The BRGM is France’s leading public institution in the Earth Sciences applications for the sustainable management of natural resources and surface and subsurface risks.

**Key objectives**

> **Understanding geological processes and associated risks**, developing new methodologies and techniques, producing and disseminating relevant, high-quality data.

> **Developing and supplying the necessary tools** to manage surface and subsurface areas and natural resources, to prevent natural risks and pollution and to implement climate change policies.
Shale gas in France
underground resources & legal situation

D. DARMENDRAIL
European Affairs Advisor
BRGM

December 2012
Resource assessment of unconventional shale gas

Worldwide Shale gas resources

Worldwide resources: near 456 Tm3 - 180 are technically recoverable.
Europe: 6.5% - 30 Tm3
Poland & France: gas shale resources: 5 Tm3 for each.

Source: U.S. Energy Information Administration based on Advanced Resources International, Inc. data

December 2012
Unconventional Hydrocarbons / prospects in Europe
Resource assessment of unconventional shale gas

> Poland
  - First assessment from US Energy Department:
    - 5.3 Tm3
  - Revision from PGI
    - 1.9 Tm3 (35% less than expected)
  - Shows difference between preliminary and updated estimations
Potential resources in France

Jurassic targets (Toarcien…)
Shale oil & Shale gas

Bassin de Paris
Shale oil

Jura
Shale gas

Causses
Shale oil

Bassin du SE
Shale gas

www.metstor.fr
Potential resources in France

Permo-carbonifer targets
Shale gas & Coal Bed Methane

Nord Pas de Calais
Lorraine
bassin de Paris
Sillon houiller
De Blanzy à Ronchamp
Bassin du sud du Massif central
De Brive à Alès

Yellow: permo-carbonifer
(-245 à -345 Ma)

Green : Cretaceous
(-70 à -76 Ma)
## Comparison USA - France for UC oils

<table>
<thead>
<tr>
<th></th>
<th>« Shale Oil » du Bassin parisien</th>
<th>Bakken</th>
</tr>
</thead>
<tbody>
<tr>
<td>TOC</td>
<td>0 - 12% (moyenne = 5%)</td>
<td>0 - 40% (moyenne = 10%)</td>
</tr>
<tr>
<td>Tmax</td>
<td>445°C</td>
<td>445°C</td>
</tr>
<tr>
<td>Roche mère</td>
<td>Type II</td>
<td>Type II</td>
</tr>
<tr>
<td>Matière organique</td>
<td>Plancton marin + bactéries anaérobies</td>
<td>Plancton marin + bactéries anaérobies</td>
</tr>
<tr>
<td>Contenu quartzique</td>
<td>26% - 58%</td>
<td>20% - 68%</td>
</tr>
<tr>
<td>Environnement de dépôt</td>
<td>marin et anoxique</td>
<td>marin et anoxique</td>
</tr>
<tr>
<td>« Competent Layer »</td>
<td>Banc de Roc</td>
<td>Middle Bakken</td>
</tr>
<tr>
<td>Epaisseur nette</td>
<td>1 - 40 mètres</td>
<td>2 - 20 mètres</td>
</tr>
<tr>
<td>Porosité</td>
<td>Jusqu’à 12%</td>
<td>8 à 12%</td>
</tr>
<tr>
<td>Perméabilité</td>
<td>Jusqu’à 5mD</td>
<td>0,05 - 0,5 mD</td>
</tr>
<tr>
<td>Densité API</td>
<td>38°</td>
<td>42°</td>
</tr>
</tbody>
</table>

Source: Toreador à partir de données publiques

Bakken (USA / Canada), Toreador

Sources: www.toreador.net
Lias in South East Basin

Preliminary estimation around 2400 billion m³.

To be compared to global annual consumption of gas in France of 45 billions m³.
## Comparison USA – France – Shale gaz

<table>
<thead>
<tr>
<th></th>
<th>Gas shale South East Basin*</th>
<th>Gas shale Barnett Basin **</th>
</tr>
</thead>
<tbody>
<tr>
<td>TOC</td>
<td>4 à 6%</td>
<td>4,5%</td>
</tr>
<tr>
<td>Tmax</td>
<td>500-510°C</td>
<td>455°C</td>
</tr>
<tr>
<td>Geology</td>
<td>Clays</td>
<td>Clays</td>
</tr>
<tr>
<td>Organic Matter</td>
<td>Type 2 probable</td>
<td>Type 2</td>
</tr>
<tr>
<td>Deposit Environment</td>
<td>Deep Marin</td>
<td>Limited Marine</td>
</tr>
<tr>
<td>Net length</td>
<td>200 m ?</td>
<td>90 m</td>
</tr>
<tr>
<td>Porosity</td>
<td>?</td>
<td>6%</td>
</tr>
<tr>
<td>Permeability</td>
<td>?</td>
<td>0,02 mD</td>
</tr>
</tbody>
</table>

French Law of July 13rd 2011, notably :

- Prohibits exploration and extraction of hydrocarbons using Hydraulic Fracturing

- Establish a procedure to review permits granted for exploration of hydrocarbons

- The operators had two months to produce a report on the necessity to use fracking technology in order to explore the resources

- French government had one month to assess the report and make decision on the possible cancellation of existing permits

Based on the application of the precautionary principle
Guide sur la maîtrise des impacts et risques liés à l’exploitation des hydrocarbures de roche-mère : enjeux, verrous et pistes de recherche (September 2011)

Revision of the Mining Code

- Creating an instance involving community associations and professionals, NGOs, lawyers and trade unions to propose changes to Mining Code (Commission TUOT);
  - Reconciliation of mining law and environmental code;
  - Strengthening public participation in the allocation of mining projects;
  - Brainstorming on fiscal issues of the development of mines in France
- The report will be submitted to the Ministers in charge of mines at the end of December 2012
Conclusions for France

> No detailed information on resources:
  • Shale Gaz or Oil
  • Estimation from a limited number of drilling
  • Assessment uncertainties on resource availability and accessibility

> No further exploration of shale gaz or oil until alternative technology to hydraulic fracking is available

> Scientific monitoring on evolution of technologies and related impacts / risks
Thanks for your attention

www.brgm.fr

d.darmendrail@brgm.fr / d.bonijoly@brgm.fr