RRS Charles Darwin Cruise 29
Cruise Report
Transindian Hydrographic Section
Supported by the
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Overview

RRS Charles Darwin cruise 29 successfully occupied a transindian hydrographic section between Africa and Australia in late 1987. Modern Conductivity-Temperature-Depth-dissolved Oxygen (CTD/O2) profiling equipment was employed, complemented by discrete water sample analysis for salinity, oxygen, dissolved nutrients, chlorofluoromethanes, tritium and helium-3. A U.S. scientific contingent of 13, joined by 4 shipboard technicians from NERC/RVS, table 1, collected data along a cruise track extending between Durban, South Africa and Fremantle, Australia at latitudes 29^{o}-34^{o} S, fig 1. Durban departure was on 12 Nov. 1987 and arrival Fremantle occurred on Dec. 17. A total of 109 stations was occupied, 106 of which comprise the transindian section, table 2. Additional temperature profile information was obtained with XBT's along the track and continuous surface temperature, salinity and upper ocean velocity data were collected. The data return from the cruise was exceptional; the major cruise objectives were met. This may be credited to careful preparation for the cruise, and hard work by both scientific and shipboard personnel during the trip.

Personnel and Equipment

The CTD work and water sample analysis of salinity and dissolved oxygen were conducted by personnel from WHOI. A. Morton and J. Kinder of the WHOI CTD Group prepared and maintained the CTD and rosette equipment on the cruise in addition to watch standing duties. G. Knapp and R. Stanley were responsible for the water sample equipment and analysis work. They also stood watch. M. Francis' tasks included data processing and watch standing. B. Warren performed quality control of the water sample observations and helped to draw samples; J. Toole and J. Zemba stood watch and assisted in data archiving. J. Jennings and J. Johnson from Oregon State University were responsible for water sample analysis of dissolved nutrient concentrations.

Joining this team were R. Fine, K. Sullivan and L. Pope from the University of Miami who were involved with a companion tracer chemical program. Freon concentrations (F11, F12) from selected rosette bottles were determined at sea and samples drawn for subsequent laboratory determination of ^{3}H and ^{3}He. A separate cruise report for these activities is available from R. Fine.

R. Griffiths and K. Smith from NERC/RVS operated the CTD winch during the cruise. W. Miller operated shipboard scientific equipment and assisted with CTD operations. G. Knight maintained the shipboard computer system which logged the underway data. Finally ship personnel assisted in CTD deployment/recovery operations; help which was invaluable to the success of the cruise.

Two NBIS CTD/O2 underwater units were sent out for the cruise (WHOI instruments #8 and #9) along with two 24-position GO rosette underwater units. One system of 1.2 liter bottles with frame was defined as a back-up system. Primary rosette unit was a 24-place 10-l bottle system obtained by R. Fine from the Scripps facility. The 10-l bottle size was dictated by F11/F12 analysis requirements. Twenty-six bottles of SIO manufacture were aboard along with a complete back-up of GO 10-l bottles from WHOI and RSMAS.

One of the WHOI portable laboratories (a modified 20 foot long container) was sent on the cruise to house the salinity and oxygen analysis equipment. Two Guildline salinometers and two oxygen titration systems were aboard. This van and a rented container were used to transport equipment from WHOI to Durban. A second portable laboratory, previously sent to the Indian Ocean for another program was trans-shipped from Mombasa to Durban and loaded aboard Darwin for equipment storage and shipment home. The two portable laboratories were offloaded in Singapore, the ship's port of call after Fremantle.

The CTD data acquisition system employed was built around the NBIS 1150 deck unit. Digital data were recorded on 1/4" cartridge tapes and displayed graphically and listed in real time by an HP-85 computer. Audio tape back-up recordings were also obtained. A primary and complete back-up set of acquisition hardware were taken. Data transcription and processing were performed on a Microvax II computer system. Two independent systems were employed, the first devoted to basic processing, the second to data archiving and higher level processing/analysis.

The ship's equipment inventory included an acoustic Doppler velocity profiling system (RD 150-kHz profiler with IBM AT acquisition computer) and a digital XBT recorder (Bathysystems Inc. with HP-85 computer.) A thermosalinograph was used on the leg with data recorded by the ship's main computer system. This system also recorded position information (transit and GPS fixes.)

There were relatively few failures of equipment on the cruise. Upon set-up in Durban CTD #9 was found to be faulty but the failed components were quickly identified and repaired before ship departure. On an irregular and infrequent basis during the trip one of the nutrient autoanalyzer channels would yield faulty information. Rapid repair resulted in minimal loss of data. Late in the cruise one of the 9-track tape drives used to archive data from the Microvax computer failed. A functional unit was shared between computer systems for the balance of the leg.

By far our greatest problems came from the SIO supplied gear. At a test station occupied shortly after Durban departure the GO underwater unit for the SIO rosette system was found to be faulty. This unit was subsequently replaced by one from the WHOI inventory. The SIO bottles suffered leakage and breakage problems. (These bottles were employed initially because of their reported superiority for F11/F12 work.) Bottles frequently leaked water at the end caps or through spigots prior to venting. Water sample analysis confirmed that these samples were contaminated. Increasing spring tension helped minimize these leaks but at the expense of endcap breakage. A few inadvertent but unavoidable impacts of the underwater unit and ship resulted in broken bottles and broken welds on the aluminum rosette frame. The rosette frame did not afford sufficient protection for the bottles. Fortunately, good weather graced most of the cruise and so ship impact was a rare occurence. Those bottles which persistently leaked were replaced by GO bottles as the cruise progressed. No leakage problems were experienced with these bottles.

Cruise Narrative

The Darwin was scheduled to be available for staging in Durban on Nov. 8 with departure slated for the 12th. The U.S. scientific party arrived in Durban between the 7th and 8th. The WHOI and OSU equipment shipments had arrived intact, unloading began after the weekend on Monday the 9th. The RSMAS air shipment containing the bulk of the tracer chemistry equipment had been delayed. Cruise departure was held until 9 PM on the 12th to accomodate the late arrival of that gear.

The ship, upon leaving port, transited to a test station site roughly 100 km off the African coast in 3000 m of water. Arrival was on the morning of Nov. 13. CTD #9, mounted in the small rosette package, was successfully deployed to within 10 m of the sea floor. The test station for CTD #8 mounted in the large rosette package was aborted at 900 m depth when the CTD signal was lost. The balance of daylight hours were spent trouble shooting this problem.

During the test station, I was notified that the ship was required to return to Durban to put the ship's electrician ashore because of a home emergency. The replacement electrician was scheduled to arrive Durban on the afternoon of the 15th. Complicating matters, the winds had increased to 40 knots with growing seas. Since the large rosette package was not yet functional, it was decided to work westward from the test station site and occupy the coastal stations of the section using CTD #9 in the small, easily handled rosette package. Upon completion of the coastal transect, the ship occupied another test station off Durban for the large rosette system (with replacement rosette pylon unit.) This test was successful, and the ship returned to port for the personnel exchange.

Second departure from Durban occurred at 5PM on Nov. 15. The ship steamed back to re-occupy the easternmost station collected earlier and proceeded to work to the east. The balance of the CTD casts was done with the large rosette system. The combination of the large underwater package and the slow winch presently mounted on Darwin led to excessively long station times. The first half of the cruise suffered average lowering/raising rates of 37 m/min. Cruise time was also compromised by excessive biological fouling on the ship's hull which restricted cruising speed between stations. Some station position modifications were made in response to the slower than expected ship and winch speeds. As weather improved and more experience was gained in the system, stations were accomplishd a bit more rapidly. The planned station spacing was achieved in the eastern half of the section. Good weather also minimized wear on the CTD cable. Combination of the large rosette (with slow terminal velocity) and heavy swell, particularly during the last week of the cruise, did result in several kinks and "bird cages" in the wire. The cable was reterminated a total of 5 times on the cruise.

Station work was completed on the afternoon of Dec. 16 off Cape Naturaliste, Australia. The ship proceeded north and berthed in Fremantle on the morning of 17 Dec., one day ahead of the original schedule. Remarkably, no time was lost to weather and only a few hours to equipment breakdown on the cruise.

Ship and Crew

The Darwin is one of the best ships I have worked from. A positive attitude exists aboard and all ships personnel are eager to help with the science. We thank Master S. Mayl and the bridge officers, Chief Anderson and the engineering team, and G. Pook and the deck force for all their efforts during the cruise. We also applaud the high concern for safety aboard ship exhibited by ship's personnel. I wish also to acknowledge the four RVS technicians who went beyond their nominal duties to assist us in our work. Of particular value was B. Miller's vigilant care of ship's science equipment, his retrofitting of the ship's thermosalinograph and with G. Knight, effecting transmission of XBT data to the ship's computer system. R. Griffith's and K. Smith's assistance in rosette and wire repairs was invaluable.

The steward's department under the direction of K. Peters competently performed their difficult duties. Our thanks are extended especially for our Thanksgiving Day dinner and the cook-outs we enjoyed during the trip.

The vessel itself rides exceptionally well and is a superior platform for physical oceanographic research. However, the CTD winch is presently deficient. It is slow and does not level wind well. Also, the oversized A-frame employed results in a large (and at times dangerous) swinging moment arm during CTD deployment and recovery. Every effort should be made to upgrade this gear, which would place Darwin among the finest research vessels in the world. The Darwin is unique in our experience of research vessels in providing single cabins for everyone aboard. The privacy gained is immensely beneficial, especially on sustained voyages, and is something to be emulated in future research-vessel design. The unlimited availability of fresh water and low vibration and noise levels were also most welcome. Habitability could be improved though, for all personnel on long voyages by the installation of an exercise facility. Overall however, the ship was easy to work from and I would enjoy sailing on her again.

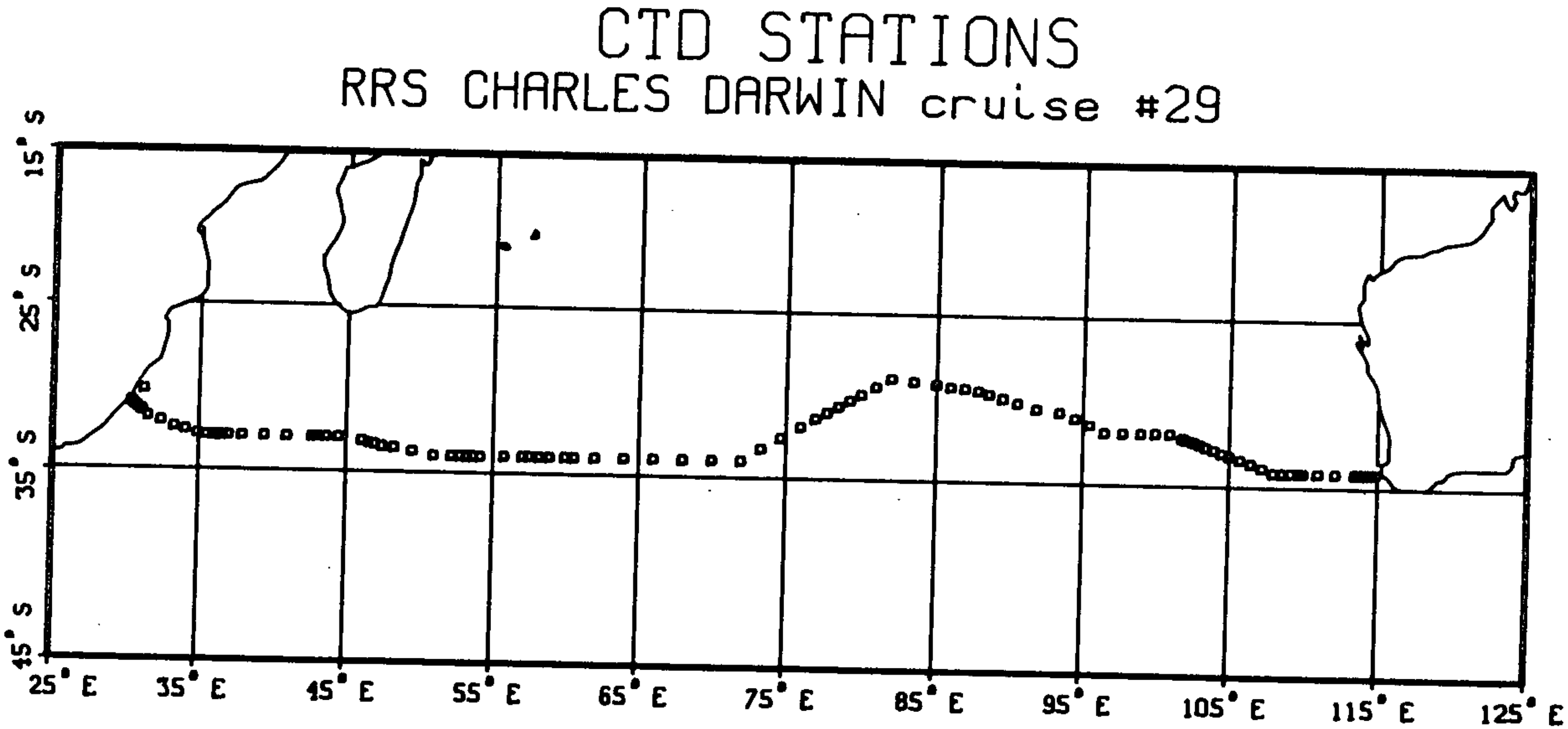
Table 1.

RRS Charles Darwin Cruise 29
Personnel List

Science Party

J. Toole B. Warren R. Stanley G. Knapp A. Morton M. Francis J. Kinder J. Zemba	WHOI
J. Jennings J. Johnson	OSU
R. Fine K. Sullivan L. Pope	RSMAS
G. Miller G. Knight R. Griffiths W. Smith	NERC/RVS

Officers and Engineers	Crew
S. Mayl	G. Pook
G. Harries	P. Hough
S. Sykes	C. Woods
G. Procter	A. Olds
J. Baker	D. Buffery
D. Anderson	M. Metcalfe
A. Greenhorn	K. Peters
W. Groody	P. Bishop
	J. McKeown
	A. Philp
	J. Coleman
	I. Gibb



CTD STATIONS
RRS CHARLES DARWIN cruise #29
15° S
25° S
35° S
45° S
25° E
35° E
45° E
55° E
65° E
75° E
85° E
95° E
105° E
115° E
125° E

Figure 1

RRS CHARLES DARWIN
cruise # 29

STATION SUMMARY

SH	CRU	STAT	DV	CST	CTD	DA	MO	YR	ST GMT	END GMT	LATITUDE	LONGITUDE	P MAX
CD	29	1	E	000	9	13	11	87	625	746	-31 35.07	31 10.56	3127.
CD	29	2	X	000	8	13	11	87	1000	1100	-31 34.86	31 9.55	889.
CD	29	2	X	001	8	13	11	87	1350	1420	-31 34.86	31 9.55	911.
CD	29	2	X	002	9	13	11	87	1652	1723	-31 35.13	31 8.09	1505.
CD	29	3	E	000	9	13	11	87	2035	2140	-31 22.54	30 50.10	2951.
CD	29	4	E	000	9	14	11	87	125	230	-31 15.59	30 39.30	2935.
CD	29	5	E	000	9	14	11	87	546	658	-31 12.09	30 35.84	2655.
CD	29	6	X	000	9	14	11	87	929	1025	-31 9.14	30 32.08	2247.
CD	29	7	X	000	9	14	11	87	1219	1300	-31 6.12	30 27.82	1783.
CD	29	8	X	000	9	14	11	87	1440	1508	-31 2.91	30 24.17	893.
CD	29	9	E	000	9	14	11	87	1637	1649	-31 2.95	30 22.07	245.
CD	29	10	X	000	9	14	11	87	1720	1729	-31 2.31	30 21.21	65.
CD	29	11	X	000	8	15	11	87	332	415	-30 18.46	31 19.84	1175.
CD	29	12	E	000	8	16	11	87	148	303	-31 34.73	31 9.67	3107.
CD	29	13	E	000	8	16	11	87	1138	1249	-31 56.62	31 36.31	3567.
CD	29	14	X	000	8	16	11	87	1947	2122	-32 11.67	32 30.13	3581.
CD	29	15	E	000	8	17	11	87	442	610	-32 32.75	33 24.74	3519.
CD	29	16	X	000	9	17	11	87	1214	1310	-32 41.54	34 10.30	2461.
CD	29	17	X	000	9	17	11	87	1849	1930	-32 53.96	35 0.12	1615.
CD	29	18	X	000	9	17	11	87	2330	8	-33 0.14	35 35.04	1469.
CD	29	19	X	000	9	18	11	87	340	421	-32 59.37	36 4.75	2011.
CD	29	20	X	000	9	18	11	87	656	750	-33 0.87	36 20.65	2603.
CD	29	21	E	000	9	18	11	87	1029	1130	-33 0.69	36 30.87	3315.
CD	29	22	E	000	9	18	11	87	1416	1551	-33 0.32	36 40.49	4751.
CD	29	23	E	000	9	18	11	87	2033	2213	-32 59.65	37 4.82	5157.
CD	29	24	E	000	9	19	11	87	608	742	-33 0.39	37 59.97	5121.
CD	29	25	E	000	9	19	11	87	1802	1935	-32 59.42	39 29.43	5139.
CD	29	26	E	000	9	20	11	87	540	714	-33 0.32	41 0.34	5091.
CD	29	27	E	000	9	20	11	87	1752	1915	-32 59.71	42 44.81	4413.
CD	29	28	X	000	9	20	11	87	2304	2350	-32 59.87	43 2.46	2337.
CD	29	29	X	000	9	21	11	87	420	443	-32 59.95	43 40.13	909.
CD	29	30	X	000	9	21	11	87	911	933	-32 59.64	44 29.41	959.
CD	29	31	X	000	9	21	11	87	1815	1853	-33 12.41	46 4.79	2201.
CD	29	32	X	000	9	21	11	87	2227	2321	-33 18.70	46 30.25	2673.
CD	29	33	X	000	9	22	11	87	302	401	-33 22.78	46 54.98	3187.
CD	29	34	X	000	9	22	11	87	832	940	-33 29.94	47 26.84	3627.
CD	29	35	E	000	9	22	11	87	1538	1653	-33 33.66	48 14.68	4031.
CD	29	36	E	000	9	23	11	87	123	245	-33 45.01	49 30.39	4393.
CD	29	37	E	000	9	23	11	87	1135	1257	-33 59.75	50 55.55	4391.
CD	29	38	E	000	9	23	11	87	2039	2206	-33 59.54	52 10.57	4583.
CD	29	39	E	000	9	24	11	87	249	415	-33 59.91	52 44.66	4551.

CD	29	40	E 000	9	24	11	87	904	1032	-34	0.42	53	10.22	4683.
CD	29	41	E 000	9	24	11	87	1522	1649	-34	0.45	53	36.86	4609.
CD	29	42	E 000	9	24	11	87	2148	2309	-34	0.73	54	7.11	4453.
CD	29	43	E 000	9	25	11	87	919	1052	-33	59.46	55	46.98	4385.
CD	29	44	E 000	9	25	11	87	1945	2117	-33	58.35	57	2.08	5199.
CD	29	45	E 000	9	26	11	87	221	401	-33	59.68	57	29.09	5423.
CD	29	46	E 000	9	26	11	87	953	1124	-33	59.93	58	10.05	5195.
CD	29	47	E 000	9	26	11	87	1725	1842	-33	59.73	58	53.63	4009.
CD	29	48	E 000	9	27	11	87	218	357	-33	59.61	59	56.99	5199.
CD	29	49	E 000	9	27	11	87	940	1124	-33	59.67	60	34.15	5437.
CD	29	50	E 000	9	27	11	87	2102	2248	-33	59.37	61	59.67	5187.
CD	29	51	E 000	9	28	11	87	1024	1146	-33	59.53	63	59.93	4751.
CD	29	52	E 000	9	28	11	87	2340	100	-33	59.81	66	0.21	4585.
CD	29	53	E 000	9	29	11	87	1200	1321	-34	0.14	67	59.86	4615.
CD	29	54	E 000	9	30	11	87	120	242	-33	59.95	70	0.33	4393.
CD	29	55	E 000	9	30	11	87	1435	1606	-34	0.10	71	59.84	5057.
CD	29	56	E 000	9	1	12	87	133	250	-33	19.52	73	20.15	4131.
CD	29	57	E 000	9	1	12	87	1224	1330	-32	40.09	74	39.66	3787.
CD	29	58	X 000	9	1	12	87	2354	55	-31	59.89	76	0.09	3419.
CD	29	59	X 000	9	2	12	87	826	923	-31	30.03	76	59.91	3033.
CD	29	60	X 000	9	2	12	87	1510	1609	-31	7.67	77	44.36	3073.
CD	29	61	X 000	9	2	12	87	2212	2313	-30	45.01	78	29.81	3557.
CD	29	62	E 000	9	3	12	87	522	631	-30	22.43	79	15.32	3795.
CD	29	63	X 000	9	3	12	87	1241	1345	-30	0.44	80	0.14	3565.
CD	29	64	X 000	9	3	12	87	2125	2242	-29	30.23	80	59.51	4217.
CD	29	65	E 000	9	4	12	87	633	739	-29	0.23	82	0.09	4171.
CD	29	66	E 000	9	4	12	87	1816	1932	-29	9.41	83	29.55	4443.
CD	29	67	E 000	9	5	12	87	500	613	-29	19.23	84	59.44	3991.
CD	29	68	E 000	9	5	12	87	1315	1437	-29	27.94	85	58.69	4523.
CD	29	69	X 000	9	5	12	87	2205	2311	-29	32.16	86	55.20	3587.
CD	29	70	X 000	9	6	12	87	540	609	-29	39.75	87	50.08	1355.
CD	29	71	X 000	9	6	12	87	1030	1107	-29	49.81	88	34.84	1843.
CD	29	72	X 000	9	6	12	87	1649	1731	-30	4.66	89	29.86	2283.
CD	29	73	X 000	9	7	12	87	11	46	-30	20.00	90	30.30	1663.
CD	29	74	X 000	9	7	12	87	825	902	-30	40.05	91	49.63	1935.
CD	29	75	X 000	9	7	12	87	1720	1746	-30	50.29	93	24.64	1237.
CD	29	76	X 000	9	8	12	87	101	131	-31	10.82	94	26.11	1559.
CD	29	77	X 000	9	8	12	87	731	755	-31	33.96	95	27.31	1211.
CD	29	78	X 000	9	8	12	87	1401	1429	-31	59.70	96	29.67	1293.
CD	29	79	X 000	9	8	12	87	2136	2210	-32	0.06	97	44.79	1619.
CD	29	80	E 000	9	9	12	87	451	535	-31	59.88	99	0.12	2105.
CD	29	81	X 000	9	9	12	87	1102	1147	-31	59.61	99	58.56	2423.
CD	29	82	X 000	9	9	12	87	1822	1906	-31	59.94	100	59.48	2235.
CD	29	83	X 000	9	10	12	87	36	128	-32	14.54	101	49.73	2873.
CD	29	84	E 000	9	10	12	87	429	538	-32	20.11	102	0.03	3785.
CD	29	85	E 000	9	10	12	87	953	1105	-32	24.90	102	29.69	4067.
CD	29	86	E 000	9	10	12	87	1356	1520	-32	29.73	102	39.41	4629.
CD	29	87	X 000	9	10	12	87	1917	2045	-32	35.90	102	59.45	4851.
CD	29	88	X 000	9	11	12	87	109	248	-32	44.88	103	24.00	5333.
CD	29	89	E 000	9	11	12	87	824	1003	-32	54.91	103	59.00	5549.

CD	29	90	E	000	9	11	12	87	1519	1658	-33	5.54	104	30.27	5525.
CD	29	91	E	000	9	11	12	87	2207	2353	-33	14.90	105	0.14	6037.
CD	29	92	E	000	9	12	12	87	646	826	-33	26.35	105	44.89	5409.
CD	29	93	E	000	9	12	12	87	1524	1717	-33	39.61	106	29.47	5597.
CD	29	94	X	000	9	13	12	87	13	204	-33	53.66	107	13.45	5377.
CD	29	95	E	000	8	13	12	87	846	958	-34	9.78	107	59.77	5065.
CD	29	96	E	000	9	13	12	87	1514	1701	-34	9.85	108	34.38	5535.
CD	29	97	E	000	9	13	12	87	2226	14	-34	10.00	109	9.05	5139.
CD	29	98	X	000	9	14	12	87	514	620	-34	9.89	109	42.30	3303.
CD	29	99	X	000	9	14	12	87	920	1018	-34	9.92	110	0.08	2589.
CD	29	100	X	000	9	14	12	87	1647	1736	-34	9.80	110	59.81	2123.
CD	29	101	X	000	9	15	12	87	12	109	-34	9.66	112	9.72	2635.
CD	29	102	X	000	9	15	12	87	1201	1259	-34	9.26	113	29.39	3039.
CD	29	103	X	000	9	15	12	87	1613	1709	-34	10.10	113	43.81	2223.
CD	29	104	X	000	9	15	12	87	1945	2023	-34	10.06	113	59.84	1503.
CD	29	105	X	000	9	15	12	87	2240	2307	-34	10.93	114	14.53	1067.
CD	29	106	X	000	9	16	12	87	49	111	-34	10.22	114	24.64	685.
CD	29	107	X	000	9	16	12	87	220	226	-34	9.71	114	30.26	141.
CD	29	108	X	000	9	16	12	87	353	358	-34	10.27	114	44.85	111.
CD	29	109	X	000	9	16	12	87	438	440	-34	9.52	114	49.64	41.