

MARGINI DI PIATTAFORMA CARBONATICA E *REEFs* CARBONATICI



I **reefs** carbonatici sono ottimi indicatori delle condizioni ambientali (clima, profondità d'acqua, ossigenazione).
Il loro riconoscimento lungo i profili sismici è una fase fondamentale per la ricostruzione degli antichi domini sedimentari.

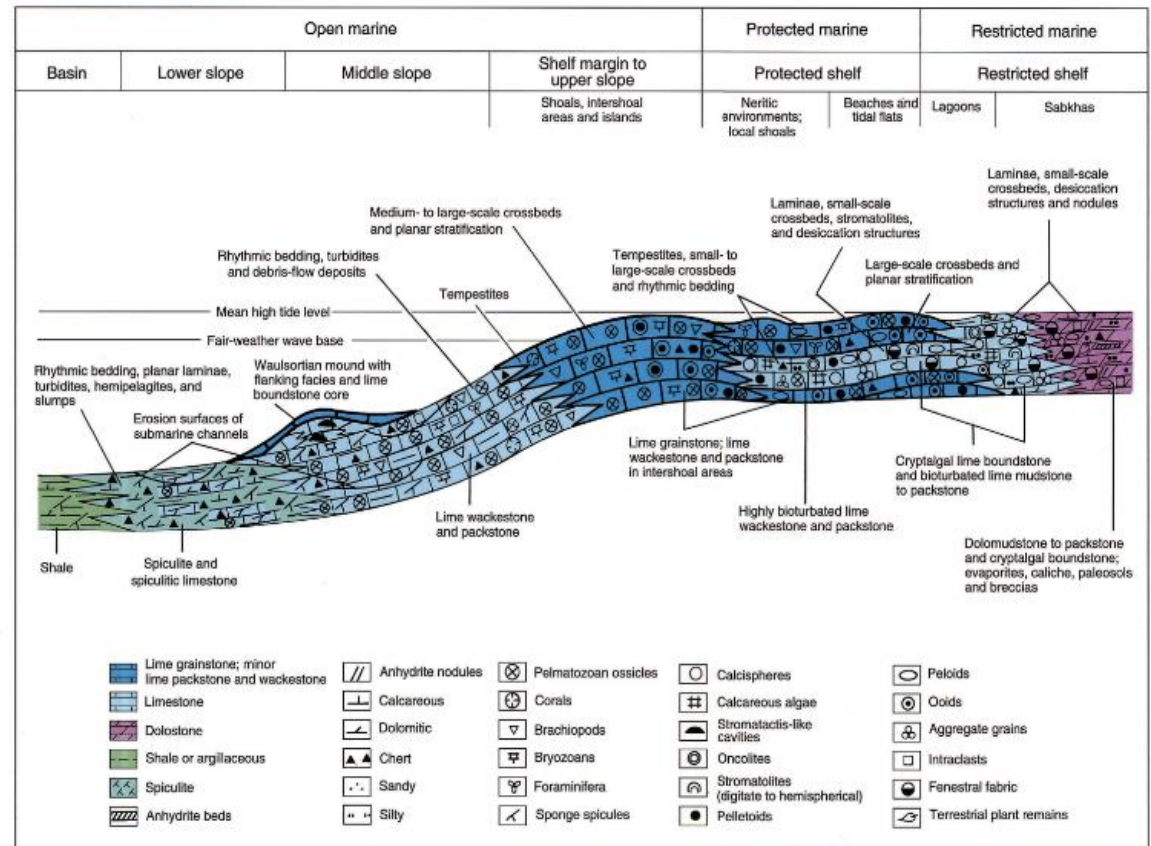
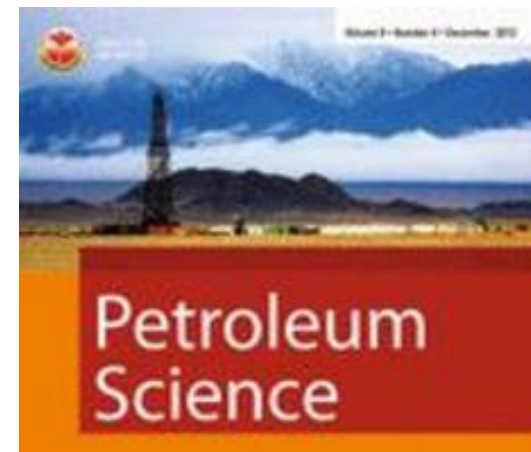


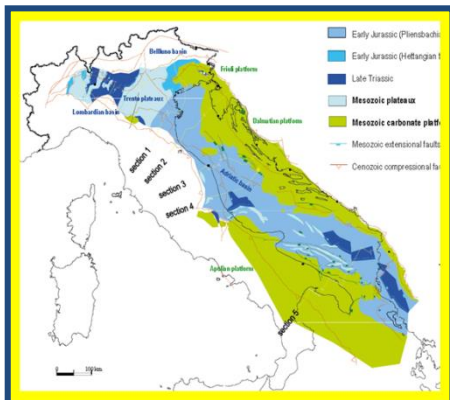
Figure 14.18 Generalized model of a Carboniferous carbonate platform (from Richards, 1989a).

MARGINI DI PIATTAFORMA CARBONATICA E *REEFS* CARBONATICI



I *reefs* carbonatici sono generalmente ottime trappole stratigrafiche per gli idrocarburi: in Canada il 60% della produzione petrolifera proviene dai *reefs* sviluppatisi nel Devoniano, presenti anche in molte regioni petrolifere degli USA.

In Italia i campi petroliferi dell'Italia meridionale sono ubicati lungo il margine della piattaforma Apula (es. in sud-Adriatico: Aquila, Giove, etc.) o in prossimità di essa (Rospo Mare) o nella piattaforma Apula sepolta sotto i *thrust* dell'Appennino meridionale (Val d'Agri, Tempa Rossa, etc).



Anche l'attuale esplorazione dell'offshore croato è focalizzata prevalentemente sul margine della piattaforma carbonatica Dinarica.

Piattaforma Carbonatica (dominio *shallow water*)

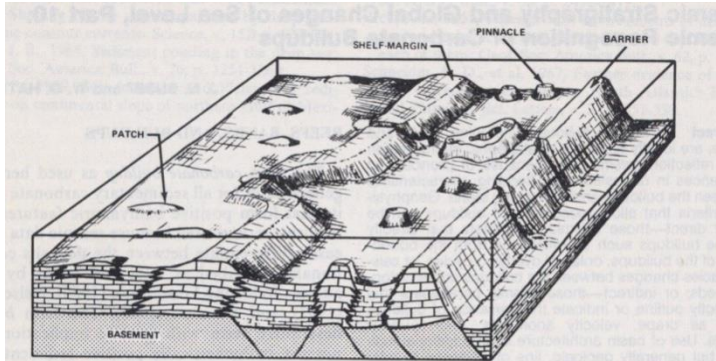


FIG. 1—Types of carbonate buildups most easily recognized from seismic interpretation. Conventional classification of reefs and banks, although preferred, is not easily applicable to seismic data.

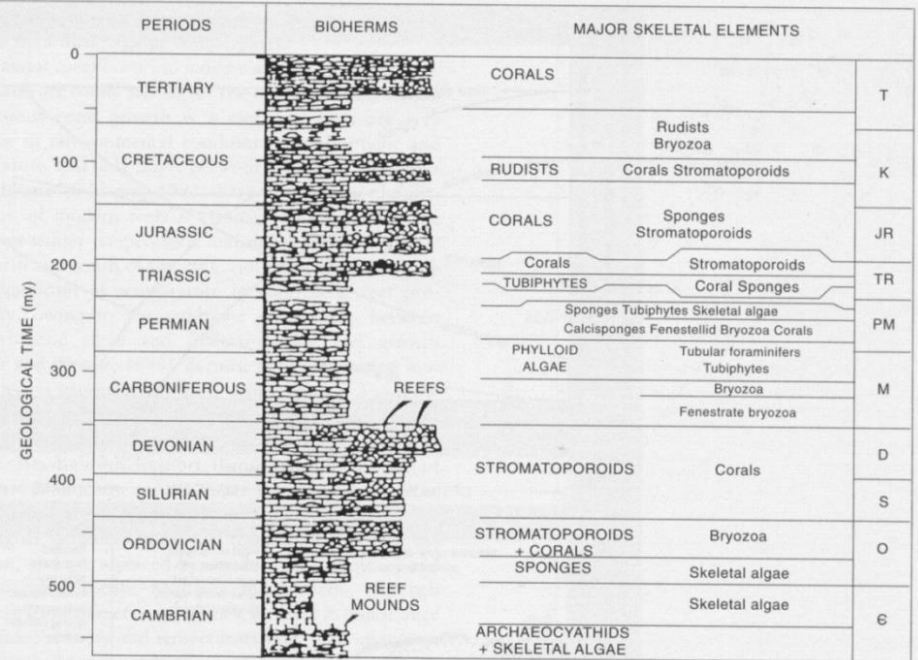
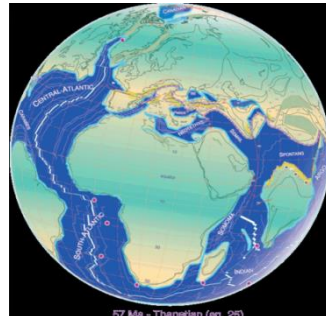
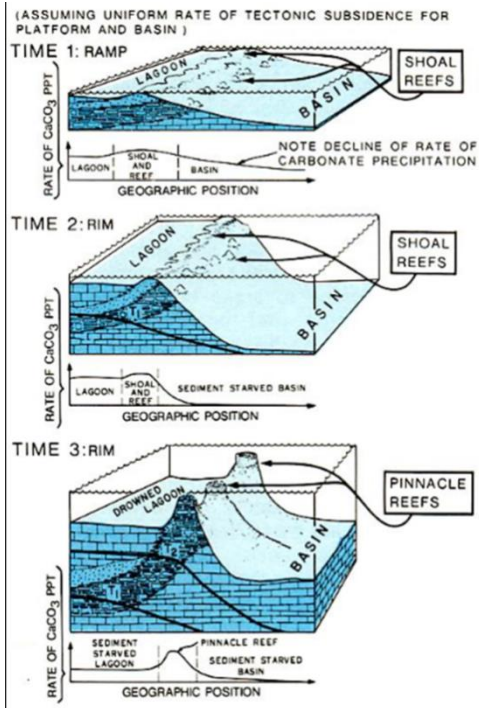
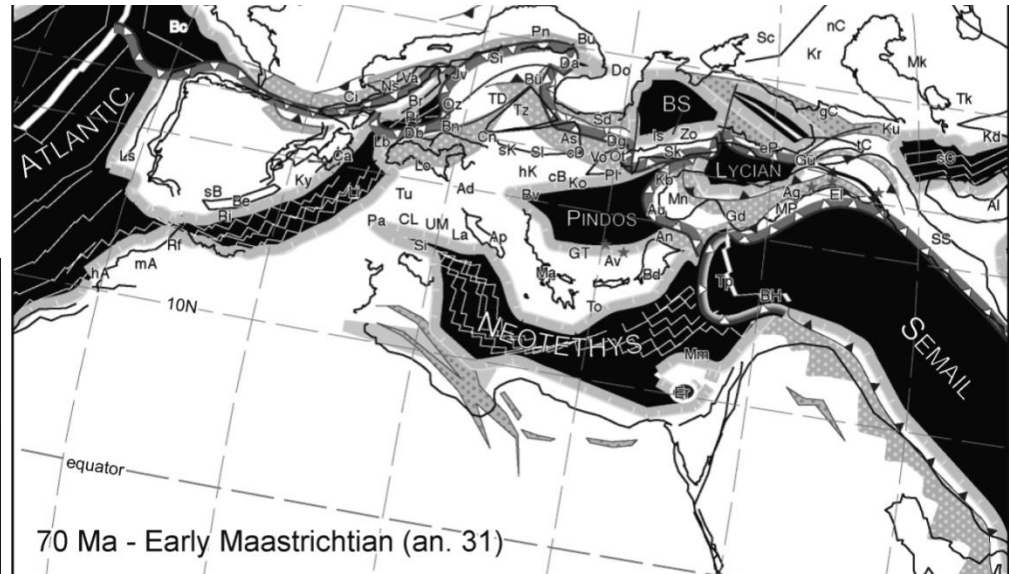
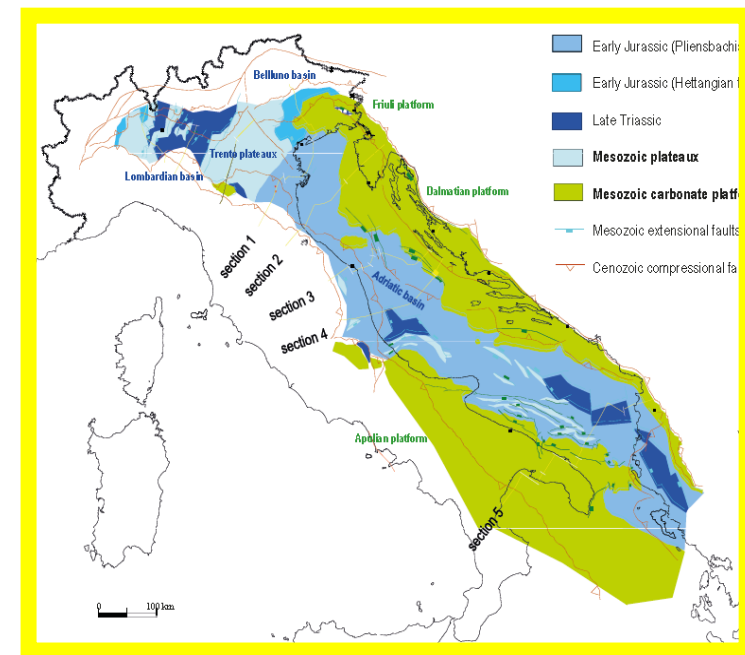


Fig. 10.3 Simplified stratigraphic column indicating the major framework-building organisms through time (from James, 198

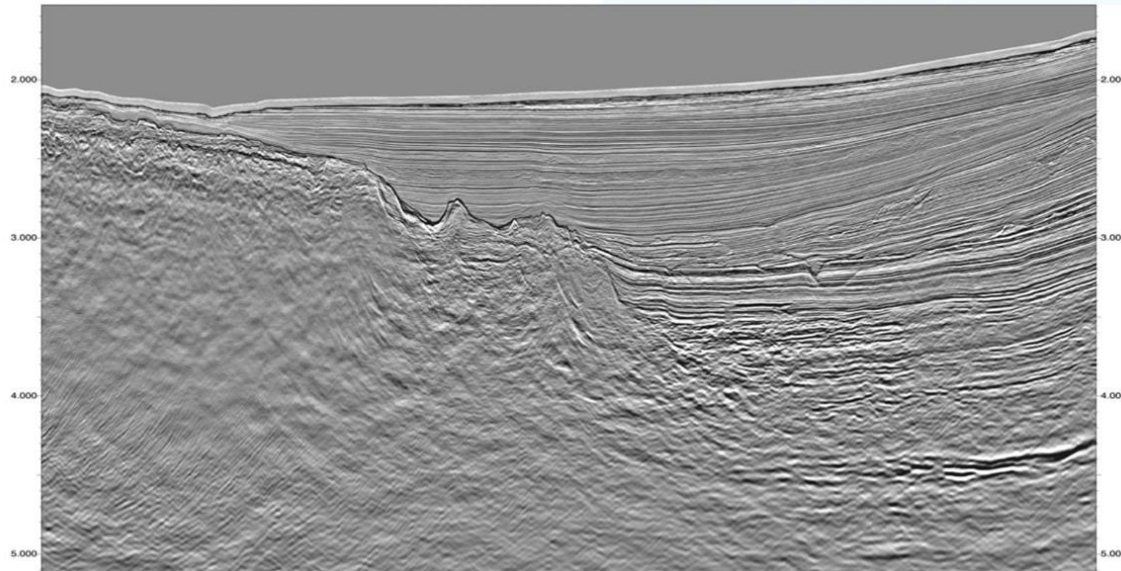


I margini di piattaforma carbonatica rappresentano spesso un importante obiettivo di indagine in quanto costituiscono il passaggio tra un dominio di acque poco profonde (*shallow water*) ed un dominio bacinale, anche molto profondo. I due domini si sono generalmente separati in seguito ad una fase tettonica distensiva (tipici ambienti interessati sono i margini continentali). L'esempio a noi più vicino riguarda le piattaforme carbonatiche Friulana/Istriana/Dalmata e quella Apula, distinte dai bacini pelagici circostanti (bacino di Belluno, bacino Umbro-Marchigiano, bacino Ionico, bacino Lagonegrese) generalmente durante il Triassico in connessione ad un'importante fase di apertura oceanica Tetidea.



Tali margini sono spesso caratterizzati da formazioni ad alta porosità (possibili *reservoir*) a causa di fratturazione, dolomitizzazione, depositi di *slope*, etc., talvolta prossime a rocce con alto contenuto di materiale organico (possibili *source rocks*). Sono quindi un obiettivo importante della interpretazione sismica per esplorazione petrolifera.

3DExPro



Margine di Piattaforma

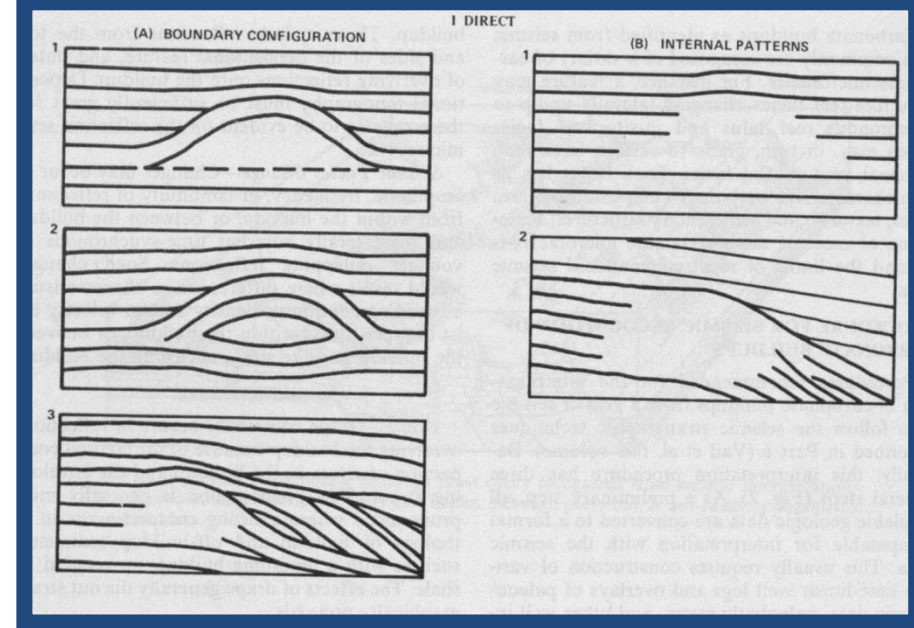
Evidenze Sismiche Dirette

Configurazioni di margine (a sn)

- 1 & 2 – forma a “tumulo” e brusca interruzione dei riflettori adiacenti
- 3 - diverse facies sismiche sui due lati struttura

Configurazioni interne (a ds)

- 1 – assenza di riflettori
- 2 – crescita della struttura su una “*hinge line*”



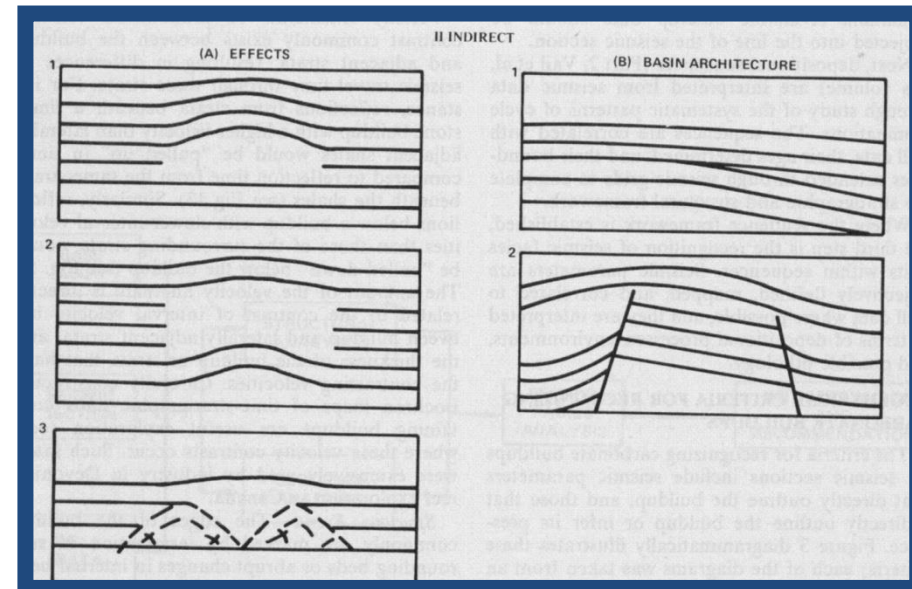
Evidenze Sismiche Indirette

Effetti (a sn)

- 1- drappeggio sopra la struttura
- 2- *pull-up velocity*
- 3- diffrazioni ai margini della struttura

Architettura (a ds)

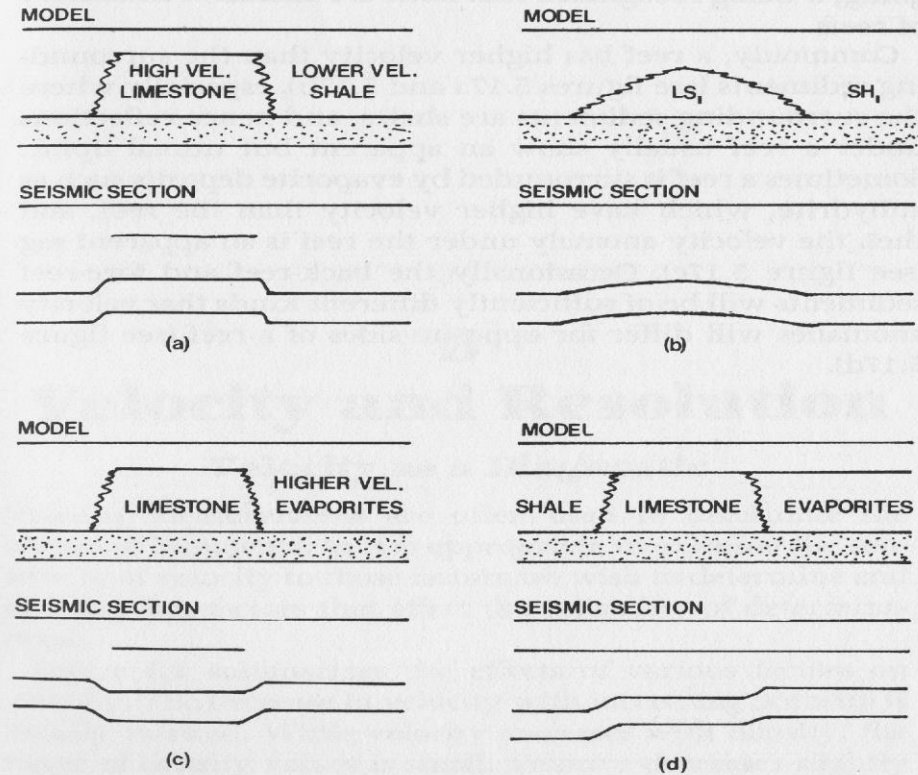
- 1- crescita su “*hinge line*”
- 2- crescita su di un alto strutturale



Distinguishing Characteristics of Reefs

Figure 5.16 is a summary of criteria for distinguishing reefs on seismic sections. These criteria include:

- (1) Reflections that partially outline reefs.
- (2) Reflection voids, distinguishable by the sharp termination of reflections that onlap the reef.
- (3) Changes in amplitude, frequency, or continuity of reflections at reef edges.
- (4) Differences between reflection patterns on one side of the reef compared to those on the other; this is often especially marked for shelf-margin and barrier reefs where the back-reef and fore-reef patterns may differ markedly.
- (5) The presence of diffractions and other types of events that mark reef edges.
- (6) Differential compaction effects that produce a drape in the sediments over the reef; this is generally due to the off-reef sediments being more compactable than the reef itself, but occasionally the porous parts of a reef collapse and produce compaction effects. Compaction effects usually become gradually less with distance above the reef.
- (7) Velocity anomaly for reflections underneath the reef (see below and figure 5.17).
- (8) Location where reef growth should be propitious, such as on a hinge line, at the edge of a shelf, or on the uptilted edge of a fault block.
- (9) Regional factors, such as the knowledge that the climate or environment associated with a particular reflection was propitious for reef growth.



Reefs are usually evidenced by a combination of the foregoing, it being recognized that none are exclusive indicators of reefs.

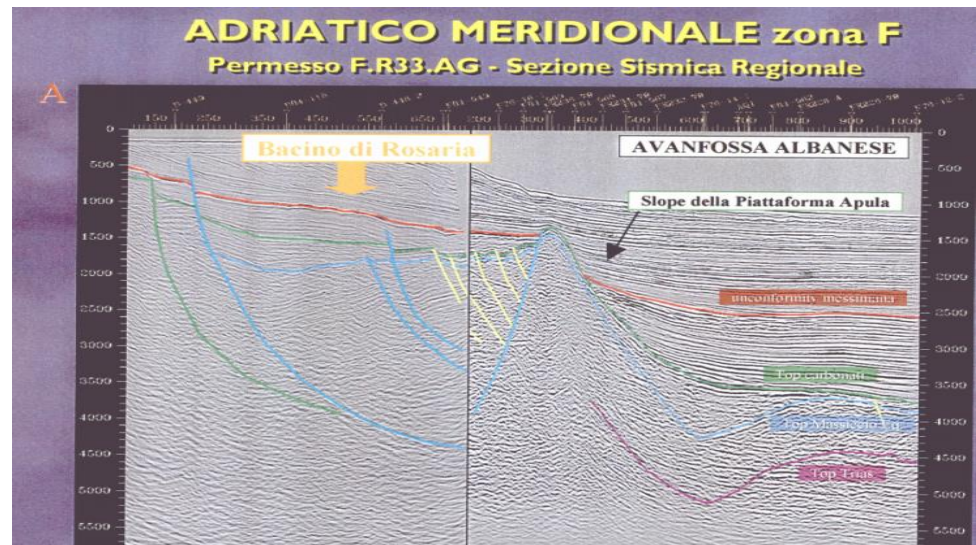
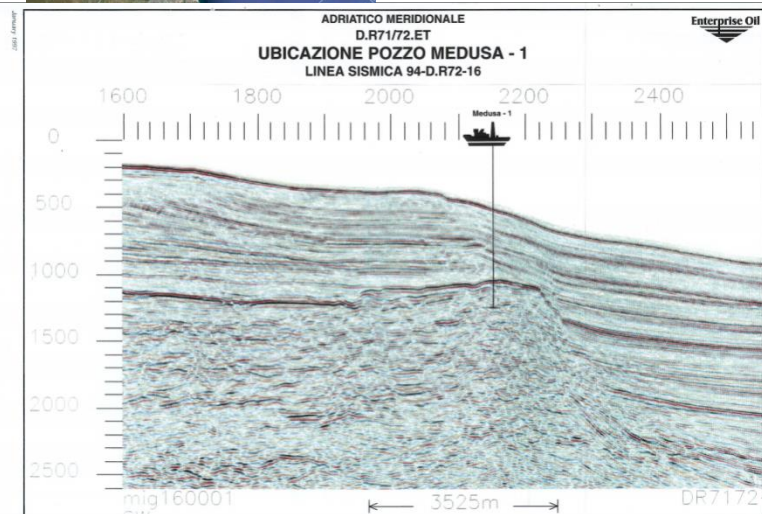
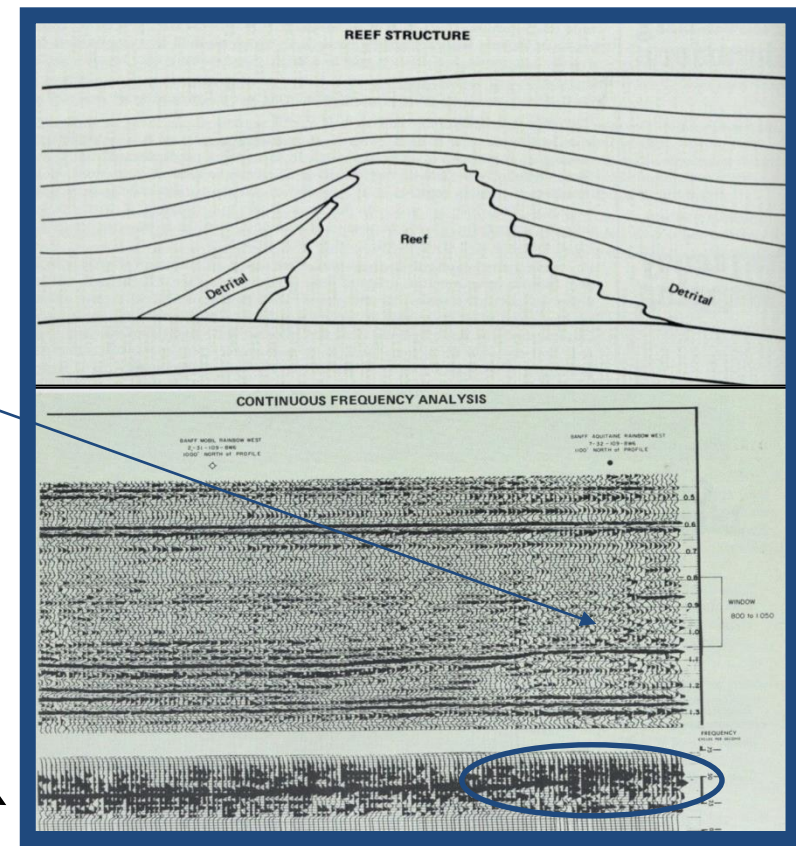
Commonly, a reef has higher velocity than the surrounding sediments (see figures 5.17a and 5.17b), especially where the surrounding sediments are shales, and hence reflections under a reef usually show an apparent but unreal uplift. Sometimes a reef is surrounded by evaporite deposits such as anhydrite, which have higher velocity than the reef, and then the velocity anomaly under the reef is an apparent sag (see figure 5.17c). Occasionally the back-reef and fore-reef sediments will be of sufficiently different kinds that velocity anomalies will differ for opposite sides of a reef (see figure

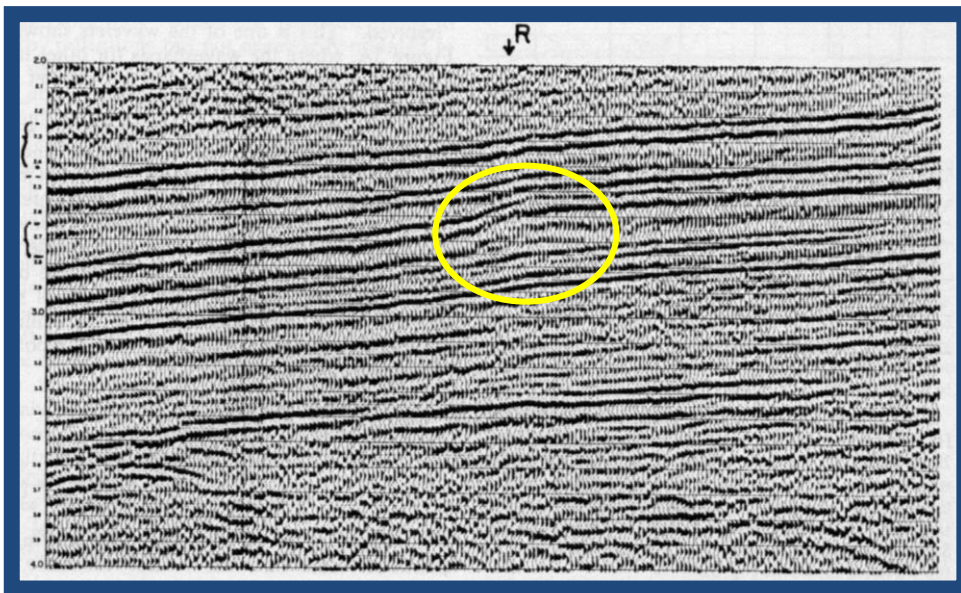
Compattazione Differenziata in corrispondenza di un *build-up*:

effetti sul contenuto in frequenze:
sopra la struttura di *build-up* la
serie sedimentaria mostra un
contenuto in frequenza più alte



spettro di frequenza

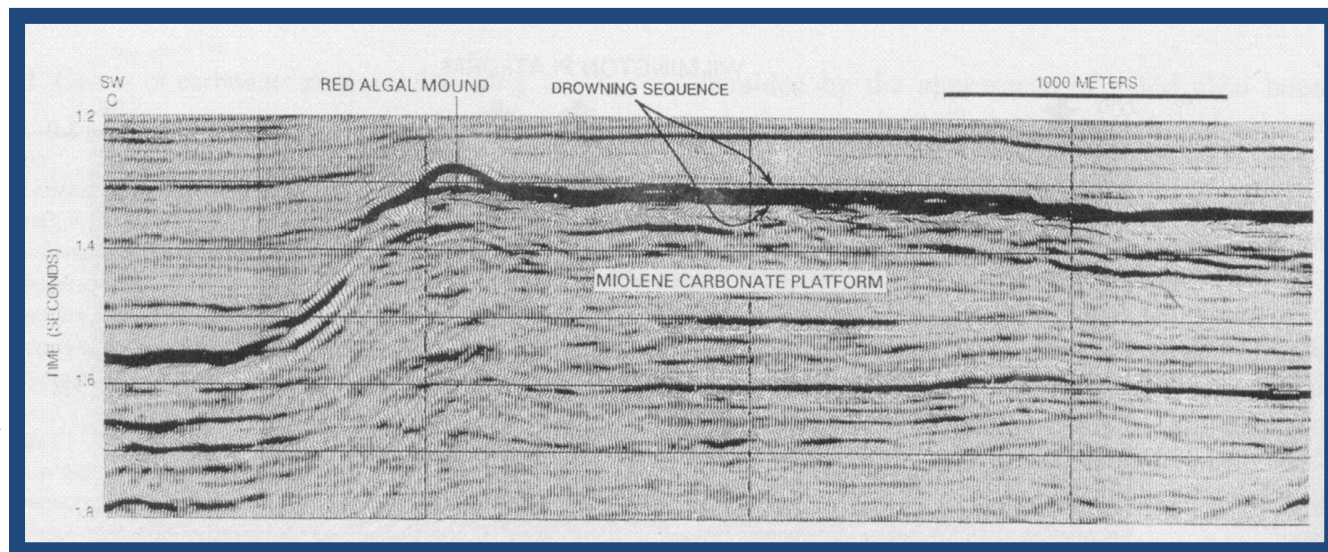




Esempio di margine di piattaforma: spesso i margini di piattaforma, soprattutto se profondi, sono di dimensioni prossime al limite della risoluzione sismica

In questo profilo il margine della spessa piattaforma è reso maggiormente evidente dal *reef*.

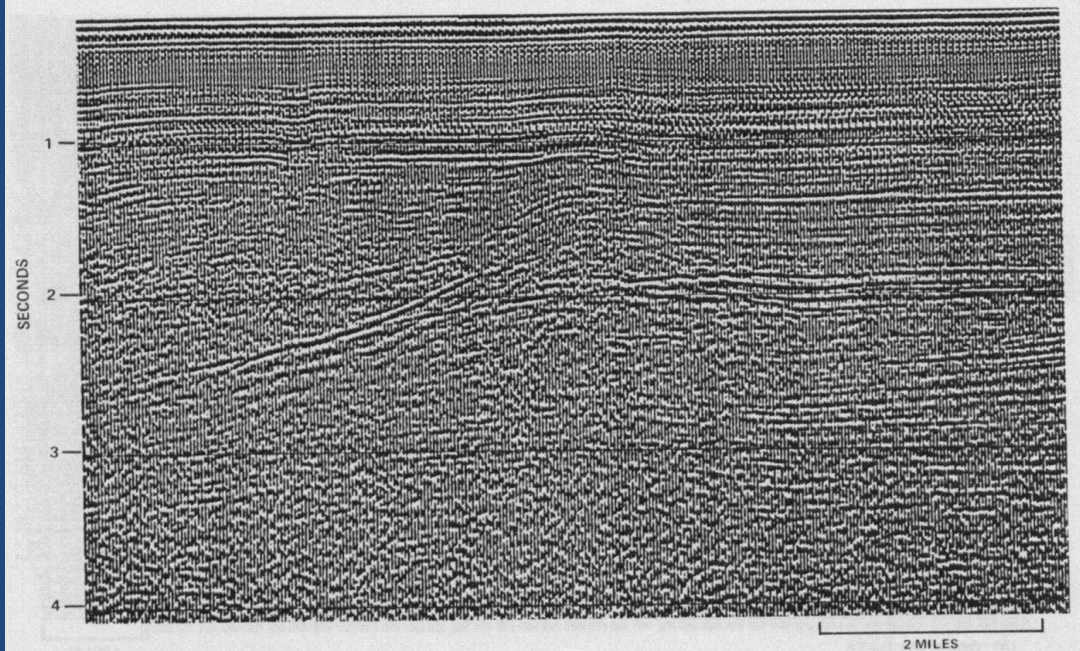
Si notino le diverse facies sismiche dei domini *shallow water (sw)* (piattaforma) e bacinale.



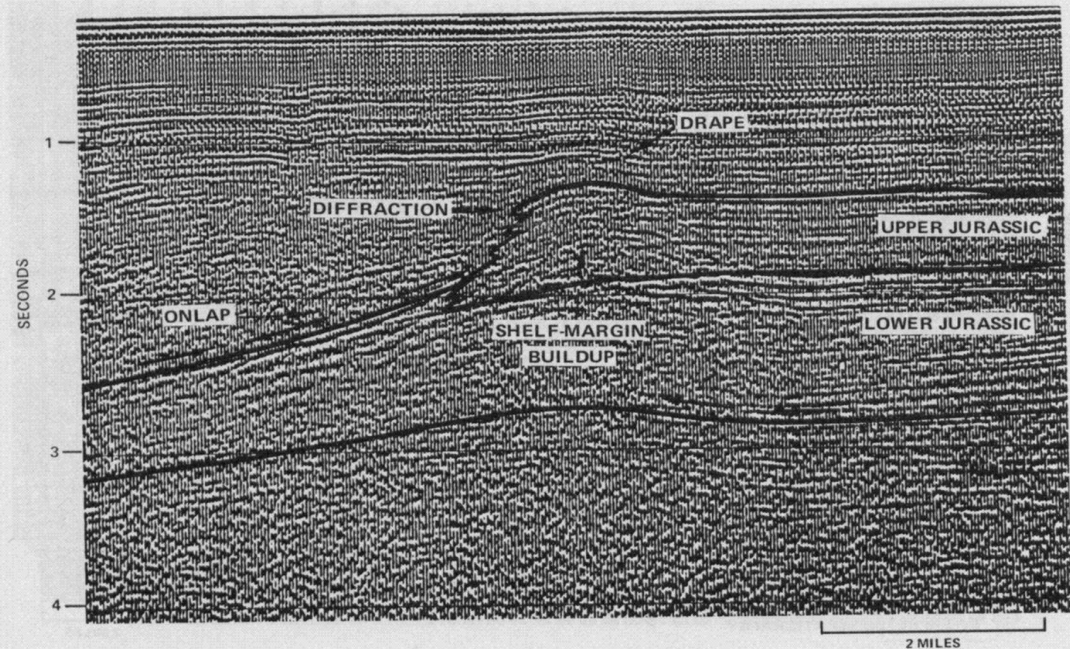
Esempio di Margine di Piattaforma

si distinguono :

- le diverse facies sismiche dei domini
 - < di piattaforma sw a ds
 - < bacinale a sn
- le diffrazioni dal margine
- il *pull-up velocity*
- il drappeggio e la compattazione differenziata dei sedimenti di copertura



(A) ORIGINAL DATA



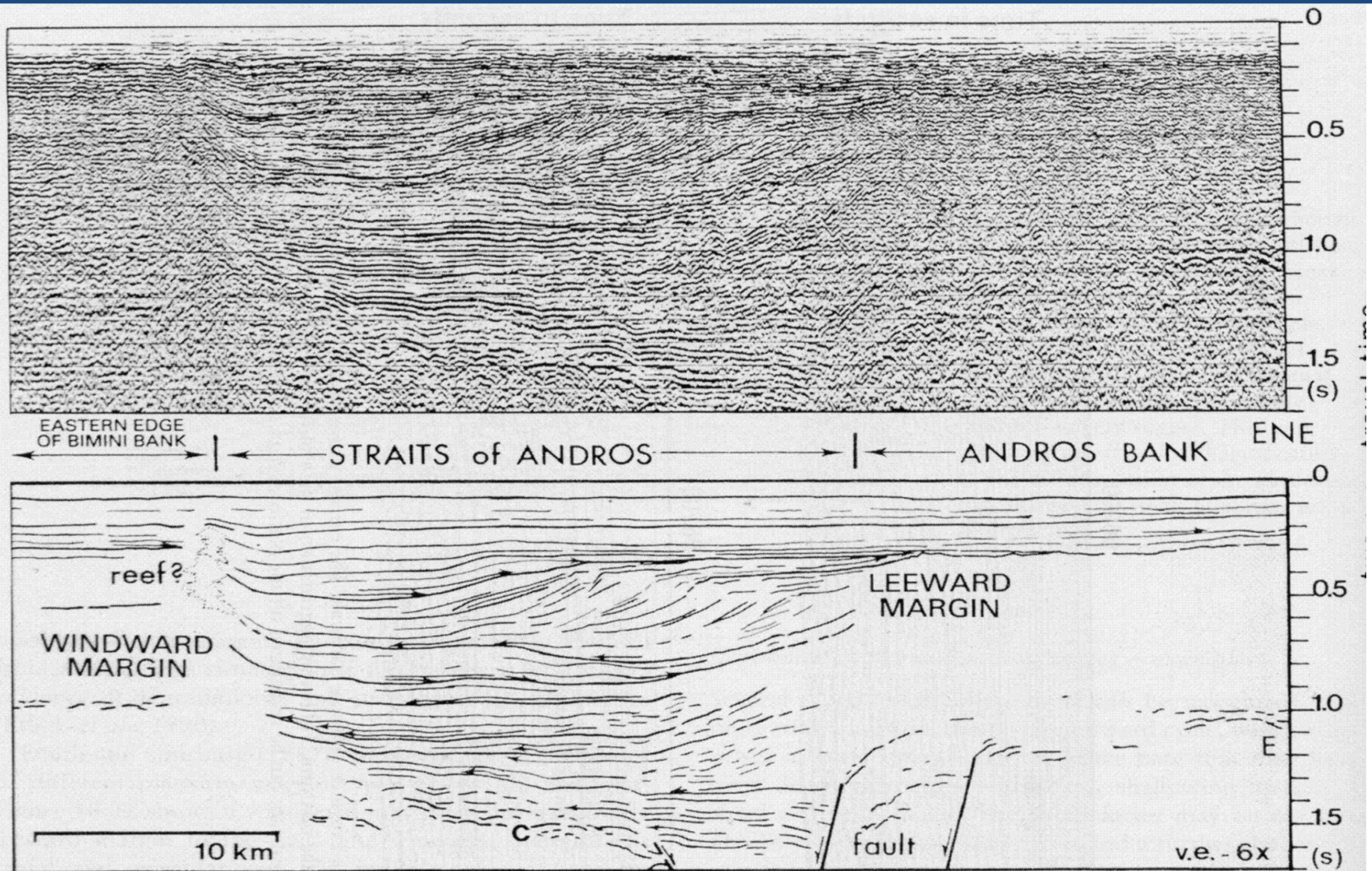
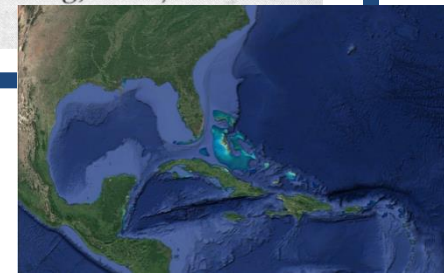


Fig. 10.27 Windward (left) and leeward (right) platform margins of the Bahamas (from Eberli and Ginsburg, 1987). See text for details

Esempio di Margine di Piattaforma nelle *Bahamas*



Schema per il Margine di Piattaforma in E-Adriatico proposto da Grandic (1999)

in questo modello si associa al
margine di piattaforma un sistema
di faglie distensive (faglie Liassiche
del margine passivo Tetideo), dei
depositi di scarpata (alta porosità e
quindi buona probabilità di fungere
da *reservoir* per idrocarburi);
inoltre la presenza delle evaporiti in
profondità avrebbe dato origine a
dei domi salini (originando l'Isola di
Jabuka- o l. del Pomo - e ulteriori
strutture positive)

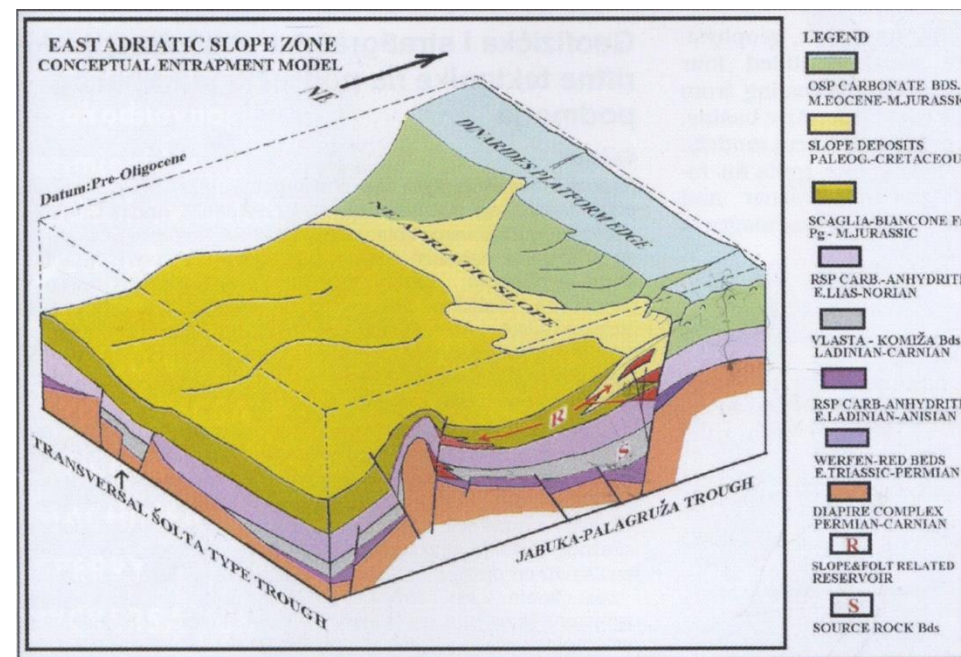
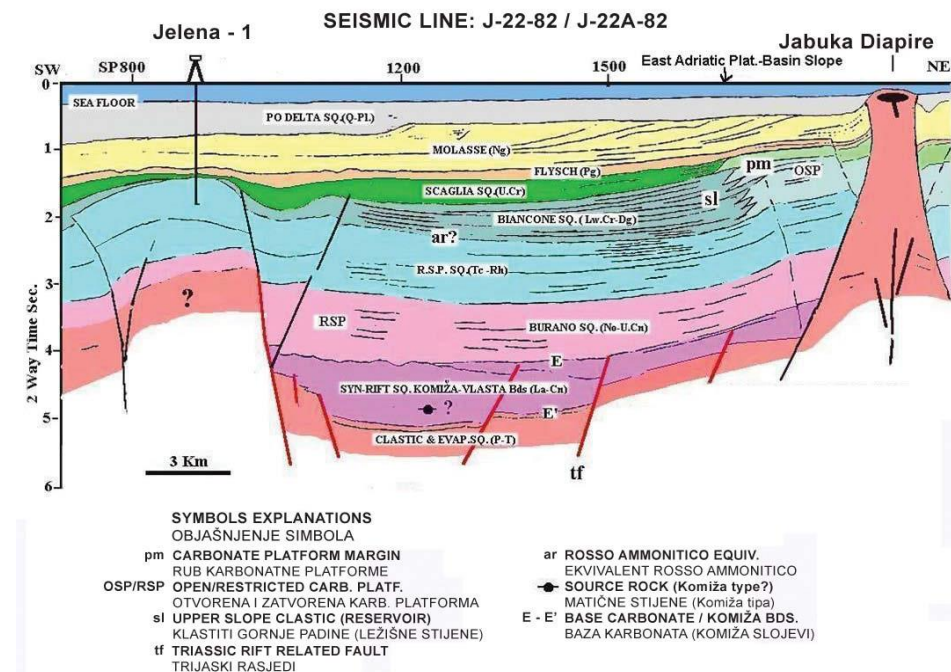
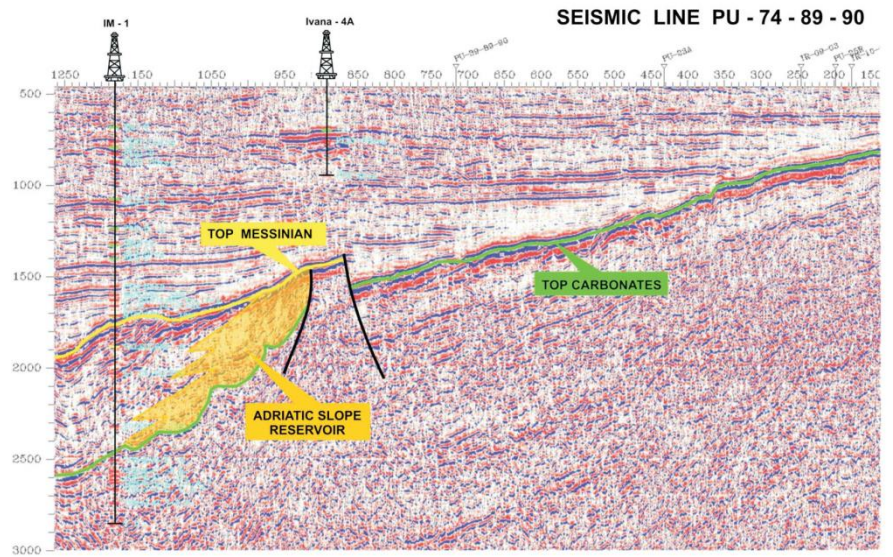
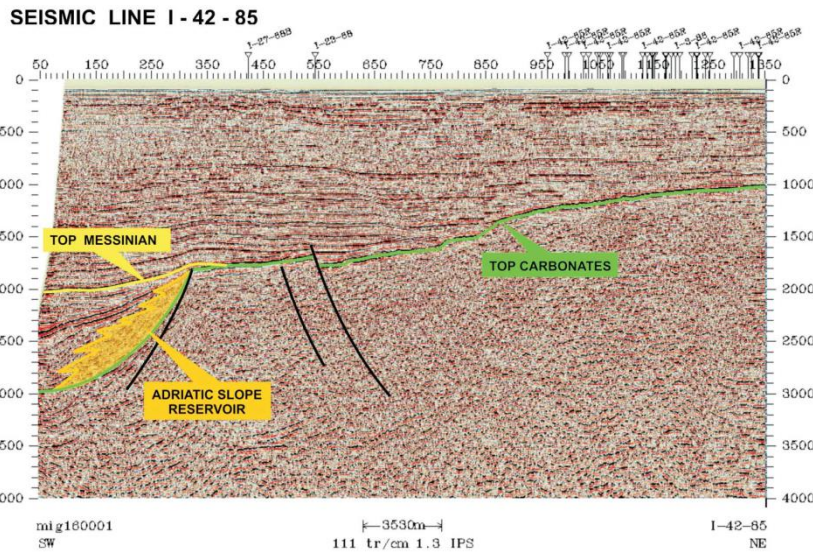
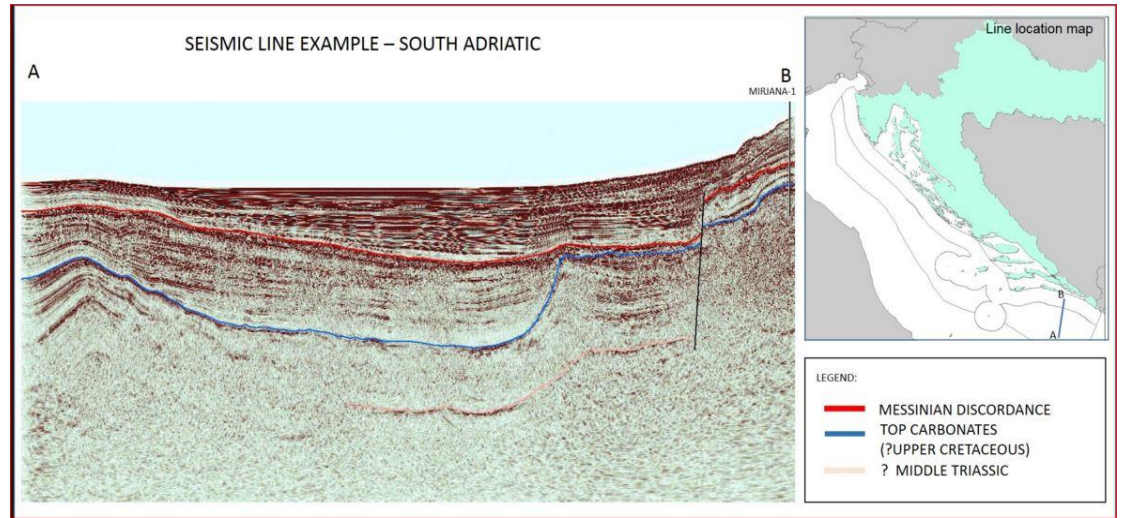
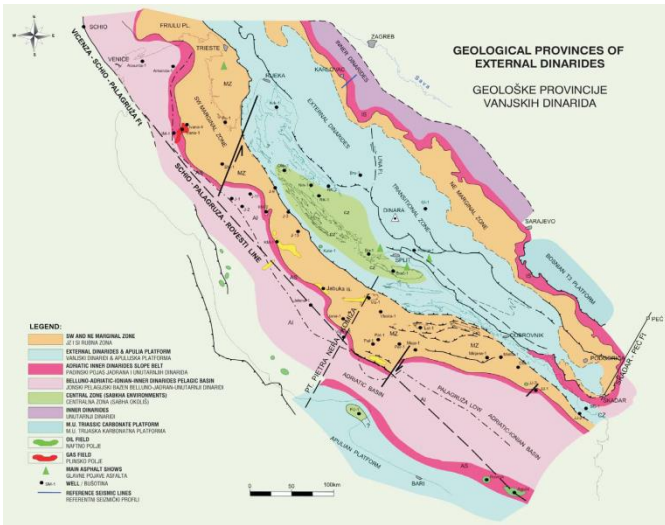
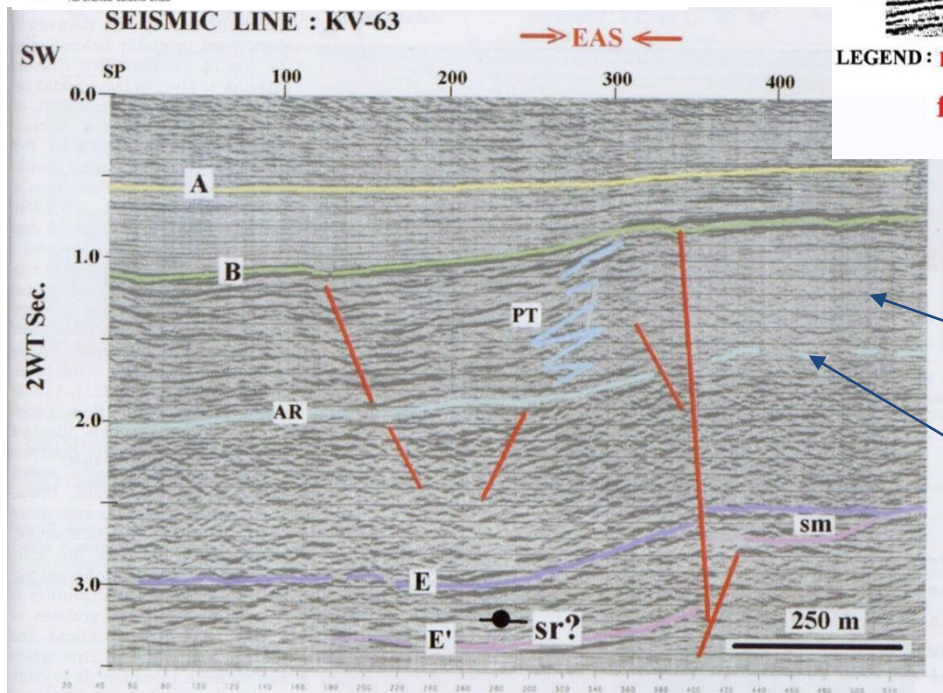
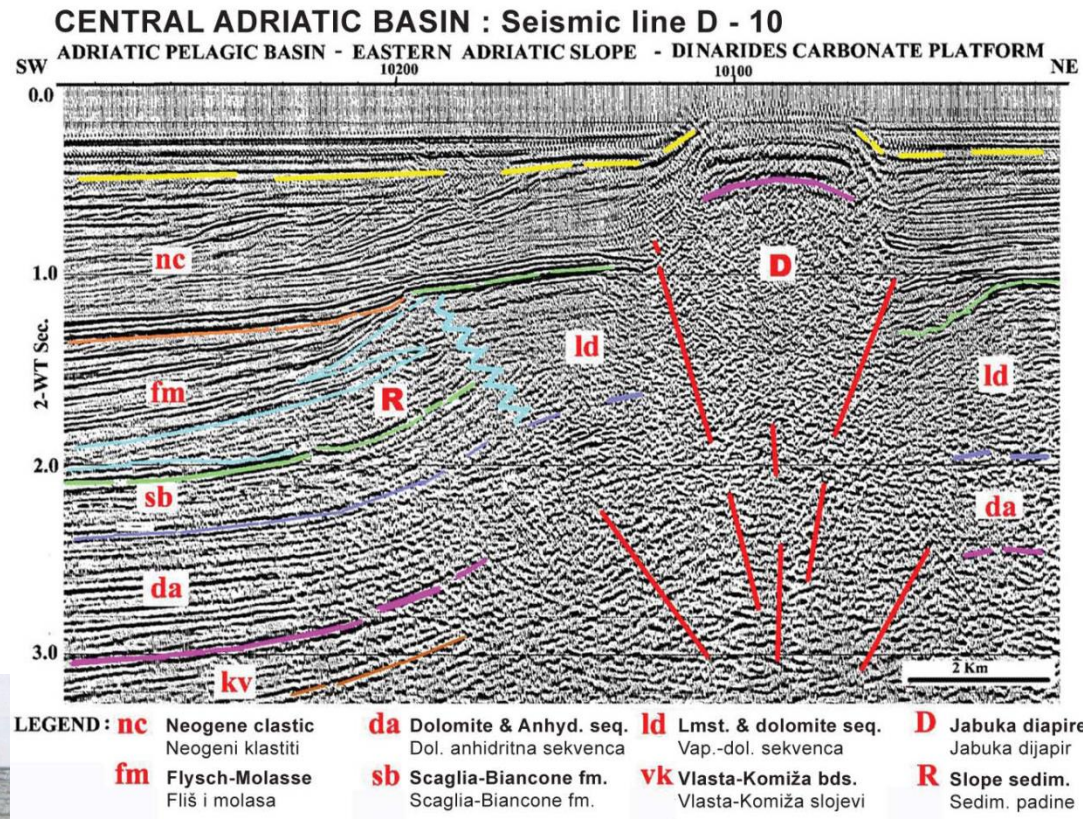
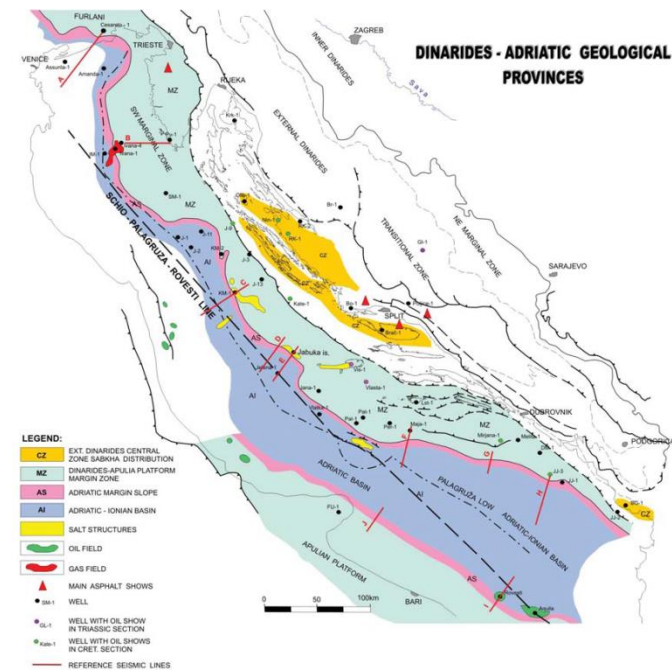


Fig. 18. This hydrocarbon conceptual model was created mostly on the basis of the well and seismic interpretation between the Maja-1 well and the Palagruža high (After GRANDIĆ et al 1999)



ESPLORAZIONE DI IDROCARBURI NELL'OFFSHORE CROATO





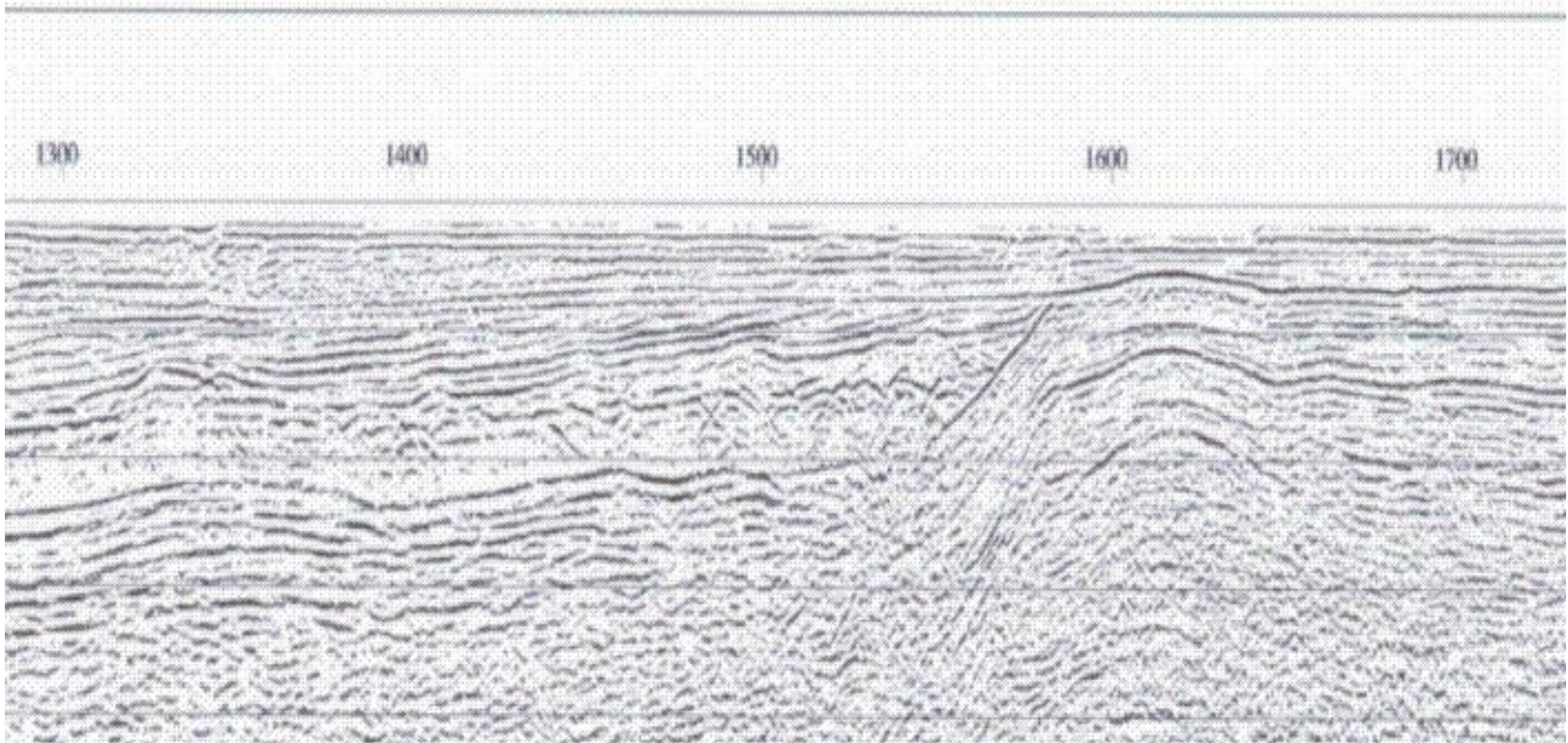
Piattaforma
carbonatica:

-facies sismica
trasparente

(Grandic, 1999)

-velocity pull-up

Fig. 9. Seismic line KV-63 represents configuration of the "EAS" zone. Symbols B and E indicate flexured "Top and Base Carbonate".

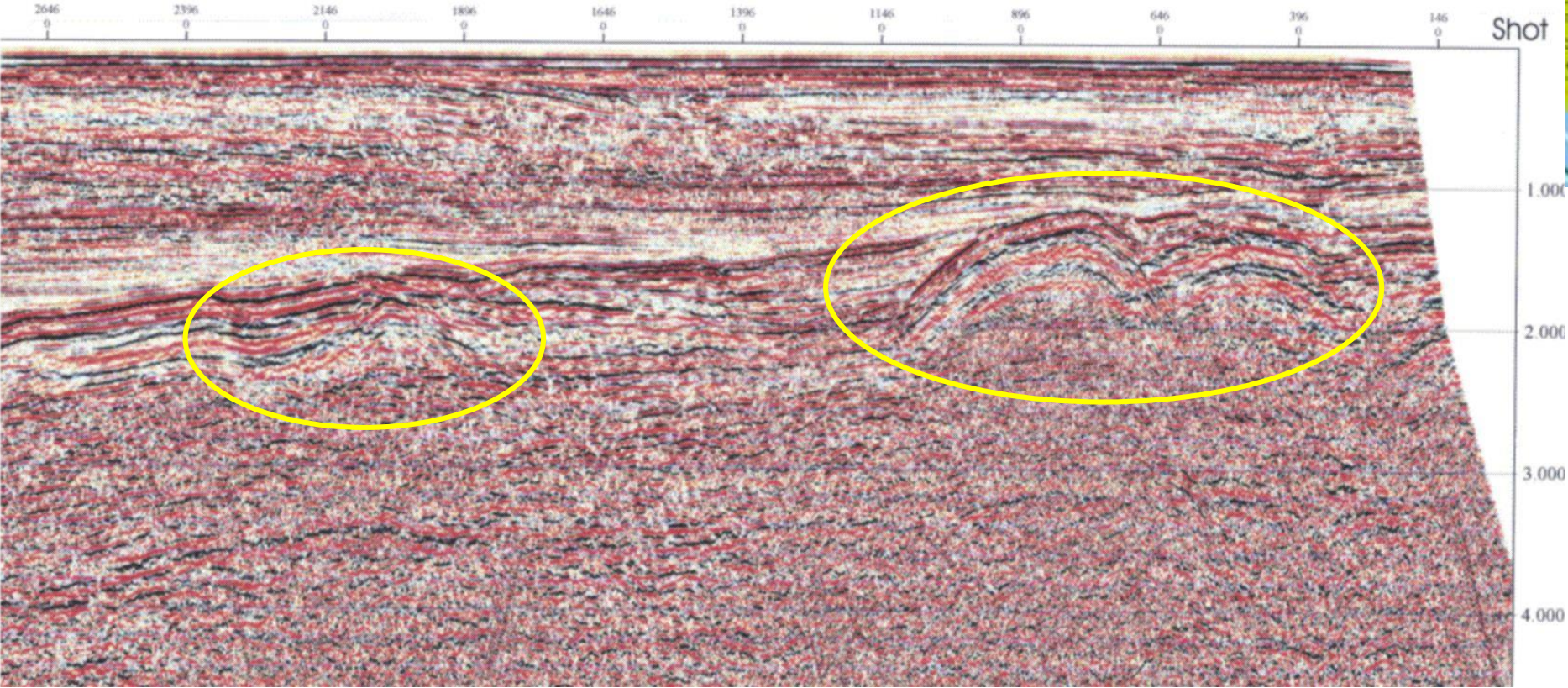


Profilo sismico attraverso il Golfo di Trieste
 Il margine della piattaforma carbonatica
 Friulana/Istriana separa il bacino pelagico ad
 ovest rispetto al dominio di piattaforma ad est

Esempio di profilo sismico in Adriatico:

Piattaforma Isolata
di Barbara

Margine della
Piattaforma Adriatica



Chapter 15

Seismic Modeling of a Carbonate Platform Margin (Montagna della Maiella, Italy): Variations in Seismic Facies and Implications for Sequence Stratigraphy

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Abstract

Synthetic seismic sections across the exposed Cretaceous–Miocene carbonate platform margin of the Montagna della Maiella (central Italy) explain the seismic facies of a carbonate platform margin system and show the limitations of relating seismic sequences to depositional sequences. To define a layered impedance model, velocities and densities of 186 minicores from all major outcropping lithologies were determined. The impedance model was converted to synthetic seismic data by applying a computer-simulated model that uses the normal incidence ray-tracing method at variable frequencies, amplitude gains, and noise levels. The resulting synthetic seismic sections show a mostly transparent platform that is overlapped along the escarpment by a succession of high-amplitude slope reflections. The different reflectivities of platform and slope can be explained by their differences in impedance contrasts. The small impedance contrasts within platform carbonates results in weak reflections nearly indistinguishable from noise, whereas the large impedance contrasts within the slope and basin carbonates yield coherent high-amplitude reflections. The seismic image with incoherent to transparent platform, high-amplitude slope reflections, and recognizable prograding units is similar to observed seismic data across other steep carbonate platform margins (e.g., Great Bahama Bank and Adriatic Sea).

In outcrop, seven unconformity-bounded supersequences were mapped. Comparison with the synthetic seismic section shows that, at a frequency of 20 Hz, only five of these depositional supersequences can be recognized using seismic unconformities. With an increase in frequency, an increasing number of unconformities become visible, and at a frequency of 60 Hz, all seven are imaged. The synthetic seismic sections also reveal that some of the seismic unconformities are pseudo-unconformities—they do not exist in outcrop, but the seismic image shows erroneous or nonexistent geometric patterns. These are a result of the thinning of layers below seismic resolution. These observations document the problem of seismically imaging depositional sequences. Depending on the dominant frequency, an erroneous number of sequences might be interpreted. This limitation must be taken into account when making sequence stratigraphic interpretations based solely on seismic information.

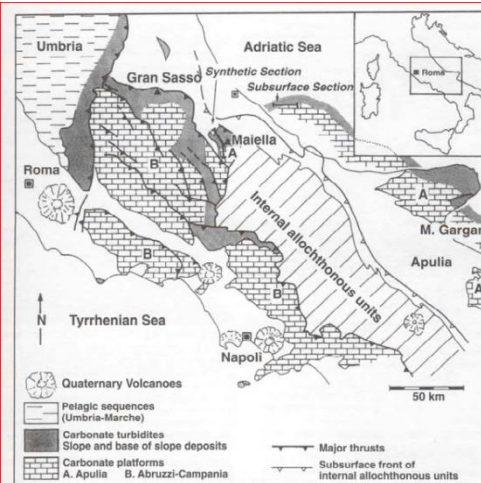
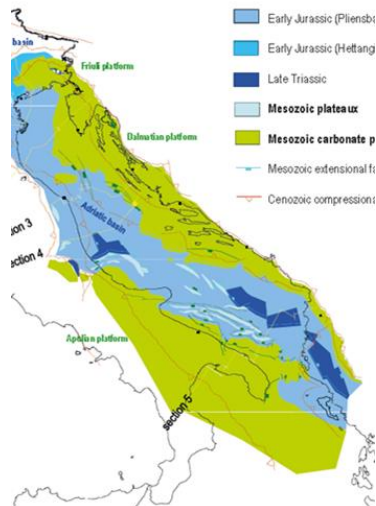


Fig. 3. Location map of the Montagna della Maiella in central Italy and the relative positions of the carbonate platforms of Apulia (A) and the Abruzzi–Campania limestone of the southern Apennines (B). The Apulian platform is partially covered by foreland deposits and allochthonous units of the internal southern Apennines and only marginally involved in Tertiary thrusting in the Montagna della Maiella. The seismic section of the Adriatic subsurface images the continuation of the Maiella platform margin.

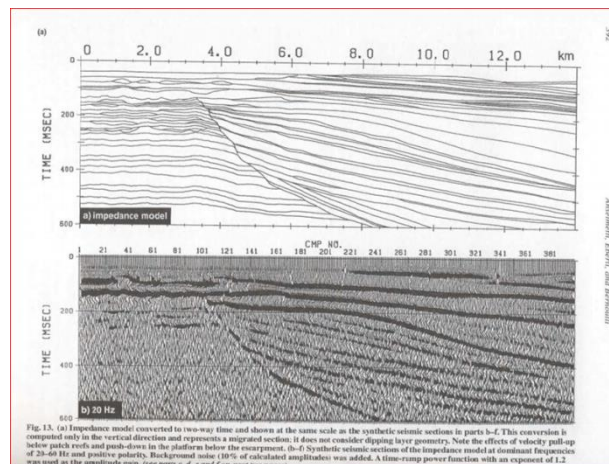


Fig. 13. (a) Impedance model converted to two-way time and shown at the same scale as the synthetic seismic sections in parts b–f. This conversion is computed only in the vertical direction and represents a migrated section. It does not consider dipping layer geometry. Note the effects of velocity pull-up at below patch reefs and push-down in the platform below the escarpment. (b–f) Synthetic seismic sections of the impedance model at dominant frequency of 20–60 Hz and positive polarity. Background noise (10% of calculated amplitudes) was added. A time-ramp power function with an exponent of 1.2 was used as the amplitude gain. (See text, p. 14, and Fig. 14a and 14b for details.)



Fig. 18. Plot of synthetic seismic section (30 Hz, Figure 13c) over the modeled valley flank outcrop (Valle dell'Orfento, Figure 6). This overlay, distorted and plotted at approximately the same scale and position, shows that all major elements of the geologic section (e.g., escarpment, megarecesses, and reefs) are well imaged. However, seismic resolution is not comparable to detailed geologic information obtained from outcrops.

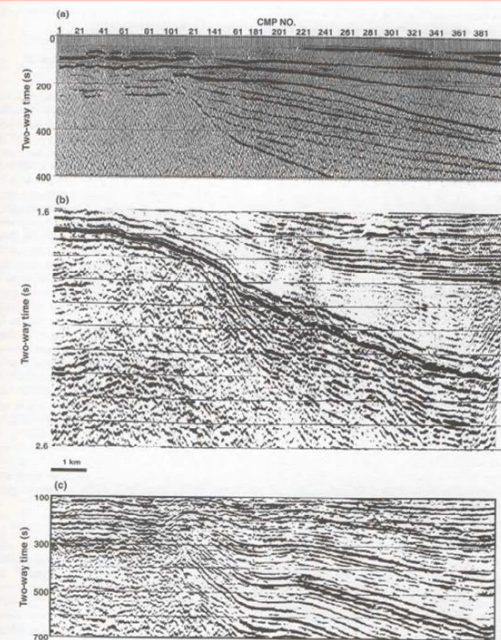
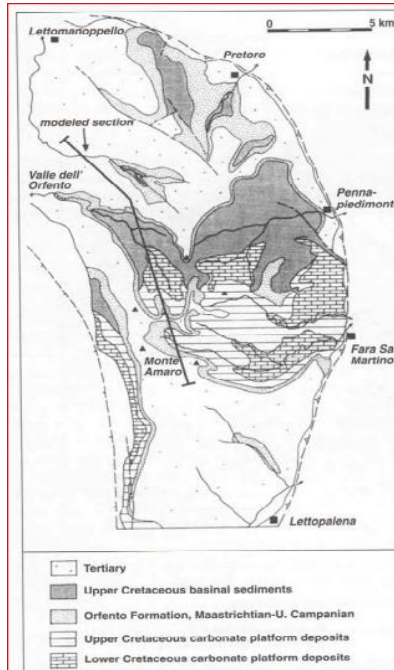
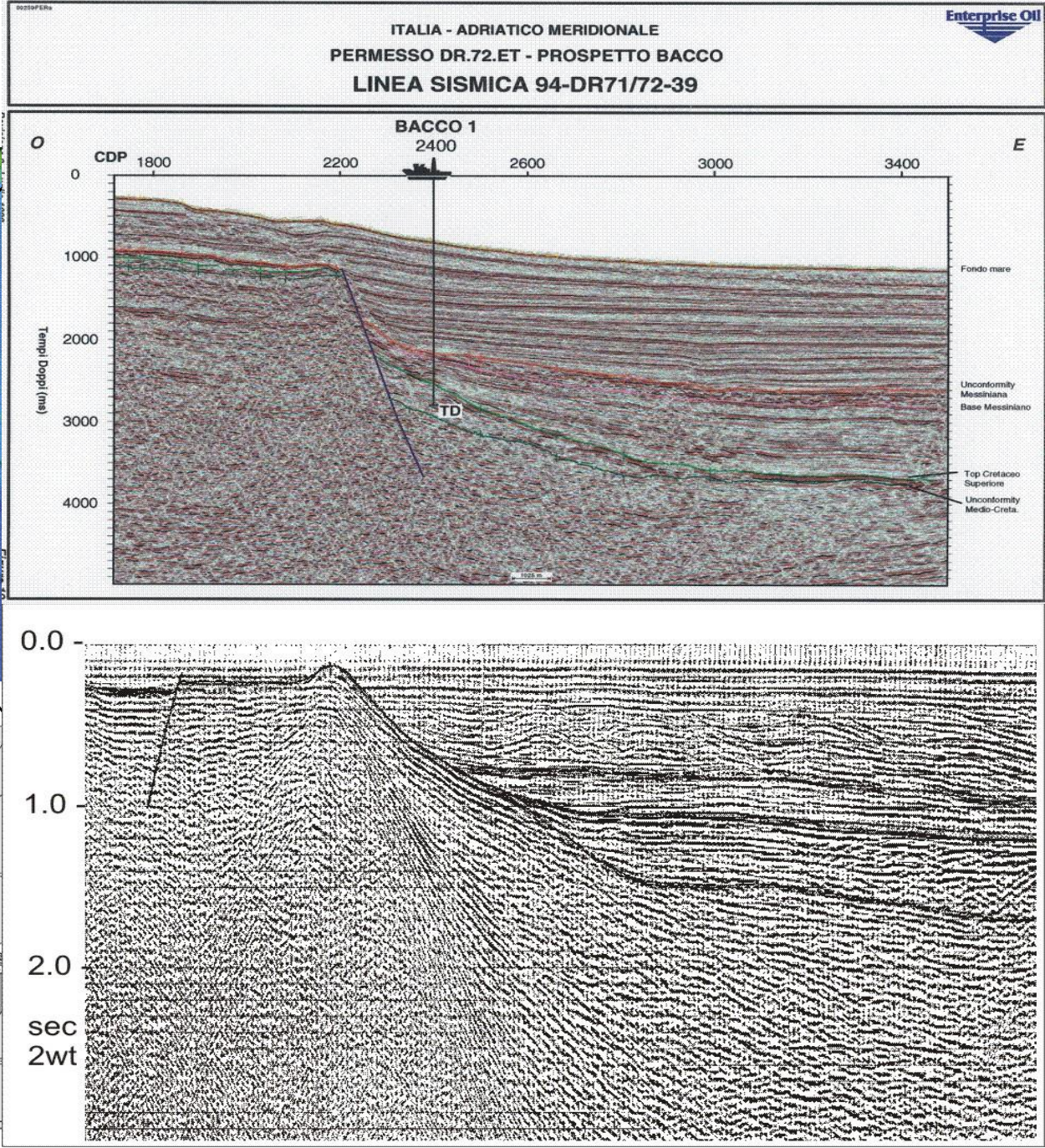
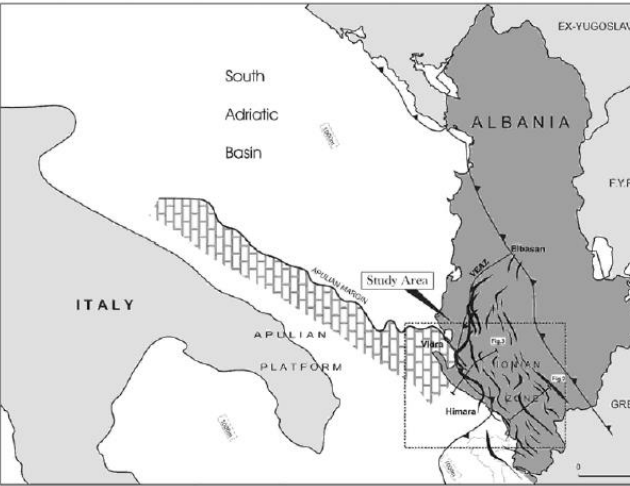
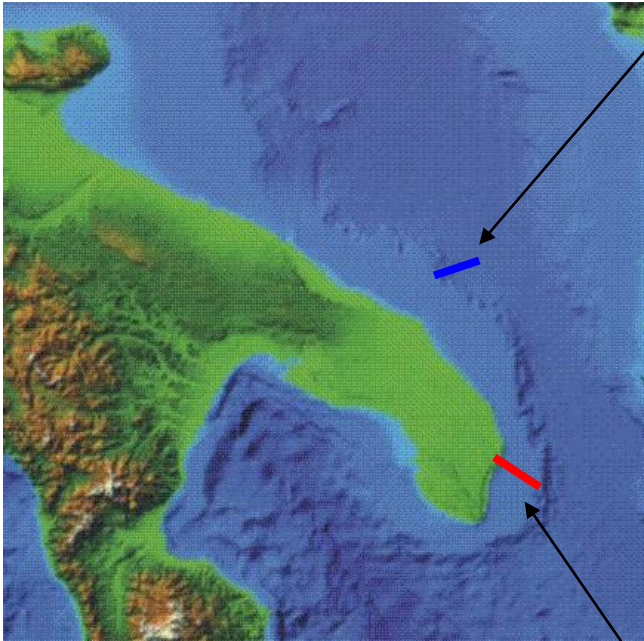
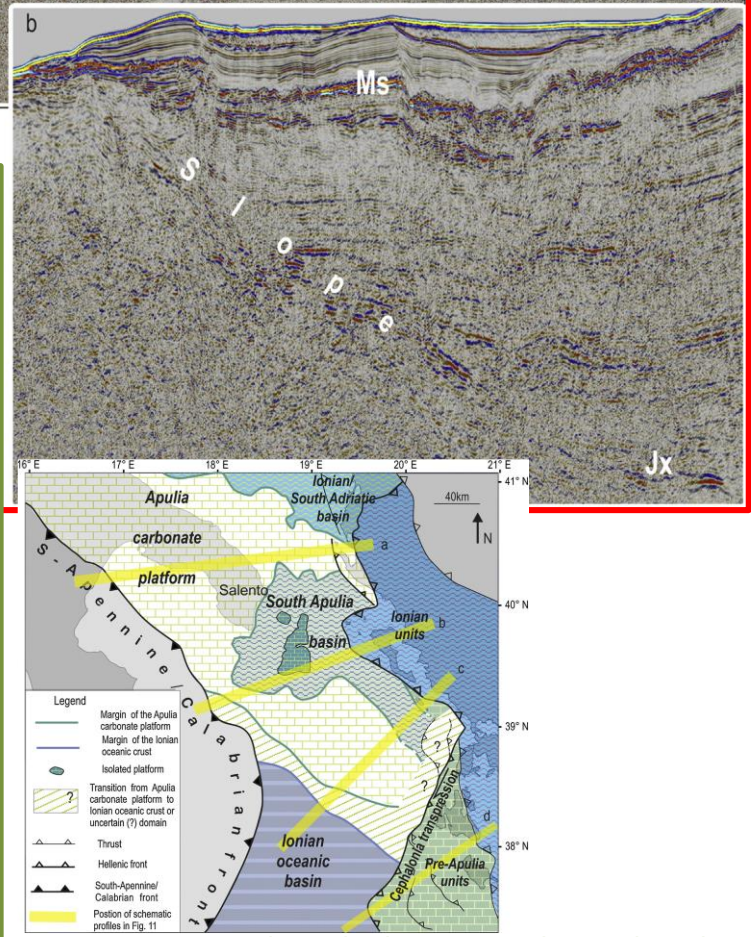
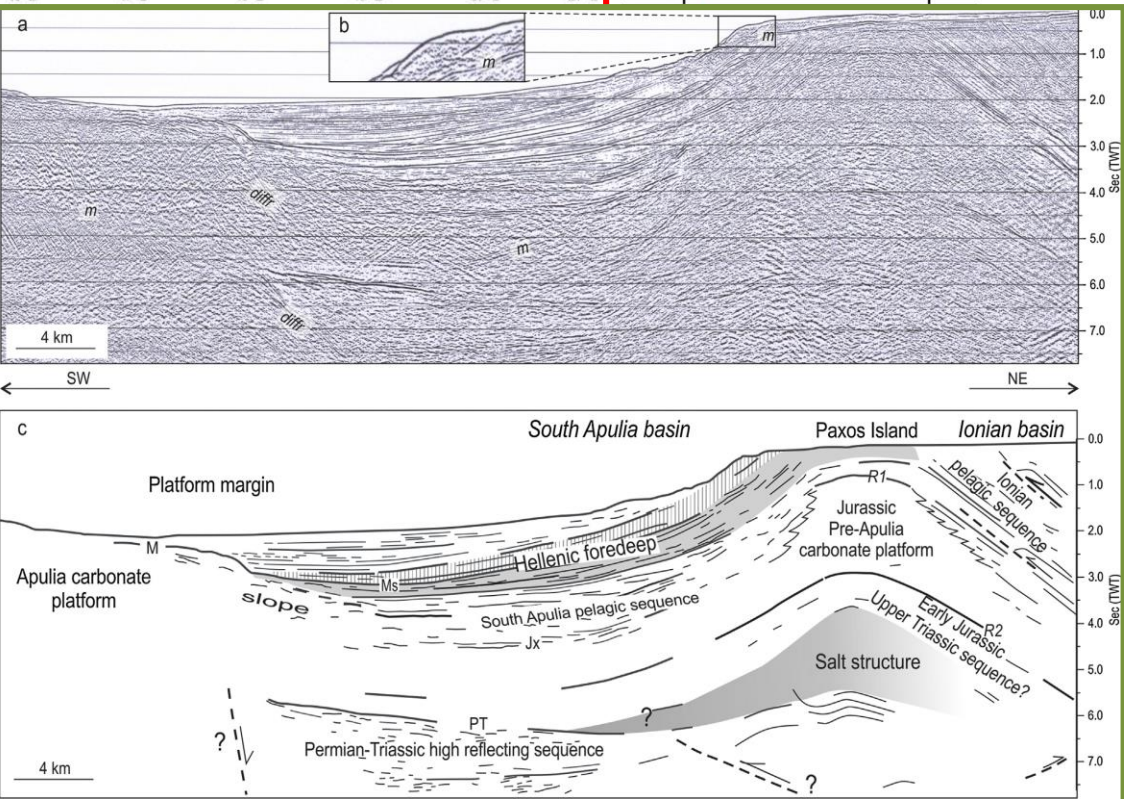
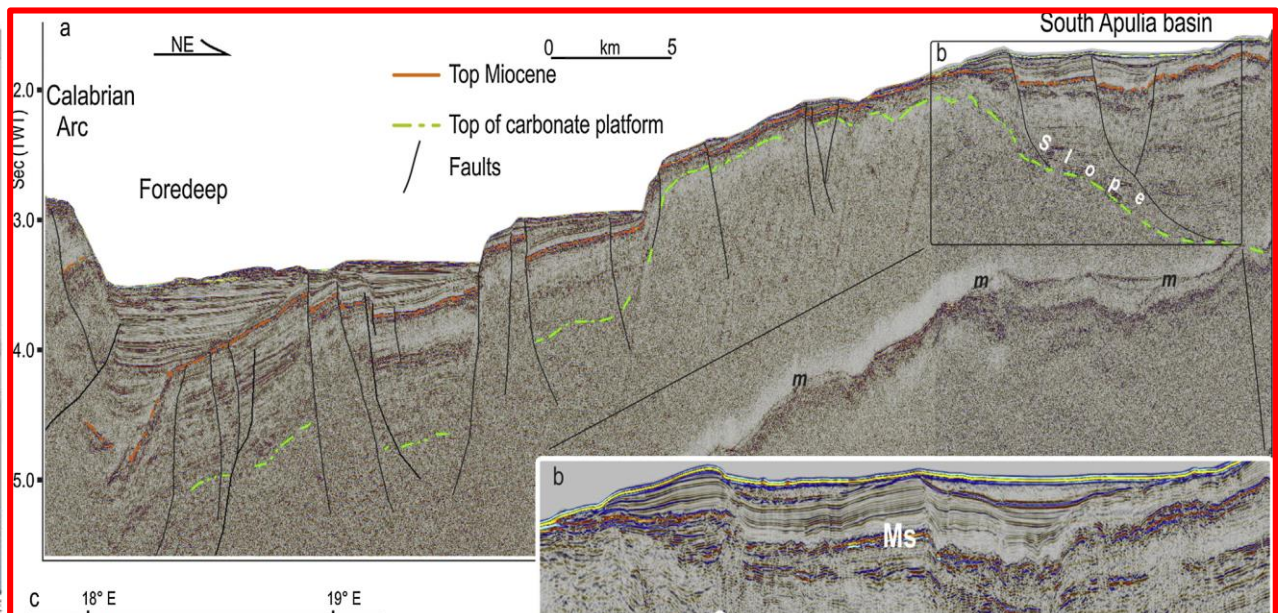
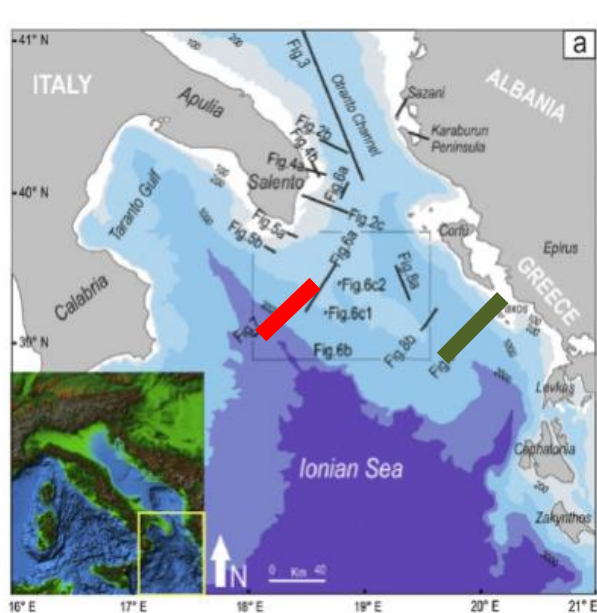


Fig. 15. Comparison of seismic sections from similar geologic environments plotted at equal horizontal and vertical scales (total width of sections is 14 km). (a) Synthetic seismic section across the platform-to-basin transition in the Montagna della Maiella (30 Hz). (b) Seismic section of the eastward continuation of the Maiella platform margin (Apulian platform) located ~40 km east of the Maiella where the margin plunges into the subsurface beneath the Adriatic Sea (Figure 3). The reflection pattern is characterized by a transparent platform overlapped by a wedge-like succession of high-amplitude reflections. (c) Part of the Western seismic line from Great Bahama Bank (Eberli and Ginsburg, 1989). The reflection pattern is similar to that above, confirming the differences in seismic facies of platform and slope.

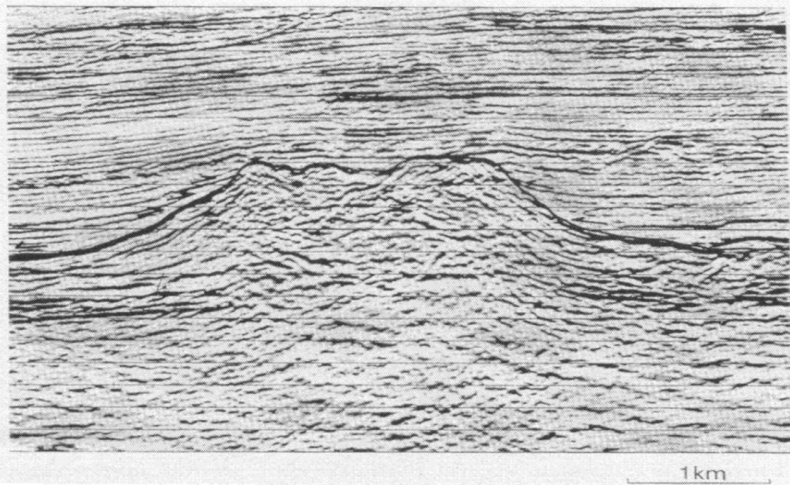
MARGINI DELLA PIATTAFORMA CARBONATICA APULA (CANALE D'OTRANTO)





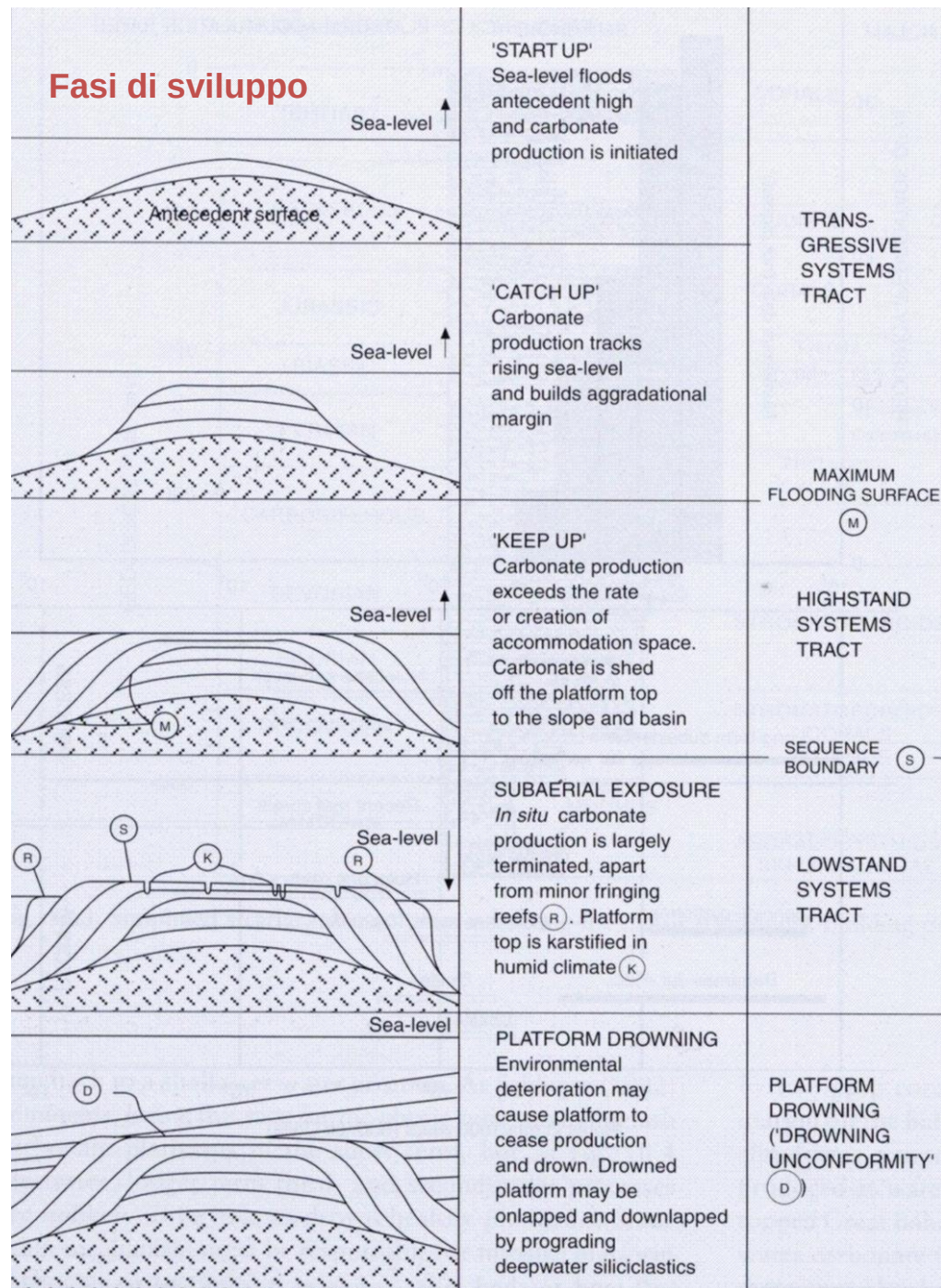
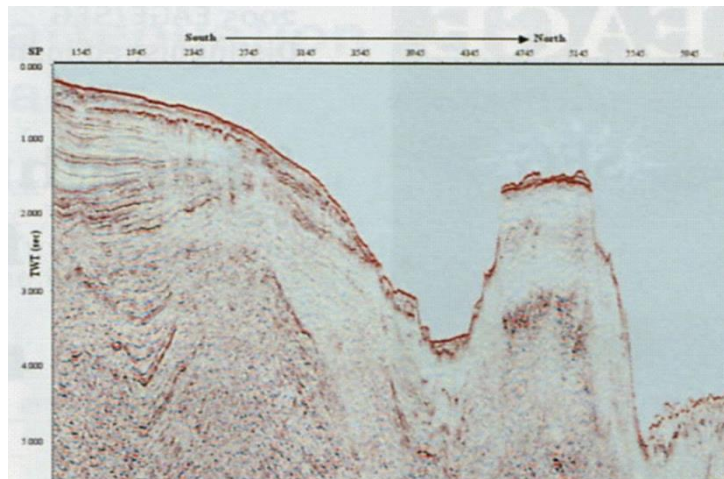
Ben Anna - Interpretazione Sismica – Marg. Piatt. Carbonatica

Piattaforma isolata



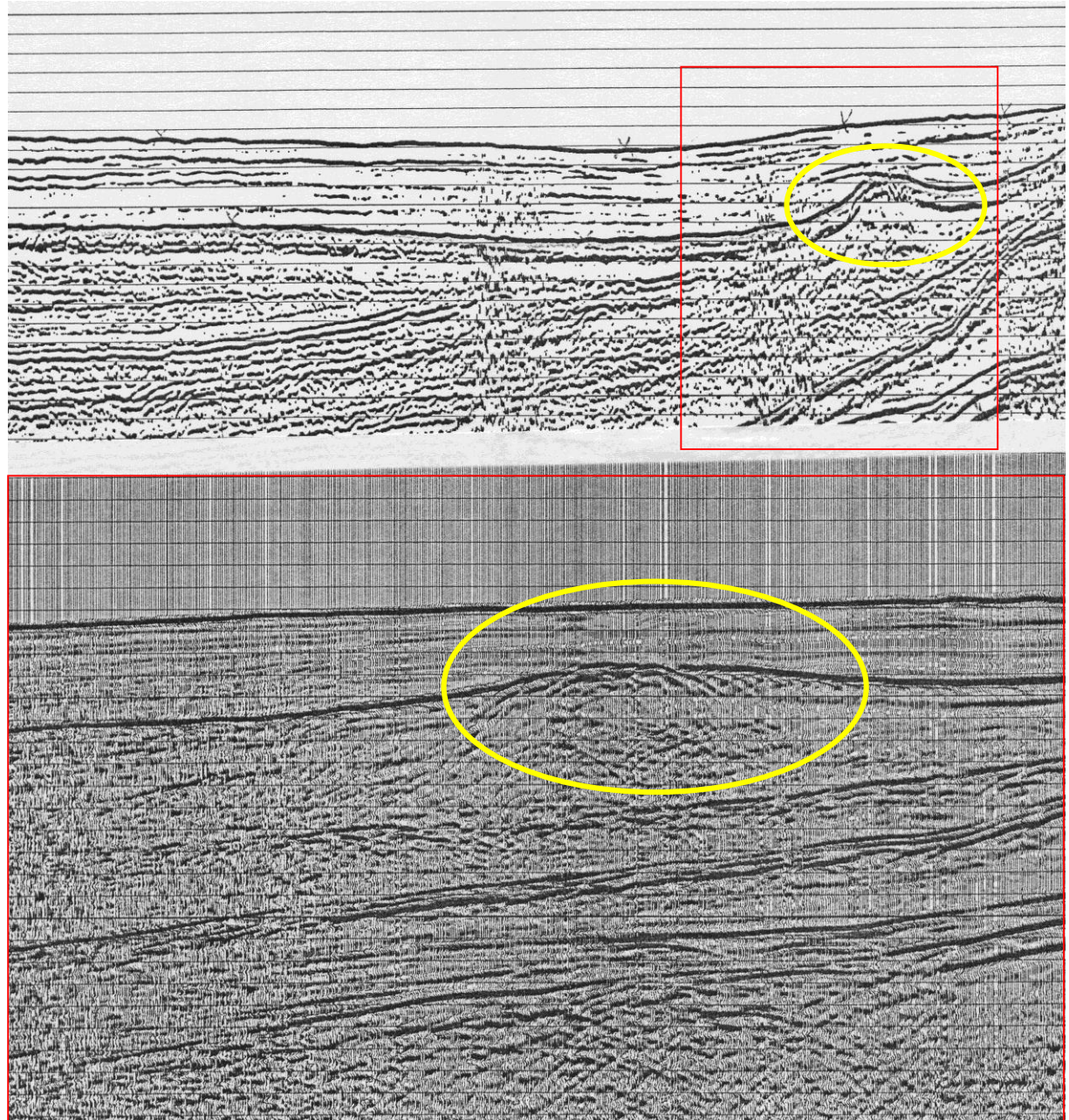
Esempio di profili sismici attraverso piattaforme isolate

offshore Libia

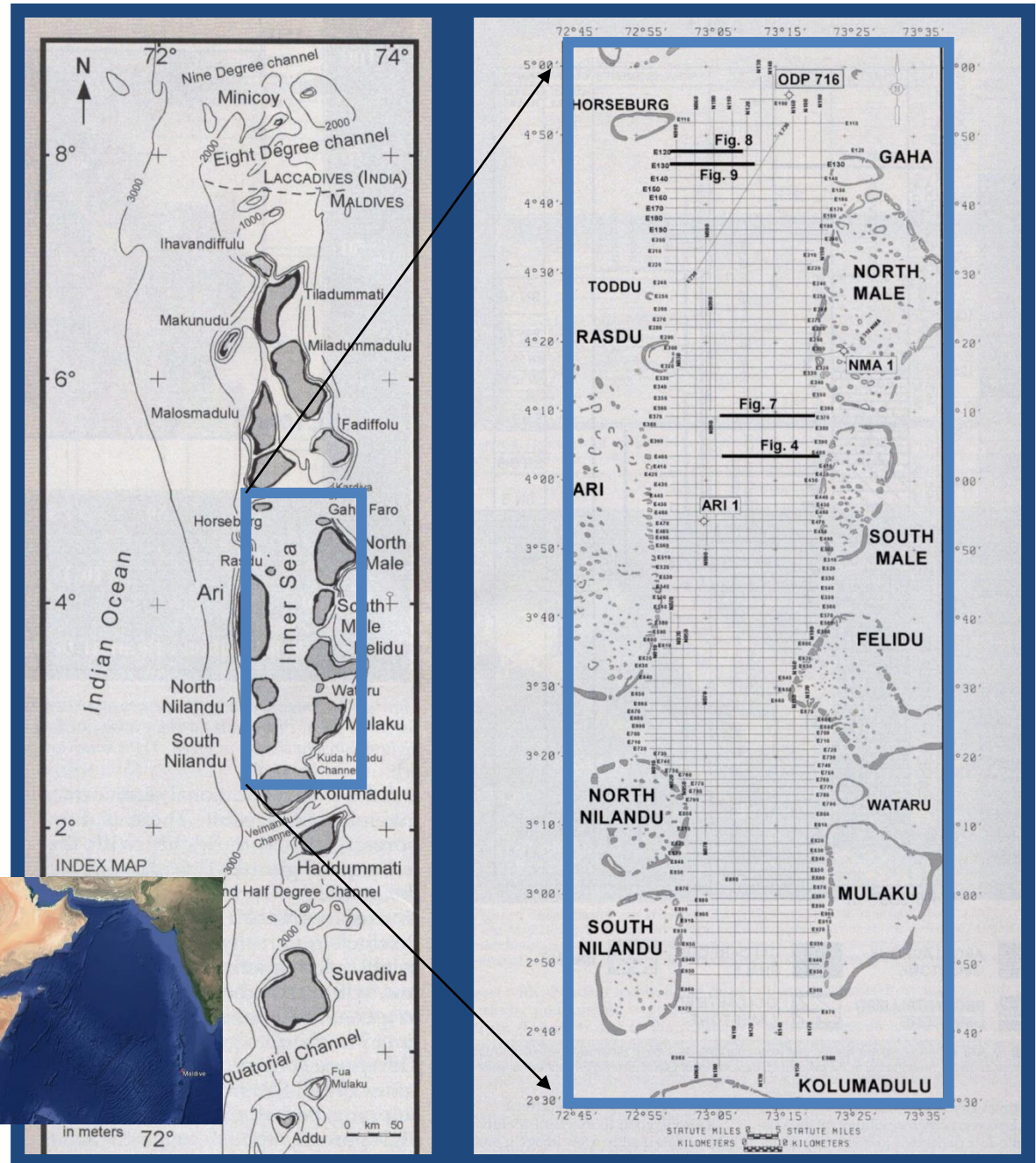
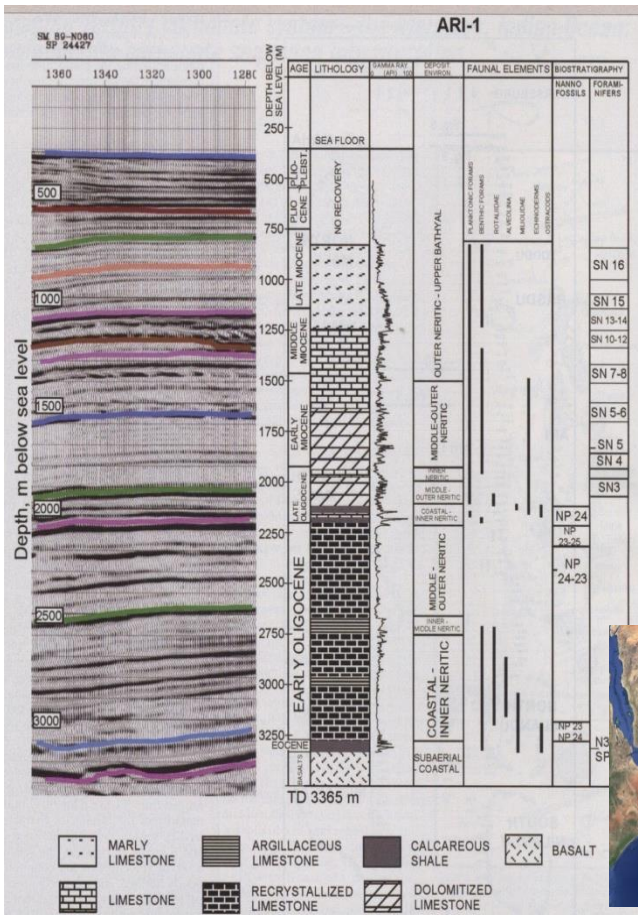


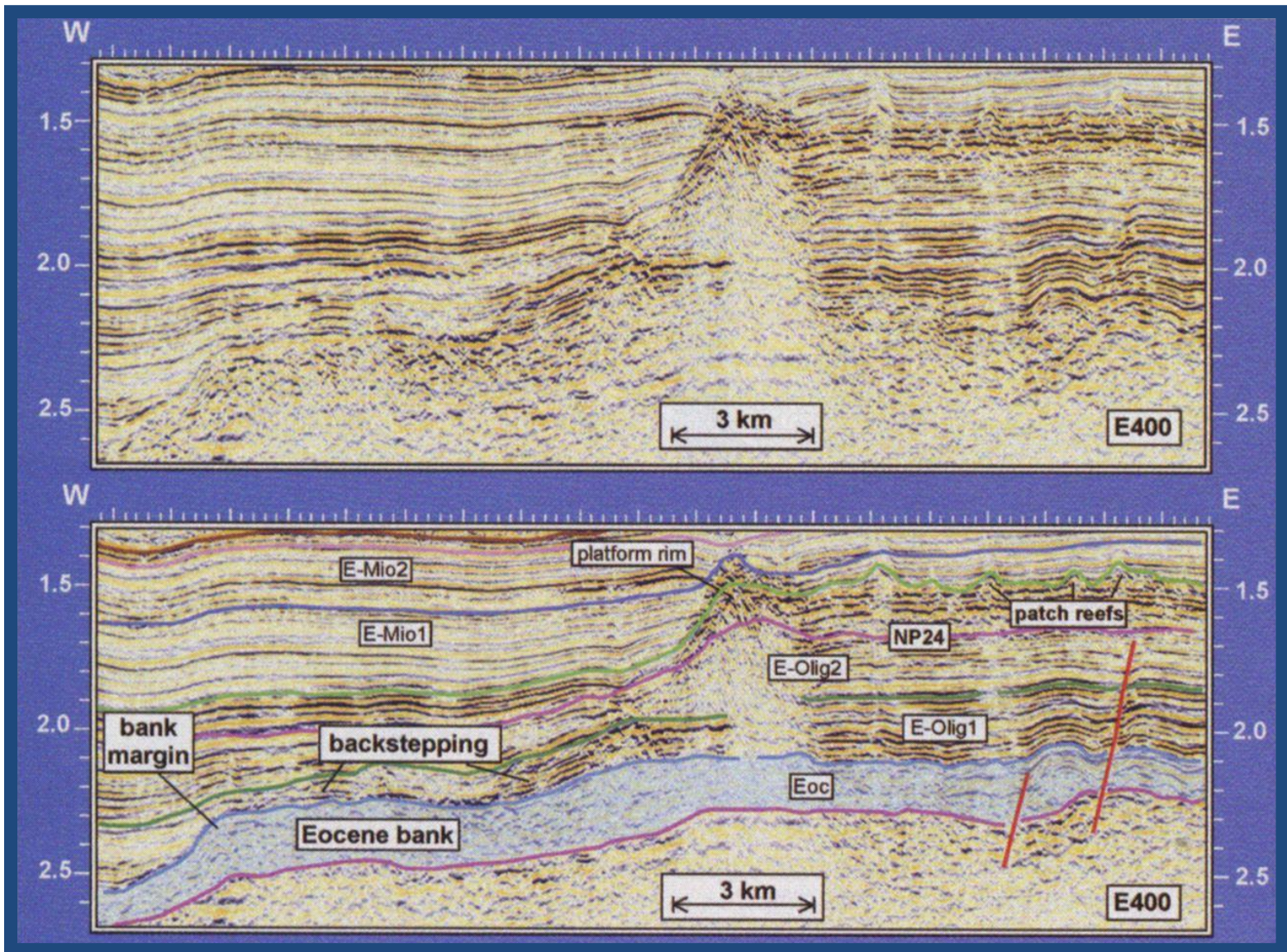
Esempio di
build-up isolato nel
Falkland Plateau,
margine Atlantico
meridionale:

l'immagine in basso
rappresenta
una parte dello
stesso profilo
sismico,
con diversa
esagerazione
verticale.



esempio di piattaforma carbonatica sviluppata dalla fine dell'Eocene all'Attuale





Profilo attraverso le Maldive

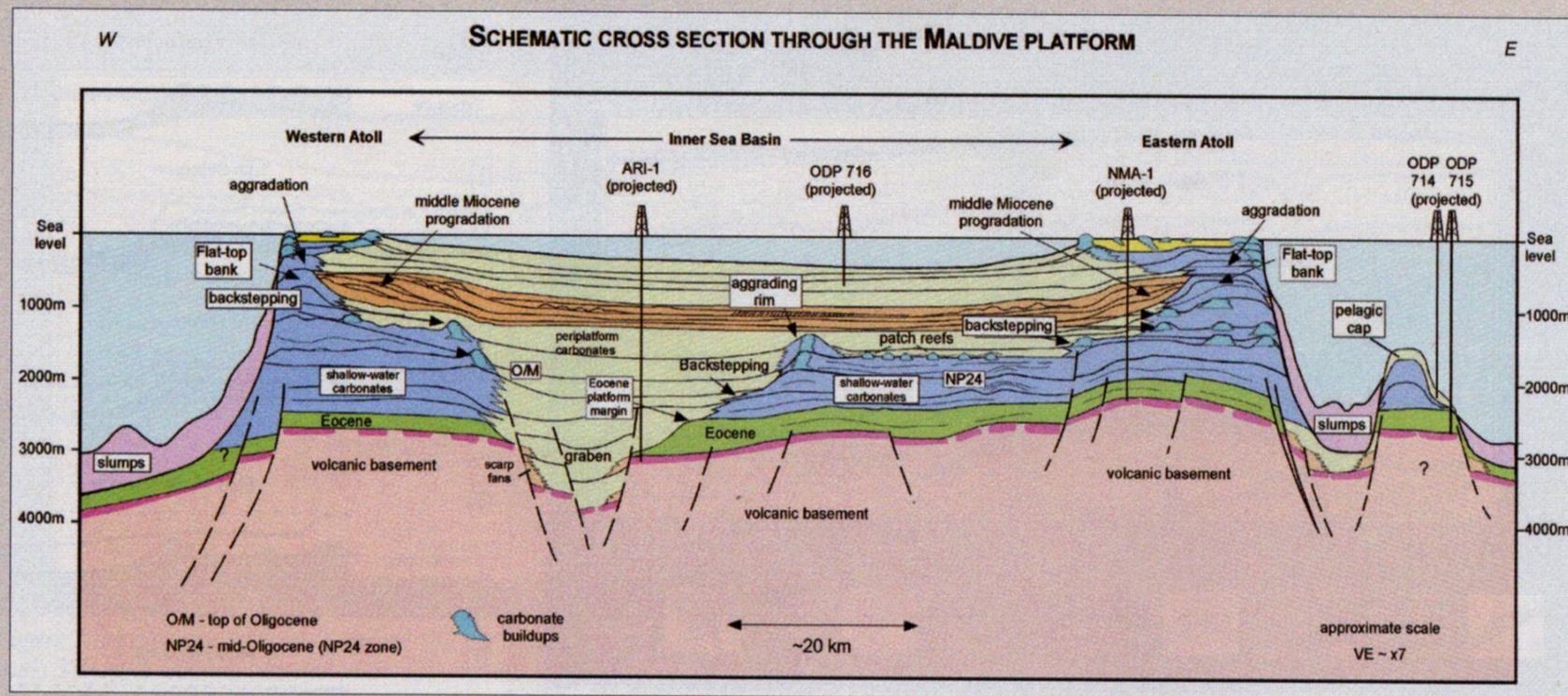


Figure 11. Schematic cross-section through the Maldives platform. Substantially modified from van Gils and Rubbens (1992).

I dati dimostrano come i margini della piattaforma carbonatica delle Maldive siano migrati nel tempo, con annegamento di settori diversi della piattaforma e talvolta con successivi episodi di ripresa dell'attività di bio-costruzione.