Petroleum Research

Petroleum Research 2018 (February-March), Vol. 28, No. 102. 33-35

DOI: 10.22078/pr.2018.3191.2472

Stacking Velocity Analysis with Model-based Common-Diffraction-Surface (CDS) Stack Attributes

Hashem Shahsavani

1Department of Mining, Faculty of Engineering, University of Kurdistan, Sanandaj, Kurdistan, Iran

h.shahsavani@uok.ac.ir

DOI: 10.22078/pr.2018.3191.2472

Received: February/24/2018 Accepted: August/11/2018

INTRODUCTION

As the velocity analysis is applied on a common-mid-point (CMP) gather, the operator of CMP method cannot estimate the reflector event properly and does not use the data redundancy in multi-coverage data set. Hence, the common-reflection-surface (CRS) stack method has been introduced [1-4].

The CRS method in depth domain instead of a point on the reflector considers a part of the circle. The seismic response of this part of the circle, in time domain, in addition to one CMP considers the neighboring CMPs [5]. Consequently, the CRS method uses the data redundancy in multi coverage data set and simulate a zero offset (ZO) stack section with high signal to noise ratio. Moreover, the attribute which control the shape of operator so called wave field attributes [6]. The Normal-Incidence-Point (NIP) wave, which is one of these attributes, has been used to calculate the stacking velocity [7]. But this attribute in CRS obtains in data driven manner. As results, the NIP ware is influenced by Normal wave. In this research, R_{NIP} has been applied by us. Moreover, R_{NIP} is obtained by model based Common-Diffraction-Surface (CDS) stack. In addition, it is so important that the NIP wave in model-base CDS stack method not be influenced by N waves [8].

THEORY

Based on the second order approximation of travel time, it is possible to obtain the travel time, which is read as:

$$t^2(x_m,h)=\left[t_0+\frac{2\sin\alpha}{v_0}(x_m-x_0)\right]^2+\frac{2t_0\cos^2\alpha}{v_0}\left[\frac{(x_m-x_0)^2}{R_N}-\frac{h^2}{R_{NIP}}\right] \quad (1)$$

Here, x_0 is the location of the point which is considered for the stacking, xm is the distance to the x_0, t_0 is the time which considered for the stacking, v_0 velocity at the surface, α is the emergence angle, h is offset, R_{NIP} is the radius of NIP wave front, and R_N is the radius of N wave. For an underground diffractor, the wavefront when reaches to the surface the $RN=R_{NIP}=R_{CDS}$, so the Equation 1 is simplified to CDS equation (as seen in Equation 2):

$$t^2(x_m,h)=\left[t_0+\frac{2\sin\alpha}{v_0}(x_m-x_0)\right]^2 + \frac{2t_0\cos^2\alpha}{R_{CDS}v_0}\left[(x_m-x_0)-h^2\right] \qquad (2)$$

As for a CMP, x_m and x_0 is equal; therefore, it is possible to obtain stacking velocity from Equations 1 and 2. By substituting $x_m=x_0$ the stacking velocity is read as:

$$V_{stack}=\sqrt{\frac{2v_0R_{NIP}}{t_0\cos^2\alpha}} \qquad (3)$$

All parameters in Equation 3 is ready by applying CRS on a seismic data. In this research, the R_{CDS}, which is not affected by R_N, instead of R_{NIP} has been applied.

IMPLEMENTATION

In order to test the proposed method, a synthetic velocity mode with five reflectors is generated by Seismic Unix [9]. This model is shown in Fig. 1.

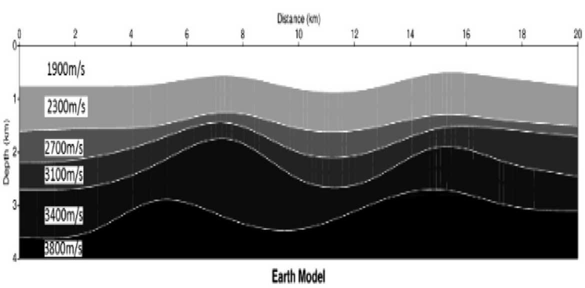

Figure 1: Synthetic velocity model with 6 layers.

The stacking velocities are obtained by CRS and CDS attribute along the first reflector are shown in Fig. 2.

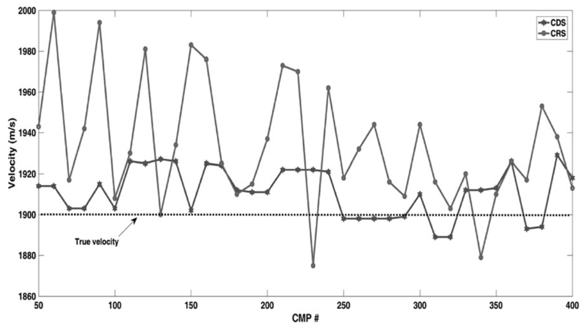

Figure 2: The stacking velocities are obtained along the first reflector.

For a better comparison, the RMS and the standard deviation of the calculated stacking velocity along all reflectors are presented in Table 1.

Table 1: RMS and standard deviation of stacking velocity along layers.

	Standard deviation		RMS Error	
	CDS	CRS	CDS	CRS
reflector1	1.00262	3.35410	1.36867	3.25457
Reflector2	16.508	32.9896	2.84231	3.25439
Reflector3	1.51678	3.25963	2.84122	4.52750
Reflector4	1.64869	3.27195	2.65844	4.41261
Reflector5	2.27913	4.85378	2.54127	4.87434

As presented in Table 1. Along all profiles, the RMS error and the Standard deviation of the calculated stacking velocity decrease for the proposed method.

CONCLUSION

The wave field attribute of CDS stack method are not affected from each other. Hence, the velocity stacking which obtain by this method is more reliable than the CRS method. For instance, for the first reflector the true velocity is equal to 1900 m/s. The mean of stacking velocity a long this reflector which calculated by CRS and CDS method is 1933 m/s and 1923 m/s, respectively. In addition, the standard deviation of the estimated stacking velocity along all profiles for CDS method is less than CRS method. For example, the standard deviation of velocity staking estimation along the first reflector are 30.3541 and 12.0026 for the CRS and CDS method, respectively. Finally, these results show that the stacking velocity which is obtained by the proposed method is more accurate and precise in comparison with CRS.

REFERENCES

[4]. Müller T., *"Common reflection surface stack vs. NMO/STACK and NMO/DMO/STACK,"* 60th EAGE Conference and Exhibition, 1998.

[5]. Müller T., Jäger R. and Höcht G. *"Common reflection surface stacking method - imaging with an unknown velocity model,"* 68th EAGE Conference and Exhibition, 1998.

[6]. Jäger R., *"The Common reflection surface stack-introduction and application,"* Ms thesis, University of Karlsruhe. Germany, 1999.

[7]. Mann J., Höcht G., Jäger R. and Hubral P., *"Common reflection surface stack — an attribute analysis,"* 61th EAGE Conference and Exhibition, 1999.

[14]. Bergler S., Chira P., Mann J., Vieth K. and Hubral P., *"Stacking velocity analysis with CRS Stack attributes,"* 64th EAGE Conference, 2002.

[15]. Shahsavani H., Mann J., Piruz I. and Hubral P., *"A model-based approach to the common-diffraction- surface stack—theory and synthetic case study,"* Journal of Seismic Exploration, Vol. 20, pp. 289–308, 2011.

[20]. Cohen J. K. and Stockwell J. J. W., *"CWP/SU: Seismic Unix release 34: a free package for seismic research and processing. Center for Wave Phenomena,"* Colorado School of Mines, Issue 9, November 2017.