Conventional reverse time migration (RTM) needs two wave equation propagations: the forward modeling of each shot record and the backward propagation of recorded receiver data to obtain an image of the subsurface. By transforming the shot gathers into the double slant stacked plane-wave domain, we can define a RTM procedure for migrating double plane wave components which has several advantages over the conventional RTM. First, because the dataset we used is in the double slant stacked plane-wave domain, we only need to forward propagate a limited number of synthetic source plane-wave components for the whole velocity model, and this number is small compared with the number of forward propagations of synthetic point sources for conventional RTM. Our method is quite suitable for large datasets that have thousands of shot gathers and would need thousands of forward propagations for conventional shot record RTM. Second, the double plane wave RTM is very flexible. We can select a limited range of plane wave components for migration for enough horizontal and vertical resolution based on our previous knowledge of the subsurface, further reducing the computing time for velocity analysis. Last, the double plane wave RTM can generate offset ray parameter domain common-image gathers (CIGs) directly after migrating plane wave components. No extra work is needed to obtain the ray parameter CIGs as is the case for conventional RTM, which is again convenient for velocity analysis. We solve the acoustic wave equation by employing a pseudo spectral method for the spatial derivatives and the rapid expansion method (REM) for time marching of the plane wave fields because of their high accuracy and stability.
Migration result of double plane wave reverse time migration for EAGE/SEG salt model. For panel a), 41 offset plane wave components ranging from 0.0s/km to 0.4s/km and 21 source plane wave components ranging from -0.1s/km to 0.1s/km are used for migration. As a result, only nearly horizontal reflectors can be imaged. For panel b), 41 offset plane wave components ranging from 0.0s/km to 0.4s/km and 121 source plane wave components ranging from -0.6s/km to 0.6s/km are used for migration. Most reflectors can be imaged with good resolution. Panel c) is the ray-parameter common image gathers (CIGs) of the model with 20 imaging points increment. Each shown imaging point contains 41 offset plane wave components ranging from 0.0s/km to 0.4s/km. Most of the events are even, which suggests that the true velocity is used for migration.