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BMR RECORD 1992/14

QUAKES

BMR-ASC WORLD EARTHQUAKE DATABASE USER'S MANUAL

by

S.L. LENZ, K.F. MCCUE & G.R. SMALL

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QUAKES
BMR-ASC WORLD EARTHQUAKE DATABASE
USERS' MANUAL

S. L. Lenz, K. F. McCue and G. R. Small

BMR Record 1992/14
March 1992

Commonwealth of Australia, 1992

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ISSN 0811-062X
ISBN 0 642 175 22 5

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1. INTRODUCTION

This manual describes the origin and structure of QUAKES, the BMR-ASC World Earthquake Database, and how to insert, update or delete records in the database as well as how to retrieve reports and produce plots of subsets of the data. It also describes how the database administrator (DBA) can make amendments to the database structure should they be necessary.

On average this century, earthquakes have killed more than 10,000 people per year. It is usually not the infrequent great earthquakes of magnitude 8 or more which account for most of the destruction but the more frequent earthquakes in the magnitude range 6.5 to 7.5. Great earthquakes, of magnitude 8 or more, occur about once each year, those of magnitude 7 or greater are more frequent at about 10 per year, and those of magnitude 6 and above occur at the rate of more than 100 per year.

The spatial distribution of epicentres is not uniform and most of the great earthquakes occur around the Pacific Ocean rim (see plot p. 16). A glance at any recent map of world epicentres confirms the basic tenet of plate tectonics theory: that most earthquakes occur in narrow belts enclosing large areas of low seismicity (the plates). But even in the interior of the plates, destructive earthquakes do occur and occasionally with tragic consequences. The 1976 Tangshan earthquake in northeast China, magnitude Ms 7.6, reportedly killed 300,000 people in the city. The relatively small earthquake at Newcastle NSW on 28 December 1989, Richter magnitude 5.6, killed 13 people and seriously injured 160 others. The damage bill topped $1.2 billion, the highest loss from any natural disaster in Australia's recent history.

To minimise future injuries and loss of life and prevent building collapse, the earthquake hazard must be properly evaluated. We need to know where and with what frequency such earthquakes are likely to occur, and estimate the nature of the ground shaking that buildings must resist, its amplitude, frequency content and duration. Information on the relative frequency and spatial distribution of earthquakes can be qualitatively assessed from epicentre maps. Such maps are plotted from any of several world earthquake databases such as those compiled by the International Seismological Centre (ISC-UK) or National Earthquake Information Centre (NEIC-US) to which BMR contributes data from a large and important sector of the planet.

The Australian Seismological Centre (ASC) at BMR, in cooperation with State and university seismological agencies, operates the Australian National Seismographic Network with seismographs in all States and Territories including Antarctica. The data collected, both analogue and digital, are used to compute the parameters of all earthquakes of magnitude 3 and above: location, depth, magnitude, origin time, mechanism etc. and this information is appended monthly to the data file at the ASC. The seismological data are telemetered to international agencies which compile whole-earth catalogues including selected Australian data.

The data on Australian earthquakes are used to update the Australian Hazard Map in the Australian Loading Code, every five to ten years. It is regularly searched for insurance and engineering companies based in Australia. The world data are essential for seismological research into the causes of earthquakes, their location and frequency, and the relative frequency of earthquakes in different regions. Australian structural and geotechnical engineers, architects and seismologists are increasingly being engaged in overseas projects requiring a knowledge of past and likely future earthquakes. Over recent years projects have been undertaken by Australian firms in many places including New Zealand, Papua New Guinea, Fiji, Indonesia, Nepal, China and South America. It is anticipated the BMR-ASC World Earthquake Database described in this Record will be readily accessible to such people.

THE NEIC DATABASE: A World-Wide Standardised Seismographic Network (WWSSN) was established by the United States Geological Survey (USGS) through the early 1960s to determine whether seismological methods would be sufficient to monitor a proposed ban on the testing of nuclear weapons, a Comprehensive Test Ban Treaty. Australian WWSSN stations are at Mundaring WA (MUN), Adelaide SA (ADE), Hobart Tasmania (TAU), Riverview NSW (RIV) and Charters Towers Qld (CTA). Phase data (seismic wave arrival times) from these and all other BMR seismographs are telexed daily to a World Data Centre at the USGS in Colorado where preliminary epicentres are determined. These data are distributed to contributing stations, within 10 days via telex (Quick Epicentre Determinations - QEDs), within a month as monthly listings (Preliminary Determination of Epicentres - PDEs), and 6 months as comprehensive Earthquake Data Reports (EDRs) containing not only the focal coordinates but the phase data from each station.

The NEIC data together with data which did not arrive at the NEIC in time for inclusion, or were corrected using residual times reported in the EDRs, are compiled for a final epicentre determination by the ISC at Newbury, England.

THE ISC DATABASE: The first rudimentary world seismographic network was established through the British Association for the Advancement of Science (BAAS) at the end of the 19th century. They recognised the need for a worldwide network of similar instruments and distributed the underdamped low-gain Milne seismograph. In Australia, the Australian Association for the Advancement of Science installed these seismographs at Perth, Adelaide, Melbourne and Sydney, between 1901 and 1906. The BAAS also published annual reports of Seismological Investigations for the period 1896 to 1917.

From 1918, phase data were collected by the International Seismological Summary (ISS) at Kew Observatory, UK. Epicentres were computed manually and the results distributed in bulletins for the years 1918 to 1963. The early post-1904 BAAS data were reworked and added to the catalogue. The ISS and the Bureau Central International de Seismologie (BCIS) combined to produce the ISC bulletins from January 1964. They are published monthly, two years in arrears.

Computer locations were introduced routinely at the ISS on 1July 1960 and at the USGS on 1August 1960. The original computer database was established then and earlier historical data were added later. Date, time, latitude, longitude, focal depth, magnitude (various scales), seismic moment, focal mechanism parameters, and errors in all parameters are stored as well as the phase data and descriptions of damage, tsunamis, landslides and other secondary effects.

Such databases are important; they enable seismologists to study seismic wave travel times which in turn are used to refine earthquake focal parameters and, on inversion, model the internal structure of the earth. Relative seismic hazard analyses can be made such as between inter-plate and intra-plate regions, and discriminants can be devised for identifying nuclear explosions from earthquakes.

Accumulating sufficient data on intra-plate seismicity may yield patterns in the epicentres allowing seismologists to establish a cause for such activity, or alternatively demonstrate that there is no pattern. Either outcome will lead to an improvement in hazard estimation and modelling. An important subset of the world database is the Australian Plate subset, both edge-plate and intra-plate foci.

Following are the sources of data in the ISC database:

1904 - 1952	Gutenberg & Richter: Seismicity of the Earth.
1913 - 1963	International Seismological Summary (ISS).
1935 and 1950 - Nov 29, 1963	Bureau Central International de Seismologie (BCIS).
1950 - 1963	L.R. Sykes catalogue of ridge events.
1928 - 1960	United States Coast and Geodetic Survey.
1964 - 1981	International Seismological Centre (ISC) prime estimates.
1982 - 1984	Preliminary Determination of Epicentres from United States National Earthquake Information Service (NEIS).
1983 - 1989	Telex reports from NEIS and other sources.

THE AUSTRALIAN EARTHQUAKE DATA FILE: Overall seismological coverage of the Australian Plate is poor. Until 1980 even a magnitude 4 earthquake could have gone unnoticed in some areas although as early as the mid 1960s in areas such as southeast South Australia, Tasmania, southwest Western Australia and southeast Victoria and New South Wales, every magnitude 2 earthquake could be located with an accuracy of about 20 km. The net result is that the current Australian earthquake data file, like the world databases, is not homogeneous; it contains relevant information on all earthquakes of magnitude 6 or greater back to 1900, those down to magnitude 5 since 1960 and to magnitude 4 since 1980. BMR's goal is to locate every magnitude 3 earthquake in the continent, to reduce the error to less than 15 km and, with the cooperation of State governments, to improve that capability around the major population centres.

THE BMR-ASC WORLD EARTHQUAKE DATABASE: Data from the Australian Earthquake Data file and the ISC database have been combined to form QUAKES, the BMR-ASC World Earthquake Database. Only earthquakes of magnitude 4 or more have been transferred from the Australian Earthquake Data file to QUAKES. In addition, information on revised 'great' earthquakes (magnitude 8 or more) has been extracted from Kanamori (1983); the revised list of major New Zealand earthquakes (magnitude 7 or more) has been extracted from Dowrick (1991), and the major Papua New Guinea earthquakes have been updated from Ripper (1991).

Care must be exercised in using the data extracted from the database because they are incomplete and inhomogeneous. Users of the database should discuss any problems associated with interpretation of the data with ASC seismologists.

2. STRUCTURE OF THE DATABASE

2.1 The relational model

The BMR-ASC World Earthquake Database has been set up on BMR's DG MV20000 in ORACLE, a relational database management system (RDBMS). Because relational database terms are used inconsistently in the literature (Brathwaite, 1989, p. 66) short definitions of the terms used in this manual are given here.

In the relational database model we talk about **data entities** and the **relationships** between these entities. The basic (and only) unit of data storage in a relational database is the **table**, a two-dimensional grid of columns and rows. An **entity** is any distinguishable object that is to be represented in the database; usually at least one table is set up to contain the **attributes** of each entity. Every table within the database is defined with a name and a set of columns. The attributes which characterise the entity are the columns in the table. Each column is given a name, a datatype, and a width. The distinct instances or occurrences of the entity, the so-called records or table rows, each have a certain set of attribute values.

Relational databases are firmly based on mathematical set theory and relational algebra. Operators like UNION, INTERSECT and DIFFERENCE can be used to create new tables from existing ones. The **relationships** between entities are logical links between them which can be used to associate data in one table with data items in another. This is usually done by "joining" two tables through data values which are common to both tables.

If one record in a table relates to a single record in another table we talk of a **one-to-one** relationship. Similarly, if one record in the first table corresponds to more than one record in the second table, we are looking at a **one-to-many** relationship. Finally, a **many-to-many** relationship occurs when several records in the first table correspond to more than one record in the second table.

A **key** within a table is an attribute (column) or attributes whose values uniquely identify each record (row). For instance, in the QUAKES database the record number (*recno*) is the key to the DETAILS table, and the combination of *recno* with order number (*ordno*) is the key to the ECOMMENTS table.

Indexes can be used to speed up execution of transactions and, in the case of "unique indexes", to guarantee uniqueness of records.

2.2 Tables

QUAKES comprises a total of 10 tables, of which 3 are temporary tables, for the following data entities: **earthquake details**, **epicentre comments**, **effects**, **intensities of Australian earthquakes**, **non-epicentre comments** and **contributing agencies** (see Appendix A: Logical data structure). The temporary tables only exist for a short period while data are being loaded from data files into ORACLE. A view (subset of data attributes) of the LOCATION database called LOCS can be accessed from within SQL*Plus or the DETAILS form. It is used when entering localities for reports on intensities of Australian earthquakes.

The main table is called DETAILS and it contains all the basic attributes like date, origin time, latitude, longitude, focal depth and magnitude of all events with recorded magnitudes. Events without recorded magnitude values are stored in table NOMAGS. The unique identifier (key) for each event is a system-generated sequential number, the record number (*recno*).

There can be more than one secondary effect like structural damage, tsunamis or landslides reported for an event, as there can be many reports on intensities for a given Australian event. Because of these one-to-many relationships between an event and effects/intensities, separate tables called EFFECTS and INTENSITIES contain these attributes. They are linked to the main tables DETAILS and NOMAGS through the record number (*recno*).

The data tapes from ISC with the yearly updates contain epicentre and non-epicentre comments for some events. These data are loaded into tables ECOMMENTS and COMMENTS. The epicentre comments are linked to a particular event through field *recno*, non-epicentre comments can be related back to an event through fields *qdate* and *origin_time*. Table SOURCES contains a list of codes and descriptions of the agencies contributing data to ISC.

Temporary tables called TEMP_DETAILS and TEMP_ECOMMENTS (for ISC data), as well as TEMP_AUSDETAILS (for Australian data) are created once each year for loading data from data files on the DG into ORACLE and for conversion of data items into the format required in the permanent tables. After all data have been transferred to the permanent tables the temporary tables are deleted.

The database schema (Appendix B) contains a description of the tables and their attributes, and the relationships between them. Appendix H gives definitions of the seismic parameters contained in the database.

3. QUAKES IN ORACLE

3.1 ORACLE tools and utilities

The ORACLE relational database management system may be accessed via the **S**tructured **Q**uery **L**anguage (**SQL**). There are four different types of SQL statements:

-	data definition	e.g.	CREATE TABLE...
-	data control	e.g.	GRANT SELECT...
-	data manipulation	e.g.	INSERT...
-	data query	e.g.	SELECT * FROM...

The data definition and data control statements are used when setting up, or changing the structure of, the database, and for controlling data access. These are mainly tasks performed by the DBA. Data manipulation and data query statements are used for inserting, updating and deleting records as well as for data retrieval.

SQL*Plus is an extended version of SQL for ORACLE which allows for limited report formatting in addition to the ANSI standard SQL functions.

Data manipulation and query, as well as some of the data control statements, are invoked from within **SQL*Forms** without the user having to learn the SQL syntax. SQL*Forms is a full-screen interface tool for creating, modifying and using forms for data entry and retrieval in an ORACLE database. Records may also be updated or deleted through SQL*Forms (see Chapter 5: Querying/updating the database).

SQL*Loader is an ORACLE tool used to load data from ASCII files on the DG into ORACLE tables after a data tape has been received from ISC or after data have been extracted from the ASC data file (see Chapter 4: Loading data into the database, for the load procedures).

The utilities **EXPORT** and **IMPORT** are discussed briefly in Chapter 8: Database administration.

For more detailed information on the use of these tools and utilities refer to the user guides and reference guides listed in Chapter 9: References.

3.2 The MENU form

In the near future BMR's DG MV20000 will be replaced with a database server running UNIX and all databases will be moved progressively to this new machine. This changeover will bring changes to the logon procedures but all ORACLE procedures will remain the same. It is assumed that anyone attempting to use the QUAKES database at this stage is familiar with the DG and its operating system AOS, and also has some basic knowledge of SQL.

In order to access the database and use the QUAKES forms the prospective user must be a registered ORACLE user with a username and a password. On BMR's DG MV20000, all forms and files for accessing QUAKES reside in a directory called :ULD:QUAKES. Any DG user may add this directory to his/her search list (at the DG prompt, type **SEA :ULD:QUAKES [!SEA]**) and read or execute the forms, the report file etc. as the public has been granted SELECT privileges to all tables which means they can be viewed by any ORACLE user. Public synonyms have been created for all tables in QUAKES which allows them to be called by the names used in this manual without having to prefix them with the name of the owner ('QUAKES.'). Only ASC seismologists may manipulate (INSERT, UPDATE, DELETE) data in the database.

Keyboard **keys** are referred to by their SQL*Forms **function** in this manual (see Appendix D: Keyboard overlays for ORACLE). The available functions are different for designers and operators, and different again in query and entry mode. A listing of the available functions within SQL*Forms can be displayed on the screen by pressing the key called **<SHOW FUNCTION KEYS>.**

A menu-based system for accessing the database has been set up. To access QUAKES, log on to the LAN and the DG, add the QUAKES directory to your search list (see above), then type

QUAKES

You will be prompted for your ORACLE username and password, and then the following menu will come up on your screen:

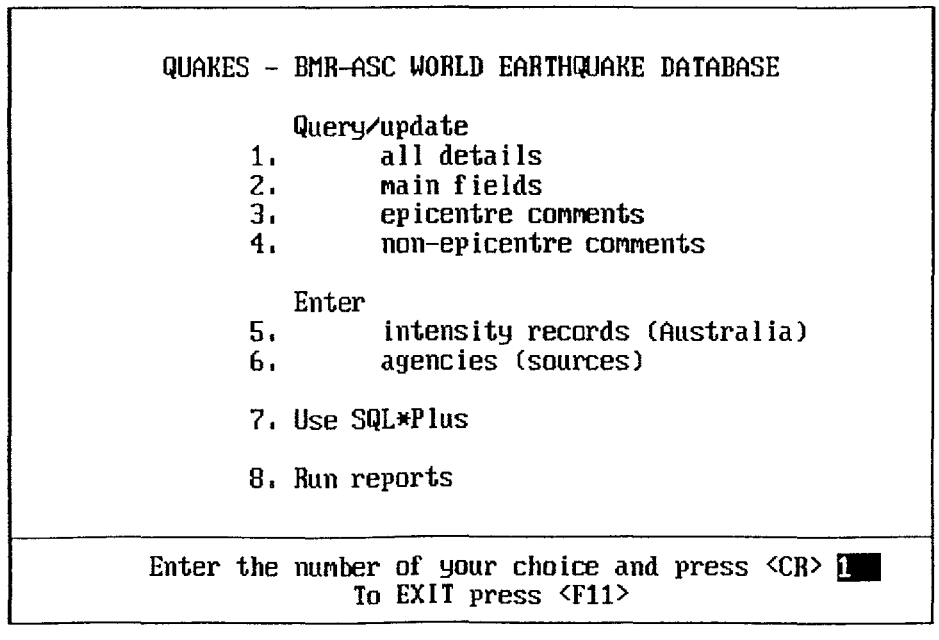


Figure 1. The QUAKES menu.

The individual menu options are discussed in chapters 5 and 6.

To exit the form, press **<EXIT/CANCEL>**.

4. LOADING DATA INTO THE DATABASE

This chapter is only relevant to ASC staff who are the custodians of the earthquake data.

The procedure for loading data into the database incorporates the following steps:

transfer data from tape/other computer to DG;
create temporary tables;
check for the maximum existing record number;
load data into temporary tables;
check for numbers of records to be updated in individual updates;
update records in the temporary tables;
transfer records to the final tables; and
delete the temporary tables.

Appendix C gives an overview of the processing steps involved in transferring data from tape to DG, and also listings of the SQL files used in the subsequent steps. The following is a description of the individual steps.

4.1 Transferring data from ISC tape to ORACLE tables

The data received on ISC tapes have to be transferred to the DG in a decompressed and somewhat changed format (e.g. decimal points inserted into fields origin time, latitude and longitude). This is achieved by running a Fortran program called TOFIX_4. Before this program is run, a program called TLOOK which resides in the BMR commands directory is run to ascertain the record size. From within your DG directory,

type **TLOOK p1 p2**

where p1 is the tape number supplied by the BMR computer operators when they receive the tape;
p2 is the number of end of file markers (EOF) - usually 2.

Check the output file TLOOK.OUT for information on file and record sizes of all files on the specified tape. If the record size is **not** 16384, the number 16384 in the macro LOAD_DATA.CLI has to be changed to the maximum record size specified in TLOOK.OUT.

The tapes received from the ISC contain data for one year, i.e. there is one data file per month and one program file for decompressing the data files. The program TOFIX_4 is a modified version of the program supplied on the ISC tape.

A macro has been set up to run the de-compressing and re-formatting program:

type **LOAD_DATA p1 p2**

where p1 is the tape number
and p2 is the file number (the first file is number 0 - zero, it contains the source code and does not need to be processed).

Run the program for all twelve data files. It creates two files per month of data: one file with epicentre records, the second with non-epicentre comments, which are named **ASC_JAN_1.2** to **ASC_DEC_1.2** and **ASC_JAN_3.4** to **ASC_DEC_3.4** respectively.

At this stage it is advisable to ask the Information Systems Branch computer operators for a user backup of the QUAKES directory to ensure that there is no need to re-run this program in case of data loss or corruption in subsequent steps.

From the next processing step on ORACLE tools are used: To create temporary tables, go into SQL*Plus (option 7 on the menu, see page 5) and

type **START TEMP**

which runs the SQL script TEMP.SQL creating tables TEMP_DETAILS and TEMP_ECOMMENTS (see Appendix C).

Before leaving SQL*Plus, run the SQL script that checks for the maximum record number in the database:

type **START CHECKMAX**

It produces an output listing called CHECKMAX.LIS containing two maximum record numbers, one for table DETAILS, the other for table NOMAGS. The higher of the two is the maximum record number in the database and is needed in the next processing step.

Exit SQL*Plus and the menu by typing: **BYE** and pressing **<EXIT/CANCEL>**.

The next step is to load the data from the data files on the DG using SQL*Loader. The command for invoking SQL*Loader is:

SQLLOAD username/password control-filename

where username/password is your ORACLE username and password combination,
and control-filename is QUAKES12.CTL for epicentre records
QUAKES34.CTL for non-epicentre comments
and QUAKESAU.CTL for the Australian data file.

The control files (see Appendix C) reside in the QUAKES directory. They have to be edited in SLATE or some other editor on your machine prior to running SQL*Loader for each month's data files.

For the non-epicentre comments (ASC_JAN_3.4 to ASC_DEC_3.4) which are loaded straight into table COMMENTS:

- change the data filename in control file QUAKES34.CTL to **'ASC_JAN_3.4'**
- at the DG prompt, type in

SQLLOAD username/password QUAKES34.CTL

- repeat the procedure for all subsequent months.

Check file QUAKES34.BAD after each run as existing "bad records" (records that don't fit the specifications in the control file) will be written to this file. There are usually a few records in each yearly batch which are simply too long to fit into the four fields of 240 characters length provided in table COMMENTS. They are reported as bad records and can in general be ignored. But there might be some other problems with the data (e.g. changed record format in the ISC data files) which will show up in the bad file QUAKES34.BAD and the log file QUAKES34.LOG and which will need to be rectified before proceeding with data loading.

To load the epicentre data, edit the control file QUAKES12.CTL:

For the first month,

- change the name of the data file to **'ASC_JAN_1.2'** and change the specifications of field recno from **'MAX'** to the numeric value of **max(recno) + 1** (add 1 to the highest number resulting from running the CHECKMAX procedure - see above);
- at the DG prompt, type in

SQLLOAD username/password QUAKES12.CTL

For the next month, February,

- change the name of the data file to '**ASC_FEB_1.2**' and change the numeric value for recno back to '**MAX**'. Before loading any data SQL*Loader will scan the TEMP_DETAILS table for the maximum record number and will automatically create the following sequential numbers from then on;

- run SQL*Loader: At the DG prompt, type in

SQLLOAD username/password QUAKES12.CTL

For subsequent months only the name of the data file need to be changed (to ASC_MAR_1.2, ASC_APR_1.2 etc.) in the control file QUAKES12.CTL before re-running SQL*Loader.

After each run of SQL*Loader check files QUAKES12.BAD and QUAKES12.LOG for any bad records which might have to be amended before they can be loaded using the renamed QUAKES12.BAD file (renamed to say QBAD.DAT) as data filename in the control file.

The next steps involve using SQL*Plus: select option 7 from the menu (see page 5):

- check for numbers of records to be updated. At the SQL> prompt, type

START PRECHECK

- update the magnitude fields. Type

START UPDATE1

- create and update epicentre comments records in table ECOMMENTS. Type

START UPDATE2

The output listing of the checking procedure (PRECHECK.LIS) shows the number of records each update statement will process - compare listing PRECHECK.LIS with listings UPDATE1.LIS and UPDATE2.LIS.

If you are satisfied that the correct numbers of records have been updated, run the procedure for transferring the epicentre records from the temporary tables to the final tables. At the SQL> prompt, type

START INSERTS

A final check of the output listing INSERTS.LIS should satisfy you that all the data for a complete year have been transferred and now the temporary tables can be deleted. At the SQL> prompt, type:

DROP TABLE TEMP_DETAILS;

DROP TABLE TEMP_ECOMMENTS;

4.2 Transferring data from ASC data file to ORACLE tables

The previous year's data from the Australian data file are loaded into the ORACLE database at the beginning of each year. The individual steps involved are basically the same as for ISC data; only the names of the temporary table and the SQL script files are different, in most cases.

To create the temporary details file called TEMP_AUSDETAILS, go into SQL*Plus (option 7 on the menu) and

type **START TEMPAUS**

which runs the SQL script TEMPAUS.SQL (see Appendix C). Then run the SQL script that checks for the maximum record number in the database:

type **START CHECKMAX**

The output listing it produces, CHECKMAX.LIS, contains two maximum record numbers, one for table DETAILS, the other for table NOMAGS. The higher of the two is the maximum record number in the database and is needed in the next processing step.

Exit SQL*Plus and the menu by typing: **BYE** and pressing **<EXIT/CANCEL>**.

The data file containing one year's data is called AUSQUAKE.DAT after it has been produced on the ASC's Webster computer and transferred to the DG via their Sun computer. Before loading the data into ORACLE with SQL*Loader, change the specifications of field *recno* in the control file QUAKESAU.CTL to the numeric value of **max(recno) + 1** (add 1 to the highest number resulting from running the CHECKMAX procedure - see above). Then, at the DG prompt, type

SQLLOAD username/password QUAKESAU.CTL

Check files QUAKESAU.BAD and QUAKESAU.LOG for any bad records which can be amended before being loaded using the renamed QUAKESAU.BAD file (renamed e.g. to QBAD.DAT) as data filename in the control file QUAKESAU.CTL.

The next steps involve using SQL*Plus: select option 7 from the menu (see page 5):

- check for the number of records contained in table TEMP_AUSDETAILS:

1) **SELECT COUNT(RECNO) FROM TEMP_AUSDETAILS;**

- update the maximum magnitude field *m_max*. Type

2) **START UPDAUS**

- insert the records into table DETAILS:

3) **START INSAUS**

The number of records updated and inserted in the last two steps should be the same as the result of the count in step 1. Now the temporary table can be deleted. At the SQL> prompt, type

DROP TABLE TEMP_AUSDETAILS;

5. QUERYING/UPDATING THE DATABASE

5.1 Using SQL*Forms

5.1.1 General comments

The following forms have been set up for use with the QUAKES database: DETAILS, MAIN FIELDS, ECOMMENTS, COMMENTS, INTENSITIES and SOURCES (menu options 1 - 6). Following is a general description of how to use the query/entry forms. The individual forms are discussed under 5.1.2 to 5.1.4.

The query/entry forms are made up of **blocks**. Each block corresponds to a different table (= base table) in the database. The DETAILS form is made up of five blocks on two screens, representing one event and the effects and epicentre comments relating to it on the first screen (3 blocks). The second screen has two blocks: one corresponding to the view LOCS of the LOCATION database, the second represents the intensities of Australian earthquakes. The individual blocks in this multi-block form are indicated by solid lines on the screen.

The **cursor** generally moves within the screen from left to right and from top to bottom. Watch the **message line** at the bottom of the screen closely as you move through the fields using the **<NEXT FIELD>** key to go forwards and the **<PREVIOUS FIELD>** key to go backwards. The message line displays help messages for data entry and error messages should something go wrong. There is also a **<DISPLAY ERROR>** key that gives additional information on errors which have occurred.

Blocks can either display only one record per screen (e.g. the DETAILS block of the DETAILS form), or they can display several records at a time (the MAIN FIELDS form and the EFFECTS block in the DETAILS form are examples). Some fields are **mandatory** which means a valid value must be entered before the cursor can move out of the field. Look at the help message or the database schema (Appendix B) if you are uncertain about the data type for a particular field.

Should you realize after leaving a field that you have made a mistake while entering data, you can always take the cursor back by pressing the **<PREVIOUS FIELD>** key for moving within a block or the **<PREVIOUS BLOCK>** key to take you back through blocks. Correct the mistake by typing over it.

It is generally recommended that users save the added/updated record/s in each block to the database (which is accomplished by pressing **<COMMIT TRANSACTION>**) before moving to the next one or exiting the form. The message **"n records processed"** indicates that changes have been committed to the database.

QUERYING THE DATABASE: Access the appropriate form by entering the corresponding number on the menu. To retrieve all records in a particular block which satisfy certain conditions, press **<ENTER QUERY>** and then enter the values of the attributes (fields) which you are interested in, moving from field to field by using the **<NEXT FIELD>** and **<PREVIOUS FIELD>** keys. Pressing **<EXECUTE QUERY>** will result in the record/s being displayed on the screen. To scroll through the records which satisfy your query criteria use the **<NEXT RECORD>** and **<PREVIOUS RECORD>** keys.

DELETING RECORDS: If a record has to be deleted, use the above procedure to call it up on the screen and then press **<DELETE RECORD>. Caution:** Make sure the cursor is really positioned on the record you want to delete before pressing the delete key.

UPDATING RECORDS: To update or make changes to a record, use the above procedure to display it on the screen and then place the cursor in the field you want to update or change. Make the necessary amendments to the field/s using the editing keys (**<LEFT ARROW>, <RIGHT ARROW>, <BACKSPACE>** and **<INSERT/REPLACE>**) and by typing over the existing field value.

ENTERING NEW RECORDS: After pressing the corresponding number on the menu for a certain form the cursor enters an empty block. A new record can be entered straight away by typing values into all fields for which data exist. If the block already contains data, press **<CLEAR BLOCK>** to clear the screen/block ready for entering a new record.

5.1.2 The DETAILS form - menu option 1

From the QUAKES opening menu (page 5) choose option 1. The following form will appear on the screen (without data):

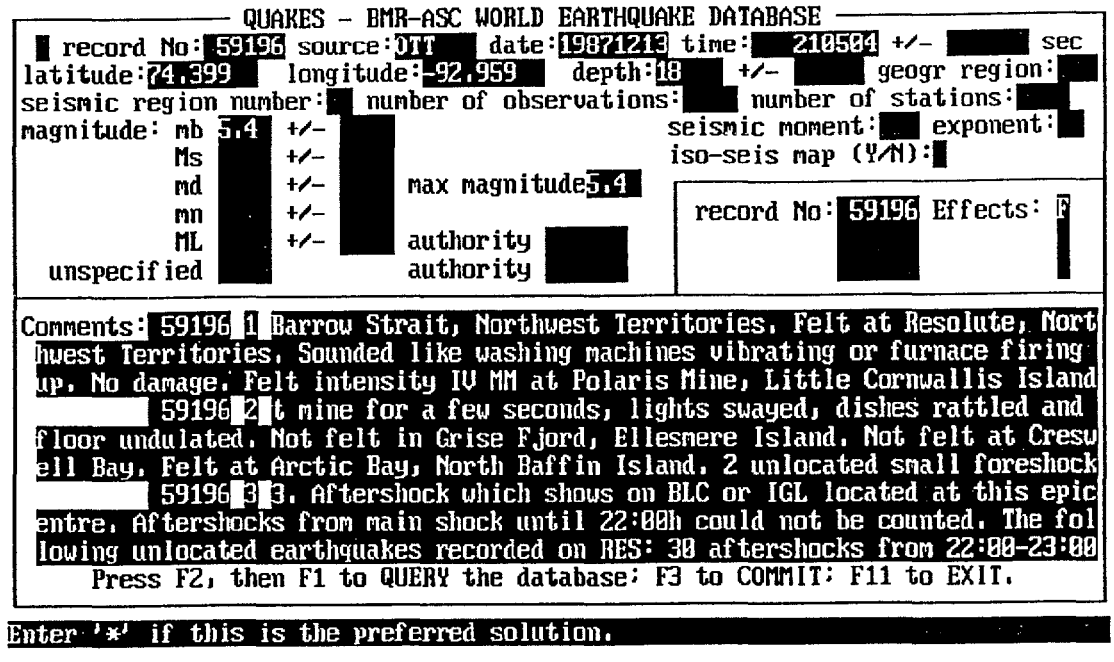


Figure 2. The DETAILS form, first screen.

The top half of the screen contains a block for the seismic parameters of one event and a (small) block for the secondary effects associated with the earthquake. The bottom half of the screen provides space for comments on the particular event displayed at the top. Three comments fields can be displayed on the screen at the same time which is the equivalent of 720 characters of text. A maximum of four comments fields can be associated with any one event in the database. In practice most events have no epicentre comments at all relating to them, and of the events with epicentre comments the majority only have text in the first comments field.

To retrieve data, press **<ENTER QUERY>** and input your selection criteria, e.g. an individual record number, a specific date, an individual source code etc., or a combination of any of the attributes. Pressing **<EXECUTE QUERY>** will retrieve the records that satisfy the specified condition/s.

To specify a range of record numbers, say, or a range of dates, press **<ENTER QUERY>** and enter a '**&**' into any field and then press **<EXECUTE QUERY>**. An additional, scrollable entry line will be displayed at the bottom of the screen prompting for the conditions of the WHERE clause (see also 5.2). Enter e.g. **'QDATE BETWEEN 19800101 AND 19800110'** to retrieve all the events between the first and the tenth of January 1980, and press the **<NEXT FIELD>** key which results in the specified retrieval. Note that the database fieldnames have to be used here, **not** the names on the screen (see Appendix B: Database Schema).

To specify a more complex WHERE clause, e.g. a combination of a range of dates, a range of depths and a range of magnitudes, press **<ENTER QUERY>** and then enter short substitutes for the fieldnames into the fields to be selected on, in the form of **'&A'**, **'&B'**, **'&C'** etc. In the WHERE clause on the bottom line you can now use the substitutes in place of the fieldnames. Thus,

where **&A between 19800101 and 19800110 and &B between 10 and 50 and &C between 6 and 8**

with &A in date, &B in depth and &C in max magnitude will result in the same retrieval as the WHERE clause

where **qdate between 19800101 and 19800110**
and depth between 10 and 50
and m_max between 6 and 8.

The blocks within the DETAILS form have been coordinated which means that with each event displayed in the top block the effects and epicentre comments relating to that particular event will also be displayed in their blocks. Not all events have effects and/or comments associated with them.

For updating the seismic moment, exponent and isoseismic map fields (*seis_mom, exp, isoseis_map*), press the **<PREVIOUS FIELD>** key which takes the cursor straight from the top of the block to these fields (eliminating the need to tab forwards through the whole block). The values for the seismic moment and exponent fields can usually be extracted from the epicentre comments on the screen.

To be able to update/add records in the EFFECTS or ECOMMENTS blocks of this form, press the **<NEXT BLOCK>** key to move the cursor to the desired block.

In the case of earthquakes felt in Australia, the ASC sends out questionnaires requesting information on the felt intensity in different regions of the continent. The returned information can be input into the INTENSITY block of the DETAILS form:

Press **<FUNCTION KEY 5>**

from anywhere in the first screen, and the following form appears:

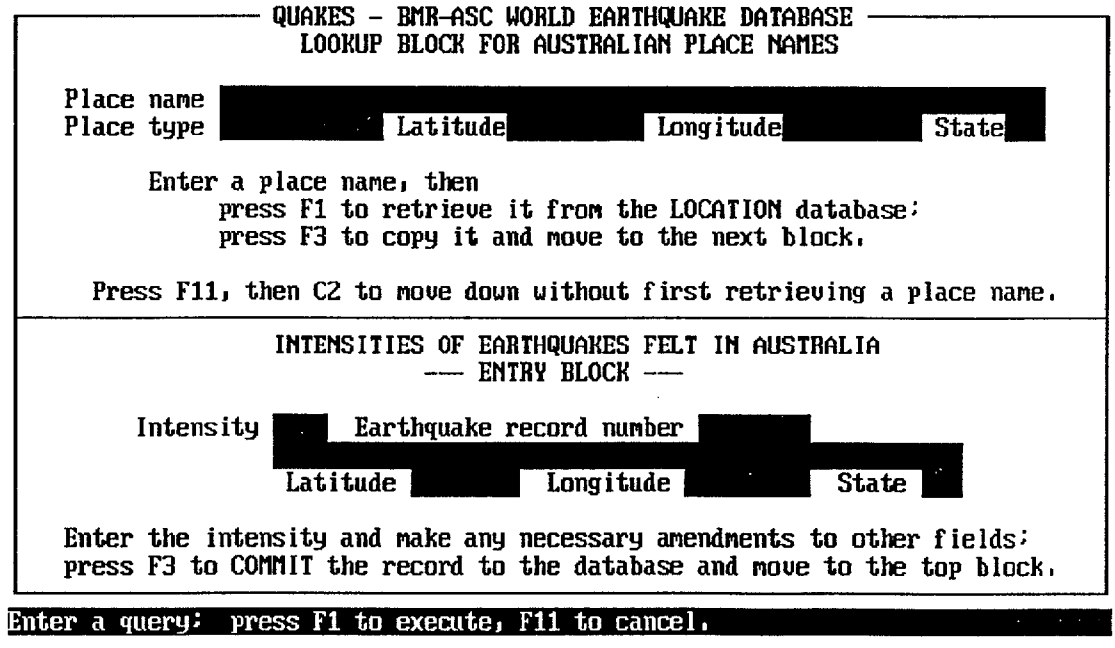


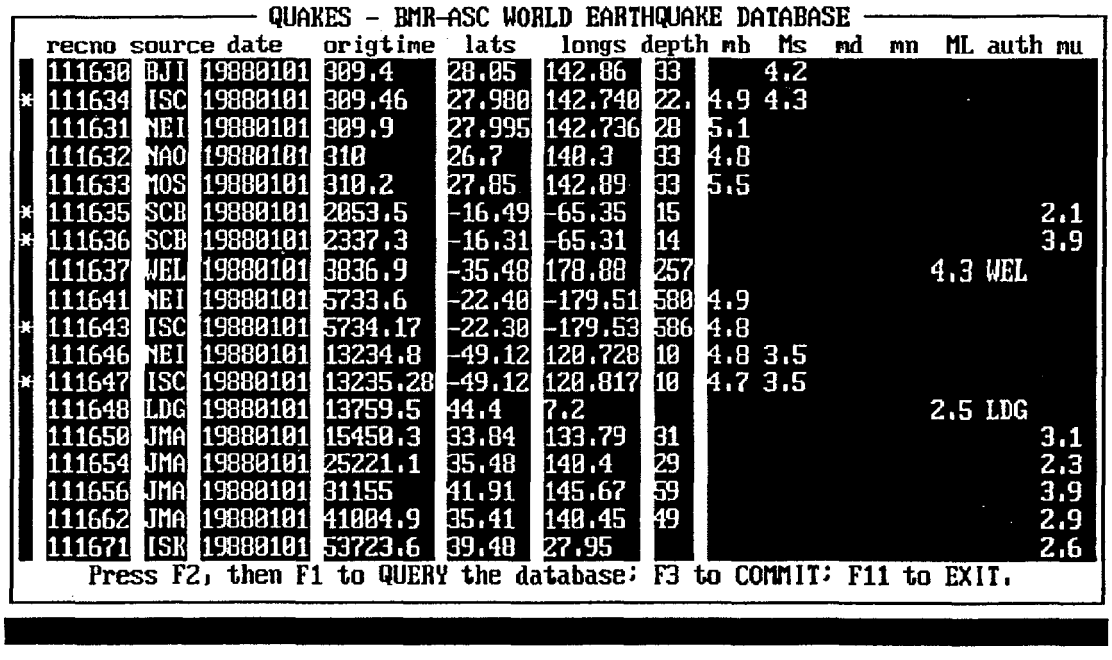
Figure 3. The DETAILS form, second screen.

The top portion of the screen is a query form for retrieving place names in the categories 'Populated place' (POPL) and 'Homestead' (HMSD) with their corresponding latitude and longitude values from the LOCATION database which also resides on the DG. The LOCATION database is based on the Australian gazetteer of place names (see AUSLIG, 1989 for instance). To retrieve data from the LOCATION database, type the place name into the first field and press **<EXECUTE QUERY>**. All the localities in the categories 'Populated Place' and 'Homestead' which have that name will be retrieved. Press **<NEXT RECORD>** to scroll through the records retrieved and check for the wanted one (check the state, place type and/or latitude and longitude fields). To copy the correct one and at the same time move the cursor into the bottom block, press **<COMMIT>.** Any necessary amendments to the entries can be made in this block. The record number (*recno*) of the earthquake is copied into this block from the first screen. Now the intensity value can be added into field *intensity* and the record added to the database (press **<COMMIT>**). The cursor moves into the top part of the form and the screen is cleared ready for a new retrieval from the LOCATION database.

Repeat the procedure for all the intensities reported for this particular event. Should a place name not be retrievable from the LOCATION database, it can be added to the INTENSITIES table in the following way: Press **<EXIT/CANCEL>** to exit query mode and **<NEXT BLOCK>** for the cursor to enter the INTENSITIES block. Now the values for all fields can be entered manually and committed to the database.

5.1.3 The MAIN FIELDS form - menu option 2

From the QUAKES opening menu (page 5) choose option 2. The following form will appear on the screen (without data):


QUAKES - BMR-ASC WORLD EARTHQUAKE DATABASE

	recno	source	date	origtime	lats	longs	depth	mb	Ms	md	mn	ML	auth	nu
	111630	BJI	19880101	309.4	28.05	142.86	33		4.2					
*	111634	ISC	19880101	309.46	27.980	142.740	22.	4.9	4.3					
	111631	NEI	19880101	309.9	27.995	142.736	28	5.1						
	111632	NAO	19880101	310	26.7	140.3	33	4.8						
	111633	MOS	19880101	310.2	27.85	142.89	33	5.5						
*	111635	SCB	19880101	2053.5	-16.49	-65.35	15							2.1
*	111636	SCB	19880101	2337.3	-16.31	-65.31	14							3.9
	111637	WEL	19880101	3836.9	-35.48	178.88	257					4.3	WEL	
	111641	NEI	19880101	5733.6	-22.40	-179.51	580	4.9						
*	111643	ISC	19880101	5734.17	-22.30	-179.53	586	4.8						
	111646	NEI	19880101	13234.8	-49.12	120.728	10	4.8	3.5					
*	111647	ISC	19880101	13235.28	-49.12	120.817	10	4.7	3.5					
	111648	LDG	19880101	13759.5	44.4	7.2						2.5	LDG	
	111650	JMA	19880101	15450.3	33.84	133.79	31							3.1
	111654	JMA	19880101	25221.1	35.48	140.4	29							2.3
	111656	JMA	19880101	31155	41.91	145.67	59							3.9
	111662	JMA	19880101	41004.9	35.41	140.45	49							2.9
	111671	ISK	19880101	53723.6	39.48	27.95								2.6

Press F2, then F1 to QUERY the database; F3 to COMMIT; F11 to EXIT.

Figure 4. The MAIN FIELDS form.

This form displays only a subset of the attributes in the DETAILS table. It was set up to enable easy comparison of the main attributes of several events. 18 records (events) can be displayed on the screen at the same time. Use this form for deciding which record is the preferred solution where several exist for a given earthquake - enter '*' into the first field of the preferred solution (and, by the same token, delete '*' where you decide a particular, previously preferred, solution is **not** the preferred one).

Retrieve records in the same way as described under 5.1.2. Scroll through the retrieved records by pressing **<NEXT RECORD>**, **<NEXT SET OF RECORDS>** (a screenful at a time) or **<PREVIOUS RECORD>**. Make amendments/changes and press **<COMMIT>**.

Through this form, records in the DETAILS table can be updated, added or deleted. Remember however that this form does not necessarily display all the existing data for each event as only the main fields are shown on the screen. To check on all data fields for each event use the DETAILS form (menu option 1, see above) or SQL*Plus (menu option 7, see 5.2).

5.1.4 Other forms - menu options 3 - 6

Options 3 - 6 on the QUAKES opening menu give access to tables ECOMMENTS (3), COMMENTS (4), INTENSITIES (5) and SOURCES (6). To query these tables, go into the appropriate form by selecting the corresponding number on the menu, press **<ENTER QUERY>** and type in conditions for the query (e.g. a specific record number), then press **<EXECUTE QUERY>**. Scroll through the records using **<NEXT RECORD>**, **<PREVIOUS RECORD>**, **<NEXT SET OF RECORDS>**. Make any necessary amendments/ additions/deletions and **<COMMIT>** the changes to the database. Press **<EXIT/CANCEL>** to get back to the menu.

5.2 Using SQL*Plus - menu option 7

Any registered BMR ORACLE user can query the QUAKES database through SQL*Plus as all have SELECT privileges for all tables. But only the members of the ASC have the right to INSERT, UPDATE or DELETE data in the database.

To run SQL*Plus, choose option 7 on the QUAKES opening menu (page 5) or, alternatively, log on to the LAN and the DG, then into SQL*Plus by typing

SQLPLUS

You will be prompted for your ORACLE username, then your password.

The general statement for retrieving data is

```
SELECT  column FROM table
WHERE condition;                    (optional)
```

For instance, to retrieve all the records from the SOURCES table, at the SQL> prompt type:

```
SELECT * FROM SOURCES;
```

or to retrieve date, origin time, latitude, longitude and maximum magnitude of all events with magnitudes > 6 type:

```
SELECT QDATE,ORIGIN_TIME,DLAT,DLONG,M_MAX
FROM DETAILS
WHERE M_MAX > 6;
```

Combinations of conditions are also possible:

```
SELECT QDATE,ORIGIN_TIME,DLAT,DLONG,M_MAX
FROM DETAILS
WHERE QDATE BETWEEN 19800101 AND 19801231
AND M_MAX > 7;
```

as are combinations of columns from several tables ("table joins"):

```
SELECT QDATE,ORIGIN_TIME,INTENSITY
FROM DETAILS,INTENSITIES
WHERE DLAT BETWEEN -40 AND -10
AND DLONG BETWEEN 116 AND 152
AND DETAILS.RECNO = INTENSITIES.RECNO;
```

The last line in this statement shows which attributes in the two tables are to be used for "joining" them. If this condition is left out a so-called "Cartesian join" is done which combines **every** record in one table with **every** record in the other table. This has the potential of creating a huge output listing - probably not what the user was looking for. Care should therefore be taken to ensure that the conditions imposed on the retrieval are tight enough to retrieve the required information.

Type **BYE** to exit from SQL*Plus.

6. PRODUCING STANDARD REPORTS - menu option 8

To produce a standard report on earthquake details (see Appendix G for an example) choose option 8 on the QUAKES opening menu (page 5). You will be prompted for your ORACLE username and password, then the following selection menu comes up on your screen:

```
Selection menu for extracting details on events from the
        BMR-ASC World Earthquake Database QUAKES

 1 - name of output file.............DETAILS.LIS
 2 - start date.......................19850101
 3 - end date.........................19881231
 4 - lower latitude.....................-40.000
 5 - upper latitude.....................-10.000
 6 - lower longitude.....................110.000
 7 - upper longitude.....................152.000
 8 - top depth.................................0
 9 - bottom depth.............................33
10 - lower magnitude.........................6.00
11 - upper magnitude.........................9.99
12 - other conditions:

              G - Go              X - Exit

Enter a number to change the above defaults or G/X :
```

Figure 5. Selection menu for the DETAILS report.

You can change the displayed defaults by entering the corresponding number for each item and then the desired value. Numbers 2 to 11 stand for **ranges** of dates, latitudes, longitudes, depths and magnitudes, whereby the first number is the lower, the second the higher value of the range. If you do **not** want to limit the database search to just a specific range of any of those attributes enter the corresponding numbers one at a time and press **<CARRIAGE RETURN>** or **<ENTER>** for both values of the range. This effectively sets the WHERE clause to NULL and speeds up the retrieval.

Appendix F is a listing of the SQR report program which resides in the QUAKES directory. It can be edited in SLATE or some other editor on your computer should you desire to change the defaults or even the format of the reports (this applies to ASC staff members only). Note that only the preferred solutions are retrieved with this program.

The report produces a listing in your DG directory called DETAILS.LIS (or whatever you have changed the output filename to - option 1 on the selection menu) which you can send to the lineprinter in the BMR computer room: at the DG prompt, type **QPRINT DETAILS.LIS**. Definitions of the earthquake parameters contained in the report are printed out at the bottom of the report. A complete listing of the earthquake parameters in the database is attached as Appendix H.

To obtain a listing of the acronyms and names of the contributing agencies ("sources") run the file QSOURCES.SQL from within SQL*Plus (option 7 on the QUAKES opening menu - page 5). Type **START QSOURCES** at the SQL> prompt. The program produces a listing in your directory called QSOURCES.LIS which you can print off on the lineprinter in the BMR computer room by typing **QPRINT QSOURCES.LIS** at the DG prompt.

7. PRODUCING PLOTS

Several plotting programs exist which need the latitude and longitude of an epicentre as input. A third parameter, magnitude or focal depth, can often also be shown. ASC seismologists use a program called **GMT-Systems** which can produce plots like the one below.

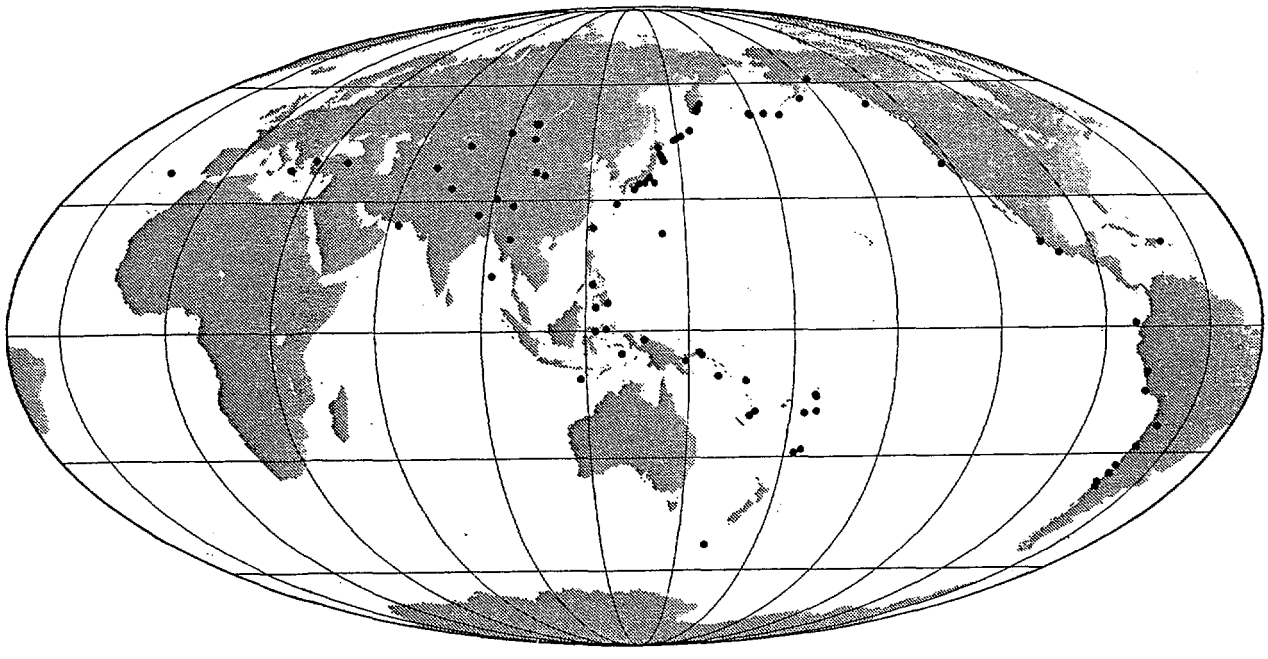


Figure 6. Magnitude 8+ earthquake epicentres, 1904 - 1989.

To produce an ASCII input file of ORACLE data for GMT-Systems, run an SQL statement similar to the following one (use option 7 from the QUAKES opening menu - page 5):

```
SET PAGESIZE 50000
SET LINESIZE 35
SET FEEDBACK OFF
SET HEADING OFF
SPOOL filename
SELECT DLAT,DLONG,M_MAX
FROM DETAILS
WHERE M_MAX > 7.99
AND PREF = '*'
ORDER BY DLONG,DLAT;
```

This SQL statement produces three columns of data: latitude, longitude and magnitude in a file with the specified filename which can be used as input for the plotting program. After the retrieval is completed, type

```
SPOOL OFF
```

MAPDAT is a BMR program on the DG which can extract spatial data from a relational database and plot them on to maps of Australia or parts of the Australian continent. It supports a variety of map projections and can produce plots at any scale. MAPDAT can be run interactively or in batch. See BMR Record 1990/79 for instructions and further details. Following is an example of a plot produced by MAPDAT:

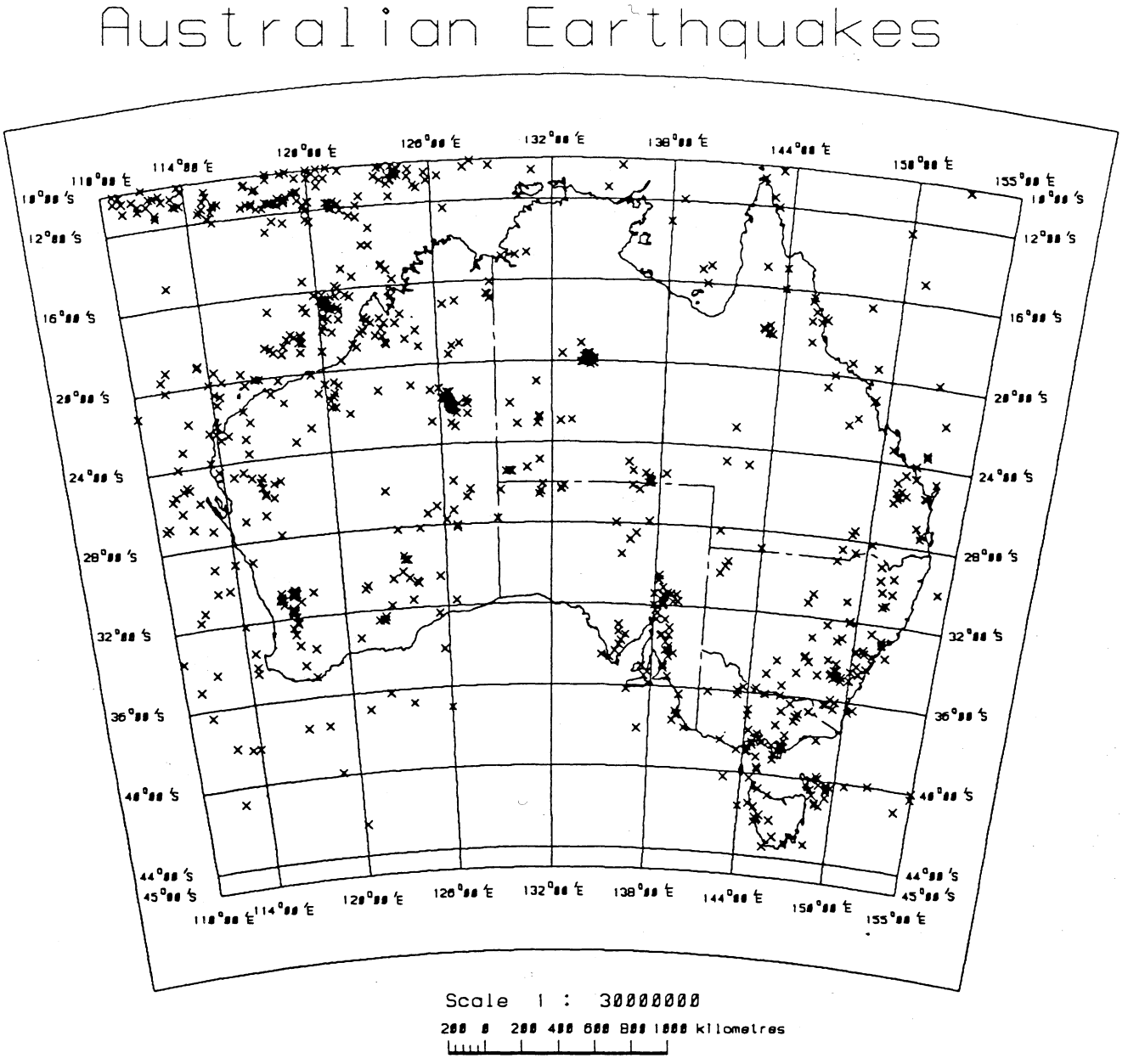


Figure 7. MAPDAT plot of Australian epicentres, 1859 - 1991.

8. DATABASE ADMINISTRATION

8.1 Changing the database structure - menu option 7

As the database is used it will most certainly become apparent that the present design is not perfect and tables might have to be added or dropped, columns added to existing tables or their width and/or datatype changed. The DBA has the right to make changes like these to the structure of the database.

The following sets out the basic procedures for making those changes. Choose option 7 on the QUAKES opening menu (see page 5) or, alternatively, log on to the LAN and DG, then into SQL*Plus by typing

SQLPLUS

You will be prompted for your ORACLE username and password.

ADDING A TABLE: At the SQL> prompt, enter

```
CREATE TABLE tablename
        (column1 datatype1(size1),
         column2 datatype2(size2),
         etc)
SPACE space name;
```

Mandatory columns must be specified as NOT NULL. See Appendix B: Database Schema for examples of CREATE statements. The space name must be a valid space definition that has already been created on the system. To list the available space definitions, type

SELECT * FROM SPACES;

There should be one contained in the list that suffices for the future space requirements of your new table, otherwise a new space definition must be created. For more information on space definitions refer to the ORACLE Database Administrator's Guide.

DROPPING A TABLE: Before dropping a table make sure that it does not contain data which are still needed as the table can **NOT** be restored (there is no UN-DROP command). At the SQL> prompt, type

DROP TABLE tablename;

Existing indexes on the table will be dropped at the same time. See Chapter 4 for examples of SQL statements for dropping tables, in this case the temporary tables TEMP_DETAILS and TEMP_ECOMMENTS.

CREATING/DROPPING AN INDEX: Indexes on tables are a means of speeding up retrieval times on big tables. However, too many indexes will slow down update activity unduly. An index can be **concatenated** which means that a combination of columns is used for indexing.

To create an index in SQL*Plus, specify its name and the table with its column/s that contain/s the information to go into the index:

```
CREATE INDEX indexname
        ON tablename (column1,column2,...);
```

If the index is specified as a **unique** index ORACLE will make sure that there are no two entries (records) in the table with the same value/s in the specified column or combination of columns.

For instance, a unique index on the record number (*recno*) in table DETAILS was created with the following SQL statement:

CREATE UNIQUE INDEX DETAILS1 ON DETAILS(RECNO);

which ensures that each event in the database can be uniquely identified by its record number. For further examples refer to Appendix B: Database Schema.

An index can be dropped with the following SQL statement:

DROP INDEX indexname;

MODIFYING A COLUMN: A column's width and/or datatype can be changed with the following SQL statement:

ALTER TABLE tablename
MODIFY (columnname datatype(size));

For instance, to change field *pref* from a one-character to a two-character field, at the SQL> prompt, type:

ALTER TABLE DETAILS
MODIFY (PREF CHAR(2));

To modify more than one column at a time, use commas within the parantheses to separate each column and its definitions from the next.

To change a mandatory field to a non-mandatory one, add the NULL clause to the end of the column specification. A non-mandatory field can only be changed to a mandatory one (NOT NULL) if there are no null values in the column.

ADDING A COLUMN: A column can be added to an existing table with the command:

ALTER TABLE tablename
ADD (columnname datatype(size));

To add more than one column, use commas within the parantheses to separate each column and its definitions from the next.

For example, field *m_max* was added to table DETAILS with the SQL statement:

ALTER TABLE DETAILS
ADD (M_MAX NUMBER(3,2));

All fields in a new column initially have a value of null. Therefore, a new column added to an existing table cannot be defined as NOT NULL when the table already contains records. If a new column is to be made mandatory, add the column, then give every record a non-null value, and finally, use the ALTER TABLE command with the MODIFY clause to change it to NOT NULL.

8.2 Data export, import and backup

EXPORT and **IMPORT** are two ORACLE utilities for moving ORACLE data to and from operating system files. The files can be used for archiving data (= data backup) or moving data between operating systems or ORACLE databases. The following types of ORACLE data can be stored in this way: table definitions, table data, indexes, space definitions, grants, synonyms, and view definitions.

With the export utility, data in the database are copied to a special kind of backup file. This export file is in a special format and, therefore, it should not be edited. It can only be used by the import utility which restores the exported data into an ORACLE database - each table is re-created and its data loaded back into it.

Export and Import are interactive utilities - you are asked questions and the utility proceeds according to your answers. To run the utilities, at the DG prompt, add the ORACLE directory to your search list:

SEA :UDD:ORACLE_V5 [!SEA]

then type

EXP or **IMP**

and respond to the questions (first, you will be prompted for your ORACLE username and then your password).

For details and further information refer to ORACLE Utilities User's Guide.

On BMR's DG, full backups of all databases are done on a regular basis by the Information Systems Branch computer operators. In the case of a system failure or human error with consequent data loss or corruption, the databases can be restored. Contact the database administrator in Informations Systems Branch if this kind of help is needed.

8.3 Modifying/creating forms

Only the DBA can modify an existing form or create a new one for use within the QUAKES database.

The need for modifying an existing form arises when the underlying table (= base table) is changed, i.e. column/s added, column size/s and/or data type/s changed (see 8.1). If the form is not modified after such changes are made to the table structure it may not be possible to use the form for correct data entry. Indeed, sometimes it cannot be used at all and the attempted use will only create error messages.

Likewise, a form might have to be modified if a new table is added to the database or a table is dropped. Sometimes a completely new form might have to be created in these cases.

Refer to the SQL*Forms Designer's Reference or Designer's Tutorial for full instructions for creating or modifying a form.

9. REFERENCES/ACKNOWLEDGMENTS

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Les Dixon from BMR's Information Systems Branch modified the Fortran program supplied by the ISC for decompressing the earthquake data files to simultaneously convert some of the data items to the format required in the final ORACLE tables. He also set up and documented the procedures for loading the data from ISC tapes to DG data files. We thank him for his help and perseverance.

Robert Apps worked on the database in January and February 1992 to update the list of great earthquakes from Kanamori (1983), the major (M > 7) Papua New Guinea earthquakes from Ripper and Letz (1991) and the large (M > 6) New Zealand earthquakes from Dowrick (1991). Robert also amended earthquake parameters in the period 1985-1988. We are grateful for his important contribution to improving the database.

10. GLOSSARY

DATABASE TERMS:

ADD part of SQL command ALTER TABLE for adding a new column to a table;

ALTER SQL command for making changes to the database structure;

ASCII **A**merican **S**tandard **C**ode for **I**nformation **I**nterchange;

ATTRIBUTE column in a database table;

BACKUP duplicate of database objects which enables them to be restored later to the state they were in at the time of backup;

COLUMN fields representing one kind of data (one attribute) in a table;

COMMIT SQL*Plus command for storing (making permanent) changes made to database tables;

CREATE SQL command for setting up new database objects;

DATABASE SCHEMA SQL script for creating all objects of a database including a detailed description of the objects and their data items;

DBA Database Administrator;

DELETE SQL command to remove rows from a table;

DROP SQL command to permanently remove database objects;

ENTITY distinguishable system object represented in the database;

EXPORT ORACLE utility for moving database objects and data to operating system files;

GRANT SQL command for assigning access rights to a database user;

IMPORT ORACLE utility for moving exported database objects and data back into the database;

INDEX database object that enables finding a specific row without examining the whole table;

INSERT SQL command for adding new rows to a table;

JOIN retrieve parts of a row from two or more tables at the same time;

KEY column/s in a table whose values uniquely identify the records in that table;

MODIFY part of SQL command ALTER TABLE to change the definition of an existing table column;

ORACLE RDBMS relational database management system sold by Oracle Corporation;

RDBMS data storage and retrieval program which organises data into tables whose rows all have the same set of data items (columns);

RECORD data in one row of a table; instance of an entity;

ROLLBACK SQL*Plus command to discard changes made to tables before they have been committed;

SELECT SQL command to retrieve data from one or more tables and/or views;

SQL **S**tructured **Q**uery **L**anguage; user interface for storing and retrieving data in a database;

SQL*FORMS interface tool for creating, modifying and using forms to access an ORACLE database;

SQL*LOADER tool for loading data from ASCII files into an ORACLE database;

SQL*PLUS extension of SQL for producing formatted reports from an ORACLE database;

SQR **S**tructured **Q**uery **R**eport Writer used for accessing relational databases;

SYNONYM name assigned to a table in addition to its actual name;

TABLE grid of columns and rows; basic unit of data storage in an RDBMS;

UTILITY program run by an operating system command to perform functions associated with ORACLE;

VIEW database object similar to a table derived from another/other table/s; has no storage of its own;

WHERE clause in SQL to specify conditions for an operation on a relational database.

EARTHQUAKE TERMS:

EARTHQUAKE vibrations of the Earth caused by the passage of seismic waves radiating from the rupture of rock along a fault (shallow earthquakes) or the sudden change of mineral composition (deep earthquakes);

EPICENTRE point on the Earth's surface directly above the focus (hypocentre) of an earthquake;

FAULT fracture in rock along which the two sides have been displaced relative to each other;

FOCAL DEPTH depth of the focus (hypocentre) below the surface of the Earth;

FOCUS place at which fault rupture commences or change of mineral composition occurs;

INTENSITY subjective measure of the level of ground shaking assigned by an experienced observer from the damage done to man-made structures, ground deformation and how strongly the earthquake was felt;

ISOSEISMALS contour lines drawn to separate one level of seismic intensity from another;

MAGNITUDE quantity characteristic of the total energy released by an earthquake and measured from the amplitude of seismic waves recorded on a seismogram;

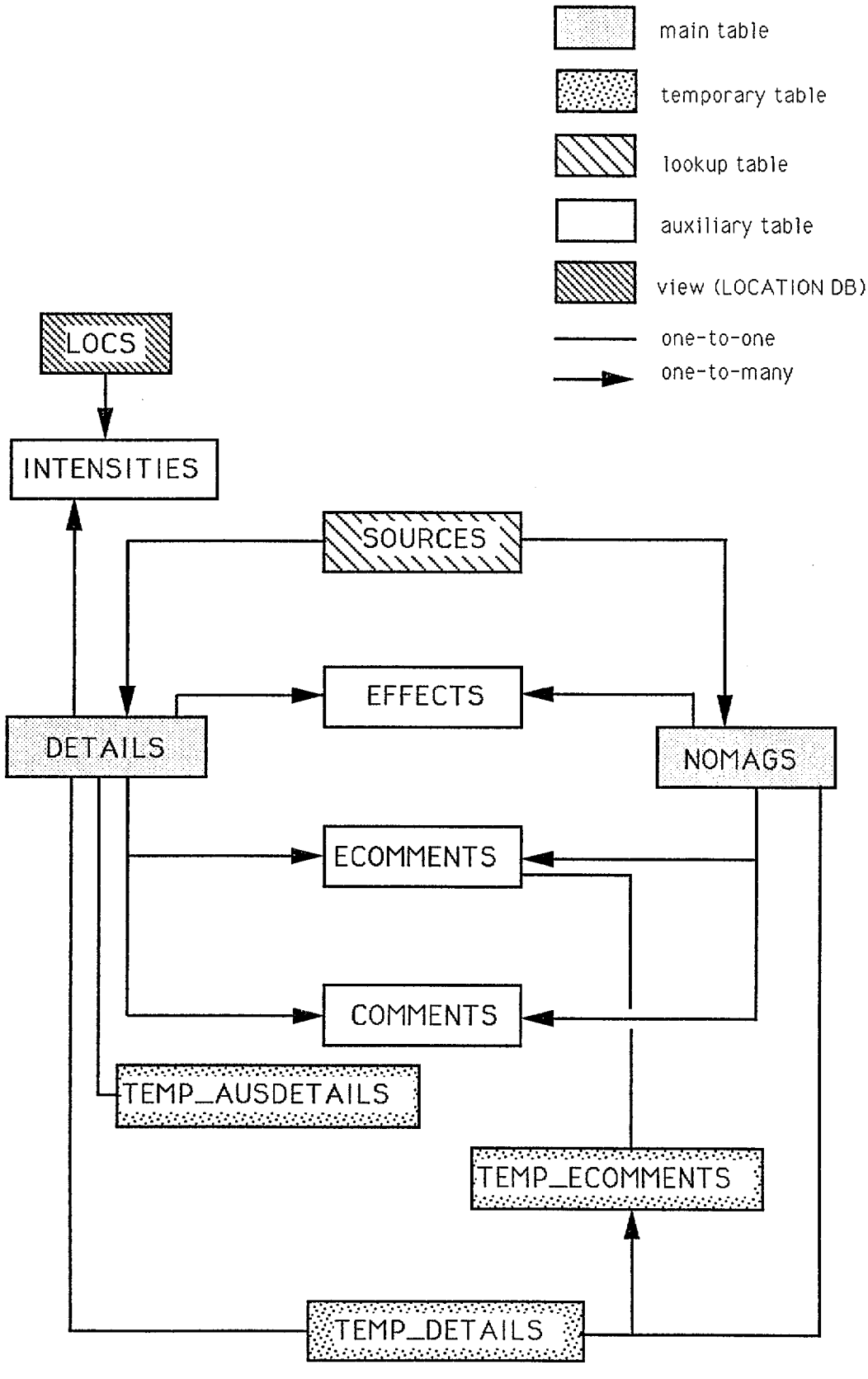
SEISMIC RISK the probabality of earthquake damage within a given time interval;

SEISMICITY distribution of earthquakes in space and time;

SEISMOGRAPH instrument for recording, as a function of time, the motions of the Earth's surface caused by seismic waves;

SEISMOLOGY study of earthquakes and their effects.

APPENDIX A: LOGICAL DATA STRUCTURE



APPENDIX B: DATABASE SCHEMA

```
rem    The earthquake database contains one lookup table called SOURCES for the sources of data
rem    on earthquakes, and six data tables. The main tables are called DETAILS and NOMAGS, the
rem    other tables called INTENSITIES, EFFECTS, ECOMMENTS and COMMENTS are associated
rem    with them in one-to-many ('many' can also be null) relationships.

rem    This schema contains the SQL statements for creating the tables and any necessary
rem    indexes and also a description of the data attributes.

rem    A view of two tables in the LOCATION database (which is based on the Gazetteer of
rem    Australian Place Names), namely tables LOCALITY and LOCALITY_NAME is used
rem    to create records in the INTENSITIES table.

create view LOCS          (place_name,dlat,dlong,place_type,state)
       as select          name_locality,round(-cod_latitude,3),round(cod_longitude,3),
                          code_place_type,name_state_abbreviated
       from               location.locality_name l1,location.locality l2
       where              l1.code_locality_name = l2.code_locality_name
                          and code_place_type in ('POPL','HMSD');

create table SOURCES      (source        char(6)        not null,
                           description   char(150)      not null)
                                 space   SPB05;

rem    The two fields in this table contain a unique abbreviation and a full description of the sources
rem    of data ('Agencies') on earthquakes.

create table DETAILS      (recno         number(6)      not null,
                           source        char(6)        not null,
                           qdate         number(8)      not null,
                           origin_time   number(8,2)    not null,
                           time_prec     number(5,3),
                           dlat          number(7,4)    not null,
                           dlong         number(8,4)    not null,
                           depth         number(4,1),
                           depth_prec    number(4,1),
                           pref          char(1),
                           isoseis_map   char(1),
                           gregion       number(3),
                           sregion       number(2),
                           mb_aver       number(3,2),
                           mb_prec       number(3,2),
                           ms_aver       number(3,2),
                           ms_prec       number(3,2),
                           md_aver       number(3,2),
                           md_prec       number(3,2),
                           mn_aver       number(3,2),
                           mn_prec       number(3,2),
                           ml_aver       number(3,2),
                           ml_prec       number(3,2),
                           ml_auth       char(6),
                           m_unsp        number(3,2),
                           m_auth        char(6),
                           m_max         number(3,2),
                           no_obs        number(4),
                           no_stat       number(4),
                           seis_mom      number(2,1),
```

```
                    exp             number(2))
                space SPB50;

create unique index DETAILS1 on DETAILS (recno);
create index DETAILS2 on DETAILS (qdate,origin_time);
create index DETAILS3 on DETAILS (source);
create index DETAILS4 on DETAILS (dlat);
create index DETAILS5 on DETAILS (dlong);
create index DETAILS6 on DETAILS (m_max);

rem   This table contains details of all recorded earthquakes.
rem   Field recno is a system-generated sequential number which is the unique identifier for each
rem   record.
rem   Field source is an abbreviation of the agency/authority.
rem   Date, time and standard error of origin time of the earthquake go into fields qdate (format:
rem   YYYYMMDD), origin_time (format: hhmmss.ss) and time_prec (format:ss.sss).
rem   Decimal latitudes and longitudes are entered in fields dlat and dlong.
rem   Depth and standard error of depth in kilometres go into fields depth and depth_prec.
rem   Field pref will contain an '*' if the record is the preferred solution.
rem   (If record format = '1' in temporary table, then pref = '*'.)
rem   'Y' in field isoseis_map indicates the existence of a map containing this record.
rem   The Flinn-Engdahl geographic region number is entered in field gregion.
rem   The seismic region number is entered in field sregion.
rem   The averages and standard errors of the earthquake magnitude go into fields mb_aver and
rem   mb_prec (body wave magnitude), ms_aver and ms_prec (surface wave magnitude), md_aver
rem   and md_prec (duration magnitude), ml_aver and ml_prec (Richter local magnitude), mn_aver
rem   and mn_prec (Nuttli magnitude).
rem   If there is a value for ml_aver field ml_auth should contain the abbreviation for the source (field
rem   source = field ml_auth).
rem   If the type of magnitude is not specified field m_unsp will contain the magnitude value and the
rem   source of that value.
rem   Field m_max is a derived field containing the maximum magnitude value.
rem   The number of observations and the number of stations contributing to the record go into fields
rem   no_obs and no_stat.
rem   Seismic moment and exponent go into fields seis_mom and exp (they will be updated from
rem   information contained in the comments fields).

create table INTENSITIES    (recno          number(6)       not null,
                             place_name     char(50),
                             dlat           number(7,4),
                             dlong          number(8,4),
                             intens         number(2))
                        space SPB07;

create index INTENS1 on INTENSITIES (recno);

rem   This table relates Australian earthquakes to intensities measured in different geographical
rem   locations through the record number, recno.

create table EFFECTS        (recno          number(6)       not null,
                             effect         char(1)         not null)
                        space SPB07;

create index EFFECTS1 on EFFECTS (recno);

rem   This table relates earthquakes to associated phenomena through the record number, recno.
```

```
create table ECOMMENTS      (recno          number(6)       not null,
                            ordno           number(1)       not null,
                            epic_comment    char(240))
                                    space   SPB40;

create unique index ECOMMENTS1 on ECOMMENTS (recno,ordno);

rem     This table contains epicentre comments and relates back to the DETAILS table through the
rem     record number, recno.


create table COMMENTS       (form           char(1),
                             source         char(6),
                             qdate          number(8),
                             origin_time    number(8,2),
                             comments           char(240),
                             comments2          char(240),
                             comments3          char(240),
                             comments4          char(240))
                                    space   SPB35;

create index COMMENTS1 on COMMENTS (qdate,origin_time);

rem     This table contains non-epicentre comments which can be related to the DETAILS table
rem     through fields qdate and origin_time.

rem     Create a table for the events with no magnitude values, create a temporary space first:

create space SPB_TEMP2      datapages       (initial        4300,
                                            increment       2500,
                                            pctfree         1)
                            indexpages      (initial        500,
                                            increment       500)
                            partition       B;

create table NOMAGS         (recno          number(6)       not null,
                            source          char(6)         not null,
                            qdate           number(8)       not null,
                            origin_time     number(8,2)     not null,
                            dlat            number(7.4)     not null,
                            dlong           number(8,4)     not null,
                            depth           number(4.1),
                            pref            char(1),
                            effect          char(1),
                            gregion         number(3),
                            sregion         number(2),
                            no_obs          number(4),
                            no_stat         number(4),
                            comments        char(20))
                                    space SPB_TEMP2;

create unique index OLDDATA1 on NOMAGS (recno);
create index OLDDATA2 on NOMAGS (qdate,origin_time);
create index OLDDATA3 on NOMAGS (source);

rem     This file called TEMP.SQL contains the SQL commands for creating temporary tables for the
rem     world earthquake database. These tables are set up for loading the data from the original files
rem     on tapes received from the ISC. Before SQL*Loader can be used the data have to be
rem     decompressed, selectively retrieved and put into separate data files on the DG (e.g.
rem     ASC_JAN_1.2, ASC_JAN_3.4).
rem     In addition, spaces within field origin_time are replaced with zeros, and decimal points are
```

```
rem   inserted into the following fields: origin_time, dlat, dlong, depth, mag1, mag1_to, mag2 and
rem   mag2_to.
rem   All this is done by an ISC Fortran program modified by Les Dixon from Computing Services
rem   Section, Information Systems Branch.

rem   First, create temporary space definitions:

create space        SPB_TEMP1
                    datapages     (initial      2000,
                                   increment    500,
                                   pctfree      2)
                    indexpages    (initial      3,
                                   increment    3)
                                   partition    B;

create space        SPB_TEMP2
                    datapages     (initial      30,
                                   increment    10,
                                   pctfree      1)
                    indexpages    (initial      3,
                                   increment    3)
                                   partition    B;

rem   Create two temporary tables for the epicentre data records. All data go into TEMP_DETAILS
rem   first, the comments are then split off into table TEMP_ECOMMENTS.

create table TEMP_DETAILS     (recno        number(6),
                               form         char(1),
                               source       char(6),
                               qdate        number(8),
                               origin_time  number(8,2),
                               time_prec    number(5,3),
                               dlat         number(7,4),
                               dlong        number(8,4),
                               depth        number(4,1),
                               depth_prec   number(4,1),
                               mag1         number(3,2),
                               mag1_prec    number(3,2),
                               mag1_type    char(2),
                               mag1_to      number(3,2),
                               gregion      number(3),
                               sregion      number(2),
                               no_obs       number(3),
                               mag2         number(3,2),
                               mag2_prec    number(3,2),
                               mag2_type    char(2),
                               mag2_to      number(3,2),
                               effect       char(1),
                               mb_aver      number(3,2),
                               mb_prec      number(3,2),
                               ms_aver      number(3,2),
                               ms_prec      number(3,2),
                               md_aver      number(3,2),
                               md_prec      number(3,2),
                               ml_aver      number(3,2),
                               ml_prec      number(3,2),
                               ml_auth      char(6),
                               mn_aver      number(3,2),
                               mn_prec      number(3,2),
                               m_unsp       number(3,2),
```

```
                                m_auth          char(6),
                                m_max           number(3,2),
                                pref            char(1),
                                epic_comment    char(240),
                                epic_comment2 char(240),
                                epic_comment3 char(240),
                                epic_comment4 char(240))
                                        space   SPB_TEMP1;

create table TEMP_ECOMMENTS     (recno          number(6)       not null,
                                ordno           number(1) ,
                                epic_comment    char(240)       not null)
                                        space   SPB_TEMP2;

rem     No temporary table has to be created for the non-epicentre comments, data from file
rem     ASC_JAN_3.4 etc. can be loaded straight into table COMMENTS.

rem     Now delete the temporary space definitions:

drop space SPB_TEMP1;

drop space SPB_TEMP2;


rem     This file called TEMPAUS.SQL creates a temporary table for data from the Australian datafile
rem     to be incorporated into QUAKES, the BMR-ASC World Earthquake database.

rem     To run it from within SQL*Plus, type START  TEMPAUS at the SQL prompt.

create table TEMP_AUSDETAILS    (recno          number(6),
                                source          char(4),
                                qdate           number(8),
                                origin_time     number(8,2),
                                dlat            number(6,3),
                                dlong           number(6,3),
                                depth           number(3),
                                pref            char(1),
                                mb_aver         number(3,2),
                                ms_aver         number(3,2),
                                ml_aver         number(3,2),
                                ml_auth         char(3),
                                m_unsp          number(3,2),
                                m_auth          char(3),
                                no_stat         number(3),
                                m_max           number(3,2))
                                        SPACE   SPB20;
```

APPENDIX C: PROCEDURES FOR DATA LOADING

1. ISC TAPE PROCESSING

Introduction:

The need to enter earthquake data into the ORACLE Database has necessitated the development of a system to extract the data from magnetic tape and massage it into the required format. This task has been made much simpler with the provision of software by ISC which enables the data to be decoded and expanded. It is this software which has been modified and adapted to provide the required output.

Data used covers the period from 1904 to 1988, initially.

This note assumes that the reader is familiar with the Data General operating environment and file naming conventions.

Processing:

1904-1979: Three tapes with the data in EBCDIC covered this period. The first of the three tapes had only one end of file marker at the end of information and as a precaution it was copied to another tape placing two EOFs at the end of the data. The remaining two tapes were treated likewise.

Prior to loading the data, the program TLOOK was run to ascertain the record size. This program is run as follows:

User Name> **TLOOK P1 P2**
where: P1 = tape number, P2 = number of EOFs, usually two(2)

The output from this program is contained in the file TLOOK.OUT which can be sent to the printer in the normal manner.

Data were then loaded to disk using the macro TAPE_FX_READ. Typically this macro would look like the following:

User Name> **TAPE_FX_READ F30 FRED EBCDIC**
where: F30 = foreign tape number, FRED = command file name consisting of the file details. eg. 1,'QUAKE',80/
where: 1= tape file number, 'QUAKE' = disk file to be created, 80 = record size, EBCDIC = option to convert EBCDIC tape.

Data from each tape was processed separately due to the size of the file and the files created. These data were then manipulated using a program called ASC_04.69. The output from this process was then split according to year grouping into the following files:

ASC_04.25	ASC_26.36	ASC_37.47	ASC_48.58
ASC_59.63	ASC_64.66	ASC_67.69	ASC_69.DAT
ASC_70.DAT	ASC_71.DAT	ASC_72.DAT	ASC_73.DAT
ASC_74.DAT	ASC_75.DAT	ASC_76.DAT	ASC_77.DAT
ASC_77L.DAT	ASC_78.DAT	ASC_79.DAT	

Upon completion of this processing a USR BACKUP was made of the complete directory so that in the future no undue processing is required to retrieve the data. These data can be found on tape USR052.

1980-1984: The data are contained on two tapes in EBCDIC format. Initial processes of loading the data to disk prior to format change were the same as those for the data from 1904-1979. Years 1980 and 1981 are contained on one tape and 1982 to 1984 on the other.

Single tape processing was again employed due to the size of the input file and the files created. This constraint was due to the limited space available at the time.

As there were some minor variations in the format of the data, the previous program ASC_04.69 was copied with some modifications and named ASC_80. This program was used to reformat and split the data into the following files:

ASC_80.DAT ASC_81.DAT

In 1982 the Kintbury format was introduced thus requiring another change to the software to enable the now accepted format to be output. This program is called KINTB. For ease of further processing the data was split into the following files:

ASC_82.DAT ASC_83.DAT ASC_84.DAT

At the completion of processing for the period 1982 to 1984 a USR BACKUP was made and the data can be found on tape USR050.

1985: The records from 1985 on contain far more data and therefore the output from this processing was adopted as the standard for all output mentioned previously.

Due to the increased amount of data there are thirteen (13) files on the tape, one for each month, and one, normally the first file, with software which enables expansion to be carried out. The exception to this was the data for 1985 and 1986 which were contained on one tape with the last file containing the source code for extraction. The data for each month is compacted. Modifications to this software were carried out to filter the records and also automatically name the output files.

Again the first process was to run the program TLOOK.

A macro called LOAD_DATA was written to enable the user to carry out the various processes involved. This macro is run as follows:

User Name> **LOAD_DATA P1 P2**
where: P1= tape number, P2 = file number, the first file being zero (0)

Typically the batch macro would look like the following:

```
 [!NEQUAL,,%2%]
QBATCH/M/QUEUE=TAPEQ/NOT%0/%
PUSH
DEF SONJA.MIS OWARE +.ASC OWARE + RE
DIR :ULD:QUAKES
ADDPRE
MOUNT/DIR== MYTAPE %1% PLEASE
TAPEIN,MYTAPE:%2%,QUAKE,16384,128,TXT
XEQ TOFIX_4,%2%
REWIND MYTAPE
DISMOUNT/DIR== MYTAPE THANKS for %1%
POP
)
    [!ELSE]
Write
Write,,,This macro requires TWO PARAMETERS
Write,,,TAPE NAME usually Fnn format
Write,,,Tape name obtained from ISB computer
Write,,,operators.
Write,,,TAPE FILE NUMBER 1 - 12
Write,,,File number 0 usually contains source
Write,,,code and does not need to be processed
    [!END]
```

TAPEIN. This utility copies a file from magnetic tape to disc in a format suitable as input for TOFIX_4.

TOFIX_4. The routine decodes and expands the data as well as providing a filtering capability. This filtering is required to select just the wanted records. TOFIX_4 produces two files as output. These files are as follows:

- 1&2 file containing information on the epicentre, ie date, time, position and other associated data;
- 3&4 file containing date, time and comments relevant to the event.

It should be noted that the value 16384 was obtained from the program TLOOK and care should be exercised to ensure that this value is in agreement with that shown as the maximum record size for the file in listing TLOOK.OUT. Otherwise the value 16384 has to be changed to the maximum record size.

The disc input file "QUAKE" is deleted after each pass thus eliminating the need to use a different filename for each run of the program.

In accordance with the backup procedure used before, backups of the data for 1987 and 1988 can be found on tapes USR050 and USR051.

Les Dixon, Information Systems Branch, October 1991.

2. TRANSFERRING ISC DATA FROM DG DATAFILE TO ORACLE TABLES

SQL*Loader control file QUAKES12.CTL:

```
LOAD DATA
INFILE asc_dec_1.2
APPEND
INTO TABLE TEMP_DETAILS
(recno          SEQUENCE(max,1),
form            position(01)          char,
source          position(02:07)       char,
qdate           position(08:15)       integer external,
origin_time     position(16:24)       decimal external,
dlat            position(26:33)       decimal external,
dlong           position(35:43)       decimal external,
depth           position(45:49)       decimal external,
mag1            position(51:54)       decimal external,
mag1_type       position(56:57)       char,
mag1_to         position(58:61)       decimal external,
mag1_prec       position(65:68)       decimal external,
gregion         position(70:72)       integer external,
sregion         position(73:74)       integer external,
no_obs          position(75:77)       integer external,
mag2            position(86:89)       decimal external,
mag2_type       position(91:92)       char,
mag2_to         position(93:96)       decimal external,
mag2_prec       position(100:103)     decimal external,
time_prec       position(105:110)     decimal external,
depth_prec      position(126:130)     decimal external,
effect          position(132)         char,
epic_comment    position(165:404)     char,
epic_comment2   position(405:644)     char,
epic_comment3   position(645:884)     char,
epic_comment4   position(885:1124)    char)
```

SQL*Loader control file QUAKES34.CTL:

```
LOAD DATA
INFILE asc_dec_3.4
APPEND
INTO TABLE COMMENTS
(form           position(01)        char,
source          position(02:07)     char,
qdate           position(08:15)     integer external,
origin_time     position(16:24)     decimal external,
comments        position(25:264)    char,
comments2       position(265:504)   char,
comments3       position(505:744)   char,
comments4       position(745:984)   char)
```

SQL SCRIPTS:

```
rem   This file called CHECKMAX.SQL retrieves the maximum and minimum record numbers and
rem   also counts the records in tables DETAILS and NOMAGS. Run it before loading new data
rem   from the ISC tapes.

rem   At the SQL prompt, type      START CHECKMAX

spool checkmax.lis

select count(recno),min(recno),max(recno) from details;
select count(recno),min(recno),max(recno) from nomags;

spool off


rem   This file called PRECHECK.SQL is run before updating records in the temporary tables
rem   TEMP_DETAILS and TEMP_ECOMMENTS. It retrieves the number of records to be updated
rem   in each pass. An output listing called PRECHECK.LIS is produced.

rem   It is run from within SQL*Plus by typing START PRECHECK at the SQL prompt.

spool precheck.lis

select count(recno),min(recno),max(recno) from temp_details;
select count(recno),min(recno),max(recno) from details;
select count(recno),min(recno),max(recno) from nomags;

select source,count(source) from temp_details group by source;

select count(recno) from temp_details
     where not (mag1 is null and mag2 is null);
select count(recno) from temp_details
     where (mag1 is null and mag2 is null);

select mag1_type,count(mag1) from temp_details
     where mag1 > 0 group by mag1_type;
select mag2_type,count(mag2) from temp_details
     where mag2 > 0 group by mag2_type;

select count(depth_prec),count(time_prec),count(mag1_prec),count(mag2_prec)
     from temp_details;

select effect,count(effect) from temp_details group by effect;
```

```
select count(epic_comment),count(epic_comment2),count(epic_comment3),
    count(epic_comment4) from temp_details;

spool off


rem   This file called UPDATE1.SQL updates fields pref, mb_aver, ms_aver, mn_aver, md_aver,
rem   ml_aver, ml_auth, m_unsp, m_auth and m_max in table TEMP_DETAILS.
rem   It is run from within SQL*Plus by typing START UPDATE1at the SQL prompt.
rem   The output listing is called UPDATE1.LIS.

spool update1.lis

update temp_details set pref = '*' where source = 'ISC';

update temp_details set mb_aver = mag1 where mag1_type = 'B';
update temp_details set mb_aver = mag2 where mag2_type = 'B';
update temp_details set ms_aver = mag1 where mag1_type = 'S';
update temp_details set ms_aver = mag2 where mag2_type = 'S';
update temp_details set mn_aver = mag1 where mag1_type = 'N';
update temp_details set mn_aver = mag2 where mag2_type = 'N';
update temp_details set md_aver = mag1 where mag1_type = 'D';
update temp_details set md_aver = mag2 where mag2_type = 'D';
update temp_details set ml_aver = mag1 where mag1_type = 'L';
update temp_details set ml_aver = mag2 where mag2_type = 'L';
update temp_details set ml_auth = source where ml_aver > 0;
update temp_details set m_unsp = mag1 where mag1 > 0 and mag1_type is null;
update temp_details set m_unsp = mag2 where mag2 > 0 and mag2_type is null;
update temp_details set m_auth = source where m_unsp > 0;

commit

update temp_details set m_max =
greatest(nvl(mb_aver,0),nvl(ms_aver,0),nvl(md_aver,0),nvl(mn_aver,0),nvl(ml_aver,0),nvl(m_unsp,0))
;

commit
spool off


rem   This file called UPDATE2.SQL inserts epicentre comments from table TEMP_DETAILS into
rem   table TEMP_ECOMMENTS and updates their order number.
rem   An output listing called UPDATE2.LIS is created.

rem   It is run from within SQL*Plus by typing START UPDATE2 at the SQL prompt.

spool update2.lis

insert into temp_ecomments(recno,epic_comment)
    select recno,epic_comment from temp_details
    where not epic_comment is null;
update temp_ecomments set ordno = 1 where ordno is null;

insert into temp_ecomments(recno,epic_comment)
    select recno,epic_comment2 from temp_details
    where not epic_comment2 is null;
update temp_ecomments set ordno = 2 where ordno is null;
```

```
insert into temp_ecomments(recno,epic_comment)
     select recno,epic_comment3 from temp_details
     where not epic_comment3 is null;
update temp_ecomments set ordno = 3 where ordno is null;

insert into temp_ecomments(recno,epic_comment)
     select recno,epic_comment4 from temp_details
     where not epic_comment4 is null;
update temp_ecomments set ordno = 4 where ordno is null;

spool off


rem    This file called INSERTS.SQL transfers all data from the temporary tables TEMP_DETAILS
rem    and TEMP_ECOMMENTS into tables EFFECTS, ECOMMENTS and DETAILS. It produces
rem    an output listing called INSERTS.LIS.

rem    It is run from within SQL*Plus by typing START INSERTS at the SQL prompt.

spool inserts.lis

insert into effects(recno,effect)
     select recno,effect from temp_details where not effect is null;

commit

insert into ecomments select * from temp_ecomments;

commit

INSERT INTO DETAILS
(recno,source,qdate,origin_time,time_prec,dlat,dlong,depth,depth_prec,pref,gregion,sregion,mb_aver,
mb_prec,ms_aver,ms_prec,md_aver,md_prec,mn_aver,mn_prec,ml_aver,ml_prec,ml_auth,m_unsp,
m_auth,m_max,no_obs)
SELECT  recno,source,qdate,origin_time,time_prec,dlat,dlong,depth,depth_prec,pref,gregion,
sregion,mb_aver,mb_prec,ms_aver,ms_prec,md_aver,md_prec,mn_aver,mn_prec,ml_aver,ml_prec,
ml_auth,m_unsp,m_auth,m_max,no_obs
from TEMP_DETAILS
WHERE not m_max = 0;

commit

rem    The following procedure transfers records in table TEMP_DETAILS which have no values for
rem    magnitude into table NOMAGS.

INSERT INTO NOMAGS
(recno,source,qdate,origin_time,dlat,dlong,depth,pref,gregion,sregion,no_obs)
SELECT        recno,source,qdate,origin_time,dlat,dlong,depth,pref,gregion,sregion,no_obs
from TEMP_DETAILS
WHERE m_max = 0;

commit

spool off
```

3. TRANSFERRING DATA FROM ASC DATAFILE TO ORACLE TABLES

SQL*Loader control file QUAKESAU.CTL:

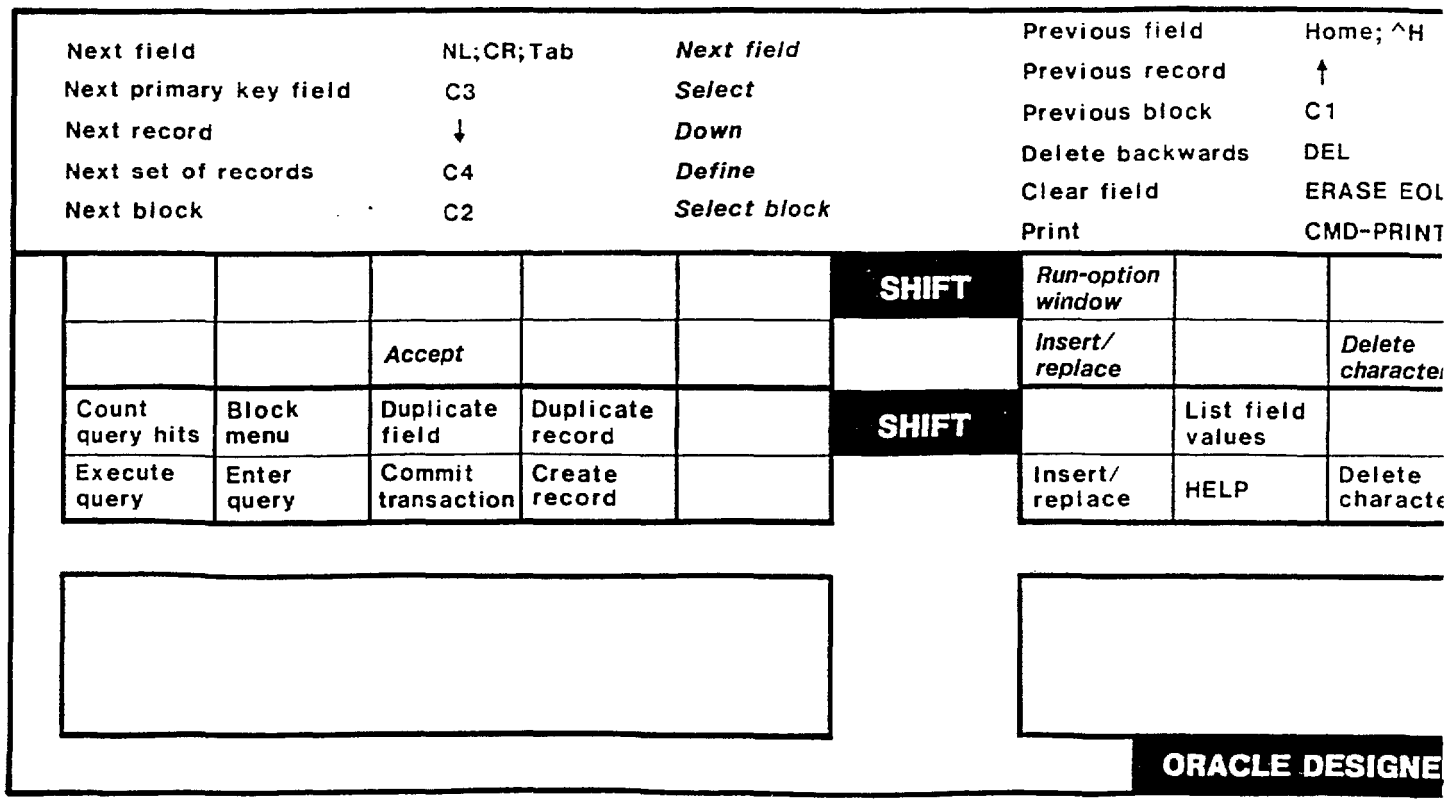
```
LOAD DATA
INFILE ausquake.dat
INTO TABLE temp_ausdetails
(recno          SEQUENCE(619437,1),
source          position(1:4)          char,
qdate           position(6:13)         integer external,
origin_time     position(15:23)        decimal external,
dlat            position(25:31)        decimal external,
dlong           position(34:40)        decimal external,
depth           position(42:44)        integer external,
pref            position(50)           char,
mb_aver         position(67:69)        decimal external,
ms_aver         position(80:82)        decimal external,
ml_aver         position(93:95)        decimal external,
ml_auth         position(97:99)        char,
m_unsp          position(106:108)      decimal external,
m_auth          position(102:104)      char,
no_stat         position(116:118)      integer external)
```

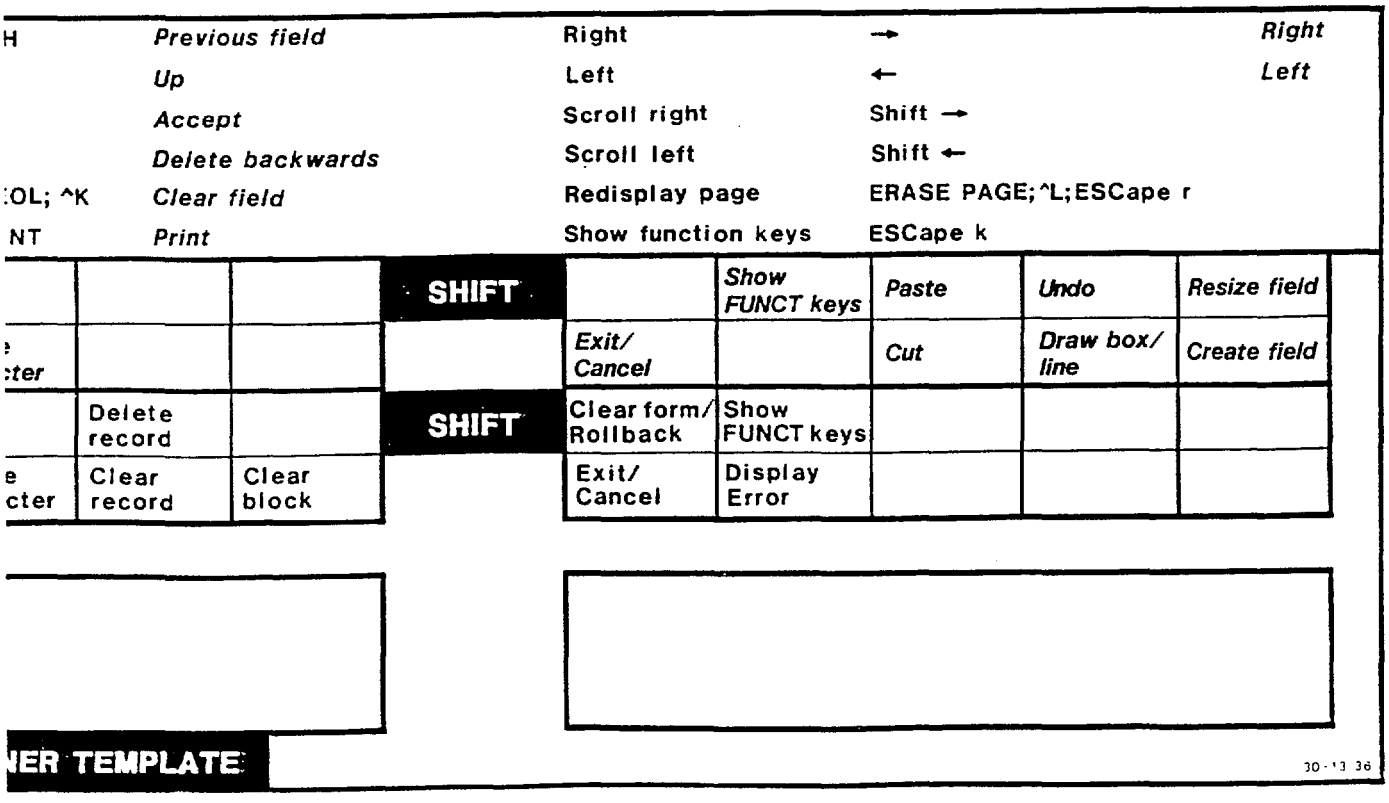
SQL SCRIPTS:

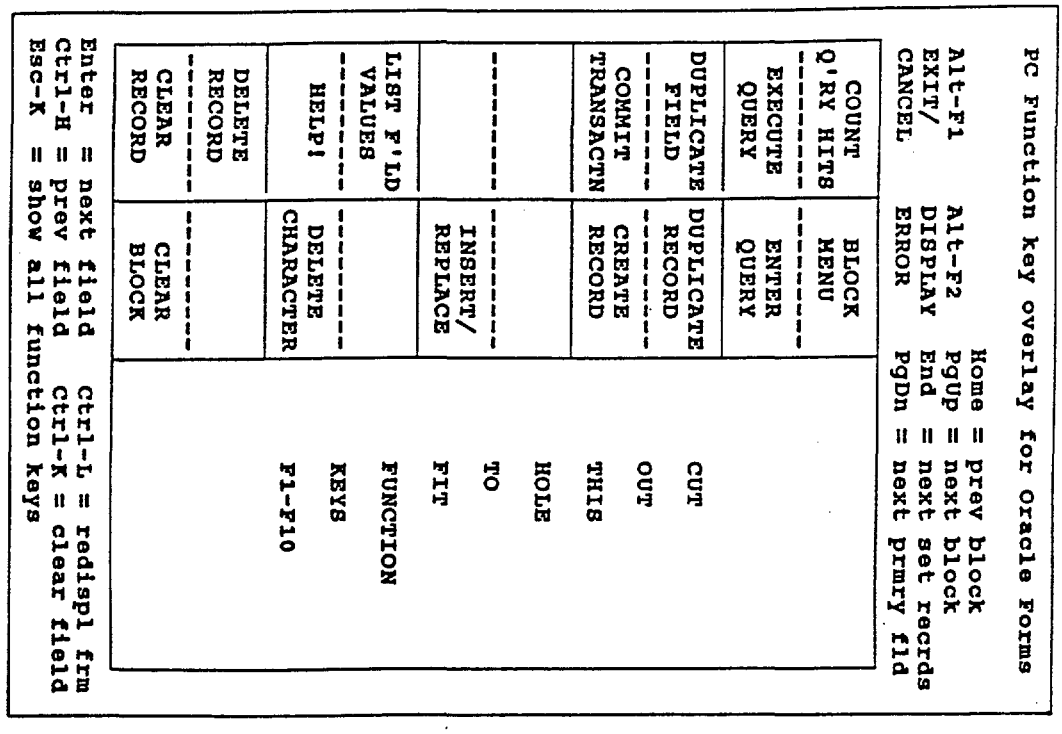
```
rem    This file called UPDAUS.SQL selects the maximum value for a magnitude and puts it in field
rem    m_max. For comparison null values are set to zero. (A WHERE clause can be inserted, if
rem    necessary.)

spool updaus

update temp_ausdetails set m_max =
  greatest(nvl(mb_aver,0),nvl(ms_aver,0),nvl(ml_aver,0),nvl(m_unsp,0));

commit

spool off

rem    This file called INSAUS.SQL is run to insert records from table TEMP_AUSDETAILS into
table
rem    DETAILS after loading data from the Australian datafile into ORACLE and after field m_max
rem    has been updated.

rem    To run it from within SQL*Plus, type START INSAUS at the SQL prompt.

insert into DETAILS
(recno,source,qdate,origin_time,dlat,dlong,depth,pref,mb_aver,ms_aver,ml_aver,ml_auth,m_unsp,
m_auth,no_stat,m_max)
SELECT
recno,source,qdate,origin_time,dlat,dlong,depth,pref,mb_aver,ms_aver,ml_aver,ml_auth,m_unsp,m_
auth,no_stat,m_max
from TEMP_AUSDETAILS;
```

APPENDIX D: KEYBOARD OVERLAYS FOR ORACLE

DG Keyboard







PC/AT function key overlay for Oracle Forms

Home = prev block, PgUp = next block,

COUNT Q'RY HITS	BLOCK MENU	DUPLICATE FIELD	DUPLICATE RECORD
EXECUTE QUERY	ENTER QUERY	COMMIT TRANSACTN	CREATE RECORD

		LIST F'LD VALUES	
	INSERT/ REPLACE	HELP!	DELETE CHARACTER

CUT OUT THESE HOLES TO FIT OVER

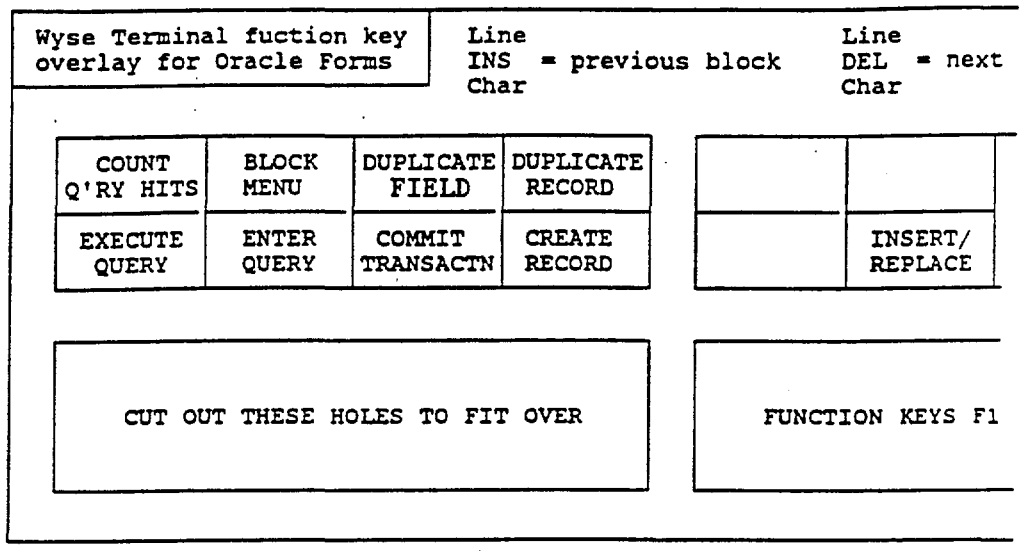
FUNCTION KEYS F1 -12 ON A PC/AT

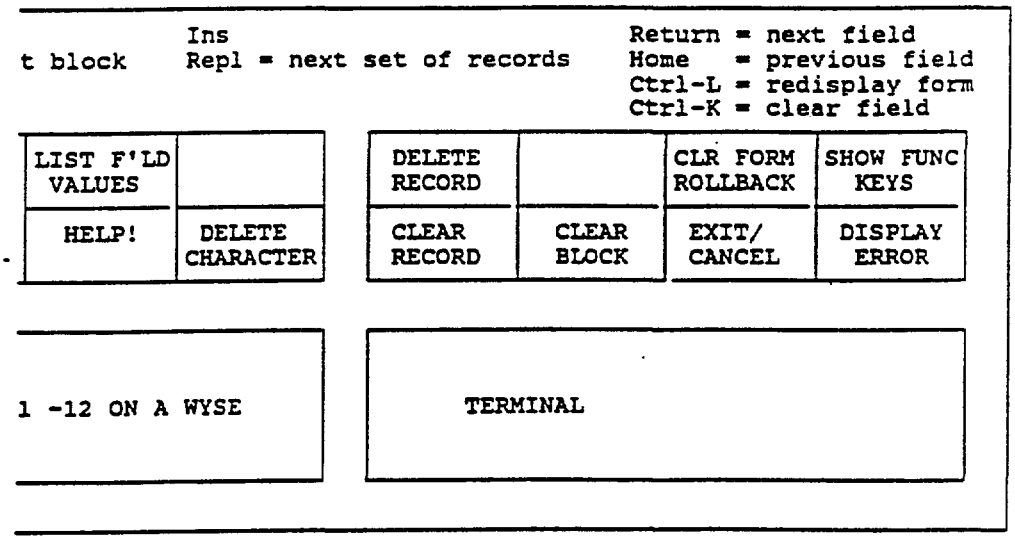
, End = next primary key fld, PgDn = next set of record

DELETE RECORD		CLR FORM ROLLBACK	SHOW FUNC KEYS
CLEAR RECORD	CLEAR BLOCK	EXIT/ CANCEL	DISPLAY ERROR

Enter = next field
Ctrl-H = prev field
Ctrl-L = redisplay
Ctrl-K = clr field
Esc-K = clr field

WITH AN EXTENDED KEYBOARD


Wyse Terminal fuction key overlay for Oracle Forms
Line INS Char = previous block
Line DEL Char = next
COUNT Q'RY HITS
BLOCK MENU
DUPLICATE FIELD
DUPLICATE RECORD
EXECUTE QUERY
ENTER QUERY
COMMIT TRANSACTN
CREATE RECORD
INSERT/ REPLACE
CUT OUT THESE HOLES TO FIT OVER
FUNCTION KEYS F1


t block
Ins
Repl = next set of records
Return = next field
Home = previous field
Ctrl-L = redisplay form
Ctrl-K = clear field
LIST F'LD VALUES
HELP!
DELETE CHARACTER
DELETE RECORD
CLEAR RECORD
CLEAR BLOCK
CLR FORM ROLLBACK
EXIT/ CANCEL
SHOW FUNC KEYS
DISPLAY ERROR
1 -12 ON A WYSE
TERMINAL

APPENDIX E: EXAMPLE OF AN SQL RETRIEVAL AND ITS OUTPUT

```
rem    This file called EXAMPLE.SQL retrieves all earthquakes with magnitude 7 and over for the
rem     year 1989.

set pagesize 1000
column recno format 999999
column qdate format 99999999
column origin_time format 999999.99
column dlat format 999.999
column dlong format 999.999
column m_max format 9.99
spool example.lis
select recno,source,qdate,origin_time,dlat,dlong,m_max
from details
where qdate between 19890101 and 19891231
and m_max > 6.99;
spool off
```

RECNO	SOURCE	QDATE	ORIGIN_TIME	DLAT	DLONG	M_MAX
628753	HFS	19890210	111536.00	4.600	123.700	7.50
629197	HFS	19890212	41508.00	49.800	78.700	7.00
643910	BJI	19890425	142858.30	17.250	-98.600	7.30
650365	BJI	19890523	105444.00	-52.390	160.800	8.10
650370	ISC	19890523	105446.24	-52.371	160.642	8.10
650366	NEIC	19890523	105446.30	-52.341	160.568	8.20
667670	HFS	19890803	113115.00	22.500	123.200	7.10
671602	HFS	19890821	231229.00	22.900	123.900	7.10
674152	ISC	19890904	131458.60	55.577	-156.858	7.10
674148	BJI	19890904	131500.10	55.830	-156.980	7.50
682493	NAO	19891018	413.00	37.500	-122.000	7.30
682500	ISC	19891018	414.75	37.061	-121.790	7.10
682494	BJI	19891018	414.90	37.160	-121.680	7.20
682495	NEIC	19891018	415.20	37.036	-121.883	7.10
682496	BRK	19891018	415.40	37.038	-121.882	7.00
682499	HFS	19891018	433.00	40.000	-120.900	7.30
685083	NEIC	19891027	210451.80	-11.022	162.350	7.00
686258	NAO	19891101	64032.00	-17.700	-68.700	7.00
686417	JMA	19891101	182533.50	39.850	143.060	7.10
686418	BJI	19891101	182534.50	39.900	142.840	7.50
686419	NEIC	19891101	182534.90	39.837	142.760	7.40
686424	ISC	19891101	182535.19	39.854	142.820	7.40
686421	HFS	19891101	182538.00	40.000	141.400	7.40
686430	BJI	19891101	183632.40	39.640	143.020	7.10
695825	NEIC	19891215	184345.00	8.337	126.729	7.30
695831	ISC	19891215	184346.05	8.318	126.724	7.10
695826	BJI	19891215	184346.10	8.560	126.900	7.20
695830	HFS	19891215	184412.00	12.300	123.100	7.20

28 records selected.

APPENDIX F: THE DETAILS.SQR REPORT

```
!    This report file called DETAILS.SQR retrieves details on earthquakes from the BMR-ASC World
!    Earthquake Database QUAKES.

!    The user can input values for      output filename
!                                       start and end date
!                                       lower and upper latitude
!                                       lower and upper longitude
!                                       top and bottom depth
!                                       lower and upper magnitude
!    and also has the option of entering an additional condition for the retrieval.
!    If none of these attributes are entered by the user the program can be run with default values.

!    Written by S. Lenz, Information Systems Branch, BMR
!    Date:  11 October 1991


begin-setup
  page-size 1000 93
  no-formfeed
end-setup

begin-report
  do menu
end-report

begin-heading 3
  print 'BMR-ASC World Earthquake Database' (1,1)
  date-time    (1,60)
! print 'Page ' (1,85)
! page-number  (1,90)
  print 'Source   Date    UTC    Lat    Long   Depth' (+2,1)
  print 'mb  Ms  MD  MN  ML auth unsp auth  obs stat' (,+1)

end-heading

!    start the main procedure and initialise variables

begin-procedure menu
  move 'DETAILS.LIS' to $oldfile
  move 'DETAILS.LIS' to $newfile
  move 'and qdate between 19850101 ' to $and_qdate_between
  move 'and 19881231' to $and_qdate2
  move 'and dlat between -40 ' to $and_dlat_between
  move 'and -10' to $and_dlat2
  move 'and dlong between 110 ' to $and_dlong_between
  move 'and 152' to $and_dlong2
  move 'and depth between 0 ' to $and_depth_between
  move 'and 33' to $and_depth2
  move 'and m_max between 6 ' to $and_mag_between
  move 'and 9.99' to $and_mag2
  move '' to $and_other
  move 19850101 to $qdate1
  move 19881231 to $qdate2
  move     -40 to $dlat1
  move     -10 to $dlat2
```

```
move     110 to $dlong1
move     152 to $dlong2
move       0 to $depth1
move      33 to $depth2
move       6 to $mag1
move    9.99 to $mag2
move '99' to $choice
move 0 to #ecount

!     display menu and get input for WHERE clause of SELECT statement

while $choice != 'X'
display ''
display '   Selection menu for extracting details on events from the'
display '          BMR-ASC World Earthquake Database QUAKES'
display ''
display ''
display '       1 - name of output file.....' noline
display $newfile
display '       2 - start date.....' noline
display $qdate1 99999999
display '       3 - end date.....' noline
display $qdate2 99999999
display '       4 - lower latitude.....' noline
display $dlat1 999.999
display '       5 - upper latitude.....' noline
display $dlat2 999.999
display '       6 - lower longitude.....' noline
display $dlong1 9999.000
display '       7 - upper longitude.....' noline
display $dlong2 9999.000
display '       8 - top depth.....' noline
display $depth1 999
display '       9 - bottom depth.....' noline
display $depth2 999
display '      10 - lower magnitude.....' noline
display $mag1 9.00
display '      11 - upper magnitude.....' noline
display $mag2 9.00
display '      12 - other conditions: ' noline
display $other
display ''
display '                G - Go          X - Exit'
display ''
display ''
input $choice '   Enter a number to change the above defaults or G/X '
display ''
uppercase $choice
evaluate $choice
when = '1'
  input $newfile '   Enter new pathname for output file '
  if $newfile != $oldfile
    move $newfile to $oldfile
    new-report $newfile
  end-if
  break
when = '2'
  input $qdate1 '   Enter the starting date e.g. 19850101 ' type=number
```

```
  if $qdate1 = ''
    move $qdate1 to $and_qdate_between
  else
    string 'and qdate between' $qdate1 by ' ' into $and_qdate_between
  end-if
  break
 when = '3'
  input $qdate2 '  Enter the last date e.g. 19851231 ' type=number
  if $qdate2 = ''
    move $qdate2 to $and_qdate2
  else
    string ' and' $qdate2 by ' ' into $and_qdate2
  end-if
  break
 when = '4'
  input $dlat1 '  Enter the lower latitude ' type=number
  if $dlat1 = ''
    move $dlat1 to $and_dlat_between
  else
    string ' and dlat between' $dlat1 by ' ' into $and_dlat_between
  end-if
  break
 when = '5'
  input $dlat2 '  Enter the upper latitude ' type=number
  if $dlat2 = ''
    move $dlat2 to $and_dlat2
  else
    string ' and' $dlat2 by ' ' into $and_dlat2
  end-if
  break
 when = '6'
  input $dlong1 '  Enter the lower longitude  ' type=number
  if $dlong1 = ''
    move $dlong1 to $and_dlong_between
  else
    string 'and dlong between' $dlong1 by ' ' into $and_dlong_between
  end-if
  break
 when = '7'
  input $dlong2 '  Enter the upper longitude  ' type=number
  if $dlong2 = ''
    move $dlong2 to $and_dlong2
  else
    string ' and' $dlong2 by ' ' into $and_dlong2
  end-if
  break
 when = '8'
  input $depth1 '  Enter the top depth   ' type=number
  if $depth1 = ''
    move $depth1 to $and_depth_between
  else
    string 'and depth between' $depth1 by ' ' into $and_depth_between
  end-if
  break
 when = '9'
  input $depth2 '  Enter the bottom depth   ' type=number
  if $depth2 = ''
    move $depth2 to $and_depth2
```

```
    else
      string ' and' $depth2 by ' ' into $and_depth2
    end-if
    break
  when = '10'
    input $mag1 '   Enter the lower magnitude   ' type=number
    if $mag1 = ''
      move $mag1 to $and_mag_between
    else
      string ' and m_max between' $mag1 by ' ' into $and_mag_between
    end-if
    break
  when = '11'
    input $mag2 '   Enter the upper magnitude   ' type=number
    if $mag2 = ''
      move $mag2 to $and_mag2
    else
      string ' and' $mag2 by ' ' into $and_mag2
    end-if
    break
  when = '12'
    input $other '   Enter additional condition, e.g. source = "ISC"'
    if $other = ''
      move $other to $and_other
    else
      string ' and' $other by ' ' into $and_other
    end-if
    break
  when = 'G'
    do details
    do qparams
    break
  when-other
    display $beep
    break
  end-evaluate
  end-while
end-procedure


begin-procedure details
begin-select
source          (+1,1,6)
qdate           (,+1,8)
origin_time     (,+1,9) edit 999990.9
dlat            (,+1,7) edit 990.999
dlong           (,+1,8) edit 9990.999
depth           (,+1,4) edit 999
mb_aver
  if &mb_aver > 0
    print &mb_aver (,+1,3) edit 9.0
  else
    print '   ' (,+1)
  end-if
ms_aver
  if &ms_aver > 0
    print &ms_aver (,+1,3) edit 9.0
  else
```

```
    print '   ' (,+1)
  end-if
md_aver
  if &md_aver > 0
    print &md_aver (,+1,3) edit 9.0
  else
    print '   ' (,+1)
  end-if
mn_aver
  if &mn_aver > 0
    print &mn_aver (,+1,3) edit 9.0
  else
    print '   ' (,+1)
  end-if
ml_aver
  if &ml_aver > 0
    print &ml_aver (,+1,3) edit 9.0
  else
    print '   ' (,+1)
  end-if
ml_auth        (,+1,4)
m_unsp
  if &m_unsp > 0
    print &m_unsp  (,+1,3) edit 9.0
  else
    print '   ' (,+1)
  end-if
m_auth         (,+1,4)
no_obs         (,+1) edit 9999
no_stat        (,+1) edit 9999
  add 1 to #ecount

from details

where pref = '*'
[$and_qdate_between]
[$and_qdate2]
[$and_dlat_between]
[$and_dlat2]
[$and_dlong_between]
[$and_dlong2]
[$and_depth_between]
[$and_depth2]
[$and_mag_between]
[$and_mag2]
[$and_other]

order by qdate,origin_time

end-select

  print 'Preferred solutions selected: ' (+1,1)
  print #ecount (,+1) edit 999999

end-procedure

begin-procedure qparams
```

begin-document (+2,1)

Seismic Parameters:
.b
Source : contributing agency
Date : date of earthquake
UTC : Universal Coordinated Time
Lat : decimal latitude
Long : decimal longitude
Depth : focal depth in km
mb : body wave magnitude
Ms : surface wave magnitude
MD : duration magnitude
MN : Nuttli magnitude
ML : local magnitude
auth : agency that assigned the magnitude
unsp : unspecified magnitude
obs : number of observations
stat : number of stations

end-document

end-procedure

APPENDIX G: EXAMPLE OUTPUT FROM THE DETAILS REPORT

BMR-ASC World Earthquake Database 11-Mar-1992 02:38 PM

Source	Date	UTC	Lat	Long	Depth	mb	Ms	MD	MN	ML	auth	unsp	auth	obs	stat
ISC	19890523	105446.2	-52.371	160.642	10	6.4	8.1							702	
ISC	19890904	131458.6	55.577	-156.858	11	6.2	7.1							708	
ISC	19891018	414.8	37.061	-121.790	8	6.2	7.1							673	
ISC	19891101	182535.2	39.854	142.820	29	6.2	7.4							845	
ISC	19891215	184346.1	8.318	126.724	24	6.3	7.1							600	

Preferred solutions selected: 5

Seismic Parameters:

Source: contributing agency
Date: date of earthquake
UTC: Universal Coordinated Time
Lat: decimal latitude
Long: decimal longitude
Depth: focal depth in km
mb: body wave magnitude
Ms: surface wave magnitude
MD: duration magnitude
MN: Nuttli magnitude
ML: local magnitude
auth: agency that assigned the magnitude
unsp: unspecified magnitude
obs: number of observations
stat: number of stations

APPENDIX H: DESCRIPTION OF THE DATABASE FIELDS

TABLES DETAILS AND NOMAGS:

recno: record number, system-assigned unique event identifier;
source: seismographic agency code (3 - 6 letter code, e.g. ISC);
qdate: date of earthquake (Universal Coordinated Time UTC, e.g. 19870108);
origin_time: origin time of earthquake (UTC, e.g. 235024.10);
time_prec: precision of origin time;
dlat: epicentre latitude in decimal degrees (e.g. 38.870, +ve N, -ve S);
dlong: epicentre longitude in decimal degrees (e.g. 134.890, +ve E, -ve W);
depth: focal depth in km;
depth_prec: focal depth precision;
pref: the preferred solution of a number of solutions from various agencies;
isoseis_map: whether or not an isoseismal map has been prepared;
gregion: geographic region number;
sregion: Flinn-Engdahl region number (see Gutenberg & Richter, 1954);
mb_aver: average magnitude (body wave scale);
mb_prec: precision of body wave magnitude;
ms_aver: average magnitude (surface wave scale);
ms_prec: precision of surface wave magnitude;
md_aver: average magnitude (Richter scale, but measured from the coda duration);
md_prec: precision of duration magnitude;
mn_aver: average magnitude (Nuttli scale, used in Eastern USA);
mn_prec: precision of Nuttli magnitude;
ml_aver: average magnitude (Richter or local scale);
ml_prec: precision of local magnitude;
ml_auth: the seismographic station or agency who assigned the ML value;
m_unsp: average magnitude (unspecified scale);
m_auth: the seismographic station or agency who assigned the magnitude value;
m_max: maximum of all magnitude values;
no_obs: number of observations - number of phase arrivals, p or s, used to determine the origin time and focus;
no_stat: number of stations - number of seismographs used to determine the origin time and focus;
seis_mom: measure of the size of an earthquake determined from analysis of seismograms or field studies of faulting;
exp: the exponent of the moment as a power of 10;

TABLE EFFECTS:

recno: record number, system-assigned unique event identifier;
effect: F = felt; D = damage; C = collapse of nuclear explosion; H = non-nuclear explosion; R = rockburst in coal mine; N = nuclear explosion;

TABLE INTENSITIES:

recno: record number, system-assigned unique event identifier;
place_name: town or location where the earthquake was reported felt;
dlat: latitude in decimal degrees;
dlong: longitude in decimal degrees;
state: abbreviated Australian state name;
intens: Modified Mercalli (MM) intensity (Eiby,1966);

TABLE ECOMMENTS:

recno: record number, system-assigned unique event identifier;
ordno: order number;
epic_comment: epicentre comment;

TABLE COMMENTS:

form: format, ISC tape number code;
source: seismographic agency code;
qdate: date of earthquake (UTC);
origin_time: origin time of earthquake (UTC);
comments: non-epicentre comment field 1;
comments2: non-epicentre comment field 2;
comments3: non-epicentre comment field 3;
comments4: non-epicentre comment field 4;

TABLE SOURCES:

source: seismographic agency code;
description: seismographic agency.