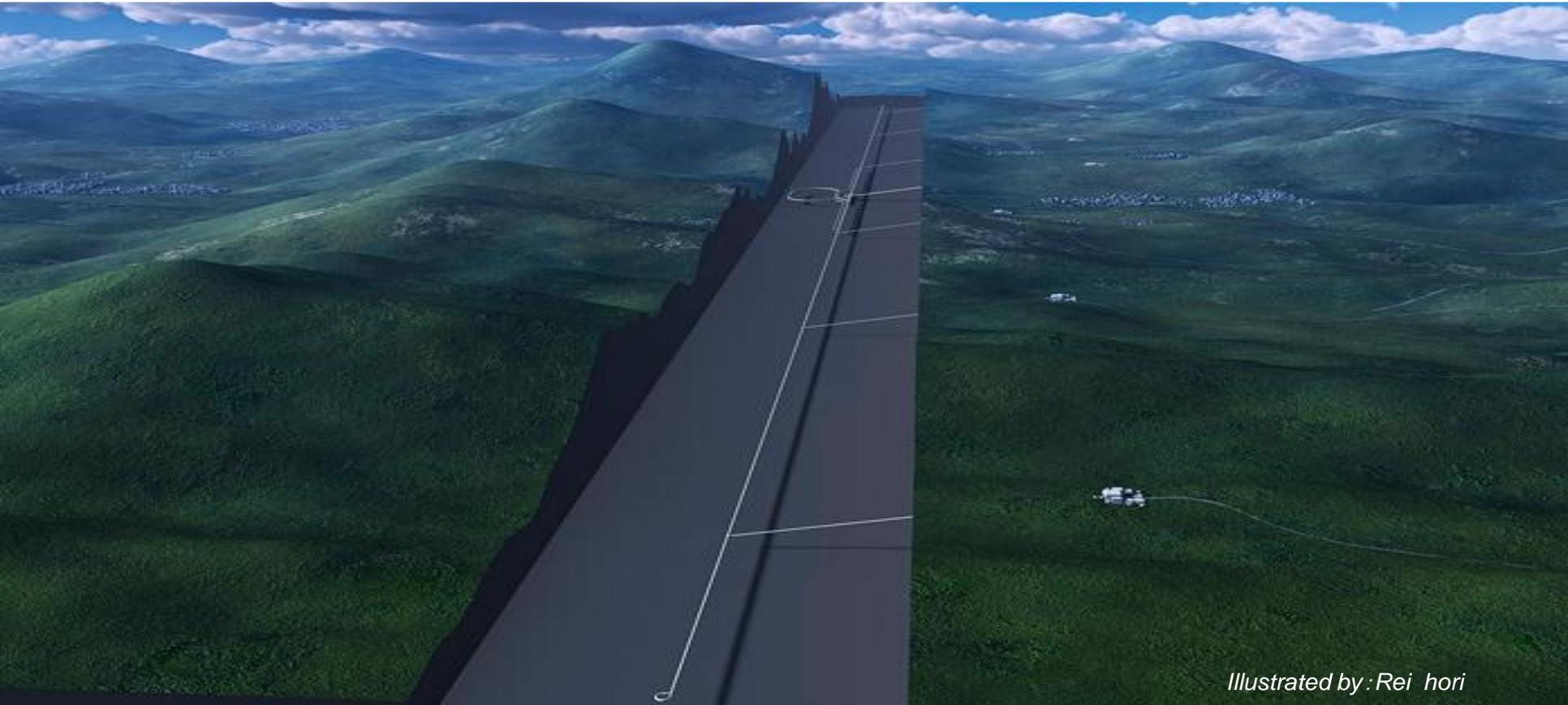


Progress of the Geological Investigation Plan in Asian Mountain Site



Illustrated by : Rei hori

M. Miyahara
High Energy Accelerator Research Organization (KEK)

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- 1. Outline of the Two Domestic Candidate Sites in Japan**
- 2. Some Issues of the Geological Investigation Plan in the Mountain Site**
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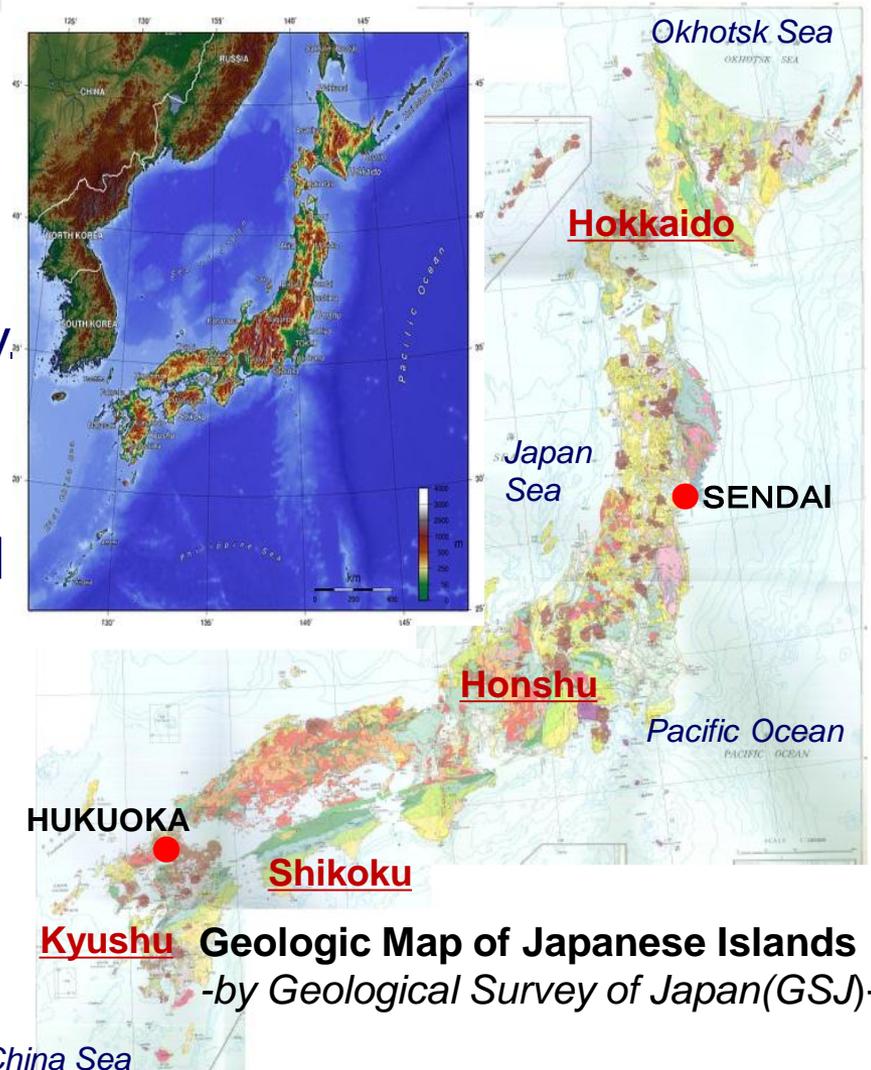
M. Miyahara

**Department of Advanced Accelerator Technologies/KEK
Linear Collider Project Office**

Background on the Japanese Land

Mountain Country

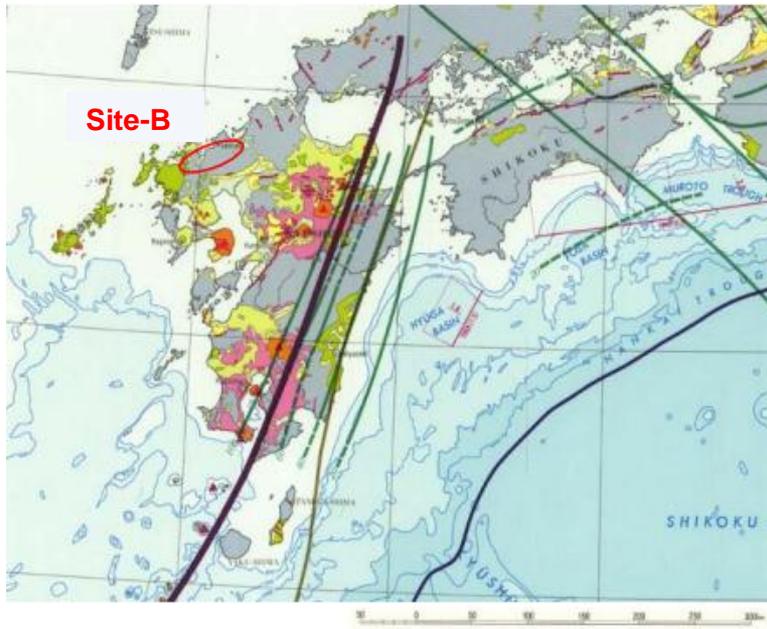
- 75% of the Japan Land is Covered in a **Mountainous region**
- Plains is only 10% of whole country
- the Alluvial Plains;
The ground consists of the **Soft Earth and Sand** , and is considered generally to be Vulnerable to an Earthquake.
- the Mountainous Area;
The ground consists of **Hard Rock**, and is considered generally to be Resistant to an Earthquake.



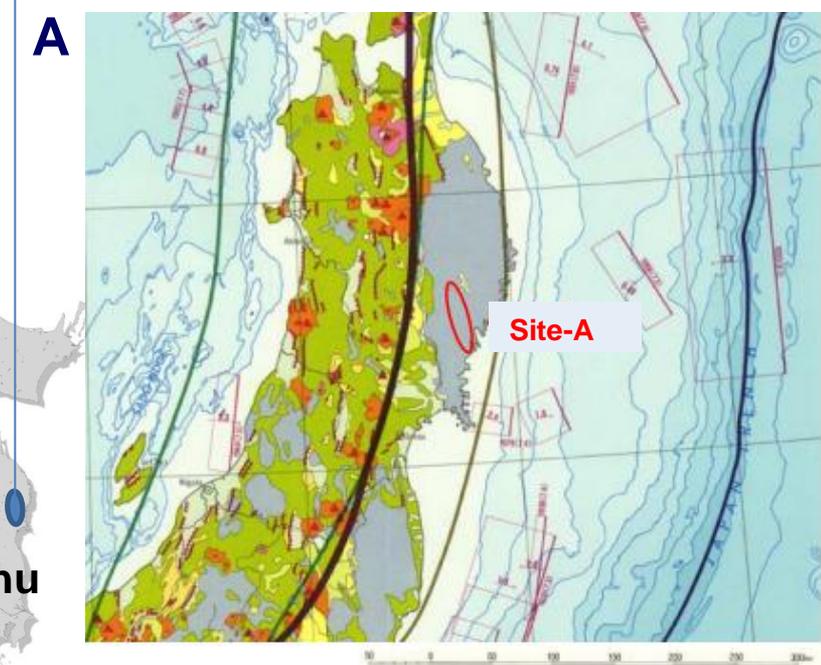
1. Outline about Two Candidate Sites in Japan

SEFURI-Site

KITAKAMI-Site



B



A

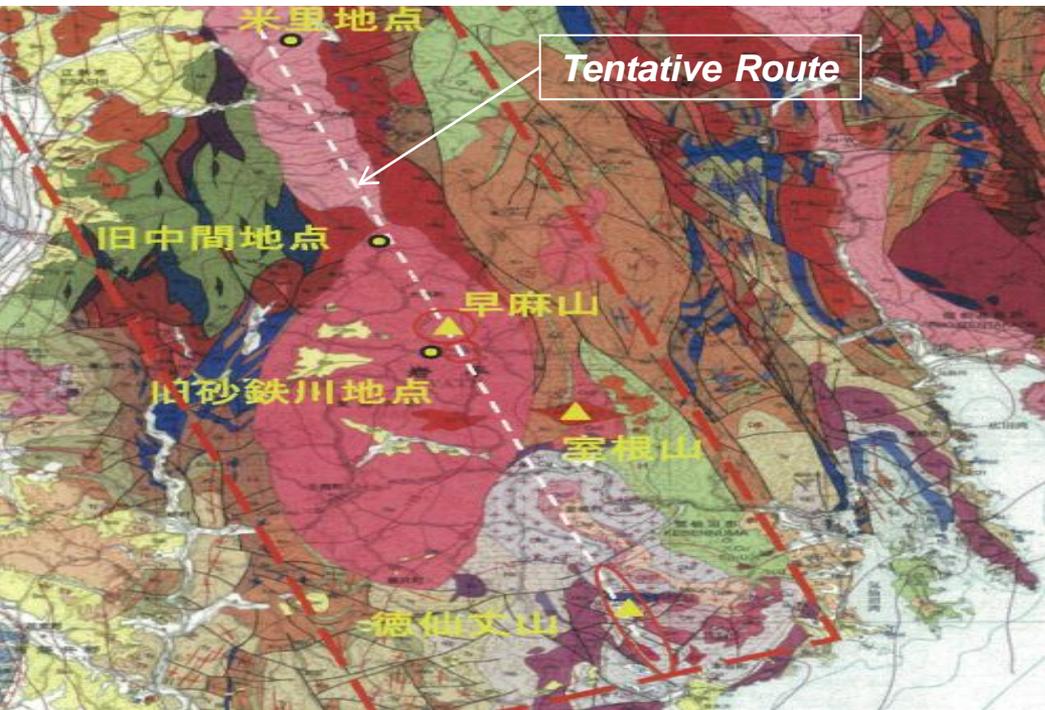
Honshu

kyushu

- Belong to FUKUOKA & SAGA Prefecture in KYUSHU District
- Located in stable Granite zone
- Have not Active Fault zone
- Separate from Volcano Front line
- Annual average Temperature: 12°C
- Annual total Precipitation : 2,400mm

- Belong to IWATE & MIYAGI Prefecture in TOHOKU District
- Located in stable Granite zone
- Have not Active Fault zone
- Separate from Volcano Front line
- Annual average Temperature: 10°C
- Annual total Precipitation : 1,300mm

KITAKAMI Site



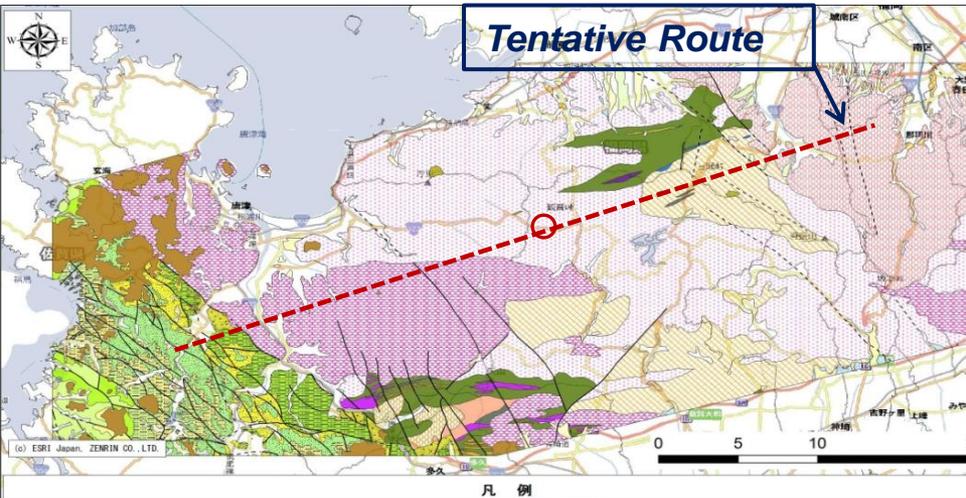
Scenery from Mt. AWARA



Scenery from Mt. MURONE

Landscape of KITAKAMI Site

SEFURI Site



Scenery of Karatsu Bay and Genkai sea



Whole View of of WAKIYAMA District



Landscape of SEFURI Site

Similar points in Both Candidate Sites

- KITAKAMI Site & SEFURI Site -

Topography & Geological Feature

- *Both sites are located in the natural woodland region.*
- *Located in the representative Granite zone in Japan.*
- *Estimated that there is not an **Active fault** in the Planning zone.*
- *There is not a **Volcano** in the neighborhood.*

Infrastructure & Social Condition

- *There are a lot of villages in the neighborhood, and the access road is in a comparatively good state.*
- *High Voltage Transmission Line passes near the Site.*
- *The local government is active the invitation of the ILC project.*
- *Local community is cooperative to the project.*

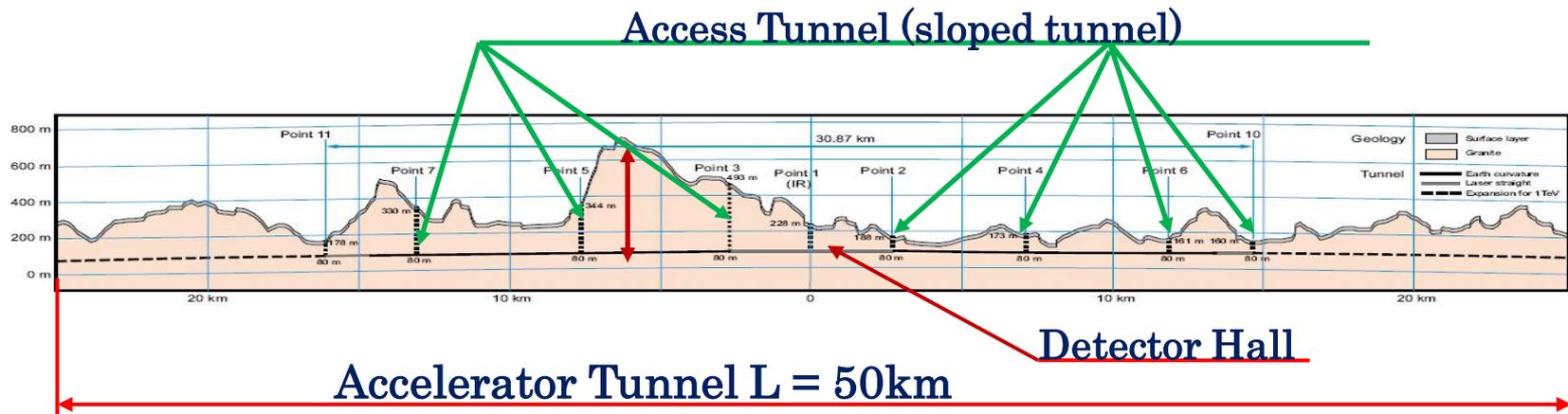
2. Some Issues of the Geological Survey in Mountain Site

What should we understand for Geological survey?

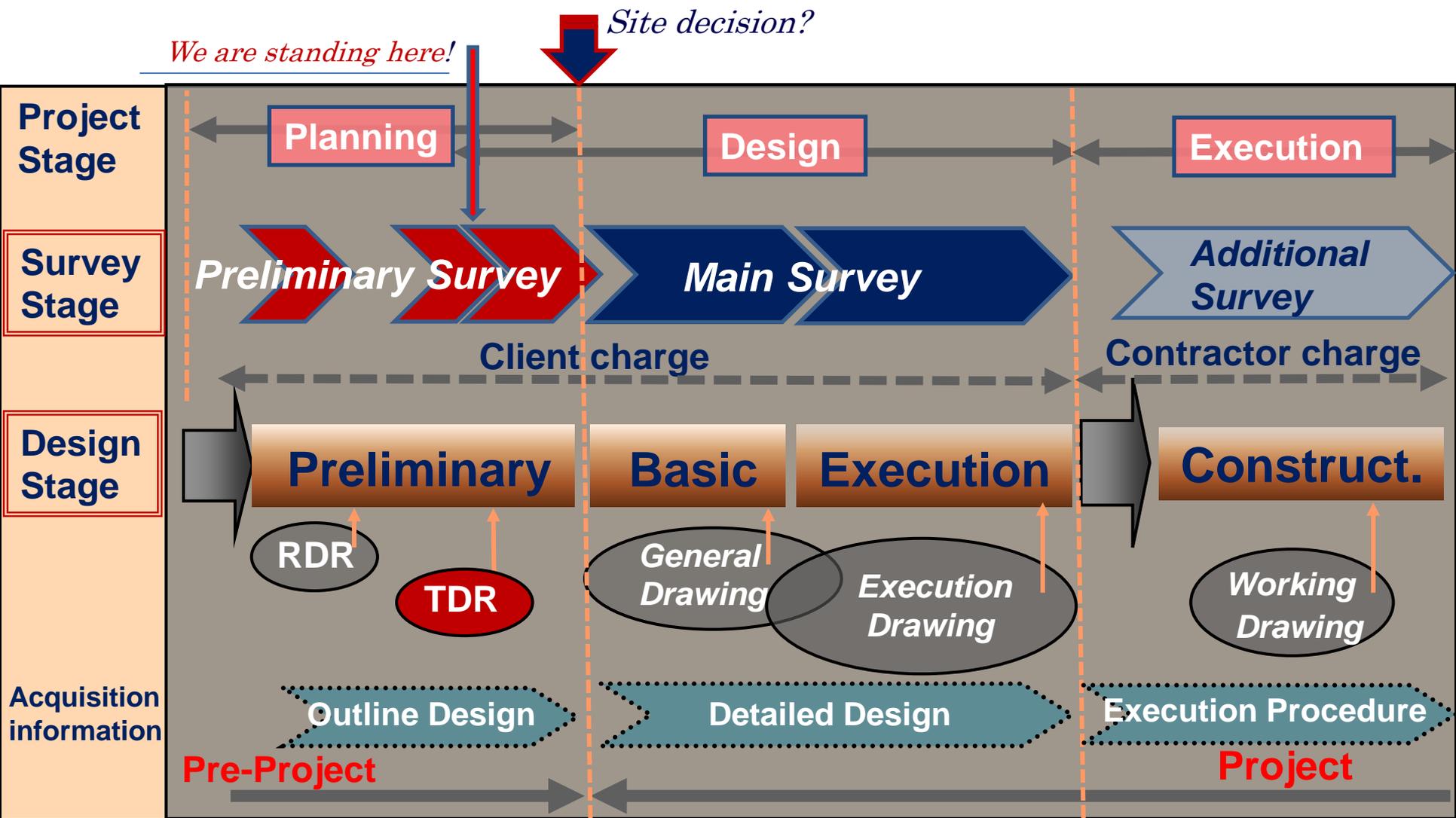
- Originally, the Geological Feature Prediction in the Large Depth Underground is very difficult.
- But we must predict the Geological Feature of the Site to Design and build the ILC Facilities.

What should we do for the Geological Prediction in Mountain Site ?

- We must make the better Investigation plan.
- We must choose the most suitable Investigation Technology.
- We need the best Investigation Analysis and Evaluation.

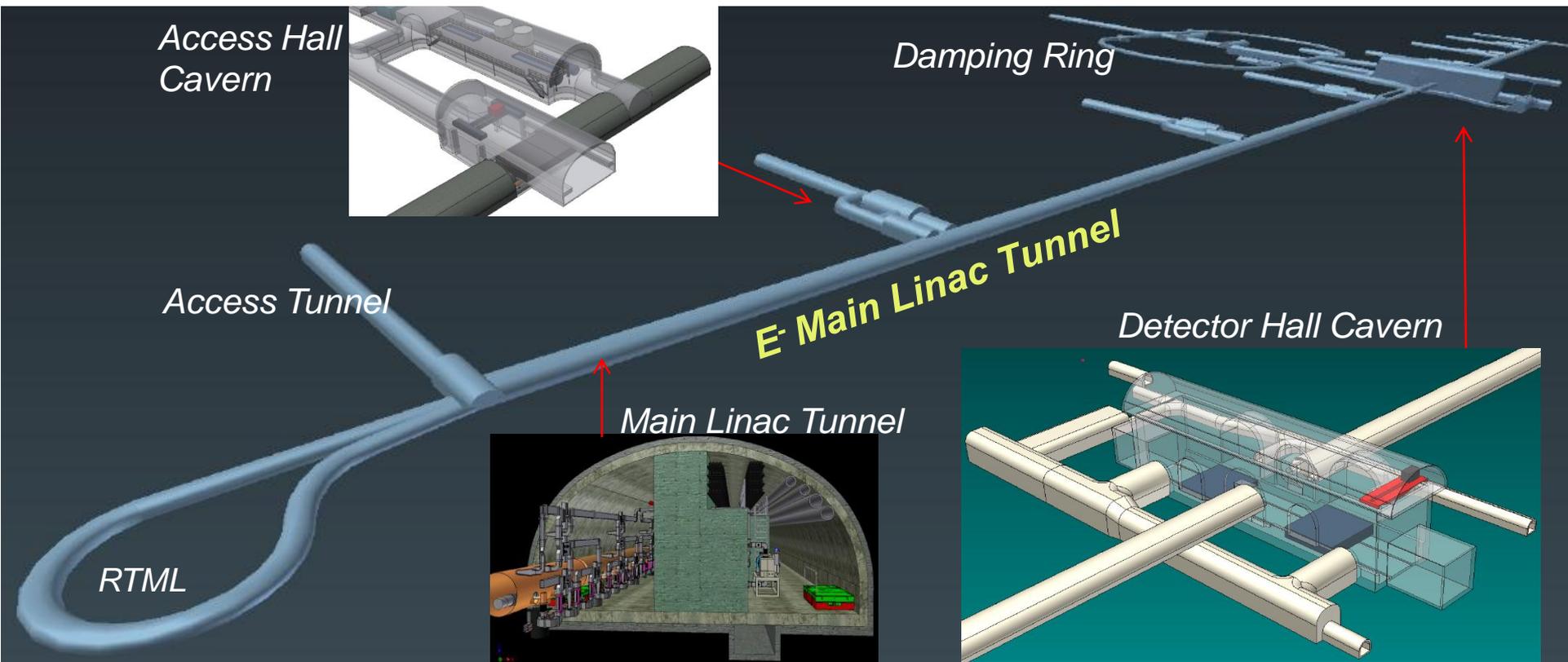


Perspective of the Geological Survey for ILC in Japanese Mountain Site



Various structures group under the ground in Asian Mountainous Site

- **Beam Tunnel;** ML-Tunnel , BDS Tunnel, Damping Ring Tunnel, RTML
- **Other tunnel ;** Service Tunnel, Access Tunnel, Refuge Tunnel, etc.
- **Cavern ;** Detector Hall Cavern, Access Hall cavern, and Various kind of Cavern for Cryogenics Plant , Machine & Electric, etc.



3. Progress of the Current Investigation Plan by the Government Budget

Basic Policy in this Investigation Plan

1. Confirmation of the Geological Feature Constitution

- Distribution of the **Stable bedrock** zone to 50 km Length
- Natural Ground Condition, Weathering Layer, Intrusive Rocks, Border of the Different Rock zone, etc.

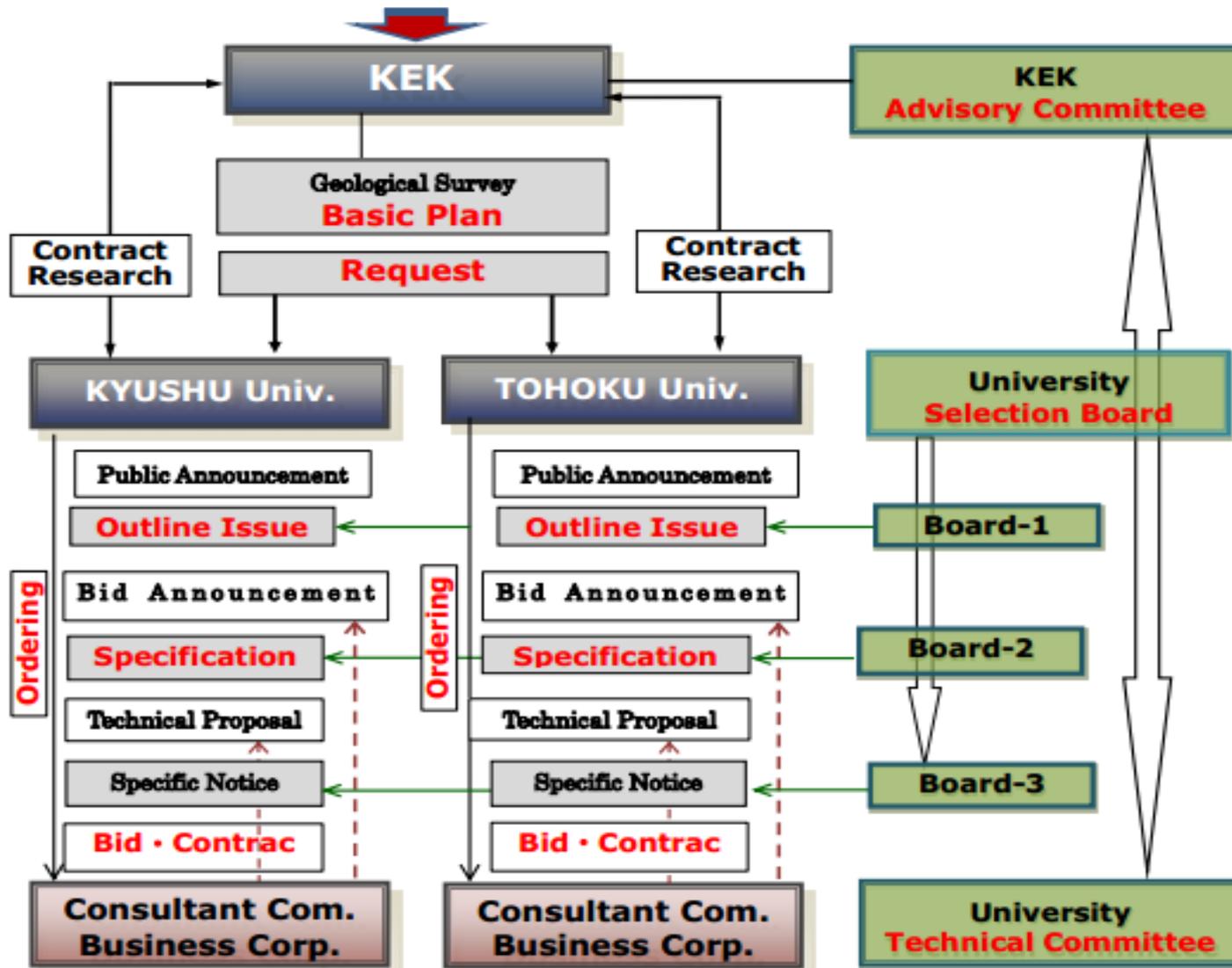
2. Confirmation of the Bedrock Property

- Grasp of the **Bedrock Property** & Bedrock Strength without the hindrance for the Construction of the Tunnel & Cavern

3. Confirmation of the Dislocation Zone

- Extraction of the Fault Line by the Lineament Survey
- It is a necessary condition that there is not an **Active Fault**

Flow of the Geological Investigation by **Government Budget**



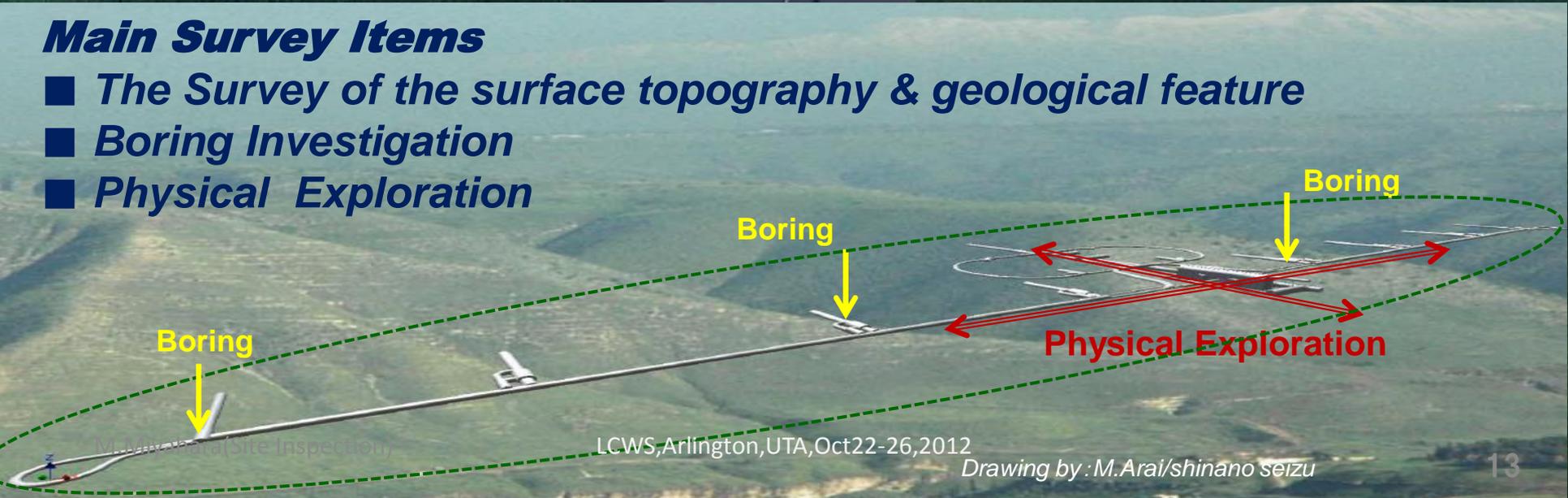
■ Geological Survey Plan in Progress



Illustrated by :Rei hori

Main Survey Items

- **The Survey of the surface topography & geological feature**
- **Boring Investigation**
- **Physical Exploration**



LCWS, Arlington, UTA, Oct22-26, 2012

Drawing by : M.Arai/shinano seizu

Main Geological Survey Contents

Lineament Survey

Survey Item	Survey Contents
Lineament Survey (Aerial photo mapping)	Reading of the geological feature information based on topography information by the aerial photograph <ul style="list-style-type: none">- Confirmation of the dislocation- The extraction of the lineament

Example: Lineament Mapping

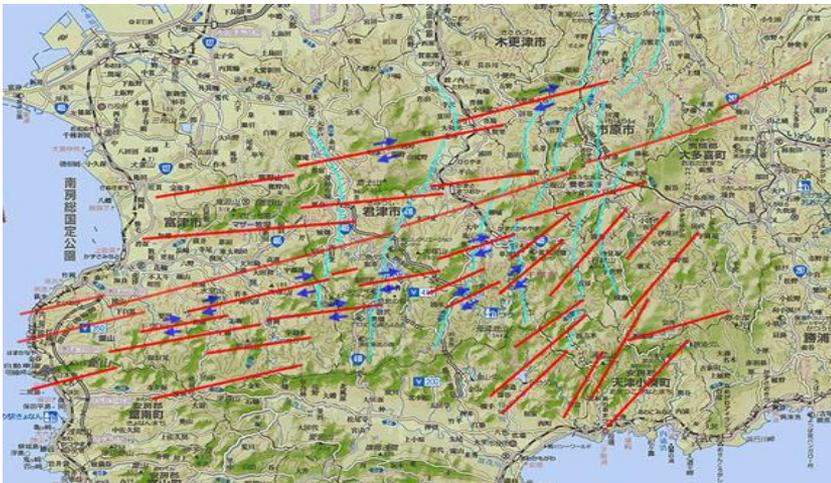
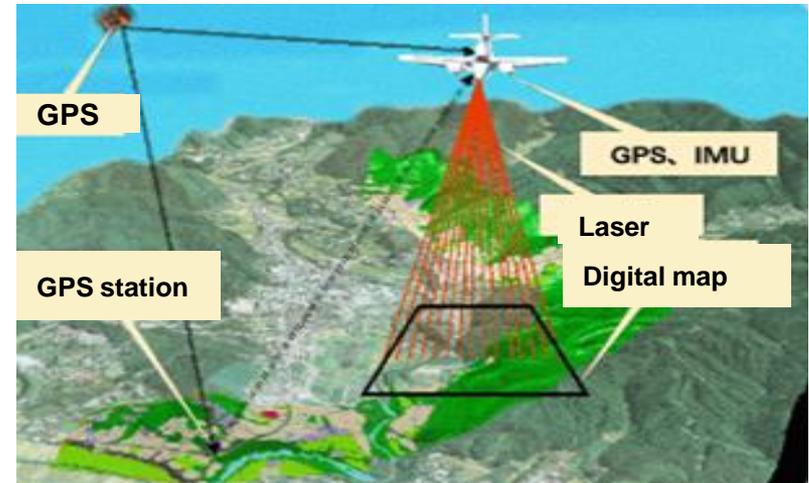


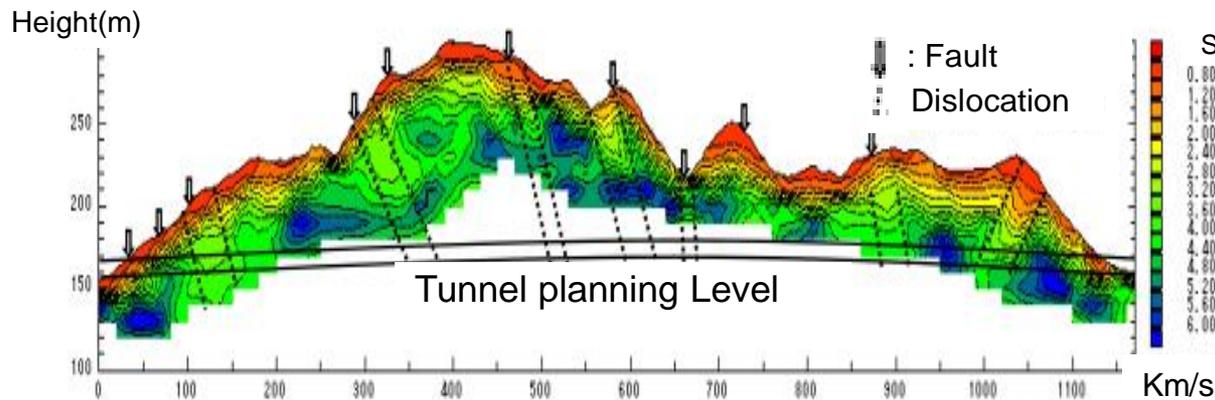
Image: Aviation laser survey



Geophysical Investigation (1)

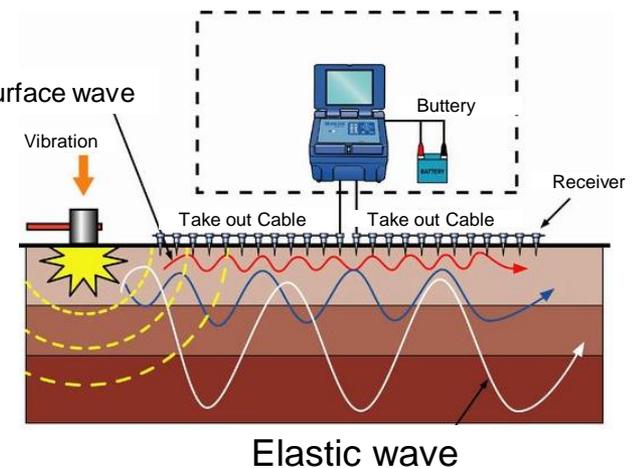
Survey Item	Survey Contents
<p>Geophysical Exploration</p>	<p>Grasp of bedrock depth and the bedrock constitution by the elastic wave speed of the natural ground</p> <ul style="list-style-type: none"> - elastic wave exploration - electric exploration - electromagnetic wave exploration

Example:
Geological Section by Elastic wave Exploration



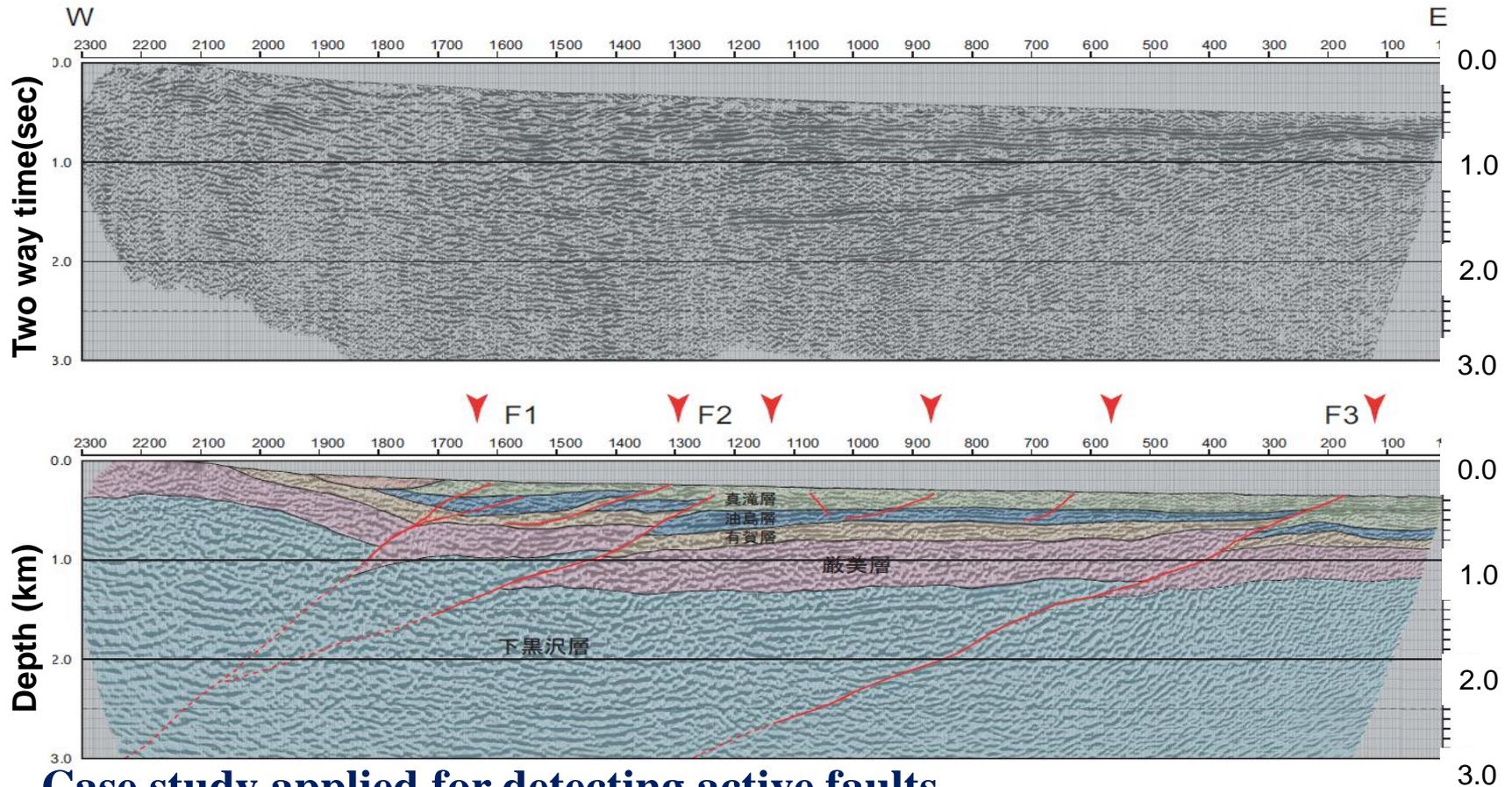
M.Miyahara(Site Inspection)

LCWS,Arlington,UTA,Oct22-26,2012



Geophysical Investigation (2)

Example of survey



Case study applied for detecting active faults

Upper :Time section of Kitakami lowland west fault zone

Lower :Depth converted seismic section and interpretations. Reflection events more than 2km depth are clearly imaged.

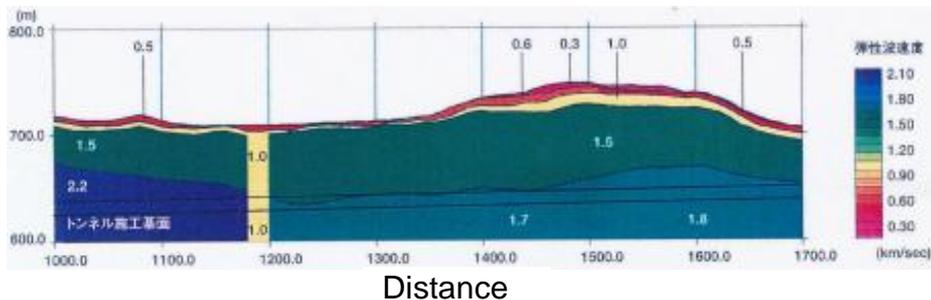
Geophysical Investigation (3)

High-Accuracy Refraction Seismic Survey

We can get the data of the high quality by the measurement with digital and multi channel measuring instrument.

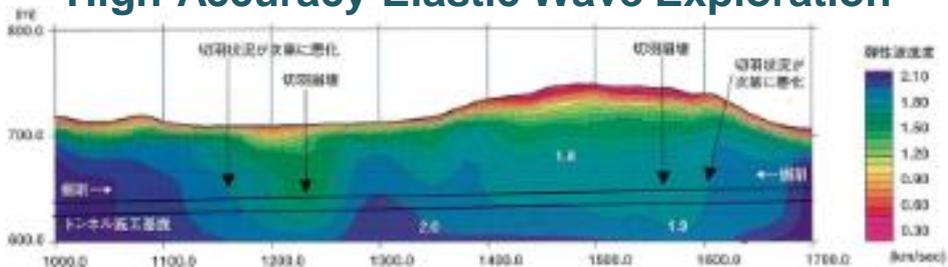
As a result, we got possible to know highly precise elastic wave speed by the complicated topography which seems to be mountains area.

Traditional Elastic Wave Exploration



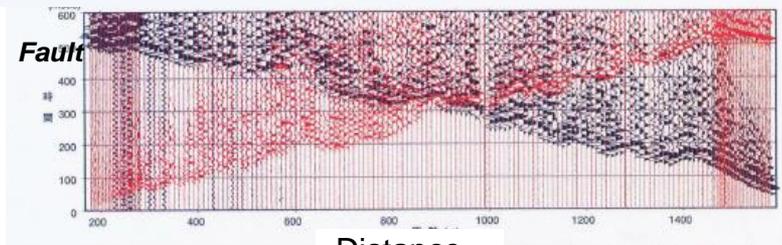
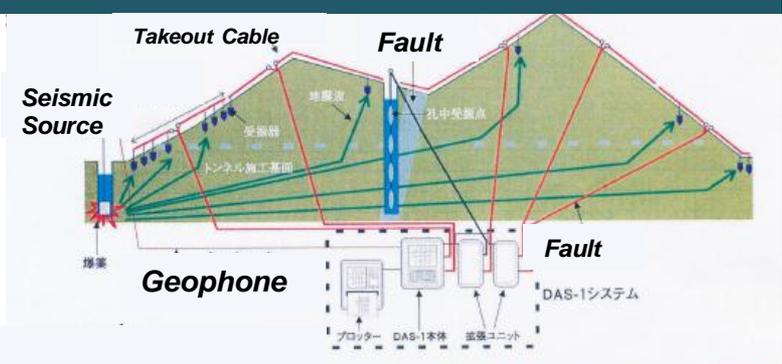
Distance

High-Accuracy Elastic Wave Exploration



Distance

Measurement Example in Mountain Site



Distance

Main Contents of the Geological Survey Plan **in KITAKAMI Site / TOHOKU Univ.**

Basic policy

- *Lineament extraction based on a correct topographical map*
- *Confirmation of the geological feature condition by geophysical survey and the boring survey*

Main item of the field survey

- *Aviation Laser Survey :Making the Correct Topographical Map.*
- *Elastic wave speed exploration in central region.*
- *Boring Survey in the vicinity of the detector hall area.*

Item	Quantity	Remarks
Aviation Laser Survey	100km ²	Making the correct topographical map
Geophysical Exploration	14 km	Elastic wave exploration
Bedrock Boring survey	1~2 point	Various examinations in field & by the core sample

Main Contents of the Geological Survey Plan in SEFURI Site / KYUSHU Univ.

Basic policy

- *Geological analysis by the inflection of the existing documents.*
- *Lineament extraction by the existing aerial photo reading.*
- *Contribute to positioning of the Detector hall & Tunnel route by various geological feature information.*

Main item of the field survey

- *Surface survey for topographical map making.*
- *Geophysical exploration in the experiment hall area.*
- *Boring survey in the vicinity of the detector hall area.*

Item	Quantity	Remarks
Surface Survey	200km ²	Making the correct topographical map
Geophysical Exploration	10 km	Electro magnetic wave survey
Bedrock Boring survey	1~2 point	Various survey in field & physical Test by the core sample

4. Future Plan of Geological Survey

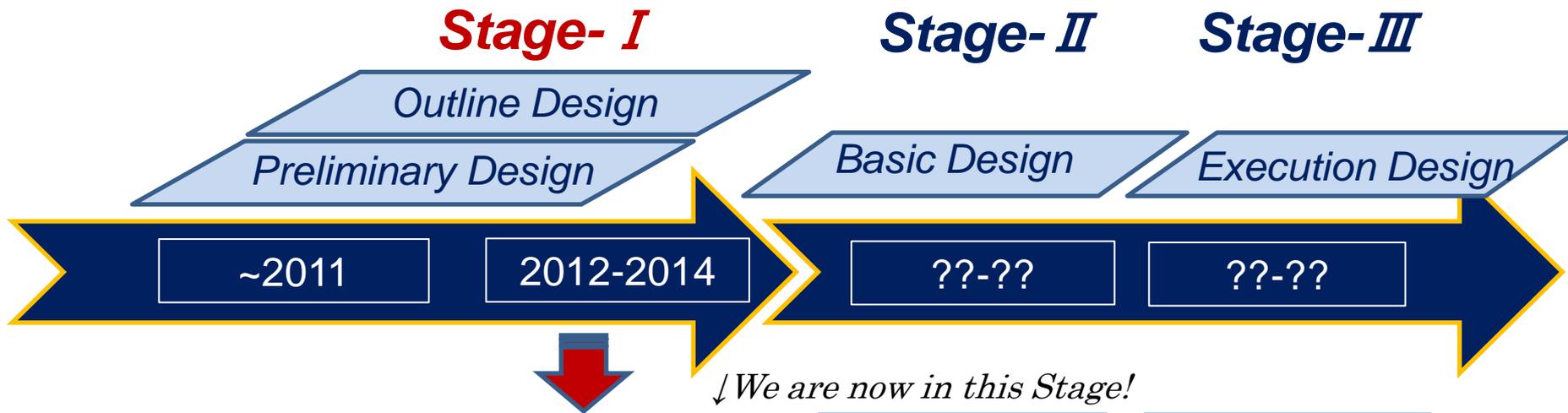
Purpose of the Geological Survey at the Next Stage

- *Bedrock Property important for the detailed structure Design of the Tunnel and Cavern. For Example; Support Structure*
- *Collection of Information that is necessary for an Execution plan*

Viewpoint in ILC

- *Depths weathering of the Granite,*
- *Fractured Zone and Alteration Zone with the crush*
- *Correspondence to a Different Rock Kind*
- *Detailed Groundwater Information to need for the anti-Drainage Measure.*
- *Introduction of the Pilot Tunnel for Investigation in the Experiment hall Area.*

Development of the Geological Survey for Asian Mountain Site



Survey Items	Stage- I	Stage- II	Stage- III
Surface Exploration	●	○	—
Linearment Survey	●	—	—
Geophysical Exploration	○	●	○
Boring Investigation	○	●	●
Groundwater Survey	○	○	●

●: Main Investigation ○: Sub-Investigation

Summary

- *We push forward the geological survey in two domestic candidate site now.*
- *We are going to summarize findings in the half in 2013.*
- *We must plan the secondary survey following this survey to conclude preliminary geological survey.*
- *Large-scale survey is necessary at the design stage.*
- *We should develop the result by this pilot investigation at the next stage*
- *We should do the investigation by the cooperation with the civil-engineer and designer at the next stage.*