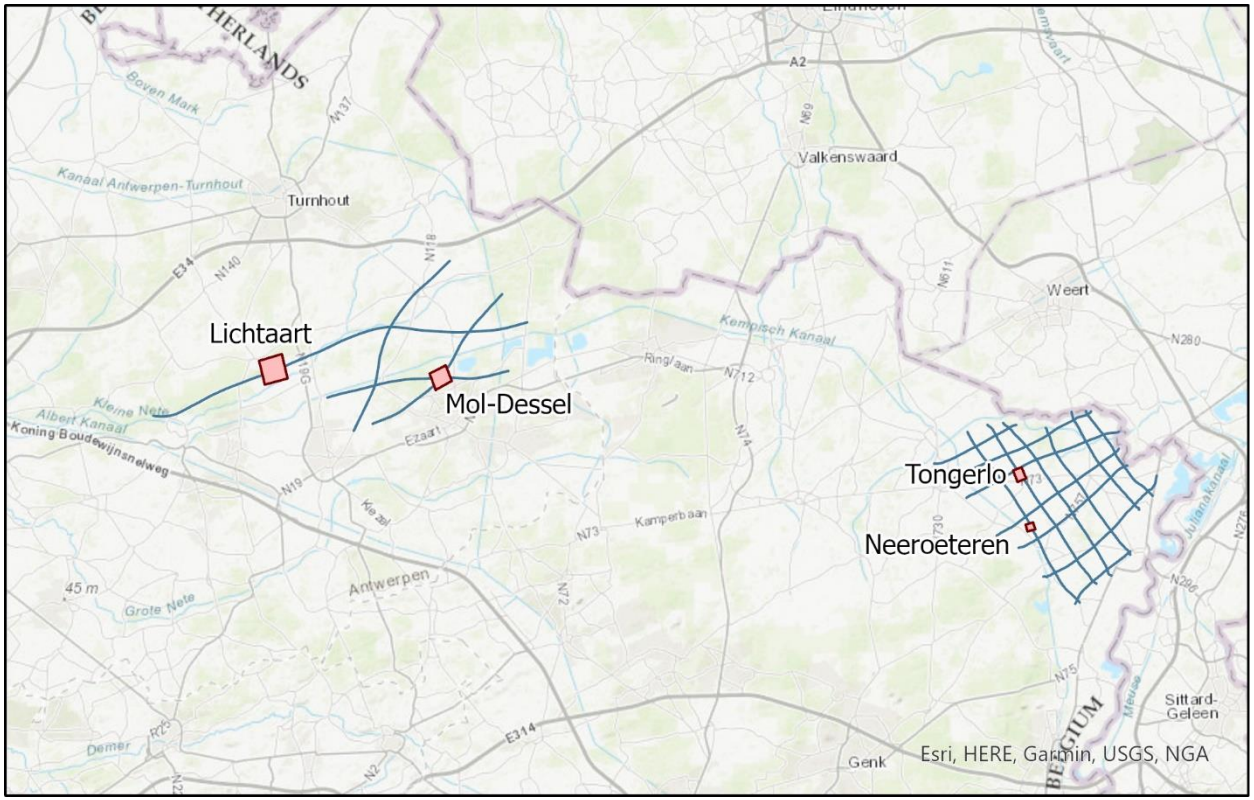
Seismic amplitude anomalies in Flanders

Flanders is covered by a dense network of 2D seismic lines of different age and varying quality. Several seismic surveys of good quality have been recently acquired due to the upcoming geothermal interest in the region. During the study of these lines, seismic amplitude anomalies were locally observed, mostly in association with faults.

Generalities

Seismic amplitude anomalies (SAA's) are distinct expressions on a seismic image that may be caused by abrupt changes in geophysical contrasts (in density and acoustic velocity) in the subsurface. These abrupt changes in geophysical contrasts can represent geomanifestations, such as local cemented layers (higher density and acoustic velocity) or gas accumulations (lower density and acoustic velocity). However, a SAA can often be explained by more than one geomanifestation (c.f. Vernengo et al., 2017) and also be attributed to non-geological processes (e.g. acquisition or processing issues). Therefore, the SAA's have to be thoroughly examined in order to establish whether they actually represent a geomanifestation and which type of geomanifestation we are dealing with. The most straightforward way to examine this would be by drilling a well into the observed SAA. As drilling wells is very expensive, other, more indirect techniques have been developed. AVO analysis (Amplitude Variation with Offset) is such a technique. It allows to analyse lateral changes of amplitude trends with offset (the distance from shotpoint to receiver during seismic data acquisition). The amplitude variation with offset will depend mainly on lithology, but also the pore volume and its content (gas, oil or water). This analysis can therefore provide more clarity into the cause of a SAA. Interpretations of AVO anomalies should be based on the comparison with literature, ideally in combination with well data. AVO analyses on their turn also allow the detection of seismic anomalies that are not clear on the stacked seismic image.



This file is part of the GeoConnect³d project that has received funding by the European Union's Horizon 2020 research and innovation programme under grant agreement n.731166.

Anomaly

Based purely on the stacked seismic image, three SAA's were observed (Lichtaart, Tongerlo and Neeroeteren). In order to be able to perform reliable AVO-analysis several prestack processing steps and requirements need to be fulfilled. These include amplitude preservation, multiple attenuation, zero phasing and prestack time migration. For the seismic survey including the Lichtaart SAA, limited reprocessing still needed to be carried out in order to meet these requirements, and therefore this was performed during this research project. The seismic survey including the two SAA's in the eastern part of Flanders data needed a lot more reprocessing in order to be AVO ready, and reprocessing was therefore not conducted.

On the reprocessed seismic survey, Westphalian and Namurian strata (including the Lichtaart SAA) were extensively analysed with the standard intercept-gradient AVO method applying Shuey's 2-term approximation (Shuey, 1985). The classification schemes of Rutherford and Willams (1989) and Castagna and Swan (1997) were used to interpret the observed anomalies. In this way, new AVO anomalies were detected in addition to the Lichtaart SAA. In the Mol-Dessel area, these anomalies could be linked to slightly gas bearing layers also encountered in three recently drilled wells.

Data

ID	Coordinates (EPSG: 3034)		Name	Seismic anomaly	AVO anomaly	Depth
	X	Y			Class	m
VITO_c0003	3658815.62	2727608.69	Lichtaart seismic high amplitude anomaly	High amplitude, link with faults	1	2500-2650
VITO_c0004	3669703.27	2726245.09	Mol-Dessel AVO anomalies	Amplitude contrasts with offsets	1 and 4	900-2800
VITO_c0005	3708318.38	2713217.42	Neeroeteren seismic high amplitude anomaly	High amplitude including shadow zone	Not investigated	450-650
VITO_c0006	3707859.10	2716845.37	Tongerlo polarity reversal	Polarity reversal	Not investigated	1050-1100

References

Castagna, J.P. and Swan, H.W., 1997, Principles of AVO crossplotting: The Leading Edge, 16, 337-342.

Rutherford, S. R., and R. H. Williams, 1989, Amplitude versus-offset variations in gas sands: Geophysics, 54, p. 680-688.

This file is part of the GeoConnect³d project that has received funding by the European Union's Horizon 2020 research and innovation programme under grant agreement n.731166.

Shuey, R.T., 1985, A simplification of the Zoeppritz equations: Geophysics, 50, p. 609-614.

Vernengo, L., Trinchero, E. and Chopra, S., 2017, Deciphering Seismic Amplitude Language. Search and Discovery Article #41981; Adapted from the Geophysical Corner column, prepared by the authors, in AAPG Explorer, January, 2017.

Cite this source

Rombaut, B., Deckers, J. & Dirix, K., 2021. Seismic amplitude anomalies in Flanders [Fact sheet]. Flemish Institute for Technological Research (VITO).

This file is part of the GeoConnect³d project that has received funding by the European Union's Horizon 2020 research and innovation programme under grant agreement n.731166.