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## Review for Underwater Explosions based on Depth and Source Types

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Most of underwater explosions show characteristics of bubble pulse and reverberation effects. Therefore it is most important to find these two phenomena in order to identify an underwater explosion for any sinking and/or missing a ship or a submarine. The best known studies to find bubble pulse and propagation effects are spectral analysis and cepstral analysis. The review technologies for underwater explosion includes Kursk submarine disaster, ARA San Juan Missing, some Russian underwater nuclear explosion as well as the ROKS Cheonan Sinking which is the main topic in this study. Seismologically it is also the most important to find a positive polarity of the first P-wave arrival from the vertical component record whether or not it is an underwater explosion. Nonetheless it is not always clear to find the upward (compression) of the first P-wave onsets in case of an underwater explosion inside a submarine. This paper is stressed on a shallow underwater explosion near the surface like the ROKS Cheonan Sinking showing a bubble jet characteristic resulting in splitting the ship into two pieces. The phenomena of a bubble jet and a toroidal bubble are highlighted in high resolution spectral analysis for a shallow underwater explosion.

### Promotional text

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