Projections: a new look at an old diagnostic

David C. Henley*
dhenley@ucalgary.ca [contact info for first author]

Introduction

Projections are one of the oldest mathematical tools used in processing seismic data—we project data every time we stack, for example; we re-examine the topic here with an eye to new ***diagnostic*** uses.

We demonstrate projections using a 4D seismic time-lapse experiment from Violet Grove, Alberta.

We outline a possible method for finding and applying ***nonstationary statics*** using ***'focal point'*** projections.

The concept of projections

Figure 1 illustrates the most commonly used projections for analyzing seismic data—as well as a less common one: the common-offset stack. As portrayed in **Figure 1**, projections are summations or stacks, along particular directions, of seismic traces sorted by surface location coordinates. Projections parallel to a single surface coordinate (S or G) highlight details related to the surface; while projections along other directions enhance deeper attributes. **Figure 2** shows that other projection directions can be considered—the so-called 'focal point' projections, which highlight anomalies between the surface and the reflection depth.

"Common" data projections as diagnostics

Henley
(dhenley@ucalgary.ca)

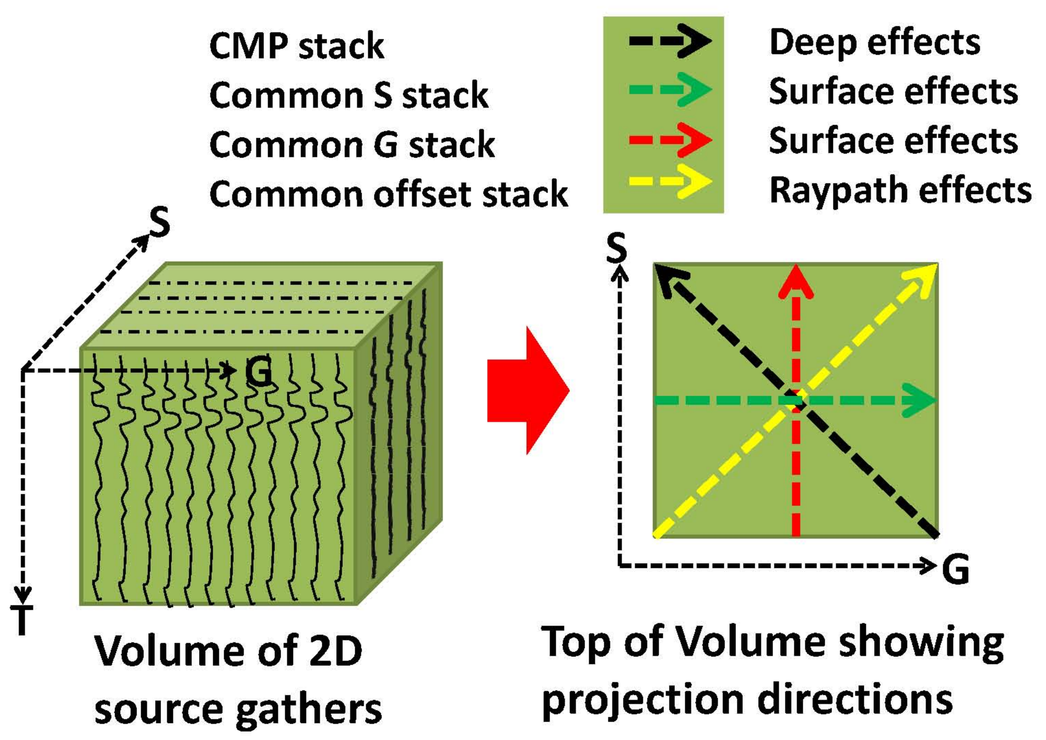

FIG. 1. The most common projections used on multifold 2D data volumes. Common S or G stacks help analyze surface statics; CMP stack images reflections; Common offset stack looks at AVO.

"Uncommon" data projections as diagnostics

Henley
(dhenley@ucalgary.ca)

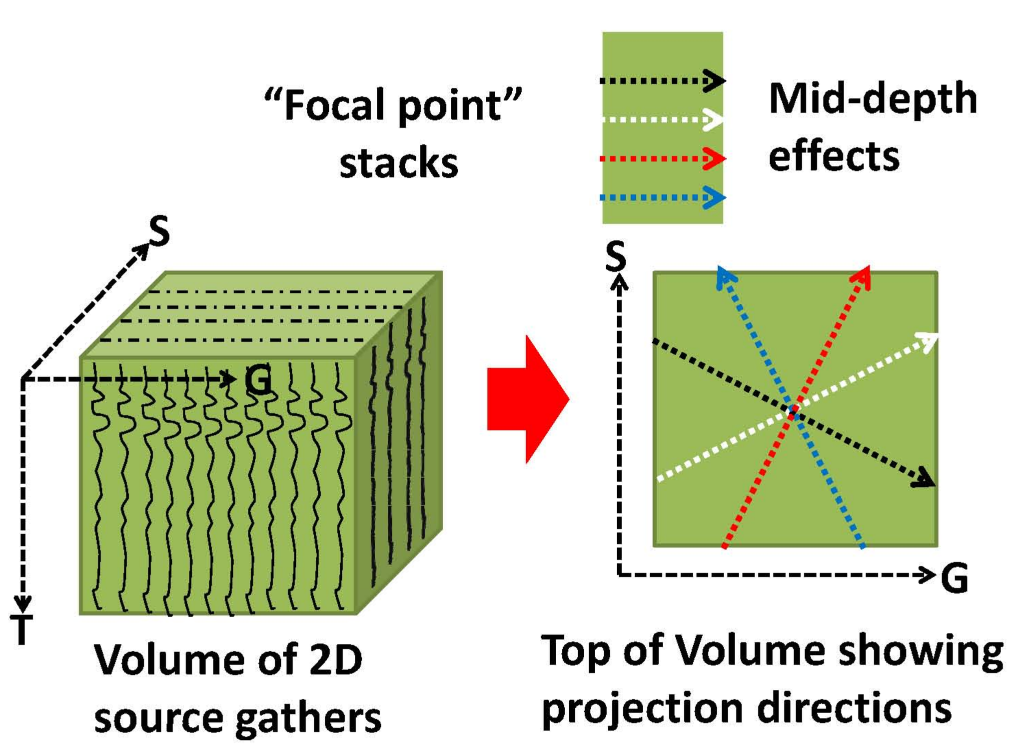

FIG. 2. Stacking along directions intermediate to those in Figure 1 help highlight anomalies that are intermediate between the surface and reflecting horizons—'focal points'.

Demonstrating projections at Violet Grove

Below, we use **CMP** stacks, **common-source** stacks, **common-offset** stacks, **common-raypath** stacks, and inverse-RT-transformed common-raypath stacks, as well as **least-square differences** of these stacks to look for the domain in which a time-lapse anomaly is most visible.

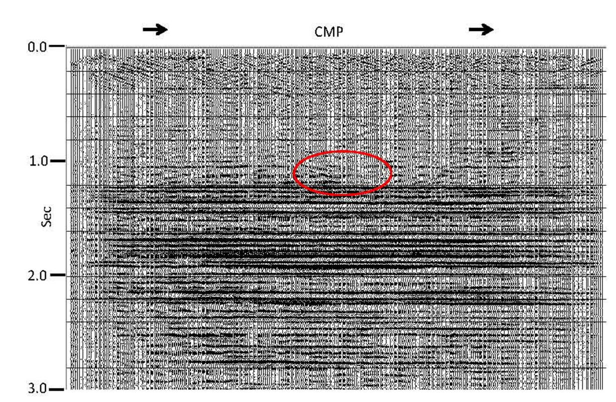

FIG. 3. CMP stack of 2005 survey

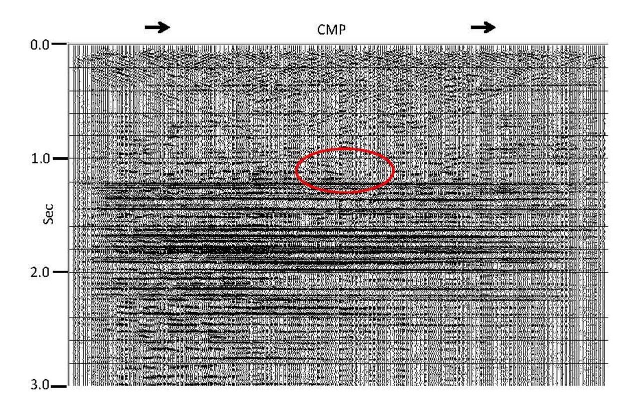

FIG. 4. CMP stack of 2007 survey

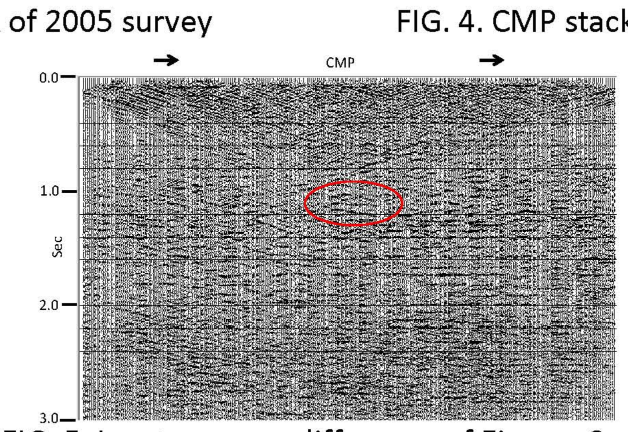

FIG. 5. Least-squares difference of Figures 3 and 4

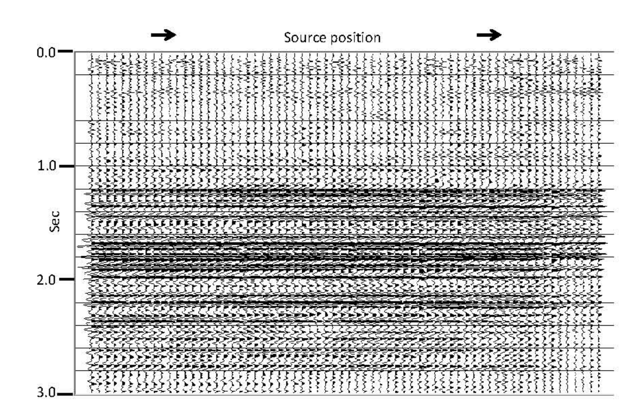

FIG. 6. Common-shot stack of 2005 survey

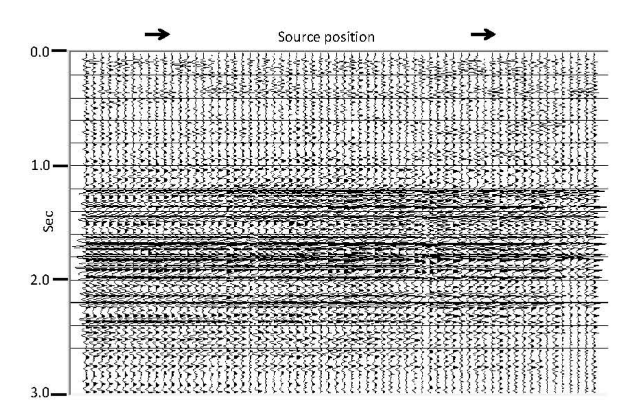

FIG. 7. Common-shot stack of 2007 survey; *statics and amplitude problems are evident*

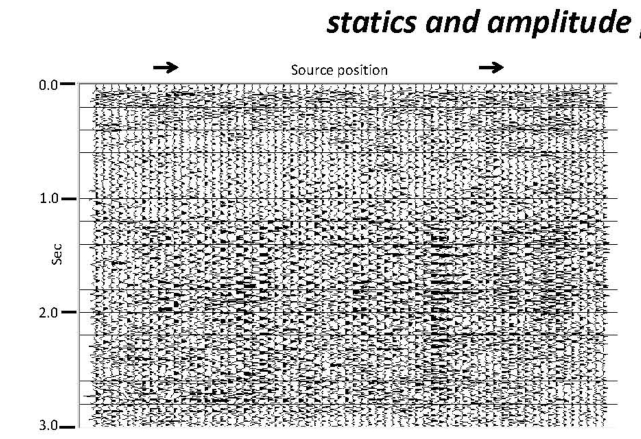

FIG. 8. Least-squares difference of Figures 6 and 7

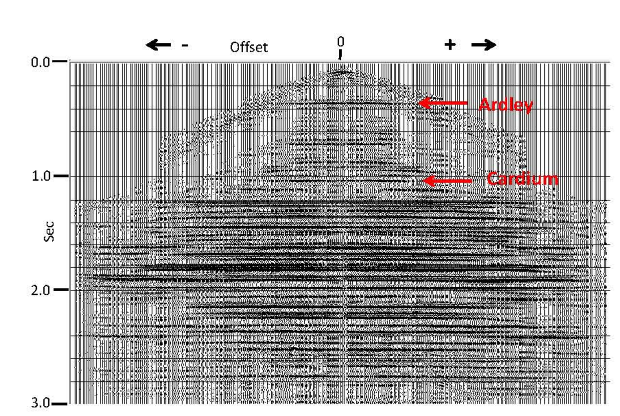

FIG. 9. Common-offset stack of 2005 survey

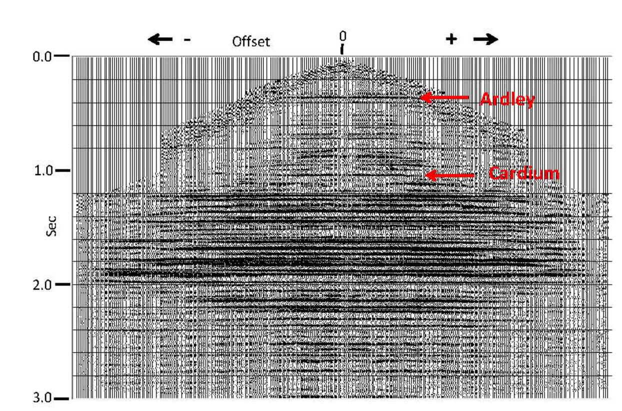

FIG. 10. Common-offset stack of 2007 survey

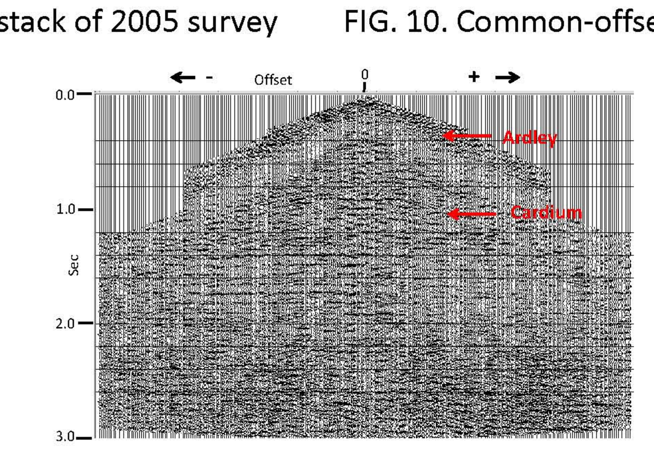

FIG. 11. Least-squares difference of Figures 9 and 10

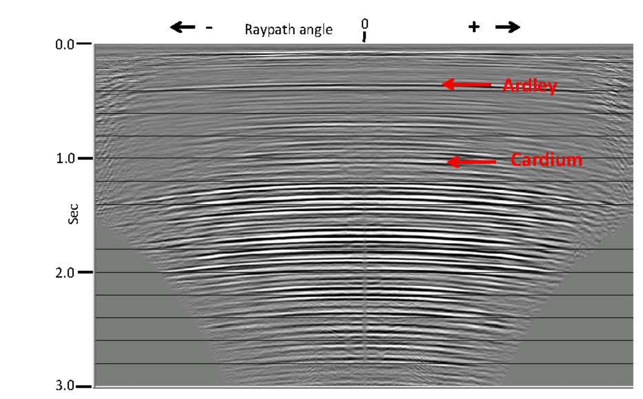

FIG. 12. Common-raypath stack of 2005 survey

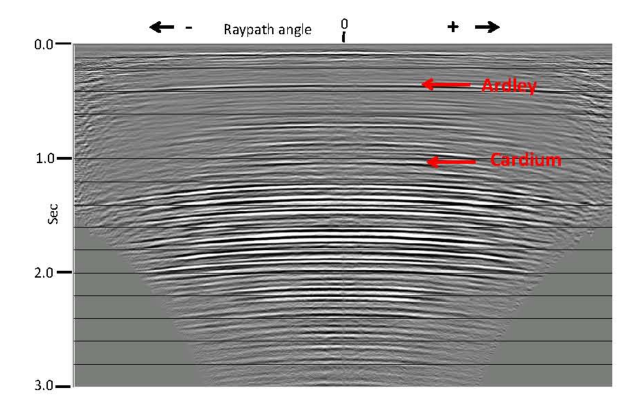

FIG. 13. Common-raypath stack of 2007 survey

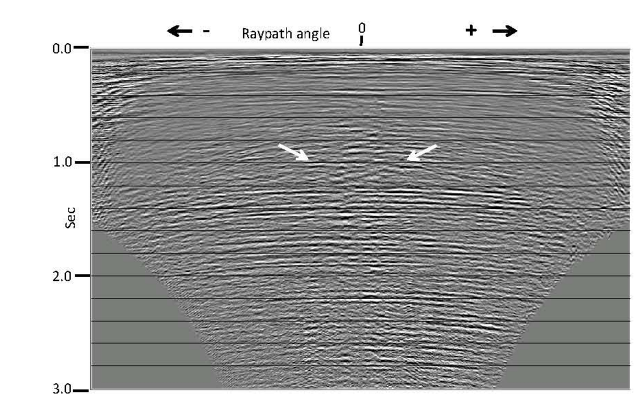

FIG. 14. Least-squares difference of Figures 12 and 13

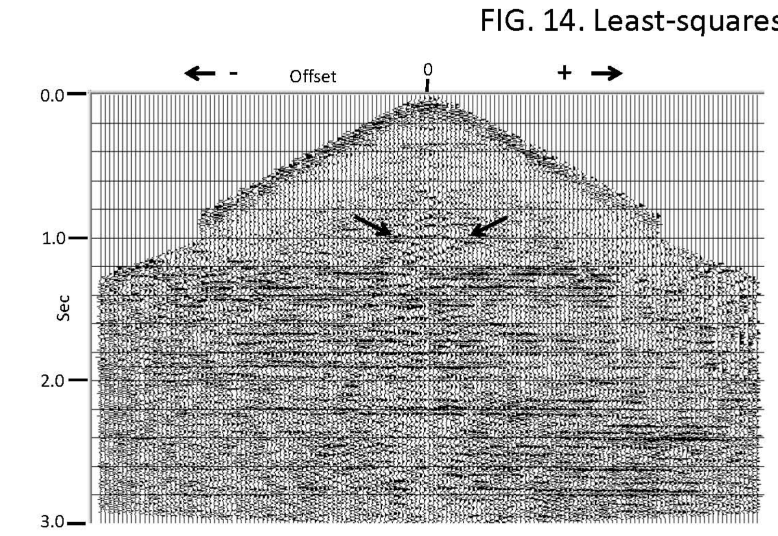

FIG. 15. Inverse RT transform of Figure 14

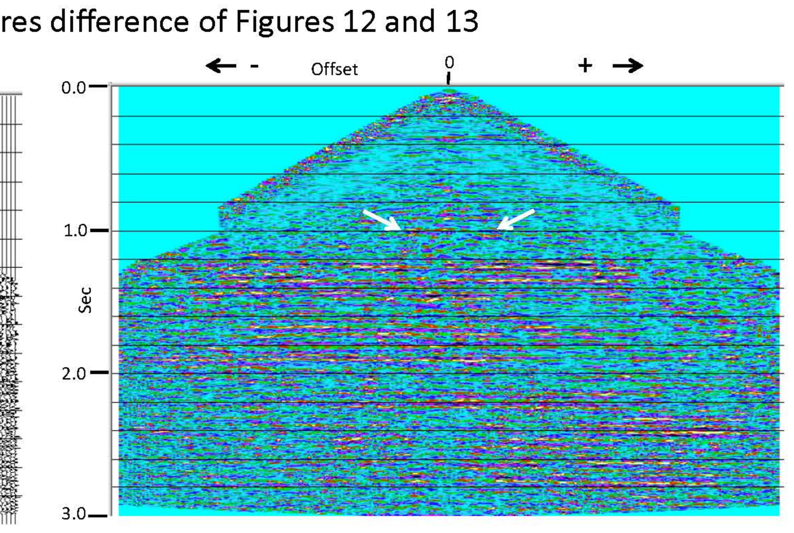

FIG. 16. Colour version of Figure 15

Comments

The various projections of two vintages of Violet Grove 2D data are more instructive than definitive. ***There are no displays on which amplitudes in the potential anomalous zone are large enough, when compared to the background, to identify an amplitude anomaly unambiguously.*** The common-source projections show us that some of the image differences we detect on other projections may be due to unresolved statics/amplitude differences.

Future 'Project-ion'

We intend to investigate 'Focal Point' projections as a way to accommodate nonstationary statics in the following way:

- Project a raw 2D data set along ***S direction***; find and apply ***G statics*** from reflection cross-correlations.
- Project the G-corrected data along ***G direction***; find and apply ***S statics***.
- Project the G + S-corrected data along a ***focal point direction*** near the S direction; find and apply these ***focal point statics***.
- Project the focal-point-corrected data along a ***conjugate focal point direction*** near the G direction; find and apply ***these focal point statics***.
- Continue as above until focal point direction is the same as ***CMP direction***; find and apply final ***"trim" statics*** in the CMP domain.

The method outlined above would constitute a kind of "iterated back-projection" algorithm, closely related to the SIRT algorithm used in travel-time tomography .