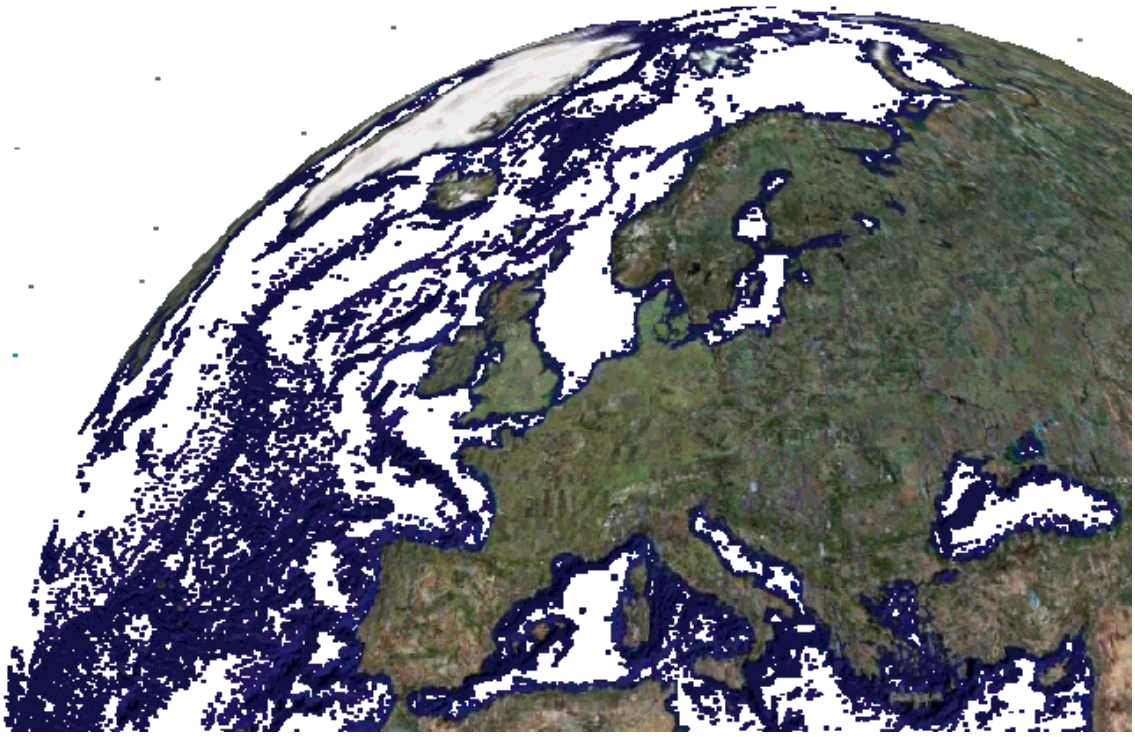
Gas Shales in Europe



An industry project
... now open for participation

coordinated by

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Executive summary

GASH is an interdisciplinary **Gas Shale research** program run by a multinational expert task force drawn from research institutions, geological surveys, universities and consultants.

Its overall goal is to predict shale gas formation and occurrence in time and space.

GASH focuses on the potential gas shales of **Europe. Importantly, it also** integrates proven US gas shales (e.g. Barnett Shale) for calibration of key variables.

The GASH program is subdivided into two fundamental parts:

- Compilation of a European black shale database
- Basic research on the key elements of gas shales

Black shale database:

- Constructed for exploration and exploitation of gas shales
- Web-based infrastructure
- First tier Germany, The Netherlands, Scandinavia
- Second tier France, Austria, Baltic states, Great Britain

Basic research:

Regional scale:

- Source and reservoir properties of organic matter
- Basin and fracture modeling
- Advanced exploration geophysics
- Advanced basin modeling techniques

Reservoir scale:

- Source and reservoir properties of organic matter
- Sedimentological, diagenetic and tectonic control of sweet spots
- Single- and multiphase (gas-water) flow
- Rock physics of black shales
- Microbial methane generation

Natural laboratories:

- Alum Shale (Cambrian) – Sweden
- Namurian marine Shales – Holland, Germany, etc.
- Posidonia Shale (Lower Jurassic) - Holland, Germany, etc.
- Reference gas shale in the US:
  - *Barnett Shale (Mississippian, Fort Worth Basin)*

Timeline

- GASH is a 6-year project
- Phase I begins January 2009 and runs 3 years.

Funding

- Industrial partners pay 160,000€ per year, initially committing to 3 years.

Contents

1 – Introductory comments

Gas shales are currently amongst the hottest plays in the **United States** as a result of high gas prices, and the remarkable technological successes exploiting the Barnett Shale of the Fort Worth Basin. Furthermore, viable gas shales most likely occur in many developed basins where an underutilized distribution infrastructure exists and markets are readily accessible. Annual natural gas production from shale gas reservoirs in the US is approximately 1.0 Tcf and comes from more than 40,000 shale gas wells (around 6-10% of total natural-gas production in the US today; numbers vary according to reference).

While high energy prices and advances in fracturing technology have enabled shale gas production to become a lucrative reality, it is the prediction of gas concentration, partition behaviour and rock properties ahead of drilling that is of paramount importance for reducing risk and identifying “sweet spots” or fairways. In other words, there is still a lot to learn scientifically about how shale gas systems actually work. Significant advances have been made over the last five years, but there are great opportunities for major advances in science and technology.

2 - European Shale Gas Potential

No commercial shale-gas enterprises are currently known from outside of North America. Estimations of more than 16,000 Tcf worldwide shale-gas resources (510 Tcf for Western Europe) are indications that a tremendous potential exists for future growth.

Many parts of Europe, dead as far as conventional fossil fuel is concerned, contain prime targets for shale gas exploration. Compared to North America, Europe has a much more complex and compartimentalized setting of geological units. In order to get shale gas exploration going, a multi-disciplinary state-of-the-art re-evaluation of available data, an evaluation of tracer regions and their shale gas potential is needed.

That the need for evaluation is a reality is demonstrated by recent happenings in the European shale gas scene. For instance, in October 2007 Lane Energy Poland, a subsidiary company of 3Legs Resources plc, was granted licences in Poland to explore shale gas from Silurian black shales (http://www.3legsresources.com), and Swedish newspapers have announced Shell’s interest in the Skåne region (e.g. in *Nyheter*).

The GASH initiative comes at the right time.

3 – What is GASH?

GASH is an interdisciplinary **Gas Shale** research project carried out by a multi-national expert task force.

GASH focuses on the potential gas shales of Europe. Importantly, it also integrates proven US gas shales (e.g. Barnett Shale) for calibration of key variables.

Our philosophy

The GASH project will predict shale gas formation and occurrence in time and space because the geological evolution of gas shales is a key control of economic viability. The distribution of prospective shales will be ascertained using existing and enhanced regional databases. Physical, chemical and biological processes contributing to shale gas formation will be examined by experiment, monitoring, surveying and modelling.

Seismic and magnetotelluric surveys will be employed for remote detection. Well log correlations will be employed at the finer scale. Shale property determinations will address both organic and inorganic constituents, and involve their chemical, isotopic and physical characteristics. Regional structural evolution and petroleum system modelling will be employed to model generation, transport and rock-fluid interactions.

GASH is no ivory tower research marathon. It is goal-orientated and designed to meet the short-, and longer-term needs of both sponsors and researchers alike.

4 – Who is in GASH?

The GASH team is mainly European, but with the right mixture of American-based experience and know-how.

The project is coordinated by GeoForschungsZentrum Potsdam (GFZ), the national laboratory for geosciences in Germany. Working alongside them are the Institut Français du Pétrole (France) and TNO (The Netherlands). The universities involved to date include Newcastle (UK), Aachen, FU Berlin, Clausthal, Leipzig (all Germany), VU Amsterdam (The Netherlands) and MU Leoben (Austria).

National and state geological surveys play a key central role not only in regional analysis and application, but also in basic research: GEUS (Denmark), BGR (Germany), BGS (England) are at the heart of the project.

The team:

GFZ-Potsdam
Petroleum systems and basin modelling
Brian Horsfield, Hans-Martin Schulz, Rolando di Primio, Volkmar Neumann

Geophysics
Oliver Ritter, Christian Haberland

Deformation and Rheology
Georg Dresen and team

Newcastle University
Shale diagenesis and overpressure prediction
Andrew Aplin and team

IFP
Modelling of chemical and physical change, and rock properties
Francois Lorant, Francoise Béhar, Jean-Marc Daniel

TNO
European black shale database, Tectonics
Jan-Diderik van Wees and team

GEUS
European black shale database
Jørgen Bojesen-Koefoed

BGS
European black shale database
Nick Riley

RWTH Aachen
Transport through shales
Bernd Krooss

Free University of Berlin
Seismics
S. A. Shapiro and team

TU Clausthal
Hydrogeochemical modelling
Wolfgang van Berk and team

University of Leipzig
NMR
Frank Stallmach, Jörg Kärger

University of Leoben
Sedimentology
Reinhard Sachsenhofer and team

VU University of Amsterdam
Basin analysis
Sierd Cloetingh and team

BGR Hannover
Geomicrobiology
Martin Krüger and team
European black shale database and carbon isotopes
Bernhard Cramer, Peter Gerling and teams

Regional consultants
US coordinator and European projects participant - Dan Jarvie (Worldwide geochemist, USA)
Alum Shale - Bjorn Buchardt (Geological Institute, Denmark)
Posidonia Shale (Hils Syncline) - Ulrich Mann (FZ Jülich, Germany)

5 – Sponsoring GASH

The project will run for 6 years. Phase I begins January 2009 and runs 3 years.

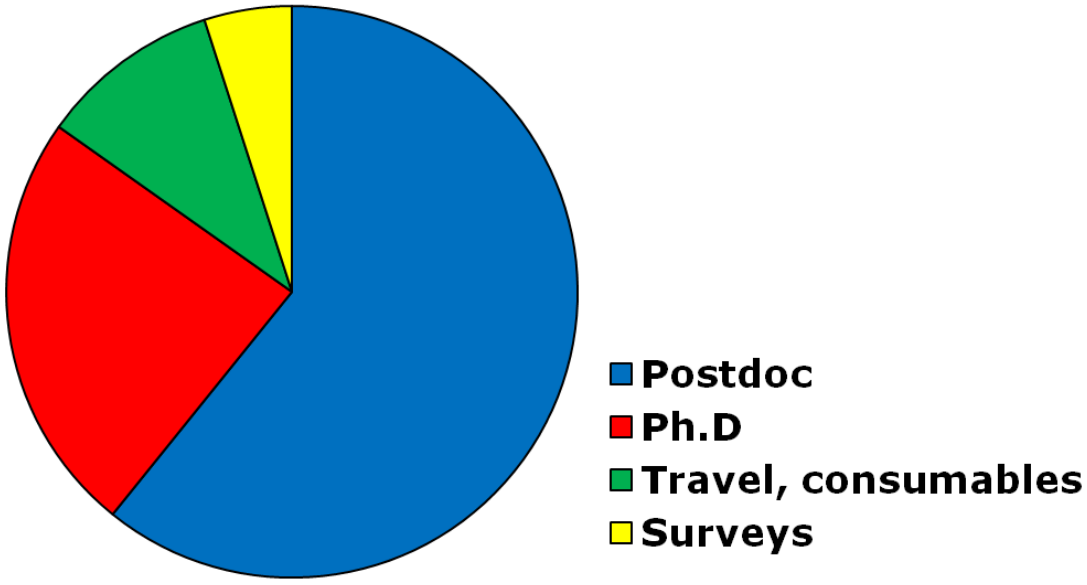
The total cost of the project is 6.25 MM€ over 3-years.

Industrial partners pay 160,000€ per year, initially committing to 3 years.

Sponsors buy into the whole program.

Sponsors help direct the work, initially at the kick-off meeting (early 2009) and thereafter at progress meetings.

Interactive web-based project complemented by delivery of reports and datasets.



Distribution of projected funding from GASH sponsoring

6 – List of GASH projects

1 - European black shale database

Coordinated by Van Wees (TNO, The Netherlands), integrating data from in close collaboration with European geological surveys.

2 – Research projects

2.1 - Tectonic models
Van Wees (TNO, The Netherlands)

2.2 - The organic matter component of gas shales: evolving source and reservoir properties
B. Horsfield (GFZ, Germany), A.P. Aplin (Newcastle, England), B.M. Krooss, R. Littke (Aachen, Germany), B. Cramer (BGR, Hannover), F. Lorant and F. Béhar (IFP, France)

2.3 - **Migration and Retention Processes in Shale Gas: Basin Modeling and Sensitivity Analysis**
F. Lorant et al. (IFP)

2.4 - Single- and multiphase (gas-water) flow in gas shales and tight-gas systems
B.M. Krooss (Aachen, Germany)

2.5 - 3D petroleum system modeling of shale-gas plays
V. Neumann, R. di Primio, B. Horsfield (GFZ, Germany)

2.6 - Exploration geophysics

Part I: Characterizing the electrical conductivity structure of black shale horizons
O. Ritter, M. Becken, U. Weckmann (GFZ, Germany), Ulrich Mann (KFZ Jülich, Germany)

Part II: Seismic characterization of shale gas reservoirs
Christian Haberland, Manfred Stiller, Klaus Bauer, Michael Weber (GFZ, Germany), Ulrich Mann (KFZ Jülich, Germany)

2.7 - Development of rock-physics modelling and microseismic interpretation for geophysical characterization of shale-gas reservoirs
S.A. Shapiro (FU Berlin, Germany), S. Stanchits, G. Dresen (GFZ, Germany)

2.8 - Natural fracturing and pressure modeling in gas shales: reconstuction of geopressures and specific fracturation ratio law calibration
J-M. Daniel (IFP, France)

2.9 - Mechanical and Hydraulic Properties of Shales and Healing of Induced Fractures

G. Dresen, A. Reinicke, E. Rybacki (GFZ, Germany), M. Rouainia, A.C. Aplin (Newcastle, England)

2.10 - Feasibility study for gas shales with bacterial gas - Microbiology and carbon mass balances of bacterial gas formation in gas shales and potential gas shale targets

H.-M. Schulz (GFZ, Germany), M. Krüger (BGR, Germany), W. van Berk (Techn. University of Clausthal, Germany),

2.11 - Multi-Scale Petrophysical Characterisation of Gas Shales

Andrew Aplin (Newcastle University, UK), Bernd Krooss (RWTH Aachen), Brian Horsfield (GFZ Potsdam), Frank Stallmach (Leipzig University, Germany)