

## **Oil & Gas Exploration in the Styrian Neogene: A Brief History of RAG's Activities 1951–1996**

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RAG (Rohöl-Aufsuchungs AG) has pursued hydrocarbon exploration in Styria for about 45 years. Main target was the Styrian Basin, a western margin basin of the Pannonian Basin. To a minor degree and only for a short period the Fohnsdorf Basin, an inner-alpine basin with coal mining history, was investigated for its coal bed methane (CBM) potential.

Before RAG was awarded a Styrian concession in 1955 – covering the major parts of the Fürstenfeld and Gnas Subbasins – exploratory work had already started in 1951 under a research agreement with the Geological Survey with geological surface mapping, regional studies and the acquisition of single fold 2D-seismic. Not at least due to the rather disappointing drilling results the exploration activity in Styria was not continuous – it was characterized by phases of intensive drilling alternating with study and re-assessment ones. From a hydrocarbon exploration standpoint all wells were dry. However, many of them tested hot water and three of them, Binderberg 1, Waltersdorf 1 and Blumau 1a have not been abandoned – they are still serving as geothermal sources for spas (Fig. 1-2).

### **Short characterisation of the drilled wells**

**Übersbach 1** (TD 2692 m in Paleozoic limestones): target was a structural trap of Sarmatian, Badenian and Karpatian clastics. The well was dry, minor hydrocarbon traces, indicating existing generation within the basin, and young volcanogenic CO<sub>2</sub> was recorded.

**Walkersdorf 1** (TD 2141 m in Paleozoic dolomites): well tested an anticlinal structure for presence of hydrocarbons within the Badenian (main target) and Karpatian. Minor oil and gas shows were observed within the Badenian and Karpatian section. The temperature of the Paleozoic aquifer is in the range of ~85°C.

**Mitterlabill 1** (TD 1781 m in “Helvetian” shales) located in the SW part of the Gnas Basin. Exploration objectives were hydrocarbons from a seismically mapped anticlinal high zone. Both objectives horizons (Badenian, Karpatian) showed only minimum gas traces.

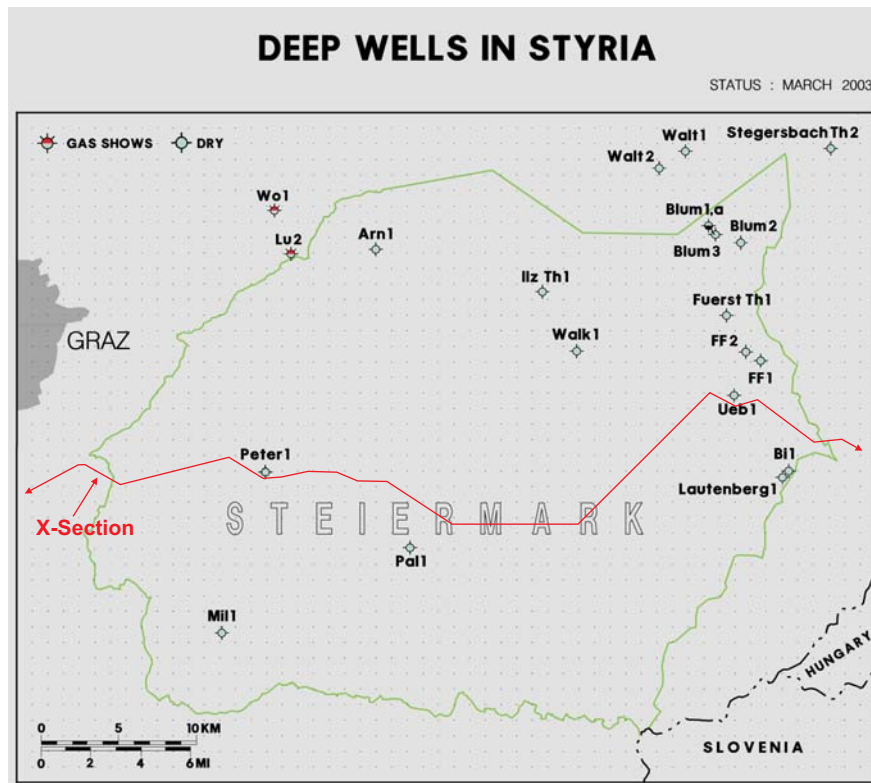


Fig. 1: Location map of wells and geological cross-section.

**Paldau 1** (TD 1440m in Karpatian vulcanites): in a more central position within the Gnas Basin. Structure type is stratigraphic, target formation are Badenian strata. No gas or oilshows were encountered.

**Binderberg 1** (TD 1727m in Paleozoic phyllites): target of this gas exploration well, located on the South Burgenland Swell, were clastics of the Badenian and Karpatian. Gas migration was assumed to come from deeper parts of the Styrian as well as from the Pannonian Basin.

The dry Binderberg 1 well was the first RAG well which was used for a geothermal project. During well assessment RAG carried out several water tests (salinity –4% NaCl) in the deep marine coarse clastics of the Karpatian (Miocene). Some of them had remarkable CO<sub>2</sub> rates (70000 Nm<sup>3</sup>/d, maximum temperature >70°C) and open water flow. The CO<sub>2</sub> expansion drastically reduced the temperature of the hot water on the surface. Binderberg 1 is the basis for the thermal spa Loipersdorf, which has been attracting tourists since the late 1970s.

# GEOLOGICAL PROFILE

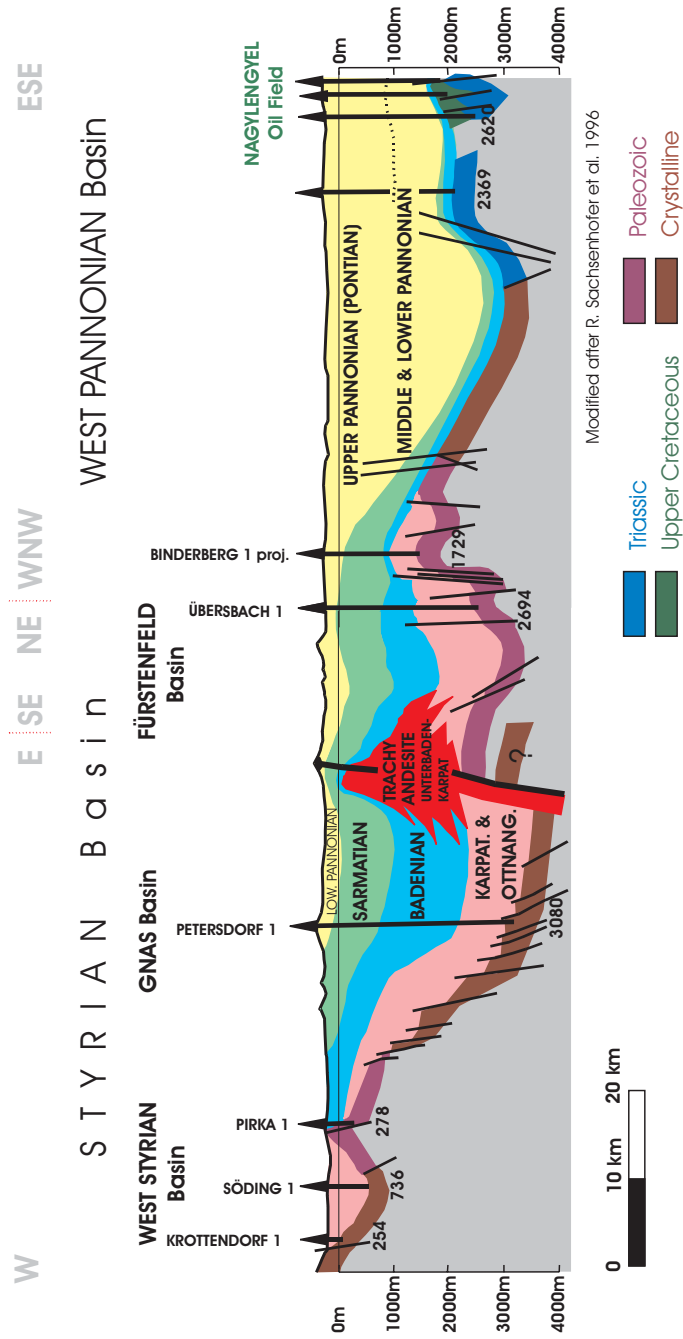


Fig. 2: Geological cross-section through the Styrian Basin.

The water is derived from the basal part of “Middle” Sarmatian (delta front sands, at approximately 1100 m). Water temperature is ~62°C which corresponds to a geothermal gradient of about 5°C/100 m.

**Waltersdorf 1** (TD 1553 m in the crystalline basement): located in the northern shallower part of the Fürstenfeld Basin. The well concept was still based on interpretation of single fold dynamite seismic. Again the objective was gas in Sarmatian and Badenian strata, which are trapped by an antithetic fault. No hydrocarbons were encountered, all porous layers in the Sarmatian, Badenian and Paleozoic are water-bearing. Two tests in Badenian turbidites and coastal plain deposits recovered freshwater. The Paleozoic strata could not be tested because of technical problems.

The well was given to the local community. A re-entry in 1978 resulted in a water influx from Devonian dolomites (temperature 61°C). The hot water is used for a spa (Heiltherme Waltersdorf) and for geothermal district heating.

**Blumau 1/1a** (TD 1907 m and 3045 m in Paleozoic phyllites) tested a domed block associated with a major NE trending synthetic fault, providing the lateral seal.

Since Blumau 1 hit the Paleozoic on the upthrown block the well was sidetracked as Blumau 1a. This well encountered a thick section of coarse clastics (alluvial fan along the growth fault) of the basal Badenian and Karpatian. In the Paleozoic rocks (Silurian–Devonian) circulation was lost several times.

A test at the top part of the Paleozoic dolomites recovered ~10 m<sup>3</sup> water (3600 ppm NaCl). 75°C water temperature was measured at the surface. Traces of CO<sub>2</sub> and CH<sub>4</sub> were recorded. In later years, after re-entry oil shows were reported. 1997 the spa “Blumau” was opened. Its unconventional architecture was designed by Friederich Hundertwasser, a leading member of the “Vienna School” of painters.

**Arnwiesen 1** (TD 951 m within the Schöckl Nappe): this gas exploration well was drilled in the NW part of RAG’s concession area, close to OMV’s non commercial gas discovery Ludersdorf 1. Exploration target was gas in *Lithothamnium* limestones (Badenian) in an antithetic fault structure. No hydrocarbons were encountered.

**Petersdorf 1** (TD 3080 m in the crystalline basement) chased a new play type for the Gnas Basin, mapped on base of new 2D-seismic, acquired in 1994. Main gas target was a structural trap within a prograding sequence of the Karpatian. A secondary target was identified within Lower Badenian sediments. The well reached final depth in crystalline rocks of central Alpine units. According to the log interpretation all porous sections were water bearing, therefore the well was suspended without test.

After the Petersdorf failure a careful post completion analysis of the past drilling activity and a reassessment of the hydrocarbon potential of the concession was carried out. This resulted in RAG’s decision to pull out of this area and relinquish the concession (Fig. 3).

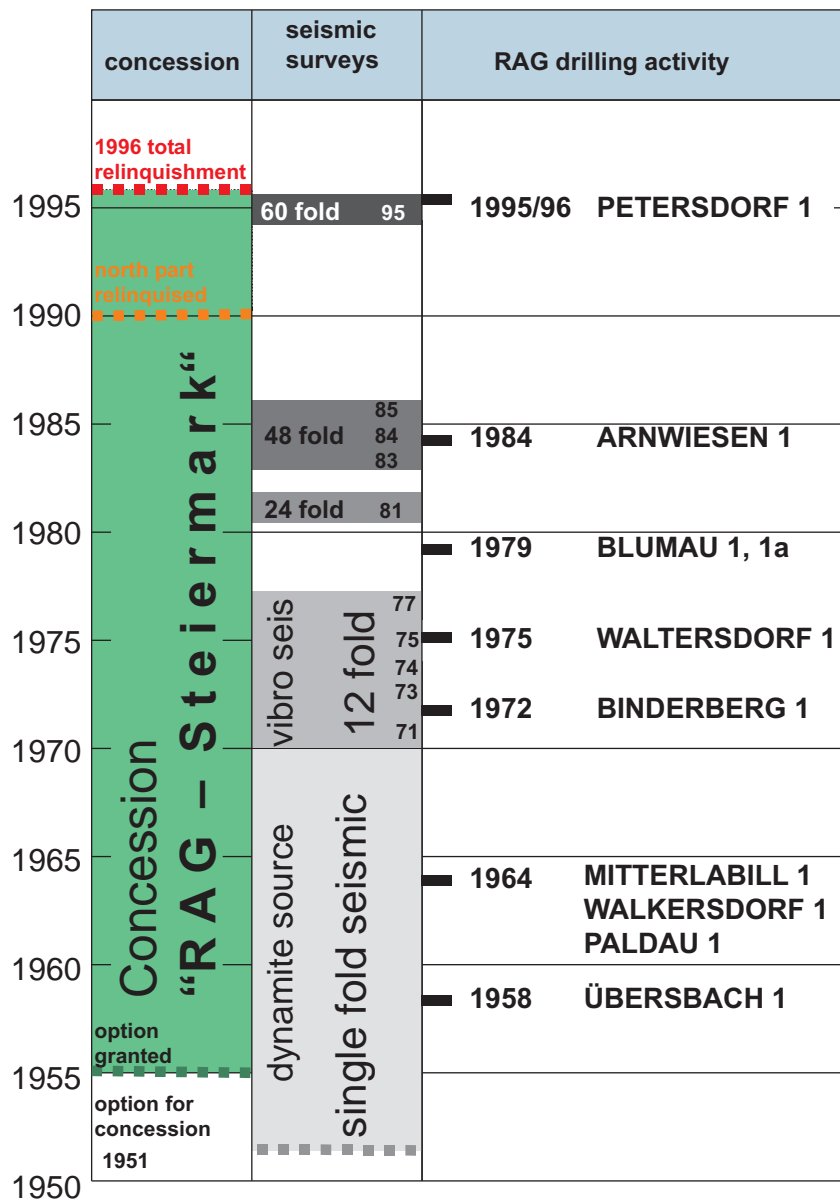


Fig. 3: Chronology of RAG-activities in the Styrian Basin.

The disappointing results of the exploration efforts in the Styrian Subbasins are caused by the relatively late and independent (different) geological history of the Styrian Basin compared to the prolific areas of the Pannonian Basin. Main sourcing within the Pannonian Basin comes from Mesozoic rocks, which are not preserved in the subcrop of the Styrian Basin. Therefore the Ottnangian and the Karpatian strata must serve as the only sources for thermal gas. TOC-rich Badenian sediments may have generated hydrocarbons through the higher heat potential near volcanic bodies. At the same time heat pulses from the Styrian volcanism may have overcooked large areas in the Styrian Basin. Contributions of bacterial gas from relatively shallow strata can be expected. Hydrocarbon-generation modelling showed start of generation shortly after deposition, due to high sedimentation/subsidence rates. Peak generation and main migration phase occurred in the Badenian. Gas quality appears to be a major concern: due to high CO<sub>2</sub> and N<sub>2</sub> contributions from the volcanism gas quality is rather poor as we know from OMV's Ludersdorf 1 tests. Adequate vertical and/or lateral seal seems to be missing for several of the drilled prospects.

#### **CBM-Exploration in the Fohnsdorf Basin**

**RAG-Kohle 1** (TD 916m in Miocene/Karpatian): in 1995 RAG conducted investigations to determine the expected gas potential (coal bed methane) of the inner-alpine Fohnsdorf Basin where lignite had been mined from the 17<sup>th</sup> to the late 20<sup>th</sup> century. This CBM campaign included also the exploration well RAG-Kohle 1, some 4 km SE of the abandoned coal mine. Targets of this well were to prove extension of the coal seams across the basin, to take cores from the coal bearing formation for desorption, adsorption and other analysis and to test the coal formation.

To make a long story short: the well did not encounter any coal seams; after final appraisal of conducted studies and well results the CBM-project Fohnsdorf was abandoned.

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