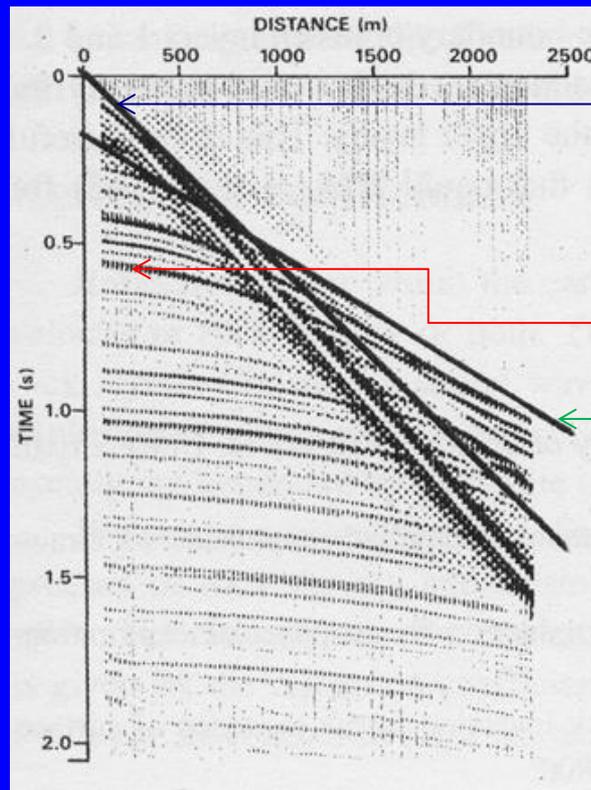


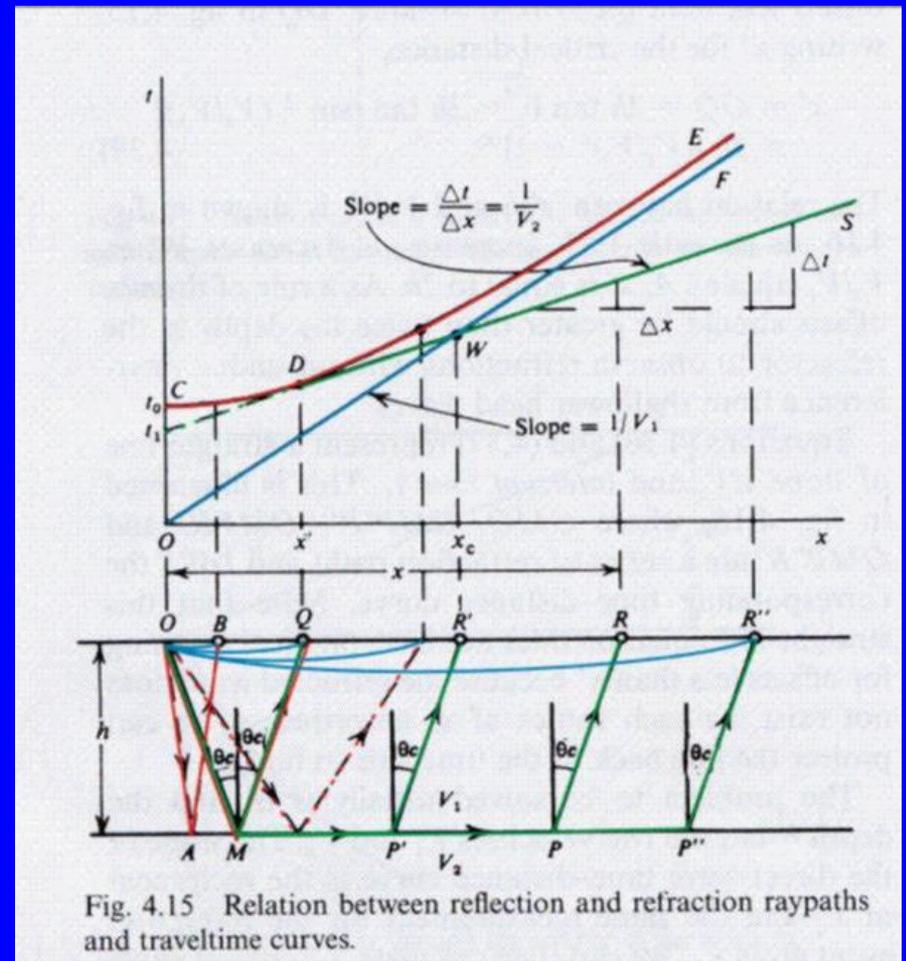
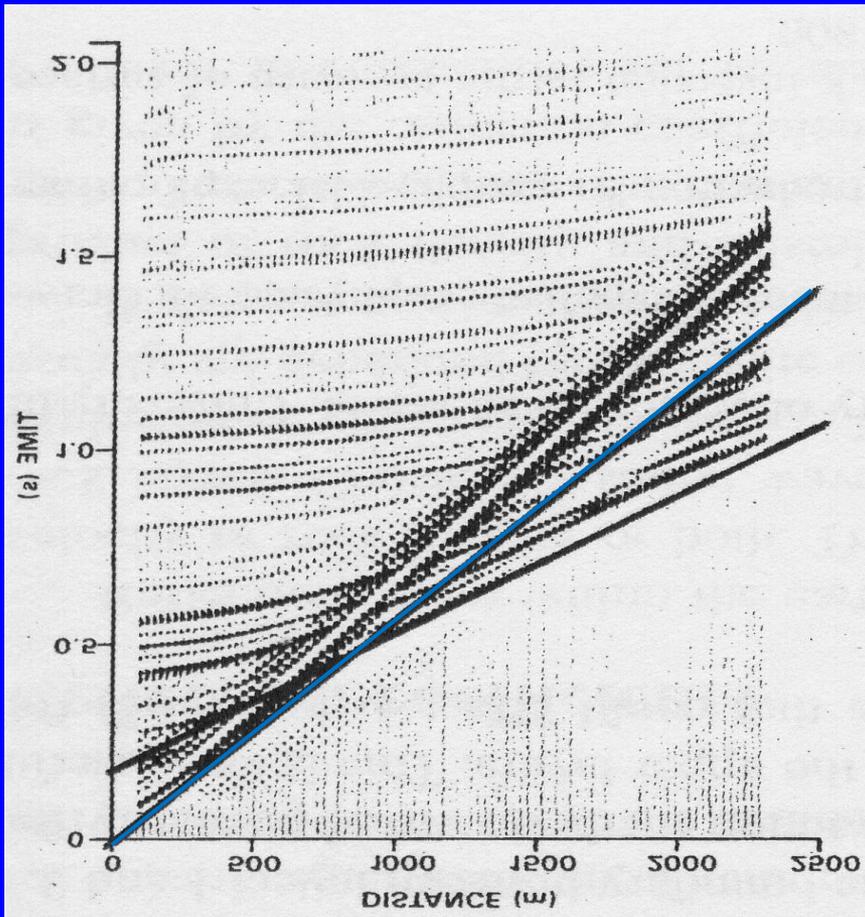
Assunzioni Geofisiche di Base



direct arrivals

reflected arrivals

refracted arrivals



T = tempo di arrivo

x = distanza sorgente-ricevitore (*offset*)

V_1 = velocità onde P nello strato superiore

Onda diretta $T = \frac{x}{V_1}$

Onda rifratta

$$T = \frac{x}{v_2} + \frac{2h \cos i_c}{v_1}$$

Legge di Snell

$$\frac{\sin \theta_1}{v_1} = \frac{\sin \theta_2}{v_2} = p.$$

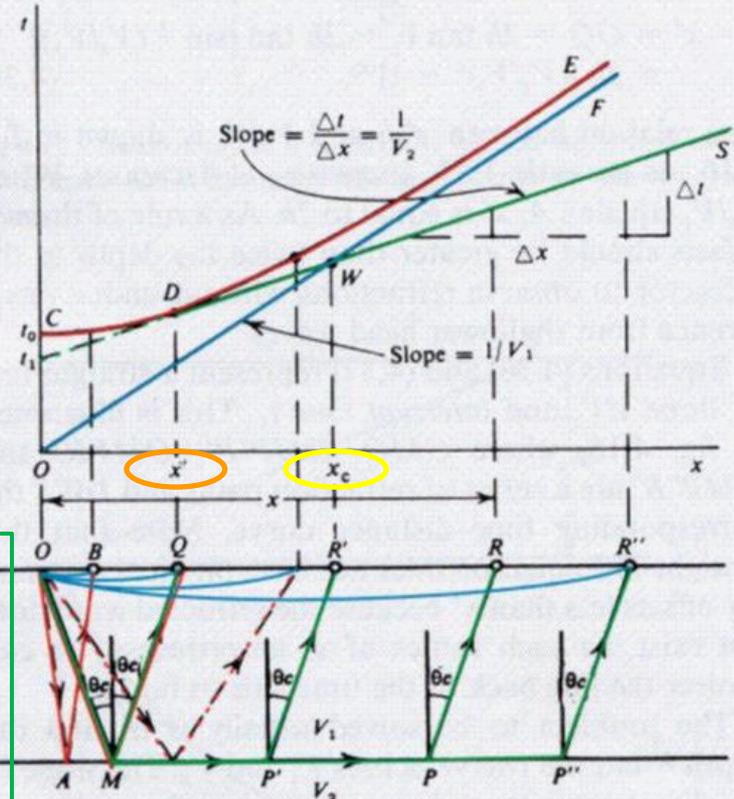
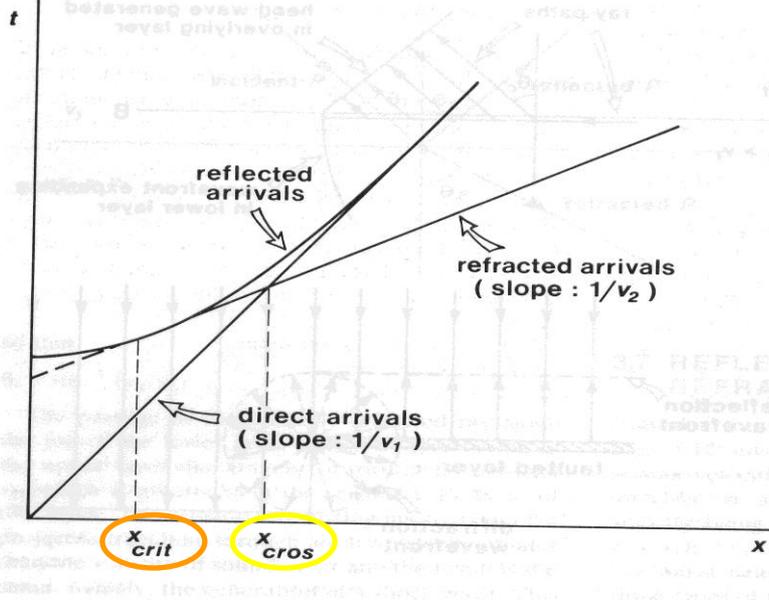


Fig. 4.15 Relation between reflection and refraction raypaths and traveltimes.

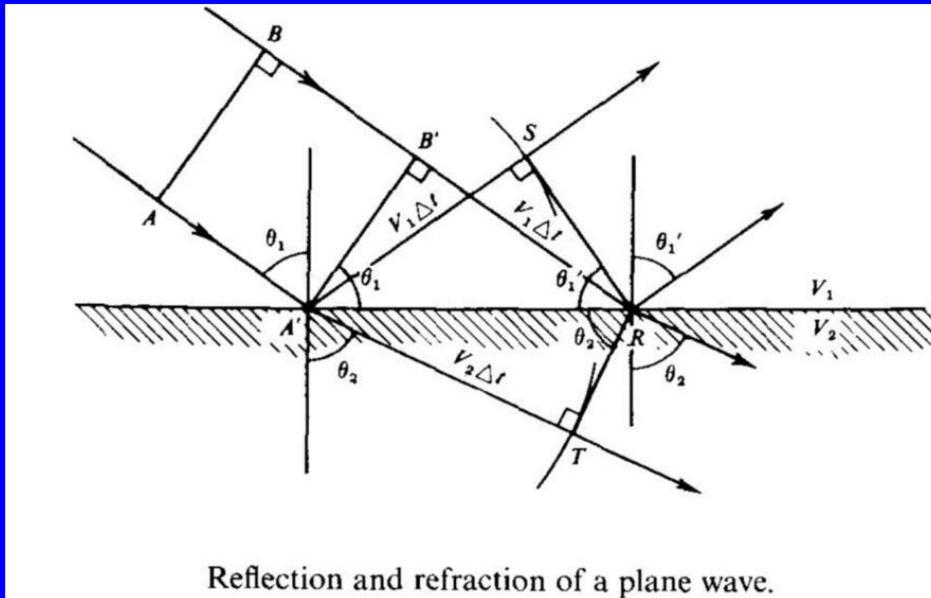
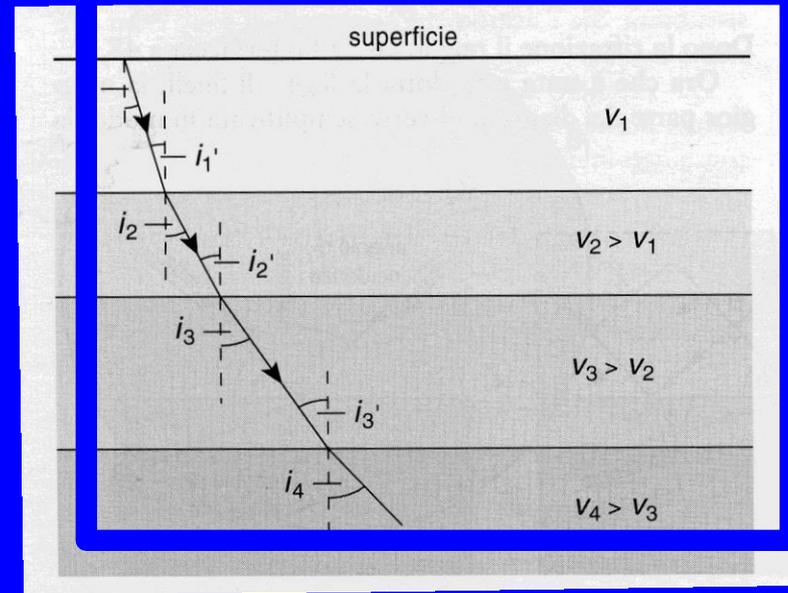


$x_c \circ x_{crit}$ = distanza critica

x_{cros} = distanza di crossover

Onde rifratte

La sismica a rifrazione utilizza le onde rifratte originate da onde incidenti con angolo d'incidenza pari all'angolo critico $i_c \rightarrow$ angolo di rifrazione pari a 90°



In sismica a riflessione, il fenomeno della rifrazione è molto importante: in corrispondenza delle discontinuità la maggior parte di energia viene trasmessa in profondità attraverso rifrazione delle onde P

Principio di Huygens

stabilisce che ogni punto di un fronte d'onda può essere considerato come una nuova sorgente di onde

Principio di Huygens

Ogni punto di un fronte d'onda può essere pensato come una sorgente puntiforme di onde con stessa fase.

La figura di interferenza (l'involuppo) ottenuta dall'insieme delle onde sferiche costituisce il nuovo fronte dell'onda avanzante.

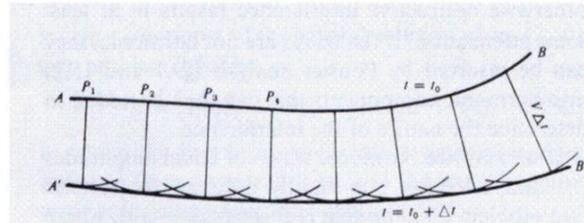


Fig. 2.8 Using Huygens' principle to locate new wavefronts.

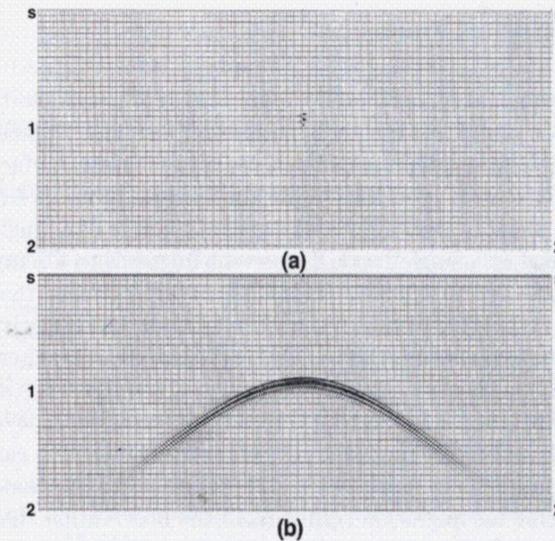


FIG. 4.1-11. A point that represents a Huygens' secondary source (a) produces a diffraction hyperbola on the zero-offset time section (b). The vertical axis in this section is two-way time.

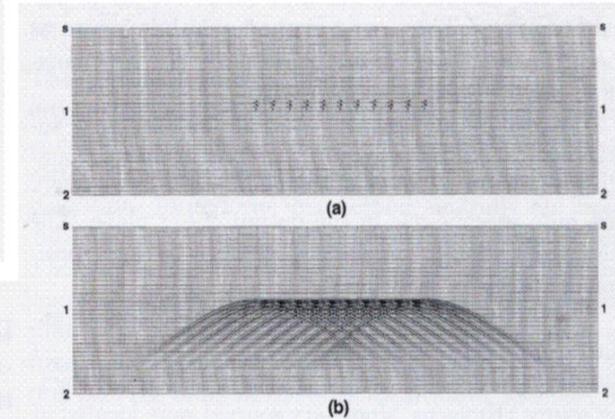


FIG. 4.1-12. Superposition of the zero-offset responses (b) of a discrete number of Huygens' secondary sources as in (a).

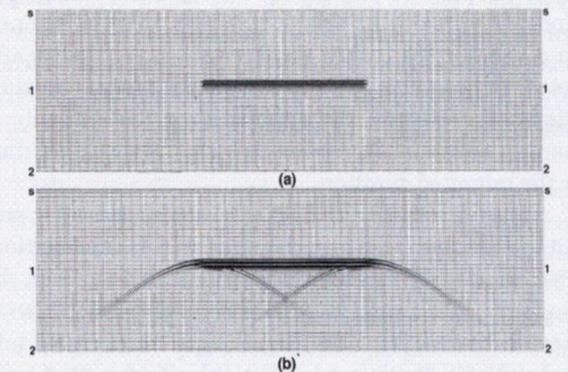
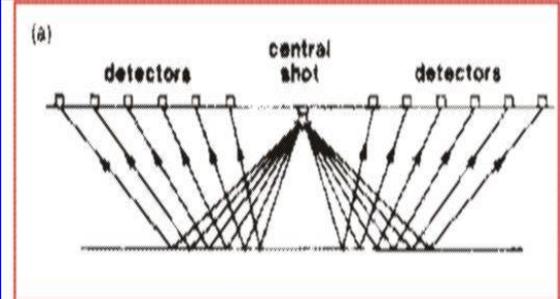
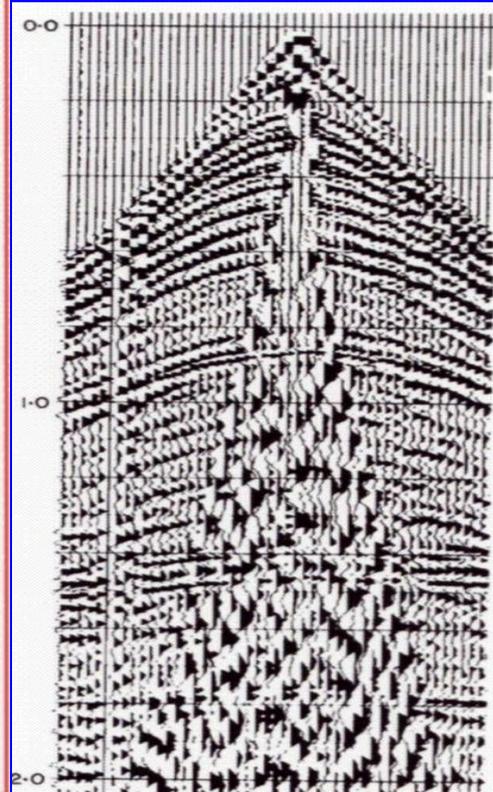
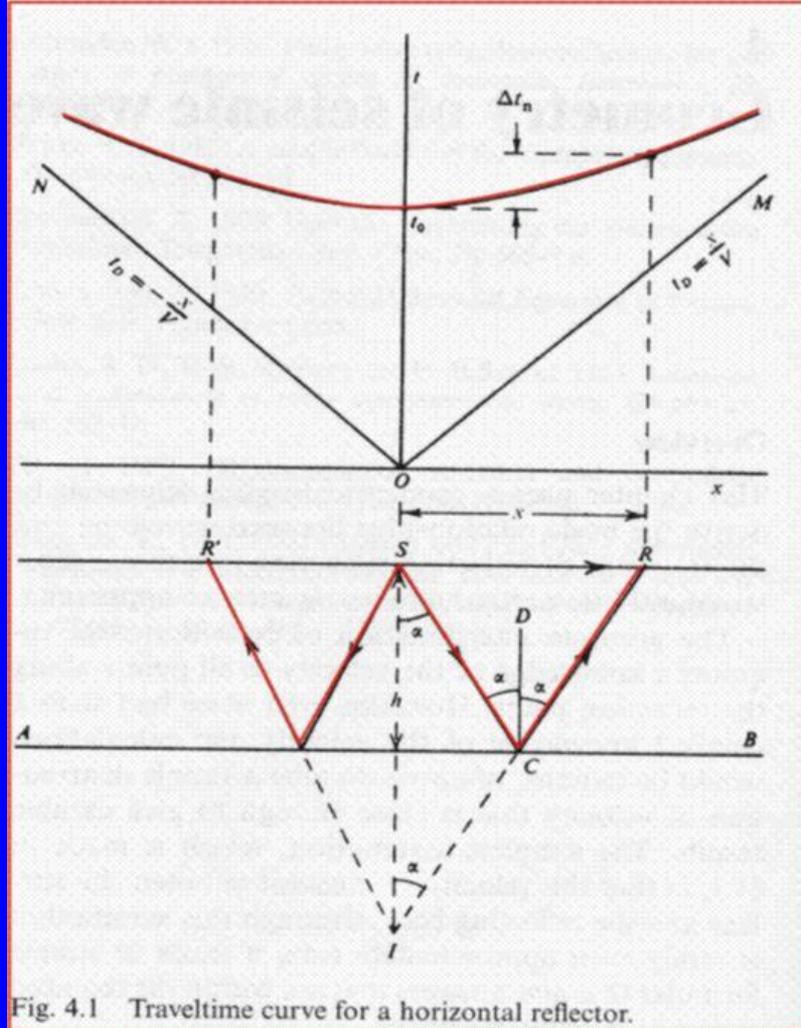
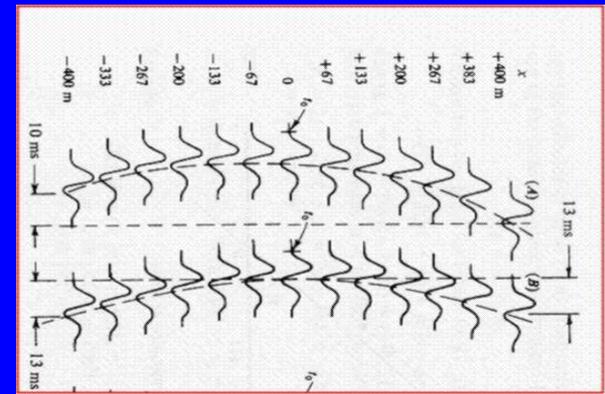


FIG. 4.1-13. Superposition of the zero-offset responses (b) of a continuum of Huygens' secondary sources as in (a).

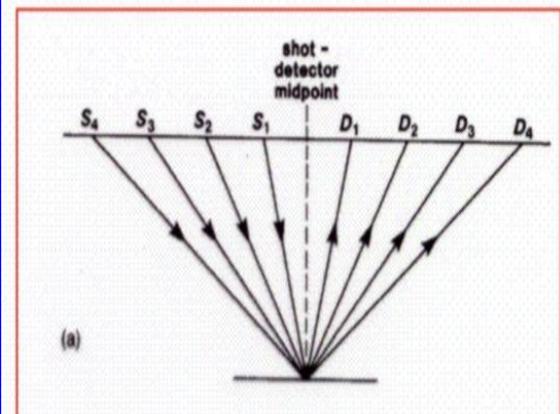
Onda riflessa

$$T^2 = \left(\frac{x}{v_1}\right)^2 + \left(\frac{2h}{v_1}\right)^2$$

L'equazione dell'onda riflessa viene descritta da una iperbole che tende asintoticamente alla retta dell'onda diretta.



Common Shot Gather



Common Midpoint Gather

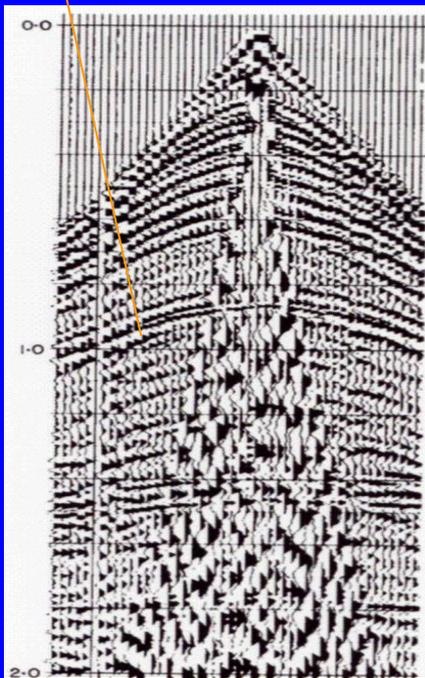
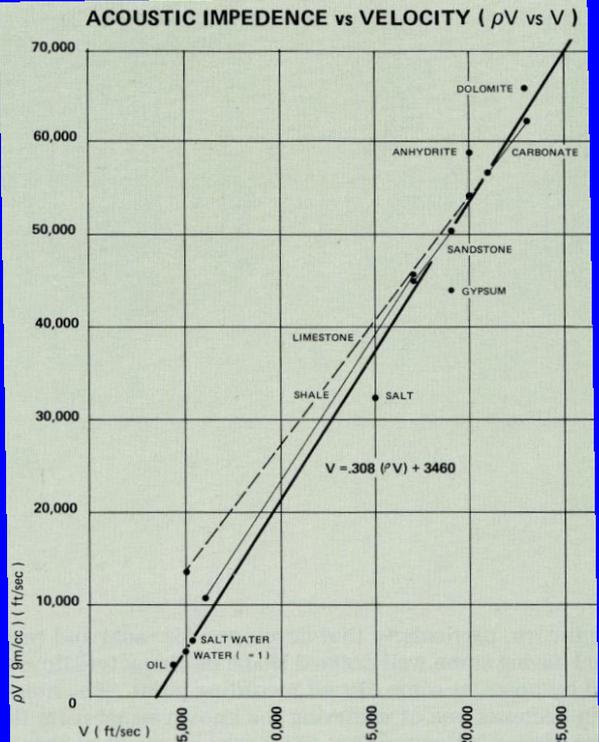
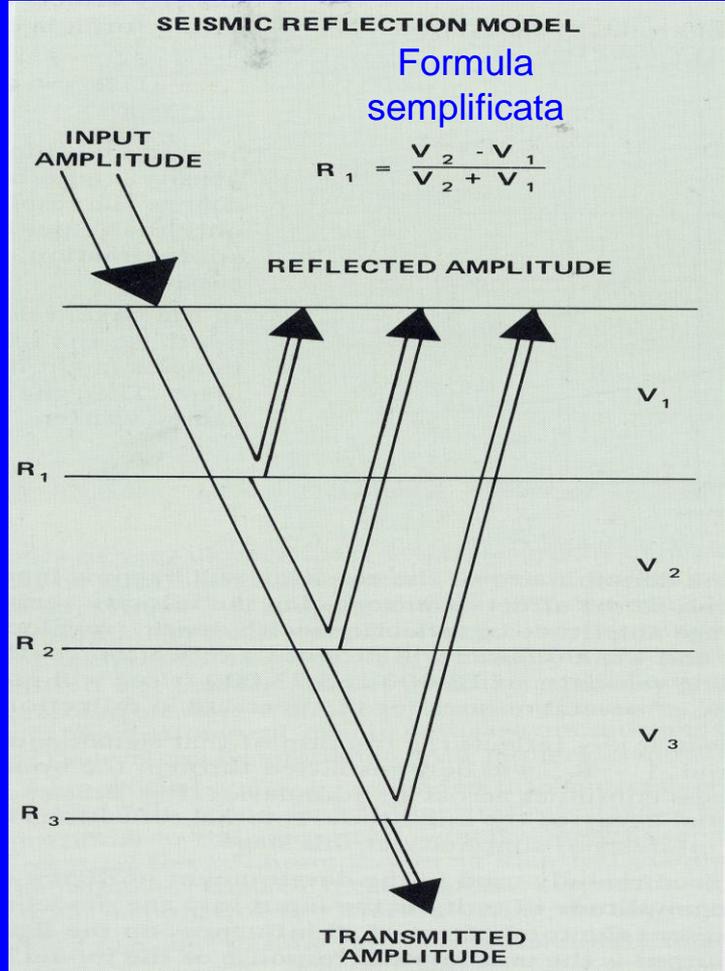
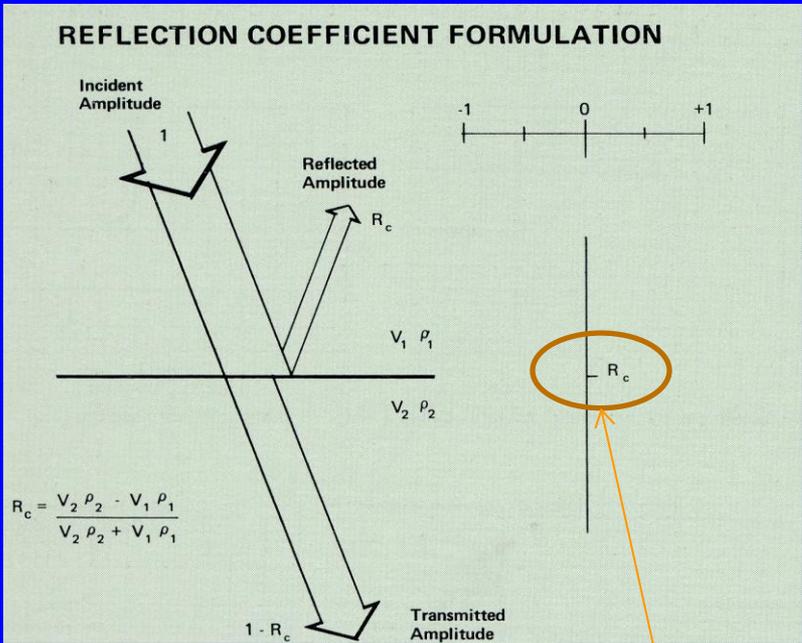
Impedenza Acustica Coefficiente di Riflessione

Le rocce sedimentarie sono le meno dense ~ 2.1 ± 0.3 gr/cm³
Il contrasto di densità fra rocce sedimentarie adiacenti è raramente maggiore di 0.25 g/cm³

$$R_{c1} = \frac{V_2 - V_1}{V_2 + V_1} \quad \text{Basic approximation}$$

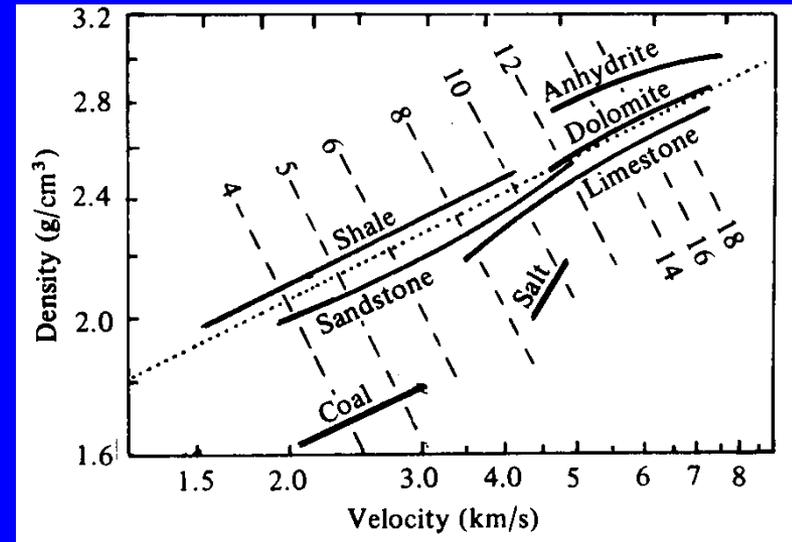
$$R_{c1} = \frac{\rho_2 V_2 - \rho_1 V_1}{\rho_2 V_2 + \rho_1 V_1} \quad \text{Better approximation}$$

$\rho = \text{Density}$



La funzione lineare tra impedenza acustica e velocità delle onde P prevedrebbe una densità pressochè costante.

In effetti ciò non è vero, ma esiste generalmente una correlazione tra i valori di densità e velocità.



Una relazione più precisa è stata formulata da Gardner (qui velocità = α)

Gardner's formula for density, this relationship given by $\rho = c\alpha^{0.25}$, where c is a constant that depends on the rock type, is useful to estimate density from velocity when the former is unknown. With the exception of anhydrites, most rock types — sandstones, shales, and carbonates, tend to obey Gardner's equation for density.

Esempi di valori di velocità, densità e coefficienti di riflessione in situazioni di litologie standard

Table 3.1 *Energy reflected at interface between two media*

Interface	First medium		Second medium		Z_1/Z_2	R	E_R
	Velocity	Density	Velocity	Density			
Sandstone on limestone	2.0	2.4	3.0	2.4	0.67	0.2	0.040
Limestone on sandstone	3.0	2.4	2.0	2.4	1.5	-0.2	0.040
Shallow interface	2.1	2.4	2.3	2.4	0.93	0.045	0.0021
Deep interface	4.3	2.4	4.5	2.4	0.97	0.022	0.0005
"Soft" ocean bottom	1.5	1.0	1.5	2.0	0.50	0.33	0.11
"Hard" ocean bottom	1.5	1.0	3.0	2.5	0.20	0.67	0.44
Surface of ocean (from below)	1.5	1.0	0.36	0.0012	3800	-0.9994	0.9988
Base of weathering	0.5	1.5	2.0	2.0	0.19	0.68	0.47
Shale over water sand	2.4	2.3	2.5	2.3	0.96	0.02	0.0004
Shale over gas sand	2.4	2.3	2.2	1.8	1.39	-0.16	0.027
Gas sand over water sand	2.2	1.8	2.5	2.3	0.69	0.18	0.034

All velocities in km/s, densities in g/cm³; the minus signs indicate 180° phase reversal.

Il modello più semplice di riflessione considera due strati omogenei sovrapposti caratterizzati da diverse proprietà elastiche

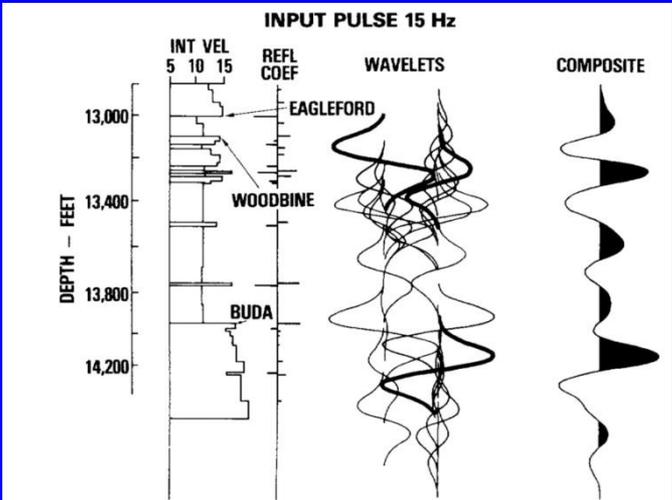
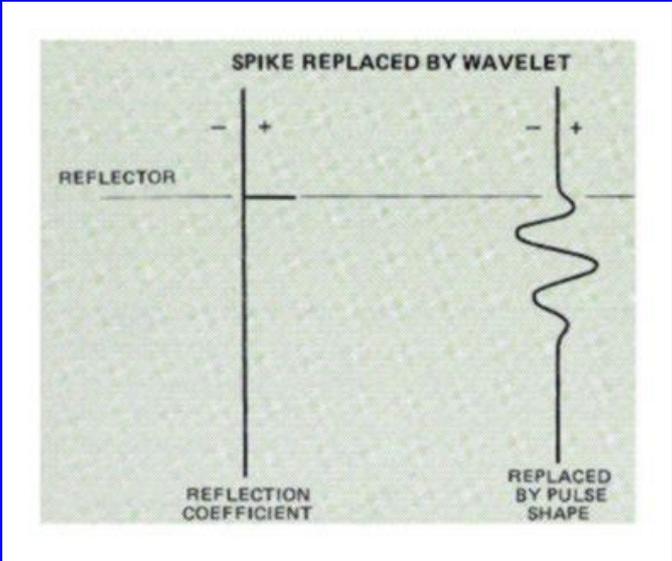
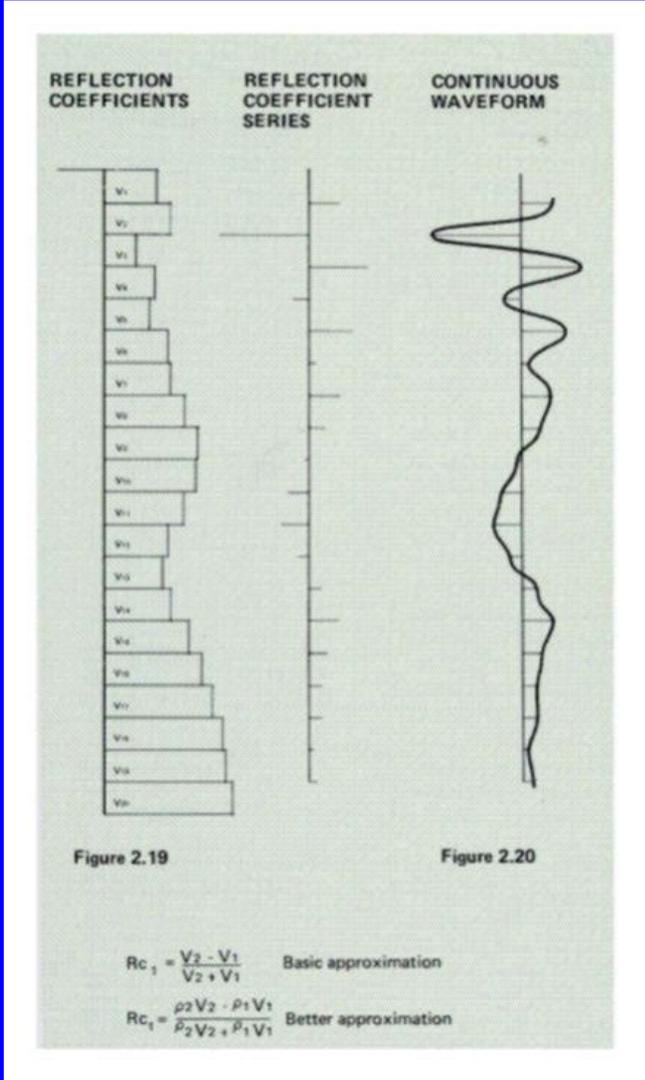
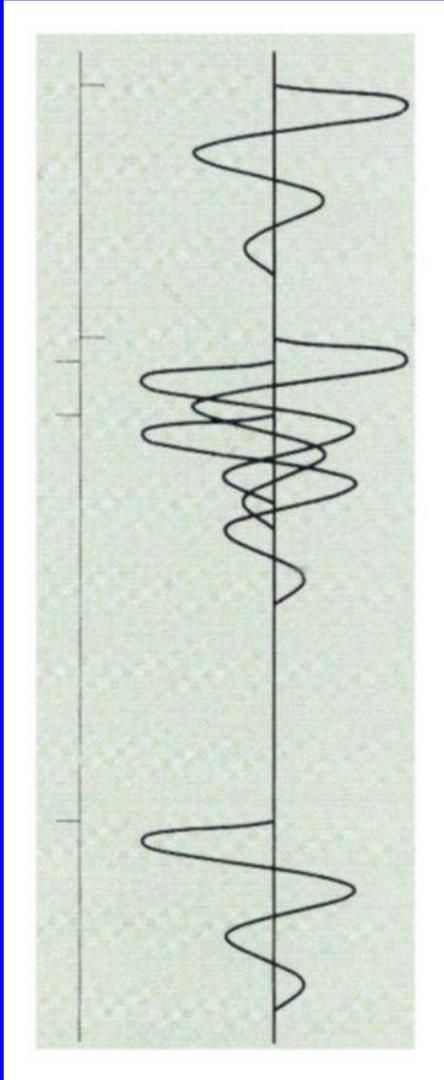


FIG. 14—Synthetic seismogram, Shell 1 Southland Paper Mills, Polk County, Texas. Interval velocity in thousands of feet per second.



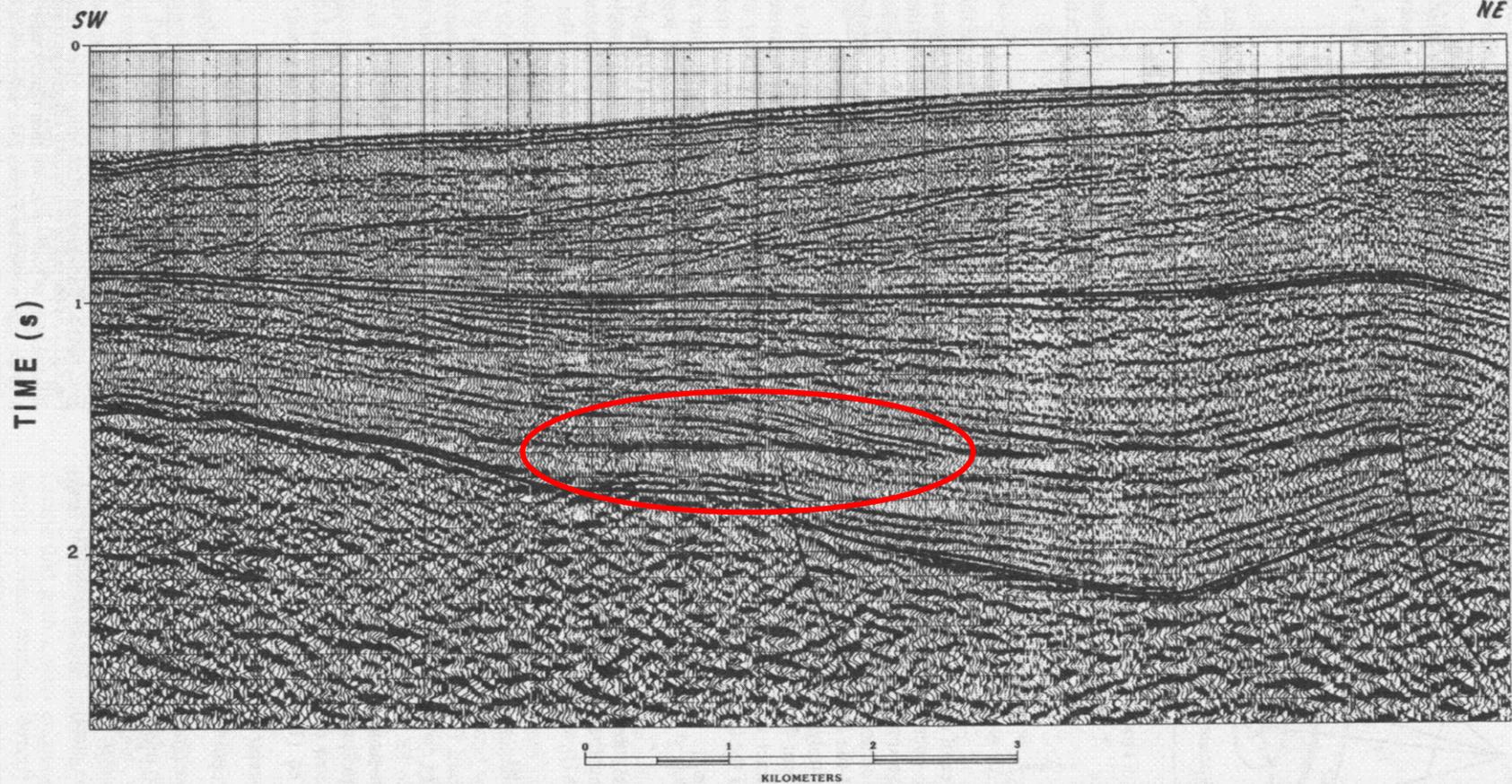


Fig. 6.11 Seismic section showing a horizontal reflector (at ~ 1.57 s) attributed to pressure-controlled diagenetic change from opal-CT porcellanites above to quartz chert below. A change from opal- λ to opal-CT at 1.20 s may also produce reflections. (From Hubbard, Pape, and Roberts, 1985: 85; reprinted with permission.)

Esempio di profilo sismico, *display wiggle/variable area*: oltre alle sequenze sedimentarie e ad alcune faglie, si individua un riflettore (ca 1.2 sec TWT) originato da una variazione dei parametri fisici dovuta a **ricristallizzazione**: il riflettore è trasversale ai riflettori relativi i limiti delle sequenze sedimentarie.