Unconventional Gas in Italy: the Ribolla Basin*

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Search and Discovery Article #80203 (2012)
Posted January 9, 2012

*Adapted from oral presentation at AAPG International Convention and Exhibition, Milan, Italy, October 23-26, 2011

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Abstract

CBM and Shale Gas production is growing fast and is becoming an important energy source in many countries.

CBM is methane produced directly from coal seams. Methane is found adsorbed into the coal matrix and it is produced at low pressure by pumping away any water from the coal seam and stimulating the methane flow through the coal cleats to the well bore. Similarly, Shale Gas is natural gas that is produced by desorption from organic rich clay at low pressure, after multistage stimulation of long horizontal boreholes, often from formations that are less permeable than coal.

Independent Resources plc is developing the first unconventional gas project in Italy, at the 100% owned “Fiume Bruna” and “Casoni” exploration licences (Central Italy), where some 300 BCF of natural gas are calculated to be in place, of which 160 BCF are interpreted to be primarily recoverable from the two blocks. The gas is interpreted to be producible from both the coal and the organic rich shale that is associated with the coal seam, at an average depth of approximately 1000 m.

Results to date include knowledge that the Miocene age organic rich sequence:
- consists of one laterally continuous 9-11 meter thick seam of coal and black shale,
- is saturated with thermogenic gas,
- is dry,
- is able to produce excellent quality natural gas by desorption after stimulation,
- has a permeability of 1-2 mD,
- responds more like a gas shale than a classic high permeability coal.
Additionally, there are indications that the 70 meter thick laminated marl and clay sequence immediately above the main seam may be prospective for shale gas as well.

The initial challenges of the project are:
- characterization of the coal and of the organic rich shale, including its mineralogy and gas content, gas composition and gas productivity, and any associated water;
- identification of the best formation stimulation technique;
- technology transfer from areas where CBM and Shale Gas production is mastered with economic success;
- procurement of suitable equipment and services in a safe and value-for-money manner.

ECBM (Enhanced Coal Bed Methane) is one way to implement CO$_2$ geological storage, by injecting CO$_2$ in unmineable coal seams to enhance methane recovery. This technique may find application toward the end of the primary production cycle in the Ribolla Basin.

**Selected Reference**

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AAPG International Conference & Exhibition  
Milano Convention Centre, Milan, Italy, 23-26 October 2011
The Ribolla Basin is covered by two Exploration Licences:

• “Fiume Bruna”
• “Casoni”

100% IR plc
RIBOLLA COAL MINING

COAL DISCOVERED IN 1830

1848, R. I. Murchison
NET “COAL” THICKNESS
DEPOSITIONAL MODEL

NORTH

- Feccia
- Castanei
- Ribolla
- FB 2
- Casoni (projected)
- Cana

SOUTH

RIBOLLA BASIN

Argille Lignitifere formation

Gas Shale (gas potential under study)

Shaley Coal (Bagaglia)

Coal

 Depths:
- 11 m
- 60-70 m

Distances:
- 27 km
- 22 km
- 30 km
GAS INTERVALS

low GR lacustrine organic rich gas shale

bed dip = 25-32°

Carbonaceous shale, black, moderately firm to friable, very rich in coal bands and occurrence of pyrite.

Coal, black, friable, with vitrinite bands, occurrence of pyrite.

Shale, grey to dark grey, firm to very firm, occurrence of some bands of coal.

ribolla play

high GR marine organic rich bagaglia

Fiume Bruna 2 well
FIUME BRUNA 2 - Mineralogy of "Argille Lignitifere" Formation

- Non-swelling clay and mica
- Swellable clay
- Quartz
- Calcite
- Total feldspar
- TOC
- TOC x 10

Depth (m): 260, 265, 270, 275, 280, 285, 290, 295, 300, 305, 310, 315, 320, 325, 330, 335, 340, 345
COAL WIRELINE CORING
SATURATED COAL BUBBLING GAS

gas bubbles
Coal and Gas Shale at Ribolla are gas saturated.
SEISMIC ACQUISITION
2008-2010 SEISMIC SURVEYS
RIBOLLA SEISMIC SECTION

Miocene coal / gas shale seam

Miocene conglomerate

Miocene coal / gas shale seam
2010 COAL STIMULATION

FIUME BRUNA 2, a small footprint site
2010 COAL STIMULATION

- Proppant used
- Pre-job safety meeting
- Upgraded water well rig, UNMIG approved
- Frac job
GOOD NEWS:
Methane  93-94%
Ethane   1-2%
Nitrogen 4%
CO₂      1%

SPECIAL GOOD NEWS:
the gas is of thermogenic origin (Δ¹³C methane = -28 permil)

Considering that the section has not been uplifted, this means that the coal/gas shale seam produced many times the gas it is able to trap by absorption in the matrix, and that the seam is always saturated with gas.
STRUCTURE AND GRAVITY MAP

- Outcrop limit
- Poor coal area
- 2D seismic profiles
- 5 miles
- 5 km
- Geo-electric profiles
- Limit of uplifted area (Larderello cooling granite stock influence)
SCHEMATIC CROSS-SECTION

Legend
- Quaternary, clay, sand, conglomerate
- Pliocene, clay, sand
- Miocene, claystone, siltstone, coal, evaporites
- Cretaceous-Eocene, claystone, marl, limestone (alloclhonious units)
- Oligocene, sandstone, marls (Macigno Fm)
- Jurassic, limestone (Calcare Massicchio Fm)
- Triassic, dolomitic limestone (Calcare Cavernoso Fm)
- Triassic, quartzites, shales (Verrucano Fm)

Ribolla Basin

Vertical exaggeration: 2

Coal, Bagaglia, Gas Shale interval

thermogenic methane seep

Poggetti Vecchi

gas migration

thermal maturity
Liptinite generates abundant gas at lower temperature than other types of macerals, and has high gas capacity.

Notes:

FB-2 well sapropelic, lacustrine coaly sequence:
- suppressed maturity indicator (V_o=0.46%);
- exceptionally high content of Liptinite (12-22%);
- high geothermal gradient (twice the normal);
- young age of rocks (Late Miocene, 6 MY).

Modelled vitrinite reflectance is based on FB-2 values, extrapolated on the basis of Horseshoe Canyon / Drumheller coal maturity vs depth in the Alberta Basin, and corrected for suppression (V_o_corr = V_o + 0.6%, after P. Mukhopadhyay, 1994).
Mapped horizon: lower part of gas zone ("top coal")
Contouring interval: 100 m (328 ft)
Datum: m.s.l.
RESULTS TO DATE

• Single play: coal and gas shale (tens of metres thick)
• Coal and Gas Shale have similar gas content of 4.7 m$^3$/t (152 scf/ton) at approx. 80 bar
• Dry organic rock with 1-2 mD permeability, gas saturated
• Water-based frac tried. Next: nitrogen frac
• Seam responds overall more like Gas Shale than classic high permeability CBM coal

• More than 190 km$^2$ (47,000 acres) of potentially productive area with seam at an average depth of 1000 m (3280 ft)
• Estimated **27.4 BCM** (968 BCF) of gas in place
• Estimated **5.7 BCM** (203 BCF) of recoverable gas
  69% Shale Gas and 31% CBM/CSM
WORK PROGRAMME

- Test future wells - dry Shale Gas style
- Obtain “Exploitation Concession”
- Produce material amount of methane
- Test CO$_2$ injection and methane recovery
- Inject CO$_2$ at full rate and recover methane
- Abandon site safely and responsibly
thank you for attention