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Wide-angle Seismic Imaging in the Peninsular Ranges

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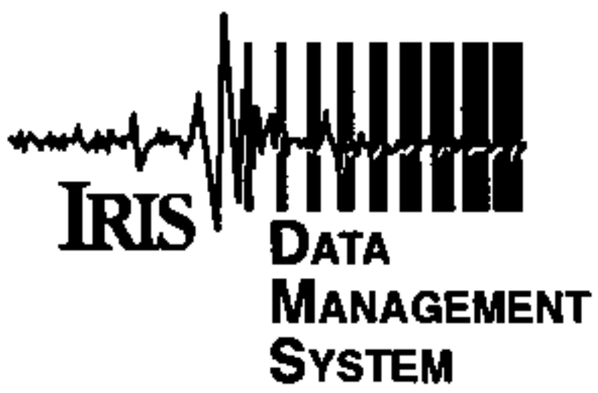

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Wide-angle Seismic Imaging in the Peninsular Ranges, Southern California: Piggyback onshore recording of marine airgun sources

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Paul Davis (UCLA), Steve Day (SDSU), Bob Bohannon (USGS)

The USGS collected marine multichannel seismic reflection profiles in the southern California Borderlands during May, 1990. A group of southern California researchers cooperated with the USGS to conduct an onshore/offshore piggyback experiment as a pilot study to examine wave propagation, attenuation, and imaging aspects of the southern California Borderlands and Peninsular Ranges. The offshore Borderlands have a complex history of compressional and extensional tectonics and the Peninsular Ranges are composed of large-scale Mesozoic batholiths. Both regions are prominently dissected by major strike-slip faults associated with the San Andreas fault system. The USGS collected 30 multichannel profiles totaling 3000 km using the S.P. Lee.

In order to examine wave propagation characteristics in this region using marine airgun sources, portable seismometers were deployed in a fixed array oriented N59E degrees from the coastal city of Oceanside, CA to Anza, CA, 85 km inland (Figure 1). Six PASSCAL 3-component Refteks and four 2-component Kinemetric SSR seismometers at approx. 10 km spacing were deployed in night-time continuous-mode recording. The USGS SP Lee began at a designated time an offshore transect between offshore Oceanside and Santa Catalina Island using a 2300 cubic-inch airgun source at 20 sec intervals. Absolute timing was recorded at the source and at all receiver sites to allow for subsequent zero shot-time seismogram reconstruction.

The Reftek instruments stored the continuous recording of each component in five minute blocks. After the experiment, all blocks for each component from each station were transferred from Exabyte to SUN disk. Using zero-time information provided by the USGS, seismograms of 40 sec length were cut from the blocks and stored as SIERRA-SEIS-compatible binary data. SIERRASEIS was used to display all seismograms recorded at a given component/station (i.e., plot of a common receiver gather). Data was archived in SEG-Y format on magnetic tape.

Figure 2 illustrates first arrivals for a station 20 km inland from the Oceanside coastline with source point locations 40-55 km offshore for a total of 60-75 km offsets. The primary first arrival is interpreted as Pg; the structure exhibited in the arrival is due to sea floor topography beneath the S.P. Lee airguns. The major arrival 0.7 sec after Pg is not caused by a water bottom multiple as the sea floor is approximately 1.2 sec as observed in the vertical incidence CDP profile.

The primary objective of this field exercise was to determine propagation distances and quality of seismic energy generated by the S.P. Lee. P-wave first arrivals are recorded to a distance of at least 60 km inland for airgun sources offset up to an additional 80 km from the coastline. Also, P-S converted energy appears after the P arrivals and may be due to conversion at the sea floor and at more local interfaces. Strong-amplitude wide-angle reflections are visible at >60 km offset. Examination of horizontal components indicates anisotropic wave propagation.

Although the airgun source of the S.P. Lee was relatively small (2300 cubic inches), the source propagated fairly well given the transmission properties of the Borderlands and batholithic Peninsular Ranges. Given the difficulties of access within the Peninsular Ranges, both in terms of concentrated cultural regions and the ruggedness of the ranges in remote areas, onshore fixed receiver recording of walkaway offshore sources appears to be an effective approach to imaging the Borderlands/Peninsular Ranges transition region. Improved data quality will be possible with a larger airgun source and careful selection of additional receiver sites.

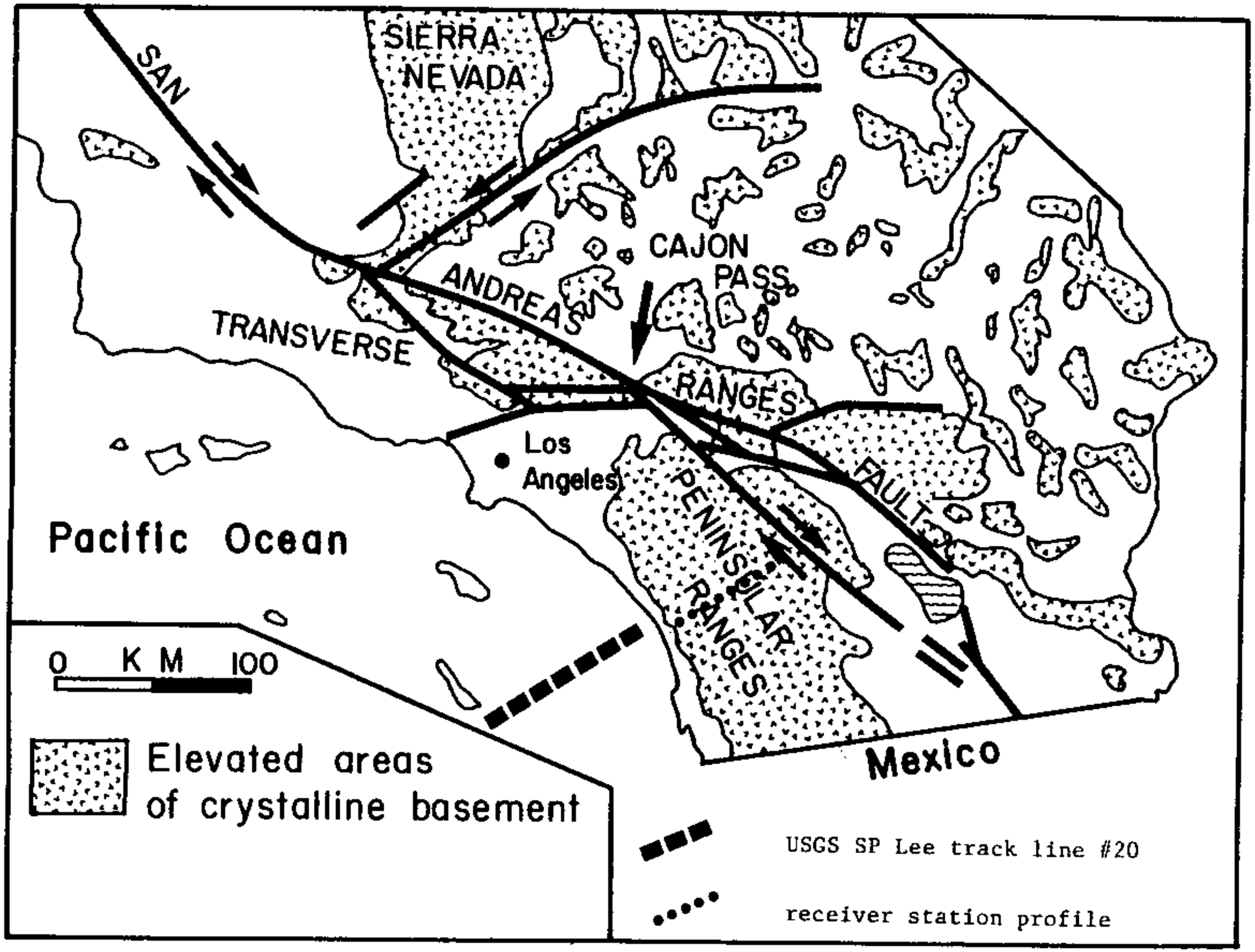
SAN
ANDREAS
TRANSVERSE
RANGES
SIERRA
NEVADA
CAJON
PASS
Los
Angeles
PENINSULAR
RANGES
FAULT
Pacific Ocean
Mexico
0 K M 100
Elevated areas
of crystalline basement
USGS SP Lee track line #20
receiver station profile

Figure 1

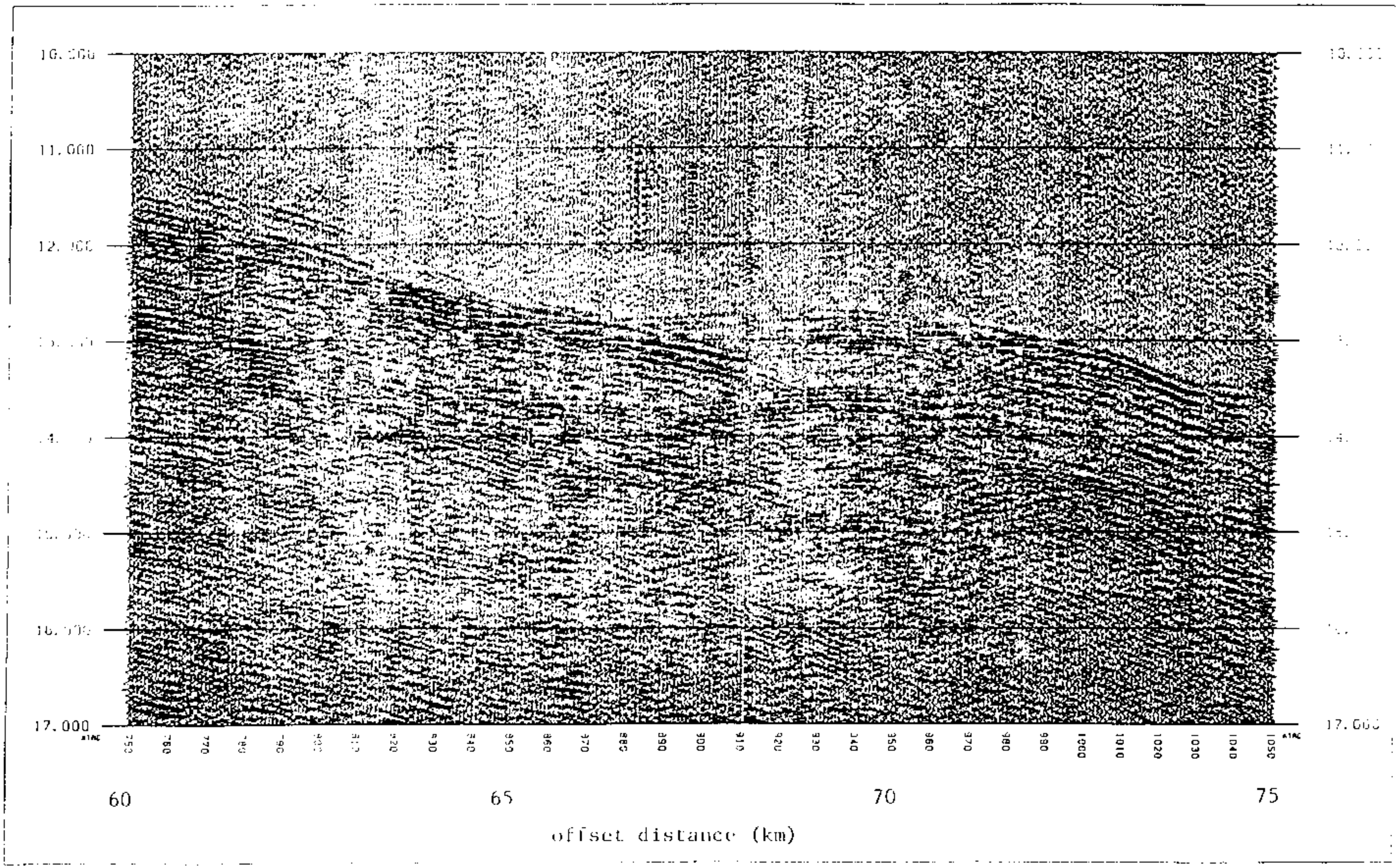

Figure 2

Data

There are two data tapes. The first tape is a tar tape containing the following files:

README	Description of the other files.
SEGYIN.DAT	Job description file compatible with SierraSEIS v1.5 which will read the archive SEGY tape.
archive.list	Description of the SEGY tape
segytape.dump	A record dump of the SEGY tape
segytape.listing	An IRIS-SEIS listing of traces and airgun X-Y values extracted from the SEGY data trace headers.
shot.xytime	A table of SP Lee airgun source shot times and X-Y coordinates (UTM system).
stations.xy	A table of instrument locations indicating X-Y coordinates (UTM system).