

## **APPENDIX C CURRENT MEASUREMENT SURVEY**

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### C.1 Introduction

La Unión city is in the region of El Salvador that faces the Gulf of Fonseca, close to the border of Honduras. The entrance of the Gulf faces south-west and the navigation channel to La Unión Port follows the western fringe of the engulfment, passing between volcanic outcrops such as Isla Conchaguita and Isla Zacatillo. The Gulf is relatively sheltered from wave activities, whereas the tidal range of more than 3 m on spring tides gives rise to tidal currents that reach 2-3 knots.

In August 2001, the JICA Study Team commenced the Detailed Design on Port Reactivation Project in La Unión Province of the Republic of El Salvador under Japan's technical assistance and various field investigations were carried out in order to grasp the existing natural condition at the site. A current measurement survey was carried out as one of the field surveys on site with an aim at grasping the existing current speeds and directions at the project site. Also, a harmonic analysis was carried out based on the data gained through the survey. The results of the tidal current measurement survey were utilized for the succeeding simulation studies of sedimentation and ship simulation.

### C.2 The Project Specification

#### C.2.1 Outline

The objective of the Current Measurement Survey at the Project site was to collect the information on speeds and directions of the tidal currents and carry out a harmonic analysis.

#### C.2.2 The Scope of Work

The scope of the Works are listed below.

- a) Carry out the necessary preparations in San Salvador, in which all available information about the Project area will be collected and analyzed.
- b) Field preparations and installation of Acoustic Doppler Current Profiler (ADCP) at the designated locations in navigation channel, turning basin, and disposal site of dredged materials.
- c) Carry out a 15-day current measurement survey in order to obtain the data of the current speeds and directions at 5 basic stations.
- d) Carry out a 25-hour current measurement survey in order to obtain the data of the current speeds and directions at 5 secondary stations.

- e) Perform processing and evaluating all the raw field-data into harmonic constants and current ellipse.
- f) Perform processing and evaluation all the raw field-data into appropriate charts, tables.
- g) Predict future currents in terms of speeds and direction at the survey locations.

### **C.3 Field Operation and Methodology**

#### **C.3.1 15-day Current Measurement Survey**

##### **(1) Outline**

The field operation of the 15-day Current Measurement Survey was carried out at 5 basic stations as shown in Figure C.3.1. In general, the Survey progressed smoothly without major problems.

The purpose of the Current Measurement Survey was to obtain current speeds and directions at upper layer (-1m from the surface), middle layer, and lower layer (+1.5m from the bottom).

Each ADCP unit was installed with stainless steel basement and supported by buoys and sinkers. The current observations were made every 10 minutes for 15 days continuously.

Figure C.3.2 illustrates how ADCPs were installed on the seabed.



Figure C.3.1 Location of Current Measurement Survey

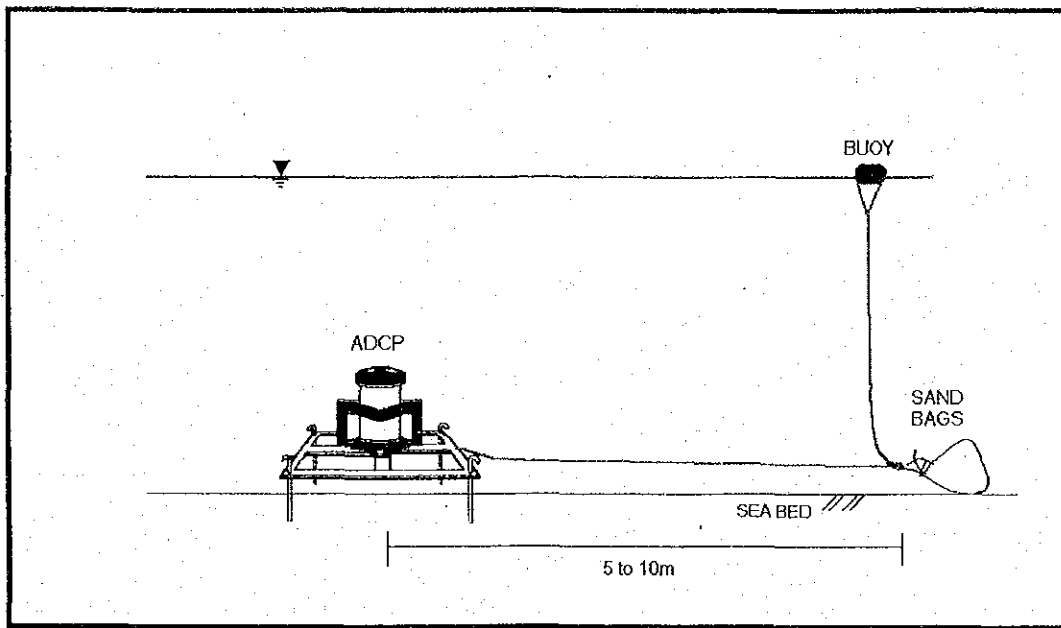


Figure C.3.2 Current Observation for 15 Days by ADCP

Each ADCP was deployed at the designated locations as shown in Figure C.3.1 and each coordinate is shown in Table C.3.1.

Table C.3.1 Coordinates of Basic Stations

Location	Latitude (N)	Longitude (W)	Depth (m)
B-1	13° 19.99'	87° 49.08'	5.5
	13° 19' 59"	87° 49' 05"	
B-2	13° 18.83'	87° 47.31'	6.5
	13° 18' 50"	87° 47' 19"	
B-3	13° 15.90'	87° 46.85'	14
	13° 15' 54"	87° 46' 51"	
B-4	13° 12.17'	87° 48.29'	11
	13° 12' 10"	87° 48' 17"	
B-5	12° 56.32'	88° 02.31'	50
	12° 56' 19"	88° 02' 19"	

ADCP-Broad-Band made by RD Instruments, implements advanced signal-processing technology known as pulse-to-pulse coherent sonar. Broad-Band's improved capabilities expand the scope of applications for ADCP measurements.

Specifications of ADCP are as follows:

Current Profiling

Max profiling range: 140m  
Depth cell size: 0.2~8m  
Number of depth cells: 4~128  
Beginning of first cell: 2m  
Speed range:  $\pm 10$ m/sec  
Accuracy:  $\pm 1\%$  or 0.5cm/sec

Echo intensity

Accuracy:  $\pm 1.5$ dB

Temperature

Range:  $-5 \sim +45$ °C  
Accuracy:  $\pm 0.4$ °C

Tilt

Range:  $\pm 20$ °  
Accuracy:  $\pm 0.4$ °

Compass

Accuracy:  $\pm 2$ °

### C.3.2 25-hour Current Measurement Survey

#### (1) Outline

The field operation of the 25-day Current Measurement Survey was carried out at 5 secondary stations as shown in Figure C.3.1. In general, the Survey progressed smoothly without major problems.

The purpose of the 25-hour Current Measurement Survey was to obtain current speeds and directions at each position. Observations were carried out in order to supplement the data gained through the 15-day Current Measurement Survey.

Coordinates of secondary survey stations are shown in Table C.3.2.

**Table C.3.2 Coordinates of Secondary Stations**

Location	Latitude (N)	Longitude (W)	Depth (m)
S-1	13° 20' 16"	87° 49' 38"	8
S-2	13° 19' 17"	87° 47' 51"	6
S-3	13° 17' 49"	87° 46' 26"	20
S-4	13° 14' 10"	87° 47' 35"	12
S-5	13° 10' 35"	87° 49' 00"	12

#### C.4 Survey Results

##### C.4.1 15-day Current Measurement Survey

The results of the 15-day current measurement survey are shown in Table C.4.1.

**Table C.4.1 Fastest Current Speed During Ebb and Flood Tide at Each Layer**

Observation Layer	Ebb Tide			Flood Tide			
	M/D/H/M	Speed (cm/s)	Direction	M/D/H/M	Speed (cm/s)	Direction	
B-1	L	9/20/8/50	133.1	120	9/21/2/20	84.6	301
	M	9/20/8/50	148.3	124	9/20/1/20	96.6	303
	U	9/19/20/10	159.5	128	9/19/0/50	97.4	307
B-2	L	9/19/8/30	118.4	137	9/20/1/20	80.0	309
	M	9/20/8/50	142.0	138	9/19/14/30	98.2	314
	U	9/19/20/30	178.9	136	9/19/1/20	115.8	324
B-3	L	9/21/21/10	128.7	222	9/19/12/00	102.9	30
	M	9/21/21/10	139.1	218	9/20/1/40	111.3	41
	U	9/21/21/10	155.7	215	9/20/1/40	112.3	50
B-4	L	9/18/6/30	87.1	206	9/19/11/40	81.7	44
	M	9/19/20/20	101.3	191	9/19/1/20	85.4	37
	U	9/19/7/50	116.8	194	9/21/3/50	66.0	36
B-5	L	9/17/17/10	55.2	223	9/19/0/30	46.2	54
	M	9/21/8/40	48.5	262	9/19/13/50	45.3	80
	U	9/21/20/40	68.1	259	9/20/13/00	43.1	6

L: Lower Layer, M: Middle Layer, U: Upper Layer

M/D/H/M: Month/Day/Hour/Minute

##### C.4.2 25-hour Current Measurement Survey

The fastest current speed and direction at each station for the 25-hour current measurement survey are shown in Table C.4.2.

**Table C.4.2 Fastest Current at Each Station**

Location	S-1	S-2	S-3	S-4	S-5
Month/Day/Hour	9/17/7	9/17/7	9/21/15	9/21/10	9/19/9
Speed (m/sec)	1.23	1.62	1.45	1.47	0.93
Direction(°)	120	135	355	195	225

## C.5 Findings

### C.5.1 15-day Current Measurement Survey

A harmonic analysis has been conducted by using the current data gained through the survey in order to characterize the currents at each station. Section C.7 of this appendix shows the detailed results of the harmonic analysis of each station. The following can be said according to the results.

- 1) As for the components of the tidal currents, M2 components were dominant in all the stations. The amplitudes of M2 components of upper layer at B-1, B-2 and B-3, amounted to about 0.62, 0.72 and 0.69 m/sec respectively, and they are larger than B-4 and B-5. Since the tidal currents were influenced by the shape of sea bottom and the coastal topography, the directions of currents at B-1, B-2 and B-3 agree with those of the channel, and those are almost parallel to the coastlines. Thus, shapes of ellipses are relatively flat. The constant currents derived from the harmonic analysis are very important, because the movable materials in the sea, such as pollutants and sediments, are moved into the direction of the constant currents. Out of La Unión Gulf, in open sea at B-4 and B-5, the constant currents whose velocity amounted to 0.081 and 0.080 m/sec respectively, which are weaker than those at other stations. However, the characteristics of the directions of both currents are different; the current at B-1, B-2, and B-3 show changing "back and forth or two ways" trends, and that at B-4 and B-5 show changing "go around with time changing" trends.
- 2) According to Table C.4.1, current speeds are getting faster from the bottom to the surface at each station during the ebb tide in general. However, since B-4 and B-5 are located out of the Gulf, the current speeds are getting faster from the surface to the bottom during the flood tide period. The fastest current speed was 178.9 cm/sec at upper layer of B-2 during the ebb tide.
- 3) Currents during the ebb tide are faster than those of the flood tide at all the stations.
- 4) Table C.4.3 summarizes the predicted fastest current and direction at each station according to the results of the harmonic analysis. The predicted fastest current speed is slower than recorded one. But the direction of the fastest current is almost same as the recorded one.



**Table C.4.3 Fastest Current Predicted at Each Station**

Station	Speed (cm/sec.)	Direction
B-1	119	124
B-2	136	137
B-3	145	214
B-4	78	196
B-5	34	265

Table C.4.4 shows constant current speed at each station.

**Table C.4.4 Constant Current at Each Station**

Station	Speed (cm/sec.)	Direction
B-1	10.0	125
B-2	13.9	130
B-3	11.0	196
B-4	8.1	155
B-5	8.0	317

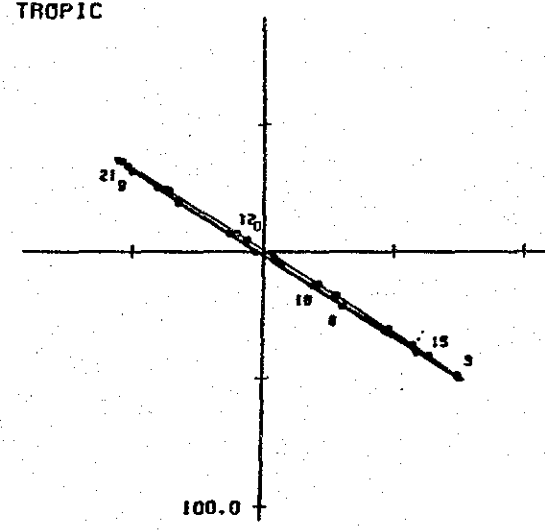
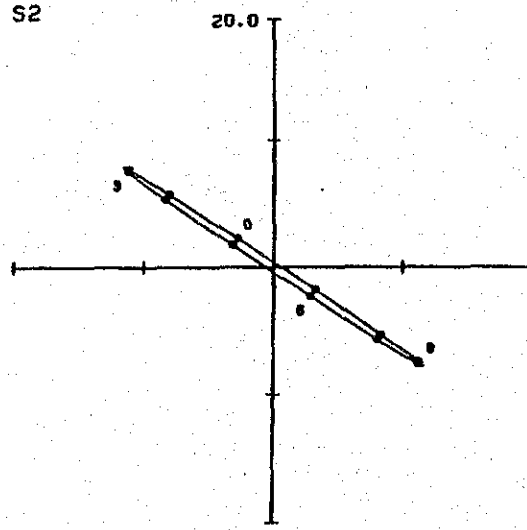
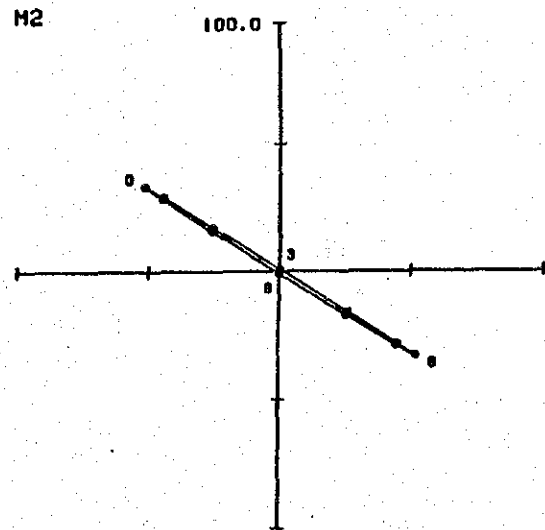
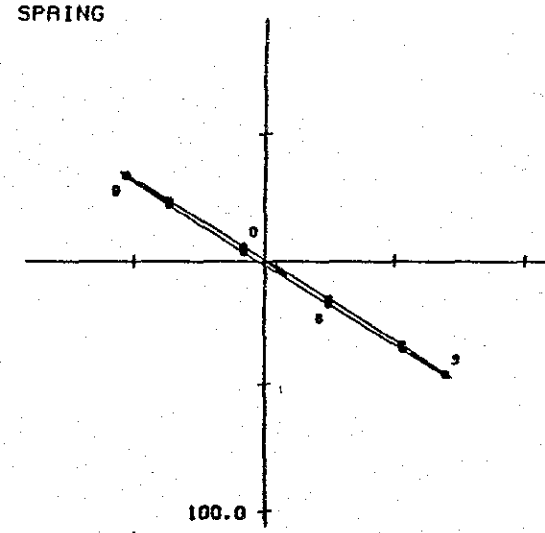
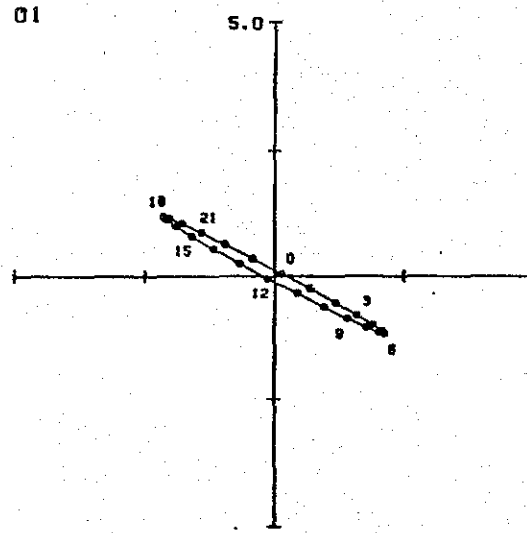
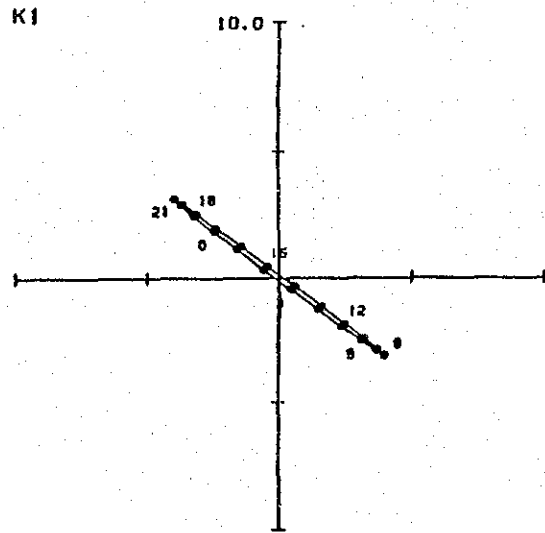
### C.5.2 25-hour Current Measurement Survey

The results of the 25-hour Current Measurement Survey are summarized below. Findings are described below.

- 1) As for the components of the tidal currents, M2 components were dominant in all stations. The main characteristics of the result are similar to the 15-day observation outputs.

## **C.6 Tidal Eclipse at Observation Stations**

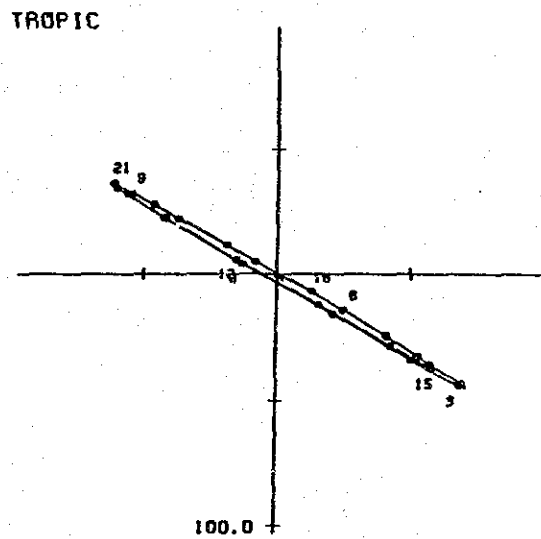
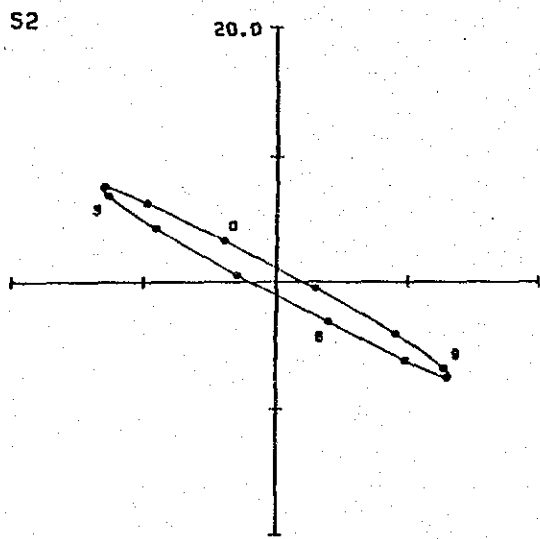
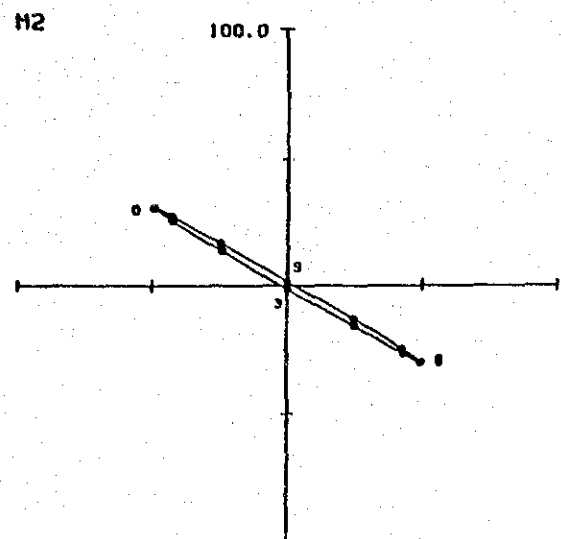
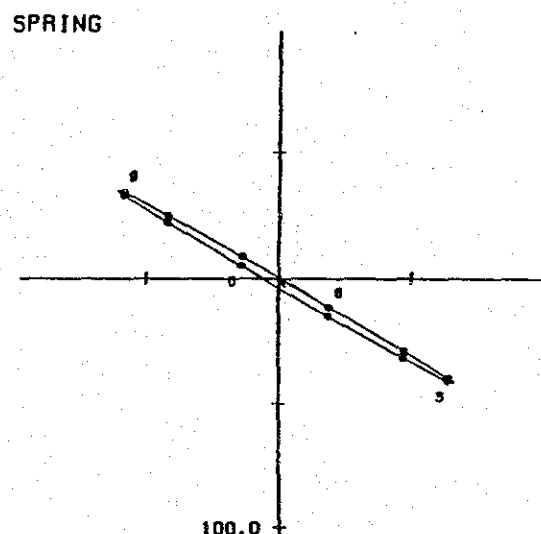
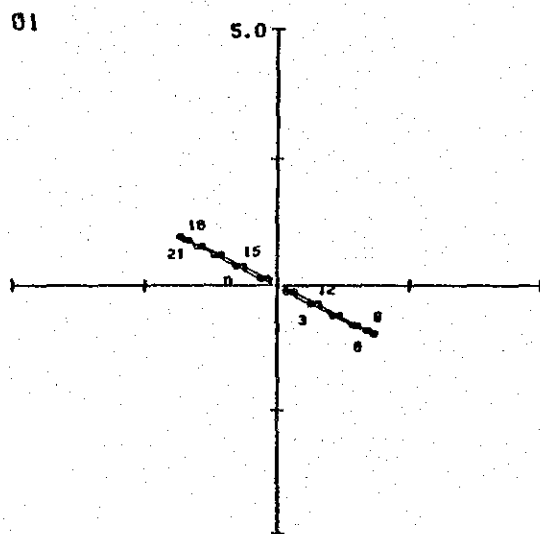
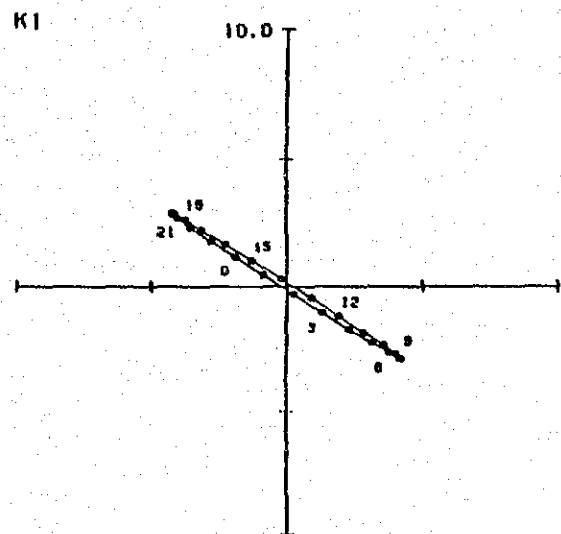
C-10



Tidal Eclipses at St. B-1 Upper

Unit: cm/sec.

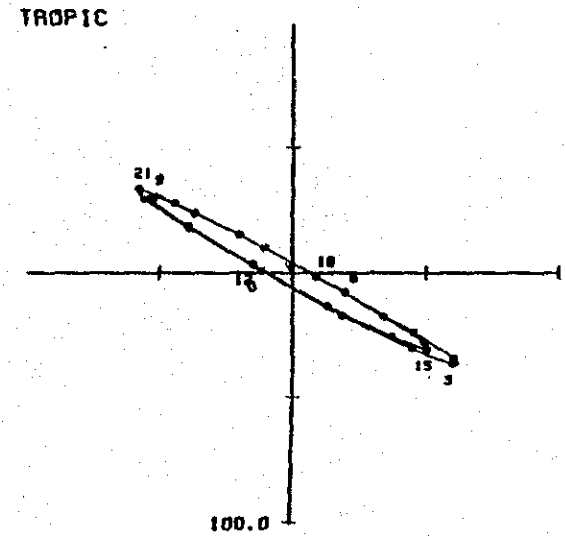
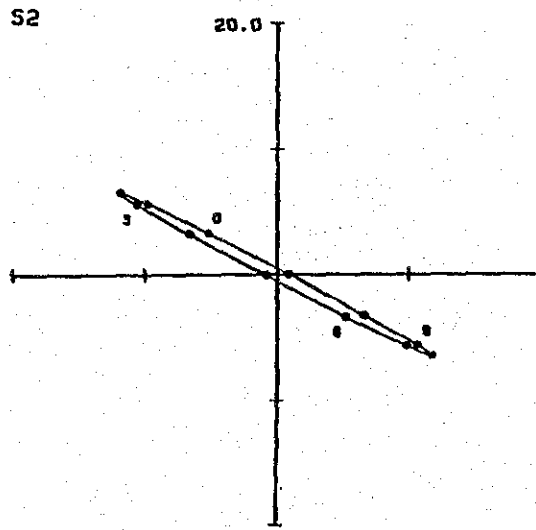
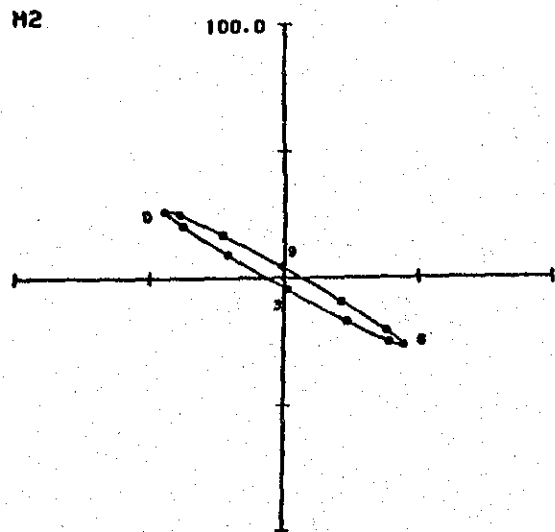
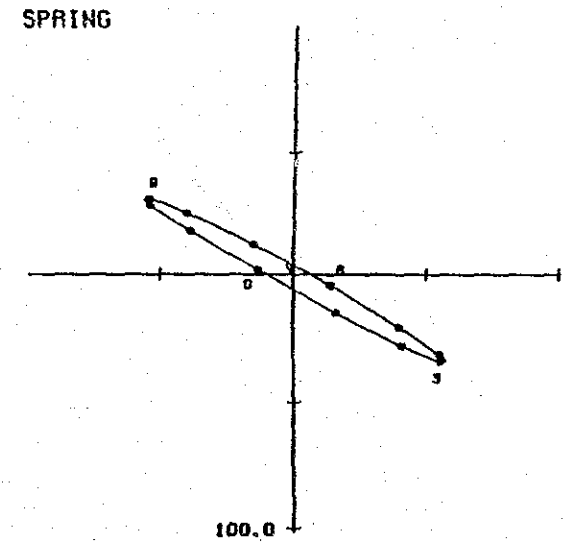
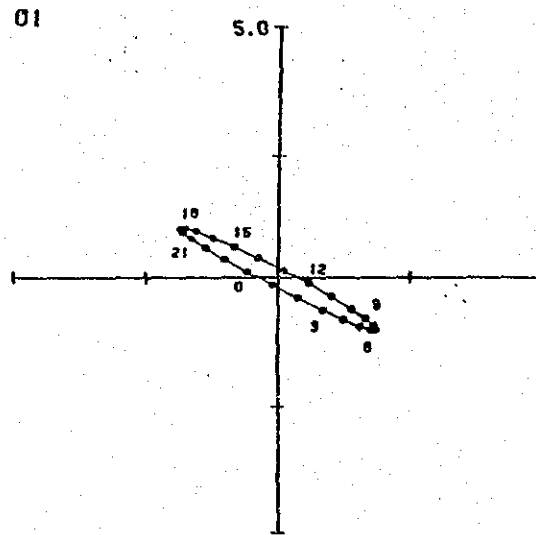
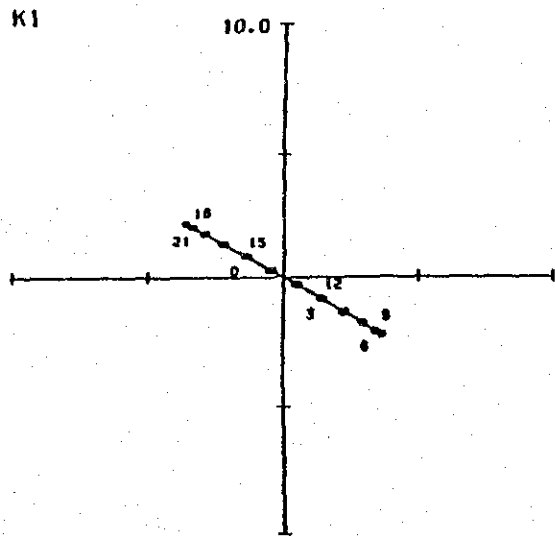
C-11



Tidal Eclipses at St. B-1 Middle

Unit: cm/sec.

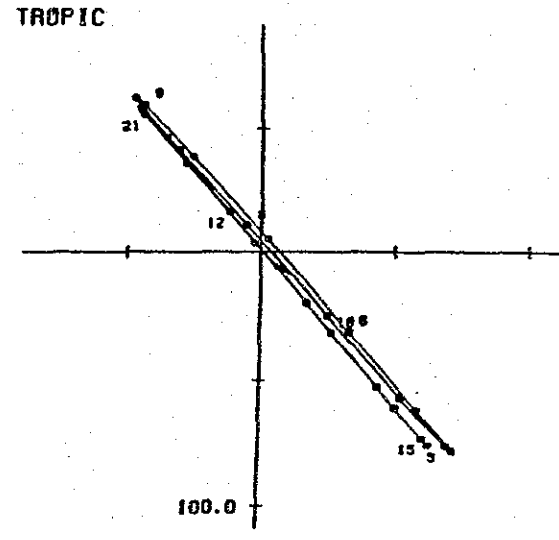
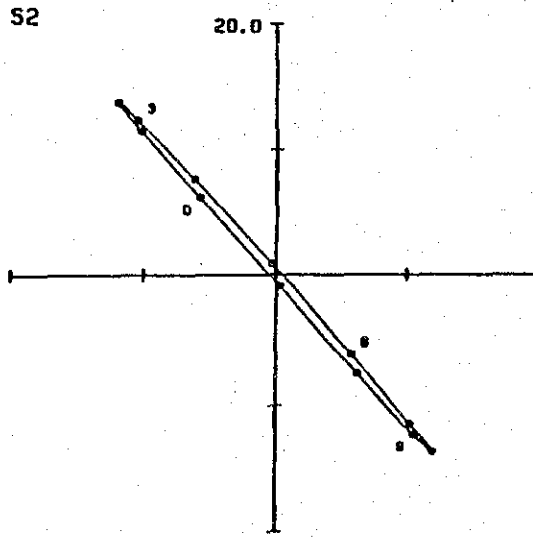
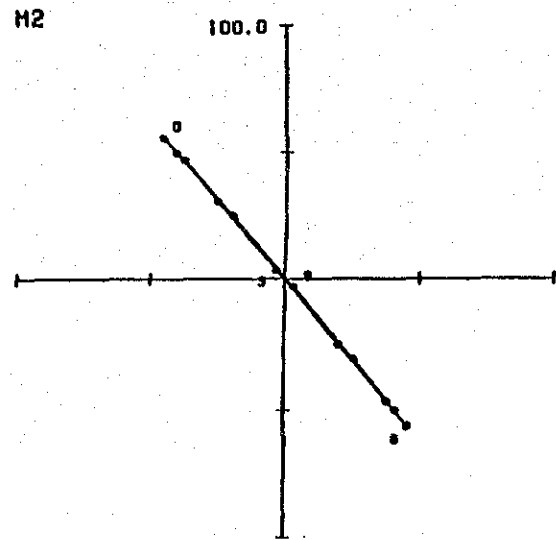
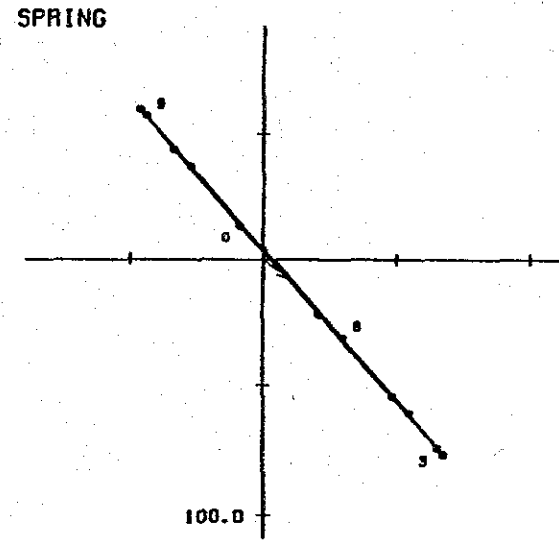
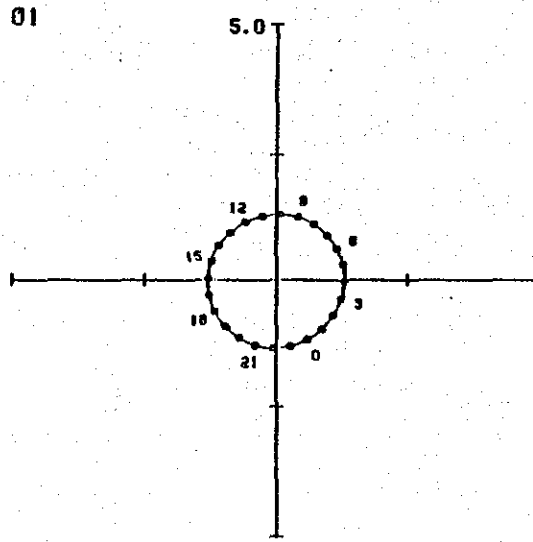
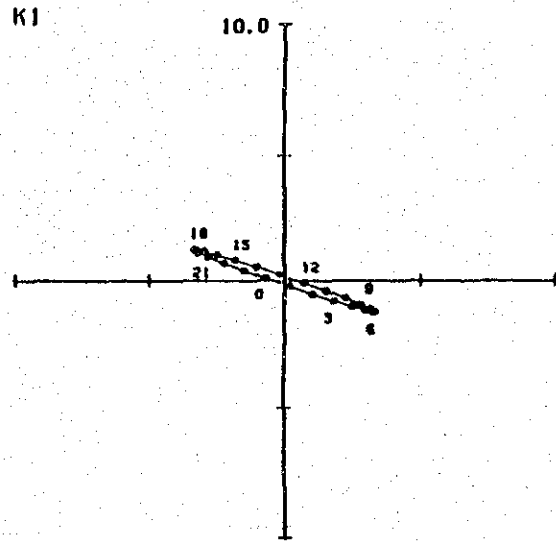
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Tidal Eclipses at St. B-1 Lower

Unit: cm/sec.

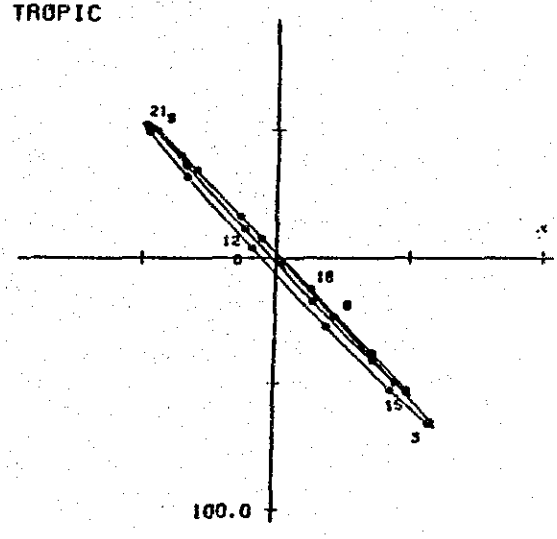
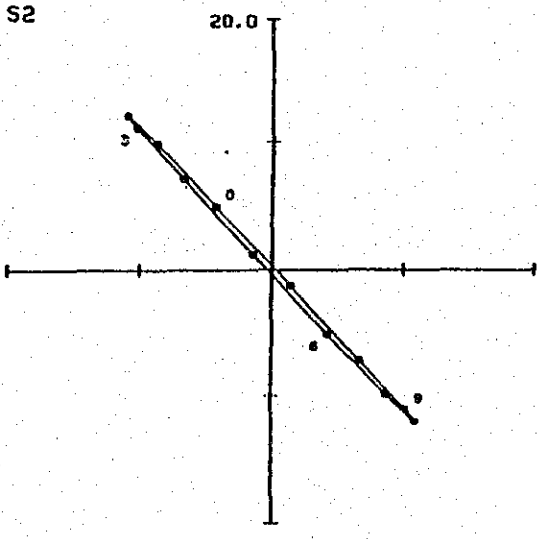
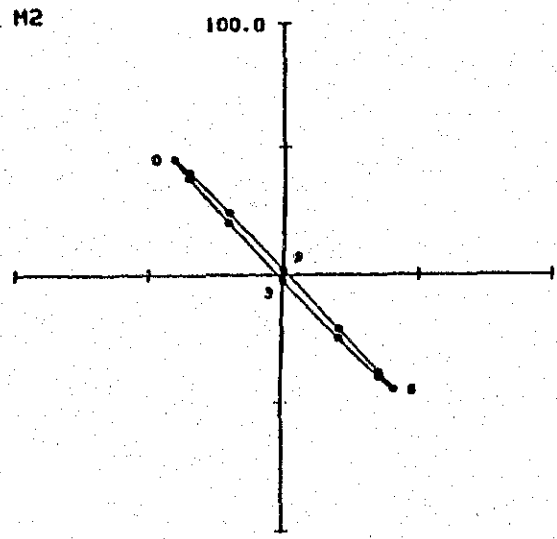
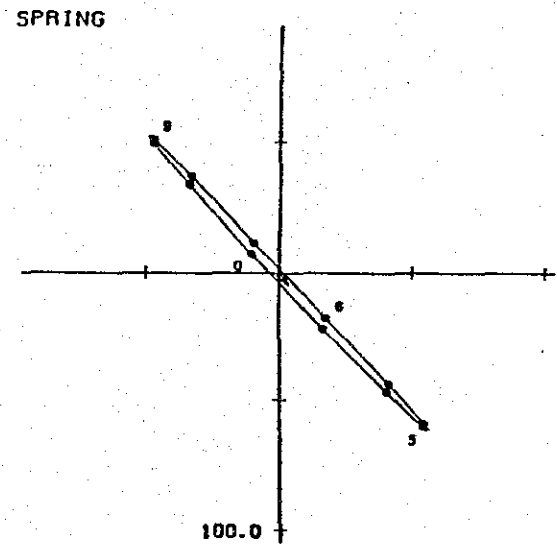
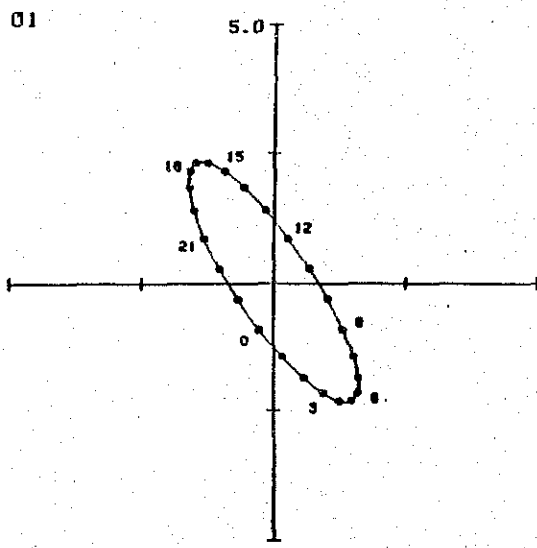
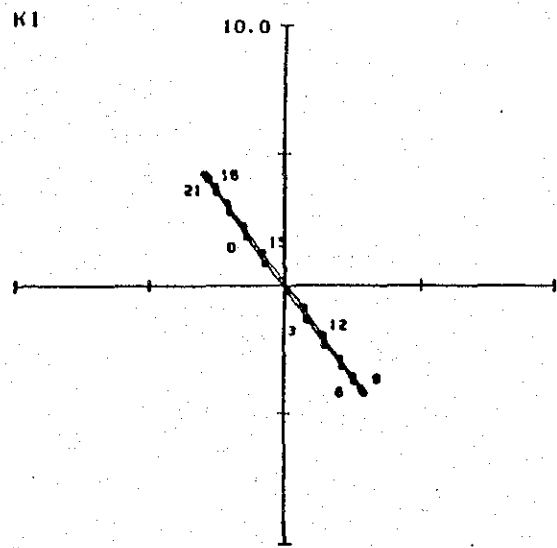
C-13



Tidal Eclipses at St. B-2 Upper

Unit: cm/sec.

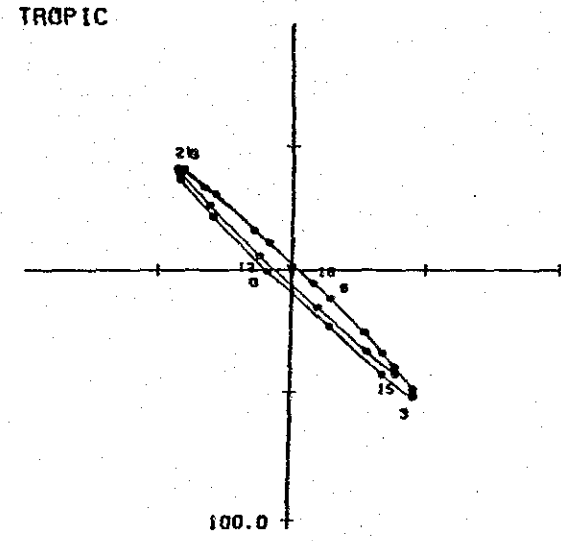
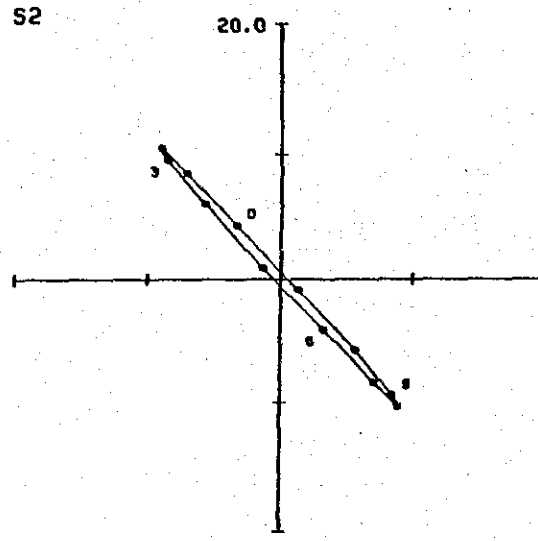
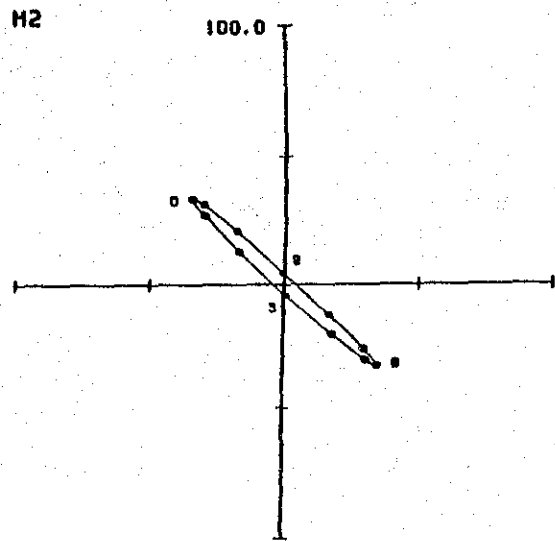
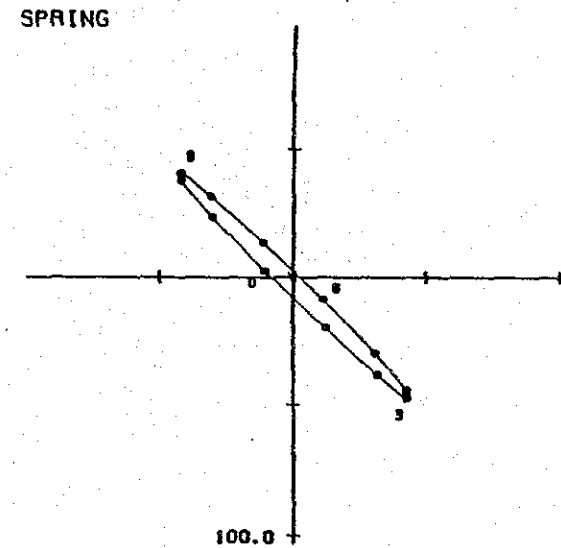
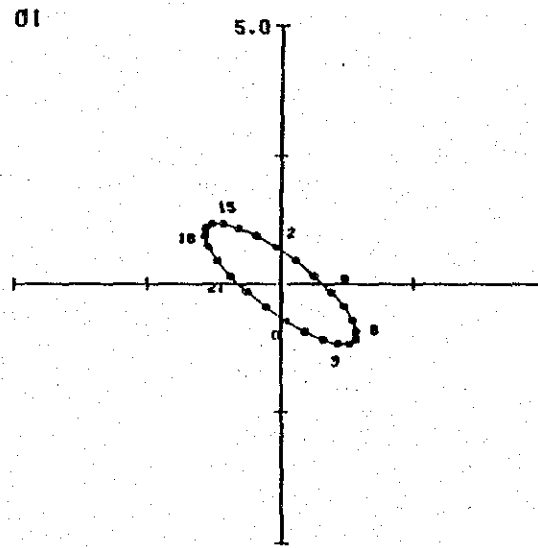
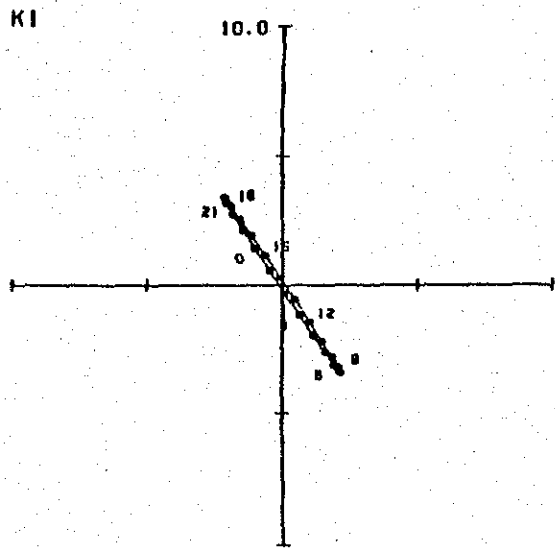
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Tidal Eclipses at St. B-2 Middle

Unit: cm/sec.

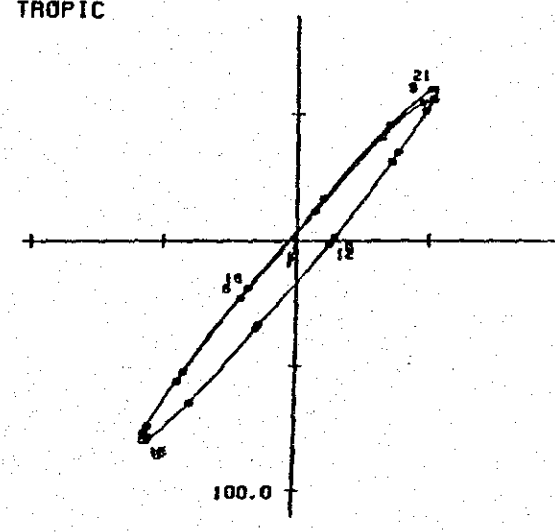
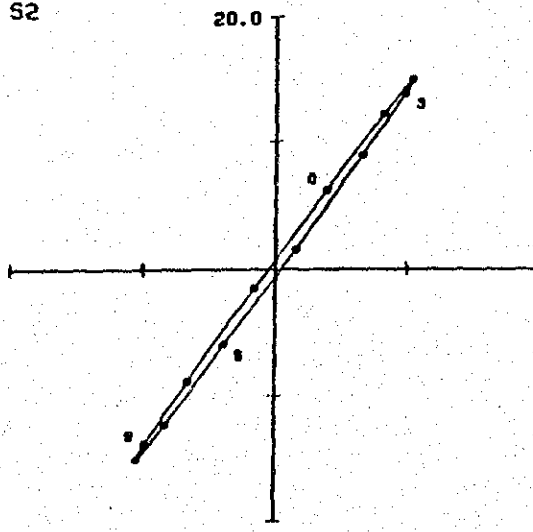
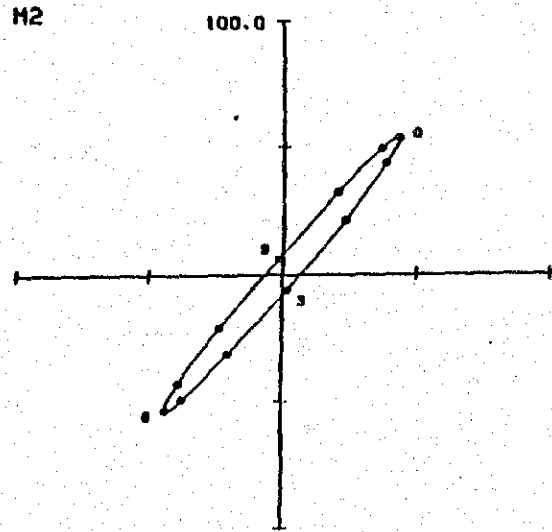
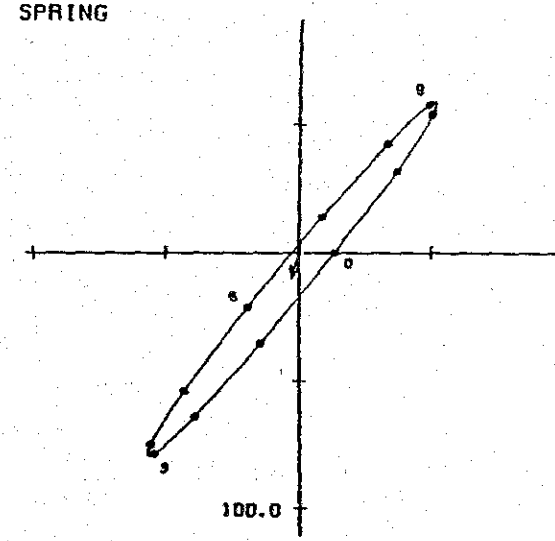
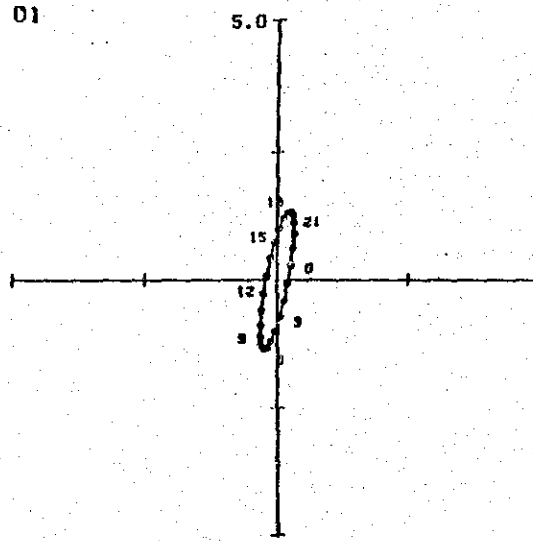
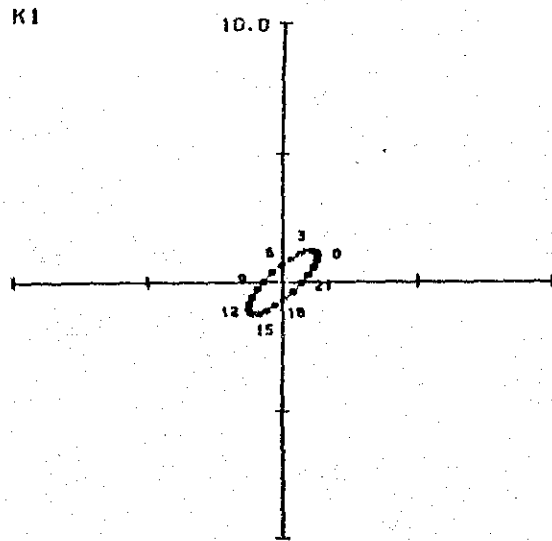
C-15



Tidal Eclipses at St. B-2 Lower

Unit: cm/sec.

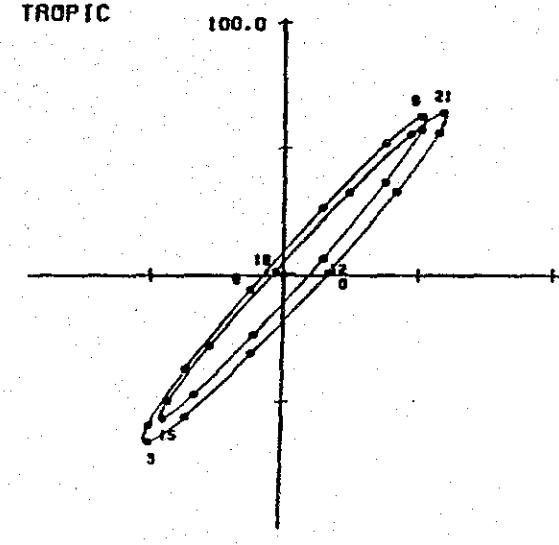
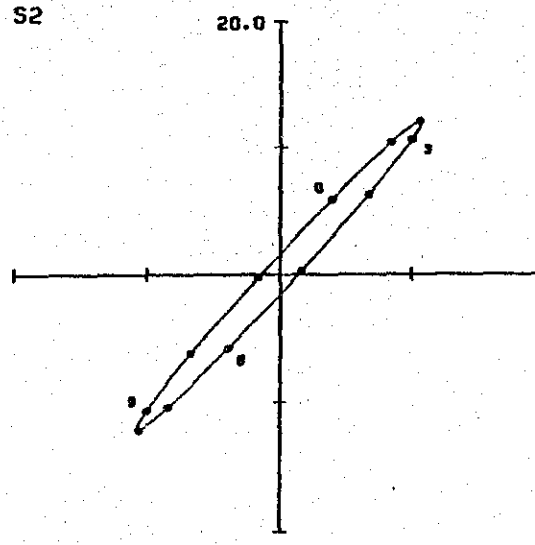
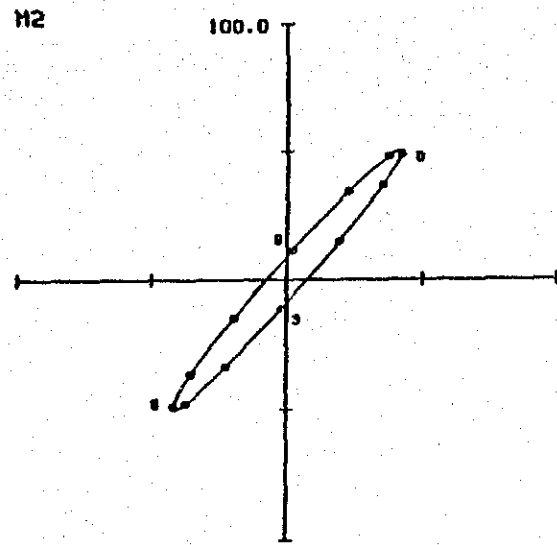
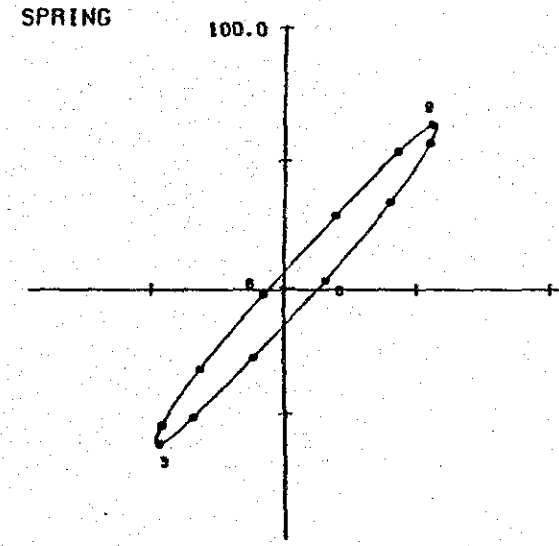
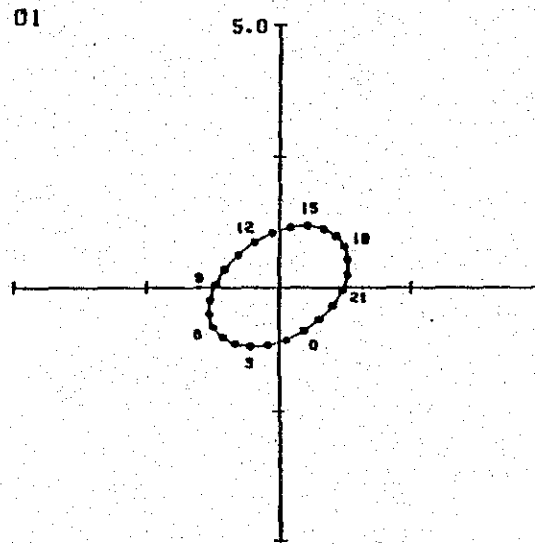
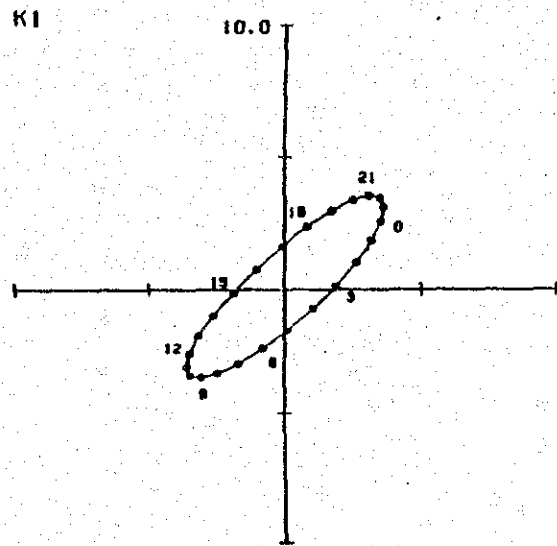




Tidal Eclipses at St. B-3 Upper

Unit: cm/sec.

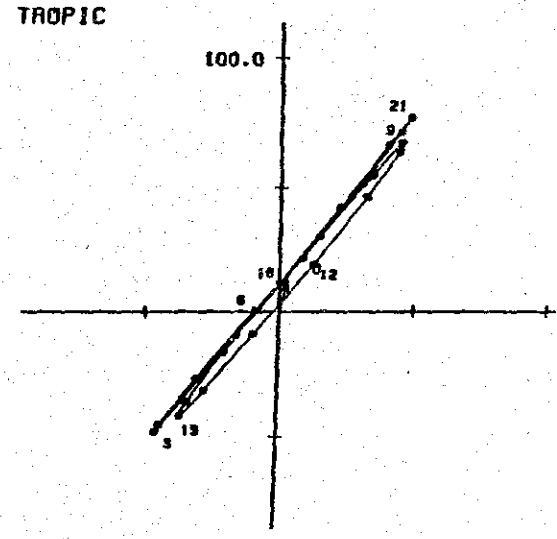
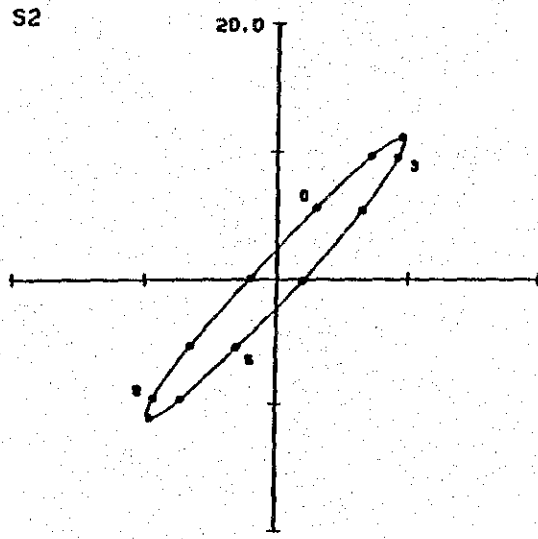
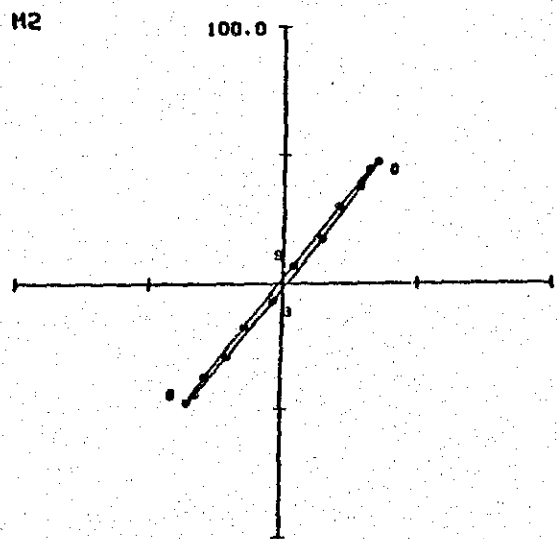
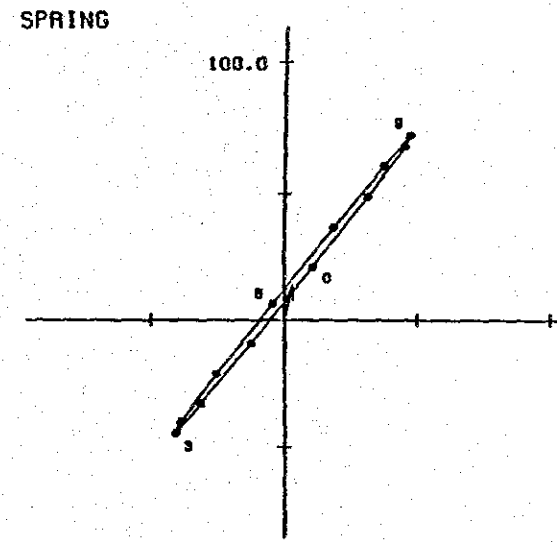
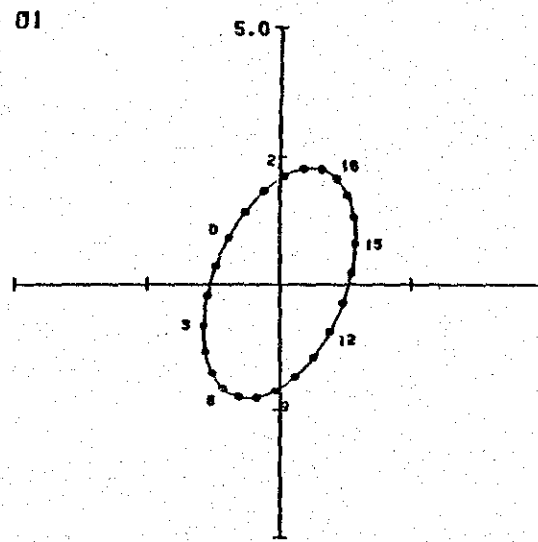
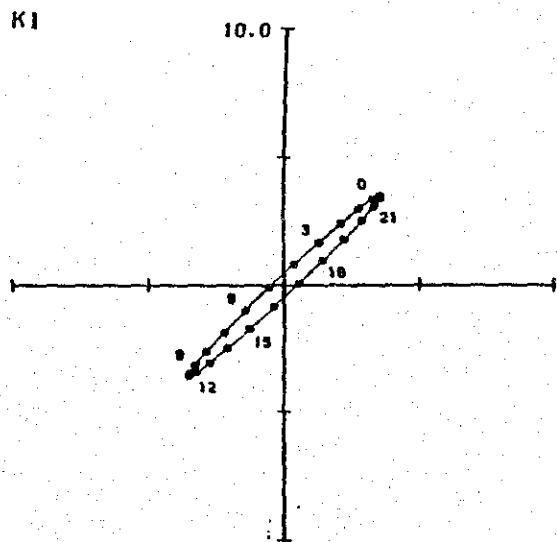
C-17



Tidal Eclipses at St. B-3 Middle

Unit: cm/sec.

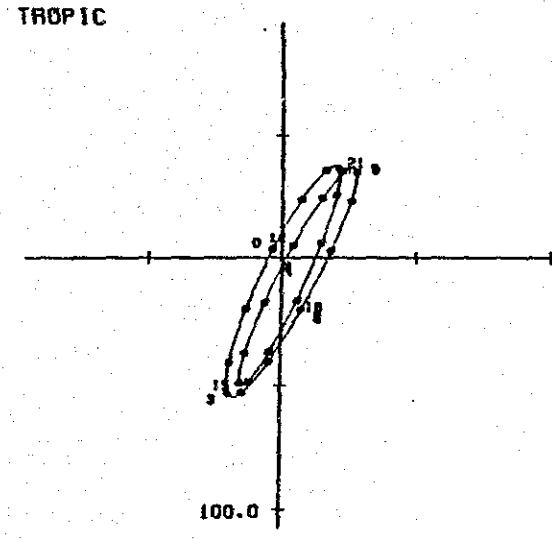
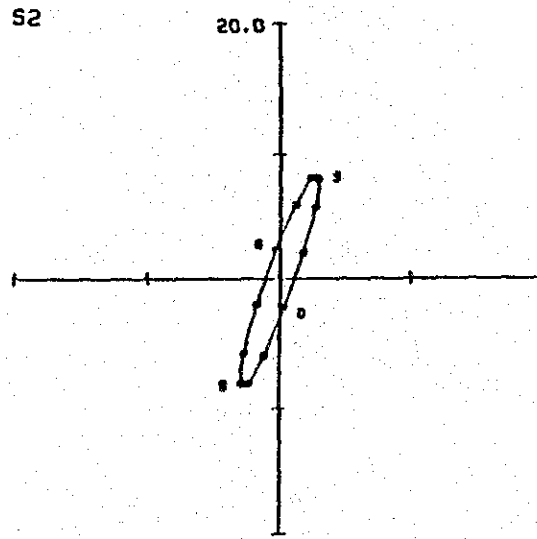
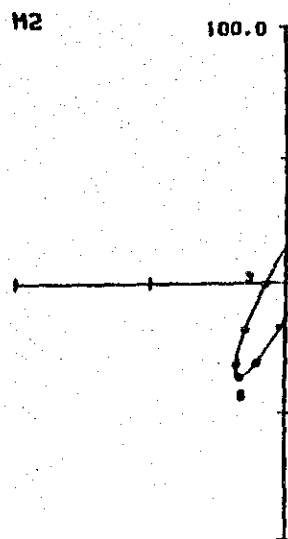
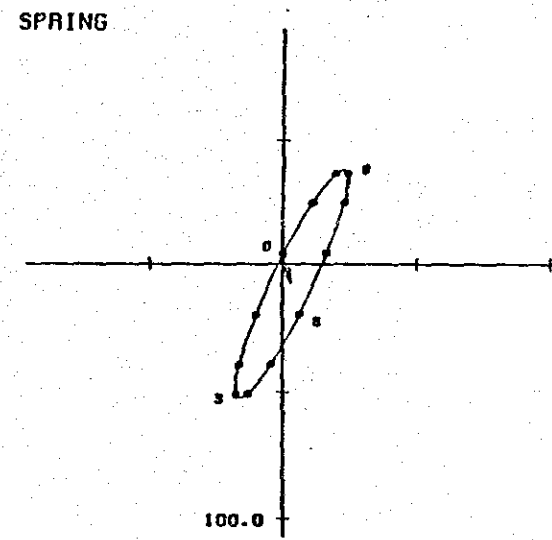
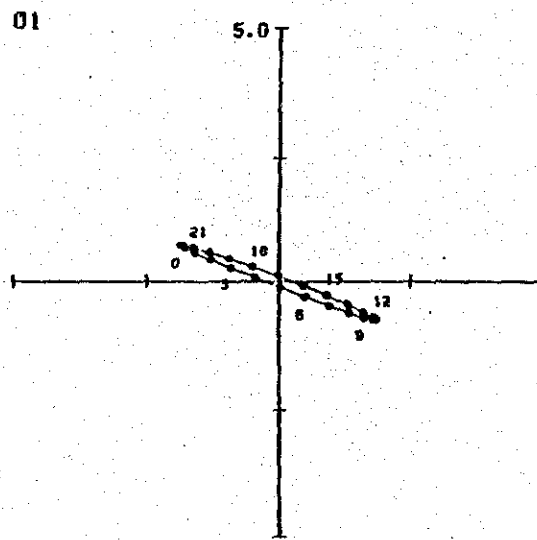
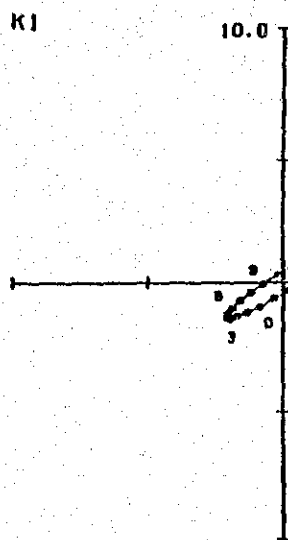
C-18



Tidal Eclipses at St. B-3 Lower

Unit: cm/sec.

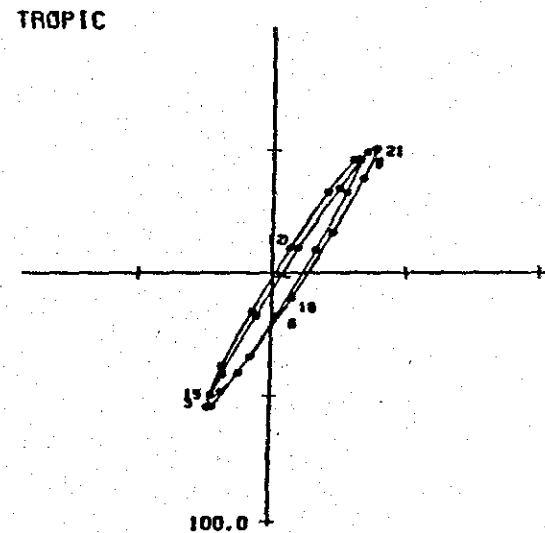
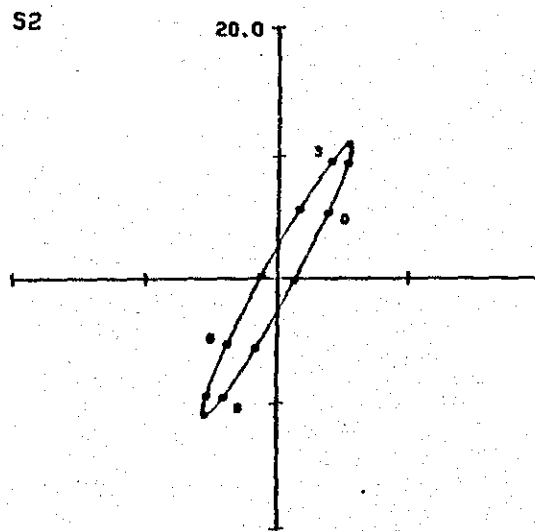
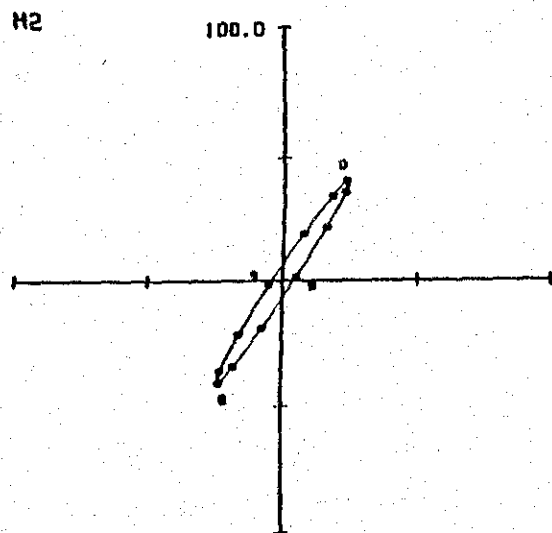
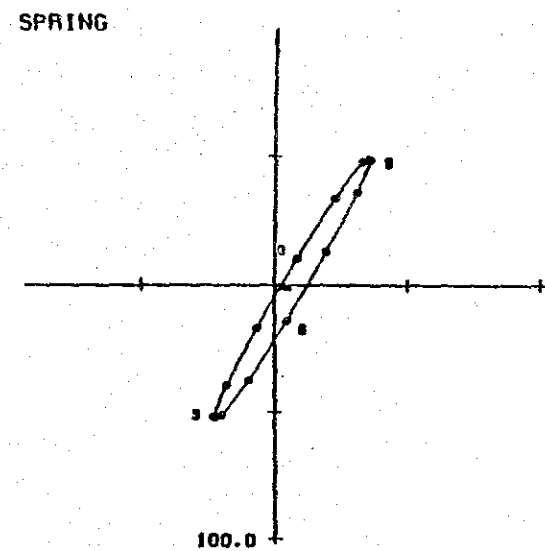
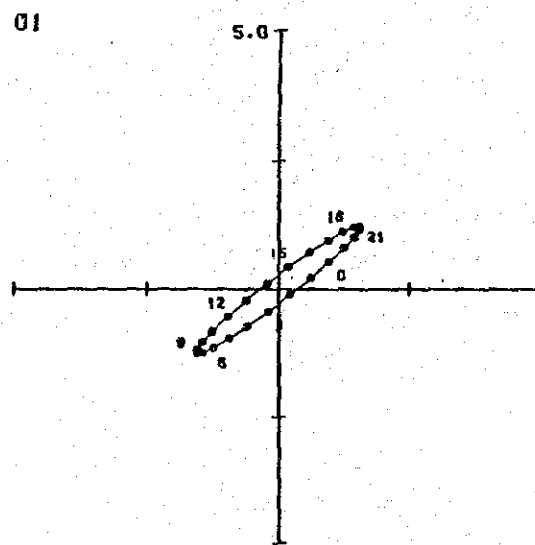
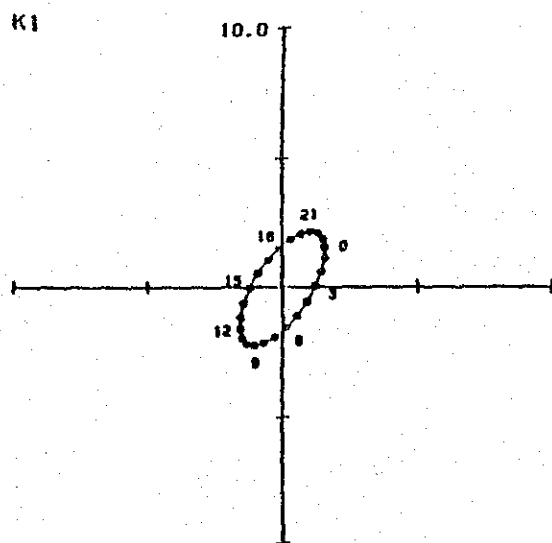
C-19



Tidal Eclipses at St. B-4 Upper

Unit: cm/sec.

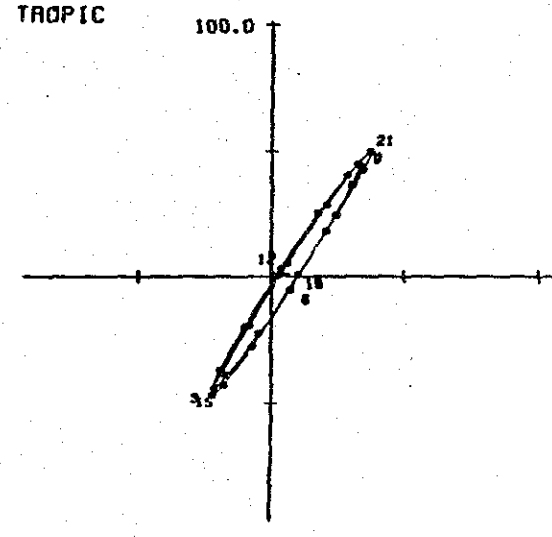
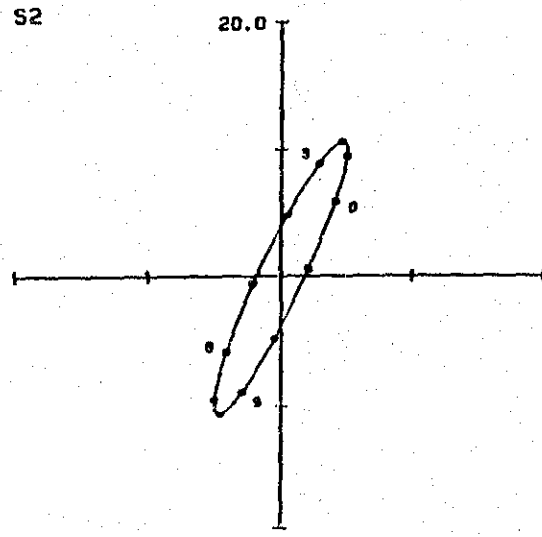
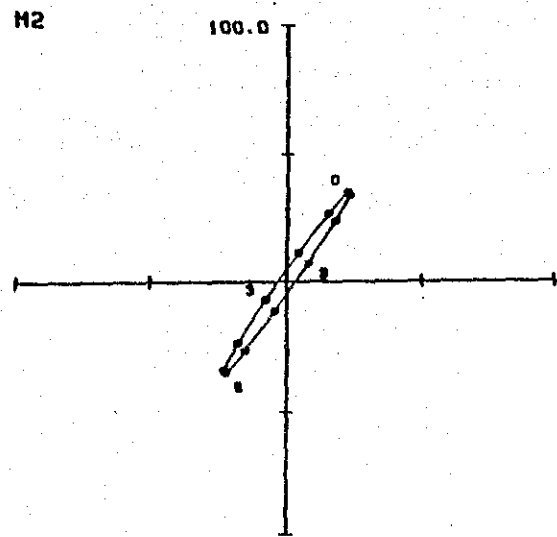
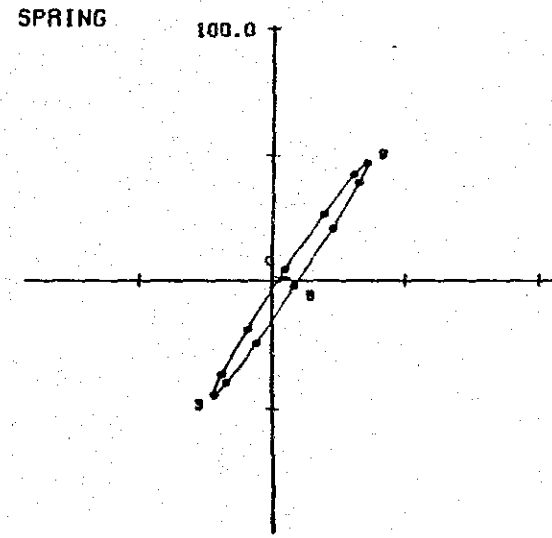
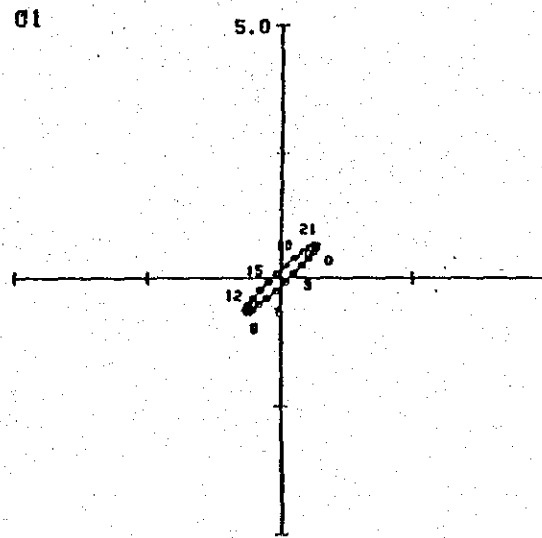
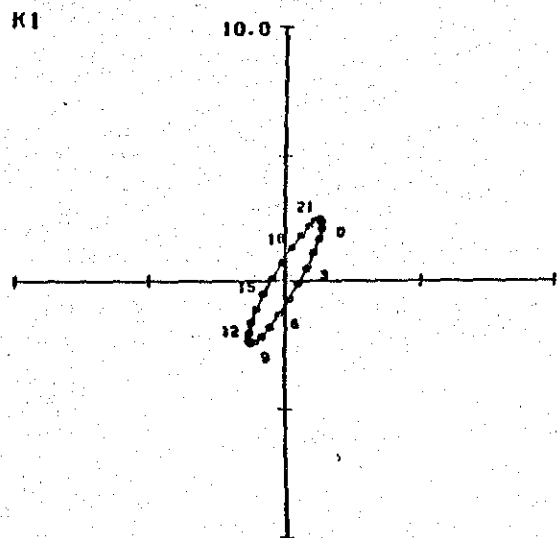
C-20



Tidal Eclipses at St. B-4 Middle

Unit: cm/sec.

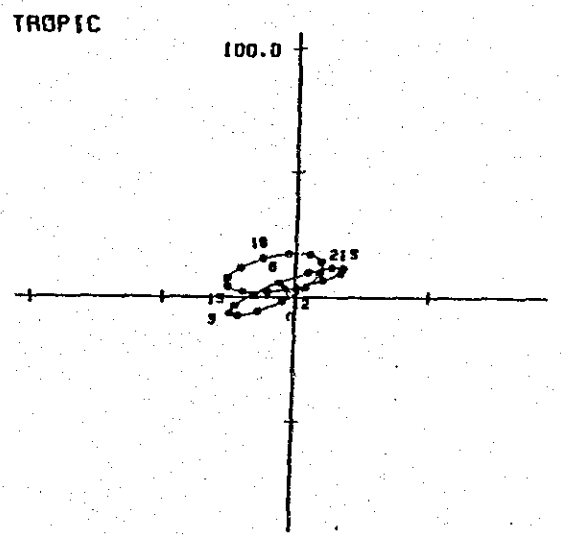
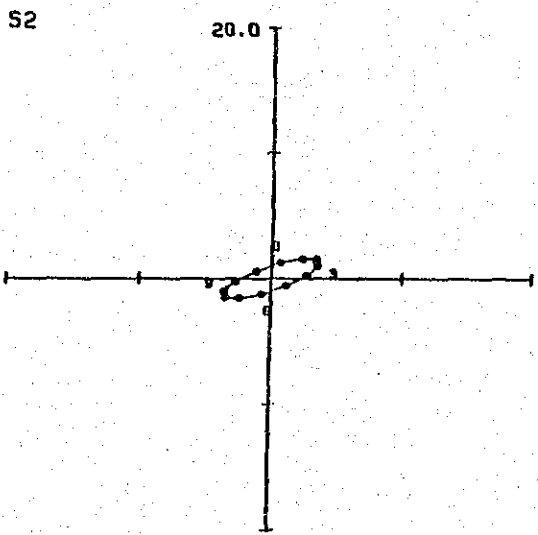
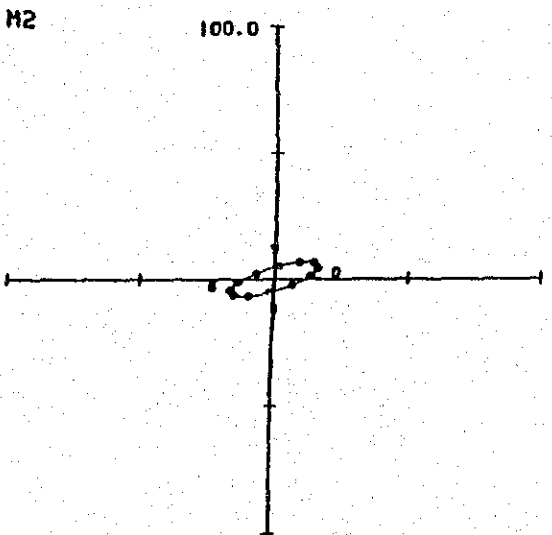
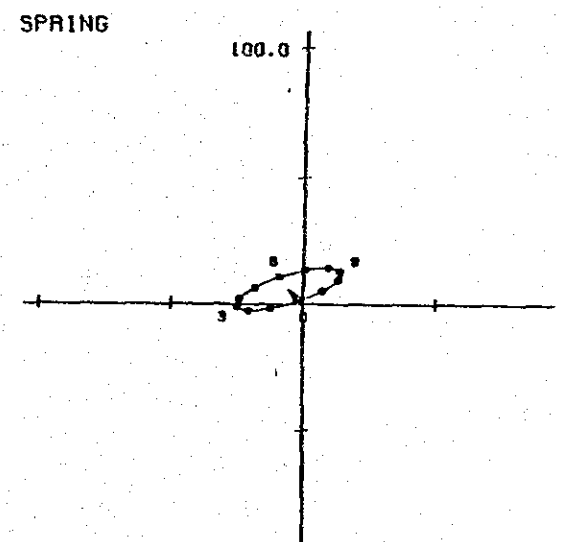
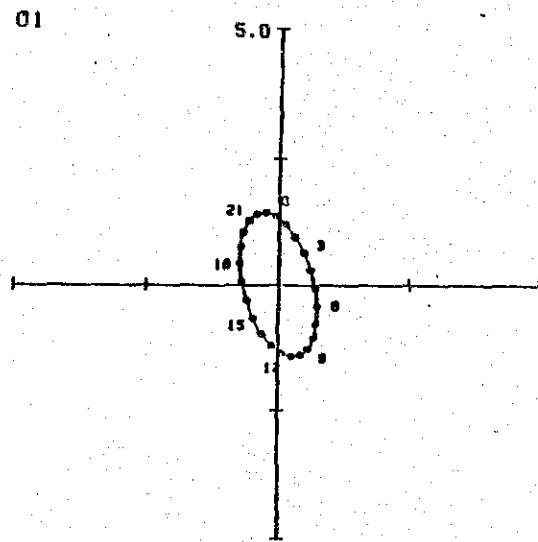
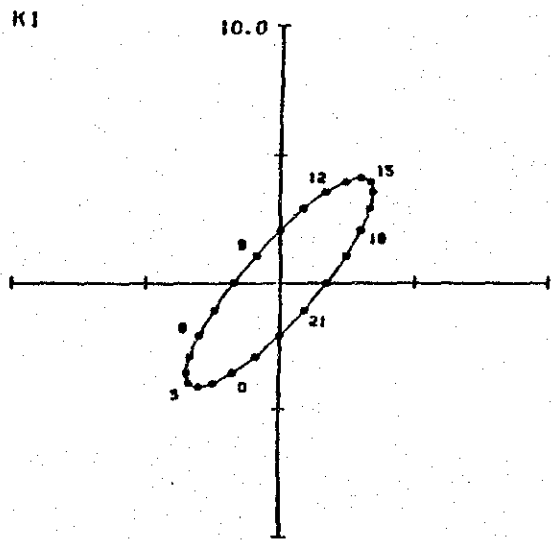
C-21



Tidal Eclipses at St. B-4 Lower

Unit: cm/sec.

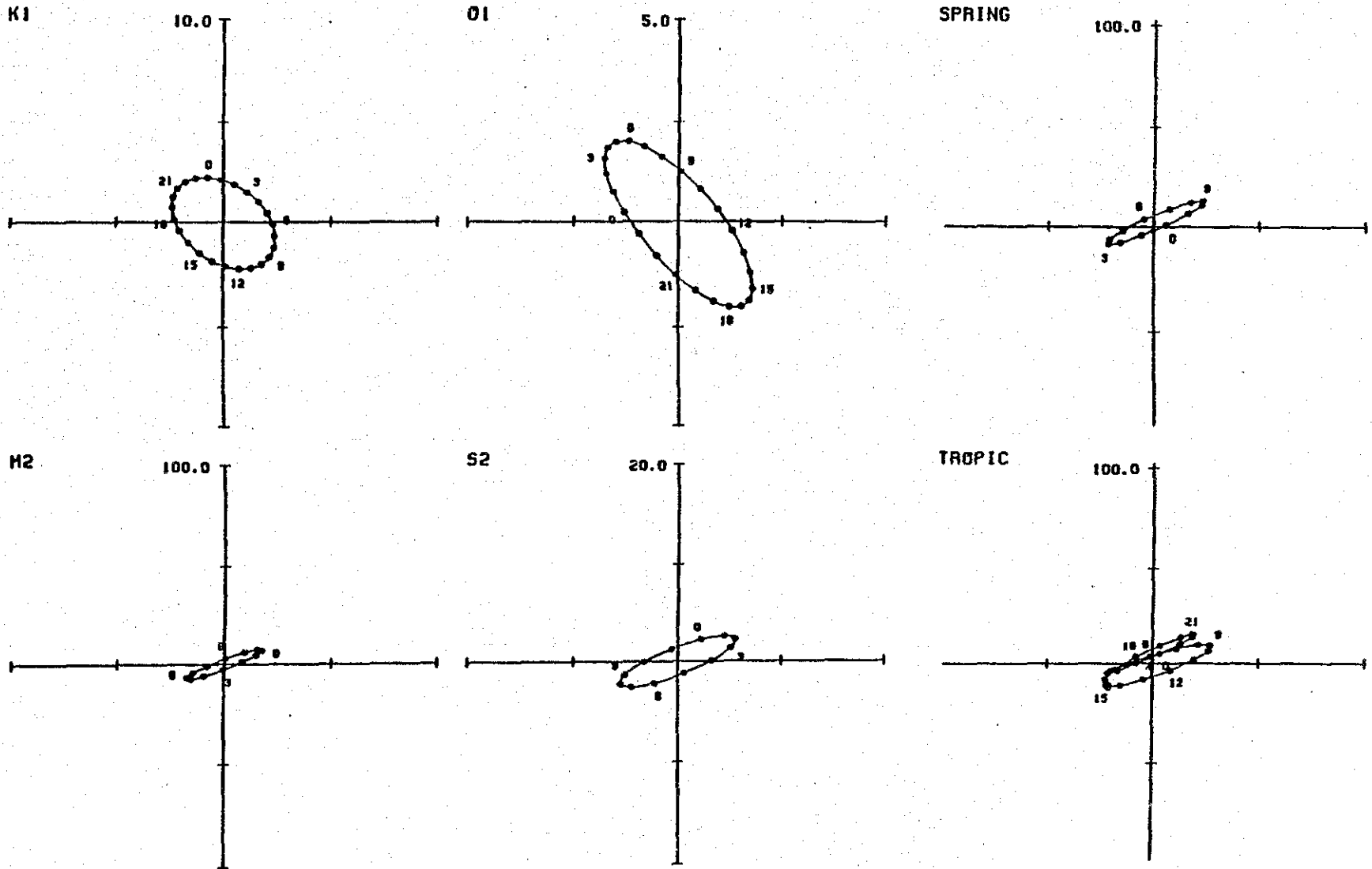
C-22



Tidal Eclipses at St. B-5 Upper

Unit: cm/sec.

C-23

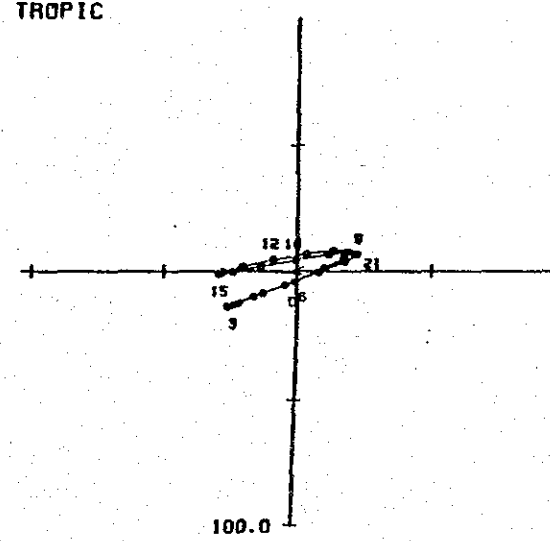
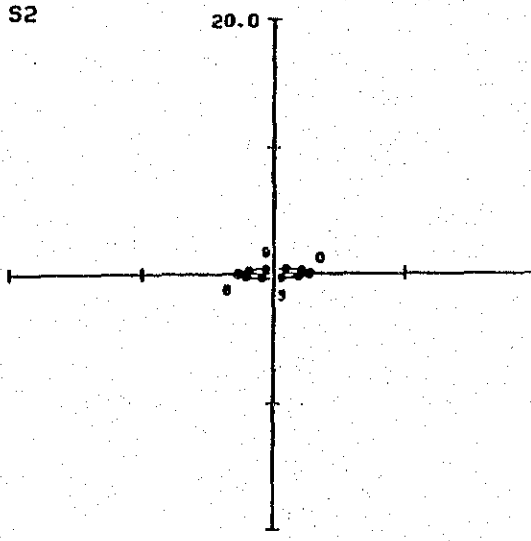
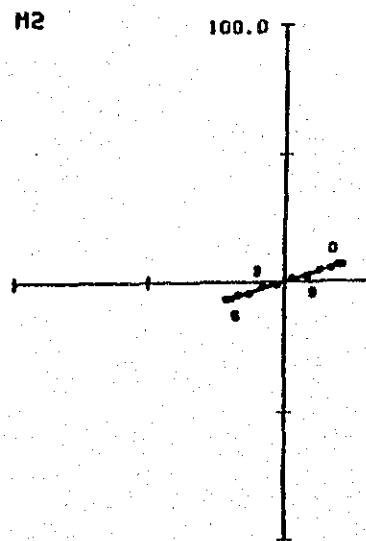
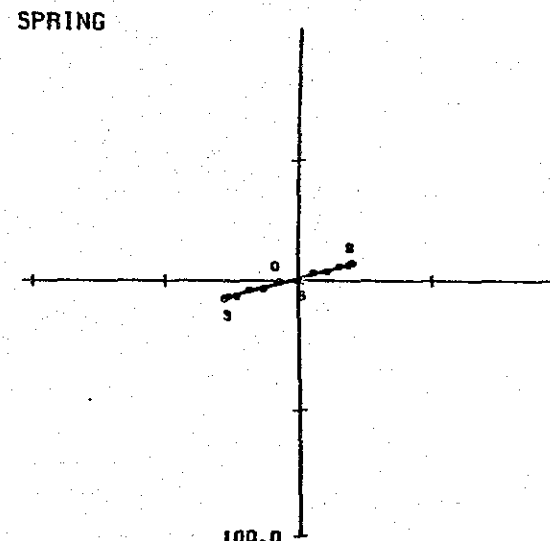
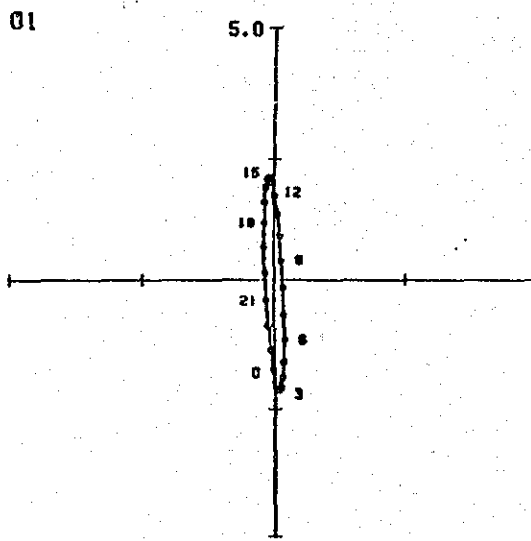
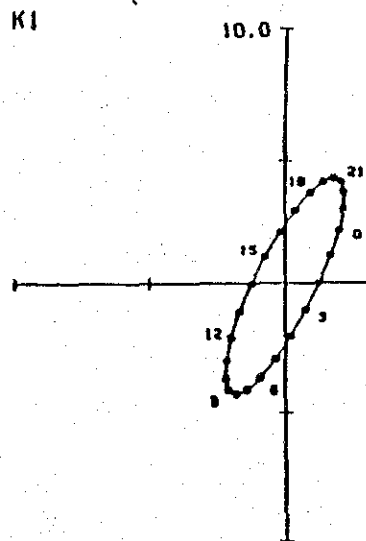


Tidal Eclipses at St. B-5 Middle

Unit: cm/sec.

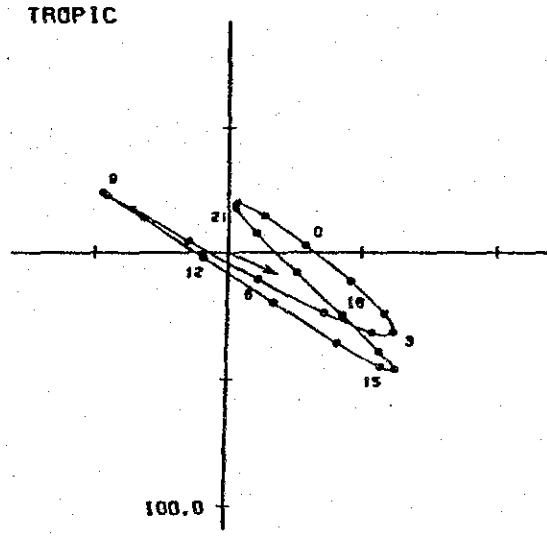
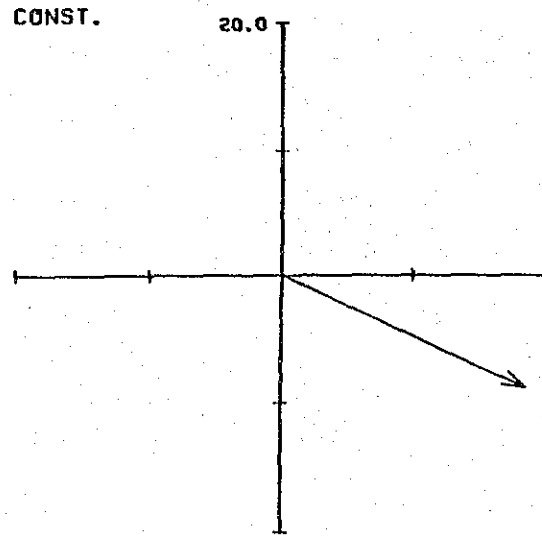
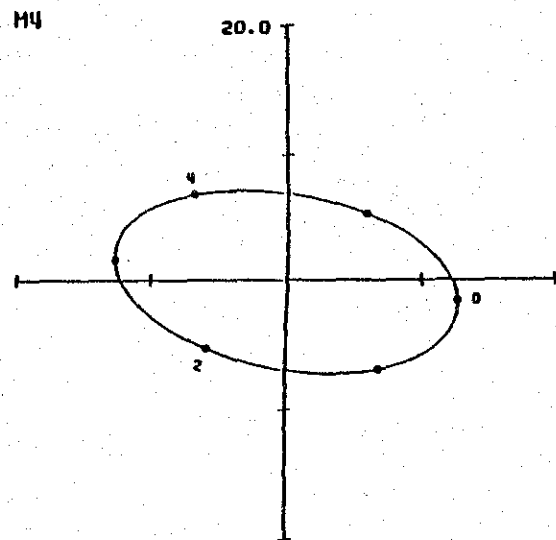
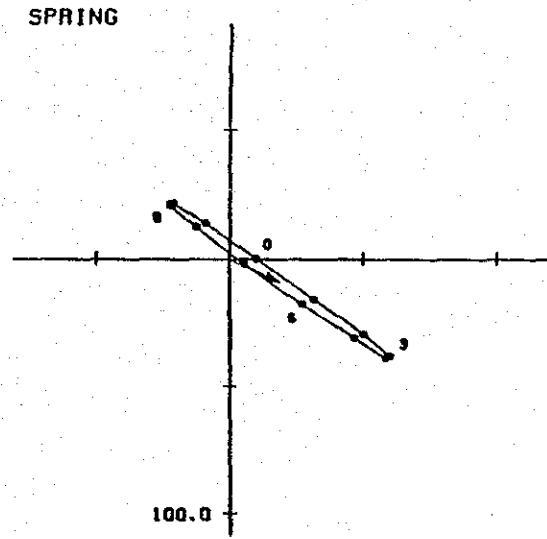
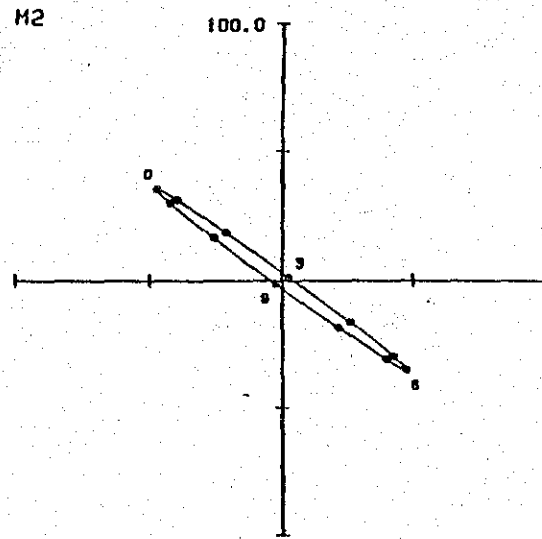
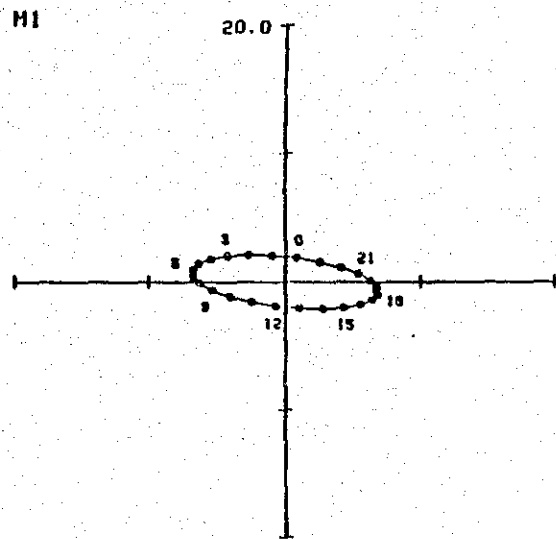


C-24



Tidal Ranges of St. D. E. L. ...

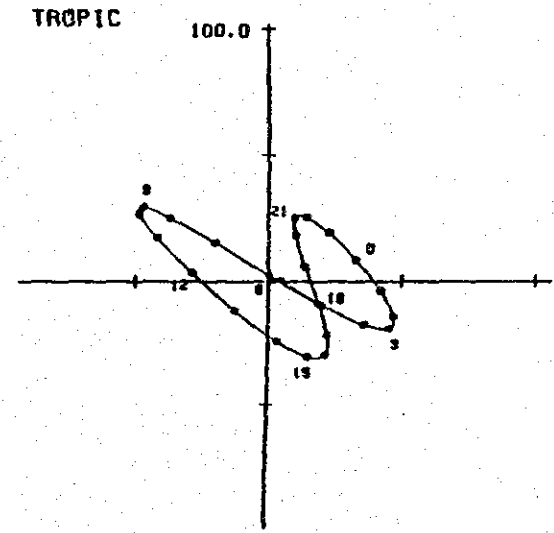
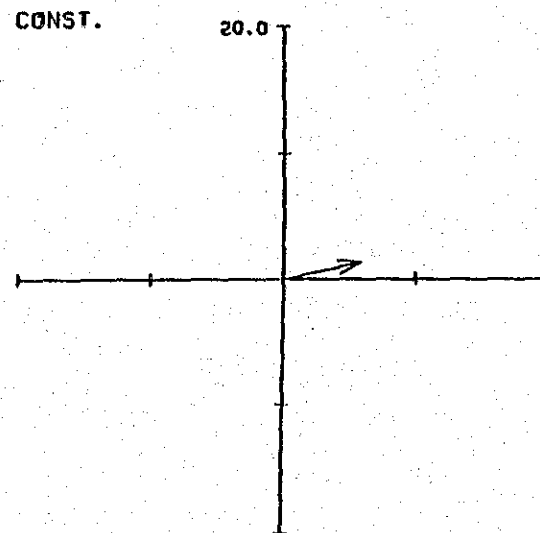
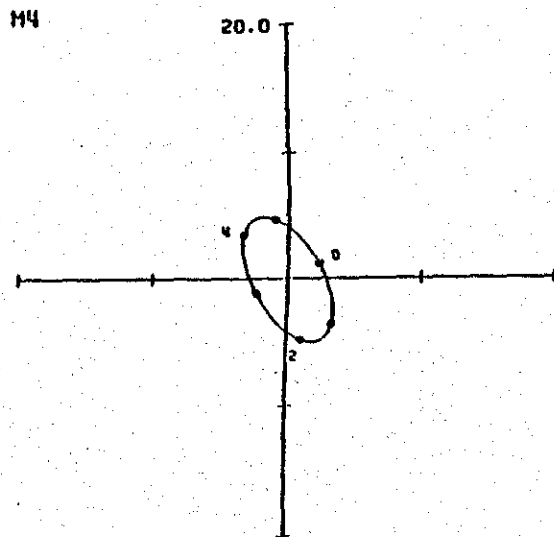
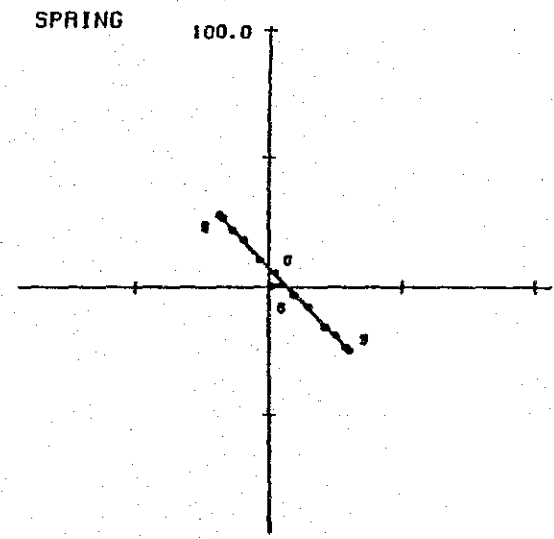
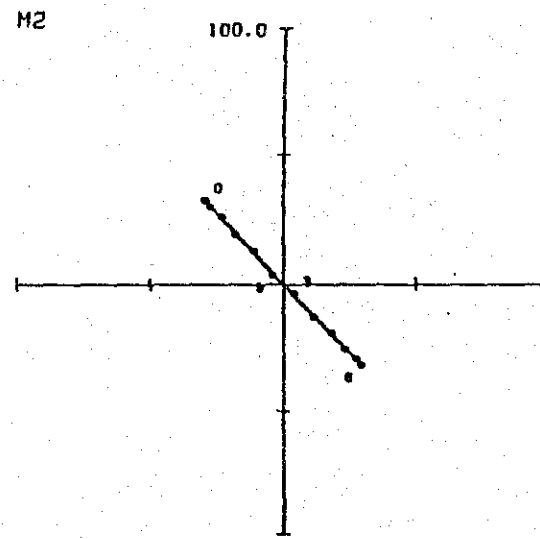
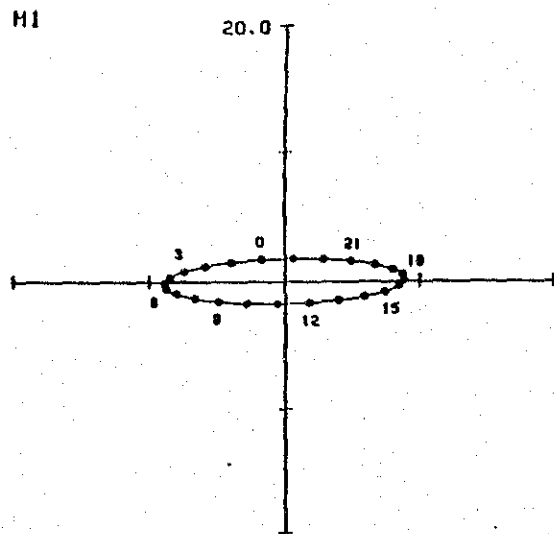
C-25



Tidal Eclipses at St. S-1 Upper

Unit: cm/sec.

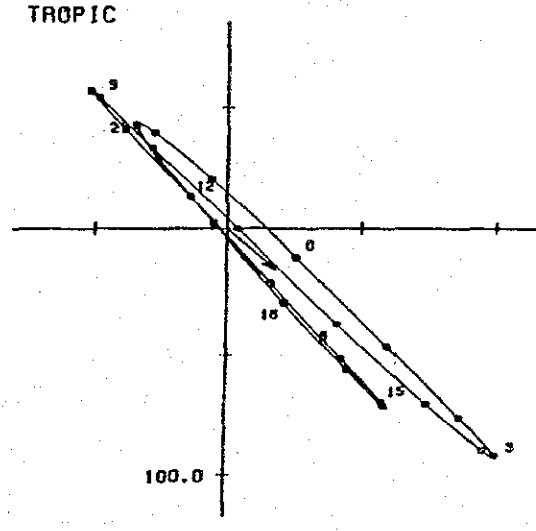
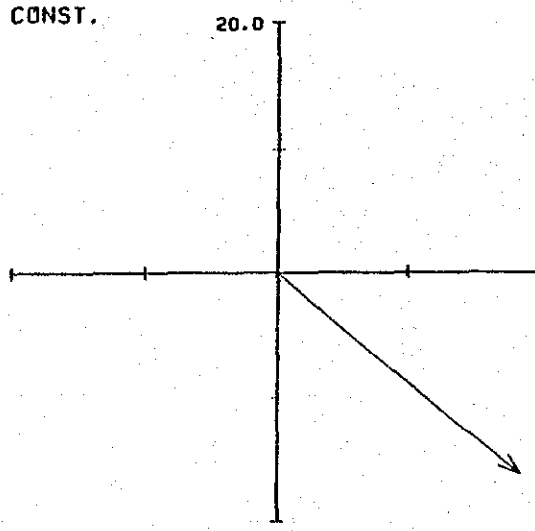
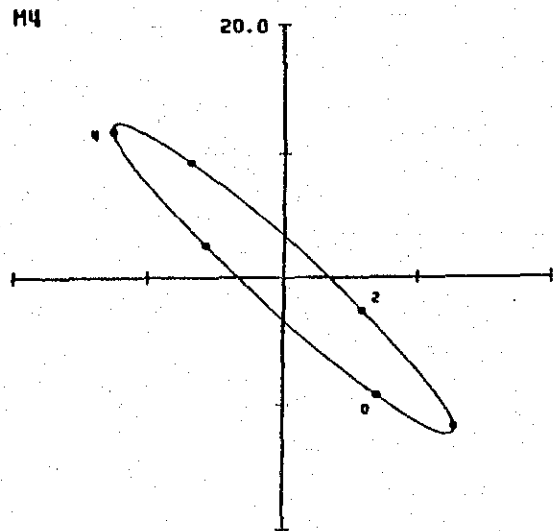
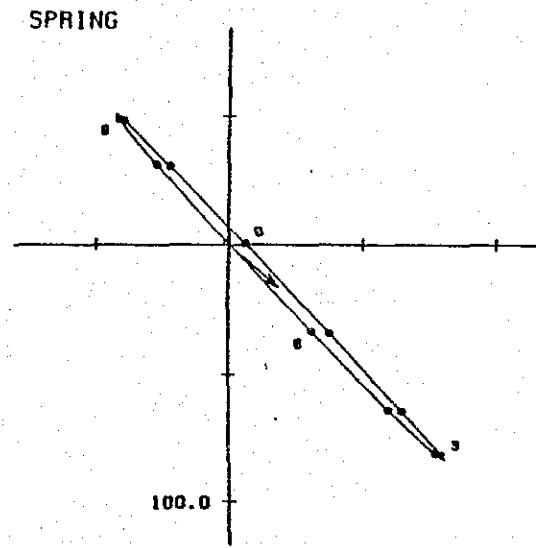
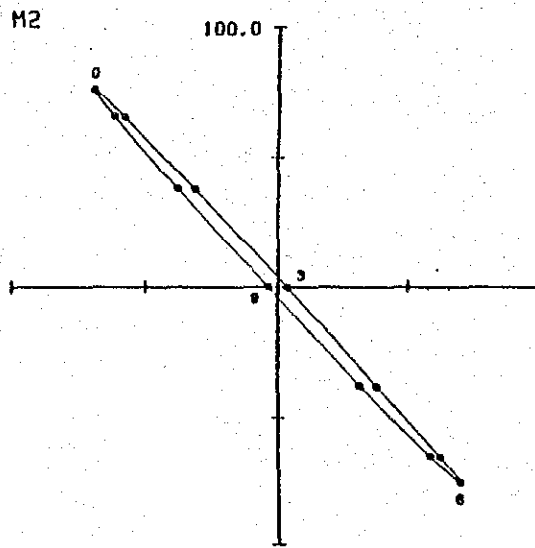
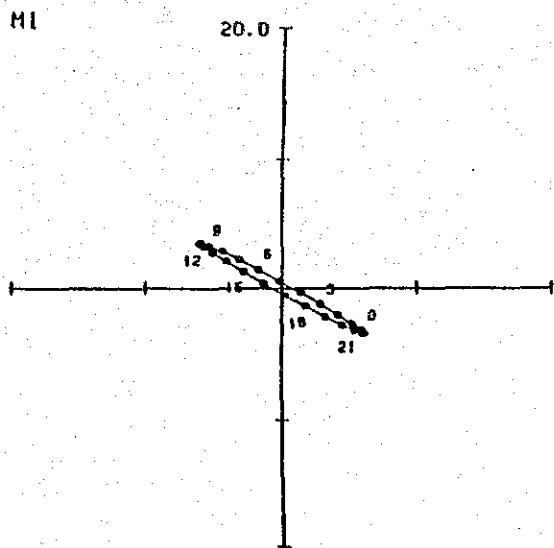
C-26



Tidal Eclipses at St. S-1 Lower

Unit: cm/sec.

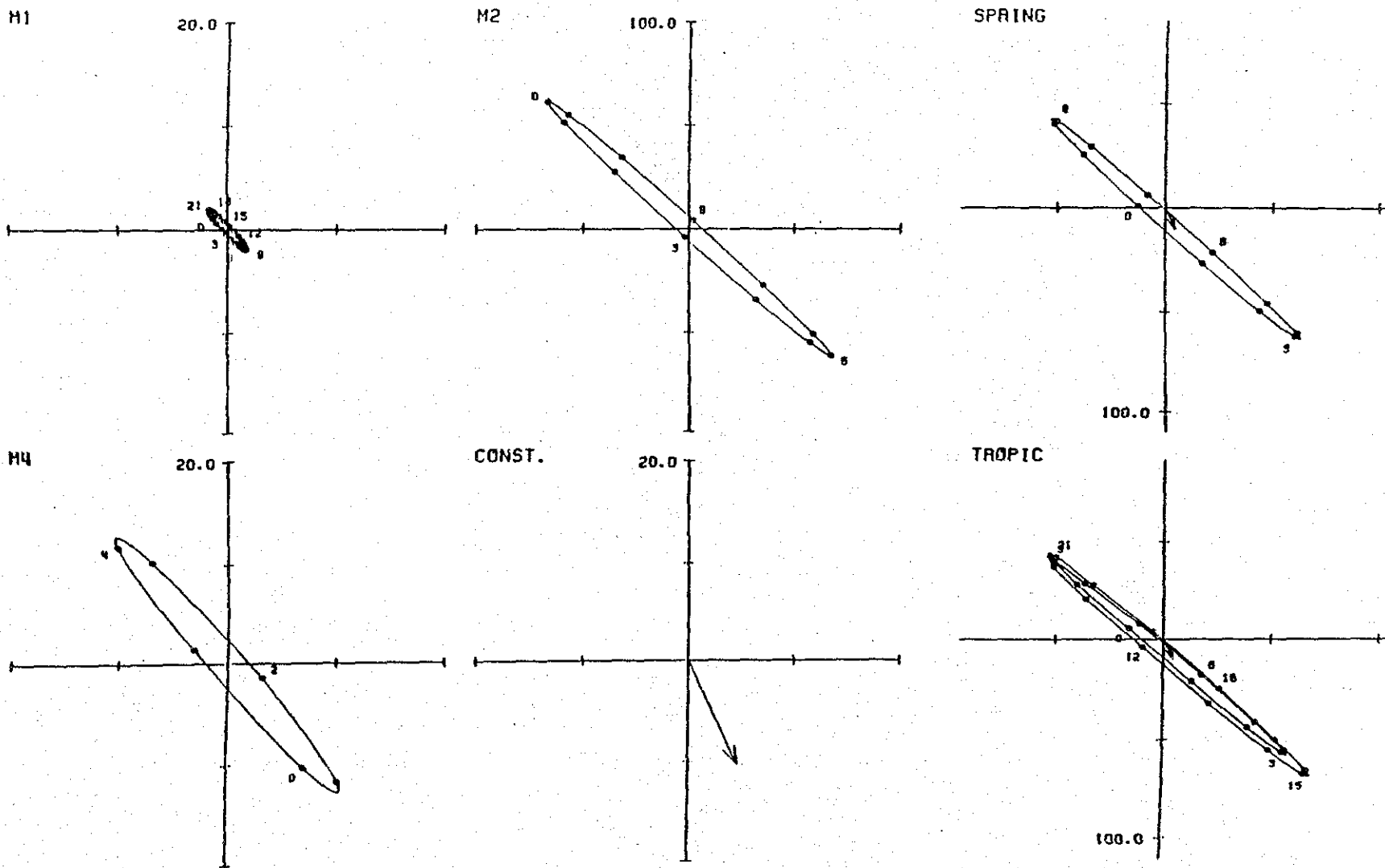
C-27



Tidal Eclipses at St. S-2 Upper

Unit: cm/sec.

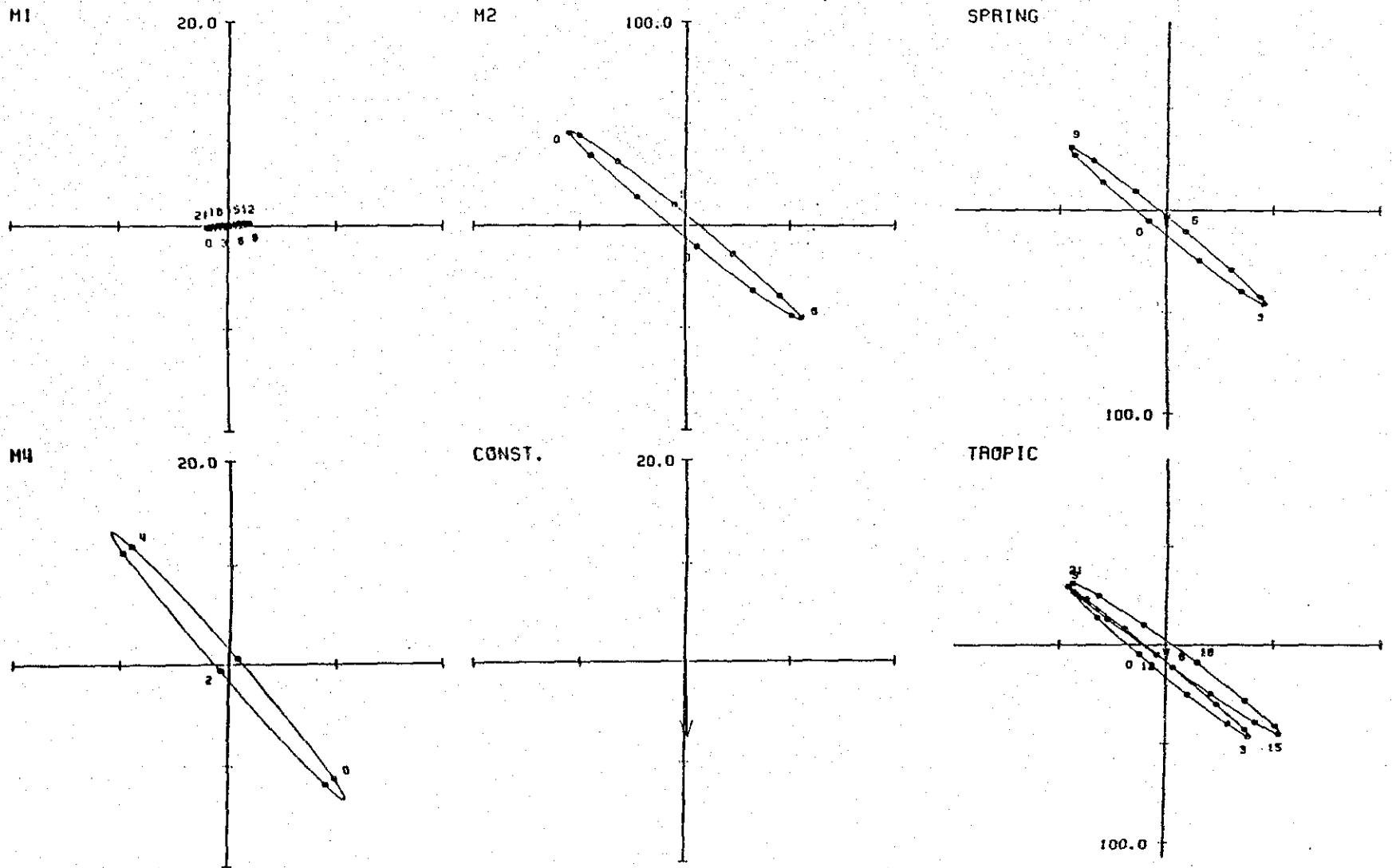
C-28



Tidal Ellipses at St. S-2 Middle

Unit: cm/sec.

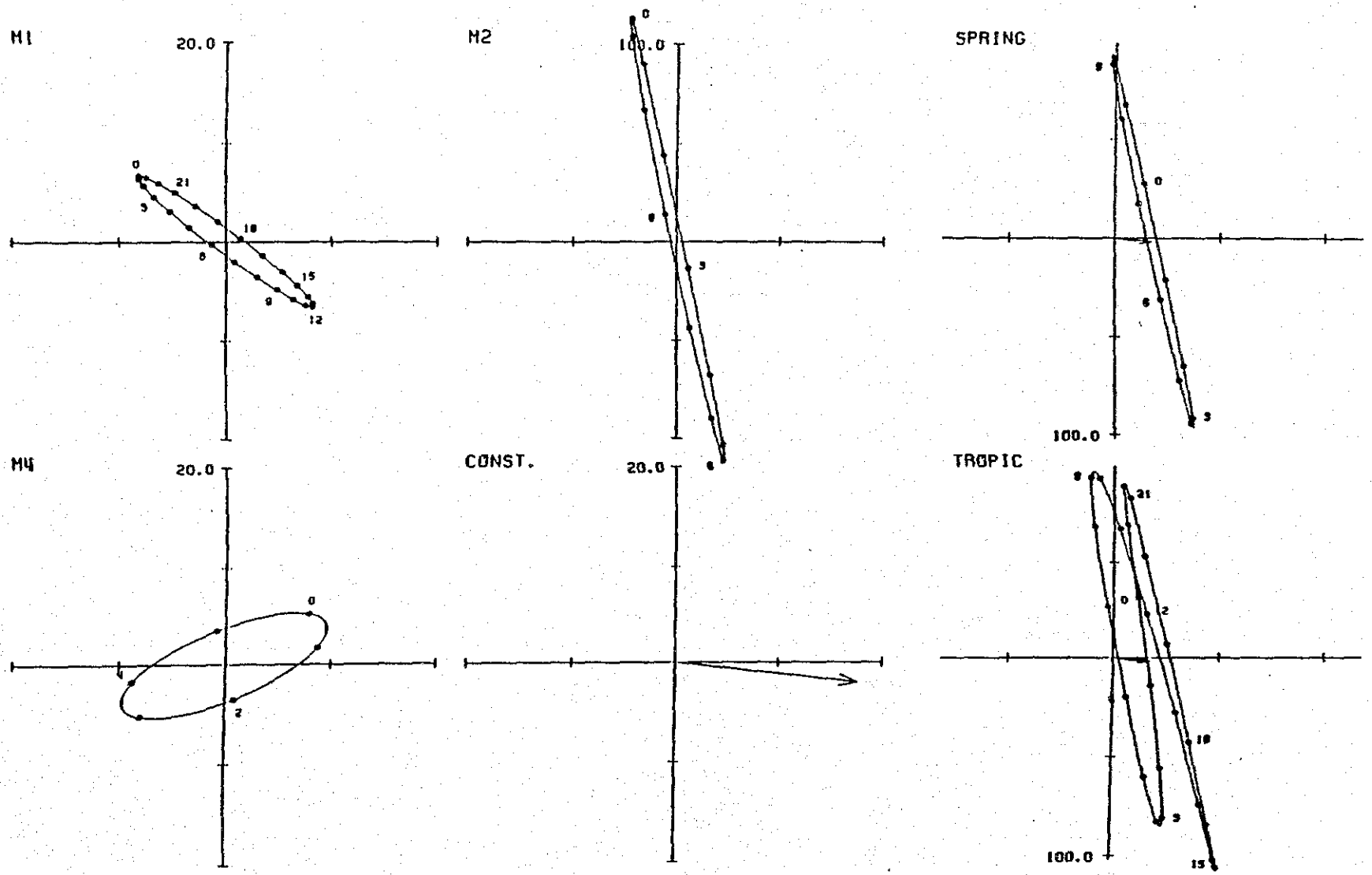
C-29



Tidal Eclipses at St. S-2 Lower

Unit: cm/sec.

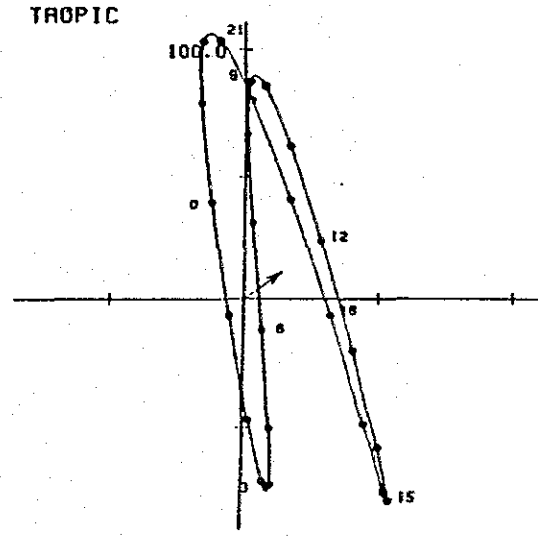
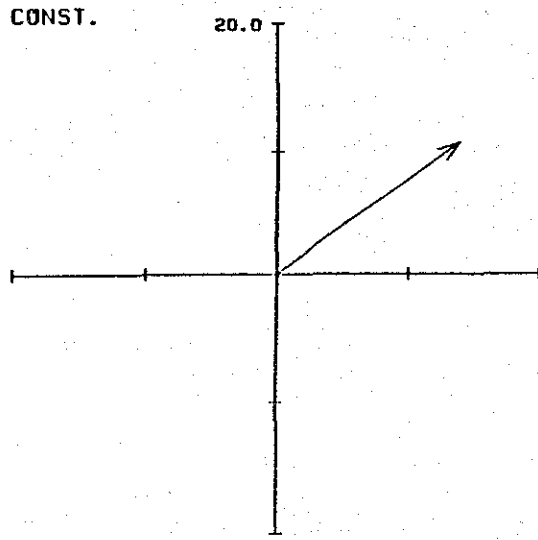
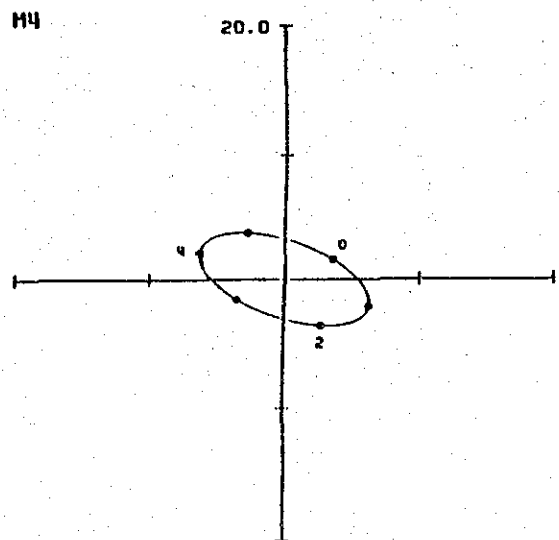
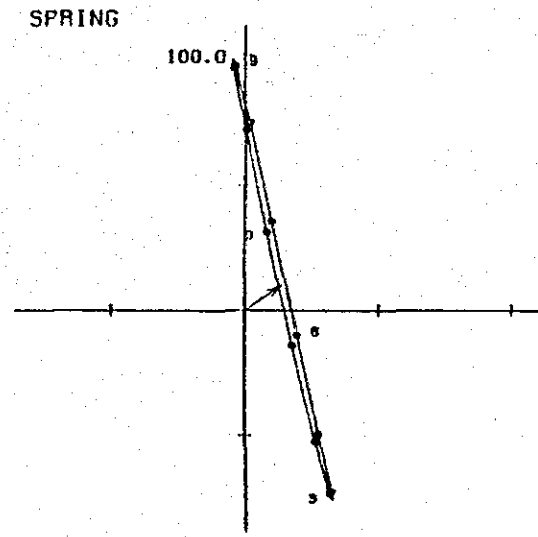
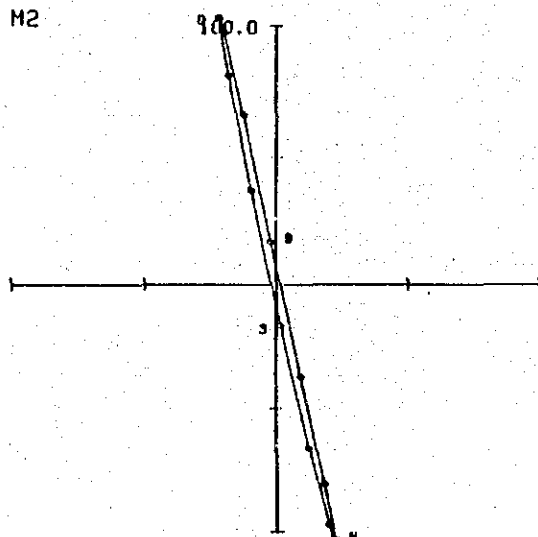
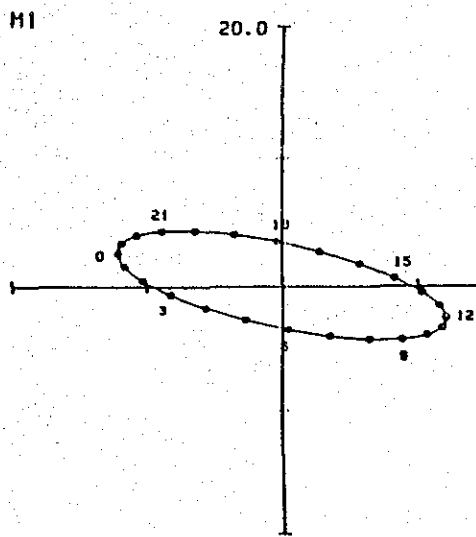
C-30



Tidal Eclipses at St. S-3 Upper

Unit: cm/sec.

C-31

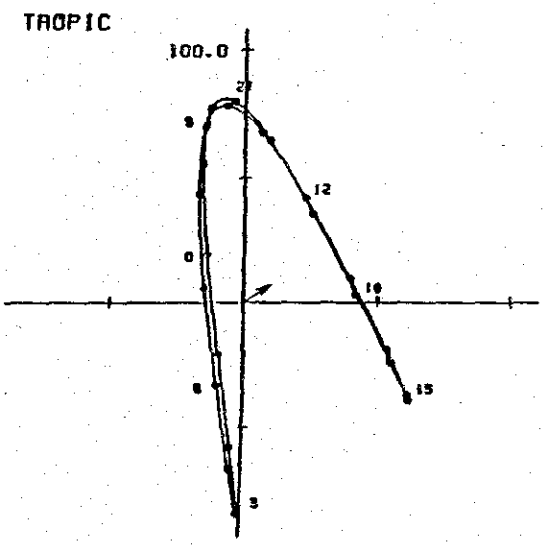
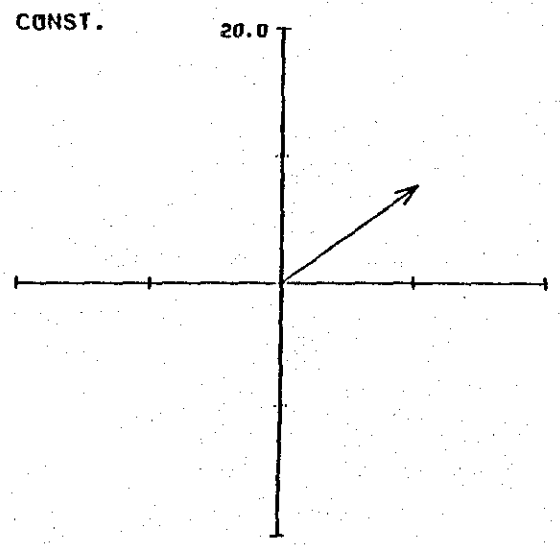
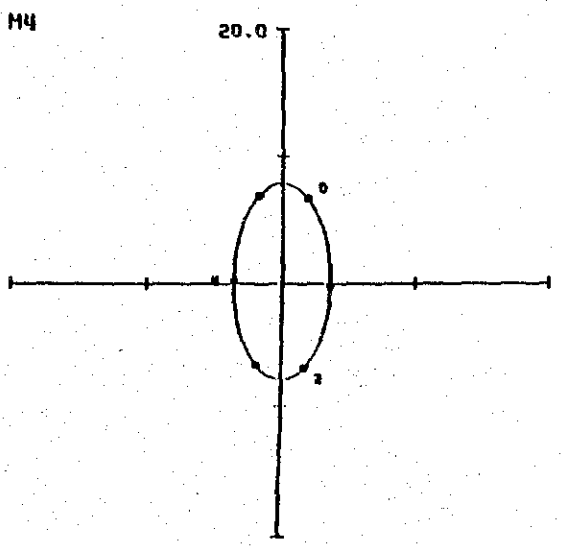
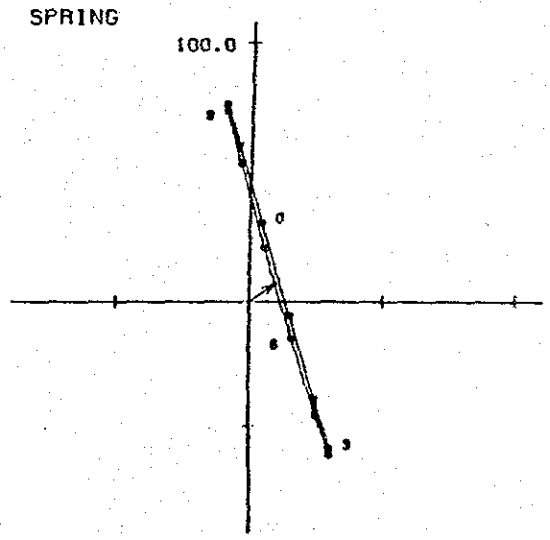
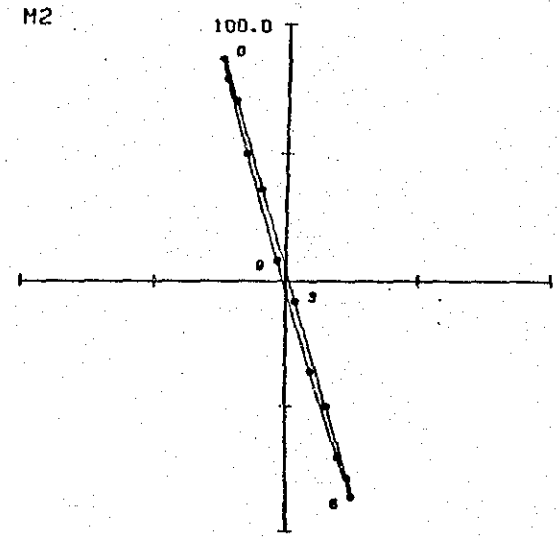
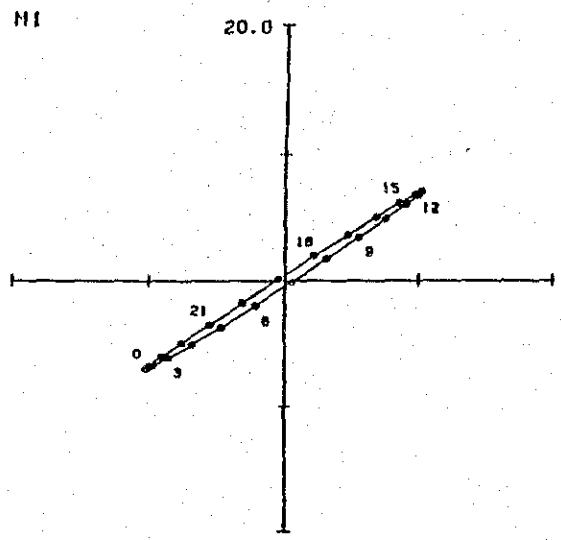


Tidal Eclipses at St. S-3 Middle

Unit: cm/sec.



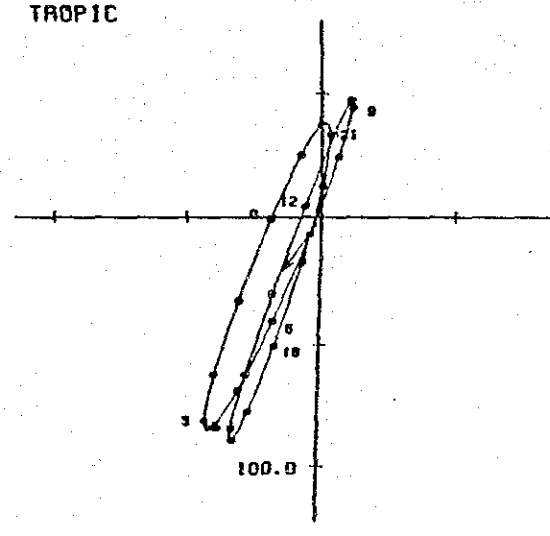
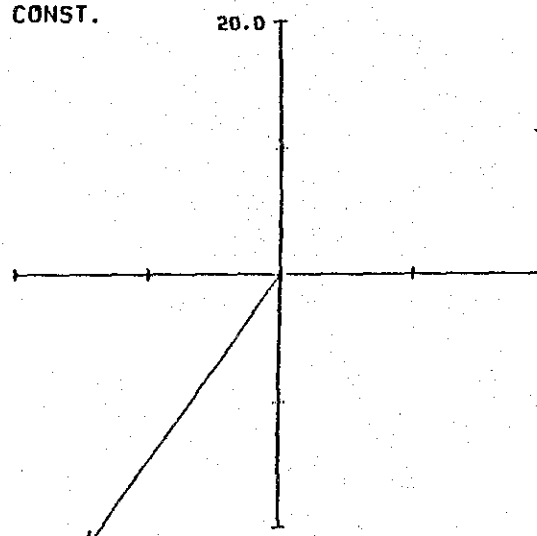
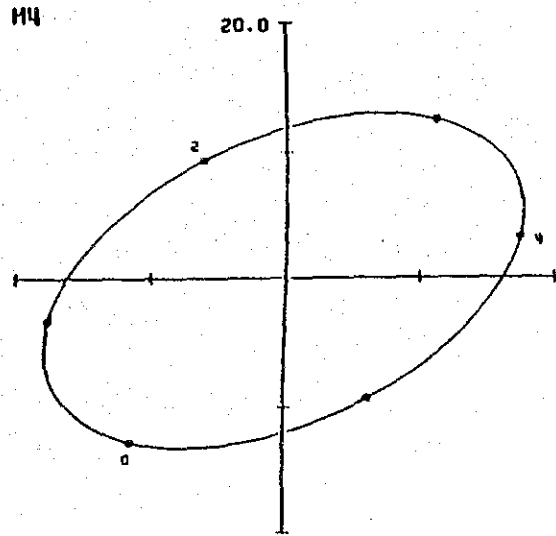
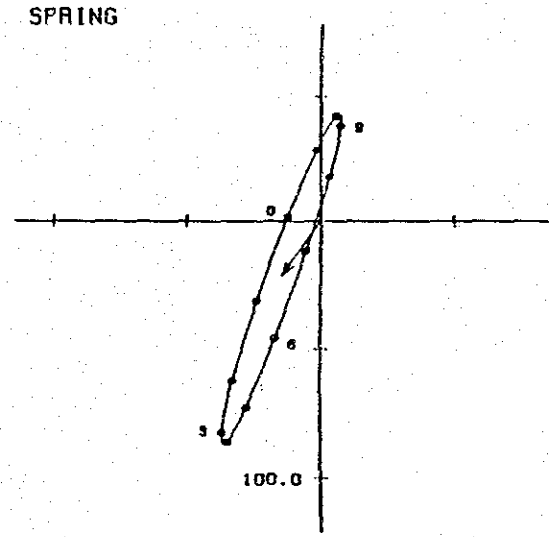
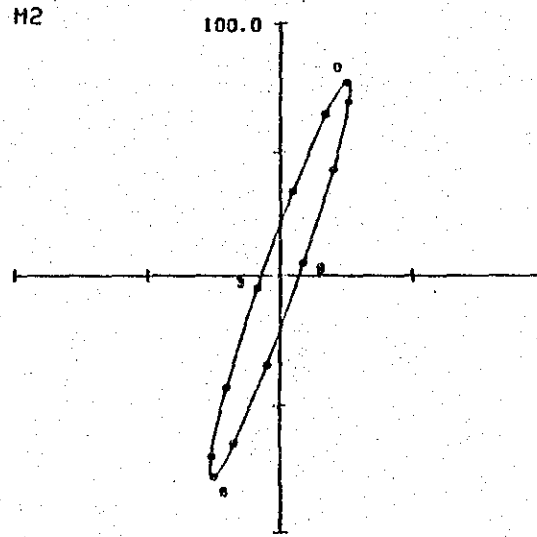
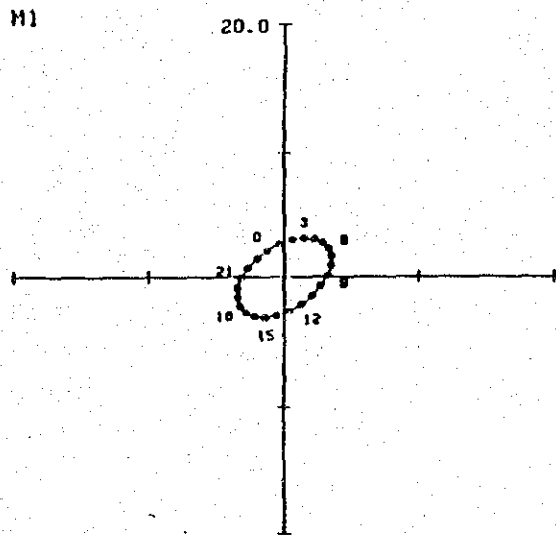
C-32



Tidal Eclipses at St. S-3 Lower

Unit: cm/sec.

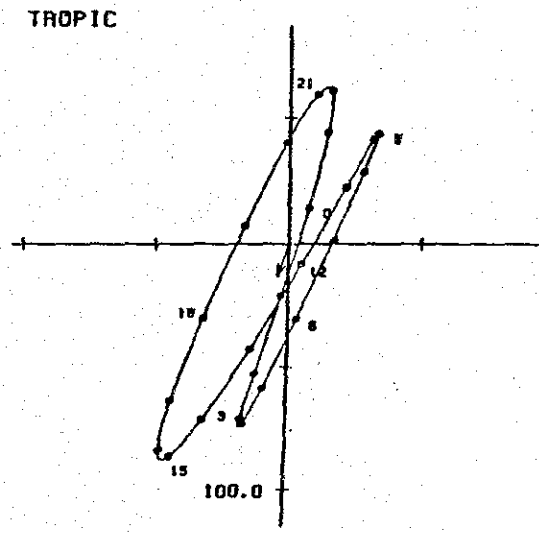
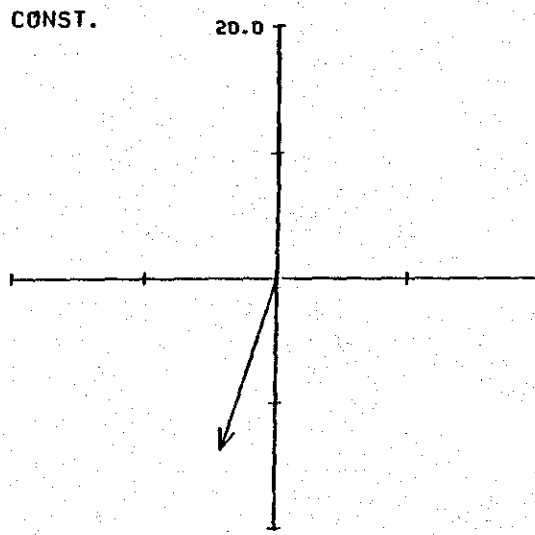
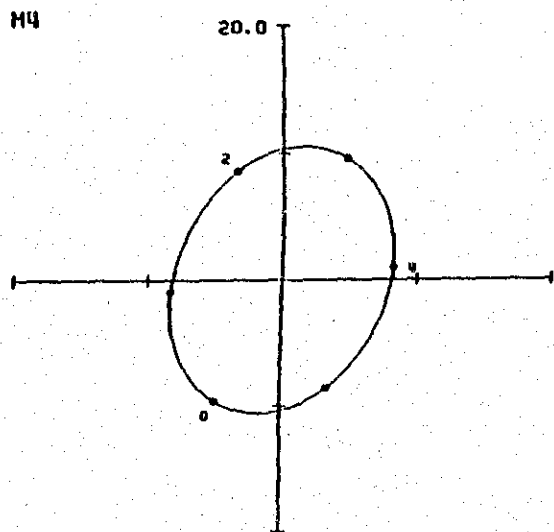
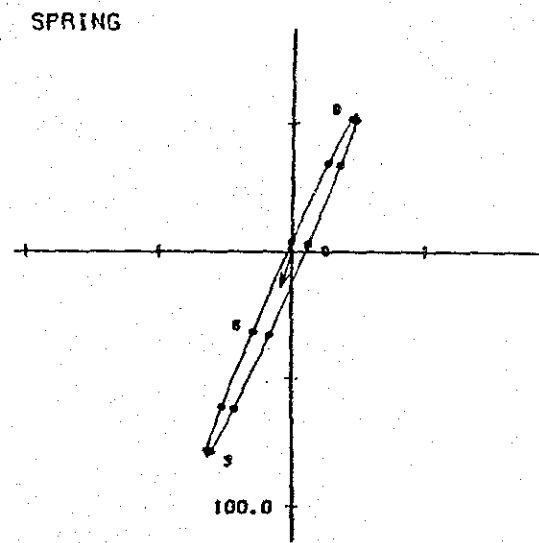
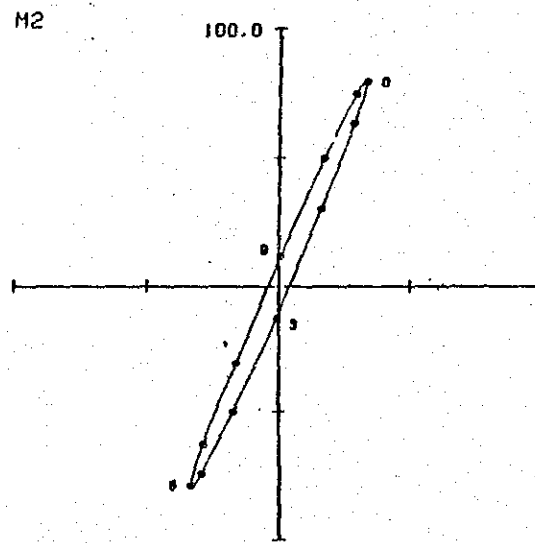
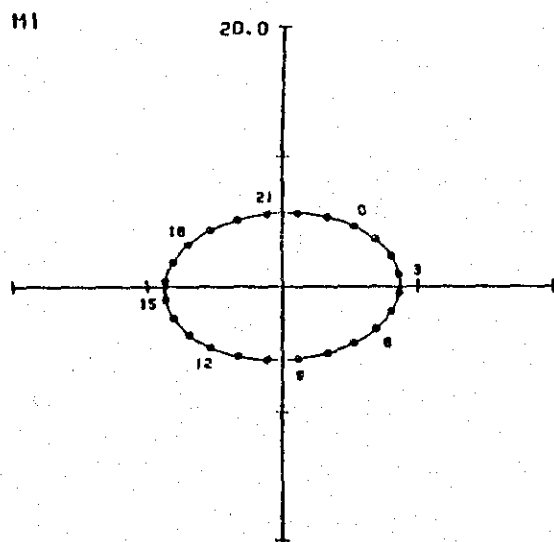
C-33



Tidal Eclipses at St. S-4 Upper

Unit: cm/sec.

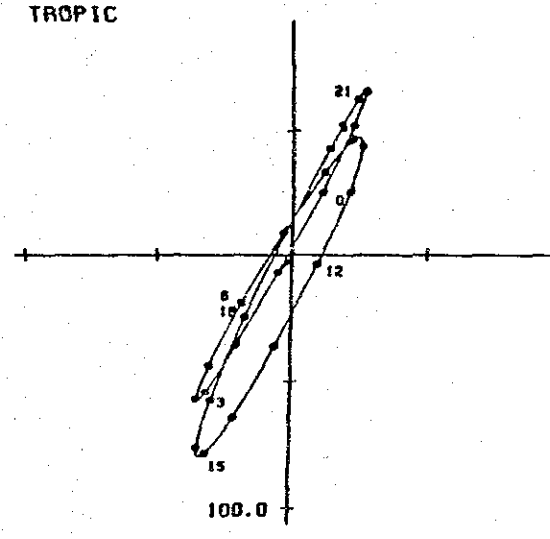
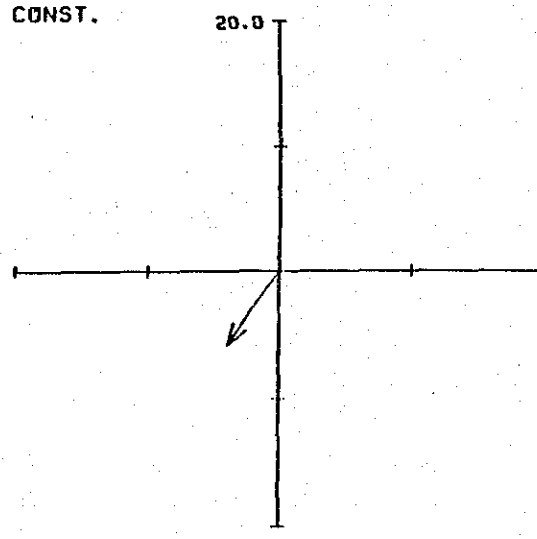
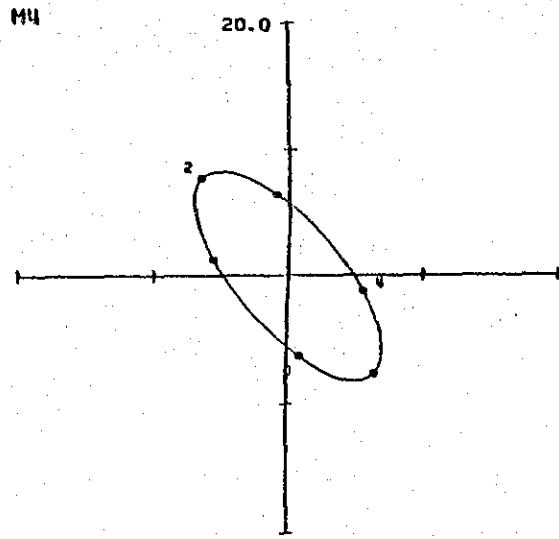
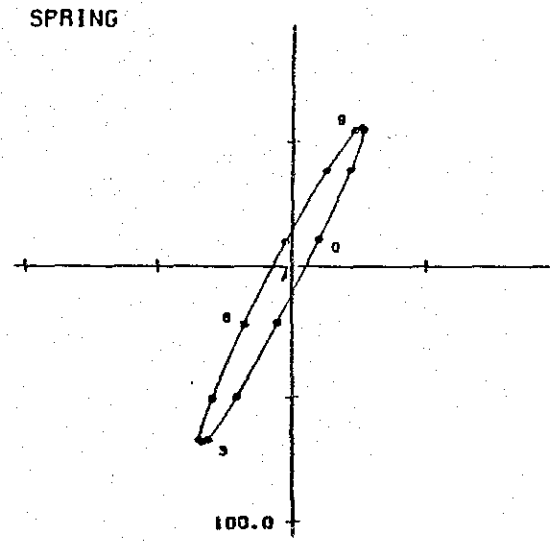
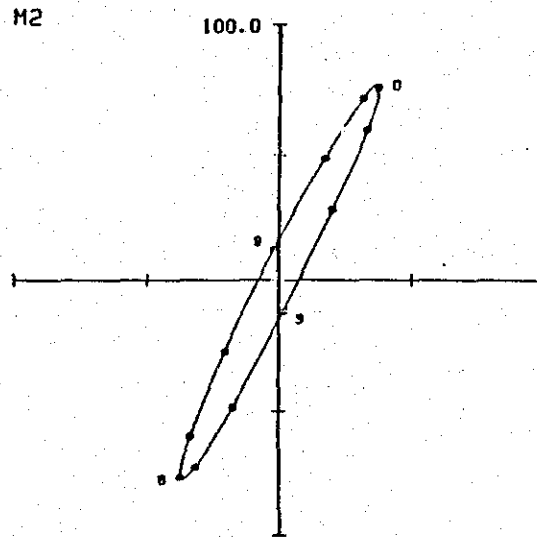
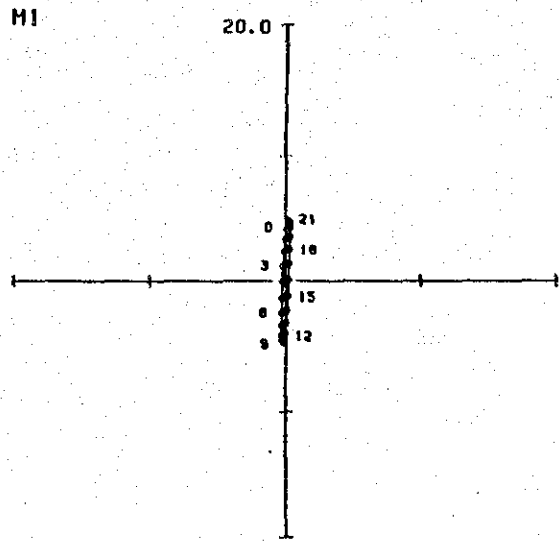
C-34



Tidal Eclipses at St. S-4 Middle

Unit: cm/sec.

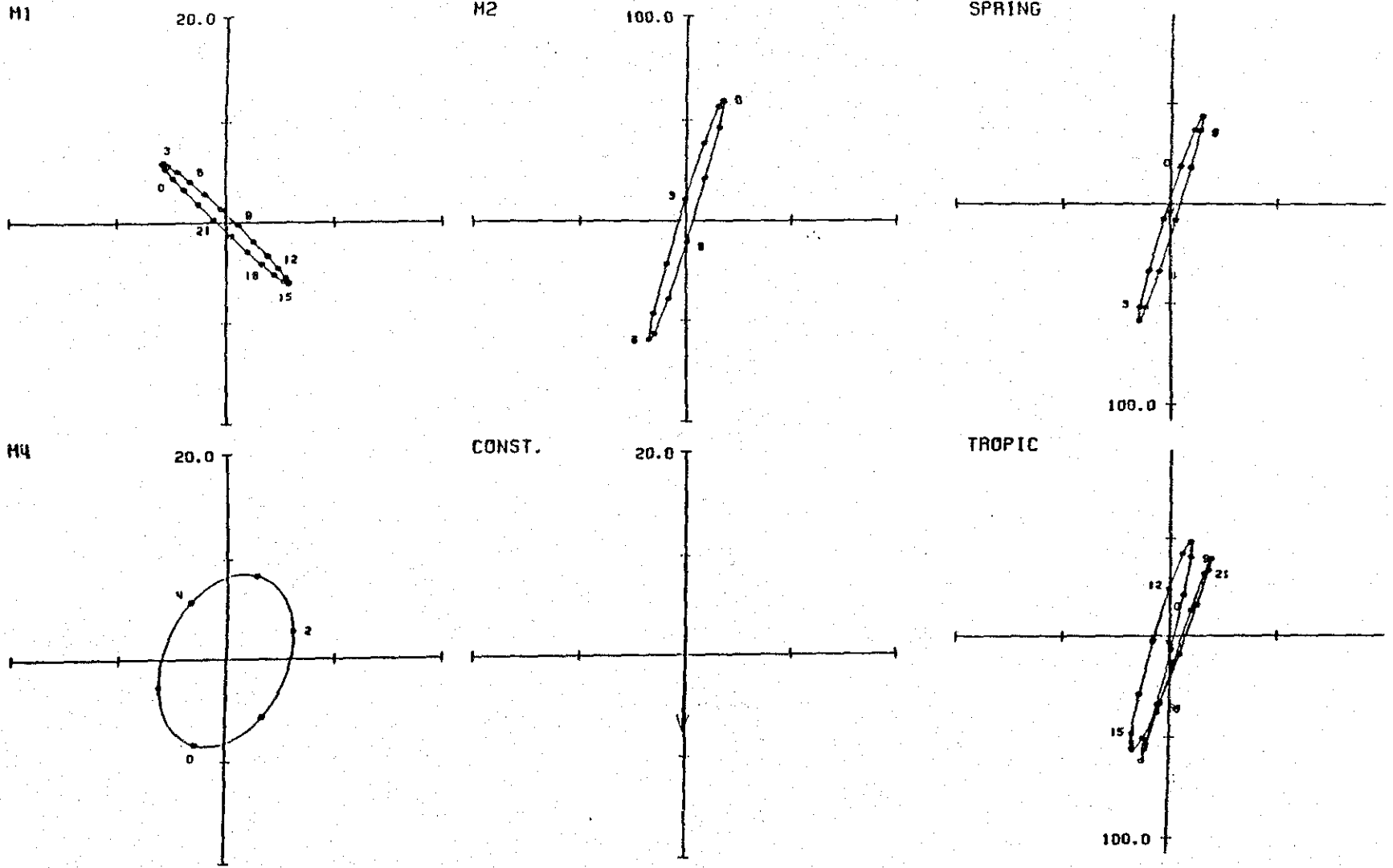
C-35



Tidal Eclipses at St. S-4 Lower

Unit: cm/sec.

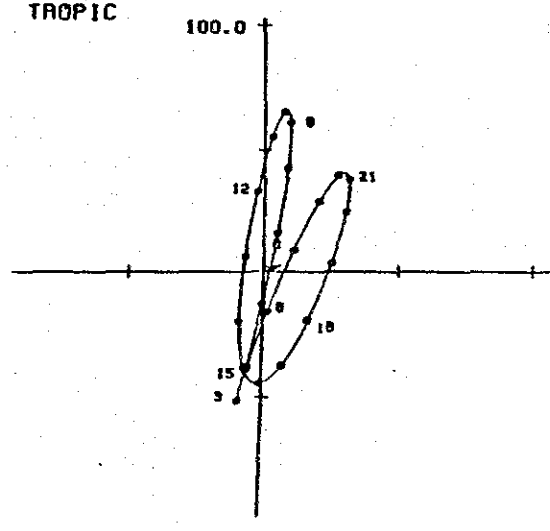
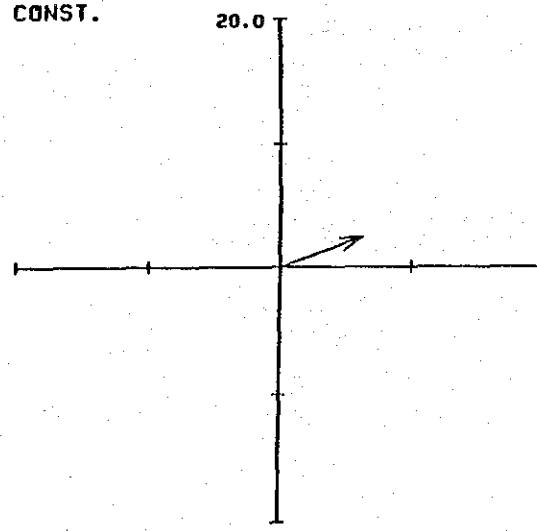
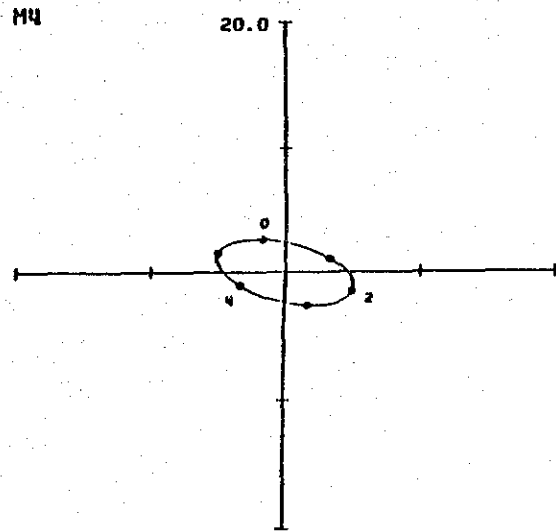
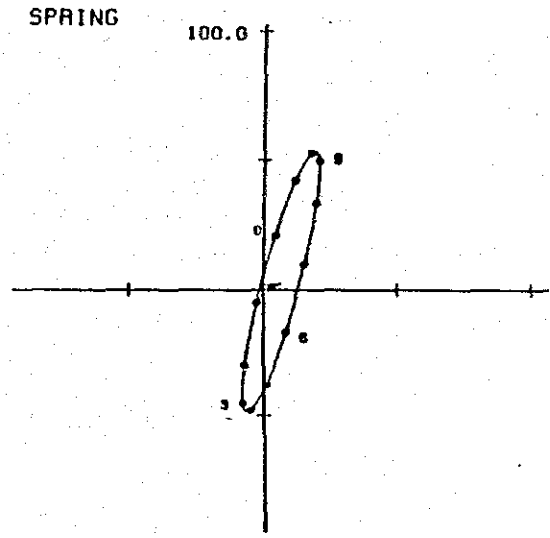
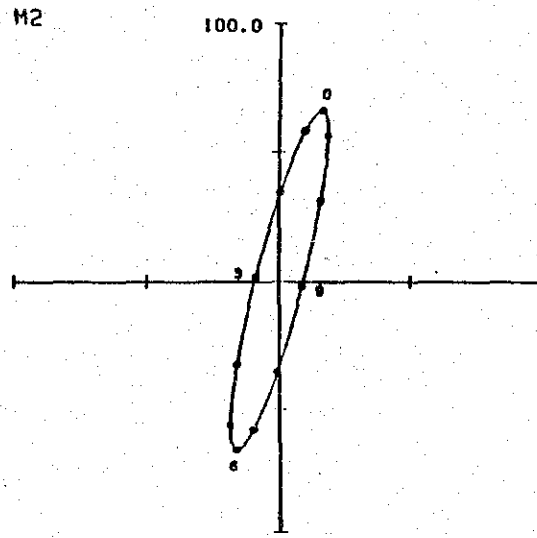
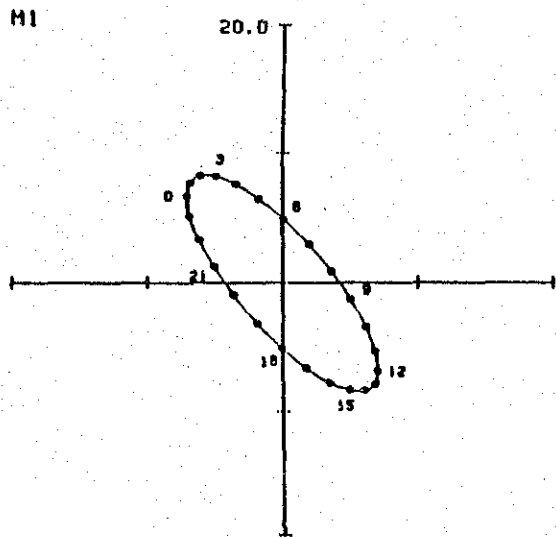
C-36



Tidal Eclipses at St. S-5 Upper

Unit: cm/sec.

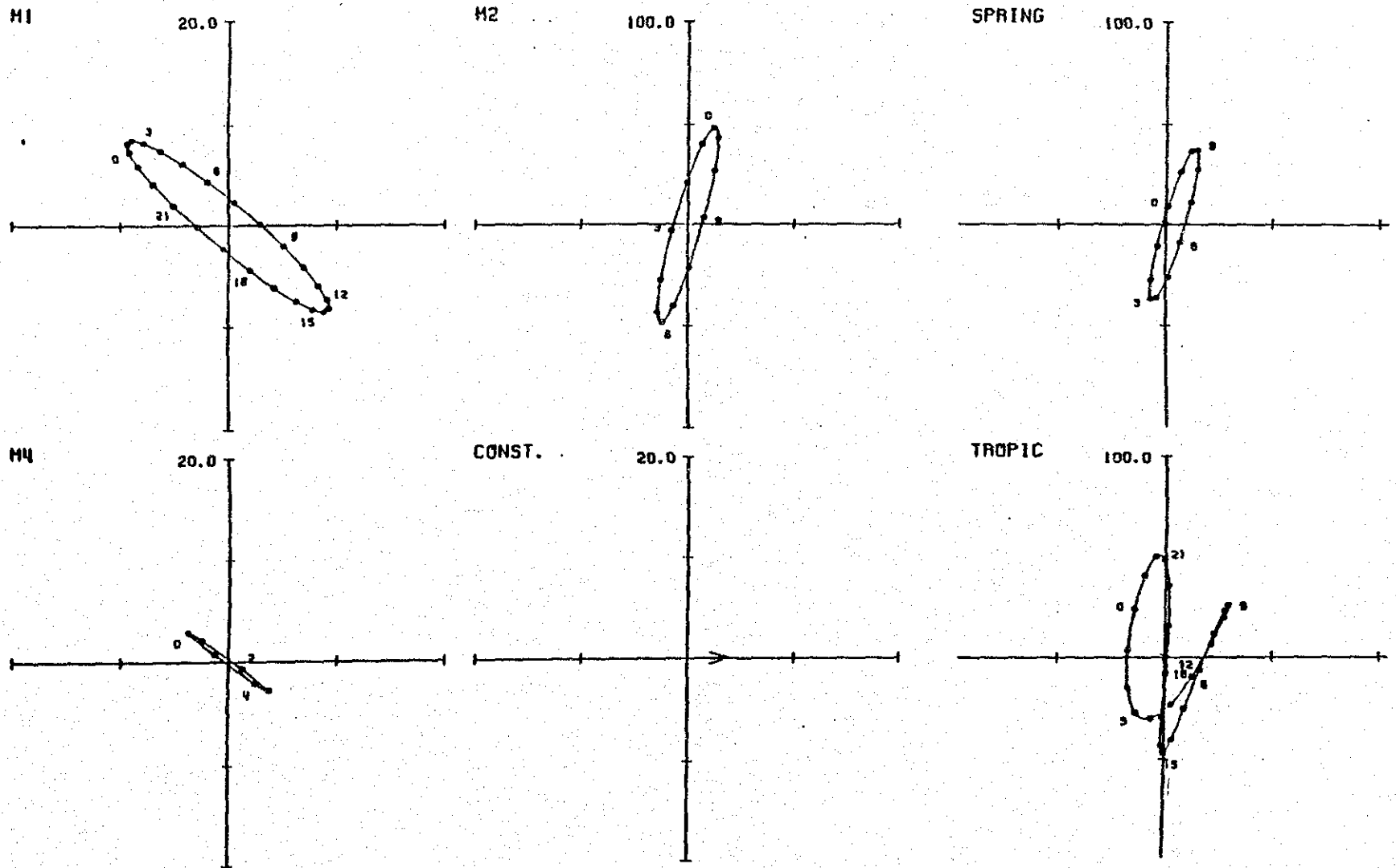
C-37



Tidal Eclipses at St. S-5 Middle

Unit: cm/sec.

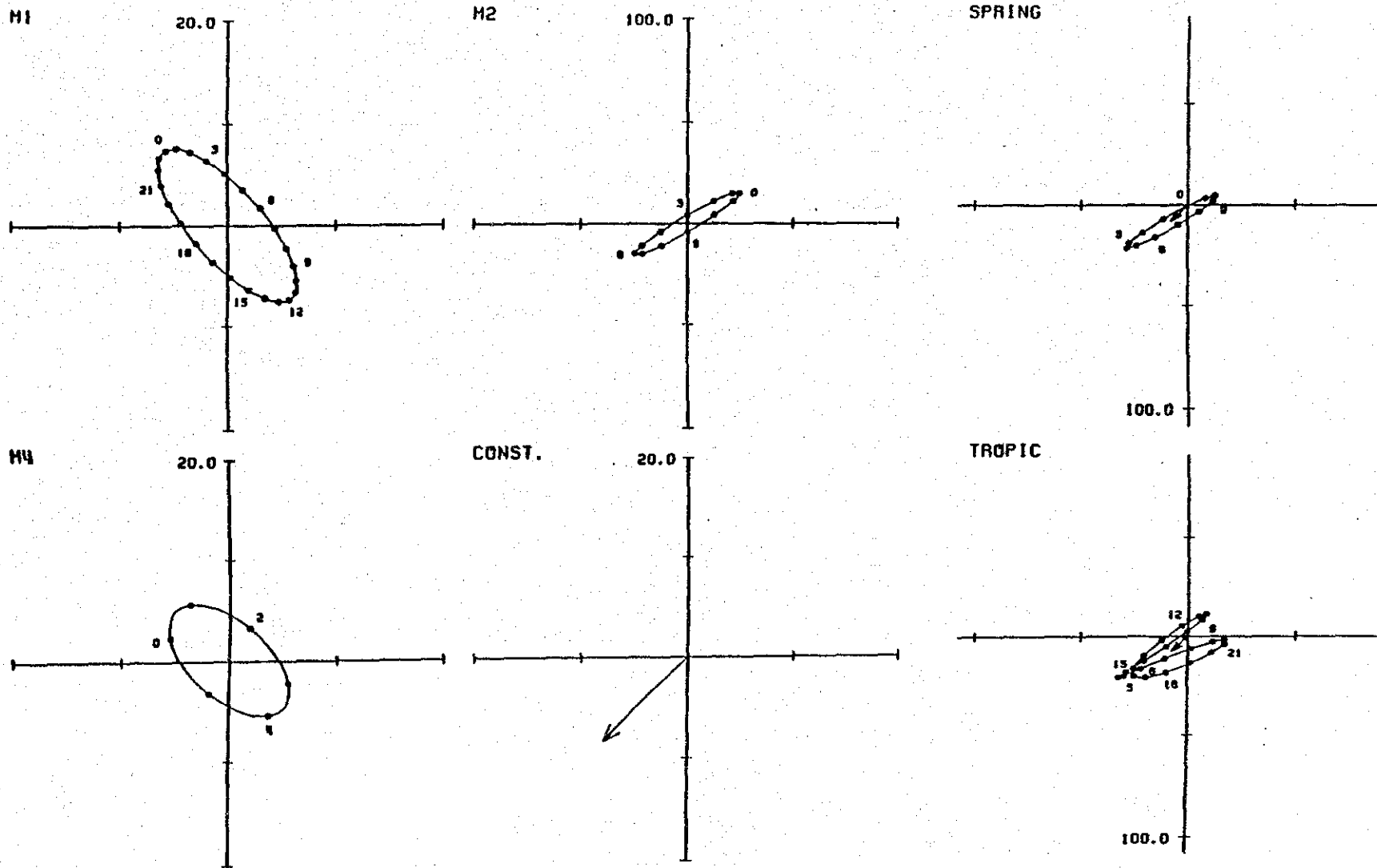
C-38



Tidal Eclipses at St. S-5 Lower

Unit: cm/sec.

C-39

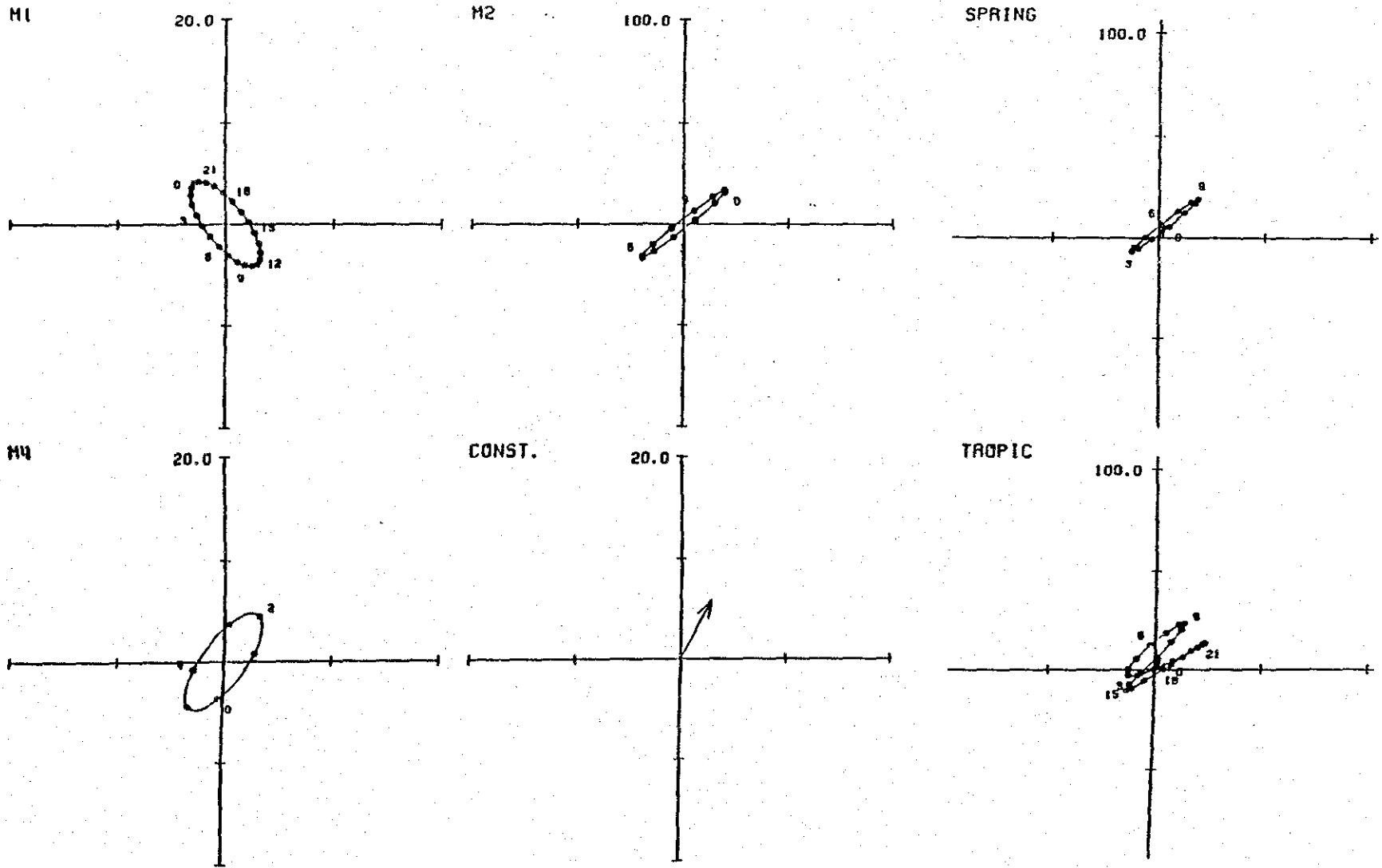


Tidal Eclipses at St. S-6 Upper

Unit: cm/sec.



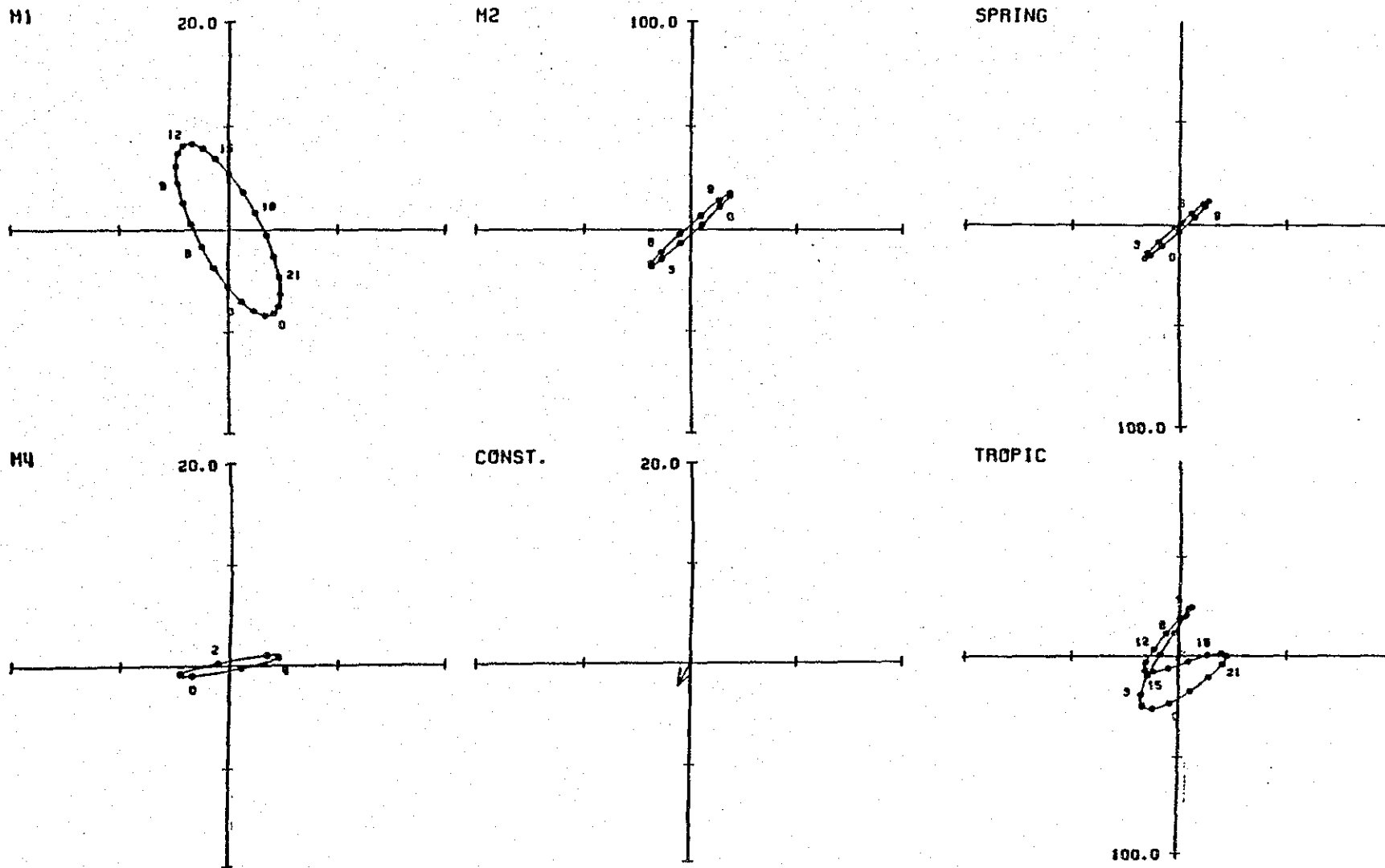
C-40



Tidal Ellipses at St. S-6 Middle

Unit: cm/sec.

C-41



Tidal Eclipses at St. S-6 Lower

Unit: cm/sec.

## C.7 Harmonic Analysis Results

HARMONIC ANALYSIS OF TIDAL CURRENT FOR 15 DAYS

POSITION ; La Union, El Salvador B-1  
 LAYER ; Upper  
 LATITUDE ; 13 19 59 N  
 LONGITUDE ; 87 49 5 W  
 TIME ZONE ; 90.0 W  
 OBSERVATION START ; 2001 9 8 14  
 UNIT ; m/sec  
 DIRECTION ; true

HARMONIC CONSTANT

ELEMENT OF ELLIPSE

C-43

	N - COMP.		E - COMP.		MAIN DIR. 303.4			MAJOR			MINOR		
	V	K	V	K	V	K		KL	VL	TL	KS	VS	TS
K1	0.032	306.3	0.040	128.7	0.051	307.9	K1	308.5	0.051	20.5 (307.8)	38.5	0.001	14.5 (217.8)
O1	0.012	272.6	0.021	86.6	0.024	268.2	O1	299.1	0.024	17.9 (268.0)	29.1	0.001	23.9 (358.0)
P1	0.011	306.3	0.013	128.7	0.017	307.9	P1	308.5	0.017	20.5 (307.8)	38.5	0.000	14.5 (217.8)
Q1	0.008	350.5	0.009	193.3	0.012	5.2	Q1	309.7	0.012	0.3 ( 3.9)	39.7	0.002	18.3 (273.9)
M2	0.334	1.3	0.518	179.6	0.616	0.1	M2	302.8	0.616	0.0 ( 0.1)	32.8	0.009	3.0 ( 90.1)
S2	0.079	73.0	0.117	256.0	0.141	75.1	S2	304.1	0.141	2.5 ( 75.1)	34.1	0.003	11.5 (345.1)
k2	0.021	73.0	0.032	256.0	0.038	75.1	k2	304.1	0.038	2.5 ( 75.1)	34.1	0.001	11.5 (345.1)
N2	0.100	311.9	0.145	130.9	0.176	311.2	N2	304.5	0.176	10.4 (311.2)	34.5	0.001	1.4 ( 41.2)
M4	0.055	233.4	0.093	48.0	0.108	229.6	M4	300.7	0.108	3.8 (229.5)	30.7	0.004	5.3 (319.5)
MS	0.040	308.8	0.045	120.3	0.059	303.5	MS	311.9	0.060	5.1 (304.1)	41.9	0.004	0.6 ( 34.1)
A0	-0.058		0.082		-0.100		A0	125.4	0.100				

HARMONIC ANALYSIS OF TIDAL CURRENT FOR 15 DAYS

POSITION ; La Union, El Salvador B-1  
 LAYER ; Middle  
 LATITUDE ; 13 19 59 N  
 LONGITUDE ; 87 49 5 W  
 TIME ZONE ; 90.0 W  
 OBSERVATION START ; 2001 9 8 14  
 UNIT ; m/sec  
 DIRECTION ; true

HARMONIC CONSTANT

ELEMENT OF ELLIPSE

	N - COMP.		E - COMP.		MAIN DIR. 301.5		ELEMENT OF ELLIPSE						
	V	K	V	K	V	K	KL	VL	TL	KS	VS	TS	
C-44 K1	0.029	293.9	0.042	117.0	0.051	296.1	K1	304.7	0.051	19.7 (296.0)	34.7	0.001	13.7 (206.0)
O1	0.010	292.5	0.019	114.7	0.021	294.2	O1	298.2	0.021	19.6 (294.2)	28.2	0.000	13.6 (204.2)
P1	0.010	293.9	0.014	117.0	0.017	296.1	P1	304.7	0.017	19.7 (296.0)	34.7	0.000	13.7 (206.0)
Q1	0.004	12.7	0.008	170.4	0.009	355.4	Q1	294.2	0.009	23.6 (354.3)	24.2	0.001	5.6 ( 84.3)
M2	0.309	356.7	0.496	179.8	0.584	359.0	M2	301.9	0.584	12.0 (359.0)	31.9	0.014	9.0 (269.0)
S2	0.077	64.2	0.134	252.8	0.154	70.6	S2	299.6	0.154	2.4 ( 70.7)	29.6	0.010	11.4 (340.7)
k2	0.021	64.2	0.036	252.8	0.042	70.6	k2	299.6	0.042	2.4 ( 70.7)	29.6	0.003	11.4 (340.7)
N2	0.102	300.4	0.172	126.5	0.200	304.9	N2	300.6	0.200	10.2 (305.0)	30.6	0.009	7.2 (215.0)
M4	0.087	217.5	0.122	36.8	0.149	217.0	M4	305.6	0.149	3.6 (217.0)	35.6	0.001	5.1 (307.0)
MS	0.039	308.6	0.063	123.2	0.075	304.7	MS	301.7	0.075	5.1 (304.7)	31.7	0.003	0.6 ( 34.7)
A0	-0.031		0.025		-0.038		A0	141.1	0.040				

HARMONIC ANALYSIS OF TIDAL CURRENT FOR 15 DAYS

POSITION ; La Union, El Salvador B-1  
 LAYER ; Lower  
 LATITUDE ; 13 19 59 N  
 LONGITUDE ; 87 49 5 W  
 TIME ZONE ; 90.0 W  
 OBSERVATION START ; 2001 9 8 14  
 UNIT ; m/sec  
 DIRECTION ; true

HARMONIC CONSTANT

ELEMENT OF ELLIPSE

C45

	HARMONIC CONSTANT				ELEMENT OF ELLIPSE								
	N - COMP.		E - COMP.		MAIN DIR. 299.9		MAJOR			MINOR			
	V	K	V	K	V	K	KL	VL	TL	KS	VS	TS	
K1	0.023	292.5	0.037	113.5	0.043	293.2	K1	301.5	0.043	19.5	31.5	0.000	13.5
O1	0.010	276.6	0.019	108.2	0.021	285.4	O1	298.4	0.021	19.0	28.4	0.002	13.0
P1	0.008	292.5	0.012	113.5	0.014	293.2	P1	301.5	0.014	19.5	31.5	0.000	13.5
Q1	0.003	356.8	0.008	178.8	0.008	358.5	Q1	288.6	0.009	23.9	18.6	0.000	17.9
M2	0.263	350.2	0.447	178.6	0.518	356.4	M2	300.3	0.518	11.9	30.3	0.033	8.9
S2	0.064	59.4	0.119	244.0	0.135	62.9	S2	298.4	0.135	2.1	28.4	0.004	11.1
k2	0.017	59.4	0.032	244.0	0.037	62.9	k2	298.4	0.037	2.1	28.4	0.001	11.1
N2	0.085	302.9	0.169	126.0	0.189	305.3	N2	296.6	0.189	10.2	26.6	0.004	7.2
M4	0.080	203.9	0.128	26.9	0.151	206.1	M4	302.1	0.151	3.4	32.1	0.004	1.9
MS	0.035	286.5	0.065	114.5	0.073	292.6	MS	297.9	0.074	4.9	27.9	0.004	3.4
A0	-0.011		0.003		-0.009		A0	163.6	0.012				

HARMONIC ANALYSIS OF TIDAL CURRENT FOR 15 DAYS

POSITION ; La Union, El Salvador B-2  
 LAYER ; Upper  
 LATITUDE ; 13 18 50 N  
 LONGITUDE ; 87 47 19 W  
 TIME ZONE ; 90.0 W  
 OBSERVATION START ; 2001 9 8 14  
 UNIT ; m/sec  
 DIRECTION ; true

HARMONIC CONSTANT

ELEMENT OF ELLIPSE

C-46

	N - COMP.		E - COMP.		MAIN DIR. 319.6		ELEMENT OF ELLIPSE						
	V	K	V	K	V	K	KL	VL	TL	KS	VS	TS	
K1	0.013	274.1	0.033	102.0	0.031	279.6	K1	290.6	0.036	18.7 (281.0)	20.6	0.002	12.7 (191.0)
O1	0.013	151.6	0.013	63.1	0.013	191.8	O1	23.2	0.013	8.6 (129.1)	113.2	0.013	2.6 (39.1)
P1	0.004	274.1	0.011	102.0	0.010	279.6	P1	290.6	0.012	18.7 (281.0)	20.6	0.001	12.7 (191.0)
Q1	0.009	274.7	0.004	247.8	0.005	289.0	Q1	22.1	0.010	18.1 (270.8)	112.1	0.002	12.1 (180.8)
M2	0.559	3.3	0.460	184.0	0.724	3.6	M2	320.6	0.724	0.1 (3.6)	50.6	0.004	9.1 (273.6)
S2	0.138	63.6	0.120	241.2	0.183	62.6	S2	319.0	0.183	2.1 (62.6)	49.0	0.004	5.1 (152.6)
k2	0.038	63.6	0.033	241.2	0.050	62.6	k2	319.0	0.050	2.1 (62.6)	49.0	0.001	5.1 (152.6)
N2	0.150	308.0	0.147	117.6	0.208	303.3	N2	315.6	0.209	10.1 (302.9)	45.6	0.019	1.1 (32.9)
M4	0.038	165.2	0.053	34.8	0.057	192.3	M4	301.0	0.060	3.3 (200.5)	31.0	0.025	1.8 (110.5)
MS	0.011	292.0	0.030	110.5	0.028	290.9	MS	289.3	0.032	4.8 (290.6)	19.3	0.000	0.3 (20.6)
A0	-0.089		0.107		-0.137		A0	129.7	0.139				

HARMONIC ANALYSIS OF TIDAL CURRENT FOR 15 DAYS

POSITION ; La Union, El Salvador B-2  
 LAYER ; Middle  
 LATITUDE ; 13 18 50 N  
 LONGITUDE ; 87 47 19 W  
 TIME ZONE ; 90.0 W  
 OBSERVATION START ; 2001 9 8 14  
 UNIT ; m/sec  
 DIRECTION ; true

HARMONIC CONSTANT

ELEMENT OF ELLIPSE

C47

	N - COMP.		E - COMP.		MAIN DIR. 318.4			MAJOR			MINOR		
	V	K	V	K	V	K		KL	VL	TL	KS	VS	TS
K1	0.042	296.7	0.029	118.4	0.051	297.3	K1	325.3	0.052	19.8	55.3	0.001	13.8
O1	0.023	247.4	0.016	99.4	0.027	259.5	O1	327.0	0.028	17.1 (297.3)	57.0	0.007	11.1 (207.3)
P1	0.014	296.7	0.010	118.4	0.017	297.3	P1	325.3	0.017	19.8 (257.2)	55.3	0.000	13.8 (167.2)
Q1	0.015	344.6	0.007	169.4	0.016	346.0	Q1	334.0	0.017	23.0 (297.3)	64.0	0.001	17.0 (207.3)
M2	0.450	357.2	0.414	180.1	0.611	358.5	M2	317.4	0.611	12.0 (345.5)	47.4	0.015	9.0 (255.5)
S2	0.122	65.8	0.111	247.5	0.165	66.5	S2	317.8	0.165	2.2 (358.6)	47.8	0.002	11.2 (268.6)
k2	0.033	65.8	0.030	247.5	0.045	66.5	k2	317.8	0.045	2.2 (66.6)	47.8	0.001	11.2 (336.6)
N2	0.171	307.5	0.135	122.6	0.217	305.5	N2	321.9	0.218	10.2 (66.6)	51.9	0.009	1.2 (336.6)
M4	0.066	199.1	0.077	39.8	0.099	209.7	M4	310.2	0.100	3.5 (305.7)	40.2	0.018	2.0 (35.7)
MS	0.040	245.2	0.034	84.6	0.051	253.6	MS	320.0	0.052	4.2 (211.1)	50.0	0.009	2.7 (121.1)
A0	-0.049		0.036		-0.060		A0	144.1	0.061				2.7 (163.3)



HARMONIC ANALYSIS OF TIDAL CURRENT FOR 15 DAYS

POSITION ; La Union, El Salvador B-2  
 LAYER ; Lower  
 LATITUDE ; 13 18 50 N  
 LONGITUDE ; 87 47 19 W  
 TIME ZONE ; 90.0 W  
 OBSERVATION START ; 2001 9 8 14  
 UNIT ; m/sec  
 DIRECTION ; true

HARMONIC CONSTANT

ELEMENT OF ELLIPSE

C-48

	N - COMP.		E - COMP.		MAIN DIR. 316.5		ELEMENT OF ELLIPSE						
	V	K	V	K	V	K	KL	VL	TL	KS	VS	TS	
K1	0.035	294.7	0.021	117.8	0.040	295.8	K1	328.3	0.041	19.7	58.3	0.001	13.7
O1	0.012	232.4	0.014	86.2	0.018	250.3	O1	309.2	0.018	(295.6) 16.8	39.2	0.005	(205.6) 10.8
P1	0.012	294.7	0.007	117.8	0.013	295.8	P1	328.3	0.014	(252.5) 19.7	58.3	0.000	(162.5) 13.7
Q1	0.011	320.0	0.007	137.7	0.013	319.1	Q1	327.7	0.013	(295.6) 21.3	57.7	0.000	(205.6) 3.3
M2	0.343	352.1	0.348	179.0	0.488	355.5	M2	314.5	0.488	(319.4) 11.9	44.5	0.029	(49.4) 8.9
S2	0.104	65.3	0.091	248.7	0.138	66.9	S2	318.9	0.138	(355.6) 2.2	48.9	0.004	(265.6) 11.2
k2	0.028	65.3	0.025	248.7	0.038	66.9	k2	318.9	0.038	(66.8) 2.2	48.9	0.001	(336.8) 11.2
N2	0.167	306.0	0.132	125.2	0.212	305.7	N2	321.8	0.212	(66.8) 10.2	51.8	0.001	(336.8) 1.2
M4	0.062	190.8	0.066	33.5	0.089	202.3	M4	312.8	0.089	(305.8) 3.4	42.8	0.018	(35.8) 1.9
M5	0.049	254.8	0.041	80.5	0.063	257.3	M5	320.2	0.064	(203.0) 4.3	50.2	0.003	(113.0) 2.8
A0	-0.032		0.003		-0.026		A0	174.0	0.032	(257.2)			(167.2)

HARMONIC ANALYSIS OF TIDAL CURRENT FOR 15 DAYS

POSITION ; La Union, El Salvador B-3  
 LAYER ; Upper  
 LATITUDE ; 13 15 54 N  
 LONGITUDE ; 87 46 51 W  
 TIME ZONE ; 90.0 W  
 OBSERVATION START ; 2001 9 8 14  
 UNIT ; m/sec  
 DIRECTION ; true

HARMONIC CONSTANT

ELEMENT OF ELLIPSE

C49

	N - COMP.		E - COMP.		MAIN DIR. 37.7			MAJOR			MINOR		
	V	K	V	K	V	K		KL	VL	TL	KS	VS	TS
K1	0.012	31.9	0.013	357.7	0.017	16.8	K1	45.9	0.017	1.0	135.9	0.005	19.0
										( 14.3)			(284.3)
O1	0.014	281.8	0.003	322.4	0.012	287.8	O1	10.5	0.014	18.9	100.5	0.002	0.9
										(283.4)			( 13.4)
P1	0.004	31.9	0.004	357.7	0.006	16.8	P1	45.9	0.006	1.0	135.9	0.002	19.0
										( 14.3)			(284.3)
Q1	0.024	344.8	0.005	345.9	0.022	345.0	Q1	10.7	0.024	23.0	100.7	0.000	5.0
										(344.9)			( 74.9)
M2	0.537	353.5	0.435	2.2	0.689	356.8	M2	38.9	0.689	11.9	128.9	0.052	2.9
										(357.0)			( 87.0)
S2	0.151	65.9	0.105	68.5	0.184	66.8	S2	34.8	0.184	2.2	124.8	0.004	5.2
										( 66.7)			(156.7)
k2	0.041	65.9	0.029	68.5	0.050	66.8	k2	34.8	0.050	2.2	124.8	0.001	5.2
										( 66.7)			(156.7)
N2	0.178	313.6	0.124	310.0	0.216	312.4	N2	34.7	0.217	10.4	124.7	0.006	7.4
										(312.5)			(222.5)
M4	0.124	162.6	0.061	163.9	0.136	162.9	M4	26.1	0.138	2.7	116.1	0.001	4.2
										(162.9)			(252.9)
MS	0.058	215.5	0.048	235.1	0.074	223.1	MS	38.8	0.074	3.7	128.8	0.013	5.2
										(223.3)			(313.3)
A0	-0.106		-0.030		-0.102		A0	195.6	0.110				

HARMONIC ANALYSIS OF TIDAL CURRENT FOR 15 DAYS

POSITION ; La Union, El Salvador B-3  
 LAYER ; Middle  
 LATITUDE ; 13 15 54 N  
 LONGITUDE ; 87 46 51 W  
 TIME ZONE ; 90.0 W  
 OBSERVATION START ; 2001 9 8 14  
 UNIT ; m/sec  
 DIRECTION ; true

HARMONIC CONSTANT

ELEMENT OF ELLIPSE

C-50

	N - COMP.		E - COMP.		MAIN DIR. 40.7		ELEMENT OF ELLIPSE						
	V	K	V	K	V	K	KL	VL	TL	KS	VS	TS	
K1	0.036	317.2	0.036	346.6	0.049	330.8	K1	45.3	0.049	22.1	135.3	0.013	4.1
O1	0.012	222.2	0.013	290.7	0.015	255.2	O1	51.4	0.015	(332.1) 17.5	141.4	0.010	( 62.1) 23.5
P1	0.012	317.2	0.012	346.6	0.016	330.8	P1	45.3	0.016	(262.4) 22.1	135.3	0.004	(352.4) 4.1
Q1	0.016	358.6	0.014	39.0	0.020	16.4	Q1	42.1	0.020	(332.1) 1.1	132.1	0.007	( 62.1) 7.1
M2	0.502	347.2	0.419	357.4	0.652	351.5	M2	39.8	0.652	( 17.0) 11.7	129.8	0.057	(107.0) 2.7
S2	0.121	61.1	0.108	68.6	0.162	64.3	S2	41.6	0.162	(351.4) 2.1	131.6	0.011	( 81.4) 5.1
k2	0.033	61.1	0.029	68.6	0.044	64.3	k2	41.6	0.044	( 64.4) 2.1	131.6	0.003	(154.4) 5.1
N2	0.158	311.6	0.147	318.0	0.215	314.5	N2	42.9	0.215	( 64.4) 10.5	132.9	0.012	(154.4) 1.5
M4	0.107	170.5	0.080	160.6	0.132	166.6	M4	36.7	0.133	(314.6) 2.8	126.7	0.011	( 44.6) 1.3
MS	0.046	263.6	0.042	240.1	0.061	253.3	MS	41.9	0.061	(167.0) 4.2	131.9	0.013	( 77.0) 2.7
A0	0.009		0.041		0.034		A0	77.4	0.042	(253.1)			(163.1)

HARMONIC ANALYSIS OF TIDAL CURRENT FOR 15 DAYS

POSITION ; La Union, El Salvador B-3  
 LAYER ; Lower  
 LATITUDE ; 13 15 54 N  
 LONGITUDE ; 87 46 51 W  
 TIME ZONE ; 90.0 W  
 OBSERVATION START ; 2001 9 8 14  
 UNIT ; m/sec  
 DIRECTION ; true

HARMONIC CONSTANT

ELEMENT OF ELLIPSE

C-51

	N - COMP.		E - COMP.		MAIN DIR. 37.4		ELEMENT OF ELLIPSE						
	V	K	V	K	V	K	KL	VL	TL	KS	VS	TS	
K1	0.036	343.8	0.036	336.1	0.050	340.5	K1	45.0	0.050	22.7	135.0	0.003	16.7
O1	0.023	294.2	0.014	228.2	0.023	273.9	O1	20.4	0.024	18.9	110.4	0.013	12.9
P1	0.012	343.8	0.012	336.1	0.017	340.5	P1	45.0	0.017	22.7	135.0	0.001	16.7
Q1	0.013	49.7	0.014	356.1	0.017	26.1	Q1	47.0	0.017	1.4	137.0	0.009	19.4
M2	0.478	351.5	0.349	354.1	0.591	352.4	M2	36.1	0.591	11.7	126.1	0.013	2.7
S2	0.111	59.5	0.097	72.0	0.146	64.5	S2	41.1	0.146	2.2	131.1	0.016	5.2
k2	0.030	59.5	0.026	72.0	0.040	64.5	k2	41.1	0.040	2.2	131.1	0.004	5.2
N2	0.144	296.1	0.150	316.1	0.202	305.0	N2	46.4	0.205	10.2	136.4	0.036	1.2
M4	0.086	156.3	0.085	174.3	0.119	164.0	M4	44.8	0.120	2.8	134.8	0.019	4.3
MS	0.052	259.2	0.049	258.7	0.071	259.0	MS	43.1	0.071	4.3	133.1	0.000	2.8
A0	0.136		0.032		0.127		A0	13.1	0.140				

HARMONIC ANALYSIS OF TIDAL CURRENT FOR 15 DAYS

POSITION ; La Union, El Salvador B-4  
 LAYER ; Upper  
 LATITUDE ; 13 12 10 N  
 LONGITUDE ; 87 48 17 W  
 TIME ZONE ; 90.0 W  
 OBSERVATION START ; 2001 9 8 14  
 UNIT ; m/sec  
 DIRECTION ; true

HARMONIC CONSTANT

ELEMENT OF ELLIPSE

C-52

	N - COMP.		E - COMP.		MAIN DIR. 28.7			MAJOR			MINOR		
	V	K	V	K	V	K		KL	VL	TL	KS	VS	TS
K1	0.014	226.7	0.021	245.3	0.022	235.1	K1	56.9	0.025	16.0 (239.7)	146.9	0.004	22.0 (329.7)
O1	0.007	336.2	0.019	164.2	0.003	183.4	O1	291.3	0.020	22.9 (343.2)	21.3	0.001	16.9 (253.2)
P1	0.005	226.7	0.007	245.3	0.007	235.1	P1	56.9	0.008	16.0 (239.7)	146.9	0.001	22.0 (329.7)
Q1	0.011	351.6	0.011	341.5	0.015	348.1	Q1	45.0	0.016	23.1 (346.6)	135.0	0.001	17.1 (256.6)
M2	0.366	359.3	0.181	336.0	0.402	354.4	M2	25.2	0.403	11.8 (355.0)	115.2	0.065	8.8 (265.0)
S2	0.084	105.8	0.029	83.7	0.087	102.3	S2	18.2	0.088	3.5 (103.6)	108.2	0.010	0.5 ( 13.6)
k2	0.023	105.8	0.008	83.7	0.024	102.3	k2	18.2	0.024	3.5 (103.6)	108.2	0.003	0.5 ( 13.6)
N2	0.098	324.7	0.032	285.1	0.098	319.0	N2	14.6	0.101	10.7 (321.9)	104.6	0.020	7.7 (231.9)
M4	0.064	203.6	0.035	144.0	0.066	190.9	M4	19.4	0.067	3.2 (194.9)	109.4	0.029	1.7 (104.9)
MS	0.033	298.1	0.009	270.3	0.033	294.7	MS	13.0	0.034	4.9 (296.6)	103.0	0.004	3.4 (206.6)
A0	-0.073		0.034		-0.048		A0	155.2	0.081				

HARMONIC ANALYSIS OF TIDAL CURRENT FOR 15 DAYS

POSITION ; La Union, El Salvador B-4  
 LAYER ; Middle  
 LATITUDE ; 13 12 10 N  
 LONGITUDE ; 87 48 17 W  
 TIME ZONE ; 90.0 W  
 OBSERVATION START ; 2001 9 8 14  
 UNIT ; m/sec  
 DIRECTION ; true

HARMONIC CONSTANT

ELEMENT OF ELLIPSE

C-53

	N - COMP.		E - COMP.		MAIN DIR. 30.0			MAJOR			MINOR		
	V	K	V	K	V	K		KL	VL	TL	KS	VS	TS
K1	0.022	315.9	0.016	4.7	0.025	329.8	K1	31.9	0.025	22.0	121.9	0.010	4.0
O1	0.012	294.9	0.016	307.9	0.018	300.4	O1	51.8	0.020	(330.6) 20.2	141.8	0.002	( 60.6) 2.2
P1	0.007	315.9	0.005	4.7	0.008	329.8	P1	31.9	0.008	(302.9) 22.0	121.9	0.003	( 32.9) 4.0
Q1	0.009	8.9	0.014	34.9	0.015	21.2	Q1	58.5	0.017	(330.6) 1.8	148.5	0.003	( 60.6) 7.8
M2	0.406	357.9	0.237	348.2	0.469	355.4	M2	30.1	0.469	( 27.6) 11.8	120.1	0.035	(117.6) 8.8
S2	0.109	60.9	0.056	47.0	0.122	57.8	S2	26.6	0.122	(355.4) 1.9	116.6	0.012	(265.4) 10.9
k2	0.030	60.9	0.015	47.0	0.033	57.8	k2	26.6	0.033	( 58.1) 1.9	116.6	0.003	(328.1) 10.9
N2	0.157	306.4	0.049	291.1	0.160	304.1	N2	16.8	0.164	( 58.1) 10.2	106.8	0.012	(328.1) 7.2
M4	0.035	216.8	0.031	140.0	0.037	193.1	M4	29.3	0.037	(305.1) 3.2	119.3	0.028	(215.1) 1.7
MS	0.033	287.8	0.009	288.4	0.033	287.9	MS	15.5	0.035	(193.7) 4.8	105.5	0.000	(103.7) 0.3
A0	-0.018		0.064		0.017		A0	105.5	0.067	(287.8)			( 17.8)

HARMONIC ANALYSIS OF TIDAL CURRENT FOR 15 DAYS

POSITION ; La Union, El Salvador B-4  
 LAYER ; Lower  
 LATITUDE ; 13 12 10 N  
 LONGITUDE ; 87 48 17 W  
 TIME ZONE ; 90.0 W  
 OBSERVATION START ; 2001 9 8 14  
 UNIT ; m/sec  
 DIRECTION ; true

HARMONIC CONSTANT

ELEMENT OF ELLIPSE

C-54

	N - COMP.		E - COMP.		MAIN DIR. 31.1			MAJOR			MINOR		
	V	K	V	K	V	K		KL	VL	TL	KS	VS	TS
K1	0.025	327.5	0.014	350.4	0.028	333.2	K1	27.8	0.028	22.2	117.8	0.005	4.2
O1	0.007	322.3	0.007	336.7	0.009	327.7	O1	44.5	0.009	22.0	134.5	0.001	4.0
P1	0.008	327.5	0.005	350.4	0.009	333.2	P1	27.8	0.009	22.2	117.8	0.002	4.2
Q1	0.009	325.9	0.001	65.0	0.008	330.9	Q1	358.7	0.009	21.7	88.7	0.001	3.7
M2	0.355	348.5	0.235	340.7	0.424	346.3	M2	33.4	0.425	11.5	123.4	0.027	8.5
S2	0.106	56.8	0.050	35.4	0.116	52.1	S2	24.4	0.116	1.8	114.4	0.017	10.8
k2	0.029	56.8	0.014	35.4	0.031	52.1	k2	24.4	0.032	1.8	114.4	0.005	10.8
N2	0.160	304.7	0.048	286.9	0.161	301.9	N2	16.2	0.167	10.1	106.2	0.014	7.1
M4	0.052	219.6	0.029	173.5	0.056	208.6	M4	23.8	0.056	3.5	113.8	0.019	2.0
MS	0.032	311.0	0.009	224.5	0.028	301.6	MS	1.0	0.032	5.2	91.0	0.009	3.7
A0	0.010		0.067		0.043		A0	81.4	0.068				

HARMONIC ANALYSIS OF TIDAL CURRENT FOR 15 DAYS

POSITION ; La Union, El Salvador B-5  
 LAYER ; Upper  
 LATITUDE ; 13 4 56 N  
 LONGITUDE ; 87 58 13 W  
 TIME ZONE ; 90.0 W  
 OBSERVATION START ; 2001 9 8 14  
 UNIT ; m/sec  
 DIRECTION ; true

HARMONIC CONSTANT

ELEMENT OF ELLIPSE

C-55

	N - COMP.		E - COMP.		MAIN DIR. 59.6		ELEMENT OF ELLIPSE						
	V	K	V	K	V	K	KL	VL	TL	KS	VS	TS	
K1	0.041	209.9	0.034	240.0	0.049	227.6	K1	39.1	0.052	14.8 (222.0)	129.1	0.014	20.8 (312.0)
O1	0.014	342.3	0.007	95.2	0.008	33.6	O1	345.5	0.015	22.4 (335.6)	75.5	0.007	4.4 ( 65.6)
P1	0.014	209.9	0.011	240.0	0.016	227.6	P1	39.1	0.017	14.8 (222.0)	129.1	0.005	20.8 (312.0)
Q1	0.010	232.8	0.032	7.7	0.024	358.9	Q1	283.4	0.033	12.7 (190.6)	13.4	0.007	18.7 (280.6)
M2	0.070	310.4	0.162	354.9	0.167	346.4	M2	71.5	0.170	11.7 (349.7)	161.5	0.047	2.7 ( 79.7)
S2	0.016	39.4	0.036	78.9	0.038	70.9	S2	69.3	0.038	2.4 ( 73.4)	159.3	0.010	5.4 (163.4)
k2	0.004	39.4	0.010	78.9	0.010	70.9	k2	69.3	0.010	2.4 ( 73.4)	159.3	0.003	5.4 (163.4)
N2	0.029	214.1	0.038	301.8	0.036	277.9	N2	85.6	0.038	9.9 (298.4)	175.6	0.029	0.9 ( 28.4)
M4	0.003	291.3	0.012	168.5	0.009	177.3	M4	279.3	0.012	5.8 (346.3)	9.3	0.003	4.3 (256.3)
MS	0.004	76.1	0.002	149.0	0.003	102.2	MS	6.7	0.004	1.3 ( 78.3)	96.7	0.001	2.8 (168.3)
A0	0.059		-0.055		-0.017		A0	317.1	0.080				



HARMONIC ANALYSIS OF TIDAL CURRENT FOR 15 DAYS

POSITION ; La Union, El Salvador B-5  
 LAYER ; Middle  
 LATITUDE ; 13 4 56 N  
 LONGITUDE ; 87 58 13 W  
 TIME ZONE ; 90.0 W  
 OBSERVATION START ; 2001 9 8 14  
 UNIT ; m/sec  
 DIRECTION ; true

HARMONIC CONSTANT

ELEMENT OF ELLIPSE

	N - COMP.		E - COMP.		MAIN DIR. 79.7		MAJOR			MINOR			
	V	K	V	K	V	K	KL	VL	TL	KS	VS	TS	
K1	0.022	356.5	0.024	107.7	0.022	98.1	K1	309.6	0.027	21.1 (317.0)	39.6	0.018	3.1 ( 47.0)
O1	0.020	83.6	0.018	223.2	0.015	214.2	O1	319.8	0.025	4.4 ( 66.5)	49.8	0.009	10.4 (156.5)
P1	0.007	356.5	0.008	107.7	0.007	98.1	P1	309.6	0.009	21.1 (317.0)	39.6	0.006	3.1 ( 47.0)
Q1	0.012	285.6	0.007	318.2	0.009	310.7	Q1	28.3	0.014	19.6 (293.3)	118.3	0.003	1.6 ( 23.3)
M2	0.077	336.7	0.173	357.5	0.183	356.0	M2	67.0	0.188	11.8 (354.3)	157.0	0.025	2.8 ( 84.3)
S2	0.026	31.4	0.055	66.1	0.058	63.5	S2	67.3	0.060	2.0 ( 60.5)	157.3	0.014	5.0 (150.5)
k2	0.007	31.4	0.015	66.1	0.016	63.5	k2	67.3	0.016	2.0 ( 60.5)	157.3	0.004	5.0 (150.5)
N2	0.018	255.4	0.059	308.7	0.060	306.3	N2	79.4	0.060	10.2 (306.3)	169.4	0.014	1.2 ( 36.3)
M4	0.010	127.2	0.017	164.5	0.018	161.2	M4	63.4	0.019	2.6 (156.5)	153.4	0.005	4.1 (246.5)
MS	0.004	190.4	0.015	250.5	0.015	248.0	MS	81.7	0.015	4.1 (248.5)	171.7	0.003	5.6 (338.5)
A0	0.021		0.008		0.012		A0	20.9	0.023				

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HARMONIC ANALYSIS OF TIDAL CURRENT FOR 15 DAYS

POSITION ; La Union, El Salvador B-5  
 LAYER ; Lower  
 LATITUDE ; 13 4 56 N  
 LONGITUDE ; 87 58 13 W  
 TIME ZONE ; 90.0 W  
 OBSERVATION START ; 2001 9 8 14  
 UNIT ; m/sec  
 DIRECTION ; true

HARMONIC CONSTANT

ELEMENT OF ELLIPSE

C-57

	N - COMP.		E - COMP.		MAIN DIR. 60.4			ELEMENT OF ELLIPSE					
	V	K	V	K	V	K		KL	VL	TL	KS	VS	TS
K1	0.043	300.5	0.022	335.0	0.038	316.8	K1	24.3	0.047	20.5	114.3	0.011	2.5
O1	0.021	214.2	0.002	94.3	0.010	205.9	O1	357.5	0.021	14.3 (306.8)	87.5	0.002	8.3 (124.4)
P1	0.014	300.5	0.007	335.0	0.013	316.8	P1	24.3	0.016	20.5 (214.4)	114.3	0.004	2.5 (36.8)
Q1	0.022	71.2	0.020	212.9	0.011	177.0	Q1	317.6	0.028	3.6 (53.7)	47.6	0.010	9.6 (143.7)
M2	0.069	341.5	0.212	337.4	0.219	338.0	M2	72.0	0.223	11.3 (337.8)	162.0	0.005	8.3 (247.8)
S2	0.004	288.5	0.028	11.5	0.025	7.2	S2	89.0	0.028	0.4 (11.4)	179.0	0.004	3.4 (101.4)
k2	0.001	288.5	0.008	11.5	0.007	7.2	k2	89.0	0.008	0.4 (11.4)	179.0	0.001	3.4 (101.4)
N2	0.061	325.4	0.055	319.3	0.078	321.6	N2	42.1	0.082	10.8 (322.7)	132.1	0.004	7.8 (232.7)
M4	0.011	142.1	0.017	210.8	0.017	194.1	M4	70.8	0.018	3.3 (199.9)	160.8	0.010	4.8 (289.9)
MS	0.008	176.1	0.008	192.3	0.011	186.5	MS	45.3	0.011	3.1 (184.3)	135.3	0.002	4.6 (274.3)
A0	-0.001		-0.037		-0.033		A0	268.2	0.037				

position ; La Union, El Salvador S-1  
 layer ; Lower  
 lat. ; 13 20 16 N long. ; 87 49 38 W  
 epoch ; 2001 9 17 11 0  
 moon age ; dec. ;  
 moon transit ; 17 12 10  
 unit ; m/sec dir. = True

harmonic coefficient

	R1	T1	R2	T2	R4	T4	A0
N	0.017	342.1	0.320	353.5	0.050	284.4	0.013
E	0.089	258.6	0.296	172.3	0.034	47.7	0.059

ellipse

	L-dir	VL	HL	S-dir	VS	HS	S/L
M1	88.7	0.089	258.8	178.7	0.017	168.8	0.19
M2	317.2	0.436	353.0	47.2	0.005	83.0	0.01
M4	332.3	0.054	270.3	62.3	0.026	0.3	0.48
A0	77.1	0.060		M1/M2=	0.204		

harmonic constant standard ; B-1 Lower

	vn	kn	ve	ke	rat.n	rat.e	dif.n	dif.e
K1	0.042	107.8	0.217	24.2	0.97	5.04	174.6	91.0
O1	0.020	100.0	0.106	16.4				
M2	0.211	354.4	0.196	173.2	0.41	0.38	358.0	176.8
S2	0.055	60.9	0.051	239.7				

ellipse

	l-dir	vl	hl	s-dir	vs	hs	s/l
K1	88.7	0.217	24.5	178.7	0.041	294.5	0.19
O1	88.7	0.106	16.7	178.7	0.020	286.7	0.19
M2	317.2	0.288	353.9	47.2	0.003	83.9	0.01
S2	317.2	0.075	60.4	47.2	0.001	150.4	0.01

position ; La Union, El Salvador S-1  
 layer ; Lower  
 lat. ; 13 20 16 N long. ; 87 49 38 W  
 epoch ; 2001 9 17 11 0  
 moon age ; dec. ;  
 moon transit ; 17 12 10  
 unit ; m/sec dir. = True

t=0; La Union k= 74.5 h=0; transit

	spring	tropic	m2	m1
t	dir v	dir v	h dir v	h dir v
0	20 0.063	76 0.341	0 317 0.433	0 313 0.024
1	118 0.168	95 0.424	1 318 0.348	1 290 0.042
2	127 0.315	107 0.492	2 319 0.170	2 281 0.060
3	129 0.392	113 0.493	3 132 0.054	3 276 0.075
4	129 0.373	116 0.402	4 136 0.263	4 272 0.084
5	127 0.265	115 0.224	5 137 0.402	5 269 0.089
6	109 0.101	5 0.025	6 137 0.433	6 267 0.087
7	344 0.109	307 0.253	7 138 0.348	7 263 0.080
8	328 0.256	305 0.449	8 139 0.170	8 259 0.068
9	326 0.332	302 0.557	9 312 0.054	9 253 0.052
10	327 0.314	299 0.556	10 316 0.263	10 239 0.033
11	333 0.208	293 0.453	11 317 0.402	11 198 0.018
12		277 0.290		12 133 0.024
13		227 0.172		13 110 0.042
14		173 0.243		14 101 0.060
15		154 0.342	m4	15 96 0.075
16		144 0.368		16 92 0.084
17		134 0.313	h dir v	17 89 0.089
18		115 0.210	0 62 0.026	18 87 0.087
19		68 0.151	1 137 0.049	19 83 0.080
20		29 0.208	2 168 0.049	20 79 0.068
21		22 0.272	3 242 0.026	21 73 0.052
22		29 0.294	4 317 0.049	22 59 0.033
23		50 0.298	5 348 0.049	23 18 0.018

h	dir	v
0	326	0.335
1	329	0.269
2	343	0.129
3	98	0.089
4	124	0.250
5	129	0.366
6	130	0.394
7	128	0.327
8	122	0.183
9	37	0.049
10	332	0.191
11	327	0.306

harmonic analysis one day tidal current

position ; La Union, El Salvador S-1  
 layer ; Upper  
 lat. ; 13 20 16 N long. ; 87 49 38 W  
 epoch ; 2001 9 17 11 0  
 moon age ; dec. ;  
 moon transit ; 17 12 10  
 unit ; m/sec dir.= True

harmonic coefficient

	R1	T1	R2	T2	R4	T4	A0
N	0.021	27.2	0.350	2.2	0.072	251.1	-0.088
E	0.068	276.5	0.476	176.9	0.127	2.7	0.187

ellipse

	L-dir	VL	HL	S-dir	VS	HS	S/L
M1	276.6	0.069	94.7	6.6	0.019	4.7	0.28
M2	306.3	0.590	358.8	36.3	0.026	88.8	0.04
M4	282.0	0.129	189.1	12.0	0.068	279.1	0.53

A0 115.3 0.206 M1/M2= 0.116

harmonic constant standard ; B-1 Upper

	vn	kn	ve	ke	rat.n	rat.e	dif.n	dif.e
K1	0.051	128.1	0.169	17.4	1.00	3.32	180.2	69.5
O1	0.024	88.4	0.080	337.7				
M2	0.252	1.5	0.342	176.3	0.41	0.56	1.4	176.2
S2	0.058	76.5	0.078	251.3				

ellipse

	l-dir	vl	hl	s-dir	vs	hs	s/l
K1	276.6	0.170	195.6	6.6	0.048	105.6	0.28
O1	276.6	0.080	155.9	6.6	0.022	65.9	0.28
M2	306.3	0.424	358.1	36.3	0.019	88.1	0.04
S2	306.3	0.097	73.1	36.3	0.004	163.1	0.04

C-59

table of tidal current diagram

position ; La Union, El Salvador S-1  
 layer ; Upper  
 lat. ; 13 20 16 N long. ; 87 49 38 W  
 epoch ; 2001 9 17 11 0  
 moon age ; dec. ;  
 moon transit ; 17 12 10  
 unit ; m/sec dir.= True

t=0; La Union k= 74.5 h=0; transit

spring			tropic			m2			m1		
t	dir	v	dir	v	h	dir	v	h	dir	v	
0	89	0.101	85	0.294	0	306	0.590	0	23	0.020	
1	116	0.355	104	0.476	1	308	0.505	1	333	0.022	
2	121	0.582	112	0.635	2	311	0.285	2	307	0.034	
3	123	0.710	117	0.697	3	63	0.029	3	295	0.047	
4	124	0.703	120	0.629	4	122	0.307	4	288	0.057	
5	124	0.562	123	0.434	5	125	0.518	5	282	0.065	
6	123	0.326	134	0.156	6	126	0.590	6	278	0.068	
7	109	0.058	286	0.155	7	128	0.505	7	274	0.068	
8	314	0.177	296	0.399	8	131	0.285	8	269	0.063	
9	313	0.306	297	0.531	9	243	0.029	9	263	0.054	
10	315	0.301	296	0.512	10	302	0.307	10	255	0.042	
11	326	0.167	293	0.346	11	305	0.518	11	239	0.029	
12			256	0.094				12	203	0.020	
13			139	0.265				13	153	0.022	
14			131	0.545				14	127	0.034	
15			128	0.731				15	115	0.047	
16			126	0.780				16	108	0.057	
17			124	0.691				17	102	0.065	
18			120	0.498				18	98	0.068	
19			107	0.271				19	94	0.068	
20			55	0.130				20	89	0.063	
21			8	0.176				21	83	0.054	
22			9	0.202				22	75	0.042	
23			43	0.196				23	59	0.029	

h	dir	v
0	314	0.321
1	318	0.246
2	0	0.074
3	110	0.228
4	119	0.481
5	122	0.664
6	123	0.724
7	124	0.646
8	124	0.448
9	121	0.186
10	322	0.076
11	313	0.259

position ; La Union, El Salvador S-2  
 layer ; Upper  
 lat. ; 13 19 17 N long. ; 87 47 51 W  
 epoch ; 2001 9 17 11 0  
 moon age ; dec. ;  
 moon transit ; 17 12 10  
 unit ; m/sec dir. = True

harmonic coefficient

	R1	T1	R2	T2	R4	T4	A0
N	0.035	155.8	0.761	359.9	0.124	221.7	-0.164
E	0.061	343.0	0.698	176.9	0.128	57.0	0.187

ellipse

	L-dir	VL	HL	S-dir	VS	HS	S/L
M1	299.9	0.070	161.2	29.9	0.004	71.2	0.05
M2	317.5	1.032	358.5	47.5	0.027	88.5	0.03
M4	314.0	0.177	229.6	44.0	0.024	139.6	0.13
A0	131.3	0.249		M1/M2=	0.068		

harmonic constant standard ; B-1 Upper

	vn	kn	ve	ke	rat.n	rat.e	dif.n	dif.e
K1	0.087	256.7	0.151	83.9	1.71	2.96	308.8	136.0
O1	0.041	217.0	0.071	44.2				
M2	0.546	359.2	0.501	176.2	0.89	0.81	359.1	176.1
S2	0.125	74.2	0.115	251.2				

ellipse

	l-dir	vl	hl	s-dir	vs	hs	s/l
K1	299.9	0.174	262.1	29.9	0.009	172.1	0.05
O1	299.9	0.082	222.4	29.9	0.004	132.4	0.05
M2	317.5	0.741	357.9	47.5	0.019	87.9	0.03
S2	317.5	0.170	72.9	47.5	0.004	162.9	0.03

table of tidal current diagram

position ; La Union, El Salvador S-2  
 layer ; Upper  
 lat. ; 13 19 17 N long. ; 87 47 51 W  
 epoch ; 2001 9 17 11 0  
 moon age ; dec. ;  
 moon transit ; 17 12 10  
 unit ; m/sec dir. = True

t=0; La Union k= 74.5 h=0; transit

spring			tropic			m2			m1		
t	dir	v	dir	v	h	dir	v	h	dir	v	
0	84	0.062	114	0.284	0	317	1.032	0	119	0.066	
1	132	0.511	128	0.759	1	318	0.880	1	118	0.058	
2	135	0.911	131	1.159	2	320	0.493	2	116	0.046	
3	136	1.135	133	1.366	3	92	0.038	3	114	0.031	
4	136	1.121	134	1.321	4	135	0.539	4	105	0.014	
5	137	0.874	134	1.029	5	137	0.907	5	339	0.006	
6	137	0.459	133	0.560	6	137	1.032	6	309	0.023	
7	334	0.014	87	0.040	7	138	0.880	7	305	0.039	
8	319	0.415	320	0.440	8	140	0.493	8	303	0.053	
9	319	0.639	318	0.726	9	272	0.038	9	301	0.063	
10	321	0.626	317	0.769	10	315	0.539	10	301	0.069	
11	324	0.380	317	0.567	11	317	0.907	11	300	0.070	
12			313	0.186				12	299	0.066	
13			143	0.269				13	298	0.058	
14			140	0.668				14	296	0.046	
15			140	0.908				15	294	0.031	
16			141	0.925				16	285	0.014	
17			141	0.722				17	159	0.006	
18			144	0.362	0	143	0.116	18	129	0.023	
19			294	0.056	1	133	0.174	19	125	0.039	
20			318	0.389	2	113	0.063	20	123	0.053	
21			321	0.552	3	323	0.116	21	121	0.063	
22			325	0.487	4	313	0.174	22	121	0.069	
23			344	0.211	5	293	0.063	23	120	0.070	

h	dir	v
0	320	0.663
1	322	0.525
2	332	0.184
3	127	0.286
4	134	0.734
5	135	1.054
6	136	1.159
7	137	1.019
8	137	0.674
9	137	0.214
10	319	0.237
11	319	0.558

C-60

harmonic analysis one day tidal current

position ; La Union, El Salvador S-2  
 layer ; Middle  
 lat. ; 13 19 17 N long. ; 87 47 51 W  
 epoch ; 2001 9 17 11 0  
 moon age ; dec. ;  
 moon transit ; 17 12 10  
 unit ; m/sec dir.= True

harmonic coefficient

	R1	T1	R2	T2	R4	T4	A0
N	0.019	302.8	0.616	356.2	0.128	216.6	-0.103
E	0.017	139.9	0.672	181.6	0.104	47.6	0.047

ellipse

	L-dir	VL	HL	S-dir	VS	HS	S/L
M1	318.5	0.026	310.3	48.5	0.004	220.3	0.15
M2	312.5	0.911	359.1	42.5	0.043	269.1	0.05
M4	320.9	0.164	221.0	50.9	0.016	131.0	0.09
A0	155.4	0.113		M1/M2=	0.028		

harmonic constant standard ; B-1 Middle

	vn	kn	ve	ke	rat.n	rat.e	dif.n	dif.e
K1	0.041	72.7	0.037	269.8	0.81	0.72	136.6	333.7
O1	0.017	70.8	0.015	267.9				
M2	0.420	356.5	0.458	181.9	0.72	0.79	357.5	182.9
S2	0.111	68.1	0.121	253.5				

ellipse

	l-dir	vl	hl	s-dir	vs	hs	s/l
K1	318.5	0.054	80.2	48.5	0.008	350.2	0.15
O1	318.5	0.022	78.3	48.5	0.003	348.3	0.15
M2	312.5	0.621	359.5	42.5	0.029	269.5	0.05
S2	312.5	0.164	71.1	42.5	0.008	341.1	0.05

table of tidal current diagram

position ; La Union, El Salvador S-2  
 layer ; Middle  
 lat. ; 13 19 17 N long. ; 87 47 51 W  
 epoch ; 2001 9 17 11 0  
 moon age ; dec. ;  
 moon transit ; 17 12 10  
 unit ; m/sec dir.= True

t=0;La Union k= 74.5 h=0;transit

spring			tropic			m2			m1		
t	dir	v	dir	v	h	dir	v	h	dir	v	
0	274	0.127	289	0.168	0	312	0.911	0	308	0.017	
1	147	0.318	148	0.250	1	311	0.782	1	301	0.012	
2	139	0.663	138	0.588	2	308	0.445	2	279	0.006	
3	136	0.864	136	0.788	3	204	0.045	3	200	0.004	
4	135	0.863	135	0.790	4	137	0.469	4	161	0.009	
5	134	0.659	134	0.594	5	134	0.796	5	151	0.015	
6	134	0.307	135	0.255	6	132	0.911	6	146	0.020	
7	308	0.100	306	0.137	7	131	0.782	7	143	0.023	
8	310	0.452	309	0.470	8	128	0.445	8	140	0.025	
9	310	0.656	308	0.654	9	24	0.045	9	138	0.026	
10	308	0.657	306	0.635	10	317	0.469	10	135	0.024	
11	304	0.456	301	0.419	11	314	0.796	11	133	0.021	
12			247	0.103				12	128	0.017	
13			146	0.386				13	121	0.012	
14			139	0.738				14	99	0.006	
15			136	0.941			m4	15	20	0.004	
16			135	0.936				16	341	0.009	
17			134	0.724	h	dir	v	17	331	0.015	
18			133	0.358	0	146	0.124	18	326	0.020	
19			311	0.064	1	139	0.155	19	323	0.023	
20			311	0.435	2	115	0.035	20	320	0.025	
21			311	0.658	3	326	0.124	21	318	0.026	
22			309	0.678	4	319	0.155	22	315	0.024	
23			306	0.495	5	295	0.035	23	313	0.021	

h	dir	v
0	309	0.683
1	306	0.576
2	297	0.292
3	169	0.138
4	141	0.509
5	137	0.790
6	135	0.890
7	134	0.781
8	134	0.490
9	136	0.097
10	310	0.295
11	310	0.580

C-61

harmonic analysis one day tidal current

position ; La Union,El Salvador S-2  
 layer ; Lower  
 lat. ; 13 19 17 N long. ; 87 47 51 W  
 epoch ; 2001 9 17 11 0  
 moon age ; dec. ;  
 moon transit ; 17 12 10  
 unit ; m/sec dir.= True

harmonic coefficient

	R1	T1	R2	T2	R4	T4	A0
N	0.003	191.3	0.462	347.4	0.133	212.6	-0.076
E	0.020	149.9	0.558	174.4	0.110	25.8	0.003

ellipse

	L-dir	VL	HL	S-dir	VS	HS	S/L
M1	83.8	0.020	150.5	173.8	0.002	60.5	0.09
M2	309.6	0.723	351.6	39.6	0.043	261.6	0.06
M4	320.5	0.173	209.8	50.5	0.010	299.8	0.06
A0	177.7	0.076		M1/M2=	0.027		

harmonic constant standard ; B-1 Lower

	vn	kn	ve	ke	rat.n	rat.e	dif.n	dif.e
K1	0.007	316.9	0.048	275.6	0.16	1.11	23.7	342.4
O1	0.003	309.1	0.023	267.8				
M2	0.305	348.3	0.368	175.3	0.59	0.71	351.9	178.9
S2	0.079	54.8	0.096	241.8				

ellipse

	l-dir	vl	hl	s-dir	vs	hs	s/l
K1	83.8	0.048	276.2	173.8	0.005	186.2	0.09
O1	83.8	0.023	268.4	173.8	0.002	178.4	0.09
M2	309.6	0.477	352.5	39.6	0.029	262.5	0.06
S2	309.6	0.124	59.0	39.6	0.007	329.0	0.06

table of tidal current diagram

position ; La Union,El Salvador S-2  
 layer ; Lower  
 lat. ; 13 19 17 N long. ; 87 47 51 W  
 epoch ; 2001 9 17 11 0  
 moon age ; dec. ;  
 moon transit ; 17 12 10  
 unit ; m/sec dir.= True

t=0;La Union k= 74.5 h=0;transit

spring			tropic			m2			m1		
t	dir	v	dir	v	h	dir	v	h	dir	v	
0	239	0.098	249	0.135	0	309	0.716	0	261	0.017	
1	148	0.291	158	0.267	1	307	0.567	1	259	0.014	
2	138	0.531	144	0.493	2	301	0.269	2	255	0.010	
3	135	0.649	140	0.607	3	152	0.114	3	245	0.006	
4	134	0.610	139	0.567	4	134	0.451	4	179	0.002	
5	133	0.422	141	0.384	5	131	0.673	5	104	0.005	
6	138	0.136	164	0.116	6	129	0.716	6	93	0.010	
7	302	0.176	293	0.212	7	127	0.567	7	89	0.014	
8	305	0.425	302	0.444	8	121	0.269	8	87	0.017	
9	304	0.547	303	0.553	9	332	0.114	9	85	0.019	
10	302	0.512	302	0.503	10	314	0.451	10	84	0.020	
11	295	0.330	296	0.306	11	311	0.673	11	82	0.019	
12			220	0.067				12	81	0.017	
13			139	0.322				13	79	0.014	
14			133	0.573				14	75	0.010	
15			131	0.696			m4	15	65	0.006	
16			129	0.658				16	359	0.002	
17			127	0.466			h dir v	17	284	0.005	
18			122	0.174			0 139 0.150	18	273	0.010	
19			315	0.147			1 142 0.149	19	269	0.014	
20			308	0.407			2 234 0.010	20	267	0.017	
21			306	0.542			3 319 0.150	21	265	0.019	
22			302	0.521			4 322 0.149	22	264	0.020	
23			294	0.355			5 54 0.010	23	262	0.019	

h	dir	v
0	303	0.549
1	299	0.433
2	283	0.200
3	165	0.159
4	141	0.426
5	136	0.611
6	134	0.649
7	133	0.529
8	134	0.282
9	273	0.035
10	304	0.317
11	305	0.507

C-62

harmonic analysis one day tidal current

position ; La Union, El Salvador S-3  
 layer ; Upper  
 lat. ; 13 17 49 N long. ; 87 46 26 W  
 epoch ; 2001 9 21 10 0  
 moon age ; dec. ;  
 moon transit ; 21 15 38  
 unit ; m/sec dir.= True

harmonic coefficient

	R1	T1	R2	T2	R4	T4	A0
N	0.066	357.4	1.124	353.0	0.054	348.7	-0.020
E	0.083	189.6	0.235	166.2	0.096	35.0	0.176

ellipse

	L-dir	VL	HL	S-dir	VS	HS	S/L
M1	308.5	0.105	4.9	38.5	0.011	274.9	0.10
M2	348.3	1.148	352.8	78.3	0.027	82.8	0.02
M4	65.8	0.104	26.2	155.8	0.036	116.2	0.34
A0	96.6	0.177		M1/M2=	0.092		

harmonic constant standard ; B-3 Upper

	vn	kn	ve	ke	rat.n	rat.e	dif.n	dif.e
K1	0.071	151.5	0.089	343.7	4.17	5.23	134.7	326.9
O1	0.050	62.5	0.063	254.7				
M2	0.744	2.7	0.156	175.9	1.08	0.23	5.9	179.1
S2	0.199	72.7	0.042	245.9				

ellipse

	l-dir	vl	hl	s-dir	vs	hs	s/l
K1	308.5	0.113	159.0	38.5	0.012	69.0	0.10
O1	308.5	0.080	70.0	38.5	0.008	340.0	0.10
M2	348.3	0.760	2.4	78.3	0.018	92.4	0.02
S2	348.3	0.203	72.4	78.3	0.005	162.4	0.02

table of tidal current diagram

position ; La Union, El Salvador S-3  
 layer ; Upper  
 lat. ; 13 17 49 N long. ; 87 46 26 W  
 epoch ; 2001 9 21 10 0  
 moon age ; dec. ;  
 moon transit ; 21 15 38  
 unit ; m/sec dir.= True

t=0;La Union k= 74.5 h=0;transit

		spring		tropic		m2		m1	
t	dir v	dir v	dir v	h	dir v	h	dir v	h	dir v
0	27 0.307	20 0.337		0	348 1.139	0	309 0.105		
1	132 0.320	128 0.230		1	349 0.914	1	307 0.104		
2	153 0.725	157 0.601		2	352 0.444	2	306 0.095		
3	158 0.987	163 0.843		3	158 0.148	3	303 0.081		
4	159 1.011	165 0.853		4	166 0.695	4	300 0.061		
5	157 0.786	165 0.623		5	168 1.059	5	292 0.037		
6	146 0.382	162 0.212		6	168 1.139	6	258 0.014		
7	33 0.206	354 0.272		7	169 0.914	7	159 0.021		
8	3 0.608	352 0.691		8	172 0.444	8	141 0.046		
9	359 0.875	353 0.932		9	338 0.148	9	136 0.068		
10	359 0.902	356 0.925		10	346 0.695	10	133 0.087		
11	4 0.684	2 0.672		11	348 1.059	11	131 0.099		
12		34 0.281				12	129 0.105		
13		133 0.411				13	127 0.104		
14		151 0.851				14	126 0.095		
15		154 1.137				15	123 0.081		
16		155 1.176				16	120 0.061		
17		152 0.960		h	dir v	17	112 0.037		
18		140 0.563		0	56 0.095	18	78 0.014		
19		74 0.263		1	79 0.089	19	339 0.021		
20		16 0.550		2	167 0.037	20	321 0.046		
21		5 0.827		3	236 0.095	21	316 0.068		
22		3 0.883		4	259 0.089	22	313 0.087		
23		5 0.696		5	347 0.037	23	311 0.099		

h	dir v
0	359 0.921
1	1 0.817
2	10 0.497
3	83 0.192
4	148 0.536
5	157 0.887
6	159 1.032
7	158 0.923
8	154 0.591
9	112 0.175
10	9 0.417
11	360 0.772

C-63



harmonic analysis one day tidal current

position ; La Union, El Salvador S-3  
 layer ; Middle  
 lat. ; 13 17 49 N long. ; 87 46 26 W  
 epoch ; 2001 9 21 10 0  
 moon age ; dec. ;  
 moon transit ; 21 15 38  
 unit ; m/sec dir.= True

harmonic coefficient

	R1	T1	R2	T2	R4	T4	A0
N	0.043	306.3	1.042	350.8	0.037	295.1	0.108
E	0.121	178.1	0.221	175.2	0.063	56.0	0.139

ellipse

	L-dir	VL	HL	S-dir	VS	HS	S/L
M1	283.5	0.124	354.5	13.5	0.033	264.5	0.27
M2	348.1	1.065	351.1	78.1	0.016	261.1	0.02
M4	291.2	0.067	245.8	21.2	0.030	335.8	0.45
A0	52.2	0.176		M1/M2=	0.116		

harmonic constant standard ; B-3 Middle

	vn	kn	ve	ke	rat.n	rat.e	dif.n	dif.e
K1	0.066	55.1	0.185	286.8	1.35	3.78	84.3	316.0
O1	0.020	339.5	0.057	211.2				
M2	0.701	358.1	0.149	182.4	1.07	0.23	6.6	190.9
S2	0.174	70.9	0.037	255.2				

ellipse

	l-dir	vl	hl	s-dir	vs	hs	s/l
K1	283.5	0.190	103.2	13.5	0.051	13.2	0.27
O1	283.5	0.058	27.6	13.5	0.016	297.6	0.27
M2	348.1	0.716	358.3	78.1	0.011	268.3	0.02
S2	348.1	0.178	71.1	78.1	0.003	341.1	0.02

C-64

table of tidal current diagram

position ; La Union, El Salvador S-3  
 layer ; Middle  
 lat. ; 13 17 49 N long. ; 87 46 26 W  
 epoch ; 2001 9 21 10 0  
 moon age ; dec. ;  
 moon transit ; 21 15 38  
 unit ; m/sec dir.= True

t=0;La Union k= 74.5 h=0;transit

spring			tropic			m2			m1		
t	dir	v	dir	v	h	dir	v	h	dir	v	
0	15	0.324	343	0.414	0	348	1.052	0	282	0.123	
1	128	0.226	218	0.088	1	347	0.828	1	278	0.117	
2	153	0.588	177	0.471	2	346	0.383	2	273	0.103	
3	157	0.807	174	0.710	3	174	0.167	3	265	0.083	
4	156	0.798	172	0.724	4	169	0.670	4	253	0.060	
5	151	0.567	169	0.513	5	168	0.994	5	225	0.038	
6	117	0.219	152	0.145	6	168	1.052	6	173	0.035	
7	16	0.369	6	0.307	7	167	0.828	7	139	0.053	
8	1	0.741	1	0.675	8	166	0.383	8	124	0.077	
9	358	0.959	1	0.880	9	354	0.167	9	116	0.098	
10	357	0.948	5	0.864	10	349	0.670	10	110	0.114	
11	0	0.711	15	0.646	11	348	0.994	11	106	0.122	
12			51	0.369				12	102	0.123	
13			117	0.460				13	98	0.117	
14			139	0.770				14	93	0.103	
15			145	0.954				15	85	0.083	
16			144	0.917			m4	16	73	0.060	
17			137	0.666			h dir v	17	45	0.038	
18			102	0.330			0 66 0.039	18	353	0.035	
19			23	0.439			1 109 0.066	19	319	0.053	
20			2	0.808			2 143 0.046	20	304	0.077	
21			355	1.041			3 246 0.039	21	296	0.098	
22			351	1.044			4 289 0.066	22	290	0.114	
23			348	0.814			5 323 0.046	23	286	0.122	

h	dir	v
0	357	0.983
1	358	0.851
2	4	0.521
3	59	0.153
4	148	0.420
5	156	0.727
6	157	0.832
7	154	0.704
8	142	0.386
9	47	0.201
10	5	0.572
11	359	0.880

harmonic analysis one day tidal current

position ; La Union, El Salvador S-3  
 layer ; Lower  
 lat. ; 13 17 49 N long. ; 87 46 26 W  
 epoch ; 2001 9 21 10 0  
 moon age ; dec. ;  
 moon transit ; 21 15 38  
 unit ; m/sec dir.= True

harmonic coefficient

	R1	T1	R2	T2	R4	T4	A0
N	0.070	196.0	0.867	354.7	0.079	328.4	0.077
E	0.102	192.3	0.252	171.9	0.036	58.8	0.103

ellipse

	L-dir	VL	HL	S-dir	VS	HS	S/L
M1	55.4	0.124	193.5	145.4	0.004	103.5	0.03
M2	343.8	0.903	354.5	73.8	0.012	84.5	0.01
M4	359.8	0.079	328.4	89.8	0.036	58.4	0.46
A0	53.0	0.129		M1/M2=	0.137		

harmonic constant standard ; B-3 Lower

	vn	kn	ve	ke	rat.n	rat.e	dif.n	dif.e
K1	0.150	309.0	0.217	305.2	2.99	4.33	328.5	324.7
O1	0.069	242.4	0.100	238.6				
M2	0.566	3.6	0.164	180.9	0.96	0.28	11.2	188.5
S2	0.140	75.7	0.041	253.0				

ellipse

	l-dir	vl	hl	s-dir	vs	hs	s/l
K1	55.4	0.263	306.5	145.4	0.008	216.5	0.03
O1	55.4	0.121	239.9	145.4	0.004	149.9	0.03
M2	343.8	0.589	3.4	73.8	0.008	93.4	0.01
S2	343.8	0.145	75.5	73.8	0.002	165.5	0.01

table of tidal current diagram

position ; La Union, El Salvador S-3  
 layer ; Lower  
 lat. ; 13 17 49 N long. ; 87 46 26 W  
 epoch ; 2001 9 21 10 0  
 moon age ; dec. ;  
 moon transit ; 21 15 38  
 unit ; m/sec dir.= True

t=0;La Union k= 74.5 h=0;transit

spring			tropic			m2			m1		
t	dir	v	dir	v	h	dir	v	h	dir	v	
0	8	0.312	325	0.238	0	344	0.899	0	236	0.120	
1	110	0.161	203	0.233	1	344	0.735	1	235	0.124	
2	148	0.455	184	0.577	2	345	0.375	2	235	0.119	
3	153	0.661	181	0.801	3	156	0.087	3	234	0.105	
4	154	0.685	181	0.834	4	163	0.524	4	234	0.085	
5	151	0.521	184	0.667	5	163	0.821	5	232	0.059	
6	134	0.222	196	0.354	6	164	0.899	6	228	0.029	
7	15	0.217	292	0.159	7	164	0.735	7	105	0.005	
8	356	0.540	339	0.467	8	165	0.375	8	61	0.035	
9	353	0.750	348	0.708	9	336	0.087	9	58	0.065	
10	353	0.776	355	0.779	10	343	0.524	10	57	0.090	
11	356	0.613	5	0.676	11	343	0.821	11	56	0.109	
12			28	0.481				12	56	0.120	
13			75	0.408				13	55	0.124	
14			110	0.565				14	55	0.119	
15			122	0.718				15	54	0.105	
16			123	0.734			m4	16	54	0.085	
17			114	0.601			h dir v	17	52	0.059	
18			86	0.420	0	16	0.070	18	48	0.029	
19			35	0.442	1	93	0.036	19	285	0.005	
20			8	0.650	2	166	0.072	20	241	0.035	
21			357	0.795	3	196	0.070	21	238	0.065	
22			351	0.774	4	273	0.036	22	237	0.090	
23			344	0.570	5	346	0.072	23	236	0.109	

h	dir	v
0	353	0.788
1	354	0.714
2	360	0.468
3	39	0.158
4	139	0.311
5	151	0.581
6	154	0.698
7	153	0.622
8	146	0.376
9	73	0.111
10	0	0.391
11	354	0.669

C-65

harmonic analysis one day tidal current

position ; La Union, El Salvador S-4  
 layer ; Upper  
 lat. ; 13 14 10 N long. ; 87 47 35 W  
 epoch ; 2001 9 21 10 0  
 moon age ; dec. ;  
 moon transit ; 21 15 38  
 unit ; m/sec dir.= True

harmonic coefficient

	R1	T1	R2	T2	R4	T4	A0
N	0.031	47.0	0.775	356.3	0.131	164.4	-0.220
E	0.035	110.5	0.265	340.7	0.177	230.7	-0.147

ellipse

	L-dir	VL	HL	S-dir	VS	HS	S/L
M1	53.0	0.040	85.9	143.0	0.024	175.9	0.61
M2	18.3	0.816	354.8	108.3	0.067	264.8	0.08
M4	63.7	0.190	214.5	153.7	0.112	304.5	0.59
A0	213.8	0.265		M1/M2=	0.049		

harmonic constant standard ; B-3 Upper

	vn	kn	ve	ke	rat.n	rat.e	dif.n	dif.e
K1	0.033	201.0	0.038	264.6	1.95	2.22	184.2	247.8
O1	0.023	112.0	0.027	175.6				
M2	0.513	6.0	0.175	350.4	0.74	0.25	9.2	353.6
S2	0.137	76.0	0.047	60.4				

ellipse

	l-dir	vl	hl	s-dir	vs	hs	s/l
K1	53.0	0.043	239.9	143.0	0.026	329.9	0.61
O1	53.0	0.030	150.9	143.0	0.018	240.9	0.61
M2	18.3	0.540	4.4	108.3	0.045	274.4	0.08
S2	18.3	0.144	74.4	108.3	0.012	344.4	0.08

table of tidal current diagram

position ; La Union, El Salvador S-4  
 layer ; Upper  
 lat. ; 13 14 10 N long. ; 87 47 35 W  
 epoch ; 2001 9 21 10 0  
 moon age ; dec. ;  
 moon transit ; 21 15 38  
 unit ; m/sec dir.= True

t=0;La Union k= 74.5 h=0;transit

	spring			tropic			m2			m1		
t	dir	v	dir	v	h	dir	v	h	dir	v		
0	278	0.126	267	0.189	0	18	0.813	0	330	0.024		
1	217	0.395	222	0.446	1	15	0.667	1	353	0.026		
2	208	0.705	212	0.732	2	8	0.347	2	11	0.030		
3	204	0.903	207	0.909	3	240	0.101	3	25	0.034		
4	202	0.931	205	0.918	4	205	0.474	4	37	0.038		
5	201	0.779	203	0.749	5	201	0.742	5	46	0.040		
6	200	0.488	203	0.444	6	198	0.813	6	55	0.040		
7	205	0.136	212	0.081	7	195	0.667	7	65	0.039		
8	10	0.188	14	0.249	8	188	0.347	8	75	0.036		
9	11	0.392	15	0.455	9	60	0.101	9	88	0.032		
10	7	0.426	13	0.484	10	25	0.474	10	104	0.028		
11	357	0.289	8	0.331	11	21	0.742	11	125	0.025		
12			307	0.076	12			12	150	0.024		
13			210	0.349	13			13	173	0.026		
14			203	0.681	14			14	191	0.030		
15			201	0.899	15			15	205	0.034		
16			199	0.945	16			16	217	0.038		
17			199	0.811	17			17	226	0.040		
18			198	0.534	18	222	0.169	18	235	0.040		
19			201	0.192	19	259	0.178	19	245	0.039		
20			1	0.128	20	326	0.112	20	255	0.036		
21			5	0.332	21	42	0.169	21	268	0.032		
22			0	0.374	22	79	0.178	22	284	0.028		
23			343	0.261	23	146	0.112	23	305	0.025		

h	dir	v
0	10	0.432
1	4	0.374
2	337	0.176
3	230	0.239
4	211	0.564
5	205	0.826
6	203	0.940
7	201	0.873
8	200	0.642
9	201	0.308
10	353	0.045
11	11	0.312

C-66

harmonic analysis one day tidal current

position ; La Union, El Salvador S-4  
 layer ; Middle  
 lat. ; 13 14 10 N long. ; 87 47 35 W  
 epoch ; 2001 9 21 10 0  
 moon age ; dec. ;  
 moon transit ; 21 15 38  
 unit ; m/sec dir.= True

harmonic coefficient

	R1	T1	R2	T2	R4	T4	A0
N	0.056	325.3	0.806	351.7	0.106	155.4	-0.139
E	0.087	52.6	0.333	358.7	0.083	234.6	-0.041

ellipse

	L-dir	VL	HL	S-dir	VS	HS	S/L
M1	87.1	0.087	50.7	177.1	0.056	140.7	0.64
M2	22.4	0.871	352.7	112.4	0.038	82.7	0.04
M4	18.7	0.108	169.4	108.7	0.079	259.4	0.73
A0	196.3	0.145		M1/M2=	0.100		

harmonic constant standard ; B-3 Middle

	vn	kn	ve	ke	rat.n	rat.e	dif.n	dif.e
K1	0.086	74.0	0.134	161.3	1.75	2.73	103.2	190.5
O1	0.026	358.4	0.041	85.7				
M2	0.542	358.9	0.224	6.0	0.83	0.34	7.4	14.5
S2	0.135	71.7	0.056	78.8				

ellipse

	l-dir	vl	hl	s-dir	vs	hs	s/l
K1	87.1	0.134	159.5	177.1	0.086	249.5	0.64
O1	87.1	0.041	83.8	177.1	0.026	173.8	0.64
M2	22.4	0.586	360.0	112.4	0.025	90.0	0.04
S2	22.4	0.146	72.7	112.4	0.006	162.7	0.04

table of tidal current diagram

position ; La Union, El Salvador S-4  
 layer ; Middle  
 lat. ; 13 14 10 N long. ; 87 47 35 W  
 epoch ; 2001 9 21 10 0  
 moon age ; dec. ;  
 moon transit ; 21 15 38  
 unit ; m/sec dir.= True

t=0;La Union k= 74.5 h=0;transit

spring			tropic			m2			m1		
t	dir	v	dir	v	h	dir	v	h	dir	v	
0	65	0.068	27	0.159	0	23	0.864	0	49	0.070	
1	194	0.331	187	0.215	1	24	0.693	1	62	0.078	
2	199	0.658	193	0.540	2	28	0.338	2	73	0.084	
3	201	0.849	193	0.736	3	184	0.117	3	83	0.087	
4	202	0.852	192	0.754	4	199	0.529	4	93	0.087	
5	203	0.665	189	0.592	5	201	0.804	5	103	0.083	
6	205	0.339	174	0.311	6	203	0.864	6	115	0.076	
7	1	0.043	86	0.167	7	204	0.693	7	129	0.068	
8	21	0.369	44	0.400	8	208	0.338	8	146	0.061	
9	23	0.561	38	0.549	9	4	0.117	9	168	0.056	
10	25	0.564	37	0.519	10	19	0.529	10	191	0.057	
11	28	0.379	43	0.310	11	21	0.804	11	212	0.062	
12			149	0.097				12	229	0.070	
13			198	0.450				13	242	0.078	
14			203	0.783				14	253	0.084	
15			206	0.973			m4	15	263	0.087	
16			209	0.969				16	273	0.087	
17			214	0.771			h dir v	17	283	0.083	
18			226	0.440	0	207	0.107	18	295	0.076	
19			294	0.180	1	263	0.083	19	309	0.068	
20			358	0.402	2	338	0.093	20	326	0.061	
21			10	0.606	3	27	0.107	21	348	0.056	
22			15	0.631	4	83	0.083	22	11	0.057	
23			18	0.466	5	158	0.093	23	32	0.062	

h	dir	v
0	24	0.587
1	26	0.490
2	33	0.225
3	184	0.153
4	198	0.512
5	200	0.779
6	201	0.876
7	202	0.777
8	204	0.509
9	209	0.144
10	19	0.223
11	22	0.490

C-67

harmonic analysis one day tidal current

position ; La Union, El Salvador S-4  
 layer ; Lower  
 lat. ; 13 14 10 N long. ; 87 47 35 W  
 epoch ; 2001 9 21 10 0  
 moon age ; dec. ;  
 moon transit ; 21 15 38  
 unit ; m/sec dir.= True

harmonic coefficient

	R1	T1	R2	T2	R4	T4	A0
N	0.048	329.0	0.771	351.0	0.083	141.1	-0.060
E	0.003	277.8	0.375	2.7	0.071	277.6	-0.039

ellipse

	L-dir	VL	HL	S-dir	VS	HS	S/L
M1	2.2	0.048	328.9	92.2	0.002	238.9	0.05
M2	25.7	0.854	353.2	115.7	0.069	83.2	0.08
M4	321.0	0.101	123.5	51.0	0.040	213.5	0.39
A0	212.9	0.071		M1/M2=	0.056		

harmonic constant standard ; B-3 Lower

	vn	kn	ve	ke	rat.n	rat.e	dif.n	dif.e
K1	0.101	81.9	0.006	30.8	2.03	0.12	101.4	50.3
O1	0.047	15.3	0.003	324.2				
M2	0.503	359.9	0.245	11.6	0.85	0.41	7.5	19.2
S2	0.124	72.0	0.060	83.7				

ellipse

	l-dir	vl	hl	s-dir	vs	hs	s/l
K1	2.2	0.101	81.8	92.2	0.005	351.8	0.05
O1	2.2	0.047	15.2	92.2	0.002	285.2	0.05
M2	25.7	0.557	2.1	115.7	0.045	92.1	0.08
S2	25.6	0.138	74.2	115.6	0.011	164.2	0.08

table of tidal current diagram

position ; La Union, El Salvador S-4  
 layer ; Lower  
 lat. ; 13 14 10 N long. ; 87 47 35 W  
 epoch ; 2001 9 21 10 0  
 moon age ; dec. ;  
 moon transit ; 21 15 38  
 unit ; m/sec dir.= True

t=0;La Union k= 74.5 h=0;transit

spring			tropic		m2		m1			
t	dir	v	dir	v	h	dir	v	h	dir	v
0	43	0.146	23	0.273	0	26	0.848	0	1	0.041
1	194	0.225	215	0.086	1	29	0.685	1	359	0.033
2	202	0.540	209	0.413	2	36	0.342	2	357	0.023
3	205	0.733	210	0.624	3	172	0.122	3	351	0.012
4	207	0.750	211	0.665	4	200	0.515	4	250	0.002
5	210	0.586	214	0.532	5	204	0.786	5	192	0.013
6	218	0.288	223	0.269	6	206	0.848	6	187	0.025
7	347	0.101	341	0.094	7	209	0.685	7	185	0.034
8	18	0.401	20	0.354	8	216	0.342	8	184	0.042
9	23	0.592	26	0.514	9	352	0.122	9	183	0.046
10	26	0.608	31	0.506	10	20	0.515	10	182	0.048
11	29	0.443	39	0.329	11	24	0.786	11	181	0.046
12			112	0.101				12	181	0.041
13			189	0.371				13	179	0.033
14			198	0.673				14	177	0.023
15			202	0.847				15	171	0.012
16			204	0.837				16	70	0.002
17			207	0.642				17	12	0.013
18			214	0.308	0	172	0.065	18	7	0.025
19			352	0.109	1	283	0.058	19	5	0.034
20			18	0.449	2	320	0.101	20	4	0.042
21			21	0.672	3	352	0.065	21	3	0.046
22			23	0.713	4	103	0.058	22	2	0.048
23			23	0.566	5	140	0.101	23	1	0.046

h	dir	v
0	25	0.624
1	27	0.544
2	33	0.301
3	160	0.065
4	200	0.398
5	204	0.660
6	206	0.765
7	209	0.686
8	213	0.444
9	240	0.116
10	13	0.261
11	21	0.520

C-68

harmonic analysis one day tidal current

position ; La Union, El Salvador S-5  
 layer ; Upper  
 lat. ; 13 10 35 N long. ; 87 49 0 W  
 epoch ; 2001 9 19 10 0  
 moon age ; dec. ;  
 moon transit ; 19 13 55  
 unit ; m/sec dir.= True

harmonic coefficient

	R1	T1	R2	T2	R4	T4	A0
N	0.060	42.6	0.604	9.8	0.085	191.6	-0.076
E	0.058	214.2	0.175	359.0	0.062	116.6	-0.002

ellipse

	L-dir	VL	HL	S-dir	VS	HS	S/L
M1	315.7	0.083	38.5	45.7	0.006	128.5	0.07
M2	15.9	0.628	9.0	105.9	0.032	279.0	0.05
M4	19.2	0.088	178.7	109.2	0.058	88.7	0.66
A0	181.7	0.076		M1/M2=	0.133		

harmonic constant standard ; B-5 Upper

	vn	kn	ve	ke	rat.n	rat.e	dif.n	dif.e
K1	0.045	135.9	0.044	307.5	0.93	0.90	268.3	79.9
O1	0.007	301.9	0.007	113.5				
M2	0.416	14.7	0.120	3.9	2.49	0.72	28.3	17.5
S2	0.095	99.2	0.027	88.4				

ellipse

	l-dir	vl	hl	s-dir	vs	hs	s/l
K1	315.7	0.063	131.8	45.7	0.005	221.8	0.07
O1	315.7	0.010	297.8	45.7	0.001	27.8	0.07
M2	15.9	0.432	13.8	105.9	0.022	283.8	0.05
S2	15.9	0.098	98.4	105.9	0.005	8.4	0.05

C-69

table of tidal current diagram

position ; La Union, El Salvador S-5  
 layer ; Upper  
 lat. ; 13 10 35 N long. ; 87 49 0 W  
 epoch ; 2001 9 19 10 0  
 moon age ; dec. ;  
 moon transit ; 19 13 55  
 unit ; m/sec dir.= True

t=0;La Union k= 74.5 h=0;transit

spring		tropic		m2		m1	
t	dir v	dir v	h	dir v	h	dir v	h
0	14 0.186	37 0.161	0	16 0.620	0	312 0.065	
1	202 0.080	172 0.127	1	15 0.586	1	314 0.077	
2	197 0.345	189 0.381	2	12 0.396	2	315 0.082	
3	195 0.537	191 0.567	3	358 0.103	3	316 0.083	
4	194 0.605	192 0.627	4	203 0.227	4	317 0.078	
5	192 0.531	191 0.545	5	198 0.489	5	319 0.067	
6	189 0.337	190 0.339	6	196 0.620	6	321 0.052	
7	162 0.081	175 0.066	7	195 0.586	7	325 0.034	
8	28 0.201	17 0.213	8	192 0.396	8	342 0.014	
9	21 0.390	14 0.413	9	178 0.103	9	103 0.011	
10	18 0.457	11 0.489	10	23 0.227	10	125 0.031	
11	17 0.383	8 0.422	11	18 0.489	11	130 0.050	
12		359 0.233			12	132 0.065	
13		253 0.081			13	134 0.077	
14		206 0.316			14	135 0.082	
15		200 0.510		m4	15	136 0.083	
16		197 0.584			16	137 0.078	
17		194 0.518		h dir v	17	139 0.067	
18		188 0.334	0	198 0.088	18	141 0.052	
19		154 0.100	1	149 0.066	19	145 0.034	
20		39 0.197	2	66 0.067	20	162 0.014	
21		28 0.374	3	18 0.088	21	283 0.011	
22		26 0.434	4	329 0.066	22	305 0.031	
23		27 0.355	5	246 0.067	23	310 0.050	

h	dir v
0	19 0.442
1	17 0.436
2	16 0.294
3	8 0.054
4	198 0.222
5	196 0.457
6	195 0.589
7	193 0.584
8	191 0.443
9	183 0.206
10	47 0.086
11	23 0.311

harmonic analysis one day tidal current

position ; La Union, El Salvador S-5  
 layer ; Middle  
 lat. ; 13 10 35 N long. ; 87 49 0 W  
 epoch ; 2001 9 19 10 0  
 moon age ; dec. ;  
 moon transit ; 19 13 55  
 unit ; m/sec dir.= True

harmonic coefficient

	R1	T1	R2	T2	R4	T4	A0
N	0.083	36.3	0.662	1.5	0.027	354.3	0.025
E	0.071	179.3	0.186	331.8	0.051	109.5	0.063

ellipse

	L-dir	VL	HL	S-dir	VS	HS	S/L
M1	320.9	0.104	21.3	50.9	0.034	111.3	0.33
M2	14.0	0.682	359.7	104.0	0.090	269.7	0.13
M4	286.0	0.053	296.8	16.0	0.024	26.8	0.45
A0	68.4	0.068		M1/M2=	0.152		

harmonic constant standard ; B-5 Middle

	vn	kn	ve	ke	rat.n	rat.e	dif.n	dif.e
K1	0.077	144.6	0.065	287.5	3.48	2.95	46.5	189.4
O1	0.052	260.7	0.044	43.6				
M2	0.386	6.1	0.108	336.3	2.11	0.59	10.1	340.3
S2	0.122	73.6	0.034	43.8				

ellipse

	l-dir	vl	hl	s-dir	vs	hs	s/l
K1	320.9	0.095	129.6	50.9	0.031	219.6	0.33
O1	320.9	0.065	245.7	50.9	0.021	335.7	0.33
M2	14.0	0.398	4.2	104.0	0.052	274.2	0.13
S2	14.0	0.126	71.8	104.0	0.017	341.8	0.13

table of tidal current diagram

position ; La Union, El Salvador S-5  
 layer ; Middle  
 lat. ; 13 10 35 N long. ; 87 49 0 W  
 epoch ; 2001 9 19 10 0  
 moon age ; dec. ;  
 moon transit ; 19 13 55  
 unit ; m/sec dir.= True

t=0;La Union k= 74.5 h=0;transit

spring			tropic			m2			m1		
t	dir	v	dir	v	h	dir	v	h	dir	v	
0	11	0.217	52	0.141	0	14	0.682	0	314	0.097	
1	207	0.055	174	0.162	1	10	0.590	1	319	0.103	
2	193	0.299	188	0.386	2	1	0.347	2	324	0.103	
3	190	0.454	190	0.521	3	281	0.090	3	329	0.096	
4	186	0.480	190	0.520	4	207	0.353	4	336	0.084	
5	178	0.373	188	0.378	5	198	0.594	5	345	0.067	
6	153	0.182	181	0.130	6	194	0.682	6	1	0.049	
7	57	0.181	17	0.171	7	190	0.590	7	32	0.036	
8	30	0.393	12	0.440	8	181	0.347	8	76	0.037	
9	22	0.538	9	0.616	9	101	0.090	9	104	0.052	
10	18	0.556	6	0.656	10	27	0.353	10	118	0.070	
11	15	0.439	3	0.553	11	18	0.594	11	127	0.086	
12			356	0.338				12	134	0.097	
13			313	0.093				13	139	0.103	
14			203	0.216				14	144	0.103	
15			190	0.388				15	149	0.096	
16			181	0.444				16	156	0.084	
17			169	0.380				17	165	0.067	
18			139	0.258				18	181	0.049	
19			82	0.254				19	212	0.036	
20			51	0.394				20	256	0.037	
21			39	0.498				21	284	0.052	
22			34	0.490				22	298	0.070	
23			35	0.358				23	307	0.086	

h	dir	v
0	20	0.565
1	17	0.512
2	14	0.334
3	4	0.079
4	196	0.188
5	192	0.393
6	188	0.485
7	183	0.440
8	170	0.279
9	104	0.124
10	38	0.292
11	25	0.482

C-70

harmonic analysis one day tidal current

position ; La Union, El Salvador S-5  
 layer ; Lower  
 lat. ; 13 10 35 N long. ; 87 49 0 W  
 epoch ; 2001 9 19 10 0  
 moon age ; dec. ;  
 moon transit ; 19 13 55  
 unit ; m/sec dir.= True

harmonic coefficient

	R1	T1	R2	T2	R4	T4	A0
N	0.085	31.0	0.484	356.0	0.029	16.0	0.001
E	0.093	192.0	0.141	327.8	0.038	190.5	0.039

ellipse

	L-dir	VL	HL	S-dir	VS	HS	S/L
M1	312.2	0.125	20.6	42.2	0.021	110.6	0.17
M2	14.7	0.500	354.1	104.7	0.065	264.1	0.13
M4	307.2	0.048	12.5	37.2	0.002	102.5	0.05
A0	88.9	0.039		M1/M2=	0.249		

harmonic constant standard ; B-5 Lower

	vn	kn	ve	ke	rat.n	rat.e	dif.n	dif.e
K1	0.119	89.6	0.130	250.6	3.13	3.43	132.8	293.8
O1	0.031	338.7	0.034	139.7				
M2	0.341	357.9	0.099	329.6	1.56	0.45	19.9	351.6
S2	0.039	27.1	0.011	358.8				

ellipse

	l-dir	vl	hl	s-dir	vs	hs	s/l
K1	312.2	0.174	79.2	42.2	0.029	169.2	0.17
O1	312.2	0.046	328.3	42.2	0.008	58.3	0.17
M2	14.7	0.352	356.0	104.7	0.046	266.0	0.13
S2	14.7	0.040	25.1	104.7	0.005	295.1	0.13

table of tidal current diagram

position ; La Union, El Salvador S-5  
 layer ; Lower  
 lat. ; 13 10 35 N long. ; 87 49 0 W  
 epoch ; 2001 9 19 10 0  
 moon age ; dec. ;  
 moon transit ; 19 13 55  
 unit ; m/sec dir.= True

t=0;La Union k= 74.5 h=0;transit

spring			tropic			m2			m1		
t	dir	v	dir	v	h	dir	v	h	dir	v	
0	7	0.089	329	0.278	0	14	0.498	0	309	0.117	
1	200	0.115	282	0.174	1	9	0.407	1	311	0.124	
2	194	0.283	229	0.226	2	359	0.213	2	314	0.123	
3	191	0.375	206	0.299	3	246	0.082	3	317	0.114	
4	186	0.365	192	0.301	4	205	0.298	4	320	0.097	
5	178	0.260	173	0.231	5	198	0.458	5	325	0.074	
6	142	0.110	126	0.160	6	194	0.498	6	336	0.048	
7	47	0.160	74	0.225	7	189	0.407	7	12	0.024	
8	28	0.313	55	0.337	8	179	0.213	8	87	0.029	
9	22	0.398	49	0.394	9	66	0.082	9	112	0.055	
10	18	0.383	51	0.363	10	25	0.298	10	121	0.081	
11	15	0.270	64	0.258	11	18	0.458	11	125	0.102	
12			111	0.174				12	129	0.117	
13			160	0.267				13	131	0.124	
14			175	0.492				14	134	0.123	
15			181	0.469			m4	15	137	0.114	
16			182	0.431				16	140	0.097	
17			182	0.291			h dir v	17	145	0.074	
18			176	0.079			0 307 0.047	18	156	0.048	
19			6	0.157			1 310 0.033	19	192	0.024	
20			2	0.359			2 119 0.015	20	267	0.029	
21			359	0.482			3 127 0.047	21	292	0.055	
22			355	0.500			4 130 0.033	22	301	0.081	
23			347	0.419			5 299 0.015	23	305	0.102	

h	dir	v
0	19	0.403
1	16	0.335
2	12	0.182
3	232	0.022
4	196	0.209
5	192	0.342
6	189	0.383
7	183	0.321
8	167	0.181
9	81	0.096
10	34	0.243
11	24	0.368

C-71



harmonic analysis one day tidal current

position ; La Union, El Salvador S-6  
 layer ; Upper  
 lat. ; 12 56 19 N long. ; 88 2 19 W  
 epoch ; 2001 9 19 10 0  
 moon age ; dec. ;  
 moon transit ; 19 13 56  
 unit ; m/sec dir.= True

harmonic coefficient

	R1	T1	R2	T2	R4	T4	A0
N	0.076	13.0	0.155	15.3	0.057	65.7	-0.084
E	0.064	152.3	0.247	359.6	0.056	190.9	-0.079

ellipse

	L-dir	VL	HL	S-dir	VS	HS	S/L
M1	321.4	0.093	356.8	51.4	0.034	86.8	0.36
M2	58.3	0.289	4.0	148.3	0.036	274.0	0.12
M4	315.4	0.071	38.7	45.4	0.037	128.7	0.52
A0	223.2	0.116		M1/M2=	0.322		

harmonic constant standard ; B-5 Upper

	vn	kn	ve	ke	rat.n	rat.e	dif.n	dif.e
K1	0.058	106.6	0.049	245.9	1.18	0.99	239.0	18.3
O1	0.009	272.6	0.008	51.9				
M2	0.107	20.7	0.170	4.9	0.64	1.02	34.3	18.5
S2	0.024	105.2	0.039	89.4				

ellipse

	l-dir	vl	hl	s-dir	vs	hs	s/l
K1	321.4	0.071	90.4	51.4	0.026	180.4	0.36
O1	321.4	0.012	256.4	51.4	0.004	346.4	0.36
M2	58.3	0.199	9.3	148.3	0.025	279.3	0.12
S2	58.3	0.045	93.9	148.3	0.006	3.9	0.12

table of tidal current diagram

position ; La Union, El Salvador S-6  
 layer ; Upper  
 lat. ; 12 56 19 N long. ; 88 2 19 W  
 epoch ; 2001 9 19 10 0  
 moon age ; dec. ;  
 moon transit ; 19 13 56  
 unit ; m/sec dir.= True

t=0;La Union k= 74.5 h=0;transit

spring			tropic			m2			m1		
t	dir	v	dir	v	h	dir	v	h	dir	v	
0	223	0.009	168	0.068	0	59	0.289	0	323	0.093	
1	238	0.134	222	0.160	1	55	0.261	1	328	0.089	
2	237	0.253	232	0.280	2	48	0.164	2	335	0.080	
3	235	0.334	235	0.364	3	357	0.041	3	344	0.067	
4	233	0.357	236	0.387	4	253	0.131	4	357	0.052	
5	230	0.315	236	0.343	5	243	0.241	5	22	0.038	
6	223	0.222	237	0.243	6	239	0.289	6	60	0.034	
7	204	0.108	242	0.114	7	235	0.261	7	93	0.043	
8	120	0.062	355	0.025	8	228	0.164	8	112	0.058	
9	79	0.118	37	0.107	9	177	0.041	9	123	0.073	
10	70	0.135	36	0.140	10	73	0.131	10	131	0.085	
11	66	0.089	25	0.112	11	63	0.241	11	137	0.092	
12			333	0.059				12	143	0.093	
13			260	0.122				13	148	0.089	
14			244	0.228				14	155	0.080	
15			236	0.304			m4	15	164	0.067	
16			230	0.328				16	177	0.052	
17			222	0.293			h dir v	17	202	0.038	
18			207	0.217	0	293	0.060	18	240	0.034	
19			175	0.144	1	327	0.067	19	273	0.043	
20			129	0.141	2	29	0.038	20	292	0.058	
21			104	0.174	3	113	0.060	21	303	0.073	
22			97	0.172	4	147	0.067	22	311	0.085	
23			104	0.119	5	209	0.038	23	317	0.092	

h	dir	v
0	73	0.134
1	68	0.119
2	67	0.044
3	238	0.072
4	238	0.198
5	236	0.301
6	234	0.354
7	231	0.343
8	227	0.272
9	217	0.163
10	172	0.064
11	91	0.092

C-72

harmonic analysis one day tidal current

position ; La Union, El Salvador S-6  
 layer ; Middle  
 lat. ; 12 56 19 N long. ; 88 2 19 W  
 epoch ; 2001 9 19 10 0  
 moon age ; dec. ;  
 moon transit ; 19 13 56  
 unit ; m/sec dir.= True

harmonic coefficient

	R1	T1	R2	T2	R4	T4	A0
N	0.041	327.5	0.165	337.2	0.048	140.7	0.059
E	0.032	191.0	0.204	346.4	0.035	96.6	0.029

ellipse

	L-dir	VL	HL	S-dir	VS	HS	S/L
M1	324.0	0.049	343.1	54.0	0.019	253.1	0.38
M2	51.0	0.261	342.8	141.0	0.021	72.8	0.08
M4	32.7	0.056	127.1	122.7	0.021	37.1	0.38
A0	25.8	0.066		M1/M2=	0.186		

harmonic constant standard ; B-5 Middle

	vn	kn	ve	ke	rat.n	rat.e	dif.n	dif.e
K1	0.038	76.1	0.030	299.5	1.71	1.35	338.0	201.4
O1	0.026	192.2	0.020	55.6				
M2	0.096	342.2	0.119	351.4	0.53	0.65	346.2	355.4
S2	0.031	49.7	0.038	58.9				

ellipse

	l-dir	vl	hl	s-dir	vs	hs	s/l
K1	324.0	0.045	91.6	54.0	0.017	1.6	0.38
O1	324.0	0.031	207.7	54.0	0.012	117.7	0.38
M2	51.0	0.152	347.8	141.0	0.012	77.8	0.08
S2	51.0	0.048	55.3	141.0	0.004	145.3	0.08

table of tidal current diagram

position ; La Union, El Salvador S-6  
 layer ; Middle  
 lat. ; 12 56 19 N long. ; 88 2 19 W  
 epoch ; 2001 9 19 10 0  
 moon age ; dec. ;  
 moon transit ; 19 13 56  
 unit ; m/sec dir.= True

t=0;La Union k= 74.5 h=0;transit

	spring	tropic	m2	m1
t	dir v	dir v	h dir v	h dir v
0	41 0.072	62 0.098	0 52 0.250	0 317 0.047
1	255 0.034	275 0.004	1 56 0.178	1 311 0.042
2	241 0.110	250 0.084	2 70 0.061	2 302 0.036
3	242 0.143	257 0.125	3 217 0.080	3 288 0.028
4	247 0.125	271 0.124	4 227 0.193	4 265 0.021
5	270 0.065	304 0.104	5 230 0.255	5 229 0.019
6	9 0.065	350 0.129	6 232 0.250	6 196 0.023
7	35 0.155	15 0.196	7 236 0.178	7 176 0.030
8	42 0.230	25 0.253	8 250 0.061	8 164 0.038
9	45 0.261	30 0.271	9 37 0.080	9 156 0.044
10	46 0.240	31 0.239	10 47 0.193	10 149 0.048
11	46 0.170	29 0.161	11 50 0.255	11 143 0.049
12		8 0.062		12 137 0.047
13		254 0.064		13 131 0.042
14		236 0.138		14 122 0.036
15		231 0.169	m4	15 108 0.028
16		227 0.145		16 85 0.021
17		217 0.074	h dir v	17 49 0.019
18		88 0.042	0 186 0.038	18 16 0.023
19		64 0.146	1 74 0.029	19 356 0.030
20		61 0.230	2 35 0.056	20 344 0.038
21		60 0.270	3 6 0.038	21 336 0.044
22		60 0.256	4 254 0.029	22 329 0.048
23		61 0.193	5 215 0.056	23 323 0.049

h	dir	v
0	46	0.257
1	46	0.209
2	45	0.121
3	15	0.021
4	243	0.077
5	241	0.134
6	244	0.140
7	254	0.097
8	319	0.043
9	28	0.111
10	39	0.198
11	44	0.253

C-73

harmonic analysis one day tidal current

position ; La Union, El Salvador S-6  
 layer ; Lower  
 lat. ; 12 56 19 N long. ; 88 2 19 W  
 epoch ; 2001 9 19 10 0  
 moon age ; dec. ;  
 moon transit ; 19 13 56  
 unit ; m/sec dir.= True

harmonic coefficient

	R1	T1	R2	T2	R4	T4	A0
N	0.083	191.4	0.179	307.3	0.010	195.9	-0.024
E	0.048	329.5	0.192	315.6	0.047	223.1	-0.012

ellipse

	L-dir	VL	HL	S-dir	VS	HS	S/L
M1	333.8	0.092	182.5	63.8	0.029	272.5	0.32
M2	47.0	0.262	311.8	137.0	0.019	41.8	0.07
M4	78.9	0.048	222.1	168.9	0.005	312.1	0.10
A0	206.2	0.026		M1/M2=	0.350		

harmonic constant standard ; B-5 Lower

	vn	kn	ve	ke	rat.n	rat.e	dif.n	dif.e
K1	0.116	250.3	0.068	28.4	3.06	1.78	293.5	71.6
O1	0.031	139.4	0.018	277.5				
M2	0.126	309.7	0.135	318.0	0.58	0.62	331.7	340.0
S2	0.014	338.9	0.015	347.2				

ellipse

	l-dir	vl	hl	s-dir	vs	hs	s/l
K1	333.8	0.128	241.4	63.8	0.041	331.4	0.32
O1	333.8	0.034	130.5	63.8	0.011	220.5	0.32
M2	47.0	0.184	314.1	137.0	0.013	44.1	0.07
S2	47.0	0.021	343.3	137.0	0.002	73.3	0.07

table of tidal current diagram

position ; La Union, El Salvador S-6  
 layer ; Lower  
 lat. ; 12 56 19 N long. ; 88 2 19 W  
 epoch ; 2001 9 19 10 0  
 moon age ; dec. ;  
 moon transit ; 19 13 56  
 unit ; m/sec dir.= True

t=0;La Union k= 74.5 h=0;transit

spring			tropic			m2			m1		
t	dir	v	dir	v	h	dir	v	h	dir	v	
0	217	0.131	190	0.244	0	52	0.175	0	153	0.092	
1	222	0.204	204	0.294	1	66	0.057	1	158	0.090	
2	225	0.230	214	0.304	2	215	0.084	2	163	0.082	
3	226	0.202	222	0.262	3	223	0.196	3	170	0.070	
4	229	0.126	234	0.176	4	226	0.257	4	180	0.055	
5	240	0.024	275	0.086	5	228	0.249	5	199	0.039	
6	44	0.079	349	0.115	6	232	0.175	6	236	0.030	
7	48	0.154	9	0.195	7	246	0.057	7	279	0.035	
8	50	0.181	13	0.239	8	35	0.084	8	302	0.050	
9	53	0.153	11	0.231	9	43	0.196	9	315	0.066	
10	63	0.080	0	0.182	10	46	0.257	10	322	0.079	
11	184	0.036	332	0.125	11	48	0.249	11	328	0.088	
12			285	0.120				12	333	0.092	
13			257	0.157				13	338	0.090	
14			245	0.172				14	343	0.082	
15			235	0.144				15	350	0.070	
16			216	0.079				16	0	0.055	
17			125	0.054				17	19	0.039	
18			90	0.132				18	56	0.030	
19			86	0.198				19	99	0.035	
20			90	0.224				20	122	0.050	
21			102	0.208				21	135	0.066	
22			128	0.179				22	142	0.079	
23			164	0.189				23	148	0.088	

h	dir	v
0	57	0.120
1	90	0.035
2	211	0.084
3	220	0.173
4	224	0.224
5	226	0.222
6	227	0.168
7	231	0.075
8	38	0.032
9	47	0.123
10	49	0.174
11	51	0.173

C-74