Notice on using the OBS data

Seismic data obtained by using mobile and borehole ocean bottom seismometers (OBSs) are not the same as those obtained at land stations due to various deployment conditions. Here, information, conditions and limitations of the OBS data to be opened for public use from this data center are described. Users of the data should read this notice before downloading the data.

1. Available seismic data

Each OBS has its own time standard, such as a high precision digital crystal oscillator, and the time difference of a mobile OBS to the UTC was measured before and after the observation. Because of small change in temperature at the ocean floor and small drift of the OBS time, a linear interpolation is applied to correct the OBS time. The overall time precision is less than 10 ms that is enough for usual analyses. In some OBSs, we could not measure the time difference after the observation caused by some trouble in a recorder. In such a case, we estimated the time drift using a method to measure a temporal change of ambient noise cross correlation function [1]. For borehole OBSs, we could not apply a linear interpolation caused by the system limitation and the overall time precision is less than 1 second.

Another problem is a direction of horizontal components due to deployment ways for OBSs. For mobile OBSs, an electric compass with an inclinometer is equipped on the seismic sensor. And, for borehole OBSs, circle shooting of the airgun was performed to determine the direction. The magnetic azimuth of mobile OBS thus determined (from the north, clockwise in degree) for the H1 component is indicated in the station list on the web page and in the data header. The coordinate system is the right-hand system, X: H2, Y: H1 and Z, those correspond to EW, NS and UD outputs from the seismic sensor. Azimuth of WP2, borehole OBS, determined by an airgun shooting [11], is also indicated in the station list on the web page. However, we recommend users to determine the azimuth by analyzing seismic waves (e.g., long-period P-waves, long-period Rayleigh wave) by themselves.

2. Difference in type of sensors and data IDs

There are two type of sensors used, the PMD (WB2023LP) and the CMG-1T (or -3T EBB) for the OBS. The CMG sensor is used with an active leveling mechanism, but the PMD sensor is operated under possible inclination. The horizontal components of the PMD sensors work correctly anyway, but the vertical component could be contaminated by horizontal components. So that, the data of the inclinometer, within the electric compass, on the PMD sensor is used to obtain the true vertical component after the instrumental response correction of three components. The information about the inclination of PMD sensor is also indicated in the station list. Pitch indicates an inclination of H1 axis in degree (up is positive) and roll indicates an inclination of H2 axis in degree (down is positive). The data are not corrected to remove the instrumental response. Some BBOBS were equipped with a differential pressure gauge (DPG) [17]. Sensor response of DPG in a seed file is based on manufacture's data sheet. Please note that the response of DPG on the seafloor may be different.

IDs of the mobile OBS data and the type of sensor are as following;

PMD: PHS, MAR, MRG

CMG: OHP, FP, SSP, TIARES, NOMan, OJP array

All of borehole OBSs have the CMG-1T sensors. IDs of them are WP1 and WP2.

In the Normal Oceanic Mantle project (NOMan), we deployed a new type of a broadband ocean bottom seismometer, namely the next-generation broadband ocean bottom seismometer (BBOBS-NX)[2] using a special CMG-3T sensor can be operated correctly up to ±8° inclination. The BBOBS-NX has no active leveling mechanism, so that vertical component could be contaminated by horizontal components caused by a possible inclination. The information of the inclination measured by the inclinometer in the sensor of the BBOBS-NX is shown in the station list on the web page. Pitch indicates an inclination of H1 axis in degree (up is positive) and roll indicates an inclination of H2 axis in degree (down is positive). The data of the vertical component of BBOBS-NX are not corrected to remove the contamination of horizontal components caused by a possible inclination.

3. Reference for the data

It is preferable to refer one of these papers related to the OBS of each type and representative analyses for each observation.

Project	Stations	References
PHS	PHS03,PHS04,PHS05,PHS08,PHS09,PHS11,PHS12,PHS13	[3][4]
MAR	MAR03,MAR04,MAR05,MAR06,MAR07,MAR08,MAR09	[3][5]
MRG	MRG03,MRG04,MRG16,MRG22,MRG40,MRG42,MRG58	[3][6]
OHP	NOT1,NWPAC1,NWPAC2,NWPAC3,SWSB1,SWSB2	[7]
FP	FP2,FP3,FP4,FP5,FP6,FP7,FP8,S1,S2	[8]
OHP	WP1,WP2	[9][10][11]
SSP	T01, T02, T03, T05, T06, T07, T08, T09, T11, T12, T13, T14, T15, T16, T17, T18, T19, T21	[12]
TIARES	SOC1, SOC2, SOC3, SOC4, SOC5, SOC6, SOC7, SOC8, SOC9	[13]
NOMan	NM01, NM02, NM03, NM04, NM05, NM12, NM14, NM15, NM16, NM17, NM18, NM19, NM20, NM21, NM22, NM23, NM24, NM25	[14][15]
OJP array	OJ02*, OJ03, OJ04, OJ05, OJ06*, OJ08*, OJ09, OJ11*, OJ12, OJ13, OJ14*, OJ15, OJ16, OJ18, OJ19, OJ20, OJ22, CHUK, CHUK2, KOSR, KOSR2 *: DPG data are available.	[16][17]*

[1] Isse, T., A. Takeo, and H. Shiobara, Time correction and clock stability of ocean bottom seismometer using recorded seismograms, JAMSTEC Rep. Res. Dev., doi: 10.5918/jamstecr.19.19, 19, 19-28, 2014 (in Japanese with English abstract).

[2] Shiobara, H., T. Kanazawa and T. Isse, New Step for Broadband Seismic Observation on the Sea Floor: BBOBS-NX, IEEE-JOE, doi: 10.1109/JOE.2012.2222792, 2012.

[3] Shiobara, H. and T. Kanazawa, Development of a light weight and autonomic sensor system for ocean bottom seismometer, Zisin 2, 61, 3, 137-144, 2009 (in Japanese).

[4] Isse, T., H. Shiobara, Y. Fukao, K. Mochizuki, T. Kanazawa, H. Sugioka, S. Kodaira, R. Hino and D. Suetsugu, Rayleigh wave phase velocity measurements across the Philippine sea from a broad-band OBS array, Geophys. J. Int., **158**, 257-266, 2004.

[5] Shiobara, H., H. Sugioka, K. Mochizuki, S. Oki, T. Kanazawa, Y. Fukao and K. Suyehiro, Long Term Seismic Observation in Mariana by OBSs: Double Seismic Zone and Upper Mantle Structure, Eos Trans. AGU, Fall Meet. Suppl., Abstract, **86**, T53A-1407, 2005.

[6] Pozgay, S. H., D. A. Wiens, J. A. Conder, H. Shiobara and H. Sugioka, Complex mantle flow in the Mariana subduction system: evidence from shear wave splitting, Geophys. J. Int., **170 (1)**, 371–386, 2007.

[7] Shiobara, H., T. Kanazawa and Y. Fukao, Revealing the Earth interior by using mobile broadband ocean bottom seismometers, Chikyu Monthly, **51**, 181-187, 2005 (in Japanese).

[8] Suetsugu, D., H. Shiobara, H. Sugioka, G. Barruol, E. Schindele, D. Reymond, A. Bonneville, E. Debayle, T. Isse, T. Kanazawa, and Y. Fukao, Probing South Pacific Mantle Plumes With Ocean Bottom Seismographs, Eos Trans. AGU, **86**, 429,435, 2005.

[9] Araki, E., M. Shinohara, S, Sacks, A. Linde, T. Kanazawa, H. Shiobara, H. Mikada, and K. Suyehiro, Improvement of seismic observation in the ocean by use of seafloor boreholes, Bull. Seism. Soc. Am., **94**, 2, 678-690, 2004.

[10] Shinohara, M., E. Araki, T. Kanazawa, K. Suyehiro, M. Mochizuki, T. Yamada, K. Nakahigashi, Y. Kaiho, and Y. Fukao, Deep-sea borehole seismological observatories in the western Pacific: temporal variation of seismic noise level and event detection, Annals of Geophysics, **49**, 2/3, 625-642, 2006.

[11] Shinohara, M., T. Fukano, T. Kanazawa, E. Araki, K. Suyehiro, M. Mochizuki, K. Nakahigashi, T. Yamada, K. Mochizuki, Upper mantle and crustal seismic structure beneath the Northwestern Pacific Basin using a seafloor borehole broadband seismometer and ocean bottom seismometers, Phys. Earth Planet. Inter., **170**, 95-106, 2008.

[12] Shiobara, H., K. Baba, H. Utada, Y. Fukao, Ocean Bottom Array Probes Stagnant Slab Beneath the Philippine Sea, EOS, Trans. AGU, **90**, 70-71, 2009.

[13] Suetsugu, D., H. Shiobara, H. Sugioka, A. Ito, T. Isse, T. Kasaya, N. Tada, K. Baba, N. Abe, Y. Hamano, P. Tarits, J-P. Barriot, and D. Reymond, TIARES Project—Tomographic investigation by seafloor array experiment for the Society hotspot, Earth Planets Space, **64**, 1-4, 2012.

[14] Matsuno, T., D. Suetsugu, K. Baba, N. Tada, H. Shimizu, H. Shiobara, T. Isse, H. Sugioka, A. Ito, M. Obayashi, H. Utada. Mantle transition zone beneath a normal seafloor in the northwestern Pacific: Electrical conductivity, seismic thickness, and water content. Earth and Planetary Science Letters, **462**, 189-198, 2017.

[15] Takeuchi, N., H. Kawakatsu, H. Shiobara, T. Isse, H. Sugioka, A. Ito, H. Utada, Determination

of intrinsic attenuation in the oceanic lithosphere-asthenosphere system. Science, **358**, 1593–1596. doi:10.1126/science.aao3508, 2017.
[16] Suetsugu, D., H. Shiobara, H. Sugioka, N. Tada, A. Ito, T. Isse, K. Baba, H. Ichihara, T. Ota, Y. Ishihara, S. Tanaka, M. Obayashi, T. Tonegawa, J. Yoshimitsu, T. Kobayashi, H. Utada, The OJP array: seismological and electromagnetic observation on seafloor and islands in the Ontong Java Plateau, JAMSTEC Rep. Res Dev., **26**, 54-64, doi:10.5918/jamstecr.26.54, 2018.
[17] Araki, E. and H. Sugioka, Calibration of deep sea differential pressure gauge, JAMSTEC Rep. Res. Dev., Special Issue, 141–148, 2009 (in Japanese with English abstract).

4. Caution and contact

We will not be responsible for any loss or damage caused by the data. If he/she has any question about the data or request for the continuous data, please contact the data center.