

Shale Gas Research for Europe*

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Introduction

The success of shale-gas production in the United States has prompted a worldwide exploration effort for such resources. Especially in Europe, where most countries are dependent on natural gas imports to satisfy their domestic demand the incentive for developing shale gas appears high.

As a consequence of the Fukushima catastrophe in Japan in 2011, Germany, the largest economy in Europe, has declared its exit from nuclear power and intends to replace it by renewable alternatives. On the way to such a modified energy balance, shale gas can be a transitional contribution to an efficient energy mix. However, the concerns of the public with respect to environmental problems, especially in connection with fracking, has spread all over Europe.

Europe as a whole has technically recoverable shale-gas resources of more than 600 Tcf (EIA, April 2011, “World Shale Gas Resources”). However, the resources are concentrated in only a few countries, with Poland and France as the majors, both having around 180 Tcf resources. Until now research on European black shales focused on “conventional” source-rock properties, and many shale-gas relevant questions concerning properties like adsorption, porosity, permeability, brittleness, etc. were left open. The interest in European licenses to explore for shale gas, thus go hand in hand with an interest in basic shale-gas research. Several projects initiated and coordinated by the Helmholtz Centre Potsdam - GFZ German Research Centre for Geosciences, therefore, focus on shale gas and may serve as entry points for the understanding of general features for efficient shale-gas production, not only in Europe. The integrated research on European shale gas started by launching the prominent Gas Shales in Europe project (GASH) in 2009 and slightly earlier in 2008 the GeoEnergie project (GeoEn). The Herald Tribune declared in August 2008 “*Europe starting search for shale gas*”. New on the agenda is the ESOP initiative (European Sustainable Operating Practices) which addresses environmental concerns.

Gash – Gas Shales in Europe

The industry-funded GASH project (<http://www.gas-shales.org>), the first interdisciplinary shale-gas research initiative in Europe, includes research and database development. GFZ's research partners are the leading academic institutions in geosciences from across Europe (e.g., Institut Français du Pétrole, France; TNO, The Netherlands; Universities of Aachen, Clausthal, Germany and Newcastle, GB; GEUS, Denmark, and others). The current ten sponsors are BayernGas, ExxonMobil, Gaz de France Suez, Marathon Oil, Repsol, Schlumberger, Statoil, Total, Vermilion Energy, and Wintershall AG. The companies do not act as sponsors alone. Both the companies and scientific partners support GASH by delivering access to core and data material, or by provision and application of their own analytical facilities.

GASH focuses on two aspects: development of a European black shale database and basic research.

One main gap in European shale-gas exploration is the access to shale-gas relevant data from promising stratigraphic horizons crossing national borders ([Figure 1](#) shows promising black shale horizons in European countries). To overcome this issue, a web-serviced GIS database is being developed (European Black Shale DataBase, EBSD). The digital framework will allow assessment of distribution of shales, their regional sedimentary facies and paleogeographic/tectonic context (as maps), as well as outcrop locations and attributes. Key attributes to be stored in the database include, for example., depth, thickness, TOC contents, organic matter type, thermal maturity data, gas shows and kicks, geochemistry analysis results, and sedimentary facies. The database will include data from 32 European countries ([Figure 2](#)). The data are compiled and provided by the participating national geological surveys.

Basic research projects are working on different scales from nanometre to basin range.

The scientific approach of analytically oriented subprojects requires core material from well defined natural laboratories, and includes the Cambro-Ordovician Alum Shale from North Europe, the Lower Jurassic Posidonia Shale from Northern Germany, and Lower Carboniferous black shales from northern Germany and The Netherlands. As most accessible core material for laboratory analyses is mainly from wells drilled years or even decades ago, GASH faces the strong need for fresh core material to determine meaningful physical and chemical properties. Accordingly, GASH drilled the older Palaeozoic Alum Shale on the island of Bornholm (Baltic Sea) in 2010. The next well is planned for early in 2012 and targets the Lower Jurassic Posidonia Shale in northern Germany. In parallel, core material from successful U.S. gas shales (Barnett, Haynesville) is being analysed for comparison.

The topics of the subprojects on reservoir scale (from nanometre to metre) cover geomechanical, physical, chemical, and microbiological aspects, all of which are being interpreted in a wholistic approach. The overall goals are to determine gas-in-place and producibility, and to unravel quantitatively the influencing factors. Methodologically, the masses, volumes, and physical state of gas and oil generated throughout thermal evolution are analysed in order to unravel the relationship between kerogen structure, gas retention, and maturation level. TOC/Rock-Eval and pyrolysis methods are used to assess organic content (including total sorbed and free gas), source-rock potential, maturity, and degree of kerogen transformation, identify heterogeneity, and perform a mass balance of generation and expulsion. Insights into the gas-forming processes, including biogenic gas formation, are coupled to a better understanding of pore-forming processes (with a

focus on nanometre-sized pores), fluid flow, and sorption for both the organic and inorganic matrix to unravel the gas-storage capacity. In addition, geomechanical experiments complete the methodological chain and deliver data regarding the mechanical and hydraulic heterogeneities of the matrix, but also of fracture integrity. Analysis of fluid inclusions in fracture cements allow us to trace and unravel the origin of the gas in time and space.

Additional subprojects focus on features on a basin scale. Basin modelling studies have been carried out on selected European basins which host the natural laboratories (e.g., Lower Saxony Basin and The West Nederland Basin). It is the aim to determine the timing of gas formation in connection to heat flow, pore-forming processes and petrophysical properties. These studies are supported by analogue studies of shale-gas-hosting basins in the U.S.A. (e.g., Williston Basin and Fort Worth Basin) for the calibration of property development. In addition, the spatial occurrence and characteristics of proven black shales in the subsurface is visualized by seismic and magnetotelluric methods. Field campaigns have been carried out to detect seismically the Cambro-Ordovician Alum Shale on Bornholm, and to characterize the Lower Jurassic Posidonia Shale in northern Germany by magnetotellurics.

Geoenergie - Geoen

The GeoEn project (<http://www.geoen.de>) is funded by the German ministry of research and education (BMBF). After a first three-year phase with basic research topics like basin modelling and sedimentology of TOC-rich Carboniferous strata in the Northeast German basin, the second phase now addresses environmentally oriented questions concerning shale-gas extraction.

Although long experience with individual technologies used in shale-gas production exists, more research and development is needed towards environmentally friendlier shale-gas production. This need is emphasized by reports in the media about environmental concerns. Issues under scrutiny include induced seismicity, leakage of gas through casing into aquifers, the potential toxicity of fluids used for hydraulic fracturing and the disposal of fluids returning to the surface. However, the opinions on environmental risks diverge strongly: risks are minor and controllable according to industry, while environmental groups often claim the opposite. With the Shale Gas Information Platform SHIP (online early 2012), GFZ engages in the public discussion of technical and environmental issues related to shale-gas exploration and production. SHIP will bring the perspective of science to the discussion, because the pros and cons need to be viewed based on factual argument rather than speculation. SHIP will not only showcase but provide a discussion forum on what is known and what is not yet known about environmental challenges and potential risks. Current scientific results and best practice approaches will be featured by SHIP, building on a network of international experts.

European Sustainable Operating Practices (ESOP) Initiative

The ESOP Initiative is a research collaboration of unconventional gas researchers, academia, industry players, government, and other stakeholders in Europe with the intention of identifying, developing, demonstrating, and deploying sustainable field operating practices, safety standards, and environmental assurance. The initiative is led by the Gas Technology Institute GTI (Des Plaines, Illinois) and the Helmholtz Centre Potsdam in partnership with Environmentally Friendly Drilling program (EFD) Europe.

Specific stakeholder concerns in Europe that ESOP will address include the impact on drinking water supplies and quality, air quality, noise, wastewater and solid wastes, greenhouse gas emissions, truck traffic, and surface disturbance.

ESOP will also address the general public's and policymakers' need for comprehensive and transparent information on the benefits and risks associated with developing these resources. There are significant opportunities to provide technical, training, demonstration, and outreach support to stakeholders and industry.

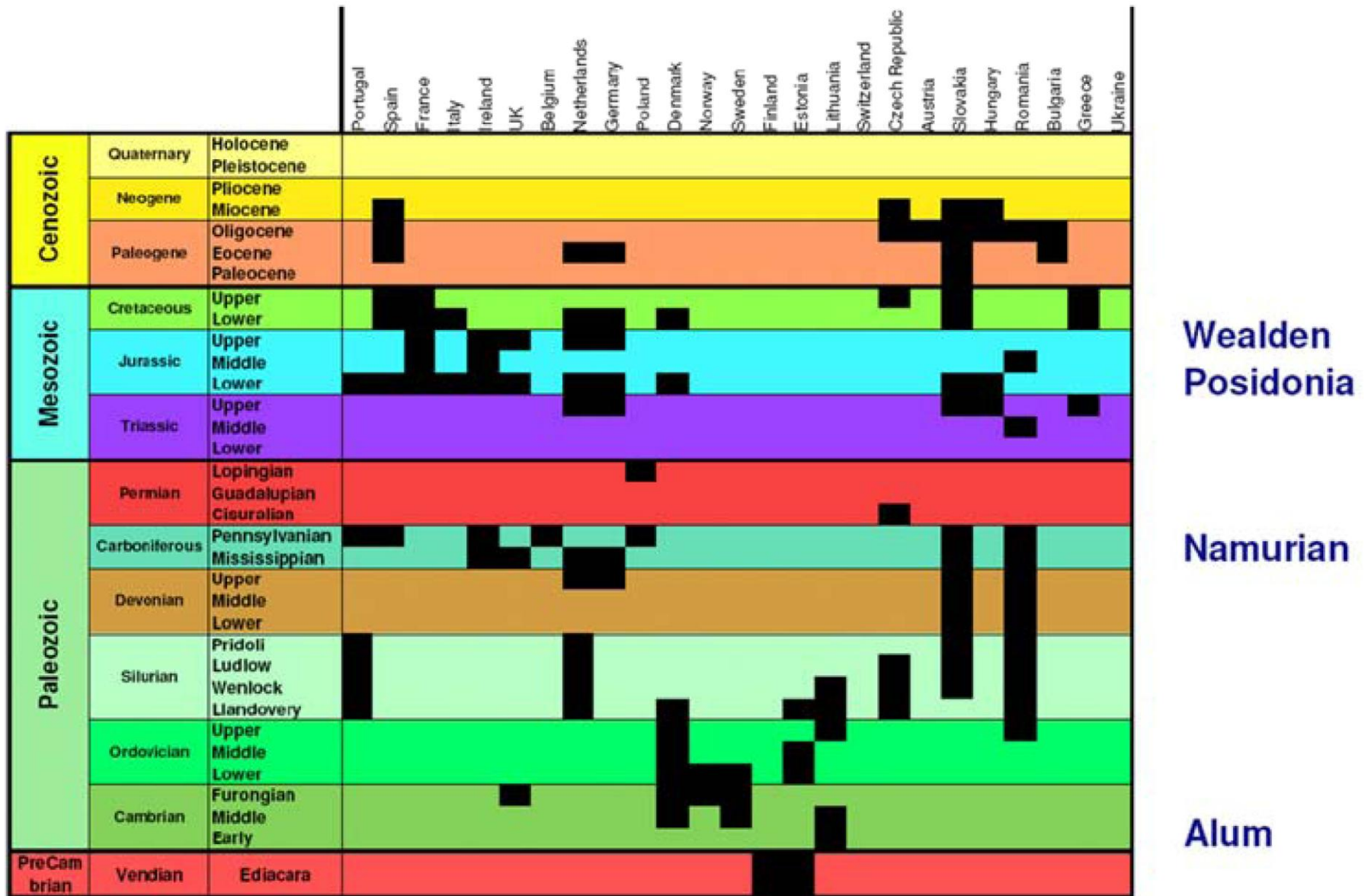


Figure 1: Occurrence of black shales with potential for shale-gas in Europe, based on the input from national geologic surveys. The main source rocks being studied in the GASH project are highlighted.

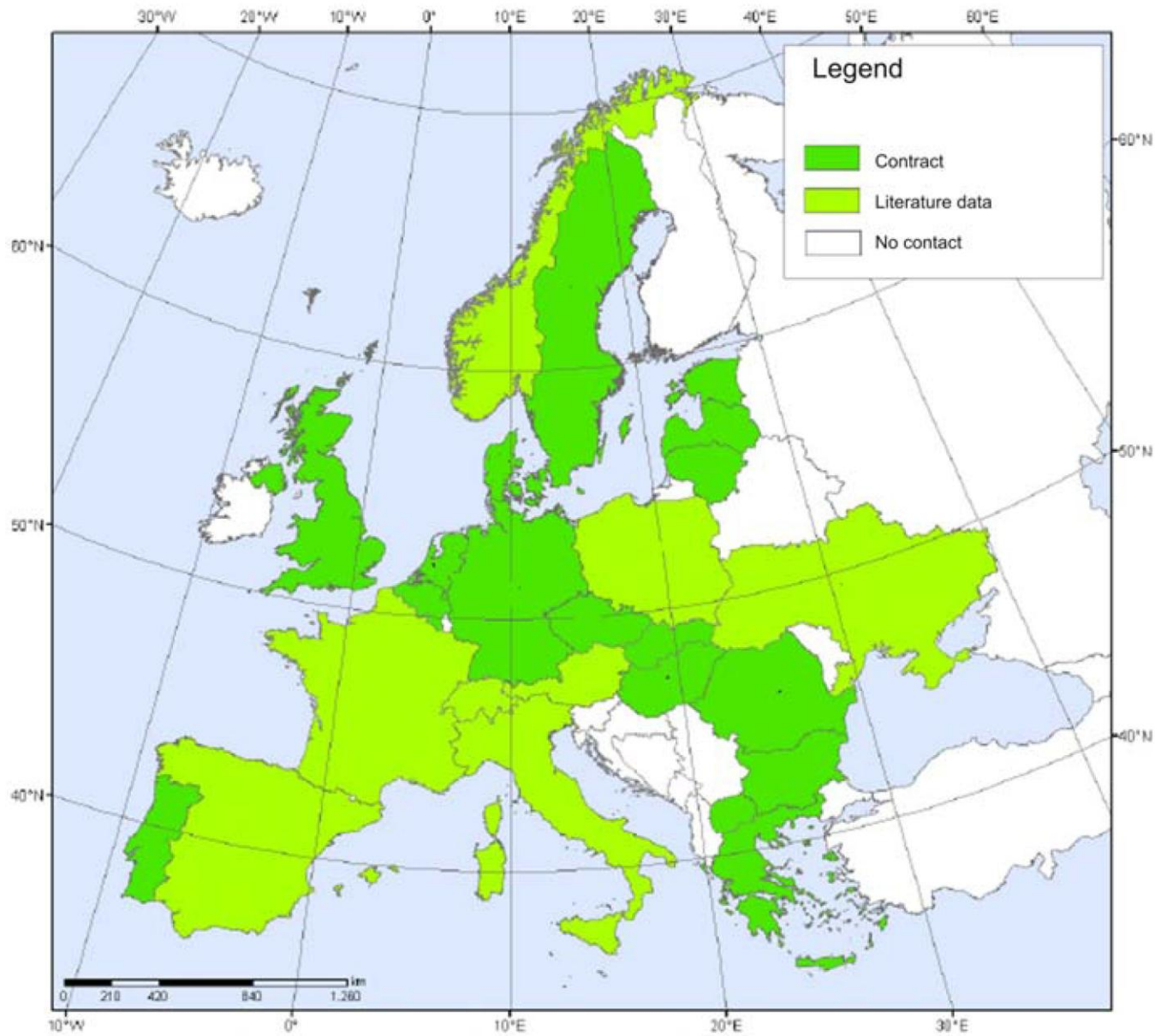


Figure 2: Overview of the European countries that signed an EBSD contract for the first data-request (dark green). Also countries are displayed (light green), where geochemical data and maps have been gathered from open source data by TNO.