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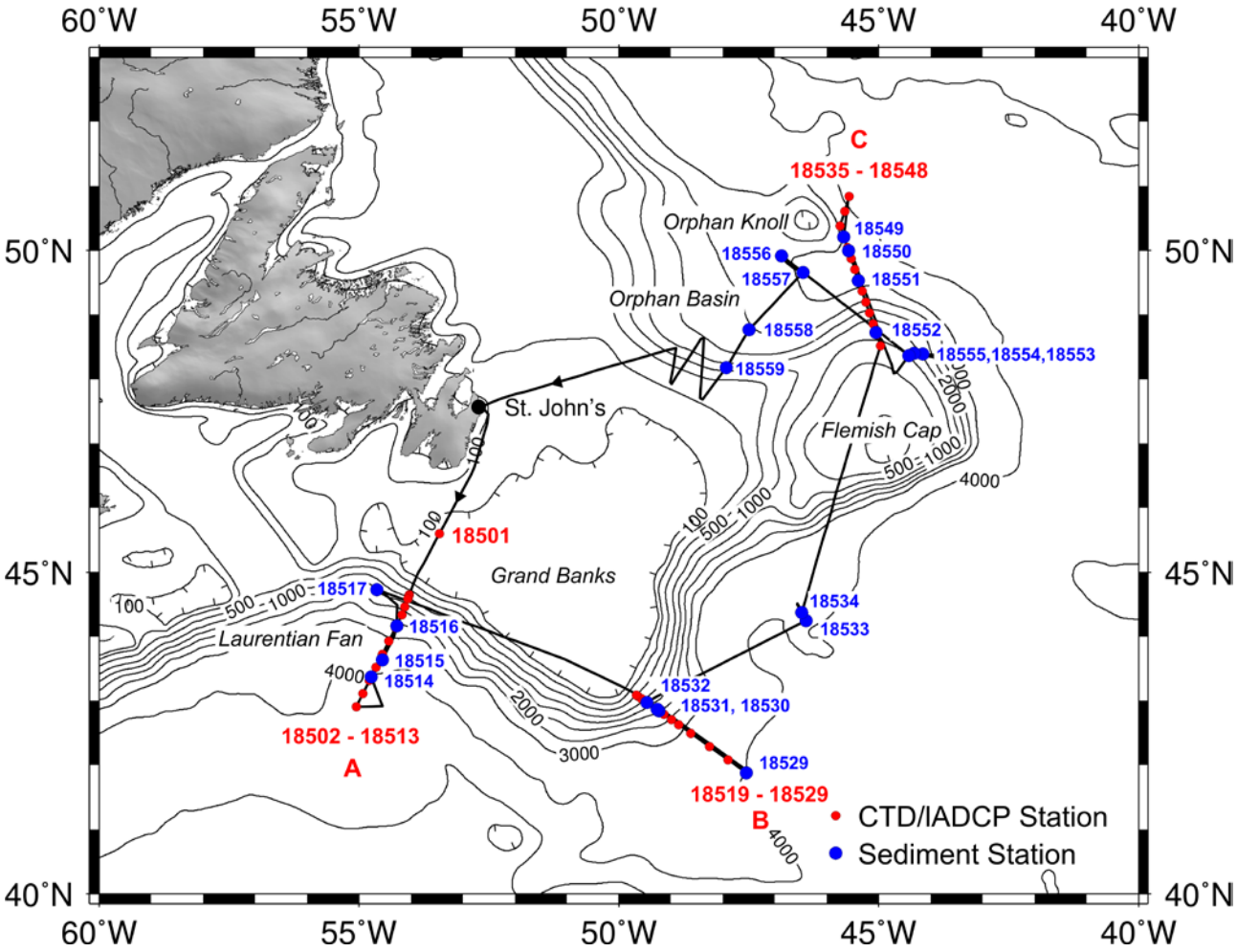
Short Cruise Report
MARIA S. MERIAN-CRUISE MSM 39

St. John's – St. John's
07.06.2014 – 25.06.2014
Chief Scientist: Dr. Stefan Mulitza
Captain: Ralf Schmidt



Cruise track and stations of Maria S. Merian Expedition 39

Objectives

Through the formation of water masses contributing to North Atlantic Deep Water (NADW), the subpolar North Atlantic is one of the key regions to understand world ocean circulation. The lightest and probably best observed contribution to NADW is the Labrador Seawater (LSW) formed by wintertime convective mixing in the Labrador Sea. Since LSW (in its two modes, upper and deep) contributes to the deep branch of the Atlantic Meridional Overturning Circulation (AMOC), any changes in the formation of LSW will likely have an impact on the strength of the AMOC. The main goals of expedition MSM-39 were to study the modern deep water spreading along the western boundary from the Labrador Sea to the Laurentian Fan and to obtain sediment cores to investigate the history of subtropical/subpolar gyre interactions, deep-water formation and the relation of both to the AMOC on longer time scales. Specifically we intend to address the following questions:

In the area of the Laurentian Fan/Grand Banks Margin:

- How is the confluence of the Labrador Current and the Gulf Stream recorded by modern planktic foraminifera, and what are the main isotopic signatures of the water masses in this region?
- Has its relative strength/position changed gradually or abruptly during the Holocene due to insolation forcing?
- Do variations in Gulf-Stream intensity co-vary with variations in LSM formation?
- What was the response of the LSW to a catastrophic freshwater release from Lake Agassiz 8.2 kyrs B.P.?

In the Flemish Cap/Orphan Knoll region:

- Was the formation of Labrador Seawater active during the Last Interglacial?
- How did the Labrador Seawater evolve during the last glacial inception?
- What is the change in the deep-water properties from the Orphan Basin to the southern exit of the Laurentian Channel, and how fast do anomalies travel along the western boundary?

Narrative

MARIA S. MERIAN departed from St. John’s, Canada on the afternoon of June 7 with 16 scientists from MARUM/University of Bremen, two scientist from the Alfred-Wegener-Institut for Polar- and Marine Research and three guest scientist from the Universities of São Paulo, Québec and British Columbia. After leaving the three-mile zone, about one hour after departure, all continuous measurements (thermosalinograph, pump systems, hydroacoustics) were started and a test of the CTD/rosette system was carried out at a shallow site (GeoB18501) on the western Grand Banks. We arrived in our first working area on the southwestern flank of the Grand Banks in the early afternoon of June 8 where we immediately started with CTD/lADCP transect A, perpendicular to the slope down to a water depth of 4379 m. In total, 12 CTD stations (GeoB18502 to GeoB18513) were performed on this transect. At two stations (GeoB18502 and GeoB18509), we additionally deployed the multinet in order to catch living planktonic foraminifera for DNA analyses. Transit between stations was done at 8 kn in order to allow a simultaneous Parasound survey to select coring positions. The upper slope on transect A is characterized by numerous canyons. Between canyons, however, Parasound revealed sites with clear sub-

bottom reflectors suitable for sediment sampling. The lower slope shows evidence for mass deposits but also areas with clear reflectors that are continuous over larger distances. Below ~4000 m depth the seafloor is mostly hummocky. The combined CTD/lADCP/parasound transect ended on June 10. Parasound allowed to identify three stations (GeoB18514 to GeoB18516) for sediment sampling with multicorer and gravity corer in 4015 m, 3625 m and 2504 m on transect A, and, after a short additional survey to the northwest, a shallow station (GeoB18517) in 1460 m water depth. The multicorer did not release on station GeoB18514 due to a jammed central mounting. After exchanging the central mounting, the multicorer released on station GeoB18515, but only four small tubes were filled. After adjusting the elastic straps and the springs, the multicorer worked well on all subsequent stations. Gravity coring was successful on all four stations and provided sediment cores between 9.23 m and 10.95 m length. Work on the southwestern flank of the Grand Banks was finished in the early afternoon of June 11.

We arrived on the southeastern Grand Banks margin in the afternoon of June 12 and proceeded with CTD/lADCP-transect B until about midnight on June 13. On this transect the concomitant Parasound survey showed well-stratified sediments between about 1100 m to 1200 m, and again between 1700 m and 2600 m and around 4000 m water depth. In total four suitable coring locations (GeoB18529 to GeoB18532) were selected at 3989 m, 1888 m, 1749 m and 1119 m water depth and subsequently sampled with multicorer and gravity corer.

In the afternoon of June 14, Maria S. Merian started to head north to the western Newfoundland Basin. Here, Parasound showed a deep penetration and clear and traceable sub-bottom reflectors only below about 3800 m water depth. In this area, we deployed a 12 m- and a 15 m-long gravity corer at two stations (GeoB18533 and GeoB18534) in 3905 m and 3862 m water depth where we gained 10.70 m and 13.94 m of sediment. Above ~3800 m sediments are characterized by blocky thick mass transport deposits and are not suitable for coring.

After crossing the Flemish Cap, we started with CTD/lADCP-transect C in northern direction to Orphan Knoll (Stations GeoB18535 to GeoB18548). The northern part of the transect showed relatively warm sea-surface temperatures and westward currents, presumably due to the influence of warm waters derived from the North Atlantic Current. Multinet casts were performed on stations GeoB18539 and GeoB18545. Four coring locations (GeoB18549 to GeoB18552) were identified with Parasound during CTD/lADCP transect C. These stations were successfully sampled on our way back to the Flemish Cap between June 19 and June 20. At the northernmost station (GeoB18549) at Orphan Knoll, two gravity cores with more than 13 m length were retrieved. One of the cores was immediately frozen to allow later investigation of DNA preserved in the sediment.

On June 21 we arrived at the eastern flank of the Flemish Cap where we started a Parasound survey downslope in easterly direction. Three relatively shallow stations (GeoB18553 to GeoB18555) were sampled between 1484 m and 987 m water depth and provided sediment cores with length between 8.87 m and 5.35 m length.

On the subsequent site survey to the Northwest into the central Orphan Basin we identified and sampled two stations (GeoB18556 and GeoB18557) in 2924 m and 3056 m water

depth with multicorer and gravity corer. After completion of station GeoB18557, the site survey was continued to the west towards the margin of the Orphan Basin, where we performed another sediment station (GeoB18558) that provided a 9.30 m-long sediment core. On the last coring station of this transect (GeoB18559), the 12 m long gravity corer only penetrated the upper meters and the core tube was slightly bent during coring. The core liner with a 1.15 m long sediment core, however, was retrieved without disturbance. A continued site survey at the upper slope of the western Orphan Basin did not provide further suitable coring locations and we concluded sampling in the afternoon of July 24. Maria S. Merian reached the harbor of St. John's in the morning of July 25 and entered the St. John's dockyard in the early morning of July 26. This unexpected stay deemed necessary due to a leakage at the portside POD that already occurred during MSM-38.

Acknowledgements
We thank Captain Ralf Schmidt and his crew for the friendly cooperative atmosphere and the competent technical assistance. David Piper (Geological Survey of Canada) provided valuable and helpful site survey data. We thank the Canadian authorities for the permission to work in the exclusive economic zones off Canada. Götz Ruhland and his team (MARUM), the Control Station German Research Vessels, Klaus Bohn (LPL Projects + Logistics GmbH), Ira Weigert (Contiways) and Wolfgang Mahrle (Auswärtiges Amt) provided perfect logistical and administrative support. This expedition was funded by the Deutsche Forschungsgemeinschaft through the DFG Research Centre/Cluster of Excellence MARUM.

Participants

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4.	MAX, Lars Wolfgang	Paleoceanography	AWI
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9.	SCHADE, Tobias	Hardware maintenance	MARUM
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Station list

GeoB-Nr.	Ship's Stationr.	Area	Gear	Date [dd.mm.yy]	Time [UTC]	Latitude (N)	Longitude (W)	Water depth [m]	Recovery [cm]	Remarks
18501-1	-	SW Grand Banks Slope	CTD-Ro	08.06.2014	11:02	45°35.55	53°27.26	94	-	CTD-Ro test, bottle 18 leaky
18502-1	481-1	SW Grand Banks Slope	CTD-Ro	08.06.2014	17:26	44°38.55	54°01.91	470	-	
18502-2	481-2	SW Grand Banks Slope	MN	08.06.2014	17:57	44°38.54	54°01.91	474	-	250-150-100-50-25-0
18503-1	482-1	SW Grand Banks Slope	CTD-Ro	08.06.2014	19:15	44°37.27	54°02.57	906	-	
18504-1	483-1	SW Grand Banks Slope	CTD-Ro	08.06.2014	20:54	44°34.67	54°03.58	1428	-	
18505-1	484-1	SW Grand Banks Slope	CTD-Ro	08.06.2014	23:13	44°27.27	54°07.02	1848	-	bottle 9 not closed
18506-1	485-1	SW Grand Banks Slope	CTD-Ro	09.06.2014	01:47	44°19.95	54°10.29	2331	-	
18507-1	486-1	SW Grand Banks Slope	CTD-Ro	09.06.2014	05:07	44°07.70	54°17.78	2574	-	
18508-1	487-1	SW Grand Banks Slope	CTD-Ro	09.06.2014	08:45	43°55.44	54°25.33	3012	-	bottle 17 leaky
18509-1	488-1	SW Grand Banks Slope	CTD-Ro	09.06.2014	12:40	43°43.17	54°32.82	3446	-	
18509-2	488-2	SW Grand Banks Slope	MN	09.06.2014	13:56	43°43.17	54°32.82	3447	-	250-150-100-50-25-0
18510-1	489-1	SW Grand Banks Slope	CTD-Ro	09.06.2014	17:25	43°30.92	54°40.38	3821	-	
18511-1	490-1	SW Grand Banks Slope	CTD-Ro	09.06.2014	21:42	43°18.65	54°47.91	4098	-	
18512-1	491-1	SW Grand Banks Slope	CTD-Ro	10.06.2014	02:16	43°06.41	54°55.41	4312	-	bottle 12 not closed
18513-1	492-1	SW Grand Banks Slope	CTD-Ro	10.06.2014	06:48	42°54.16	55°02.91	4377	-	
18514-1	493-1	SW Grand Banks Slope	MUC	10.06.2014	14:41	43°22.14	54°45.68	4015	0	not released, no recovery
18514-2	493-2	SW Grand Banks Slope	GC	10.06.2014	16:50	43°22.14	54°45.68	4017	926	
18515-1	494-1	SW Grand Banks Slope	GC	10.06.2014	21:40	43°38.01	54°32.90	3628	1095	
18515-2	494-2	SW Grand Banks Slope	MUC	10.06.2014	23:43	43°38.01	54°32.89	3632	18-20	4/0
18516-1	495-1	SW Grand Banks Slope	MUC	11.06.2014	04:53	44°09.65	54°16.31	2503	13-27	4/7
18516-2	495-2	SW Grand Banks Slope	GC	11.06.2014	06:52	44°09.65	54°16.32	2505	923	
18517-1	496-1	SW Grand Banks Slope	GC	11.06.2014	13:30	44°43.34	54°39.23	1464	906	
18517-2	496-2	SW Grand Banks Slope	MUC	11.06.2014	14:32	44°43.34	54°39.23	1470	27-32	4/7
18518-1	497-1	SE Grand Banks Slope	CTD-Ro	12.06.2014	13:00	43°05.13	49°40.20	519	-	bottle 18 leaky
18518-2	497-2	SE Grand Banks Slope	MN	12.06.2014	13:30	43°05.13	49°40.22	500	-	250-150-100-50-25-0
18519-1	498-1	SE Grand Banks Slope	CTD-Ro	12.06.2014	14:53	43°03.98	49°38.23	906	-	
18520-1	499-1	SE Grand Banks Slope	CTD-Ro	12.06.2014	16:38	43°01.86	49°34.44	1516	-	
18521-1	500-1	SE Grand Banks Slope	CTD-Ro	12.06.2014	18:55	42°56.92	49°25.72	1246	-	

GeoB-Nr.	Ship's Stationr.	Area	Gear	Date [dd.mm.yy]	Time [UTC]	Latitude (N)	Longitude (W)	Water depth [m]	Recovery [cm]	Remarks
18522-1	501-1	SE Grand Banks Slope	CTD-Ro	12.06.2014	21:18	42°52.04	49°17.07	1798	-	
18523-1	502-1	SE Grand Banks Slope	CTD-Ro	12.06.2014	23:55	42°47.17	49°08.33	2198	-	
18524-1	503-1	SE Grand Banks Slope	CTD-Ro	13.06.2014	02:46	42°42.22	48°59.90	2557	-	
18525-1	504-1	SE Grand Banks Slope	CTD-Ro	13.06.2014	05:47	42°37.32	48°51.34	2836	-	bottle 18 leaky
18526-1	505-1	SE Grand Banks Slope	CTD-Ro	13.06.2014	09:34	42°29.41	48°37.41	3197	-	
18527-1	506-1	SE Grand Banks Slope	MN	13.06.2014	13:25	42°17.09	48°15.91	3463	-	250-150-100-50-25-0
18527-2	506-2	SE Grand Banks Slope	CTD-Ro	13.06.2014	14:54	42°17.09	48°15.91	3463	-	
18528-1	507-1	SE Grand Banks Slope	CTD-Ro	13.06.2014	20:04	42°04.78	47°54.56	3700	-	
18529-1	508-1	SE Grand Banks Slope	CTD-Ro	14.06.2014	01:12	41°52.61	47°33.43	3989	-	
18529-2	508-2	SE Grand Banks Slope	GC	14.06.2014	03:32	41°52.61	47°33.43	3989	1118	
18530-1	509-1	SE Grand Banks Slope	GC	14.06.2014	13:58	42°50.37	49°14.09	1888	1074	
18530-2	509-2	SE Grand Banks Slope	MUC	14.06.2014	15:10	42°50.37	49°14.09	1887	21-26	4/7
18531-1	510-1	SE Grand Banks Slope	GC	14.06.2014	16:47	42°51.83	49°16.20	1749	910	
18532-1	511-1	SE Grand Banks Slope	GC	14.06.2014	18:45	42°58.23	49°28.09	1119	657	
18532-2	511-2	SE Grand Banks Slope	MUC	14.06.2014	19:36	42°58.23	49°28.09	1121	20-32	4/8
18533-1	512-1	SE Grand Banks Slope	MUC	15.06.2014	12:37	44°14.49	46°24.75	3907	28-34	4/8
18533-2	512-2	SE Grand Banks Slope	GC	15.06.2014	14:39	44°14.49	46°24.75	3905	1070	
18534-1	513-1	SE Grand Banks Slope	GC	15.06.2014	20:39	44°22.08	46°29.48	3862	1394	
18534-2	513-2	SE Grand Banks Slope	MUC	15.06.2014	22:50	44°22.08	46°29.48	3868	31-37	4/8
18535-1	514-1	Flemish Cap/Orphan Knoll	CTD-Ro	17.06.2014	00:23	48°30.78	44°58.80	818	-	malfunction CTD, cast repeated
18535-2	514-2	Flemish Cap/Orphan Knoll	CTD-Ro	17.06.2014	01:50	48°30.78	44°58.85	818	-	bottle 18 not closed
18536-1	515-1	Flemish Cap/Orphan Knoll	CTD-Ro	17.06.2014	04:11	48°40.96	45°03.07	1134	-	
18537-1	516-1	Flemish Cap/Orphan Knoll	CTD-Ro	17.06.2014	06:38	48°51.17	45°07.28	1236	-	
18538-1	517-1	Flemish Cap/Orphan Knoll	CTD-Ro	17.06.2014	09:18	49°01.29	45°11.51	1673	-	
18539-1	518-1	Flemish Cap/Orphan Knoll	CTD-Ro	17.06.2014	12:10	49°11.42	45°15.72	2260	-	
18539-2	518-2	Flemish Cap/Orphan Knoll	MN	17.06.2014	13:06	49°11.42	45°15.72	2259	-	250-150-100-50-25-0
18540-1	519-1	Flemish Cap/Orphan Knoll	CTD-Ro	17.06.2014	16:02	49°21.62	45°19.95	2882	-	
18541-1	520-1	Flemish Cap/Orphan Knoll	CTD-Ro	17.06.2014	19:38	49°31.69	45°24.22	3166	-	bottle 7 leaky
18542-1	521-1	Flemish Cap/Orphan Knoll	CTD-Ro	17.06.2014	23:25	49°41.82	45°28.50	3569	-	

GeoB-Nr.	Ship's Stationr.	Area	Gear	Date [dd.mm.yy]	Time [UTC]	Latitude (N)	Longitude (W)	Water depth [m]	Recovery [cm]	Remarks
18543-1	522-1	Flemish Cap/Orphan Knoll	CTD-Ro	18.06.2014	03:01	49°51.99	45°32.71	3122	-	
18544-1	523-1	Flemish Cap/Orphan Knoll	CTD-Ro	18.06.2014	06:26	50°02.13	45°36.91	2574	-	bottles 12, 21, 22 not closed
18545-1	524-1	Flemish Cap/Orphan Knoll	CTD-Ro	18.06.2014	09:55	50°12.27	45°41.14	3522	-	
18545-2	524-2	Flemish Cap/Orphan Knoll	MN	18.06.2014	11:12	50°12.28	45°41.14	3520	-	250-150-100-50-25-0
18546-1	525-1	Flemish Cap/Orphan Knoll	CTD-Ro	18.06.2014	14:12	50°22.44	45°45.37	3390	-	
18547-1	526-1	Flemish Cap/Orphan Knoll	CTD-Ro	18.06.2014	18:27	50°35.98	45°40.02	4096	-	
18548-1	527-1	Flemish Cap/Orphan Knoll	CTD-Ro	18.06.2014	23:01	50°49.98	45°35.00	4100	-	
18549-1	528-1	Orphan Knoll	GC	19.06.2014	06:15	50°12.28	45°41.15	3522	1333	frozen for DNA analysis
18549-2	528-2	Orphan Knoll	GC	19.06.2014	09:09	50°12.34	45°41.15	3523	1315	
18549-3	528-3	Orphan Knoll	MUC	19.06.2014	11:11	50°12.34	45°41.15	3521	32-38	4/8
18550-1	529-1	Orphan Knoll	GC	19.06.2014	14:53	49°59.29	45°35.66	2518	968	
18550-2	529-2	Orphan Knoll	MUC	19.06.2014	16:28	49°59.29	45°35.66	2515	28-35	4/8
18551-1	530-1	Orphan Knoll	MUC	19.06.2014	22:36	49°31.38	45°24.49	3153	24-31	4/6
18551-2	530-2	Orphan Knoll	GC	20.06.2014	00:23	49°31.38	45°24.49	3155	481	
18552-1	531-1	Flemish Cap	GC	20.06.2014	09:05	48°43.11	45°04.01	1203	725	
18552-2	531-2	Flemish Cap	MUC	20.06.2014	10:11	48°43.11	45°04.01	1204	29-35	4/8
18553-1	532-1	Flemish Cap	GC	21.06.2014	06:44	48°22.97	44°10.04	1484	887	
18553-2	532-2	Flemish Cap	MUC	21.06.2014	07:48	48°22.97	44°10.04	1487	25-44	4/7, living sponge below on MUC tube
18554-1	533-1	Flemish Cap	GC	21.06.2014	10:09	48°23.65	44°20.13	1135	776	
18555-1	534-1	Flemish Cap	GC	21.06.2014	11:45	48°21.65	44°26.10	987	535	
18555-2	534-2	Flemish Cap	MUC	21.06.2014	12:32	48°21.65	44°26.10	986	10-16	4/8
18556-1	535-1	Orphan Basin	GC	22.06.2014	07:14	49°54.56	46°52.88	2924	1058	
18556-2	535-2	Orphan Basin	MUC	22.06.2014	08:58	49°54.57	46°52.88	2925	15-30	4/8
18557-1	536-1	Orphan Basin	MUC	22.06.2014	14:04	49°39.12	46°28.04	3058	21-31	4/8
18557-2	536-2	Orphan Basin	GC	22.06.2014	15:44	49°39.12	46°28.04	3056	959	
18558-1	537-1	Orphan Basin	GC	23.06.2014	03:06	48°45.71	47°30.19	2439	930	
18558-2	537-2	Orphan Basin	MUC	23.06.2014	04:36	48°45.71	47°30.19	2439	22-27	4/8
18559-1	538-1	Orphan Basin	MUC	23.06.2014	11:26	48°10.36	47°56.64	1303	32-37	4/8
18559-2	538-2	Orphan Basin	GC	23.06.2014	12:17	48°10.36	47°56.64	1304	115	upper core barrel slightly bent, core OK