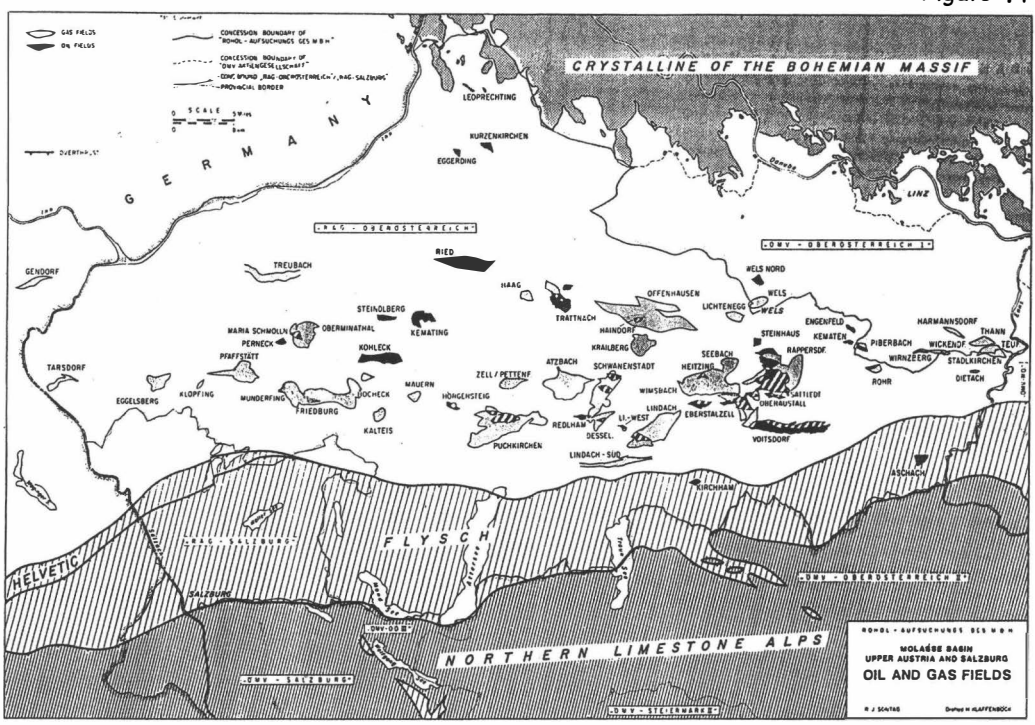
THE MOLLASSE BASIN IN UPPER AUSTRIA.

L. Wagner, Rohöl-Aufsuchungs Gesellschaft mbH, Vienna.

The Molasse Basin is the second most important gas and oil region in Austria besides the main region of the Vienna Basin (fig 14). Production began more than 80 years ago in the natural gas fields near the town Wels. Prospection for gas was not successful until after world war II, when in 1956 the first RAG deep well of Puchkirchen 1 was drilled. It struck oil at 2578 m.

Figure 14



Introduction:

The "Molasse Zone" of Upper Austria and Salzburg forms part of the Alpine-Carpathian Cenozoic foredeep, the Molasse Basin, which extends from France through Switzerland, Germany and Austria to Czechoslovakia. In Upper Austria and Salzburg, this basin contains Late Eocene to Quaternary sediments which were deposited unconformably on Mesozoic series overlaying the crystalline basement of the southern extension of the Bohemian Massif.

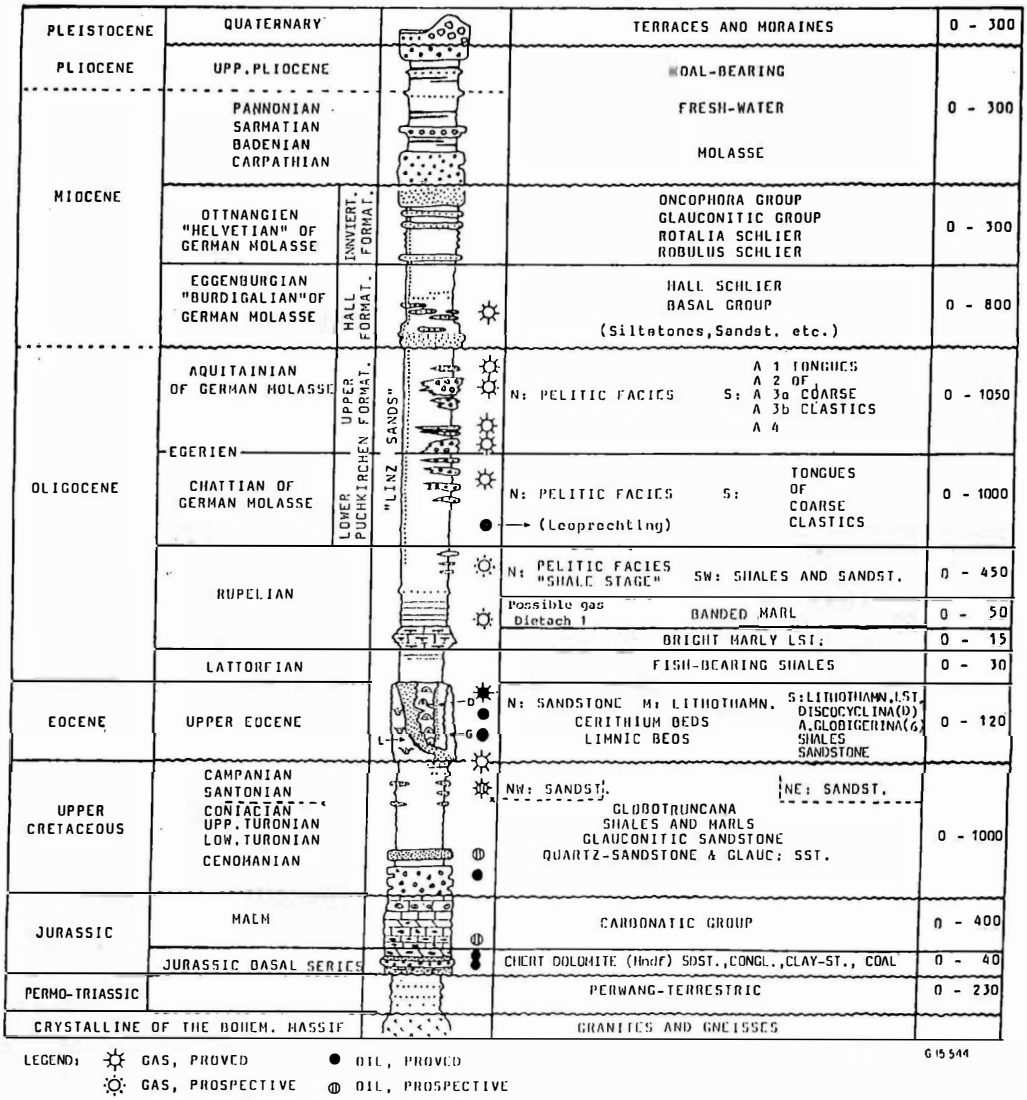


Fig.15: Stratigraphic Table of the Molasse Zone in Upper Austria and Salzburg

The Cenozoic Molasse Basin of Upper Austria and Salzburg has the geometry of an asymmetrical, south dipping, 30 to 55 km wide trough. Its northern margin is formed by the outcropping basement of the Bohemian Massif whilst its southern margin corresponds to the Alpine thrust front. In this basin the thickness of Cenozoic series ranges from a few meters along its northern margin to over 3000 m along the Alpine deformation front.

During the Oligocene and Early Miocene phases of the Alpine orogeny the southern parts of the Molasse Basin were overridden by the Alpine nappe system. Seismic reflection and well data indicate that the autochthonous foreland basement, with its Mesozoic and partial Cenozoic cover, extends for a considerable distance unter the Alpine nappes.

Sedimentary sequences: (fig 15)

Late Paleozoic:	Late Carbonian–Permian. fluvial braided stream sandstones with coal layers; floodplain siltstones and shales Flora: reworked Stephanian. Spores corroded.
Mesozoic:	
Dogger:	Transgressive sequence. fluvial braided stream sandstones with coal layers, marsh and shallow marine sandstones, dolomite with chert nodules and quartz grains, glauconitic limestones. Flora: Bathonian–Bajocian Spores. Fauna: Lumachelles, corroded ammonites, belemnites, echinoids, sponges, corals.
Malm:	shallow marine–shelf limestones and dolomites – algal and sponge banks and bioherms, oolites and grain stone banks, coral reefs, lagoonal limestones, breccias.
Purbeckian:	regressive sequence – freshwater influenced tidal flats. Tight fine crystalline dolomites, cherty limestones, stromatolites, breccias. Flora: Algae, Characea Tectonics: uplifting of central swell zone, erosion and karstification
Early Cretaceous:	restricted to south of the central swell zone – marine glauconitic sandstones, shale. Flora: Berriasian/Hauterivian nannoflora
Cenomanian:	transgressive sequence "Schutzfelsschichten"; Karstfilling, fluvial braided stream sandstones, glauconitic sandstone – poorly preserved beachsands; bulk of Cenomanian: burrowed and laminated glauconitic sandstone – storm–dominated shelf deposits.
Early Turonian:	offshore glauconitic clay and glauconitic sandstone–storm deposits

GEOLOGICAL CROSS SECTION THROUGH THE WESTERN PART OF THE MOLASSE ZONE OF UPPER AUSTRIA

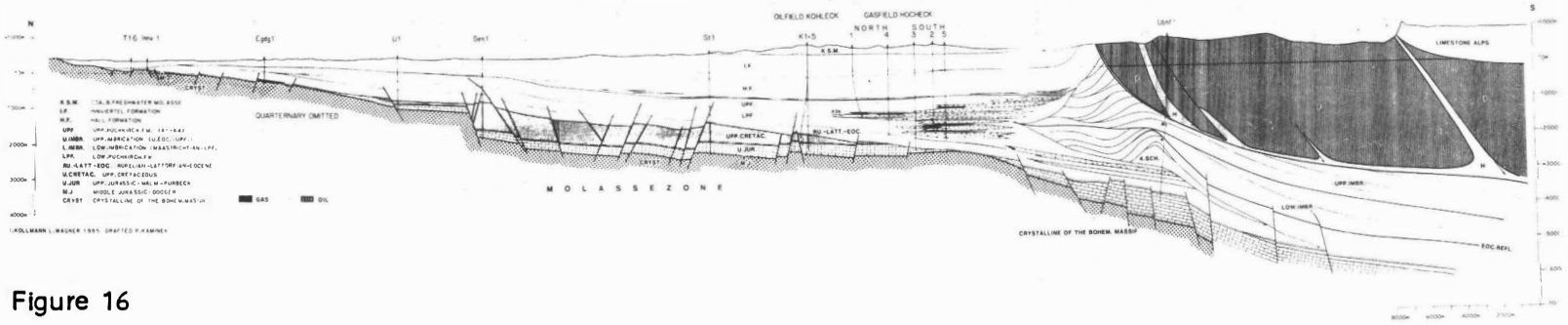


Figure 16

Late Turonian to Late Campanian: offshore clays.
Restricted to the easternmost part of the upper Austrian Cretaceous basin from late Cenomanian to early Turonian marine storm deposits and shales. Beginning late Turonian fluvio-deltaic clastic fan deposits.

Late Campanian: north of swell zone - shallow marine conglomerates and sandstones; south of swell zone - shale.
Tectonics: uplift, dissection of the Cretaceous basin by NW-SE and NNW-SSE trending faults, and uniform tilting to the east, extensive erosion.

Tertiary:

Eocene: Transgressive sequence. North of central swell zone: Limnic beds: channel sandstones of meandering rivers cut into floodplain clays (Characea), coal layers. Cerithium beds: fossiliferous shales and sandstones from intertidal channels. Lithothamnium limestone: red algal limestone and shallow marine sandstones.
South of central swell zone: marine sandstones, Lithothamnium limestone, Discocyclina shale, Nummulite limestone and limestone with Uvigerina and Globigerina.
Tectonics: subsidence (maximum rate of change)

Latdorfian: Dark organic rich fish-bearing limestone and shale. Immature sourcerock

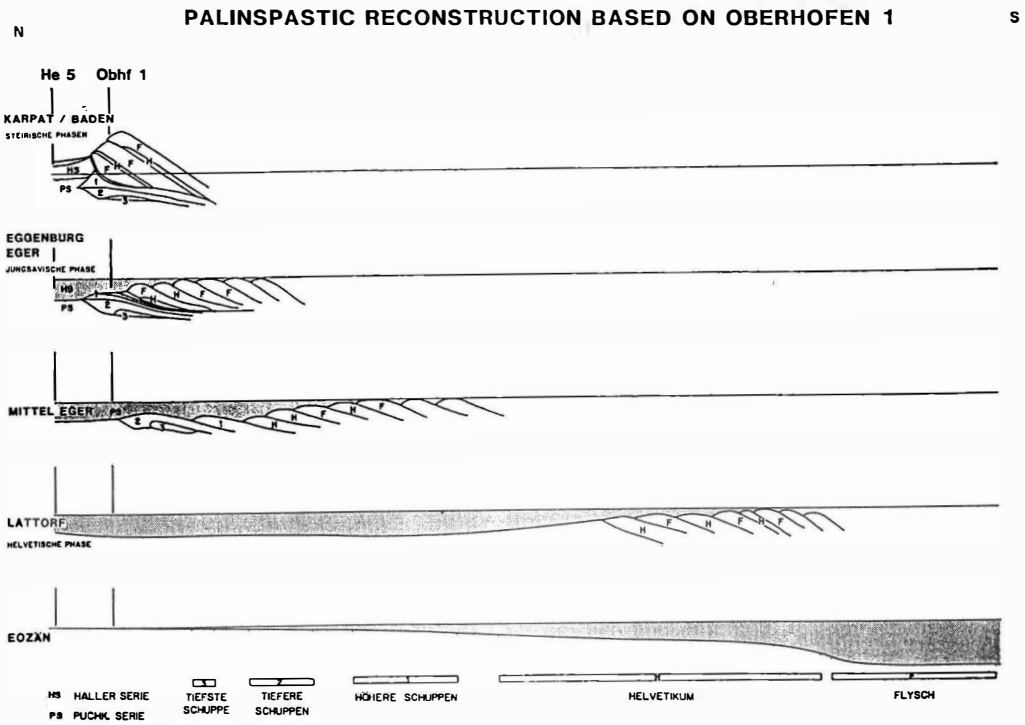
Rupelian: Light marly limestone - deep marine nanno ooze.
Banded marl - soft sediment deformed shale with thin intercalations of nanno ooze. "Shale stage" - deep marine shale-hemipelagites and distal parts of turbidites.
In the area around Salzburg: intercalations of sandstones and conglomerates from turbidites.
In the north, shallow marine sandstones were deposited directly on top of the Crystalline.

Egerian: "Lower und Upper Puchkirchen Formation" - deep marine shale, conglomerates and sandstones - turbidites. The "Linzer Sande" in the N - shallow marine sandstones resting on the Crystalline of the Bohemian Massif.
Tectonics: Submarine erosion, Flysch nappes reached approximate present position.

Eggenburgian-Hall Formation: shale, sandy and sandstone intercalations from turbidites - slope and basin deposits.

Ottnangian - Innviertler Formation: shallowing sequence from basin deposits with turbidites to tidal flats - shale and sandstones.

Figure 17


PALINSPASTIC RECONSTRUCTION BASED ON OBERHOFEN 1
N
S
He 5
Obhf 1
KARPAT / BADEN
STEIRISCHE PHASEN
EGGENBURG
EGER
JUNGSAVISCHE PHASE
MITTEL EGER
LATTORF
HELVETISCHE PHASE
EOZÄN
HS HALLER SERIE
PS PUCHK. SERIE
TIEFSTE SCHUPPE
TIEFERE SCHUPPEN
HÖHERE SCHUPPEN
HELVETIKUM
FLYSCH

Productive foramtions:

Oil and associated gas:

Middle Jurassic	sandstone
Middle Jurassic	limestones with chert
Cretaceous-Cenomanian	sandstones
Cretaceous-Santonian	sandstones only in the E
Eocene	sanstones and limestones

Heavy oil:

Rupelian to Egerian	shallow marine sandstones in the north

Bacterial gas:

Egerian	turbidite sandstones
Eggenburgian	turbidite sandstones

Palinspastic reconstruction: (fig 17):

The well Oberhofen 1, drilled in 1981/1982, encountered Late Eocene sediments seven times, indicating a variety of tectonic units.

Geologic range of separate units:

Autochthonous:	Malm-Early Egerian
Lower Molasse imbrications:	Eocene-Early Egerian
Upper Molasse imbrications:	Eocene-Latest Egerian
Helvetic Zone:	Santonian-Late Eocene
Flysch Zone:	Neokomian-Late Eocene

Water depth continously increased to the south. Greatest water depth in Flysch, lowest water depth in the Molasse. Reconstruction of Eocene reflections from the seismic lines indicates a distance of at least 200 km between Molasse Late-Eocene and Flysch Late-Eocene.

Eocene:

Subduction effective on the Molasse Zone from Eocene time on. The subduction zone was situated at the Central Alps and pulled the basement of the foreland to the south, resulting in extensive E-W striking extensional faulting. Nappes and imbrications piled up due to the subduction in the S. The weight of the N-ward moving nappes caused progressively northern parts to subside and to be involved in the extensional tectonic activity.

The following reconstructions are based on the maturity profile, stratigraphic and dip angles:

Latdofian- Earliest Rupelian:

Helvetic Zone and Flysch were imbricated far in the S in a NNE-SSW direction and coalified in their entirety as a whole package.

Egerian:

Molasse imbrications (lower and upper units) arrived at about their present position. Sediments from Late Egerian were then deposited on top of these imbrications.

Egerian-Eggenburgian:

Movement of imbrications ceased during this time. Only basin/slope sediments with turbiditic sands were preserved. Shelf and beach sediments were totally removed in Salzburg and Upper Austria. The so-called Hall transgression was caused by the shortening of the Hall Formation trough by the Egerian imbrications. These events rearranged the sea current system which resulted in Upper Puchkirchen erosion.

Karpatian:

Flysch and Helvetic Zones were internally further overthrusted and uplifted. The southern parts of the Hall and Innviertel Formation were then compressed and tilted.

We follow the foothills of the Alps to the west where a series of N-S stretching lakes indicates the force of Pleistocene glaciers; these lakes are sealed to the N by end-moraines. The northern front of the Alps is formed by the Flysch Zone. The northern tectonic unit - the Helvetic Zone - is exposed only at a few small sites at the northern rim or is imbricated and present in the form of windows. The Northern Calcareous Alps end with steep northern walls. A very impressive cliff forms the Traunstein near Gmunden on the Traunsee.

STOP 2:

* Gmunden, Gmundner Berg, southern flank of Pinsdorf Berg, near the summit; quarry of the Hatschek cement plant.
* Flysch Zone, Mürbsandsteinführende Oberkreide (friable sandstones series), Late Cretaceous.

The formation of the "friable sandstone series" is exposed with steeply S dipping beds and shows a rhythmic change of sandstones, limestones, marls, and clays. Sole makes and trace fossils are common. Characteristic are the sandy micaceous friable parts. The clay layers contain agglutinated assemblages with large forms of Psammosiphonella, Trochamminoides, Recurvoides, and rare Rzehakina (compare Prey, 1951, and Cicha & al., 1968, p. 37).

On highway A1 we approach lake Attersee and Nussdorf from the W. A small country road crosses the hills in the direction of Mondsee (Nussdorf - Limberg - Lichtenbuch - Radau - road to Mondsee).