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Advanced seismic imaging of deep seismic reflection data

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We present two novel seismic imaging approaches based on Kirchhoff prestack depth migration (KPSDM). The first, Fresnel Volume Migration (FVM) uses emergence angles at receivers to restrict the backpropagation to the physical relevant reflector part. The second, Reflection Image Spectroscopy (RIS) uses frequency-selective imaging to overcome the problem of strong heterogeneities causing strong scattering and diffuse images.

We applied these techniques to a deep seismic reflection profile across the Chilean subduction zone at 38.2° S (project TIPTEQ). The standard prestack depth section shows the subducted Nazca plate with varying reflectivity. Below the coast the plate interface occurs at 25 km depth as the sharp lower boundary of a 2-5 km thick, highly reflective region, which we interpret as a subduction channel. The plate interface can be traced down to depths of 50-60 km below the Central Valley. We observe strong reflectivity at the plate interface and in the continental mantle wedge further down-dip than the seismogenic coupling zone. The sections show a segmented forearc crust in the overriding South American plate. Major features in the accretionary wedge, such as the Lanalhue fault zone, can be identified. At the eastern end of the profile a bright west-dipping reflector lies perpendicular to the plate interface and may be linked to the volcanic arc.

A comparison of KPSDM and FVM shows a significant increase in resolution and reduced ambiguity in the Fresnel images. The frequency-selective images of the RIS approach explain the reflectivity pattern in the context of lateral variable heterogeneities and reveal more structural details.