

**ePS Geometry of Upper Jurassic Sponge/Microbial Bioherms: 3-D Georadar Analysis and Modelling,
Swabian Alb, SW-Germany***

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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

Pawellek, T., 2001, Facies, sequence, and gamma-ray analysis in the upper Malm of the Swabian Alb, southwestern Germany; with remarks on the geology of raw materials, specifically high purity limestones: *Fazies, Sequenz, und Gamma-Ray-Analyse im höheren Malm der Schwabischen Alb (SW-Deutschland) mit Bemerkungen zur Rohstoffgeologie (hochreine Kalke)*: Tubinger geologische Arbeiten Reihe, A61, 246 p.

Pawellek, T., and T. Aigner, 2004, Dynamic stratigraphy as a tool in economic mineral exploration; ultra-pure limestones; Upper Jurassic, SW Germany: *Marine and Petroleum Geology*, v. 21/4, p. 499-516.

Rathgeber, T., 2002, Fossil-bearing karst fissures near Sonnenbühl-Genkingen: *Fossilführende Karstspalten bei Sonnenbühl-Genkingen*: *Abhandlung zur Karst- und Höhlenkunde*, v. 34, p. 83-85.

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

Diploma thesis



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Outline

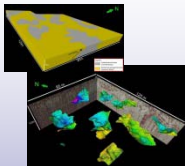
Introduction



Methods



GPR 2D-sections



GPR 3D analysis



GPR facies
atlas





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

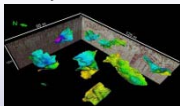
type (class)		examples
mound		mud mounds, rudist mounds
bar		shoals, barrier reefs, tidal-, channel bars
bow		atoll, fringing reef, tidal-, channel bars
pinnacle		pinnacle reef, knob
wedge		reef debris, aprons, wedges
fan		fans, reef debris, spill-over lobes
clinoform		progradational debris, aprons,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

(Jung, 2011)



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.

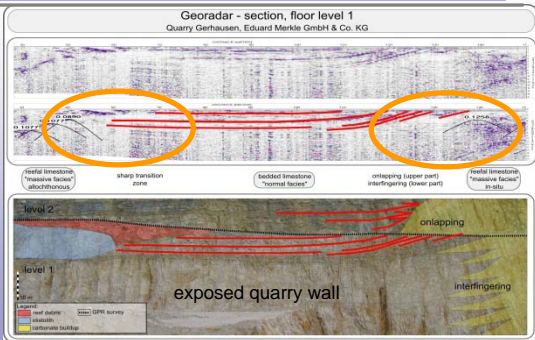
Quarry Gerhausen: 4 lines

Quarry Genkingen: 133 lines from which

129 lines build up a „pseudo 3D“ GPR grid



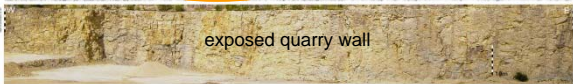
GPR 2D - sections





GPR 2D - sections

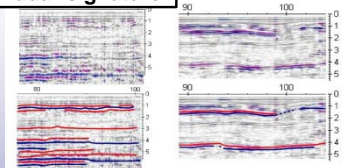
GPR 2D-section, wall panel 1 (EW-striking part)
Quarry Genkingen, Leibfritz GmbH & Co. KG





GPR carbonate facies atlas

Radar signature



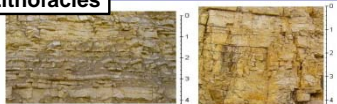
Bedded limestone

Depth of penetration:

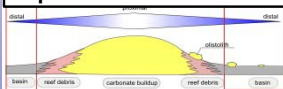
Limestone areas with high marl content:
9m and higher than in massive facies

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

Lithofacies



Depositional environment





GPR carbonate facies atlas

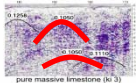
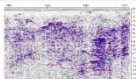


Radar signature

Velocity of GPR waves calculated by means of the width of the hyperbolic reflex.
Typical value for limestone: 0.12m/s



massive limestone with higher marl content (kl 2.3)



pure massive limestone (kl 3)

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

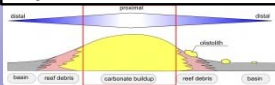
Lithofacies



A: sponge
B: thrombolites



Depositional environment

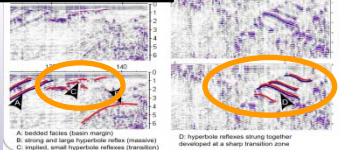




GPR carbonate facies atlas



Radar signature



Transition zone

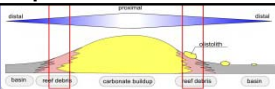
Lithofacies



E: sponge fragments

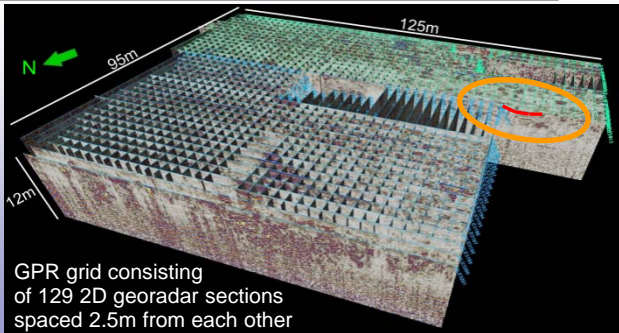


Depositional environment





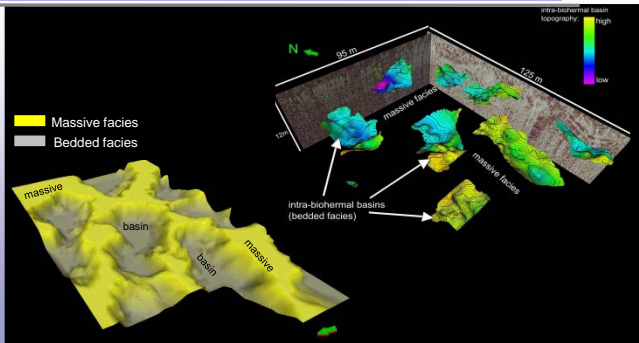
GPR 3D analysis



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

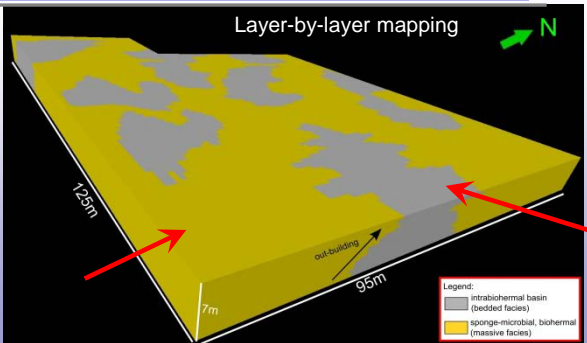


GPR 3D analysis



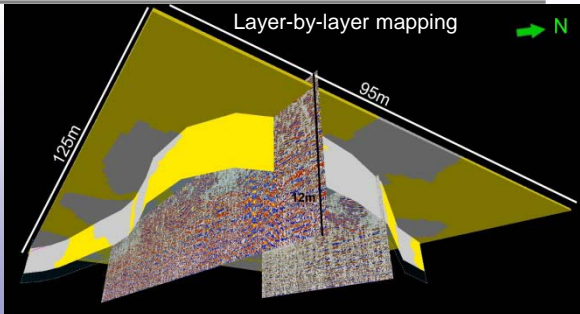


GPR 3D analysis





GPR 3D analysis

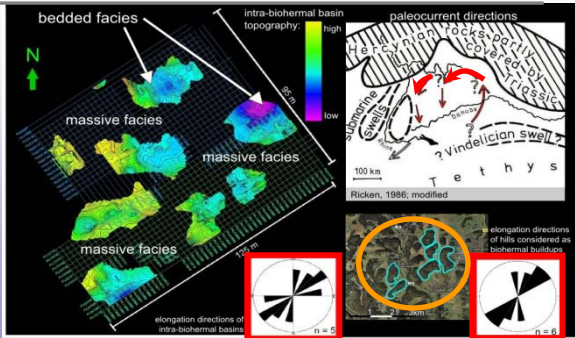


Legend:

intrabiohermal basin (bedded facies) sponge-microbial, biohermal (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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