Interference and the art of static correction: raypath interferometry at Hussar

David C. Henley
dhenley@ucalgary.ca

Introduction

A technique called ***'raypath interferometry'*** was developed by Henley (2012, Interferometric application of static corrections, Geophysics **77**, No. 1, Q1-Q13) specifically to address the application of ***near-surface corrections*** to data for which ***surface-consistency is violated***, or where near-surface structure leads to ***non-unique reflection arrivals***, and thus violates the static correction model assumptions. Two key ideas form the basis for the technique: the concept of ***'deconvolving' surface functions*** from seismic traces rather than 'static shifting' them; and the concept of replacing surface-consistency with ***'raypath-consistency'***, which In turn enables ***nonstationary near-surface corrections***. The method is a type of ***interferometry*** because it utilizes ***cross-correlation functions*** between raw traces and reference, or 'pilot' traces to create deconvolution operators to remove the ***surface functions*** from the raw traces; and it is ***raypath*** interferometry because the surface functions are estimated and deconvolved in the ***'common-angle' domain*** constructed from the ***radial trace (RT) transforms*** of the original trace gathers. The technique has been shown to be effective on several difficult data sets. Because of its less-restrictive assumptions, the method can also be applied to seismic data where conventional methods are effective, although its application is more involved. Because of interesting hints on earlier data sets that the method ***may enhance interpretable details*** relative to conventional approaches, we decided to test it on low-frequency data from our Hussar experiment. ***Judgment is still pending.***

Results

We processed several of the available sets of seismic data, but we present here only the ***vertical component Vectorseis data with buried dynamite source***, as well as the corresponding ***radial component Vectorseis data***. With the vertical component data, we pre-processed the data with specially designed (low-frequency) RT filters and Gabor deconvolution to attenuate coherent noise and whiten the reflection signal spectrum while ***preserving low freqencies***. These pre-processed data were subjected to ***conventional residual statics methods*** (Isaac) and, independently, to ***raypath interferometry*** for close comparison. The radial component data, on the other hand, were processed completely independently by Isaac (correct CCP, conventional processing), and Henley (approximate CCP, raypath processing), and are not as comparable. Figure 1 shows the CMP stack of the ***conventionally processed*** vertical component data, while Figure 2 shows the CMP stack of the same data after ***raypath interferometry***. Figure 3 is the power spectra of the CMP stack in Figure 2, while Figure 4 is the phase spectra, both as functions of CMP. These two figures appear to verify that the ***coherent reflection spectrum*** for Figure 2 covers the range of about ***3Hz-65Hz***. Figure 5 shows the (correct) CCP stack of the conventionally processed radial component data, while Figure 6 shows the (approximate) CCP stack of the radial data after raypath interferometry. Because of other processing differences, the image differences between Figures 5 and 6 may be due to more than the difference in static correction procedures. To verify that raypath interferometry does, in fact, correct the large receiver statics in these data, Figure 7 shows the common-receiver stack ***before interferometry***, and Figure 8 the receiver stack ***after interferometry***.

Comments: ***We welcome any comments on the comparisons shown***

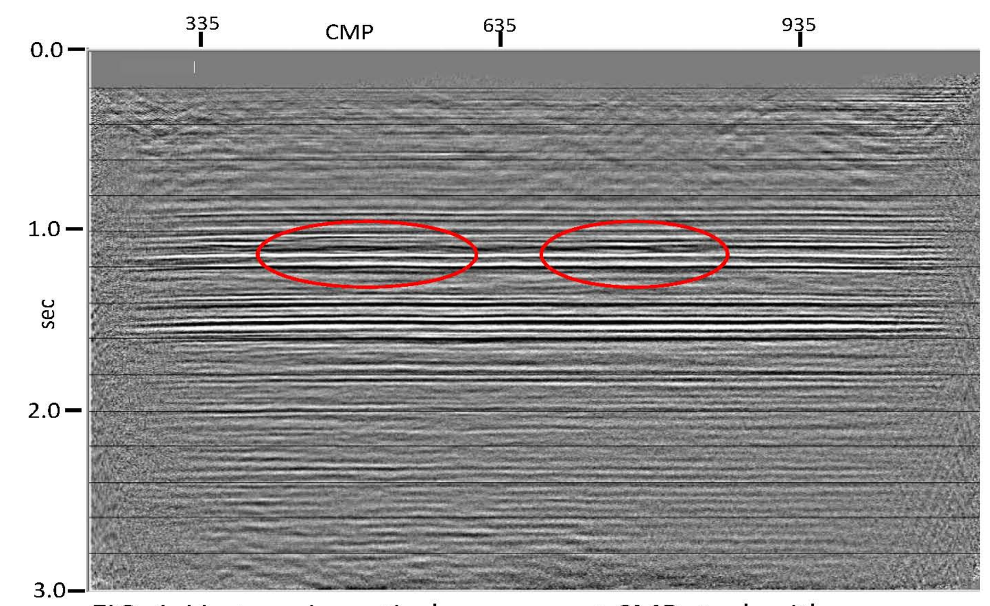

FIG. 1. Vectorseis vertical component CMP stack with conventional processing and residual statics—no post-stack processing.

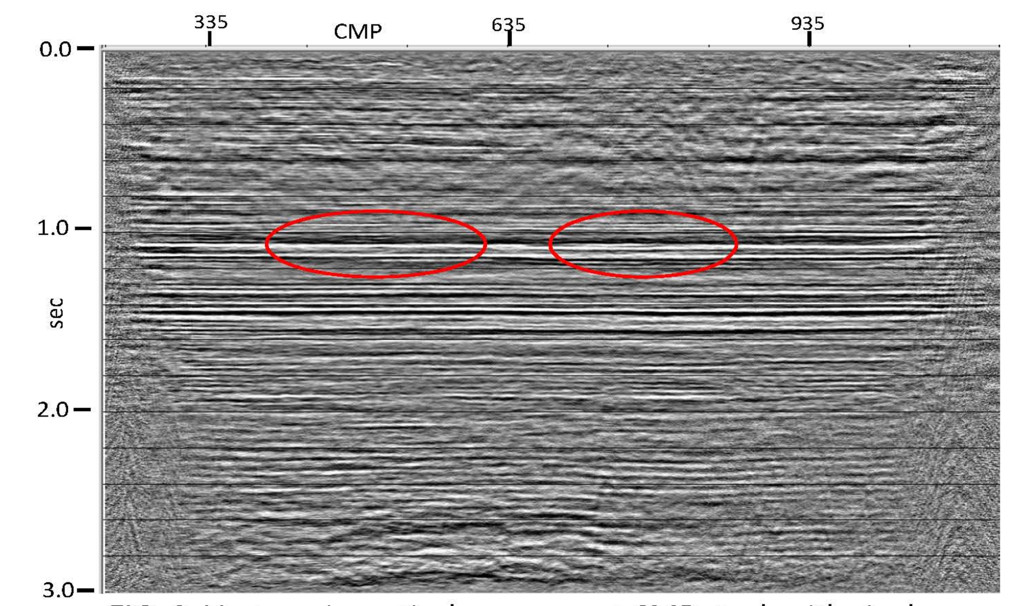

FIG. 2. Vectorseis vertical component CMP stack with single NMO function, raypath interferometry, post-stack Gabor decon and FX decon to attenuate random noise.

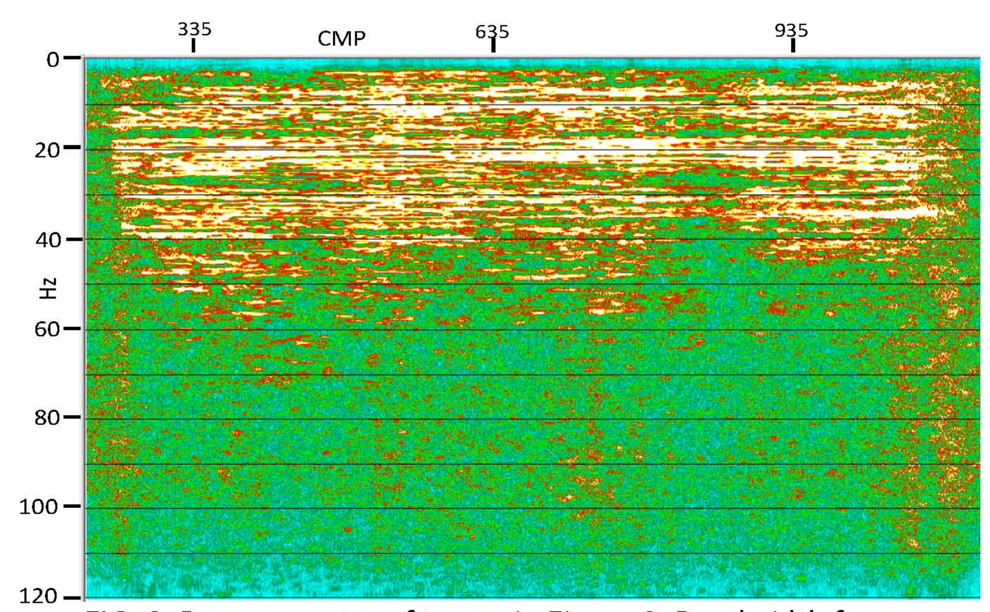

FIG. 3. Power spectra of traces in Figure 2. Bandwidth for these data appears to be about 3Hz-65Hz.

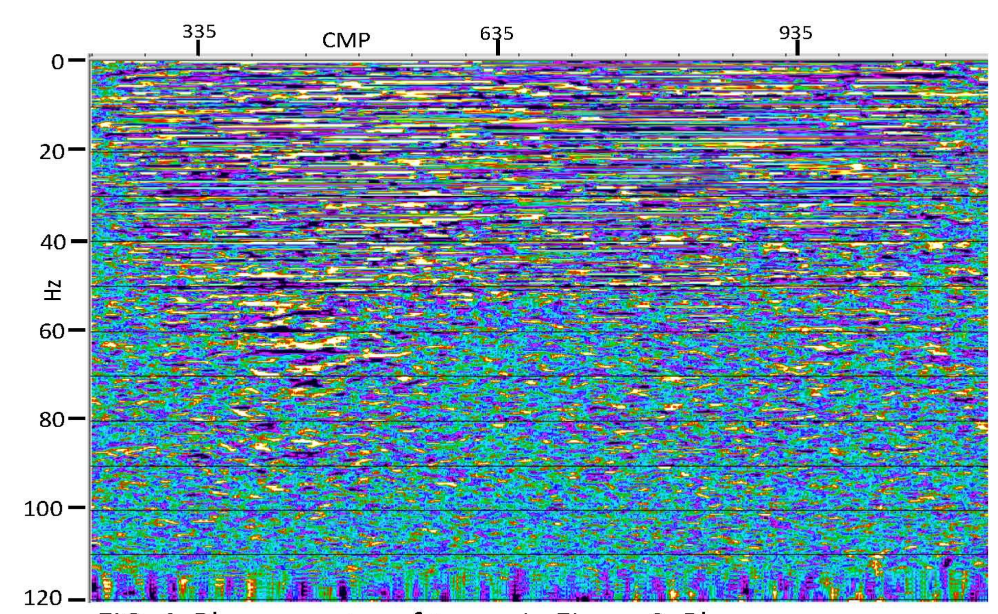

FIG. 4. Phase spectra of traces in Figure 2. Phase appears coherent from about 3Hz to 65Hz.

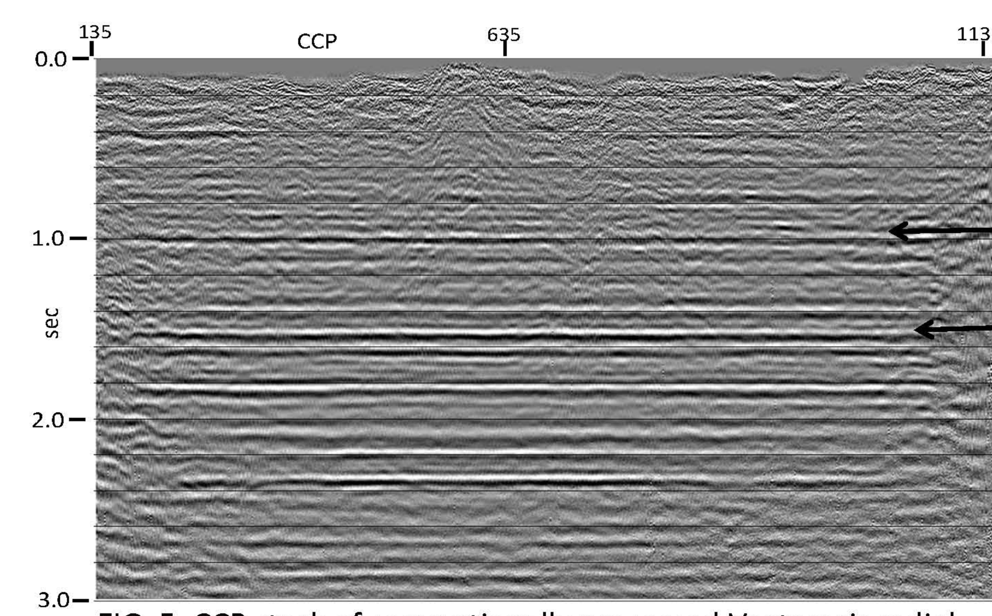

FIG. 5. CCP stack of conventionally processed Vectorseis radial component.

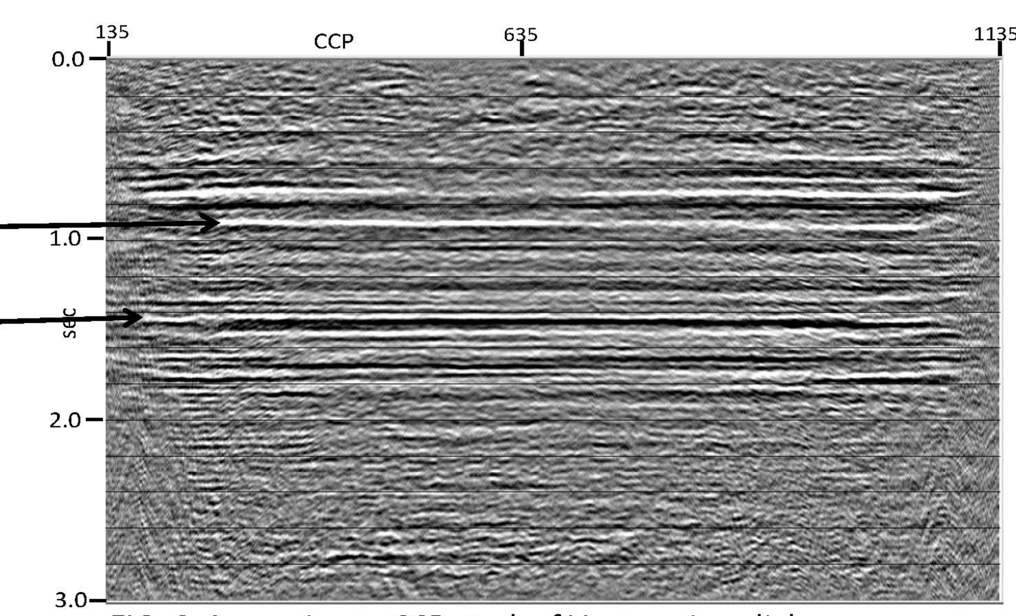

FIG. 6. Approximate CCP stack of Vectorseis radial component after raypath interometry.

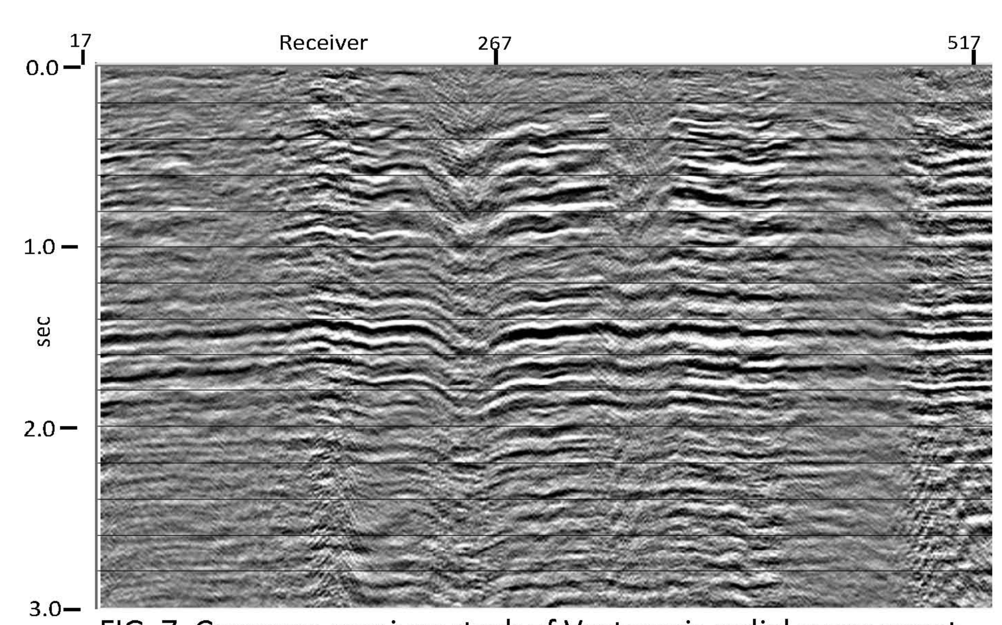

FIG. 7. Common receiver stack of Vectorseis radial component data before raypath interferometry.

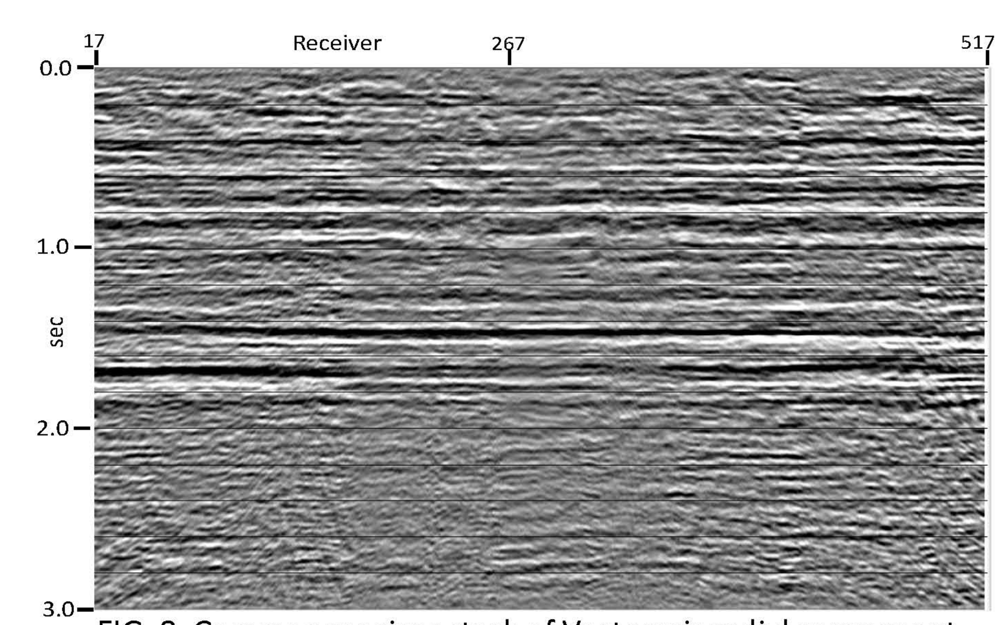

FIG. 8. Common receiver stack of Vectorseis radial component data after raypath interferometry.