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Autor: Kempter, Enrico H.K.
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Weiach: A "Tight" Gas Sandstone Play in Northern Switzerland

with 1 figure

ENRICO H.K. KEMPTER*

This note is dedicated to the memory of the late Dr. Hans Anderegg, an enthusiastic Swiss petroleum geologist, died in 1995. In 1973, the author had the privilege to venture with him into visions of petroleum production from rocks in Switzerland, including from the Permocarboniferous.

Abstract

The Consortium Forest Oil - SEAG is preparing to drill an exploration well to about 1800 m depth at Weiach in northern Switzerland, in a gravel pit adjacent to Nagra's Weiach core hole of 1983. Weiach-2 will be the first petroleum exploration well in Switzerland since eleven years, and the first one to test the concept of "tight" reservoirs in this country: Whether tight Permocarboniferous sandstones of northern Switzerland, associated with thick, mature coals are able to produce natural gas in commercial quantities.

Zusammenfassung

Das Konsortium Forest Oil - SEAG bereitet eine Aufschlussbohrung in der Nordschweiz vor: Weiach-2, soll in einer Kiesgrube nahe der Sondierbohrung Weiach der Nagra von 1983 bis in eine Tiefe von etwa 1800 m vordringen. Weiach-2 ist die erste Petroleum-Explorationsbohrung in der Schweiz seit elf Jahren und die erste, um das Konzept der Gasförderung aus "tight reservoirs" in diesem Lande zu testen, nämlich: Ob in der Nordschweiz dichte Sandsteine des Permokarbons in der Nachbarschaft von thermisch reifer Kohle von beträchtlicher Mächtigkeit in der Lage sind, Erdgas in wirtschaftlichen Mengen zu fördern.

1. Preliminary Remarks

In November 1999 in a press conference in Zurich, the Consortium Forest Oil - SEAG announced their intention to drill a gas exploration well near the village of Weiach in northern Switzerland. The well location chosen is close to Nagra's Weiach core hole, drilled in 1983 to explore basement rocks for nuclear waste disposal sites. The area is situated within SEAG's concession, which covers the north-eastern part of Switzerland.

The new well will be known as Weiach-2. The borehole will be drilled some 350 m north of Nagra's hole to a depth of about 1800 m to test Permocarboniferous "tight" sandstones. These are expected to contain natural gas in commercially producible quantities. Weiach-2 will be the first well in Switzerland to test that type of play.

* Föhrenstrasse 7, 5442 Fislisbach

Forest Oil, founded in 1916 and registered in Denver, Colorado, has considerable experience in producing hydrocarbons from "tight" rocks in North America. Since 1956, SEAG (Aktiengesellschaft für schweizerisches Erdöl, Winterthur) holds a concession that extends over 7495 km² (1.85 million acres), granted by ten cantons in northern Switzerland, joined in a concordat. It also holds additional acreage in two cantons outside of the concordat.

The well announcement by the consortium must have taken many people by surprise: Expectations by the public in Switzerland are low. In view of previous exploration disappointments, SEAG had taken a low profile even before the liquidation of its parent company Swisspetrol in 1994.

In 1994, petroleum exploration in Switzerland was in a difficult situation. Previous operators had pulled out of the country. Oil and gas prices were low, and potential investors flocked to opening-up areas in eastern Europe. Swisspetrol, the key player and major holding company on the exploration scene in Switzerland for some 35 years, was in the state of liquidation due to difficulties in financing its projects. At that time, few people in Switzerland believed that petroleum exploration in this country still had a realistic chance in the foreseeable future. Remarkably however, SEAG, Swisspetrol's affiliate with the largest acreage holding, survived and carried on with its licence on the concordat area. The present note may explain some of the reasoning behind.

2. Visions of Gas Production from Paleozoic Rocks in Northern Switzerland

In January 1990, an American petroleum geologist on a stop-over from an inter-continental flight, gave a presentation at the ETH (Federal Technical University) in Zurich on coalbed methane production in the U.S. Visualizing the possible significance of such plays for Switzerland, the author proposed to Swisspetrol to investigate the potential of coalbed methane in northern Switzerland. From that area, Nagra had reported an impressive net thickness of 32 m of coal, cored in their Weiach well (Matter et al., 1988).

Subsequently, Swisspetrol sent a delegation to the U.S. and Canada on a fact-finding mission to collect information on this type of resource. As a result, the delegates got into contact with top experts, companies and institutions, knowledgeable about unconventional gas resources. As an outcome of this effort, several confidential reports and project proposals were produced, related to the Weiach area. Additionally, Swisspetrol commissioned Bob Sneider of *R. M. Sneider Exploration, Inc.*, Houston, to critically review a number of selected wells all over Switzerland in the light of new concepts and international experience, including unconventional hydrocarbon resources.

Bob Sneider is regarded as one of the most successful experts of the U.S. regarding hydrocarbon production from previously downgraded and nonconventional resources. For his merits, Sneider in 1994 was nominated as an honorary member of the *American Association of Petroleum Geologists* (AAPG 1994).

In 1992, confidential reports by Sneider to Swisspetrol painted a surprisingly optimistic picture of hydrocarbon prospects in Switzerland, including from the Paleozoic interval. This view was based on a careful review of all available data from the wells selected, complemented by meticulous analyses of rock samples and logs.

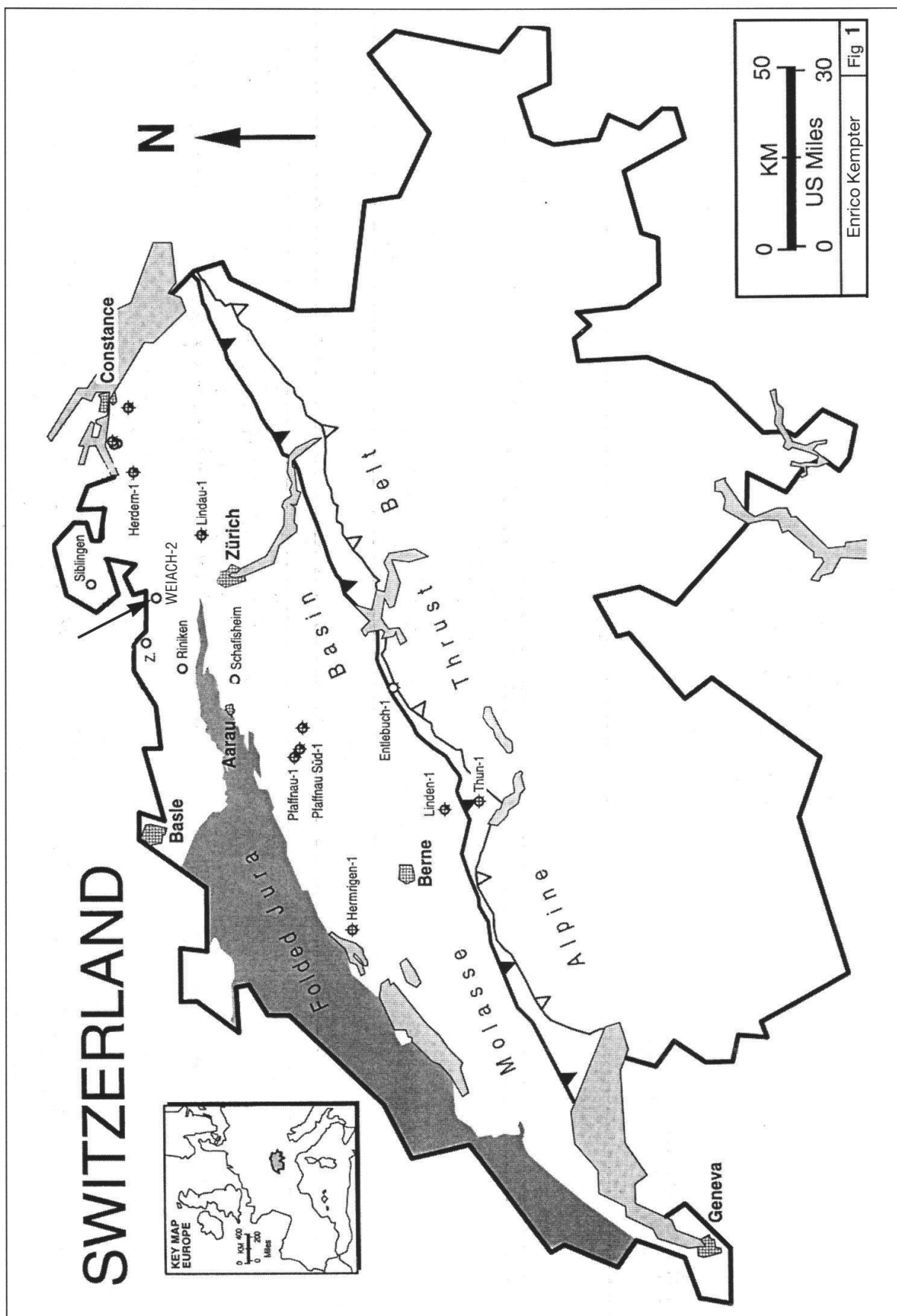


Fig. 1: Northern Switzerland: Important hydrocarbon exploration wells and Nagra coreholes around Weiach.

According to Sneider, the disappointing outcome of the previous exploration boreholes he investigated, was largely due to inconclusive, if not misleading results of tests and technical failures. Experiences with similar rock types and trapping conditions in the U.S., and modern criteria for assessing prospects, did not fit with the pessimistic views upheld by the previous operators. In Sneider's view, Switzerland is a highly underexplored and promising terrain.

Sneider's investigations of 1992 did not immediately lead to activities in the SEAG concession, although Sneider did have an optimistic view of possibilities there. At that stage, due to financial restrictions, Swisspetrol was not able to follow up more than one play at a time. Activities of Swisspetrol were focused on plays in the subalpine belt of Switzerland, in the concession areas of LEAG and BEAG. These were two other affiliates of Swisspetrol. Unfortunately, neither the plays in the subalpine belt, nor anywhere else in Switzerland could be tested before Swisspetrol went into liquidation.

In November 1993, a number of petroleumgeological concepts, including those related to coalbed methane and "tight" gas sandstone reservoirs, were summarized by the author and included in a brochure, originally produced on behalf of Swisspetrol for possible farm-in discussions. The brochure was followed up in January 1995 by an updated version for SEAG. Later, that document attracted the interest of U.S. investors, that were guided by advisers with top experience in tight reservoir production in North America. As a consequence, Anschutz Overseas Corporation, Denver, advised by John Masters, signed a joint venture agreement with SEAG. John Masters is the founder and former president of Canadian Hunter, who discovered and developed the huge Elmworth gasfield in Western Canada (Masters 1984, 1992), a "tight" gas sandstone play. Anschutz later on transferred their interest in Switzerland to Forest Oil.

3. Potential Gas Traps in Paleozoic Sediments

Any petroleum explorationist worth his salt would immediately react realizing the potential as a source of natural gas of 32 m of net coal in an optimum maturity range, as cored at Weiach by Nagra. But there are critical restrictions to be considered.

The rock interval at the Weiach borehole, identified as Upper Trough Fill by Nagra (mainly Upper Permian redbeds) does contain some sandstones of good porosity in its uppermost part, with probably reasonable conventional reservoir potential. But most of the section consists of rocks with microporosity and low or even very low permeability. This is a type of rock, normally downgraded as nonprospective by most operators. Moreover, the almost complete lack of reliable seismic response and structural information from below the base of the Mesozoic, precluded conventional hydrocarbon exploration for seismically expressed structures in the past.

Structural closure of attractive size would certainly be a major asset in any exploration venture, particularly as a selling point. Closures may probably come to light in the future as a result of additional seismic and further advances in subsurface mapping. But technically, mappable closures may not even be essential for production, seen the number of non-structural, even synclinal traps of the "tight" reservoir type in other parts of the world. In this context, the model of the Pecos Slope gasfield in New Mexico may serve as an example (see Kempter 1999 b later in this

issue). It is particularly illustrative, as it displays surprising similarities to geological conditions in Northern Switzerland.

Structural or non-structural hydrocarbon trapping conditions in Paleozoic sandstones, in many respects similar to, but probably better than the ones in New Mexico, are well conceivable for northern Switzerland. Weiach-2 should verify that point.

4. Gas Accumulations in Nonconventional Reservoirs of the Permocarboniferous

The pessimistic common wisdom among previous operators (Brink et al. 1992), the Swiss public and some advisors contrasted with the enthusiasm, expressed in confidential reports of Sneider to Swisspetrol. It also didn't agree with the conclusions drawn from information about gas production from *tight reservoirs*, gathered in 1992 and 1993 by this author during several trips to the United States and Canada. His ideas were expressed in several unpublished reports to Government authorities and Swisspetrol.

In 1994, information about gas - and to a lesser degree also about oil production from tight reservoirs in North America, was well publicly available, such as in Crow & Coen 1992; and in Law & Spencer 1993. Surprisingly, this sort of information did not catch on in Europe at the time. Accordingly, the potential of unconventional plays was generally underestimated, even by otherwise well informed petroleum experts. In 1990 in contrast, production from unconventional sources in the U.S. already amounted to 48 billion cubic meters of gas, or about 10% of the total gas production, with a continuously rising trend (Kempter 1994).

According to Sneider, Nagra in 1983 unnoticeably cored through a substantial gas accumulation. Such an interpretation, seemingly absurd, gained weight by the fact, that Sneider successfully redrilled or retested several thousand wells, where predecessors had overlooked hydrocarbon production.

One of the best documented cases, where Sneider had acted as an advisor, were wells drilled by Canadian Hunter in the Deep Basin of Western Canada. This is an area, where predecessors, including all the major companies, had already drilled 85 wells, abandoned as dry holes. In 1976 the new campaign, started by Canadian Hunter, led to the discovery of the Elsworth gasfield - a "tight" sandstone reservoir play, with ultimate reserves of 450 billion m³. 57 billion m³ were already produced at the time of publishing (Masters 1992). Meanwhile, production from many hydrocarbon accumulations of a similar or related type has been established in quite a number of sedimentary basins in North America, as summarized by Law & Spencer 1993 and by Kempter 1994.

It should be noted that the Permian interval in the Weiach borehole of Nagra displays the same cross-over effect between Neutron and Density Logs, as regarded as typical for the gas-productive intervals at the Pecos Slope gas field in New Mexico (compare to Dutton et al. 1993, Fig. 95). The stratigraphic age and the reservoir type of rocks are surprisingly similar at both locations: For more details see Kempter (1999) in this issue. At Weiach, the net thickness of potential reservoir sandstones is several times as thick as at Pecos Slope, adding to the attraction of Weiach.

5. Possible Direct Hydrocarbon Indications (DHI)

While interpreting regional seismic sections from northern Switzerland for HSK (Federal Nuclear Safety Inspectorate, an agency of the Swiss government), the author repeatedly observed possible seismic reflection and attribute anomalies of varying quality. The anomalies consist of subhorizontal reflections that do not fit into the regional attitude. They are often combined with amplitude and frequency anomalies or phase effects. Such features suggest changes in seismic impedance properties, possibly due to changes in the properties of fluids, that fill the rock pores. However, some or all of these observations could be related to artefacts, created by seismic processing or other non-geological reasons. But as long as they are not clearly identified and explained, they have to be considered as possible effects of phase boundaries in the subsurface, related to gas-water, or even gas-oil contacts.

In at least one case, similar anomalies have been observed on five differently oriented seismic profiles that cross each other. These profiles from different vintages were shot by different operators with differing parameters. They were processed in different years in various ways. These observations render geological rather than technical origins of the anomalies more likely.

References: See Kempter (1999) later in this issue.

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