New approach of seismic surface generation via deep CNN

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Summary

Seismic surface is a key input for building the geology structure and stratigraphy models. Unfortunately, 3D seismic surface interpretation on the 1x1 grid is a time-consuming task. Huge effort have been put on the automatically seismic surface interpretation methods. However, it is still extremely hard to automatically obtain an accurate interpretation within the complicate structure zone like faults and unconformities. We propose a novel automatically seismic surface interpretation method by applying deep convolutional neural network. Three field data examples demonstrate that our proposed method can accurately generate seismic surfaces by only using manually interpreted seismic surfaces on a 50×50 grid. The interpretation result from our proposed method is superior to the interpretation result by using the traditional method of seeded auto-tracking.

Method

In geology, seismic surfaces mark the lithology change of sedimentary layers. The lithology change in geophysics refers to a seismic reflection event follows an impedance contrast associated with different depositional beddings. Seismic data can be treated as image and the seismic surfaces segment the image into several different objects. Those different objects contain different image features that related to different depositional beddings. Thus, seismic surface interpretation turns to be an image segmentation task.

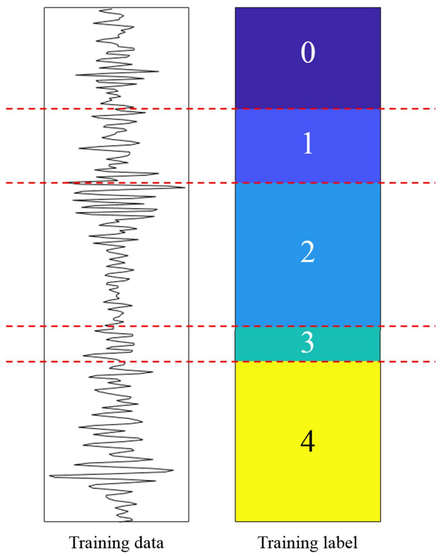

Figure 1. One example of a training trace and the corresponding label, the red dash lines represent different seismic surfaces.

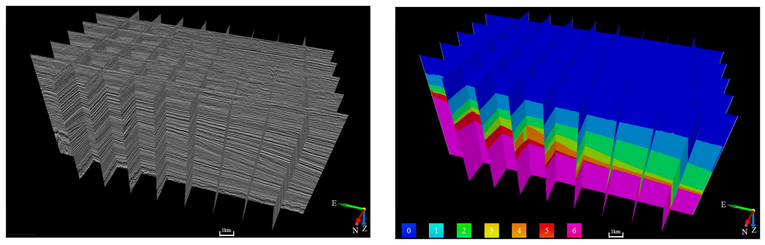

Figure 2. Selected traces on a coarse grid and the corresponding label model.

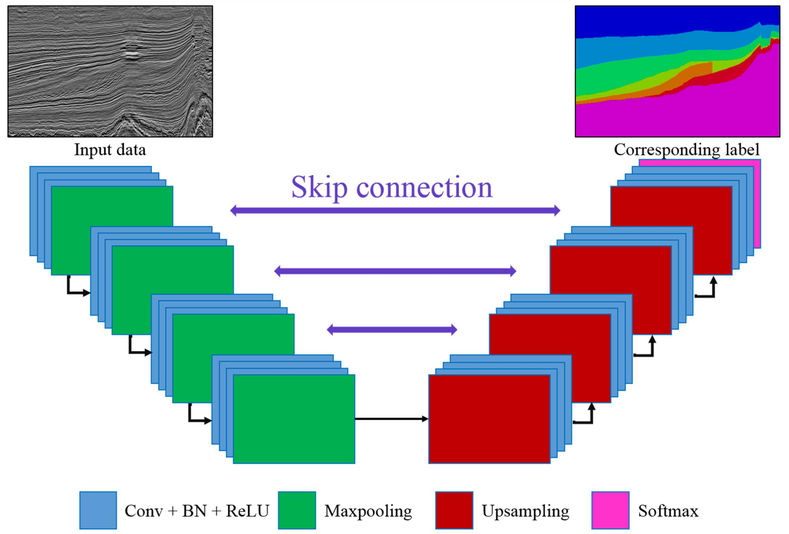

Figure 3. One representative architecture of deep convolutional neural network.

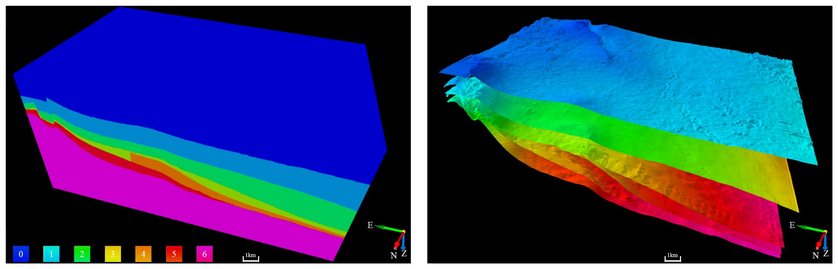

Figure 4. The predicted label model (left) obtained by using DCNN and the corresponding extracted seismic surfaces (right).

Field data example

We test on a field data example and compare with the tradition method of seeded auto-tracking.

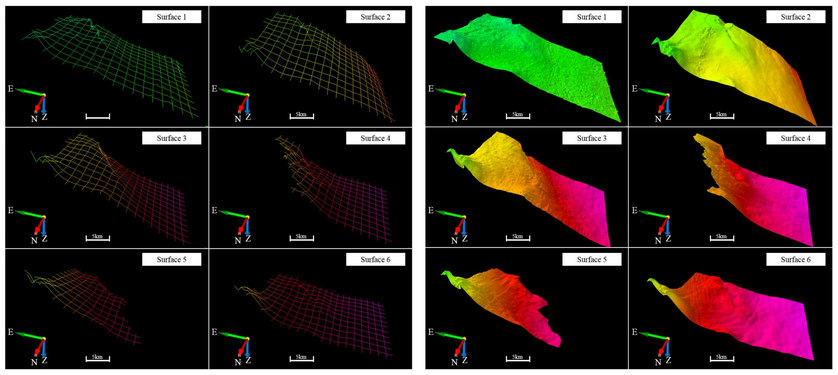

Figure 5. The manually interpreted seismic surfaces on a coarse grid for the first field data example and the ground truth (manually picking for whole survey).

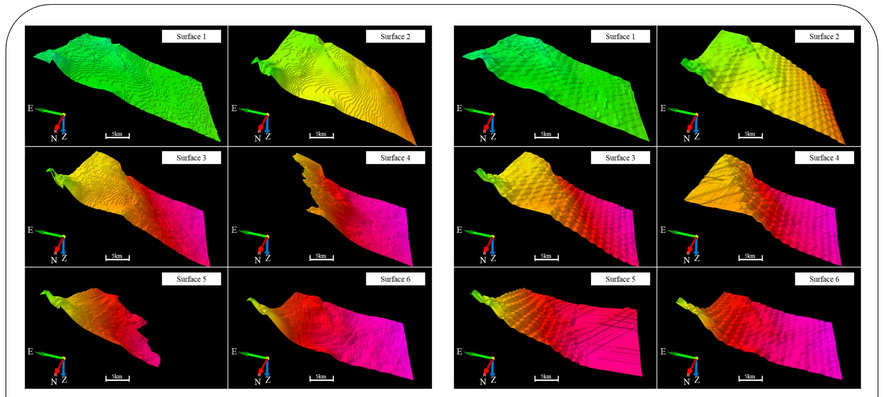

Figure 6. The predicted seismic surfaces obtained by using our proposed method (left) and the seeded auto-tracking (right)

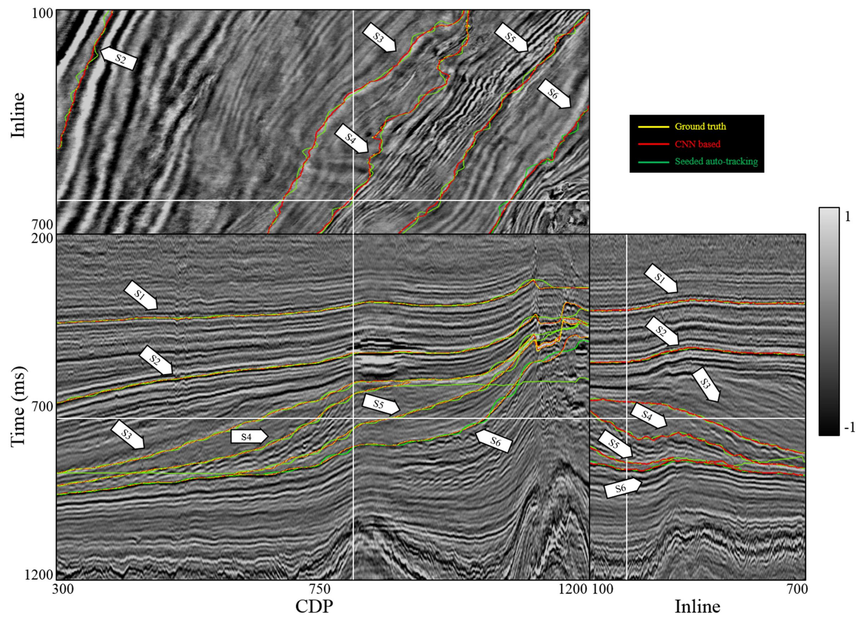

Figure 7. Illustration of the comparison in the first field data example within different methods from the view of front (CDP), side (inline) and above (time-slice), respectively.

Conclusion

We proposed a novel approach for seismic surface generation based on the deep convolutional neural network. The field data example illustrates that our proposed method can produce accurate seismic surfaces even if we only have manually seismic surfaces interpretation on the coarse seismic grid. Testing on different seismic surveys demonstrate the generalization ability of applying deep convolutional neural network in assisting seismic surface interpretation. Meanwhile, it also proves that our proposed method can produce the same level seismic surface interpretation result with the manually interpretation (ground truth) on the complicated structure zone.