Energy distribution on CSP gathers as they approach a scatterpoint

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ABSTRACT

CSP gathers that have the same migration aperture contain identical input energy as they contain the same input traces. It is the arrangement of these input traces with offset that allows constructive and destructive interference to form coherent hyperbolic energy when the CSP gather is located at a scatterpoint. When the CSP gather moves away from a scatterpoint the input energy will tend to cancel. This effect is illustrated with a number of examples.

INTRODUCTION

The equivalent offset method for prestack time migration (Bancroft, et. al.) consists of the formation of CSP gathers followed by Kirchhoff NMO and stack to complete the Kirchhoff prestack migration.

To form CSP gathers, the input data is moved to the CSP gathers to an *equivalent offset* that is the distance between the scatter point and a colocated source and receiver location. The *equivalent offset* becomes a reformulation of the double square root equation (DSR) of the Kirchhoff time migration into a single square root that moves scattered energy to hyperbolic paths on CSP gathers.

But how do the CSP gathers look if all of them have the same input energy from a given scatterpoint? In the next section we discuss a qualitative approach of the energy distribution on the CSP gathers as they move away from a scatterpoint. We will see graphically how the hyperbolic path for the CSP gather located above the scatter point changes as the CSP gathers move away from the scatterpoint.

DISCUSSION

The model used for the formation of the CSP gathers illustrated in Figure 1 contains two reflectors and a scatter point. For the purpose of this work, we are going to discuss only the results and the behavior of the hyperbolic paths related to the scatter point knowing that the reflectors must behave in a similar way as they are composed by scatter points one next to other. Figure 2 shows two shot gathers for this model, and the prestack migrated section is illustrated in Figure 3. A close up zoom of the migrated scatterpoint in Figure 3 is shown in Figure 4.

Images (Figures 5-8) show the scatter point energy on a number of CSP gathers as they move away from the scatter point location. Each image contains four panels: (a) a two-sided CSP gather, (b) a one-sided CSP gather, (c) a two-sided CSP gather NMO corrected and (d) one-sided CSP gather NMO corrected. The stack of all traces in the NMO corrected gathers will produce the corresponding migrated traces in

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Figure 3. The CSP gathers are located at 196 (above the scatterpoint), 199, 203 and 150 as illustrated in Figures 3 and 4.

For the CSP gather above the scatter point (Figure 5 (a) and (b)) we notice that the energy is distributed along a hyperbolic path that will be corrected by NMO to a horizontal event Figure 5 (c) and (d).

As the CSP gather moves away from the scatterpoint (Figures 6-8), the energy is not distributed along a hyperbola and is dispersed.

The stacking of these CSP gathers is evident in Figure 3. For the CSP gather above the scatter point all scattered energy is summed to produce a large amplitude. On the other hand, for the CSP gathers moving away from the scatterpoint location, the energy in the CSP gather destructively interferes and sums to smaller values as shown in the stacked traces for these CSP gathers.

CONCLUSIONS

The energy in the CSP gathers is reconstructed along a hyperbola for the CSP gathers close to the scatterpoint. As they move away from this location the energy is dispersed leading to a destructive interference after NMO correction and stack.

REFERENCES

Bancroft, J.C., Geiger, H. and Margrave, G.F., 1998, The equivalent offset method of prestack time migration: in press for November – December 1998 issue of Geophysics.

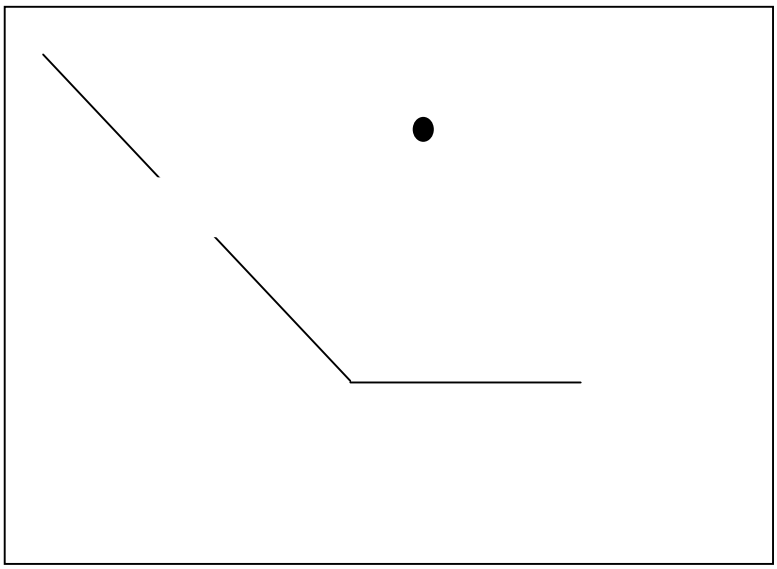

Fig 1. Model

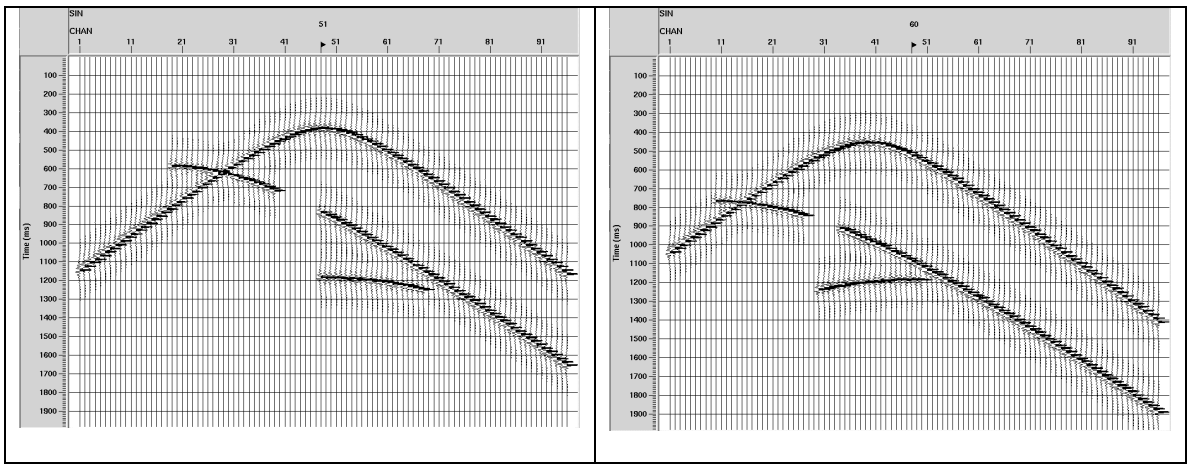

Fig 2. Examples of two shot gathers at a) 51, and b) 60.

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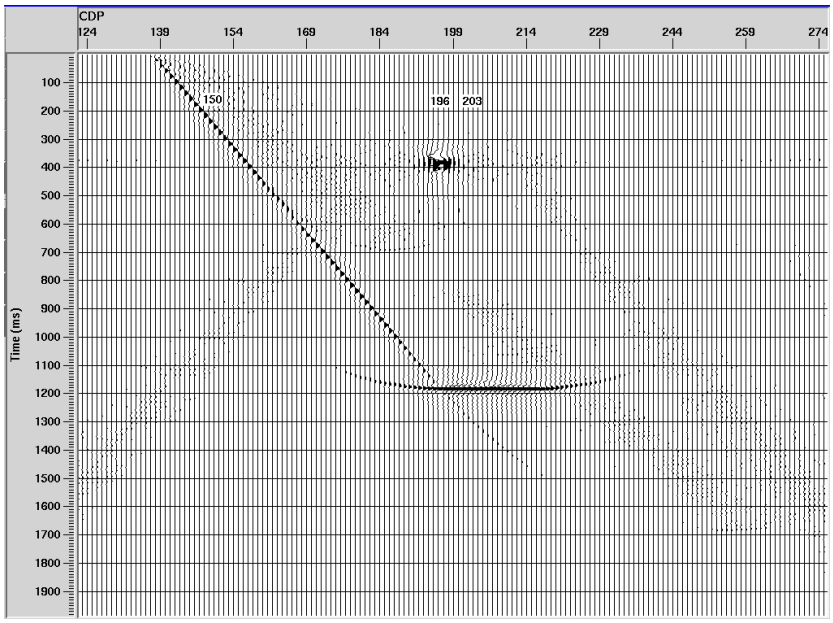

Fig 3. CSP stack. (Prestack migrated section)

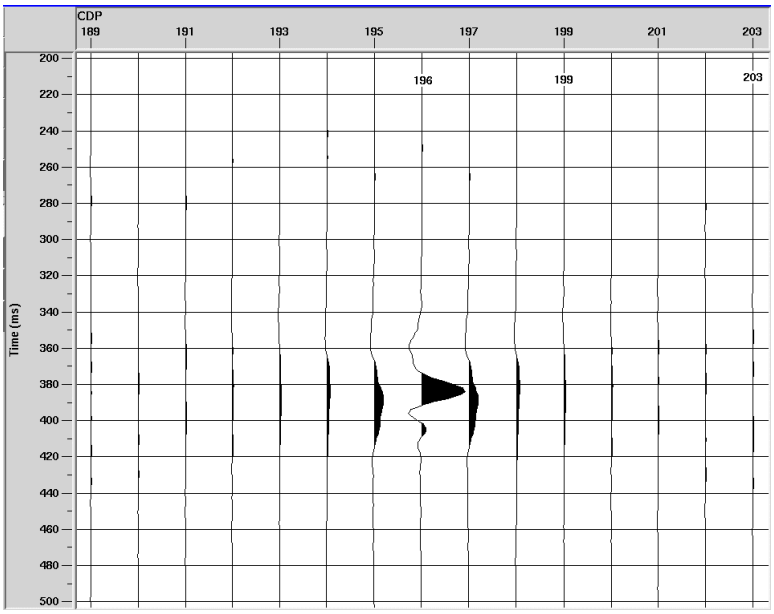

Fig 4. Zoom on the migrated scatterpoint.

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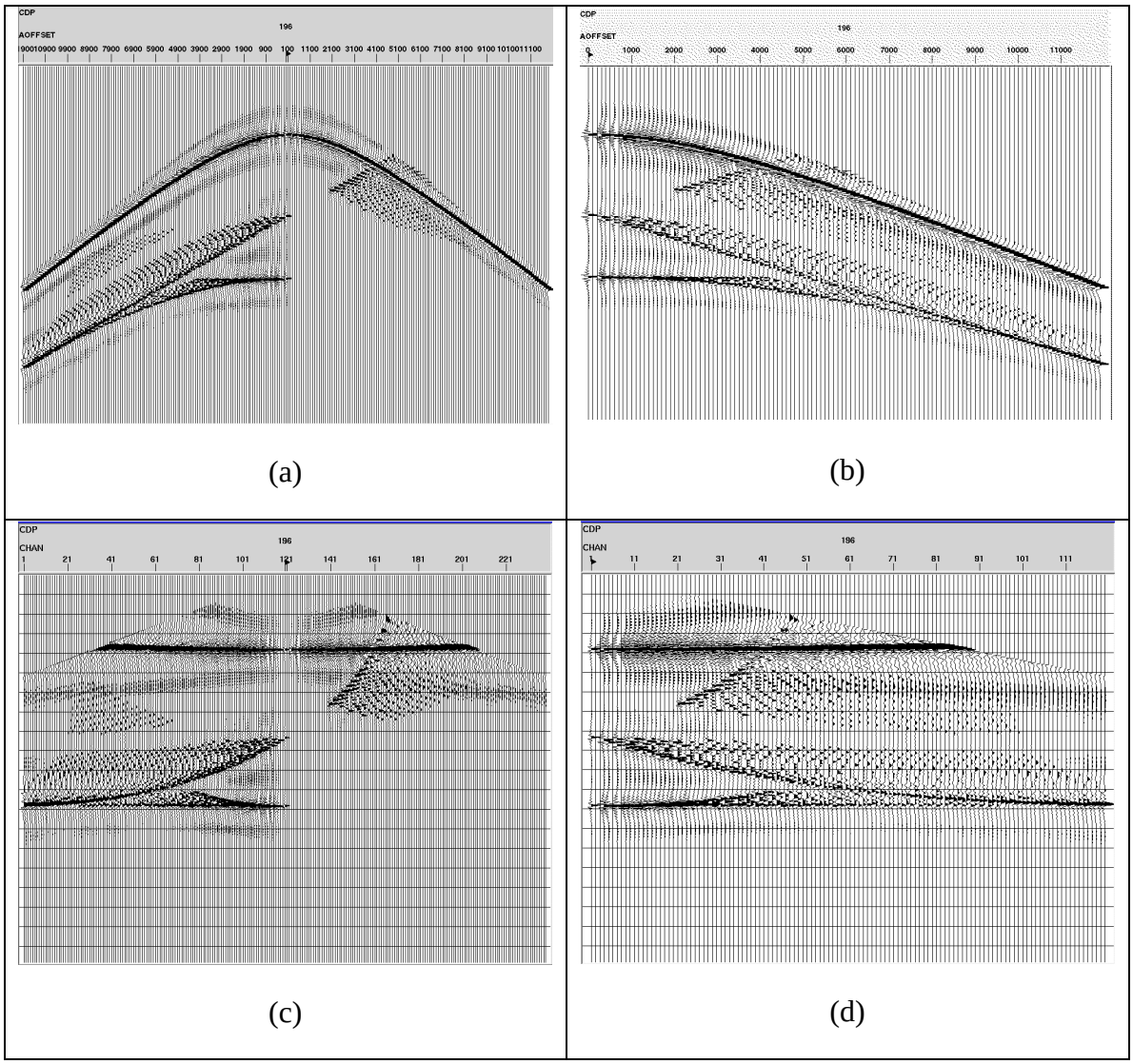

Fig 5. CSP gathers at location 196 with a) two-sided CSP gather, b) one-sided CSP gather, c) two-sided CSP gather with NMO, d) one-sided CSP gather with NMO.

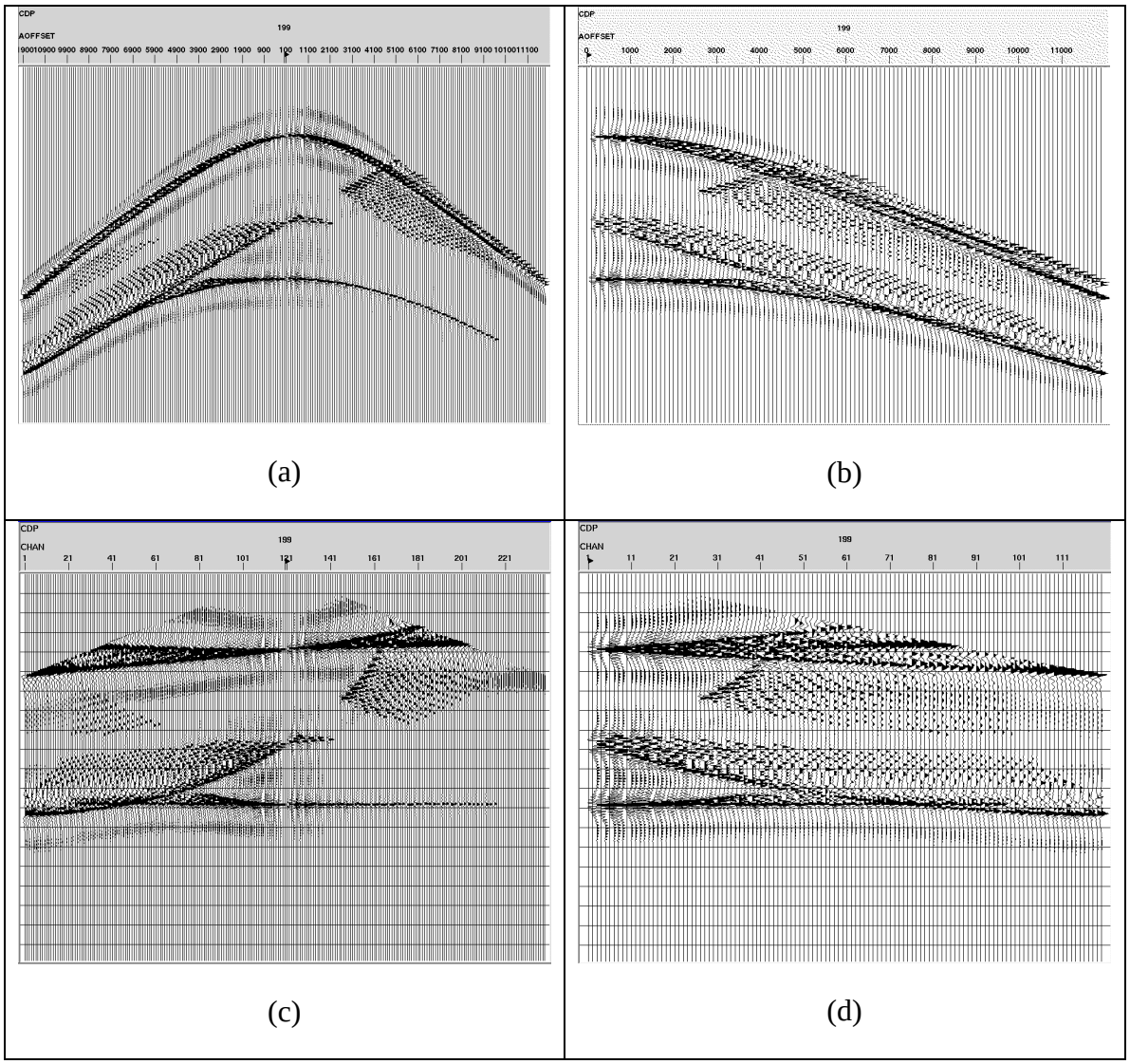

Fig 6. CSP gathers at location 199 with a) two-sided CSP gather, b) one-sided CSP gather, c) two-sided CSP gather with NMO, d) one-sided CSP gather with NMO.

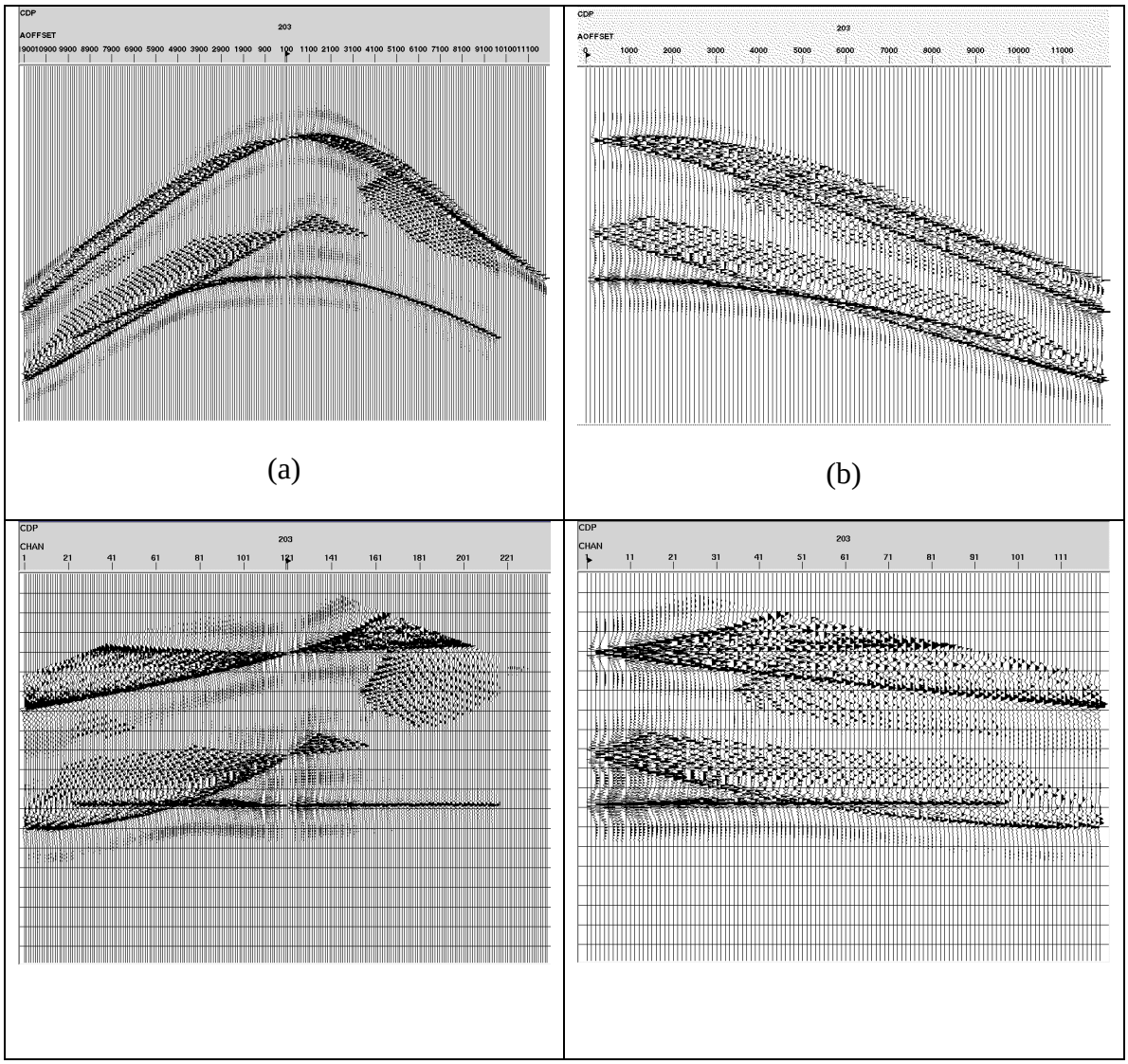

Fig 7. CSP gathers at location 203 with a) two-sided CSP gather, b) one-sided CSP gather, c) two-sided CSP gather with NMO, d) one-sided CSP gather with NMO.

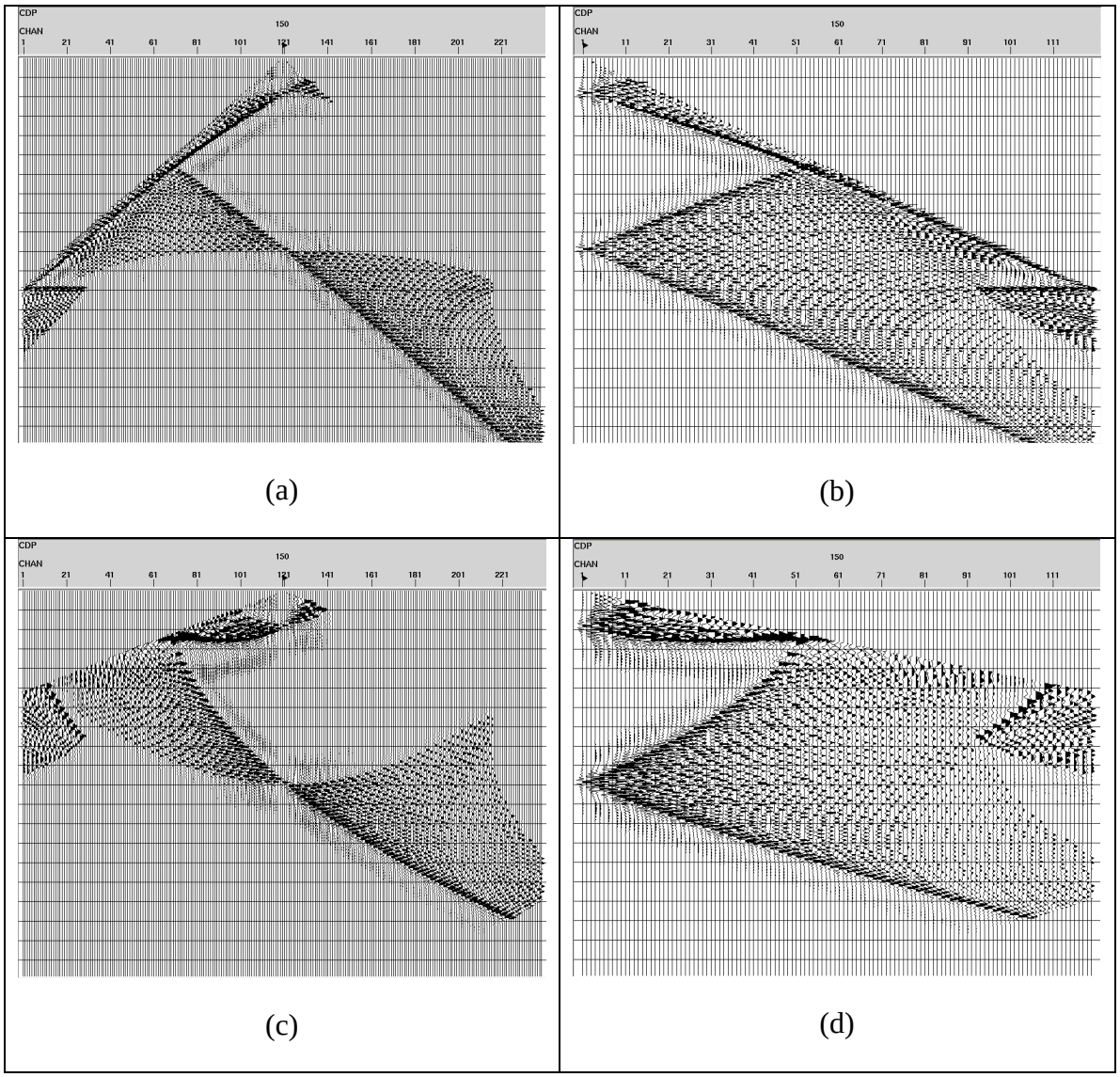

Fig 8. CSP gathers at location 150 with a) two-sided CSP gather, b) one-sided CSP gather, c) two-sided CSP gather with NMO, d) one-sided CSP gather with NMO.