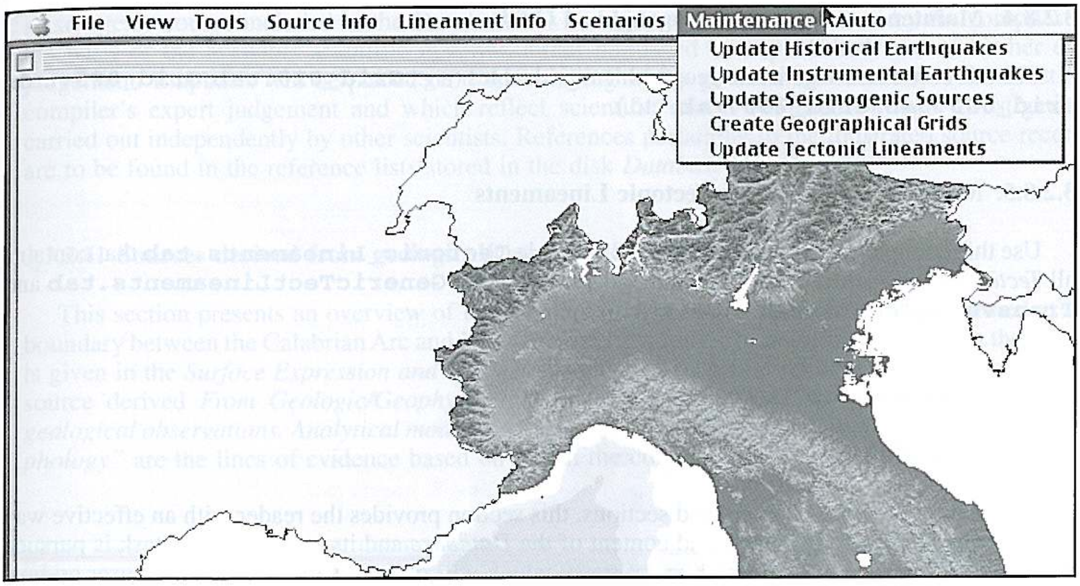

Fig. 3.15. Submenus of the menu "Maintenance".

3.2.8. The *Maintenance* menu

Any user can update the *Database* by entering new seismogenic sources, modifying the existing ones or adding new background information (see Chapter 4 for details on how to enter new information in the structural and support tables). To update the graphic information after having modified or updated a table and to display correctly the newly-entered information the user has to run an appropriate command chosen from those listed in the *Maintenance* menu (fig. 3.15).

3.2.8.1. Maintenance > Update Historical Earthquakes

Use this command after having modified any of the tables that contain historical seismicity (`CFTI_q.tab`, `CPTI_q.tab`, and `NT_q.tab`).

3.2.8.2. Maintenance > Update Instrumental Earthquakes

Use this command after having modified the catalogue of instrumental earthquakes (`inst_q.tab`).

3.2.8.3. Maintenance > Update Seismogenic Sources

Use this command after having modified any of the tables containing seismogenic sources (`SourceGeol.tab`, `SourceHistA.tab`, `SourceHistARev.tab`, `SourceHistB.tab`, `SourceHistBRev.tab`, `SourceDeep.tab`). This command generates a new `SourcePreferred.tab` automatically.

3.2.8.4. Maintenance > Create Geographical Grids

Use this command to generate geographical grid tables (*e.g.*, **`Grid_010.tab`**, **`Grid_025.tab`**, **`Grid_050.tab`**, **`Grid_100.tab`**, etc.).

3.2.8.5. Maintenance > Update Tectonic Lineaments

Use this command after having modified the table **`Tectonic_Lineaments.tab`** that contains all *Tectonic Lineaments*. This command updates the tables **`GenericTectLineaments.tab`** and **`TransverseTectLineaments.tab`** automatically.

3.3. CONSULTING THE *DATABASE*

3.3.1. Generalities

Building on previous chapters and sections, this section provides the reader with an effective way to get acquainted with the compound content of the *Database* and its structure. This task is pursued by guiding the reader through the lines of travel which will better instruct the potential user on how to consult the records of seismogenic sources and the background information that lies behind them.

The following § 3.3.2. gives an overview of several sample records pertaining to the six different categories in which the seismogenic sources are grouped, while § 3.3.3. illustrates a series of examples of the several ways in which an individual seismogenic source record can be analysed within its geologic and seismotectonic context.

To get the most out of this guided tour the user should have already installed the necessary software and correctly copied onto his/her computer all folders and files that form the *Database*. It is also necessary that the user be already familiar with menu-bars and tools of the *Database* cartographic interface and with its commands and procedures. The user is also suggested to follow this section with the *Database* running on the computer and to try to bring forward the content of the *Database* that is currently illustrated and commented. Refer to Chapter 2 for details concerning the structure of the *Database*, and to sections 3.1., 3.2. to check the operational procedures.

3.3.2. Browsing sample records

This section illustrates the content of several records that are considered good representatives of the six categories of seismogenic sources contained in the *Database*. The six categories (see details about the definition of various categories in § 2.2.3.) are illustrated and commented in four subsections concerning respectively:

a. sources that were derived from geological and/or geophysical investigations (§ 3.3.2.1.);
b. sources that were derived from well constrained and from poorly constrained historical data and for which background geological information is given (§ 3.3.2.2.);
c. sources that were derived from well constrained and from poorly constrained historical data without any background geological information (§ 3.3.2.3.);
d. sources that were derived from historical data which are suspected to be deeper than usual (§ 3.3.2.4.).

For each example in the following sections only the information that can be drawn from the series of items listed in the *Source Info* down-drop menu will be illustrated. The user is reminded that each seismogenic source included in the *Database* has been identified and described by the compiler on the basis of the available scientific material, either published or unpublished, and of his/her own judgement. Emphasis will be placed on discriminating which parts of the source record reflect the compiler's expert judgement and which reflect scientific results achieved through investigations carried out independently by other scientists. References pertaining to the illustrated source records are to be found in the reference lists stored in the disk *Database*.

3.3.2.1. Sources derived from geological/geophysical investigations

This section presents an overview of the *Messina Straits* source (ID 13), which is located at the boundary between the Calabrian Arc and Sicily, in Southern Italy. The basic information on the source is given in the *Surface Expression and Geometry* window, which first reminds the user that this is a source derived *From Geologic/Geophysical Data* (fig. 3.16). More specifically, *"Geodetic and geological observations. Analytical modelling of coseismic elevation changes and long-term geomorphology"* are the lines of evidence based on which the compiler constrained the source in its final

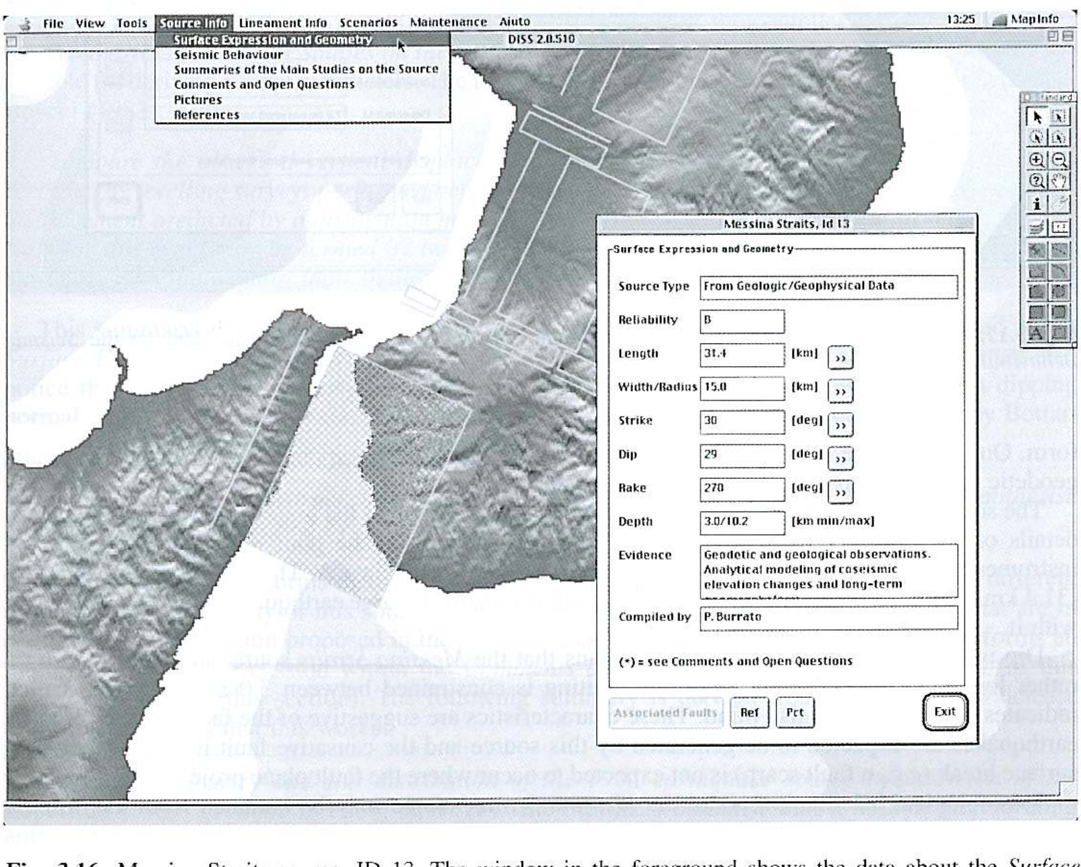

Fig. 3.16. Messina Straits source, ID 13. The window in the foreground shows the data about the *Surface Expression and Geometry* of this source.

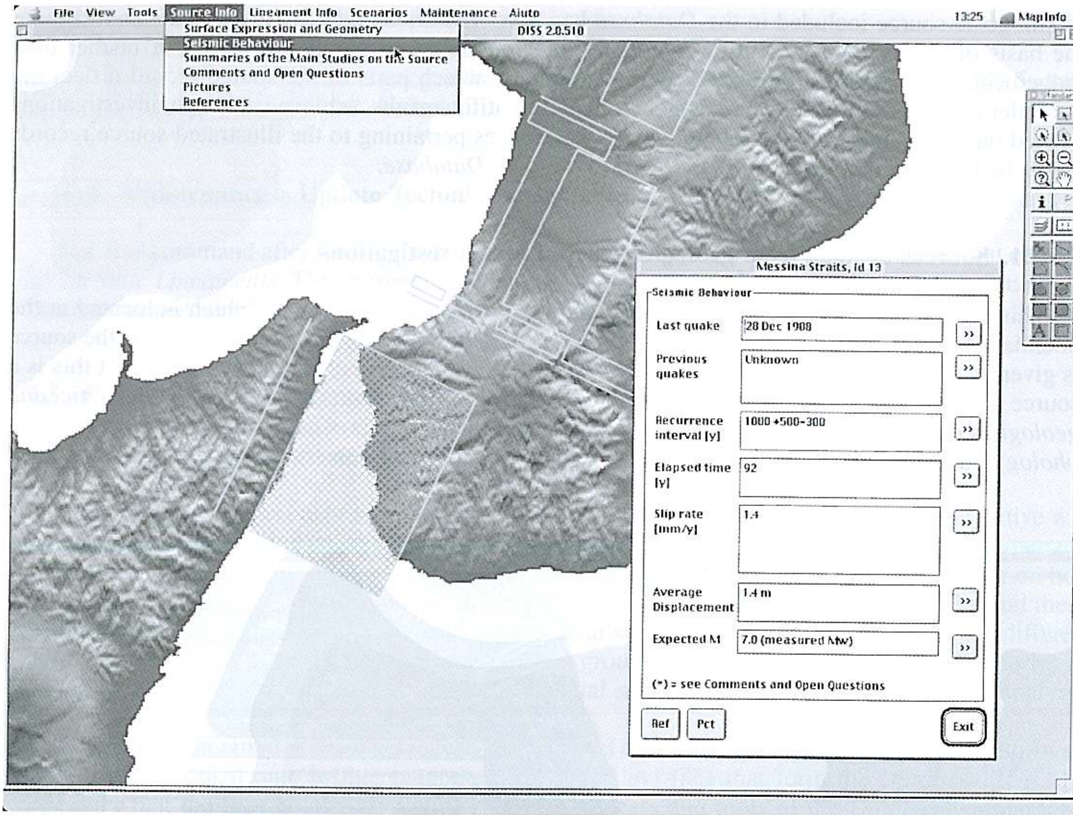

Fig. 3.17. *Messina Straits* source, ID 13. The window in the foreground shows the data on the *Seismic Behaviour* of this source.

form. One may notice that, even from this short description, it appears that some instrumental data, geodetic data in this particular case, were available.

The source reliability is B, which is quite high (considering that the scale ranges from A to D; see details on the source reliability rating in § 2.2.3.1.). However, the poor quality of the available instrumental data prevented the source from being assigned to Class A. The source size is quite big (31.4 km length, 15.0 km width), which implies that a relatively large earthquake should be associated with it.

Dip is 29° while rake is 270°, which means that the *Messina Straits* source is represented by a rather low-angle normal fault. Depth of faulting is constrained between 3.0 and 10.2 km, which indicates that the fault is also blind. These characteristics are suggestive of the fact that even if large earthquakes are expected to be generated by this source and the causative fault is rather shallow, a surface break (*e.g.*, a fault scarp) is not expected to occur where the fault plane projects to the surface.

Seismological information about the *Messina Straits* source may be obtained from the *Seismic Behaviour* window, which begins by informing that the most recent earthquake produced by this source is the 28 December 1908 event (fig. 3.17). The expected magnitude for the source is M_w 7.0, which corresponds to the estimated magnitude of the 1908 event. Not coincidentally, this earthquake size is also the size needed to rupture the entire area encompassed by this source in a single event. The expected magnitude for other sources may come from different observations depending on whether the source is correlated with a historical or instrumentally recorded earthquake or is not correlated with any earthquake. The reported magnitude can be either an M_e, if derived from intensity data, or an M_w, if measured or derived from empirical relationships between fault size and moment-magnitude.

Previous earthquakes for the *Messina Straits* source are not known at present. The time elapsed between the most recent event and the year 2000 (taken as a reference datum for the entire *Database*) is 92 years. The average displacement is 1.4 m, which is the amount of coseismic slip derived from modelling of the coseismic elevation changes induced by the 1908 earthquake. Assuming that this earthquake is the "characteristic earthquake" for the source, the average displacement value may be also assumed to be the typical displacement per event. That is to say that previous earthquakes generated by this source made the causative fault slip by approximately the same amount. Following this reasoning and comparing the coseismic displacement with the long-term geomorphic features of the area, previous investigators proposed an average recurrence interval of 1000 (+ 500; – 300) years. The estimated slip rate is hence 1.4 mm/yr, which is obtained dividing the average displacement per event by the average recurrence interval.

As mentioned earlier, the *Messina Straits* source is related to the 1908 Calabria meridionale earthquake for which there exist contemporary studies by Baratta (1910), Loperfido (1909), Martinelli (1909), Oddone (1909), Omori (1909), Rizzo (1910). However, the compiler decided to include in the *Summaries of the Main Studies on the Source* only studies that present data and evidence that are suitable for deriving source parameters. The first of these "modern era" studies is that by Mulargia and Boschi (1983), who

"... *compare the observed vertical displacement induced by the 28 December 1908 earthquake, recorded by levelling surveys performed before and after the event* (Loperfido, 1909), *and the vertical displacement predicted by a dislocation model. They propose that the seismogenic structure responsible for this event may be formed by two N22° trending normal faults, organised in a graben-like structure, with the western fault shallower and dipping at a low angle. ...*".

This summary also informs the user that the geodetic observations that were mentioned in the *Surface Expression and Geometry* window are those obtained by Loperfido (1909). One may also notice that the paper by Mulargia and Boschi (1983) already hinted at a low-angle, East-dipping normal fault as the source of the 1908 earthquake. In contrast, the summary of the paper by Bottari *et al.* (1986) reminds that these investigators

"... *re-examine and reconstruct the macroseismic field of the 1908 earthquake .... they hypothesise that the event was generated by a NE-SW trending, NW60° dipping normal fault...*".

The compiler thus informs the user that different approaches and views were taken by different investigators in the study of this source, and in doing so acknowledges scientific results that are in contrast with the solution proposed in the *Database*. One may also notice that this subject forms an important point of discussion within the *Comments and Open Questions* text elaborated for this source (see later in this section). The following summary is derived from the paper by Valensise (1988) and informs that this worker

"... *estimates geometry and slip distribution of the 1908 earthquake source by inversion of the* Loperfido (1909) *geodetic levelling data-set ... the best fit is obtained with a normal fault striking NNE and dipping 36° to the East ... the coseismic displacement profile shows a graben-like shape in agreement with the topographic profile of the Straits ... the structure of the Straits may be considered as the result of repeated characteristic earthquakes generated by the same fault. ...*".

This summary is important not only in the definition of the geometry and kinematics of the seismogenic source, but also for the association between the behaviour of the fault during the earthquake and its long-term behaviour revealed by the main topographic and geomorphic features of the area.

In addition to the several summaries which complete the revision of the main published papers about the *Messina Straits* source, the following summary, derived from Anzidei *et al.* (1998), stresses the importance of modern geodetic measurements as well as of frequent follow-ups for a finer characterisation of a seismogenic source. The summary informs that these authors

"... analyse the results of geodetic measurements across the Messina Straits. A geodetic network set up in 1970 was repeatedly measured with conventional techniques until 1980. In 1987 and 1994 the network was also measured with GPS techniques. The analysis shows that no significant horizontal deformation has taken place across the Messina Straits between 1980 and 1994. This observation is interpreted as evidence for the absence of secondary faulting near or above the causative fault of the 1908 earthquake. ...".

The results and interpretations summarised in this text suggest that, about 80 years after one of the largest earthquakes of Italian history, this large fault is in the process of storing elastic energy to be released in a future large event, and hence is not generating sizeable horizontal strains. This piece of information is a good example of a link between the content of the *Database* and geophysical investigations being carried out in the vicinity of the *Messina Straits* source.

In the example of the *Messina Straits* source record the main debated points concern the geometry and extent of the fault plane. Even if geomorphic, geological and geodetic evidence are strongly suggestive of the existence of a low-angle normal fault, some investigators claim that the 1908 source is represented by a two-sided graben-like structure. These points of debate are discussed in the *Comments and Open Questions* as follows:

"The main point that is still debated concerns the geometry of the seismogenic fault responsible for the 28 December 1908 earthquake, and consequently the structural setting of the Messina Straits. There are two main contrasting hypotheses derived using different approaches. Based on seismologic, geodetic and geomorphic evidence, some workers (among which are De Natale and Pingue, 1987; Capuano *et al.*, 1988; Valensise, 1988; Boschi *et al.*, 1989, *and the compilers of this Database), suggest the existence of a low-angle, E-dipping normal fault, characterised by a cumulative vertical deformation field that would mimic the shape of an asymmetric trough; this hypothesis is seen by* Valensise and Pantosti (1992) *to suit the overall long-term deformation recorded by the geology and geomorphology of the Straits.*
A second group of investigators (among which are Bottari *et al.*, 1986; Bottari *et al.*, 1992; Tortorici *et al.*, 1995*) uses a standard structural approach along with geomorphic observations to propose the existence of a graben structure composed of three main fault systems (trending NE-SW, NW-SE and E-W). According to this scheme, the master, earthquake-generating element would be a high-angle, NE-trending, W-dipping fault reaching the surface on the Calabrian side east of Reggio Calabria.*

... It should be remarked that, despite the great deal of field work performed by several contemporary investigators, no coseismic fault scarps were reported after the occurrence of the 1908 earthquake, in agreement with the hypothesis of blind faulting. This circumstance might indeed suggest offshore faulting, but this option would be in contrast with several other lines of evidence and has never been seriously advocated by any of the investigators of the recent tectonics of the Straits. It should also be pointed out that the overall reliability of the coseismic elevation changes measured by Loperfido (1909) *has never been questioned and that these observations positively do not support significant (*i.e., *seismogenic) shallow faulting on the Calabrian side of the Straits. ...".*

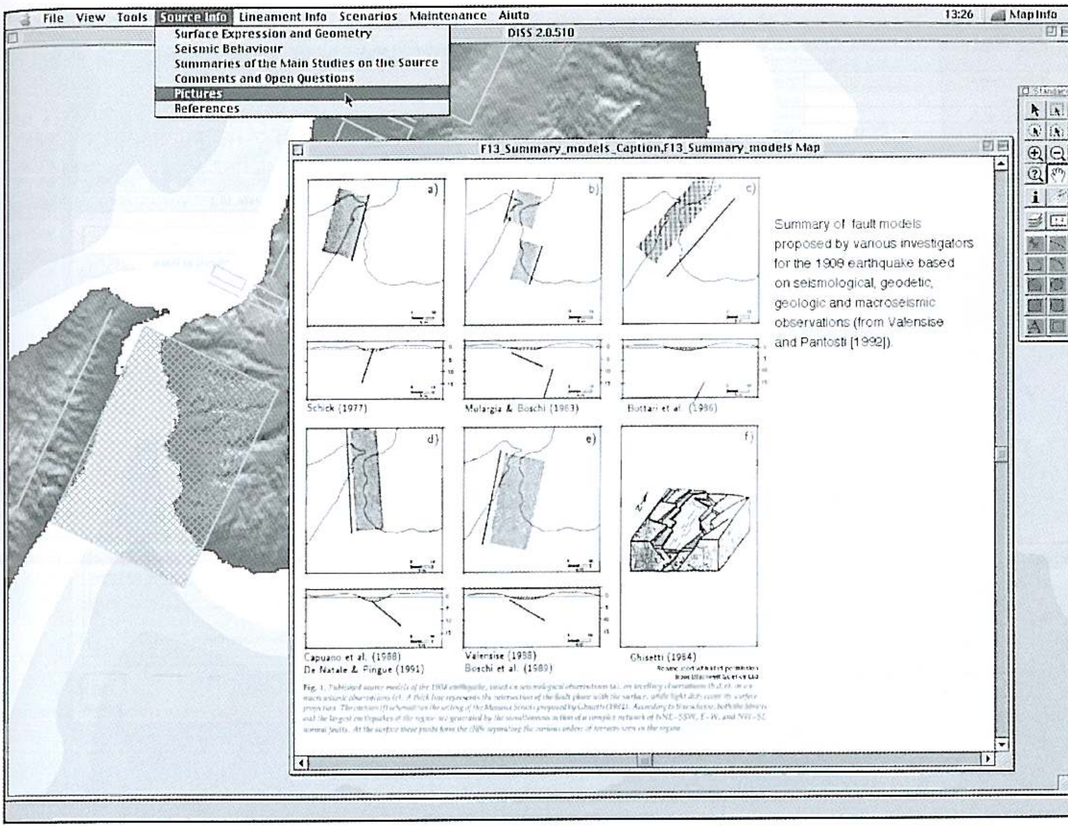

Fig. 3.18. *Messina Straits* source, ID 13. The window in the foreground shows one of the 18 *Pictures* available for this record.

A much more descriptive way to survey the results of previous works is to see the original pictures that were used by different investigators to present their results. Thanks to the large number of previous studies on the *Messina Straits* source, 18 significant pictures can be provided within the *Pictures* record. Figure 3.18 shows a picture entitled "Summary of fault models" (the title is shown in the *Pictures* dialog window) which compares several fault models and is taken from Valensise and Pantosti (1992). This figure appears with its original caption, which makes it more easily readable, but not all the figures in the *Database* include their caption. In this case the user can compare at a glance the different fault models with the solution adopted by the compiler. The user may also notice that the *Database* solution takes into account results of previous workers attained over a long period of time. The adopted solutions generally correspond to those that show the highest degree of accordance with different types of independent data.

To facilitate further analyses of the work done on the *Messina Straits* source and of the relevant literature, even if not directly related to the identification of the source itself, one can refer to the *References* record. A total of 76 references are listed for this source. This list includes all the papers that were consulted during the preparation of the source record and many other papers that contain geologic, geomorphologic, geophysical information about the region where the source is located. This

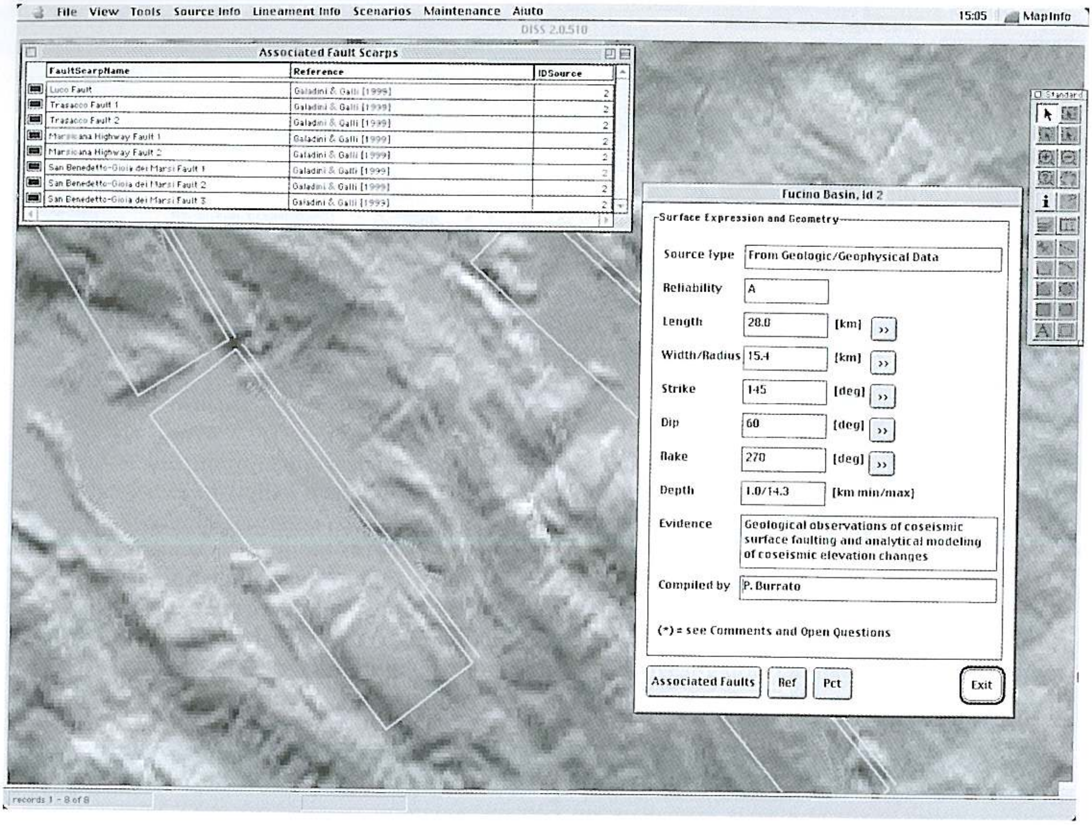

Fig. 3.19. Fault scarps associated with the *Fucino Basin* source, ID 2. The window in the foreground lists the names of all fault scarps.

gives the user of the *Database* the opportunity to make further investigations or to complete the process of reviewing published materials that were not used by the compilers.

Let us now have a quick look at other sample records that embrace a complete spectrum of the cases that the user might encounter in consulting the *Database*. In addition to the information presented above, an important piece of information can be retrieved from the records of sources associated with a surface faulting event, either historical or pre-historical. In this case the associated fault scarps are also shown in the map with a hachured red line. A good example of such a source is represented by the *Fucino Basin* source (ID 2), that is associated with the well known fault scarps generated by the 13 January 1915, Avezzano earthquake (fig. 3.19).

In this case the button *Associated Faults* of the *Surface Expression and Geometry* window becomes highlighted. Clicking it opens a child-window that lists the references from which the data concerning each individual fault scarp (essentially its conventional name and its exact location) were taken.

Another special case is represented by those sources of the *Database* that are not correlated with any historical earthquake but for which enough geological and/or geophysical information exists to allow a complete source characterisation. An example is that of the *Fano-Ardizio* source (ID 31) (fig. 3.20). The existence of this particular source was inferred from observations of the adjacent,

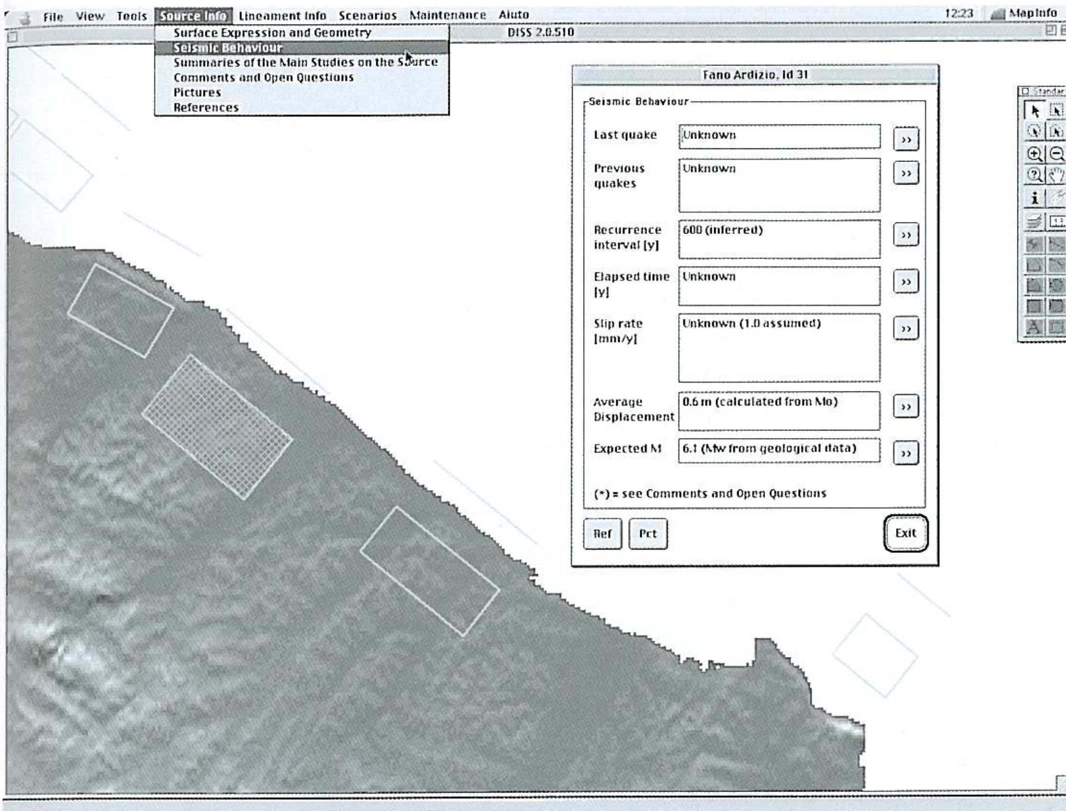

Fig. 3.20. *Fano-Ardizio* source, ID 31. The window in the foreground shows the data about the *Seismic Behaviour* of this source. Notice that the window in the foreground informs that for this source the *Last Quake* is unknown.

more constrained, *Senigallia* source (ID 30), that is interpreted as the causative source of the 30 October 1930 earthquake, and from observations of the tectonic setting of the surrounding region. Sources like this one are fully-fledged sources, although with a lower reliability rating (C for the *Fano-Ardizio* source), that may also be considered as seismic gaps. As such, they may have a compelling impact onto the seismic hazard assessment of the region where they occur. In addition, they usually occur in areas where current knowledge about seismogenic sources is rather poor and that may hide additional, as yet totally unidentified sources.

3.3.2.2. Sources derived from well-constrained and from poorly-constrained historical data with geological background

This section presents an overview of the *Irpinia North* source (ID 402), located in the middle of the Southern Apennines mountain belt.

The basic information on the source is given in the *Surface Expression and Geometry* window, which first reminds the user that the source is one of those derived from good historical data and that

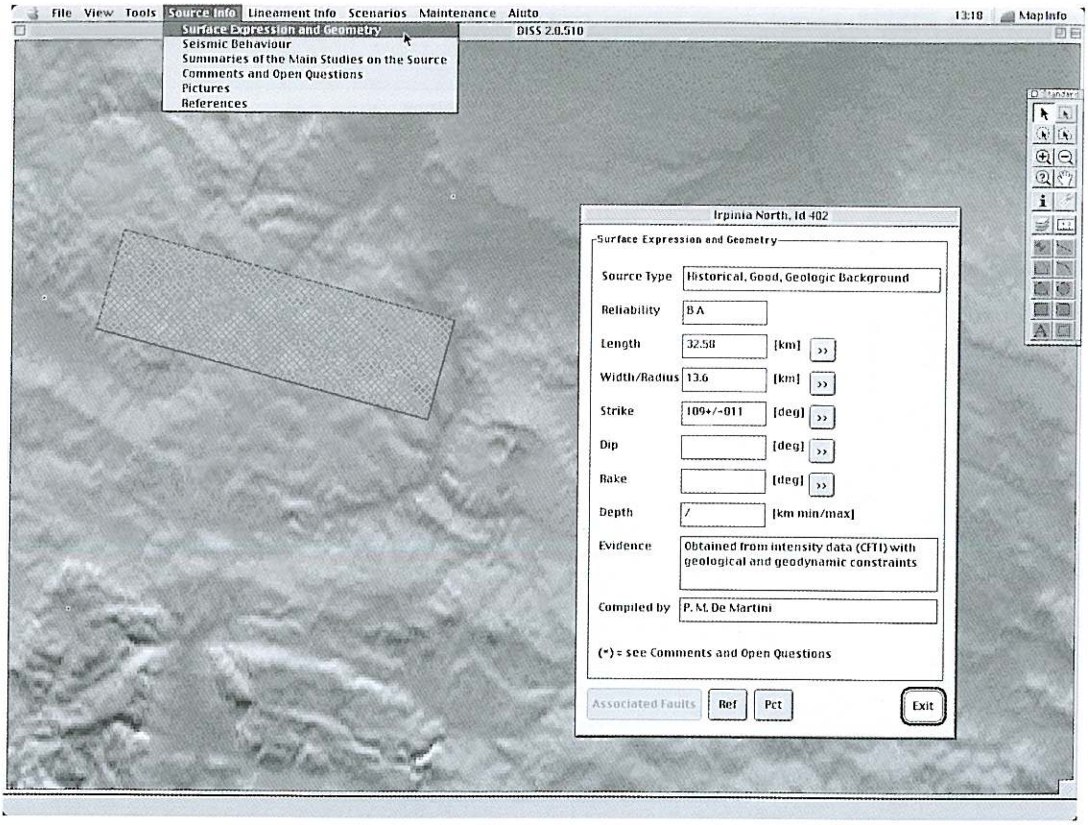

Fig. 3.21. *Irpinia North* source, ID 402. The window in the foreground shows the data about the *Surface Expression and Geometry* of this source.

some geological information exists in the background. This information was not enough for the compiler to turn this source into a *Geologic/Geophysical* source, but is nevertheless supplied in the same manner as for better quality sources to promote future work and, hopefully, a better understanding of the source characteristics. The *Database* record shown in fig. 3.21 informs that the location, geometry and size of the fault were *"Obtained from intensity data (CFTI) with geological and geodynamic constraints"*. The source is represented by an oriented rectangle whose orientation and size were derived from intensity data exclusively, following the approach by Gasperini *et al.* (1999).

The source reliability is B-A, which indicates conventionally that the uncertainty of the source orientation is between 10° and 24° and that more that 500 intensity data points were available from the historical catalogue used (CFTI in this case) for the associated earthquake (see also § 2.2.3.2. for details on reliability rating criteria). The source size is quite big (length 32.58 km, width 13.60 km), which implies that a relatively large earthquake is associated with it because these dimensions are obtained from empirical relationships of magnitude *versus* length/width. However, it is well known that the magnitude of a historical earthquake is seldom underestimated and often overestimated, and hence a careful consideration of the source size is required before further interpretations.

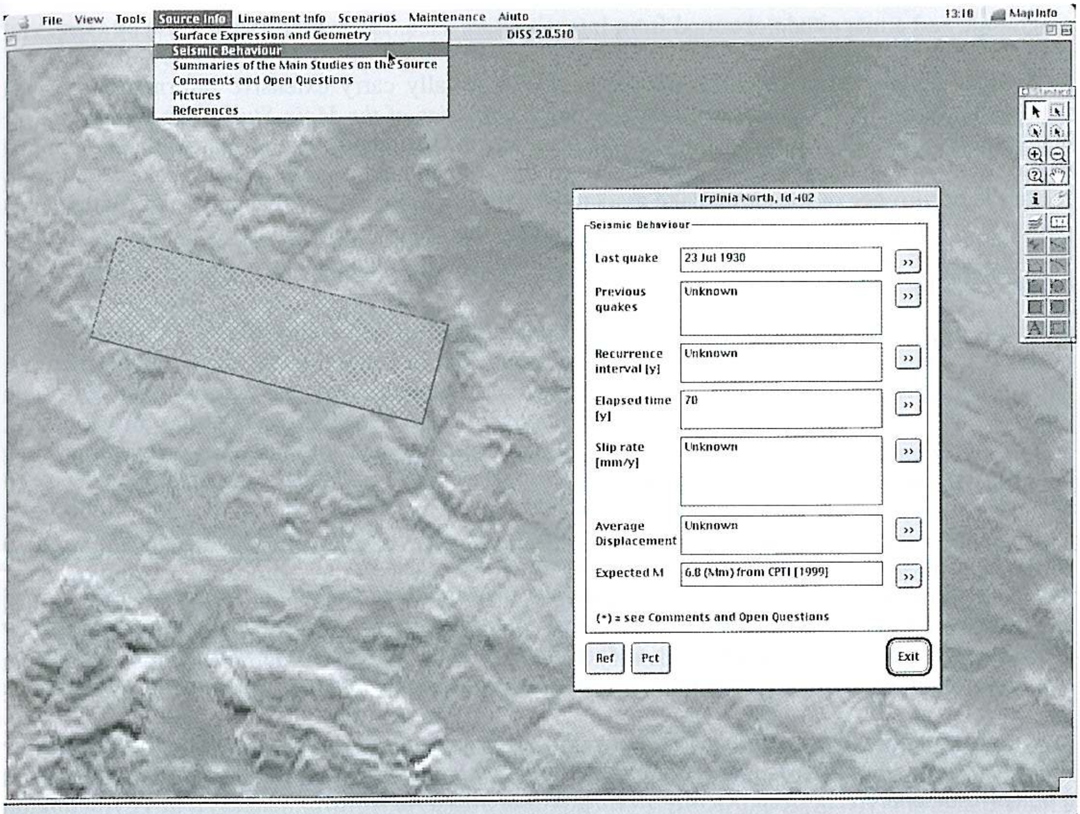

Fig. 3.22. *Irpinia North* source, ID 402. The window in the foreground shows the data on the *Seismic Behaviour* of this source.

Source strike is 109° ± 011°. For sources of this type strike may be very important for discriminating a seismogenic source belonging to the main Apennines system, the locus of the largest earthquakes, from a source associated with a transverse structure. However, in this particular case it is not easy to make such prediction because the source is located about 10 km East of the main Apennines normal fault system and strikes about 20° more westerly.

Finally, notice that for this type of sources, although geological data are indeed included in the *Database*, no information can be supplied concerning the dip, rake, and depth of the earthquake causative fault.

The *Seismic Behaviour* window informs that the *Irpinia North* source is correlated with the 23 July 1930 earthquake (fig. 3.22). Only 70 years have passed since the earthquake occurred, and this alone suggests that a strong earthquake is not likely to be generated by the same source in the near future. However, a strong earthquake occurred in 1980 in Southern Irpinia (see *Irpinia South* source, ID 7) on a different, although quite near, seismogenic source. The expected magnitude for the *Irpinia North* source is M_a 6.7, which is the estimated magnitude taken from the CPTI Working Group (1999) catalogue. Notice that M_a is an average magnitude obtained by combining with appropriate weights a purely macroseismic magnitude (that is, based on epicentral intensity only), an instrumental magnitude and a magnitude obtained from intensity data using the approach proposed by Gasperini *et al.* (1999).

Sources derived from *Geologic/Geophysical* data usually carry extensive information derived from published scientific materials. Likewise the *Summaries of the Main Studies on the Source* for historical sources with geological background represent the main body of information that is supplied to the user. As common for large earthquakes of the 20th century, several papers make attempts to relate the occurrence of the earthquake associated with the source. These papers are of fundamental importance for determining the source parameters and therefore were taken in great consideration by the compiler of this source record. For example, the following sentence is taken from the summary of the paper by Vari (1930), who states that

"*... the duration of the earthquake was about 35 seconds. ...*".

while Alfano (1931)

"*... interprets the long duration of the shaking as due to three different events, that gave three intensity peaks in Villanova, Trevico and Lacedonia. ...*".

These two excerpts inform the user of the *Database* that, similarly to the 23 November 1980 earthquake in Southern Irpinia, the 23 July 1930 earthquake was most probably a complex event formed by three separate shocks. As such, correctly identifying its source may be more difficult than if it occurred with a single shock. Nevertheless, Oddone (1932) supplies several observations of ground deformations that could help identify the expression of the fault at the surface, as this excerpt from the following summary of Oddone's (1932) paper suggests:

"*... Several fractures formed over a wide area: the most interesting features were (1) a NW-SE striking fracture, running from the damaged S. Spirito bridge, on the Miscano river, to Foiano sul Fortore, (2) a 60 cm-wide and 40 cm-deep fracture striking N-S at Masseria Novario, and (3) a large fracture on the road between Montecalvo Irpino and Corsano....*".

Several later papers provide seismological interpretations which prompt further hypotheses in the characterisation of the source. For example, an hypothesis about the fault kinematics can be obtained from the paper by Martini and Scarpa (1983), who

"*... present a first motion focal mechanism which indicates normal faulting with a small horizontal component along roughly E-W striking planes...*".

Another, not drastically different interpretation is that given by Jimenez (1991), who performs single-station waveform modelling and

"*... obtains two focal mechanisms using two different velocity models of the Irpinia region; the first solution indicates strike-slip faulting along approximately N-S and E-W striking planes, while the second (preferred by the author) shows a similar direction of the principal stress with predominant normal faulting. ...*".

Another interpretation along the same line of the previous two ones is that by Selvaggi *et al.* (1997). His paper

"*... presents a fault plane solution which indicates predominant normal faulting along roughly E-W striking planes. The focal mechanism is based on selected P-wave polarities. ...*".

Gasperini *et al.* (1999) supply a purely intensity-based solution, described by the following excerpt of the summary of their paper:

"Based on a method that analyses macroseismic intensity data, these workers determine the location, the physical dimensions and a 109° ± 11° azimuth for the source of the 23 July 1930 earthquake. ...".

Notice that the solution proposed by Gasperini *et al.* (1999) is identical to that adopted in the *Database* because the two solutions share the very same modelling approach and intensity dataset.

Unfortunately, and in spite of the apparently rich and informative geological and geophysical data summarised above, the compiler had to face also contradictory pieces of evidence and very ambiguous field observations, and for this reason decided not to supply a complete set of parameters for the *Irpinia North* source. Nevertheless, the most meaningful papers were indeed considered and summarised, which gives the user of the *Database* the opportunity to assess the current level of understanding by specialists. This set of summaries also provides an overview of the approaches used so far. It is important to remind that the compiler does not only consider papers that deal with the earthquake record, but also papers that may help directing further studies.

The *Comments and Open Questions* section of the source record presents the compiler's comments based on his/her expert judgement of what he/she found in the literature and the questions on the main debated points. In this particular case, the compiler explains the reasons why, in spite of the available geologic literature, it was not possible to derive a complete set of parameters for the *Irpinia North* source. For example, the compiler remarks that

"... The exact location and direction of dip of the fault responsible for the 1930 earthquake are still being debated, also due to the dominating lithology of the area, mainly clay-rich sediments, which allow an easy development of fractures and landslides. We selected the ESE-WNW oriented source derived by Gasperini *et al.* (1999) *as the most reliable, taking into account its agreement with the focal mechanisms and the good quality of the available macroseismic intensity dataset. The available fault plane solutions (*Martini and Scarpa, 1983; Jimenez, 1991; Selvaggi *et al.*, 1997*) all suggest normal faulting with secondary strike-slip component along roughly E-W striking planes. The contemporary reports describe several fractures and landslides having occurred in the epicentral area, but due to their small extent and to a probably predominant gravitational component, none of them could be easily interpreted as evidence for surface faulting...*

...

*A possible Apennines-parallel source is shown in the Neotectonic Map of Southern Italy (*Ciaranfi et al., 1983*), where a 30-40 km-long, NW-SE striking, west dipping normal fault (or set of faults) is traced between Monteverde and Savignano Irpino. Notice that on the sheet 174 of the geological map of Italy (scale 1:100 000) this fault probably corresponds to a tectonic lineament of undefined type separating Pliocene and Miocene deposits.*

The location and geometry of Ciaranfi *et al.'s* (1983) *fault are very similar to the parameters (length 32 km, strike ~130°, dip 50°-60° to the W) tentatively proposed by* De Martini *(unpublished manuscript) as the causative fault of the 1930 earthquake. The work is mainly based on geodetic levelling data (IGMI) surveyed at the northern end of the epicentral region around the end of the XIX century and in the middle of the 20th century. A similar source could also explain the westward extent of damage (*Alfano, 1931*) and the subsidence of the S. Angelo hill near Savignano (*Vari, 1930*)."*

In addition to these comments, the compiler brings up the following questions as a summary of the

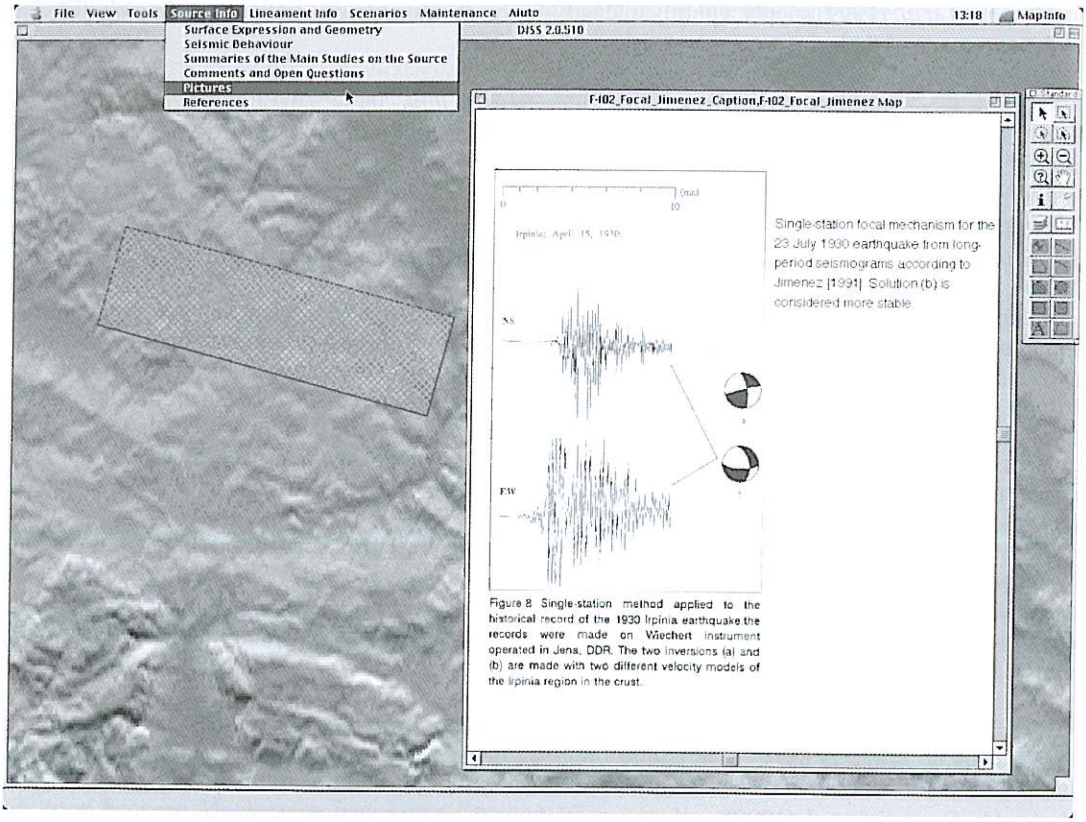

Fig. 3.23. *Irpinia North* source, ID 402. The window in the foreground shows one of the 5 *Pictures* available for this record.

current status of research on this source:

"1) What is the true geometry of the fault(s) responsible for the 23 July 1930 earthquake? 2) Did the 23 July 1930 earthquake generate primary surface faulting? 3) Was the event a single or a double shock? or did it contain two or more sub-events?".

Although these open questions concern the very fundamental aspects of the process of identification and characterisation of a seismogenic source, the user of the *Database* is reminded that all these issues should be regarded optimistically. The scientific materials collected and commented in the record of this source represents a valuable basis for further investigations and for assessing the hazard of the region concerned with an adequate degree of awareness of its earthquake potential.

The record of the *Irpinia North* source is complemented by five *Pictures* (fig. 3.23), three of which show the various focal mechanisms obtained for the 1930 earthquake.

The list of *References* includes papers that were considered to characterise the source and to express either the level of knowledge or the extent of uncertainty about it. The small amount of studies carried out so far is evidence for the objective difficulties in the characterisation of this source.

Similar content of information can be found for the sources derived from poorly-constrained