P-34 BIG'95 – A RECENT DEBRIS FLOW IN THE EBRO CONTINENTAL SLOPE, NORTHWESTERN MEDITERRANEAN

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Summary

A Recent debris flow (named BIG'95) on the Ebro slope (North-western Mediterranean) is reported in this study and examined by means of swath bathymetry, high and very high-resolution seismic records, TOBI side-scan sonar, and coring. Here we present the preliminary results of this study, including geometry, description and dating of the debris flow, as well as a first move towards its triggering mechanisms.

Introduction

During a survey onboard the R/V Hespérides in 1995, a landslide was discovered, named from here onwards BIG'95, on the Ebro margin slope (North-western Mediterranean). Since oil platforms and phone and electric cables are present in the Ebro margin, an immediate and accurate study of the landslide was approved in order to determine its triggering mechanisms and the potential of the Ebro slope for future instability events. In consequence the landslide was further investigated in two new surveys onboard the R/V L'Atalante in 1997, and the R/V Hespérides in 1999. The debris flow extends over an area of ~2000 km^2, four times the area of the neighbouring Ibiza Island. It is located in front of the city of Castellon (Valencia, Spain), between 39°30' and 40°10'N and 0°55' and 1°55'E, at depths ranging from 800 to 2000 m near the Columbretes Islands, a small volcanic archipelago.

The three surveys carried out in the landslide area have provided a complete set of data, including swath bathymetry, 3.5 kHz records, both conventional mud penetrator and bottom parametric source (BPS), air-gun seismic reflection profiles, deep-towed side-scan sonar (TOBI) and coring.

Geological setting

The Ebro margin (fig.1) is located on the western side of Valencia Trough, a structurally controlled depression formed during the Early Miocene that lies between the Balearic Islands and the Iberian Peninsula. A widespread volcanism is present in this area: Columbretes Islands, DSDP sites 122 and 123 (Ryan *et al.*, 1973).

In the Ebro margin Neogene sediments are characterised by a thick progradational sequence of Pliocene to Pleistocene sediments (the Ebro Group, which includes the lower Ebro Clay, mainly Pliocene prograding shales, and the upper Ebro Sand, mainly Pleistocene clastic shelf complex) overlying the Messinian unconformity (Soler *et al.*, 1983; Maillard *et al.*, 1992). The present base-of-slope was formed by series of migrating, laterally developed channel-levee complexes and non-channelled aprons. Several canyons developed during the Pleistocene in this area (Field and Gardner, 1990).

BIG'95 debris flow

The BPS records of the first survey carried out in 1995 showed a large sediment body of transparent seismic facies in the southern area of the Ebro slope. This body was related to a large-scale debris flow, forming the very top of the Plio-Quaternary sequence at the base-of-slope, at depths ranging from 800 to 2000 m. Its upper and middle part has a rough rectangular shape (40x30 km) where flow occurred from the NW to the SE, while its most distal part displays a more elongated tail-like shape and flow occurred from the SW to the NE, partially filling the Valencia Channel. The BIG'95 event had an important impact on the previous sea-floor morphology, cutting pre-existing channels in its both southern and northern boundaries, where it additionally buries a channel-levee complex. Its average thickness is 20 ms, but at the base of the head scar it is thicker than 120 ms (fig.2).

The main scar is located at 1050 m and is 200 m high (fig.3a, 3c). It extends down into the sedimentary sequence as a tectonic fault related to a dome-like structure of chaotic seismic facies on air-gun seismic reflection profiles (fig. 3a), which has been interpreted as a volcanic dome (Maillard *et al.*, 1992). Upslope the main scar there are some second order scars, and BPS records show a thin (10 ms) transparent layer overlying stratified sediments (fig. 3b). Downslope the main scar, BPS records show a thick transparent layer overlying sediments with broken stratified reflectors (fig. 3d) as if they had been dragged by the BIG'95 debris flow. In this part, the debris flow has a blocky surface while further downslope, near the partially buried Valencia channel, the debris flow surface becomes flat.

The presence of a buried chaotic sediment body on the air-gun seismic reflection profiles (fig. 3a) at the same location of the BIG'95 debris flow, indicates the recurrence of instability events in this section of the Ebro slope. In addition, other near surface transparent bodies have been reported all along the Ebro slope; however, none of them is as large as the BIG'95.

Seven long piston cores from the area of the debris flow have been opened and described. The base of a thin (20-120 cm) hemipelagic layer that just overlies the debris flow has been dated by AMS using ^{14}C, showing an age of 9950 ±50 to 10430 ±60 years BP.

Factors favouring instability

There are at least three factors that could have contributed to trigger the BIG'95 debris flow, namely:

a. volcanic or tectonic processes associated to the presence of the volcanic archipelago of the Columbretes Islands, such as earthquakes triggered by volcanic activity or the oversteepening due to the emplacement of the dome-like volcanic structure observed just under the main scar.

b. the overloading of the slope by rapid sedimentation enhanced by the presence of a shelf break sedimentary depocentre in the upper parts of the Ebro Group and the consequent instability of the prograding architecture of the slope (Casablanca Unit and Amposta Unit) (Farran and Maldonado, 1990)

c. the overpressure due to sea level rise and an increase of the temperature of the near-bottom water at the end of the last glacial could have lead to a clathrate destabilisation like the one cited by Rothwell *et al.* (2000) to explain the triggering of the Balearic megaturbidite. Nevertheless, clathrate have never been reported in the Western Mediterranean.

Probably, the combination of some of these processes contributed to a general destabilisation of the Ebro slope, triggering not only the BIG'95 debris flow but also the other smaller debris flows reported in the area.

Acknowledgements

This study was supported by the EC-VFP project COSTA (Continental Slope Stability, EVK3-1999-00028), CYTMAR project GRANDES (MAR98-0347), Generalitat de Catalunya

Grups de Recerca Consolidats and Ministerio de Educación y Cultura fellowship (Galderic Lastras).

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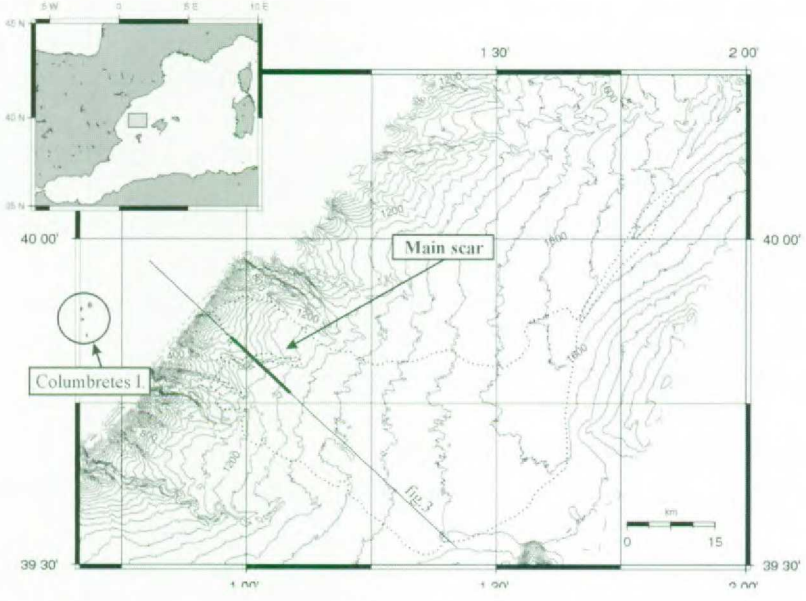

Fig 1.
Bathymetric chart of the BIG'95 debris flow area (limited by the dotted line), showing the debris flow pathway from the slope into the Valencia Channel and the location of the main scar. In the upper left frame, general situation of the studied area.

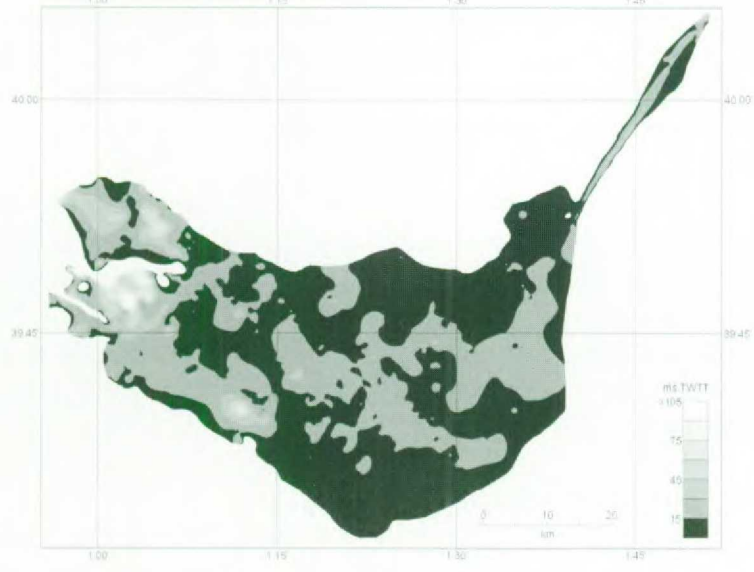

Fig 2.
Isopach map (ms TWTT) of the BIG'95 debris flow, based on the digitalisation of the BPS profiles. The average thickness is 20 ms, but at the base of the scar the accumulation of sediment is over 120 ms.

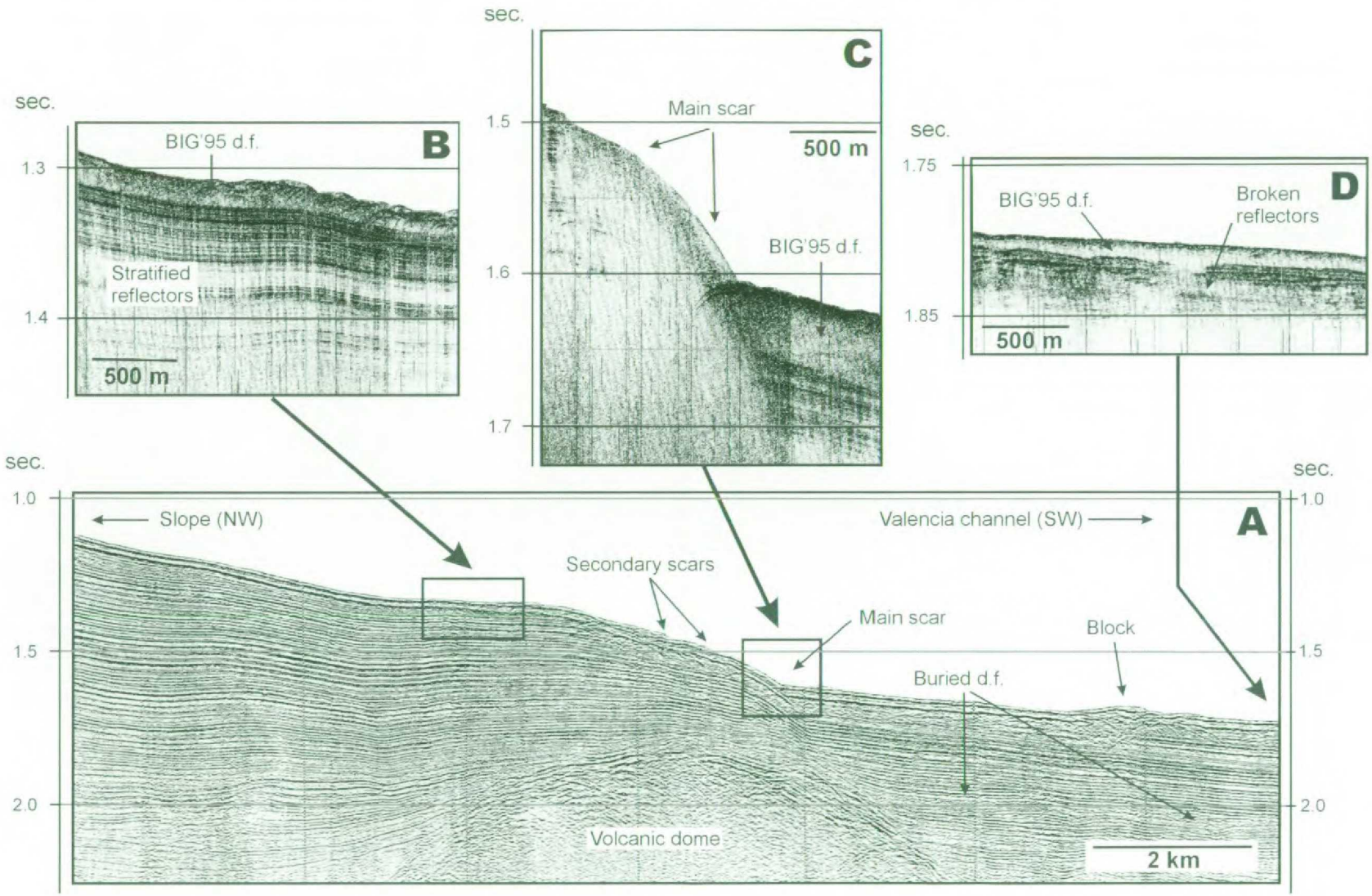

Fig 3. (a) Air-gun profile crossing the BIG'95 debris flow from the Ebro continental slope down to the Valencia Channel. A volcanic dome can be outlined under the main scar of the debris flow. One of the blocks on the surface can be observed. Also, a buried debris flow can be seen at the same location of the recent one indicating the persistence of the instability in this area. (b) BPS profile of the area upslope the scar, showing a thin transparent layer over undisturbed stratified reflectors. (c) BPS profile crossing the scar, where the debris flow gets thicker. (d) BPS profile of the distal part of the debris flow, showing disturbed broken stratified reflectors under the debris flow.