GSETT

Conference on Disarmament / Group of Scientific Experts
Second Technical Test
Seismic Parameter and Waveform Data
April 22 – June 2, 1991

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INTRODUCTION TO GSETT-2

January 1992

The Group of Scientific Experts Second Technical Test (GSETT-2) was an ambitious experiment in terms of the international nature of its participants, the volume of data collected and exchanged, the analysis procedures followed, and the time schedule under which the experiment took place. In rough numbers, the GSETT-2 archives contain parametric data from 3,000 seismic events as recorded by 60 globally-distributed stations over a 42-day period from 22 April through 2 June 1991. Evaluation of the success of GSETT-2 by the Group's delegations and working groups is still underway. The data on this two-volume set of CD-ROMs promise to provide a foundation for the continued evaluation of GSETT-2, but also promise to be an important resource for the broader seismic research community.

In this document, we provide an overview of GSETT-2 that aimed at giving potential users of the CD-ROMs who are unfamiliar with the test a perspective on the origins and intent of the data. We review the concepts, operational logistics, analysis procedures, and results. Note that what we provide here is only a very brief summary of the information contained in many documents published by the Group of Scientific Experts and its national delegations. We strongly encourage users to reference these documents for details. Please contact your national GSE delegation (see CONTACTS.DOC file) to request GSE documentation.

1.0 HISTORICAL BACKGROUND

The Ad Hoc Group of Scientific Experts to Consider International Co-operative Measures to Detect and Identify Seismic Events (GSE) was established in 1976 by what is now the Conference on Disarmament. Through many conference reports (starting with the first, CCD/558, 1978), the GSE defined the concepts for an international system of seismic data exchange capable of providing all parties equal access to data useful for monitoring a limited or comprehensive nuclear test-ban treaty. The concepts included a global network of about 50 high-quality seismic stations, capable of supplying both parametric "Level I" data (arrival times, amplitudes, periods, etc.) and digital waveform data ("Level II") to a system of data centers for processing and dissemination according to strict procedures. During the first large-scale test of these concepts in 1984 (the Group of Scientific Experts Technical Test, or GSETT), parameter data were routinely sent to International Data Centers for event location processing. Waveform data were to be available on request, but never exchanged routinely (CD/720, 1986).

Rapid developments in seismic acquisition systems, communications, and computer processing led the GSE to propose an expansion of the global system. In particular, there was a concensus that the routine exchange and processing of seismic waveforms in conjunction with parameter data could significantly improve the efectiveness of the system. A second technical test (called GSETT-2), including several warm-up phases and a full-scale test, was conducted during 1990 - 1991 to evaluate these and other new concepts. The data on the GSETT-2 CD-ROMs are from the full-scale test of GSETT-2, with data collected between 22 April and 2 June 1991.

2.0 OPERATIONAL CONCEPT AND SCHEDULE

The GSE system for the full-scale test included National Data Centers (NDC) which collected and forwarded seismic data to four Experimental International Data Centers (EIDC) in Canberra, Moscow, Stockholm, and Washington. The EIDCs followed agreed procedures to produce and dispatch a series of seismic event bulletins with the objective of obtaining a unified final bulletin that represents the best hypotheses of the four. A difficult requirement was that all data centers adhere to a demanding and rigid schedule in which they had to process the data from several "Data Days" simultaneously. Days 0 - 7 represent the days in the eight-day GSE processing cycle relative to each given data day (Day 0). Instructions for the test, including message formats, processing procedures, and schedules are given in CRP 190/Rev 4, 1990.

On Days 0 - 1, the NDCs were responsible for recording seismic data from one or more stations run by their country, then for analyzing these data to detect and identify seismic phases, measure the required parameters or features as specified by CRP 190 (arrival time, amplitude, period, etc.), and, if possible, use national means to locate events. Measured detection parameters, accompanying waveform segments, and event solutions were dispatched via various communications channels (e.g., by direct satellite links to communications nodes, electronic mail, Internet links, etc.) to all four EIDCs in strictly-formatted messages by the end of Day 1.

EIDCs continuously received, parsed, and archived the incoming data. Daily logs of all messages sent and received were exchanged by the EIDCs to assure that their databases were identical. By the end of Day 2 EIDCs computed and dispatched an Initial Event List (IEL) prepared following strict rules from the parameter data by an automatic association program. A primary focus of GSETT-2 was to determine the value of analyzing waveform data in conjunction with seismic parameters for producing an improved seismic bulletin, and the EIDC did this analysis during Days 3 - 6. EIDCs could request supplemental data from NDCs to better define hypothesized events. A Current Event List (CEL) showing the current state of each EIDC's analyzed bulletin, was exchanged daily as a means of communicating the current thinking of each EIDC on the events of the Data Day. A final CEL was dispatched from each EIDC at the end of Day 6, and these were combined using prescribed rules by the "responsible EIDC" (a rotating assignment) to form the Final Event Bulletin (FEB) for dissemination to all data centers. All parameter and waveform data had to be readily accessible at each data center from Day 0 - 15. Representative of the demands of the schedule is the fact the an EIDC had to compile and dispatch up to six event lists and bulletins in a single day.

3.0 NDC PROCESSING PROCEDURES

The most important procedures at a GSE National Data Center that pertain to the data on these CD-ROMs are those governing the reporting of seismic waveform and parameter data. Details on these procedures are given in Appendices A and C, respectively, of CRP 190/Rev 4 (1990). Modified excerpts of these appendices are given at the end of this file.

4.0 EIDC PROCESSING PROCEDURES

The most important procedures at a GSE Experimental International Data Center that pertain to the data on these CD-ROMs are those governing the compilation of the Initial Event List (IEL), Current Event List (CEL), and Final Event Bulletin (FEB). Details on these procedures are given in Appendices B, F and J, respectively, of CRP 190/Rev 4 (1990). Modified excerpts of these appendices are given at the end of this document.

5.0 PRELIMINARY SEISMOLOGICAL RESULTS

GSETT-2 was comprised of 42 data days starting from 22 April 1991 and running through 2 June 1991. The last FEB was scheduled to be dispatched on 9 June 1991. Below, we provide some rough statistics that will be useful for assessing the content of the GSETT-2 CD-ROMs. These statistics are from the Washington EIDC database and are rounded to the nearest one or two significant digits. These statistics will be further refined and presented to greater precision as the GSE evaluation proceeds.

NETWORK	
EIDCs	4 data centers
NDCs	35 data centers
Stations	60 stations
arrays	12 stations
1 or 3 component	48 stations
Min and Max Latitude of stations	78S lat. to 77N lat.
Min and Max Longitude of stations	160W lon. to 175E lon.
PHASE ARRIVALS	
Number	66,000 phases
% Associated	39 %
WAVEFORMS	
Segments	85,000 segments
Volume	1.2 Gbytes
EVENTS	
Washington CEL (WASCEL directories)	2,700 events
FEB (GSEBULL directories)	3,700 events

Please forward questions and comments on any related subject to:

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EXCERPTS FROM CRP 190/REV 4 APPENDICES

NDC PROCEDURES: WAVEFORM TIME SEGMENTS TRANSMITTED FOR EACH DETECTED SIGNAL
(Excerpt from Appendix A, CRP 190/Rev 4, 1990)

During GSETT-2, short-period waveform time segments will be regularly transmitted by NDCs for each detected seismic signal. The length of these segments will be 120 seconds of vertical component data, starting 30 seconds before a detected arrival. Array stations will send such segments from both the best beam and from one sensor. For local and regional events, the waveform will consist of short-period vertical waveform segments commencing 30 seconds before P and continuing for 30 seconds after the last clearly discernable phase.

The regular transmission of long-period data for detected Rayleigh waves is optional, but as many NDCs as possible are urged to attempt this during GSETT-2. For those NDCs that will do so, time segments will be regularly transmitted for all detected Rayleigh waves, whether or not such Rayleigh waves can be associated with events whose P waves have been detected. The length of these segments will be 30 minutes of vertical component data, starting 5 minutes before the estimated onset time of the Rayleigh waves.

Abbreviated reporting of waveform data would be permitted during especially large sequences of local earthquakes, rockbursts and quarry blasts, similar to the abbreviated reporting of parameter data described in Appendix C. If the number of events exceeds about 10 per day from the same location, waveform time segments may be reported only for the largest event each day. The parameter message will give the number of similar events on that day.

NDC PROCEDURES: LEVEL I PARAMETERS TO BE REPORTED FROM THREE-COMPONENT STATIONS AND ARRAY STATIONS
(Excerpt from Appendix C, CRP 190/Rev 4, 1990)

Parameter reports from each station contain only information required to permit IDC's to locate seismic events, determine the focal depth, determine Mb, and determine Ms when associated Rayleigh waves are detected. A summary of the wave types and the parameters to be reported is given in Table C.1.

The basis for the definitions of the parameters is the set of instructions for extraction of level 1 data described in earlier GSE CD documents (CCD/558, CD/43 and CD/448) and used for the GSETT (Conference Room Paper 131/Rev1). The definitions as presented here apply to extraction by an analyst and include the experience gained during the GSETT (documented in CD/720). Definitions for procedures based on automatic processing, including those for back azimuth, angle of incidence, as well as level of rectilinearity have to be further developed and tested.

For amplitude and period measurements, the stated precisions may not be achievable at all stations, and in this context it should be noted that the reporting formats (see Annex D1) are `free' format and permit some latitude in precision of reported values. Two significant figures are considered adequate for both amplitude and period.

C.1 First arrival time of P-wave

On a visual record a first arrival time is defined by a change in amplitude or phase. The time reading is given in hours, minutes, seconds, and tenths of a second in Universal Coordinated Time (UTC). If the time is uncertain (clock problems) by more than 0.05 second, it must be reported in qualitative remarks. The first arrival should always be identified, if possible, by one of standard symbols. The symbols (phase codes) used by the International Seismological Center are recommended.

Because of the high accuracy of time measurements the problem of instrumental time delay must be noted. As an example, for WWSSN (World Wide Standardized Seismograph Network) SP instruments at 1 Hz, phase delay is about 0.3 seconds and group delay time is about 0.4 seconds. Corrections for these delays should be made before reporting arrival times.

C.2 First Motion Sign and Clarity

Direction (or sign) of the first motion on vertical short- and long-period instruments should be reported. For complicated or weak signals, the direction of the first motion may be in doubt; if so, it is not to be reported. Theoretically the first onset should have the same sign on short-period (SP) and long-period (LP) instruments. However, due to different noise conditions, frequency response and magnification of SP and LP recordings the first motions do not need to agree, particularly for multiple events starting with weak arrivals. In the case of a discrepancy in the directions the reasons should be checked by the operator before the information is reported.

The following first motion notations should be used:

C - SP compression (Up)
D - SP dilatation (Down)
U - LP compression
R - LP dilatation

The clarity parameter is used to indicate whether a recorded seismic signal represents a clear onset. If the signal onset can be identified within +/- 0.2 seconds for P waves or +/- 1 second for S waves, the clarity notation I is used, while if the onset identification is less accurate, the clarity notation E is to be used. The clarity parameter Q is to be used for initial phases whose onset cannot be determined to better than 1 second accuracy.

C.3 Time of Maximum P-wave Amplitude

This time corresponds to the maximum amplitude measured in the interval 0-6 seconds after the arrival of the P-wave. In case of large teleseismic events this interval would be extended to 20 seconds.

C.4 Associated Amplitude

The amplitude of the first phase is to be determined from maximum trace amplitude within the first six seconds, corrected to ground motion using the measured period and the instrument response curve. Trace amplitude is measured on the vertical component as the center-to-peak deflection from the median line or may be obtained by taking one half of the peak-to- trough deflection of symmetrical waves. The ground amplitude is reported in nanometers to a precision of 0.01 nanometres. Since the upper limit for an absolute calibration of seismographs is 5-10%, it is understood that the amplitude cannot be measured with a better accuracy than two significant figures.

C.5 Associated Period

The period of the maximum amplitude is measured on the vertical component at zero crossings or between two neighbouring peaks or troughs. Period should be read to two significant figures and to a maximum precision of 0.01 seconds.

C.6 Back azimuth, apparent angle of incidence, level of rectilinearity of the polarized wave.

Back azimuth and angle of incidence should be computed to one degree. Level of rectilinearity should be computed to 0.01.

Rectilinearity =1- (a2 + a3)/2a1,

where a1, a2, a3 are the principle axes lengths of the polarization ellipsoid.

C.7 Secondary Phases

The standard notation for all phases is that used by the International Seismological Center. Arrival times of clear identified phases should be reported. Measurements of arrival time, maximum recorded amplitude, corresponding period, back azimuths, apparent angles of incidence and levels of rectilinearity of secondary phases (when appropriate) follow the same rules mentioned under 1-6. It is important that secondary phases, in particular pP, sP, and PcP are reported when possible. Another secondary phase of special important for stations at island or coastal locations is the hydro-acoustic wave (T-phase). The reporting of T-phases is recommended to improve the network capability in oceanic areas of the southern hemisphere.

C.8 Arrival Time of a Maximum Rayleigh Wave

The arrival time of the maximum trace amplitude of the Rayleigh wave train is measured with a precision of 1 second.

C.9 Maximum Amplitude of the Rayleigh Wave

The magnitude of the maximum deflection (center-to-peak from median) of the Rayleigh wave is measured from the maximum trace amplitude on the vertical component, corrected to true ground motion using the measured period and the instrument response curve. The ground amplitude is reported in micrometers with a maximum precision of 0.001 micrometer.

C.10 Period of the Rayleigh Wave

The observed period of the maximum amplitude of the Rayleigh wave is reported in seconds.

C.11 Back azimuth, level of rectilinearity of the Rayleigh wave.

Back azimuth is reported with precision of one degree. Level of rectilinearity of the polarised wave is reported with precision of 0.01 for estimate of the quality of the measurement.

C.12 Noise Amplitude

If no Rayleigh wave can be associated to a detected P-phase, the largest amplitude of the seismic noise with period between 10-30 seconds is measured on the vertical component within one minute of the section of the record preceding the initial P-wave. The ground amplitude in micrometers is reported.

C.13 Noise Period

The period of the corresponding noise amplitude is reported to a precision of one second.

Practically the same information is also reported from seismic arrays. The only difference is that, instead of angle of incidence, the arrays report the slowness value dt/d (s/deg) with a precision to 0.1, as well as approximate values for the source parameters (source time, epicentre, mb and Ms).

C.14 Qualitative Remarks

It is very important that the report is accompanied by remarks of the experienced analyst qualifying, if possible, the character of the event as seen from the visual inspection of the record or by a more sophisticated analysis. The following identifiers are suggested:

CL .. Instrument offscale; accompanied by 999999 on reported amplitude.

DD .. Multiple (double) event: complex wave pattern particularly in the P-wave group justifying such statement according to the analyst's experience.

DE .. Deeper than normal, intermediate; qualification made by the analyst if the wave pattern and amplitude ratios of main phases warrant it.

LA .. Local event within a very short distance, not possible to separate P and S phases.

LB .. Local event within a short distance. P and S separated but S-P interval less than 25 sec. i.e., focal distance less than about 2 degrees.

ME .. Mixed events: two events overlapping and causing some confusion in reading an interpretation: if possible, they should be identified (local, regional, teleseismic).

NO .. Non-seismic origin: intended for local disturbances such as sonic booms, meteoroids, passing aircraft, etc., which do not justify separate codes. Intended for automatic use in EIDC processing, and should generally be accompanied by a separate explanation in (( )).

NP .. Confirmation that no corresponding P wave is being reported for this event.

PQ .. Possible quarry blast.

QB .. Quarry blast: event announced by responsible authorities as a quarry blast, total charge in tons and coordinates should be indicated if known.

R .. Regional event somewhere between 2 degrees and 20 degrees, i.e., the wave pattern is influenced by waves travelling between the crust and the 20 degree discontinuity.

RB .. Rock burst: event announced by authorities or qualified to this category by a typical wave pattern.

TA .. Teleseismic event, a simple seismogram with largest amplitudes within first few seconds.

TB .. Teleseismic event, seismogram is made up of more than one discrete arrival.

TC .. Teleseismic event with a complex waveform made up of many arrivals.

TU .. Uncertain time: if the time correction is uncertain by more than 0.05 seconds because of clock problems.

The above parameters are transmitted within double parentheses according to the International Telegraphic Seismic Code. In the same way, location information (if available) and additional comments may be transmitted.

C.15 NDC Location Information

NDCs are encouraged to provide information on location and other parameters of seismic events detected at their participating stations by use of a "FOCUS" group in their parameter reports. Sufficient information may be available within sufficient time from a local network to provide this information. A "FOCUS" group may also be produced from information recorded at a single array or three-component station which has one defining measurement of a P type phase (i.e., defining observations of time of arrival, azimuth and slowness or angle of incidence) and one observation of an S-type phase, provided that the event is located within 10 degs. of the station.

If EIDCs do not receive sufficient additional data on these NDC-reported events to undertake a separate estimate of the event parameters, the NDC-reported events will be listed in a separate section of the unassociated data in the FEB (see Appendix D, Section D.3.4.2, and Appendix J, Section J.3).

C.16 Abbreviated Reporting

For practical reasons of handling a manageable amount of data events classified by the station analyst as

(i) local earthquakes, quarry blasts or rockbursts
(ii) belonging to an earthquake sequence (e.g. more than ten events a day from the same place)

an abbreviated report would be allowable.

Parameter reports on local events should be limited to the arrival time, amplitude and period of P, or first clear phase, (parameters 2, 4, 5 of Table C.1) and a comment on the event.

During an especially large local earthquake sequence, it would be allowable to give a general description of the seismic field, such as "A local sequence took place between (time A) and (time B)", reporting level 1 data only for the largest event each day, and giving the number of events on that day.

Table C.1

	Unit of	Precision of

Group(1)	Component	Parameter	Measurement	Measurement	Code(2)
IFASE	Short-period vertical	1. First Arrival			
		2. Arrival Time	h, min,s	0.1 s	P
		3. Time of Maximum Amplitude	h, min,s	0.1 s	XA
		4. Amplitude(3) A	nm	as needed(5)	A
		5. Period T corresponding to Amplitude A	s	as needed(5)	T
(COMP3 /SLOW)	Short-period vertical and horizontal	6. Back Azimuth	degree	1 degree	AZ
		7. Angle of incidence	degree	1 degree	INC(4)
	(for arrays:	Slowness	sec/degree	0.1	SLO)
		8. Level of rectilinearity (P-only)	ratio	0.01	REC(4)
(SFASE(n))(6)		9. Secondary phase description:			
		Arrival time	min,s	0.1 s	
		Amplitude	nm	as needed(5)	
		Period	s	as needed(5)	
		Back Azimuth	degree	1 degree	
		Angle of Incidence	degree	1 degree	
LPREP(7)	Long-period vertical	10. Arrival time of maximum in the Rayleigh wave	h, min,s	1 s	LPZ LR XA
		11. Maximum amplitude in the Rayleigh wave	micrometer	as needed(5)	A
		12. Period of corresponding Rayleigh wave	s	1 s	T
	Long-period vertical and horizontal	13. Back azimuth	degree	1 degree	AZ
	Long-period vertical	Noise identifier			LPZ NB
		14. Noise amplitude	micrometer	as needed(5)	A
		15. Noise period	s	1 s	T

(EVCOMM) 16. Qualitative remarks on local and regional events (may include locations and magnitudes)

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1 GROUP names in accordance with Annex D1 of Appendix D. Parameters of GROUPS without parentheses, e.g., IFASE, are mandatory. Parameters of GROUPS designated by parentheses (e.g., COMP3) are optional.
2 Codes used by the International Seismological Center (ISC) are recommended.
3 The value of A corresponds to the maximum amplitude in the interval of 0 - 6 seconds after the arrival of the P-wave. In case of large teleseismic events this interval would be extended to 20 seconds.
4 These symbolic designators and the corresponding values are not part of the International Seismic Code and must be enclosed in double parenthesis (( )).
5 To at least two significant figures, and to a maximum precision of 0.01 nm or 0.01 seconds.
6 Clear secondary phases should be reported whenever possible.
7 Arrival time, amplitude and period are mandatory for reported Rayleigh waves. Noise identifier, noise amplitude and period are mandatory if no Rayleigh wave is reported.

EIDC PROCEDURES FOR PREPARING AND COMPILING THE IEL
(Excerpt from Appendix B, CRP 190/Rev 4, 1990)

This appendix describes the procedures for preparation and compilation of the Initial Event List (IEL). The IEL is based on automatic processing of the station parameter data directly as reported by the NDC's.

Procedures for the processing of parameter data were first described in CCD/558 and then further in CD/43 and CD/448. The last of these gives the more complete description, in Appendix 7 of Addendum 1 to CD/448 under section 3, entitled "Procedures for Automatic Association and Location of Seismic Events", and thus is the obvious starting point for any revised procedures. The procedures given there are a combination of formal rules and suggestions as to how the bulletin satisfying these rules might be best achieved. These suggestions can be termed "algorithmic" in nature and are not mandatory. As long as the IEL contains only events which satisfy rigid event formation criteria, the exact means by which these were produced from the input data is not of great importance. The following, derived from Appendix 7 (section 3) of CD/448 are intended as procedures for GSETT-2. To facilitate comparison with the original text, the same headings are kept as far as possible.

The objectives of the processing of parameter data at EIDCs remain unchanged from those described in CD/43: "The association of arrival times should be carried out in a way that maximizes the probability of defining new events."

B.1 Definitions

The process of forming seismic events and estimating their origin times and hypocenters is here referred to as association and location. This process is based on phases with related phase-names and observations reported from the seismic stations.

A phase refers to a more or less prominent onset on the seismic record that can be associated with a seismic wave type along some specifiable path through the earth's interior or along its surface. Phases believed to originate from the same seismic event are grouped together with the first arriving phase referred to as the primary phase and later phases referred to as secondary phases respectively (Appendix D, Annex D.1, page D39).

A phase is described by a phase-name (indicating wave type and path). A reported phase-name may be changed in the association and location process and the phase-name that is finally given by this process is called assigned phase-name.

A phase is also described by one or more observations. The following observations can be used in the association and location process: time of arrival, back-azimuth, and slowness or equivalent from angle of incidence reported by three component station. Observations of angle of incidence from a three component station are initially converted to slowness in the association and location process using the appropriate (P or S) phase velocity. The appropriate phase velocity may have been provided by the NDC responsible for the station; in the absence of such information the velocities of the upper crust (P=5.57 km/s, S=3.37 km/s) implied in the Jeffreys-Bullen tables are to be used.

A set of joint observations of time of arrival, back-azimuth, and slowness (or equivalent from angle of incidence) of a phase at an array (or 3 component station) is called a phase measurement. That is to say a phase measurement, as defined here, consists of three observations.

Phases with related phase-names and observations underlying the formation of seismic events and the estimation of origin time and hypocenter are called defining. A defining phase has to have a defining time of arrival. A defining station has one or more defining phases. Only certain types of phases may be used in this process. There are also restrictions on how reported phase-names may be changed in the association and location process. Furthermore, a minimum number of a certain combination of observations is necessary to form a seismic event. The observations must also satisfy certain residual requirements. The minimum number of combinations, the rules for changing phase-names, and the residual requirements together define the event formation criteria.

Phases may also be flagged so that they may not be used as defining for other events. Phases may also be associated so that they appear in the event listing even if they are neither defining nor flagged.

B.2 Defining Phase Types

Reported phases with the following assigned phase-names may be used for forming events:

- P
- PKP (initial DF branch only)
- S
- local and regional P phases: Pg, P*, Pn
- local and regional S phases: Sg(Lg), S*, Sn

- depth phases pP, sP

A secondary phase may be defining only if the corresponding primary phase is defining.

B.3 Event Formation Criteria

Each seismic event in the IEL should meet the following criteria:

B.3.1 Minimum Number of Observations

The formation of a seismic event must be based on defining phases with at least the following minimum numbers of observations or measurements:

(i) Four defining observations, not all of which are related to PKP phases, at three or more stations.

OR

(ii) One defining measurement (i.e., defining observations of time of arrival, azimuth and slowness or equivalent from angle of incidence) at one station and two observations at another station, where at least one of these stations is an array or within 10 degrees of the event.

B.3.2 Restrictions on the Use of Reported Phases

The following restrictions apply to phase-names assigned to phases that are defining:

(i) Phases assigned as P and PKP must have been reported as primary phases

(ii) Observations of phases reported as originating from local or regional events may be used only within local and/or regional distances (based on qualitative remarks, S-P time, reported location or distance, or phase name, etc.)

(iii) Observations of secondary phases assigned as pP and sP may be used only if reported phase-names were pP, sP, PP, PcP, or unknown.

B.3.3 Residual Requirements

All observations must have final residuals of less than 1.5 a priori standard deviations. These a priori standard deviations expressed in terms of residuals with respect to the Jeffreys-Bullen travel time table (used for all phases in the event location procedure), are as follows:

(i) time of arrival:

- P (25<distance<100 deg) 1.0 second
- P (all types;distance<25 deg) 3.0 seconds
- S (all types) 5.0 seconds

-PKP (DF branch only) 1.5 seconds

-pP, sP 2.0 seconds

(ii) array slowness vector residual (in units of seconds/degree), or equivalent from three component processing:

	Station/Phase Type			
	3-Component		HF Array	SP Array
Distance	P-type	S-type	All Phases	All Phases
Local/Regional (0 - 20 deg)	4.0	6.0	2.0	3.0
Teleseismic (20 - 105 deg)	3.0	6.0	2.0	1.5
Core	4.0	6.0	3.0	2.0

The slowness vector referred to above has components Sx = S * cos(Az) and Sy = S * sin(Az) where S is the scalar slowness and Az the azimuth. The slowness vector residual is the length (scalar) value of the vector difference between the observed slowness vector and that predicted for the associated phase by Jeffreys-Bullen travel time derivative.

For SP arrays, the allowable slowness vector residual should decrease linearly from 3.0 to 1.5 sec/deg over the distance range 17.5 to 22.5 degrees.

B.4 Hypocenter Location

Jeffreys-Bullens travel time tables should be used in the estimation of origin times and hypocenters of the events. Only those observations (time, azimuth, slowness/incidence angle) classified as defining may be used to locate. If the arrival time observation for a phase is defining, but the slowness/azimuth vector is not, then the arrival time should be used to locate. However, if the slowness/azimuth vector is defining, but the arrival time is not, then none of the observations should be used. When the slowness/azimuth vector and arrival time are both defining, the arrival time, slowness and azimuth observations must all be used to locate. The uncertainties of source parameters should be estimated from the a priori standard deviation. Uncertainties must be at the one standard deviation level for each parameter (latitude, longitude, depth, origin time). The units for latitude and longitude are great circle degrees, for depth are kilometers, and for time are seconds.

B.5 Flagging of Phases as Removed from Further Consideration

One way of avoiding excessive processing time would be to flag phases corresponding to events with five or more defining observations at four or more stations such that they may not be used as defining for other events, provided that they satisfy the following requirements:

(i) The predicted 87% confidence interval of the expected arrival time for the given station and phase should be less than 30 seconds.

(ii) The arrival time residual should lie in the interval (-3 to +10 seconds) or in the smaller of (-c to + 2 c) and (-5 to +10 seconds) where:

c**2 = {event, phase}**2 + {phase}**2

{phase}**2 is the a priori standard deviation in the arrival time for that phase (section B.3.3), and {event, phase}**2 is the standard deviation in arrival time observation predicted from the calculated uncertainty in the event location and origin time.

Non-defining secondary phases (i.e., phases of types other than those given in section B.3.3 above) may also be flagged, provided that they satisfy the requirements given above.

The following secondary phases should be flagged for all events, if assigned as such:

PKP(BC branch)
PKP(AB branch)
PP

For large events, with more that 10 defining phases at distances greater than 25 degrees, the following associated secondary phases should also be flagged, subject to the same restrictions, however they may have been reported:

PcP
PKKP
PKPPKP (all branches)
SKP (all branches)

The a priori standard deviations of the arrival times of these later phases are:

PcP, PP	2.0 seconds
PKP (AB, BC)	1.5 seconds
All others	3.0 seconds

B.6 Association of Phases

Phases may be associated to an event so that they appear in the event listing even if they are neither defining nor flagged according to the conditions given above. A phase is associated provided at least one of the following is true:

(i) the phase arrival time residual lies in the range -5 to +10 seconds

OR

(ii) the phase belongs to the same NDC-reported event section (annex D1, section D1.2.3) as at least one other phase that has been associated, except in cases where the automatic association process has determined that the phase is defining for another event.

Note that phases may be multiply associated if they are not flagged. However, associated but unflagged arrivals may later become defining, whereas flagged phases may not.

Note that defining phases for a given event need not necessarily be flagged for that event, and in such a case are "free" to become defining to a later event. If they are also flagged by a later event, they may no longer be defining phases for the earlier event and this may then require that the earlier event be deleted if the event formation criteria are no longer satisfied. If a given phase appears to be defining to both (a contradiction in terms), but is flagged for neither, both events have to be included in the IEL.

B.7 Amplitude Consistency Check

CD/43 recommends the application of statistical procedures involving not only the stations which have defining phases but also those which have not. This information is compared with a priori estimates of detection capabilities of the individual stations for an event, in order to establish whether or not the pattern of stations with and without defining phases fulfills a preset probability requirement for forming an event.

Potentially this method is very powerful in deciding whether or not small events, which only just satisfy event formation criteria, are valid, and this technique should routinely be applied only to events with defining phases from six stations or less. It can be used to point out inconsistencies in the solution without affecting the solution, for larger events.

B.8 Calculation of Body Wave Magnitude

Individual station body wave magnitudes should be computed using the amplitude and period observations, corrected for distance by the Gutenberg-Richter amplitude-distance relation. Station magnitudes should only be calculated from observations for which the corresponding phase is defining for the event, and only for distances greater than 20 degrees.

Event magnitudes based on the average of individual station magnitudes are often strongly biased, and maximum likelihood methods should be applied in computing them. Care should be exercised in the application of such methods, as the a priori estimates of station noise levels and/or detectability often appear to be over-optimistic. The average magnitude should also be reported - in calculating this average observations differing from the mean by more than 3 standard deviations should be excluded and the mean then recomputed.

B.9 Association of Long-Period Data

Reported long-period data should be associated with an event if the theoretical arrival time at the reported period agrees with the reported arrival time of the maximum of the Rayleigh wave within three minutes plus one tenth of the theoretical travel time. The theoretical travel time is calculated according to the method given in Appendix 6.5 of CD/43. This procedure may give rise to multiple associations, which should be resolved as follows:

(i) If back-azimuth is reported, it is not allowed to deviate more than 50 degrees from the calculated station-to-epicenter azimuth;

(ii) If the arrival time residual of one of the events is less than three minutes, associations with a time residual of more than five minutes should be excluded;

(iii) Amplitude consistency checks, as described in sub section 7 above for short-period data, should be applied.

If multiple associations cannot be resolved by any of the above, the surface wave report should not be allowed to enter into the calculation of an event surface wave magnitude.

B.10 Calculation of Surface Wave Magnitude

Individual station magnitudes should be calculated using the Prague formula. Maximum likelihood techniques, as described in sub-section 10 above, should be used to calculate the event surface wave magnitude.

EIDC PROCEDURES: INSTRUCTIONS FOR PREPARING CELS USING WAVEFORM ANALYSIS
(Excerpt from Appendix F, CRP 190/Rev 4, 1990)

The use of global network waveform data for seismic bulletin preparation is in its infancy. Strict rules for the waveform analysis are therefore difficult to define at this point in time and the procedures suggested here should be considered only as preliminary examples of what kind of processing might be useful preparing the event lists.

This appendix describes the preparation and compilation of the Current Event List (CEL). This process is based on information initially obtained from all IELs, analysis of waveform data and seismological judgement and, as it proceeds, from the CELs. The preparation of CELs will thus be a bootstrap process with each EIDC updating its own CEL to reflect the results of waveform analysis and seismological judgements as they are made in the interpretation of events. In turn, information contained in a CEL will provide a basis for various hypotheses which will be tested by the analysis of waveform data.

The objectives of CELs are to upgrade the quality of the IEL by extracting additional information not normally available or apparent to the NDC analysts, and to correct existing information. The preparation of CELs is guided by the same principle as the automatic formation of IELs, that is to maximize the number of valid events.

Each EIDC will exchange CELs daily and will be responsible for reviewing the information combined in all other CELs in order to converge on a common set of results among the EIDCs. This reconciliation should minimize differences prior to merging CELs to form a Final Event Bulletin.

F.1 Content of the CEL

Preparation of the CELs includes use of the IELs of all EIDCs, the routinely reported station parameter and waveform data, and supplemental station parameter and waveform data that may be requested in the course of interactive analysis.

The preparation and compilation of the CELs involve daily editions of the CEL. The last CEL will represent the EIDCs view of what should appear in the final event bulletin, the FEB.

F.2 Rules

The information in the last edition of the CEL should be unique with respect to event hypotheses as well as defining phases.

Each event included in the list should meet the event formation criteria of Appendix B with the exception that the standard deviation may exceed the rules by 20% provided that additional confirmatory seismological evidence is available.

All defined events must be seismologically sound.

Phases reported by the NDCs, or new phases defined by the IDCs, must be entered only once as defining in the bulletin, or in the list of unassociated phases. If a phase initially appears as defining with more than one event or with more than one phase name for one event in the CEL, the analyst must select only one of the options using his best seismological judgement. Comments may be entered to note any remaining ambiguity in the analyst's mind.

All phases belonging to the same event section (annex D1, section D1.2.3) will remain together in chronological order in either the associated or unassociated event lists, unless the EIDC determines that the phase originated from another event.

All changes to information originally reported by the NDCs must be explained by use of comment codes, as follows:

N - the reported phase name has been changed.

M - one or several of the parameters reported by the NDC for this phase has been remeasured by the EIDC.

D - phases reported by the NDC as being from the same event have been disassociated by the EIDC.

A - phase added by the EIDC.

The comment codes can be combined.

F.3 Analysis Procedures and Guidelines

The analysis steps suggested for preparation of CELs are grouped together in five categories that largely make up one cycle in the analysis:

(i) determine data to be requested;

(ii) reject spurious event hypotheses;

(iii) improve event solutions;

(iv) form additional events;

(v) review unassociated phases;

It may be necessary to iterate through this cycle several times.

F.3.1 Determine data to be requested

On the basis of the EIDC event lists and the available station parameter and waveform data, supplemental data that need to be requested for the subsequent analysis are determined and are requested.

F.3.2 Reject Spurious Event Hypotheses

The automatic location and association for the IEL often generates spurious events that can be rejected by waveform analysis and seismological judgements.

Events formed by Multiple Phase Associations

Events generated by the automatic IEL procedures may contain observations which are multiply defining. The result of the analysis should be that the EIDC must determine from which of the events the phase originated. Once this determination is made, the phase in question must be removed from all other event hypotheses and this may require that some other event hypothesis be rejected.

Split Events

The large number of phases that are generated by a large seismic event may not all be associated with the event in the automatic association and location process that results in the IEL. Quite often such unassociated phases become "free" and generate spurious so called split events, which frequently have origin times and hypocenters close to those of the large event. The EIDCs should determine when this has happened and reject the split event.

Other spurious Events

Because of the large number of phases reported from the station network, events may sometimes be generated in the automatic association and location process from phases that by chance meet the event formation criteria. EIDCs should use waveform analysis to assist with the identification of such events and reject them.

F.3.3 Improve Event Solutions

Many of the events that are located in the automatic processing are small and are often afflicted with large estimated errors in hypocentral co-ordinates, in particular depth. There are a large number of analysis steps and processing techniques that should be applied to improve the quality of the event location:

Disassociate and Reassociate Phases

Select Among Multiply Associated Phases.

The EIDCS should try to develop automated procedures to correctly associate a phase to one event only.

Verify and Improve Reported Parameter Measurements

Rename Phases

Add Phases

Search for and identify depth phases to assist in event definition.

Search for and identify secondary phases, e.g. PP and PcP, which could help confirm an event solution.

Resolve possible Interference of Surface Waves

Characterize arrivals by correlation with data from reference events.

F.3.4 Form Additional Events

Many events are reported by NDCs but are not included in the IELs. These NDC event hypotheses are obvious starting points in the search for additional events and waveform analysis would aim at associating additional observations.

Phases that could be available to generate additional events may be obtained from phases of events that are rejected (see Section F.3.2 above), from additional phases added by EIDCs and from the review of unassociated phases.

F.3.5 Review Unassociated Phases

The analysis of unassociated arrivals should aim at characterizing the signals so that as much as possible can be said about their origin, even if no hypocenter estimate can be obtained.

F.4 Required Analysis Techniques

The EIDCs should be able to display waveforms and perform standard signal processing (bandpass filtering, deconvolution, and cross-correlation). Information regarding reported or expected secondary phases should be available. The EIDCs should also be able to repeat the waveform processing done at the NDCs.

EIDC PROCEDURES: COMPILATION OF THE FINAL EVENT BULLETIN
(Excerpt from Appendix J, CRP 190/Rev 4, 1990)

This appendix describes the procedures for compilation of the Final Event Bulletin (FEB). The FEB is compiled automatically from the final CELs reported by all four of the EIDCs. The final CELs are merged so that identical or similar event solutions are represented only once in the FEB, which thus will contain a list of "unique" seismic events. Supporting station parameter data are also listed for each such "unique" event.

J.1 Definitions

An event group contains all event solutions from the final CELs whose location and origin time are within 3 degrees and 60 seconds, respectively, of the location and origin time of one other event in the group. Also, if there is an event that does not meet the distance and time requirements but that has two or more defining phases in common with another event, then this event should be put into a common event group, unless the originating EIDC insists that it be reported separately.

A representative event is the event solution chosen to represent an event group in the FEB.

J.2 Criterion for Choosing Representative Event

One EIDC solution is chosen to be representative of each event group. If there are five or more defining observations:

> the representative solution is the one with the maximum number of defining observations.
>
> if two or more solutions have an equal number of defining observations, the next selection criterion is the solution with the maximum number of defining time observations.
>
> if two or more solutions have an equal number of defining time observations, the next selection criteria is the solution with the smallest sum of the squares of the residuals for the defining time observations.

If there are fewer than five defining observations:

> the representative solution is the one which contains the defining observation with the smallest station-to-event distance.

The event parameters for the representative solution are presented in the FEB. In addition event parameters are given for non-representative solutions of an event group, if any, as comments (see example) following the presentation of the event parameters of the representative solution. A maximum of one additional comment line must be presented for each EIDC CEL solution if it exists.

All phases and only those phases associated with the representative event are listed with the event.

J.3 Listing of Unassociated Phases

The list of unassociated phases should include all phases that are not listed as defining or associated with an event. If a phase is within 3 seconds of a retimed phase from the same station that is associated with a representative event, then the phase is considered to be the same as the associated one and thus is excluded from the unassociated phase list. The unassociated data are listed in two sections. The first section contains locations provided by NDCs via a FOCUS line, together with their corresponding phases. The second section contains all other unassociated data. (See Appendix D, Section D.3.4.2.)

J.4 Format for an Abbreviated Final Event Bulletin

A message format to be used for an abbreviated final event bulletin is defined here.

This message contains only seismic event source parameters (origin time, hypocenters, magnitudes etc.) and no lists of associated and unassociated station parameter reports.

All EIDC events are grouped together according to the procedures for the complete final event bulletin.

This abbreviated FEB would provide participants, in summary form, with a complete list of all seismic events reported by the EIDCs in one short message.

It would also serve to provide a convenient overview of differences and similarities in EIDC seismic event solutions.

J.4.1 Header Identification

This message uses the header identification XB02 in the message header.

J.4.2 Structure of Data Section

The data section of the message consists of a listing of event groups.

J.4.3 Format

The format of the abbreviated bulletin will be identical to the event sections (Appendix D, Section D.3.4.1) of the FEB.

File Name: CONTENTS.DOC

CONTENTS OF THE GSETT-2 CD-ROMS

February 1992

This file describes both the physical directory (or folder) structure of the
GSETT-2 CD-ROMs, and the contents of each directory.

1.0 BRIEF OVERVIEW OF CONTENTS

Given below is a schematic represenation of the directory hierarchy and a very
brief explanation of contents of each directory. Greater details about the
contents are given in subsequent sections.

1.1 Directory Hierarchy

```
                             GSETT
     _________________________|_________________________________
    |               |                       |                   |
   1991 (Year)     DOC                    README            STATIONS
  __|_____ _____ _____ ____                       __________|___
 |    |||   |          |              |           |
112        119        153 (Day of Year)          STAPARM       RESPONSE
       |                          -----------   ----------
   ________|_________________________               AFFILIATION    NRA0_SP.1
   |            |         |           |             INSTRUMENT     GBA_SP.1
NDCPARM      NDCWAVE   WASCEL      GSEBULL          NETWORK       .
-----------  --------  ----------- ---------        SENSOR        .
ARRIVAL.119  100000.w  ARRIVAL.119 FEB.119            SITE            .
REMARK.119   100005.w  ASSOC.119   WASIEL.119       SITEAUX        STA_PD.n
STASSOC.119     .      ORIGIN.119  STOIEL.119         SITECHAN
STAOUT.119      .      ORIGERR.119 MOSIEL.119
WFDISC.119   nnnnnn.w  NETMAG.119  CNBIEL.119
                       REMARK.119  WASCEL.119
                       STAMAG.119  STOCEL.119
                       STASSOC.119 MOSCEL.119
                                   CNBCEL.119
```

1.2 Brief Explanation of Directories and Contents

GSETT: Top Level of CD-ROM

1991: Data that varies by data day STATIONS: Data about the specific
Data Day (Represented below as DD#) stations

```
   GSEBULL: Summary Bulletins           STAPARM: Tables describing the
    Final Event Bulletin, First & Last CEL   station & sensor parameters
    from each IDC as compiled during           AFFILTN Network station
    GSETT-2                            affiliations
                                 INSTRMNT  Default calibration
   NDCPARM:  Best,most recent parameters      info about a station
       provided by NDCs                 NETWORK     Description and
    ARRIVAL.DD#  station detections           identification of network
    REMARK.DD#   NDC comments           SENSOR    Specific calibration
    STASSOC.DD#  station associations         info for physical channels
    STAOUT.DD#   station outages        SITE        Station location
info
    WFDISC.DD#   waveform parameters           SITEAUX     Auxiliary site
                                  dependent info
    NDCWAVE:    Digital waveforms recorded
     SITECHAN    Station-channel info by sensors
     nnnnnnn.w  File containing several      waveforms
     RESPONSE: Instrument response data files
    WASCEL: Parameters from WASIDC analysis   STA_PD.n  File containing
     ARRIVAL.DD#  WAS IDC detections         instrument response.
     ASSOC.DD#    WAS IDC associations       See below for information
     ORIGIN.DD#   WAS IDC origins       on file names.
     ORIGERR.DD#  Errors in origin estimation
     NETMAG.DD#   Network magnitude
     REMARK.DD#   Analyst comments
     STAMAG.DD#   Station magnitude
     STASSOC.DD#  station associations

README: Short introduction to the CD-ROMs
DOC:    Text Files containing information about the Experimentand the Data
  GSEINTRO.DOC: Overview of GSETT-2
  HARDWARE.DOC: Hardware issues and details
  CONTENTS.DOC: Directory/folder hierarcy of the CD-ROMs
  FORMAT.DOC:   Formats of the files on the CD-ROMs.
  PROBLEMS.DOC: Known and suspected data problems
  CONTACTS.DOC: Names and contact information for the GSE data centers.
  COMMENTS.DOC: Form for reporting any problems or comments.
```

1.3 Detailed Explanation of Directories and Contents

GSETT: Top level directory. The only file present is README, which provides an introduction to the disks.

DOC: Contains extensive explanations of the rationale of the experiment, the formats of the files used on the disks, details of inconsistencies or problems with the data, and supplementary information. Due to the length restriction on file names, the "AFFILIATION" table is in the file AFFILTN and the "INSTRUMENT" table is in the file INSTRMNT.

STATIONS/STAPARM: Holds descriptive information about the stations that participated in the test. All data is in Center table format as explained in the FORMAT.DOC text file.

STATIONS/RESPONSE: Contains the calibration information for the stations that participated in the test. The files are constructed of the name of the station (eg "NRA0"), an underscore, "_", the frequency band represented (eg "SP"), a period, ".", and the number of the generation of the data. The initial response is provided as generation 1 so an example file name would be NRA0_SP.1 . One response is contained in each file with the exception of YKR2_SP.1, since CAN provided both poles and zeros and fir information. For details on the format of these files, please see section 4 of the FORMAT.DOC text file.

1991: Below here are directories for each Data Day of the experiment. The structure of each day is the same.

1991/DD#/GSEBULL: Contains the Final Event Bulletin (FEB) and the Initial and last Current Event Lists (IEL & CEL) for each EIDC for the Data Day. For information on the format and the criteria used for these files, please consult Section 6 of the FORMAT.DOC text file.

1991/DD#/NDCWAVE: All of the waveforms received from the NDCs for this Data Day are in this directory. They are separated into files by station and the name of the file is composed of the waveform id of the first waveform in the file, a period, ".", and the capital letter "W". For more information on the layout of the waveform files, consult Section 3 of the FORMAT.DOC text file.

1991/DD#/NDCPARM: These are the parameters reported by the NDCs to the EIDCs for the Data Day. Any corrections or additional data provided by the NDCs after the conclusion of EIDC analysis will be present. See Section B of the next Item for more information on the impact of this.

1991/DD#/WASCEL: Here are the parameters compiled by the analysts at the Washington EIDC based on the data that was available during the test. Please examine Section 2.0 below and the GSEINTRO.DOC file for clarification on the criteria followed during analysis.

2.0 RATIONALE FOR THE COMPILATION OF THE GSETT-2 CD-ROMS

The data contained on these CD-ROMs were chosen based on two objectives:

1. To accurately reflect the performance and experiences of GSETT-2 so the GSE can rigorously evaluate the test, and provide recommendations on future systems for global seismic data exchange.

2. To provide a database of the best seismic parameter and waveform data to the seismological community for use in basic and applied research.

The file GSEINTRO.DOC contains a summary of the rules under which the GSETT-2 systems were to operate under ideal conditions. However, to understand the slight tension between objectives 1 and 2, one must appreciate that ambitious experiments like GSETT-2 rarely if ever operate under ideal conditions. Hardware and software problems, communication outages, misunderstanding of the rules, and the demanding schedules under which all data centers worked all contribute to a dataset that is less than perfect at the time of the experiment. During and subsequent to the experiment, the data centers had the opportunity to reconcile their databases (i.e., make sure that all messages sent were received by all intended data centers) and to report and/or correct known problems in their data. In many cases, new, corrected data were sent and/or received long past the associated deadline. In these cases, the corrected data are most likely the "best" data, however, they do not correctly represent the data that available within the time schedules of GSETT-2.

In an effort to satisfy both objectives on these CD-ROMs, we have followed these principles:

A. Data Source: The contents of the CD-ROMs reflect the contents of the Washington EIDC database, though every effort was made to assure that our database is identical to those at the other three EIDCs and that it contains representatives of all data sent during the full-scale GSETT-2.

B. "Best" Data: The CD-ROMs contain what we believe to be the "best" parameter and waveform data reported by each NDC. These are in the directories named "NDCPARM", "NDCWAVE", and "STATIONS". This was compiled after GSETT-2 by taking the representation for a given datum most recently sent by the NDC (example: if two P phases from a given station and at a given time differ only in amplitude, it is assumed that the last phase received was the corrected and, hopefully, the best phase). The only exceptions to this were if an NDC specifically instructed us to do otherwise. These data are provided in Center for Seismic Studies Version 3.0 database format (CSS V3.0), which is a "computer friendly" format familiar to many in the seismological community and used by several of the participating data centers.

C. GSETT-2 Snapshot: The CD-ROMs contain a snapshot of the parameter database as it existed during GSETT-2. We provide the seismic event lists and bulletins (IELs, CELs, and FEBs) compiled by all four EIDC during the test in GSE XB01 (bulletin) format in the directories named "GSEBULL". We also provide the complete set of CSS V3.0 tables upon which the Washington EIDC's CELs were based in the directory named "WASCEL".

D. Quality Control: In the "NDCWAVE" and "NDCPARM" directories ("best" data), additional corrections were made to the data when sufficient information existed to indicate a problem and specify a solution. If at all possible, the source of the corrected data or of the specific instructions for correcting the data was the NDC reponsible for furnishing the data in the first place. Where we had strong indications that there might be a problem and we were confident of the solution, every effort was made to confirm our solution with the responsible NDC. Much attention was focussed on assuring that the amplitude parameters (in the CSS V3.0 arrival files) and the waveform amplitude calibrations (in the CSS V3.0 wfdisc files) are correct. Much attention was also focussed on assuring the the instrument responses in the "RESPONSE" directory are correct. No corrections were made to phase or waveform timing or to other parameters, since no NDC offered accurate specifications for making such corrections. The presence of data provided after the close of the experiment results in the following situation: An arrival in the "WASCEL" directory may also be in the "NDCPARM" directory with the same arrival identifier (arid) but with corrected information provided by the NDC after the end of the experiment.

E. Data Differentiation: Since the "WASCEL" directory can contain data that arrived before the end of the test but too late for use within the test schedule, the "author" field in the "ARRIVAL.DD#" file can be used to determine when an arrival was received by the Washington EIDC. This field is composed of the name of the reporting NDC and the classification into which the data is grouped. For example, an arrival from the NDC that was received by midnight GMT on the day after the Data Day (Day 1) is considered to be on time by the rules of GSETT and can be included into the Initial Event List (IEL) for that Data Day. The author field for this arrival is NDC/IEL. The second category was when an arrival was received after midnight on Day 1, but before the end of analysis for the Data Day. For the CD-ROM's, this means that the data was received at the Washington EIDC before midnight on Day 5. Since this data could be included into the final Current Event List (CEL) for the Data Day, the author would be NDC/CEL. Any data that arrived after this time was not included in the analysis or the bulletins and therefore would have the author specified as NDC/POST-CEL. This last classification includes data received both during the remainder of the text and the period from the end of the experiment to the date of compilation of GSETT-2 CD-ROMs.

The data in the "GSEBULL" and "WASCEL" directories are as they existed during the test. No subsequent corrections have been applied.

All reported and suspected data problems, and corrections applied by the Washington EIDC have been cataloged in the PROBLEMS.DOC file in this directory. Please report any additional confirmed or suspected problems to the Washington EIDC at the address given below, and to the associated NDC or EIDC.

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File Name FORMAT.DOC

FORMATS OF FILES USED ON CD-ROMS

January 1992

TABLE OF CONTENTS

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1 DOCUMENT INTRODUCTION

This volume describes the schema of the Version 3.0 database, the standard for data and software at the Center for Seismic Studies. This schema is used for the parameter data provided on these CD-ROM's. Detailed descriptions of the database structure, relations, and attributes appear in chapters 2, 3 and 4. Descriptions are also provided for the waveform and inst- rument files. A pointer to the geographic/seismic region designations used for this experiment is included. The explanation of the format used for the GSETT bulletins present in the "GSEBULL" directories is included.

---

2 DATABASE DESCRIPTION

2.1. INTRODUCTION

There are many relations in the core of Version 3.0. These are separated into "Primary" and "Lookup" relations. The Primary relations are dynamic and contain attributes used in automated and interactive processing (e.g., seismic arrivals, event locations). The Lookup tables change infrequently and are used for auxiliary information used by the processing (e.g., station locations). In general terms, the information stored in the core relations includes:

- arrivals (seismic signals)
- events, origins, association of arrivals
- magnitude information
- station information (networks, site descriptions, instrument responses)
- pointers to disk files storing waveform data
- attributes describing the contents of the dynamic relations
- administrative data (counters, seismic and geo-graphic regions)

2.2 DATABASE STRUCTURE

This chapter defines the physical structure of each table, as it exists within the ORACLE data dictionary and as it can exist as a flat file. The name of the relation appears in bold print at the top. Key attributes are shown first, convenience attributes next, followed by data fields. This hierarchy is described in the introduction to Chapter 3. Formats for "external" files specify fixed field widths and precisions in the style of FORTRAN. Exactly one blank separates fields in these files. This improves readability and makes it easier for C programs to scan the records. All numeric entries are right justified and all character strings are left justified. Having the field number quickly accessible is useful when dealing with flat files (e.g. awk and shell scripts).

Relation: affiliation
Description: Network station affiliations

attribute	field	storage	external	character	attribute
net	1	c8	a8	1-8	unique network identifier
sta	2	c6	a6	10-15	station identifier
lddate	3	date	a17	17-33	load date

Relation: arrival

attribute name	field no.	storage type	external format	character positions	attribute description
sta	1	c6	a6	1-6	station code
time	2	f8	f17.5	8-24	epoch time
arid	3	i4	i8	26-33	arrival id
jdate	4	i4	i8	35-42	julian date
stassid	5	i4	i8	44-51	stassoc id
chanid	6	i4	i8	53-60	instrument id
chan	7	c8	a8	62-69	channel code
iphase	8	c8	a8	71-78	reported phase
stype	9	c1	a1	80-80	signal type
deltim	10	f4	f6.3	82-87	delta time
azimuth	11	f4	f7.2	89-95	observed azimuth
delaz	12	f4	f7.2	97-103	delta azimuth
slow	13	f4	f7.2	105-111	observed slowness (s/deg)
delslo	14	f4	f7.2	113-119	delta slowness
ema	15	f4	f7.2	121-127	emergence angle
rect	16	f4	f7.3	129-135	rectilinearity
amp	17	f4	f10.1	137-146	amplitude, instrument corrected, nm
per	18	f4	f7.2	148-154	period
logat	19	f4	f7.2	156-162	log(amp/per)
clip	20	c1	a1	164-164	clipped flag
fm	21	c2	a2	166-167	first motion
snr	22	f4	f10.2	169-178	signal to noise ratio
qual	23	c1	a1	180-180	signal onset quality
auth	24	c15	a15	182-196	source/originator
commid	25	i4	i8	198-205	comment id

Relation: assoc

attribute name	field no.	storage type	external format	character positions	attribute description
arid	1	i4	i8	1-8	arrival id
orid	2	i4	i8	10-17	origin id
sta	3	c6	a6	19-24	station code
phase	4	c8	a8	26-33	associated phase
belief	5	f4	f4.2	35-38	phase confidence
delta	6	f4	f8.3	40-47	station to event distance
seaz	7	f4	f7.2	49-55	station to event azimuth
esaz	8	f4	f7.2	57-63	event to station azimuth
timeres	9	f4	f8.3	65-72	time residual
timedef	10	c1	a1	74-74	time = defining,

attribute name	field no.	storage type	external format	character positions	attribute description
					non-defining
azres	11	f4	f7.1	76-82	azimuth residual
azdef	12	c1	a1	84-84	azimuth = defining, non-defining
slores	13	f4	f7.2	86-92	slowness residual
slodef	14	c1	a1	94-94	slowness = defining, non-defining
emares	15	f4	f7.1	96-102	incidence angle residual
wgt	16	f4	f6.3	104-109	location weight
vmodel	17	c15	a15	111-125	velocity model
commid	18	i4	i8	127-134	comment id

Relation: instrument

attribute name	field no.	storage type	external format	character positions	attribute description
inid	1	i4	i8	1-8	instrument id
insname	2	c50	a50	10-59	instrument name
instype	3	c6	a6	61-66	instrument type
band	4	c1	a1	68-68	frequency band
digital	5	c1	a1	70-70	(d,a) analog
samprate	6	f4	f11.7	72-82	sampling rate in samples/second
ncalib	7	f4	f16.6	84-99	nominal calibration
ncalper	8	f4	f16.6	101-116	nominal calibration period
dir	9	c64	a64	118-181	directory
dfile	10	c32	a32	183-214	data file
rsptype	11	c6	a6	216-221	response type

Relation: netmag

attribute name	field no.	storage type	external format	character positions	attribute description
magid	1	i4	i8	1-8	network magnitude identifier
net	2	c8	a8	10-17	unique network identifier
orid	3	i4	i8	19-26	origin id
evid	4	i4	i8	28-35	event id
magtype	5	c6	a6	37-42	magnitude type (ml,sms, mb, etc.)
nsta	6	i4	i8	44-51	number of stations used
magnitude	7	f4	f7.2	53-59	magnitude
uncertanty	8	f4	f7.2	61-67	magnitude uncertainty
auth	9	c15	a15	69-83	source/originator
commid	10	i4	i8	85-92	comment id

Relation:	network				
attribute name	field no.	storage type	external format	character positions	attribute description
net	1	c8	a8	1-8	unique network identifier
netname	2	c80	a80	10-89	network name
nettype	3	c4	a4	91-94	network type, array, local, world-wide, etc.
auth	4	c15	a15	96-110	source/originator
commid	5	i4	i8	112-119	comment id

Relation:	origerr				
attribute name	field no.	storage type	external format	character positions	attribute description
orid	1	i4	i8	1-8	origin id
sxx	2	f4	f15.4	10-24	covariance matrix element
syy	3	f4	f15.4	26-40	covariance matrix element
szz	4	f4	f15.4	42-56	covariance matrix element
stt	5	f4	f15.4	58-72	covariance matrix element
sxy	6	f4	f15.4	74-88	covariance matrix element
sxz	7	f4	f15.4	90-104	covariance matrix element
syz	8	f4	f15.4	106-120	covariance matrix element
stx	9	f4	f15.4	122-136	covariance matrix element
sty	10	f4	f15.4	138-152	covariance matrix element
stz	11	f4	f15.4	154-168	covariance matrix element
sdobs	12	f4	f9.4	170-178	std err of obs
smajax	13	f4	f9.4	180-188	semi-major axis of error
sminax	14	f4	f9.4	190-198	semi-minor axis of error
strike	15	f4	f6.2	200-205	strike of the semi-major axis
sdepth	16	f4	f9.4	207-215	depth error
stime	17	f4	f8.2	217-224	origin time error
conf	18	f4	f5.3	226-230	confidence

commid	19	i4	i8	232-239	comment id

Relation: origin

attribute name	field no.	storage type	external format	character positions	attribute description
lat	1	f4	f9.4	1-9	estimated latitude
lon	2	f4	f9.4	11-19	estimated longitude
depth	3	f4	f9.4	21-29	estimated depth
time	4	f8	f17.5	31-47	epoch time
orid	5	i4	i8	49-56	origin id
evid	6	i4	i8	58-65	event id
jdate	7	i4	i8	67-74	julian date
nass	8	i4	i4	76-79	number of associated phases
ndef	9	i4	i4	81-84	number of locating phases
ndp	10	i4	i4	86-89	number of depth phases
grn	11	i4	i8	91-98	geographic region number
srn	12	i4	i8	100-107	seismic region number
etype	13	c7	a7	109-115	event type
depdp	14	f4	f9.4	117-125	estimated depth from depth phases
dtype	15	c1	a1	127-127	depth method used
mb	16	f4	f7.2	129-135	body wave magnitude
mbid	17	i4	i8	137-144	mb magid
ms	18	f4	f7.2	146-152	surface wave magnitude
msid	19	i4	i8	154-161	ms magid
ml	20	f4	f7.2	163-169	local magnitude
mlid	21	i4	i8	171-178	ml magid
algorithm	22	c15	a15	180-194	location algorithm used
auth	23	c15	a15	196-210	source/originator
commid	24	i4	i8	212-219	comment id

Relation: remark

attribute name	field no.	storage type	external format	character positions	attribute description
commid	1	i4	i8	1-8	comment id
lineno	2	i4	i8	10-17	comment line number
remark	3	c80	a80	19-98	free format comment

Relation: sensor

attribute name	field no.	storage type	external format	character positions	attribute description
sta	1	c6	a6	1-6	station code
chan	2	c8	a8	8-15	channel code
time	3	f8	f17.5	17-33	epoch time of start of recording period
endtime	4	f8	f17.5	35-51	epoch time of end of recording period
inid	5	i4	i8	53-60	instrument id
chanid	6	i4	i8	62-69	channel id
jdate	7	i4	i8	71-78	julian date
calratio	8	f4	f16.6	80-95	calibration
calper	9	f4	f16.6	97-112	calibration period
tshift	10	f4	f6.2	114-119	correction of data processing time
instant	11	c1	a1	121-121	(y,n) discrete/ continuing snapshot

Relation: site

attribute name	field no.	storage type	external format	character positions	attribute description
sta	1	c6	a6	1-6	station identifier
ondate	2	i4	i8	8-15	Julian start date
offdate	3	i4	i8	17-24	Julian off date
lat	4	f4	f9.4	26-34	latitude
lon	5	f4	f9.4	36-44	longitude
elev	6	f4	f9.4	46-54	elevation
staname	7	c50	a50	56-105	station description
statype	8	c4	a4	107-110	station type: single station, virt. array, etc.
refsta	9	c6	a6	112-117	reference station for array members
dnorth	10	f4	f9.4	119-127	offset from array reference (km)
deast	11	f4	f9.4	129-137	offset from array reference (km)

Relation: siteaux

attribute name	field no.	storage type	external format	character positions	attribute description

sta	1	c6	a6	1-6	station code
chan	2	c8	a8	8-15	channel
time	3	f8	f17.5	17-33	epoch time
nois	4	f4	f10.1	35-44	noise
noissd	5	f4	f5.2	46-50	noise standard deviation
amcor	6	f4	f10.1	52-61	amplitude correction
amcorsd	7	f4	f5.2	63-67	correction standard deviation
snthrsh	8	f4	f5.2	69-73	signal/noise detection threshold
rely	9	f4	f5.2	75-79	station reliability
ptmcor	10	f4	f6.3	81-86	P arrival time correction
stmcor	11	f4	f6.3	88-93	S arrival time correction
staper	12	f4	f5.2	95-99	period for measurements
auth	13	c15	a15	101-115	author
commid	14	i4	i8	117-124	comment id

Relation: sitechan

attribute name	field no.	storage type	external format	character positions	attribute description
sta	1	c6	a6	1-6	station identifier
chan	2	c8	a8	8-15	channel identifier
ondate	3	i4	i8	17-24	Julian start date
chanid	4	i4	i8	26-33	channel id
offdate	5	i4	i8	35-42	Julian off date
ctype	6	c4	a4	44-47	channel type
edepth	7	f4	f9.4	49-57	emplacement depth
hang	8	f4	f6.1	59-64	horizontal angle
vang	9	f4	f6.1	66-71	vertical angle
descrip	10	c50	a50	73-122	channel description

Relation: stamag

attribute name	field no.	storage type	external format	character positions	attribute description
magid	1	i4	i8	1-8	magnitude id
sta	2	c6	a6	10-15	station code
arid	3	i4	i8	17-24	arrival id
orid	4	i4	i8	26-33	origin id
evid	5	i4	i8	35-42	event id
phase	6	c8	a8	44-51	associated phase
magtype	7	c6	a6	53-58	magnitude type (ml, ms, mb, etc.)
magnitude	8	f4	f7.2	60-66	magnitude
uncertainty	9	f4	f7.2	68-74	magnitude uncertainty
auth	10	c15	a15	76-90	source/originator
commid	11	i4	i8	92-99	comment id

Relation: staout

Attribute Name	Field No.	storage type	external format	character positions	attribute description
sta	1	c6	a6	1-6	Station code
chan	2	c8	a8	8-15	Channel code
jdate	3	i4	i8	17-24	Day, Julian date
stime	4	f8	f15.3	26-40	Stop time, epochal time
btime	5	f8	f15.3	42-56	Start time, epochal time
msgid	6	i4	i8	58-65	Message id

Relation: stassoc

attribute name	field no.	storage type	external format	character positions	attribute description
stassid	1	i4	i8	1-8	stassoc id
sta	2	c6	a6	10-15	station code
etype	3	c7	a7	17-23	event type
location	4	c32	a32	25-56	apparent location description
dist	5	f4	f7.2	58-64	estimated distance
azimuth	6	f4	f7.2	66-72	observed azimuth
lat	7	f4	f9.4	74-82	estimated latitude
lon	8	f4	f9.4	84-92	estimated longitude
depth	9	f4	f9.4	94-102	estimated depth
time	10	f8	f17.5	104-120	estimated origin time
imb	11	f4	f7.2	122-128	initial estimated mb
ims	12	f4	f7.2	130-136	initial estimated ms
iml	13	f4	f7.2	138-144	initial estimated ml
auth	14	c15	a15	146-160	source/originator
commid	15	i4	i8	162-169	comment id

Relation: wfdisc

attribute name	field no.	storage type	external format	character positions	attribute description
sta	1	c6	a6	1-6	station
chan	2	c8	a8	8-15	channel
time	3	f8	f17.5	17-33	epoch time of first sample in file
wfid	4	i4	i8	35-42	waveform id
chanid	5	i4	i8	44-51	channel operation id
jdate	6	i4	i8	53-60	julian date
endtime	7	f8	f17.5	62-78	time+(nsamp-1)/ samprate

nsamp	8	i4	i8	80-87	number of samples
samprate	9	f4	f11.7	89-99	sampling rate in samples/sec
calib	10	f4	f16.6	101-116	nominal calibration
calper	11	f4	f16.6	118-133	nominal calibration period
instype	12	c6	a6	135-140	instrument code
segtype	13	c1	a1	142-142	indexing method
datatype	14	c2	a2	144-145	numeric storage
clip	15	c1	a1	147-147	clipped flag
dir	16	c64	a64	149-212	directory
dfile	17	c32	a32	214-245	data file
foff	18	i4	i10	247-256	byte offset
commid	19	i4	i8	258-265	comment id

2.3 DATABASE RELATIONS

This chapter describes the ORACLE relations that comprise the Version 3.0 Schema. The information given here, along with that in Chapter 4, Database Attributes, constitutes the data dictionary. There is an entry for each relation. Within the entry, the relation's name appears first, followed by a list of its attributes. A brief description completes the entry. The attributes of the relation are arranged in the following order: Keys, Convenience, Data. Key attributes link relations. Convenience attributes are redundant data whose real home is another relation, but are included in this table for the sake of convenience. Data attributes, the reason this table exists, are split into three categories: Descriptive, Measurement and Administrative. The following tableau explains the format used in the entries.

Name: This is the name of the relation.

Keys: Primary. These are the attributes which, taken together, uniquely identify a row in the table.

Alternate. These are other attributes which also uniquely identify a row and may be used as primary keys.

Foreign. These attributes are primary keys in another table.

Convenience: Attributes in this class, if any, are data-attributes in another table.

Data: Descriptive. Qualitative attributes are listed under this heading.

Measurement. This class contains a list of quantitative attributes.

Administrative. This class lists attributes used for database administration.

Description: This paragraph describes the relation.

Keys provide the links by which tables are joined. The following definitions explain the several types of keys.

A primary key (which often is the concatenation of several attributes) uniquely identifies a row in the table. For example, each origin record is unique by lat, lon, depth, and time.

An alternate key also uniquely identifies a row in the table and may be used as the primary key. For example, orid may also be used as the primary key for the origin table.

A foreign key is another table's primary key. Thus, evid is a foreign key in the origin table, but is the primary key in the event table. Similarly, commid is a foreign key in many of the tables and the primary key in remark.

Name: affiliation

Keys: Primary. net, sta
Data: Administrative. lddate

Description: Network-Station affiliations. This is an intermediate relation by which seismic stations may be clustered into networks.

Name: arrival

Keys: Primary. sta, time
Alternate. arid
Foreign. stassid, chanid, commid
Convenience: jdate

Data: Descriptive. chan, iphase, stype
Measurement. deltim, azimuth, delaz, slow, delslo, ema, rect, amp, per, logat, clip, fm, qual
Administrative. auth, lddate
Description: Summary information on a seismic arrival. Information characterizing a "seismic phase" observed at a particular station is saved here. Many of the attributes conform to seismological convention and are listed in earthquake catalogs.

Name: assoc

Keys: Primary. arid, orid

Foreign. commid
Convenience: sta

Data: Descriptive.phase, belief
Measurement. delta, seaz, esaz, timeres, timedef, azres, azdef, slores, slodef, emares, wgt
Administrative. vmodel, lddate

Description: Data associating arrivals with origins. This table has information that connects arrivals (i.e., entries in the arrival relation) to a particular origin. It has a composite key made of arid and orid. There are two kinds of measurement data: three attributes are related to the station (delta, seaz, esaz), and the remaining measurement attributes are jointly determined by the measurements made on the seismic wave (arrival), and the inferred event's origin (origin). The attribute sta is intentionally duplicated in this table to eliminate the need for a join with arrival when doing a lookup on station.

Name: instrument

Keys: Primary. inid
Data: Descriptive.insname, instype, band, digital, dir, dfile, rsptype
Measurement. samprate, ncalib, ncalper
Administrative. lddate

Description: Ancillary calibration information. This table serves three purposes. It holds nominal one-frequency calibration factors for each instrument. It holds pointers to the nominal frequency-dependent calibration for an instrument. Finally, it holds pointers to the exact calibrations obtained by direct measurement on a particular instrument. See sensor.

Name: netmag

Keys: Primary. magid
Foreign. evid, net, orid, commid
Data: Descriptive.magtype, nsta
Measurement. magnitude, uncertainty
Administrative. auth, lddate

Description: Network magnitude. This table summarizes estimates of network magnitudes of different types for an event. Each network magnitude has a unique magid. Station magnitudes used to compute the network magnitude are in the relation stamag.

Name: network

Keys: Primary. net

Foreign. commid
Data: Descriptive.netname, nettype
Administrative. auth, lddate

Description: Network description and identification. This relation gives general information about seismic networks. See affiliation.

Name: origerr

Keys: Primary. orid
Foreign. commid
Data: Descriptive.sdobs, smajax, sminax, strike, sdepth, stime, conf
Measurement. sxx, syy, szz, stt, sxy, sxz, syz, stx, sty, stz
Administrative. lddate

Description: Summary of confidence bounds in origin estimations. The error estimates associated with the parameters in the origin relation are saved in this table. The measurement attributes are the elements of the location covariance matrix. The descriptive attributes, which are more meaningful, describe the uncertainities in location, depth and origin time. These quantities are calculated from the covariance matrix, assuming gaussian errors and a confidence level conf.

Name: origin

Keys: Primary. lat, lon, depth, time
Alternate. orid
Foreign. evid, commid
Convenience: jdate

Data: Descriptive.nass, ndef, ndp, grn, srn, etype
Measurement. depdp, dtype, mb, mbid, ms, msid, ml, mlid
Administrative. algorithm, auth, lddate

Description: Summary of hypocentral parameters. Information describing a derived or reported origin for a particular event is stored in this table.

Name: remark

Keys: Primary. commid, lineno
Data: Descriptive.remark
Administrative. lddate

Description: Comments. This relation may be used to store free-form comments that embellish records of other relations. The commid field in many relations refers to a tuple in the remark table.

If commid is null (-1) in a tuple of any other relation, there are no comments stored for that tuple.

Name: sensor

Keys: Primary. sta, chan, time, endtime
Foreign. inid
Convenience: chanid, jdate

Data: Descriptive.instant
Measurement. calratio, calper, tshift
Administrative. lddate
Description: Calibration information for specific sensor channels. This table provides a record of updates in the calibration factor or clock error of each instrument, and links a sta/chan/time to a complete instrument response in the relation instrument.
Waveform data are converted into physical units through multiplication by the calib attribute located in wfdisc. It can happen that the correct value of calib is not accurately known when the wfdisc record is entered into the data base. The sensor relation provides the mechanism (calratio and calper) to "update" calib, without requiring that possibly hundreds of wfdisc records be updated.
Through the foreign key inid this table is linked to instrument which has fields pointing to flat files holding detailed calibration information in a variety of formats. See instrument.

Name: site

Keys: Primary. sta, ondate
Data: Descriptive.staname, statype, refsta
Measurement. offdate, lat, lon, elev, dnorth, deast
Administrative. lddate

Description: Station location information. Site names and describes a point on the earth where seismic measurements are made (e.g. the location of a seismic instrument or array). It contains information that normally changes infrequently, such as location. In addition, site contains fields to describe the offset of a station relative to an array reference location. Global data integrity implies that the sta/ondate in site be consistent with the sta/chan/ondate in sitechan.

Name: siteaux

Keys: Primary. sta, chan, time

Foreign. commid
Data: Measurement.nois, noissd, amcor, amcorsd, snthrsh, rely, ptmcor, stmcor, staper
Administrative. auth, lddate

Description: Auxiliary site dependent parameters.

Name: sitechan

Keys: Primary. sta, chan, ondate
Alternate. chanid
Data: Descriptive.offdate, ctype
Measurement. edepth, hang, vang, descrip
Administrative. lddate

Description: Station-Channel information. This relation describes the orientation of a recording channel at the site referenced by sta. This relation provides information about the various channels (e.g. sz, lz, iz) that are available at a station and maintains a record of the physical channel configuration at a site.

Name: stamag

Keys: Primary. magid, sta
Foreign. arid, orid, evid, commid
Data: Descriptive.phase, magtype
Measurement. magnitude, uncertainty
Administrative. auth, lddate

Description: Station magnitude. This table summarizes station magnitude estimates based upon measurements made on specific seismic phases. See netmag.

Name: staout

Keys: Primary. msgid, sta

Description: This table gives the time intervals for station outages. Fields 2-5 correspond to information on line starting with "OUT" of GSE parameter data messages (see page D 38 of Annex D.1 in GSE CRP 190/Rev.4). The external format for field 2, chan is here a8 to allow expressions like SPALL (all short period channels).

Name: stassoc

Keys: Primary. stassid
Foreign. commid
Data: Descriptive.sta, etype, location
Measurement. dist, azimuth, lat, lon,

depth, time, imb, ims, iml
Administrative. auth, lddate

Description: Summary information on groups of related arrivals. This table defines the group of phases seen at a single station from the same event.

Name: wfdisc

Keys: Primary. sta, chan, time
Alternate. wfid
Foreign. chanid, commid
Convenience: jdate, endtime

Data: Descriptive. nsamp, samprate, calib, calper, instype, segtype, datatype, clip, dir, dfile, foff
Administrative. lddate
Description: Waveform header file and descriptive information. This relation provides a pointer (or index) to waveforms stored on disk. The waveforms themselves are stored in ordinary disk files called wfdisc or .w files, containing only a sequence of sample values (usually in binary representation).

2.4 DATABASE ATTRIBUTES

This chapter describes each of the attributes used in the Version 3.0 Schema. Descriptions of the relations are found in Chapter 3, Database Relations. Attributes are presented as follows:

Name: This is the name of the attribute.
Relation: These are the database relations which contain the attribute.

Description: This paragraph describes the attribute.
ORACLE: This identifies the ORACLE data type.

NA Value: This is a value used to indicate that information is not available for this attribute. Many attributes in this schema are optional. The NA value is defined for these attributes and should be used when the actual value is not known. Essential attributes must always be given a value; they are documented as NA Value NOT ALLOWED.
Units: This lists the unit of measurement for the attribute, if applicable.

Range: This is the range of permissible or recommended values for this attribute, if such a range exists. For most strings, the range indicates the recommended values, but is not restricted to those values.

The following conventions are applied throughout.

Dates and Times

The time attribute throughout the database is stored as epochal time, the number of seconds since January 1, 1970. Epochal time has a precision of 1 millisecond. Often time is matched by the more readable attribute, jdate. This so called "Julian date" represents a day in the form, for example, 1981231 where 1981 is the year (YYYY) and 231 is the day of year (DOY).

Units of Measurement

Attribute descriptions also include the unit of measurement, if applicable. Here are some quantities with their corresponding measurement units:

period, time	seconds	calper, time, endtime, etc.
julian date	YYYYDOY	jdate
amplitude	nanometers	Note that long-period measurements are frequently reported in microns so conversion is required.
angular measurements	degrees	delta, azimuth, etc.
depth, errors in location	kilometers	deast, depdp, depth, etc.

NA Values

Whenever possible, explicit ranges are defined for each attribute. This is important for data integrity and prepares us for future database management systems which will perform range checking automatically. When the range consists of some element in a finite set, we use the notation {e1 | e2 | ... | en } where "|" denotes the logical OR operation. No range is documented for attributes whose value may be any floating point number.

Sometimes no information is available for an attribute. In that case, an NA (NOT AVAILABLE) value is assigned. An NA value is outside the range of permissible or recommended values for the attribute. This special NA value alerts users and applications that the desired attribute was not available when the record was created. For example, in the origin relation, the attribute ms, surface wave magnitude, may be unknown for a given record, since it often can't be measured. Then the NA value for magnitudes (-999.0) should be assigned to ms and msid should be set to -1, the NA value for msid. Some attributes are essential to defining a meaningful record and they must be specified; the NA value is not allowed. For example, the attribute time in arrival must be given a value in the valid range, not an NA value.

Another example is magnitude in netmag and stamag. Magnitude must be given a meaningful value for each record, so there is no NA value defined.

Some general guidelines and specific examples of NA values are given in the following table.

Representative	NA
character fields	- (a dash)
non-negative integer numbers	-1
non-negative real numbers	-1.0
negative real numbers	-999.0
conf	0.0
deast, dnorth	0.0
endtime	+9999999999.999
time	-9999999999.999

Format of Character Data

Most character fields are lowercase. The following two lists of attributes define the exceptions:

Uppercase: auth, instype, grname, srname, sta, staname, volname
Mixed Case: phase, iphase, remark

ORACLE Data Types

The Version 3.0 database uses four of the available ORACLE data types:

VARCHAR All character data in the database is defined to be VARCHAR(n) where "n" is the number of characters in the string (not including a null terminator as in C strings).

NUMBER All integer fields in the database are defined to be NUMBER(n) where "n" is the number of digits allowed in the number.

FLOAT ORACLE supports the FLOAT(n) data type where "n" is the number of binary digits. FLOAT allows the approximation of single and double precision floats commonly used in scientific programming. The decimal point may be specified anywhere from the first to the last digit (or not at all). All real numbers in the database are single precision FLOAT(24), except for time and endtime which are double precision FLOAT(53).

DATE The only field in the database which is declared to be the ORACLE DATE data type is the lddate field which stores the day and time a record was inserted into the database.

Name: algorithm

Relation: origin

Description: Location algorithm used. This is a brief textual description of the algorithm used for computing a seismic origin.

ORACLE: VARCHAR(15)

NA Value: - (a dash)

Range: Any string up to 15 characters long

Name: amcor

Relation: siteaux

Description: Amplitude correction.

ORACLE: FLOAT(24)

NA Value: -999.0

Units: Log nanometers

Range: amcor > -999.0

Name: amcorsd

Relation: siteaux

Description: Standard deviation for amplitude correction.

ORACLE: FLOAT(24)

NA Value: -1.0

Units: Log nanometers

Range: amcorsd > 0.0

Name: amp

Relation: arrival

Description: Signal amplitude. This is the zero-to-peak amplitude of the earth's displacement for a seismic phase. Amp is assumed to be corrected for the response of the instrument.

ORACLE: FLOAT(24)

NA Value: -1.0

Units: Nanometers

Range: amp > 0.0

Name: arid

Relations: arrival, assoc, stamag

Description: Arrival identifier. Each arrival is assigned a unique positive integer identifying it with a unique sta, chan and time. This number is used in the assoc relation along with the origin identifier to link arrival and origin.

ORACLE: NUMBER(8)

NA Value: -1 Allowed only in stamag. A valid entry is required for arrival and assoc.

Range: arid > 0

Name: auth

Relations: arrival, netmag, network, origin, siteaux, stamag, stassoc

Description: Author. This records the originator of an arrival (in arrival relation) or origin (in origin relation). Possibilities include externally supplied arrivals identified according to their original source, such as WMO, NEIS, CAN(adian), UK(array), etc. This may also be an identifier of an application generating the attribute, such as an automated interpretation or signal processing program.

ORACLE: VARCHAR(15)

NA Value: - (a dash)

Range: Any string with no more than 15 upper case characters.

Name: azdef

Relation: assoc

Description: Azimuth defining code. This is a one character flag that indicates whether or not the azimuth of a phase was used to determine the event's origin. It is defining (azdef = d) if used to help locate the event or non-defining (azdef = n) if it is not used.

ORACLE: VARCHAR(1)

NA Value: - (a dash)

Range: {d | n}, lower case

Name: azimuth

Relations: arrival, stassoc

Description: Observed azimuth. This is the estimated station-to-event azimuth measured clockwise from north. Azimuth is estimated from f-k or polarization analysis. In stassoc, the value may be an analyst estimate.

ORACLE: FLOAT(24)

NA Value: -1.0

Units: Degrees

Range: 0.0 < azimuth < 360.0

Name: azres

Relation: assoc

Description: Azimuth residual. This is the difference between the measured station-to-event azimuth for an arrival and the true azimuth. The "true" azimuth is the bearing to the inferred event origin.

ORACLE: FLOAT(24)

NA Value: -999.0

Units: Degrees

Range: -180.0 < azres < 180.0

Name: band

Relation: instrument

Description: Frequency band. This is a qualitative indicator of frequency pass-band for an instrument. Values should reflect the response curve rather than just the sample rate. Recommended values are s (short-period), m (mid-period), i (intermediate-period), l (long-period), b (broad-band), h (high frequency, very short-period), and v (very long-period). For a better notion of the instrument characteristics, see the instrument response curve.

ORACLE: VARCHAR(1)

NA Value: - (a dash)

Range: {s | m | i | l | b | h | v}, lower case.

Name: belief

Relation: assoc

Description: Phase identification confidence level. This is a qualitative estimate of the confidence that a seismic phase is correctly identified.

ORACLE: FLOAT(24)

NA Value: -1.0

Range: 0.0 < belief < 1.0

Name: calib

Relation: wfdisc

Description: Calibration factor. This is the conversion factor that maps digital data to earth displacement. The factor holds true at the oscillation period specified by the attribute calper. A positive value means ground motion increasing in component direction (up, north, east) is indicated by increasing counts. A negative value means the opposite. Calib generally reflects the best calibration information available at the time of recording, but refinement may be given in sensor reflecting a subsequent recalibration of the instrument. See calratio.

ORACLE: FLOAT(24)

NA Value: NOT ALLOWED. A valid entry is required.

Units: Nanometers/digital count

Range: Any non-zero floating point number.

Name: calper

Relations: sensor, wfdisc

Description: Calibration period. This gives the period for which calib, ncalib and calratio are valid.

ORACLE: FLOAT(24)

NA Value: NOT ALLOWED. A valid entry is required.

Units: Seconds

Range: calper > 0.0

Name: calratio

Relation: sensor

Description: Calibration conversion ratio. This is a dimensionless calibration correction factor which permits small refinements to the calibration correction made using calib and calper from the wfdisc relation. Often, the wfdisc calib contains the nominal calibration assumed at the time of data recording. If the instrument is recalibrated, calratio provides a mechanism to update calibrations from wfdisc with the new information without modifying the wfdisc relation. A positive value means ground motion increasing in component direction (up, north, east) is indicated by increasing counts. A negative value means the opposite. Calratio is meant to reflect the most accurate calibration information for the time period for which the sensor record is appropriate, but the nominal value may appear until other information is available.

ORACLE: FLOAT(24)

NA Value: NOT ALLOWED. A valid entry is required.

Range: Any non-zero floating quantity.

Name: chan

Relations: arrival, sensor, siteaux, sitechan, wfdisc

Description: Channel identifier. This is an eight-character code, which, taken together with sta, jdate and time, uniquely identifies the source of the seismic data, including the geographic location, spatial orientation, sensor and subsequent data processing.

ORACLE: VARCHAR(8)

NA Value: "-" (a dash) Allowed only in arrival. A valid entry is required in sensor, sitechan and wfdisc.

Range: Any sequence of up to 8 lower case characters.

Name: chanid

Relations: arrival, sensor, sitechan, wfdisc

Description: Channel recording identifier. This is a surrogate key used to uniquely identify a specific recording. Chanid duplicates the information of the compound key sta, chan, time. As a single identifier it is often convenient. Chanid is very database dependent and is included only for backward compatibility with historical databases. Sta, chan and time is more appropriate to the human interface.

ORACLE: NUMBER(8)

NA Value: -1

Range: chanid > 0

Name: clip

Relations: arrival, wfdisc

Description: Clipped data flag. This is a single-character flag to indicate whether (c) or not (n) the data were clipped. Typically, this flag is derived from status bits supplied with GDSN or RSTN data, but could also be supplied as a result of analyst review.

ORACLE: VARCHAR(1)

NA Value: - (a dash)

Range: {c | n}, lower case

Name: commid

Relations: arrival, assoc, network, netmag, origerr, origin, remark, siteaux, stamag, stassoc, wfdisc

Description: Comment identification. This is a key used to point to free-form comments entered in the remark relation. These comments store additional information about a tuple in another relation. Within the remark relation, there may be many tuples with the same commid and different lineno, but the same commid will appear in only one other tuple among the rest of the relations in the database. See lineno.

ORACLE: NUMBER(8)

NA Value: -1 NOT ALLOWED in remark where a valid entry is required.

Range: commid > 0

Name: conf

Relation: origerr

Description: Error confidence. This attribute denotes the confidence attached to the event attributes smajax, sminax, sdepth and stime.

ORACLE: FLOAT(24)

NA Value: 0.0

Range: 0.0 < conf < 1.0

Name: ctype

Relation: sitechan

Description: Channel type. This attribute specifies the type of data channel: n (normal, a normal instrument response), b (beam, a coherent beam formed with array data), or i (an incoherent beam or energy stack).

ORACLE: VARCHAR(4)

NA Value: - (a dash)

Range: {n | b | i}, lower case

Name: datatype

Relations: wfdisc

Description: Numeric data storage. This attribute specifies the format of a data series in the file system. Datatypes i4, f4 and s4 are typical values. Datatype i4 denotes a 4-byte integer and f4 denotes a 32-bit real number in DEC/VAX format. s4 is an integer where the most significant byte is in the low address position in memory (used by Motorola and Sun chipsets) and is opposite to the order used on DEC and Intel chipsets. Machine dependent formats are supported for common hardwares to allow data transfer in native machine binary formats. ASCII formats have also been defined to retain full precision of any binary data type. ASCII may be used when exchanging data between computer systems with incompatible binary types. See the "wfport" command manual page for information about converting formats. Datatype can only describe single values or arrays of one data type.

ORACLE: VARCHAR(2)

NA Value: - (a dash)

Range: The currently recognized types (lower case is mandatory) are:

datatype value	size (bytes)	description
a0	15	ASCII single precision
b0	24	ASCII double precision
c0	12	ASCII integer
a#	15	ASCII single precision
b#	24	ASCII double precision
c#	12	ASCII integer
t4	4	SUN IEEE single precision real
t8	8	SUN IEEE double precision real
s4	4	SUN IEEE integer
s2	2	SUN IEEE short integer
f4	4	VAX IEEE single precision real
f8	8	VAX IEEE double precision real
i4	4	VAX IEEE integer
i2	2	VAX IEEE short integer

Name: deast

Relation: site

Description: Distance east. This attribute gives the "easting" or relative position of an array element, east of the location of the array center specified by the value of refsta. See dnorth.

ORACLE: FLOAT(24)

NA Value: 0.0

Units: Kilometers

Range: -20,000.0 < deast < 20,000.0

Name: delaz

Relation: arrival

Description: Delta azimuth. This attribute gives the standard deviation of the azimuth of a signal.

ORACLE: FLOAT(24)

NA Value: -1.0

Units: Degrees

Range: delaz > 0.0

Name: delslo

Relation: arrival

Description: Delta slowness. This attribute gives the standard deviation of the slowness of a signal.

ORACLE: FLOAT(24)

NA Value: -1.0

Units: Seconds (of time)/degree

Range: delslo > 0.0

Name: delta

Relation: assoc

Description: Source-receiver distance. This attribute is the arc length, over the earth's surface, of the path the seismic phase follows from source to receiver. The location of the origin is specified in the origin record referenced by the attribute orid. The attribute arid points to the record in the arrival relation that identifies the receiver. The value of the attribute can exceed 180 degrees, it can even exceed 360 degrees. The geographic distance between source and receiver is delta mod(180).

ORACLE: FLOAT(24)

NA Value: -1.0

Units: Degrees

Range: delta > 0.0

Name: deltim

Relation: arrival

Description: Delta time. This attribute gives the standard deviation of a detection time.

ORACLE: FLOAT(24)

NA Value: -1.0

Units: Seconds

Range: deltim > 0.0

Name: depdp

Relation: origin

Description: Depth as estimated from depth phases. This is a measure of event depth estimated from a depth phase or an average of several depth phases. Depth is measured positive in a downwards direction starting from the earth's surface. See ndp.

ORACLE: FLOAT(24)

NA Value: -999.0

Units: Kilometers

Range: 0.0 < depdp < 1000.0

Name: depth

Relations: origin, stassoc

Description: Source depth. This attribute gives the depth of the event origin. In stassoc this may be an analyst estimate.

ORACLE: FLOAT(24)

NA Value: -999.0 origin.

Units: Kilometers

Range: 0.0 < depth < 1000.0

Name: descrip

Relation: sitechan

Description: Channel description. This is a description of the data channel. For non-instrument channels (e.g. beams) this can be the only quantitative description of channel operations in the core tables.

ORACLE: VARCHAR(50)

NA Value: - (a dash)

Range: Any free-format string up to 50 characters

Name: dfile

Relations: instrument, wfdisc

Description: Data file. In wfdisc, this is the file name of a disk-based waveform file. In instrument, this points to an instrument response file. See dir.

ORACLE: VARCHAR(32)

NA Value: NOT ALLOWED. A valid entry is required.

Range: Any free-format string up to 32 characters long

Name: digital

Relation: instrument

Description: Digital/Analog. This attribute is a single character flag denoting whether this instrument record describes an analog or digital recording system.

ORACLE: VARCHAR(1)

NA Value: - (a dash)

Range: {d | a}, lower case

Name: dir

Relations: instrument, wfdisc

Description: Directory. This attribute is the directory-part of a path name. Relative path names or "." (dot), the notation for the current directory, may be used.

ORACLE: VARCHAR(64)

NA Value: NOT ALLOWED. A valid entry is required.

Range: Any string up to 64 characters long

Name: dist

Relation: stassoc

Description: Estimated distance. This attribute gives the approximate source-receiver distance as calculated from slowness (array measurements only), incident angle, or (S-P) times.

ORACLE: FLOAT(24)

NA Value: -1.0

Units: Degrees

Range: 0.0 < dist < 180.0

Name: dnorth

Relation: site

Description: Distance north. This attribute gives the "northing" or relative position of array element north of the array center specified by the value of refsta. See deast.

ORACLE: FLOAT(24)

NA Value: 0.0

Units: Kilometers

Range: -20,000.0 < dnorth < 20,000.0

Name: dtype

Relation: origin

Description: Depth determination flag. This single-character flag indicates the method by which the depth was determined or constrained during the location process. The recommended values are f (free), d (from depth phases), r (restrained by location program) or g (restrained by geophysicist). In cases r or g, either the auth field should indicate the agency or person responsible for this action, or the commid field should point to an explanation in the remark relation.

ORACLE: VARCHAR(1)

NA Value: - (a dash)

Range: {f | d | r | g}, lower case

Name: edepth

Relation: sitechan

Description: Emplacement depth. This attribute gives the depth at which the instrument is positioned, relative to the value of elev in the site relation.

ORACLE: FLOAT(24)

NA Value: NOT ALLOWED. A valid entry is required.

Units: Kilometers

Range: edepth > 0.0

Name: elev

Relations: site

Description: Elevation. This attribute is the elevation of a seismic station relative to mean sea level.

ORACLE: FLOAT(24)

NA Value: -999.0

Units: Kilometers

Range: -10.0 < elev < 10.0

Name: ema

Relation: arrival

Description: Emergence angle. This attribute is the emergence angle of an arrival, as observed at a three-component station or array. The value increases from the vertical direction towards the horizontal.

ORACLE: FLOAT(24)

NA Value: -1.0

Units: Degrees

Range: 0.0 < ema < 90.0

Name: emares

Relation: assoc

Description: Emergence angle residual. This attribute is the difference between an observed emergence angle and the theoretical prediction for the same phase, assuming an event location as specified by the accompanying orid.

ORACLE: FLOAT(24)

NA Value: -999.0

Units: Degrees

Range: -90.0 < emares < 90.0

Name: endtime

Relations: sensor, wfdisc

Description: Time of last datum. In wfdisc, this attribute is the time of the last sample in the waveform file. Endtime is equivalent to time + (nsamp - 1)/samprate. In sensor, this is the last time the data in the record are valid.

ORACLE: FLOAT(53)

NA Value: +9999999999.999

Units: Epochal seconds

Range: endtime > time

Name: esaz

Relation: assoc

Description: Event to station azimuth. This attribute is the calculated event-to-station azimuth, measured in degrees clockwise from North.

ORACLE: FLOAT(24)

NA Value: -999.0

Units: Degrees

Range: 0.0 < esaz < 360.0

Name: etype

Relations: origin, stassoc

Description: Event type. This attribute is used to identify the type of seismic event, when known. For etypes l, r, t the value in origin will be the value determined by the station closest to the event.

ORACLE: VARCHAR(7)

NA Value: - (a dash)

Range: The recommended codes (all lower case) are:

etype code	meaning of code

qb	Quarry blast or mining explosion
eq	Earthquake
me	Marine explosion
ex	Other explosion
o	Other source of known origin
l	Local event of unknown origin
r	Regional event of unknown origin

Name: evid

Relations: netmag, origin, stamag

Description: Event identifier. Each event is assigned a unique positive integer which identifies it in a database. It is possible for several records in the origin relation to have the same evid. This indicates there are several opinions about the location of the event.

ORACLE: NUMBER(8)

NA Value: -1 Allowed in netmag, origin and stamag.

Range: evid > 0

Name: fm

Relation: arrival

Description: First motion. This is a two-character indication of first motion. The first character describes first motion seen on short-period channels and the second holds for long-period instruments. Compression (dilation) on a short-period sensor is denoted by c(d) and compression (dilation) on a long-period sensor is denoted by u(r). Empty character positions will be indicated by dots (e.g., ".r").

ORACLE: VARCHAR(2)

NA Value: - (a dash)

Range: All two-letter permutations of {c | d | . }, {u | r | . }, lower case

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Name: foff

Relation: wfdisc

Description: File offset. This is the byte offset of a waveform segment within a data file. It is used when data are multiplexed. See dir and dfile.

ORACLE: NUMBER(8)

NA Value: NOT ALLOWED. A valid entry is required.

Range: foff > 0

Name: grn

Relation: origin

Description: Geographic region number. This is a geographic region number, as defined by Flinn, Engdahl and Hill (Bull. Seism. Soc. Amer. vol 64, pp. 771-992, 1974). See Section 7 of this document.

ORACLE: NUMBER(4)

NA Value: -1 Allowed in origin.

Range: grn > 0

Name: hang

Relation: sitechan

Description: Horizontal orientation of seismometer. This attribute specifies the orientation of the seismometer in the horizontal plane, measured clockwise from North. For a North-South orientation with the seismometer pointing toward the north, hang=0.; for East-West orientation with the seismometer pointing toward the west, hang=270. See vang.

ORACLE: FLOAT(24)

NA Value: NOT ALLOWED. A valid entry is required.

Units: Degrees

Range: 0.0 < hang < 360.0

Name: imb

Relation: stassoc

Description: Initial body wave magnitude. This is an analyst's estimate of the body wave magnitude using data from a single station. See iml, ims, magnitude, magtype, mb, ml and ms.

ORACLE: FLOAT(24)

NA Value: -999.0

Name: iml

Relation: stassoc

Description: Initial local magnitude. This is an analyst's estimate of the local magnitude using data from a single station. See imb, ims, magnitude, magtype, mb, ml and ms.

ORACLE: FLOAT(24)

NA Value: -999.0

Name: ims

Relation: stassoc

Description: Initial surface wave magnitude. This is an analyst's estimate of surface wave magnitude using data from a single station. See magnitude, magtype, mb, ml, ms, imb and iml.

ORACLE: FLOAT(24)

NA Value: -999.0

Name: inid

Relations: instrument, sensor

Description: Instrument identifier. This is a unique key to the instrument relation. Inid provides the only link between sensor and instrument.

ORACLE: NUMBER(8)

NA Value: -1 Allowed only in sensor. A valid entry is required for instrument.

Range: inid > 0

Name: insname

Relation: instrument

Description: Instrument name. This is a character string containing the name of the instrument.

ORACLE: VARCHAR(50)

NA Value: - (a dash)

Range: Any free-format string up to 50 characters long.

Name: instant

Relation: sensor

Description: Snapshot indicator. When this attribute has the value instant = "y", it means that the snapshot was taken at the time of a discrete procedural change, such as an adjustment of the instrument gain; n means the snapshot is of a continuously changing process, such as calibration drift. This is important for tracking time corrections and calibrations.

ORACLE: VARCHAR(1)

NA Value: NOT ALLOWED. If the value is unknown, default to "y".

Range: {y | n}

Name: instype

Relations: instrument, wfdisc

Description: Instrument type. This character string is used to indicate the instrument type. Some examples are: SRO, ASRO, DWWSSN, LRSM, and S-750.

ORACLE: VARCHAR(6)

NA Value: - (a dash)

Range: Upper case and too numerous to mention, but see "Directory of World Digital Seismic Station", Ganse & Hutt, World Data Center A, Report SE-32, August, 1982.

Name: iphase

Relation: arrival

Description: Reported phase. This eight-character field holds the name initially given to a seismic phase. Standard seismological labels for the types of signals (or phases) are used (e.g., P, PKP, PcP, pP). Both upper and lower case letters are available and should be used when appropriate, for example, pP or PcP. See phase.

ORACLE: VARCHAR(8)

NA Value: - (a dash)

Range: Any string up to 8 characters long which conforms to seismological practice.

Name: jdate

Relations: arrival, origin, sensor, wfdisc

Description: Julian date. This attribute is the date of an arrival, origin, seismic recording, etc. The same information is available in epoch time, but the Julian date format is more convenient for many types of searches. Dates B.C. are negative. Note: there is no year = 0000 or day = 000. Where only the year is known, day of year = 001; where only year and month are known, day of year = first day of month. Note: only the year is negated for BC, so Jan 1 of 10 BC is -0010001. See time.

ORACLE: NUMBER(8)

NA Value: -1

Range: Julian dates of the form yyyyddd. Must be consistent with the accompanying time attribute.

Name: lat

Relations: origin, site, stassoc

Description: Latitude. This attribute is the geographic latitude. Locations north of the equator have positive latitudes.

ORACLE: FLOAT(24)

NA Value: -999.0 Allowed only in stassoc. A valid entry is required in origin and site.

Units: Degrees

Range: -90.0 < lat < +90.0

Name: lddate

Relations: all

Description: Load date. This is the date and time the record was inserted into the database.

ORACLE: DATE

Range: Any valid date.

Name: lineno

Relation: remark

Description: Comment line number. This integer attribute is assigned as a sequence number for multiple line comments. The combination of commid and lineno is unique.

ORACLE: NUMBER(4)

NA Value: NOT ALLOWED. A valid entry is required.

Range: lineno > 0

Name: location

Relation: stassoc

Description: Location description. This character string describes the location of an event identified from data recorded at a single station. Two examples are Fiji-Tonga and Semipalatinsk.

ORACLE: VARCHAR(32)

NA Value: - (a dash)

Range: Any free-format string up to 32 characters long

Name: logat

Relation: arrival

Description: Log of amplitude divided by period. This measurement of signal size is often reported instead of the amplitude and period separately. This attribute is only filled if the separate measurements are not available.

ORACLE: FLOAT(24)

NA Value: -999.0

Units: Log (Nanometers/seconds)

Name: lon

Relations: origin, site, stassoc

Description: Longitude. This attribute is the geographic longitude in degrees. Longitudes are measured positive east of the Greenwich meridian.

ORACLE: FLOAT(24)

NA Value: -999.0 Allowed only in stassoc. A valid entry is required in origin and site.

Units: Degrees

Range: -180.0 < lon < +180.0

Name: magid

Relations: netmag, stamag

Description: Network magnitude identifier. This key is assigned to identify a network magnitude in the netmag relation. It is required for every network magnitude. Magnitudes given in origin must reference a network magnitude with magid = mbid, mlid or msid, whichever is appropriate. See mbid, mlid, or msid.

ORACLE: NUMBER(8)

NA Value: NOT ALLOWED. A valid entry is required.

Range: magid > 0

Name: magnitude

Relations: netmag, stamag

Description: Magnitude. This gives the magnitude value of the type indicated in attribute magtype. It is derived in a variety of ways, which are not necessarily linked directly to an arrival. See imb, iml, ims, magtype, mb, ml and ms.

ORACLE: FLOAT(24)

NA Value: NOT ALLOWED. An entry is required to define a valid record.

Name: magtype

Relations: netmag, stamag

Description: Magnitude type. This character string is used to specify whether the magnitude value represents mb (body wave magnitude), ms (surface wave magnitude), ml (local magnitude) or other appropriate magnitude measure. See imb, iml, ims, magnitude, mb, ml, ms.

ORACLE: VARCHAR(6)

NA Value: NOT ALLOWED. A valid entry is required.

Range: Any free-format string up to 6 characters long.

Name: mb

Relation: origin

Description: Body wave magnitude. This is the body wave magnitude of an event. Associated with this attribute is the identifier mbid which points to magid in the netmag relation. The information in that record summarizes the method of analysis and data used. See imb, iml, ims, magnitude, magtype, ml and ms.

ORACLE: FLOAT(24)

NA Value: -999.0

Name: mbid

Relation: origin

Description: Magnitude identifier for mb. This stores the magid for a record in netmag. Mbid is a foreign key joining origin to netmag where origin.mbid = netmag.magid. See magid, mlid and msid.

ORACLE: NUMBER(8)

NA Value: -1

Range: mbid > 0

Name: ml

Relation: origin

Description: Local magnitude. This is the local magnitude of an event. Associated with this attribute is the identifier mlid, which points to magid in the netmag relation. The information in that record summarizes the method of analysis and the data used. See imb, iml, ims, magnitude, magtype, mb and ms.

ORACLE: FLOAT(24)

NA Value: -999.0

Name: mlid

Relation: origin

Description: Magnitude identifier for ml. This stores the magid for a record in netmag. Mlid is a foreign key joining origin to netmag where origin.mlid = netmag.magid. See magid, sid and mbid.

ORACLE: NUMBER(8)

NA Value: -1

Range: mlid > 0

Name: ms

Relation: origin

Description: Surface wave magnitude. This is the surface wave magnitude for an event. Associated with this attribute is the identifier msid, which points to magid in the netmag relation. The information in that record summarizes the method of analysis and the data used. See imb, iml, ims, magnitude, magtype, mb and ml.

ORACLE: FLOAT(24)

NA Value: -999.0

Name: msid

Relation: origin

Description: Magnitude identifier for ms. This stores the magid for a record in netmag. Msid is a foreign key joining origin to netmag where origin.msid = netmag.magid. See magid, mlid and mbid.

ORACLE: NUMBER(8)

NA Value: -1

Range: msid > 0

Name: nass

Relation: origin

Description: Number of associated arrivals. This attribute gives the number of arrivals associated with the origin.

ORACLE: NUMBER(8)

NA Value: -1

Range: nass > 0

Name: ncalib

Relation: instrument

Description: Nominal calibration factor. This is the conversion factor that maps digital data to earth displacement. The factor holds true at the oscillation period specified by ncalper. A positive value means ground motion increasing in component direction (up, north, east) is indicated by increasing counts. A negative value means the opposite. Actual calibration for a particular recording is determined using the wfdisc and sensor relations. See calratio.

ORACLE: FLOAT(24)

NA Value: NOT ALLOWED. A valid entry is required.

Units: Nanometers/digital count

Range: Any non-zero floating point number

Name: ncalper

Relation: instrument

Description: Calibration period. This attribute is the period for which ncalib is valid.

ORACLE: FLOAT(24)

NA Value: NOT ALLOWED. A valid entry is required.

Units: seconds

Range: ncalper > 0.0

Name: ndef

Relation: origin

Description: Number of time-defining phases. This attribute is the number of arrivals used to locate an event. See timedef.

ORACLE: NUMBER(4)

NA Value: -1

Range: 0 < ndef < nass

Name: ndp

Relation: origin

Description: Number of depth phases. This attribute gives the number of depth phases used in calculating depth and/or depdp. See depdp.

ORACLE: NUMBER(4)

NA Value: -1

Range: ndp > 0

Name: net

Relations: affiliation, netmag, network

Description: Unique network identifier. This character string is the name of a seismic network. One example is WWSSN.

ORACLE: VARCHAR(8)

NA Value: - (a dash) Allowed only in netmag. A valid entry is required in affiliation and network.

Range: Any free-format string up to 8 characters

Name: netname

Relation: network

Description: Network Name. String containing the name of a network.

ORACLE: VARCHAR(80)

NA Value: - (a dash)

Range: Any string up to 80 characters

Name: nettype

Relation: network

Description: Network type. This 4 character string specifies what type of network (ar = array), (lo = local area), (ww = world-wide) for the given value of net.

ORACLE: VARCHAR(4)

NA Value: - (a dash)

Range: Any lower case string up to 4 characters

Name: nois

Relation: siteaux

Description: Nominal background noise level.

ORACLE: FLOAT(24)

NA Value: -1.0

Units: Nanometers

Range: nois > 0.0

Name: noissd

Relation: siteaux

Description: Noise standard deviation.

ORACLE: FLOAT(24)

NA Value: -999.0

Units: Log nanometers

Range: noissd > -999.0

Name: nsamp

Relation: wfdisc

Description: Number of samples. This quantity is the number of samples in a waveform segment.

ORACLE: NUMBER(8)

NA Value: NOT ALLOWED. A valid entry is required.

Range: nsamp > 0

Name: nsta

Relation: netmag

Description: Number of stations. This quantity is the number of stations used to compute the magnitude of the event.

ORACLE: NUMBER(8)

NA Value: -1

Range: nsta > 0

Name: offdate

Relations: site, sitechan

Description: Turn off date. This attribute is the Julian Date on which the station or sensor indicated was turned off, dismantled, or moved. See ondate.

ORACLE: NUMBER(8)

NA Value: -1

Range: Julian date of the form yyyyddd

Name: ondate

Relations: site, sitechan

Description: Turn on date. This attribute is the Julian Date on which the station or sensor indicated began operating. Offdate and ondate are not intended to accommodate temporary downtimes, but rather to indicate the time period for which the attributes of the station (lat, lon, elev) are valid for the given station code. Stations are often moved, but with the station code remaining unchanged.

ORACLE: NUMBER(8)

NA Value: NOT ALLOWED. A valid entry is required.

Range: Julian date of the form yyyyddd

Name: orid

Relations: assoc, netmag, origerr, origin, stamag

Description: Origin identification. Each origin is assigned a unique positive integer which identifies it in a data base. The orid is used to identify one of the many hypotheses of the actual location of the event.

ORACLE: NUMBER(8)

NA Value: NOT ALLOWED. A valid entry is required for all relations.

Range: orid > 0

Name: per

Relation: arrival

Description: Signal period. This attribute is the period of the signal described by the arrival record.

ORACLE: FLOAT(24)

NA Value: -1.0

Units: Seconds

Range: per > 0.0

Name: phase

Relations: assoc, stamag

Description: Associated phase. This field holds the identity of a seismic phase which has been associated to an event. Standard seismological labels for phases are used (e.g., P, PKP, PcP, pP, etc.). Both upper and lower case letters are available and should be used when appropriate, for example, pP or PcP. See iphase.

ORACLE: VARCHAR (8)

NA Value: - (a dash)

Range: Any string up to 8 characters long which conforms to seismological practice.

Name: ptmcor

Relation: siteaux

Description: P arrival time correction.

ORACLE: FLOAT(24)

NA Value: -999.0

Units: Seconds

Range: Any floating point value.

Name: qual

Relation: arrival

Description: Onset quality. This single-character flag is used to denote the sharpness of the onset of a seismic phase. This relates to the timing accuracy as follows:

i (impulsive) - accurate to +/-

0.2 seconds
e (emergent) - accuracy between +/-(0.2 to 1.0 seconds)
w (weak) - timing uncertain to > 1 second.

ORACLE: VARCHAR (1)

NA Value: - (a dash)

Range: {i | e | w}, lower case

Name: rect

Relation: arrival

Description: Rectilinearity. This attribute is a measure of signal rectilinearity. The value is obtained from polarization analysis of 3-component data.

ORACLE: FLOAT(24)

NA Value: -1.0

Range: 0.0 < rect < 1.0

Name: refsta

Relation: site

Description: Reference station. This string specifies the reference station with respect to which array members are located. See deast, dnorth.

ORACLE: VARCHAR (6)

NA Value: - (a dash)

Range: Any sta from site.

Name: rely

Relation: siteaux

Description: Station reliability.

ORACLE: FLOAT(24)

NA Value: -1.0

Range: 0.0 < rely < 1.0

Name: remark

Relation: remark

Description: Descriptive text. This single line of text is an arbitrary comment about a record in the database. The comment is linked to its "parent" relation only by forward reference from commid in the tuple of the relation of interest. See commid and lineno.

ORACLE: VARCHAR(80)

NA Value: - (a dash)

Range: Any free-format string up to 80 characters long.

Name: rsptype

Relation: instrument

Description: Instrument response type. This denotes the style in which detailed calibration data are stored. The neighboring attribute dfile tells where the calibration data are saved. When rsptype = paz, it indicates the data are the poles and zeroes of the Laplace transform. rsptype = fap indicates they are amplitude/phase values at a range of frequencies. rsptype = fir indicates it is a finite impulse response table. rsptype = pazfir indicates a combination of poles, zeros and finite impulse response. Other codes may be defined.

ORACLE: VARCHAR(6)

NA Value: NOT ALLOWED. A valid entry is required.

Range: Any lower case string up to 6 characters long

Name: samprate

Relations: instrument, wfdisc

Description: Sampling rate. This attribute is the sample rate in samples/second. In the instrument relation this is specifically the nominal sample rate, not accounting for clock drift. In wfdisc, the value may vary slightly from the nominal to reflect clock drift.

ORACLE: FLOAT(24)

NA Value: NOT ALLOWED. A valid entry is required.

Units: 1/seconds

Range: samprate > 0.0

Name: sdepth

Relation: origerr

Description: Depth error. This is the maximum error of a depth estimate for a level of confidence given by conf. See smajax, sminax, stx.

ORACLE: FLOAT(24)

NA Value: -1.0

Units: Kilometers

Range: sdepth > 0.0

Name: sdobs

Relation: origerr

Description: Standard error of one observation. This attribute is derived from the discrepancies in the arrival times of the phases used to locate an event. It is defined as the square root of the sum of the squares of the time residuals, divided by the number of degrees of freedom. The latter is the number of defining observations (ndef in origin) minus the dimension of the system solved (4 if depth is allowed to be a free variable, 3 if depth is constrained).

ORACLE: FLOAT(24)

NA Value: -1.0

Range: sdobs > 0.0

Name: seaz

Relation: assoc

Description: Station to event azimuth. This attribute is calculated from the station and event locations. It is measured clockwise from North.

ORACLE: FLOAT(24)

NA Value: -999.0

Units: Degrees

Range: 0.0 < seaz < 360.0

Name: segtype

Relation: wfdisc

Description: Segment type. This attribute indicates if a waveform is o (original), v (virtual), s (segmented) or d (duplicate).

ORACLE: VARCHAR (1)

NA Value: - (a dash)

Range: {o | v | s | d}, lower case

Name: slodef

Relation: assoc

Description: Slowness defining code. This one-character flag indicates whether or not the slowness of a phase is d (defining), or n (non-defining) for this arrival. See azdef and timedef.

ORACLE: VARCHAR (1)

NA Value: - (a dash)

Range: {d | n}

Name: slores

Relation: assoc

Description: Slowness residual. This attribute gives the difference between an observed slowness and a theoretical prediction. The prediction is calculated for the related phase and event origin described in the record.

ORACLE: FLOAT(24)

NA Value: -99999.0

Units: Seconds/degree

Name: slow

Relation: arrival

Description: Observed slowness. This is the observed slowness of a wave as it sweeps across an array.

ORACLE: FLOAT(24)

NA Value: -1.0

Units: Seconds/degree

Range: slow > 0.0

Name: smajax

Relation: origerr

Description: Semi-major axis of error ellipse for a given confidence. This is the length of the semi-major axis of the location error ellipse. It is found by projecting the covariance matrix onto the horizontal plane. The level of confidence is specified by conf. See sdepth, sminax and stx.

ORACLE: FLOAT(24)

NA Value: -1.0

Units: Kilometers

Range: smajax > 0.0

Name: sminax

Relation: origerr

Description: Semi-minor axis of error ellipse. This is the length of the semi-minor axis of the location error ellipse. It is found by projecting the covariance matrix onto the horizontal plane. The level of confidence is specified by conf. See sdepth, smajax and stx.

ORACLE: FLOAT(24)

NA Value: -1.0

Units: Kilometers

Range: sminax > 0.0

Name: snr

Relation: arrival

Description: Signal-to-noise ratio. This is an estimate of the size of the signal relative to that of the noise immediately preceding it.

ORACLE: FLOAT(24)

NA Value: -1.0

Range: snr > 0.0

Name: snthrsh

Relation: siteaux

Description: Nominal signal/noise detection threshold.

ORACLE: FLOAT(24)

NA Value: -1.0

Range: snthrsh > 1.0

Name: srn

Relation: origin

Description: Region number. This is a seismic region number, as given by Flinn, Engdahl and Hill (Bull. Seism. Soc. Amer. vol 64, pp 791-992, 1974). See grn, grname and srname.

ORACLE: NUMBER(8)

NA Value: -1 Allowed only in origin. A valid entry is required in sregion.

Range: srn > 0

Name: sta

Relations: affiliation, arrival, assoc, sensor, site, siteaux, sitechan, stamag, stassoc, wfdisc

Description: Station code. This is the common code-name of a seismic observatory. Generally only three or four characters are used.

ORACLE: VARCHAR (6)

NA Value: "-" (a dash) Allowed only in stassoc. A valid entry is required for all other relations.

Range: Any upper case string up to 6 characters long

Name: staname

Relation: site

Description: Station name/description. This is the full name of the station whose code-name is in sta. As an example, one record in the site relation connects sta = ANMO to staname = ALBUQUERQUE, NEW MEXICO (SRO).

ORACLE: VARCHAR (50)

NA Value: - (a dash)

Range: Any upper-case string up to 50 characters long

Name: staper

Relation: siteaux

Description: Period for measurements.

ORACLE: FLOAT(24)

NA Value: -1.0

Units: Seconds

Range: staper > 0.0

Name: stassid

Relations: arrival, stassoc

Description: Station association identification. The wavetrain from a single event may be made up of a number of arrivals. A unique stassid joins those arrivals believed to have come from a common event as measured at a single station. Stassid is also the key to the stassoc relation, which contains additional signal measurements not contained within the arrival relation, such as station magnitude estimates and computed signal characteristics.

ORACLE: NUMBER(8)

NA Value: -1 Allowed only in arrival.

Range: stassid > 0

Name: statype

Relation: site

Description: Station type. This character string specifies the station type. Recommended entries are ss (single station) or ar (array).

ORACLE: VARCHAR (4)

NA Value: - (a dash)

Range: {ss | ar}, lower case

Name: stmcor

Relation: siteaux

Description: S arrival time correction.

ORACLE: FLOAT(24)

NA Value: -999.0

Units: Seconds

Range: Any floating point value.

Name: stime

Relation: origerr

Description: Origin time error. This attribute denotes the time uncertainty that accompanies the location. The level of confidence is specified by conf. See smajax, sminax, and sdepth.

ORACLE: FLOAT(24)

NA Value: -1.0

Units: Seconds

Range: stime > 0.0

Name: strike

Relation: origerr

Description: Strike of major axis of error ellipse. This attribute is the strike of the semi-major axis of the location error ellipse, measured in degrees clockwise from North. See smajax.

ORACLE: FLOAT(24)

NA Value: -1.0

Units: Degrees

Range: 0.0 < strike < 360.0

Name: stx, sty, stz, sxx, sxy, sxz, syy, syz, stt, szz

Relation: origerr

Description: Elements of the covariance matrix for the location identified by orid. The covariance matrix is symmetric (and positive definite) so that sxy = syx, etc., (x,y,z,t) refer to latitude, longitude, depth and origin time, respectively. These attributes (together with sdobs, ndef and dtype) provide all the information necessary to construct the K-dimensional (K=2,3,4) confidence ellipse or ellipsoids at any confidence limit desired.

ORACLE: FLOAT(24)

NA Value: -1.0

Units: sxx,syy,szz,sxy,szx,syz - kilometers squared, stt - seconds squared, stx,sty,stz - km/sec

Range: sxx, syy, szz, stt > 0.0

Name: stype

Relation: arrival

Description: Signal type. This single-character flag indicates the event or signal type. The following definitions hold:

- l = local event
- r = regional event
- t = teleseismic event
- m = mixed or multiple event
- g = glitch (i.e., non-seismic detection)
- c = calibration activity upsets the date

l, r, and t are supplied by the reporting station, or as an output of post-detection processing. g and c come from analyst comment or from status bits from GDSN and RSTN data.

ORACLE: VARCHAR(1)

NA Value: - (a dash)

Range: {l | r | t | m | g | c}, lower case

Name: time

Relations: arrival, origin, sensor, siteaux, stassoc, wfdisc

Description: Epoch time. Epochal time given as seconds and fractions of a second since hour 0 January 1, 1970, and stored in a double precision floating number. Refers to the relation data object with which it is found. E.g., in arrival - arrival time; in origin - origin time; in wfdisc, - start time of data. Where date of historical events is known, time is set to the start time of that date; where the date of contemporary arrival measurements is known but no time is given, then the time attribute is set to the NA value. The double-precision floating point number allows 15 decimal digits. At 1 millisecond accuracy this is a range of 3 * 104 years. Where time is unknown, or prior to Feb. 10, 1653, set to the NA value.

ORACLE: FLOAT(53)

NA Value: -9999999999.999 Allowed only in stassoc, all other relations require a valid time.

Units: Seconds

Name: timedef

Relation: assoc

Description: Time-defining code. This one character flag indicates whether the time of a phase is d (defining), or n (non-defining) for this arrival. See azdef and slodef.

ORACLE: VARCHAR(1)

NA Value: - (a dash)

Range: {d | n}

Name: timeres

Relation: assoc

Description: Time residual. This attribute is a travel time residual, measured in seconds. The residual is found by taking the observed arrival time (saved in the arrival relation) of a seismic phase and subtracting the expected arrival time. The expected arrival time is calculated by a formula based on earth velocity model (attribute vmodel), an event location and origin time (saved in table origin), the distance to the station (attribute dist in table assoc), and the particular seismic phase (attribute phase in table assoc).

ORACLE: FLOAT(24)

NA Value: -999.0

Units: Seconds

Name: tshift

Relation: sensor

Description: Correction for clock errors. This attribute is designed to accommodate discrepancies between actual time and the numerical time written by data recording systems. Actual time is the sum of the reported time plus tshift.

ORACLE: FLOAT(24)

NA Value: NOT ALLOWED. An entry is required to define a valid record.

Units: Seconds

Name: uncertainty

Relation: netmag, stamag

Description: Magnitude uncertainty. This is the standard deviation of the accompanying magnitude measurement.

ORACLE: FLOAT(24)

NA Value: -1.0

Range: uncertainty > 0.0

Name: vang

Relation: sitechan

Description: Vertical orientation of seismometer. This attribute measures the angle between the sensitive axis of a seismometer and the outward-pointing vertical direction. For a vertically oriented seismometer, vang = 0. For a horizontally oriented seismometer, vang=90. See hang.

ORACLE: FLOAT(24)

NA Value: NOT ALLOWED. A valid entry is required.

Units: Degrees

Range: 0.0 < vang < 90.0

Name: vmodel

Relation: assoc

Description: Velocity model. This character string identifies the velocity model of the earth used to compute the travel times of seismic phases. These are required for event location (if phase is defining) or for computing travel-time residuals.

ORACLE: VARCHAR(15)

NA Value: - (a dash)

Range: Any free-format string up to 15 characters

Name: wfid

Relation: wfdisc

Description: Waveform identifier. The key field is a unique identifier for a segment of digital waveform data.

ORACLE: NUMBER(8)

NA Value: NOT ALLOWED. A valid entry is required.

Range: wfid > 0

Name: wgt

Relation: assoc

Description: Location weight. This attribute gives the final weight assigned to the allied arrival by the location program. It is used primarily for location programs that adaptively weight data by their residuals.

ORACLE: FLOAT(24)

NA Value: -1.0

Range: 0.0 < wgt < 1.0

3.0 WAVEFORM FILE FORMAT

3.1. What Seismic Data is Stored

3.1.1. Storing Digital Waveform Data

The digital waveform data samples are not stored within the database management system. They are stored in one or more separate operating system files -- "non-DBMS" files -- which contain nothing but digital samples. The identifying information for a waveform segment is stored in the record (tuple) of the wfdisc relation that contains the name of the file with the waveform samples.

The Center database structure places few constraints on where a digital waveform segment is stored. It may be in an ordinary disk file, either by itself or with other segments stored in the same file. The waveform data may also be stored on magnetic tape, and is readily partitioned into tape files by station so that hardware tape positioning can be used to speed retrieval. Although the current practice at the Center is to place segments from only one channel into a single disk file, it is not a requirement of the database format. Placing more than one channel's data into a single file is convenient to reduce the number of open files in a program, but each segment must have its own index record so it should not be used to imitate fine grained multiplexing. By convention, the waveform file names end with ".w" (called the file suffix), and therefore the waveform files are often referred to as .w files. No other constraints are placed on waveform file names so people are free to choose any file prefix (the part of the file name preceding ".w") which is meaningful for their project.

To obtain flexibility nothing but data samples are stored in a .w file. The identifying information is stored in separate index records. The index records for .w files are maintained in the wfdisc relation. A similar relation called wftape is defined to index waveforms stored on magnetic tape, the only difference between the two relations being that the foff and adate fields of wfdisc are replaced by volnam, tpfile, and tpblck fields in wftape to specify the tape volume, tape file number, and block number within the tape file where the data is stored. For simplicity, the rest of this section will discuss only wfdisc records but, aside from the exception noted, it applies to wftape too.

Each wfdisc tuple describes a specific waveform segment and contains an id number in the chid field to designate detailed information on the station and instrumentation that recorded the trace. The length of the waveform segment is given in samples by the nsamp field, and the length in seconds is found by dividing nsamp by smprat, the sample rate field. The wfid field is a unique id number assigned to each original waveform segment; in practice this number is unique only within a coherent data set such as a group of waveforms being analyzed together. It would be useful for implementing a disk library of event or arrival templates, but in the general case waveforms are identified by the station name, channel name, and start time stored in the sta, chan, and time fields of the wfdisc record.

Five attributes (fields) in the wfdisc relation are needed to locate a waveform segment in a disk file and to determine the physical space it occupies in that file. This is commonly called "pointing to" a non-DBMS file. Thus a wfdisc record points to a waveform segment in a waveform file, and several other relations point to other non-DBMS files. One of the five fields, dattyp (data type), also specifies the physical format (i.e., ASCII, VAX floating point, IEEE integer) used to represent the sample values in the .w file. In newer index relations, datsw (data switch) appears instead of dattyp. The data type implies the number of bytes occupied by a single sample; with that and the number of samples (nsamp) we can compute the number of bytes that a waveform segment occupies on disk. So we use two fields (dattyp and nsamp) to specify the space. Three others, dir, file, and foff, give the directory name, file name, and byte offset within the named file ("file offset" for short) where the waveform segment begins.

To further aid implementation of a waveform disk library, or a buffer of waveforms received in the last 2 or 3 weeks, adate and segtyp fields are included in the wfdisc relation. The former is the date the segment was last accessed or the date the segment was placed on disk, which could be used to remove inactive segments automatically. The latter, segment type, tells if the waveform file is "original", i.e., the waveform file was the initial copy placed in the library; "virtual", i.e., the wfdisc tuple references part of an original in the library; "segment", meaning it is a duplicate of part of the original; or "duplicate", where the waveform file is a complete copy of the original.

3.1.2. Representing Time

Within the Center database, all times are stored as "epoch times". Since date is a useful search key, the Julian date appears in each relation for which time is an identifying attribute. The date and day relations are defined to help with date-based searches. Utility and application software will accept time and date formats which are more familiar to people.

Time is pervasive in seismology -- there are waveform sample times, phase arrival times, origin times, and so forth. In wfdisc records, the start time of a waveform segment is given, and a time field appears in many other relations in the Center database structure. All of the time values are stored as "epoch times", the number of seconds since hour 0 of January 1, 1970. Times before that are negative numbers, later times are positive numbers and, of course January 1, 1970 00:00:00 is represented as "0.0" in epoch time. Within the database system, time fields are stored and used as double precision floating point numbers. Time is right justified in a 15 character field in fixed point form with 3 decimal places (i.e., the FORTRAN format would be f15.3) when printed. Note that a double precision floating point number can accurately represent epoch times only for dates between roughly 300 years before and after 1970. A "null" value, -9999999999.999, is used for time outside the range that can be represented accurately. The null value corresponds to Feb 10,1653 6:13:20.001. Null is also used when a contemporary date is known, but not the hour, minute or second. For historical events, if a date is known, time is set to the start time of the day if it is within the representable range.

Although it is redundant, the Julian date is also given in each relation that has a time field because date is a useful search key for seismic data. The date field in the wfdisc and other relations is presented as the year and day of year in a 7 character integer. For example, July 31, 1987 is stored as 1987212. Such a format is often denoted as "yyyyddd" or "yeardoy" to indicate that a 4 digit year is followed by a 3 digit day of year.

While epoch times and Julian dates are often computationally convenient when working with waveform segments, they are difficult for people to use, so the date and day relations are defined to facilitate conversions between the familiar representation of time ("human time") and epoch time or Julian date. Other relations are currently being tested to further simplify the conversion process within the scope of commercial database tools. Utility software also exists to do the conversion outside of a commercial database management system. In addition, Center software currently expects the familiar hh:mm:ss.sss form for command line arguments. At present, only Julian dates are accepted by command lines of most programs, but this will be changed soon so that a more familiar form may be used. When this is accomplished, the manual page for the command will be changed to reflect the improvement. Only one compact and unambiguous form will be required for the human date specification to speed implementation and elicit cooperation from all application software writers. Those using Center facilities will have library routines available to do the job. The required form is a single string of eight characters, with a 4-digit year, followed by 2-digit month, followed by a 2-digit day of month. This order is easily remembered since it places larger time units in higher order digits, and it has the nice property that, while readily understood by people, dated records can be placed in order with a standard numeric or alphanumeric sort utility. This format will be denoted as "yyyymmdd" or "yearmmdd". An example, again for July 31, 1987, is 19870731.

The date relation has five fields to show the Julian date for a given epoch time and also the year month and day. The names of the fields are date, time, year, mon, day, where mon and day are two digit integers, year is a four digit integer, and date and time are as just described. The date relation may be advantageous for a data set that spans no more than one year, or has a reasonably small number of dates involved, but has not been used in the current Center databases. To facilitate conversion to Julian date within a database management system, another relation, day, has been devised which has exactly 731 tuples (records). Each tuple has mon, mname, day, leap, doy fields for the month number, 3 character month abbreviation, day of month, boolean leap year flag (1 implies leap year, 0 non-leap year), and day of year. Having a definite size and content, the day relation should be readily inserted in each database created within a database management system.

Picture	Meaning	Comments
yyyydoy	Julian date	4-digit year; 3-digit day of year
yyyymmdd	human date	alternate date input form
hh:mm:ss.sss	hours, minutes, seconds	
hh:mm	hours, minutes	

Figure 1. Summary of time utilities and formats.

4.0 INSTRUMENT RESPONSE FORMAT

Instrument Response File Format

This memo describes the calibration and response file pointer fields in the tables as well as the first version (1.0) of the format for the response files.

The calibration information is stored in three different tables; wfdisc, sensor, and instrument. The wfdisc table contains the calib and calper fields which give the calibration in nm/count at the calibration period. This is usually the best estimate of the calibration at the time of recording and does not change as better estimates are obtained.

The sensor table is also linked to an instrument table through the inid field. The instrument table contains the nominal calibration factors in the ncalib and ncalper fields, pointers to the directory and file containing the instrument response, and a field giving the response type (e.g. paz, fap, fir, and mult for poles and zeros, frequency amplitude phase, finite impulse response, and multiple response types, respectively). Like the relationship between the wfdisc and sensor tables, several sensor entries can be linked to the same instrument.

This structure allows a small number of instrument responses and calibrations to be used for a great number of stations and waveforms.

By defining the various "calibration" values in units of nm/count at a specific period in the Center databases, the scaling of the response curves is explicitly defined. Thus, the responses stored in the external files need only preserve the true shape of the response curve, not the amplitude. The responses defined by poles and zeros, how- ever, do include a "normalization" factor in the format. It is included primarily to remain consistent with the response information as it is received at the Center. Although the Center will include these normalization features in the response files, we will not vouch for their appropriateness. We strongly recommend using the calibration and calibration period values to scale the response curve properly.

The format allows the complete response to be given as a series of response groups that can be cascaded. Each response group can have a different format or representation including frequency, amplitude, phase; finite impulse response filters; and poles and zeros. Other representations can easily be added in the future. Modern instruments are composed of several different components, each with its own response. This format can mimic the actual configuration of the instrumentation. One of the benefits of this design is that the response shapes from standard instrument components can be kept separately and combined into complete response files as the need arises. In addition, one will be able to choose which parts of the complete response curve they wish to remove from their data. For example, it may be preferable not to remove the anti-alias filter when removing the instrument response from waveform data. Of course, responses are sometimes given as frequency, amplitude, phase triplets that represent the response of the entire system, and in these cases, the advantages of the cascading responses will not be realized.

In most cases, theoretical responses are given as poles and zeros, finite impulse response filters, or a combination of the two. Measured responses, on the other hand, are given as frequency, amplitude, phase triplets. The format labels each response group as either "theoretical" or "measured" which allows both types to be stored in the same file for retrieval as needed.

When frequency, amplitude, phase values are given, interpolation routines are usually used to fill in the missing points of the response curve. Unless points are included in the response file at very low and very high frequencies, extrapolation may be required to generate some of these points. The following policy will be adhered to concerning fap responses. When the fap values are "theoretical", amplitude and phase values will be given at frequencies of 0.000001 and 1000.0 Hz. For "measured" fap responses, only the values reported will be included in the response file. We suggest that the "theoretical" curve be used to fill in any response values at frequencies outside the "measured" band.

The format for the response curves is given below. The data will be stored in ASCII. In the version 1.0 format only three response groups are defined; paz, fap, and fir.

To get the response of a particular instrument, the calibration and calibration period values must be known. The response shape curve defined in the external file is adjusted so that its displacement value is one at the cali- bration period. The calibration value can then be used to scale the curve to the appropriate value. If the displace- ment response is desired, this would be nm/count. Velocity or acceleration responses can also be obtained by multiply- ing the response curve by iw or -w2, respectively. The best estimate of the response at the time of the recording will be obtained using calib and calper in the wfdisc and sensor tables. The nominal response is found using ncalib and ncalper in the instrument table.

Table 1:

Response File Format				
Line #	Position	Field	Format	Description
1-L	1-80	-	a80	General comments preceded by a #
L+1	1	1	a1	#
	3-80	2	a78	instrument type/description (KS36000, GS-13, etc.)
Instrument Response Group Using Poles and Zeros (paz)				
L+2-K	1-80	1	a80	comments (preceded by a "#")
K+1	1-12	1	a12	response source (theoretical or measured)
	14-15	2	i2	sequence number
	17-28	2	a12	description (instrument, anti-alias, etc.)
	30-35	3	a6	response type (fir, paz, fap, etc.)
	37-80	4	a44	author or source of information
K+2	-	1	f or e	normalization factor (A0)
K+3	1-8	1	i8	number of poles
K+4-N	-	1-4	4(f or e)	complex pole and complex error
N+1	1-8	1	i8	number of zeros
N+2-M	-	1-4	4(f or e)	complex zero and complex error
Instrument Response Group Using Frequency, Amplitude, Phase (fap)				
L+2-K	1-80	1	a80	comments (preceded by a "#")
K+1	1-12	1	a12	response source (theoretical or measured)
	14-15	2	i2	sequence number
	17-28	2	a12	description (instrument, anti-alias, etc.)

	30-35	3	a6	response type (fir, paz, fap, etc.)
	37-80	4	a44	author or source of information
K+2	1-8	1	i8	number of fap triplets
K+3-N	-	1-5	5(f or e)	frequency (in deg), amp, phase (in deg), amp err, phase err
Instrument Response Group Using Finite Impulse Response Filters (fir)				
L+2-K	1-80	1	a80	comments (preceded by a "#")
K+1	1-12	1	a12	response source (theoretical or measured)
	14-15	2	i2	sequence number
	17-28	2	a12	description (instrument, anti-alias, etc.)
	30-35	3	a6	response type (fir, paz, fap, etc.)
	37-80	4	a44	author or source of information
K+2	1-12	1	f12.4	input samples/sec
K+3	1-8	1	i8	number of numerator coefficients
K+4-N	-	1-2	2(f or e)	numerator coefficient and error
N+1	1-8	1	i8	number of denominator coefficients
N+2-M	-	1-2	2(f or e)	denominator coefficient and error
Additional Response Groups as Needed				

Example Response File (Fictional)

```
#
#             ** CAUTION ** CAUTION ** CAUTION **
#
# All responses in this file are displacement curves and have
# arbitrary scales.  The scaling information required to use
# this file is contained in the calib (or ncalib) and calper
# (or ncalper) fields of the wfdisc (or instrument) tables.
# The calib value defines how many nm/count there are at the
# calper period.  Scale appropriately.
# The convention followed for the Fourier transform is that the
# forward transform (from the time domain to the frequency domain)
# is defined with a negative exponent and the inverse transform
# (from the frequency domain to the time domain) is defined with
# a positive exponent. # # S-750 borehole instrument with GS1400
# amplifier
#
# Response shapes with poles and zeros are defined by:
#
```

```
#    T = A0 * (s-z1)(s-z2)....(s-zn)/((s-p1)(s-p2)....(s-pm))
#
# where T = unscaled transfer function,
#       A0 is the normalization factor,
#       s = j*omega (imaginary angular frequency),
#       z1 through zn are the n complex zeros (in radians/sec),
#       and p1 through pm are the m complex poles (in radians/sec)
#
#
# The response of this instrument is considered excellent up to
# about 20 Hz where instrument noise can become a problem at quiet
# sites.
#
# Jeff Stevens of S-cubed compiled and verified this data
# theoretical   1 instrument   paz    Teledyne Geotech manual
0.46678E+22
20
-.78828E+05    0.0           0.0    0.0
-.500E+05      0.0           0.0    0.0
-.990E+04      0.0           0.0    0.0
-.672E+04      0.0           0.0    0.0
-.263E+03      +.4067E+03    0.0    0.0
-.263E+03      -.4067E+03    0.0    0.0
-.530E+03      0.0           0.0    0.0
-.625E-01      0.0           0.0    0.0
-.997E+00      +.7653E+00    0.0    0.0
-.997E+00      -.7653E+00    0.0    0.0
-.12566E+04    0.0           0.0    0.0
-.628E+03      0.0           0.0    0.0
-.28270E+01    0.0           0.0    0.0
-.28270E+01    0.0           0.0    0.0
-.28270E+01    0.0           0.0    0.0
-.28270E+01    0.0           0.0    0.0
-.862E+02      +.2584E+02    0.0    0.0
-.862E+02      -.2584E+02    0.0    0.0
-.6264E+02     +.791E+02     0.0    0.0
-.6264E+02     -.791E+02     0.0    0.0
13
-.3737E+03     0.0           0.0    0.0
-.1148E+04     0.0           0.0    0.0
-.6505E+04     0.0           0.0    0.0
-.78344E+05    0.0           0.0    0.0
-.2112E+06     0.0           0.0    0.0
0.0            0.0           0.0    0.0
0.0            0.0           0.0    0.0
0.0            0.0           0.0    0.0
0.0            0.0           0.0    0.0
0.0            0.0           0.0    0.0
0.0            0.0           0.0    0.0
0.0            0.0           0.0    0.0
0.0            0.0           0.0    0.0
#
# Response shapes with frequency, amplitude, phase triplets have
# units of Hz, displacement (arbitrary units, usually nm),
# and degrees.
#
# This response was derived from the complete calibration done
# on June 16, 1987 at RSNY
# measured   1 instrument   fap    Sandia report S-1425
```

21

0.1	+.740E-04	538.0	0.0	0.0
0.15	+.724E-03	495.0	0.0	0.0
0.2	+.502E-02	444.0	0.0	0.0
0.3	+.535E-01	357.0	0.0	0.0
0.4	+.105E+00	326.0	0.0	0.0
0.5	+.212E+00	290.0	0.0	0.0
0.6	+.331E+00	264.0	0.0	0.0
0.7	+.449E+00	246.0	0.0	0.0
0.8	+.664E+00	221.0	0.0	0.0
1.0	+.100E+01	193.0	0.0	0.0
1.2	+.142E+01	168.0	0.0	0.0
1.4	+.171E+01	154.0	0.0	0.0
1.7	+.210E+01	140.0	0.0	0.0
2.0	+.262E+01	124.0	0.0	0.0
2.5	+.337E+01	105.0	0.0	0.0
3.3	+.455E+01	82.0	0.0	0.0
4.0	+.544E+01	67.5	0.0	0.0
5.0	+.667E+01	48.3	0.0	0.0
8.0	+.840E+01	20.2	0.0	0.0
10.0	+.104E+02	-29.7	0.0	0.0
20.0	+.650E+01	-146.0	0.0	0.0

5.0 GEOGRAPHIC/SEISMIC REGIONS

The geographic and seismic regions utilized in the bulletins and the parameters on these CD-ROMS are based on the designations provided by Flinn, Engdahl and Hill (Bull. Seism. Soc. Amer. vol 64, pp. 771-992, 1974). The numbers are the same, while the names may have changed due to changing political circumstances (e.g., old RHODESIA = new ZIMBABWE).

6.0 GSETT BULLETIN FORMAT

The "XB" message is used for event bulletins (FEB) and lists (IEL and CEL). All EIDCs should make every effort to compute all parameters in the bulletin. If parameters cannot be computed, or if no valid data are available, the fields should be left blank and the labels omitted. If the phase detections have slowness and azimuth measurements, the RES group should be presented. If the phase detections were associated in the original parameter message with a FOCUS group, that information should be presented with both the associated and unassociated phases. The XB message has the following format:

Line 1:Header
Header Identification: "XB01"

Position	Field	Name	Format	Description

47-49	10	List or Bulletin Type	a3	IEL,CEL or FEB
51-52	11	Version no.	i2	Only for CEL
54-59	12	Data day	3i2	YYMMDD
61-63	13	Producing IDC	a3	CNB,MOS,STO or WAS
65-70	14	Day of creation	3i2	YYMMDD
72-75	15	Time of creation	2i2	HHMM
76-80	16	Reserved	a5	Blanks

Lines 3 - (n-1): Message text containing a number of events, station reports and one section for unassociated observations.
Line n="STOP"

6.1 Event Section

Subheader first line:

Position	Field	Name	Format	Description
3-6	1		a4	`DATE'
10-14	2		a5	`EVENT'
18-23	3		a6	`ORIGIN'
32-40	4		a9	`EPICENTER'
46-50	5		a5	`DEPTH'
53-56	6		a4	`NOBS'
58-61	7		a4	`NOBS'
68-77	8		a10	`MAGNITUDES'

Subheader second line:

Position	Field	Name	Format	Description
3-5	1		a3	`IDC'
11-13	2		a3	`NO'
19-22	3		a4	`TIME'
47-50	4		a4	`(KM)'
53-55	5		a3	`DEF'
59-60	6		a2	`LP'
65-66	7		a2	`MB'
69-73	8		a5	`MBAVE'
77-78	9		a2	`MS'

Subheader third line:

Position	Field	Name	Format	Description
1-80	1		a80	`XXX...'

Subheader fourth line:

Position	Field	Name	Format	Description

Position	Field	Name	Format	Description
1-8	1	Data day	i2,a1,i2,a1,i2	YY-MM-DD
10-13	2	Event number	i4	
16-25	3	Origin time	i2,a1,i2,a1,f4.1	HH:MM:SS.D
28-33	4	Latitude	f6.2	
34	5		a1	`N' or `S'
36-42	6	Longitude	f7.2	
43	7		a1	`E' or `W'
48-50	8	Depth	i3	
53-55	9	Num. def. obs.	i3	
58-60	10	Num. assoc. LP	i3	
65-67	11	mb, max. lklhd	f3.1	MB, maximum likelihood
70-72	12	mb, average	f3.1	
77-79	13	MS, max. lklhd	f.31	MS, maximum likelihood

The number of defining observations (field 9) is counted according to the definition of an observation given in Appendix B. Thus defining phases with the * mark count as one observation, and those with the # mark count as three observations.

Subheader fifth line:

Position	Field	Name	Format	Description
1-3	1	Producing IDC	a3	CNB,MOS,STO or WAS
5-7	2	List or Bulletin type	a3	IEL, CEL or FEB
20-21	3		a2	`+-'
22-25	4	Origin time error	f4.1	SS.D
27-28	5		a2	`+-'
29-33	6	Latitude error	f5.2	
36-37	7		a2	`+-'
38-42	8	Longitude error	f5.2	
46-47	9		a2	`+-'
48-50	10	Depth error	i3	
63-64	11		a2	`+-'
65-67	12	mb error	f3.1	
75-76	13		a2	`+-'
77-79	14	Ms error	f3.1	

Subheader sixth line:

Position	Field	Name	Format	Description
26-55	1	Region name	a30	Flinn-Engdahl geographical region

Option comment lines:

Position	Field	Name	Format	Description
1-2	1	Comment mark	a2	`(('
3-78	2	Comments	a76	Text
79-80	3	Comment mark	a2	`))'

==

Subheader seventh line:

Position	Field	Name	Format	Description
1-80	1		a80	`===...'

Subheader eighth line:

Position	Field	Name	Format	Description
2-4	1		a3	`STA'
8-11	2		a4	`DIST'
14-15	3		a2	`AZ'
21-25	4		a5	`PHASE'
38-41	5		a4	`TIME'
45-47	6		a3	`RES'
54-57	7		a4	`AMPL'
60-62	8		a3	`PER'
66-67	9		a2	`MB'
70-71	10		a2	`MS'
73	11		a1	`C'
75-76	12		a2	`QR'
78-80	13		a3	`COM'

Subheader ninth line:

Position	Field	Name	Format	Description
18-21	1		a4	`REPT'
26-28	2		a3	`ASS'
45-47	3		a3	`(S)'
54-57	4		a4	`(NM)'
60-62	5		a3	`(S)'

Subheader tenth line:

Position	Field	Name	Format	Description
1-80	1		a80	`---...'

6.2 Station Report Section

Station reports, defining and associated observations belonging to the event are listed here. One or more lines for each connected observation. All parameter values in the station report are the values used in the calculations.

Data, one or more lines per report:

Position	Field	Name	Format	Description
1	1	Defining mark	a1	`*', `#' or blank
2-5	2	Station code	a4	
7-11	3	Calculated distance	f5.1	
13-15	4	Azimuth,event-station	i3	
17-25	5	Reported phase code	a9	
26-30	7	Associated phase code	a5	
32-41	9	Arrival time	i2,a1,i2,a1,f4.1	HH:MM:SS.D
43-47	10	Time residual	f5.1	
49-57	11	Amplitude(nm)	f9.2	
59-63	12	Period (seconds)	f5.2	
65-67	13	mb	f3.1	
69-71	14	MS	f3.1	
73	15	Station category	i1	
75-76	16	Qualifying remark	a2	
78-80	17	Comment codes	a3	N,M,D,A and combinations

The # sign (Field 1) should be used as a defining mark if the phase has three defining observations.

For surface waves reports the format of field 10 is i5, field 11 is i8 and field 12 is i5.

For use of the comment codes in field 17, see Appendix F, Section F.2.

Station report, continuation. If no data are available, the following line is omitted:

Position	Field	Name	Format	Description
8-11	1		a4	`RES:'
13-15	2		a3	`SLO' or `INC'
16-20	3	Slowness residual or Angle of inc residual	f5.1 i5	
22-23	4		a2	`AZ'
24-27	5	Azimuth residual	i4	
32-35	6		a4	`REP:'
37-38	7		a2	`XA'
40-44	8	Time of maximum amplitude relative arrival time	f5.1	
46-48	9		a3	`LAT'
49-54	10	Reported latitude	f6.2	
56-58	11		a3	`LON'
59-65	12	Reported longitude	f7.2	
67-68	13		a2	`MB', `MS' or `ML'
69-71	14	Reported magnitude	f3.1	
73-75	15		a3	`REC'
76-79	16	Reptd rectilinearity	f4.2	

If the input data has been changed or added by the operator, the operator comments are written on the following line(s). The comment should contain the original values.

Position	Field	Name	Format	Description
1-2	1	Comment mark	a2	`(('
3-78	2	Comments	a76	Text
79-80	3	Comment mark	a2	`))', optional

A report consists of a group of reported phases (e.g., P, S and Lg) reported by a given station as being from the same event.

For observations that are associated to an event only through other observations in the report, the associated phase code field and the time residual field will be left blank (and also the mb, MS and station category fields). The continuation line of the station report should not be given in these cases.

In the event sections, there should normally be only one report for each station associated to the event. If two or more reports are associated to the same event, they should be listed together with a blank line as a separator.

6.3. UNASSOCIATED OBSERVATIONS SECTION:

In the FEB, the list of unassociated data is in two sections. The first section has a subheader as follows:

Subheader

Position	Field	Name	Format	Description
1-41	1	Subheader id	a41	`UNASSOCIATED, WITH NDC-REPORTED LOCATIONS'
42-80	2	Reserved	a39	Blanks

These are the unassociated data for which an NDC has reported a location using a FOCUS line. The second section has the subheader identifier "OTHER UNASSOCIATED" and contains all other unassociated data.

Data lines:

Position	Field	Name	Format	Description
1-4	1	Station code	a4	
6-14	2	Phase code	a9	Phase identification, including onset prefix and first motion suffix
16-23	3	Arrival time	2i2,f4.1	HHMMSS.D
25-34	4	Amplitude(nm)	f10.2	
36-40	5	Period(seconds)	f5.2	
42-46	6	Slowness	f5.2	
48-52	7	Azimuth	f5.1	
54-55	8	QR	a2	Qualifying remark
57-58	9	Seismometer type	a2	`SZ',`SE',`SN',`LE', `LN',`LZ'
60-63	10	Angle of incidence	f4.1	3-component

65-68	11	Reptd Rectilinearity	f4.2	3-component
70-73	12	Report number	i4	
74-80	13	Reserved	a7	Blanks

Use `E', `I', `Q' as onset prefix and `C', `D', `U', `R', `CU', `CR', `DU', `DR' as onset suffix in field 2, Phase code. (See definition in Annex D1).

Report numbers are used to denote groups of reported phases, such as P, S and Lg. These numbers will be internal database numbers and as such will be different for each EIDC. They should however be unique for a given EIDC and observations belonging to the same report should have the same number.

Optional line with supplementary information if reported by the station.

Position	Field	Name	Format	Description
1	1	Continuation mark	a1	`+'
3-5	2	Latitude identifier	a3	`LAT'
6-11	3	Latitude	f6.2	
13-15	4	Longitude identifier	a3	`LON'
16-22	5	Longitude	f7.2	
24-25	6	Origin time ident.	a2	`OT'
26-33	7	Origin time	2i2,f4.1	
35-36	8	XA identifier	a2	`XA'
38-42	9	Time of maximum amplitude	f5.1	
		Relative arrival time		
44-45	10	Body wave mag. id.	a2	`MB'
46-48	11	Body wave magnitude	f3.1	
50-51	12	Surface wave magnitude id.	a2	`MS'
52-54	13	Surface wave mag.	f3.1	
56-57	14	Local magnitude id.	a2	`ML'
58-60	15	Local magnitude	f3.1	
62-78	16	Comment	a17	Text

Optional line:

Position	Field	Name	Format	Description
1-2	1	Comment mark	a2	`(('
3-78	2	Comments	a76	Text
79-80	3	Comment mark	a2	`))'

File Name: PROBLEMS.DOC

KNOWN AND SUSPECTED PROBLEMS ON THE GSETT-2 CD-ROMS

February 1992

This file contains information on inaccuracies and corrections to the data present on these CD-ROM's which were reported by the NDC's or discovered during analysis. Comments that were made by the NDC are identified by being placed in quotes. These comments made by NDCs are simply comments, and had no effect on the data on the CD-ROM (unless otherwise noted).

NDC	Data Time Period	Station Channel	Problem Description-Correction
AUS	Inst	ASAR	Two waveforms sent sent on 1991132 have a calib of .08, all others have one of .005. The calibs for these waveforms have been changed to .08 nm/count in the all WFDISC files and the INSTRUMENT file. The instrument response supplied for this station was in FAP format, and contains no values for phase.
	Inst	WRA	The instrument response supplied for this station does not include an anti-aliasing filter.
	Wave	CTA	BN, BE are sometimes reported as SN,SE. All SZ,SE,SN channel names for CTA have been changed to BZ,BE,BN in all WFDISC files.
	Wave	STK	The N and E components were reported as SN,SE, while the Z component was reported as BZ. All SZ,SE,SN channel names for STK have been changed to BZ,BE,BN in all WFDISC files.
	Wave	MAW	BN,BE are sometimes reported as SN,SE. BN, BE are sometimes reported as SN,SE. All SZ,SE,SN channel names for MAW have been changed to BZ,BE,BN

				in all WFDISC files.
AUT	Inst		SQTA	The instrument response supplied for this station does not include an anti-aliasing filter.
CAN	Inst		YKA	For YKR2, the calib that was reported in WID1 sections of XW01 messages was reported incorrectly as .015916 nm/count @ 1Hz. CAN later supplied the correct value, which is .2516 nm/count @ 1Hz. This change has been made in all WFDISC files and the INSTRUMENT file. "Sourcebook has response with FIR but at the wrong place (assumes Nyquist at 20, not 10hz). Level of curve is wrong, or at least different from others."
CHN	Both	25May-31May 00:30	BJT	"We believe there was a timing error introduced into our BJT station clock on 25 May 91 amounting to approximately 1.5 minutes. It was reported to the PRC NDC on 29 May and was corrected on 31 May at approximately 00:30 GMT." The instrument response supplied for this station was in FAP format, and contains no values for phase.
CZK	Inst		VRAC	The amplitude in each frequency-amplitude-phase triplet had to be inverted so that the response would be in units of counts/nm. This change is reflected in the response file VRAC_SP.1. The original messages from CZK had incorrect calibration values. The correct value was supplied later in correction messages, and these changes were made to all the WFDISC files and the INSTRUMENT file. The correct calibration value

is .006 nm/count @ 1 Hz.

The response curve plotted in the Sourcebook is incorrect. With a calibration value of .006 at 1Hz, the response curve should have a value of around 166 counts/nm at 1Hz. The response in the Sourcebook has somewhere between 7 and 8 counts/nm at 1Hz.

	Param	All Data Days		"Erroneous reporting of calibration resulted in incorrect amplitude. Azimuth and slowness reported in comment fields." Note: this problem has been resolved in the ARRIVAL files in the NDCPARM directory, but not in the WASCEL directory, since new parameters were sent by CZK after the experiment.
	Wave	All Data Days		"Erroneous reporting of calibration resulted in incorrect sensitivity." Note: this problem has been resolved in all the WFDISC files and the INSTRUMENT file, since new waveforms were sent by CZK after the experiment.
DEU	Inst		GRA1	We had to convert the response that was supplied in the XW01 from velocity to displacement. CRP/190 states that they should always be in terms of ground displacement (see CRP/190, pg D48). This change is reflected in the GRA1_BB.1 response file. We had to convert the calibration value to displacement (divided by 2 * PI * (1 / calibration

period)). In the original XW01 messages, the calibration values were not identified as being in units of (nm/s) / cnt. This change has been made in all of the WFDISC files and the INSTRUMENT file.

		GEA0	Several waveforms on 1991112 were reported with an incorrect calibration value of .005999 nm/count @ 1Hz. These were changed to have the correct value of .008387 nm/count @ 1Hz in all the WFDISC files and the INSTRUMENT file.
		GEC2	We had to convert the response that was supplied in the XW01 from velocity to displacement. CRP/190 states that they should always be in terms of ground displacement (see CRP/190, pg D48). This change is reflected in the response file GEC2_SP.1.
		GEC2	The instrument response for this station does not include an anti-aliasing filter.
P/W		GRFB	The elevation was reported in units of kilometers rather than meters. This has been fixed in the SITE file.
P/W	All Data Days	GEA0	All waveform data of the GERESS array have wrong coordinates in the header. The published coordinates in the Sourcebook are correct. In the GSETT-2 period the following two stations had been used as references. The correct coordinates are:

```
GEA0 13.70188333 E (lat)
     48.83680472 N (lon)
     1027.55 m (elevation)
GEC2 13.70155917 E (lat)
     48.84510611 N (lon)
     1132.46 m (elevation)
```

```
                                For the same reason all
                                reported GERESS (NDC)
                                epicenters in the STASSOC
                                files data would need a small
                                correction: The latitudes must
                                be shifted 0.025 deg to the
                                North.  The longitudes must be
                                shifted 0.132 deg to the East.
                                This change has not been made
                                in the STASSOC files in either
                                the WASCEL or NDCPARM
                                directories.


                                This may result in incorrect
                                origin and origin error
                                determination, as well as
                                errors in time residuals in
                                the WASCEL tables and in the
                                bulletins in the GSEBULL
                                directories.  The information
                                in the site table for these
                                sites include the correct
                                location.  The (incorrect)
                                locations used during the
                                experiment are available as
                                the station name plus the
                                letter 'X'(eg GEA0X). Note
                                however that NO changes have
                                been made to the station
                                locations in the STASSOC files
                                or to the WASIDC locations in
                                the WASCEL directory.


ESP  Param     All DataDays   3CC LP    All the LP Amplitude reported
                                in nM instead of uM. Corrected
                                messages were sent, and the
                                correct amplitudes can be
                                found in the ARRIVAL files in
                                the NDCPARM directory,
                                however, the amplitudes in the
                                WASCEL directory remain
                                unchanged.

FIN  Inst                KEF  No response information was supplied
                         NUR  in the XW01 messages for theses
                         PKK  stations, although we did receive these
                         PRF  through e-mail after the experiment.
                         SUF  These response files can be found in
                              the RESPONSE directory.

FRA  Inst                LOR  The calibration factor
                              reported in the WID1 sections
```

			of XW01 messages was in units of (nm/s)/count, not nm/count as was indicated. The correct calibration value for the sz channel of LOR is .097148 nm/count. This has been updated in all WFDISC files and the INSTRUMENT file.
GBR	Inst	EKA	The instrument response for this station does not include an anti-aliasing filter.
IND	Inst	GBA	The instrument response for this station does not include an anti-aliasing filter.
	Wave	All Data Days	GBA The start time for the waveform segments are generally misreported as the time of the initial phase arrival contained within the segment. This makes the segment start time approximately 30 seconds later. Note: No change has been made in the WFDISC file, due to the lack of precise start time of the waveforms.
ITA	Inst	AQU	The calibration factor reported in the WID1 sections of XW01 messages was incorrect. The correct value is .1355014 nm/count at 1Hz, which was sent to us by ITA after the experiment. This has been changed in all the WFDISC files and the INSTRUMENT file.
	P/W	All Data Days	All waveform data for AQU have the incorret longitude in the header. The correct location for AQU is latitude 42.3539, longitude 13.4031. This change has been made to the SITE file. The incorrect location of the station remains in the SITE file under the station name AQUX. This may result in incorrect origin and origin error determination, as well

as errors in time residuals in the WASCEL tables and in the bulletins in the GSEBULL directories.

	Param		AQU	"Outages reported: 06May 14:04 to 21:00 19May 11:35 to 13:55"
	Wave 22Apr-23May 23:59		AQU	"The start time of the segments is 30 seconds too early due to software problems."
JPN	Inst		MAT DIR IRK JZO SGD TKM WDR	The calibration factor reported in the WID1 sections of XW01 messages for short period channels was incorrect. The correct value is .24288 nm/count at 1Hz, which was sent to us by JPN after the experiment. This has been updated in all WFDISC files and the INSTRUMENT file.
			MAT	The calibration period reported in the WID1 sections of XW01 messages for long period channels was incorrect. The correct value is 16 sec, which was sent to us by JPN after the experiment. This has been updated in all WFDISC files and the INSTRUMENT file.
			MAT	The response curve for MAT was reported in PAZ format, and there appeared to be an extra set of zeroes. These zeroes have been removed from the response in order to produce the correct response. This changes can be found in the response files MAT_LP.1, MAT_LP.2, and MAT_LP.3. We have no response information for DIR,IRK,JZO,SGD,TKM, and WDR.
	Param	10May	MAT	"To correct an hour entry between "LPZ LR" and "0509" In our report, one rayleigh wave was described as "LPZ LR0509". However this was inadvertent. The correct

report is "LPZ LR140509". "LR0509" was associated as "LR130509" in "12:-15:58.4 COLORADO" in FEB."

Note: The correct time has been put in the ARRIVAL file in the NDCPARM directory, however, the incorrect value remains in the ARRIVAL file in the WASCEL directory.

12May MAT "Add the following description:
MAT IPC123923.9
SLO8.17 AZ143
S4857.0 PCP3936.0 SSS5708.0
LPZ LR130000.0"

Note: This report has been put in the ARRIVAL file in the NDCPARM directory, however, it does not appear in the ARRIVAL file in the WASCEL directory.

20May MAT "Correct an hour entry between "LPZ LR" and "0300" The correct report is "LPZ LR170300". "LR030-0" was misassociated as "LR160300" in FEB."

Note: The correct time has been put in the ARRIVAL file in the NDCPARM directory, however, the incorrect value remains in the ARRIVAL file in the WASCEL directory.

23MAY MAT "Correct an hour entry between "SS" and "06-15.0" The correct report is "SS070615.0". "SS0615.0" was misassociated as "SS060615.0" in FEB."

Note: The correct time has been put in the ARRIVAL file in the NDCPARM directory, however, the incorrect value remains in the ARRIVAL file in

				the WASCEL directory.
		01JUN		MAT "Correct an hour entry between "ES" and "00-08.1" The correct report is "ES070008.1". "ES0008.-1" was misassociated as "ESO40008.1" in FEB." Note: The correct time has been put in the ARRIVAL file in the NDCPARM directory, however, the incorrect value remains in the ARRIVAL file in the WASCEL directory.
	Wave	22APR		MAT "We could not send data recorded earlier than 9(UT) due to failure of our system."
		24APR		MAT "The data could not be sent to due to delay in receiving them."
		13MAY		MAT "Our system was in trouble, so we could not get the waveform data of the event whose p-time at Matshushiro was 11:20:04(UT)"
NZL	P/W	25Apr-26May		WEL "Station reported in place of SNZO during outage periods for SNZO."
PAK	Inst		NIL	The instrument response for this station does not include an anti-aliasing filter.
POL	Inst		KSP	There were two different calibration values reported for the KSP/sz channel. The correct value is .008387 nm/count, and all the WFDISC files and the INSTRUMENT file has been updated to reflect this.
	Inst		SFP	The response curve for this station was not provided. Two different calibration values were supplied for SFP/sz. The correct value is .008387 nm/count, and all WFDISC files and the INSTRUMENT file have been

updated to reflect that.

	Param	22Apr-30Apr 11:59	SFP	"Time Uncertain, synchronization error at station. Vertical component scaled in a wrong manner, too large in comparison to horizontals. Azimuth,slowness and angle of incidence not meaningful due to amplitude error. Operators not experienced in Phase Identification. Outage reported for 30Apr 12pm to end of the experiment."
		All Data Days	KSP	"Operators not experienced in Phase Identification. Outages reported for 21May 02:22 to 23May 00:00, 23May 03:06 to 23May 13:18, 30May 07:59 to 30May 08:33, 31May 00:00 to 31May 00:10. Possibly other short periods of outage before 20May."
ROM	Inst		MLR	There were 2 waveforms that had a calibration value of 9.0 nm/count. These two waveforms were updated in the WFDISC files and INSTRUMENT file to have the correct value of .177800 nm/count.
	Wave	All Data Days	MLR	The location of the station is incorrect in the Sourcebook and XW01 messages transmitted by ROM. The correct coordinates are: Latitude: 45.4916 Longitude: 25.9436 This may result in incorrect origin and origin error determination, as well as errors in time residuals in the WASCEL tables and in the bulletins in the GSEBULL directories. The information in the SITE file for MLR includes the correct location. The (incorrect) location used during the experiment is available as the station name MLRX.

SOV	Inst		ARU GAR KIV OBN	These stations reported two different calibration values. The erroneous calibration values are reportedly associated with waveforms which were responses to requests. We have discussed this with SOV, and the correct values are: ARU .30860146 nm/count at 1 Hz. GAR .34441131 nm/count at 1 Hz. KIV .37067188 nm/count at 1 Hz. OBN .30907891 nm/count at 1 Hz. All WFDISC files and the INSTRUMENT file have been updated to reflect these changes.
	Param	24Apr	ARU	"Reported outage correction: 185506 to 185730" Note: this outage has been corrected in the appropriate STAOUT file.
		01May	KIV	"Reported outage correction: 050548 to 050616" Note: this outage has been corrected in the appropriate STAOUT file.
		15May	OBN	"Reported outage correction: 055845 to 055957" Note: this outage has been corrected in the appropriate STAOUT file.
SWE	Param	All Data Days	HFS	"Many local/regional events reported with slowness and azimuth of 000 although the focus line is correct." Note: these arrivals have been given null values for slowness and azimuth in both the WASCEL and NDCPARM ARRIVAL files.
USA	Inst		All	Several waveforms were reported with a calibration value of 1 nm/count at 1 Hz. These appeared to only be

			responses to requests. All of the other waveforms were reported with a calibration of .009 nm/count. All waveforms from these stations with a calibration value of 1 nm/count were updated in the WFDISC files to have the correct value of .009 nm/count.
		All	The instrument responses for the USA stations do not include anti-aliasing filters.
	P/W	All	The elevations reported in XW messages are not reliable. The values in the SITE file were obtained from the Sourcebook.
	P/W	22Apr-31May	BKS sp "All BKS short-period amplitudes before 2000 hour Data Day 151 are too large; they should be multiplied by 0.009. Later amplitudes should be correct." Note: This change has been made to all relevant WFDISC files and to the INSTRUMENT file, as well as the ARRIVAL files in the NDCPARM directory. The change has not been made in the ARRIVAL files in the WASCEL directory.
	P/W	All Data Days	BLA "Unspecified timing problems were reported."
	P/W	All Data Days	PFO "Back azimuths were off by 90 degrees due to orientation problem with horiz. channels."
ZMB	Inst	LSZ	No calibration data was supplied in the WID1 section of the XW01 messages for LSZ, so we are unable to produce a true response for LSZ.

File Name: CONTACTS.DOC

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August 1991

This file contains the names and addresses of the coordinators at the Experimental International and National Data Centers at the time of GSETT-2. Also given are the names and addresses to which specific questions about data centers and the data for which they are responsible can be forwarded (Section 3.0).

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