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HYPOGENE EXPEDITION REPORTS

LEG II CRUISE REPORT AND CHEMICAL DATA

by

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FOREWORD

HYPOGENE EXPEDITION

The discovery in the mid 1960's of the hot brine pools and metallic proto-ore sediments in the basins of the Red Sea (Degens and Ross, 1969) was an exciting and catalytic oceanographic and marine geologic event, as such phenomenon had not been encountered previously or even been predicted from theoretical models of the Earth. In 1970, a group of scientists chiefly from the University of California, noting the geologic and geophysical similarity of the Gulf of California to the Red Sea, suggested to the International Decade for Ocean Exploration (IDOE) through the National Science Foundation that analogs of the Red Sea brine pools might be found in the Gulf of California. These Scientists, led by Professor H. W. Menard of the Scripps Institution of Oceanography proposed a multi-disciplinary expedition to the Gulf of California lasting two years, involving 12 major investigators, and costing $733,301. The IDOE, however, felt that before such sums were committed that an exploratory cruise should be made to prove the existence of the hot brine pools and potentially economic sediments in the basins of the Gulf. Accordingly, the proposal was trimmed to $150,000 and three major investigators to operate a 40 day cruise on the R/V *Melville* in the spring of 1972. Professor Menard adopted the name: HYPOGENE ("a mineral deposit or enrichment formed by ascending solutions; also said of those solutions and of that environment"; A.G.I. Glossary. 1973, p. 346) for the expedition in anticipation of the discovery of Red Sea-type deposits.

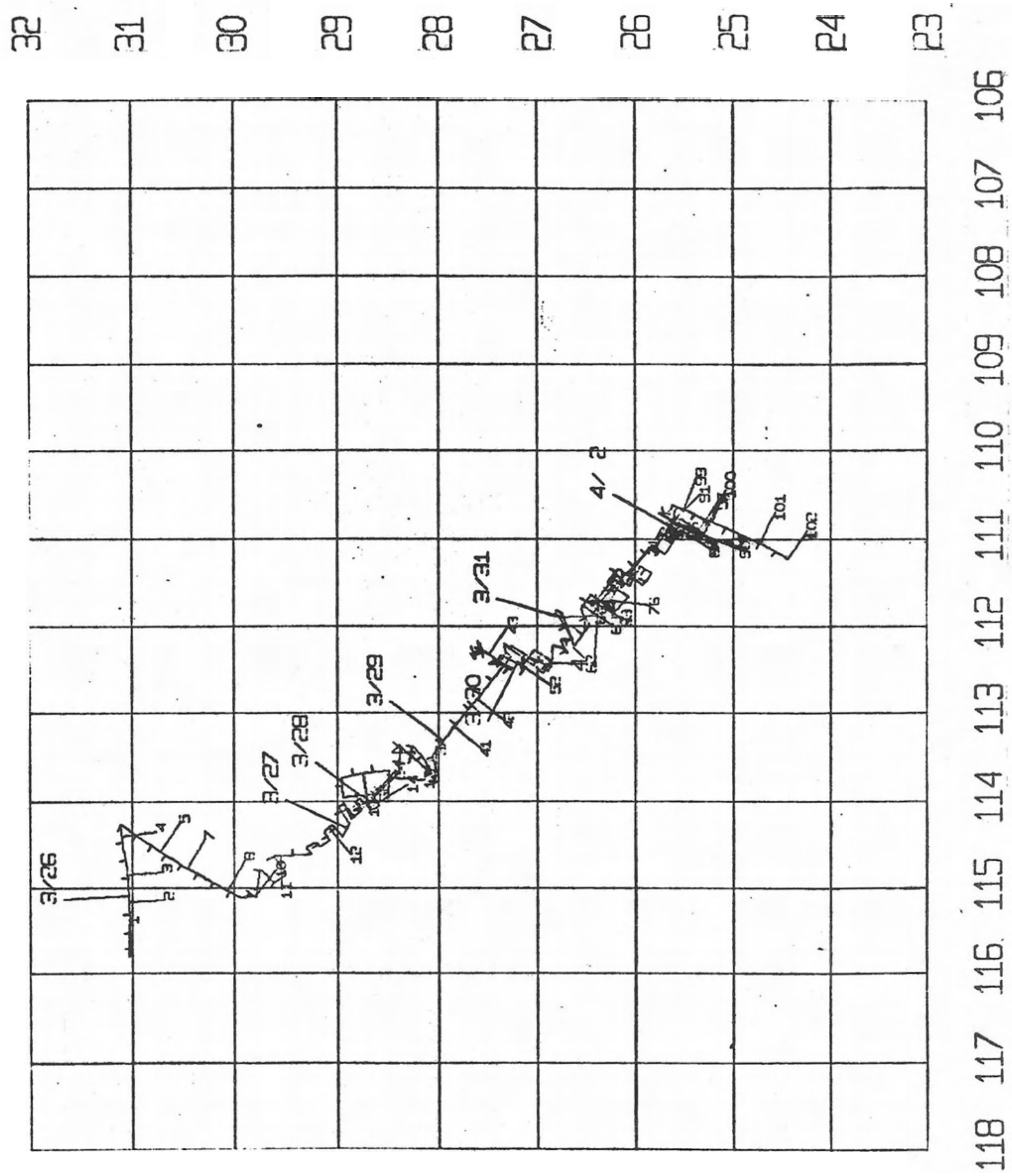
The cruise plan was to (1) survey the basins in the Gulf from south to north to locate the deepest portions of each basin as potential brine sites; (2) to probe chasm basins in reverse order from north to mouth, to confirm or deny the existence of hot brines and/or metalliferous sediments in these deeps; and (3) to return back into the Gulf for seismic and additional work on basins which proved of interest on the two previous transits of the Gulf. Thus the scientific goals and responsibilities were divided into three categories corresponding to the major operations of each leg; that is. Leg I - San Diego to San Felipe - H. W. Menard: bathymetry and marine geology; Leg II - San Felipe to La Paz - P. Wilde: brine search and water column and sediment sampling; and Leg III - La Paz to San Diego - J. Brune/J. Hawkins: Seismic geophysical and marine geologic sampling.

This report gives the operations log of Leg II and the oceanographic and geochemical data generated during the operations in search of the brine pools, with ancillary data such as heat flow and electrical resistivity of sediments. Information on availability of data derived from other operations may be obtained from the principals mentioned above or by contacting the Geologic Data Center, Scripps Institution of Oceanography. No attempt is made here to interrelate or make a complete synthesis of the various data. It was enough of a chore to present the data listed here in a readable form. Also some of the sediment analyses of samples given to outside investigators (those not funded by the Hypogene grant) have not been received as yet. Thus it is premature to draw any defendable conclusions at this time. More complete discussions of various aspects of the data from Hypogene, however, is now appearing in appropriate journals. In the Afterword, following the presentation of the data "work in progress" comments will be attempted.

ACKNOWLEDGEMENTS

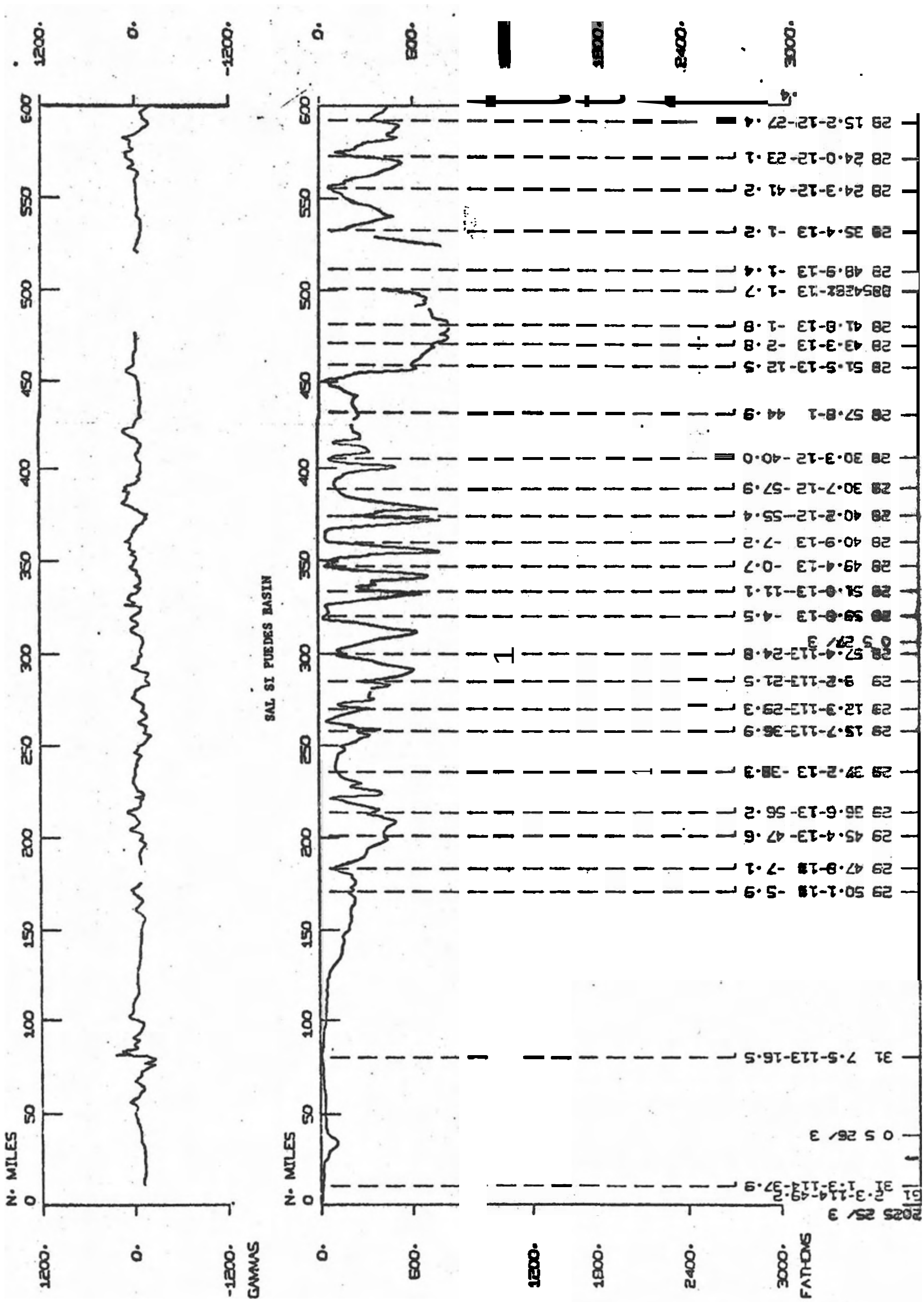
We wish to thank the officers and crew of the R/V *Melville*, particularly Captain Karl Ferris and chief Engineer Robert Fish, for their unfailing support of the shipboard scientific operations. On the beach, S. M. Smith had the thankless task of guiding the various drafts of the proposal through the expanding maze of bureaucracies. George Sharman, with his boundless energy and years of humor coordinated the cruise before and during operations. George Bohahaws kept the sampling program functioning although faced with a conglomeration of student and faculty designed equipment worthy of Rube Goldberg. This project was funded under grant from the National Science Foundation: NSF GX 31704.

TRACK CHART LEG II



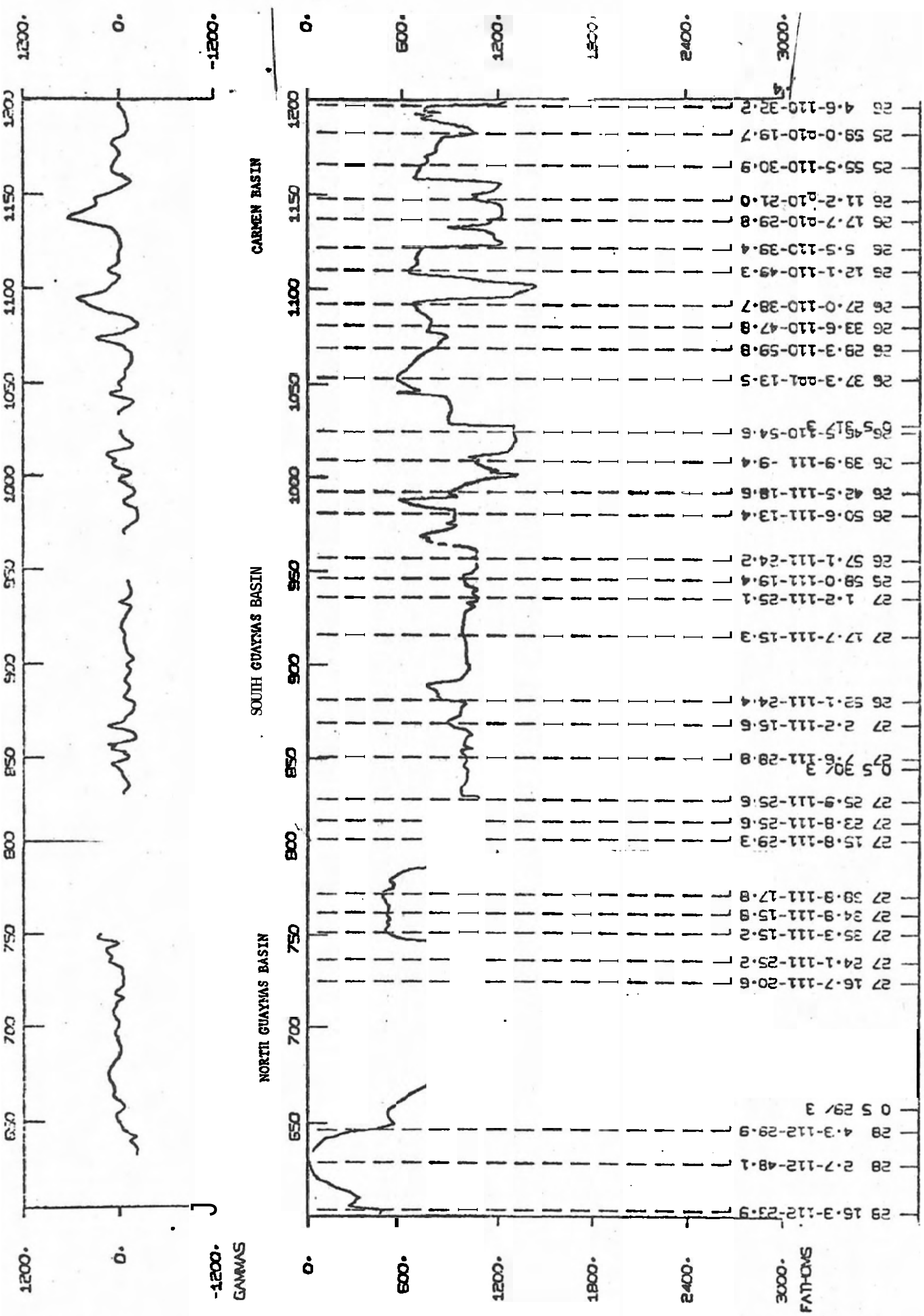
From Sharman and Ritter (1973)

BATHYMETRIC AND MAGNETIC PROFILES



From Sharman and Ritter (1973)

BATHYMETRIC AND MAGNETIC PROFILES



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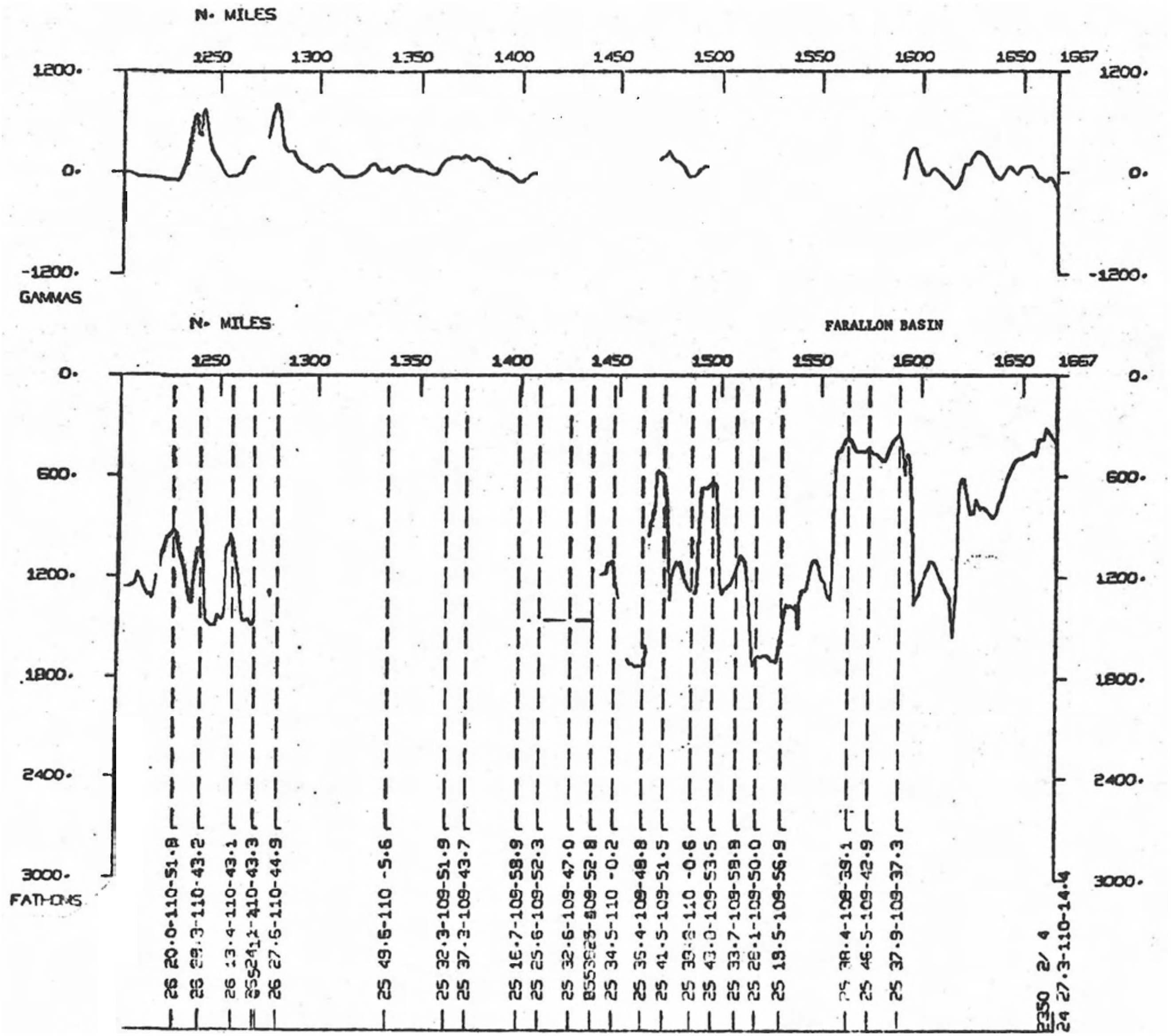
BATHYMETRIC AND MAGNETIC PROFILES



From Sharman and Ritter (1973)

25 March Saturday - Left San Felipe after exchanging part of scientific party, new scientific party as follows:

Pat Wilde - I.M.R. U.C. Berkeley, Chief Scientist
George Sharman - S.I.O. Acting Ships Technician
George Hohnhaus - S.I.O. Principal Technical - Coring Fantail Operations
Michael Hausman - S.I.O. Technician
Len Cuningham - S.I.O. Principal Technical - Hydrocast
Mark Waldorf - S.I.O. Technician - Hydrocast
Jim Rodgers - S.I.O. Technician - Heat Flow
Lawrence Lawver - S.I.O. Technician - Heat Flow
Derek Manov - U.S.C. Technician - Heat Flow
Arthur Henry - S.I.O. Technician - Computer
Jim Ott - S.I.O. Technician - Computer
Ugo Conti - U.C. Berkeley Scientist
Robert Corwin - U.C. Berkeley Scientist
Pedro De Alba - U.C. Berkeley Scientist
Hugh Bradner - S.I.O. Scientist - Seismic
A Hava - S.I.O. Scientist - Seismic
Ian Reid - S.I.O. Scientist - Seismic
Michael Reichle - S.I.O. Scientist - Seismic
Michael Marlow - U.S.G.S. Technicians - Gravity
John Lee - U.S.G.S. technicians - Gravity
Colin Brewitt-Taylor - Cambridge Univ. - Scientist - Self Potential
Martin Goldhaber - U.C.L.A. - Scientist - Interstitial Water
Emil Kalil - UCLA - Scientist - Interstitial Water
Frank Haberaka - S.I.O. - Technician Airgun
Robert Byrnes - S.I.O. - Technician Airgun

In order to traverse the straits between the Baja Mainland and Isla De La Guardia and the Sal Si Puedes during day light we surveyed the Northern end of the Gulf.

26 March Sunday

Surveyed the straits doing square patterns running parallel to the coast for 1/2 hour then running perpendicular to the coast until we encountered 100 fathoms or came within a mile of the coast. This pattern enabled us to get air gun records at essentially right angles to Moore's previous track. Just south of Isla De La Guardia we ran out into the open gulf for one jog coming back in very shoal water. Finished survey south of Sal Si Puedes Islands then stepped out into Gulf then west, then north, to survey a line down the center of the basin to find deepest point arriving there approximately dawn.

27 March Monday

Began sampling program in Sal Si Puedes basin. Basic philosophy was to sampling in a diamond pattern with center of diamond in deepest part.

The long axis of the diamond would be along the long axis of the basin. At the center we would take a hydrocast, a large diameter gravity core (a Karig piston core without the piston) and a hear flow. At the two end points along the long axis we would take long barrel gravity cores and at the and points along the short axis, heat flow stations.

If we found hot brines this pattern would be used and the diamond expanded depending on the size of the basin. The diamond sampling pattern was tested in the Sal Si Puedes basin to familiarize the crew with the operation and also to test the sampling gear.

As the USC heat probe was not ready for the diamond center sampling, 20 HC, 21 G, and 22 HF were taken at the center of the basin. Station 23G and 25G were token at the long axis ends. Station 24HFC (heat flow with a gravity core) on the west side of the basin missed the narrow sediment target. The barrel broke at the weld and two thermistors were lost. However, a safety chain between the barrel and the weight stand held preventing complete loss of the thermistor vanes. According to G. Hohnhaus the weld was faulty. However, the jury-rigged construction of the probe particularly the placing of the thermistor vanes in a spiral so that during pull-out the tendency was to unscrew the barrel from the weight stand did not fill the fan tail observers with awe as to the technical design. Because of the temporary loss of the gravity core heat probe and the apparent lack of sediment on the east side of Sal Si Puedes a Scripps heat flow probe Sta 26HF was used at the same location as Station 25G at the north end of the basin. For the eastern station a dredge Sta 27D was substituted for the heat flow station.

28 March Tuesday

After the dredge station we made for the north end of Guaymas basin first to anchor three transmitting buoys for the seismic people to listen for earthquakes, then to take a hydrocast, gravity core and heat flow in the center deep of North Guaymas basin.

After breakfast we had to stop to repair a salt water pump so made for the protected anchorage of San Juan Bautista Bay. Corwin and Conti went ashore here for a resistivity survey along the beach. The pump was fixed by lunch so we continued a tho Guaymas basin. On Leg I we already had heat flow and a preliminary hydrocast in the Guaymas basin. The basin has a central high with no sediment surrounded by thick sediment. The uppermost layer unfortunately is acoustically transparent which we found when we lowered the temperature telemetering pinger plus one water sampling bottle on top of it believing we had ten fathoms to go which the pinger showed.

29 March Wednesday

We encountered the same layer again in Sta 29HC as the bottom Niskin bottle had green muddy water plus globs of green mud on the outside. Stations 30G and 31HFG were taken at the same location as 29HC. This time with plenty of sediment and a good weld the U.S.C. heat probe worked well although Manov felt the value was questionable. We were operating with great efficiency so then went to South Guaymas basin which had not been surveyed during the first leg.

30 March Thursday

On Station 32 HC early in the morning before dawn in the center deep of south Guaymas basin. Also took St. 33G and 34 HFG at this location. Stepped off to the south for a dredge on the mouth wall of the basin recovered oily mud however. Completed work in Guaymas Basin. At this time seismic people were looking for a site to launch their recoverable bottom seismometer they abandoned initial plan of placing it at the Guaymas basin and decided for a location North of the Carmen basin. We dropped the seismometer then proceeded to Carmen basin for survey prior to sampling.

31 March Friday

Surveyed Carmen basin located deep and took Stations 37HC, 48G, 39HFC, and 40HF. As we were making good time, although not finding hot brines or metalliferous sediments, we decided to check the two heat flow system against each other by using both the Scripps' Bullard Probe and the U.S.C. thermistor vane gravity core at one location. The preliminary values showed agreement with the U.S.C. values lower. How good a test thin was with both participants knowing the test was being made is a moot question. It certainly demonstrated the reticence of heat flow people to produce a number directly from the field data. In this case the thermal conductivities were measured on the gravity core obtained with the USC Probe and not from the Scripps Finger Pilot Core.

1 April Saturday

A real April Fools' Day - the initial plan was to arrive at the north end of the Farallon basin just before dawn then go right down the long axis looking for sediment and the deepest part. From the surveys of Lez I we knew the bnoin was displaced to the northwest with respact to the old Gulf of California map (Rusnack and ochers. 1960). Thus at about 700 HRS PST we turned to run down the long axis. We ran deeper than 1700 fathoms for about 1½ hours and found sediment at either end. The basin floor in between was lumpy with very little sediment apparent on the air gun records. The deepest part of the basin apparently was at the southwest end so after coming out of the basin we slowed to retrieve the air gun and magnetometer prior to coming on station. However, once the genr was on board we could not maintain station. The wind was 20 to 30 knots out of the northwest and we thought was setting us to the South. After almost two hours of trying to find the sediment patch we gave up and heading towards the north end to sample that region at the base of the Continental Margin. We got back into the axis and stopped where the bottom was flat below 1700 FMS and lowered the hydro-east 41 HC. With about 2/3 of the wiro out Lea Cunninghan noticed the pinger traces were no longer diverging. Because of the relatively rough weather we had the pine for both 12 KH_z fathometers turned off to better see the crossings. The 3.5 KH fathometer was inoperative at this time. We checked (we thought) the depth on the CDR (by this tine the old PDR was rather unreliable), and found the bottom at the same place on the record. Unfortunately the ping was on continuous rather than gated programmed as it turned out the ship had drifted up slope almost exactly 800 fathoms so the bottoo appeared at the same place on the record. In our ignorance we continued lowering to the previous straight up-and-down depth in meters as it looked as if the pinger was inoperative. When we brought the hydrocast in, the thermometer rack on the 3rd bottle fron the bottom was gone, the next two bottles were disemboweled although the rack were intact and the pinger was hanging upside down secured only by the safety shackel. Obviously we had run the cast into the side of Che basin. With the large barrel gravity core scheduled next the main winch was on the line. However, we Could not readily find our wily back into the basin. There is the horrifying thought that the Melville sails into the wind as we always turned up on the wrong wall when trying to get back on station. For example by sailing northvest into the wind the botton shoaled instead of deepening which would be the case if we were set to the eouth and moved up the southeast side of the basin. me main engine was overheating so it was imperative we do something so we decided to dredge as we apparently could find the continental margin. The dredge saved the day. It contained serpentine, amphibolite, graywacke, phyllites a11 fresh vith no manganese stains or crusts. The amphibolite and phyllites had veins of white sulfides presumably pyrite. The graywacke had foraminifera and echinoid (?) plate fossils. After the dredge tho ship was turned over co Hugh Bradner's group to search for buoys left on the north west side of the Farallon basin and for a quiet shiy period (no air nuns etc) to facilitate listening for earth quakes.

2 April Sunday

Happy Easter! When I got up the captain informed me that the main engine problem was very serious such that the chief wished to head for La Paz for repairs. One cylinder had used over 100 gallons of lubricating oil in the past three days and still was periodically heating up. Bob Fish the chief engineer said that Enterprise (the builder of the engine had warned them tbat upping tbe rpms (previously the top speed has been about 10 knots instead of about 12.5 knots at the increased rpm of 360) might unseat one or several of the rings. So again we pay the price of Mar.Fac. penny-wise pound-foolish attitude towards maintenance. We searched for seismic buoys most of the morning homing in on what was thought to be an anchored buoy but turned out to be a sonobuoy which miraculously was close to the anchored buoy.. We now headed for La Paz hoping the engine holds vith periodic clouds of black smoke appearing particularly when we are at low rpn pulling in or putting out equipment. At the La Paz harbor entrance after pulling in the air guns and magnetometer the cylinder gave up the ghost blowing a beautiful smoke rlng then billowing black clouds of smoke - a gigantic cough then a large persistent smoke ring ala the old Camel cigarette sign to the tune of the ships alarm system ringing out a major engine casualty. The tide was apparently going out because with the "take home" engine (well named) we barely could make headway. We finally anchored off the La Paz fuel docks and cried to signal for a pilot but being Easter Sundny no hope until the morning.

3 April Monday

La Paz harbor anchored off the mnin dock during repairs on the main engine - liberty boats every two hours. The Dolphin chartered by Scripps biologist was in the harbor so was visited by Dr. Vacquier and party. The crew was chiefly interested in the activities at La Rancharita while the poor engine room crew worked around the clock. A Canadian navy ship in port acting the typical drunken sailor bit. Our boys held up wall beside them so no ugly American among the Melville crev.

4 April **Tuesday**

La Paz harbor **still** anchored **although** through the herculean **efforts** of Bob Fish and the **engine** room crew we got underway after dinner **with** a **new** piston. Most of the night **was** spent at lov **rpms** to break in the piston. The plan now **was** to go back to the **Farallon** basin redo the **hydrocast** and finish the sampling there then go on to the two Pescadero basins and be back on Friday for **Brune** and **Hawkins** to start **their leg.** As **the prime** targets of the **Guymas** and **Carmen** basins didn't yield hot **brines** or Red Sea typr **sediments we felt the last possible basin with** brine **potential** was the Pescadero. The **Mazatlan** basin to the **south** was actually **shoaler** and more open than the Pescadero so this basin was skipped on **leg** two knowing that Jim **Hawkins** planned to **work** more In **this area** on Leg III. This mean we temperature probed and took hydrocasts in seven basins **(eight hydrocasts** because of the duplication in **Farallon** basin) vhich is two more than projected by Craig **for** his **Helium sampling program.** Nso we **certainly** were **loery** of the **engine** as there vere seven more pistons to go.

5 April Wednesday

Since leaving La Paz on **Tuesday** night have **been steaming at 1/4 speed** to break in **new piston** for **about** 8 hours. **Headed** back to **North Farallon basin** to **redo hydrocast which we rammed** into **the wall. Took Stations** 44HC, 45G, and 46HFG **without** incident although the temperature teleme-**tering pinger was inoperative because the internal plugs** vere placed in **the wrong sockets. Thus** we **did** not **get** a temperature profile in this **basin.** As the **thermometers** on the Niskin bottles did not give any **anomalous temperatures, this lack** of temperature information war not critical. The **water from** the top **of 46HFG** vas not anomalous **and** the sediments **from** the two cores 45G and 46HFG were typical green muds. **We left the Farallon basin** in late after noon heading for a shallow **knoll** on **the** southern flank to take a shallow depth core for **Marty Goldhaber** to see if there vas any great chemical difference between the basin sediment and **that** outside the basins. Unfortunately we got **no recovery at all at Sta** 46C.

6 April Thursday

A very busy day **as** ve hope to sample both Pescadero basins in one day. **However,** the fates vere against us as during tho hydrocast 48HC in Sorth **Pescadero** basin the **hydrowinch** threw a loop **off the** drum. presumably Cur to a **malfunction** or **misalignment** of the level wind. **The** cast was completed successfully but we lost time.' The problem got **worse** on the **heat flow station** as the **wire was** not spooled back on the drum **properly. Again** ve **got** the sample but at a **terrible** loss of time. This meant we had to cancel **the** heat **flow** station. the dredge. and **the test** of **the Cambridge self-potential** system **at** South Pescadero basin. **After finishing** the **gravity** core **station** 50G ve made a dead run to **South Pescadero** basin and **were** able to finish tho **hydrocast 51HC** and the core **station 52C** before the 2200 **HRS** local deadline which was the **time** ve had **to leave** South Pcscadero basin to make La **Paz** at 0800 **HRS** La Pat **time on Friday to turn the ship over** to **Brune** and **Hawkins.**

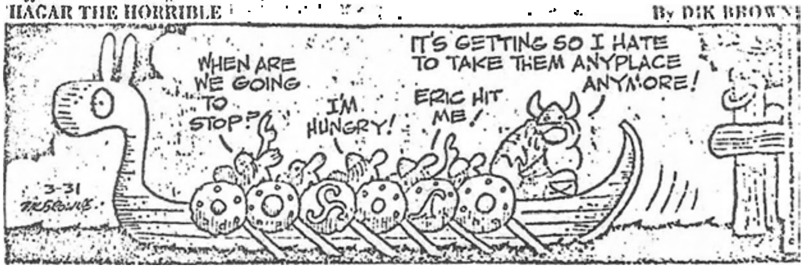
7 April Friday

Back in La **Paz** at the **fuel** docks by 0800. To save time the agent **brought** the **new** crew members out to the ship by small boat and the people were exchanged with the usual **confusion.**

General Comments

It was **disappointing** of course not to find the hot brines or sulfide **rich sediments however I** think **we** looked in **all** of the likely **locations.** The gear worked very well and the station operations vent **smoothly after** the usual breaking-in problems particularly vith the **combined** heat-flow **gravity** core apparatus. The scientific party worked very **hard** particularly the **station crews** because of the **high number** of stations. 27 stations in 11 working days. **A** valid complaint of the **students** on board **was** that their lack **of** real participation in the physical or manual aspects of the stations because most of the work was **done** by the highly qualified technicians. **This** certainly **is** a **dilemma** because one **wishes** to **train** rtudents but also **wishes** to get the job done **fast** and correctly without loss **of** equipment or injury to anyone. **With** such a large **scientific** party (25) and with a multiplicity **of programs** to be done **in** really **a limited** amount of time **I** decided to lot the **professionals** tnkc o er the **stations.** One horrible difficulty **I** had as chief **scientist was** to actually do my own work. Tha job was more like **that** of an orchestra leader **cueing** in **the** various **station** opcratlons.

HAGAR THE HORRIBLE By DIK BROWNE



SAMPLE LOG

WATER CHEMISTRY-PAT WILDE, DEPT. CIVIL ENGINEERING, UCB

TIME GMT	DATE D.M.Y.	TIME LOC	TZ LOC	SAMP CODE	SAMPLE IDENT.	SEQ. NUM.	DISP CODE	LAT.	LONG.	CRUISE LEG-SHIP
2250	23 372			HCNI	HYPO 17HC	1995	PXW	27 274N	111 233W	S HYPO MV
1645	27 372			HCNI	HYPO 20HC	1543	PXW	28 424N	113 3Y	S HYPO MV
1610	29 372			HCNI	HYPO 29HC	1969	PXW	27 237N	111 264 F	S HYPO MV
1020	30 372			HCNI	HYPO 32HC	1976	PXW	26 598N	111 246W	S HYPO MV
2332	30 372			HCNI	HYPO 37HC	2708	PXW	26 468N	110 557W	S HYPO MV
2200	1 472			HCNI	HYPO 41HC	3150	PXW	25 356N	109 467W	S HYPO MV
2020	5 472			HCNI	HYPO 44HC	3170	PXH	25 317N	109 506W	S HYPO MV
1247	6 472			HCNI	HYPO 48HC	3661	PXW	24 417N	109 86W	S HYPO MV
153	7 472			HCNI	HYPO 51HC	3795	PXW	23 587N	108 503W	S HYPO MV

*** CORES ***

TIME GMT	DATE D.M.Y.	TIME LOC	TZ LOC	SAMP CODE	SAMPLE IDENT.	SEQ. NUM.	DISP CODE	LAT.	LONG.	CRUISE LEG-SHIP
2053	20 372			C GK	HYPO 7G	2230	PXW	25 274N	109 447W	S HYPO MV
508	23 372			C GK	HYPO 11G	2000	PXW	27 274N	111 224W	S HYPO MV
1759	27 372			C GK	HYPO 21G	1534	PXW	28 425N	113 3W	S HYPO MV
2149	27 372			C GK	HYPO 23G	1274	PXW	28 361N	112 538W	S HYPO MV
217	28 372			C GK	HYPO 25G	1314	PXW	28 475N	113 52W	S HYPO MV
1832	29 372			C GK	HYPO 30GC	1969	PXW	27 231N	111 268W	S HYPO MV
1231	30 372			C GK	HYPO 33G	1949	PXW	26 574N	111 246W	S H PO MV
125	1 472			C GK	HYPO 38G	2727	PXW	26 232N	110 444W	S HYM MV
2303	5 472			C GK	HYPO 45G	3179	PXW	25 310N	109 492W	S HYPO MV
546	6 472			C GK	HYPO 47G	0000	PXW	25 50N	109 462W	S HYPO MV
1751	6 472			C GK	HYPO 50G	3361	PXW	24 421N	109 102W	S HYPO MV
415	7 472			C CK	HYPO 52G	3795	PXW	23 594N	108 510 F	S HYPO MV
303	13 472			C GK	HYPO 62G	1679	PXW	26 486N	110 523W	S HYM MV
1533	13 472			C GK	HYPO 63G	1968	PXH	27 276N	111 241W	S HYPO MV
2330	27 372			C G	HYPO 24HFG	0	PXH	28 411N	113 16	S HYPO MV.
2109	29 372			C G	HYPO 31HFG	1969	PXW	27 252N	111 258W	S HYPO MV.
1355	30 372			C G	HYPO 34HFG	1988	PXW	26 581N	111 256W	S HYPO MV
300	1 472			C G	HYPO 39HFG	2708	PXW	26 231N	110 447W	S HYPO MV
38	6 472			C G	HYPO 46HFG	3225	PXW	25 291N	109 500W	S HYPO MV
1751	6 472			C G	HYPO 49HFG	3361	PXW	24 421N	109 102W	S HYPO MV
1535	9 472			C G	HYPO 57HFG	2220	PXW	25 224N	109 394W	S HYPO MV
901	10 472			C G	HYPO 59HFG	2345	PXW	25 401N	110 0W	S HYPO MV
320	15 472			C G	HYPO 67HFG	2436	PXW	23 479N	109 69W	S HYPO MV
38	16 472			C G	HYPO 70HFG	1957	PXW	22 433N	107 126W	S 88PO MV

From Smith (1972)

STATIONS

Sta #	Position LAT	LONG	PIX	Type of Station	Locality	depth	Comments	Date
20HC	28' 38.6'W	112' 57.0W	RAD	Hydrocast with temp tele. Pinger	Center Snl 81 Puedea Basin	844	Nine bottlo cast Temp at bottom 10.5°C	27 Mar 1613-1720Z
210	"	"		Karin Corer without piston	"	838	384cm Green sandy mud	27 Mar 1733-1823
22HF	"	"		Bullard Probe	"	838	15°Tilt HP less than 2	27 Mar 1905-2025
23G	28° 36.8'N	112° 51.1	DR	Karig Corer without piston	South Sal Si Puedes Basin	696	120cm green mud with silty sand	27 Mar 2126-2212Z
24HFG	28° 43.9'N	113° 04.8'W		S.C. heat probe with gravity core10'	Bench on West side Sal Si P.	570	Core barral broke at topweld-assorted pebbles in catcher	27 Mar 2323-2425
25G	28° 43.2'N	113° 05.4'W		Karig Corer without piston	North Sal Si Puedes Basin	718	310cm green mud	28 Mar 0155-0250
26HF	28° 43.9'N	113° 04.8'W		Bullard Probe	North Sal Si Puedes Basin	720	HF extremely lw less than 1	28 Mar 0255-0400
27D	28° 44'N	113° 02'W		Dredge	East Scarp Sal Si Puedes Bas.	792-320	Basalt. pumice Mn coatings no fresh fragments	28 Mar 0426-0630
28S	27° 37'N	111° 17'W		Seismic	North Guymas Basin	530	Anchor 3 transmitting hydro-phones	29 Mar 1000-1200
29HC	27° 23.3'N	111° 26.6'W		Hydrocast	North Guymas Basin	1076	9 bottle cast	29 Hsr 1610
30G	27° 23.0'N	111° 26.9'W		Karig Corer without piston	North Guymas Basin	1076	362cm brom green mud	29 Mar 1801-1900
31HFG	27° 24.7'N	111° 26.4W	RAD	USC Heat Probe gravity core	"	1087	87cm green brown mud ~~AF value questionable~~	29 War 2000-2215
32HC	26° 59.4'N	111° 26.0'W		Hydrocast with ttp	South Guymas Basin	1080	9 bottles	30 Mar 1020-1145
33G	26° 57.2'N	111° 24.3'W		Karig Corer without piston	"	1065	309cm green mud	30 Mar 1200-1304
34HFG	26° 58.2'N	111° 25.6'W		USC Heat Probe gravity core	"	1085	155cm green brawn mud AF medium 2 to 4	30 Mar 1335-1441
35D	26° 54.3'N	111° 27.0'W	DR	Dredge	South end Guymas Basin	1020-800 FMS	Mud	30 Mar 1500-1720Z
36S	26° 46'N	110° 55'W		Drop bottom seis-mometer	North of Carmen Basin	905		30 Mar 122502
37HC	26° 23.3'N	110° 43.9'W		Hydrocast with tt Pinger	Carmen Basin	1480	9 bottles	31 Mar/1 Apr 2235-0020
38G	26° 23.2'N	110° 44.7'W		Karig Corer without piston	Carmen Basin	1490	306cm 10cm brown mud • rest dark green mud. Temp mud on deck 8°C	1 Apr 0042-0208
39HFG	26° 23.1N 110° 44.8'W		STAR	USC Heat Probe with gravity	Carmen Basin	1480	112cm green black mud HF medium 2-4	1 Apr 0215-0358
40HF	26° 23.2'N	110° 44.5'W		Bullard Probe	Carmen Basin	1484	HF approximately 4	1 Apr 0355-0540
41HC	25° 36.0'N	109° 42.0'W		Hydrocast with ttp	North end Farallon Basin	1726	9 Niskin bottles - string drifted into north wall dis-abled pingcr-lost 1 rack thermometers front 7 btls ok	1 Apr 2100-2315
42D	25° 35.2'N	109' 47.4'W		Dredge	North end Farallon Basin	1730	Mafic rocks - serpentine Amphbolited (pyrite) gray wacke with forms lithic Mn coatings	02Apr 0235 -
43S	25°38'N 109°44'W			Buoy recovery	North west side Farallon	363	None recovered	2/3 Apr 1400-1600Z
44HC	25' 31.6N	109' 49.1'W	SAT	Hydrocast	Farallon Basin	1735	3 bottles shallowcast 9 bottles dcop east ttp mis aligned	5 Apr 1900-2142
45G	25° 30.8'N	109° 49.6'W	SAT	Karig Corer without piston	Farallon Basin	1736	290cm gray-green mud	5 Apr 2212-2350Z
46HFG	25° 31.1N	109' 49.7'W	SAT	USC Probe with gravity	Farallon Basin	1738	167cm green mud - brown layer with worm borings at top (to UCB restivity menu.)	5/6 Apr 2358-0255
47G	25' 05.2'N	109' 46'W	SAT	Karig Corer without piston	Knoll S.W. of Farallon Basin	580	No recovery	6 Apr 0520-0610
48HC	24° 41.8'N	109° 09.9'W		Hydrocast with tt Pinger	North Pescadero Basin	1800	1st cast 4 bottlcn 2nd cast 8 bottles Bottom temp. 1.5°C	6 Apr 1120-1354
49HFG	24° 41.8'N	109° 09.9'W		USC Heat Probe with gravity core	North Pescadero Basin	1800	71cm green mud HF less than 2	6 Apr 1438-1650
50G	24° 41.8'N	109° 09.9'W	SAT	Karig Corer with-out piston	North Pesca-dero Basin	1800	326cm green mud brownish at top	6 Apr 1659-1830Z
51HC	23° 58.6'N	108° 50.4'W	SAT	Hydrocast with tt Pinger	South Pesca-dero Basin	2030	2 casts 1st 4 bottles 2nd 9 bottles - surface temp. 22°C, bottom temp. 1.5°C	6/7 Apr 2320-0310
52G	23° 54.5'N	108° 51.1'W	SAT	Karig Corer with-out piston	South Pesca-dero Basin	2030	277 cm green mud	7 Apr 0317-0500

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R. Corwin
P. De Alba

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Interstitial Chemistry

M. Goldhaber
E. Kalil

Measurement of Pore Fluids of Sediments

Heat Flow

L. Lawver
J. Rodgers } Bullard Probe

Derek Manov - USC Probe

Helium

L. Cunningham
M. Waldorf

Underway Records

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M. Hausman

Seismic

Hugh Bradner
A. Nava
Ian Reid
M. Reichle

Sonobuoys - bottom seismometer

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J. Ott IBM
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Airgun

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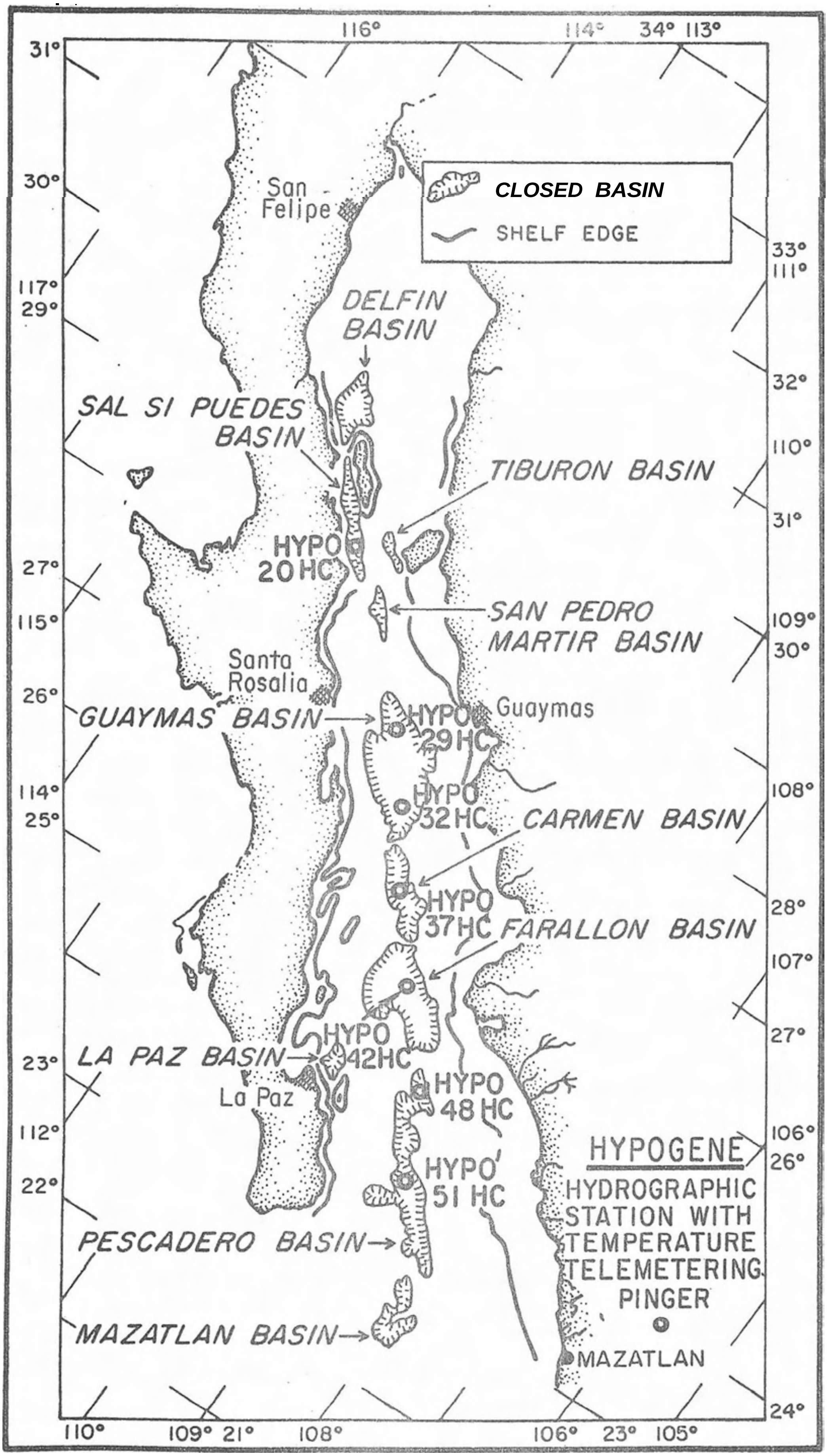
INDEX MAP OF HYDROGRAPHIC STATIONS



Base Map from Van Andel (1.904)

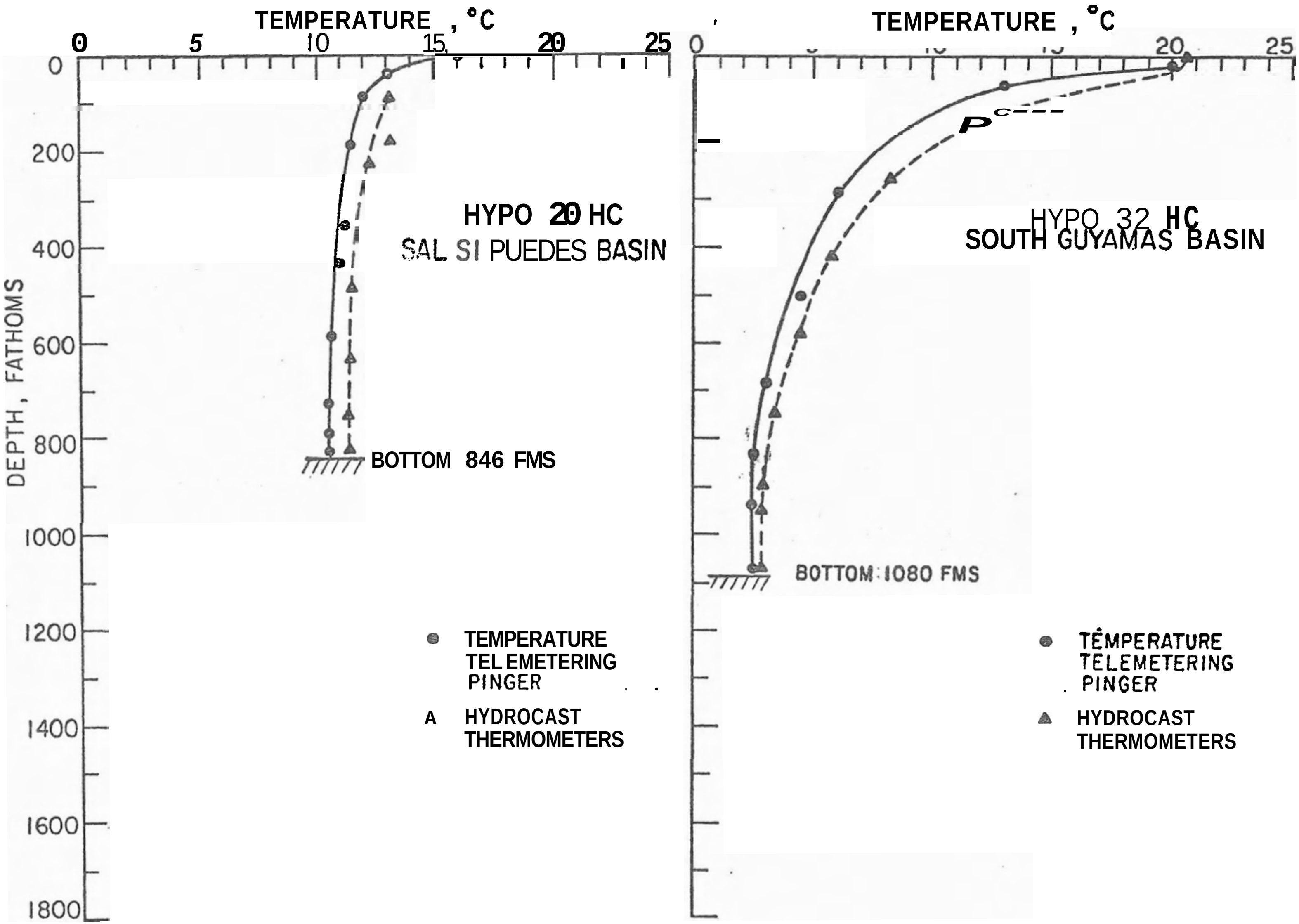
TEMPERATURE AND SALINITY

FROM HYDROCASTS

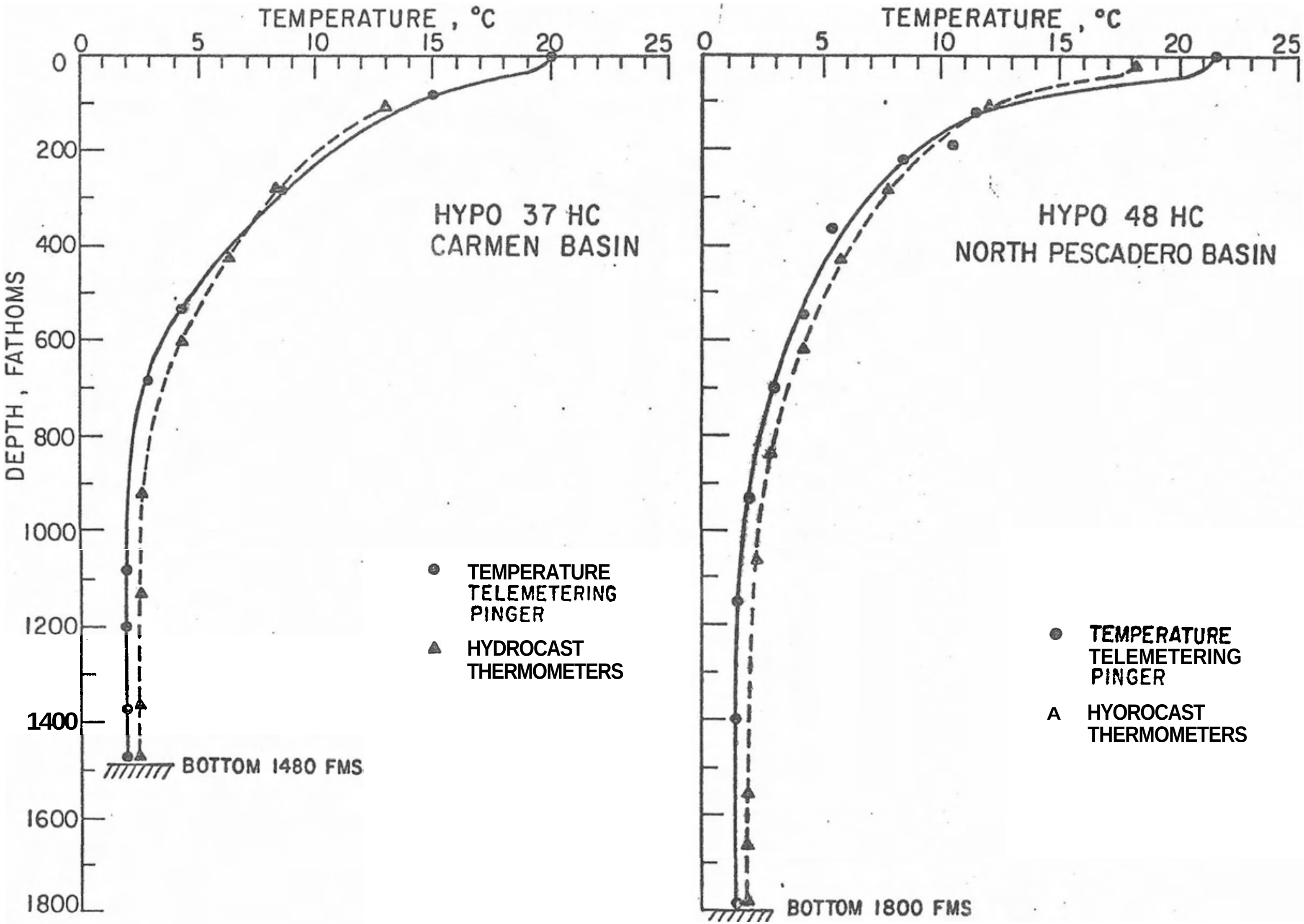
L. Cunningham and M. Waldorf: Analysts

STATION	BASIN	DEPTH[1] METERS	DEPTH FATHOMS	TEMPERATURE[2] °CENTRIGRADE	SALINITY[3] ‰
HYPO 20HC	Sal Si Puedes	175	95.6	13.16	35.049
		425	232.2	12.33	34.938
		875	478.1	11.58	34.862
		1175	642.1	11.42	34.830
		1375	751.4	11.36	34.815
		1525	833.3	11.34	34.814
HYPO 29HC	Guaymas North Deep	20	10.9	20.63	35.302
		300	163.9	11.41	34.768
		500	273.2	8.24	34.584
		800	437.2	5.63	34.522
		1100	601.2	4.24	34.547
		1400	765.0	3.34	34.583
		1670	912.6	2.92	34.604
		1900	1038.3	2.90	34.607
(sediment in sample)'		2000	1092.9	2.92	34.594
HYPO 32HC	Guaymas South Deep	14	7.7	20.74	35.307
		272	148.6	11.94	34.870
		472	257.9	8.29	34.592
		772	421.9	5.80	34.535
		1072	585.8	4.42	34.553
		1372	749.7	3.44	34.589
		1642	897.3	2.95	34.614
		1872	1022.9	2.92	34.618
		1972	1077.6	2.92	34.618
HYPO 37HC	Carmen	200	109.3	12.72	34.930
		500	273.2	8.30	34.600
		800	437.2	6.30	34.543
		1100	601.1	4.40	34.560
		1400	765.0	---	34.595
		1700	928.9	2.73	34.624
		2100	1147.5	2.55	34.634
		2500	1366.1	2.56	34.637
		2700	1475.4	2.59	34.638
HYPO 41HC	Farallon	50	27.3	17.80	35.102
		200	109.3	12.24	34.820
		500	273.2	8.11	34.578
		800	437.2	5.68	34.534
		1100	601.1	4.22	34.714
		1400	765.0	3.36	34.597
		1700	928.9	2.64	34.629
		2000	1092.9	2.39	34.641
		2300	1256.8	2.32	34.647
HYPO 44HC	Farallon	50	27.3	17.74	35.190
		200	109.3	12.29	34.818
		500	273.2	8.50	34.611
		750	B09.8	5.09	34.526
		1050	573.8	4.30	34.554
(Questionable value temperature anomaly)		1350	737.7	3.66	34.586
		1650	901.1	3.84	34.618
		1950	1065.6	---	34.634
		2250	1229.5	2.32	34.638
		2600	1420.8	2.31	34.639
		2950	1612.0	2.34	34.639
		3150	1721.3	2.36	34.647
HYPO 48HC	North Pescadero	50	27.3	18.14	34.996
		200	109.3	12.12	34.772
		500	273.2	7.92	34.942
		800	437.2	5.78	34.518
		1150	628.4	4.13	34.554
		1550	846.4	2.99	34.602
		1950	1065.6	2.20	34.636
(Questionable values Temperature anomaly) {		2250	1230.2	3 02	34.655
		2550	1394.2	2.41	34.654
		2850	1557.4	1.90	34.652
		3050	1666.6	1.90	34.654
		3250	1775.9	1.92	34.652
HYPO 51HC	South Pescadero	50	27.3	18.00	35.076
		200	109.3	11.23	34.736
		500	273.2	7.08	34.536
		800	437.2	5.44	34.524
		1200	655.7	3.82	34.573
		1600	874.3	2.96	34.612
		2000	1092.9	2.08	34.654
		2300	1256.8	1.88	34.666
		2600	1420.8	1.88	34.666
		2900	1584.7	1.87	34.668
		3200	1748.6	1.89	34.670
		3500	1925.7	1.92	34.670
		3700	2021.9	1.93	34.674

1. Depth by wire measurement. Less than 5° wire angle
2. Temperature - by calibrated reversing thermometers
3. Salinity - samples drawn from 5 and 30 liter Niskin@ bottles. Measurement on Hytech Model 6220 Salinometer



TEMPERATURE TELEMETERING PINGER DATA



TEMPERATURE TELEMETERING PINGER DATA

ANALYSIS OF SEAWATER SAMPLES

FROM GULF OF CALIFORNIA

FOR Na^+ Mg^{++} Ca^{++} K^+

~~Procedure:~~

analysis was made using **Perkin-Elmer** model 2908 Atomic **Absorption** Spectrophotometer

machine settings used:

Sodium: **oxidizing** flame. **7Å** slit width. 781 λ **setting** 0.8 **mg/L** ≈ **37%A.** linear up to **1mg/L 1000 ppm** K+ enhances **sensitivity. 2"** single slot burner

Magnesium: oxidizing **flame.** 7Å slit width. 210 λ setting 0.3 **mg/L** ≈ **37%A.** linear up to 0.5 **mg/L 1000** ppm La^{+3} enhances **sensitivity.** 2" **single** slot burner.

Calcium: reducing flame. **7Å** slit width. 459 a setting 4 mg/L ≈ 40 %A. linear up to 7 **mg/L 1000** ppm La^{+3} enhances **sensitivity.** 4" triple slot burner.

Potassium: **oxidizing** flame. **20Å** slit width. 1168 λ setting 2mg/L ≈ **50%A.** linear up to 2 **mg/L 1000 ppm** Na+ enhances sensitivity. 7" single slot burner.

Seawater Standard **Solution:** (sw standard)

preparation: transfer 0.999 gm $CaCO_3$, 2.074 gm MgO, 1.414 gm* K_2CO_3, 25.41 gm NaCl to 1 L flask. Dissolve **in** minimum volume HCl(1+1) **(about** 350 **mls).** Dilute to 1 L **with** H_2O.

***note:** for **Seawater Standard** Solution 0.707 gm K_2CO_3 **should** be used in order to get a final concentration of 600 **mg/L** K^+

standard concentrations:	approx. values in seawater(19CL)
10,000 mg/L Na+	10,550 ppm Na+
1.250 mg/L Mg++	1.270 ppm Mg++
400 mg/L Ca++	400 ppm Ca++
800 mg/L K+	380 ppm Kt

preparation of Sodium **standards** and samples

standards:

1 mg/L Na^+ - dilute sw standard 1 → **10,000**
20λ sw standard diluted to 200 nls

4 mg/L Na^+ - dilute sw standard 1 → 25,009
20A sw standard **dilute** to 503 mls

Blank - deionized H_2O

*each of the above standards **contained** 1000ppm K^+ by adding appropriate volume of stock 5% K^+ solution (4 mls to 200 ml vol. 10 **mls** to **500 ml vol)**

samples:

high - dilute sw sample 1 → **12,500**
20λ sw sample **diluted** to 250 **mls**

low - dilute sw **sample** 1 → 25.000
20λ sw sample **diluted** to 500 **mls**

both of the **above samples** contained 1,000ppm K^+ by adding **appropriate volume** of stock 57 K^+ solution (5 **mls** to **250** ml vol. 10 **mls** to 503 **ml** vol)

preparation of **Magnesium** standards and **samples***

standards:

.5 mg/L Mg^{++} - dilute **sw** standard 1 → 2.500
100λ sw standard diluted to 250 **mls**

.25 **mg/L** Mg^{++} - dilute **sw** standard 1 → 5.000
50λ SW standard diluted to 250 mls

Blank - deionized water

***each** of the above standards containted **1000ppm** La^{+3} by **adding** approprlate volume of stock **5%** La^{+3} solution (5 mls to 250 ml volume)

samples:

high - dilute **sw sample** 1 → 3333
30λ sw sample diluted to 100 mls

low - dilute **sw** sample 1 → 5000
50λ sw sample diluted to 250 **mls**

both of the **above samples** contained **1,000ppm** La^{+3} by adding appropriate volume of stock **5%** La^{+3} solution (2 **mls** to 100 ml **vol, 5 mls** to 250 ml vol)

* one λ = one μ liter = 0.001 ml

preparation of Calcium standards and **samples**

standards:

6 **mg/L** Ca^{++} - dilute **sw** standard 1 → 66.66
3 mls **sw** standard diluted to 200 mls

4 mg/L Ca^{++} - **dilute** sw standard 1 → 100
2 mls **sw** standard diluted to 203 **mls**

Olank - **deionized** H_2O

*each of the above standards contained **1000** ppm La^{+3} by adding appropriate **volume** of stock 5% La^{+3} solution (4 mls to 200 ml vol)

samples:

high - dilute sw **sample** 1 → 100
2 mls **sw sample** diluted to **200 mls**

low - dilute **sw sample** 1 → 125
2 mls **sw** sample **diluted** to 250 **mls**

both of the above samples contained 1003 ppm La^{+3} by **adding** appropriate volume of stock **5%** La^{+3} solution (5 mls to 250 ml **vol,** 4 nls to 200 **ml** vol)

preparation of **Potassium** standards and samples

standards:

2 mg/L K+ - dilute sw standard 1 → 400
2ml sw **standard** diluted to 200 als

0.8 mg/L K+ - dilute sw standard 1 → 1000
2ml **sw standard** diluted to 500 **mls**

Blank - deionized H_2O

*each of the above standards contained **1000ppm** Na^+ by adding **appropriate** volume of Stock 5% Na^+ solution (10 mls to **500 ml vol, 4 mls to** 200 ml **vol)**

Samples:

high - dilute **sw** sample 1 → 250
1 ml sw sanple diluted to 250 **mls**

low - dilute sn **sample** 1 → 500
½ nl sw sample diluted to 250 **mls**

both of the above samples **contained 1000ppm** Na^+ by adding appropriate **volume** of stock **5%** Na^+ solution (5 **mls** to 250 **ml vol)**

Reading Procedure for standards and samples

1) 15 pairs of high/low samples were prepared from 15 cltrate sw samples (contained in citrate bottles)
2) 1 set of standards were prepared for each 15 pairs
3) each individual sample was read twice while each standard was read four times for each sample as follows:
   a) Blank, high and low standards read
   b) 5 pairs of high/low sanples read (10 readings total)
   c) Blank, htgh and low standards read
   d) Blank. htgh and low standards read (readjustment of the zero for Blank-only If necessary)
   e) Same five pairs of high/low samples read second time but in reverse order
   f) Blank, high and low standards read
   g) Repeat steps a)- f) for next 5 pairs of high/low samples.

      note: readings c) and f) were used for readings d) and a) If readjustment of the zero was not necessary.
4) readings were taken from a digital readout of millivolts and rounded off (averaged) to the nearest 0.05 mV. digital readout was to the nearest 0.1 mV.
5) in order to check on the accuracy of the values. ... appropriately diluted samples of Copenhagen seawater were read. It was assumed that the exact concentrations of tho elements in the COP sw were know because of Ditmarian Ratios and the known Chlorintty of ....

   Copenhagcn water (COP) CL = 19.375%

Controls-

-Copenhagen Water was used as a control (CL = 19,3752)
-The same sample was read at six different times during the analysis of each particular element.
-These values can be used as a reference of comparison assuming that Ditmer's Ratios hold up for Copenhagcn water.

FOR MAJOR ION TABLES: Values in RATIO column arc calculated by dividing (1) measured value in moles per liter by (2) ideal value in moles per liter assuming conservancy (Culkin end Cox, 1966).

LOCATION 28 38.6 N 112 57.0 W SAL SI PUEDES BASIN

EXPEDITION NAME	CAST NUMBER/TYPE
HYPO	20 HC

FOR MAJOR ION TABLES: **Values** in RATIO **column** are calculated by dividing (1) measured value in **moles** per liter by (2) ideal value in **moles** per liter assuming conservancy (Culkin and Cox, 1966).

DEPTH (METERS)	SALINITY (O/OO)	TEMPERATURE (DEG C.)	SODIUM (MOLES/LITER)	SODIUM (RATIO)	MAGNESIUM (MOLES/LITER)	MAGNESIUM (RATIO)	POTASSIUM (MOLES/LITER)	POTASSIUM (RATIO)	CALCIUM (MOLES/LITER)	CALCIUM (RATIO)
175.	35.05	13.2	.48215	1.00505	.06051	1.10748	.01153	1.10171	.01042	.98898
425.	34.94	12.3	.47366	.99054	.05970	1.09607	.01150	1.10250	001026	.97683
875.	34.86	11.6	.46974	.98466	.05970	1.09865	.01132	1.08846	.01024	.97766
1175.	34.83	11.4	.46647	.97868	.05986	1.10203	.01142	1.09913	.01024	.97815
1375.	34.82	11.4	.46974	.98582	.05941	1.09468	.01144	1.10085	.01024	.97881
1525.	34.81	11.3	.47039	.98748	.06019	1.10930	.01127	1.08451	.01024	.97947

LOCATION 27 23.3 N 111 26.6 W NORTH GUAYMAS BASIN

EXPEDITION NAME	CAST NUMBER/TYPE
HYPO	29 HC

DEPTH (METERS)	SALINITY (O/OO)	TEMPERATURE (DEG C.)	SODIUM (MOLES/LITER)	SODIUM (RATIO)	MAGNESIUM (MOLES/LITER)	MAGNESIUM (RATIO)	POTASSIUM (MOLES/LITER)	POTASSIUM (RATIO)	CALCIUM (MOLES/LITER)	CALCIUM (RATIO)
20.	35.10	20.6	.48529	1.03430	.06044	1.09813	.01119	1.06221	.01042	.98233
300.	34.77	11.4	.48529	1.01996	.05879	1.08484	.01119	1.07883	.01024	.98055
500.	34.58	8.2	.47489	1.00372	.05879	1.0909 5	.01114	1.07939	.01023	.98493
800.	34.52	5.6	.45101	.95496	.05807	1.07946	.01112	1.07993	.01027	99014
1100.	34.55	4.2	.47099	.99636	.05850	1.08657	00111.5	1.08182	.01028	.99041
1400.	34.58	3.3	.46376	.98020	05918	1.09825	.01112	1.07810	.01036	.99722
1670.	34.60	2.9	.45548	.96212	.05866	1.08788	.01105	1.07056	001036	.99663
1900.	34.t 1	2.9	.45802	.96722	.05818	1.07910	-01104	1.06886	.01034	.99449
2000.	34.59	2.9	.45930	.97048	.05882	1.09114	.01105	1.07088	.01032	.99323

LOCATION 26 59.4 N 111 26.0 W SOUTH GUAYMAS BASIN

EXPEDITION NAME	CAST NUMBER/TYPE
HYPO	32 HC

DEPTH (METERS)	SALINITY (O/OO)	TEMPERATURE (DEG C.)	SODIUM (MOLES/LITER)	SODIUM (RATIO)	MAGNESIUM (MOLES/LITER)	MAGNESIUM (RATIO)	POTASSIUM (MOLES/LITER)	POTASSIUM (RATIO)	CALCIUM (MOLES/LITER)	CALCIUM (RATIO)
14.	35.31	20.7	.47086	1.00324	.05979	1.08594	.01123	1.06565	.01046	.98592
272.	34.87	11.9	.47282	.99082	.05940	1.09284	.01140	1.09589	.01038	.99097
472.	34.59	8.3	.47412	1.00180	.05846	1.08457	.01123	1.08831	.01025	.98659
772.	34.54	5.8	.46695	.98812	.05850	1.08690	.01116	1.08296	.01024	.98668
1072.	34.55	4.4	.48194	1.01953	.05866	1.08947	.01125	1.09099	.01024	.98677
1372.	34.59	3.4	.46644	.98556	.05859	1.08698	.01112	1.07769	.01028	.98938
1642.	34.61	3.0	.46796	.98820	.05842	1.08314	.01160	1.12369	.01021	.98222
1872.	34.62	2.9	.46390	.97933	.05857	1.08600	.01135	1.09850	.01030	.99042
1972.	34.62	2.9	.47203	.99649	.05861	1.08639	.01132	1.09574	.01032	.99227

LOCATION 26 23.3 N 110 43.9 W CARMEN BASIN

EXPEDITION NAME HYPO — CAST NUMBER/TYPE 37 HC

DEPTH (METERS)	SALINITY (0/00)	TEMPERATURE (DEG C.)	SODIUM (MOLES/LITER)	SODIUM (RATIO)	MAGNESIUM (MOLES/LITER)	MAGNESIUM (RATIO)	POTASSIUM (MOLES/LITER)	POTASSIUM (RATIO)	CALCIUM (MOLES/LITER)	CALCIUM (RATIO)
200.	34.94	12.7	.48096	1.00582	.05873	1.07831	.01146	1.09913	.01031	.98185
500.	34.60	8.3	.46959	.99193	005834	1.08203	.01122	1.08672	.01025	.98584
800.	34.54	6.3	.47185	.99848	.05969	1.10898	.01117	1.08347	.01021	.98397
1100.	34.56	4.4	.48969	1.03562	.05946	1.10399	.01121	1.08699	.01026	.98785
1400.	34.60	-0.	.49537	1.04638	.05813	1.07815	.01127	1.09126	.01033	.99374
2100.	34.63	2.5	.48482	1.02320	.05833	1.08079	.01132	1.09584	.01029	.98914
2500.	34.64	2.6	.46698	.98525	.05702	1.05622	.01113	1.07700	.01012	.97253
2700.	34.64	2.6	.47961	1.01191	.05841	1.08199	.01130	1.09355	.01044	1.00358

LOCATION 25 36.0 N 109 42.0 W FARALLON BASIN

EXPEDITION NAME HYPO — CAST NUMBER/TYPE 41 HC

DEPTH (METERS)	SALINITY (0/00)	TEMPERATURE (DEG C.)	SODIUM (MOLES/LITER)	SODIUM (RATIO)	MAGNESIUM (MOLES/LITER)	MAGNESIUM (RATIO)	POTASSIUM (MOLES/LITER)	POTASSIUM (RATIO)	CALCIUM (MOLES/LITER)	CALCIUM (RATIO)
50.	35.10	17.8	.48207	1.00342	.03577	.65363	.01156	1.10334	.01041	.98644
200.	34.82	12.2	.49107	1.03059	.05965	1.09904	.01123	1.08089	.01041	.99458
500.	34.58	8.1	.45833	.96873	.05795	1.07545	.01078	1.04482	.01012	.97442
800.	34.53	5.7	.45328	.95947	.05938	1.10365	.01081	1.04933	.01029	.99172
1100.	34.71	4.2	.45580	.95969	.05934	1.09704	.01078	1.04080	.01030	.98756
1400.	34.60	3.4	.47539	1.00420	.05931	1.09988	.01093	1.05896	.01034	.99450
1700.	34.63	2.6	.46086	.97263	.05891	1.09154	.01090	1.05507	.01032	.99176
2000.	34.64	2.4	.47320	.99838	.05858	1.08513	.01087	1.05173	.01032	.99184
2300.	34.65	2.3	.47635	1.00473	.06000	1.11114	.01086	1.04995	.01040	.99922

LOCATION 25 31.6 N 109 49.1 W FARALLON BASIN

EXPEDITION NAME HYPO — CAST NUMBER/TYPE 44 HC

DEPTH (METERS)	SALINITY (0/00)	TEMPERATURE (DEG C.)	SODIUM (MOLES/LITER)	SODIUM (RATIO)	MAGNESIUM (MOLES/LITER)	MAGNESIUM (RATIO)	POTASSIUM (MOLES/LITER)	POTASSIUM (RATIO)	CALCIUM (MOLES/LITER)	CALCIUM (RATIO)
2250.	34.64	2.3	.47950	1.01167	.05818	1.07782	.01076	1.04145	.01039	.99803
2600.	34.64	23	.49588	1.04622	.05909	1.09464	.01061	1.02677	.01036	.99505
2950.	34.64	23	.50974	1.07546	.05870	1.08733	.01099	1.06340	.01041	1.00026
3150.	34.65	2.4	.50426	1.06359	.05767	1.06804	.01089	1.05289	.01035	.99401

LOCATION 24 41.8 N 109 09.9 W NORTH PESCADERO BASIN.

EXPEDITION NAME: HYPO — CAST NUMBER/ TYPE: 48 HC

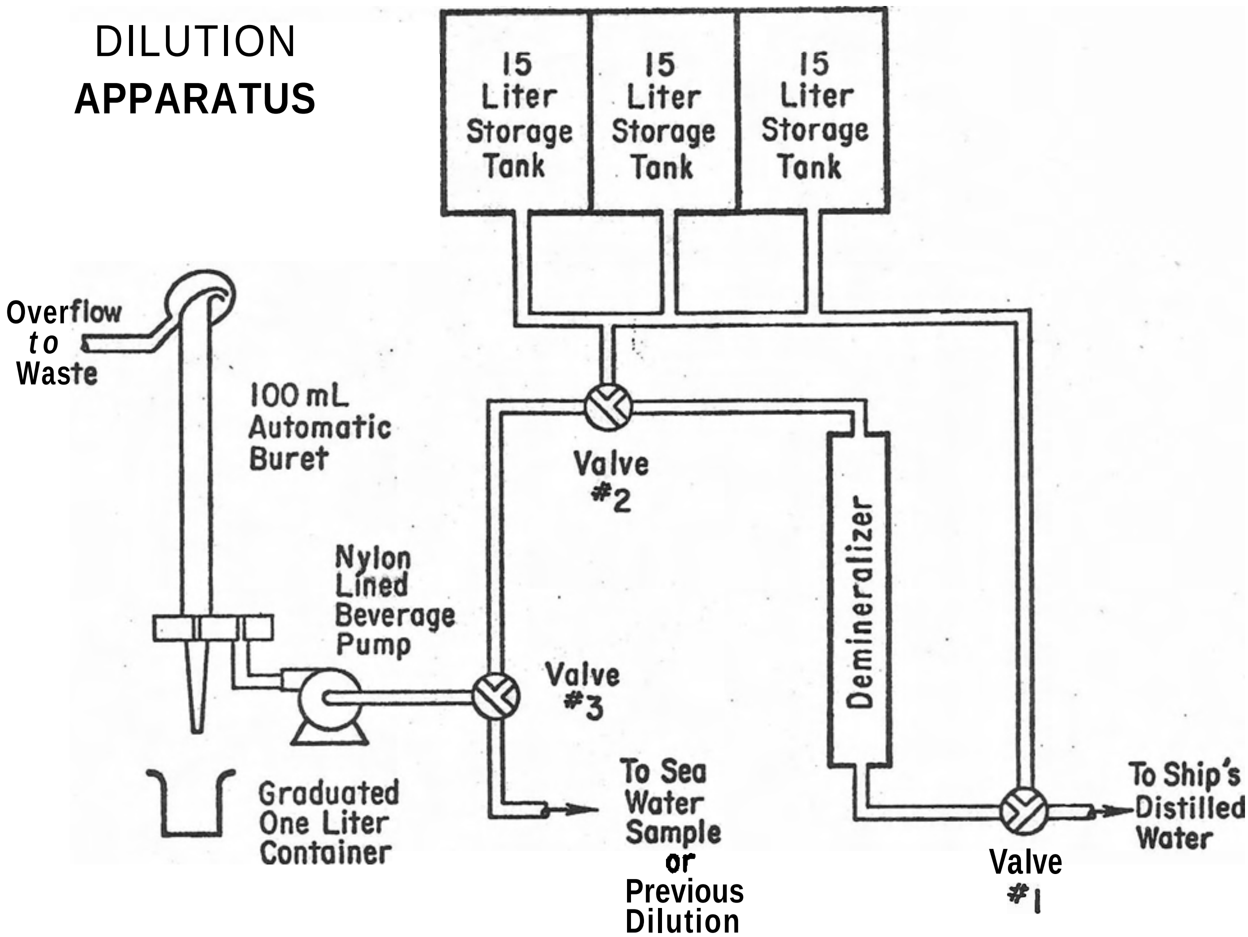
DEPTH (METERS)	SALINITY (0/00)	TEHPERATURE (DEG C.)	SCOIUM (MOLES/LITER)	SCOIUM (RATIO)	MAGNESIUM (MOLES/LITER)	MAGNESIUM (RATIO)	POTASSIUM (MOLES/LITER)	POTASSIUM (RATIO)	CALCIUM (MOLES/LITER)	CALCIUM (RATIO)
50.	35.00	18.1	.51302	1.07098	.05850	1.07227	.01093	1.04642	001045	,99377
200.	34.77	12.1	.51302	1.07825	.05740	1.05917	.01086	1.04626	.01041	.99679
500.	34.94	7.9	.50676	1.05977	.05740	1.05388	.01090	1.04537	.01035	.98551
800.	34.52	5.8	.51553	1.09156	.05858	1.08903	.01146	1.11235	.01035	.99781
1150.	34.55	4.1	.46885	.99185	.05878	1.09178	.01156	1.12095	.01009	.97210
1550.	34.60	3.0	.46492	.98206	.05874	1.08947	.01124	1.08921	.01035	.99533
1950.	34.64	2.2	.48263	1.01827	.05878	1.08887	.01122	1.08519	.01036	.99526
2250.	34.66	3.0	.46885	.98862	.05852	1.08337	.01116	1.07908	.01033	.99246
2550.	34.65	2.4	.52987	1.11761	.05901	1.09272	.01115	1.07885	.01037	.99578
2850.	34.65	1.9	.46283	.97621	.05831	1.07980	.01107	1.07076	.01033	.99210
3050.	34.65	1.9	.47063	.99267	.05907	1.09382	.01103	1.06671	.01034	.99357
3250.	34.65	1.9	.47063	.99267	.05846	1.08260	.01120	1.08290	.01026	.98584

LOCATION 23 59.6 N 108 50.4 W SOUTH PESCADERO BASIN

EXPEDITION NAYE: HYPO — CAST NUMBER/TYPE: 51 HC

DEPTH (METERS)	SALINITY (0/00)	TEMPERATURE (DEG C.)	SODIUM (MOLES/LITER)	SODIUM (RATIO)	MAGNESIUM (MOLES/LITER)	MAGNESIUM (RATIO)	POTASSIUM (MOLES/LITER)	POTASSIUM (RATIO)	CALCIUM (MOLES/LITER)	CALCIUM (RATIO)
50.	35.74	18.0	.47018	.97924	.05967	1.09118	.01133	1.08220	.01014	.94365
200.	34.54	11.2	.47811	1.00576	.05862	1.08274	.01136	1.09592	.01008	.97113
500.	34.52	7.1	.48141	1.01872	.05812	1.07980	.01111	1.07904	.01004	.96799
800.	34.57	5.4	.47679	1.00953	.05795	1.07732	.01120	1.08729	.00994	.95751
1200.	34.61	3.8	.47092	.99563	.05984	1.11081	.01089	1.05558	.01018	.97874
1600.	34.65	[illegible]	.48335	1.02071	.05864	1.08724	.01142	1.10545	.01018	.97800
2000.	34.67	2.1	.47026	.99189	.06066	1.12338	.01140	1.10266	.01028	.98731
2300.	34.67	1.9	.48270	1.01752	.06121	1.13285	.01123	1.08573	.01021	.98030
2600.	34.67	1.9	.48205	1.01614	.05906	1.09310	.01116	1.07833	.01001	.96052
2900.	34.67	1.9	.48717	1.02090	.05853	1.08326	.01118	1.08043	.01014	.97309
3200.	34.67	1.9	.45328	.95549	.05798	1.07304	.01121	1.08336	.00999	.95925
3500.	34.67	1.9	.47544	1.00221	.05878	1.08798	.01121	1.08336	.01018	.97770
3700.	34.67	1.9	.47870	1.00908	.05887	1.08955	.01136	1.09800	.01018	.97728

DILUTION APPARATUS



Dilution Technique

A. Water from either a 5 or 30 liter Niskin® bottle was permitted to come to laboratory ambient temperature

B. The valves of the system (Fig. 4) were met as follows: Valve (1) closed; Valve (2) closed; Valve (3) open to sea water and open to pump

C. The constant volume buret was flushed with the sample

D. One filling of the buret vam discharged into the appropriately marked container. Each container van marked at 100 ml intervals to prevent miscounting of the number of dilutions.

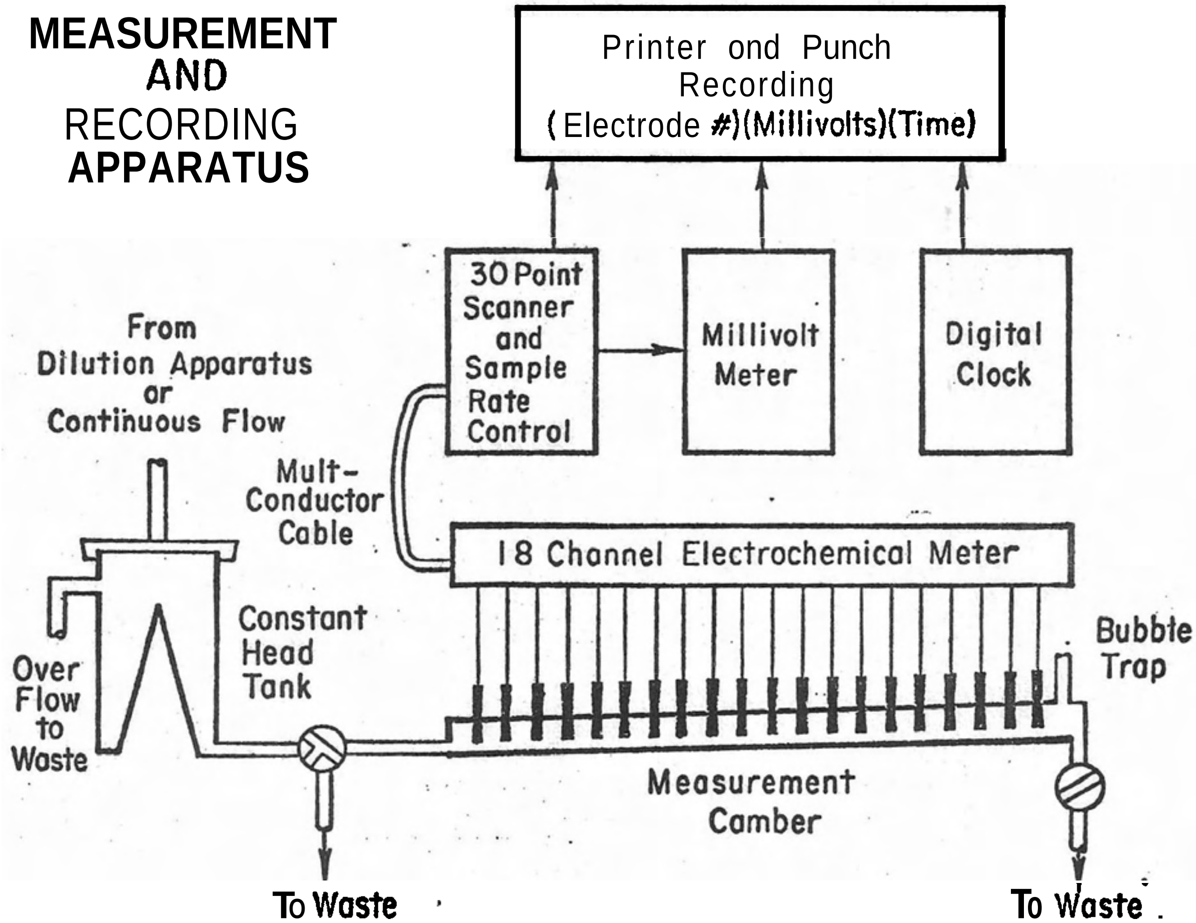
E. The valves were now set as follows: Valve (1) open to storage tank. open to demineralizer, closed to ship's water; Valve (2) closed to storage tank, open to Valve (3); Valve (3) closed to sea water, open to Valve (2). open to pump.

F. The constant volume butet was flushed with double demineralized distilled water.

G. Nine fillings of the 'buret vith distilled water were discharged into the container. Thus the fluid in the container was 0.1 by volume of the concentration of the initial shot (step D) .

The procedure was repeated using an aliquot from the previous dilution as the sample. In aucb manner dilutions of 0.1, 0.01, 0.001, and 0.0001 were obtained to be measured in the electrode chamber.

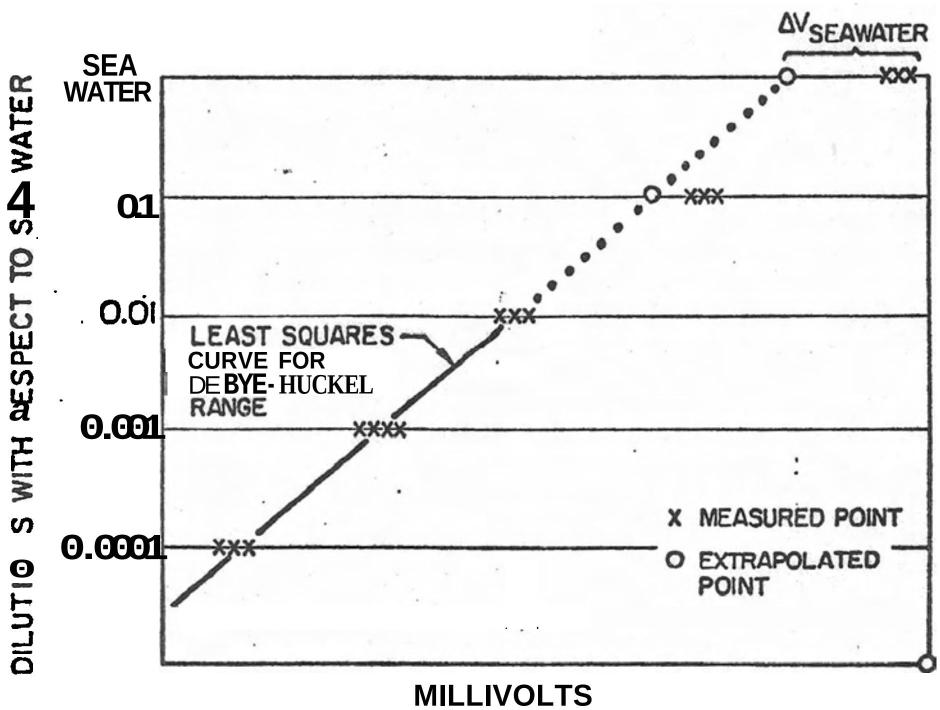
MEASUREMENT AND RECORDING APPARATUS



Electrode Array

CHANNEL	FUNCTION	ELECTRODE TYPE
0	Zero Check	
1	Chloride	Beckman 39606
2	Sodium	Orion 94-11A
3	Sodium	Corning 676210
4	Calcium	Beckman 39608
5	Divalent	Beckman 39614
6	Blank	
7	Blank	
8	Blank	
9	Potassium	Beckman 39622
10	Solution Ground	Coco*
11	Eh	Platinium
12		Platinium
13	pH	Beckman 39045
14	Na-K	Beckman 39047
15	pH	Beckman 39045
16	Temperature	
17	Conductivity.	
18	Zero Check	

Reference: Coco*: Silver chloride intervals
See Corwin and Conti (1973)



The analyses consisted of (1) making for each sample four serial decade dilutions into the Debye-Huckel range, (2) measuring the electrode response of each sample plus the various dilutions with a multi-channel electrochemical meter; (3) calculating, by assuming the conservancy of sea water, a least squares solution of the electrode response curve in the dilute range where $\gamma_i^* \to 1$: and (4) solving for in real sea water by $\ln \gamma_i^* = \frac{zF}{RT}(\Delta V) + \ln \gamma_i$ Debye-Huckel where ΔV = measured voltage - extrapolated voltage from the least squares solution of the response curve.

SUMMARY OF VALUES

	(1) Carrels and Thompson (1962)	(2) Average of Experimental Values Reported by Whitfield (1973)	(3) Theoretical γ_i Whitfield (1974)	(4) γ^* This Paper	5 No. Samples	(6) σ	(7) $M_i \Sigma K_j A_j^{z_i/z_j}$ (column 4) (-column 3)
Cl	0.64#	0.705	0.681	0.73	58	0.11	0.05
Na	0.76	0.685	0.652	{0.76 {0.76	{63 {52	{0.08 {0.13	{0.11 {0.11
Mg	0.36	0.26	0.215	0.31	32	0.14	0.09
K	0.64#	0.615	0.618	0.68	31	0.15	0.06

MacInnes Assumption that $\gamma_K = \gamma_{Cl}$

Total No. samples: 69

Column (4) Electrode

Cl : Beckman 39604

1st Na : Beckman 39047

2nd Na : Corning 476210

: Beckman 39614

K : Beckman 39622

ANALYSIS OF GULF OF CALIFORNIA MARINE SEDIMENTS FOR HEAVY METALS

Procedure

A. Sampling of Cores

1. The following Hypogene cores were sampled approximately every 10 cm of the core length. Depth (In meters) of the water above each core is also listed.

HYPO 7G	2230 meters
HYPO 11G	2030 meters
HYPO 23G	1274 meters
HYPO 25G	1314 meters
HYPO 39HFG	2708 meters
HYPO 49HFG	3361 meters
HYPO 57HFG	2220 meters
HYPO 59HFG	2345 meters
HYPO 70HFG	1957 meters

2. Sampling involved transfer of small portions of mud from hole in side of plastic core to labelled screw cap vials using plastic knives. The holes in the cores were approximately 10 cm apart and covered with tape ordinarily. The screw cap vials were labelled with Hypo core number and depth of sample from top of core (in cm).

Samples were dried inside of screw cap vials for ~48 hrs. in a 50°C oven.

After completely dry the samples were ground Into powder with a mortar and pestal and replaced in vials.

Replicate samples were prepared as above - one replicate every 10 samples

B. Nitric Acid Leach - Original Procedure (see flow diagram p. 55)

1. weigh exactly 2.000 g of powdered sample
2. add weighed sample to centrifuge tube containing 10 mls conc. HNO_3
3. immediately shake contents of tube into suspension and place tube into 80°C ultrasonerating bath
4. keep tuba in bath for exactly 1 hr. wet sides of the tube with H_2O if violent foaming occurs.
5. fill tube to 20 ml mark with H_2O
6. centrifuge 5 mins at medium speed
7. filter supernatant (Whatman No. 1) Into labelled screw cap vial
8. store vial for future Atomic Absorption Analysis

TIME (mins)	PROCEDURE
	wash glassware (using Chromate cleaning solution)
	weigh samples (12)
0-2	add 13 ml HNO_3 tube Tubes 11 - 14
	add 2.030 g sample to HNO_3 tubes #1 - #4 end place In bath
	wet sides of tube w/H_2O if foaming occurs after placing in bath
19-12	add 10 ml HNO_3/tube Tubes #5 - #8
	add 2.000 g mud to HNO_3 tubes #5 - 18 and place in bath
	wet sides of tube w/H_2O If foaming occurs after placing in bath
20-22	add 10 ml HNO_3/tube . Tubes #9 - 112
	add 2.000 g mud to HNO_3 tubes #9 - 112 and place In bath
	wet sides of tube w/H_2O if foaming occurs after placing in bath
	weigh samples
	wash glassware
one haur	position funnels and vials
0-2	fill to 20 ml mark w/H_2O Tubes #1 - 14
2	centrifuge tubes #1 - #4 position filter paper
7-9	filter tubes #1 - #4
15-12	fill to 20 ml mark w/H_2O Tubes #5 - #8
12	centrifuge tubes #5 - #8 positlon filter paper
17-13	filter tubes #5 - 68
20-22	fill to 20 ml mark w/H_2O Tubes 19 - 112
22	centrifuge tubes #9 - 112 positlon filter paper
27-29	filter tubes #9 - #12

C. Nitric Acid Leach - Revised Procedure (see flow diagram p. 56)

1. weigh exactly 2.000 g of powdered sample
2. add weighed sample to centrifuge tube containing 1 ml H_2O
3. add 10 mls conc HNO_3 dropwize to tube
4. shake contents of tube into suspension and let tube stand 10 nins
5. place tube in 80°C ultrasonerating bath for exactly 1 hr wet the sides of the tube if violent foaming occurs
6. fill tube to 20 ml mark with H_2O
7. centrifuge 5 mins at medium speed
8. filter supernatant (Whatman lo. 1) into labelled screw cap vial
9. store vial for future Atomic Absorption Analysis

TIME (mins)	PROCEDURE
	wash glassware (using chromate cleaning solution)
	weigh samples (12)
0-1	add 2.000 g sample to tube containing 1 ml H_2O Tubes #1 - #4
1-15	add 10 mls HNO_3 dropwise to tubes #1 - #4. let stand
15	place tubes #1 - 14 into bath - wet sides w/H_2O if foaming occurs
20-21	add 2.000 g sample to tube containing 1 ml H_2O Tubes 15 - #3
21-35	add 10 mls HNO_3 dropwise to tubes #5 - #8 let stand
35	place tubes 69 - 112 into bath - wet sides w/H_2O if foaming occur
40-41	add 2.000 g sample to tube containing 1 ml H_2O Tubes 19 - #12
41-55	add 10 mls HNO_3 dropwise to tubes 19 - 112 let stand
55 (one hour)	place tubes #9 - 112 into bath - wet sides w/H_2O If foaming cccur
15-17	add H_2O to 20 ml mark Tubes #1 - C4
17	centrifuges tubes #1 - #4 position filters and collecting vials
22-24	filter tubes 11 - 14
35-37	add H_2O to 20 ml mark tubes #5 - 18
37	centrifuge tubes #5 - #8 position filters and collecting vials
42-44	filter tubes #5 - #8
55-57	add H_2O to 20 ml mark tubes #9 - #12
57	centrifuge tubes 89 - #12
(two hours)	position filters and collecting vlals
2-4	filter tubes 19 - 112

ANALYSIS OF GULF OF CALIFORNIA MARINE SEDIMENTS

FOR HEAVY METALS

Procedure

A. Sampling of Cores

1. The following Hypogene cores were sampled approximately every 10 cm of the core length. Depth (In meters) of the water above each core is also listed.

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After completely dry the samples were ground Into powder with a mortar and pestal and replaced in vials.

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1. weigh exactly 2.000 g of powdered sample
2. add weighed sample to centrifuge tube containing 10 mls conc. HNO_3
3. immediately shake contents of tube into suspension and place tube into 80°C ultrasonerating bath
4. keep tuba in bath for exactly 1 hr. wet sides of the tube with H_2O if violent foaming occurs.
5. fill tube to 20 ml mark with H_2O
6. centrifuge 5 mins at medium speed
7. filter supernatant (Whatman No. 1) Into labelled screw cap vial
8. store vial for future Atomic Absorption Analysis

TIME (mins)	PROCEDURE
	wart, glassware(using Chromate cleaning solution)
	weigh samples (12)
0-2	add 13 n l HNO_3 tube Tubes 11 - 14
	add 2.030 g sample to HNO_3 tubes #1 - #4 end place In bath
	wet sides of tube w/H_2O if foaming occurs after placing in bath
19-12	add 10 ml HNO_3/tube Tubes #5 - #8
	add 2.000 g mud to HNO_3 tubes #5 - 18 and place in bath
	wet sides of tube w/H_2O If foaming occurs after placing in bath
20-22	add 10 ml HNO_3/tube . Tubes #9 - 112
	ad3 2.000 g mud to HNO_3 tubes #9 - 112 and place In bath
	wet sides of tube w/H_2O if foaming occurs after placing in bath
	weigh samples
	wash glassware
	position funnels and vials
one haur	
0-2	fill to 20 ml mark w/H_2O Tubes #1 - 14
2	centrifuge tubes #1 - #4
	position filter paper
7-9	filter tubes #1 - #4
15-12	fill to 20 ml mark w/H_2O Tubes #5 - #8
12	centrifuge tubes #5 - #8
	position filter paper
17-13	filter tubes #5 - 68
20-22	fill to 20 ml mark w/H_2O Tubes 19 - 112
22	centrifuge tubes #9 - 112
	position filter paper
27-29	filter tubes #9 - #12

C. Nitric Acid Leach - Revised Procedure (see flw diagram p. 56)

1. weigh exactly 2.000 g of powdered sample
2. add weighed sample to centrifuge tube containing 1 ml H_2O
3. add 10 mls conc HNO_3 dropwize to tube
4. shake contents of tube into suspension and let tube stand 10 nins
5. place tube in 80°C ultrasonerating bath for exactly 1 hr wet the sides of the tube if violent foaming occurs
6. fill tube to 20 ml mark with H_2O
7. centrifuge 5 mins at medium speed
8. filter supernatant (Whatman lo. 1) into labelled screw cap vial
9. store vial for future Atomic Absorption Analysis

TIME (mins)	PROCEDURE
	wash glassware (using chromate cleaning solution)
	weigh samples (12)
0-1	add 2.000 g sample to tube containing 1 ml H_2O Tubes #1 - #4
1-15	add 10 mls HNO_3 dropwise to tubes #1 - #4. let stand
15	place tubes #1 - 14 into bath - wet sides w/H_2O if foaming occurs
20-21	add 2.000 g sample to tube containing 1 ml H_2O Tubes 15 - #8
21-35	add 10 mls HNO_3 dropwise to tubes #5 - #8 let stand
35	place tubes 69 - 112 into bath - wet sides w/H_2O if foaming occur
40-41	add 2.000 g sample to tube containing 1 ml H_2O Tubes 19 - #12
41-55	add 10 mls HNO_3 dropwise to tubes 19 - 112 let stand
55 (one hour)	place tubes #9 - 112 into bath - wet sides w/H_2O If foaming cccur
15-17	add H_2O to 20 ml mark Tubes #1 - C4
17	centrifuges tubes #1 - #4
	position filters and collecting vials
22-24	filter tubes 11 - 14
35-37	add H_2O to 20 ml mark tubes #5 - 18
37	centrifuge tubes #5 - #8
	position filters and collecting vials
42-44	filter tubes #5 - #8
55-57	add H_2O to 20 ml mark tubes #9 - #12
57	centrifuge tubes 89 - #12
(two hours)	position filters and collecting vlals
2-4	filter tubes 19 - 112

D. Nitric Acid Leach - Bischoff Method

1. weigh 2.000 g of sample
2. place weighted sample in centrifuge tube containing 1 ml H_2O
3. add 10 mls conc HNO_3 and let sit 10-15 mins
4. ultrasonerate w/bath for 20 mins
5. heat exactly 1 hr in 80°C oven
6. add 6 mls H_2O and shake w/cork
7. beat exactly 1 hr in 80°C oven
8. cool to room temp
9. fill to 20 ml mark w/H_2O
10. centrifuge 5 mins at medium speed
11. pour off supernatant into glass screw cap vial

E. Controls for Leach Methods

1. unfiltered - procedure exactly the same as revised 'nitric acid leach except supernatant after step "7" was poured directly into screw cap vfal. No filtering occurred.
2. 2nd leach - after the supernatant was poured off In revfsed nitric acid leach, the solid sample remaining in the centrifuge tube was resuspended in 10 mls HNO_3 and the revised nitric acid leach was carried out again (2nd time) beginning at step "4."
3. Blank runs - procedure exactly the same as revised nftric acid leach except no sample was added to tube in step "2."

F. Atomic Absorption Metal Standards Preparation (Stack solutions)

1. Standards for $Zn^{\#}$, $Ni^{\#}$, Fe^{3+}, $Pb^{\#}$, $Mn^{\#}$, m d $Cu^{\#}$ were made using prepared standards from J.T. Baker Chemical Co. under tho trade name "Dilut-it"

   in each case 1 g of metal dlssolved in liquid substrate was diluted to a final volume of 1 liter with H_2O.

   the final concentrations of the above standards were 1000 ppm

   the substate of the prepared standards was as follows...

   $Zn^{\#}$ - $ZnSO_4$
   $Ni^{\#}$ - $NiSO_4$
   Fe^{3+} - $FeCl_3$
   $Pb^{\#}$ - $Pb(NO_3)_2$
   Mn^{H} - $MnSO_4$
   $Cu^{\#}$ - $CuSO_4$

2. Cobalt standard was prepared by dissolving 4.040 g $CoCl_2 \cdot 6H_2O$ in 1 liter H_2O for a final $Co^{\#}$ concentration of 1000 ppm
3. Cadmium Standard was prepared by dissolving 2.031 g $CdCl_2 \cdot 2\frac{1}{2}H_2O$ In 1 liter H_2O for a final Cd# concentration of 1000 ppm
4. Sample Blank was prepared as follows
   3.6 g NaCl, 30.0 g $CaCO_3$, 1000 ml HNO_3 → placed in 2000 ml volumetric flask, fill up to mark w/H_2O
5. Standard Bland "0" ppm prepared as 50% HNO_3 50% H_2O (V/V)

G. Atomic Absorption Metal Standards Preparation (linear curve standards)

1. The following ppm standards were used for standard readings with the dilution factors from 1000 ppm stock solutions llstcd to the right of the concentration In ppm.

ppm	dilution factor (from 1000 ppm stock)
0.5	2000
1	1000
2	500
2.5	400
4	250
5	200
8	125
10	100
20	50
30	33.33

2. The above standards were made in volumetric flasks containing half vol. concentrated HNO_3 then filled to the mark with H_2O so that the final solution is 50% conc HNO_3 50% H_2O.

H. Dilution of Leach Samples

1. Yhen sample reading of undiluted leach sacple was off scale then dilution with 50% HNO_3 50% solution was necessary.
2. Dilutions were made by adding very small aliquot of leach sample to a clean dry 50 ml Erlenmeyer Flask followed by the remaining aliquot of 50% HNO_3 50% H_2O solution.
3. Whenever a dilution of sample was made - the same dilution Of the sample Blank (vB) was made.
4. Following is a list of dilutions for specific elements sharing aliquot volumes.

element	dilution	Aliquots
Fe^{3+}	1 – 400	20λ/10mls
$Mn^{\#}$	1 — 100	20λ/ 2mls
$Zn^{\#}$	1 → 50	30λ/1.5mls

CODE FOR TRACE METAL TABLES

U = UNFILTERED

R = REPLICATE

S = SECOND LEACH

B = BISCHOFF'S METHOD

CODE FOR TRACE METAL TABLES

U = UNFILTERED
R = REPLICATE
S = SECOND LEACH
B = BISCHOFF'S METHOD

TRACE METALS (parts per million)

LOCATION 25.27.4 N 109 44.7 W FARALLON BASIN

EXPEDITION NAME	CAST NUMBER/TYPE	WATER DEPTH
HYPO	7 G	2230 METERS

IN-CORE DEPTH	METHOD	NI	CU	CD	CO	PB	FE	MN	ZN
51 CENTIMETERS		4.3241	3.7606	.0534	1.5028	1.8564	1504.7588	63.5948	11.8471
51	U	4.3902	3.4575	.1419	1.1824	2.0868	1508.7796	60.1779	8.8971
61		4.5180	3.8452	.0651	1.3590	2.3038	1564.9563	70.4309	12.5784
71		5.0351	3.9722	.0534	1.2872	1.6326	1745.5887	81.8245	14.0410
71	R	4.7634	3.8027	.0390	1.2418	1.9222	1440.0395	78.6319	12.9992
71	S	1.3834	1.2845		.5618	.4574	762.9617	37.7778	3.6973
81		4.7190	3.6969	.0532	1.4253	1.5119	1539.0942	79.4118	10.1305
91		4.4572	3.7394	.0072	1.2854	1.7377	1599.2309	66.2101	9.4170
91	B	4.2285	3.4322	.0074	1.0923	1.7717	1294.2804	62.9835	10.2446
100		4.5881	3.7394	.0532	1.2154	1.5119	1659.3677	77.2115	9.4170

LOCATION 27 27.4 N 111 22.4 W GUAYMAS BASIN

EXPEDITION NAME	CAST NUMBER/TYPE	WATER DEPTH
HYPO	11 G	2000 METERS

IN-CORE DEPTH	METHOD	NI	CU	CD	CO	PB	FE	MN	ZN
0 CENTIMETERS		1.0392	1.1984	.0236	.2658		406.6275	39.7052	.3500
10		2.2010	1.7950	.0461	.5401	.6124	677.4452	37.5278	1.7500
20		3.1692	2.4769	.1363	.8831	.6124	888.0812	41.8827	10.1500
20	U	2.6536	2.0744	.0788	.6049	1.2510	845.8652	38.5814	3.0363
30		2.9972	2.4769	.0712	.9602	1.0717	984.1010	36.3255	8.0986
40		2.8026	2.4769	.0712	.7550	.8386	984.1010	31.9197	9.5070
40	R	2.9323	2.5621	.0712	.7550	1.0717	923.2295	27.5139	13.7324
40	S	1.5105	1.3286	.0549	.5035	.2880	624.1415	23.0153	4.2491
50		3.4585	2.8253	.1571	1.0188	.5808	1094.8419	38.4836	11.5392
60		2.9938	2.6103	.1906	.8816	1.0459	1064.1439	29.6201	11.5392
60	B	3.3947	2.5377	.1878	.7126	1.4263	919.2524		6.6173
70		2.8611	2.6103	.1459	1.0188	.5808	941.3922	25.1884	7.2917
78		3.1354	2.8395	.1292	.9014	.6638	954.0574	30.8870	9.9480

LOCATION 28° 36.1 N 112° 53.8 W SOUTH SAL SI PUEDES BASIN

EXPEDITION NAME	CAST NUMBER/TYPE	WATER DEPTH
HYPa	23 G	1274 METERS

IN-CORE DEPTH	METHOD	NI	CU	CD	CO	PB	FE.	MN	ZN
0 CENTIMETERS		1.6108	.7706	.0516	.6963	.1975	923.6808	35.3221	14.1513
10		1.4782	.7275	.0295	.6280		1045.1872	35.3221	14.1513
10	S	.1127	.0857			.0371	343.9584	2.1034	1.6279
10	U	1.7386	.6861	.0361	.7874	1.2510	902.5735	30.5453	9.2468
21		1.6038	.7014	.0325	.7539		822.7551	33.1377	10.1160
21	B	1.3216	.7030	.0463	.5310		697.1398		8.7752
31		2.1305	.9595	.0436	1.2238		1407.0352	44.3436	15.6213
40		1.8014	.8734	.0215	1.1567	.4161	1222.5257	35.3789	14.9331
40	R	2.0372	1.0851	.1236	1.2286	1.2898	1350.5128	39.2558	15.7140
50		2.0372	.8245	.0904	1.0295	.1376	1350.5128	34.7720	14.3295
51		1.8359	.9114	.1015	.9631	.3681	1223.5967	32.5301	14.3295
61		1.6862	.9349	.0505	1.0192	.2467	1171.6962	35.1165	16.0162
61	R	1.8627	.9798	.0532	1.2418	.1742	1078.2501	37.8382	11.6014
71		2.1564	1.3722	.0394	1.0872	.4823	1108.5371	35.1165	16.0162
81		1.2159	.8474	.0171	.7472		1992.7642	30.6674	13.2429
90		1.4849	.9584	.0363	.9441		1150.6842	48.7211	14.2361
90	B	1.4181	1.7904	.0143	.6715		994.1039	44.2712	18.4028
100		1.5518	.9584	.0143	.8078	.0235	1025.4200	46.4961	14.9306
101		1.3667	.9873	.0945	.8101	.0352	949.5140	40.4255	14.7339
101	U	1.6776	.9464	.0218	.7266	.2882	1214.4692	44.6084	13.3872
120		1.3667	.7237	.0728	.8776		1017.0686	36.1702	11.9539

TRACE METALS (parts per million)

I CE METALS (parts per million)

LOCATION 28 47.5'N 113 05.2 W NORTH SAL SI PUEDES BASIN

EXPEDITION NAME	CAST NUMBER/TYPE	WATER DEPTH
HYPO	25 G	1314 METERS

IN-CORE DEPTH	METHOD	NI	CU	CD	CO	PB	FE	MN	ZN
13 CENTIMETERS		1.7067	1.6903	.0837	.7425		713.0730	27.6596	9.1739
20		2.6834	2.2729	.0555	1.3099	1.3353	1000.5672	37.1834	12.1978
20	U	2.7371	2.1064	.1003	.9299		925.4935	32.1546	11.7357
30		2.9644	2.2729	.0085	1.1005	.8450	1034.1791	32.9039	15.0181
39		2.7536	2.0199	.0665	.8213	.1097	866.1194	32.9039	10.7877
33	R	2.9505	2.2438	.0957	.9961	1.4227	883.4404	31.7192	12.9992
39	S	1.1498	1.0714		.2600	.2880	596.1232	23.0153	3.3730
50		2.1538	1.9728	.0501	.7754	.5349	788.5541	22.6477	9.0432
50	B	2.7469	2.0135	.1259	.7126	1.1737	780.4320		10.2137
51		2.3533	2.0543	.0650	.9525	.5349	821.6173	29.0810	F.7497
60		1.8879	1.8099	.0201	.6574	.0692	689.3646	24.7921	11.8692
70		3.0565	2.5335	.1362	1.3991	.3359	1099.8006	37.0614	1403233
70	B	2.9883	2.4517	.1213	1.3991	1.5380	1033.7751	37.0614	12.9052
80		2.7154	2.4517	.1661	1.5110	1.7784	967.7495	29.2055	7.9417
90		2.9728	2.5367	.2010	1.2840	1.9250	873.7207	22.7881	8.9468
100		2.9728	2.4133	.1109	1.3954	1.6765	873.7207	29.2055	10.3783
101		2.9728	2.3721	.1109	1.3397	1.9250	873.7207	35.9285	10.3783
112		2.9074	2.5672	.1637	1.1183	1.0895	990.8787	38.0900	12.2720
112	S	1.4172	1.1506	.0425	.4879	.4081	639.9741	22.9402	3.9192
112	U	3.4921	2.5009	.1568	1.1753	1.2054	1066.5397	36.1765	11.0454
121		2.9074	2.4026	.1637	.9433	1.8500	860.8706	31.6056	10.1439
130		3.0468	2.1558	.1335	1.2350	1.3430	763.3645	28.3891	10.8533
140		2.9576	2.4742	.1559	1.1871	2.2761	901.0315	32.7261	10.9937
150		2.8853	2.1850	.1259	1.0683	2.0377	836.5043	41.3399	8.2280
150	R	2.8853	2.0610	.0959	.9495	1.5609	836.5043	40.0029	10.3023
151		2.7122	1.9513	.1231	.9512	1.2898	785.4303	29.1973	9.4108
161		2.8538	1.9930	.1080	.9512	.8119	884.1791	37.8418	11.4868
171		3.6328	2.2433	.1837	1.3743	1.2898	917.0954	75.7456	12.1787
181		2.6899	1.9920	.1165	1.0636	.8743	837.7619	43.4679	8.5128
191		2.8990	2.5815	.1316	1.0636	.6313	870.7129	39.1033	11.3038
200		2.9686	2.1604	.1165	1.0039	.1452	870.7129	39.1033	11.3038
200	U	2.8252	2.2079	.1578	1.0527	.5942	862.2923	43.4036	11.8762
209		2.4747	1.8264	.0829	.8706	.0985	764.1745	36.9030	7.6846
220		2.5448	2.0384	.0979	.9313	.0985	862.2923	36.9039	10.4790
220	R	3.2593	2.1216	.1544	.8500	.9566	934.5309	36.4286	11.0512
220	S	1.6436	1.0649		.5482		668.0287	24.9656	4.0558
230		2.7601	1.9939	.1089	.9707	.7047	934.5309	36.4286	8.2534
239		2.6174	2.2068	.0937	.9707	.7047	967.9632	36.4286	11.0512
250		2.9948	2.1899	.1260	.9216	.9132	1009.9001	43.1825	10.9768
251		2.9948	2.1899	.1260	.7458	1.6747	1009.9001	41.0365	10.9768
260		2.9948	2.4473	.1564	.9803	1.9285	1009.9001	36.7445	9.5785
271		2.7234	2.3409	.1317	1.1962	1.6067	1208.2254	47.8229	11.8656
271	U	3.1775	2.1941	.1426	1.1140	.7181	1066.5397	48.2421	13.8067
281		3.0124	2.4280	.1164	1.1375	1.0964	1141.9277	41.3137	14.7077
290		3.0124	3.2114	.1777	1.0788	1.8618	1208.2254	41.3137	14.7077
300		3.3984	2.5925	.1794	1.1037	2.0618	1039.0262	48.6522	13.5558
301		2.9551	2.4169	.1489	1.2811	1.2835	973.6827	48.6522	10.6716
307		2.8813	2.1975	.1183	1.1037	2.0618	973.6827	44.3217	10.6716

LOCATION 25 36.0 N 109 47.1 W CARMEN BASIN

EXPEDITION NAME	CAST NUMBER/TYPE	WATER DEPTH
HYPO	39 HFG	2708 METERS

IN-CORE DEPTH	METHOD	NI	CU	CD	CO	PB	FE	MN	ZN
0 CENTIMETERS		3.5074	4.4978	.1386	1.1392	1.5954	963.1271	172.9637	10.6925
10		2.8012	2.4894	.0517	.8795	1.3657	963.1271	203.1131	4.2770
20		2.3892	1.8057	.0662	.8795	.6768	1615.4269	69.5942	2.8513
30		2.3964	2.0571	.0950	.9441	.7096	1571.8292	53.1950	3.6140
40		2.2244	1.8857	.0659	.8789	2.0843	1571.8292	53.1950	3.6140
50		1.8231	1.7143	.0369	1.0092	1.1679	1339.1297	42.2980	4.3090
60		2.2777	1.8628	.0641	1.1214	1.1106	1467.4537	46.1538	4.0956
60	B	2.2049	1.7782	.0971	.9733	.9109	1440.8010	49.7238	4.4232
70		1.9264	1.7767	.0496	.9253	.8815	1500.4394	43.9657	2.7073
80		1.9849	1.8198	.0496	.9907	.6524	1566.4108	46.1538	4.0956
80	R	2.1833	1.9560	.0752	1.0118	1.7643	1563.7965	52.0733	3.3981
80	S	.5116	.5504		.0654		668.0287	18.8895	.6692
90		2.3078	1.9122	.0483	1.0466	.1738	1426.8314	46.5732	4.0568
100		2.0135	1.8689	.0337	.9127	.1738	1361.9846	46.5732	3.3573
100	U	1.8957	1.7388	.0044	.9127		1394.4080	40.0312	4.7562
110		2.1085	1.9171	.0830	1.0059	.5862	1657.7116	50.3813	4.9920
120		2.0496	1.8301	.0538	.8740	1.3515	1558.9628	43.7865	4.2889
130		1.8729	1.7431	.0391	.7421	1.0964	1427.2977	41.5882	1.4765
139		1.8171	1.8382	.1030	.7727	1.5429	1523.5294	43.9410	4.2596

LOCATION 24 41.8 N 109 09.3 W NORTH PESCADERO BASIN

EXPEDITION NAME	CAST NUMBER/TYPE	WATER DEPTH
HYPO	49 HFG	3361 METERS

IN-CORE DEPTH	METHOD	NI	CU	CD	CO	PB	FE	MN	ZN
0 CENTIMETERS		5.0668	7.8079	.0443	1.6064	2.5634	1623.8859	267.4394	9.9391
10		4.4036	5.6727	.0296	1.1575	1.7980	1322.8164	243.0980	9.9391
10	U	4.4851	5.1747		1.4871	1.4153	1205.4635	225.8233	7.6057
20		4.8179	5.9413	.0455	1.2854	1.2389	1481.6840	193.6184	11.9599
30		4.4175	5.7668		1.1551	1.4819	1511.5736	216.7243	9.8979
40		4.6845	6.6390	.0307	1.3506	1.9680	1780.5797	347.3181	7.1485
50		2.5381	2.5469	.0717	.8066	1.1106	1448.5255	61.9262	7.3620
50	U	1.9863	2.1383		1.0612	.1397	1233.8921	58.4111	6.2353
50	B	2.4706	2.4594	.0570	.6746	2.0875	1448.5255	55.4170	7.3620
60		2.2006	1.9344	.0864	.8066	1.1106	1567.9697	53.2472	5.3358
60	R	2.3633	1.8721	.0173	.7649	1.7643	1675.5583	60.1736	4.8139
60	S	.7865	.8251		.2297	.3510	786.6559	32.8924	2.4092

6 [illegible]E METALS (parts per million)

LOCATION 25 22.4 N 109 39.4 W FARALLON BASIN

EXPEDITION NAME	CAST NUMBER/TYPE	WATER DEPTH
HYPO	57 HFG	2220 METERS

IN-CORE DEPTH	METHOD	NI	CU	CD	CO	PB	FE	MN	ZN
0 CENTIMETERS		1.9981	2.2071	.0323	.8880	2.2190	1484.4747	63.1254	6.9070
10		1.7956	1.8117		.9536	1.2214	1606.2967	41.4950	5.5393
10	R	1.8631	1.7678	.0323	1.0193	1.9696	1575.8412	41.4950	3.4877
10	S.	.3371	.5703		.1092		701.6705	22.8692	.8031
20		2.1253	2.0303	.0763	1.0403	1.9919	1542.6517	53.9080	3.9373
30		2.2602	2.1179	.0163	.8431	1.7381	1542.6517	40.9010	3.2342
40		2.1928	2.0303	.0463	.8431	2.4996	1573.3195	40.9010	1.1249
40	U	2.6270	2.0063	.0122	1.1829	.6500	1603.4639	50.3430	5.5501
50		1.9426	1.9320	.0339	.9564	.7312	1297.3091	34.3525	.6426
60		1.8756	1.8441	.0634	.9564	.7312	1481.3160	34.3525	2.7846
70		2.4785	2.2835	.0928	.8891	.4872	1726.6587	40.8349	3.4986
80		1.8889	1.9172	.1096	1.0036	1.2979	1629.6479	39.8050	5.3009
90		1.8208	1.7411	.0517	.9364	1.7973	1537.2922	44.1489	2.5110
100		2.2981	2.0052	.1241	.9364	1.5476	1660.4331	37.6330	1.8135
110		2.2473	1.7908	.0503	.8945	1.2369	1611.7253	46.4067	3.2787
110	R	2.2039	1.8791	.0640	.6974	1.7420	1826.3533	48.5985	3.2787
110	S	.3820	.5703		.1092	.0905	758.3275	22.8692	1.3731
120		2.6377	2.0557	.0366	.8288	.4792	1550.4030	50.7902	6.0109
130		2.4033	2.1406	.0326	.9645	2.0411	1575.2091	41.5633	.6823
140		2.1490	1.9186	.0187	.8991	2.0411	1484.6364	37.2232	3.4113
150		2.4880	2.0962	.0187	.8991	1.5521	1726.1637	39.3933	4.7758
160		2.7323	2.3621	.0625	1.3440	.4083	1829.1388	51.0587	6.3859
160	U	2.6096	1.9854	.0502	1.0325		1321.3633	42.8189	3.2277
170		2.6070	2.0011	.0625	.9496	2.1433	1888.9243	48.8972	7.0652
180		2.0639	1.9108	.0486	1.1468	1.6476	1530.2113	48.8972	.2717
180	R	2.1833	1.8721	.0028	.7649	1.7643	1563.7965	52.0733	1.2743
190		2.3163	1.8552	.0696	1.1641	.9796	1712.6118	64.0879	2.8846
200		2.5296	2.2129	.0415	1.1641	1.7241	1742.5969	70.6552	2.8846
200	B	2.3312	2.0418	.0252	.9114	.9109	1022.2343	65.9669	5.8500
215		2.1456	1.8552	.0555	.8972	1.4759	1502.7162	107.8704	4.2582
215	B	2.3532	1.9014	.0318	1.0827	2.4531	1525.4171	124.5978	5.1267

TRACE METALS (parts per million)

LOCATION 25 40.1 N 110.00.0 W NORTH FARALLON BASIN

EXPEDITION NAME	CAST NUMBER/TYPE	WATER DEPTH
HYPO	59 HFG	2345 METERS

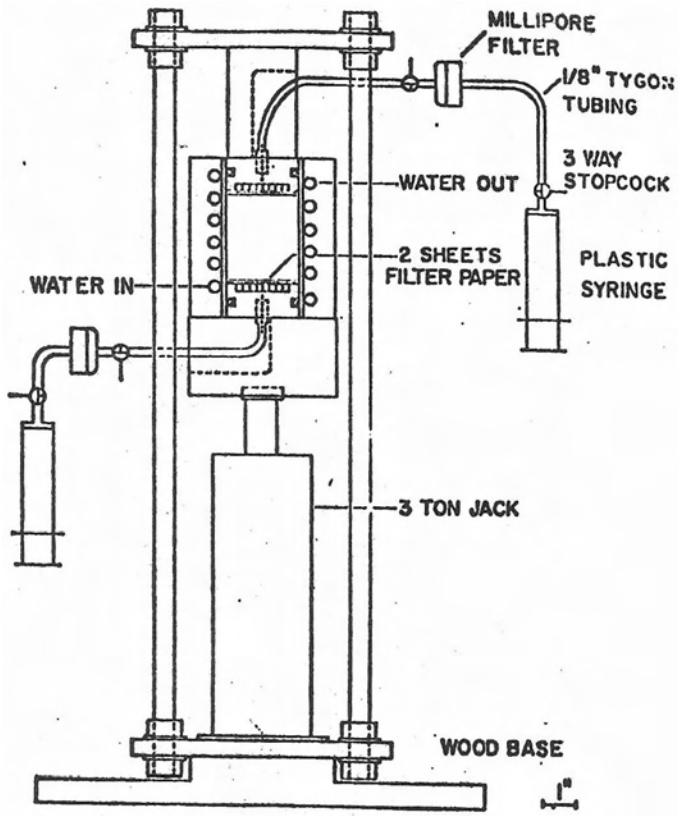
IN-CORE DEPTH	METHOD	NI	CU	CD	CO	PB	FE	MN	ZN
30 CENTIMETERS		5.3689	3.7723	.0736	1.0827	2.2053	1437.8951	121.6371	12.0546
40		5.4114	3.8614	.0876	1.2165	2.2053	1467.0691	109.7966	14.1330
50		5.9814	4.2858	.1102	1.4644	2.5474	1748.7882	150.5430	14.2450
50	U	5.3941	3.9144	.0929	1.5112	1.5185	1456.7779	109.3621	9.5429
60		5.9814	4.4545	.0268	1.5978	2.8022	1806.8533	162.3693	13.5568
60	B	5.4613	3.9733	.0546	1.2642	2.8022	1516.5274	118.0209	12.8687
70		5.7844	4.0541	.0553	1.7455	.4604	1787.5481	141.7910	11.9777
80		5.7844	4.1892	.0692	1.5427	2.5883	1787.5481	130.0896	12.6741
80	R	5.4706	4.0357	.1052	1.6048	2.4377	1569.1537	124.4856	10.2037
80	S	1.6407	1.3730		.4624		730.5979	46.3063	3.7495
90		5.4988	3.9640	.0692	1.5427	1.4061	1670.5124	150.5672	12.6741
100		6.0443	4.0482	.1009	1.7534	1.3988	1488.1113	103.0635	10.3431

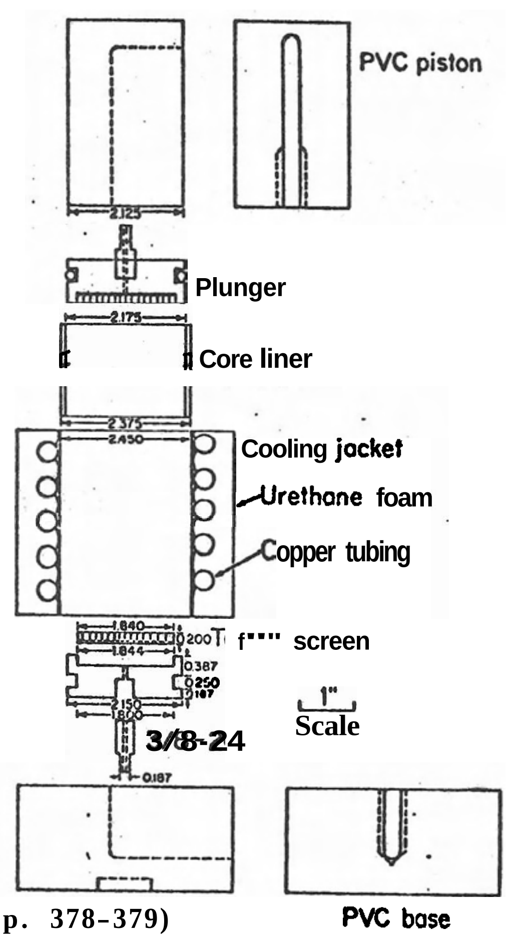
LOCATION 22 43.3 N 107 12.6 W MAZATLAN BASIN

EXPEDITION NAME	CAST NUMBER/TYPE	WATER DEPTH
HYPO	70 HFG	1957 METERS

IN-CORE DEPTH	METHOD	NI	CU	CD	CO	PB	FE	MN	ZN
0 CENTIMETERS		7.7738	9.2786		1.5560	1.3988	1429.6542	24.1098	8.9548
10		7.7738	6.8010	.0322	1.6218	.6750	1751.1681	29.9582	14.5081
20		7.8015	6.0516	.1233	1.1707	1.2105	1471.4404	27.2105	13.9639
30		8.9776	6.7937	.0680	1.8790	.7309	1762.7276	27.2105	13.9639
40		7.5401	5.4487	.0819	1.5571	1.9300	1558.8266	30.1249	15.3533
50		5.9847	4.6695	.1085	1.5034	1.3353	1446.1053	28.4263	17.6606
50	B	6.2149	4.7435	.1517	1.3865	1.5234	1290.6983	31.0324	20.8586
60		5.5124	3.9667	.0945	1.1774	1.3353	1562.5840	28.4263	19.7547
70		4.7826	4.0135	.0527	1.0470	1.0902	1446.1053	19.7298	16.9625
80		5.1257	4.1572	.0800	1.5743	.4733	1601.1136	34.8885	20.7651
90		3.1456	2.0952	.1215	1.0427	.7227	1246.2444	23.2886	8.1802
100		4.0906	3.7861	.0800	1.2421	1.2215	1246.2444	29.0886	20.0659
110		3.6308	3.5090	.0888	1.1840	2.4196	1063.6011	36.3385	14.7504
120		4.1313	4.6407	.0750	1.1840	1.1390	1481.8775	30.5386	19.0466
120	R	4.5274	4.5359	.0765	1.3594	.9525	1680.3526	33.7449	15.7947
120	S	.6040	1.0327		.0424	.2372	528.8471	1.8718	2.6933
125		4.4043	4.7665	.0750	1.3173	1.1390	1661.1388	30.5386	16.1825

SQUEEZER APPARATUS

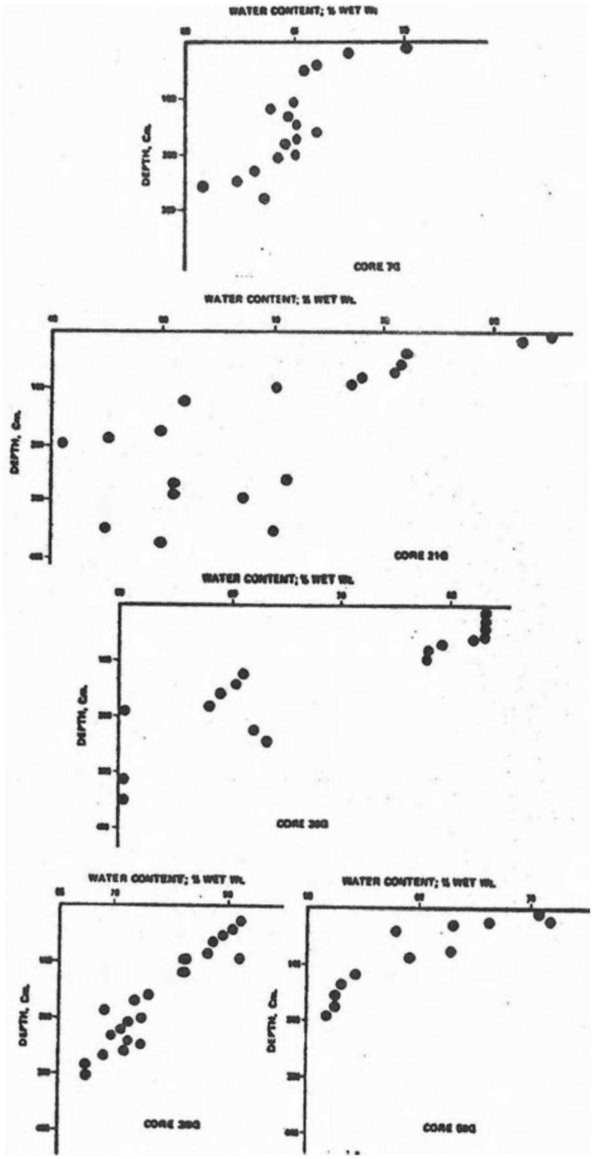




From Goldhaber (1974, p. 378-379)

INTERSTITIAL WATER CHEMISTRY

From Goldhabe (1974, P. 185; 136-137)



HYPO 7G

DEPTH INTERVAL cm	SO_4^{2-} (1) mM	δS^{34}	ALKALINITY meq/ℓ	(1,2) ΣH_2S µM	(3) pH	WATER CONTENT %W.W.	(4) FeS_2-S %D.W.	(4) FeS-S %D.W.
10-15			3.4	0	7.98	70.1	0.31	0.005
15-20			3.5	0				
20-25			3.4	0	8.01	63.9	0.42	
25-30			3.5	0	8.04			
30-35	29.2	+20.5		0	7.95		0.45	
35-40	29.9			0				
40-45			3.6	0	8.07	62.3	0.55	
45-50			3.6	0	8.07	61.2		
100-105	30.1			0			0.49	0.002
105-110	30.4	+21.3		0		60.5		
110-115			3.4	0	8.12	55.7	0.79	0.002
115-120			3.4	0	8.11			
120-125			3.3	0	8.02	58.3	0.11	0.0015
125-130			3.3	0	8.05			
130-135	30.2			0		59.4	0.41	
135-140	30.5			0				
150-155			3.2	0	7.94	60.7	0.53	
155-160				0	8.03			
160-165	30.5			0		62.6		
165-170	30.2	+21.4		0				
170-175			3.0	0	7.99		1.06	0.002
175-180				0	8.03	59.8		
190-195				0	7.99	60.5	0.62	0.0025
195-200				0				
200-205				0		58.4	0.37	0.006
205-210				0				
210-215	30.5	+21.5		8	7.94		0.96	
215-220				14	7.90			
220-225			3.4	9			0.60	0.003
225-230			3.6	12		56.7		
230-235				52			0.83	0.0015
235-240				42		54.5		
250-255			4.1	40	8.06			
255-260			4.2	50	8.09	51.4		
260-265	28.0			34	7.94		0.50	0.0015
265-270	27.1			92	7.98	57.8		
271-276			4.6	143	8.08		1.12	
276-285			5.5	451	8.14			

(1) Dissolved in pore water
(2) Reported as micromole/liter; analysts by methylene blue colorimetry
(3) Measured at 2°C.
(4) $CaCO_3$ and acid soluble free basis.

Approximately 10cm of surface sediment was lost during handling on deck.

From Goldhaber (1974, p. 138-141)

HYPO 21 G

DEPTH INTERVAL cm	(1) SO_4^{2-} mM	ALKALINITY meq/ℓ	ΣH_2S, mM (1) COLORIMETRIC	GRAVIMETRIC	(2) pH	WATER CONTENT %W.W.	ORGANIC CARBON %D.W.	$CaCO_3$ %D.W.
10-15		2.70			7.75	86.4	3.3	6.6
15-20		2.70			7.83		3.3	13.8
20-25		3.02	0.005		7.81	82.2		
25-30		2.73	0.003		7.91			
30-35	28.1			0.092				
35-40	28.2			0.139				
40-45		3.35	0.084		7.84	71.6	3.0	17.6
45-50		4.99			7.69			
50-55	24.9	7.90	0.322	0.259	7.81			
55-60	23.8	9.76		0.411		70.0	3.5	14.1
60-65		12.2	0.493		7.58			
65-70		13.9			7.65	71.0	3.5	14.6
70-75	19.2			1.10				
75-80	18.8			0.460		68.1	3.6	7.2
80-85		17.4	1.37		7.57			
85-90		17.9	1.33		7.59	67.4	3.8	14.3
90-95	16.6			1.35	7.63			
95-100	15.7			1.59		60.0	3.0	17.0
120-125		24.1	2.30		7.57	52.4	2.3	13.2
125-130		25.0	2.58		7.67		2.5	
130-135	11.0			2.55		64.9	3.4	15.4
135-140	9.9			3.17				
170-175			3.89		7.55			
175-180		36.6	3.94		7.52	49.6	1.9	18.6
180-185	1.6		4.88					
185-190	0.9			5.09		44.9	2.0	12.0
190-195		40.1	3.95		7.52	40.7	2.2	12.9
195-200		39.3	3.88				2.5	
250-255	0.3		2.80	3.65				
255-260	0.2			4.93				
260-265		50.2				62.2	2.7	10.7
265-270		50.7	3.91		7.50	51.4	2.9	15.6
270-275	0.1			0.38				
275-280	0.1			1.90		50.7	2.1	20.2
280-285	TR.	53.0	3.71		7.49			
285-290	TR.	53.3	3.64		7.53	57.0	2.8	18.3
290-295	TR.			2.64				
295-300	TR.			2.42			2.4	15.6
310-315	TR.	57.5	3.81		7.53			
315-320	TR.	58.3	3.99	3.63	7.55		2.8	18.2
320-325	TR.			3.85			3.2	12.8
325-330	TR.							
357-362	TR.	64.0	2.05		7.61	45.0	1.6	18.7
362-366	TR.	61.7	2.04		7.68			
366-372	TR.			0.81		49.9	2.3	20.4
372-377	TR.			1.03				

(1) Dissolved in pore water
(2) Measured at 10°C.

1. Frequent sand layers many large shells and fragments some In growth position.

2. Top 10 cm lost during handling on deck.

3. Black layer at ~50 cm.

4. Pore water changes from clear to a yellow tinge with depth.

HYPO 30 G

DEPTH INTERVAL cm	(1) SO_4^{2-} mM	ALKALINITY meq/ℓ	ΣH_2S, mM (1) COLORIMETRIC	GRAVIMETRIC	(2) pH	WATER CONTENT %W.W.	ORGANIC CARBON %D.W.	$CaCO_3$ %D.W.
0-5	28.0	3.1	0		8.02			
5-10		3.3	0		7.96			
10-20	28.3	3.9	0.019		7.99			
40-45		5.6	0.52		7.89			
45-50		5.6	0.58			83.1	3.2	11.9
50-55	27.7	5.6	0.60	0.72	7.84			
55-60	27.6	6.8	0.70	0.75	7.79	83.1	4.0	3.8
60-65		7.3	0.62		7.71			
65-70		7.3	0.74		7.96	83.2	2.8	3.9
70-75	26.8	7.9		1.03	7.73	83.0	3.6	9.8
75-80	22.5	9.3			7.81			
80-85		10.0						
85-90		10.7				82.1	3.2	3.7
90-95	25.0	11.9	1.55	1.64			3.1	5.7
95-100	24.6	12.9	1.45	1.47				
100-105		14.0			7.69	78.9	4.0	6.8
105-110		15.0			7.76			
110-115	22.5	16.1	1.45	1.57	7.71	77.8	4.0	5.3
115-120	22.0	16.5	1.15	1.24	7.81			
120-125		17.9	0.66		7.89	76.8	3.5	4.0
125-130			0.34		7.88			
160-165	17.0					60.8	2.7	2.8
165-170	15.7							
170-175		24.9			7.77	77.8	2.8	2.1
175-180		26.4			7.72			
210-215		37.2	0	0	7.73	58.1	3.2	
215-220		39.1			7.73			
220-225	0.6					47.4	1.3	4.8
225-230	0.3							
260-265	0.4					61.6	3.2	6.3
265-270	TR.							
270-275	TR.	42.9			7.27		3.4	14.2
275-280	TR.	42.8			7.21			
330-335	TR.							
335-340	TR.					50.1	2.5	4.4
370-375	TR.	38.0			6.86	50.3	1.7	5.7
375-380	TR.	21.6			6.86			

(1) Dissolved in pore water
(2) Measured at ~2°C.

Core is distinctly brownish green over the entire length.

Gas pockets formed at >200 cm.

Section 0-30 is mottled with darker colored material.

From Goldhaber (1974, p. 142-145)

HYPO 38 G

INTERSTITIAL WATER CHEMISTRY

Depth Interval (cm)	SO_4^{2-} 1/ mM	SO_4^{2-} 1/ δS^{34}‰	Alkalinity 1/ meq/ℓ	ΣH_2S 1/ mM Colorimetric	ΣH_2S 1/ Gravimetric mM	ΣH_2S 1/ Gravimetric δS^{34}	pH 1/ 2/	FeS-S 3/ % Dry Wt.	FeS-S 3/ δS^{34}‰	FeS_2-S 3/ % Dry Wt.	FeS_2-S 3/ δS^{34}‰	%	$CaCO_3$ %	Water Content % Wet Wt.	NH_4^+ 1/ mM	PO_4^{3-} 1/ µM
20- 27			2.23	0			8.51								0.20	6.5
27- 34	32.1	+17.7	2.00	0			8.56	0.003		0.16						
35- 39			4.32	0.06			8.37					4.7		81.4	0.36	33
39- 42			5.29	0.06			8.31								0.41	39
43- 46.5	27.8	+22.3	7.06	0.34			8.34	0.10	-28.5	0.29	-14.6	4.1	11.5	80		
46.5-50	27.4		8.65	0.37			8.34									
50- 55	26.1	+23.4	8.41	0.60			8.13					4.2	17.8	78.7		
55- 60			9.23	0.70			8.06	0.20	-25.3	0.08					0.86	60.4
60- 65	22.2	+29.8		0.68	1.00	-23.7						4.1	14.7	79.1		
65- 70	20.3	+33.2		0.86	1.01			0.25	-22.5	0.16	- 9.3					
70- 75			14.5	0.76			7.98	0.18		0.11		4.6	8.4	79.1	1.76	103
75- 80			16.1				8.03									
80- 85	15.3	+42.5	17.0	1.35	1.50	-17.4						4.3	14.2	80.6		
85- 90	14.9	+44.4	18.6	1.53	1.70			0.23		0.19						
90- 95			19.8	1.78			7.92	0.26	-16.6	0.12		4.4	12.5	76.3	2.78	145
95-100			20.5	1.58			7.94	0.14		0.17						
100-105	11.7	+51.5			1.23	-12.0						4.2	11.1	76.1		
105-110	10.0	+52.6			1.69											
110-115			24.1	0.97			8.05								3.35	147
115-120			24.4	1.55			8.03	0.23		0.10	- 8.3	4.1	6.7	76.3		
150-155	4.8	+63.2			1.64	+ 5.9		0.20		0.32		4.9	7.5	72.9		
155-160	5.3	+63.5			1.91			0.23	- 9.4	0.30					4.21	188
160-165			29.9	1.45		+ 7.5	8.03					4.7	8.0	72.4	4.45	194
165-170			30.4	1.68			8.01									
170-175	3.7				1.88	+12.9										
175-180	3.5				1.89	+14.8		0.09		0.59		5.0	13.1			
180-185			32.2	1.35			7.91									
185-190			35.4	1.50			7.97	0.06		0.87						
190-195	2.0				1.85	+19.3						5.4	10.4		4.69	199
195-200	1.8			1.65	2.09	+22.0						3.5	9.2			
200-205	0.7				1.32	+24.4										
205-210	0.1				1.23	+25.8										
210-215			34.8	1.20			7.89					3.9	10.2	72.1		
215-220			34.9	1.13			7.89									
220-225				0.35	1.02	+29.4						3.5	15.7	70.8	4.89	204
225-230				0.93	0.94		7.89									
230-235			34.9									3.7	13.7	69.6		
235-240			35.6	0.59			7.93									
240-245				0.22	0.76			0.30	+ 0.3	0.18	- 3.9					
245-250					0.55							4.1 / 4.0	10.2	72.0 / 73.3		
250-255			35.9	0.20			7.99						10.0			
255-260				0.14				0.21	-10	0.37	- 7.5	3.8	8.7	no	5.36	198
262-267			38.7	0.06												
267-272				0.04												
273-278			36.7	0.03			7.97	0.22						69.4	5.28	179
278-283				0.04				0.10	-15.3	0.69						
284-289			38.2	0.04												
289-294				0.02				0.01		1.11				67.3	5.61	197
295-306			38.1	0.02			7.87	0.008		1.05		4.4 / 4.3	12.6 / 12.7	67.7	5.71	191

1. Dissolved in pore water
2. Measured st 2°C
3. $CaCO_3$ and acid soluble free basis

*General remarks
Depth interval 0-35 cm is brown
Depth interval 35-43 cm is brown and black mottled
Below 43 cm is green mud
Sand layer st 230 a under by a 1 cm thick light green layer which, in turn, is underlain by a 1 a thick black layer.

From Goldhaber (1974, p. 146-149)

HYPO 50 G

Depth Interval (cm)	SO_4^{2-} mM	SO_4^{2-} δS^{34}‰	Alkalinity 1/ meq/ℓ	1/ mM Colorimetric	Organic Carbon % Dry Wt. Porosity Samples	Organic Carbon % Dry Wt. Homogenized Samples	pH 1 2/
0- 5			3.2	0	4.41	4.52	8.32
5- 10			4.03	0	4.08		8.04
10- 15	27.6	+21.4		0.004			
15- 20	27.1			0.022		4.10	
20- 25			5.11	0.043	4.41		8.00
25- 30			5.43				
30- 35	26.2	+24.2		0.021	4.40	4.60	
35- 40	25.8	+21.5		0.024			
40- 45			6.02	0.053	3.68	4.00	8.08
45- 50	26.1		6.23	0.050	4.06		8.06
50- 55	23.9			0.011	4.00		
55- 60	25.8	+25.3		0.014			
60- 65	25.6		6.89	0.005	4.55		8.28
65- 70	25.6		9.78	0.017			8.18
70- 75	23.4	+26.7		0.018		4.12	
75- 80	22.1	+29.8		0.009	4.20		
80- 85	19.4		14.8	0.004		3.18	8.12
85- 90			13.2	0.004	3.71		8.04
90- 95	17.6	+30.7		0.005			
95-100	17.5			0.003			
100-105	16.9	+37.4		0			
105-110	15.9	+48.0		0			
110-115			21.0	0			8.03
115-120			21.7	0	2.96		8.05
125-130	11.7			0			
130-135			24.6	0			
135-140			24.6	0		3.02	
140-145	11.5	+51.2		0	3.28		
145-150	9.2			0			7.88
150-155	9.9	+53.2		0		3.08	
155-160	9.2	+69.0		0	2.95		7.90
160-165			30.2	0			7.90
165-170			31.1	0		3.00	7.93
170-175	6.1	+72.3		0	2.85		
175-180	7.2	+65.9		0		2.90	
180-185			33.2	0	2.98		
185-190			33.1	0		3.09	
190-195	4.7			0			7.86
195-200	5.5	+80.8		0			7.94
200-210				0			
220-230				0			
240-250				0			
260-270				0			
286-296				0			
306-316				0			

Depth	FeS-S % Dry Wt.	FeS-S δS^{34}‰	FeS_2-S % Dry Wt.	FeS_2-S δS^{34}‰	$CaCO_3$ 4/ %	Water Content % Wet Wt.	NH_4^+ 1/ mM	PO_4^{3-} 1/ µM
0- 5	0.035		0.11	- 5.0	4.4			
5- 10						71.4	0.11	10
10- 15	0.028	-31.6	0.27	-22.9		71.5		
15- 20								
20- 25	0.027	-31.7	0.19	-22.2	4.0	66.0	0.20	18.9
25- 30							0.20	
30- 35	0.016	-31.7	0.29	-23.1	3.9	62.9		
35- 40								
40- 45	0.031		0.27	-23.1	4.2	57.9	0.20	23.1
45- 50							0.23	26.4
50- 55	0.032	-34.3	0.36	-21.5	3.3			
55- 60								
60- 65							0.38	39.8
65- 70							0.33	47.6
70- 75	0.040	-32.0	0.50	-23.4	4.2			
75- 80						62.0		
80- 85			0.39		3.8			
85- 90						59.7	0.53	68.1
90- 95	0.026		0.45	-21.9				
95-100								
100-105	0.003		0.71	-17.0				
105-110								
110-115	0.003		0.74					
115-120						53.5	1.07	107
120-125	0.004		0.64	-16.1				
125-130								
130-135	0.005		0.73	-15.6	3.7			
135-140						53.5	1.21	132
140-145	0.004		0.66	-14.6				
145-150								
150-155			0.63		3.4			
155-160						52.5		
160-165			0.57				1.50	161
165-170								
170-175			0.67	-13.8	4.4	52.3		
175-180								
180-185			0.59		3.5	51.3	1.65	153
185-190								
190-195			0.70	-13.6				
195-200								
200-210			0.75					
220-230			0.72					
240-250			0.77	-13.0	3.4			
260-270			0.74	-13.3				
286-296			0.74					
306-316			0.70	-14.0				

1. Dissolved in pore m—
a. Measured at a°C
3. $CaCO_3$ and acid soluble free basis
4. Average of "porosity" and "homogenized" samples (see text)

*General Remarks
Upper 30-40 cm is brown with darker mottles, the remainder of the core is homogeneous green mud

ELECTRICAL RESISTIVITY IN CORES

Data by Robert F. Corwin and Ugo Conti

SAMPLE	BASIN	DEPTH IN CORE CENTIMETERS	FORMATION FACTOR	MEAN WATER CONTENT	POROSITY %
HYPO 7G	Farallon	51-100	2.24	63.96	83.2
HYPO 23G	Sal Si Puedes-S	0-50	3.36	34.48	58.0
		51-100	3.33	32.95	56.5
HYPO 25G	Sal Si Puedes-N	0-50	1.614	75.19	90.0
		51-100	1.775	70.69	87.5
		101-150	1.860	65.96	84.5
		151-200	1.854	67.55	85.5
		201-250	2.075	64.60	83.5
		251-300	2.165	61.36	81.5
HYPO 39HPG	Carmen	0-57.5	1.405		
		57.5-115	1.603		
HYPO 45G	Farallon	0-50	1.90	59.0	
		51-100	2.12	56.03	
		101-150	2.77	57.54	
		151-200	1.77	70.31	
		201-250	1.83	69.0	
HYPO 46HFG	Farallon	0-40	1.88	60.15	80.5
		41-80	2.11	57.00	78.0
		81-120	2.64	57.90	79.0
		121-160	1.95	63.51	83.0

1) FORMATION FACTOR = (BULK RESISTIVITY)/(RESISTIVITY OF FLUID)

2) BY OVEN DRYING

HEAT FLOW

Hypogene Expedition **HF†**

Sta. No.	North Lat.	West Long.	Depth Corrected Meters	Bottom Temp. (°C)	ΔT₁ (°C)	ΔT₂ (°C)	ΔT₃ (°C)	ΔT₄ (°C)	Assumed Penetration, cm	K μcal/°C cm sec (W/mk)	Q μcal/cm² sec (mW/m²)	Tilt
2HF-2m	25°11.5'	109°27.5'	2055	2.26	0.24	0.20	NA	NA	220	1.75 (.73)	3.5 (149)	Vert.
5HF-2m	25°23.7'	109°54.2'	3265	2.26	0.19	0.16	NA	NA	230	1.75 (.73)	2.8 (119)	V
6HF-4m	25°26.9'	109°45.1'	2260	2.26	0.35	0.21	0.24	0.24	440	1.75 (.73)	4.2 (177)	V
9HF-4m	25°33.1'	109°47.2'	3245	2.26	0.22	0.18	0.18	0.17	420	1.75 (.73)	2.9 (123)	V
12HF-4m	27°27.6'	111°22.5'	2020	2.913	OS	OS	OS	0.42	400	1.71 (.71)	7.2 (301)	V
14HF-4m	27°27.5'	111°24.3'	1865	2.885	0.46	0.33	0.35	0.35	430	1.71 (.71)	5.9 (247)	V
15HF-4m	27°31.1'	111°28.8'	1845	2.886	0.51	0.37	0.28	0.27	440	1.71 (.71)	5.2 (218)	15°-30°
18HF-4m	27°27.6'	111°26.7'	1850	2.883	0.27	0.18	0.18	0.17	440	1.71 (.71)	3.0 (126)	V
22HF-4m	28°42.4'	113°01.6'	1555	11.34	-0.08	OS	0.13	0.13	350	1.65 (.69)	2.3 (96)	15°-30°
26HF-4m	28°47.0'	113°05.2'	1340	11.34	-0.06	OS	-0.05	-0.02	400	1.65 (.69)	-0.3 (-12.6)	V
40HF-4m	26°23.2'	110°44.8'	2765	2.642	0.32	0.19	0.16	0.15	440	1.68 (.70)	2.5 (105)	V
55HF-4m	25°21.5'	109°42.1'	2220	2.26	0.62	OS	OS	0.42	440	1.75 (.73)	7.4 (308)	V
61HF-4m	27°28.4'	111°19.2'	1840	2.892	0.29	0.17	0.25	0.17	440	1.71 (.71)	3.1 (130)	15°-30°
64HF-4m	26°45.1'	110°50.1'	1630	2.859	0.25	0.24	0.24	0.25	400	1.71 (.71)	4.3 (180)	V
65HF-4m	26°45.2'	110°51.0'	1620	2.918	0.25	0.24	0.25'	0.23	400	1.71 (.71)	4.0 (166)	V
66HF-4m	25°19.1'	109°49.4'	2350	2.262	0.19	0.45	OS	0.43	320	1.75 (.73)	> 8 (>335)	30°
68HF-4m	23°27.6'	108°20.9'	2630	1.810	OS	OS	OS	0.35	400	1.62 (.68)	5.7 (239)	V
69HF-4m	23°02.0'	107°59.6'	2560	1.799	0.15	0.12	0.12	0.11	420	1.62 (.68)	1.7 (72)	V
					0-167cm	167-228cm	228-289cm					
31 HFG	27°24.2'	111°26.0'	2025	2.892	0.38	0.22	0.23		289	1.63 (.68)	6.2 (260)	
					0-106cm	106-167cm	167-228cm	228-350cm				
34 HFG	26°58.2'	111°25.6'	2000	2.976	0.22	0.092	0.092	0.18	350	1.71 (.71)	2.5 (103)	
					0-61cm	61-122cm	122-183cm	183-244cm				
39 HFG	26°23.2'	110°44.5'	2755	2.642	0.07	0.06	0.09	0.07	244	1.68 (.70)	2.0 (85)	
					0-157cm	157-218cm	218-279cm					
46 HFG	25°31.4'	109'49.7'	3240	2.318	0.18	0.10	0.11		279	7 (.73)	3.0 (126)	
					0–1580	158-219cm						
57 HFG	25°21.1'	109°41.6'	2255	-----	1.14	0.36			219	1.71 (.71)	>10.0 (>420)	
					0-92cm	92-153cm	153-214cm	214-275cm				
59 HFG	25°40.0'	109°59.3'	2380	2.362	0.21	0.098	0.09	0.10	275	1 6 (.67)	2.5 (105)	
					0-123cm	123-184cm	184-245cm	245-306cm				
67 HFG	23°48.7'	109°07.2'	2435	1.841	0.06	0.015	0.023	0.027	306	1.62 (.68)	0.8 (32)	

† Depth intervals for ΔT: ΔT_1 = 0 - 140 cm; ΔT_2 = 140 - 240 cm; ΔT_3 = 240 - 340 cm; AT, = 340 - 440 cm, unless different intervals shown above T values.

OS = off-scale values

NA = not applicable

From Lawver and others (1973, p. 200)

ABSTRACT OF THE DISSERTATION

Equilibrium and Dynamic Aspects

of the Marine Geochemistry of Sulfur

by

Martin Bruce Goldhaber

Doctor of philosophy in Geochemistry

University of California, Los Angeles, 1974

Professor Isaac R. Kaplan, Chairman

This dissertation deals with the geochemistry of sulfur in nearshore, organic sitter-rich marine sediments. In such environments the major process affecting sulfur geochemistry is bacterial reduction of sulfate ion, producing dissolved sulfide. Dissolved sulfide subsequently reacts with iron oxide producing metastable iron sulfide and eventually iron pyrite. The pyrite sulfur may be present in larger amounts than sulfur originally buried with the sediment. implying some active transport mechanism of sulfur into sediments. The stable isotope ratio, S^{34}/S^{32}, in the pyrite is shifted toward lower values than are found in tho starting sulfate.

Because reactions in sulfur diagenesis occur in solution and involve dissolved sulfide, en appropriate starting point is a description of its chemistry. Accordingly, laboratory measurements were made of tho apparent dissociation constants of hydrogen sulfide. The first apparent dissociation constant was measured as a function of temperature and seawater chlorinity by a spectrophotometric technique. The second apparent dissociation constant was evaluated at constant temperature in potassium chloride solution by sulfide specific ion and pH electrode measurements. The results indicate that dissolved sulfide in pore waters of marine sediments exists predominantly as the bisulfide ion (70–90% of the total) followed by hydrogen sulfide (10-30%). The sulfide ion comprises <1% of the total.

The remainder of the study deals with sediment cores taken from the southern California borderland and the Gulf of California, from which pore waters were recovered by mechanical squeezing. The chemistry and isotopic abundance of sulfur in the pore fluids was compared to coexisting solid phases to deduce the mechanisms involved in pyrite formation.

The results suggest that burrowing activities of benthonic organisms act to supply sulfate sulfur to sediments. This is inferred by essentially constant pore water concentration profiles of dissolved ions in horizons where sulfate reduction is demonstrated by the presence of iron sulfides. The mixing process is limited to the upper half meter of the sediment column.

Below the mixed zone, the relative importance of addition of sulfate into sediments by diffusion as compared to burial of the sulfate ion is estimated for several cores. Assuming a diffusion coefficient of 10^{-6} $cm^2 sec^{-1}$, diffusion is predicted to be more important than burial in all cores studied, although the relationship between the two processes differs from care to core.

The dominance of diffusion wer burial is greatest fo a core from Pescadero basin in the Gulf of California. It is estimated that diffusion adds 0.4% sulfur by *dry* weight of sediment, whereas burial of sulfate adds less than 0.1% sulfur. The data are consistent with a diffusion coefficient of the sulfate ion frcm 0.5 to 0.8 × 10^{-6} $cm^2 sec^{-1}$. It is shown that diffusion can add isotopically light sulfur to sediments due to more rapid relative addition of $S^{32}O_4^{2-}$ compared to $S^{34}O_4^{2-}$ down a concentration gradient maintained by bacterial processes. The overall isotopic value of the sulfate so added is $\delta S^{34} = -4.5‰$. The depth distribution of sulfate-S isotopes in pore water is controlled by the balance between a bacterial kinetic isotope effect preferentially removing S^{32} over S^{34}, and the suppl of sulfate by diffusion. The isotopic fractionation facto *a*, calculated by a mathematical formulation which takes diffusion into account is larger (1.060 ± 0.010) than wher sulfate reduction is assumed to occur in a closed system (1.035). The larger value is supported by the sulfur isotope distribution in metastable iron sulfide. Essentially the same open system a was calculated for a core from Carmen basin.

An appreciable pore water sulfide concentration can result in a flux of sulfide sulfur by diffusion counter to the sulfate flux. This sulfide can enrich the surface layers' in diagenetic sulfur. The effectiveness of back diffusion of sulfide may range from about 40% of the sulfate flux down to 0%. calculation of the return sulfide flux was obtained by considering a charge balance constraint. In the Santa Barbara Basin sulfide does not escape from the sediments, but is trapped by rapid reaction with iron oxide. In other environments sulfide may be mixed out of the sediments by burrowing organisms.

The rate of sulfate reduction is positively correlat with sedimentation rate, which may in turn exert a contro on the reactivity of the sedimented organic carbon. The variability in rate of biological sulfate reduction is no paralleled by a similar variability in the rates of inorganic reactions involved in sulfur diagenesis. Therefore in rapidly deposited sediments, a buildup occurs of intermediates in the pyrite pathway such as dissolved sulfide and metastable iron sulfide.

HEAT FLOW MEASUREMENTS IN THE SOUTHERN PORTION OF THE GULF OF CALIFORNIA*

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Twenty-five new heat flow measurements made in the Gulf of California are presented. All the values except two at the mouth of the Gulf and two in the Sal si Puedes basin are high. The values ranged from 2.0 to greater than 10 μcal/cm^2 sec (82 to > 420 mW/m^2) with eight values greater than 5.2 (210 mW/m^2). Due to high rates of sedimentation throughout the Gulf, the actual heat flow, in many cases, may be up to 25% greater than that recorded.

Most of the heat flow stations are concentrated in the Farallon and Guaymas basins and show a marked increase towards the central deeps, where new crust is believed to be forming. The heat flow values in the Farallon basin show a sharp peak 10–15 km southeast of the central depression while those in the Guaymas basin peak in the depression.

The heat flow profiles across the Guaymas and Farallon basin, are remarkably similar to those observed on other well sedimented spreading centers such as the northern portion of the Explorer trough. Thus they may provide evidence that the crust is being created by an axially symmetric intrusion process with a major loss of heat due to hydrothermal circulation. The absence of magnetic anomalies in the Gulf has been attributed to the supposed presence of large grains in the intruded basalt. Large grains form by the slow cooling of the basalt under a layer of sediment. Prominent magnetic anomalies have been observed on the northern portion of the Explorer trough. Observational data suggest that the thermal processes at this ridge axis and the center of the Farallon basin are identical. We suggest that further careful study is needed in the Gulf before the slow cooling model is accepted as an explanation for the attenuation of the magnetic anomalies.

A MAJOR GEOTHERMAL ANOMALY IN THE GULF OF CALIFORNIA

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ABSTRACT

A profile of 10 heat-flow measurements was made in the southwest Guaymas depression in the Gulf of California. The 10 values describe a bell-shaped curve with a maximum of 30.3 HFU (1,250 mW/m^2). The depressions in the Gulf are considered to be surface expressions of recent extensional motion. Attempts to model the shape and magnitude of the observed anomaly indicate that the intrusion responsible for the Guaymas anomaly is episodic. Inversion of the heat-flow anomaly yields an age of 12,000 ± 5,000 years. This age is consistent with the width of intrusion observed on a seismic reflection profile. The intrusion appears to be about 1 km wide and can be accounted for by a 30 mm/yr spreading rate for 17,000 years. This most recent intrusion may be part of a larger intrusion roughly 100.000 years old that has intruded crust presumed 400.000 years old. This implies that the intrusions in the Guaymas Basin are not only episodic in place but jump sites of intrusion. This would help explain the lack of magnetic lineations observed in the Gulf. The background heat flux for the Guaymas Basin is nearly uniform at 3.4 ± .5 HFU (135 ± 20 mW/m^2) which suggests temperatures near 200°C, at a kilometer deep near the assumed basement sediment interface. This, coupled with high heat flow above the intrusions, makes the Gulf of California one of the most important geothermal prospects on the Earth.

ABSTRACTS

0127
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Temperature-Salinity-Depth Profiles from Deeps in the Gulf of California. During Hypogene expedition (March–April 1972, R/V Melville) eight closed deeps in Sal Si Puedes, Guaynas. Carmen, Farallon, and Pescadero basins of the Gulf of California vere probed to investigate the possible existence of Red Sea type hot brine pools. At each deep, stations vere made consisting of (A) a hydrocast with 5 and 30 liter Niskin bottles vith reversing thermometers and a temperature telemetering pinger belw the bottom bottle; (B) heat flw measurements; and (C) a large diameter gravity core. No anamalous hot brines vere found as (1) the temperature decreased in a11 cases with depth and (2) the' salinity throughout the vater column was normal with the salinity of the bottom bottle (0 to 5 meters off the bottom) never exceeding 34.9 °/oo. The acoustic signals from the temperature telemetering pinger vere recorded on both PDR and GDR depth sounders and vere used to construct temperature–depth profiles which vere compared to absolute temperature and depth values obtained from reversing thermometers. The values of temperature between the telemeter and the thermometers agreed to within 0.25°C after correction was made for a fixed calibration error of 0.50°C. In short there are presently no Red Sea type brine poola in the major basins of the Culf of California.

0163
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Activity Coefficients of Na^+, Cl^-, Mg^{++}, Ca^{++}, and K^+ in Sea Water from the Gulf of California by Shipboard Electrode Measurements. The apparent activity coeffident (γ) of some of the major elements in sea water was measured on the R/V Melville during Hypogene expedition to the Gulf of California. The analytical technique consisted of (1) making four serial decade dilutions into the Debye-Huckel range of water from hydrocasts into the basins of the Culf; (2) measuring the electrode response of the sample and its various dilutions vith an automatic multi-channel electrochemical wter; (3) cslculating by the least squares method the slope and intercept of the response curve (millivolts versus p Ion) in the dilute region vhere $\gamma \to 1$; (4) solving far the apparent γ in undiluted sea water by $\ln \gamma_{apparent} = \frac{nF}{Rt}\{\Delta V\} + \ln \gamma_{Debye\text{-}Huckel}$ where ΔV = measured voltage − extrapolated voltage. The composited mean values for all hydrocasts are:

γNa = .76 (63 samples) σ = 0.08
γCl = .73 (58 samples) σ 0.11
γMg = .31 (32 samples) σ = 0.14
γCa = .15 (61 samples) σ = 0.13
γK = .68 (31 samples) σ = 0.15

ELECTROCHEMICAL MEASUREMENTS IN SEA WATER FROM THE GULF OF CALIFORNIA

I. OPERATIONAL ACTIVITY COEFFICIENTS

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ABSTRACT

The operational activity coefficient $\gamma_i^* \equiv \frac{A_i^*}{M_i}$ is defined and evaluated for samples from hydrocasts from eight basins in the Gulf of California. The analyses consisted of (1) making for each ample four serial decade dilutions into the Debye-Huckel range, (2) measuring the electrode response of each sample plus the various dilutions with a multi-channel electrochemical meter; (3) calculating, by assuming the conservancy of sea water, a least squares solution of the electrode response curve in the dilute range where $\gamma_i^* \to 1$: and (4) solving for inteal sea water by $\ln \gamma_i^* = \frac{zF}{RT}(\Delta V) + \ln \gamma_i$ Dabye–luckel where ΔV = measured voltage − extrapolated voltage from the least squares solution of the response curve. The composited mean value for a11 hydrocasts are:

γ_{Cl}^* = 0.73 (58 samples) σ = 0.11

γ_{Na}^* = 0.76 (63 samples) σ = 0.08

γ_{Na}^* = 0.76 (52 samples) σ = 0.13

γ_{Mg}^* = 0.31 (32 samples) σ = 0.14

γ_{K}^* = 0.68 (31 samples) σ = 0.15

"Why no hot brines?"

The Gulf of California is structurally, geologically, and geophysically like the Red Sea, has known geothermal and hydrothermal mineralization on the adjacent Peninsula of Baja California; but as the Hypogene Expedition demonstrated the Gulf presently does not have either (1) hot brine pools or (2) proto-metallic-ore sediments in its basins. Whether there ever were hot brines in the basins of the Gulf certainly is a moot question at this stage of the analyses of the data. Lawver and his co-workers (1973, 1975 in prep.) report exceptionally high beat flow values for the Guaymas, Farallon, and Sal Si Puedes basins. However cores from these basins do not show the mineralized facies found in the brine pools of the Red Sea as described by Bischoff (1969) and the overlying wster temperature is normal. Of course, hot water or high heat flow does not necessarily mean hot brines or mineralizing solutions. As Craig (1969) has shown the high salinity of the hot brines of the deeps in the Red Sea originate by the passage of hot water through salt bede. This excess salinity makes the Red Sea brines denser than the overlying water keeping the brine in the basins. Thus the lack of brines in the Guaymas, Sal Si Puedes, and Farallon basins, in the presense of high heat flow simply may indicate that no salt deposits were encountered in the upward migration of the geothermal fluid.

The metallic content of the sediments, given by the acid leach technique, shows (1) relatively low values in the basins with high heat flow and (2) generally higher values in the southern basins with respect to the northern basins. The metallic content correlates inversely with the rate of sedimentation (Van Andel, 1964; Goldhaber, 1974) in the Gulf. This suggest as a first approximation a constant metallic flux in the Gulf with the absolute concentration determined by dilution with non metallic sediments. The values for Cu, Ni, Fe, Mn, Zn, and Pb in the sediments are higher than in sea water, but whether the flux is from or towards the overlying water column is difficult to determine. Only Hypo 11 G, from tha Guaymas basin, shows a decrease in metallic content towards the top of the core suggesting a flux towards sea water. The othor core samples either shoved no discernable trend or for Hypo 39 G (Carmen Basin); Hypo 49 G (North Pescadero Basin); and Hypo 70 HFG (Mazatlan Basin) a decrease in the metallic content with depth.

The geochemical conditions at the sen water-sediment interface and in marine bottom sediments in general favor the fixing of metallic ions in mineral phases rather than as dissolved species. This is demonstrated by Eh-pH diagrams (Schmitt, 1962) for the metals Co, Cu, Ni, Pb, Fe, and Mn for both the oxidizing and reducing conditions and the sllghtly alkaline pH found in marine environments, except that Mn tends to be dissolved in lov Eh environments. Comparison of the analyses of interstitial water in the cores from Goldhaber (1964) with the metallic values in the sediment show a correlation of high values of Ni, Cu, and Mn near the tops of the cores with (a) low alkalinity, (b) high sulfate-low sulfide, and (c) relatively high Eh. This suggest that the acid leach technique is more efficient in breaking down oxides than sulfides or that there is a real enrichment in the near surface zone. A pore complete discussion of the direction of the metallic flux will have to await the data from the complete mineralogical and metal analyses now being done by G. Arrhenius at Scripps.

Although we can see no evidence of potentially economic deposits from the acid leach analyses of the Hypogene cores, is there a possibility of economic concentrations previously formed but now buried as a result of the present relatively high rate of sedimentation in the Gulf? The samples wlth the higher metallic values come from the Mazatlan basin which is more related to the East Pacific Rise than the Gulf. The Mazatlan basin and possibly the Guaymas basin should he attractive sites for future Deep-Sea Drilling or I.P.O.D. operations.

As this section is entitled "Afterword" please do not consider this I "FinalWord". The forty days of Hypogene has produced a wealth of intriguing data whose interpretations by the numerous research workers is and will be appearing in the scientific literature.

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