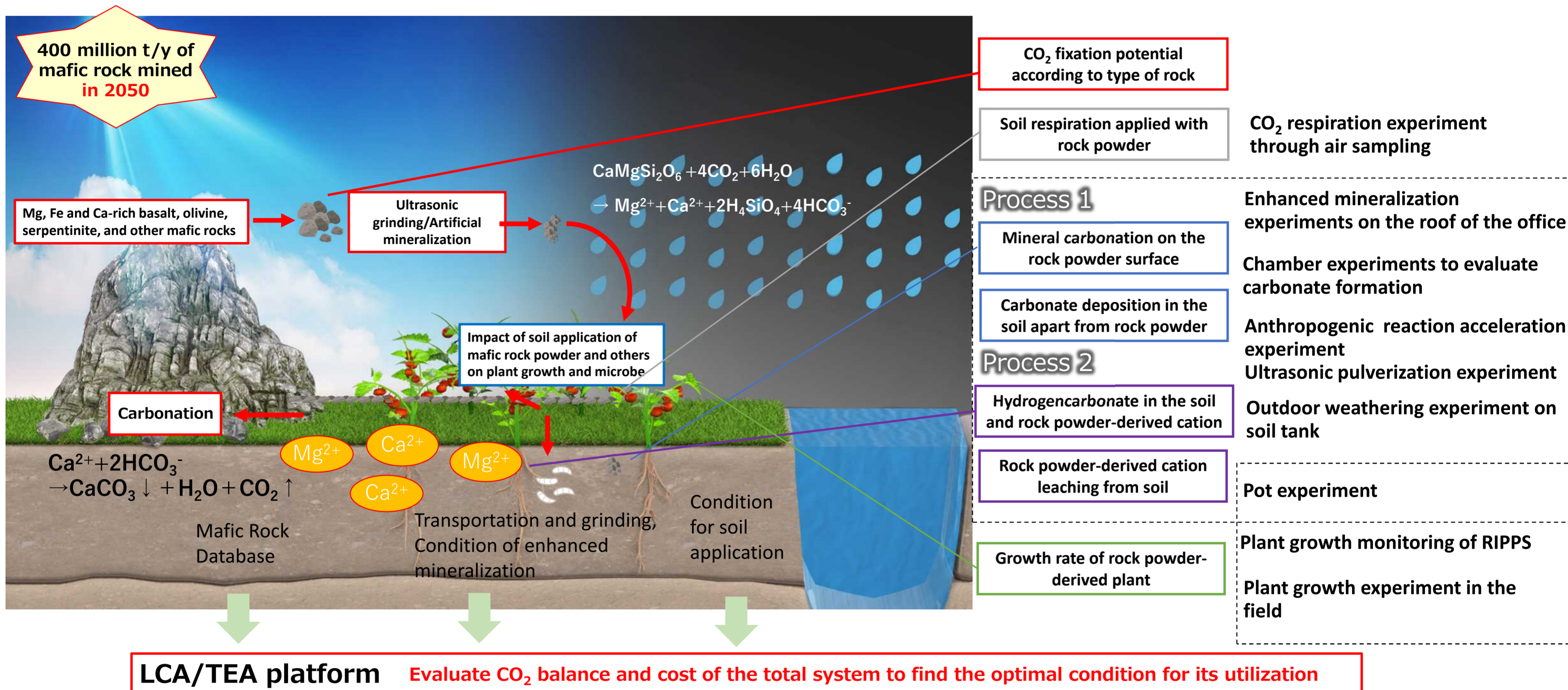
Cost Reduction

- Reduce the CO₂ mineralization cost to half of the current cost by using an ultrasonic pulverization method.
- Investigation of the effect of humidity, temperature, etc., for demonstration of engineering reaction acceleration.
- Development of **LCA/TEA platform** for evaluating annual CO₂ reduction considering temporal aspect.
- Evaluation and optimization of total system to reduce the CO₂ reduction cost.

CO₂ Application

- Measurement of the growth rate and photosynthetic activity of plants and soil environment such as **pH in soil including mafic, basaltic rocks or carbonate minerals**.
- Evaluation for the effect on CO₂ fixation and microbial activity in soil including finely-crushed rocks in the field.

AIST conducts research and technological developments of enhanced mineralization to implement it into our society: Development of LCA/TEA platform and cost-optimized total system design from mineral mining to carbonate utilization. Various experiments for CO₂ accounting method, research and development for cost reduction and development of mafic rocks database.



CO₂ Accounting

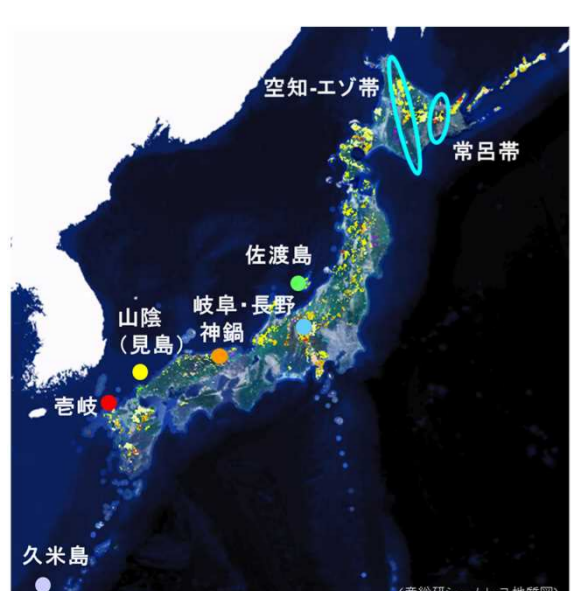
- Data of mafic rocks mined in seven areas have already been stored in our developed database. GIS analyzes correlation between transport distance and spreading area in candidate quarry sites in Japan.
- Major activities 1) Assessment of ion elution in a long-term outdoor exposure experiments is in progress. Carbonation in some of the specimens has been confirmed. 2) Observation of CO₂ absorption in soils applied with rock powder in chamber experiments is conducted. 3) Pot experiment device for measuring carbonation rate is developed.

Cost Reduction

- Ultrasonic pulverizer method reduces energy consumption for rock pulverization by 25-50% compared to the conventional technology.
- Experimental investigation of effect of humidity, temperature, CO₂ concentration, pH and time on the reaction rate has demonstrated reaction acceleration. Factors that have an impact on the dissolution rate and solid carbonate formation were clarified.
- Accelerated effect on dissolution rate by temperature, pH, organic acid and NaCl has been confirmed, and long-term prediction of the dissolution behavior is in progress.

CO₂ Application

- Industrial production and treating method of carbonation have been developed in addition to soil application of rock powder.
- Domestic parameter of enhanced mineralization has been collected to create a base of LCA/TEA platform.
- Our simplified platform estimates optimal grain size of rock for pulverization to remove CO₂ at minimal cost.



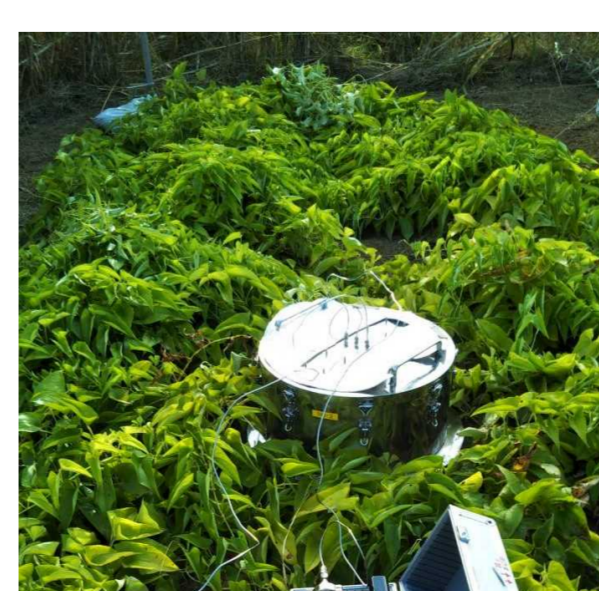
Mining site of mafic rock throughout Japan



Monitoring of weathering of mafic rock using large vessels

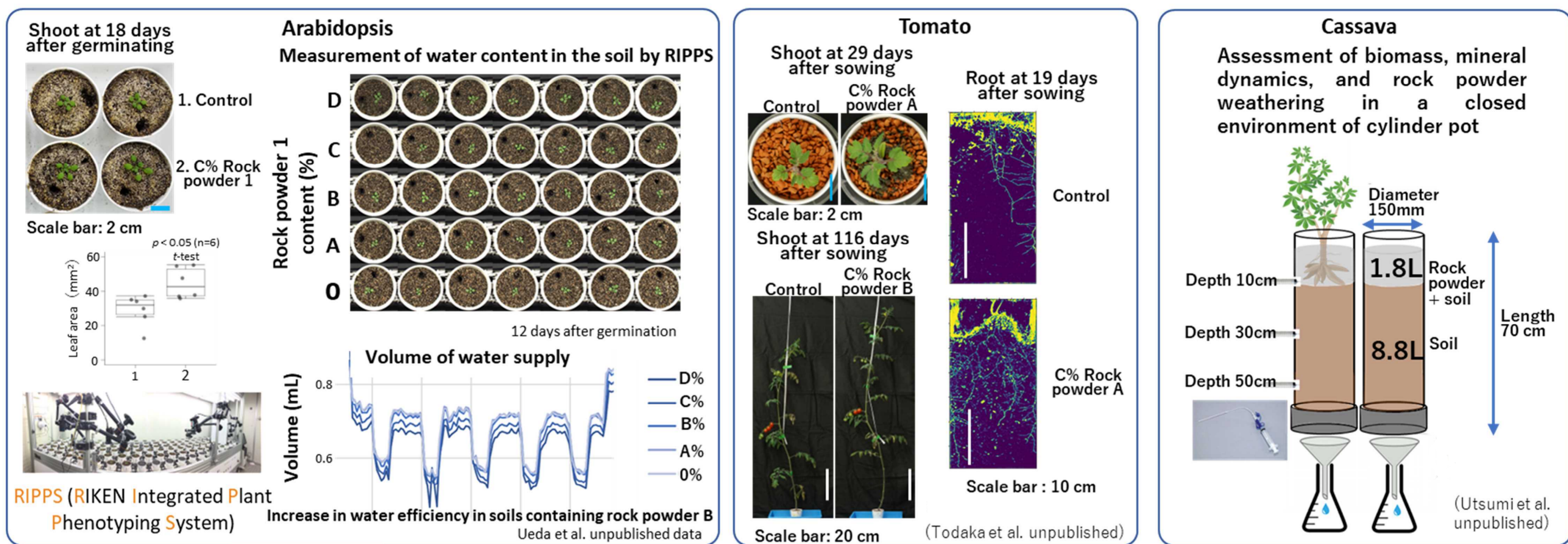


Long-term outdoor exposure experiment



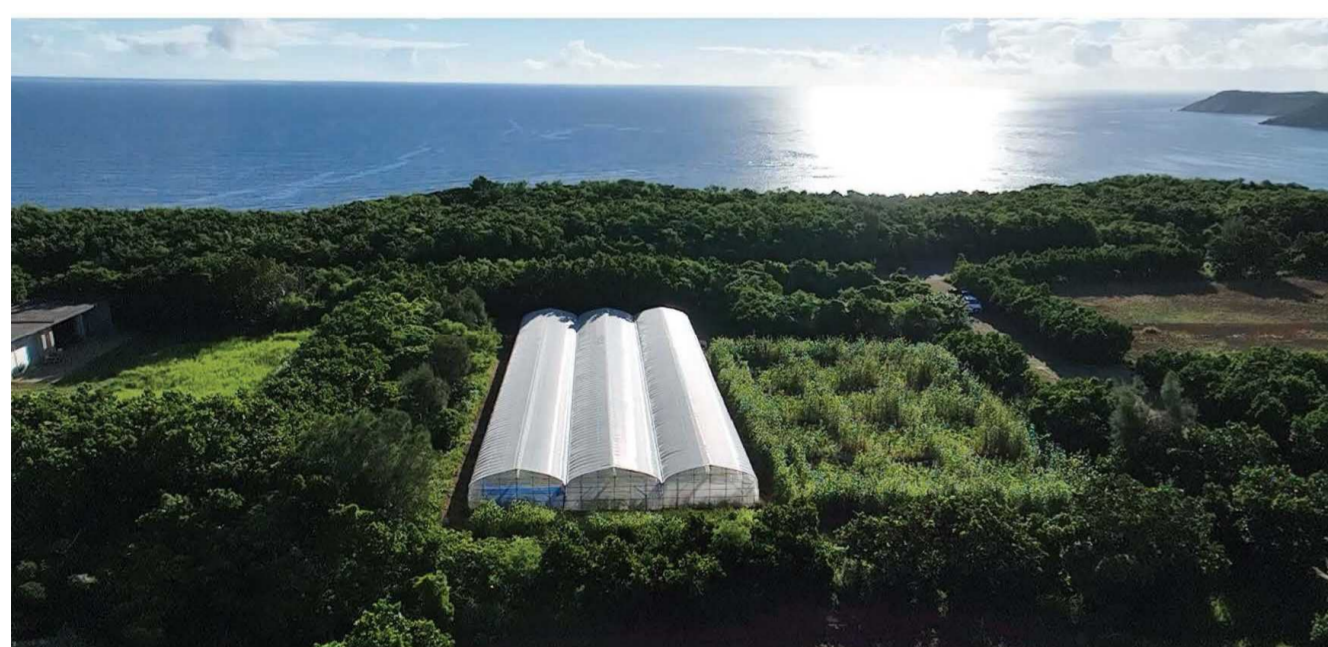
Soil chamber experiment

RIKEN and Tokyo University of Agriculture form an alliance to evaluate the effect of rock powder on plant growth, leading to the implementation into our society. In lab-based experiments, comprehensive study using multi-omics analyses has been conducted in model plants such as Arabidopsis and crops such as tomato and cassava. In field-based experiments, the effect of rock powders on plant growth (yield) and microbial flora in soils has been surveyed to find conditions to which extent rock powders are needed to improve plant growth.



Lab-based experiments

- Identification of conditions which improve plant growth in Arabidopsis: Evaluation of plant growth in plants grown under different conditions in rock type, concentration, size.
- Experimental investigation of the effect of rock conditions described above on plant growth in cassava and tomato.
- Multi-omics analysis including transcriptome is in progress.
- Real-time measurement of plant development and water supply to analyze the effect of the rock-powder treatment on plant growth
- Measurement of mineral dynamics and weathering rate under closed environment of cylinder pot.



Tokyo University of Agriculture
Miyako Subtropical Farm



Cassava



Yam



Upland rice

Field-based experiments

- Validation of the effect on plant growth in soils containing different types and particle sizes which affect mineral content and pH (pot trials). Increase in plant growth was confirmed in plants treated with rock powder under some conditions.
- Measurement of biomass in shoots and roots in cassava and yam grown in soils containing different rock conditions.
- Evaluation of the effect of rock powder on microbial flora under different field conditions.
- Evaluation of the effect of rock powder on rock weathering under different field conditions in collaboration with AIST.