FMT1-4

Comparison of Borehole Scanning Systems, Optical Digital Scanner (ODS) and Ultra Sonic Scanner (USS)

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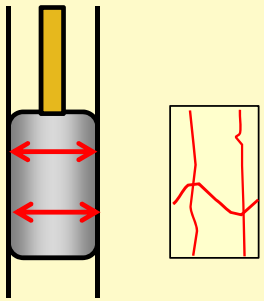
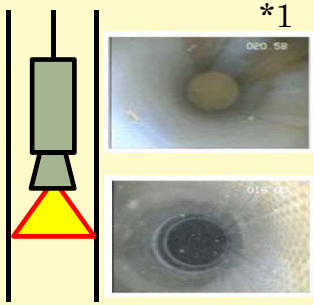
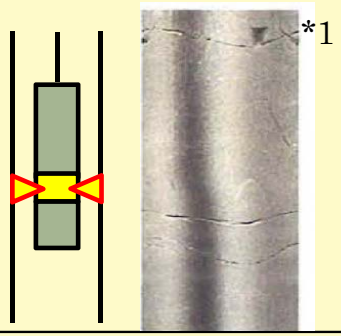
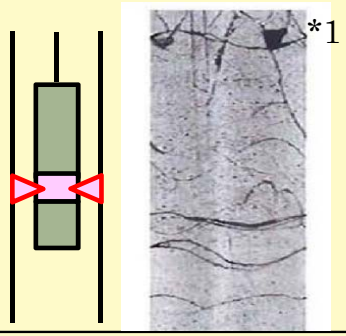
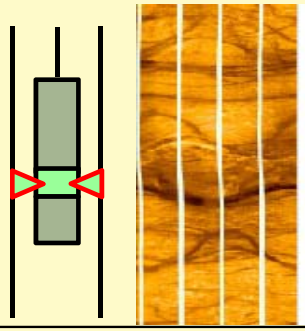
*Introduction.....*Tools for borehole wall imaging

No	1	2	3	4	5
Typical System	**Impression Packer**	**FVCS** Forward Vision Camera System	**BIPS(ODS)** Borehole Image Processing System	**BIPS(USS)** Borehole Image Processing System	**FMI or FMS** Fullbore Formation Micro-Imager
Measuring mechanism	Fracture tracing by rubber and inflation packer.	Optical downhole view.	Imaging by horizontal optical view.	Imaging by ultrasonic beam reflection.	Imaging by electric resistivity.
Sketch of equipment and data		 *1	 *1	 *1	 *2
Process and cost	**Simple** **Low**	**Simple** **Low**	**Complex** **Expensive**	**Complex** **Expensive**	**Complex** **Expensive**
Application Field	**Hydro-fracturing**	**Well inspection** **Civil/Energy**	**Frac. analysis** **Civil/Energy**	**Frac. analysis** **Civil/Energy**	**Frac. analysis** **Civil/Energy**

*1:http://www.esa.gr.jp/ *2:https://staff.aist.go.jp

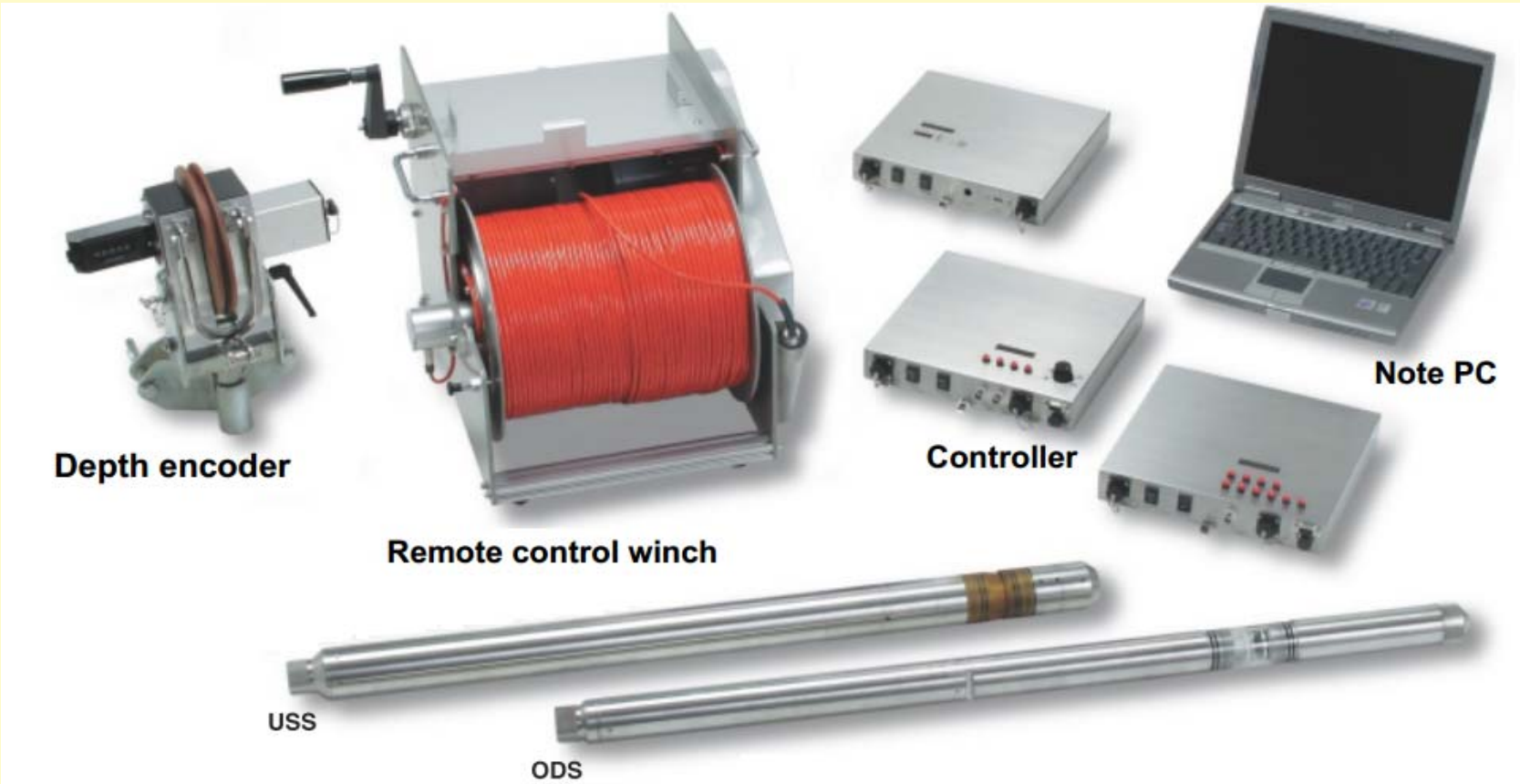


Fig. 1. System components for ODS and USS

Specification of BIP-V System for ESA (Excerpt)

Article	Item	BIP-V-ODS	BIP-V-USS
Manufacturer		RaaX Co. Ltd.	
Probe	Operation temperature	0～40℃ (without moisture)	0～50℃
	Borehole diameter	φ56～φ200mm	φ56～φ148mm
	Size(※1)	φ50mm, L=1030mm	φ50mm, L=930mm
	Optical resolution	depth 0.25mm（min.）	
		horizontal 360/720pixel	
	Groundwater	**Clean water or dry condition**	**Clean or muddy**
	Performance	Borehole projected image 180/360 degree	frequency 1.0 MHz
		built-in orientation sensor	built-in orientation sensor
		full color	shading
		built-in mechanical compass	
	Sensor rotation	no rotation	600 rpm

※1 Not including protrusions

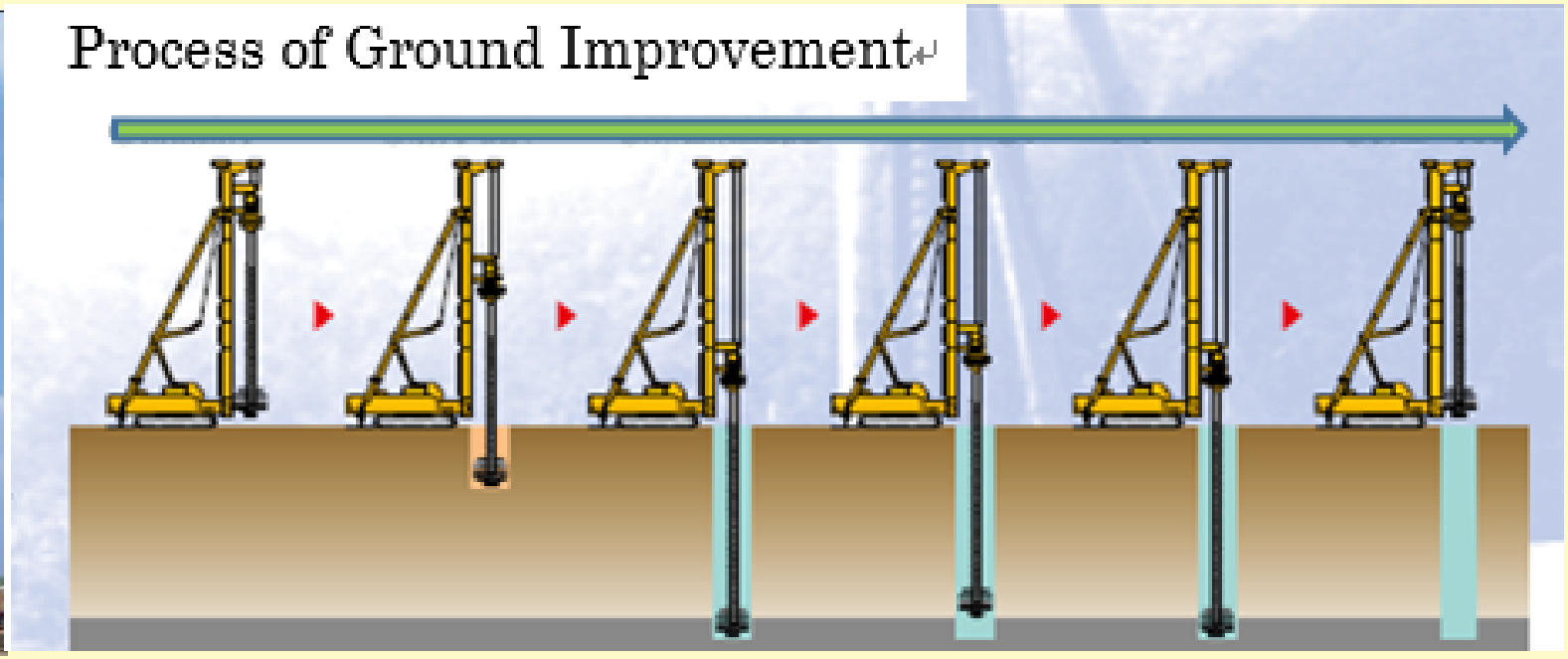
※2 Special operational（pre-install measurement application software）Possible to display over 1280x1024pixel on SXGA screen

TEST SITE

Test site is a test field for ground improvement by mixing the earth with cement.

Test 1 : Comparison of USS borehole image and ODS borehole image

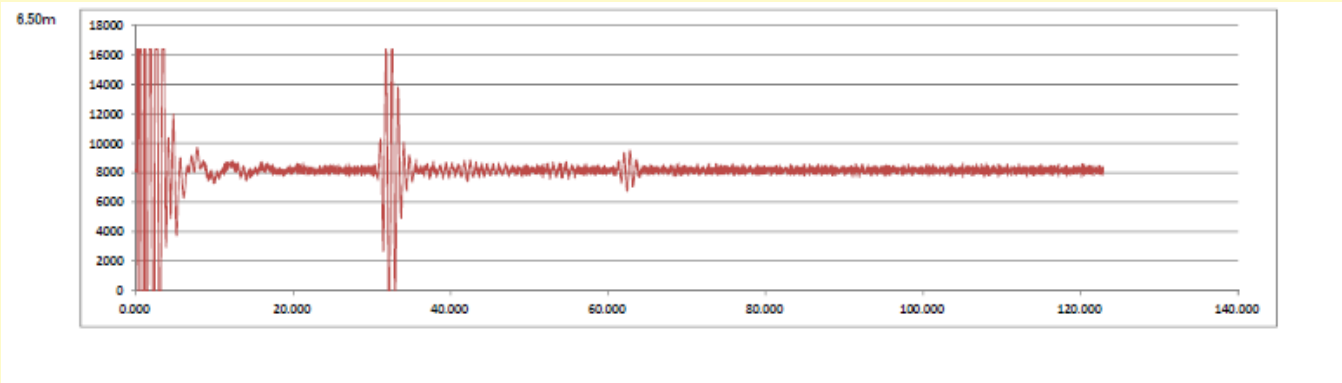
Test 2 : Ultrasonic full-waveform logging




4
3

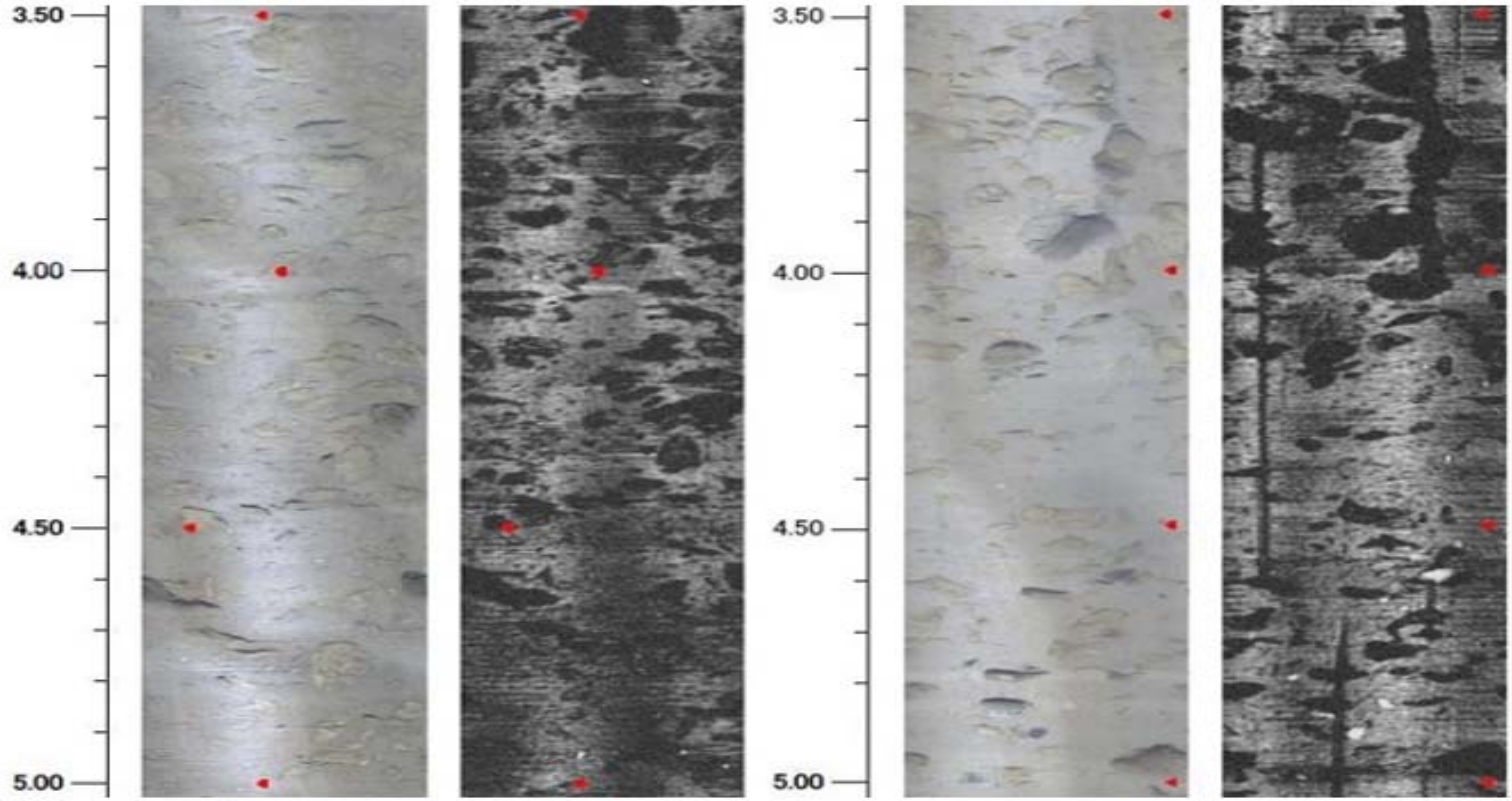
Prototype Probe for Full-waveform Ultra Sonic Log

In this experiment, as one of the evaluation of ground improvement, we made a full-waveform ultra sonic probe



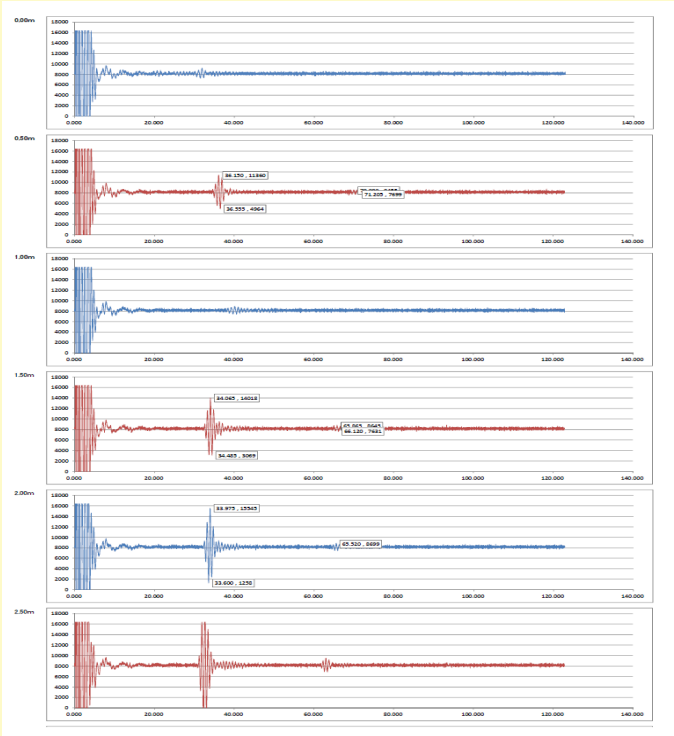
Data acquisition (field operation) situation (ODS)

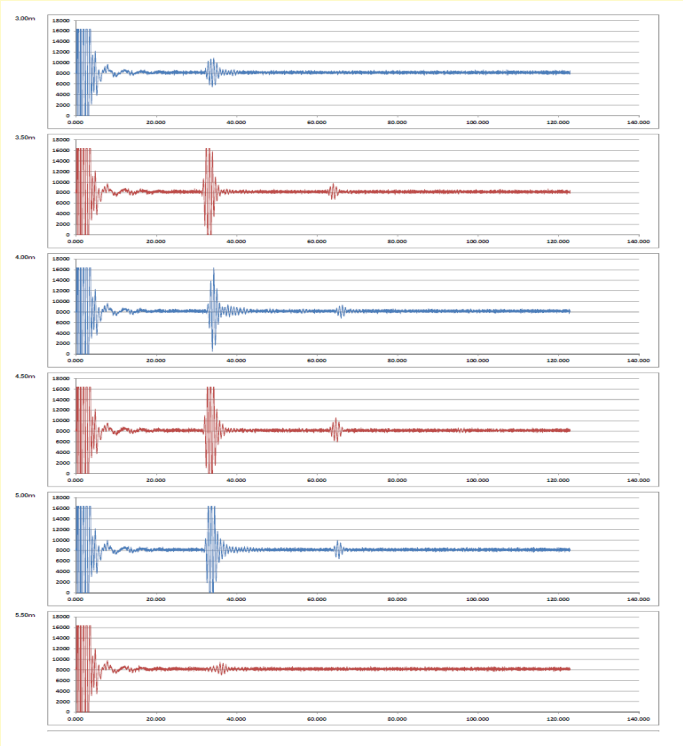
Result of field test

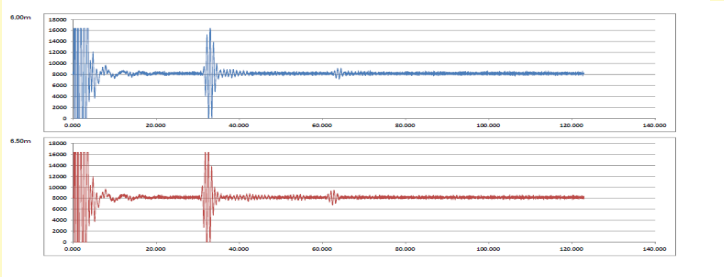


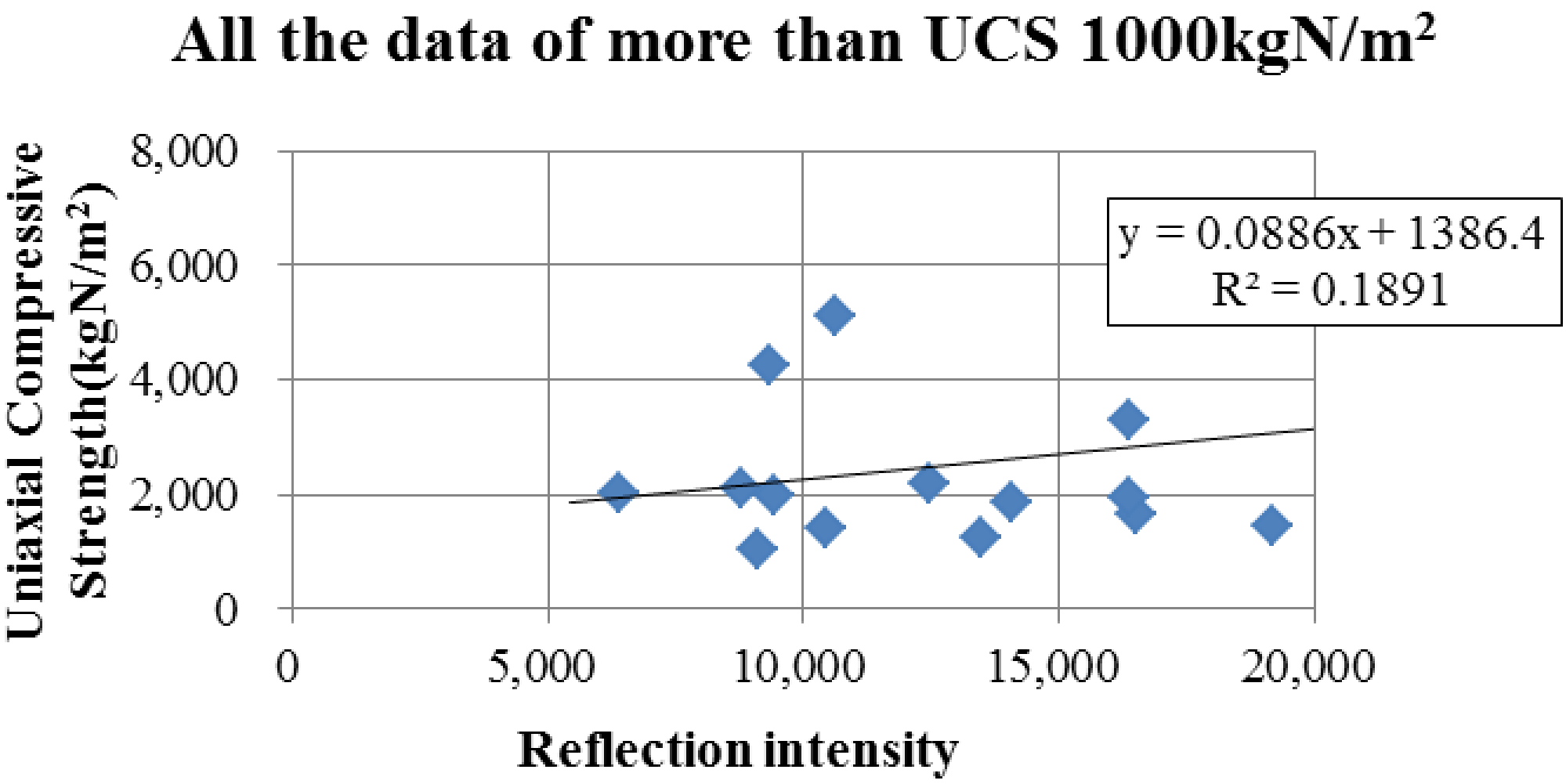
(1) ODS Projection Image | (2) USS Amplitude Image | (3) ODS Projection Image | (4)USS Amplitude Image

Result of Ultra Sonic Full-waveform Logging

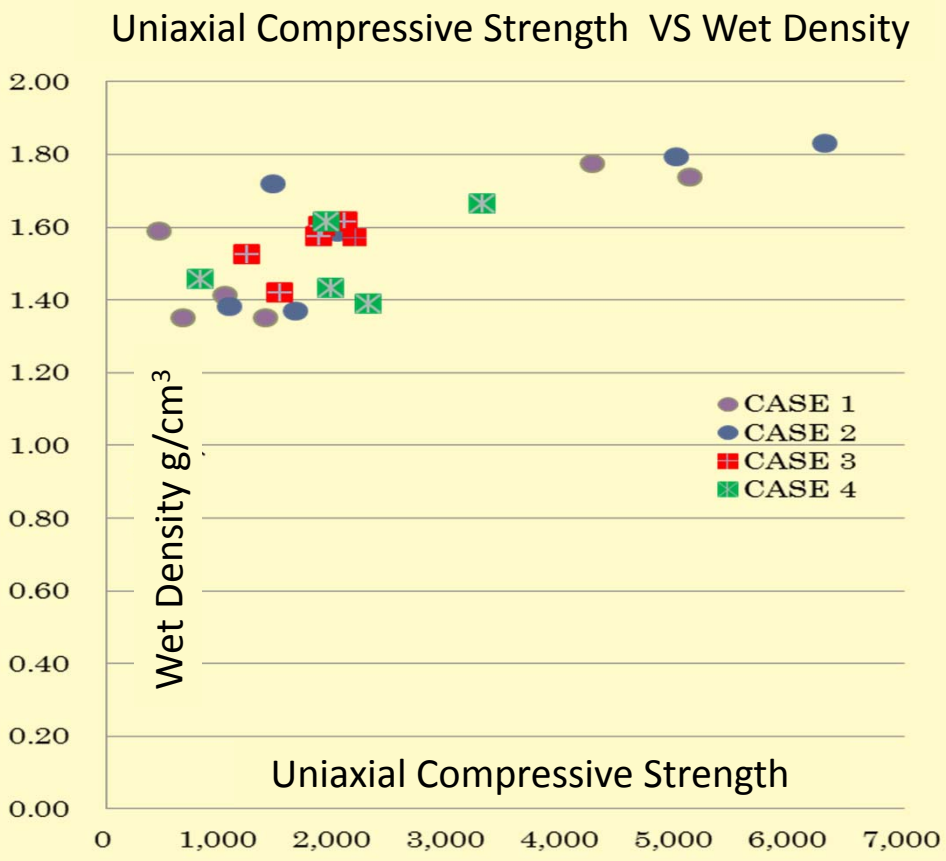


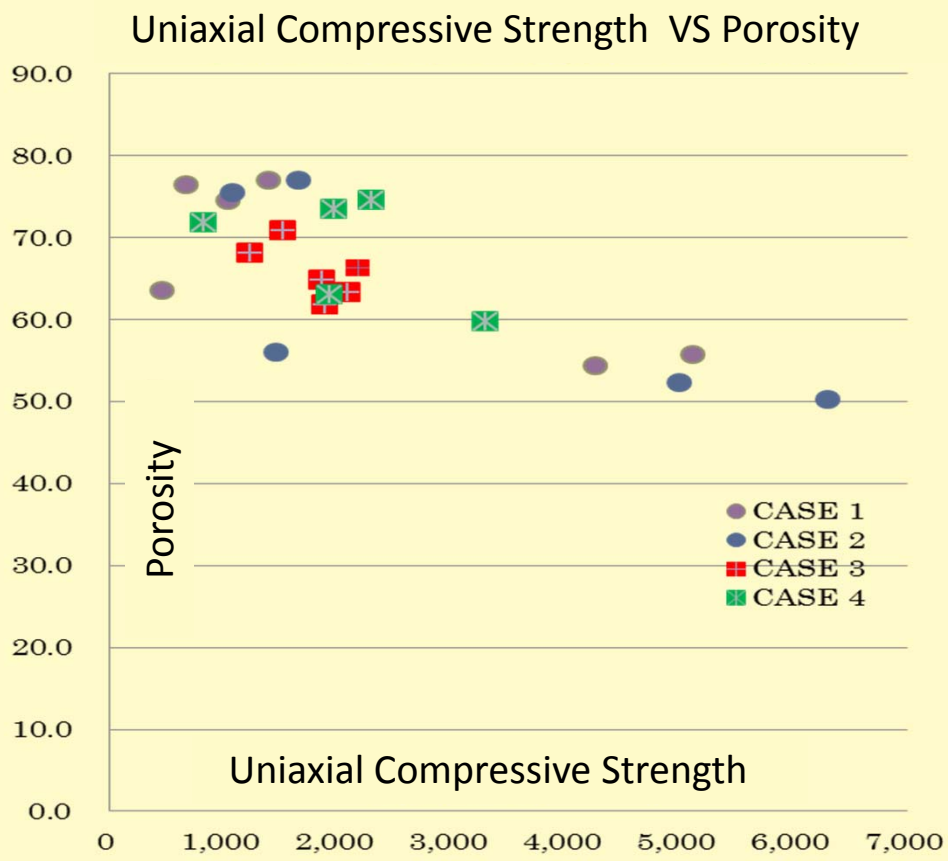





All the data of more than UCS 1000kgN/m²
Uniaxial Compressive Strength(kgN/m²)
8,000
6,000
4,000
2,000
0
0
5,000
10,000
15,000
20,000
Reflection intensity
y = 0.0886x + 1386.4
R² = 0.1891

Analysis of The Core Samples





SUMMARY

Borehole imaging test was carried out in artificially improved ground. As the ground is special, the borehole image is also different from usual. Therefore it is difficult to judge which is better from optical and ultrasonic scanner based on the image. However, in consideration of different operation conditions,

- It is obvious that the USS can be a supplement for ODS when borehole water condition does not meet the requirement of ODS.
- Because the nature of USS image is different from that of ODS image, knowing from the comparison of the 2 kinds of images of same borehole wall, the USS has advantages such as that USS is sensitive for some kind of cracks which is insensitive for ODS. The we currently suggests that both ODS and USS should be performed if possible.
- The full-waveform ultrasonic logging test is meaningful and encouraging. We will continue to commit technical development in full-waveform ultrasonic logging.

ESA Earth Scanning Association

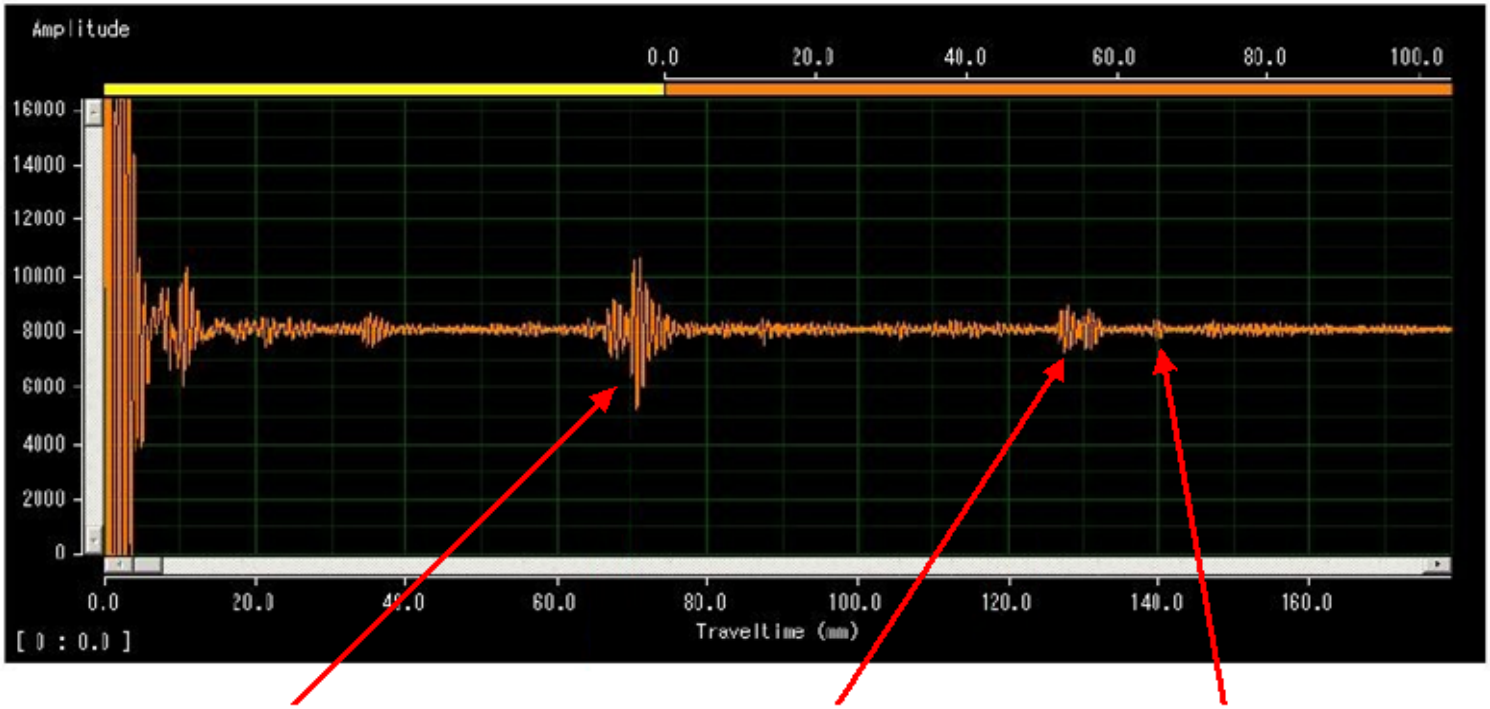
Thank you
very much

Table 2. Comparison of ODS and USS for Logging Condition

Boring Condition	ODS	USS
No water	○	×
Muddy water	×	○
Tilt borehole	○	○
Casing	×	×

Table 3. Detail Data about the 4 boreholes

Bor. Name	CASE 1	CASE 2	CASE 3	CASE 4
Diameter	86mm	86mm	86mm	86mm
Depth	6m	7m	6m	5m
Drilling Water	Fresh Water	Fresh Water	Fresh Water	Fresh Water
Coring	All Core	All Core	All Core	All Core
Logging	S-Velocity	S-Velocity	S-Velocity	S-Velocity
Lab. Test	Uniaxial Compression	Uniaxial Compression	Uniaxial Compression	Uniaxial Compression



First reflection from chamber window

Reflection from boorehole wall

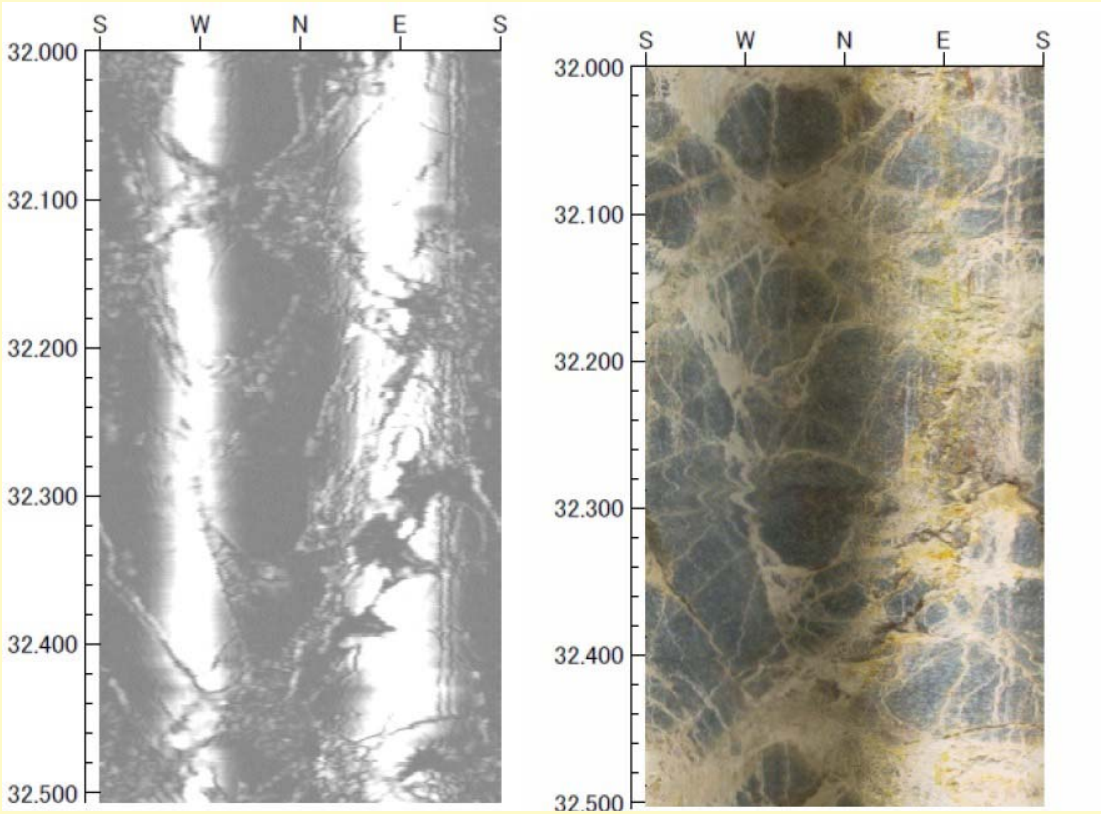
Secondary reflection from chamber window

Operation situation (ODS,USS)

USS probe inserting situation

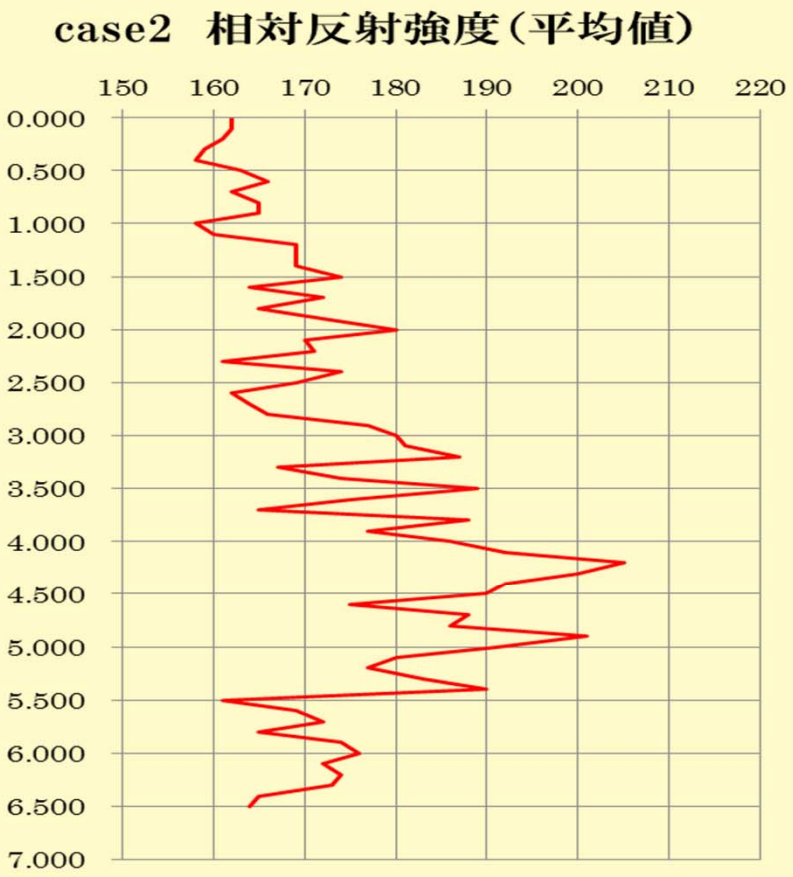
Example Images of USS and ODS

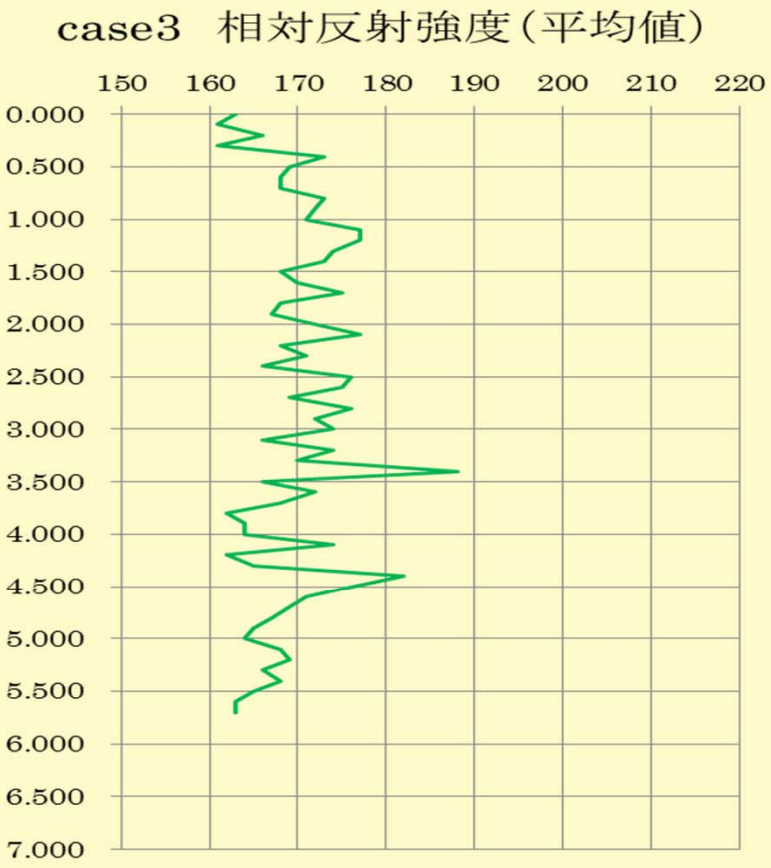
USS



ODS

波形解析(相対反射強度)の例





Scanner	Merits	Demerits
ODS	1) Can give full original color image of the borehole wall. 2) Can measure in borehole of any tilt angle. 3) Can measure in dry borehole.	1) Counter measures must be made to improve the transparency of borehole water and Cannot measure in muddy water. 2) Do not carry physical property of the core. 3) Magnetized rock may influence the image.

Scanner	Merits	Demerits
USS	1) Can measure with cloudy water, even though muddy water. 2) One scan can give 2 kinds of result: reflection intensity image reflects physical properties of the rock and travel time refllects the diameter of the hole. 3) Can measure cracks with almost no opening.	1) There is a need to set exactly in the center of the hole camera . 2) Cannot measure in tilt borehole. 3) Magnetized rock may influence the image. 4) Cannot measure in dry borehole. 5) The image is black/white or gray scaled.