investigate the structure of the continental shelf off northwest
Britain. A long-range (69 km) expanding spread profile reveals
that the crystalline basement off northern Scotland is covered
by sedimentary sections up to 2.5 km thick, and is divisible
into two seismic units with velocities of 6.1 km/s and 6.6
km/s. Prominent supercritical Moho reflections indicate a
crustal thickness of 26.7 km. Strong sedimentary and base-
ment refractions, together with oblique reflections from the
vicinity of the Moho, have been profiled at a constant air
gun–receiver offset of 10 km across a sedimentary basin
west of the Orkney Islands. On the Outer Hebridean shelf to
the west of mainland Scotland, the metamorphic basin lies
within 250 m of the sea floor, P- to S-wave conversion occurs
at the basement surface: $V_p/V_s$ gives a Poisson's ratio of
0.27–0.31 at depths of 300–1000 m. Marked changes in
mode conversion efficiency are observed on constant offset
profiles and are attributed to variations in the velocity structure
of an uppermost low-velocity (4.9 km/s) layer of weathered
basement. The deeper crustal velocity appears uniform with
depth, although there is some evidence of significant lateral
velocity changes (6.28–6.61 km/s). In contrast to the shelf
north of Scotland, reflections from within the basement and
from near the base of the crust are recorded only sporadically
on constant offset profiles. A strong event at 10.4 s two-way
reflection time appears to have arisen from a seismic
discontinuity within the upper mantle. The difference in
seismic character of the basement on the two ship profiles
suggests significant variations in crustal structure within the
Caledonian foreland of northern Britain.


Laboratory studies of the detailed relationships between
acoustic properties and the petrographic character of biotre-
and air-saturated carbonate rocks with a wide range of facies,
porosities, lithologies, and rock fabrics indicate that porosity is
the major factor influencing both P- and S-wave impedance
and velocity. Primary lithology and secondary mineralogy have
only a small influence on impedance and velocity. Combined
use of P- and S-wave velocity data discriminates porosity
changes from lithologic changes. All other variables, including
pore-fluid type and petrographic fabric, have no significant
influence on velocities. Laboratory measurements of P-wave
velocity under simulated in-situ conditions reproduce well-log
velocity values reliably. Laboratory porosity-velocity trends
agree with the time-averaged equation when the correct matrix
velocities are used. Rock property results were used to
interpret porosity/lithology variations for an inverted seismic
section from the Williston basin. Where well control was
available, the porosity/lithology interpretation was found to be
in agreement with the subsurface control.

W. J. Ostrander. Plane-wave reflection coefficients for gas sands at nonnormal angles of incidence

The P-wave reflection coefficient at an interface separating
two media is known to vary with angle of incidence. The
manner in which it varies is strongly affected by the relative
values of Poisson's ratio in the two media. For moderate
angles of incidence, the relative change in reflection
coefficient is particularly significant when Poisson's ratio
differs greatly between the two media. Theory and laboratory
measurements indicate that high-porosity gas sands tend to
exhibit abnormally low Poisson's ratios. Embedding these low-
velocity gas sands into sediments having 'normal' Poisson's
ratios should result in an increase in reflected P-wave energy
with angle of incidence. This phenomenon has been observed
on conventional seismic data recorded over known gas sands.

G. R. Sutton. The effect of velocity variations on the beamwidth of a seismic wave

The effect of depth and lateral velocity variations on the width
of a seismic beam propagating through the earth is investi-
gated. The model used is unusual and provides an interesting
alternative insight to the conventional models appearing in the
geophysical literature. Some basic calculations show that, at
frequencies and depths of interest in oil exploration, a
significant lateral shift in the centre of the seismic beam
occurs in addition to the expected broadening of the seismic
beam.

D. W. Oldenburg, S. Levy and K. Stinson. Root-mean-square velocities and recovery of the acoustic impedance

The loss of low-frequency information in reflection seismograms causes serious difficulties when attempting to
generate a full-band impedance profile. Information about the
low-frequency velocity structure is available from r.m.s.
(stackings velocities). We show how r.m.s. velocities can be
inverted with additional point velocity constraints (if they are
available) to construct either smooth or blocky velocity
structures. Backus–Gilbert averages of the constructed
velocity are then autoregressive solutions for recovering a full
band reflectivity from band-limited seismograms. Our final
result is therefore a full-band acoustic impedance which is
consistent with the seismic data section, stacking velocities,
and available point constraints.

O. Yilmaz and R. Chambers. Migration velocity analysis by wave-field extrapolation

Velocity information is essential to both common midpoint
(CMP) stacking and migration. CMP stacking provides the
basis for conventional velocity estimation techniques in that,
for a number of trial velocities, the stack response of a CMP
gather is computed and displayed in the form of a velocity
table. An alternative approach to velocity estimation makes
use of the basic ingredients of migration—downward
extrapolation and imaging of seismic wave fields. The
procedure involves migration of a CMP gather with a number
of trial velocities and collection of the zero-offset information,
again in the form of a velocity table. Operating on a CMP
gather, the migration-based approach produces results similar
to those of the conventional method. Analyses of synthetic
CMP gathers using both methods show essentially equivalent
treatments of seismic signal, and similar dependence of
accuracy and resolving power on recording geometry. We
have extended the migration-based approach to include more