Hayes

Final Cruise Report

Robert D. Conrad Cruise 26-14, Dec. 1 - 30, 1985

Stephen D. Lewis, Chief Scientist

Introduction

RC 26-14 was the third of a 3-leg marine geophysical investigation addressing selected aspects of the tectonic development of the South China Sea and its margins. The program was undertaken in cooperation with marine scientists from the People's Republic of China, and comprised Phase 2 of the ongoing cooperative effort between Lamont-Doherty Geological Observatory and the Second Marine Geology Brigade, Guangzhou, People's Republic of China. The cruise began in Hong Kong on December 1, 1985 and terminated in Singapore on December 30, 1985. The scientific compliment included two scientists from the PRC and one from France, in addition to the L-DGO personnel aboard (see crew list, Appendix 1).

RC 26-14 had three principle objectives:

1) Conduct heat flow measurements along three transects in the South China Sea (Fig.1), two of which were coincident with two-ship ESP transects conducted on the previous legs of this project. The third heat flow transect crossed the southwest sub-basin of the South China Sea, coincident with a CDP survey track.

2) Conduct a CDP seismic survey across the southwest sub-basin of the South China Sea.

3) Collect SEABEAM swath bathymetric data along the heat flow/ESP transects and along the southwest sub-basin CDP survey tracks.

Gravity data were continuously acquired, and magnetics data were acquired during all underway portions of the cruise. Navigation data were continuously acquired and recorded by the L-DGO data logger system, plotted by the Compaq-based "navigation system", and acquired through the data logger and independently processed by the SEABEAM Vax-based system for the last three weeks of the cruise. SEABEAM data were displayed in real time on the CalComp plotter and post-processed SEABEAM data merged with corrected navigation were produced off-line on a daily basis.

Cruise Narrative

Conrad departed Hong Kong at 0830 December 1, 1985 (all times are local time). At approximately 1030/1 December Sue Maggiore, URI SEABEAM trainee, reported experiencing severe abdominal pain and other symptoms to the Chief Scientist and the Captain. The decision was made to return to Hong Kong and have Ms. Maggiore consult a physician. The Hong Kong agent was contacted by radio, and met the Conrad at anchorage soon after arrival. Ms. Maggiore was taken off the vessel and was examined by a physician, who advised hospital treatment. Conrad re-cleared customs and immigration, and departed Hong Kong at 1815 December 1. Ms. Maggiore remained in Hong Kong for treatment. SEABEAM, 3.5 KHz, and magnetometer were turned on as soon as practical after leaving Hong Kong.

Transit to the landward end of the eastern transect was completed at 1430/2 December, and the SEABEAM survey of that transect began (Fig. 1).

Eastern Transect: SEABEAM, Coring, and Heat Flow

Conrad was hove-to at 1900/2 December at 21^0 52.8' N, 117^0 11.4' E (the mid-point of ESP #8) to attempt a piston core for heat flow conductivity measurements. Two attempts yielded no recovery and a bent pipe, so this station was abandoned with no success. Conrad departed this station at 2045/2 December. The initial diagnosis of the cause of this failure was pre-triggering of the core due to the heave of the ship in the rough conditions prevailing (Force 6 winds; Sea State 5). Subsequent investigation supported the notion of pre-triggering, but the reason for the pre-triggering was not rough seas.

Conrad arrived on station for the second piston core along the eastern transect at 0635/3 December (20^0 43.8' N; 117^0 48.4' E.; mid-point ESP #5). Approximately 4 m of sediment were recovered, and the ship was underway, continuing the SEABEAM survey at 0745.

We arrived at the third core station along this transect (19^0 27.5' N; 118^0 12.0' E.; mid-point ESP #2) at 1715/3 December. Recovery was only 1.5 m, even though there was mud on the outside of the barrel all the way to the weight. We had good recovery of bottom water, but not much mud! We re-rigged for heat flow and continued the SEABEAM survey southward to the first heat flow station at 2045/December 3.

Heat flow operations began at 2345/3 December, at DHF Station # 15; 19^0 09.7' N; 118^0 21.6' E. The question to be answered was whether the most efficient method to use for heat flow is towing the instrument between stations spaced roughly 5 mi. apart, or raising the apparatus to the surface and steaming at full speed between stations. The telling constraint imposed by the bridge was a maximum towing speed of 1.5 kts, despite towing speeds of up to 5 kts. on the Barbados heat flow cruise. Hence, wire time became much less than transit time, even in deep water. By 1930/December 4 DHF Stations 15 through 19 were occupied with good measurements.

Following DHF 19 we rigged for piston coring in order to get adequate recovery for conductivity measurements. In addition, leaking probes on the heat flow instrument required several more hours of repair time than was required for the transit between stations. Hence, we used this heat flow down time to attempt another piston core.

This core station (19^0 53.2' N; 118^0 01.9' E.) was occupied at 2000/4 December. Recovery was approx. 4 m. The core was aboard at 2330; the heat flow instrument was then re-rigged.

At 0112/5 December the heat flow apparatus was lowered for DHF 20. The acoustic signal from the instrument was intermittently faulty, but we proceeded with the station. After the instrument was back on deck (0520) it was discovered that:

✓ 1) The instrument pressure case had begun to leak,

✓ 2) 5 of 7 new temperature probes had failed, and

✓ 3) the intermittent acoustic "stepping" problem had become chronic.

We began a 5-hour SEABEAM survey between ESPs 3 and 4 that would have us in position for the next station by the time the heat flow instrument would be repaired.

DHF 21 was occupied at 1030/5 December, following that SEABEAM survey. The measurement appeared to be good.

DHF 22 was occupied at 1330/December 5. The measurement again appeared acceptable, but upon recovery of the instrument it was discovered that the pressure case still leaked, the erratic pinging persisted, <u>and</u> the battery pack was shorting, overheating the batteries. Because new O-rings had been installed, the leak was now thought to be in an end cap wire pass-through that had been modified during the previous heat flow program. The pinging problem was tentatively traced to a faulty component board, which must be replaced. Work began on these problems as we departed DHF 22.

We arrived at DHF 23 at 1621/December 5. Repair work was progressing, and time estimates for the completion of repairs was 1-2 hours. The instrument was launched at 2024, and the station proceeded uneventfully and successfully.

The heat flow lance was bent at DHF 25, even though the measurement was good. The short lance was substituted between DHF 25 and DHF 26.

DHF 26 was occupied at 0603/December 6. When the instrument was near the bottom, prior to penetration, the probes were off scale. The instrument was brought back to the surface and re-wired for higher water temperatures. The station proceeded smoothly and was vacated at 0936/6 December.

DHF Stations 27-29 proceeded smoothly. Operations at DHF 29 ended at 1604/6 December, making 66 hours spent on heat flow operations along the eastern transect. Budgeted time was 68 hours. Water depths for heat flow stations along this transect range from 3515 m at the seaward end to 385 m near the shelf break at the landward end. A total of 15 stations were occupied along this transect. The average spacing between stations is 10.4 mi.

Transit to western heat flow transect

We departed DHF 29 at 1610/6 December for transit to the western transect, to start at mid-point ESP 20. That position was reached at 0516/8 December, when we turned north to begin the SEABEAM survey/piston coring operations along the western transect (Fig. 1).

Western transect SEABEAM/piston core survey

Core station #17 (16^0 57.5' N; 113^0 30.28' E.) was occupied at 1000/8 December. The first attempt recovered just 1.5 m of sediment. A second core at the same location was attempted, this time with 10' less trigger weight scope than had previously been used. Roughly 5 m of material was recovered, nearly a full pipe. We departed this station at 1400/8 December.

Core station 18 (18^0 02.80' N; 113^0 25.74' E.) was reached at 2200/8 December. A full pipe was recovered. It was clear that the dominant contributing factor to the poor recovery on the eastern transect was too much trigger weight scope, causing pre-triggering of the core.

Core station 19 (18^0 56.53' N.; 112^0 54.20' E.) was occupied at 0700/9 December. By 0800 one full pipe of sediment was secure on deck, the heat flow probe was rigged, and we were underway to DHF #30, the landwardmost heat flow station of the western transect.

Western heat flow transect

The weather began to moderate, and the sun appeared! DHF 30 began at 1130/9 December. The end of 9 December saw the completion of DHF 37, a productive day helped by shallow water, good weather, and high reliability heat flow instrumentation.

DHF stations 38-51 were occupied during 10 December. No instrument malfunctions occurred.

DHF stations 52-61 were occupied on 11 December, with no difficulties.

The western transect heat flow program consists of 31 stations. The average distance between stations is 7.5 mi.

Southwest sub-basin SEABEAM/piston core survey

This part of the cruise began at 0100/12 December. The monsoon winds had built to Force 6 by this time; our weather respite had ended. The SEABEAM work would be run at 170 rpm, rather than full speed (180 rpm) for fuel conservation reasons.

0300/12 December: BGM/SEABEAM interace failed in pitch component; collected approx. 5 hours of garbage SEABEAM data.

0830/12 December: switched to Aeroflex table for vertical reference, but A/C for Aeroflex is inadequate.

1015/12 December: "portable" A/C unit was moved from main lab to Aeroflex room.

1400/12 December: BGM/SEABEAM interface was repaired and on line.

Core Station #20 was reached at 0016/14 December. Core is secure on deck with full recovery at 0201/14 December.

We reached the planned position of the next piston core station at 2100/14 December, but Force 6-7 winds and 15' seas precluded over-the-side operations. We steamed over this position without stopping.

Core station #21 was reached at 1020/15 December. Force 6 conditions are marginal for coring, but full recovery is achieved with no injuries on deck. The ship was underway to the next heat flow station with the instrument rigged by 1200.

Southwest sub-basin heat flow transect

DHF 62 commenced at 1330/15 December. The end of 15 December saw the completion of DHF 66 without incident. Four to five people on deck were required to handle the heat flow instrument in the prevailing weather conditions.

DHF 63-73 were completed on 16 December. Weather conditions were Force 5-6 from 040^0; monsoon conditions.

DHF 74-78 were completed on 17 December.

DHF 79-83 were completed on 18 December. 1202/18 December ended DHF 83 and the RC 26-14 heat flow program. The southwest sub-basin heat flow transect consists of 21 stations. The average distance between stations is 11.8 mi.

Southwest sub-basin CDP/SEABEAM survey

18 December, 1985

1220 - begin MCS streamer deployment

1600 - completion of streamer deployment and re-ballasting of streamer

1705 - airguns firing

1731 - 1st shot recorded, MCS Line #637.

19 December, 1985

0030 - 150 rpm required to make 6 kts. over the bottom into the wind

1110 - gun #1 down, solenoid problem.

1145 - gun #1 on line

1200 - 8949 gal. fuel remaining for MCS work.

20 December, 1985

0045 - End Line # 637

0120 - Begin Line #638; 30-35 kt. winds; Typhoon Hope on maps east of Luzon

0400 - End Line #638

0500 - try to speed up; streamer surfaces

0700 - streamer back down to 50', quiet; wind at 35 kts apparent, approx. 38 kts. true.

0800 - Begin Line #639

1200 - 5.0 kts through the water on this line, 4.33 kts over the ground; 30^0 rolls. Tropical storm "Irving" on the weather maps to the south.

1130 - 1600 - airgun tangle on port (windward) side; required new harness to be installed. Subsequently one gun is towed 10' shorter; no further problems.

21 December, 1985

0345 - End Line # 639

0400 - Begin Line # 640

0800 - 10-kt. winds, good conditions for streamer.

1000 - Compressor valve failure; 2 guns down

1215 - Compressor repaired and 4 guns on line

1300 - End Line #640

1345 - Begin Line #641

22 December, 1985

0800 - Force 6 winds, sea state 5; noisy sonobuoys.

1400 - End Line #641

1430 - Begin Line # 642

1930 - End Line #642

1935- Begin Line #643

23 December, 1985; Typhoon Hope turns N.E. towards Taiwan from Baler Bay!

2000 - End Line #643

2045 - Begin Line #644

24 December, 1985

Survey of Line #644; Force 6, rough ride but quiet streamer.

25 December, 1985

0230 - End Line #644

0315 - Begin Line #645

1415 - BGM internal oven problems, temp. is dropping but still in acceptable range S.B. Receiver #1 finally gave up completely.

26 December, 1985

0620 - End Line # 645 and End MCS operations, commence recovery of gear.

0900 - Lost main engine power with approx. 40% of streamer aboard; Force 5 conditions. Ship blew off to stbd. into trough and back over streamer. Streamer led from fantail forward under ship to roughly midships, and then to windward for 300 m, and looped back to leeward to tail buoy. Bow prop was activated approx. 5 minutes after engine failure; ship drove forward over streamer until it was clear of main prop; ship then steamed to windward to straighten streamer.

0930 - situation stable; streamer not broken, but kerosene slick was visible. Have at least one leak.

1045 - All gear aboard with one leak in streamer repaired and approx. 2 m of badly scraped jacket glued and taped.

1100 - Underway to Singapore with magnetometer deployed, SEABEAM, 3.5, etc. still running.

27 December, 1985

Transit

28 December, 1985

Transit

29 December, 1985

Transit

30 December, 1985

1200 - In berth at Keppel Shipyard, Singapore.

Scientific Equipment Performance

1) Data Logger

The data logger proved to be highly reliable, the system did not crash at all during this cruise. One Kennedy tape drive suffers from a poorly-defined write problem, and should receive attention.

2) MCS System

A) The DFS 4 performed well, with occasional tape loading problems caused by the begin-tape light.

B) The streamer performed well with the exception of 2 dead channels that were not operative for the entire program. The problem might be with the DFS unit rather than the streamer, but requires more than casual trouble-shooting. Depth control was marginally adequate, and required very careful and time-consuming ballasting. Another flock of birds should be on the shopping list.

C) The airguns and compressors performed well, with only minor and easily-repaired failures. The one towing problem that we encountered will not occur again with the installation of the Teledyne-style gun booms on the Conrad.

3) The magnetometer performed well.

4) The gravimeter performed well, but suffered two failures:

1) The BGM/SEABEAM interface failed. The hard-wired nature of the assembly made replacement of the failed IC a morning-long job. Had the unit been mounted in a socket, repair would have required 5 minutes.

2) The internal furnace of the BGM sensor failed near the end of the cruise. The cause of failure was not diagnosed at sea because the system continued to function within its specifications and was not turned off for repair.

5) The 3.5 KHz performed well, but a great deal of interference with SEABEAM occured. The 3.5 system was shut down when interference became a problem.

6) The sonobuoy system performed well until the end of the cruise, when receiver #1 failed for unknown reasons. The pneumatic launcher was a complete success.

7) The SEABEAM system performed well, but serious degradation of data quality occured in rough weather. There was some thought that the weather was not the sole contributor to poor data. The pitch sensor failed during the cruise, but was quickly repaired. A more complete summary can be found in the SEABEAM cruise report of S. Ferguson and J. Miller.

8) Navigation sensors performed well, with the exception of one GPS receiver. The COMPAQ-based system performed well as a real-time monitoring device, but was not adequate for any post-processing of navigation data or the production of "final" or smoothed navigation. We were completely dependent on the SEABEAM VAX computers for post-processing of navigation data as well as the processing and display of other data, such as magnetics and gravity. See comments following.

General Comments

In general, the data acquisition sytems on the ship performed very well; no long-duration repair was necessary, with the exception of the heat flow instrument. However, a serious lack of capability exists in terms of the at-sea processing and display of the data being collected. For example, it was important during this cruise to be able to monitor the magnetics being collected for the final part of the leg. It was not possible to merge navigation (smoothed by the URI SEABEAM C-NAV software) with magnetics and plot magnetic wiggles along track. There are a few routines aboard, developed by scientists from previous legs, that can handle some aspects of data processing and display, but there is no complete and organized capability to display data, such as can be done at the lab using the "Brown Book" software. It was most frustrating to see that negative progress has been made in the last five years in terms of at-sea data manipulation. Many of the "Brown Book" routines were implemented on the Vema in 1980, and nothing of the kind is presently available on the Conrad, with the exception of the SEABEAM system products. Naturally, these are available only during SEABEAM cruises.

It is my opinion that a concerted effort should be mounted to acquire the capability to routinely process and display a minimum of navigation, magnetics, gravity, and PDR depth data at sea in near-real time (a few hours to a day post-acquisition), independent or quasi-independent of concurrent SEABEAM data acquisition. The computer hardware and software to accomplish this task should be compatible with both the SEABEAM hardware and software on the ship and with the data processing and display systems at L-DGO.

The benefits of such a capability include but are not limited to:

1) Near real-time data quality control and fault diagnosis;

2) Enhanced scientific decision-making capability at sea;

3) Shorter delays in the production of "final" or archive data for inclusion in the institutional data base, as well as scientific results;

4) A more versatile and robust networked computing environment on the ship, where off-line computers can handle various post-processing and display tasks, and serve as backup for a variety of on-line acquisition computers (data logger, SEABEAM, SCS, MCS real-time demux, etc.) in the event of failures;

5) Simplicity of software development and transfer between onshore and offshore facilities.

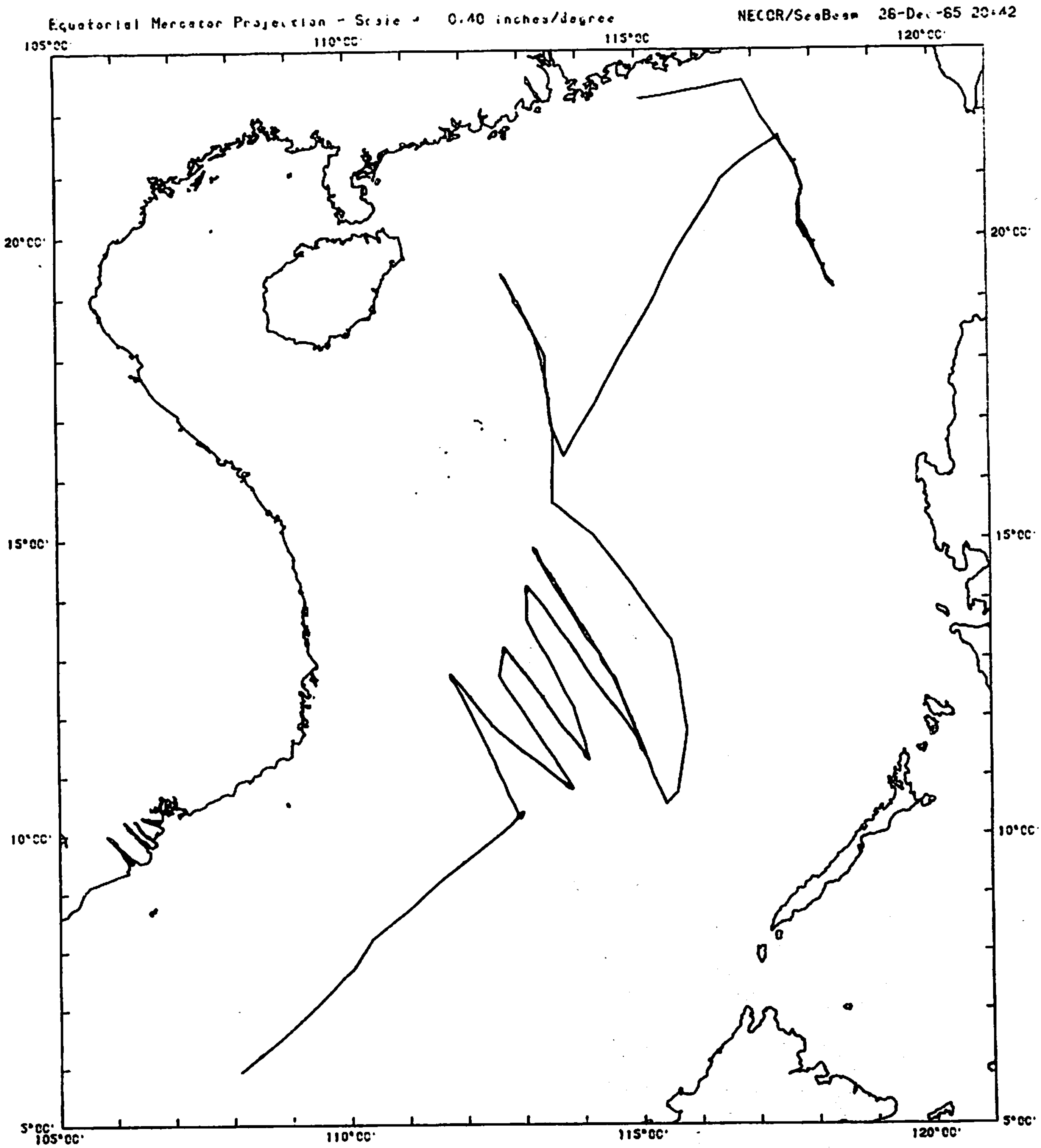
Appendix 1

Scientific Personnel, RC 26-14
December 1-30, 1985
Hong Kong to Singapore

1) S. Lewis-Ch. Sci.*
2) K. Feigl-navigation
3) S. Spangler-student
4) A. Briais-student, University of Pierre and Marie Curie, Paris
5) W. van Steveninck-HF
6) M. Hobart-HF
7) P. Medici-HF
8) Mr. Zhang Guozheng, 2nd Marine Geology Brigade, Guangzhou, PRC
9) Mr. Feng Ji-bing, 2nd Marine Geology Brigade, Guangzhou, PRC
10) J. Smith-Science Officer
11) J. Stennett-Electronics engineer
12) S. LaBrecque-Electronics technician
13) Ropate-Core Bos'n/airgun
14) M. Iltsche-airgun
15) J. DiBernardo-airgun
16) S. Ferguson-SEABEAM, URI
17) J. Miller-SEABEAM, URI
18) S. Maggiore-SEABEAM, URI**

* Personnel affiliated with Lamont-Doherty Geological Observatory unless otherwise stated.

** Taken off ship at beginning of cruise for medical emergency.



R/V CONRAD Cruise RC2614 Trackline Dec. 1 to 27, 1985

Figure 1

for D. HAYES

SOUTH CHINA SEA II: Heat Flow Data

R.D. Conrad 26-14

Eastern Heat Flow Line

Station	Latitude (N)	Longitude (E)	Depth (m)	Pen (m)	Np	Grad (mK/m)	s.d.	K	Q	s.d.	EV
15A	19 11.99'	118 25.18'	3681								
15B	19 12.38'	118 22.09'	3660								
15C	19 14.92'	118 18.62'	3645								
16	19 16.30'	118 15.94'	3613	5.4	6	90	2	.75	68	2	10
17	19 27.93'	118 11.83'	3515	5.5	6	93	3	.76	71	2	9
18A	19 40.80'	118 05.12'	3219	4.5	4	100	2	.74	74	2	8
18B	19 40.80'	118 05.12'	3219	4.5	3	106	3	.74	78	2	7
19A	19 48.31'	118 01.59'	3210	4.5	4	110	2	.74	81	2	7
19B	19 48.44'	118 01.67'	3210	4.3	3	117	4	.74	87	3	6
19C	19 48.49'	118 01.74'	3210	4.3	3	114	2	.74	84	2	7
20	19 53.03'	118 00.99'	3091	5.5	4	121	1	.75	91	1	8
21	20 01.72'	117 54.39'	2975	4.0	3	102	1	.77	78	1	8
22			2413	5.5	4	97	2	.83	81	2	8
23	20 29.52'	117 46.02'	1805	4.0	3	93	1	.91	85	1	6
24	20 44.15'	117 50.47'	1435	4.5	3	70	3	.96	67	3	7
25A	20 59.97'	117 45.69'	919	1.0	1	-	-	-	-	-	0
25B	21 00.08'	117 45.67'	919	4.0	2	-	-	-	-	-	4
26	21 11.41'	117 41.98'	824	1.0	2	-	-	-	-	-	0
27A	21 19.31'	117 36.63'	706	3.5	5	*	*	1.04			8
27B	21 19.31'	117 36.63'	706	3.5	5	*	*	1.04			8
28	21 28.11'	117 31.92'	453	3.5	5	*	*	1.07			9
29A	21 36.96'	117 26.77'	385	1.0	1	-	-	-	-	-	0
29B	21 36.97'	117 26.77'	385	3.5	5	*	*	1.08			9

Core	Latitude (N)	Longitude (E)	Depth (m)	Pen	Nk	K	s.d.
C13	21 53	117 10	120	0	-		
C14	20 43.71'	117 49.96'	1355	4.4	22	0.961	0.057
C15	19 28.23'	118 12.14'	3519	1.1	5	0.760	0.011
C16	19 53.23'	118 01.97'	2912	3.2	15	0.753	0.069

Western Heat Flow Line

Station	Latitude (N)	Longitude (E)	Depth (m)	Pen (m)	Np	Grad (mK/m)	s.d.	K	Q	s.d.	EV
30	19 22.36'	112 41.61'	188	3.5	5	*	*	1.12			7
31	19 18.14'	112 45.00'	214	3.5	5	*	*	1.10			8
32	19 13.51'	112 47.44'	248	3.5	6	*	*	1.10			8
33	19 08.93'	112 49.48'	280	3.5	6			1.09			
34	19 03.87'	112 57.57'	335	3.5	6	*	*	1.09			8
35	18 56.61'	112 57.36'	490	3.5	6	*	*	1.07			8
36	18 50.08'	113 01.74'	780	3.5	6	*	*	1.03			8
37A	18 42.63'	113 04.16'	1155	3.5	6	122	4	.99	121	4	10
37B	18 42.60'	113 04.23'	1155	3.5	6	111	7	.99	110	7	8
38	18 35.45'	113 08.26'	1615	3.5	6	120	4	.93	112	4	10
39	18 28.81'	113 10.98'	2019	4.0	6	96	7	.88	84	6	8
40	18 23.82'	113 14.26'	2275	4.5	6	130	7	.85	111	6	9
41	18 19.36'	113 16.65'	2447	3.5	6	100	10	.83	83	8	8
42	18 14.38'	113 17.66'	2996	4.0	5	110	9	.76	84	7	8
43	18 09.56'	113 18.68'	2669	4.0	6	87	4	.80	70	3	9
44	18 04.84'	113 19.97'	1590	3.5	4	49	3	.85	42	3	8
45	17 59.93'	113 21.31'	1775	3.5	4	108	9	.91	98	8	7
46	17 55.00'	113 22.43'	1957	4.0	6	92	1	.89	82	1	10
47	17 49.93'	113 23.44'	1850	4.0	6	74	2	.90	67	2	10
48	17 45.09'	113 24.92'	1695	4.0	6	80	3	.92	74	3	10
49	17 40.72'	113 25.99'	1703	3.5	6	104	8	.92	96	7	8?
50	17 35.45'	113 26.26'	1930	3.5	5	79	1	.89	70	1	10
51	17 30.40'	113 26.43'	2380	3.5	6	91	4	.84	76	3	8
52	17 25.74'	113 27.94'	2767	3.5	5	81	5	.79	64	4	8
53	17 21.28'	113 29.42'	3010	3.5	5	61	3	.76	46	2	8
54	17 15.65'	113 29.21'	3274	3.5	5	98	2	.73	72	2	10
55	17 10.80'	113 29.81'	3251	4.0	7	97	3	.73	71	2	10
56	17 05.86'	113 30.45'	3200	4.0	6	111	1	.74	82	1	10
57	16 55.93'	113 31.75'	2125	4.0	6	107	2	.85	91	2	10
58	16 46.33'	113 33.08'	2470	4.0	6	107	4	.83	89	2	10
59	16 26.18'	113 32.72'	2353	4.0	6	96	4	.84	81	3	7
60	15 56.09'	113 31.91'	2450	3.5	5	49	5	.83	41	4	8
61	15 36.68'	113 31.55'	2112	3.5	4	9	9	.87	8	7	6?

Core	Latitude (N)	Longitude (E)	Depth (m)	Pen (m)	Nk	K	s.d.	
C17A	16 57.51'	113 30.28'	2146	1.5	7	0.745	0.025	poor core
C17	16 57.49'	113 30.78'	2204	5.4	26	0.852	0.014	
C18	18 02.98'	113 25.81'	1966	5.3	27	0.850	0.023	
C19	18 56.53'	112 54.20'	445	5.6	27	1.123	0.037	

Southwestern Basin Heat Flow Line

Station	Latitude (N)	Longitude (E)	Depth (m)	Pen (m)	Np	Grad (mK/m)	s.d.	K	Q	s.d.	EV
62A	14 50.79'	113 11.06'	2554	3.5	6	52	4	.82	43	3	6
62B	14 50.67'	113 11.40'	2554	3.5	6	59	4	.82	49	3	7
63	14 44.94'	113 15.86'	2075	3.5	6	110	6	.88	97	5	8
64	14 39.60'	113 18.71'	1950	3.5	6	69	4	.89	61	3	8
65	14 34.46'	113 21.08'	3201	3.5	6	61	4	.74	45	3	7
66	14 29.45'	113 25.04'	3136	3.5	6	102	3	.75	77	3	10
67	14 25.53'	113 28.44'	2550	3.5	6	-	-	-	-	-	0
68	14 20.15'	113 31.91'	3995	4.0	6	102	2	.70	71	1	10
69A	14 15.30'	113 34.12'	3445	3.5	6	-	-	-	-	-	0
69B	14 15.36'	113 34.14'	3445	3.5	6	95	5	.71	67	4	8
69C	14 15.45'	113 34.18'	3445	3.5	6	91	3	.71	65	2	8
70	14 09.64'	113 38.33'	4220	4.5	6	107	2	.70	75	1	10
71	14 03.54'	113 41.36'	4206	4.0	6	135	2	.70	95	1	10
72	13 53.88'	113 47.53'	4295	4.5	6	119	2	.70	83	1	10
73	13 33.64'	114 00.20'	4297	3.5	6	52	4	.70	36	3	8
74	13 16.79'	114 10.95'	4322	4.5	6	13	1	.70	9	1	10
75	12 59.00'	114 21.26'	4427	6.5	5	119	1	.70	83	1	10
76	12 41.63'	114 32.35'	4363	6.0	5	117	1	.70	82	1	10
77	12 13.93'	114 43.28'	4362	5.0	4	100	1	.70	70	1	9
78	11 59.56'	114 49.49'	4369	6.0	5	100	3	.70	70	1	10
79	11 52.86'	114 52.93'	3620	3.5	5	132	3	.70	92	2	10
80	11 44.74'	114 55.63'	2449	3.5	6	97	6	.83	81	5	8
81	11 37.00'	114 58.38'	2566	3.5	6	96	2	.82	79	2	10
82	11 29.54'	115 00.91'	2283	3.5	5	37	0	.85	31	1	10
83	11 21.58'	115 04.50'	2095	3.5	5	68	2	.81	55	2	10

Core	Latitude (N)	Longitude (E)	Depth (m)	Pen (m)	Nk	K	s.d.
C20	11 21.51'	115 04.42'	2082	6.0	29	0.814	0.024
C21	14 41.12'	113 16.96'	2234	5.9	28	0.876	0.021