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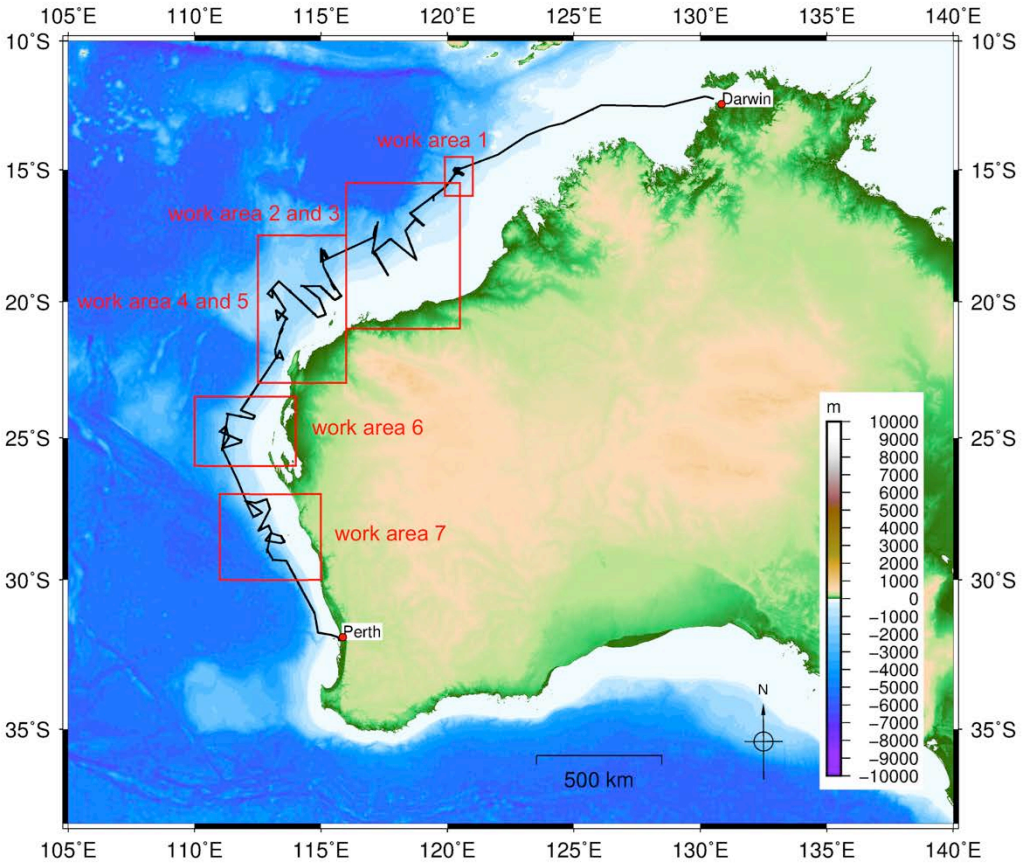
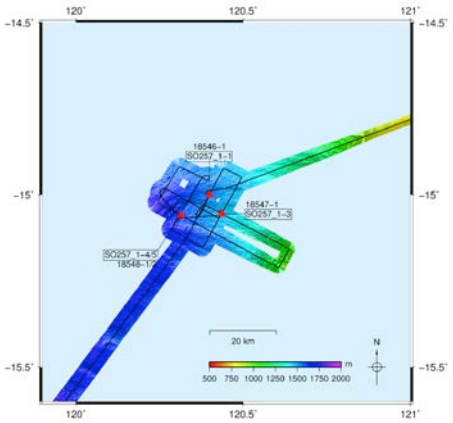
Short Cruise Report
R/V Sonne Cruise SO257 “WACHEIO”

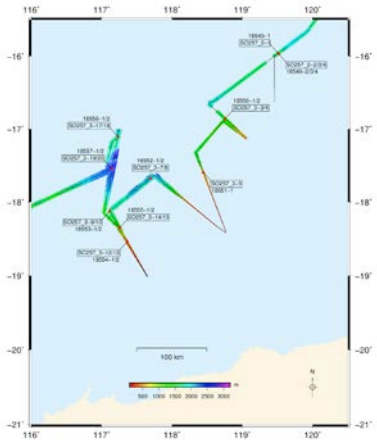
Fremantle - Darwin
12.5.2017 – 4.6.2017
Chief Scientist: Wolfgang Kuhnt
Captain: Oliver Meyer



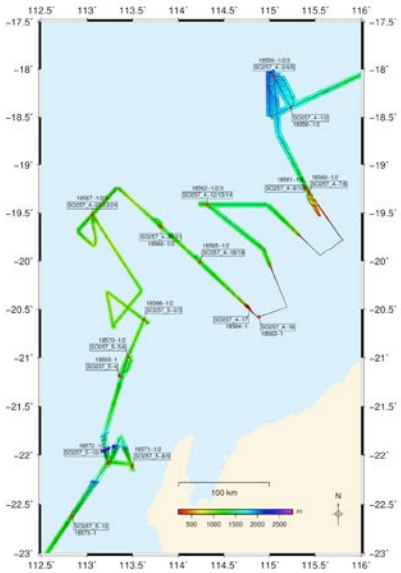
SO257 cruise track and work areas



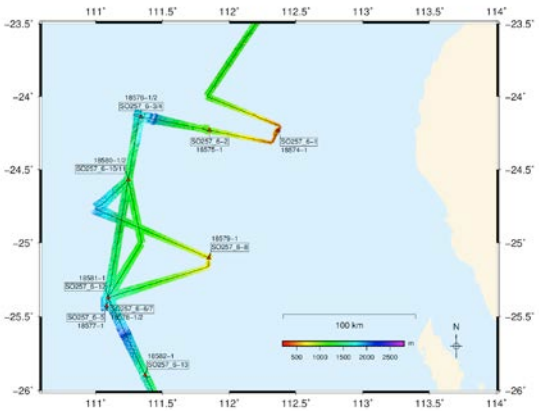
SO257 cruise track and sSO257 cruise track and stations in work area 7, offshore Abrolhos (vicinity of IODP Expedition 356 Sites U1458/U1459 and U1460)tations in work area 1 (vicinity of IODP Expedition 363 Site U1482)



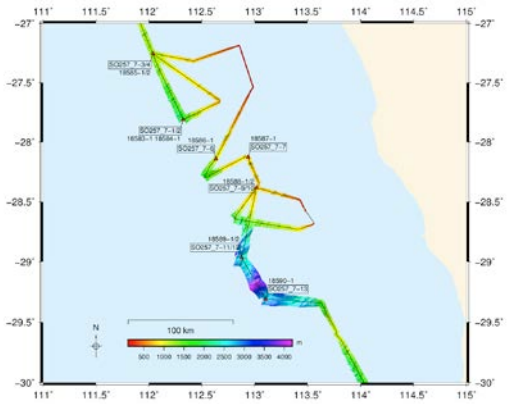
SO257 cruise track and stations in work areas 2 and 3 (vicinity of IODP Site 356-U1464 und 356-U1463), Rowley Terrace



SO257 cruise track and stations in work areas 4 and 5, Exmouth Plateau



SO257 cruise track and stations in work area 6, offshore Shark Bay (vicinity of IODP Sites 356-U1461 and U1462)



SO257 cruise track and stations in work area 7, offshore Abrolhos (vicinity of IODP Expedition 356 Sites U1458/U1459 and U1460)

Objectives

Main scientific objectives of SO257 were:
- Test hypothesis of southward (northward) shifts of westerlies and southern margin of the tropical rainbelt during warming (cooling) events in the Southern Hemisphere
- Test hypothesis of a reduction in tropical convection and weakening of the Walker circulation during tropical warming
- Explore the effects of tropical/southern hemisphere warming on the Indian Ocean Dipole and Southern Annual Mode along the coast of Western Australia

Specific objectives were:
- Develop a high-resolution chronology based on radiometric (AMS ^{14}C) dating and benthic isotope records in a series of sediment cores along the Northwestern Australian Margin.
- Establish local SST core-top calibration data set for Mg/Ca, alkenone, TEX86, clumped isotopes and foraminiferal transfer functions on a latitudinal transect along the Northwestern Australian Margin, which covers a temperature range from the tropics to the cool subtropics. Results will serve as a tool to reconstruct deglacial warming and the temporal and spatial variability oft the Leeuwin Current.
- Investigate the timing and amplitude of salinity changes, using paired Mg/Ca and $\delta^{18}O$ measurements in the near surface dwelling foraminifer *Globigerinoides ruber*. A local salinity-$\delta^{18}O_{seawater}$ calibration will be established, based on CTD stations sampled during the cruise.
- Contributions to the Pleistocene and late Neogene high-resolution sequence stratigraphy of the Northwestern Australian Margin, based on parasound and local high-resolution airgun seismic profiles in the vicinity of IODP Expedition Sites 356 and 363, which provide high quality stratigraphic control.
- Reconstruct terrigenous runoff (riverine and aeolian dust) from Western Australia into the eastern Indian Ocean from high-resolution sediment archives using XRF-scanner derived geochemical records and grain size distribution curves.
- Use benthic foraminiferal assemblages and isotope signals for estimates of changes in intermediate water masses and carbon export flux to the sea floor
- Evaluate influences of monsoonal wind strength, rainfall and runoff on radiolarian species abundance
- Use clay mineral, Nd isotope signals of bulk sediment and pollen assemblage distribution to supplement terrigenous runoff studies

A meridional transect of high-resolution Holocene to late Pleistocene sediment archives along the Northwestern Australian Margin provides crucial information to explore the spectrum of natural climate variability and to untangle dynamic processes and feedbacks controlling climate evolution in relation to high latitude climate change. These will additionally be useful to constrain modeling experiments of past and future climate change. Finally, this project was integrated within a broader research framework targeting the temporal evolution of monsoonal climate sub-systems. Our investigation on sedimentation and sea-level fluctuations along the Northwestern Australian Margin and Australian climate evolution through the Neogene complements research on newly drilled IODP Expeditions in the Eastern Indian Ocean (IODP Expeditions 353, Chief Scientists: Steve Clemens/Wolfgang Kuhnt, and 356, Chief Scientists: Stephen Gallagher/Craig S. Fullthorpe) and the Indo-Pacific Warm Pool IODP Expedition 363 (Chief Scientists: Yair Rosenthal/Ann Holbourn).

Narrative

R/V Sonne departed for the cruise SO257 on May 12 2017 at 11:00 local time from the Fort Hill Wharf in the Port of Darwin (NW Australia). Following a two-day transit, we arrived on May 14 at 10:00 local time in the first work area on the Northwestern Australian continental margin, NE of the Rowley Shoals at 14.97°S/120.48'. In the following five days we deployed the CTD, multicorer, gravity- and piston-corer along a route starting from IODP Site U1482, NW of the Rowley Shoals to the NE part of the Exmouth Plateau. CTD- und Multicorer delivered water property measurements and samples for oxygen isotope stratigraphy of water masses as well as core top samples for calibration of geochemical and micropaleontologial proxies for water temperature, salinity and productivity. In this first part of the survey we had 13 successful multicore deployments each with full recovery of 12 core tops as well as 5 piston cores and six gravity cores, which recovered 11.3 to 19.6 m sediment from water depths of 500 to 2400 m. Except for one, all cores were undisturbed with well preserved sediment that are correlative to the mud line in the multicores. All cores were immediately split into working and archive halves. Initial shipboard stratigraphic analyses (sediment description, magnetic susceptibility, digital photography, spectrophotometry, smear slides and micropaleontological analyses of the core catcher) were carried out after the cores were split. The scientific highlight in the first phase of the expedition was the discovery of a late Pleistocene tephra layer, which could be identified in three cores and provides a distinctive marker horizon for stratigraphic correlation. In total, we recovered 165 m of gravity- and piston cores, which are all of excellent quality (which was also partially due to clement weather and smooth seas). We also ran 18 seismic profiles with high resolution multichannel-seismic and penetration of over 500 m in the vicinity of IODP Sites U1482, U1464 und U1463. Preliminary shipboard analyses provided new insights on the Neogene to recent mass deposits along the Northwestern Australian continental margin.

After finishing operations NW of Rowley Shoals and along the northeastern part of the Exmouth Plateau, we focused in the second week on the central and southwestern part of the Exmouth Plateau. We occupied 14 stations in this area and sampled them with CTD, multicorer, giant box corer, gravity and piston corers following parasound and multibeam echosounder survey. In total, we deployed three CTDs, one giant box core, 12 multicores and ten gravity and piston cores with a total core length of 164 m. Eight of the ten long cores are of excellent quality and only two cores exhibit short sections of imploded core liner in the upper part, which needed special attention during cutting and curation. As on the first part of the cruise we split all cores immediately after retrieval in archive and work halves and performed initial stratigraphic, micropaleontologic and sedimentologic analyses. Using the advanced positioning capabilities of R/V Sonne we were able to retrieve a multicorer directly from the central part of a pockmark, a crater-shaped fluid and gas escape structure at the margin of the giant Gordon submarine landslide. Another highlight of the second phase expedition week were high resolution seismic images of submarine sediment gravity deposits and their transition into undisturbed pelagic sedimentation, which were obtained during routine surveys carried out during the night in order to find optimum positions for gravity and piston coring for the following days. As in the first week, all coring operations were successful through the second part of the cruise. The total length of long piston and gravity cores during the first two weeks of the SO-257 expedition amounted to 329 m. Additionally, we were able to obtain six long lines of high-resolution multichannel seismic, including lines over the IODP Sites U1461 and 1462. The stratigraphic records of these sites will allow a precise stratigraphic calibration of seismic reflectors in this region. Weather conditions remained favourable, even though the wind conditions deteriorated slightly after leaving the Northwest Shelf rendering operations more challenging.

After the successful operations in the Exmouth Plateau area, we embarked on the last phase of the expedition in the southern working areas, offshore Shark Bay and the Houtman-Abrolhos Islands. As anticipated, it proved more difficult to find expanded sediment archives in this region and the maximum core lengths considerably decreased within the last week of the expedition. Sediments were characterized by high carbonate content due to reduced river discharge of terrigenous clastics offshore and deploying the long gravity corer was less effective than in previous areas. However, the 10 m piston corer, proved very successful to recover excellent quality cores, even in stiff carbonate-rich sediments. In total we occupied 17 stations, which were sampled with CTD, multicorer, gravity and piston corer after surveys with multibeam-echosounder and parasound. In addition to four CTD deployments, we obtained 13 multicorer samples, two gravity and five piston cores. The piston cores achieved an average length of 7 m, while two gravity cores achieved insufficient penetration with low core recovery of only 2.5 and 4.5 m. As in the previous work areas, all cores were immediately split after retrieval, curated and the sedimentologic and stratigraphic analyses were carried out and documented. High resolution parasound and seismic surveys concentrated on the seaward extend of reef structures along transects in the vicinity of IODP Sites U1458/U1459 and U1460, which had been cored during IODP Expedition 356. These surveys obtained excellent records of the transition between shallow water reef-carbonate systems that were drilled during IODP Expedition 356 and of the hemipelagic deep-water sediments, which we cored during SO-257.

After the successful coring during the third phase of the expedition, the total recovery of long cores during expedition SO-257 was 369 m in 13 deployments of the piston corer and 15 deployments of the gravity corer. In addition we recovered 38 multicores and one giant spade boxcore as well as data and water samples from ten CTD deployments. The survey and coring operations were terminated at 6:00 on June 3, when we started the transit to Fremantle, which we reached in the morning of June 4. On the same day we were able to transfer the sediment cores and multicorer samples into a pre-cooled reefer, which was waiting for us on the pier in Fremantle. On June 5, R/V Sonne had an open ship event, organized by the German Embassy in Canberra and the consulate in Perth, which attracted more than 3200 interested visitors.

Acknowledgements

The international science party of Expedition SO257 wants to express its deepest gratitude to Captain Meyer and his crew, who made the extraordinary success of this expedition possible. We gratefully acknowledge the German Research Ministry (BMBF) for funding of the project 03G0257A “WACHEIO: **W**estern **A**ustralian **C**limate **H**istory from **E**astern **I**ndian **O**cean Sediment Archives”.

List of Participants

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28. Wilkens, Roy Henry	Sedimentology	HIGP, University of Hawaii, USA
29. Dillon, Alan David	Sedimentology	Moss Landing Marine Laboratories, USA
30. Gonzales, Jennifer Lynn	Sedimentology	Moss Landing Marine Laboratories, USA

Stationsliste

Station	Device	Date/Time	Latitude	Longitude	Elevation
SO257_1-1	CTD/Rosette	2017-05-14/00:46	-14.99992	120.40005	-1535
SO257_1-2	Hydroacoustic	2017-05-14/03:19	-15.03028	120.3854	-1525
SO257_1-3	MultiCorer	2017-05-14/22:17	-15.05515	120.4362	-1462
SO257_1-4	MultiCorer	2017-05-15/00:34	-15.05982	120.31423	-1609
SO257_1-5	Piston corer	2017-05-15/02:25	-15.05975	120.31432	-1608
SO257_1-6	Hydroacoustic	2017-05-15/05:04	-14.98207	120.26767	-1658
SO257_1-7	Hydroacoustic	2017-05-15/13:01	-15.13625	120.32387	-1640
SO257_2-1	CTD/Rosette	2017-05-15/21:45	-15.9672	119.51608	-1620
SO257_2-2	MultiCorer	2017-05-15/23:31	-15.96155	119.50967	-1627
SO257_2-3	Piston corer	2017-05-16/01:07	-15.96148	119.50967	-1627
SO257_2-4	Gravity corer	2017-05-16/03:35	-15.96147	119.50968	-1627
SO257_3-1	Hydroacoustic	2017-05-16/04:24	-15.96148	119.50918	-1627
SO257_3-2	Hydroacoustic	2017-05-16/09:51	-16.65997	118.5269	-1857
SO257_3-3	MultiCorer	2017-05-16/22:11	-16.85953	118.75702	-1389
SO257_3-4	Piston corer	2017-05-16/23:39	-16.85948	118.757	-1387
SO257_3-5	MultiCorer	2017-05-17/05:56	-17.59155	118.44568	-669
SO257_3-6	Hydroacoustic	2017-05-17/06:29	-17.60052	118.44963	-646
SO257_3-7	MultiCorer	2017-05-18/00:57	-17.67595	117.69402	-1952
SO257_3-8	Piston corer	2017-05-18/02:42	-17.67597	117.6941	-1952
SO257_3-9	CTD/Rosette	2017-05-18/08:16	-18.11645	117.11662	-1620
SO257_3-10	MultiCorer	2017-05-18/09:35	-18.11635	117.11663	-1620
SO257_3-11	Hydroacoustic	2017-05-18/12:20	-18.34032	117.25035	-1174
SO257_3-12	MultiCorer	2017-05-19/02:00	-18.53323	117.36642	-499
SO257_3-13	Gravity corer	2017-05-19/02:38	-18.53323	117.36648	-499
SO257_3-14	MultiCorer	2017-05-19/04:55	-18.35085	117.25673	-1113
SO257_3-15	Gravity corer	2017-05-19/05:48	-18.3509	117.25668	-1114
SO257_3-16	Hydroacoustic	2017-05-19/08:11	-18.1529	117.03138	-1280
SO257_3-17	MultiCorer	2017-05-19/21:09	-17.1036	117.23048	-1842
SO257_3-18	Piston corer	2017-05-19/22:49	-17.10367	117.23043	-1843
SO257_3-19	MultiCorer	2017-05-20/03:25	-17.54862	117.14593	-2406
SO257_3-20	Gravity corer	2017-05-20/05:09	-17.5486	117.14598	-2406
SO257_4-1	MultiCorer	2017-05-20/21:32	-18.39923	115.22788	-1757
SO257_4-2	Gravity corer	2017-05-20/22:52	-18.39922	115.22782	-1755
SO257_4-3	CTD/Rosette	2017-05-21/03:08	-18.08332	115.0477	-1976
SO257_4-4	MultiCorer	2017-05-21/04:39	-18.08332	115.04773	-1976
SO257_4-5	Gravity corer	2017-05-21/06:00	-18.0834	115.04768	-1976
SO257_4-6	Hydroacoustic	2017-05-21/11:10	-18.90983	115.22107	-1584
SO257_4-7	MultiCorer	2017-05-21/23:02	-19.30397	115.43213	-976
SO257_4-8	Gravity corer	2017-05-21/23:48	-19.30392	115.43222	-864
SO257_4-9	MultiCorer	2017-05-22/01:25	-19.24253	115.39917	-1187

SO257_4-10	Gravity corer	2017-05-22/02:22	-19.24258	115.39912	-1186
SO257_4-11	Hydroacoustic	2017-05-22/06:50	-19.78827	115.79388	-104
SO257_4-12	CTD/Rosette	2017-05-23/01:04	-19.41665	114.31897	-1299
SO257_4-13	MultiCorer	2017-05-23/02:16	-19.41668	114.31898	-1302
SO257_4-14	Gravity corer	2017-05-23/03:16	-19.41663	114.31897	-1299
SO257_4-15	Hydroacoustic	2017-05-23/08:00	-19.87737	114.92847	-1226
SO257_4-16	Box corer	2017-05-23/20:36	-20.57835	114.88002	-116
SO257_4-17	MultiCorer	2017-05-23/23:18	-20.50068	114.78462	-292
SO257_4-18	MultiCorer	2017-05-24/04:51	-20.01395	114.2391	-1253
SO257_4-19	Gravity corer	2017-05-24/05:49	-20.01388	114.23913	-1252
SO257_4-20	MultiCorer	2017-05-24/10:54	-19.64512	113.81055	-1134
SO257_4-21	Gravity corer	2017-05-24/11:51	-19.64513	113.8106	-1135
SO257_4-22	CTD/Rosette	2017-05-24/21:31	-19.52058	113.05872	-1129
SO257_4-23	MultiCorer	2017-05-24/22:36	-19.52058	113.05877	-1130
SO257_4-24	Piston corer	2017-05-24/23:54	-19.52058	113.0587	-1131
SO257_5-1	Hydroacoustic	2017-05-25/08:52	-20.65798	113.30048	-1070
SO257_5-2	MultiCorer	2017-05-25/21:46	-20.61003	113.62438	-1101
SO257_5-3	Piston corer	2017-05-25/22:56	-20.60997	113.62427	-1100
SO257_5-4	CTD/Rosette	2017-05-26/04:41	-21.19192	113.35742	-1414
SO257_5-5	MultiCorer	2017-05-26/07:42	-20.99112	113.44885	-1184
SO257_5-6	Piston corer	2017-05-26/09:01	-20.99108	113.4489	-1184
SO257_5-7	Hydroacoustic	2017-05-26/14:29	-21.80863	113.18597	-1713
SO257_5-8	MultiCorer	2017-05-26/23:43	-22.11142	113.49442	-1051
SO257_5-9	Gravity corer	2017-05-27/00:34	-22.11145	113.49445	-1052
SO257_5-10	MultiCorer	2017-05-27/03:35	-22.07827	113.22843	-1324
SO257_5-11	Gravity corer	2017-05-27/04:36	-22.07833	113.22852	-1326
SO257_5-12	MultiCorer	2017-05-27/09:03	-22.62072	112.83682	-1249
SO257_6-1	MultiCorer	2017-05-28/00:03	-24.23152	112.36853	-502
SO257_6-2	MultiCorer	2017-05-28/04:52	-24.23153	111.85302	-1034
SO257_6-3	MultiCorer	2017-05-28/09:50	-24.13985	111.34083	-1724
SO257_6-4	Gravity corer	2017-05-28/11:08	-24.13992	111.341	-1726
SO257_6-5	CTD/Rosette	2017-05-28/21:31	-25.42995	111.08313	-1792
SO257_6-6	MultiCorer	2017-05-29/00:22	-25.37097	111.09522	-1678
SO257_6-7	Gravity corer	2017-05-29/01:35	-25.37095	111.09523	-1680
SO257_6-8	MultiCorer	2017-05-29/07:06	-25.10155	111.84885	-716
SO257_6-9	Hydroacoustic	2017-05-29/07:43	-25.1005	111.84572	-722
SO257_6-10	MultiCorer	2017-05-29/21:00	-24.56893	111.24592	-1372
SO257_6-11	Piston corer	2017-05-29/22:25	-24.56893	111.24585	-1371
SO257_6-12	Piston corer	2017-05-30/05:11	-25.37097	111.09532	-1675
SO257_6-13	MultiCorer	2017-05-30/09:29	-25.89833	111.37203	-1588
SO257_7-1	CTD/Rosette	2017-05-30/20:48	-27.81353	112.32223	-1883
SO257_7-2	MultiCorer	2017-05-30/23:43	-27.76977	112.42052	-1120
SO257_7-3	MultiCorer	2017-05-31/05:46	-27.25542	112.03628	-1184
SO257_7-4	Piston corer	2017-05-31/07:05	-27.25542	112.03628	-1180
SO257_7-5	Hydroacoustic	2017-05-31/09:52	-27.32103	112.42233	-794

SO257_7-6	MultiCorer	2017-06-01/00:43	-28.1418	112.63387	-1013
SO257_7-7	MultiCorer	2017-06-01/05:36	-28.12893	112.93697	-798
SO257_7-8	Hydroacoustic	2017-06-01/12:06	-28.73045	113.42002	-903
SO257_7-9	MultiCorer	2017-06-01/22:46	-28.38473	113.01653	-812
SO257_7-10	Piston corer	2017-06-01/23:51	-28.38467	113.0166	-812
SO257_7-11	MultiCorer	2017-06-02/05:36	-28.96788	112.87597	-2391
SO257_7-12	Piston corer	2017-06-02/07:35	-28.96793	112.87603	-2497
SO257_7-13	CTD/Rosette	2017-06-02/12:27	-29.31205	113.105	-2644
SO257_7-14	Hydroacoustic	2017-06-02/14:00	-29.30818	113.0952	-2690