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Title	Diffraction imaging of sedimentary basins: An example from the Porcupine Basin
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Publication date	2021-04-30
Publication information	Lowney, Brydon, Lewis Whiting, Ivan Lokmer, G. S. O'Brien, and Christopher J. Bean. "Diffraction Imaging of Sedimentary Basins: An Example from the Porcupine Basin ." Copernicus, 2021.
Conference details	The EGU General Assembly 2021 (EGU21), Virtual Conference, 19-30 April 2021
Publisher	Copernicus
Item record/more information	http://hdl.handle.net/10197/12474
Publisher's version (DOI)	10.5194/egusphere-egu21-21

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EGU21-21

<https://doi.org/10.5194/egusphere-egu21-21>

EGU General Assembly 2021

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Diffraction imaging of sedimentary basins: An example from the Porcupine Basin

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Diffraction imaging is the technique of separating diffraction energy from the source wavefield and processing it independently. As diffractions are formed from objects and discontinuities, or diffractors, which are small in comparison to the wavelength, if the diffraction energy is imaged, so too are the diffractors. These diffractors take many forms such as faults, fractures, and pinch-out points, and are therefore geologically significant. Diffraction imaging has been applied here to the Porcupine Basin; a hyperextended basin located 200km to the southwest of Ireland with a rich geological history. The basin has seen interest both academically and industrially as a study on hyperextension and a potential source of hydrocarbons. The data is characterised by two distinct, basin-wide, fractured carbonates nestled between faulted sandstones and mudstones. Additionally, there are both mass-transport deposits and fans present throughout the data, which pose a further challenge for diffraction imaging. Here, we propose the usage of diffraction imaging to better image structures both within the carbonate, such as fractures, and below.

To perform diffraction imaging, we have utilised a trained Generative Adversarial Network (GAN) which automatically locates and separates the diffraction energy on pre-migrated seismic data. The data has then been migrated to create a diffraction image. This image is used in conjunction with the conventional image as an attribute, akin to coherency or semblance, to identify diffractors which may be geologically significant. Using this technique, we highlight the fracture network of a large Cretaceous chalk body present in the Porcupine, the internal structure of mass-transport deposits, potential fan edges, and additional faults within the data which may affect fluid flow pathways.