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The impact of cascading currents on the Bari Canyon System, SW-Adriatic Margin (Central Mediterranean)

F. Trincardi [a,*], F. Foglini [a], G. Verdicchio [a,b], A. Asioli [c], A. Correggiari [a], D. Minisini [a,b], A. Piva [a,b], A. Remia [a], D. Ridente [a], M. Taviani [a]

[a] *ISMAR–CNR, Via Gobetti, 101, 40129 Bologna, Italy*
[b] *DSTGA, Università di Bologna, Via Zamboni 67, 40126 Bologna, Italy*
[c] *IGG–CNR, Corso Garibaldi 37, 35137 Padova, Italy*

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Abstract

The Bari Canyon System (BCS) is a peculiar erosional–depositional feature characterised by two main, almost parallel, conduits emanating from a broad crescent-shaped upper slope region. When viewed in cross sections parallel to the margin, BCS appears markedly asymmetric with a right hand (southern) side that is higher and steeper (about 800 m in relief and more than 30° steep). The left-hand side of the canyon is instead much smoother. As a consequence, bottom currents flowing along the slope from the north enter the canyon and interact with its complex topography leading to preferential deposition on the up-current side of pre-existing morphological relief. Where mass-failure deposits generate morphologic relief, outside the canyon, sediment is preferentially deposited up current (N-ward). BCS includes three main EW-oriented sediment conduits: Canyon C, to the south, Channel B, in the central area, and Moat A in the north. Channel B shows a well developed levee deposit on its right-hand side and appears markedly straight and erosional on the upper slope. The deepest portion of Channel B is substantially abandoned and draped but still shows a subdued thickening of the draped unit north (and up current) of pre-existing morphologic relief, confirming the impact of along-slope flowing currents. Canyon C is flanked by erosional walls all the way to the basin floor where deep-sea furrows develop with a NW–SE orientation.

Today, dense water formation in the Adriatic is seasonally modulated and displays a significant variability on inter-decadal scales. Dense water formation during glacial intervals was likely different from the modern because most of the North Adriatic shelf was subaerially exposed and the deep water mixing in the south was likely reduced, as suggested by paleoceanographic reconstructions. The growth patterns of BCS since the LGM are characterised by concurrent erosion of the upper portion of Channel B and of the lower portion of Canyon C. It is possible that flows through the straight, narrow and steep upper segment of channel B spill over its right hand levee in ca. 600 m water depth, where the relief of levee B on the channel floor is minimal, and enter Canyon C, where substantial erosion takes place. In this view, the upper portion of Canyon C, where hard grounds and corals are encountered, is flushed by currents characterised by reduced turbidity, while the lower part of Canyon C collects additional flows from upper channel B.

Keywords: Adriatic; cascading currents; channel–levee complexes; late-Quaternary

* Corresponding author.
E-mail address: fabio.trincardi@bo.ismar.cnr.it (F. Trincardi).

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1. Introduction

Active submarine canyons are extensively described worldwide along oceanic margins (e.g., Shepard, 1933; Daly, 1936; Shepard and Dill, 1966; Shepard, 1981; McAdoo et al., 1997) and along continental margins of confined basins, such as the Mediterranean Sea. Mediterranean active canyons are documented along the Gulf of Lion slope (e.g., Droz and Bellaiche, 1985; Baztan et al., 2005), in the Catalan Margin (e.g., Field and Gardner, 1990; Palanques et al., 1994), and in the Tyrrhenian Margin (e.g., Gallignani, 1982). These sediment conduits occur in a broad range of physiographic and geological contexts, presenting an extreme variability in dimensions, morphology and seafloor sediment. The processes that feed canyon heads and transport sediment along their axes are also greatly diversified, depending primarily on the type and amount of sediment that reaches the canyon, and on the oceanographic regime impacting the canyon area (Normark, 1970; Farre et al., 1983; Normark and Piper, 1991). All these factors are commonly considered as strictly related to the presence of a sediment source close to the canyon head, either a delta or a littoral cell carrying sediment into the canyon (Cutshall et al., 1986). Variations of relative sea level are important in controlling the distance of the canyon head from a river source and the water depth in the outer shelf, in turn controlling its current and wave regime.

Where a canyon head is located on a shallow inner shelf, sediment can be supplied directly from river deltas or long-shore drift; where, instead, the canyon head is more seaward, close to the shelf edge, sediment is fed by shelf currents and/or episodic density currents triggered by the instability of the canyon shoulders. Several Authors have linked the onset of canyons and their activity to sea-level falls and lowstands, when shelves become narrow and fluvial sediment sources may reach directly into the canyon heads, which commonly are situated close to the shelf edge (e.g., Twichell and Roberts, 1982; Carlson and Karl, 1988; Galloway et al., 1991). Under these conditions, large amounts of sediment are available for remobilization and large-scale slump and turbidity currents may be generated (Mutti, 1985). However, documentation from a great number of canyons described worldwide, indicates that sea-level fall and lowstand are not mandatory requirements for canyon activity. Indeed some canyons have been documented as active during rising and the highstand of sea level (e. g., Kolla and Perlmutter, 1993; Trincardi et al., 1995).

We focused our attention on the Bari Canyon System (BCS), located along the SW Adriatic Margin, Central Mediterranean. The BCS dissects a relatively steep continental slope far away from river mouths, impacted, at least since the end of the last glacial interval, by very strong bottom currents resulting by the combined flow of the long-lasting contour-parallel slope currents, Levantine Intermediate Water (LIW), and of the episodic slope-transverse cascading currents, North Adriatic Dense Water (NAdDW) (Verdicchio et al., in press). The peculiar oceanographic context in which BCS developed strongly influences the present day activity and the sedimentary processes inside the canyon. The main interest in studying the recent evolution of the BCS is understanding how cascading and contour currents can be captured within the canyon system defining areas of erosion and increased sediment deposition during periods of sea-level rise and modern sea-level highstand.

2. Setting

2.1. Geologic setting of the SW Adriatic Margin

The western margin of the Adriatic basin belongs to the Apennine foreland domain (Ricci Lucchi, 1986; Ori et al., 1986, Royden et al., 1987; Doglioni et al., 1996), where the emerged sectors of the Gargano Peninsula and the Apulia region correspond to the flexural bulge (Doglioni et al., 1994; De Alteriis, 1995; Bertotti et al., 1999). Post-Mesozoic tectonic deformation led to the definition of the W–E-trending "Gondola deformation belt" (Fig. 1). The main structural feature of the SW Adriatic Margin, with a clear morphologic expression in the Dauno Seamount (Colantoni et al., 1990; De Alteriis and Aiello, 1993; Tramontana et al., 1995). On the Adriatic shelf and upper slope four stacked depositional sequences (termed Sequence 1–4, top down) are separated by shelf-wide unconformities (ES1–ES4) and their correlative conformities; these sequences accumulated during the last ca. 450 kyr (Trincardi and Correggiari, 2000; Ridente and Trincardi, 2002). Each sequence is composed of progradational units (low-angle clinoforms passing distally into plane-parallel mud drapes) among which forced regression deposits record phases of sea-level fall (Ridente and Trincardi, 2005). These sequences extend along strike over distances up to 300 km from the Central to the South Adriatic and form a composite shelf wedge with an overall backstepping architecture in the central Adriatic and forestepping stacking pattern north and south of Gargano Peninsula, respectively (Ridente and Trincardi, 2002), where Bari Canyon is located. The distribution and thickness variability of the four sequences suggests