Estimating anelastic dispersion from uncorrelated vibroseis data

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Towards direct measurement of phase velocities

Vibroseis sweeps and dispersive geological volumes counteract one another: the sweep delays the arrival of high frequencies, and the the Earth hurries them along. In principle we can use this idea to directly measure phase velocity *c(f)*, rather than determine a Q value and infer a parametric *c(f)*.

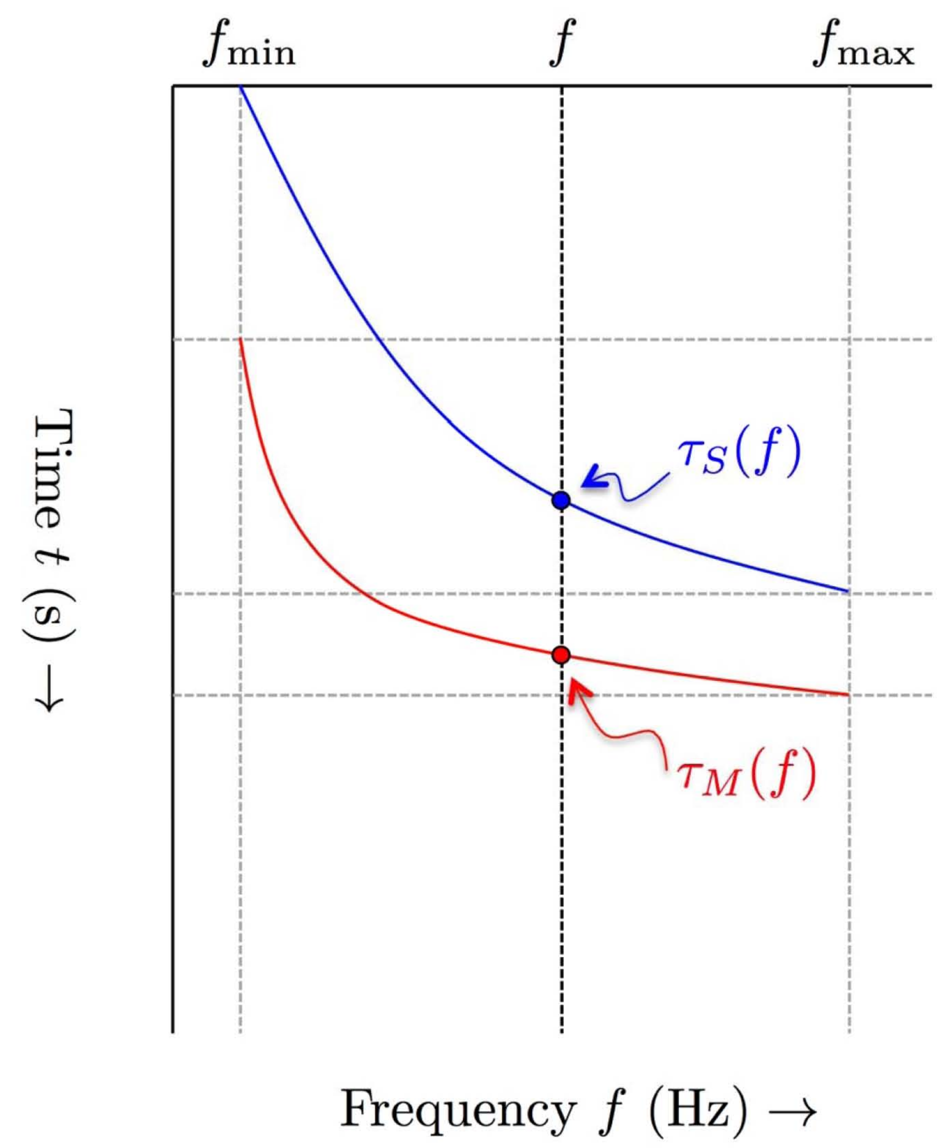

Fig. 1. Given a robust time-frequency spectrum estimate of the sweep program (blue) and a measured uncorrelated trace (red), the time at which a frequency f departs the vibe plate $\tau_S(f)$ and the time at which the same frequency arrives at a VSP geophone $\tau_M(f)$ can be used to determine the average velocity along the ray-path.

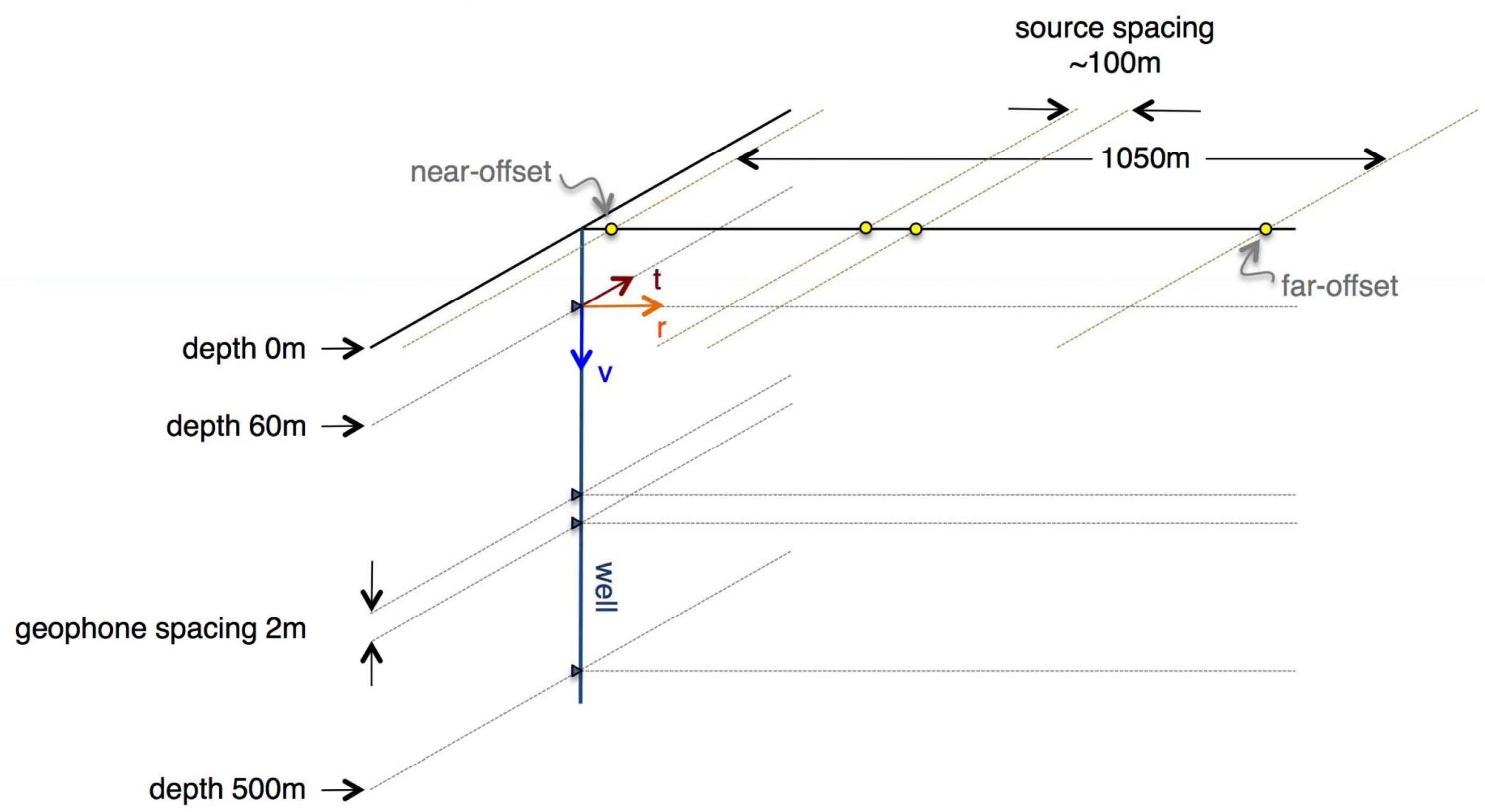

Fig. 2. Basic configuration and geometry of a3C WVSP. In this analysis we consider vertical component response at 120m depth with source point at 320m, which provides significant propagation distance through the near surface.

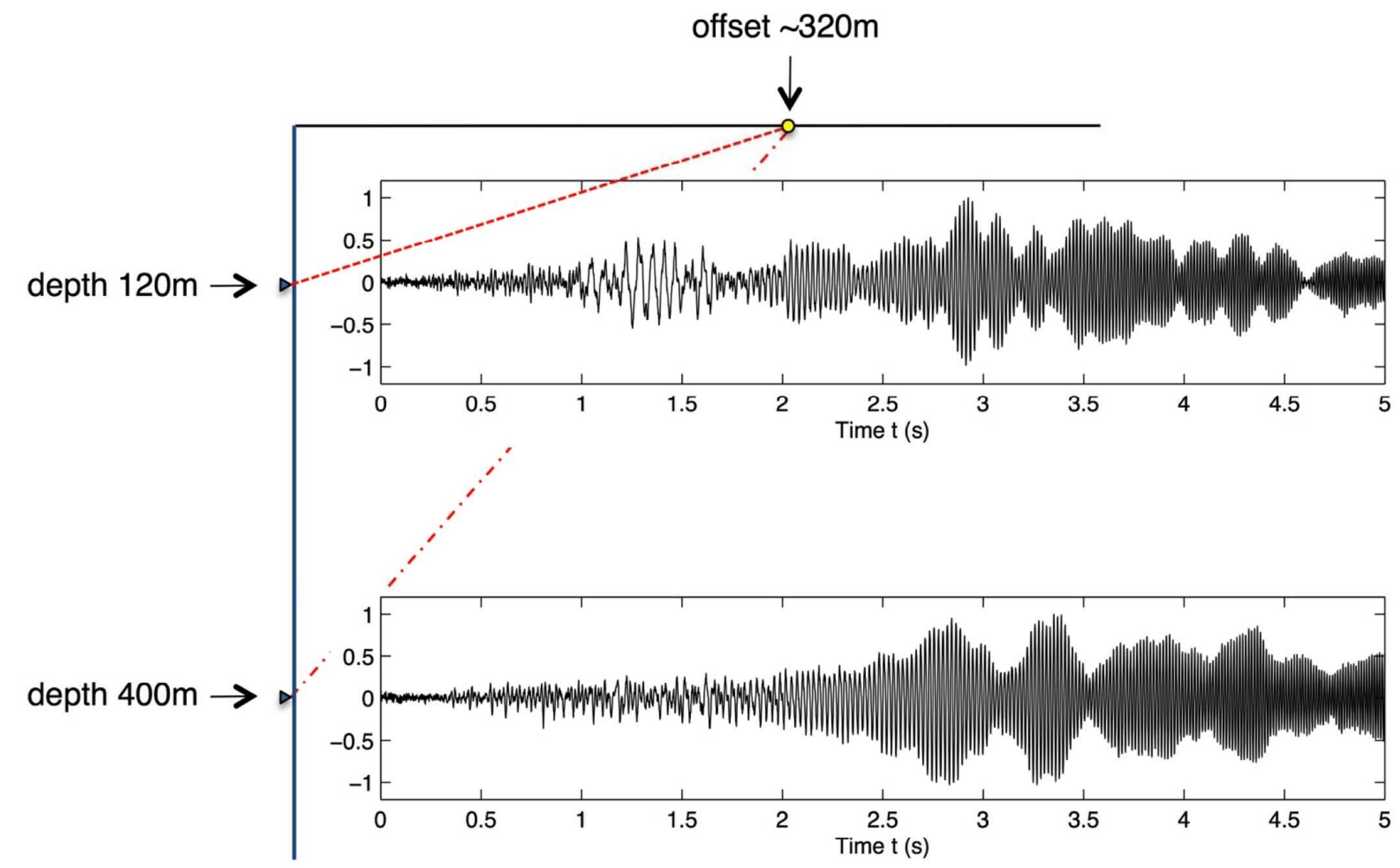

Fig. 3. Two candidate uncorrelated responses; raypath to shallower geophone samples preferentially the near surface, increasing likely degree of dispersion experienced.

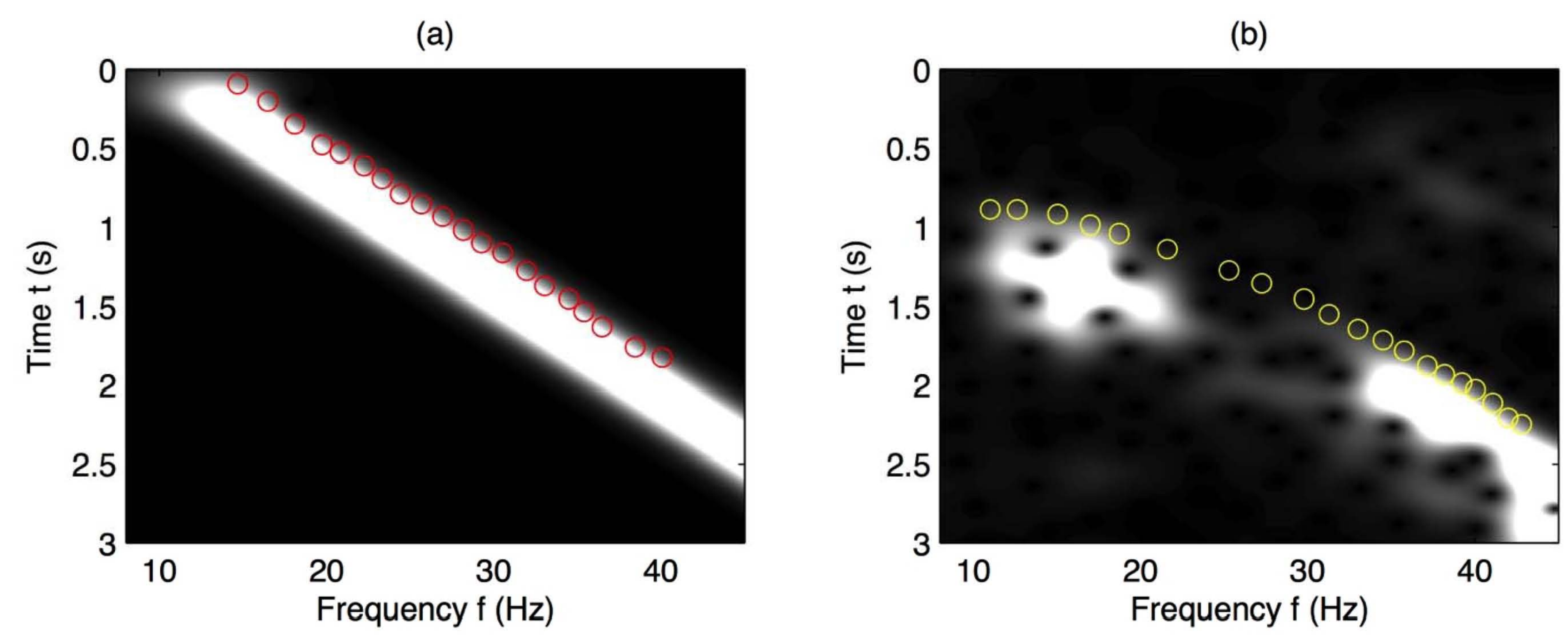

Fig. 4. Gabor spectra of (a) programmed sweep; (b) measured geophone resonse. First arrivals picked between 15-40Hz.

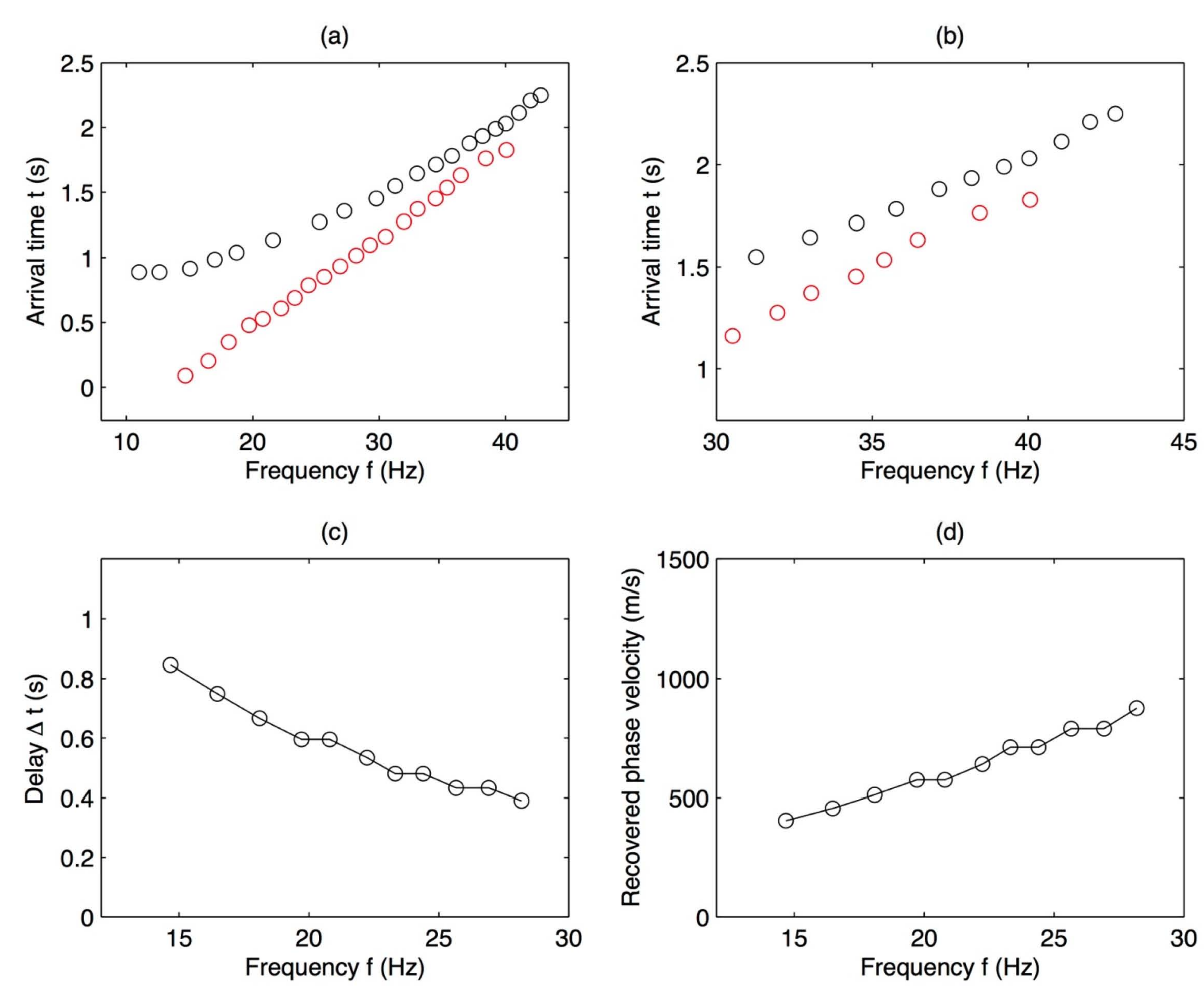

Fig. 5. (a) Sweep picks o vs observed picks o; (b) zoom on higher frequencies; (c) arrival minus departure times as a function of f, which are used with the assumption of straight raypaths to infer c(f) in panel (d). Independent validation will be carried out next.