Abstract

The aim of this research project is the three-dimensional reconstruction of Upper Jurassic sponge-microbial bioherms in SW-Germany. Knowledge of three-dimensional shapes of these carbonate buildups can be useful in hydrocarbon exploration and reservoir characterisation.

Georadar (Ground Penetrating Radar) measurements provide high-resolution images of depositional geometries. GPR measurements were carried out at two locations. For the data acquisition a 200 MHz GPR measurement tool was used. In the quarry of Gerhausen, single 2-D sections were acquired, in the quarry of Genkingen the data acquisition covers a “pseudo 3-D” georadar grid. The depth of penetration (DOP) of the GPR is dependant on the pureness of the limestone and ranges from 7 metres to 17 metres in areas with very pure limestone.

To interpret the GPR data a georadar facies atlas was developed, defining the main three carbonate facies: the massive (reefal) facies, the bedded (basinal) facies and the transition zone (reef margin) facies. The massive facies is defined by well developed hyperbolic reflections. The bedded facies displays strong and well traceable reflections. The processed GPR data was interpreted in the seismic interpretation module of the software Petrel. Within a major biohermal complex, the strong reflectors of the small basins located between the massive facies were mapped. This resulted in the reconstruction of elongated intra-biohermal basins oriented in a
northeast to southwest direction. These small scaled internal heterogeneities are possibly elongated in response to the prevailing paleocurrents, in the same way as the entire biohermal complexes themselves.

References


Geometry of Upper Jurassic sponge/microbial bioherms: 3D Georadar (GPR) analysis and modelling (Swabian Alb, SW-Germany)

Diploma thesis

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Outline

Introduction

Methods

GPR 2D-sections

GPR 3D analysis

GPR facies atlas

GPR facies atlas
Geometry of Upper Jurassic sponge/microbial bioherms: 3D Georadar (GPR) analysis and modelling

Introduction

Aim of study:
Part of larger carbonate geobody project

Imaging of carbonate buildup dimensions and shapes by means of GPR measurements.

3D - reconstruction and visualisation of Upper Jurassic sponge/microbial bioherms and possible intra-biohermal heterogeneities

→ hydrocarbon exploration
→ reservoir characterisation

(type (class) examples)

- mound mud mounds, rudit mounds
- bar shoals, barrier reefs, tidal-, channel bars
- bow atoll, fringing reef, tidal-, channel bars
- pinnacle pinnacle reef, knob
- wedge reef debris, aprons, wedges
- fan fans, reef debris, spill-over lobes
- clinoform progradational debris, aprons, wedges
- sheet biostromes, tempestites, mud flats

(Jung, 2011)
Geometry of Upper Jurassic sponge/microbial bioherms: 3D Georadar (GPR) analysis and modelling

Introduction

Study areas:

Quarry Gerhausen

Quarry Genkingen
Methods

Georadar (Ground Penetrating Radar / GPR) measurements provide high resolution images of depositional geometries.

200 MHz GPR measurement tool was used

Acquisition of 137 GPR 2D lines in total.
Quarry Gerhausen: 4 lines
Quarry Genkingen: 133 lines from which 129 lines build up a „pseudo 3D“ GPR grid
GPR 2D - sections

exposed quarry wall
GPR 2D - sections

exposed quarry wall
GPR carbonate facies atlas

Radar signature

Bedded limestone

Depth of penetration:

Limestone areas with high marl content:
9m and higher than in massive facies

Pure limestone areas:
7m and lower than in massive facies

Lithofacies

Depositional environment
Geometry of Upper Jurassic sponge/microbial bioherms: 3D Georadar (GPR) analysis and modelling

GPR carbonate facies atlas

Radar signature

Massive limestone

- Depth of penetration:
  - Limestone areas with high marl content: 5m and lower than in bedded facies
  - Pure limestone areas: 17m and higher than in bedded facies

Lithofacies

Depositional environment

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GPR carbonate facies atlas

Radar signature

Transition zone

Lithofacies

Depositional environment

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GPR 3D analysis

GPR grid consisting of 129 2D georadar sections spaced 2.5m from each other
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GPR 3D analysis

Massive facies
Bedded facies

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GPR 3D analysis

Layer-by-layer mapping
GPR 3D analysis

Layer-by-layer mapping

Legend:
- intrabiothermal basin (bedded facies)
- sponge-microbial, biothermal (massive facies)
Results
Summary

2-D georadar lines behind outcrop walls: correlation between GPR signatures and lithofacies

Georadar facies types:
- horizontal reflections: bedded facies → basinal
- hyperbolic reflections: massive facies → bioherms
- inclined reflections: transition facies → bioherm flanks

3-D georadar analysis: block of 125 m x 95 m scale
- outcrop calibration along 2 sides: biohermal complex
- intra-biohermal heterogeneities: intra-biohermal basins (10´s of meter scale)
- preferred NE/SW elongation

Neighbouring biohermal bodies: several kilometers scale
- preferred NE/SW elongation
- possible paleocurrent control
Thank you for your attention

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