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Aiello G.*, Budillon F.*

Pleistocene lowstand prograding wedges of the Salento continental shelf (Apulia, southern Italy): the role of glacio-eustatic sea level changes and regional tectonics

*Istituto per l'Ambiente Marino Costiero (IAMC), CNR, Calata Porta di Massa - Porto di Napoli, Napoli, Italy,
E-mail: aiello@gms01.geomare.na.cnr.it; budillon@gms01.geomare.na.cnr.it;

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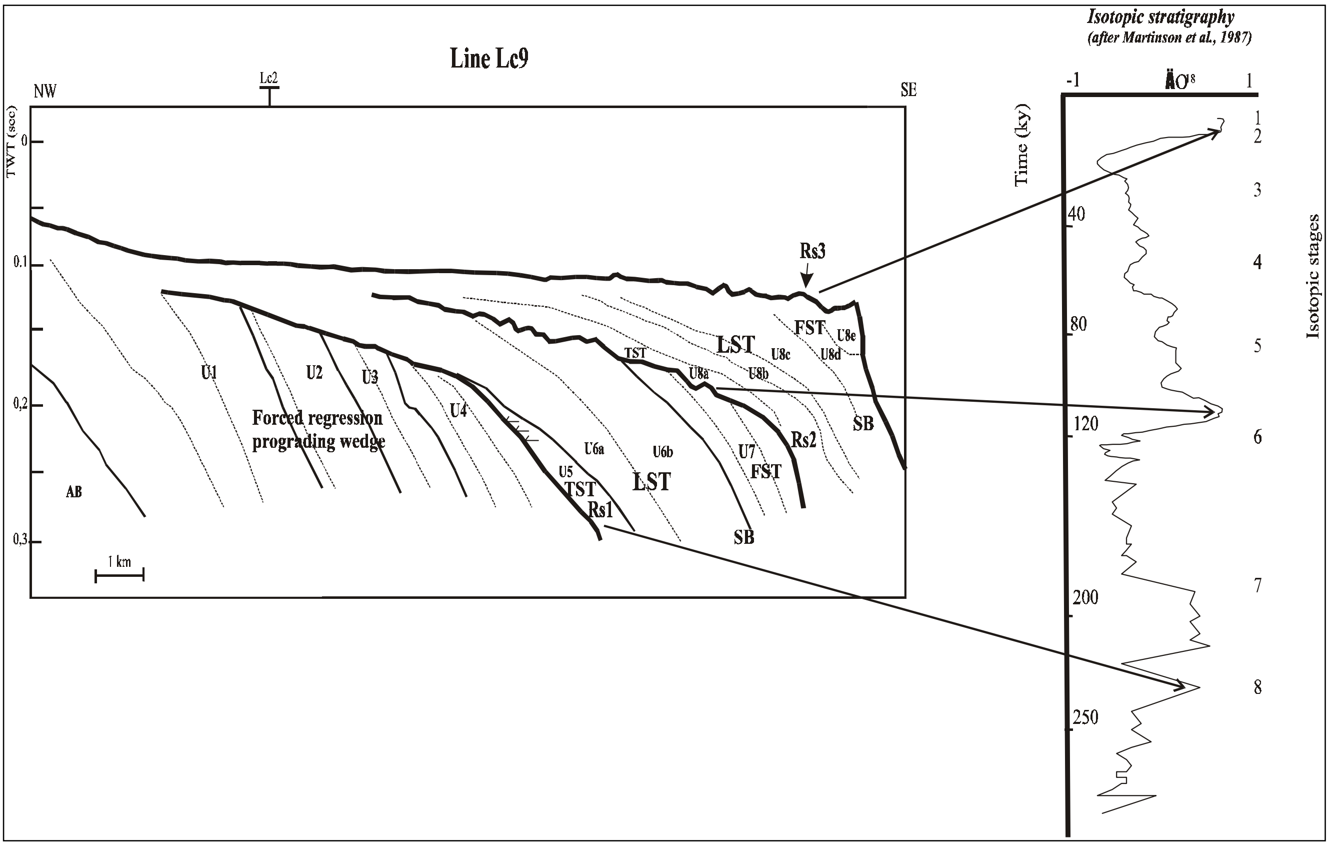
Abstract

The Salento continental shelf of Apulia (Southern Adriatic sea) shows a complex stratigraphic architecture of Pleistocene prograding wedges, that records the effects of the interplay of sediment accumulation, glacio-eustatic sea level changes and regional tectonics. One aim of this note is to discuss high resolution sequence stratigraphy of prograding wedges recognized in this area through the interpretation of seismic profiles and to put some new insights on the factors controlling the deposition of the wedges during the Late Quaternary.

Recent studies carried out on active and passive continental margins show that the stratigraphic architecture of the continental shelves is mostly made of lowstand, shelf margin and transgressive system tract deposits (Suter and Berryhill, 1985; Suter et al., 1987; Saito, 1991; Tesson et al., 1990; 1993; Okamura and Blum, 1993; Trincardi and Correggiari, 2000). The contribution of highstand deposits appears negligible in the outer shelf, while it results more substantial nearshore. In the inner shelf, relative sea level falls, subsequent to phases of rising, often cause a partial erosion of highstand deposits, along with sediment reworking in the coastal areas (Field and Trincardi, 1992; Gensous et al., 1993). Isotopic analysis of deep sea sediments and corals (Bard et al., 1990a; 1990b) shows that during the Pleistocene glacio-eustatic changes clearly exhibit high frequency (about 100 ky) oscillations; cycles are highly asymmetrical, showing rapid rises and slow falls of the sea level (Shackleton and Opdyke, 1973; Martinson et al., 1987). The stratigraphic architecture of Pleistocene continental margins is characterized by a relative abundance of lowstand prograding wedges with respect to transgressive and highstand deposits, as well known in the Mediterranean region (Trincardi and Field, 1991; Tesson et al., 1993; Chiocci et al., 1997; Catalano et al., 1998).

Shelf sediments, deposited during Pleistocene glacio-eustatic cycles, accumulated on the outer shelf and upper slope during subaerial exposures and formed thick sedimentary wedges ("shelf-perched" lowstand wedges; Posamentier and Vail, 1988). The Salento continental shelf is part of the Apulian foreland corresponding to a wide antiformal structure, WNW-ESE trending, block-faulted and variably uplifted during Late Neogene (Ricchetti et al., 1992). Transfer-faults, striking oblique or perpendicular to the main antiformal structure, segmented the Apulia in three main blocks (Gargano, Murge and Salento blocks), that show different rates of uplift during the Plio-Pleistocene, when the central Adriatic sea underwent high subsidence rates, interpreted as the effect of the eastward rollback of the hinge of the west dipping Apenninic subduction (Doglioni et al., 1994). The occurrence of regressive sedimentary sequences, overlying erosional surfaces, suggests a uniform uplift of the Murge and Salento blocks after the Middle Pleistocene, also supported by the regional distribution of the fossil shorelines (Cosentino and Gliozzi, 1992). The eustatic sea level oscillations and tectonic uplift have produced various terraces, reaching even 200 m above sea level (Ciaranfi et al., 1992; Cosentino and Gliozzi, 1992; Ricchetti et al., 1992). Average values of about 0.23 m/ky have been suggested for the rate of uplift of the Salento Peninsula during the Late Pleistocene, based on age of the Tyrrhenian deposits (Hearty and Dai Pra, 1992; Cosentino and Gliozzi, 1992). The interpretation of high resolution seismic reflection profiles collected onboard of the R/V Urania (CNR) evidences three *ravinement surfaces*, extending landwards from the shelf break and showing low gradients. They separate three main prograding wedges composed of several seismic units (fig. 1). Policyclic erosional surfaces *sensu* Posamentier and James (1993) often characterize the stratigraphic framework of continental shelf areas: they formed during phases of relative sea level fall (lowstand surface of erosion) and are subsequently reworked during relative sea level rises (ravinement surfaces). The frequent lack of transgressive deposits, due to their low thickness and poor potential of preservation, often force the sequence boundaries to coincide with transgressive surfaces of erosion.



These unconformities, namely the ravinement surfaces (Posamentier and James, 1993) develop because the erosional lanward shift of the shoreline and their formation is due to reworking by wave action (Trincardi et al., 1994; Budillon and Aiello, 1999; Trincardi and Correggiari, 2000; Ridente and Trincardi, 2002). The ravinement surfaces have been considered as stratigraphic markers and tentatively correlated to the oxygen curves of the isotopic stratigraphy (fig. 2).

Even if a direct datation of seismic sequences and corresponding unconformities is lacking, this correlation is well supported by the lateral extension and continuity of the ravinement surfaces, recognized in the whole investigated area.

The ravinement surface RS3 was produced by the last significant sea level rise, which developed from 18 ky B.P. and is well known and documented along whole the Italy offshore (Borsetti et al., 1984; Marani et al., 1986; Chiocci et al., 1989; Colantoni et al., 1989); on the isotopic curve it corresponds to the transition from the stage 2 to the stage 1.

The ravinement surface RS2 formed during previous sea level rise, corresponding to the transition from the isotopic stage 6 to 5. Accordingly, the prograding wedge limited in its uppermost part by the ravinement surface RS3 and its lowermost part by the ravinement surface RS2 can be attributed to the Late Pleistocene. Finally, the ravinement surface RS1 is due to a sea level rise of about 250 ky developing between the isotopic stages 8 and 7.

The regional geological framework of the Salento continental shelf suggests that during the Middle Pleistocene the rate of tectonic uplift interacted with the rate of glacio-eustatic fluctuations, producing the deposition of forced regression system tracts.

The forced regression prograding wedge which enlarged the shelf of about fifteen kilometers is here dated as Middle Pleistocene. Starting from the upper part of the Middle Pleistocene, the stratigraphic architecture of the prograding wedges was mainly controlled by glacio-eustatic sea level changes forced by short eccentricity cycles.

This is suggested by the stratigraphic architecture of the two last prograding wedges, interpreted as 4^{th} order incomplete depositional sequences and consisting of forced regression, lowstand and transgressive system tracts. The eustatic signal as an expression of the Earth's orbital cyclicity (short eccentricity) appears overwhelming with respect to the tectonic one and its prominence suggests a decrease in the rate of uplift of the Apulian foreland during the last 250 ky.

References

Bard E., Hamelin B., Fairbanks R. G. (1990a). *U-Th ages obtained by mass spectrometry in corals from Barbados: sea-level during the past 130.000 years.* Nature, 346, 456-458.

Bard E., Labeyrie L. D., Pichon J. J., Labracherie M., Arnold J., Duprat J., Moyes J., Duplessy J. C. (1990b). *The last deglaciation in the southern and northern hemispheres: a comparison based on oxygen isotopes, sea surface temperatures estimates and accelerator ^{14}C dating from deep-sea sediments*. In: Bleil U., Thiede J., (eds.). *Geological History of the Polar Oceans: Arctic versus Antarctic.* Kluwer Academic, Boston, USA, 405-416.

Borsetti A., Loik L., Colantoni P. (1984). *Variazioni nella sedimentazione al passaggio glaciale-postglaciale e Olocene in alcuni bacini nord-tirrenici evidenziate dal contenuto microfaunistico.* Mem. Soc. Geol. Ital., 27, 323-332.

Budillon F., Aiello G. (1999). *Evoluzione pleistocenica della piattaforma continentale del Salento orientale: fattori di controllo tettonici e/o eustatici.* Il Quaternario, 12 (2), 149-160.

Catalano R., Di Stefano E., Sulli A., Vitale F. P., Infuso S., Vail P. R. (1998). *Sequences and system tracts calibrated by high-resolution bio-chronostratigraphy: the central Mediterranean Plio-Pleistocene record.* SEPM Special Publication, 60, 155-177.

Chiocci F. L., D'Angelo S., Orlando L., Pantaleone A. (1989). *Evolution of the Holocene shelf sedimentation defined by high-resolution seismic stratigraphy and sequence analysis (Calabro-Tyrrhenian continental shelf).* Mem. Soc. Geol. Ital., 48, 359-380.

Chiocci F. L., Ercilla G., Torres J. (1997). *Stratal architecture of western Mediterranean margin as the result of the stacking of Quaternary lowstand deposits below "glacio-eustatic fluctuation base-level".* Sedimentary Geology, 112, 195-217.

Ciaranfi N., Pieri P., Ricchetti G. (1992). *Note alla carta geologica delle Murge e del Salento (Puglia centro-meridionale),* Mem. Soc. Geol. Ital., 41, 449-460.

Colantoni P., Gallignani P., Lenaz R. (1989). *Late Pleistocene and Holocene evolution of the North Adriatic continental shelf (Italy).* Marine Geology, 33, 41-50.

Cosentino D., Gliozzi E. (1992). *Considerazioni sulla velocità di sollevamento dei depositi eutirreniani dell'Italia meridionale e della Sicilia*. Mem. Soc. Geol. Ital., 41, 653-665.

Doglioni C., Mongelli F., Pieri P. (1994). *The Puglia uplift: an anomaly of the foreland of the Apenninic subduction due to the buckling of a thick continental lithosphere.* Tectonics, 13, 1309-1321.

Field M. E., Trincardi F. (1992). *Regressive coastal deposits on Quaternary continental shelves: preservation and legacy.* In: Osborne R. H., (eds.). *From shoreline to abyss: contributions in marine geology in honor of Francis Parker Shepard*. SEPM Special Publication, 46, 107-122.

Gensous B., Williamson D., Tesson M. (1993). *Late Quaternary transgressive and highstand deposits on a deltaic shelf (Rhone delta, France).* IAS Special Publication, 18, 197-211.

Hearty P. J., Dai Pra G. (1992). *The age and stratigraphy of middle Pleistocene and younger deposits along the Gulf of Taranto (Southeast Italy).* Journal of Coastal Research, 8 (4), 882-905.

Marani M., Taviani M., Trincardi F., Argnani A., Borsetti A., Zitellini N. (1986). *Pleistocene progradation and postglacial events on the tyrrhenian continental shelf between the Tiber river delta and Capo Circeo.* Mem. Soc. Geol. Ital., 36, 67-89.

Martinson D. G., Pisias N. G., Hays J. D., Imbrie J., Moore T. C., Shackleton J. (1987). *Age dating and the orbital theory of the ice ages: development of a high resolution 0 to 300.000 year chronostratigraphy.* Quaternary Research, 27, 1-29.

Okamura Y., Blum P. (1993) *Seismic stratigraphy of Quaternary stacked depositional sequences in the Southwest Japan forearc: an example of fourth order sequences of an active margin.* IAS Special Publication, 18, 213-232.

Posamentier H. W., Vail P. R. (1988). *Eustatic control on clastic deposition II - sequence and system tract models.* In: Wilgus C. K., Hastings B. S., Kendall C. G., Posamentier H. W., Ross C.A., Van Wagoner J. C. *Sea level change - an integrated approach.* SEPM Special Publication, 42, 125-154.

Posamentier H. W., James D. P. (1993). *An overview of sequence stratigraphic concepts: uses and abuses.* IAS Special Publication, 18, 3-18.

Ricchetti G., Ciaranfi N., Luperto Sinni E., Mongelli F., Pieri P. (1992). *Geodinamica ed evoluzione stratigrafico-tettonica dell'avampaese apulo.* Mem. Soc. Geol. Ital., 42, 287-300.

Ridente D., Trincardi F. (2002). *Late Pleistocene depositional cycles and syn-sedimentary tectonics on the central and south Adriatic shelf.* Mem. Soc. Geol. Ital., 57, 517-526.

Shackleton N. J., Opdyke N. D. (1973). *Oxygen isotope and paleomagnetic stratigraphy of equatorial Pacific core V28-238: oxygen isotope temperature and ice volume on a 10 year scale.* Quaternary Research, 3, 39-55.

Suter J. R., Berryhill H. L. (1985). *Late Quaternary shelf margin deltas, northwest Gulf of Mexico.* AAPG Bulletin, 69, 77-91.

Suter J. R., Berryhill H. L., Penland S. (1987). *Late Quaternary sea level fluctuations and depositional sequences, southwest Louisiana continental shelf.* In: Nummendal D., Pilkey O. H., Howard J. D., (eds.). *Sea level Fluctuation and Coastal Evolution.* SEPM Special Publication, 41, 199-219.

Tesson M., Gensous B., Allen G. P., Ravene C. (1990) *Late Quaternary deltaic lowstand wedges on the Rhone continental shelf, France.* Marine Geology, 91, 325-332.

Tesson M., Allen G. P., Ravenne C. (1993). *Late Pleistocene shelf perched lowstand wedges on the Rhone continental shelf.* IAS Special Publication, 18, 183-196.

Trincardi F., Field M. E. (1991). *Geometry, lateral variation and preservation of downlapping regressive shelf deposits: Eastern Tyrrhenian sea margin, Italy.* Journal of Sedimentary Petrology, 61 (5), 775-790.

Trincardi F., Correggiari A., Roveri M. (1994). *Late Quaternary transgressive erosion and deposition in a modern epiconental shelf: the Adriatic semienclosed basin*. Geomarine Letters, 14, 41-51.

Trincardi F., Correggiari A. (2000). *Quaternary forced regression deposits in the Adriatic basin and the record of composite sea-level cycles*, In: Hunt D., Gawthorpe R. L., (eds.). *Sedimentary Responses to Forced Regressions*. Geological Society, London, Special Publication, 172, 245-269.