



## Using 2D long-streamer seismic data waveform tomography to decipher sedimentary record of fault activity

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Acoustic full-waveform inversion (FWI), or waveform tomography, involves use of both phase and amplitude of the recorded compressional waves to obtain a high-resolution P-wave velocity model of the propagation medium. Recent theoretical and computing advances now allow the application of this highly non-linear technique to field data. This led to common use of the FWI for industrial purposes related to reservoir imaging, physical properties of rocks, and fluid flow. Application of FWI in the academic domain has, so far, been limited, mostly because of the lack of adequate seismic data. While refraction seismic datasets include large source-receiver offsets that are useful to find a suitable starting velocity model through traveltimes tomography, these acquisitions rarely reach the high density of receivers necessary for waveform tomography. On the other hand, multichannel seismic (MCS) reflection data acquisition has a dense receiver spacing but only modern long-streamer data have offsets that, in some cases, enable constraining subsurface velocities at a significant enough depth to be useful for structural or tectonic purposes.

In this study, we show how FWI can help decipher the record of a fault activity through time at the Shumagin Gap in Alaska. The MCS data were acquired on RV Marcus G. Langseth during the ALEUT cruise in the summer of 2011 using two 8-km-long seismic streamers and a 6600 cu. in. tuned airgun array. One of the most noticeable reflection features imaged on two profiles is a large, landward-dipping normal fault in the overriding plate; a structural configuration making the area prone to generating both transoceanic and local tsunamis, including from landslides. This fault dips ~40°- 45°, cuts the entire crust and connects to the plate boundary fault at ~35 km depth, near the intersection of the megathrust with the forearc mantle wedge. The fault system reaches the surface at the shelf edge 75 km from the trench, forming the Sanak basin where the record of the recent activity of the fault is not clear. Indeed, contouritic currents tend to be trapped by the topography created by faults, even after they are no longer active. Erosion surfaces and onlaps from contouritic processes as well as gravity collapses and mass transport deposits results in complex structures that make it challenging to evaluate the fault activity. The long streamers used facilitated recording of refraction arrivals in the target continental slope area, which permitted running streamer traveltimes tomography followed by FWI to produce coincident detailed velocity profiles to complement the reflection sections. FWI imaging of the Sanak basin reveals low

velocities of mass transport deposits and velocity inversions indicate mechanically weak layers linking some faults to gravity sliding on a décollement. These details question previous interpretation of a present-day active fault. Our goal is to further analyze the behavior of the fault system using the P-wave velocity models from FWI to quantitatively detect fluids and constrain sediment properties.