

# Collapses and seismic collapses in archaeology: proposal for a thematic atlas

Emanuela Guidoboni<sup>(1)</sup> and Sara Santoro Bianchi<sup>(2)</sup>

<sup>(1)</sup> SGA, Storia Geofisica Ambiente, Bologna, Italy

<sup>(2)</sup> Dipartimento di Archeologia, Università di Bologna, Italy

## Abstract

The problem of how to recognise seismic collapse lies at the basis of the possibility of using archaeological sources in the field of historical seismology. Hitherto this problem has been approached in an arbitrary and subjective manner, because there exists no systematic collection of data which permits access to a specific series of case histories in the field of archaeological collapse, distinguishing their numerous causes. The problem is also posed because archaeological techniques are by nature «destructive», and important seismic traces may disappear and no longer be utilizable in the scientific sphere. The authors point out this documentary lacuna, and propose the compilation of a thematic atlas on seismic collapses in archaeology: a new disciplinary tool, which may also prove useful for those concerned with the protection and conservation of archaeological areas.

**Key words** *seismic archaeology – seismic collapse*

How is a seismic collapse recognisable in archaeology? With what other effects due to natural phenomena may an earthquake be confused? Is it possible to recognise a seismic event through archaeological sources? And further: what has been in the past, and what is likely to be in the future, the response of still-existing ancient monumental structures to an earthquake?

These and other similar questions, prompted within those sectors concerned with long-term seismic activity, have led to the involvement of archaeological research, which has found itself largely unequipped with specific responses and devoid of a methodology able to recognise seismic effects in general and to identify particular types of «collapse».

There exist numerous qualified contributions in archaeology dealing with the problem

of the remains of ancient earthquakes from different points of view (for example: Karcz and Kafri, 1981; Soren, 1981; Rapp, 1982; Stiros, 1989, Ward-Perkins, 1989). However it seems to us that methodological aspects are not always so explicit, as each case is developed independently of any known and discussed case history, in other words each researcher finds «his own» earthquake.

One of the main problems is how to be able to place the effects of man-made and/or natural phenomena within a general context as part of a diachronic analysis of a site or an individual structure.

Building collapses form one of the main areas of stratigraphical archaeological investigation. They give rise to a stratification of human remains which is particularly rich in information, and which may be «unravelling» in a complete way, though in reverse, through precise interpretative techniques, thus reconstructing the sequence of the phases in the building's construction, its life history and its end.

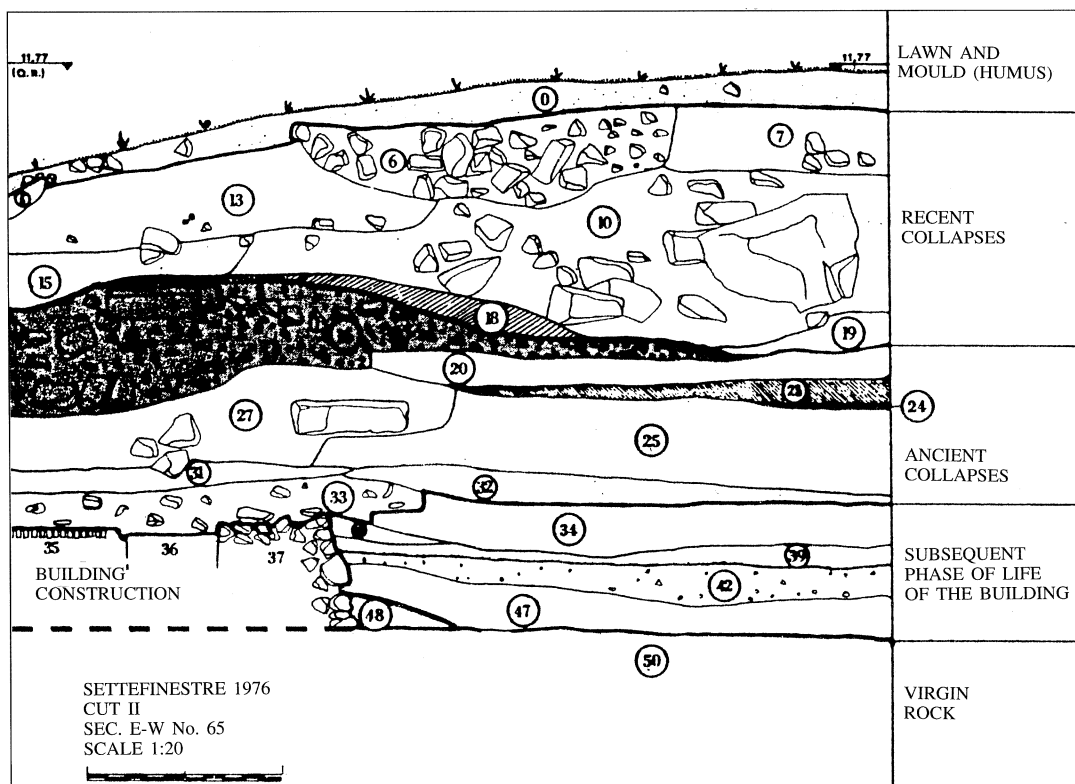


Fig. 1. Representation and interpretation of a complex stratigraphy (from Ricci, 1985).

In spite of this importance as a source of information, there still exists in archaeology as a discipline no systematic and quantified study of the morphology of building collapses. Building collapse may, as is well known, depend on numerous variables, including:

- the structure's building technique;
- its age at the moment of collapse;
- the quality, extent and frequency of the maintenance operations to which the building was subjected when still in use;
- the stresses to which it was subjected;
- the deterioration and abandonment, and any other traumatic events, which may have determined the building's sudden end, such as fire, soil instability or earthquakes.

In our opinion, it needs however to be borne in mind that, when we are dealing with ancient

buildings buried below ground, the natural position of the collapse has generally been modified by the ancient spoliation of their reutilizable building materials (Guidoboni *et al.*, 1994), such as to compromise in many cases the interpretation of the exact sequence in the collapse of the buildings' constituents. Other natural phenomena (landslides, subsidence, displacement of materials by gravitational or biological effect) and human conditioning of the natural environment (adjustment of slopes, farming methods) may also have intervened subsequent to the collapse, and modified the regular formation of its stratification (Magri, 1989).

The aim of our study is to promote research aimed at the compilation of a thematic atlas on the causes of collapses. This atlas should be able to furnish a series of case histories utiliz-

able in the sphere of still extant ancient architecture.

Generally speaking, the archaeologist as stratigrapher has a good practical or empirical knowledge of the processes that characterize the natural collapse of building structures, as a result of prolonged abandonment and structural subsidence consequent on the caving in of roofs and ceilings and the disintegrating effects of atmospheric agents.

He is equally able to recognise collapses caused by fire, which were so frequent in antiquity and are identifiable in the stratification due to the characteristic presence of the burnt residues of wooden-beamed roofs. In many cases in which anomalies are found at variance with these sequences or processes of collapse, as for example the collapse of large sections of complete walls in the same direction, with the constituents of their masonry still firmly in place, or of the corners of buildings, the archaeologist is then led to attribute different causes to the building's destruction. In many instances he will relate them to seismic events, and connect them – in his stratigraphical reconstruction, periodized and linked to often precise dates – to one of the numerous earthquakes cited by the historical sources for every period, though without paying much attention to their geographical pertinence.

It is clear that stratigraphical archaeological excavation would be of fundamental utility in the ascertainment of a past seismic event, assuming that the excavation could provide us with direct information on the real scale and characteristics of the seismic event (figs. 1 to 4). But to be able to interpret archaeological data in this sense, the *seismic indicators* that can be unambiguously recognised need to be extrapolated from the huge archaeological repertoire of case histories.

In an initial approximation, these indicators can be reduced to at least two:

- extension of the anomaly of the collapse to other buildings in the same settlement with homogeneous characteristics;
- similarities in collapse in other settlements in the same area.

It is often the case that the causes of the collapse of the walls of a building may be caused by

various factors, such as the pressure of large trees, slope subsidence, underground karst phenomena, or even intentional demolition or destruction, for example during warfare.

A different case is represented by cracks present in the walls of ancient monuments which have always remained above ground. Many of these cracks may also be attributable to seismic events. In this case, recent advances in the field of the restoration of monuments and in particular of the conservation of con-

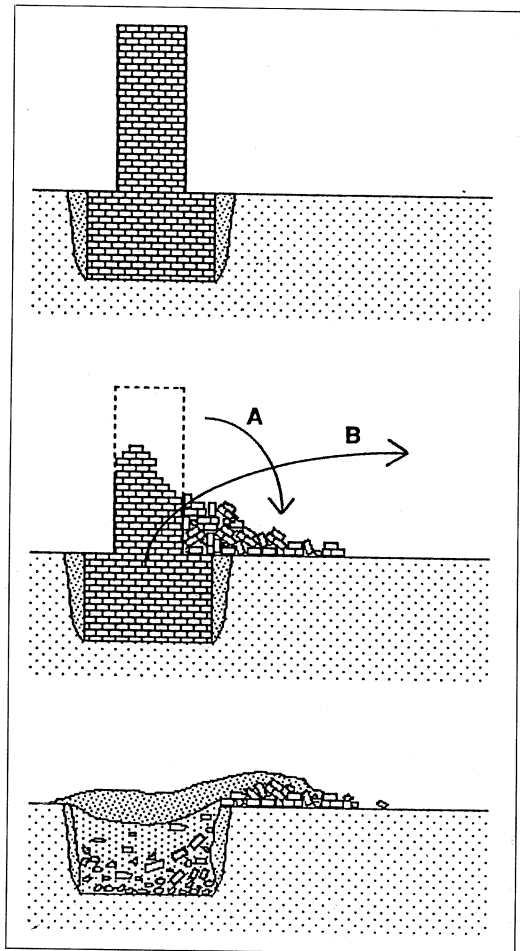
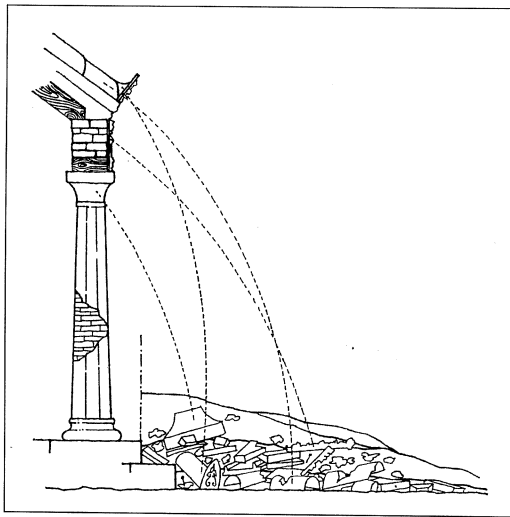


Fig. 2. Complex formative processes of archaeological stratification. Collapse and spoliation (from Leonardi, 1992).

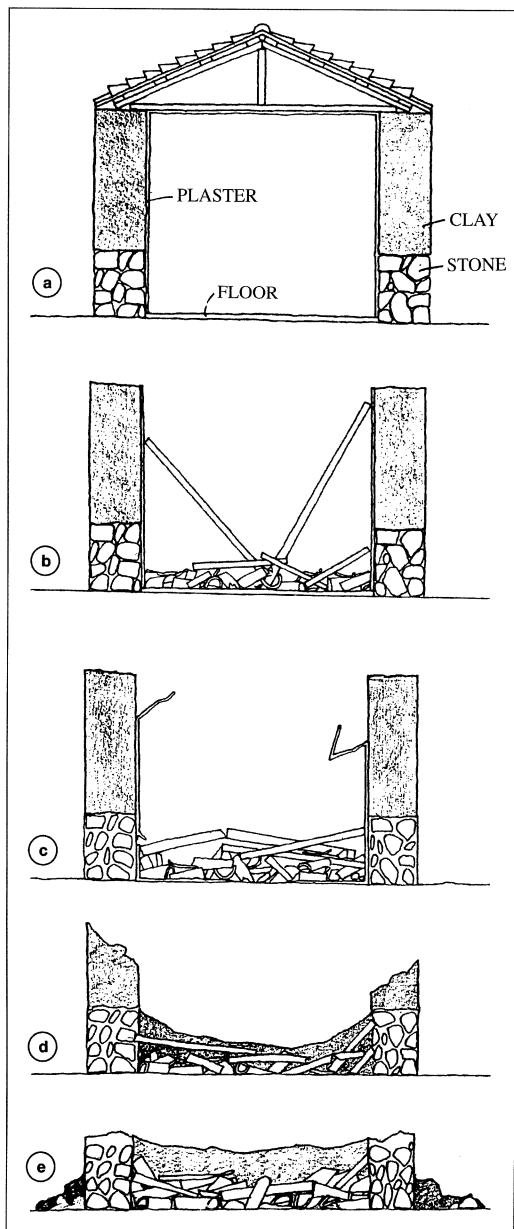


**Fig. 3.** Collapse of the upper part and falling of the elements. Surveys on collapses do not point out particular indicators for the different collapses (for severity or seismic events); from Carandini (1981).

structions in a state of ruin have given rise to analyses not only of the structural situation, but also of the iconographic documentation of the monument in time (drawings by travellers in ancient times, representations in paintings), which may help to circumscribe the time and the causes of the cracks.

The thematic atlas proposed here is aimed at involving all those concerned in the interpretation of building collapse and its contextual documentation. It should enable a basic survey to be conducted of our existing knowledge. This reference tool will be structured as an open data-bank, at the disposal of those working in the field of archaeology and seismic archaeology, and will be aimed at promoting analyses and new observations on the history of pre-modern habitational structures.

Many countries that nowadays want to improve their knowledge on fault activity in historical time get discouraged by the lack of systematic historical sources: in our view, the archaeological approach can be a complementary information resource, provided that basic systematic instruments and complex case histories are cleared up.



**Fig. 4.** Simplified sequence of a «natural» collapse of a mixed building structure (stone, clay, wood, bricks) from Carandini (1981): a) state of balance; b) collapse of the roof; c) detaching of the plaster; d) crumbling of the clay elevation; e) beginning of the wall remain levelling.

REFERENCES

- ADAM, J.P. (1989): L'edilizia romana privata: Pompei e il suo agro, in *I terremoti prima del Mille in Italia e nell'area Mediterranea*, edited by E. GUIDOBONI, Bologna, 224-244.
- CARANDINI, A. (1981): *Storie della terra*, Bari.
- GIULIANI, C.F. (1990): *L'edilizia nell'antichità*, Roma.
- GUIDOBONI, E., A. COMASTRI and G. TRAINA (1994): *Catalogue of Ancient Earthquakes in the Mediterranean Area up to the 10th Century*, published by ING, Roma, pp. 504.
- KARCZ, I. and U. KAFRI (1981): Evaluation of supposed archaeoseismic damage in Israel, *J. Archaeol. Sci.*, **5**, 237-253.
- LEONARDI, G. (editor) (1992): Processi formativi della stratificazione archeologica, in *Formation Process and Excavation Methods in Archaeology: Perspectives*, Padova.
- MAGRI, G. (1989): Dislocazioni sismiche e valutazioni d'intensità, in *I terremoti prima del Mille in Italia e nell'area Mediterranea*, edited by E. GUIDOBONI (ING, Bologna), 417-418.
- MASTRODICASA, S. (1981): *Dissesti statici nelle strutture edilizie*, 7<sup>o</sup> edition, Milano.
- RAPP, G.J. (1982): Earthquakes in Troad, *Troy. The Archaeology Geology*, edited by G.J. RAPP and J.A. GIFFORD, Princeton, 43-58.
- RICCI, A. (1985): *Settefinestre. Una villa schiavistica nell'Etruria Romana*, Modena.
- SOREN, D. (1981): Earthquake: the last day of Kourion, *Studies in Cypriote Archaeology*, edited by J.C. BIERSE and D. SOREN, Institute of Archaeology, Los Angeles, **18**, 117-33.
- STIROS, S. (1989): Ruolo storico e identificazione di antichi terremoti nei siti della Grecia, in *I terremoti prima del Mille in Italia e nell'area Mediterranea*, edited by E. GUIDOBONI (ING, Bologna), 409-413.
- WARD-PERKINS, B. (1989): Archeologia e terremoti: le tracce perdute, in *I terremoti prima del Mille in Italia e nell'area Mediterranea*, edited by E. GUIDOBONI, (ING, Bologna), 409-413.