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**Modelling fractured reservoirs from LiDAR derived digital outcrop models (DOMs)**

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Outcrop analogue studies are of great importance to reduce exploration risk. Terrestrial laser scanning (TLS), also referred to as LiDAR, allows for imaging potential reservoir units in outcrops which provides the basis of digital outcrop models (DOM). A quarry of HeidelbergCement AG in the Triassic Muschelkalk serves here as study object. Main objectives are:

1) Development of a workflow for: (i) interpretation of depositional planes, geometries and fractures based on a DOM and (ii) data transfer to Petrel/Eclipse in order to link them with 1D- and 2D-subsurface information.
2) Development of automated fracture extraction based on 3D LiDAR point clouds directly.

Methods: The digital data base for the development of the DOM consists of 3D point clouds with finite spatial information (XYZ), GPS data and high-resolution outcrop photography. Acquisition of the point cloud information has been accomplished with the terrestrial scanner ILRIS HD from Optech operated by a laptop. Altogether 60 point clouds have been recorded (each between 0.7 and 12.0 million points). Outcrop photography has been taken from the same position parallel to the scanning procedure. GPS and a compass enabled the determination of spatial orientation. The process of aligning and georeferencing the point clouds has been carried out using JRC Reconstructor 2 from Gexcel. Photography corresponding to point clouds has been extracted and optimised graphically for the photo projection which is also performed using JRC Reconstructor 2. The aligned and projected point clouds allow the interpretation of depositional planes, geometries and fracture as polyobjects. DOM and interpreted polyobjects are exported from JRC Reconstructor 2 and imported into Petrel. A method which allows an automated extraction of fractures based on 3D point clouds directly has been developed by the LiDAR Research Group at the Institute of Geography (University of Heidelberg).

Discussion: Utilisation and potential of DOMs based on TLS-data is subject of current research. The methods described lead to the development of a high-resolution DOM (21 mm point resolution). It provides the basis for hydraulic reservoir models in Petrel/Eclipse and offers the opportunity to link large-scale, optimal 3D outcrops with 1D- and 2D-data of the subsurface and diagenesis/petrophysics. This study focuses on the extraction of fractures without prior triangulation (meshing) and extracts the 3D information directly from the 3D point clouds via robust local plane fitting and subsequent region growing segmentation. Hence, there is no need for triangulation and avoids 'smoothing' of fractures that could occur by surface interpolation. Furthermore, it works fully in 3D (i.e. no plane projection required) and uses fast algorithms for parallel processing of the large data sets.

Conclusion: The method described serves as a basis for further detailed reservoir modelling. A digital, high-resolution reservoir model (Petrel) is being established using additional data (faultmap, well-logs, and profiles). This improves the interpretation of geostatistical data and can also be used for further simulations. The goal is to calculate an integrated fluid flow model with Eclipse to compare results based on different input parameters and to characterize the fractured reservoir.

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