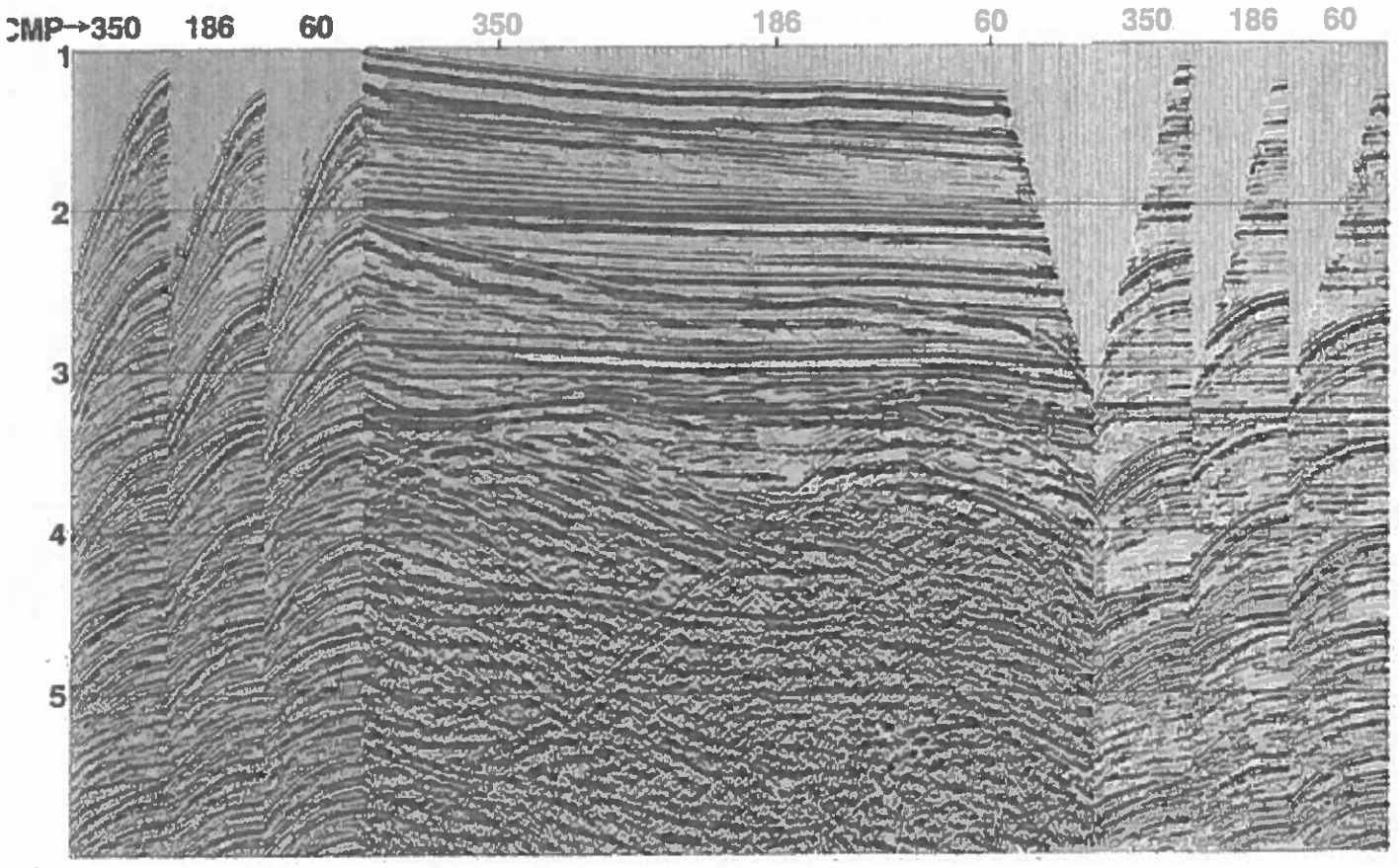
Exam Introduction to Seismology and Seismics, Part 2

29 January, 2015, 13:30-16.30

1. (a) Explain the terms common midpoint (CMP) gather, normal move out (NMO) and root mean square (RMS) velocity.
   (b) The three left panels of the figure below show three different CMP gathers. From these the three right panels are obtained. Explain how these have been obtained.
   (c) How can one determine the thickness and seismic velocity of each of the layers of a seismic section?
   (d) The middle panel shows the seismic section. What might change if migration is applied? (Indicate in the figure, if needed for clarification.)



2. An earthquake is recorded by a large number (N) seismic stations.
   Explain how location and origin time of the earthquake can be determined from the measured P-wave arrival times for a given seismic structure of the Earth.
   Explain this procedure for the case of a homogeneous medium of constant velocity and a Cartesian coordinate system.

3. (a) Sketch the travel time curves (1) for a seismic velocity model with a low velocity zone and (2) for a model with a sharp velocity increase, and sketch the corresponding ray paths.
   (b) Sketch the ray paths of PcP, PKP and PKKP originating at the same earthquake and that have the same ray parameter.

4. (a) Explain the terms dispersion, phase velocity and group velocity. Derive how, for a given frequency, the last two are related to each other as a function of wavelength.
   (b) Sketch a phase velocity curve (phase velocity as a function of period) of a Love wave for a layer with shear velocity β_1 over a half space with shear velocity β_2. Draw a second curve for a layer with a larger thickness.
   Give a brief explanation of the curves.

5. (a) What are the two types of normal modes. Explain their difference.
   (b) What are the three order numbers of a normal mode. Explain their meaning.
   (c) What is the expected difference in normal mode recording of ${}_0S_2$ between
   (1) an Earth model that is spherically symmetric, isotropic and non-rotating and
   (2) an Earth model that is not spherically symmetric, has anisotropic properties and is rotating. Explain.

6. The focal mechanism of an earthquake is given by the nodal planes:
   NP1: strike $\phi_1 = 322^o$, dip $\delta_1 = 38^o$, rake $\lambda_1 = 66^o$
   NP2: strike $\phi_2 = 172^o$, dip $\delta_2 = 56^o$, rake $\lambda_2 = 108^o$
   (a) Draw the two nodal planes, colour the compression quadrants and indicate the P- and T-axes.
   (b) If NP1 is the fault plane, give the type of fault motion as (a combination of) left/right lateral strike slip, reverse (thrust) and/or normal faulting.