INTERFEROMETRIC REFRACTION STATICS FOR SEISMIC REFLECTION DATA FROM CHEONGJU GRANITIC BODIES OF SOUTH KOREA

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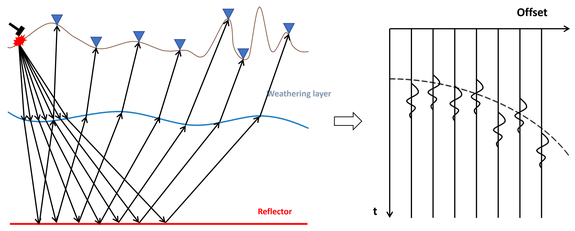
Summary

Rapid variations in the thickness of the refractor and low velocities affect greatly the imaging of the reflectors of land seismic data. Conventional solutions to obtain the weathering models employ the first break picking method, which requires time consuming steps and causes the human error in picking the first arrivals. Interferometric approach(IRS: interferometric refraction statics) which utilizes the first arrival signal instead of first break picking, is tested in this study to the synthetic data from the velocity structure provided by surface geophysics and borehole geophysics for the Cheongju granitic bodies of South Korea. The unresolved long-wavelength statics are much removed by IRS weathering correction and the overlying refractors are incidentally delineated in the refraction convolution stack(RCS).

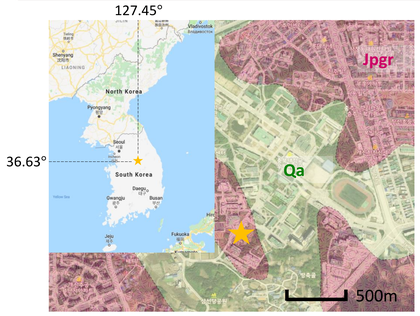
Introduction



Static correction is performed to compensate for the effect of variations in elevation of sources/receivers and geometry of the weathering zone (low-velocity-layer). In a schematic diagram of common shot gather, the reflection event appears inconsistent due to variations in the ground elevation and weathering-layer thickness corresponding to each trace. Generalized reciprocal time method(GRM), tomography, and generalized linear inversion are commonly used for weathering model utilizing the first break picks in land seismic reflection data.

An alternative IRS technique utilizing the signal of first arrivals is applied for mapping of the shallow refractor and the results are compared to the ones from conventional first break techniques in terms of continuities and resolution of reflection events.

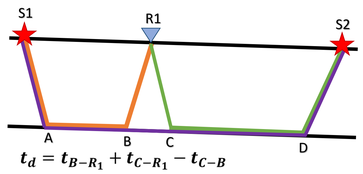
Study site



Location map representing the geology of the study area, consisting of mostly porphyric granite body of Mesozoic Jurassic(Jpgr) with alluvium of Quarternary Period(Qa). Seismic refraction survey, MASW, and SPS logging were performed to investigate the physical properties of the subsurface.

RCS / RVS

Refraction Convolution Stack (RCS)

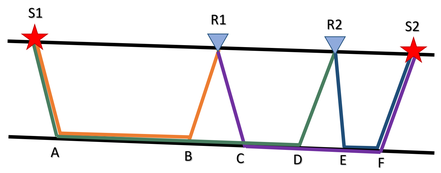


$$t_d = t_{B-R_1} + t_{C-R_1} - t_{C-B}$$

t_d : the shifted time at receiver R_1
t_{B-R_1} : the time from R to R_1
t_{C-R_1} : the time from C to R_1
t_{C-B} : the time from R to B

$$T = (S1\ A\ B\ R1) * (S2\ D\ C\ R1) \otimes (S1\ A\ D\ S2)$$

Refraction Velocity Stack (RVS)



$$T = \big((S1\ A\ B\ R1) \otimes (S1\ A\ D\ R2)\big) * \big((S2\ F\ E\ R2) \otimes (S2\ F\ C\ R1)\big)$$

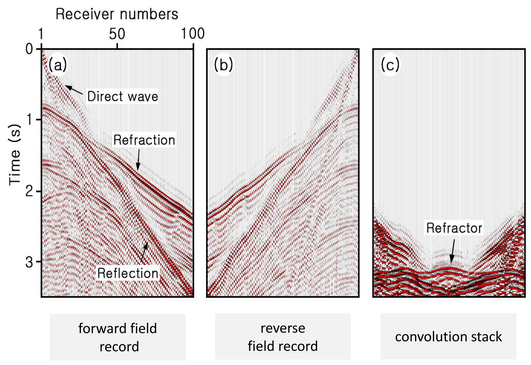
$$t_v = \frac{2X_{R_1-R_2}}{V_{C-D}}$$

t_v: the highest amplitude at time-depth
$X_{R_1-R_2}$: the distance between R_1 and R_2
V_{C-D}: the refraction velocity
$*$: convolution and $\otimes$: correlation

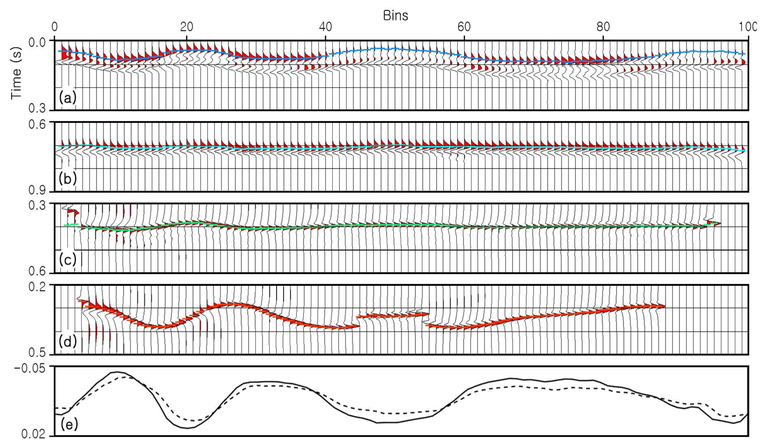
References

- Kim, J.S., Han, S.H., Seo, Y.S, Lee, Y.J., 2005, Ground Characterization of the Cheongju Granite Area Using the Geophysical Methods, The Journal of Engineering Geology, 15(1), 41-55
- Khatchatrian, V. and Galbraith, M., 2013, Interferometric Approach to Complete Refraction Statics Solution, Geoconvention 2013:Intergration.
- Michael J. G. Cox, 1999, *Static Corrections for Seismic Reflection Surveys*, Society of Exploration Geophysicists, 352-394.
- Palmer D., 2001, Imaging Refractors with the Convolution Section, Geophysics 66, 1582-1589

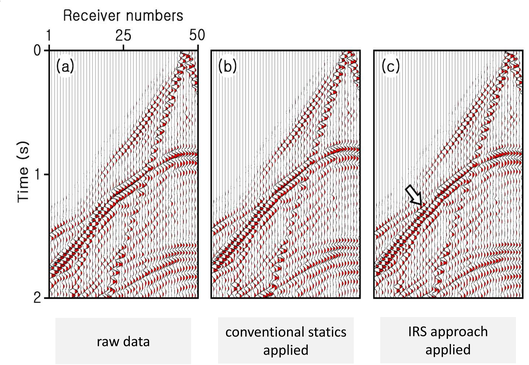
Materials and methods



An example of convolution stack: (a) forward field record, (b) reverse field record, and (c) their convolution stack. Note the refractor is not positioned correctly in time because the corresponding reciprocal time is subtracted for each interface.

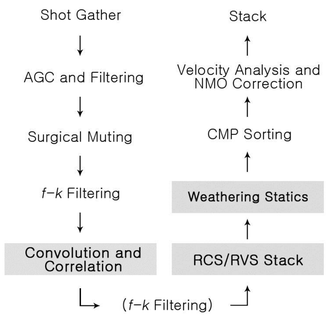


Refraction convolution stacks for (a) the weathering layer and (b) the underlying reflector. Refraction velocity stacks for (c) the weathering layer and (d) the underlying reflector. (e) Refraction statics calculated by first break picking(solid line) and IRS(dashed line) methods.



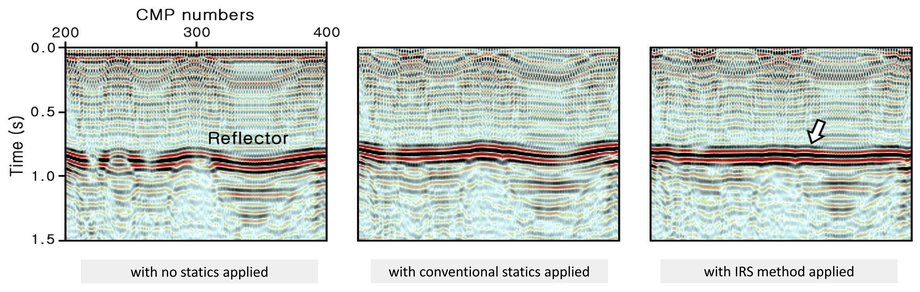
Comparison of the effects of weathering correction for a shot gather with (a) no correction, (b) first break picking, and (c) IRS methods. Reflection hyperbola is faithfully reconstructed in (c), as indicated by the white arrow.

Main processing steps



Main processing procedure for IRS-based imaging in this study.

Improved resolution with IRS in CMP stack



The result of IRS approach is found to be better than the ones from conventional first break picking in terms of continuities and horizontal resolution of reflection events. The unresolved long-wavelength statics in CMP stack are much removed by IRS correction. Reflectors with the better vertical and horizontal resolutions are highlighted at 0.8 ~ 1.0s.

Conclusions

The effects of the IRS approach are identified with the removal of reflection fluctuations in the shot gather and the improved resolution of the horizontal layer in the stack section and. In addition, a desired refractor is incidentally and distinctly mapped in the refraction convolution stack.

Acknowledgments

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