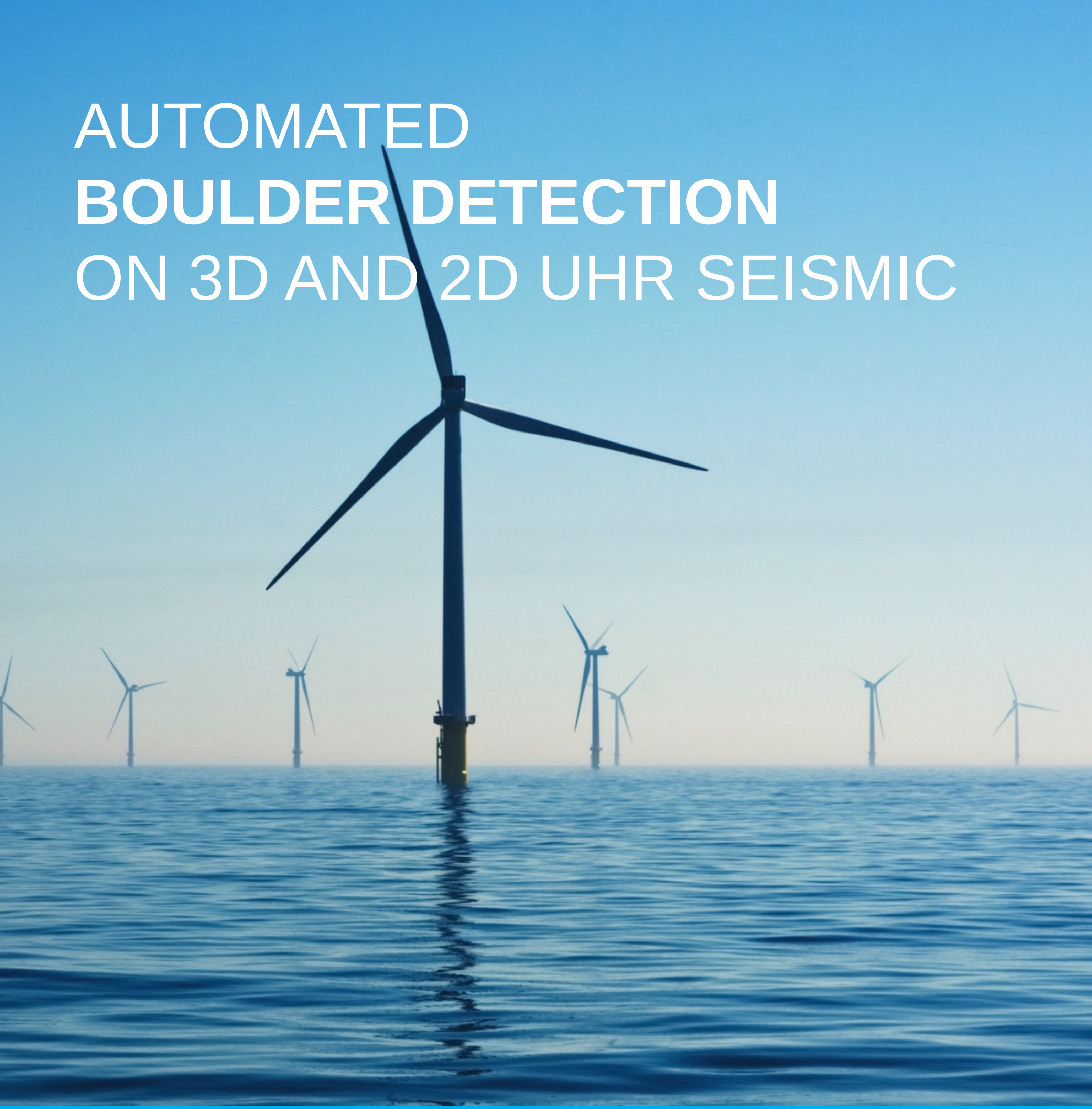
AUTOMATED **BOULDER DETECTION** ON 3D AND 2D UHR SEISMIC



RadExPro

seismic software

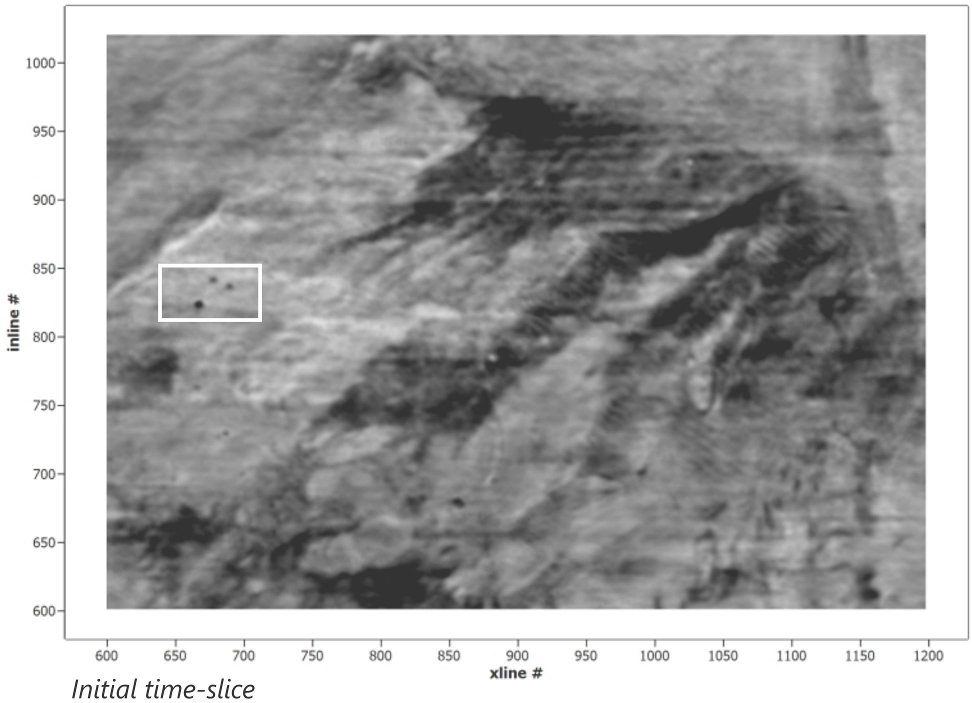
Precise identification of sub-seafloor boulders is crucial for derisking offshore windfarm installation as well as other subsea construction work and, in turn, for minimizing associated costs.

While 3D HR/UHR seismic technology remains the gold standard for accurate boulder localization, we understand that many rely on 2D seismic surveys for rough-and-ready assessments. Recognizing this, we have developed dedicated interactive tools for swift and dependable Automated Bolder Detection on both **3D** and **2D** HR/UHR seismic data.

It's important to note that the innovative Boulder Detection and Boulder Detection 2D modules are not part of the standard **RadExPro** configurations and require a separate license.

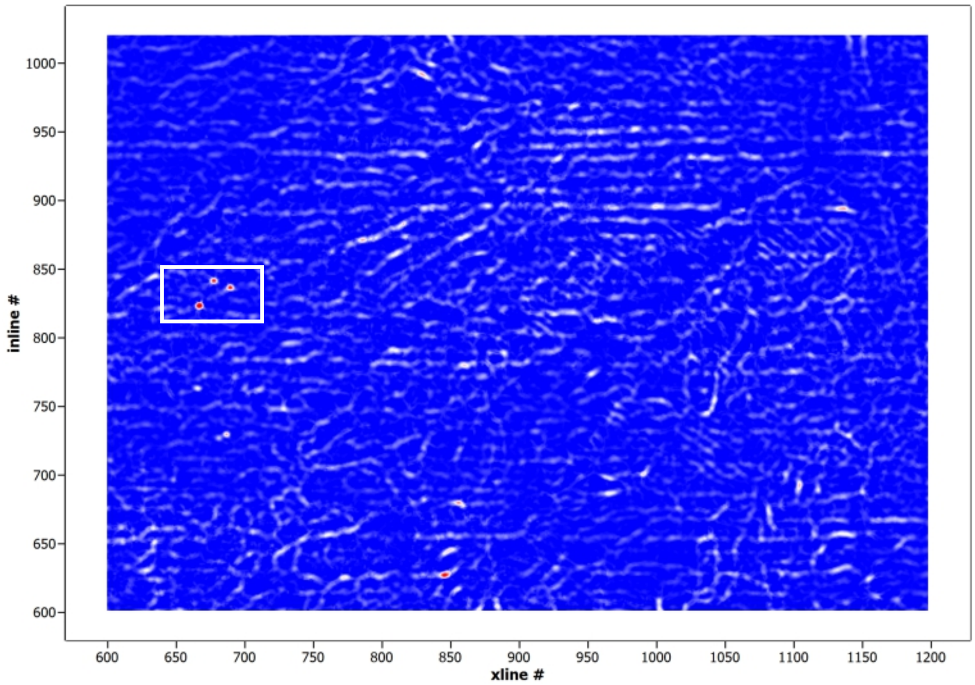
3D Boulder Detection

With the new **Boulder Detection** tool of the **RadExPro** software, you can efficiently identify and pinpoint individual boulders in 3D HR/UHR marine seismic data, all in a fraction of the time required for human interpretation. The size of recognizable objects can be as small as the spatial resolution of the seismic data allows.



Initial time-slice

On pre-migration stacked data, boulders manifest as hyperbolic events. Post-migration, they are concentrated into local amplitude anomalies, easily discernible on time slices.



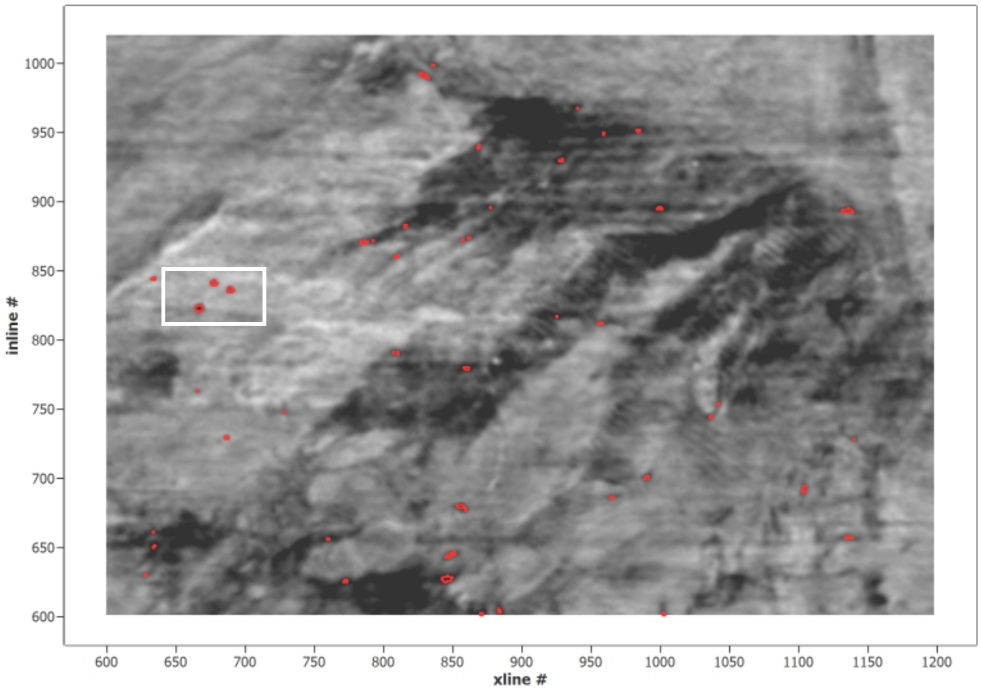
Qualitative boulder probability attribute, the boulders have the highest amplitudes.

The detection algorithm involves calculating a qualitative boulder probability attribute using an image processing technique that emphasizes local amplitude anomalies of defined size. This process is applied to migrated 3D volumes, ensuring impressively fast boulder detection, even on just a regular personal computer.

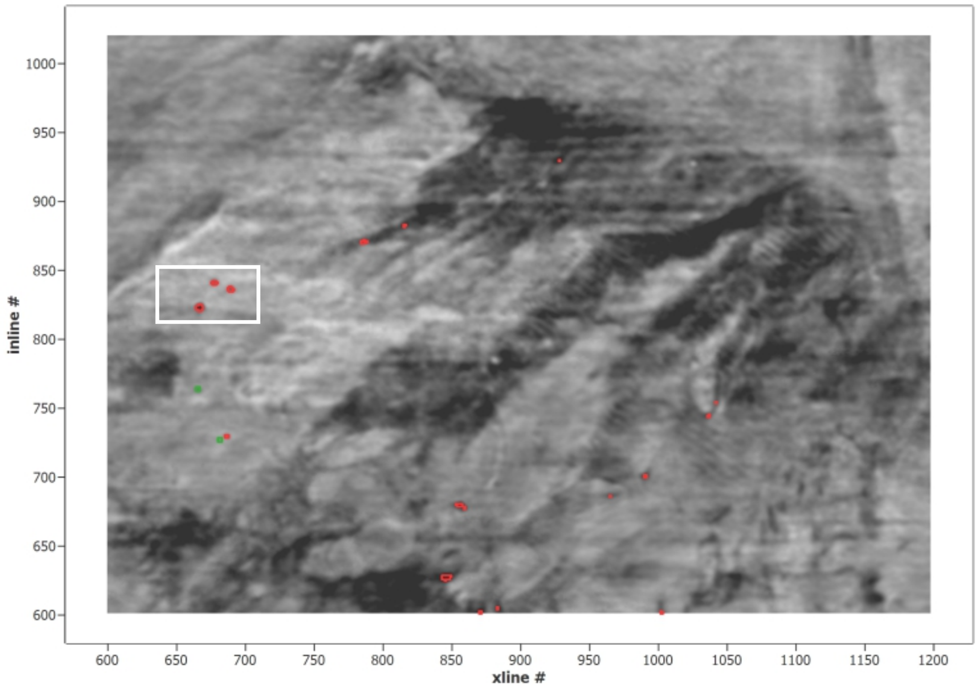
The attribute serves as the basis for the initial boulder classification using a 3D labeling algorithm. Subsequently, the properties of the identified potential boulders are utilized to filter out false positives that do not conform to the a priori constraints. The interpreter has complete control over the characteristic horizontal and vertical sizes, as well as the aspect ratio of the objects to be detected. Manual interactive editing of the results can also be carried out at the final stage.

The deliverables comprise a table containing all detected boulders, including their coordinates, depths, dimensions, and aspect ratios.

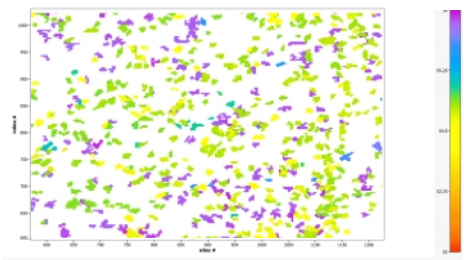
Furthermore, it is possible to generate a map of the survey area, with all boulders color-coded according to their depths.



Identified potential boulders (marked red) after 3D labeling



Final result (most false positives filtered out based on a priori constraints)

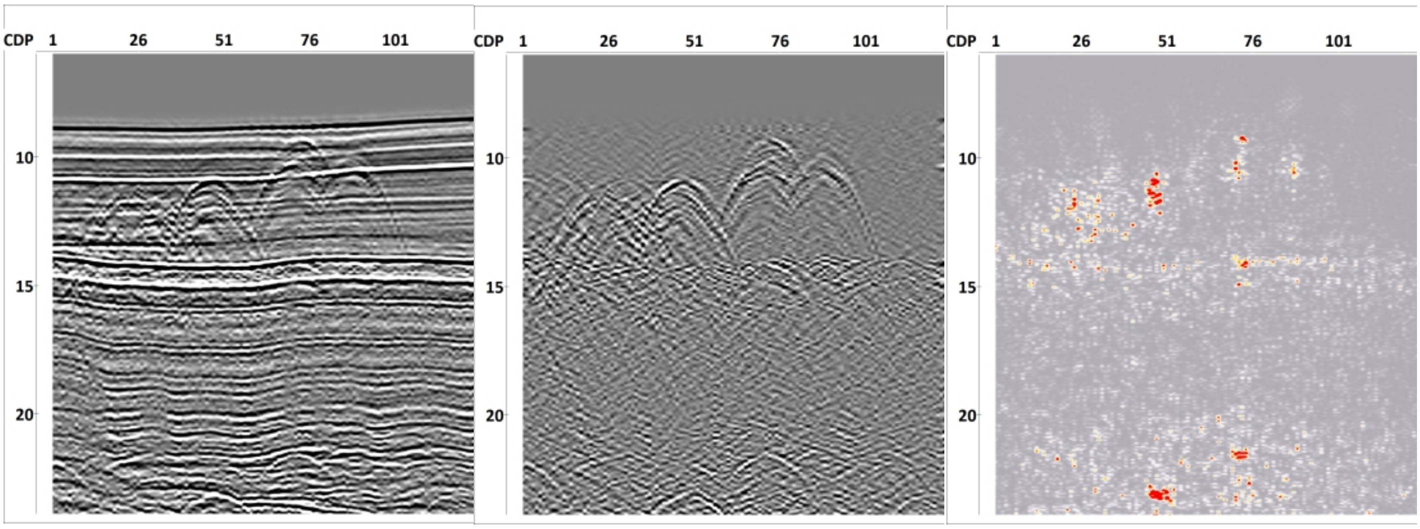

Resulting boulder map, each sample on the surface is colored according to the two-way traveltime to the top of the shallowest boulder at that location.

centroid-x-(m)	centroid-y-(m)	centroid-TWT-(ms)	top-TWT-(ms)	bot-TWT-(ms)	TWT-span-(ms)	major-axis-(m)	minor-axis-(m)	aspect-ratio
376.66667	373.72222	54.95	54.9	55.0	0.1	1.65831	0.8165	2.03101
503.23333	518.23333	53.3	53.2	53.4	0.2	2.0702	1.5353	1.3484
390.22881	513.49153	53.65	53.4	53.9	0.5	2.40001	1.72914	1.38798
336.3	431.2	55.15	55.1	55.2	0.1	0.86603	0.86603	1.0
444.1	337.9	55.05	55.0	55.1	0.1	1.5	0.61237	2.44949
327.88462	549.30769	53.55	53.5	53.6	0.1	1.80463	1.57241	1.14769
414.77778	553.16667	53.55	53.5	53.6	0.1	1.73205	0.70711	2.44949
341.46	428.38	55.2	55.1	55.3	0.2	3.33691	1.36906	2.43738
309.75	572.38636	53.7	53.6	53.8	0.2	1.82248	1.78429	1.02141

Main deliverable – resulting table of identified boulders with their parameters.

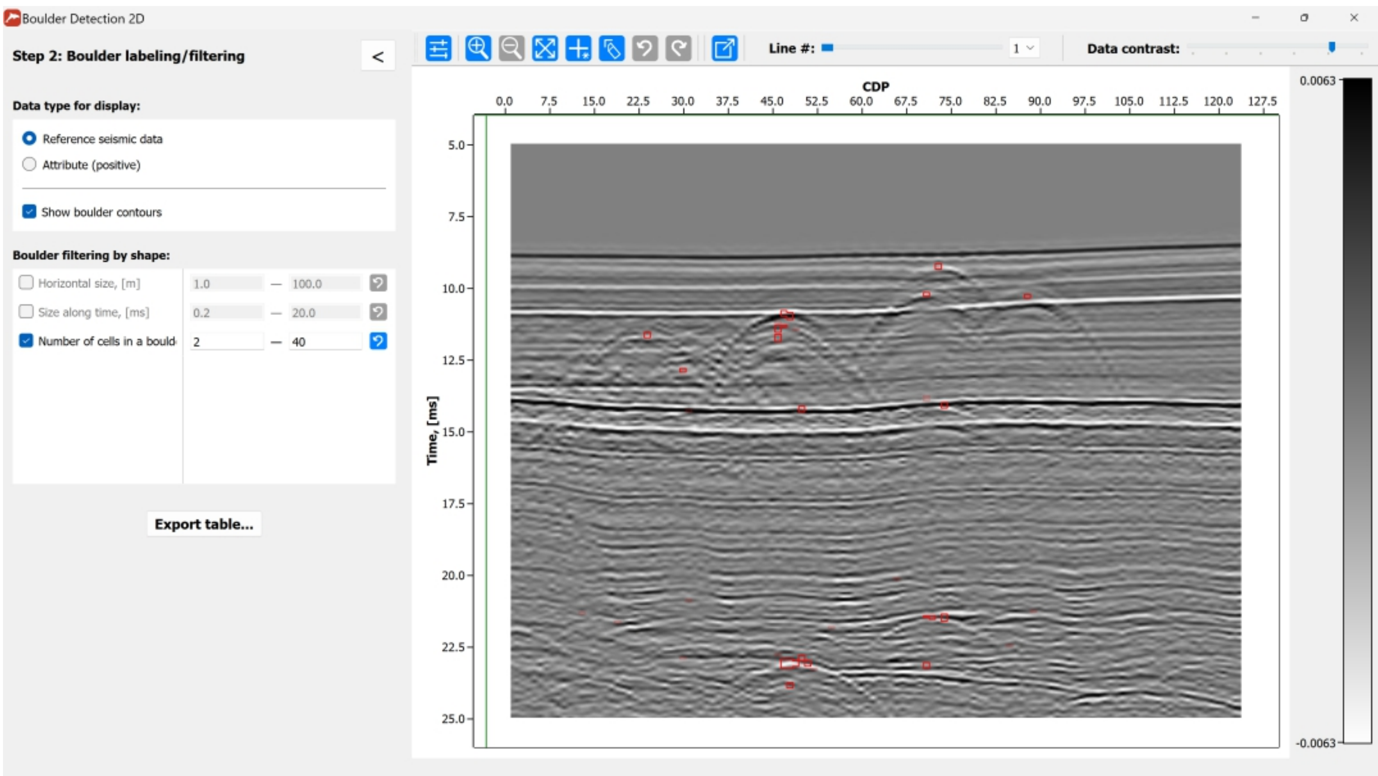
2D Boulder Detection

On 2D seismic data, the boulders appear as diffracted events. Using the diffraction imaging workflows in **RadExPro**, one can separate these diffractions from the data and compute diffraction attributes such as diffraction energy and semblance. The attributes focus the diffraction energy at the boulder locations.



Original seismic data (left), estimated diffractions (center) and diffraction energy attribute (right)

The dedicated **Boulder Detection 2D** tool uses these attributes together with the original data to locate and label the boulders and compute their spatial properties. These properties are then used to filter out those boulder candidates, which do not fit the a priori constraints on the boulder shape — too flat, too big/small, etc. The result is exported as a table of detected boulders with their locations, depths and sizes.



Interactive Boulder Detection 2D module window with highlighted contours of detected boulders