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Please fill in your manuscript title.	Near-surface Imaging Using Multiples to De-risk Shallow Geohazards - Optimizing Cost At Regional Scale

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Abstract

Objectives/Scope

Conventional imaging usually requires steps to remove the multiples from the recorded data. In this study we show an example of using the multiples for imaging instead of removing them, since multiples have smaller illumination angles, and thus provide an alternative illumination of the subsurface. We will demonstrate the method on a shallow water data acquired using a 12-cable wide-tow-spread resulting in large sail-line spacing and missing near offsets. Despite large acquisition gaps, the results show how multiples can fill in the missing information resulting in higher spatial resolution at and near waterbottom. The study area is located offshore Sarawak, one of the most actively explored area in Malaysia.

Methods, Procedures, Process

To exploit illumination benefits of the multiple wavefield, we first forward propagate the recorded primary wavefield from all the receiver locations. Then, instead of using the primary wavefield, we back propagate the multiple wavefield predicted by our Shallow Water Demultiple (SWD) method. Finally we form the image by cross correlating these two wavefields. This approach is an extension of the Reverse Time Multiple Migration (RTMM) described by Zhiping Yang et al. 2013. The benefit of RTMM is the wider illumination rendered by turning all surface receivers into a secondary source. By doing this, RTMM gains a much denser surface coverage and shorter near-offset spread, resulting in a complimentary image to that formed by conventional migration such as Kirchhoff PSDM.

Results, Observations, Conclusions

RTMM on very shallow water data (~60m) shows that the seabed profile obtained from multiple Imaging (Fig 1b) is able to pick up details at a higher resolution compared to bathymetry survey (Fig 1a), while seabed profile from Kirchhoff PSDM (Fig 1c) is inaccurate as the seabed image is severely stretched due to missing near offsets. Though usually removed, multiple wavefield can prove to be a useful source of information because of the wider and more balanced illumination pattern of multiples. The resulting image has much reduced acquisition footprint and high spatial resolution.

Novel/Additive Information

Multiple Imaging has been around for some time using various methods. However, most examples are from water depths of around 100m or more and on small scale surveys. In this study we have shown successful implementation of this technique on a very shallow water, regional scale, and conventional seismic survey. This result clearly shows how such a dataset is superior to expensive bathymetric and site surveys, and should encourage operators to use these datasets to optimize cost, while avoiding shallow geohazards and de-risking future operations.

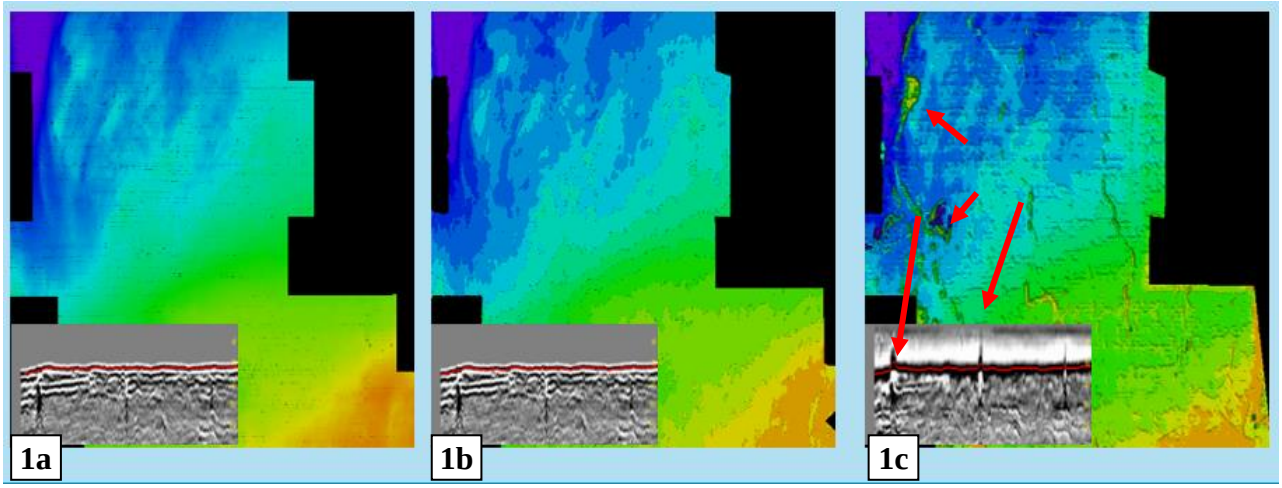


Figure 1 *(a) Seabed from Bathymetry (b) from Multiple Imaging (c) from conventional Kirchhoff PSDM*

Figure 2 Depth slice of shallow section where conventional Kirchhoff migration (2a) is unable to focus the image of the shallow gas bodies and suffers from acquisition footprint due to wide-tow cable acquisition. RTMM Multiple Imaging (2b) on the other hand, is able to delineate the gas bodies, and reduce acquisition footprint

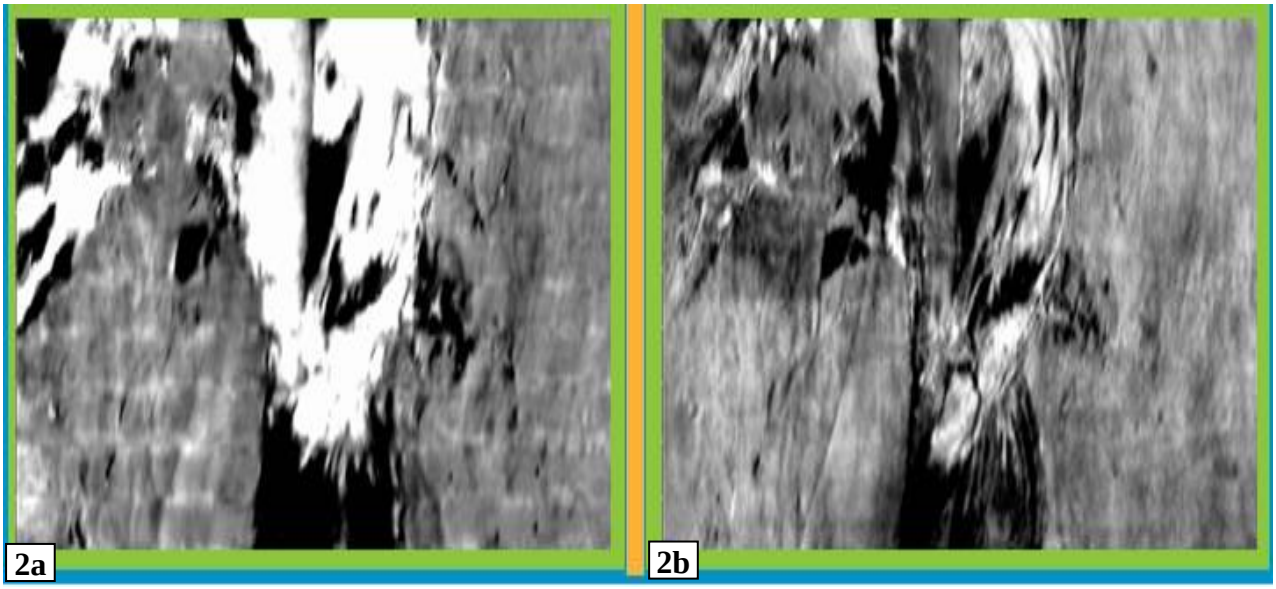
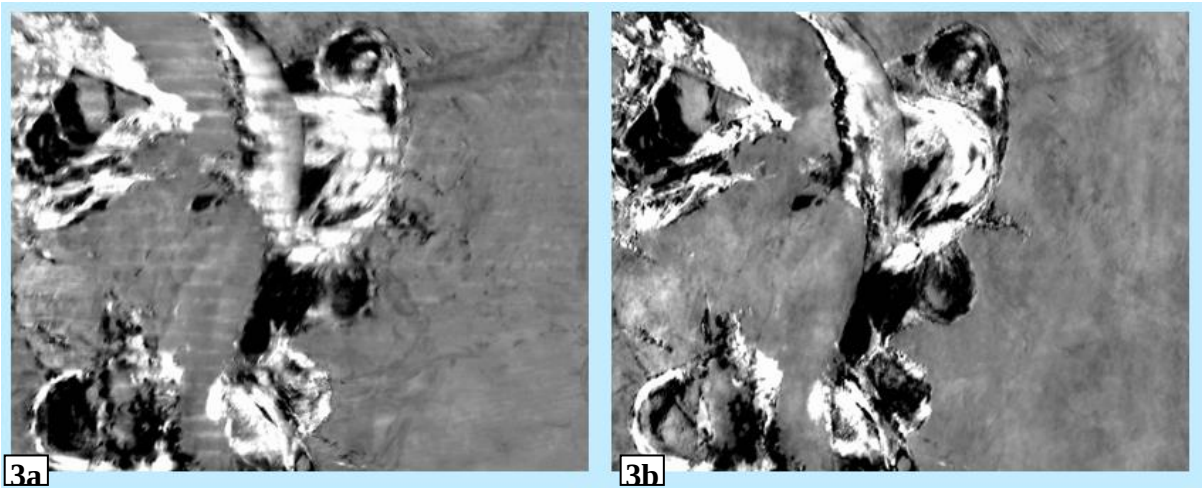


Figure 2 *(a) Conventional Kirchhoff Migration (b) RTMM Multiple Imaging*

Figure 3 Another depth slice of the shallow section where Multiple Imaging (3b) clearly improves the image of Conventional Kirchoff PSDM (3a). Multiple Imaging (3b) shows how multiples can fill in the missing information indicating, resulting in a higher resolution image.



Conclusion

To summarize, we have shown a successful application of RTMM Multiple Imaging to a field data from Offshore Malaysia. Though typically attenuated in the past, multiple wavefield can prove to be a useful source of information. Because of the wider and more balanced illumination pattern of multiple, multiple imaging can significantly improve the shallow image. Multiple Imaging reduces acquisition footprint and results in an image with high spatial resolution. This can help to de-risk positioning of rigs, or avoid drilling hazards and eventually reduce the cost and/ or need for dedicated bathymetry or site-surveys.