1. **Cruise narrative**
2. ***Highlights***

Cruise designation: RF13-06 and RF13-07 (WHP-P03W revisit)

1. EXPOCODE: 49UP20130619
2. Chief scientist: RF13-06 Kazuhiro NEMOTO ([k-nemoto@met.kishou.go.jp](mailto:k-nemoto@met.kishou.go.jp))

RF13-07 Hitomi KAMIYA

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1. Ship name: R/V Ryofu Maru
2. Ports of call: RF13-06 Leg 1: Tokyo–Naha, Leg 2: Naha–Tokyo

RF13-07 Leg 1: Tokyo–Pohnpei, Leg 2: Pohnpei–Tokyo

1. Cruise dates: RF13-06 Leg 1: 19 June 2013–1 July 2013

RF13-06 Leg 2: 5 July 2013–24 July 2013

RF13-07 Leg 1: 31 July 2013–21 August 2013

RF13-07 Leg 2: 25 August 2013–18 September 2013

1. Floats and drifters deployed: RF13-06: 1 float and 2 drifters

RF13-07: 5 floats

1. ***Cruise Summary Information***

RF13-06 and RF13-07 cruises were carried out during the period from June 19 to September 18, 2013. The observation line along approximately 24°N was observed by Scripps Institution of Oceanography (SIO), USA in 1985 and Japan Agency for Marine-Earth Science and Technology (JAMSTEC), Japan in 2005–2006. These cruises were carried out as ‘WHP-P03’, which is a part of WOCE (World Ocean Circulation Experiment) Hydrographic Programme, CLIVAR (Climate Variability and Predictability Project) and GO-SHIP (Global Ocean Ship-based Hydrographic Investigations Program).

A total of 120 stations was occupied using a Sea-Bird Electronics (SBE) 36 position carousel equipped with 10-liter Niskin water sample bottles, a CTD system (SBE911plus) equipped with SBE35 deep ocean standards thermometer, JFE Advantech oxygen sensor (RINKO III), Teledyne Benthos altimeter (PSA-916D), and Teledyne RD Instruments L-ADCP (300kHz). Cruise track and station location are shown in Figure 1.

At each station, full-depth CTDO2 (temperature, conductivity (salinity) and dissolved oxygen) profile and up to 36 water samples were taken and analyzed. Water samples were obtained from 10 dbar to approximately 10 m above the bottom. In addition, surface water was sampled using a stainless steel bucket at each station. Sampling layer is designed as so-called staggered mesh as shown in Table 1 (*Swift*, 2010). The bottle depth diagram is shown in Figure 2.

Water samples were analyzed for salinity, dissolved oxygen, nutrients, dissolved inorganic carbon (DIC), total alkalinity (TA), pH, CFC-11, CFC-12 and phytopigment (chlorophyll-a and phaeopigments). Underway measurements of partial pressure of carbon dioxide (*p*CO2), temperature, salinity, chlorophyll-a, subsurface current, bathymetry and meteorological parameters were conducted along the cruise track.

***RF13-06***

RF13-06 cruise was carried out during the period from June 19 to July 24, 2013. Before the observation at the first station, all watch standers were drilled in the method of sample drawing and CTD operations at the point (34°22’N, 138°30’E). At first, the cruise started from Stn.13 (28°42’N, 126°27’E; RF4757) and sailed south-eastward to Stn.26 (27°30’N, 128°15’E; RF4770). After observation of Stn.26 we observed from Stn.1 (30°14’N, 130°50’E; RF4771) to Stn.12 (28°35’N, 129°45’E; RF4782) and from Stn.27 (26°04’N, 127°55’E; RF4783) to Stn.31 (25°39’N, 128°34’E; RF4787). Leg 1 consisted of 31 stations. We finished Stn.31 on June 29. She called for Naha (Japan) on July 1 (Leg 1). She left Naha on July 5, we restarted observation from Stn.32 (25°39’N, 128°34’E; RF4788) that was same the station of Stn.31. Owing to the typhoon (T1307), after observation of Stn.45 (23°43’N, 133°00’E; RF4801), we sailed to Stn.63 (24°15’N, 143°38’E; RF4802). After observation of Stn.63, we sailed to westward, and observed from Stn.59 (24°14’N, 141°34’E; RF4803) to Stn.52 (24°15’N, 137°47’E; RF4810). We gave up at the station of Stn.52 and turned toward Tokyo (Japan). Leg 2 consisted of 23 stations. We arrived at Tokyo on July 24, 2013 (Leg 2).

One float and two drifting ocean data buoy were deployed along the cruise track. The information of deployed the float and the buoy are listed in Table 2a.

***RF13-07***

RF13-07 cruise was carried out during the period from July 31 to September 18, 2013. Before the observation at the first station, all watch standers were drilled in the method of sample drawing and CTD operations at the point (34°41’N, 139°51’E). We restarted observation from Stn.46 (24°14’N, 133°21’E; RF4812) on August 3 to Stn.51 (24°14’N, 137°49’E; RF4817) that was same the station of Stn.52, and from Stn.60 (24°15’N, 141°46’E; RF4818) and Stn.62 (24°15’N, 143°14’E; RF4820). We continued observation from Stn.64 (24°15’N, 143°39’E; RF4821) that was the same station of Stn.63. We sailed eastward and finished at Stn.89 (24°00’N, 164°59’E; RF4846) on August 15. Leg 1 consisted of 35 stations. She called for Pohnpei (Federated States of Micronesia) on August 21 (Leg 1). She left Pohnpei on August 25, 2013. The hydrographic cast of CTDO2 was restarted at the same station (Stn.90 (24°00’N, 165°01’E; RF4847)) of Stn.89 on August 28. We observed eastward to Stn.108 (24°00’N, 179°00’E; RF4865), we turned northward and finished Stn.120 (29°58’N, 178°58’E; RF4877). Leg 2 consisted of 31 stations from Stn.90 to Stn.120. Stn.120 was finished on September 7. She arrived at Tokyo (Japan) on September 18, 2013 (Leg 2).

Five Argo floats were deployed along the cruise track. The information of deployed the float and the buoy are listed in Table 2b.

Location data of stations is shown in Table 3.

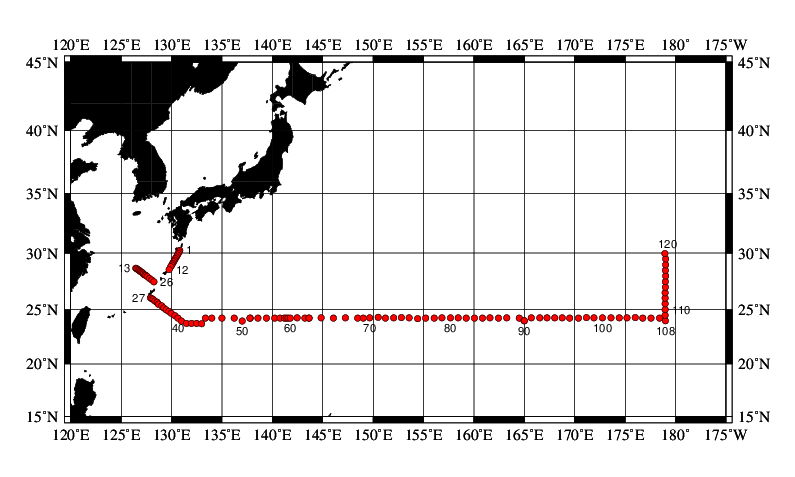


Figure 1. Cruise track of RF13-06 and RF13-07.

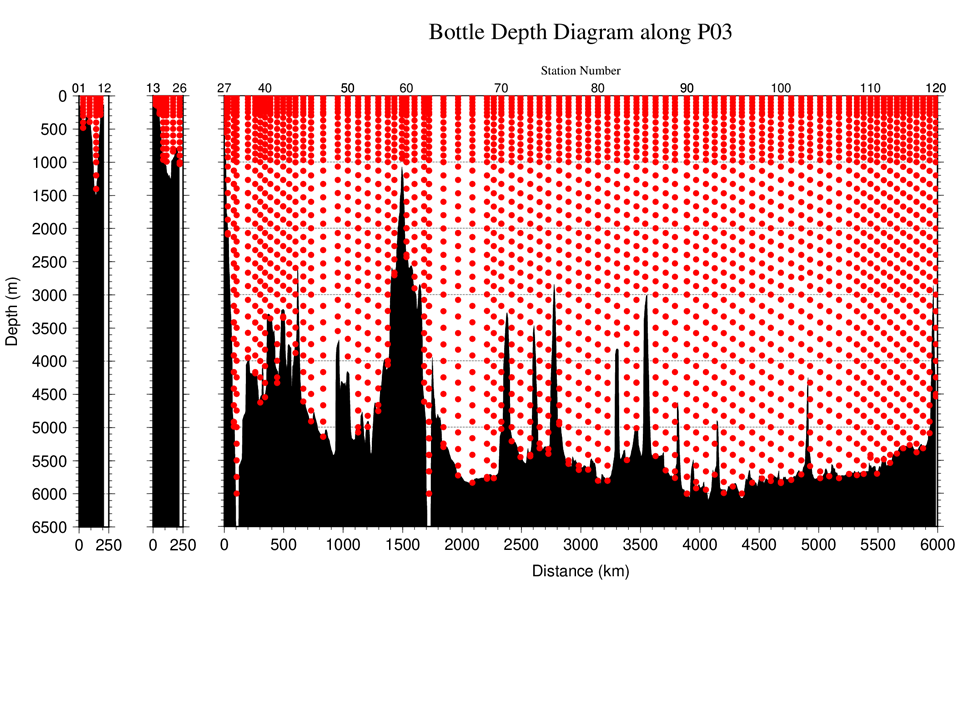


Figure 2. The bottle depth diagram for WHP-P03 revisit.

Table 1. The scheme of sampling layer in meters.

| ***Bottle count*** | ***scheme1*** | ***scheme2*** | ***scheme3*** |
| --- | --- | --- | --- |
| ***1*** | 10 | 10 | 10 |
| ***2*** | 50 | 50 | 50 |
| ***3*** | 100 | 100 | 100 |
| ***4*** | 150 | 150 | 150 |
| ***5*** | 200 | 200 | 200 |
| ***6*** | 250 | 250 | 250 |
| ***7*** | 300 | 330 | 280 |
| ***8*** | 400 | 430 | 370 |
| ***9*** | 500 | 530 | 470 |
| ***10*** | 600 | 630 | 570 |
| ***11*** | 700 | 730 | 670 |
| ***12*** | 800 | 830 | 770 |
| ***13*** | 900 | 930 | 870 |
| ***14*** | 1000 | 1070 | 970 |
| ***15*** | 1200 | 1270 | 1130 |
| ***16*** | 1400 | 1470 | 1330 |
| ***17*** | 1600 | 1670 | 1530 |
| ***18*** | 1800 | 1870 | 1730 |
| ***19*** | 2000 | 2070 | 1930 |
| ***20*** | 2200 | 2270 | 2130 |
| ***21*** | 2400 | 2470 | 2330 |
| ***22*** | 2600 | 2670 | 2530 |
| ***23*** | 2800 | 2870 | 2730 |
| ***24*** | 3000 | 3080 | 2930 |
| ***25*** | 3250 | 3330 | 3170 |
| ***26*** | 3500 | 3580 | 3420 |
| ***27*** | 3750 | 3830 | 3670 |
| ***28*** | 4000 | 4080 | 3920 |
| ***29*** | 4250 | 4330 | 4170 |
| ***30*** | 4500 | 4580 | 4420 |
| ***31*** | 4750 | 4830 | 4670 |
| ***32*** | 5000 | 5080 | 4920 |
| ***33*** | 5250 | 5330 | 5170 |
| ***34*** | 5500 | 5580 | 5420 |
| ***35*** | 5750 | 5830 | 5670 |
| ***36*** | 6000 | 6000 | 6000 |

Table 2a. Information of deployed float and buoy at RF13-06.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| ***Float*** | ***Date and Time (UTC)*** | ***Position of deployment*** | | ***PI*** |  |
| ***WMO number*** | ***of Deployment*** | *Latitude* | *Longitude* |  |  |
| 2902430 | 2013 July 9  01:32 | 23-42.54 N | 132-56.59 E | JMA | APEX |
| ***Buoy*** | ***Date and Time (UTC)*** | ***Position of deployment*** | |  |  |
| ***WMO number*** | ***of Deployment*** | *Latitude* | *Longitude* |  |  |
| 21679 | 2013 June 25  01:32 | 28-42.30 N | 126-27.04 E | JMA | YTSS-2100 |
| 21704 | 2013 July 6  00:42 | 25-32.74 N | 128-44.72 E | JMA | YTSS-2100 |

APEX：Teledyne Webb Research (USA)

YTSS-2100: JVC KENWOOD Co., Japan

Table 2b. Information of deployed float and buoy at RF13-07.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| ***Float*** | ***Date and Time (UTC)*** | ***Position of deployment*** | | ***PI*** |  |
| ***WMO number*** | ***of Deployment*** | *Latitude* | *Longitude* |  |  |
| 2902453 | 2013 August 12  05:30 | 24-16.70 N | 157-39.46 E | JAMSTEC | ARVOR |
| 2902461 | 2013 August 29  21:59 | 24-16.84 N | 168-02.16 E | JAMSTEC | ARVOR |
| 2902462 | 2013 August 31  20:45 | 24-18.38 N | 172-47.57 E | JAMSTEC | ARVOR |
| 2902463 | 2013 September 2  11:45 | 24-16.08 N | 176-47.13 E | JAMSTEC | ARVOR |
| 2902464 | 2013 September 3  10:20 | 24-00.89 N | 178-59.85 E | JAMSTEC | ARVOR |

ARVOR：nke Instrumentation (France)

Table 3a. Station data of RF13-06 cruise. The ‘RF’ column indicates the JMA station identification number.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| ***EXPOCODE*** | ***Leg*** | ***Station*** | | ***Position*** | |
| *sub number* |  | *Stn.* | *RF* | *Latitude* | *Longitude* |
| 1 | 1 | 1 | 4771 | 30-14.47 N | 130-50.26 E |
| 1 | 1 | 2 | 4772 | 30-05.87 N | 130-44.66 E |
| 1 | 1 | 3 | 4773 | 29-58.18 N | 130-40.29 E |
| 1 | 1 | 4 | 4774 | 29-48.88 N | 130-34.72 E |
| 1 | 1 | 5 | 4775 | 29-40.04 N | 130-28.82 E |
| 1 | 1 | 6 | 4776 | 29-32.26 N | 130-23.37 E |
| 1 | 1 | 7 | 4777 | 29-23.21 N | 130-17.82 E |
| 1 | 1 | 8 | 4778 | 29-15.26 N | 130-12.34 E |
| 1 | 1 | 9 | 4779 | 29-06.58 N | 130-06.60 E |
| 1 | 1 | 10 | 4780 | 28-58.18 N | 130-01.36 E |
| 1 | 1 | 11 | 4781 | 28-50.25 N | 129-55.28 E |
| 1 | 1 | 12 | 4782 | 28-35.19 N | 129-45.09 E |
| 1 | 1 | 13 | 4757 | 28-42.01 N | 126-26.87 E |
| 1 | 1 | 14 | 4758 | 28-38.37 N | 126-34.13 E |
| 1 | 1 | 15 | 4759 | 28-33.26 N | 126-41.28 E |
| 1 | 1 | 16 | 4760 | 28-29.59 N | 126-48.44 E |
| 1 | 1 | 17 | 4761 | 28-24.62 N | 126-54.41 E |
| 1 | 1 | 18 | 4762 | 28-21.11 N | 127-01.79 E |
| 1 | 1 | 19 | 4763 | 28-16.09 N | 127-08.65 E |
| 1 | 1 | 20 | 4764 | 28-10.72 N | 127-14.80 E |
| 1 | 1 | 21 | 4765 | 28-06.17 N | 127-21.50 E |
| 1 | 1 | 22 | 4766 | 28-02.56 N | 127-28.39 E |
| 1 | 1 | 23 | 4767 | 27-57.76 N | 127-34.77 E |
| 1 | 1 | 24 | 4768 | 27-48.18 N | 127-48.09 E |
| 1 | 1 | 25 | 4769 | 27-38.76 N | 128-02.00 E |
| 1 | 1 | 26 | 4770 | 27-30.08 N | 128-15.29 E |
| 1 | 1 | 27 | 4783 | 26-04.15 N | 127-54.85 E |
| 1 | 1 | 28 | 4784 | 26-00.11 N | 128-02.11 E |
| 1 | 1 | 29 | 4785 | 25-54.71 N | 128-09.77 E |
| 1 | 1 | 30 | 4786 | 25-47.16 N | 128-21.45 E |
| 1 | 1 | 31 | 4787 | 25-39.13 N | 128-33.96 E |
| 2 | 2 | 32 | 4788 | 25-38.74 N | 128-33.71 E |
| 2 | 2 | 33 | 4789 | 25-29.81 N | 128-43.41 E |
| 2 | 2 | 34 | 4790 | 25-20.88 N | 129-00.74 E |
| 2 | 2 | 35 | 4791 | 25-09.31 N | 129-14.70 E |

Table 3a. Continue.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| ***EXPOCODE*** | ***Leg*** | ***Station*** | | ***Position*** | |
| *sub number* |  | *Stn.* | *RF* | *Latitude* | *Longitude* |
| 2 | 2 | 36 | 4792 | 24-59.45 N | 129-29.38 E |
| 2 | 2 | 37 | 4793 | 24-50.65 N | 129-44.33 E |
| 2 | 2 | 38 | 4794 | 24-40.71 N | 129-58.82 E |
| 2 | 2 | 39 | 4795 | 24-28.09 N | 130-19.53 E |
| 2 | 2 | 40 | 4796 | 24-14.71 N | 130-38.28 E |
| 2 | 2 | 41 | 4797 | 23-59.02 N | 130-58.98 E |
| 2 | 2 | 42 | 4798 | 23-45.49 N | 131-28.65 E |
| 2 | 2 | 43 | 4799 | 23-45.05 N | 131-59.11 E |
| 2 | 2 | 44 | 4800 | 23-45.30 N | 132-29.45 E |
| 2 | 2 | 45 | 4801 | 23-43.71 N | 133-00.00 E |
| 2 | 2 | 52 | 4810 | 24-14.55 N | 137-47.36 E |
| 2 | 2 | 53 | 4809 | 24-15.12 N | 138-33.99 E |
| 2 | 2 | 54 | 4808 | 24-14.40 N | 139-26.01 E |
| 2 | 2 | 55 | 4807 | 24-13.83 N | 140-14.17 E |
| 2 | 2 | 56 | 4806 | 24-14.62 N | 140-46.37 E |
| 2 | 2 | 57 | 4805 | 24-14.60 N | 141-11.02 E |
| 2 | 2 | 58 | 4804 | 24-14.47 N | 141-23.34 E |
| 2 | 2 | 59 | 4803 | 24-14.07 N | 141-33.75 E |
| 2 | 2 | 63 | 4802 | 24-15.23 N | 143-37.66 E |

Table 3b. Station data of RF13-07 cruise. The ‘RF’ column indicates the JMA station identification number.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| ***EXPOCODE*** | ***Leg*** | ***Station*** | | ***Position*** | |
| *sub number* |  | *Stn.* | *RF* | *Latitude* | *Longitude* |
| 3 | 1 | 46 | 4812 | 24-13.57 N | 133-21.00 E |
| 3 | 1 | 47 | 4813 | 24-14.06 N | 133-59.75 E |
| 3 | 1 | 48 | 4814 | 24-15.17 N | 134-59.94 E |
| 3 | 1 | 49 | 4815 | 24-15.03 N | 136-12.54 E |
| 3 | 1 | 50 | 4816 | 23-59.27 N | 137-00.24 E |
| 3 | 1 | 51 | 4817 | 24-14.25 N | 137-48.60 E |
| 3 | 1 | 60 | 4818 | 24-15.40 N | 141-45.91 E |
| 3 | 1 | 61 | 4819 | 24-15.84 N | 142-26.98 E |
| 3 | 1 | 62 | 4820 | 24-15.32 N | 143-13.93 E |
| 3 | 1 | 64 | 4821 | 24-15.11 N | 143-38.58 E |
| 3 | 1 | 65 | 4822 | 24-15.63 N | 144-50.93 E |

Table 3b. Continue.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| ***EXPOCODE*** | ***Leg*** | ***Station*** | | ***Position*** | |
| *sub number* |  | *Stn.* | *RF* | *Latitude* | *Longitude* |
| 3 | 1 | 66 | 4823 | 24-14.65 N | 146-03.68 E |
| 3 | 1 | 67 | 4824 | 24-15.78 N | 147-15.35 E |
| 3 | 1 | 68 | 4825 | 24-15.50 N | 148-28.09 E |
| 3 | 1 | 69 | 4826 | 24-14.47 N | 149-01.46 E |
| 3 | 1 | 70 | 4827 | 24-16.36 N | 149-39.23 E |
| 3 | 1 | 71 | 4828 | 24-17.59 N | 150-30.54 E |
| 3 | 1 | 72 | 4829 | 24-14.47 N | 151-14.05 E |
| 3 | 1 | 73 | 4830 | 24-16.08 N | 152-02.72 E |
| 3 | 1 | 74 | 4831 | 24-16.71 N | 152-49.03 E |
| 3 | 1 | 75 | 4832 | 24-16.19 N | 153-33.69 E |
| 3 | 1 | 76 | 4833 | 24-10.97 N | 154-26.25 E |
| 3 | 1 | 77 | 4834 | 24-14.91 N | 155-12.52 E |
| 3 | 1 | 78 | 4835 | 24-14.85 N | 156-03.86 E |
| 3 | 1 | 79 | 4836 | 24-15.89 N | 156-50.46 E |
| 3 | 1 | 80 | 4837 | 24-15.92 N | 157-39.77 E |
| 3 | 1 | 81 | 4838 | 24-15.76 N | 158-27.00 E |
| 3 | 1 | 82 | 4839 | 24-14.67 N | 159-14.71 E |
| 3 | 1 | 83 | 4840 | 24-14.30 N | 160-04.14 E |
| 3 | 1 | 84 | 4841 | 24-14.98 N | 160-50.69 E |
| 3 | 1 | 85 | 4842 | 24-15.82 N | 161-35.29 E |
| 3 | 1 | 86 | 4843 | 24-15.13 N | 162-26.54 E |
| 3 | 1 | 87 | 4844 | 24-15.55 N | 163-16.16 E |
| 3 | 1 | 88 | 4845 | 24-15.36 N | 164-03.30 E |
| 3 | 1 | 89 | 4846 | 24-00.15 N | 164-59.37 E |
| 4 | 2 | 90 | 4847 | 24-00.48 N | 165-00.85 E |
| 4 | 2 | 91 | 4848 | 24-15.67 N | 165-42.12 E |
| 4 | 2 | 92 | 4849 | 24-16.16 N | 166-31.51 E |
| 4 | 2 | 93 | 4850 | 24-15.57 N | 167-15.59 E |
| 4 | 2 | 94 | 4851 | 24-15.88 N | 168-00.59 E |
| 4 | 2 | 95 | 4852 | 24-15.95 N | 168-46.09 E |
| 4 | 2 | 96 | 4853 | 24-14.85 N | 169-30.85 E |
| 4 | 2 | 97 | 4854 | 24-14.74 N | 170-21.82 E |
| 4 | 2 | 98 | 4855 | 24-16.58 N | 171-10.76 E |
| 4 | 2 | 99 | 4856 | 24-15.76 N | 171-55.30 E |
| 4 | 2 | 100 | 4857 | 24-16.08 N | 172-44.98 E |
| 4 | 2 | 101 | 4858 | 24-15.52 N | 173-36.53 E |

Table 3b. Continue.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| ***EXPOCODE*** | ***Leg*** | ***Station*** | | ***Position*** | |
| *sub number* |  | *Stn.* | *RF* | *Latitude* | *Longitude* |
| 4 | 2 | 102 | 4859 | 24-16.26 N | 174-25.87 E |
| 4 | 2 | 103 | 4860 | 24-16.23 N | 175-10.65 E |
| 4 | 2 | 104 | 4861 | 24-16.94 N | 175-59.98 E |
| 4 | 2 | 105 | 4862 | 24-15.37 N | 176-45.70 E |
| 4 | 2 | 106 | 4863 | 24-14.52 N | 177-35.05 E |
| 4 | 2 | 107 | 4864 | 24-15.14 N | 178-24.54 E |
| 4 | 2 | 108 | 4865 | 24-00.31 N | 179-00.35 E |
| 4 | 2 | 109 | 4866 | 24-30.64 N | 178-58.68 E |
| 4 | 2 | 110 | 4867 | 25-01.28 N | 178-58.69 E |
| 4 | 2 | 111 | 4868 | 25-31.64 N | 178-59.31 E |
| 4 | 2 | 112 | 4869 | 26-01.69 N | 178-59.23 E |
| 4 | 2 | 113 | 4870 | 26-30.91 N | 178-58.88 E |
| 4 | 2 | 114 | 4871 | 27-01.13 N | 178-59.51 E |
| 4 | 2 | 115 | 4872 | 27-30.64 N | 179-00.24 E |
| 4 | 2 | 116 | 4873 | 27-59.88 N | 179-00.67 E |
| 4 | 2 | 117 | 4874 | 28-30.42 N | 178-59.89 E |
| 4 | 2 | 118 | 4875 | 29-00.36 N | 179-01.84 E |
| 4 | 2 | 119 | 4876 | 29-29.78 N | 179-01.18 E |
| 4 | 2 | 120 | 4877 | 29-58.17 N | 178-57.70 E |

***List of Principal Investigators for all Measurements***

The principal investigator (PI) and the person in charge responsible for major parameters measured on the cruise are listed in Table 4a (RF13-06) and Table 4b (RF13-07).

Table 4a. List of principal investigator and the person in charge on the ship for RF13-06.

**Item** **Principal Investigator（PI） Person in charge on the ship**

***Hydrography***

CTDO2 / LADCP Toshiya NAKANO Tomoyuki KITAMURA

Salinity Toshiya NAKANO Sho HIBINO

Dissolve oxygen Toshiya NAKANO Takashi MIYAO

Nutrients Toshiya NAKANO Sonoki IWANO

Phytopigment Toshiya NAKANO Naoshi KUBO

DIC Toshiya NAKANO Kyoichi KAWAHARA

Total Alkalinity Toshiya NAKANO Kyoichi KAWAHARA

pH Toshiya NAKANO Kyoichi KAWAHARA

CFCs Toshiya NAKANO Akira WADA

***Underway***

Meteorology Toshiya NAKANO Kazuhiro NEMOTO

Thermo-Salinograph Toshiya NAKANO Kyoichi KAWAHARA

*p*CO2 Toshiya NAKANO Kyoichi KAWAHARA

Chlorophyll-a Toshiya NAKANO Naoshi KUBO

ADCP Toshiya NAKANO Tomoyuki KITAMURA

Bathymetry Toshiya NAKANO Tomoyuki KITAMURA

***Float and Buoy***

Argo float (JMA) Kazuhiro NEMOTO Kazuhiro NEMOTO

Buoy (JMA) Kazuhiro NEMOTO Kazuhiro NEMOTO

Table 4b. List of principal investigator and the person in charge on the ship for RF13-07.

**Item** **Principal Investigator（PI） Person in charge on the ship**

***Hydrography***

CTDO2 / LADCP Toshiya NAKANO Kiyoshi MURAKAMI

Salinity Toshiya NAKANO Keizo SHUTTA

Dissolve oxygen Toshiya NAKANO Hiroyuki FUJIWARA

Nutrients Toshiya NAKANO Chihiro KAWAMURA

Phytopigment Toshiya NAKANO Tomohiro UEHARA

DIC Toshiya NAKANO Shu SAITO

Total Alkalinity Toshiya NAKANO Shu SAITO

pH Toshiya NAKANO Shu SAITO

CFCs Toshiya NAKANO Etsuro ONO

***Underway***

Meteorology Toshiya NAKANO Hitomi KAMIYA

Thermo-Salinograph Toshiya NAKANO Shu SAITO

*p*CO2 Toshiya NAKANO Shu SAITO

Chlorophyll-a Toshiya NAKANO Tomohiro UEHARA

ADCP Toshiya NAKANO Keizo SHUTTA

Bathymetry Toshiya NAKANO Keizo SHUTTA

***Float***

Argo float (JAMSTEC) Shigeki HOSODA Hitomi KAMIYA

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***Reference***

Swift, J. H. (2010): Reference-quality water sample data: Notes on acquisition, record keeping, and evaluation. *IOCCP Report No.****14****, ICPO Pub. 134, 2010 ver.1*