Preliminary processing results, Spring Coulee, Alberta

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ABSTRACT

In January of 2008, a 3C-2D seismic program was by conducted by CREWES, ARAM and CGGVeritas near Spring Coulee, Alberta. A variety of data was recorded using two types of analog sensors (SM7, SM24) and one type of digital sensor (DSU3) by two different recording systems (ARAM and Sercel). The line was acquired with three different sources, dynamite, one EnviroVibe, and two Mertz Hemi vibes. Three additional 1C-2D lines were acquired in the area, using SM24 sensors and the University's ARAM system and EnviroVibe, as part of the 2008 geophysics 549 field school. Data quality is generally high, but some work remains to be done, particularly on P-S statics.

INTRODUCTION

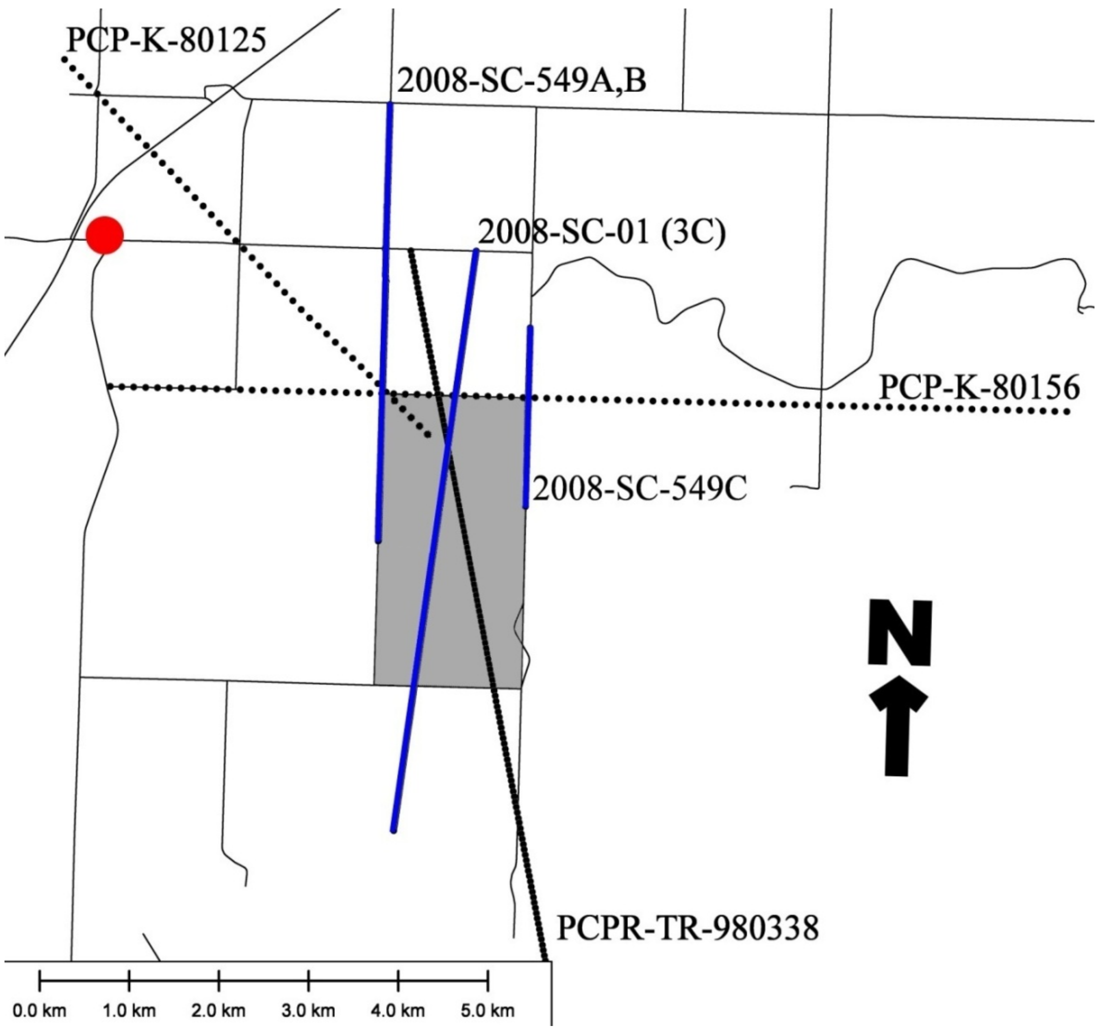

FIG. 1. Location map. The University of Calgary holds subsurface rights excluding coal for the two sections shaded in gray. Seismic lines acquired in 2008 are highlighted in blue.

In January of 2008, a 3C-2D seismic program was by conducted by CREWES, ARAM and CGGVeritas near Spring Coulee, Alberta (2008-SC-01; Figure 1). An overview of the Spring Coulee 3C-2D survey is given by Bertram et al. (2008). Two parallel ~6.5 km long receiver lines were laid out, consisting of co-located SM7 and DSU3 sensors. Near the centre of these receiver lines, there were two additional forty geophone (SM24) receiver lines, to be used for a ARAM/Sercel recording system comparison. Sensor and recording system comparisons are given by Bertram et al. (2008), and Hons and Stewart (2008). The line was shot with three different sources, the northern half with a single EnviroVibe, the north central quarter with dynamite, and the entire line with two Merz Hemi buggy-mounted vibrators.

Then, in August/September of 2008, three additional 1C-2D lines were acquired as part of the geophysics 549 field school. Two of these lines, 2008-SC-549A and 2008-SC-549B (~4.8 km long), used the same receiver line (SM24 sensors at 10 m), but 549A was shot with a VP at every flag (10 m), while 549B was shot at every second flag (20 m).

Overall, topography in the survey area slopes from south to north along the 2008-SC lines. Even after taking this slope into account, a monocline involving rocks through the entire thickness of the sedimentary basin is consistently imaged (see also van der Velden, 1996; Ostridge and Stewart, 2008). A detailed interpretation for the survey area, including the PCP lines shown in Figure 1 can be found in Ostridge and Stewart (2008).

Converted wave statics are always an issue; While the preliminary migrated radial component sections presented here clearly need more processing effort, the Spring Coulee data have since been used in at least two studies focusing on shear statics (Al Dulaijan, 2008; Henley and Daley, 2008).

This report presents preliminary vertical component (P-P) and radial component (P-S) migrated sections, processed using the standard processing flow in use at CREWES (eg. Lu and Margrave, 1998; Lu and Hall, 2003). Suarez and Stewart (2008a, 2008b) show additional processing results and data comparisons. Our initial results are presented in the same order that the data were acquired:

Line 2008-SC-01, EnviroVibe results

The first line acquired in January used the University of Calgary's EnviroVibe, as a test line using just the ARAM recorder and SM7 sensors. Just over half the line was shot, starting at the north end with a VP at every flag, as geophones were still being planted to the south. The southern part of the source line was acquired with a VP at every second station (Figure 2). The migrated vertical component section (Figure 3) clearly shows a monocline with apparent north-dip, involving sedimentary rocks from the basement to the surface. This feature is also seen on other lines in the area (van der Velden, 1996; Ostridge, 2008). Unfortunately, the monocline is obscured on the preliminary migrated P-S section, due to shear statics and general signal-to-noise issues (Figure 4).

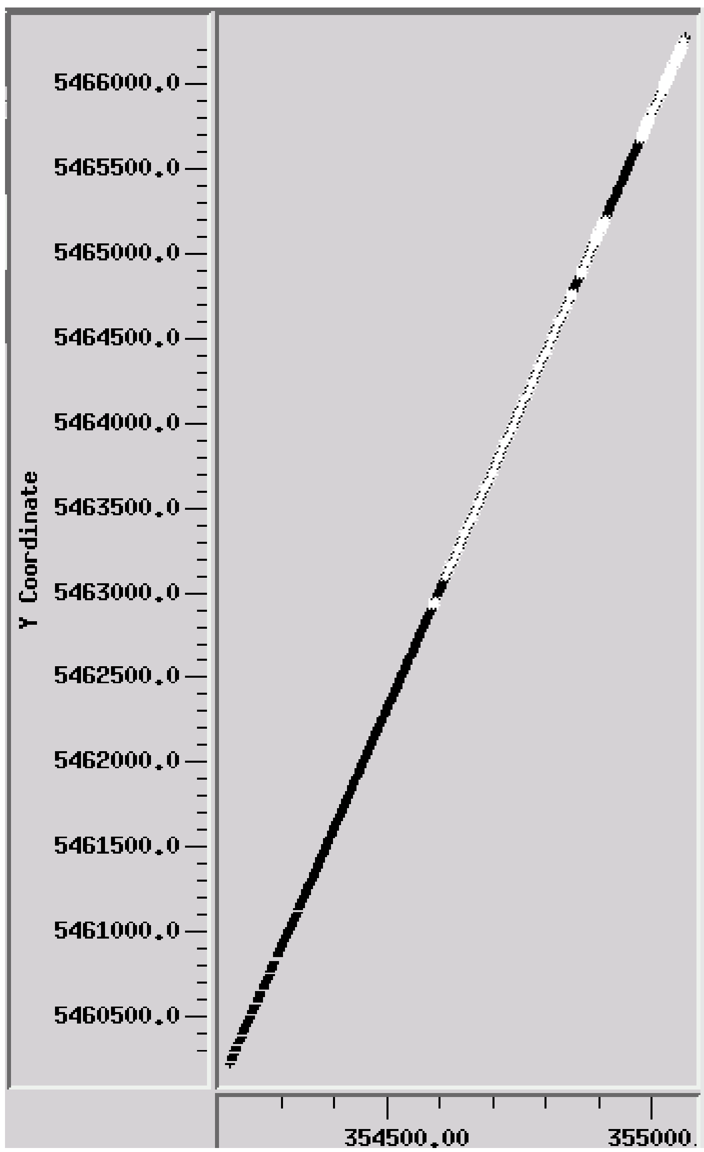

FIG. 2. Line 2008-SC-01, EnviroVibe source (Vibe points, white; Receivers, black). North is up.

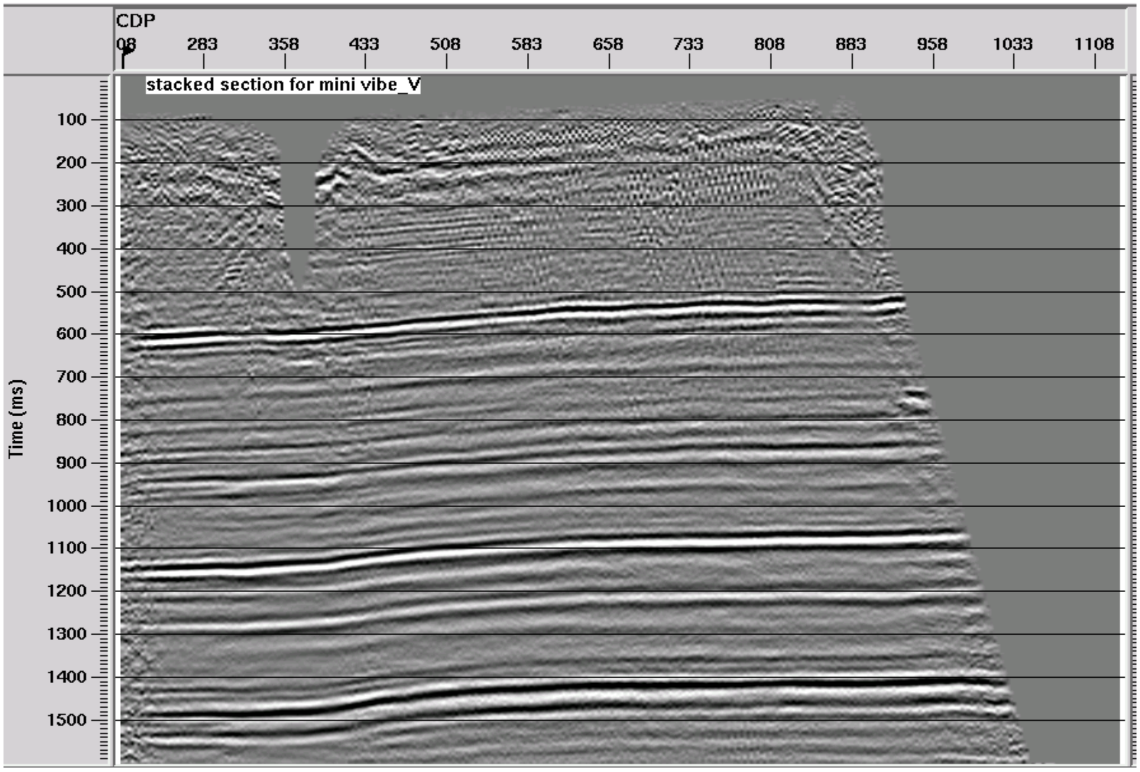

FIG. 3. Line 2008-SC-01, migrated P-P section. ARAM, EnviroVibe, SM7. North is left.

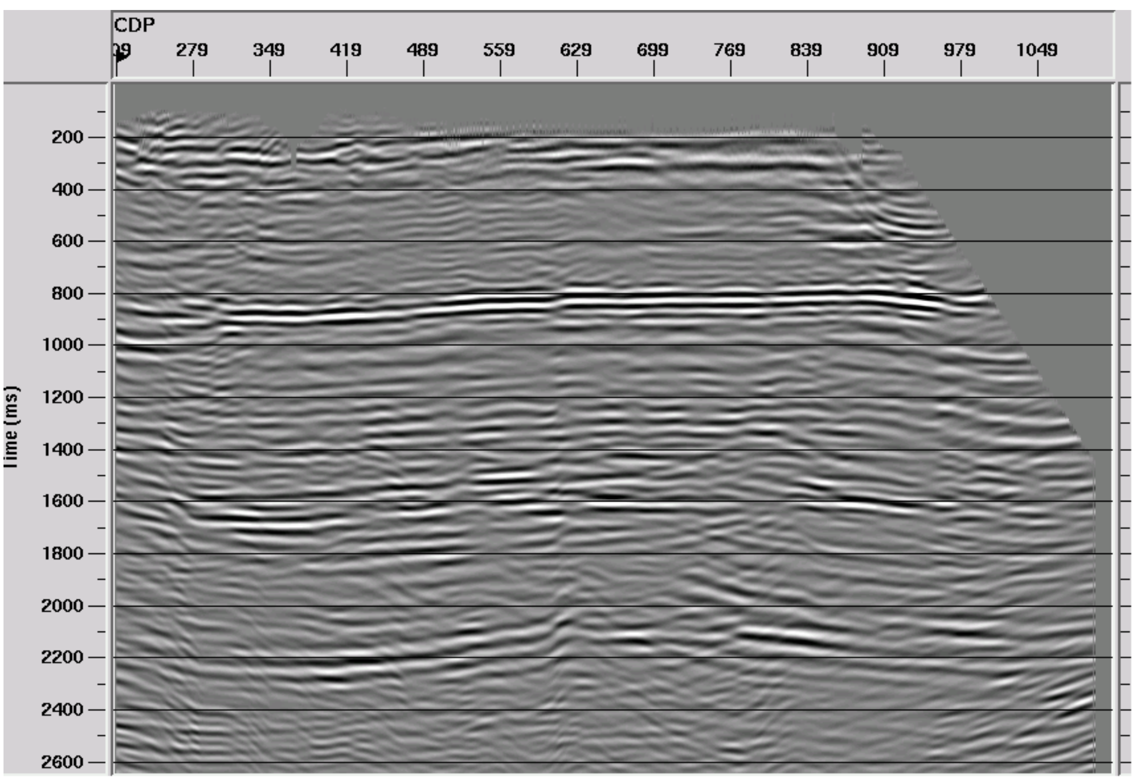

FIG. 4. Line 2008-SC-01, migrated P-S section. ARAM, EnviroVibe, SM7. North is left.P-S migrated section, ARAM, mini-vibe, north is left.

Line 2008-SC-01, Dynamite results

The second January line (production line) used 2 kg dynamite shots at 18 m depth, with a shot every third flag for about one quarter of the total receiver line length (Figure 5). At this time, the SM7 and DSU3 receiver lines were fully deployed. These shots were simultaneously recorded by the ARAM and Sercel systems. At the scale shown (Figures 6 and 7) there are no apparent differences in the migrated P-P sections. However, while the preliminary migrated P-S sections look similar (Figures 8 and 9), there are visible differences. Receiver statics are clearly an issue for these sections, and valid comparisons cannot be made until these issues are solved. Unlike the migrated EnviroVibe P-S section, the monocline is still clearly visible on these data.

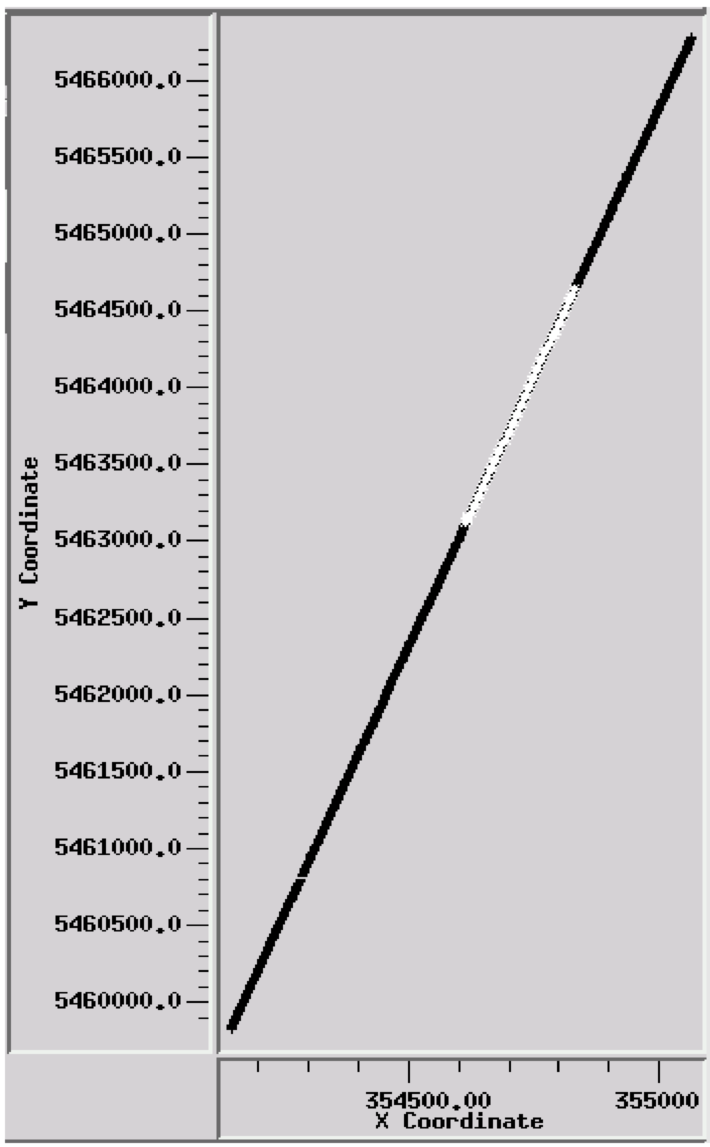

FIG. 5. Line 2008-SC-01, Dynamite source (Shot points, white; Receivers, black). North is up.

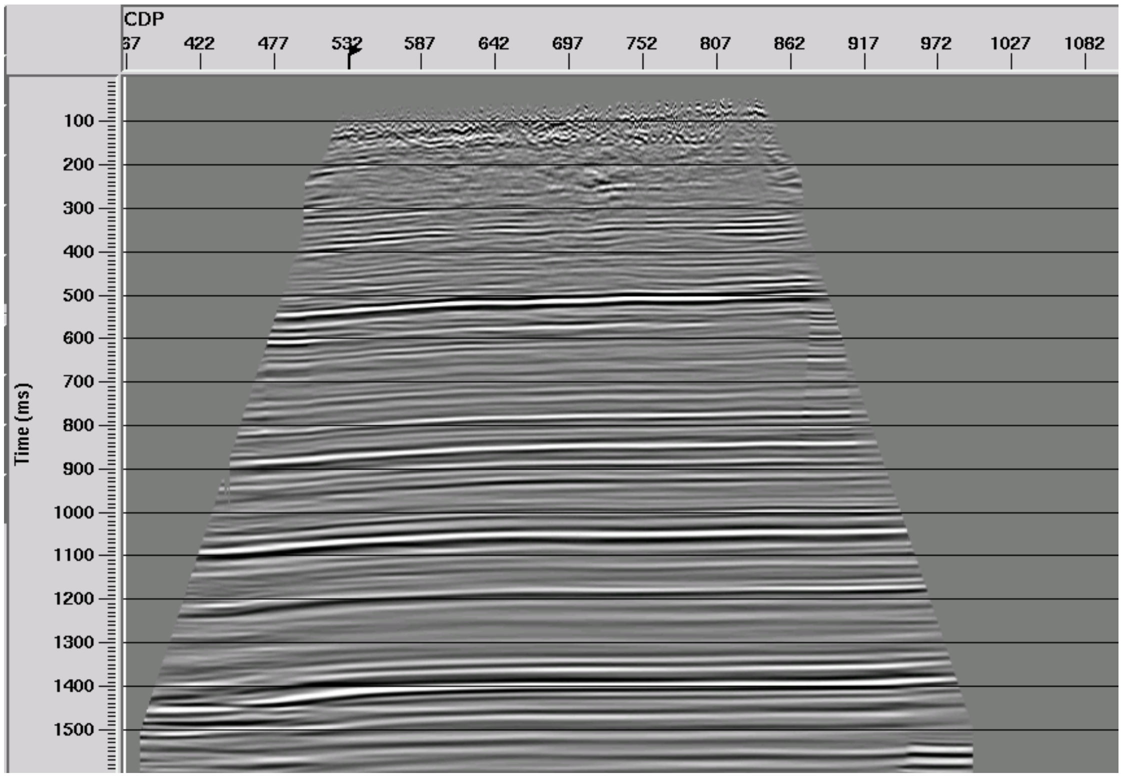

FIG. 6. Line 2008-SC-01, migrated P-P section. ARAM, dynamite, SM7. North is left.

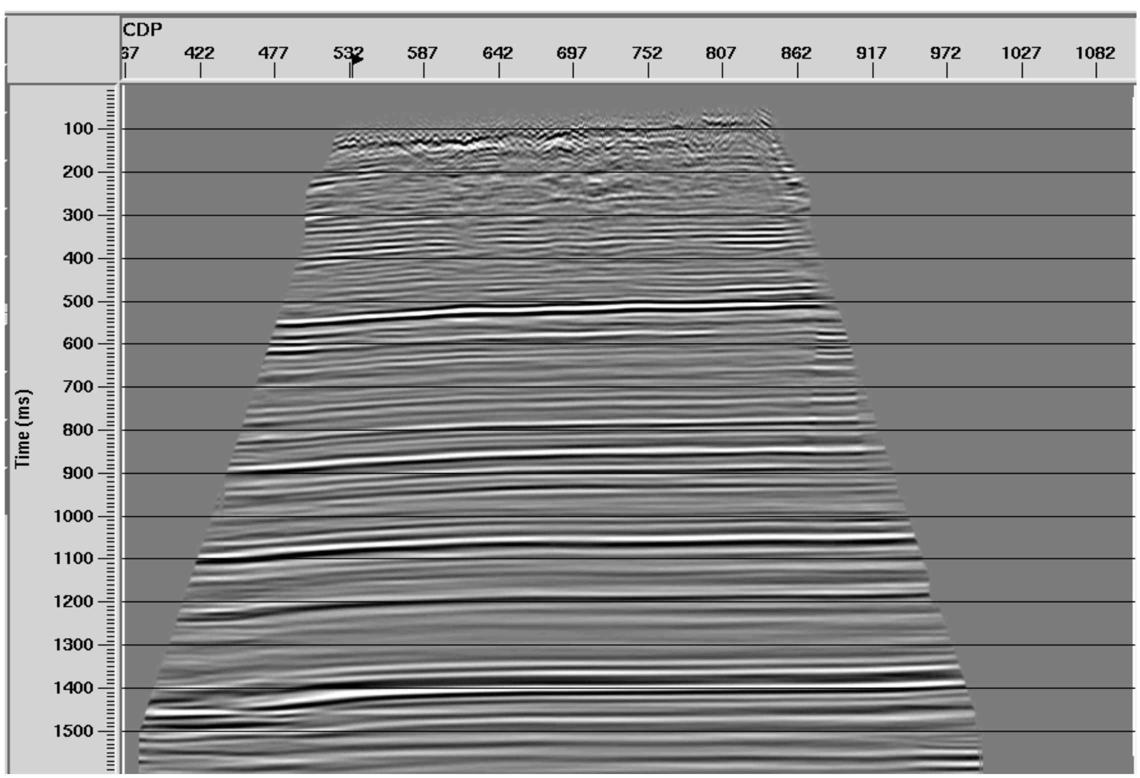

FIG. 7. Line 2008-SC-01, migrated P-P section. Sercel, dynamite, DSU3. North is left.

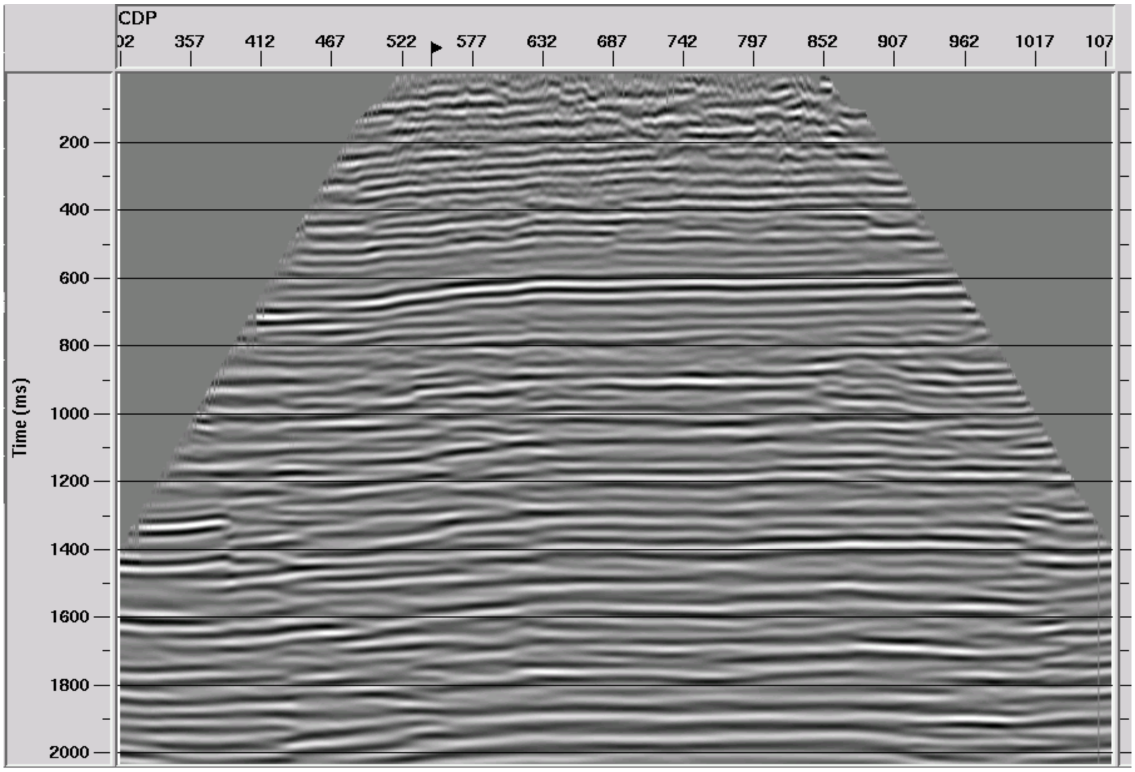

FIG. 8. Line 2008-SC-01, migrated P-P section. ARAM, dynamite, SM7. North is left.

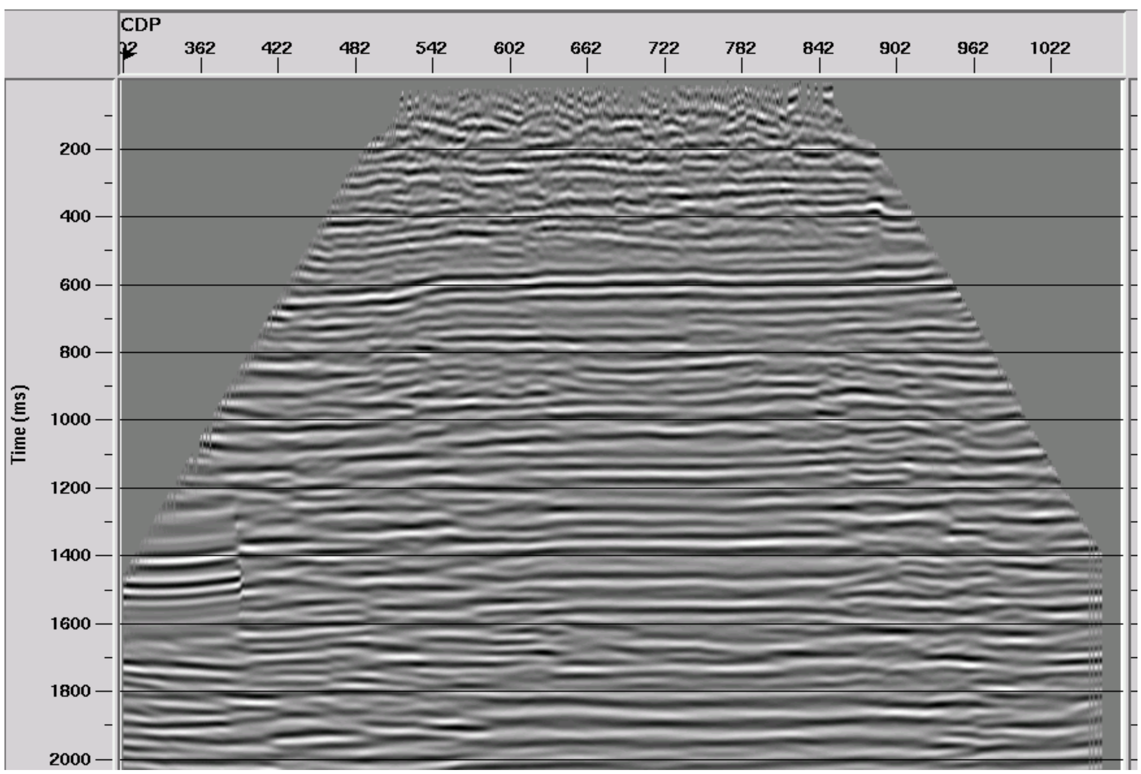

FIG. 9. Line 2008-SC-01, migrated P-S section, Sercel, dynamite, DSU3. North is left

Line 2008-SC-01, Mertz results

The second and final production line acquired in January used two Mertz buggy mounted vibrators provided by CGGVeritas, with a VP every third station acquired from north to south (Figure 10). The vibes were unable to continue to the very south end of the receiver line, due to topography. The sweeps were simultaneously recorded by the ARAM and Sercel systems. As expected, the largest source effort provides the best images (Figures 11 and 12). While there some possible statics issues are visible in these images, the monocline is clearly imaged, together with an associated fault. Once again, the migrated P-P sections are very similar, but the P-S sections differ. The monocline is still visible on the preliminary migrated ARAM P-S section (Figure 13), but has largely disappeared from the Sercel section (Figure 14), likely due to issues with our shear statics solution. Also, the Sercel/DSU3 shot records appear to show poor signal-noise on the south half of the receiver line relative to the north half. This effect carries through to the stacked and migrated P-S sections.

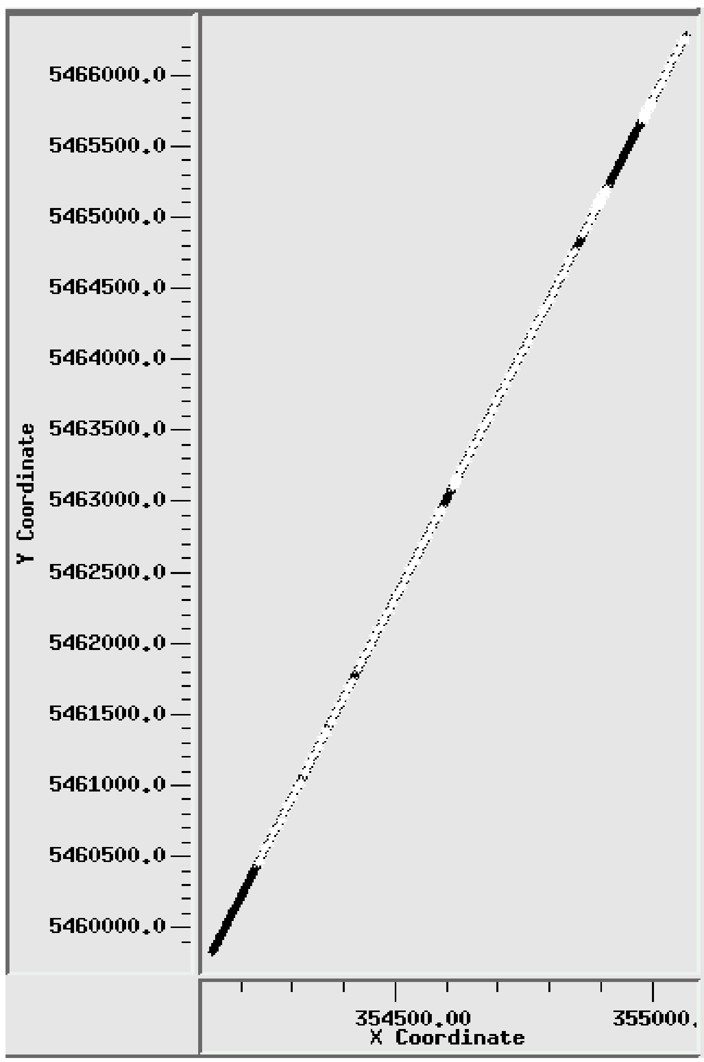

FIG. 10. Line 2008-SC-01, 2xMertz source (Vibe points, white; Receivers, black). North is up.

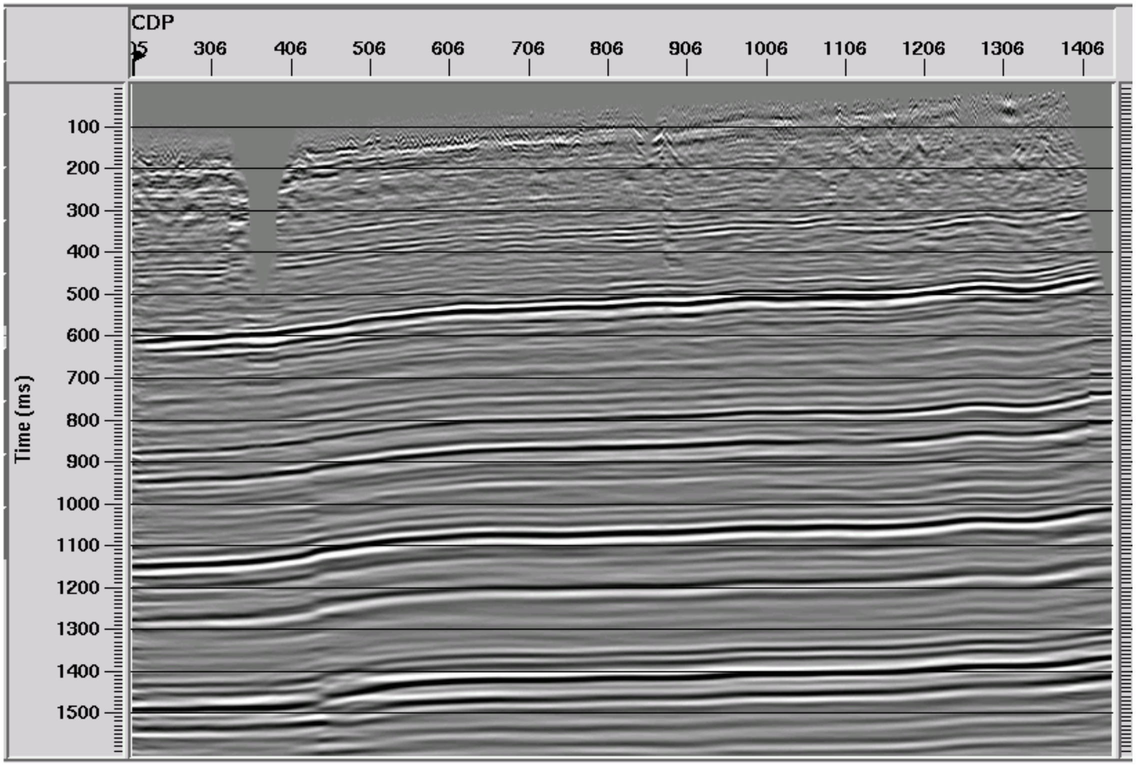

FIG. 11. Line 2008-SC-01, migrated P-P section. ARAM, 2xMertz, SM7. North is left.

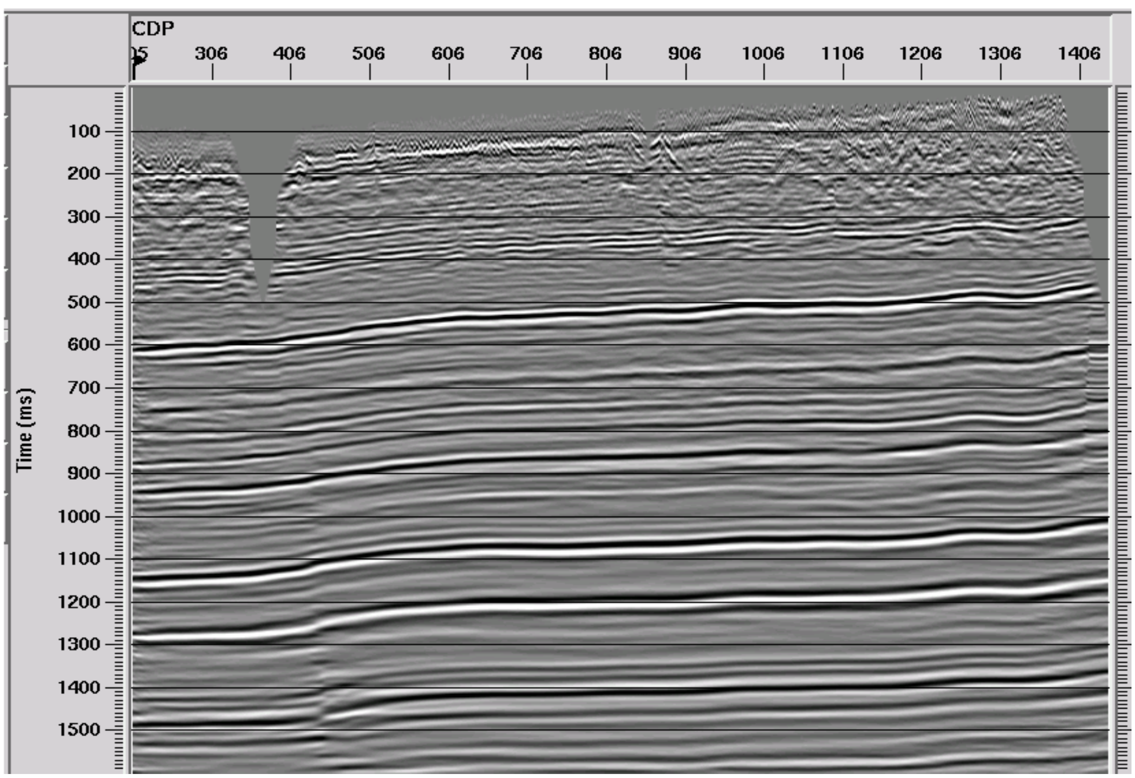

FIG. 12. Line 2008-SC-01, migrated P-P section. Sercel, 2xMertz, DSU3. North is left.

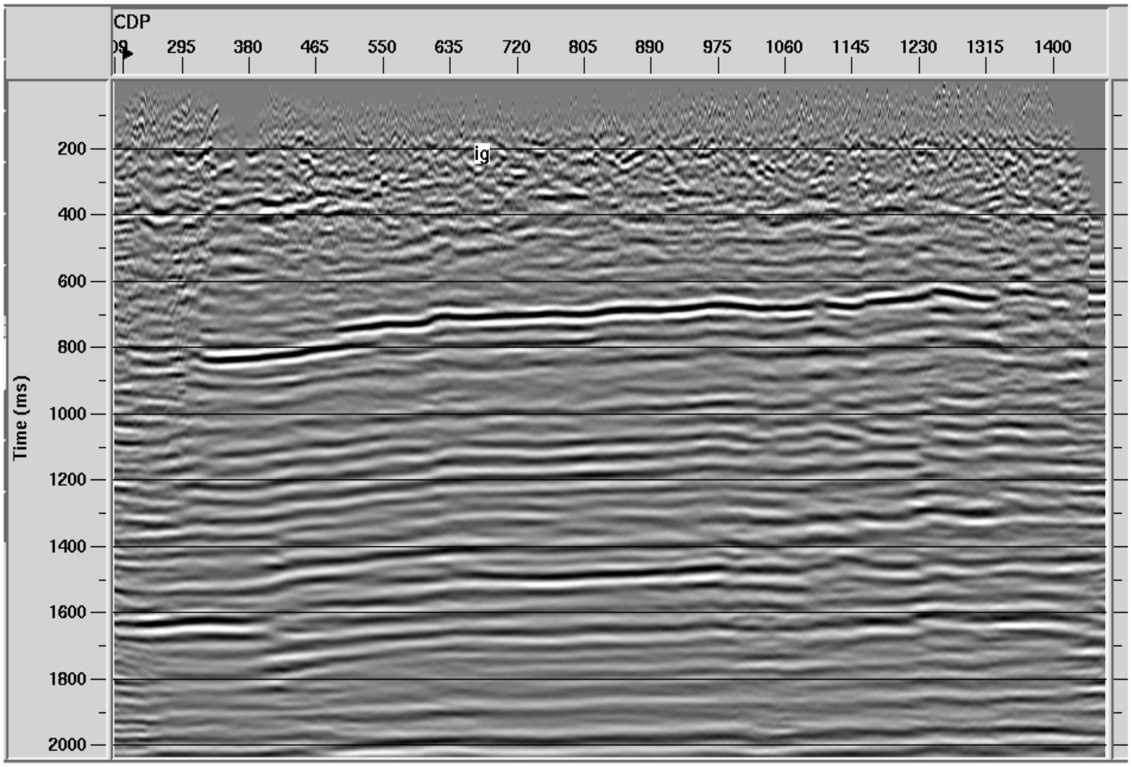

FIG. 13. Line 2008-SC-01, migrated P-S section. ARAM, 2xMertz, SM7. North is left.

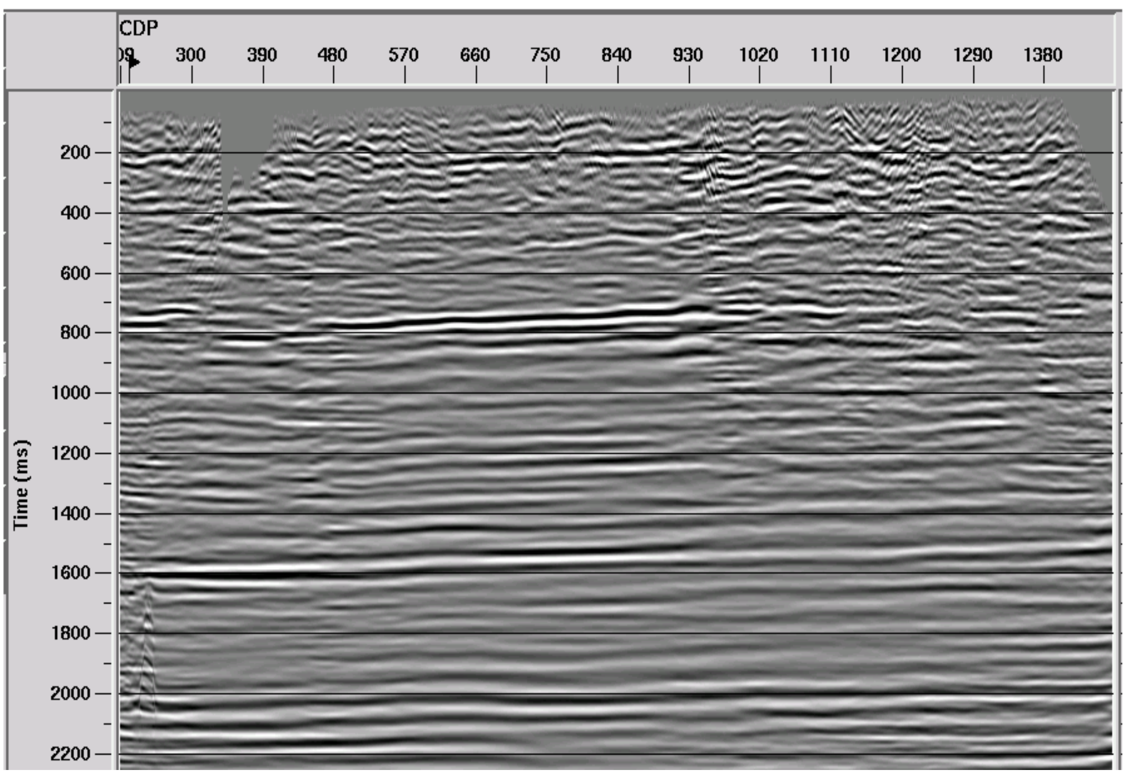

FIG. 14. Line 2008-SC-01, migrated P-S section. Sercel, 2xMertz, DSU3. North is left.

Line 2008-SC-549A and 549B, EnviroVibe results

In August/July of 2008, three additional 1-C lines were acquired as part of the geophysics 549 field school. Lines 2008-SC-549A and 2008-SC-549B (Figure 15) used the same receiver line (SM24 sensors at 10 m spacing), but the source line was acquired twice, once at 10 m VP spacing (549A) and a second time at 20 m (549B). The resulting migrated P-P sections are shown in Figures 16 and 17. While these sections are very similar, less prominent reflection on 549A appear to be brighter, and perhaps more continuous than on 549B. The monocline is clearly visible on these lines.

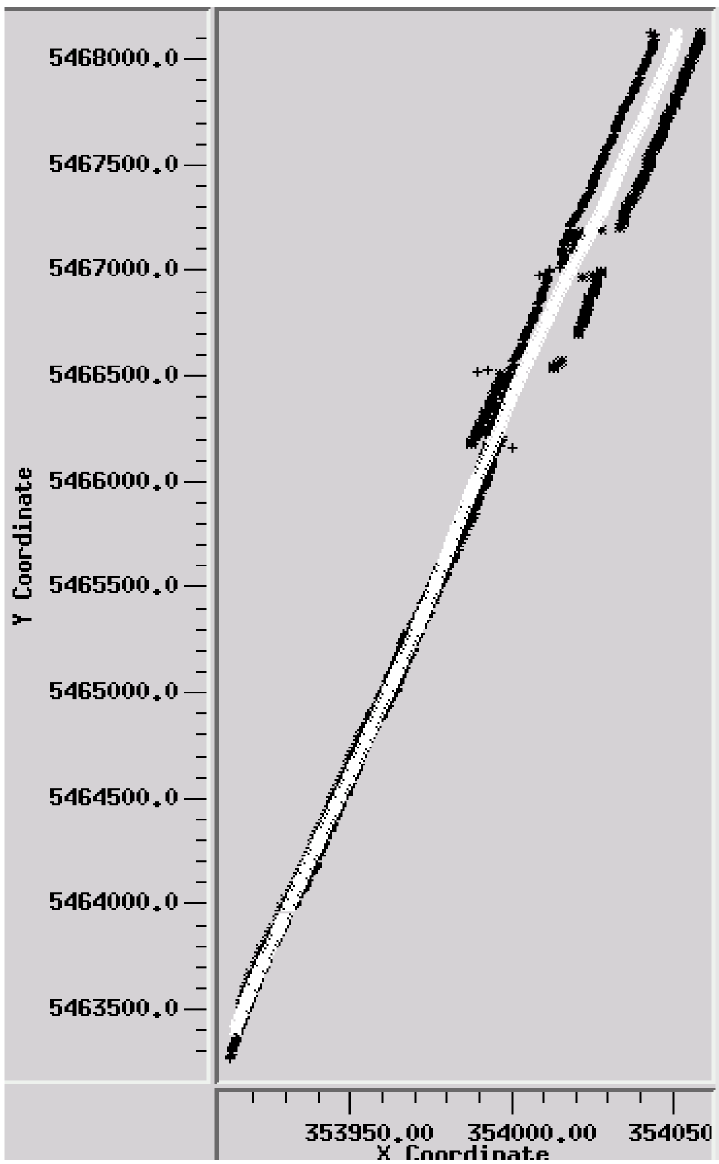

FIG. 15. Line 2008-SC-549,B, EnviroVibe source (VPs and receivers, white; CDPs, black). North is up.

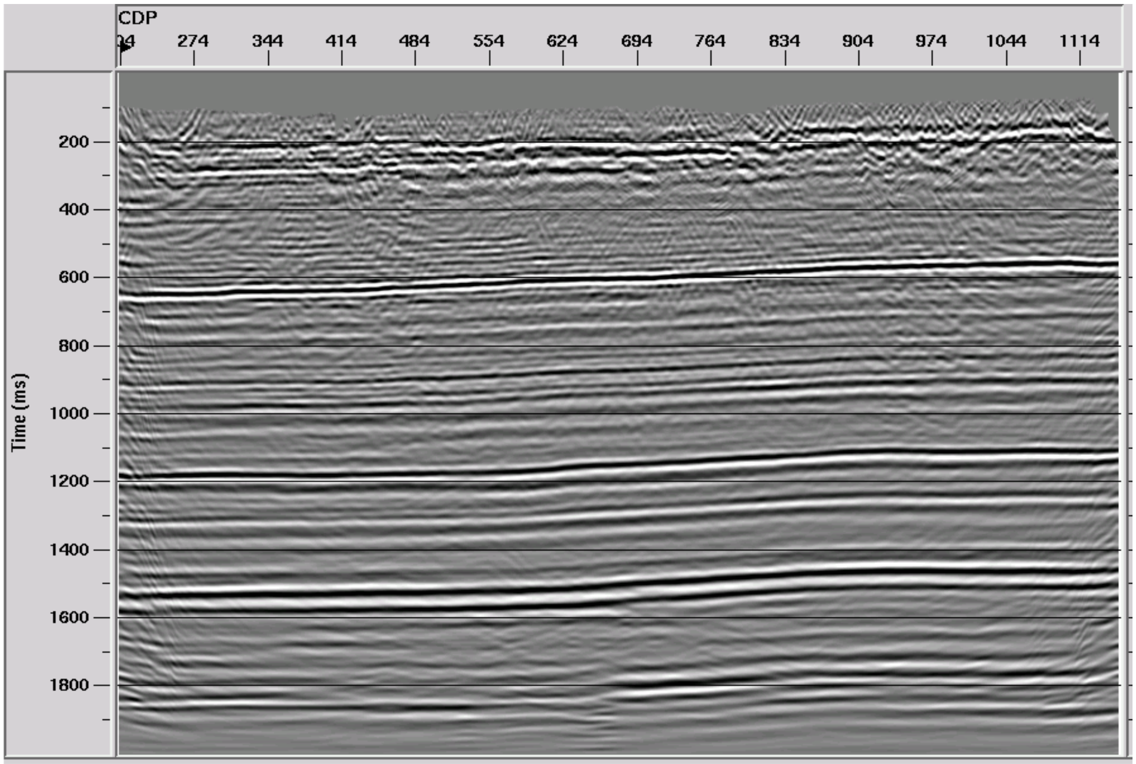

FIG. 16. Line 2008-SC-549A, migrated P-P section. ARAM, EnviroVibe, SM24. North is left.

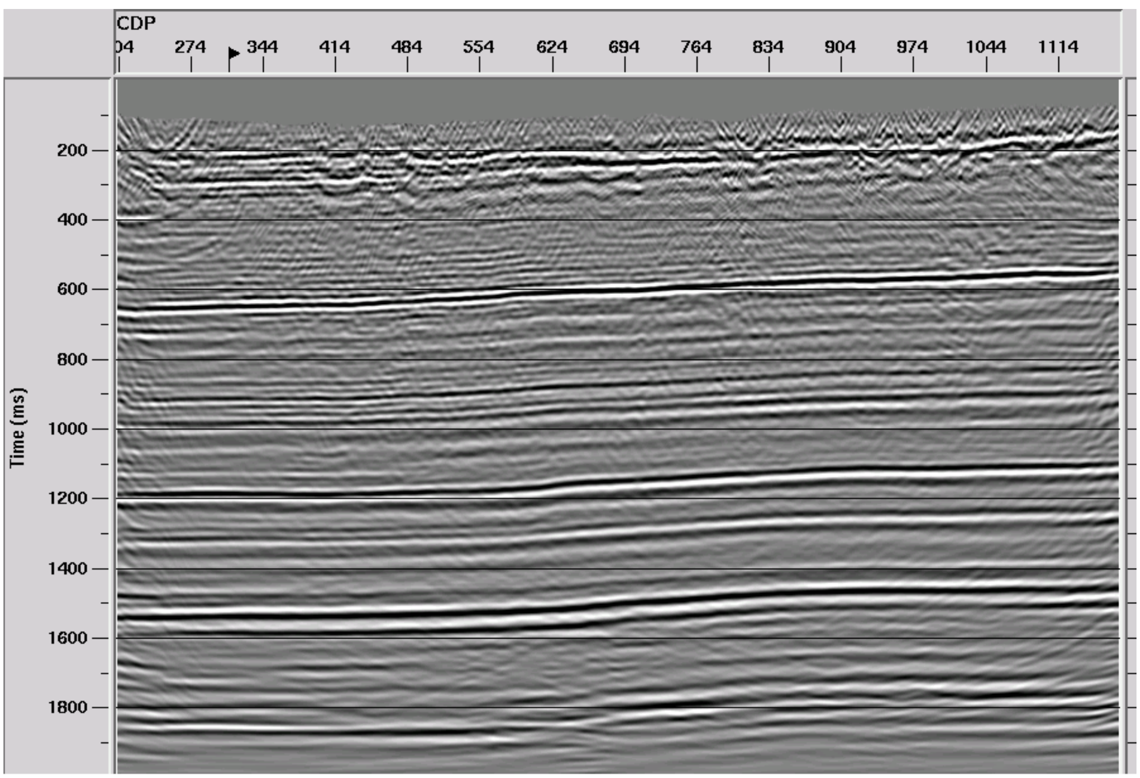

FIG. 17. Line 2008-SC-549B, migrated P-P section. ARAM, EnviroVibe, SM24. North is left.

EnviroVibe, 2008-SC-549C

The third and final line acquired at the field school also used SM24 sensors at a 10 m spacing. Geophones were planted in the west ditch, and vibe points were in the east ditch (Figure 18). While the crest of the monocline is not imaged on 549C (Figure 19), there is still a general apparent northwards dip to the reflections.

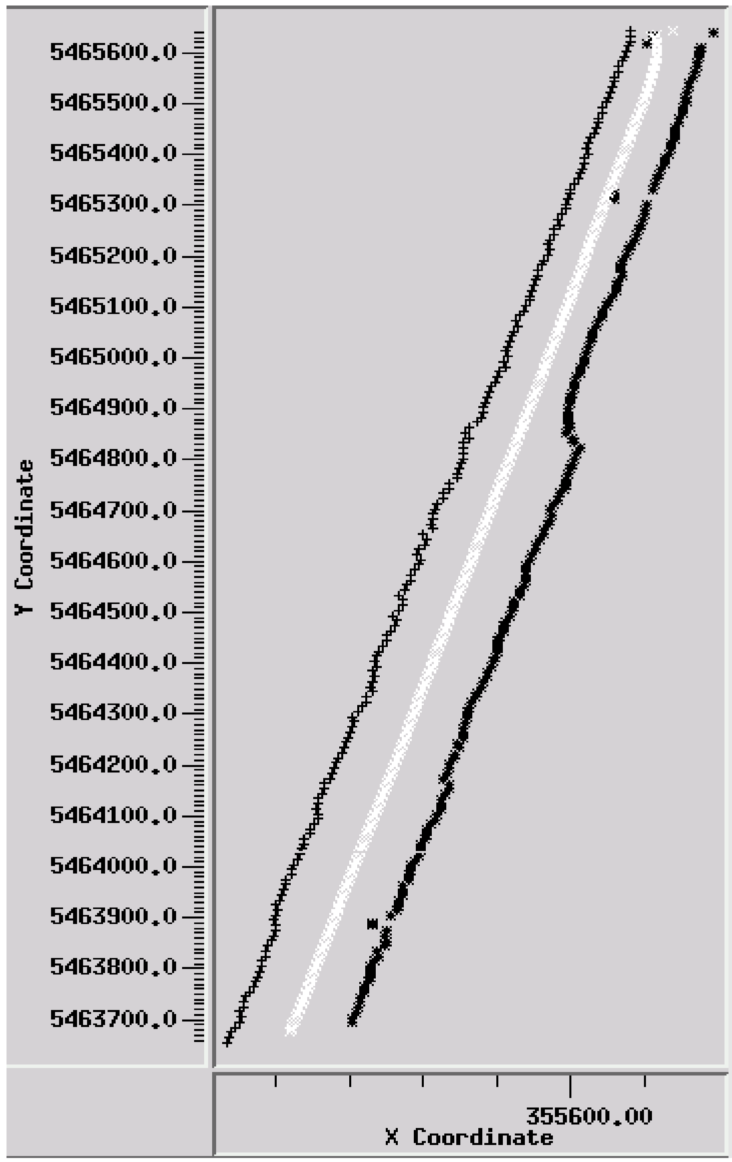

FIG. 18. Map, EnviroVibe, Shots and receivers (black),CDPs (white). North is up.

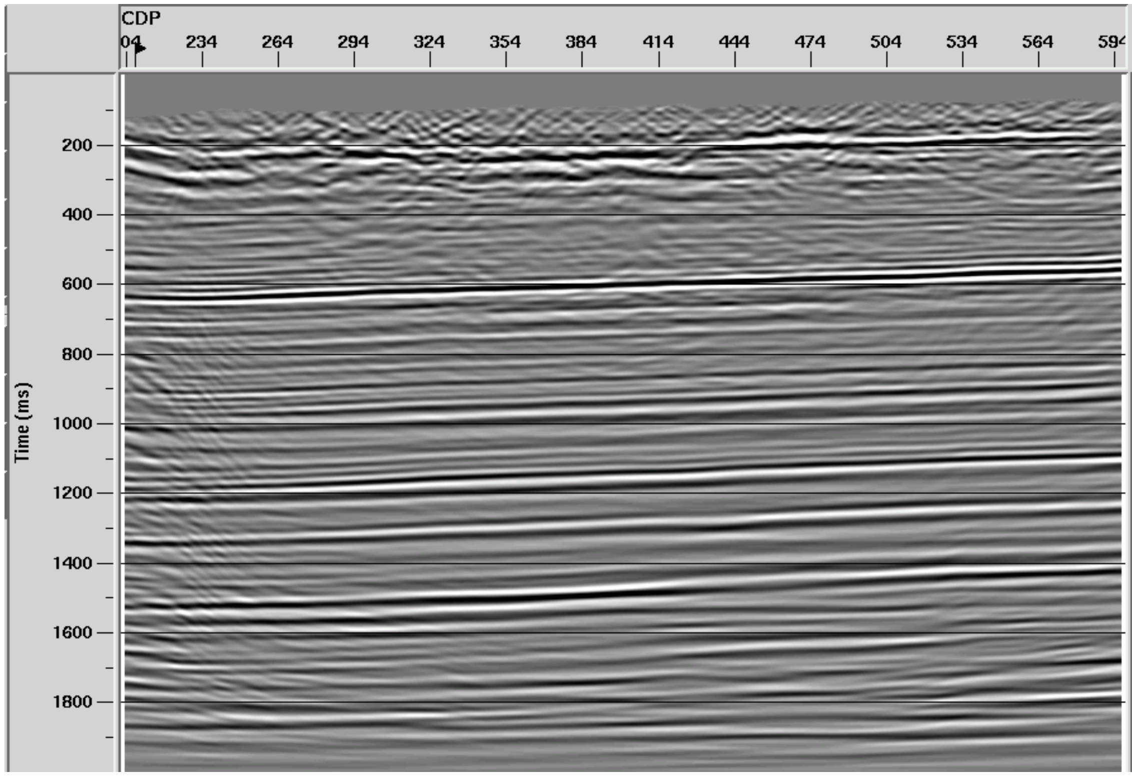

FIG. 19. Line 2008-SC-549C, migrated P-P section. ARAM, EnviroVibe, SM24. North is left.

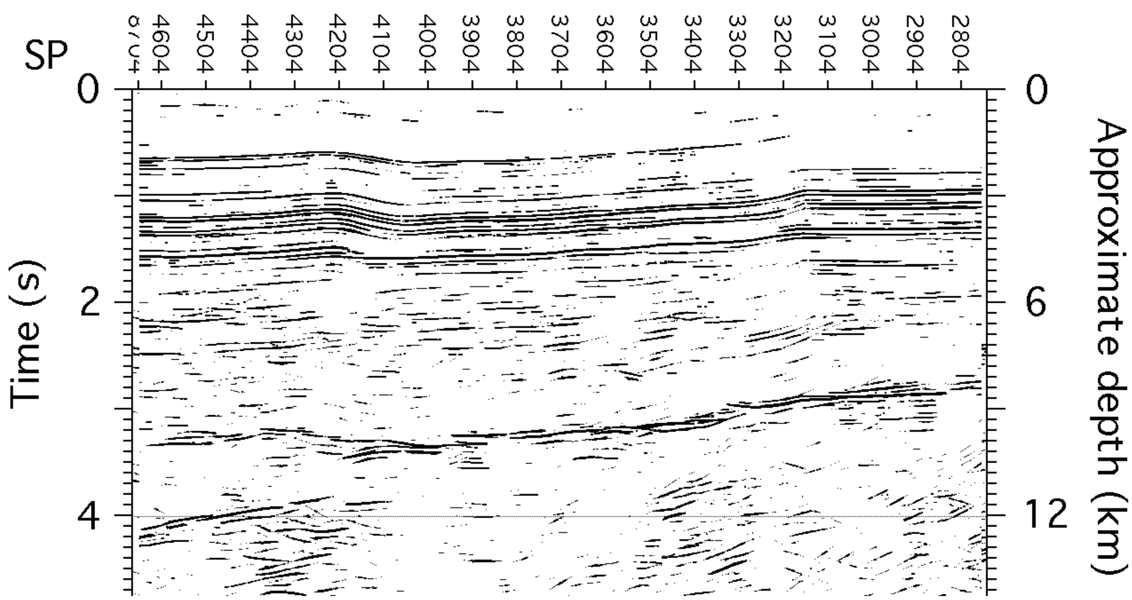

FIG. 20. SALT line 30, migrated section (modified from van der Velden, 1996). West is left. Note that the graben seen in the sedimentary basin (0-1.6 s) is associated with gravity and magnetic anomalies (not shown).

DISCUSSION

In general, the SM24 and DSU3 migrated vertical component sections appear to be quite similar. The radial component results are not. Due to unresolved issues with our shear statics solutions, no valid comparisons of the P-S migrated sections presented in this report can be made without further processing effort. Further work on shear statics using these data has been done by Al-Dulaijan (2008) and Henley and Daley (2008).

A monocline involving rocks from the crystalline basement to the surface is consistently imaged on the north-south lines acquired in 2008. This feature is also seen on older data (Ostridge, 2008), and may be the southward projection of one flank of a graben seen on Lithoprobe data to the north (Figure 20; van der Velden, 1996).

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