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Insights on the formation and evolution of Mediterranean basins

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PRELIMINARY STAGES FOR INTERPRETATION OF SEISMIC REFLEXION PROFILES COLLECTED OFFSHORE THE CORSICA ISLAND.

OBSERVATOIRE OCÉANOLOGIQUE DE VILLEFRANCHE SUR MER
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PRELIMINARY STAGES FOR SEISMIC REFLEXION PROFILE INTERPRETATION

Introduction
What is a reflector ?

1- Scales

- horizontal axis
  . average velocity of the Vessel
  . distance
- vertical axis : two way travel time
  . penetration
  . vertical exaggeration (bottom)

2- Major Characteristic

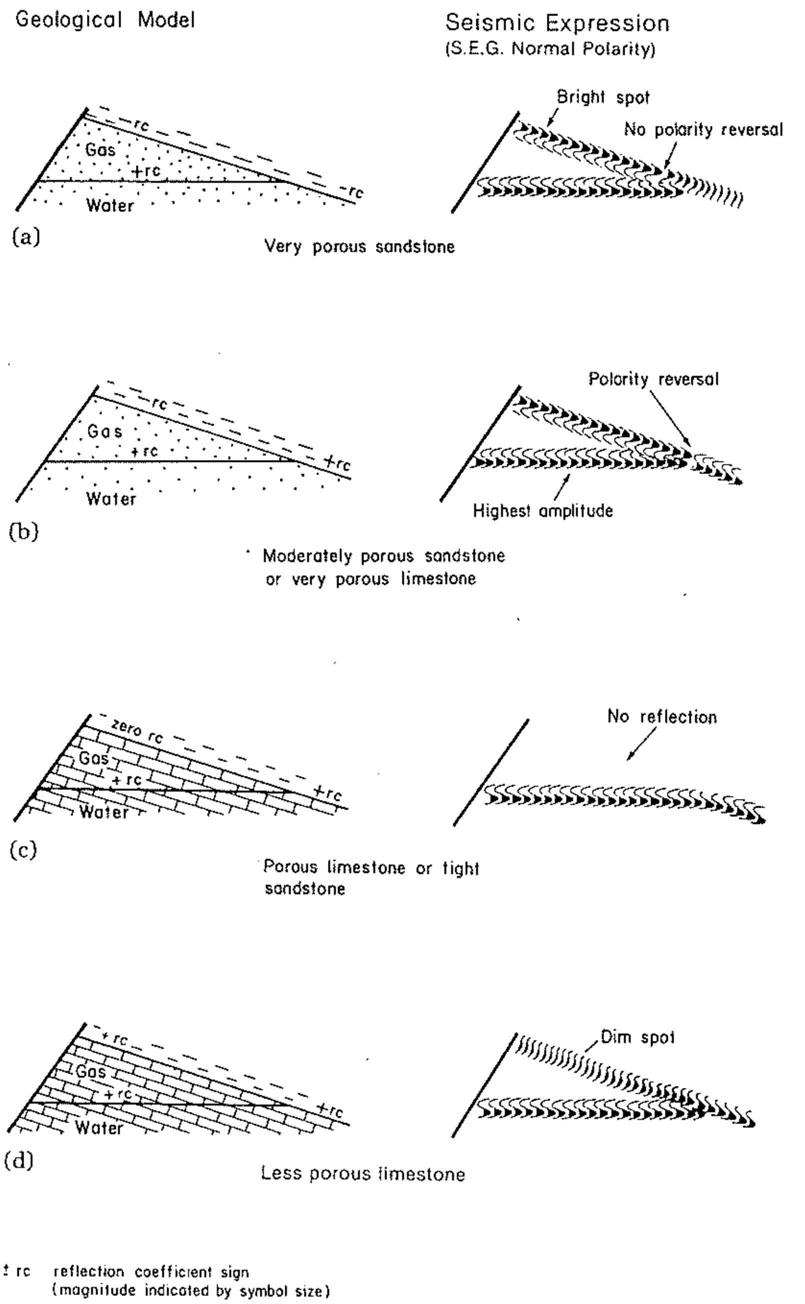
- direct wave
  source
  gun-streamer distance
- shot frequency
- recording lengh
- bandpass
- resolution
- penetration
- noise

3- Artifacts

- multiples
- bubble effect
- hyperbolas
- pull-up, pull-down effects

4- Seismic interpretation procedure

. seismic facies unit
- types of reflection characteristics (configuration, continuity, dominant frequency).
- simple reflection configuration
- configurations at unit boundaries (Onlaps, downlaps, toplap erosional surface).



Effect of different reservoir properties on the seismic response to the presence of gas. In the example, the reservoir is overlain by relatively low-acoustic-impedance shale. (a) Reservoir of porous sand with lower acoustic impedance than the shale. (b) Moderately porous sand with slightly greater acoustic impedance than the shale. (c) A porous limestone or low-porosity sandstone with greater acoustic impedance than the shale. (d) A less porous limestone with much higher acoustic impedance than the shale.

I) Caractéristiques pétrophysiques.

Les principales caractéristiques pétrophysiques de quelques roches sédimentaires sont résumées dans le tableau I, présentant des valeurs moyennes pour une porosité nulle. En raison de leurs plus fortes valeurs de densité et de vitesses en ondes P (les enregistrements sismiques classiques ne considèrent que les arrivées P) les carbonates vont générer des impédances acoustiques très élevées qui doivent les différencier sismiquement des dépôts argilo-gréseux, lorsqu'ils se trouvent intercalés dans une même série.

(Valeurs moyennes-$\emptyset$ = 0)

TYPE DE ROCHE	DENSITE (gm/cc)	VITESSES (m/s) Comp. P	Cisail. S	COEF. DE POISSON
ARGILES	2,3 à 2,6	2000 à 3000	—	—
GRES	2,65	5600	3500	0.185
CALCAIRES	2,73	6400	3350	0.311
DOLOMIES	2,84	7000	4000	0.265
ANHYDRITE	2,96	6100	3400	0.260

TABL. I. — Valeurs moyennes de quelques paramètres pétrophysiques des roches sédimentaires [d'après Gardner *et al.*, 1974 ; Domenico, 1983].

Il faut cependant prendre en compte que la porosité va être l'élément prépondérant pour le contrôle de la distribution des vitesses à l'intérieur d'un même ensemble carbonaté. Ainsi par exemple les roches dolomitiques, qui devraient avoir des vitesses supérieures aux calcaires (tabl. I), ont souvent des vitesses inférieures par le fait du développement d'une porosité inter-cristalline. Il est également intéressant de noter que, en milieu carbonaté, la nature et la qualité du fluide remplissant les pores n'a qu'un effet négligeable sur les vitesses.

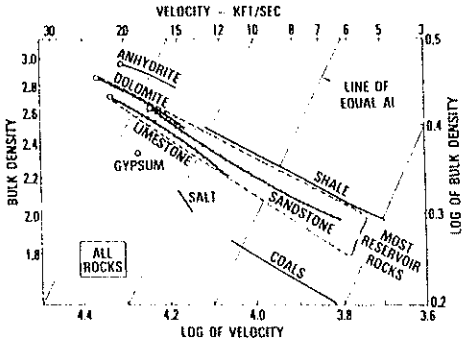


FIGURE 4.3 *Acoustic-impedance graph. Reprinted by permission of the SEG from Gardner et al., 1974.*

LITHOLOGICAL CHANGE AND REFLECTIONS

Excepting reflectors from fluid contacts, practically all other primary reflections originate from acoustic-impedance boundaries caused by lithological change. The significance of lithological change is thus a key to understanding the relationship between geology and seismic sections. In a bedded sequence, lithological change usually occurs at bed boundaries. Bedding planes arise through a multitude of causes; a change in depositional conditions, lithification, variation in sediment supply, seasonal variations, etc. Bedding planes invariably signify a break in deposition. Bedding planes define the external shape of beds. Beds come in a great variety of sizes and shapes, reflecting, to a large extent, the lithology forming the beds, depositional process, and depositional environment.

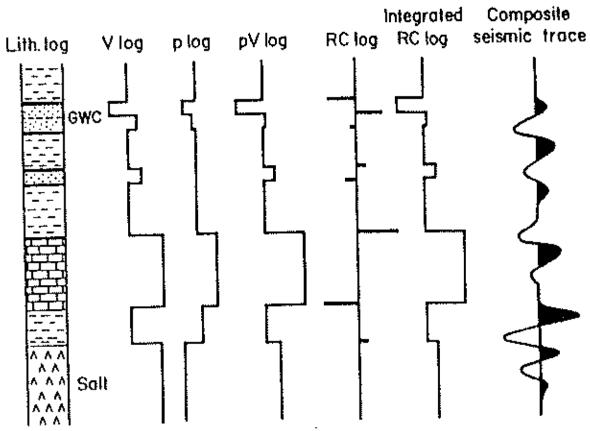
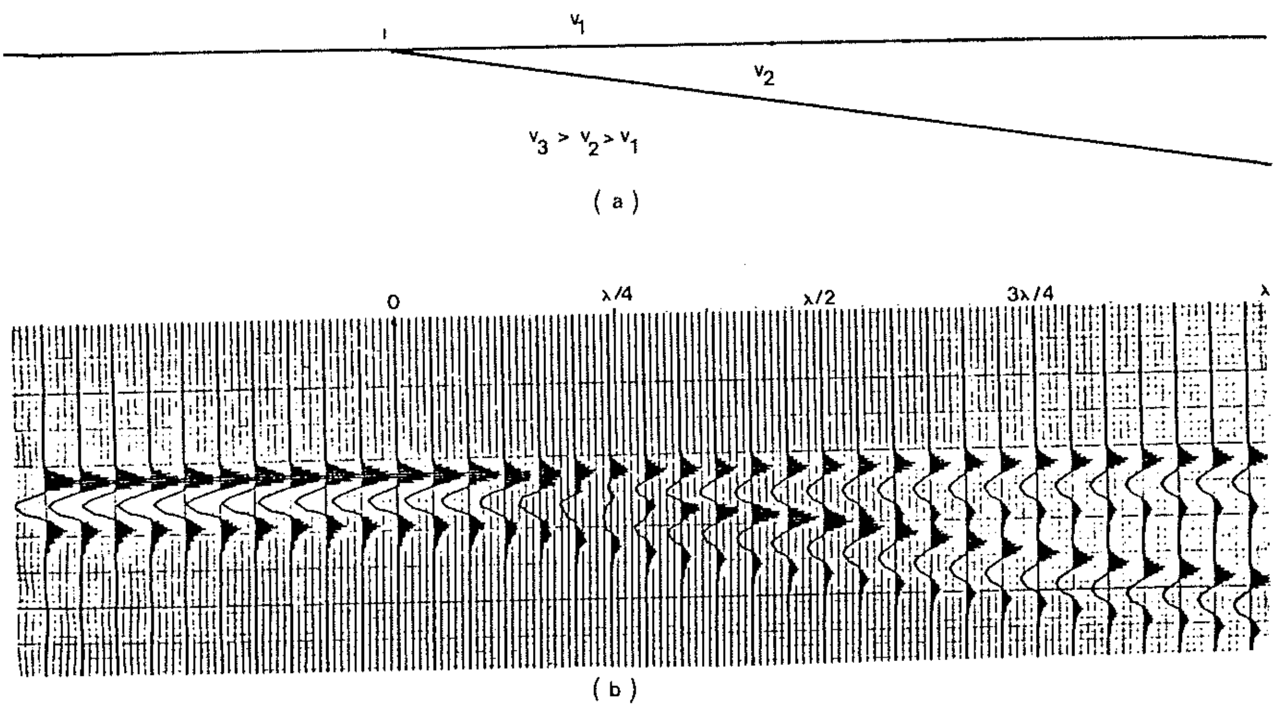
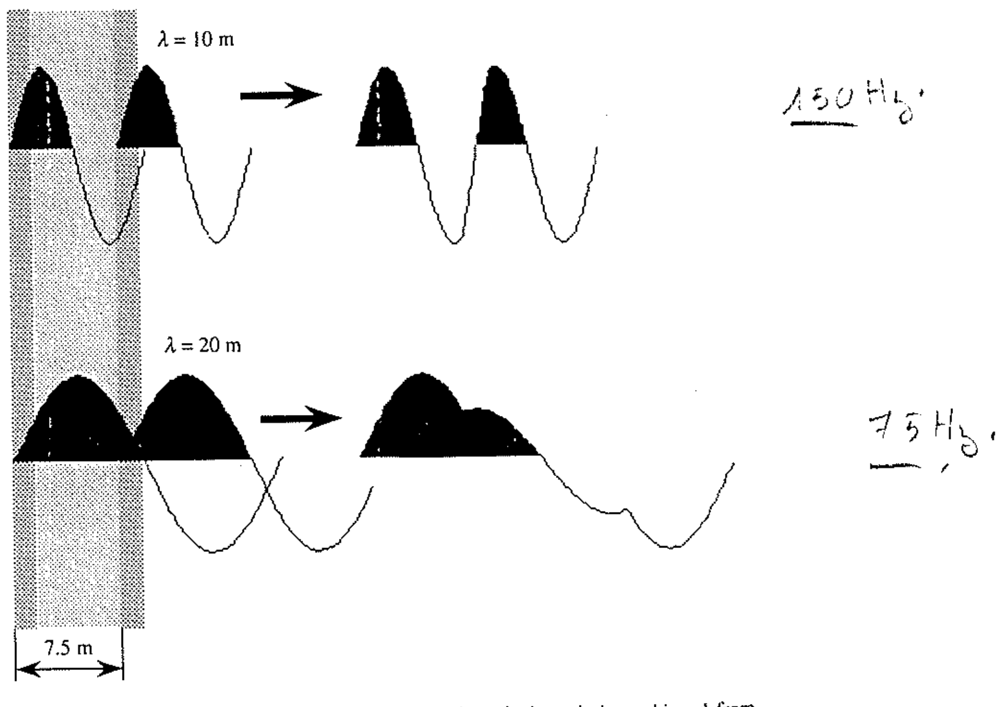


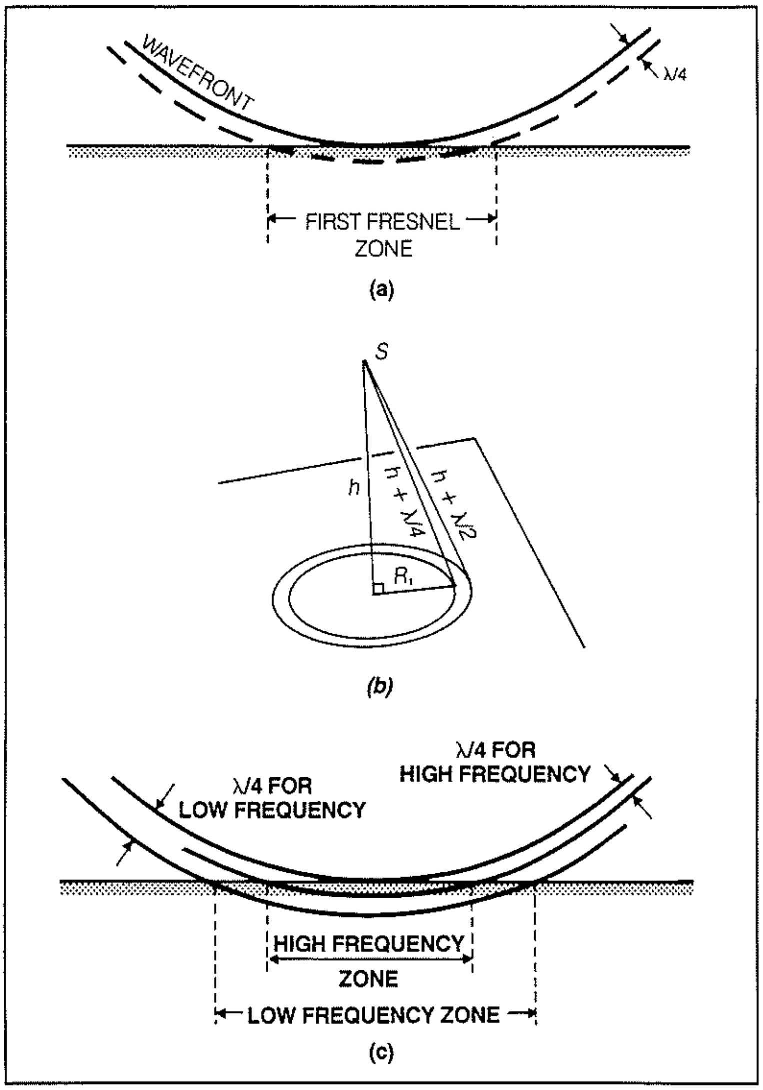
FIGURE 2.7 *The derivation of the reflection coefficient log and the resulting composite trace for a minimum-phase, normal-polarity (SEG) wavelet. The lithological sequence shown at the left consists of: a basal salt section overlain by a thick shale, massive limestone, and a shale sequence containing two sands. The lower sand is water saturated, while the upper sand contains gas overlying water-saturated sand. The velocity is shown under V log; with high velocity in the salt and limestone, a velocity in the water-wet sands slightly higher than in the shales, and a major depression of velocity in the gas sand. The density log is shown under ρ log. The salt density is very low, and the porosity in the lower sand causes the density to be coincident with that of the shales. The density in the gas sand is depressed. The acoustic-impedance log, shown under ρV log, is the product of velocity and density. For most lithologies it has similar form to the V log, excepting cases where velocity and density change in opposite directions. This occurs in the upper water sand, and is not significant; but in the salt the changes in velocity and density almost cancel. The reflection coefficients of the acoustic-impedance boundaries are shown under RC log, which shows the sign and expected strength of reflections. A composite seismic trace that would be produced by convolving a minimum-phase, normal-polarity (SEG) wavelet with the RC log is shown. The integrated RC log shows the effect of making a running sum of all values in a moving window down the RC log; this restores the ρV log. After Anstey, 1980a, and Robinson, 1983, by permission of IHRDC Press.*



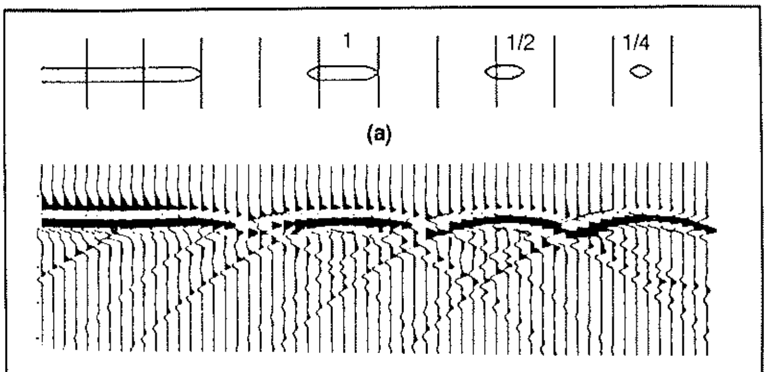
. Reflection from a wedge. The thickness of the wedge is indicated as a fraction of the dominant wavelength. (a) Model. (b) Resulting seismic section. (From Sheriff, 1975; reprinted by permission of The European Association of Exploration Geophysicists)



Diagrammatic explanation for increased vertical resolution achieved from higher-frequency (shorter-wavelength) pulse. The 10 m wavelength pulse delineates both reflectors, but the 20-m pulse effectively records only a single reflection event.



. Fresnel zone. (a) How to determine the diameter of the first Fresnel zone for coincident source and detector (such as common midpoint sections simulate). (b) Showing the second Fresnel zone (shaded annular ring). (c) Fresnel zone size depends on frequency (or wavelength). From Sheriff, 1980.



. Reflections from strips of various widths measured in Fresnel zone units (from Meckel and Nath, 1977).

... diffractions

from AAPG memoir 45

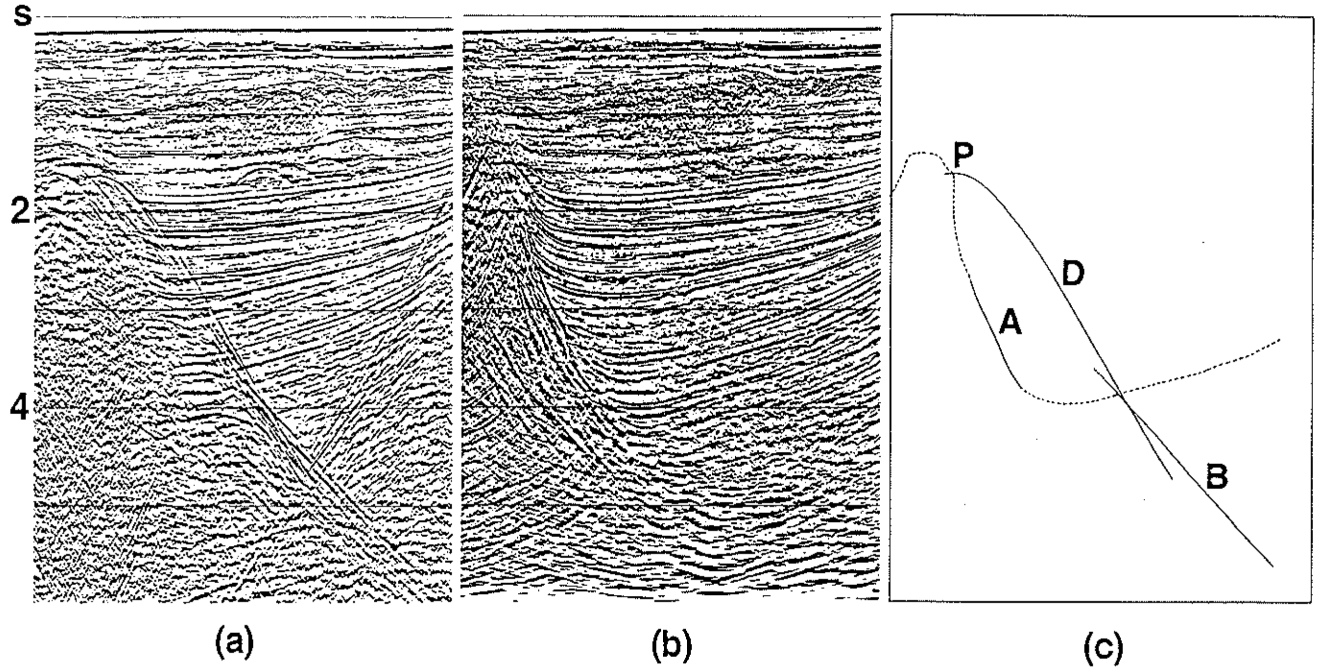


FIG. 4-1. (a) CMP stack, (b) migration, (c) sketch of a prominent diffraction D and a dipping event before (B) and after (A) migration. Migration moves the dipping event B to its assumed true subsurface position A and collapses the diffraction D to its apex P. The dotted line indicates the boundary of the salt dome.

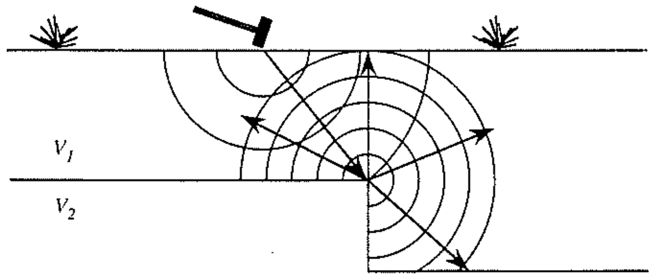
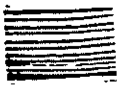
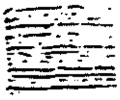
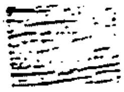
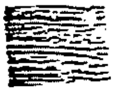
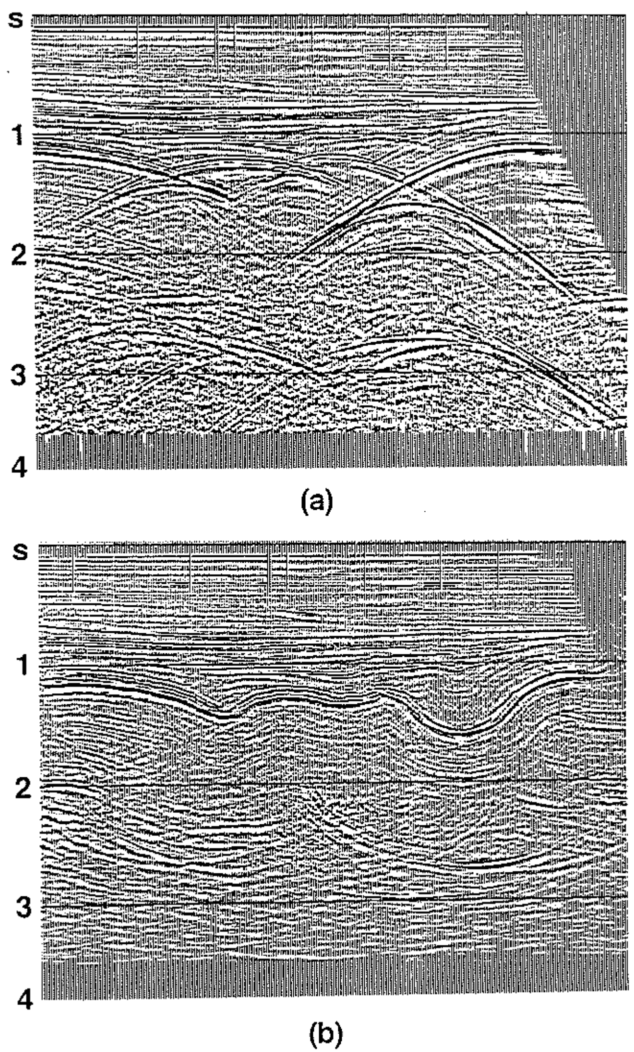
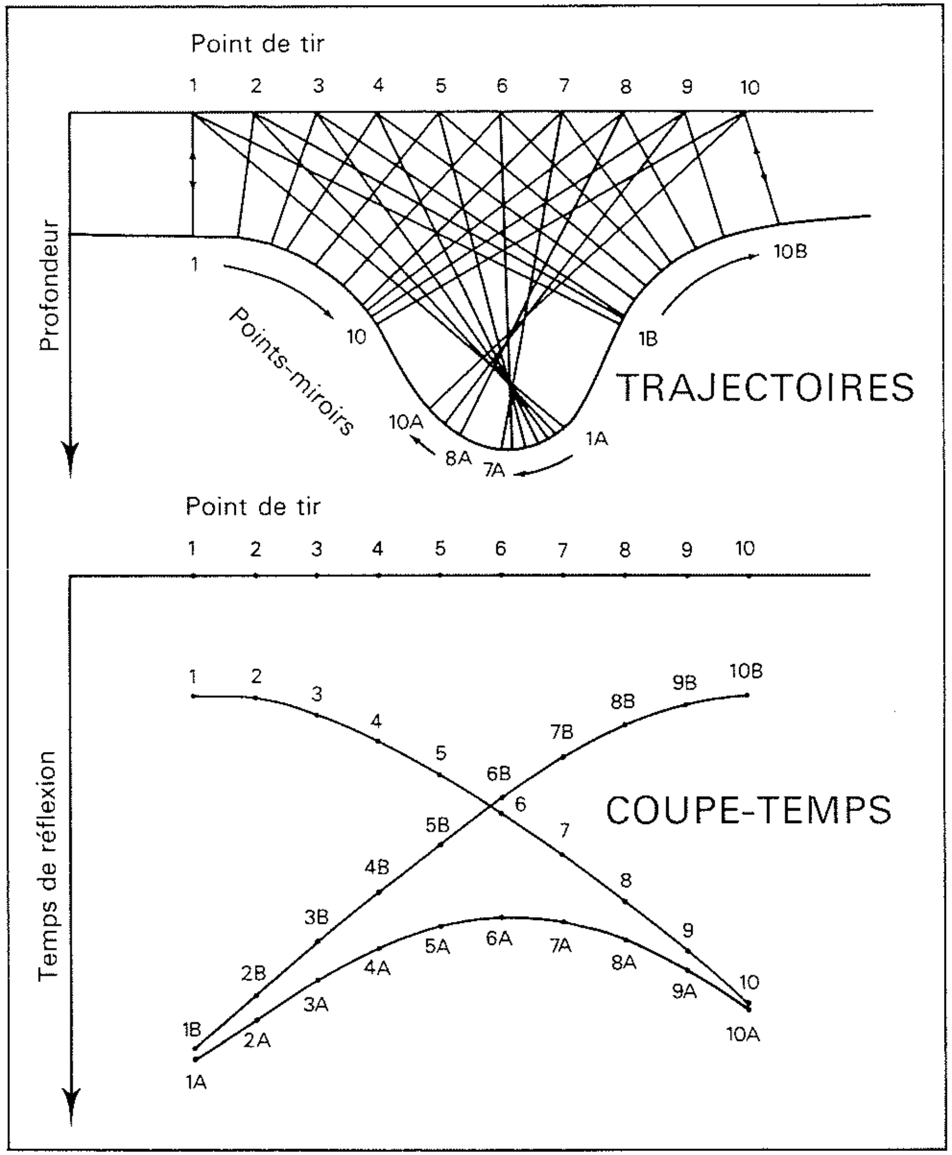


Figure 2-19 Diffracted waves are produced when wavefronts encounter a sudden change in curvature of an interface.

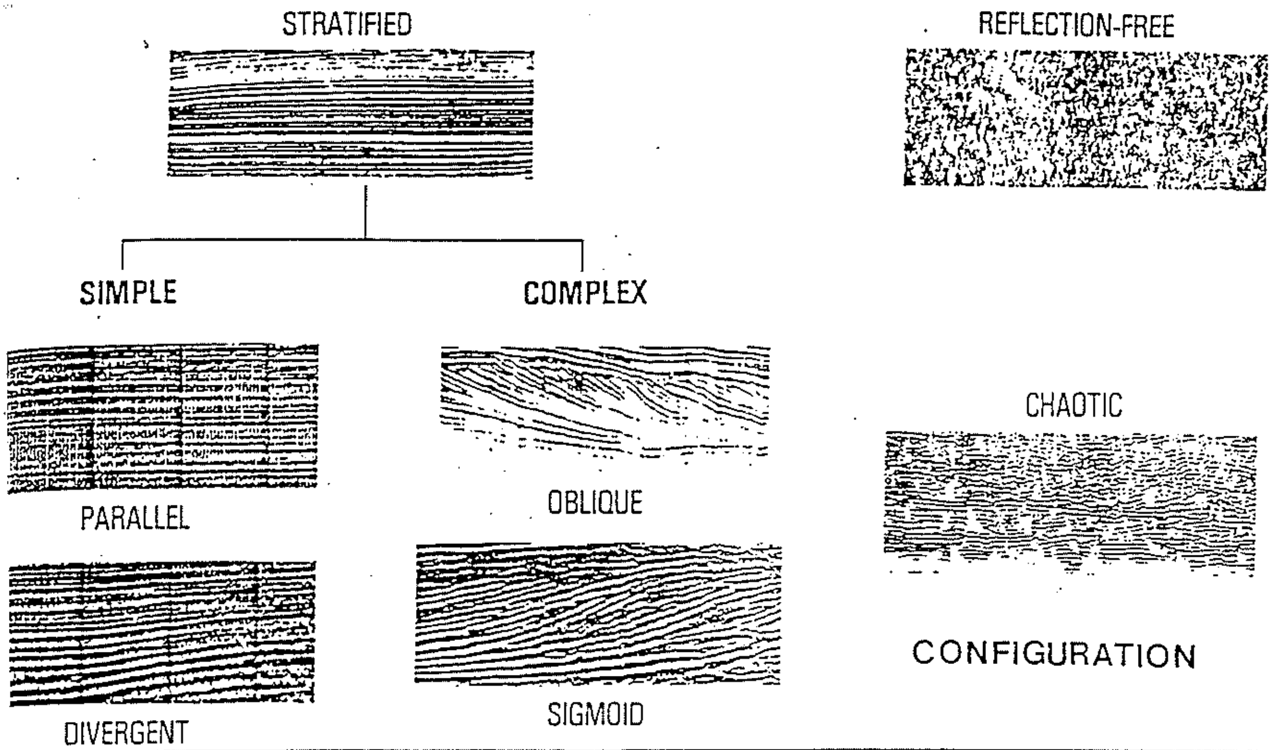
Continuité	Bonne		104 (P.T. 1900)
	Moyenne		110 (P.T. 380)
	Faible		115 (P.T. 750)
Amplitude	Forte		104 (P.T. 1900)
	Moyenne		106 (P.T. 500)
	Faible		106 (P.T. 450)
Fréquence	Haute		106 (P.T. 500)
	Moyenne		104 (P.T. 1840)
	Basse		104 (P.T. 1200)



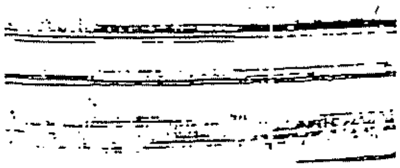
. . Migration (b) unties the bowties on the stacked section (a) and turns them into synclines. (Taner and Koehler, 1977; figure courtesy Seiscom-Delta, Inc.)

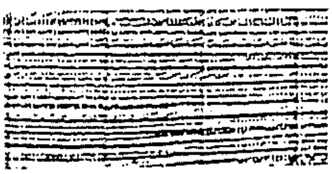


Réflexions en provenance d'un miroir concave ; le courbure ou miroir est plus forte que celle du front d'onde. Les rayons émanant de chacune des positions 1-10 de la source sont réfléchis jusqu'en trois points différents (tous à incidence normale) du miroir concave. La coupe-temps résultante montre une figure complexe de trois courbes-miroirs.

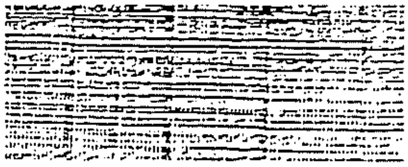


CONFIGURATION





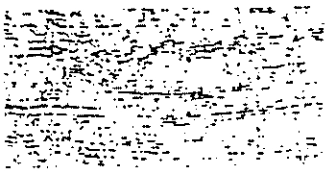
CONTINUOUS REFLECTION PATTERNS

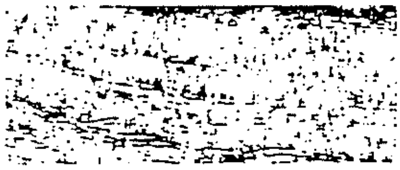


HIGH-FREQUENCY REFLECTIONS

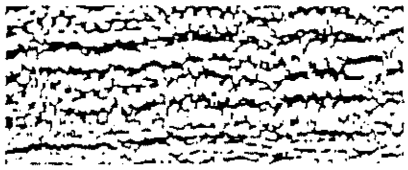
CONTINUITE

FREQUENCE



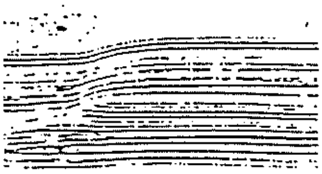


DISCONTINUOUS REFLECTION PATTERNS

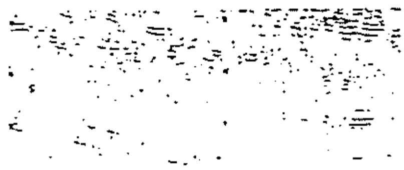


LOW-FREQUENCY REFLECTIONS

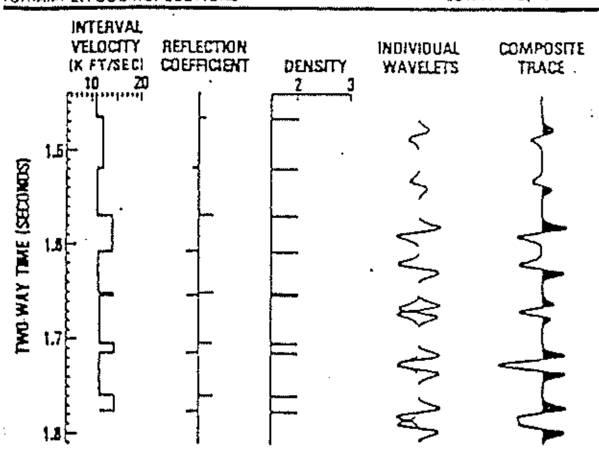
AMPLITUDE



HIGH-AMPLITUDE REFLECTIONS



LOW-AMPLITUDE REFLECTIONS



influence
EPAISSEUR

Geologic interpretation of seismic parameters.

Seismic facies parameters	Geologic interpretation
Reflection configuration	• Stratification patterns • Depositional processes • Erosion and paleotopography
Reflection continuity	• Bedding continuity • Depositional processes
Reflection amplitude	• Velocity-density contrast • Bed spacing • Fluid content
Reflection frequency	• Bed spacing • Fluid content
External form and areal association	• Gross depositional environment • Sediment source • Geologic setting

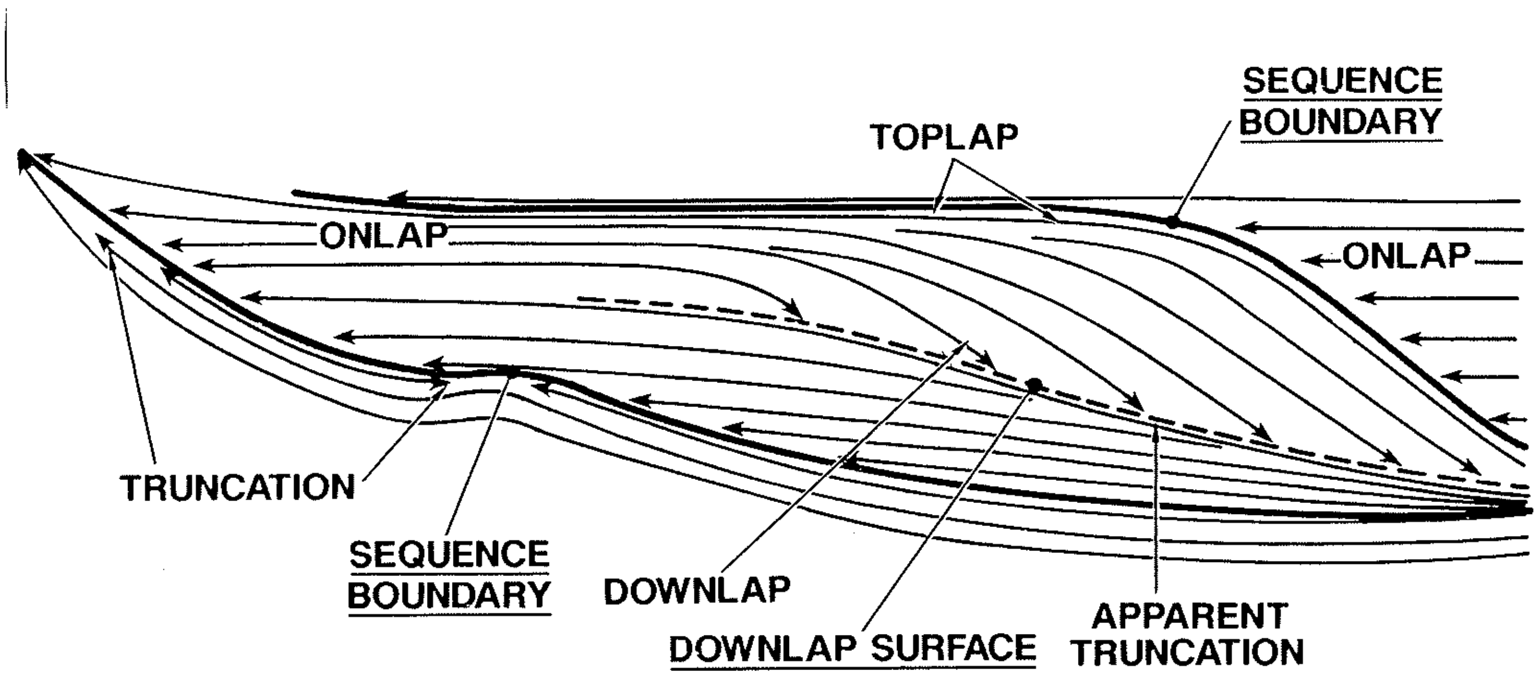
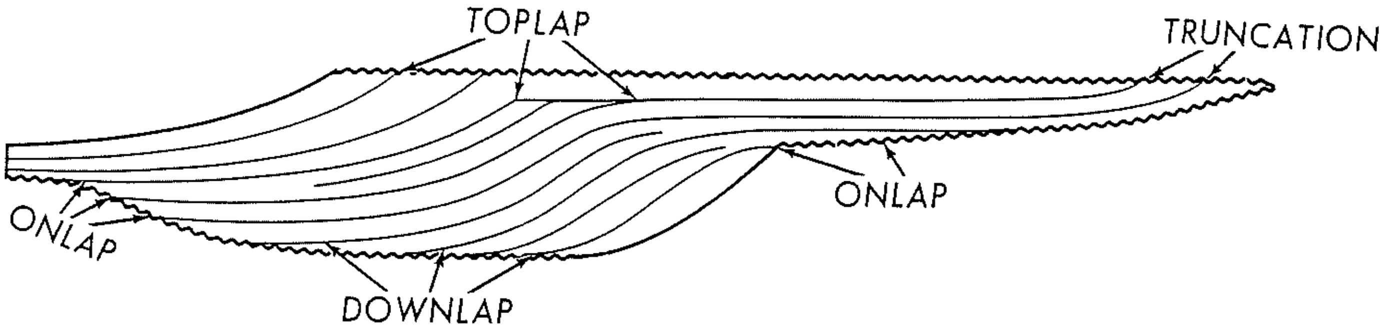
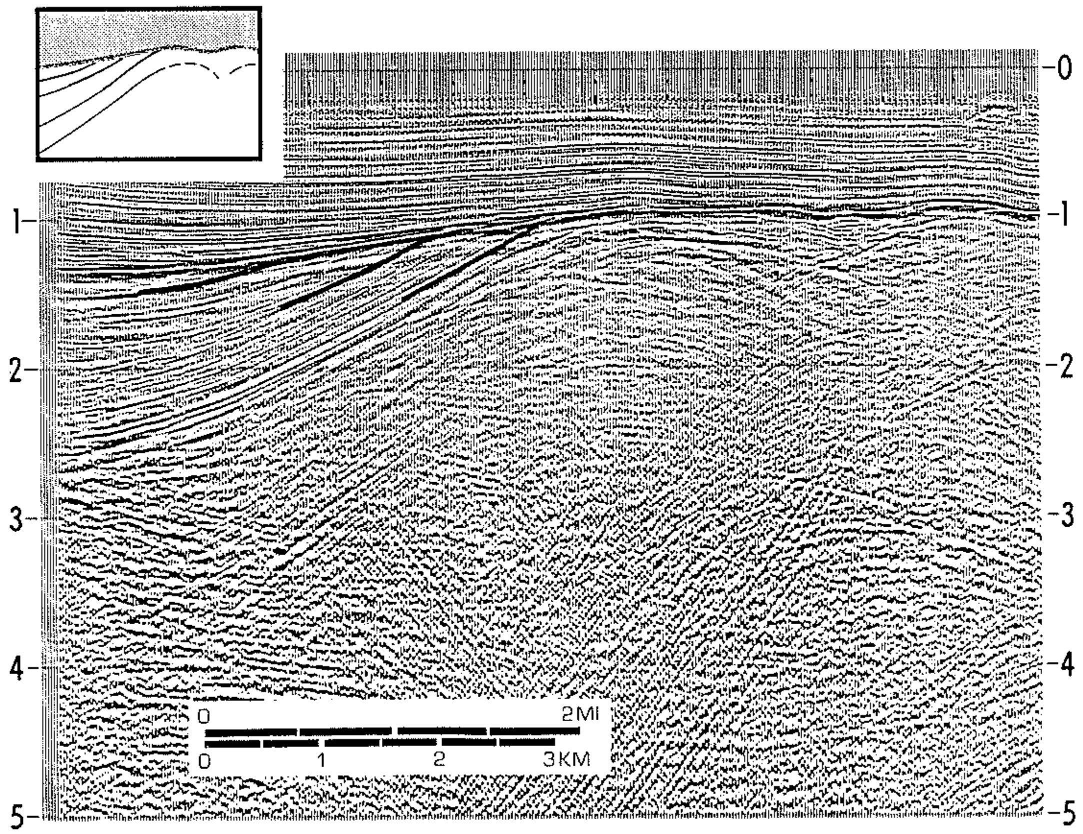


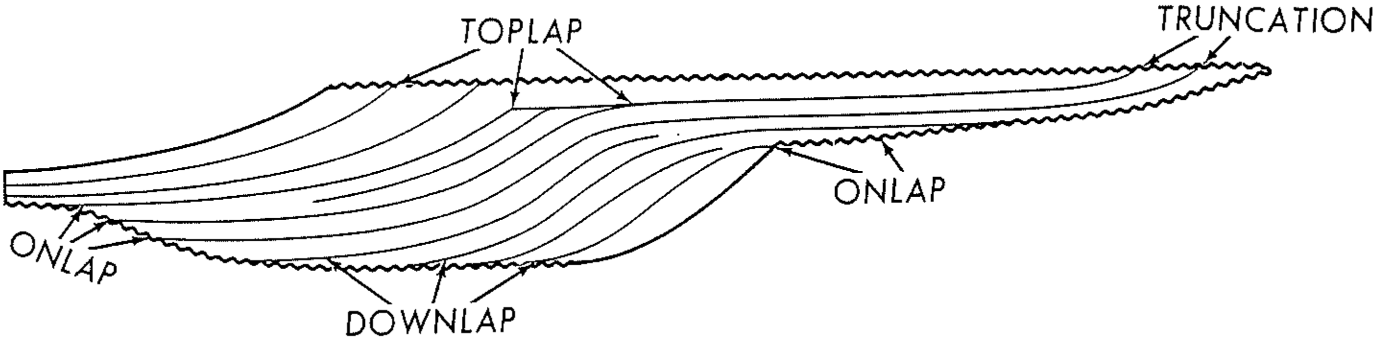
Diagram showing reflection termination patterns and types of discontinuities.
Discontinuity names are underlined.



Erosional Truncation

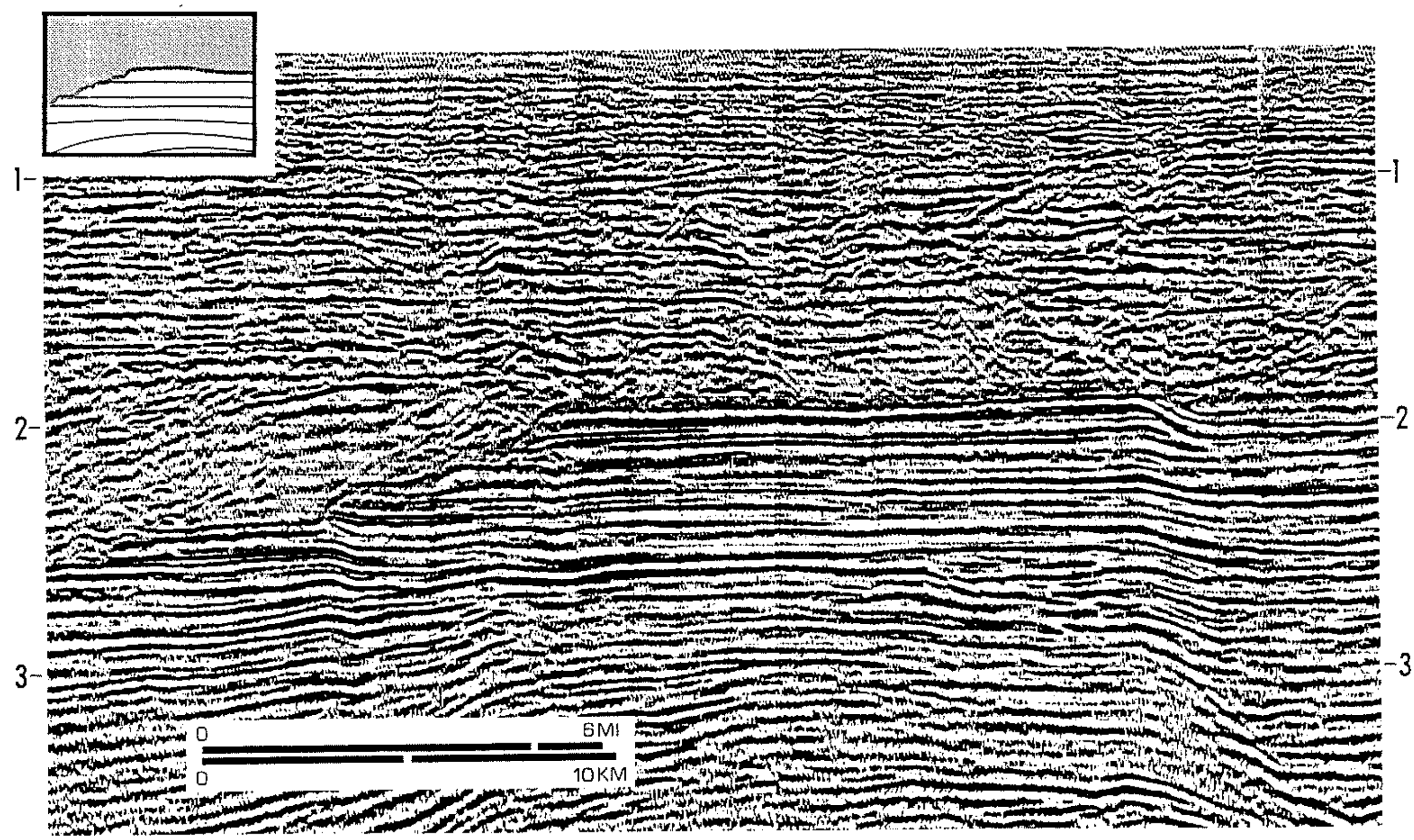


Erosional truncation implies the deposition of strata and their subsequent tilting and removal along an unconformity surface. It is the most reliable top-discordant criterion of a sequence boundary.

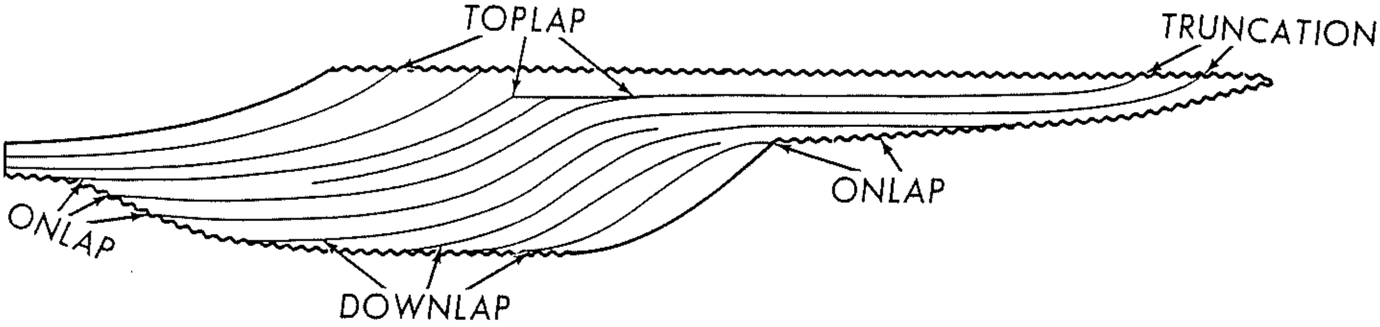


Upper Boundary

Down Cutting Erosional Truncation

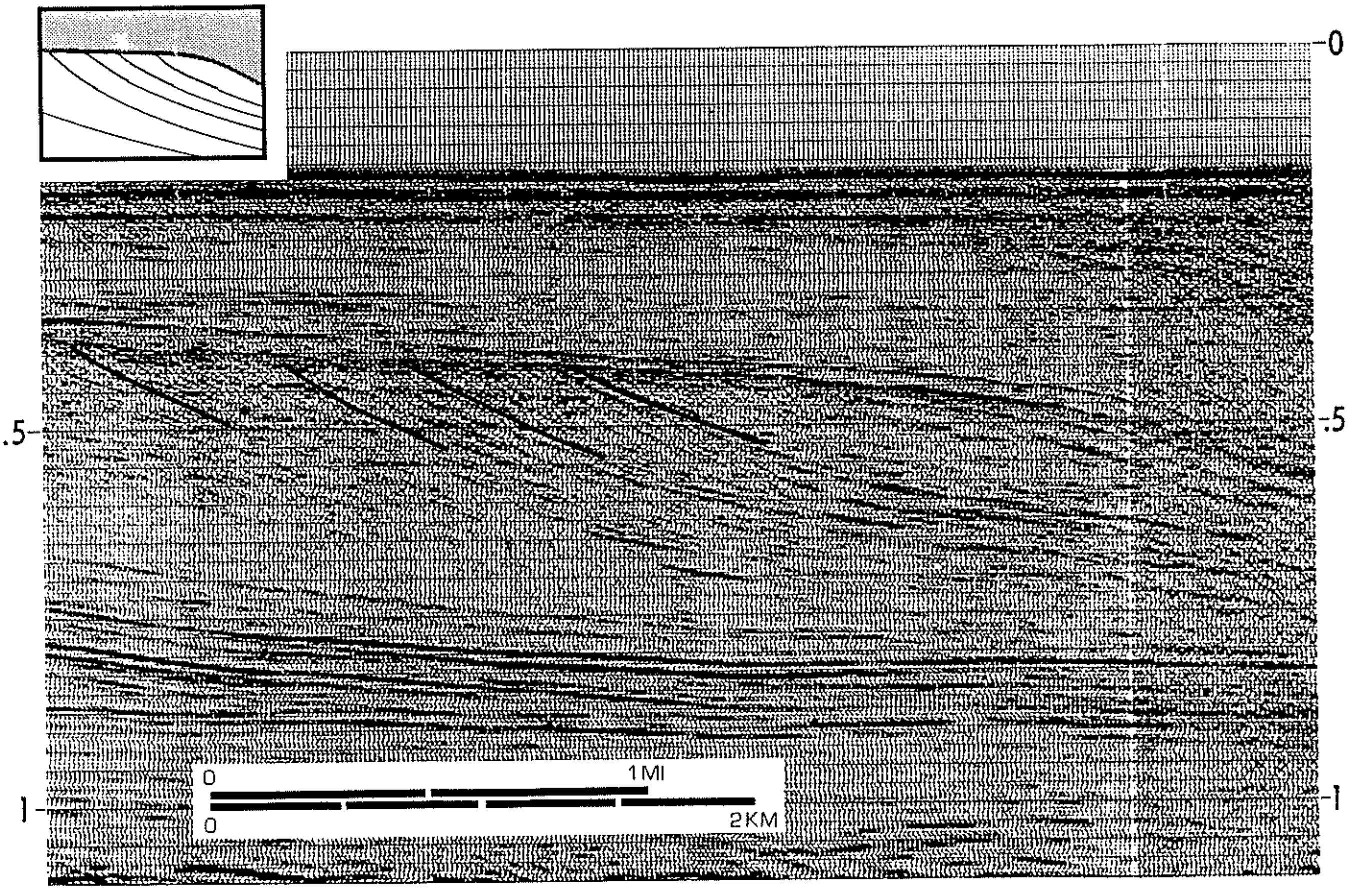


Down-cutting erosional truncation is where horizontal strata terminate against an erosional surface—in this instance against a channel or gorge.

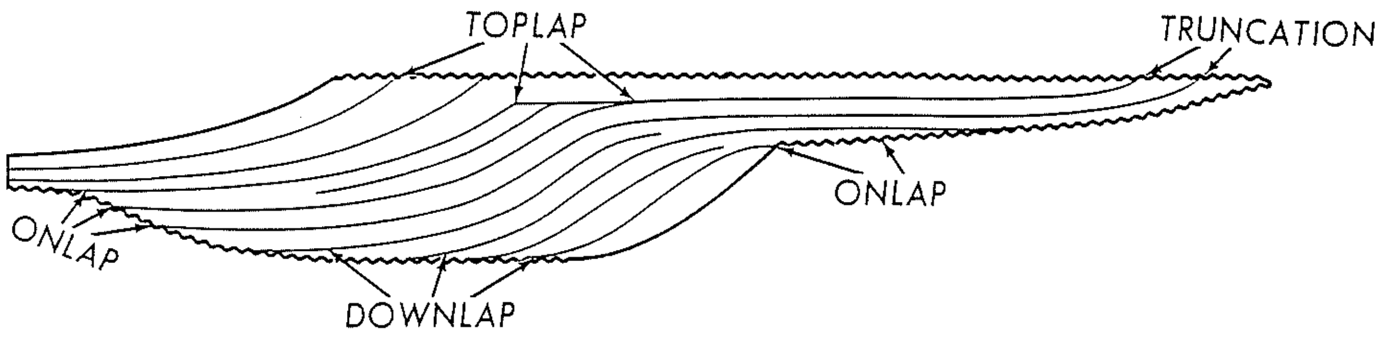


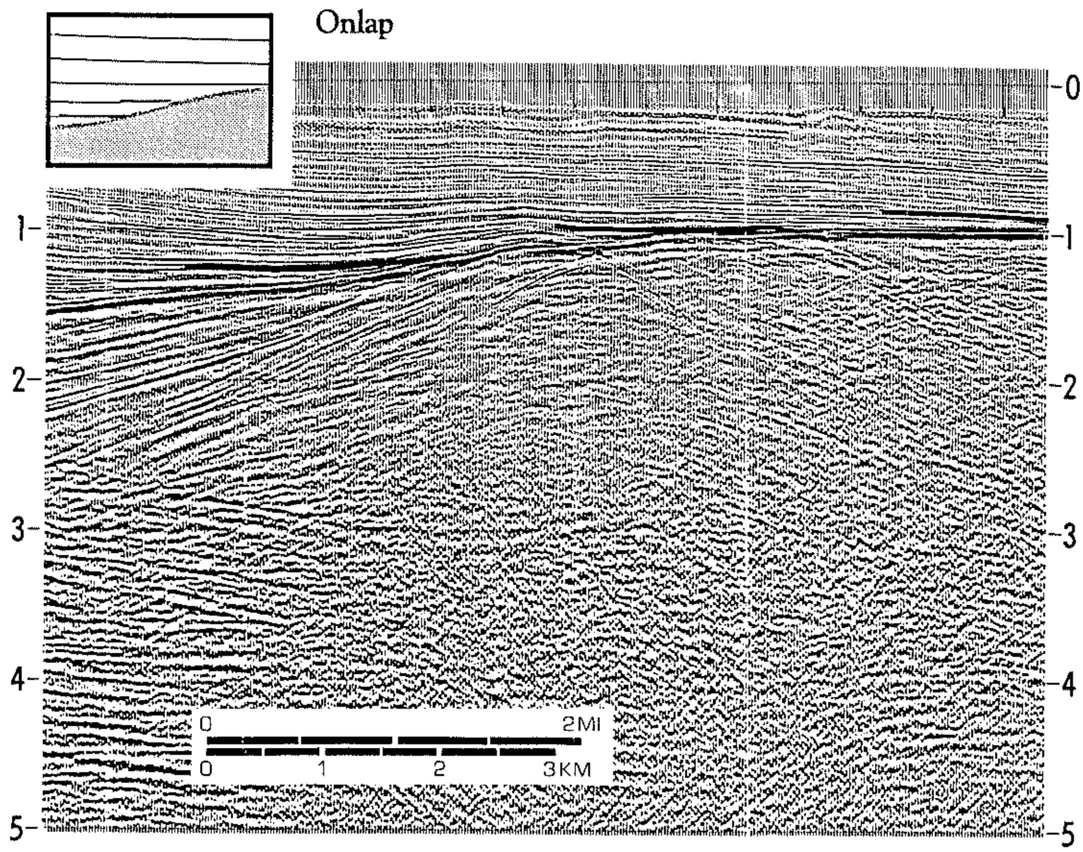
Trans-basin schematic dip section, illustrating nomenclature for the relationships of reflections (strata) to sequence boundaries.

Toplap

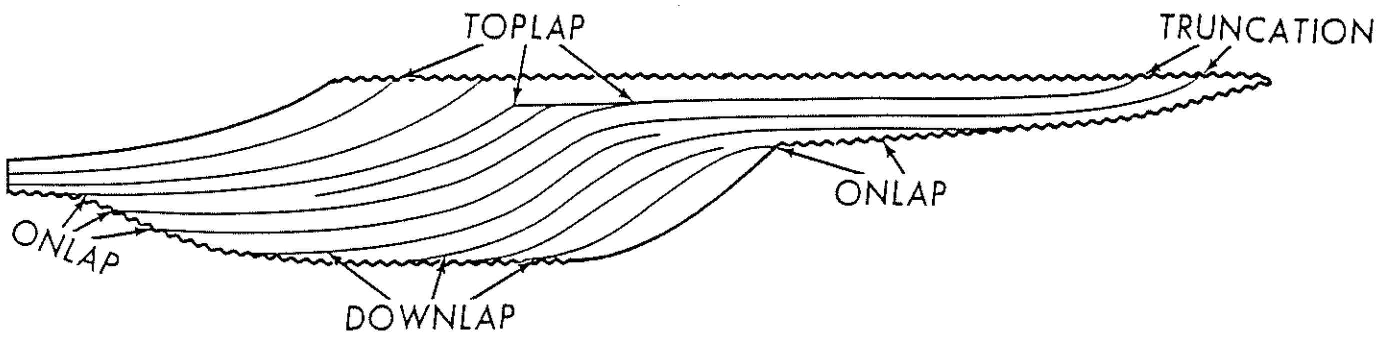


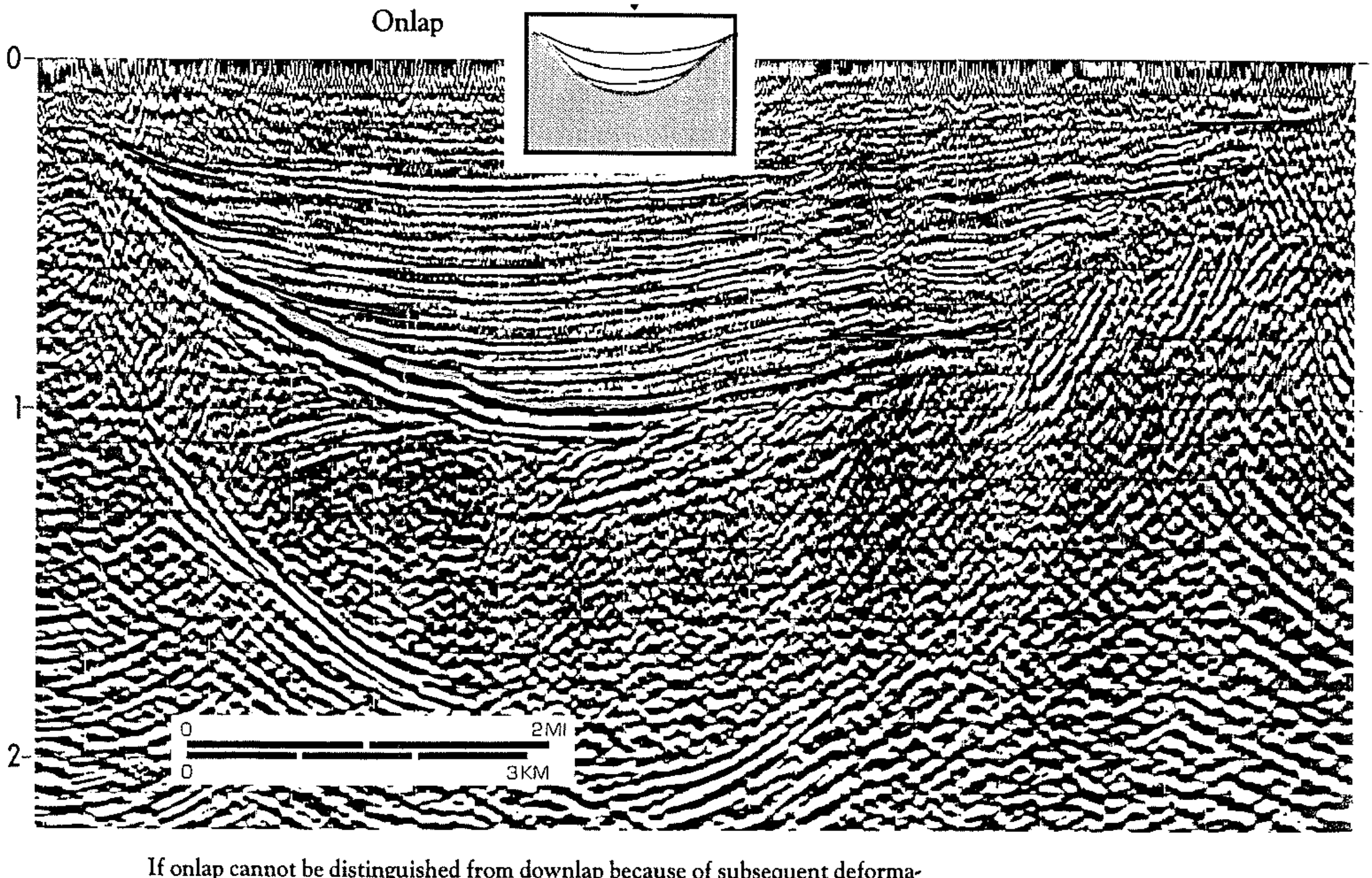
Toplap is the termination of reflections interpreted as strata against an overlying surface as a result of nondeposition (sedimentary bypassing) and only minor erosion.



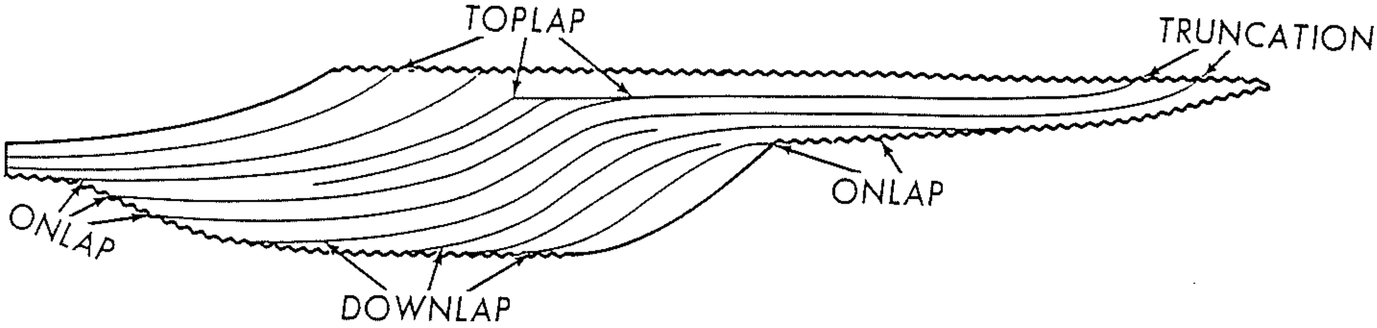


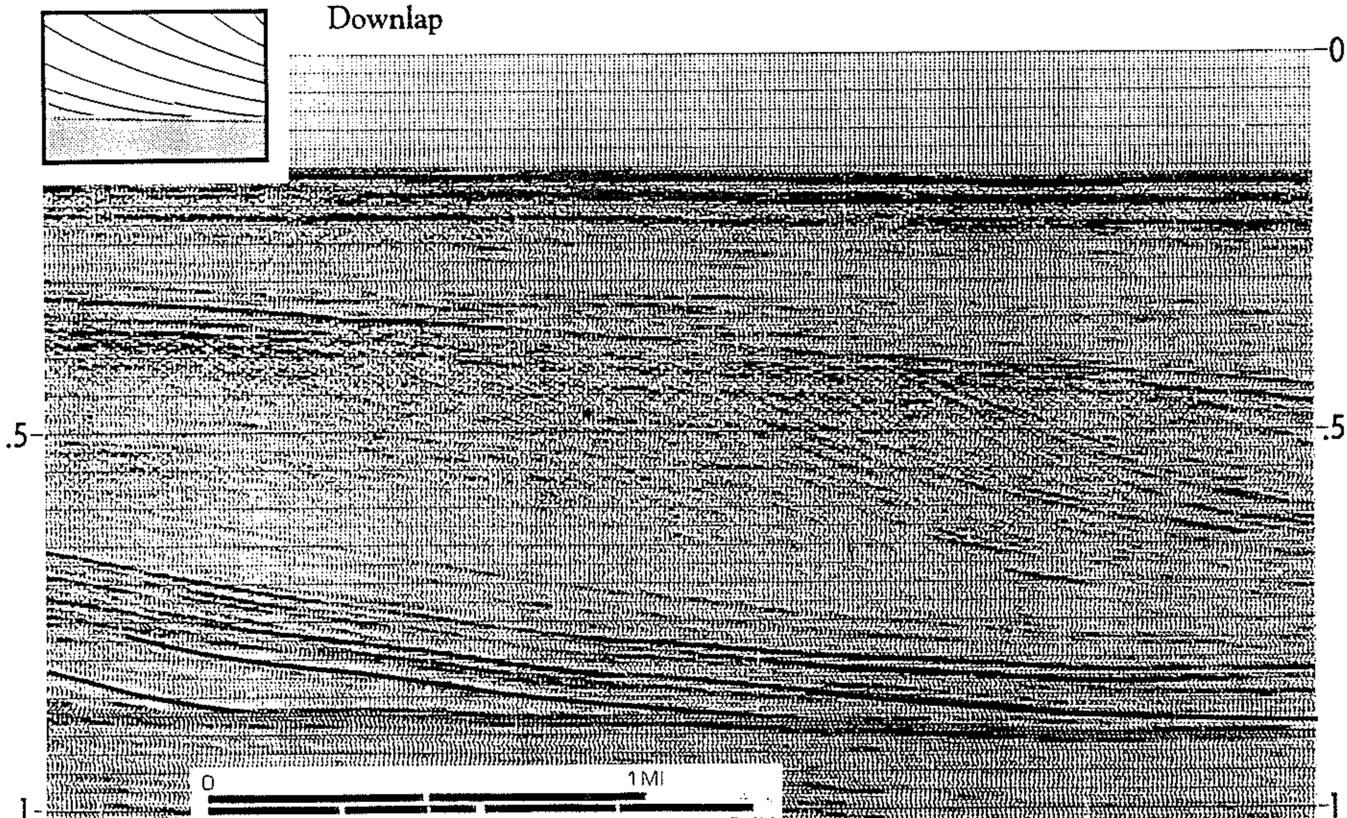
Onlap is a base-discordant relation in which initially horizontal strata terminate progressively against an initially inclined surface (Figure 8) or in which initially inclined strata terminate progressively updip against a surface of greater initial inclination (Figure 9).





If onlap cannot be distinguished from downlap because of subsequent deformation, the more inclusive term baselap may be necessary.

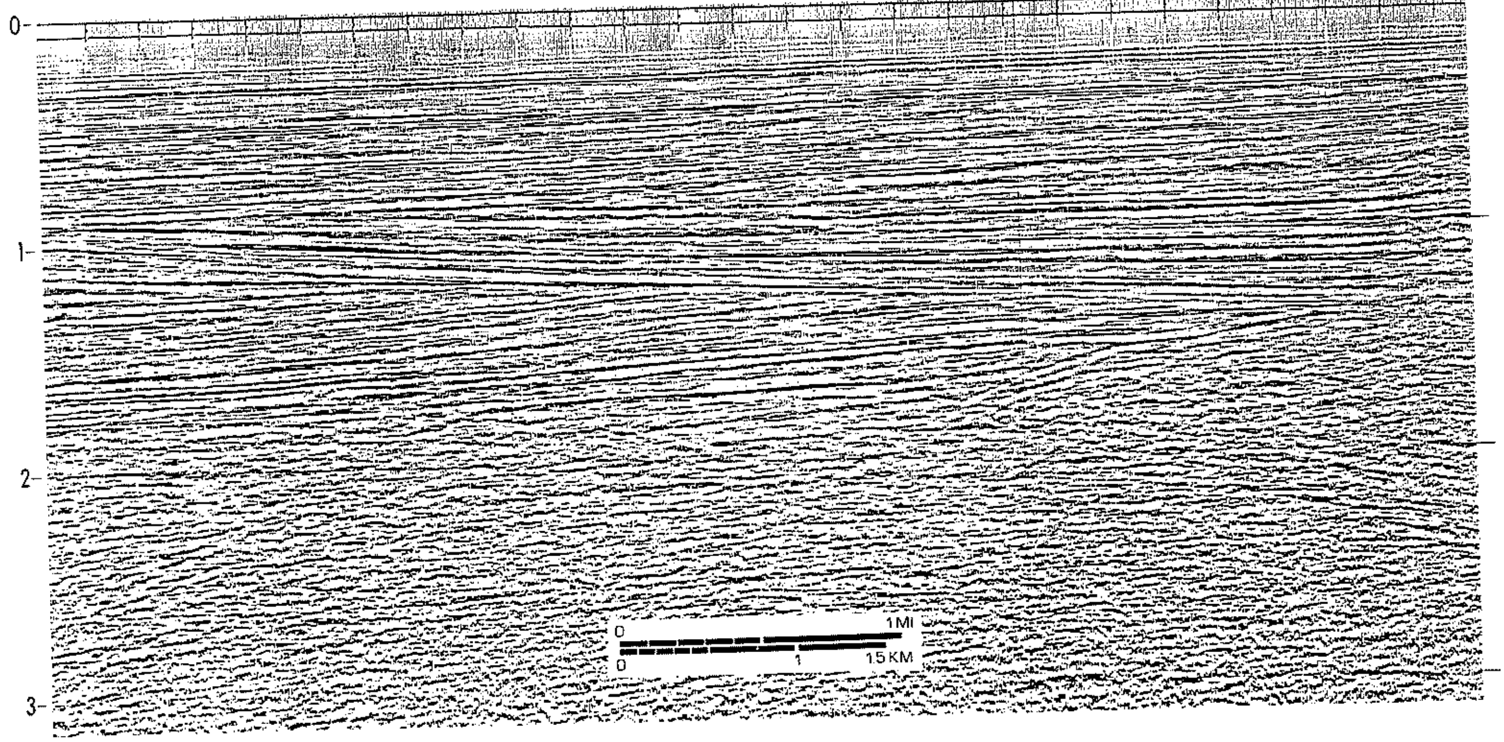




10. Downlap is a relation in which seismic reflection of inclined strata terminate downdip against an inclined or horizontal surface. Note: downdip is a stratal term, not solely restricted to seismic reflection patterns.

A seismic sequence is a depositional sequence identified on a seismic section. It is a relatively conformable succession of reflections interpreted as genetically related strata. It is bounded at its top and base by surfaces of discontinuity marked by reflection terminations interpreted as unconformities or the correlative conformities (see Figures 1 and 2). Because a seismic sequence consists of genetically related strata, it provides an ideal framework for stratigraphic analysis and is considered a basic stratigraphic unit

Uninterpreted Seismic Dip Section



Sequence Interpretation of Figure 1

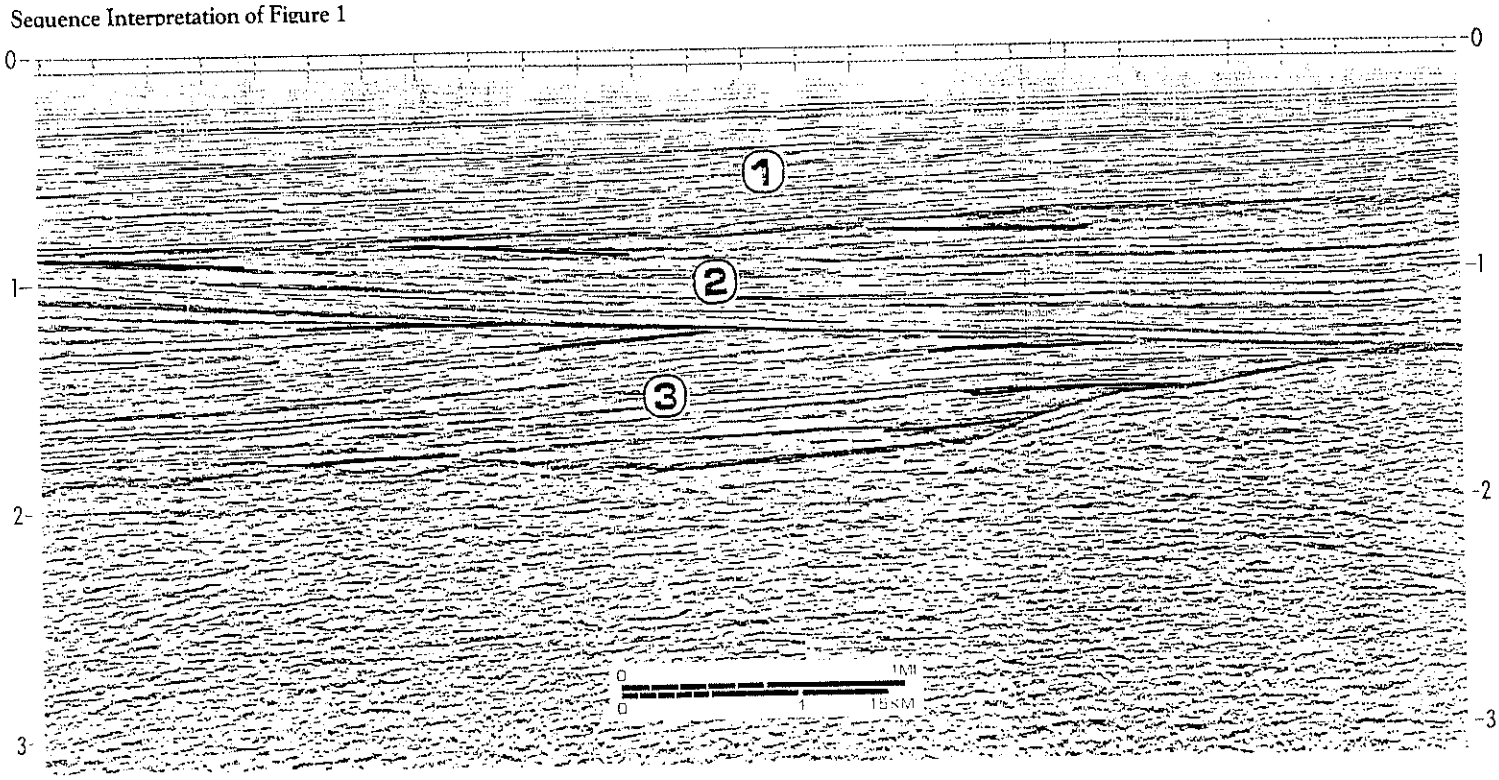
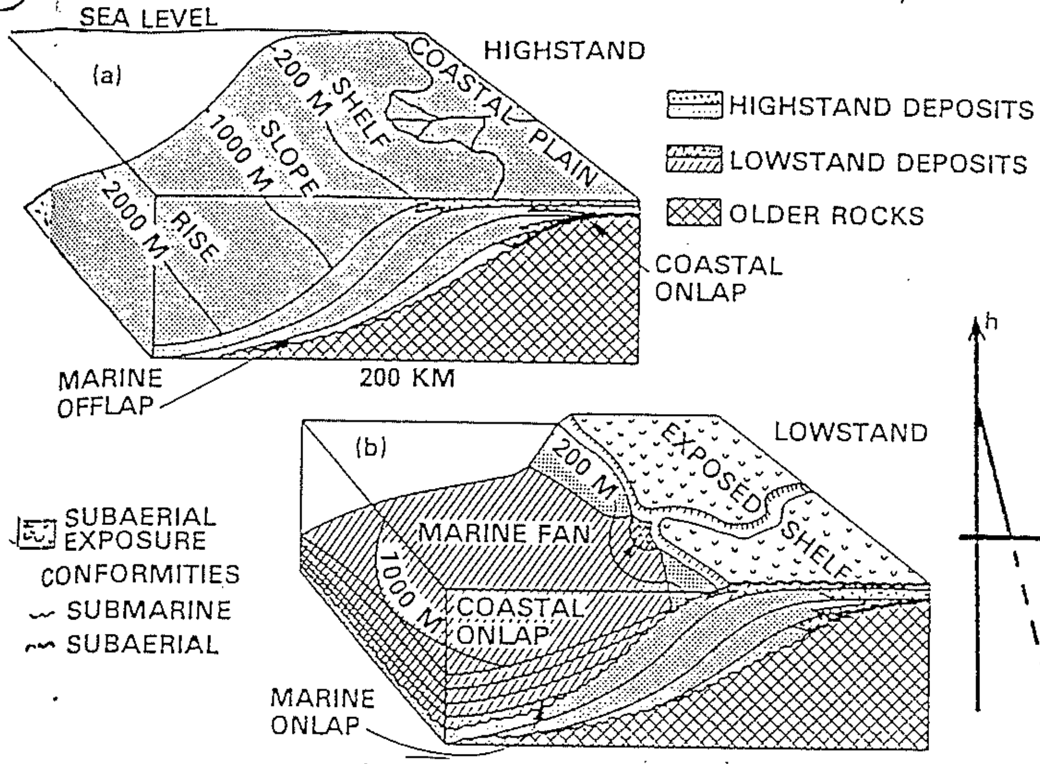
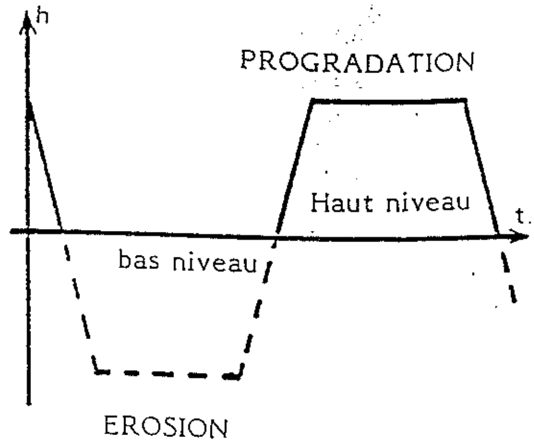


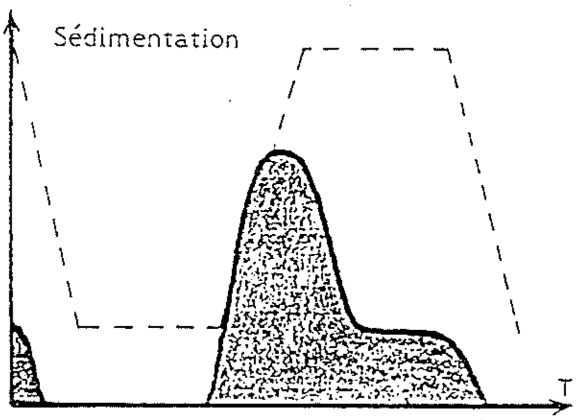
Figure 2. — REFLECTION TERMINATIONS
UNCONFORMITIES

(6)

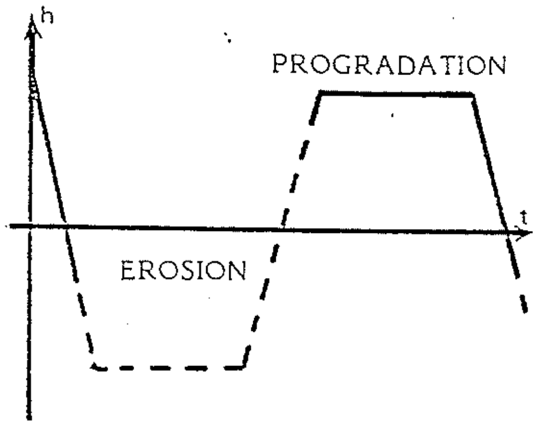


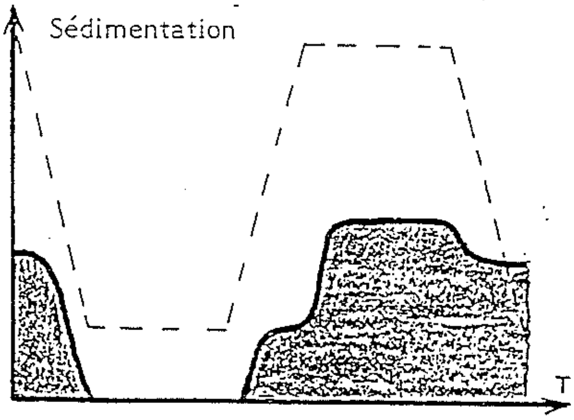
-Depositional patterns during highstand (a) and lowstand (b) of sea level.



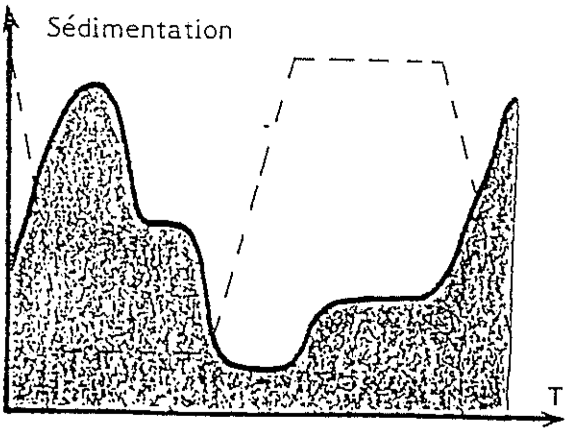


PLATEAU





REBORD



PENTE (Nardin, 1983)