CURRENT STATUS OF DATA ACQUISITION AND MANAGEMENT IN THE CRUSTAL DYNAMICS SECTION

by

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Introduction

Most of the work of defining our perceived needs for a time-series data management system was done in 1980 (Buck, 1980), but the task of designing a system according to our specifications was never completed. Recently, a survey has been conducted in the Crustal Dynamics Section to define the current status of data acquisition and the management of data. This report is an attempt to document the current data management system within the Crustal Dynamics Section and to recommand appropriate changes.

Main sources of data

Data come mainly from the following research subjects:

- 6.5.2.01 Relationship of Tilt, Strain and Gravity Variations to Seismiscity at Charlevoix, Quebec.
- 6.5.2.05 Aquifer-tide Studies for Nuclear Fuel Waste Management Program.
- 6.5.2.06 Systems development and instrument maintenance.
- 6.5.2.07 Determination of regional and large-scale deformation in Canada.

In the following pages, we will overview these four research subjects with respect to the current status of data acquisition. Data that are not directly linked to any of these will be described in the ancillary data section.

6.5.2.01

The objective of this work element is to measure and interpret tilt, strain and gravity changes as part of a multi-parameter study of the processes leading to earthquake rupture in the Charlevoix region.

This work element generates the largest amount of information available in the Crustal Dynamics Section. It includes assorted data from 1974 onwards. Until 1981 hourly data from the Charlevoix station were stored on punch cards. In 1977, a 1-min and a 10-min format was established. The observations that were made at Charlevoix were recorded on DATEL recorders, which gather information from 16 analog channels. There were 3 well-level transducers, 4 surface tiltmeters, 2 two-component borehole tiltmeters and miscellaneous meteorological data. All these sources produced five cassettes per week, each containing 4 to 7 channels of 1-min data. Hourly filtered data were then punched on cards and the cassettes recycled.

In 1981, the introduction of the Automatic Geophysical Observatory System (AGOS) permenantly replaced the old system. DATEL recorders were used irregularly to record data in parallel with the AGOS system. In 1983/84, we had to face the important problem of electrical discharges due to thunder storms in the Charlevoix area. To avoid damage due to these effects, the electric wires used to link the transducers to the AGOS computer were replaced by fiber optics. Since then, the AGOS system has recorded "cleaner" data, because background noise has been reduced significantly. The DATEL recorders are not used any more.

Raw data are sampled by AGOS at a 10 second rate on a maximum of 24 channels. There are 256K bytes of on-line data storage. Filtered data are stored at a 10 minutes rate on a TU58 cassette, which acts as a ring buffer that can hold information for two weeks. There are 3 ANAC tiltmeters, four well level transducers and meteorological data. The tiltmeter signals are simultaneously recorded at the site on analog charts.

The system has a "dial and handshake" capability that allows routine transfer of all data from the observatory to the Earth Physics Branch in Ottawa. The TU58 cassette is transcribed once a week via telephone to produce a nine track tape of 10-min data and a plot. Data are routinely transferred during the day, using Government Telecommunications Agency (GTA) lines, at a cost of approximately $27. for the 45 minutes transmission. This cost could be reduced to $5.40 if the calls were made between 17h00 and 8h00, but it would not be cost effective to develop software for overnight transmission, as we plan to terminate the project in 1986.

As a backup, hourly data from the well levels are subsampled at an houly rate without additional filtering and punched on cards.

Data users are mainly in-house personnel or colleagues at the Universities of Dalhousie, New Brunswick, Laval, Waterloo, Atomic Energy of Canada or the Department of Environment. No need has been perceived for making the data available to the general public, other than through research papers arising from the project (eg, Buchbinder et al., 1985, Lambert and Liard, 1981, Peters et al., 1977).

A gravity network comprising 32 stations located in the seismically active region of Charlevoix, Quebec was surveyed twice a year from 1976 to 1983 to provide data on temporal variations in gravity. The first year of the surveys the network was established by the Gravity and Geodynamics Division; subsequent data have been acquired since 1977 by contract. One station was added in 1980 and 5 more in 1983. All surveys were done in 1984. Since 1980, gravimeters have been calibrated before and after each survey using the 4 stations Ottawa-Gananoque calibration line.

The data:

The following table gives basic information on existing data from Charlevoix and other regions.
For more detail on data location, distribution through years, backup, future use and retention period, see annex I.

Place or Region	Transducer	Project date	Volume (Kbytes)
Charlevoix	Water level	Since 1979	5 593
Charlevoix	Wire strain meter	Since 1975	584
Charlevoix	Quartz stress meter	1975 to 1981	409
Charlevoix	Tiltmeter ANAC	Since 1978	18 325
Charlevoix	Gravimeter L&R Model D	Since 1974	680
Charlottetown (PEI)	Sand water level	1974	16
Darmstad (Germany)	Model D Calib.	1983	184
LG2 (Que)	Vertical mouv.	1978 and 1981	24
Manic-3 (Que)	Vertical mouv.	1976	40
Mt Ste-Marie (Que)	Calibration line	1976 to 1980	29
Mt-Tremblant (Que)	Calibration line	1976 and 1979	6
Ottawa-Gananoque	Calibration line	Since 1980	68
Stoneham (Que)	Vertical mouv.	1976	12

Microgravimetry data are generally coded according to the "FIELD PROCEDURES MANUAL" internally distributed to the Gravity, Geothermics & Geodynamics Division. They are transfered from field books onto coding forms which are then punched on cards. Field books are subsequently microfilmed and then stored with the films at the Laperriere depot. (See annex II and V). The punched cards are submitted to the CYBER and stored on tape. All the gravity survey data are managed on System 2000 by the Data Centre. This data base management system permits the user to interactively edit the data base. The retrieval, updating and plotting capabilities of the data base are then used extensively. A small volume of punched cards is still used because of their reliability and their economy.

6.5.2.05

The objective of this work element is to determine regional hydrological and/or fracture parameters, as appropriate, at sites drilled as part of the concept evaluation phase of the Nuclear Waste Management Program by measuring, in available suitable boreholes, the response of aquifers to strain at earth tide frequencies.

Boreholes are situated at Chalk River (Ont) and Pinawa (Man). The following table gives the basic information on existing data:

Station	Transducer	Project date	Volume (Kbytes)
Chalk River	Water level	1978 to 1982	443
Chalk River	Water pressure	1983	64
Pinawa	Water level	1983	16

A Polycorder data logger is installed at Chalk River. The Polycorder averages a sample of 100 observations on the hour and stores the result. Once a week AECL transmits the data to Ottawa where it is stored on magnetic tape. As a backup, hourly data are also punched on cards. See annex III for card format. Since 1978, 66,384 observations from water level transducers and 9,624 observations from water pressure transducers have been stored.

Data from Pinawa are collected and sent to Ottawa in the same way.

6.5.2.06

The objective of this work element is to provide systems engineering, instrument maintenance and research laboratory facilities on a project basis to meet the requirements of the Geodynamics Service.

Some data sets are collected in the course of testing various instruments under development. No specified formats are used to store the data. The retention period is generally limited to the lifetime of the development project. For example, currently a project is being conducted to develop electro-static feedback for NA-137 and for NA-85 earth tide gravimeters. This project involves the production of strip charts and/or digital data as follows:

Transducer	Project date	Volume (Kbytes)
NA-137 gravimeter	Since dec. 82	358
ET-12 gravimeter	Since dec. 82	179
Meteorological data	Since dec. 82	not spec.

6.5.2.07

The objectives of this work element are attained by utilizing new geodetic measurement techniques (Very Large Baseline Interferometry, Global Positioning System, Absolute Gravity) as they become available in addition to traditional methods, in order to monitor, analyse, and interpret large-scale deformations of the North American plate and deformations on a smaller scale of crustal phenomena of a hazardous nature.

A test was conducted during summer 1983 with the Macrometer GPS system, in a joint project with University of New Brunswick and the Geodetic Survey of Canada. The raw and reduced observations for a network of baselines around Ottawa are archived on RX02 floppy disks in a proprietory Macrometer format. The 5,250 phase observations that were collected represent 5 Mbytes of data. Plans for the permanent retention of this data are presently under discussion.

A study will be conducted in the near future to determine regional strain accumulation in Canada. This study will require a collection of data of pre 1950 and subsequent geodetic surveys. Absolute Gravity and Very Large Baseline Interferometry observations are expected to have a major impact in the future.

Ancillary data

Gravity data described in the following table comes from isolated projects such as calibration of instruments, software development tests or verification of calibration lines. Data may originate from the private sector or collaborative projects with other government agencies, universities or foreign agencies.

Place or Region	Project	Project date	Volume (Kbytes)
Austin (Texas)	Calibration line	1978 to 1980	24
Cache Creek (BC)	Vertical grad.	1977	40
Chalk River (Ont)	Vertical grad.	nov. 1978	14
Mount Seymour (BC)	Calibration line	Since 1977	51
Vancouver Island	Vertical mouv.	Since 1977	640
Ottawa (Ont)	Rotonda display	Since 1972	Chart

For more detail on data location, distribution through years, backup, future use and retention period, see table in annex I .

SUMMARY OF CURRENT STATUS

Data collected in the Crustal Dynamics Section can be summarised as follows:

Times Series Data	Volume (Kbytes)	Percentage
Charlevoix	24 911	76%
AECL	523	2%
Laboratory	537	2%
GPS	5 000	15%
	30 971	95%
Gravity		
Charlevoix	680	2%
Miscellaneous	1 148	3%
	1 828	5%
Total	32 799	100%

As we can see in the preceeding table, the AGOS system generates the majority of the information. The format of this data source has been standardized. See "Format of the AGOS data file records" in annex IV.

No calculations are done on the section computer to manipulate the actual data base. The existing software is run on the CYBER and IBM computer of the Computer Science Centre of EMR. There is:

- a plot program that produces hard copy graphics,
- an editor to correct or modify data from the screen and
- an analysis package named JANET for least square fitting of tidal constituents.

RECOMMENDATIONS

- As each experiment is a new situation requiring new apparatus and new parameters it is difficult to specify any standard format for the data. However, any new data sets recorded should be compatible as far as possible to the standard format used with the actual data loggers or field instruments.

- We need to decide on a policy for retention period and the reduction of data to managable levels.

- RAW DATA FROM AGOS ARE NOT ARCHIVED AT ALL. Only filtered results are kept, except for the 3 ANAC tiltmeters where analog charts keep an independent record of the raw signal. This situation is the same for data recorded by the Polycorder. This is suitable for the actual current analysis, but may not be so for subsequent research. We need to evaluate the costs of storing raw data and its possible future use.

- We should have a local and centralized data management system on the section mini-computer which would allow an investigator to sit down in front of a terminal and examine the data in preparation for copying it to another file for analysis. One should be able to list any message or comment from the site operator and to view a plot of the data for a particular channel over a particular time period. Refer to IV and V to see the actual and the proposed data flow process.

References

Buchbinder, G.G.R., Kurtz, R.D. and Lambert, A. 1985. A review of time-dependent geophysical parameters in the Charlevoix region, Quebec. Earthquake Prediction Research, 2, pp. 91-108.

Buck R.J., 1980. Minutes of Meeting. Standards and Information Section, March 14.

Lambert, A. and Liard, J.O. 1981. A search for long-term earthquake precursors in gravity data in the Charlevoix region, Quebec. Earthquake Prediction - An International Review, edited by D.W. Simpson and P.G. Richards, Maurice Ewing Series 4, A.G.U., Washington, pp. 473-483.

Peters, J.A., Bower, D.R. and Lambert, A. 1977. Tidal tilt response at Charlevoix, Quebec. Proceedings of the Eighth International Symposium on Earth Tides, edited by J.T. Kuo, pp. 59-67.

CRUSTAL DYNAMICS DATA INVENTORY (1984)

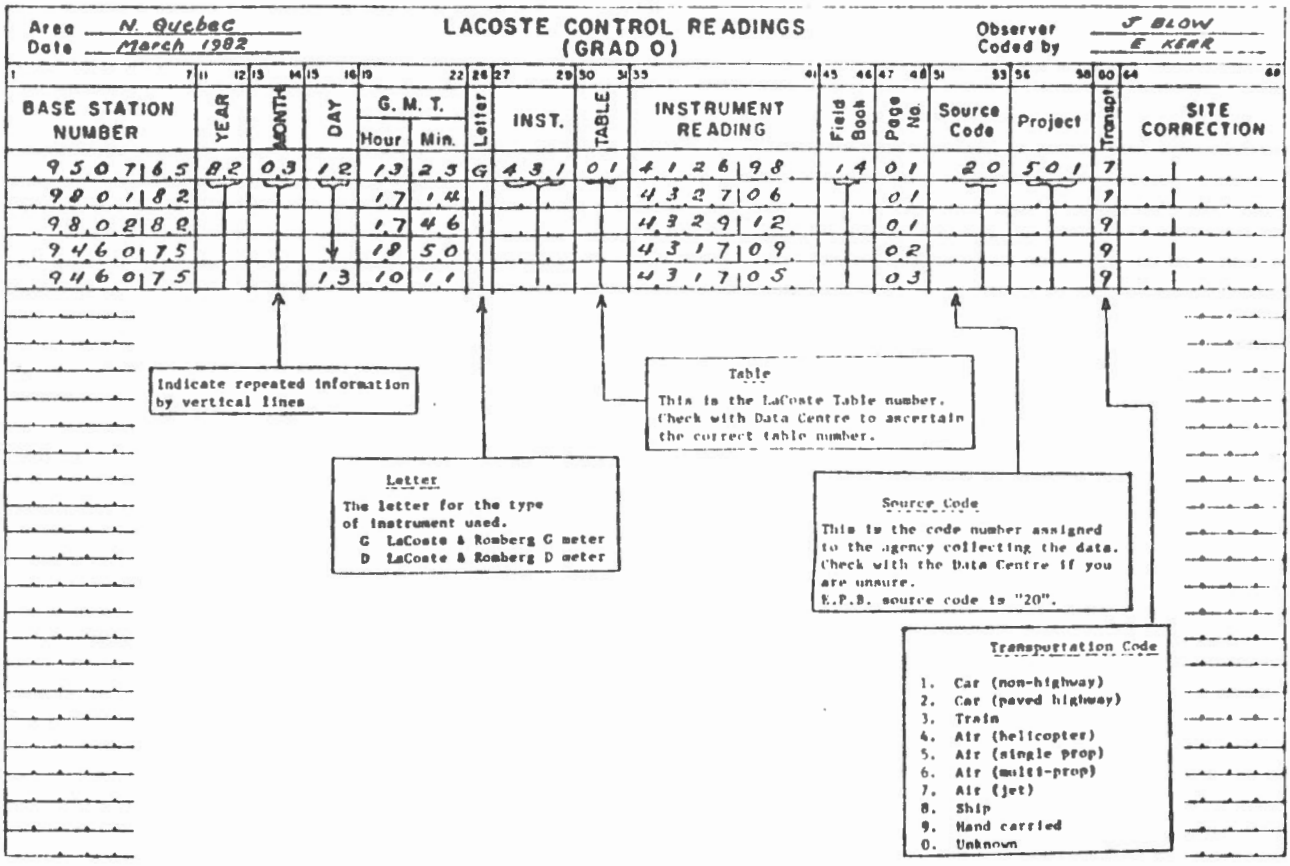
Source Locale	Parameter	Apparatus	Volume (Kbytes)	Time	Active storage					Backup storage					Manag'nt agency	Distribution
					Med.	Loc.	Ret.	Fmt	Rate	Med.	Loc.	Ret.	Fmt	Rate		
Austin Texas	Gravity	L&R, Mdl D	24	78-80	Log b	011	U	V	n/a	None	---	---	---	---	CDS	Internal
Cache Creek	Gravity	L&R, Mdl D	40	1977	Card	011	U	II	n/a	None	---	---	---	---	CDS	Internal
Chalk River	W.Level	Transducer	443	78-82	Tape	CSC	U	III	1 hour	Card	107	U	III	1 hour	CDS	Internal
Chalk River	W.Pres.	Transducer	64	83-)	Tape	CSC	U	III	10 min	Card	107	U	III	1 hour	CDS	Internal
Chalk River	Gravity	L&R, Mdl D	14	11/78	Log b	Lap.	U	V	n/a	None	---	---	---	---	AECL	Internal
Charlevoix	W.Level	Transducer	1 022	79-81	Tape	CSC	U	IV	10 min	Card	107	U	III	1 hour	CDS	Internal
Charlevoix	W.Level	Transducer	4 571	82-)	Tape	CSC	U	IV	10 min	Card	107	U	III	1 hour	CDS	Internal
Charlevoix	Tilt	Tiltmeter	4 208	78-81	Card	CDS	U	III	1 hour	None	---	---	---	---	CDS	Internal
Charlevoix	Tilt	Tiltmeter	14 117	82-)	Tape	CSC	U	IV	10 min	Card	CDS	U	III	1 hour	CDS	Internal
Charlevoix	Rain	Transducer	new	84-)	Tape	CSC	U	IV	1 hour	None	---	---	---	---	CDS	Internal
Charlevoix	Q.Strain	Transducer	409	75-81	Card	CDS	U	III	1 hour	None	---	---	---	---	CDS	Internal
Charlevoix	W.Strain	Transducer	584	75-80	Card	CDS	U	III	1 hour	None	---	---	---	---	CDS	Internal
Charlevoix	Gravity	L&R, Mdl D	680	74-)	Disk	CSC	U	II	n/a	Card	011	U	II	n/a	DC	Public
Charlottetown	Gravity	L&R, Mdl D	16	1974	Card	011	U	II	n/a	Log b	DC	U	V	n/a	DC	Internal
Darmstad Ger.	Gravity	L&R, Mdl D	184	1983	Disk	CSC	U	II	n/a	Card	011	U	?	n/a	DC	Public
LG-2	Gravity	L&R, Mdl D	12	1978	Disk	CSC	U	II	n/a	Card	011	U	II	n/a	DC	Public
[illegible]	Gravity	L&R, Mdl D	12	1981	Disk	CSC	U	II	n/a	Card	011	U	II	n/a	DC	Public
[illegible]-3	Gravity	L&R, Mdl D	40	1976	Disk	CSC	U	II	n/a	Card	011	U	II	n/a	DC	Public
Mt-Seymour BC	Gravity	L&R, Mdl D	51	77-)	Disk	CSC	U	II	n/a	Card	011	U	II	n/a	DC	Public
Mt Ste-Marie	Gravity	L&R, Mdl D	29	76-80	Disk	CSC	U	II	n/a	Card	011	U	II	n/a	DC	Public
Mt-Tremblant	Gravity	L&R, Mdl D	3	1976	Disk	CSC	U	II	n/a	Card	011	U	II	n/a	DC	Public
Mt-Tremblant	Gravity	L&R, Mdl D	3	1979	Disk	CSC	U	II	n/a	Card	011	U	II	n/a	DC	Public
Ottawa	Position	GPS	5 000	1983	Flop.	113	None	P	5 min	None	---	---	---	---	UNB	On request
Ottawa	Tides	NA-137	264	82-)	Disk	010	None	NS	10 min	Disk	010	None	NS	10 min	CSD	Internal
Ottawa	Tides	ET-12	264	82-)	Disk	010	None	NS	10 min	Disk	010	None	NS	10 min	CSD	Internal
Ottawa	Tides	L&R, Mdl D	n/a	72-)	Chart	107	1 y.	n/a	n/a	None	---	---	---	---	CSD	Public
Ott-Gananoque	Gravity	L&R, Mdl D	68	80-84	Disk	CSC	U	II	n/a	Card	011	U	II	n/a	DC	Public
Pinawa Ont.	W.Level	Transducer	16	1983	Tape	CSC	U	III	1 hour	Card	107	U	III	1 hour	CDS	Internal
Stoneham Que.	Gravity	L&R, Mdl D	12	1976	Disk	CSC	U	II	n/a	Card	011	U	II	n/a	DC	Public
Vancouver I.	Gravity	L&R, Mdl D	640	77-)	Disk	CSC	U	II	n/a	Card	011	U	II	n/a	DC	Public

Abbreviations

CDS : Crustal Dynamic Section
CSC : Computer Science Centre
DC : Data Centre
Fmt : Refer to annex
Lap. : Laperriere Street
L&R : Lacoste & Romberg gravimeter
Loc. : Location or room no.
Log b : Log book
Med : Storage Medium
NS : Non-Standard
P : Proprietory
Ret. : Retention period
U : Unlimited

ANNEX II

CODING FORM FOR GRAVITY SURVEYS



From "Field Procedures Manual" Revised March 1984

ANNEX III

CARD FORMAT

As a backup, a full day is stored on two 80-column cards at one-hour interval as follows:

1st card-
- I3 Day of the year (UT throughout)
- I2 The year
- A3 An alphanumeric code identifying the station where the observations were made. For instance: CHX Charlevoix
- I2I6 Observed values for hours 00:00 to 11:00. The units used must be determined from other project documents. (Later data includes this information on title cards etc. as part of the data deck)

2nd card-
- I3 Day of the year
- A3 Alphanumeric code for the device or the particular experiment from which the data was obtained.
- I2 A number distinguishing various versions of the same data (That nomenclature is not always adhered to). Examples: 0- Raw data.
  1- Edited data.
  2- Edited and corrected for instrument calibration.
- I2I6 Observed values for hours 12:00 to 23:00 (See first card).

FORMAT OF THE AGOS DATA FILE RECORDS AS ON THE CYBER

```
Record Id ----------------------------------File header record
|      .-------Data file: MMMM min field, from beginning of year.
|      |       .--------------------------Site name
|      |       |                    .------RSX11M filename (unused)
|      |       |                    |      Year of data
|      |       |                    |        |
H0 481880 CHARLEVOIX1          AGOREC.TMP    81

|      |
|---------------------------------------Table records
|      |                                      |
T0 481880 1 1 WELL       DEEP-#1    S2      -|--General parameter table
T1 481880  101      0    600       0       0  -|--Kalman filter table
T5 481880   0.000     0.000       0       0  -|--Step control table
T6 481880 JJL     1 1                        -|--Password table
T9 481880 60 16   1 81 33  1  0  9  0 81  -`--System control table

|      |
|---------------------------------------Table record (pure octal data)
|.--------------------------------------1=chans 1-8, 2=chans 9-16 etc.
||     |
A1 466340     3457       21     4000     3567      134        0      231     7777
A2 466340      232     7451      200        0     2314      137     1253        1

||     |
|---------------------------------------Data record (unfiltered volts)
||     |
B1 480140  -1.746  -1.564  10.000  -2.632  -2.478  -0.976   0.563   1.551
B2 480140  -0.017   0.046  -0.522   0.905  -0.136  -0.034   0.005  -0.086

||     |
|---------------------------------------Data record (filtered volts)
||     |
C1 477750  -1.589  -1.426  10.000  -2.465  -2.518  -0.818   0.564   1.552
C2 477750   0.326   0.299  -0.693   0.904  -0.020  -0.023   0.049  -0.084

||     |
|---------------------------------------Data record (filtered RMS volts)
||     |
V1 477780   0.081   0.064   0.344   0.066   0.073   0.017   0.018   0.017
V2 477780   0.020   0.021   0.022   0.009   0.001   0.002   0.003   0.004

|      |
|---------------------------------------System housekeeping record
|      |   .-----------------------------User #
Y  477810 0 LOG ON ACCEPTED

|      |
|---------------------------------------Text record
|      |   .-----------------------------User #
Z  477000 6 THIS IS A TEXT MESSAGE FOR
Z  477000 6 COMMENTS.

|      |
|---------------------------------------Step record
|      |   .-----------------------------Channel #
|      |   |       .---------------------Step size detected (Volts)
L  479400 9      0.795

|      |
|---------------------------------------Over range record for last hour
|      |   .-----------------------------Channel #
|      |   |       .---------------------Number of samples out of range
O  479400 2       24

|      |
|---------------------------------------System record
|      |   .-----------------------------Event # (0=Power failure)
S  477240 0        0
```

LOG BOOK FORMAT

DATE 1/07/84 OBSERVER / OBSERVATEUR MOUSSAOUI

TEMP.	STATION	TIME HEURE	UNCLAMP	READING	k x READ	TIDE	CORR. L.	DIFFERENCE
18°c	OTT	17:50	17:46	149901	182208	127	182335	
								44380
25°c	KEM	18:54	18:55	113379	137814	140	137954	
								11977
24°c	PRE	19:49	19:39	103527	125839	138	125977	
								19579
24°c	BROC	20:19	20:15	87430	106273	125	106398	
								20642
24°c	GANA	21:24	21:20	70479	85669	87	85756	
								20646
24°c	BROC	22:29	22:15	87499	106357	45	106402	
								19577
23°c	PRE	22:58	22:54	103631	125966	13	125979	
								11990
21°c	KEM	23:50	23:46	113528	137996	-27	137969	
								44374
	OTT	00:59	00:55	150068	182411	-68	182343	
				(READING UNITS)	(μGal)	(μGal)	(μGal)	(μGal)

OTTAWA $k = 1.21552$ 50

SENSITIVITY TEST AND ADJUSTMENT

Lecture : 149901 Time : 17:00 Tide : 102 Corr. Lect. : 150003

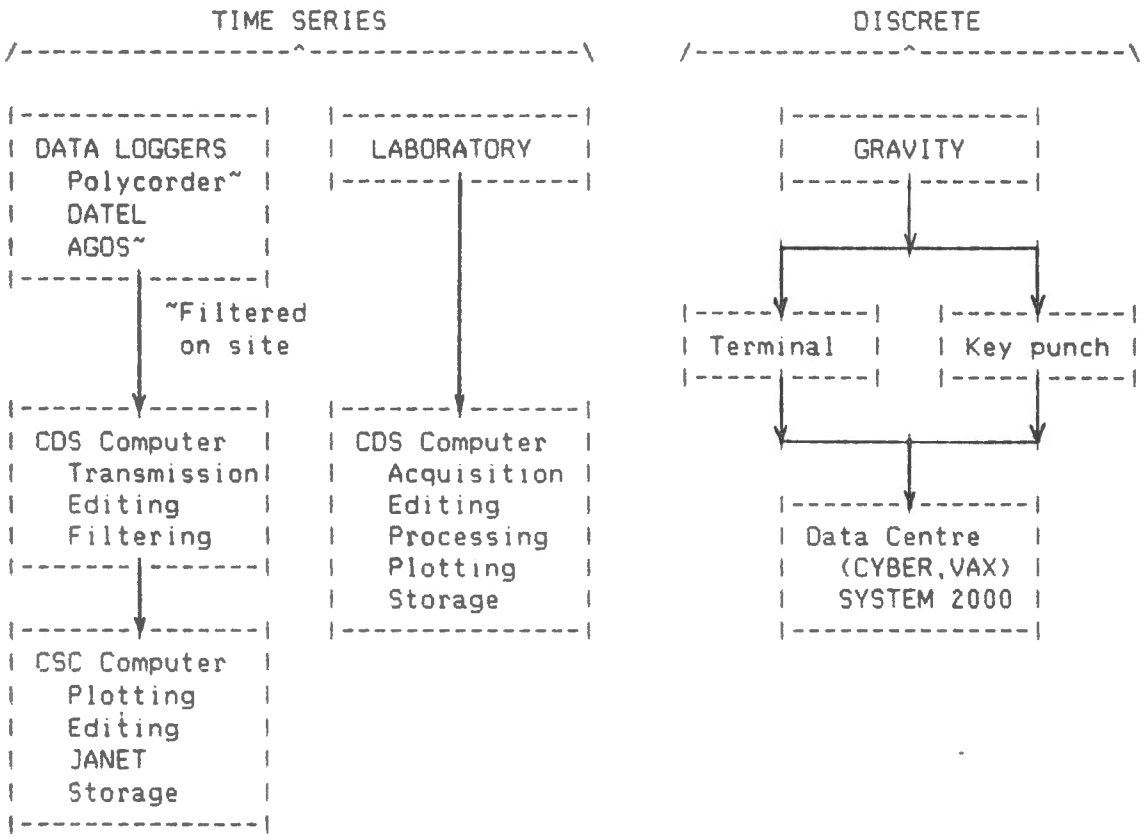
Sensitivity	2.0	149590 }	12	
	3.2	150590 }		
Sensitivity	2.1	149670 }	3.2	upper beam
	3.2	150676 }		
Sensitivity	2.0	149500 }	9.8	O.K.
	2.98	150500 }		

Reading line LEFT : -3 READJUST LEFT 2 O.K.
RIGHT : 8 RIGHT 4

Cross level DOWN : 2 O.K.
UP : 1 O.K.

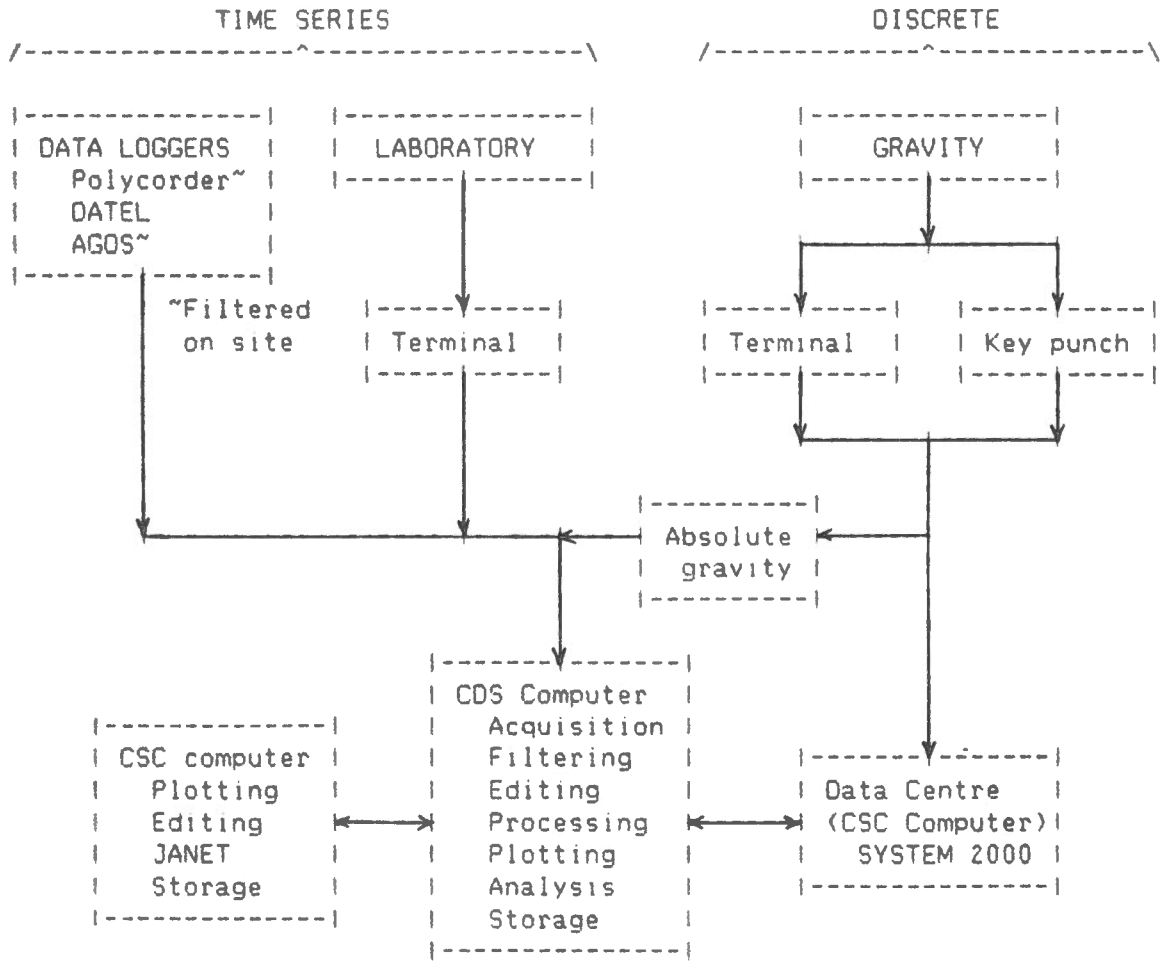
Lecture : 149902 Time : 17:30 Tide : 121 Corr. Lect. : 150023

ACTUAL DATA FLOW PROCESS IN THE CRUSTAL DYNAMICS SECTION



CDS - Crustal Dynamics Section
CSC - Computer Science Centre

PROPOSED DATA FLOW PROCESS IN THE CRUSTAL DYNAMICS SECTION



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