Development of a New Generation Ocean Bottom Seismometer (OBS2G) for large-scale seismic survey

Research Fleet Department
Masato Sugano

INMARTECH 2014
18-21 November 2014 Corvallis, Oregon, USA
Japan Agency for Marine-Earth Science and Technology (JAMSTEC)

Contents

- about JAMSTEC
- About JAMSTEC OBS
- New generation OBS “OBS2G”
- Future
- Appendix: new glass sphere made in JAPAN

about JAMSTEC

JAMSTEC Fleet (Research Vessels)

NATSUSHIMA	KAIYO	YOKOSUKA	KAIREI	MIRAI
1981	1985	1990	1997	1997
67×13m	62×28m	105×16m	105×16m	128×19m
1,739t	3,350 t	4,439 t	4,517 t	8,706t

Coming soon!

HAKUHO	SHINSEI	CHIKYU	???
1989	2013	2005	2016
100×16m	66m×13m	210m×38m	app.100m×19m
3,991 t	1,629 t	56,752t	app.5,800t

Completion
Length*Beam
Gross Tonnage

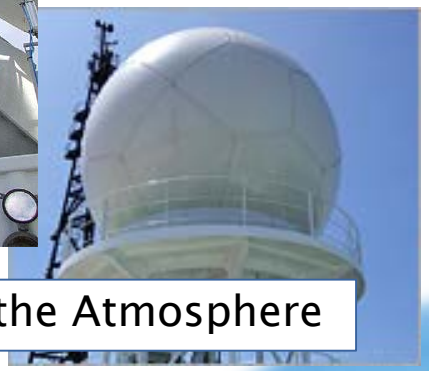
about JAMSTEC

JAMSTEC Fleet (Submersible & Vehicles)

				
SHINKAI 6500	**KAIKO 7000 Ⅱ**	**HYPER-DOLPHIN**	**URASHIMA**	**Deep-Tow**
Deep Submergence Vehicle	ROV 7000m Class	ROV 3000m Class	Deep Sea Cruising AUV	Deep Ocean Floor Survey System

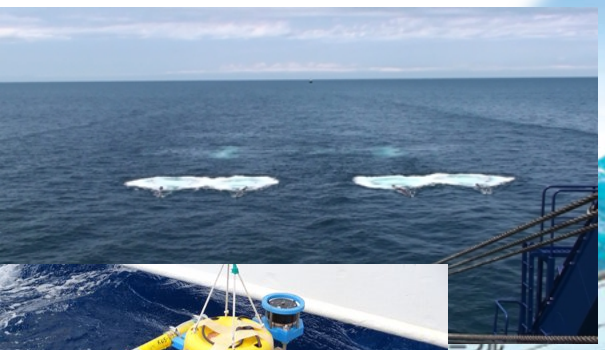
about JAMSTEC

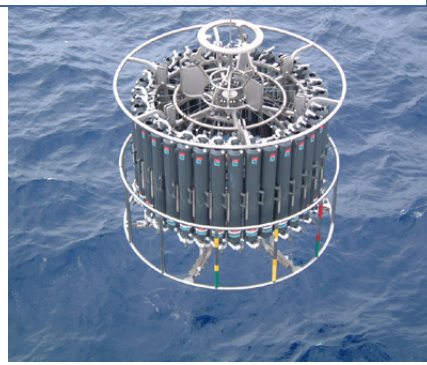
Marine Observation Systems

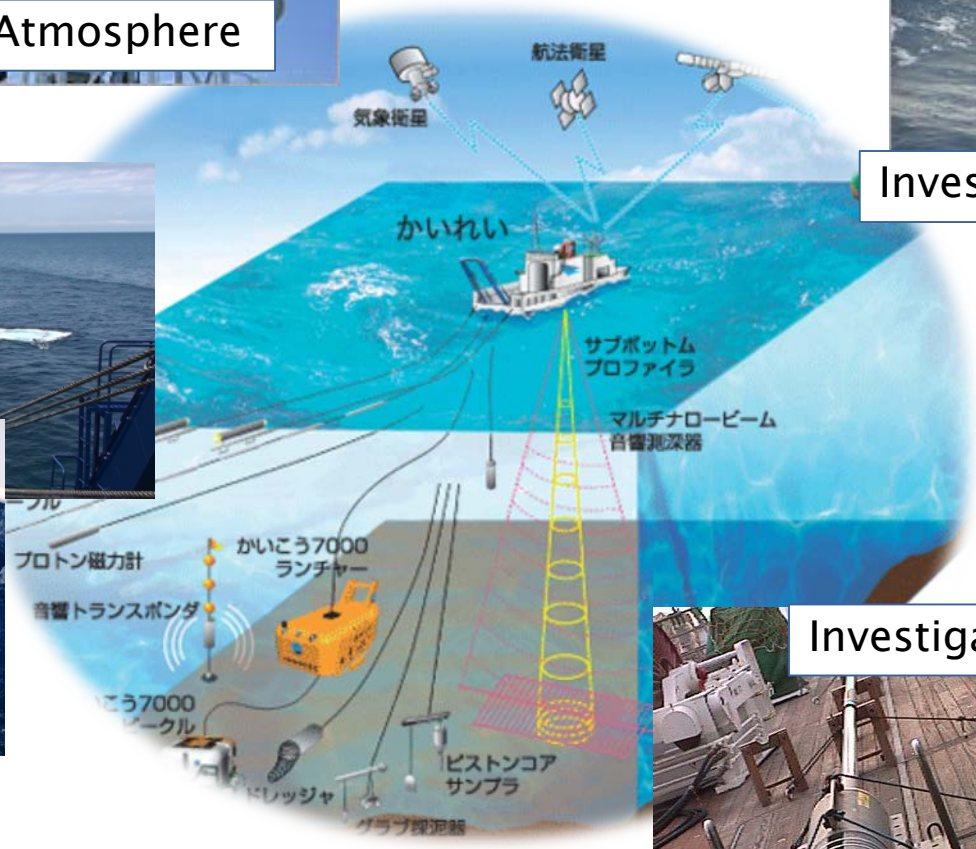


Investigating the Atmosphere

Investigating the Ocean







Investigating the Seafloor

Investigating the Subsurface Structure

about JAMSTEC

Global Ocean Development Inc.
GODI 株式会社 グローバル オーシャン ディベロップメント

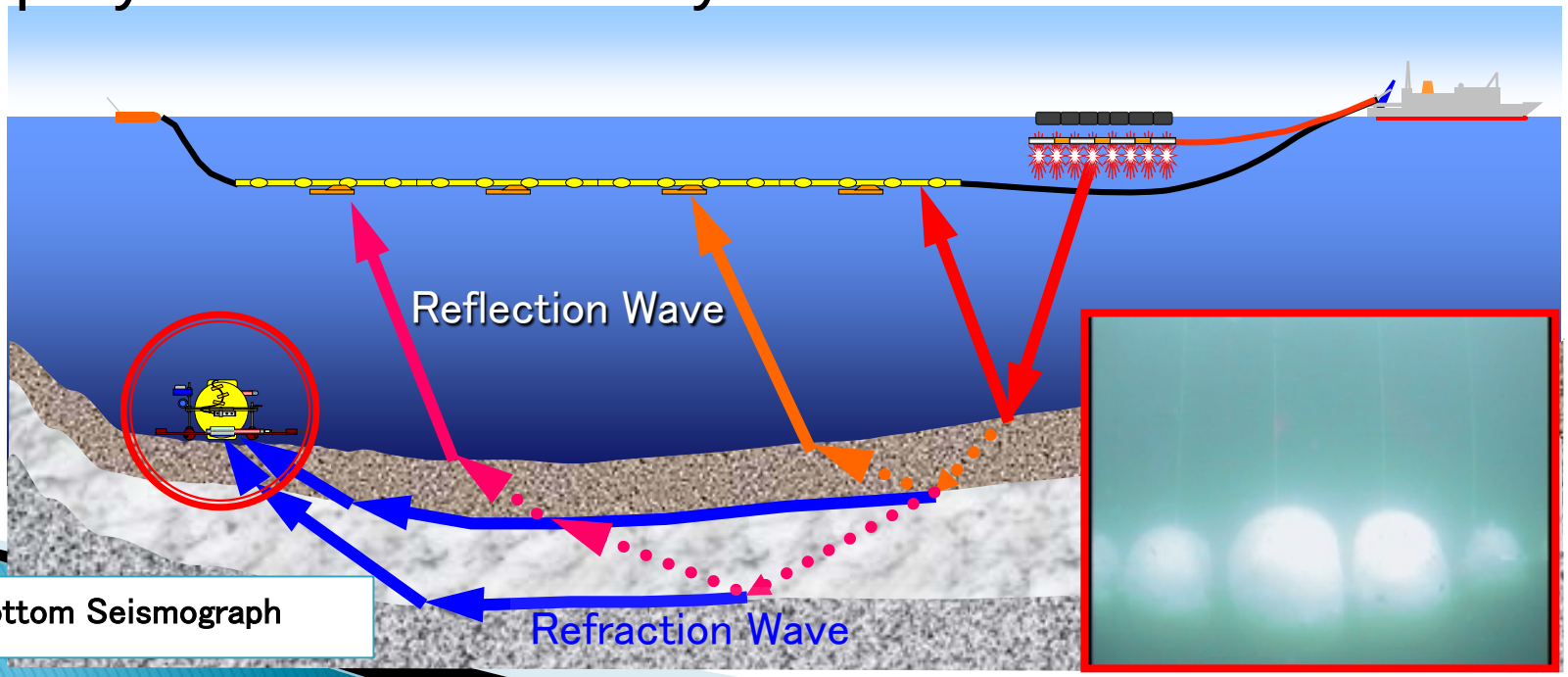
JAMSTEC

NME
Nippon
Marine
Enterprises, Ltd.

about JAMSTEC OBS

about OBS

- Two applications
  - Seismic observation
  - To study the structure under the seabed
- Stand-alone system containing;
  - 3 component seismometers
  - Recording device
  - Battery
  - Acoustic transponder
  - Flasher/Beacon
- Deployed on Seafloor by free-fall or ROV

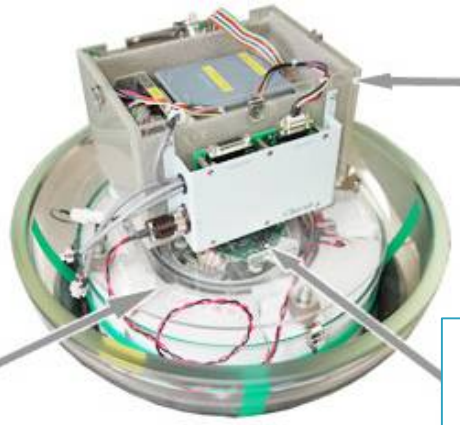


OBS: Ocean Bottom Seismograph

about JAMSTEC OBS

- Basic structure was developed by Univ. of Tokyo, Hokkaido Univ. etc. almost 20 years ago
- Compact and low-cost based on 17-inch glass sphere
- Deployed by free-fall and recovered by self-pop-up releasing

  ballast with acoustic command



Recording Device

Battery

3-componen geophones

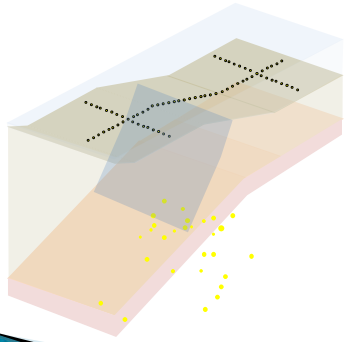
Inside of the 17inch glass sphere

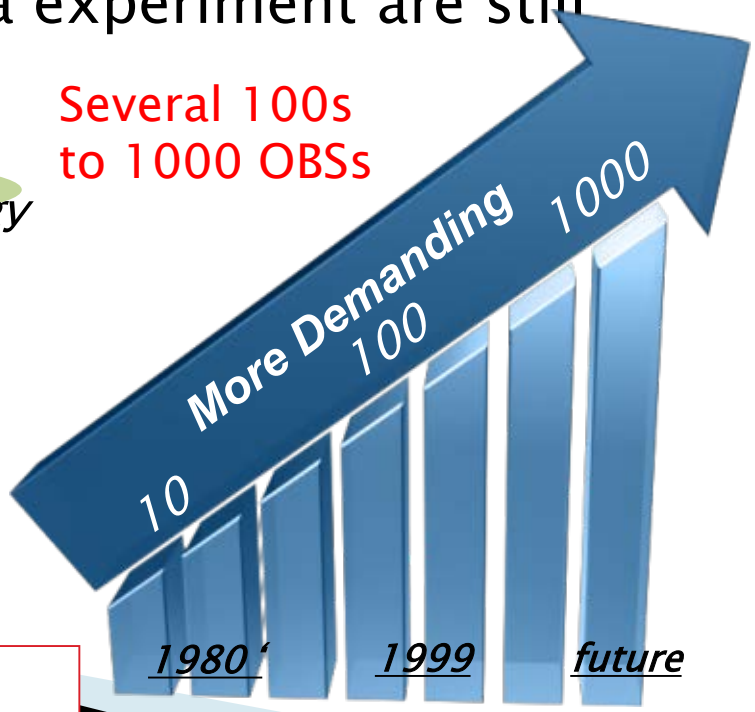
about JAMSTEC OBS

- JAMSTEC introduced 100 OBSs in 1999
- Usually, several tens OBSs employed at one experiment
- More than 5000 OBSs deployed for15 years
- However, thousands, even several hundreds in a experiment are still impractical

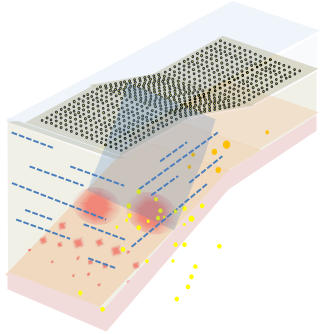
Several 100s to 1000 OBSs

Current Seismology





Future Seismology

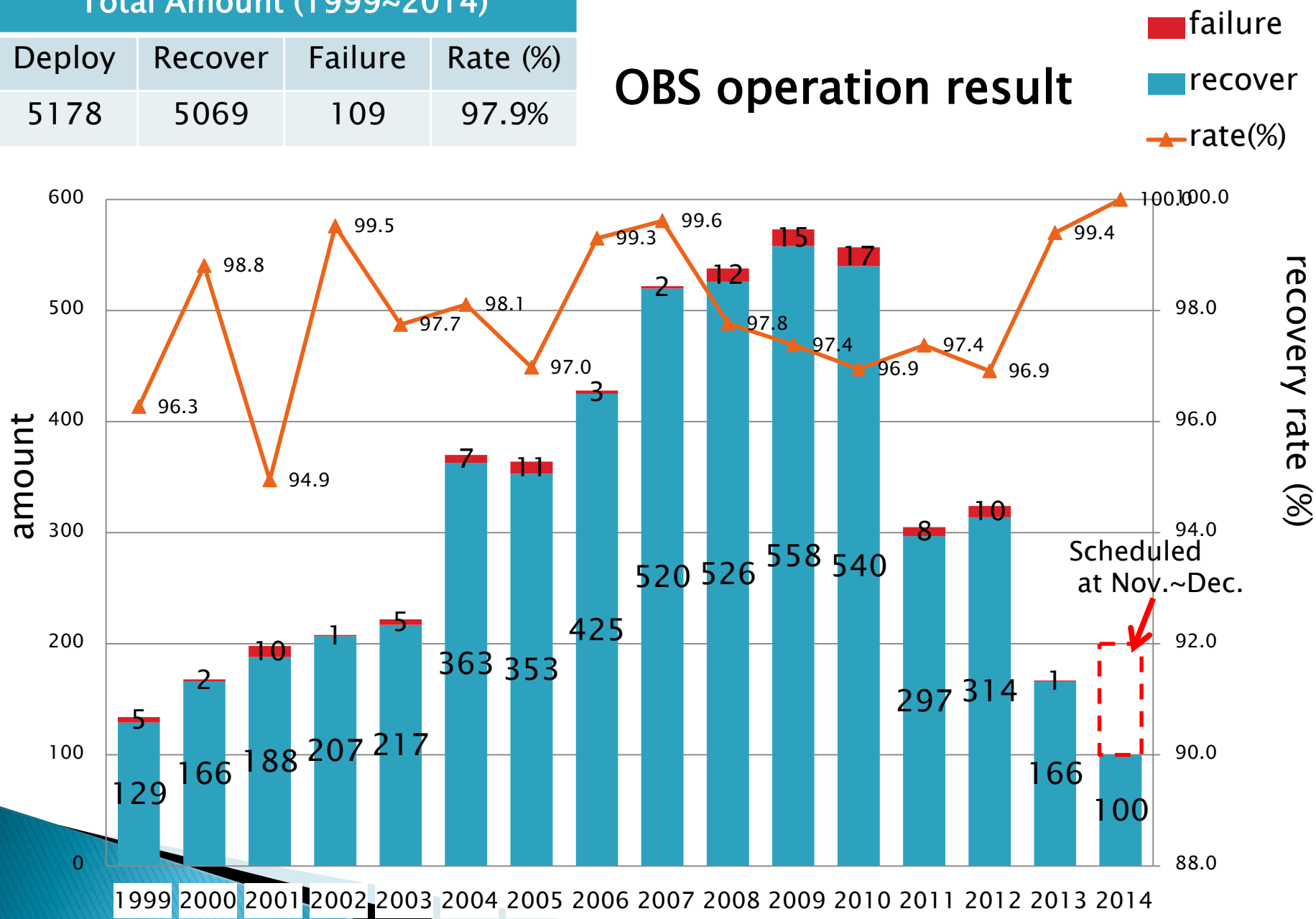


2D structure

3D structure

Total Amount (1999~2014)			
Deploy	Recover	Failure	Rate (%)
5178	5069	109	97.9%

OBS operation result



about JAMSTEC OBS

Why are the thousand OBS units impractical?

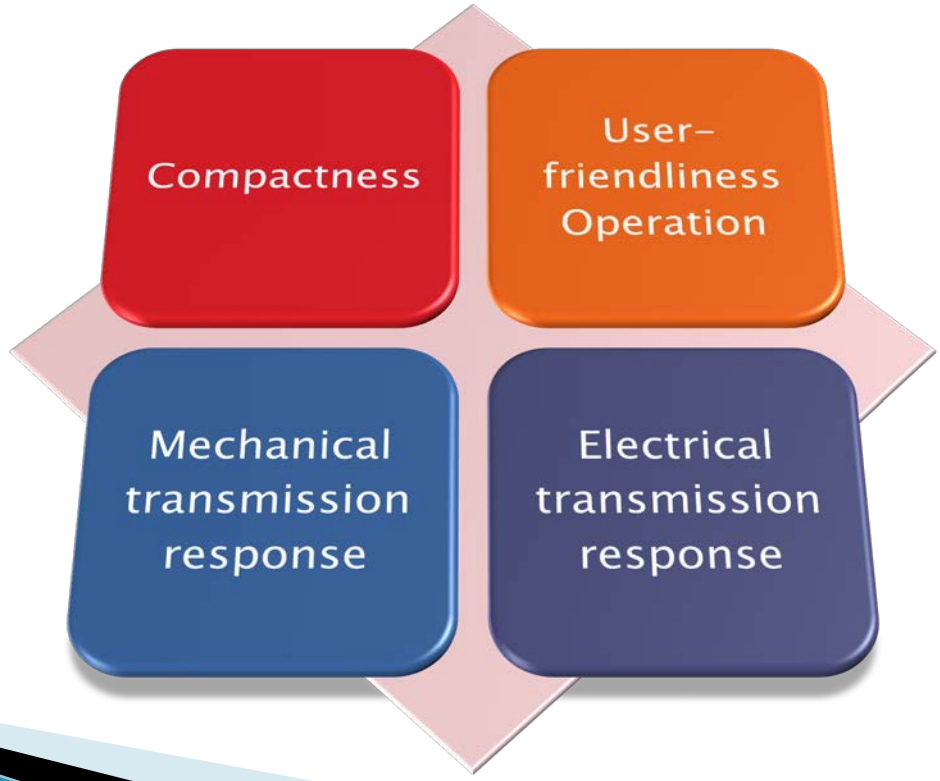
- Operation and maintenance difficulty
  glass sphere, cables, connectors, O-rings
  data access, battery etc.

- Weight and size
  safety handling and deck space

- Cost

Requirement of recent seismology

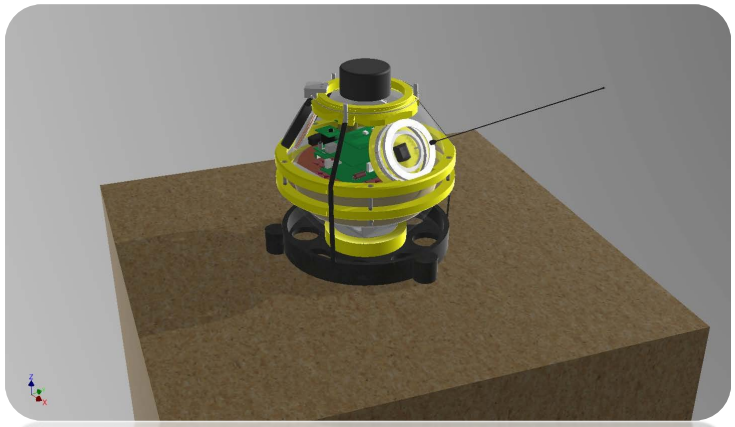
- Dense deployment
- 3-D grid
- Mechanical transmission response
- Bottom sensor-coupling



New OBS – "OBS2G"

OBS2G

2nd Generation OBS to grid

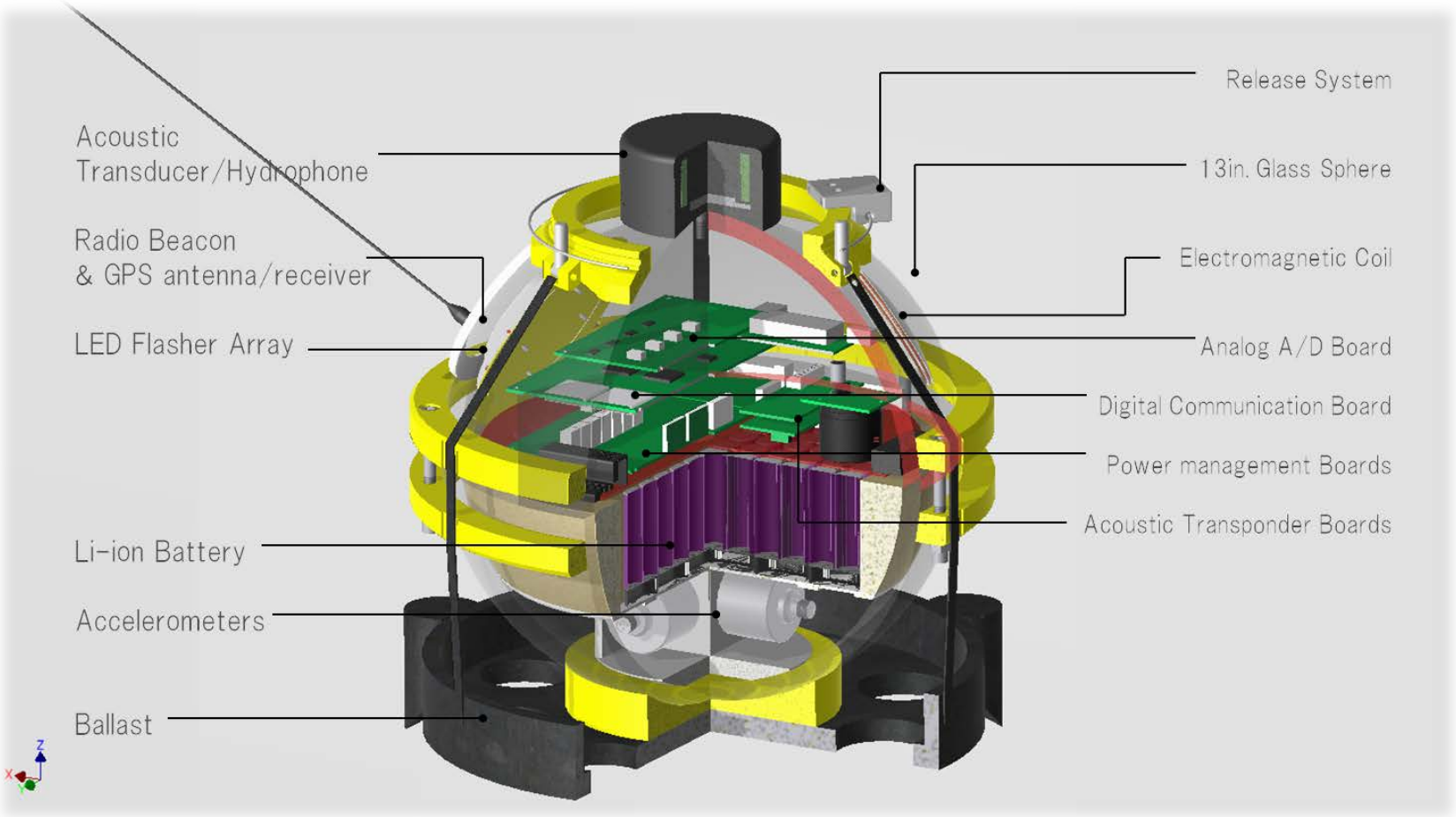


Nippon Marine Enterprises, ltd.
(NME)

Japan Agency for Marine-Earth Science Technology
(JAMSTEC)

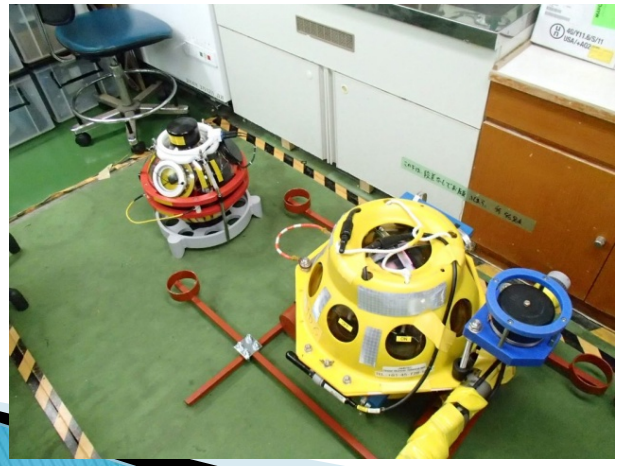
- Started the development from 2010
- Prototype "OBS2G" accomplished at May 2012

OBS2G – structure



OBS2G – Superiority

- All components are housed in 13in. glass sphere
- Light weight (35 kg)
- Maximum operation: 1000 or more for 4000 ton class vessel



OBS2G – Superiority

- Wireless Battery Charge
- Wireless data communication
- Auto GPS time synchronization
- Maintenance and setup is very easy

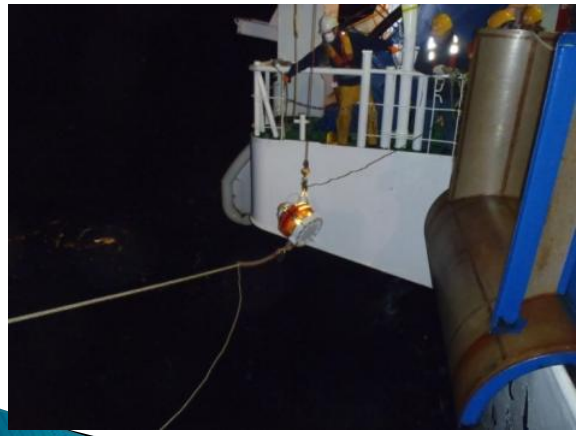
Wireless Battery Charge
And
Data Communication

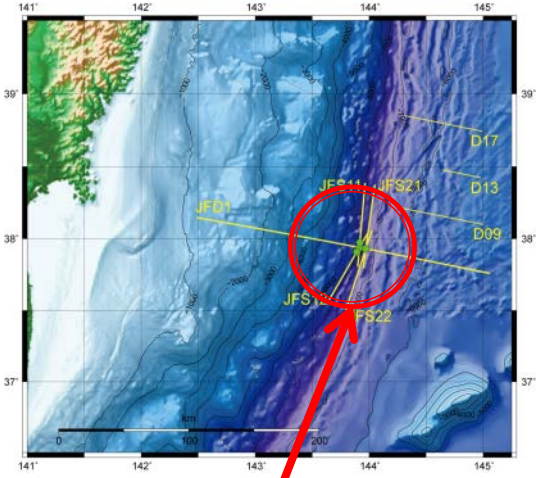
Comparison – OBS2G vs. Conventional

	OBS2G	*Conventional OBS*
Weight (w/o ballast)	35 kg (20kg)	98 kg (43kg)
Pressure Housing	13 inch glass sphere	17 inch glass sphere
Observation period	30days(accelerometers) 40days(geophones)	40 days
Sampling	100/250/500/1000Hz	100/250Hz
Seismic Sensors	3C accelerometer (or 4.5Hz geophones) + Hydrophone	4.5 Hz geophone + Hydrophone
Dynamic range	>130 dB (24bit) at 100 Hz SPS	75dB (16bit)
Batteries	All rechargeable (Li-ion)	Li-ion / Lithium / Alkaline
Communication	IEEE801.11n	RS232
Ballast release mechanism	Fuse String	Electric corrosion
Maximum Operating depth	7,000m	6,000m

Sea Trials and actual observation

Shallow water (30m)

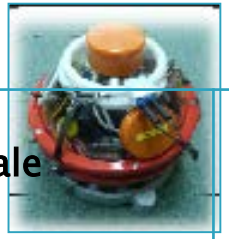




Ultra-deep water (7,000m)

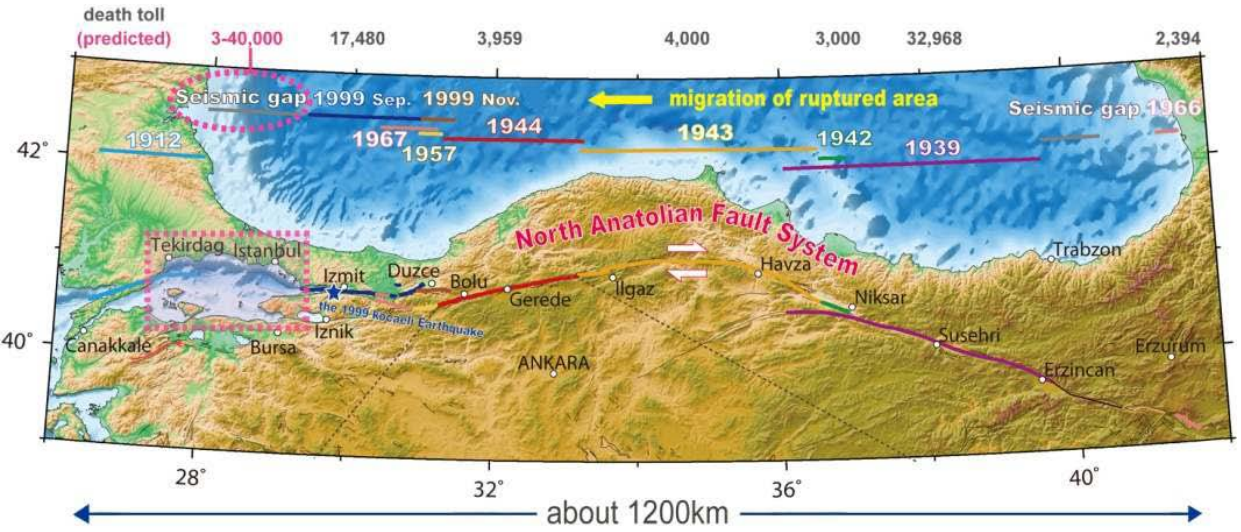
Deployed and Recovered at Japan Trench

Line-up

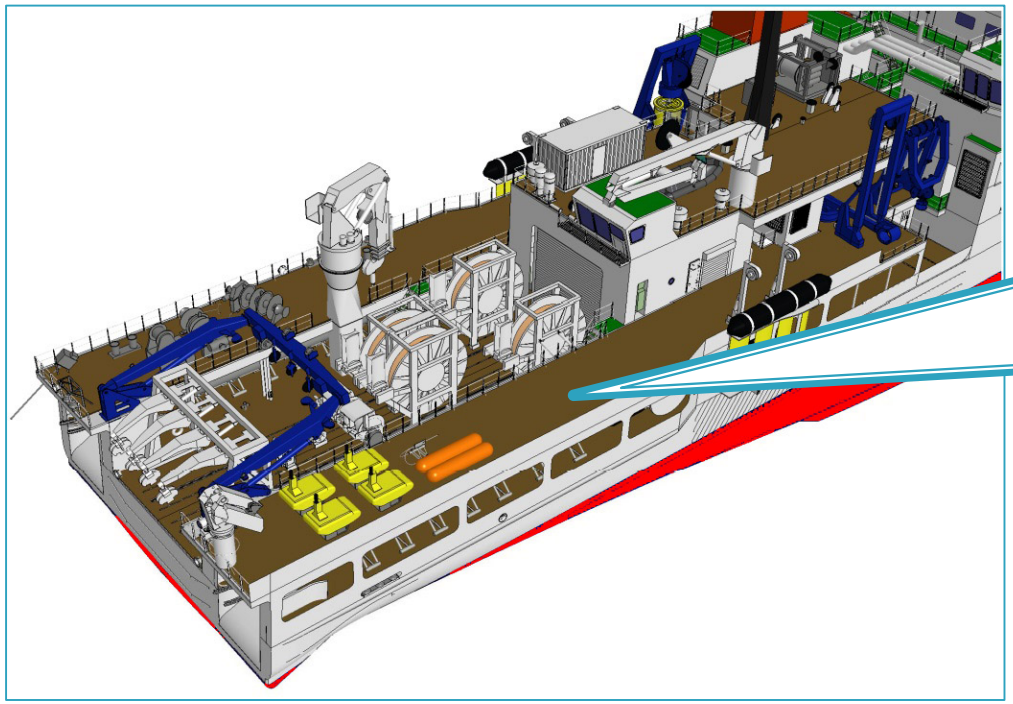
	OBS2G for large-scale operation 	OBS2G-L for long-term observation 	OBS2G-UD for Ultra Deep Sea 
Weight(w/o Anchor)	35 kg (20 kg)	77 kg (39 kg)	105kg (53 kg)
Size of glass sphere	13 inch	17 inch	17 inch
Recording period	30 days (accelerometers) 50 days(geophones)	300 days	180 days
Sampling	100/250/500/1000Hz		
Sensor	3 axis low-noise accelerometers(or 4.5Hz geophones)+ hydrophone	4.5 Hz geophones+ hydrophone	4.5 Hz geophones+ hydrophone
Dynamic range	>130dB(24bit)		
Power	Li-ion Batteries(wireless charging)		
Communication	IEEE802.11n wireless LAN		
Anchor release	Fuse string	Forced electrical corrosion	Forced electrical corrosion
Max. operational depth	7,000 m	6,000 m	11,000m

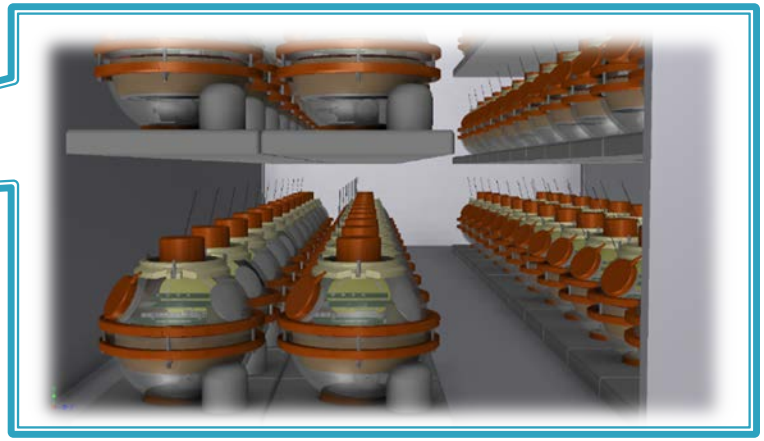
Example of practical use

- OBS2G-L for Sea of Marmara, Turkey
- (Project of Earthquake and Tsunami Disaster Mitigation in the
- Marmara Region and Disaster Education in Turkey ; JICA)
- Mar – Jun 14 : Sea trial (Successfully completed)
- Sept 14 – Jul 15 : Long term observation

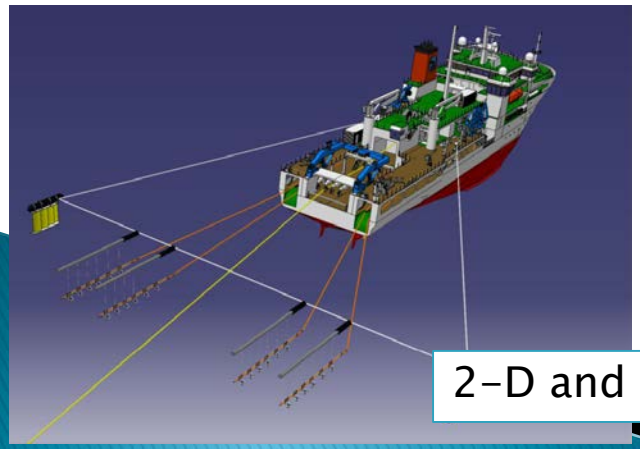


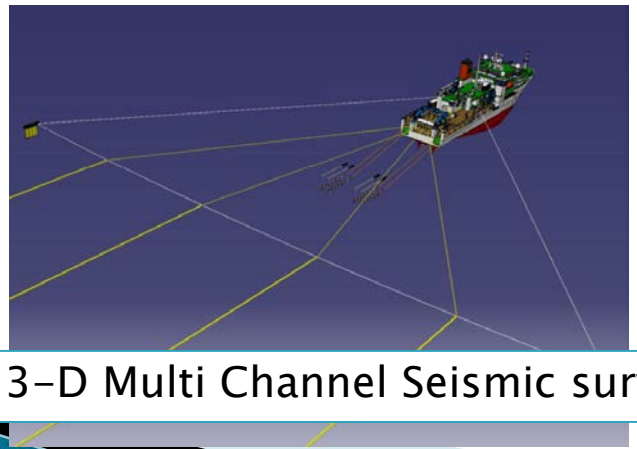
Future Plan in the New Vessel

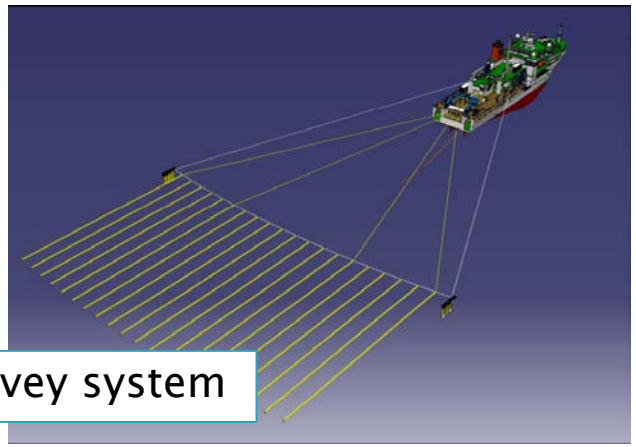




about 400 OBS2G!

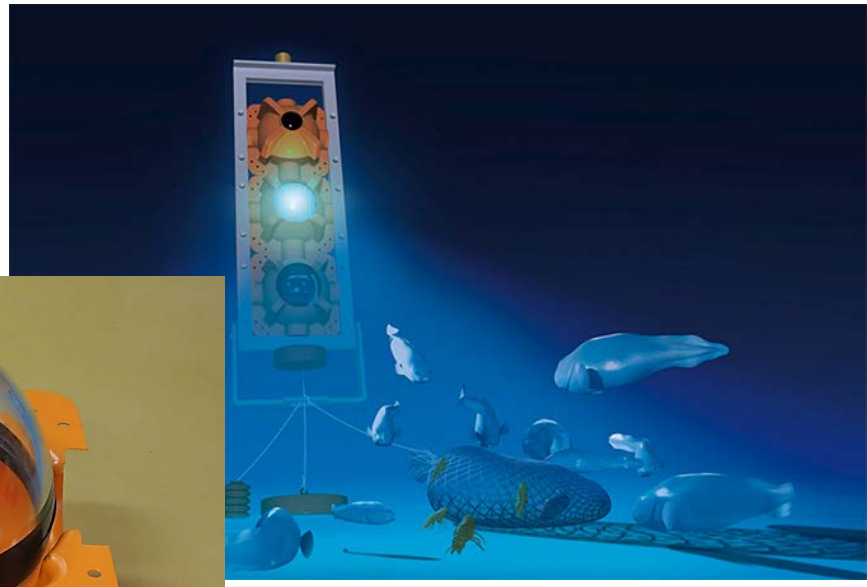






2-D and 3-D Multi Channel Seismic survey system

appendix. New 13 inch Glass sphere made in Japan!

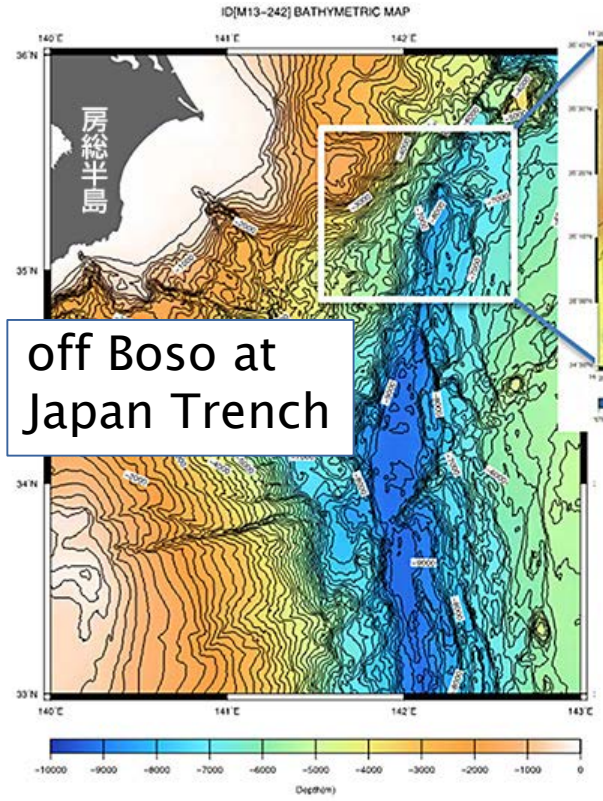


OKAMOTO GLASS Co.,Ltd.

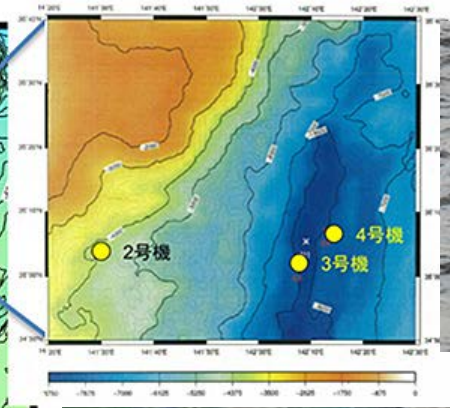
OKAMOTO GLASS CO., LTD.
Established 1928

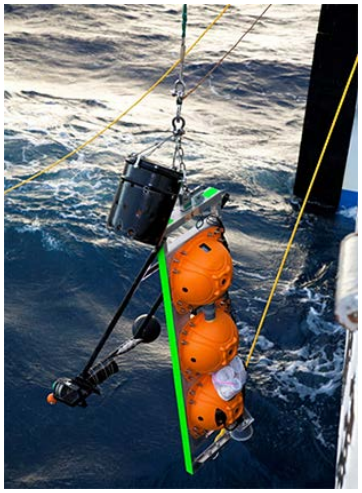
Free-fall type
Deep sea investigation shuttle device
“EDOKKO -1”

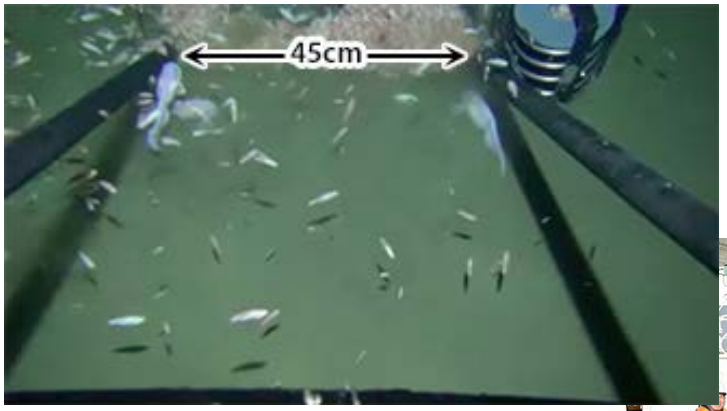
appendix. New 13 inch Glass sphere made in Japan!



off Boso at Japan Trench







3-D Full-HD camera

Now, developing 17inch glass sphere is now progress…

Summary

- JAMSTEC has operated total over 5,000 OBSs.
- Its recovery rate achieved about 98%
- However, conventional way of operation is not impractical.
- Thus, we developed new OBS (***"OBS2G"***).
- It is more compact and easy to hundle.
- Recording system achieved 135dB wide dynamic range, high clock accuracy with small power consumption
- And we succeeded to develop new glass sphere that is made in JAPAN.
- The new Japanese Glass sphere, it contributes cost saving
- Its quality is stable.

Thank you for your attention !