

O D I N 1

(16/6 - 1)

WELLFILE

FINAL GEOLOGICAL REPORT

I - GENERAL

A - Location

Exploration well ODIN 1 was drilled in field 16, block 6 at the point :

x : 02° 54' 44" E
y : 58° 42' 06" N

B - Prospect geology and objectives

ODIN 1 well was crestally located on the southern tip of a big, seismically defined, horst feature. This horst, trending N-S and sharply limited by faults on west, east and south sides, has induced a vast anticline in his Mesozoic and Tertiary overburden.

The well was due to investigate the sedimentary section down to Prepermian formations.

C - Operations data

Contractor and rig : ODECO NORWAY Inc. : " OCEAN VIKING "

Dates : Spudded 7.11.67
Start drilling 9.11.67
At. total depth 10.01.68
Completed 19.02.68

Drilling and casing data

Rotary kelly bushing 28 m above mean sea level
(drilling and logging datum)
Water depth : 117 m
Total depth : 2060,5 m Driller) below RKB
2060,8 m Logger)
36" hole 145 - 200 m
26" hole 200 - 360 m
17 1/2" hole 360 - 1362 m
12 1/4" hole 1362 - 2057 m
8 7/16" cored hole 2057 - 2060,5 m

30"	casing set at 200 m
20"	casing set at 340 m (340 logger)
13 3/8"	casing set at 1350 m (1351,5 logger)

Muds :

Seawater was used for drilling to 360 m at which depth, a sea water, Q'Broxin, CMC, type mud, was used down to T.D.

Coring :

One core was taken in basement from 2057 to 2060,5 m (TD) with 100 % recovery and 27 sidewall samples obtained (see Appendix 2 and 3).

Logging :

Two series of operations were run at 1362 m and 2060,5 m (see Appendix 1).

Trouble occurred with gumbo type clay bridging the hole during the first operations and three cleaning trips were necessary.

Tests :

None.

Status :

Plugged and abandoned.

II - STRATIGRAPHY

The ages of formations tabulated below and shown on the final log are based on microfaunal and palynological analysis of ditch cuttings supplemented by sidewall samples.

An exception to this is the basement complex dated by absolute methods (K/Ar and Sr/Rb).

A tentative comparison has been made with the danish outcrops for the tertiary section.

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A - Formation's summary

STRATIGRAPHIC UNIT	TOP DEPTH (below RKB)	TOP DEPTH (below m.s.l.)	THICKNESS, OBS.
Recent Pliocene	145	117	265 Total III-IV : 1211,5
Miocene	410	382	350
Oligocene/Upper Eocene	769	741	440
Lower Eocene	1209	1171	98
Paleocene-Danian	1307	1289	36,5
Maestrichtian	1343,5	1315,5	Total Cretaceous : 675,5 131,5
Campanian/Coniacian	1475	1447	145 Chalk facies :
Turonian	1620	1592	34 300,5
Cenomanian	1654	1626	77
Low. Cenomanian/Albian	1731	1703	165 Marls and
Aptian	1896	1868	90 Limestones :
Barremian-Neocomian	1986	1958	33 365
Jurassic-Kimmeridgian ?	2019	1991	31,5 shale
Basement-wash sand	2050,5	2022,5	4,5
Caledonian basement	2055	2027	> 5,8

(Total depth)

2060,8

2032,8

B - Detailed geological section

1 - Recent Tertiary

This interval is represented by a thick (ca 1200 m), mainly shaly section which can be divided as follows :

1.1 - Recent Pliocene : 146 - 410 m

This section was drilled without returns down to 360 m and consists of very soft light greenish grey, calcareous clays, partly sandy and locally containing thick shell fragments, pyrite, and lignite flakes.

1.2 - Miocene : 410 - 769 m

The same lithology continues down to 722 m, the clays becoming darker, more sandy and compacted below 603 m.

722-769 m : sands, two main beds (17 and 9 m thick) separated by a clay section with minor metric sand-beds. The sands are loose, poorly sorted very fine to coarse, clear to beige and have a very high porosity (> 30 %). Very small glauconite grains appear in the lower bed.

The top of unit is based on foraminiferal evidence, Microflora is continental down to 570 m, and below that depth the first marine microplankton is of Miocene age.

1.3 - Oligocene/Upper Eocene ? : 769 - 1209 m

A pronounced brown colour characterizes this calcareous micaceous and silty clay unit.

Thin hard buff to brown microcrystalline, sideritic, dolomites and limestones are interbedded in the clays. The upper part of this unit is very glauconitic (pellets) and the lower part, below 1110 m, is more radioactive with numerous dolomite stringers.

Micropaleontological and palynological data indicate an Oligocene age for the top of this sequence, middle-lower Oligocene at 875 m, and basal Oligocene, possibly upper Eocene at 1110 m.

This unit compares with the Cilleborg and Septarien clays of the Danish outcrops and with the Sovind marl for the lowest part (below 1110 m).

1.4 - Lower Eocene : 1209 - 1307 m

Green waxy clays mark the top of this formation and are underlain below 1255 m by purple and green mottled silty pyritic shales with numerous volcanic ash stringers interbedded.

In these stringers angular volcanic glass fragments are set in a shaly and calcareous purple or green matrix.

This section compares with Lillebelt, Roesnaes and the Mo formations of Denmark.

A change of nature in the clay minerals reflected on the Gamma-ray curve occur at the top of green clays.

These clays are Montmorillonites (Illite and Chlorite make up the overlying oligocene brown clays) and result from volcanic ash alteration in a basic restricted sea.

1.5 - Paleocene - Danian

This unit consists of dark-grey fissile silty shales becoming more calcareous and whitish below 1325 m.

A lower Paleocene - Danian age is indicated by microflora and foraminifera associations present in this sequence.

No basal tertiary sands were found.

2 - Upper Cretaceous chalk

2.1 - Maestrichtian 1343,5 - 1475 m

This section is composed of white soft chalk, becoming more compacted downwards.

Thin black shale laminations underline dissolution partings and some white milky or translucent chert occur throughout.

A characteristic Maestrichtian microfauna is present in this unit.

2.2 - Upper Campanian 1475 - 1545 m

The Maestrichtian chalk is underlain by more compacted chalky white limestones, very pyritic in the upper part.

Upper Campanian microfossils are encountered within this section clearly marked on the sonic log.

2.3 - Lower Campanian to Coniacian 1545 - 1620 m

This unit is made up of soft pink chalk with green marl partings and yielded microfaunas indicative of a lower Campanian to Coniacian age.

Some glauconite is present below 1600 m.

2.4 - Turonian 1620 - 1654 m

The top of this interval is marked by a very hard, glauconitic, finely sandy, bedded chert, followed downwards by white-grey glauconitic chalk with *Inoceramus* shell fragments.

The microfauna of this sequence is Turonian, while the microflora is indicative of Turonian to upper Cenomanian.

3 - Cenomanian and lower Cretaceous marls and limestones

3.1 - Cenomanian 1654 - 1731 m

Marly, chalky, grey glauconite limestones decreasing downwards and dark-grey-black micaceous marls constitute the lithologies of this unit.

In the upper samples of this interval a Cenomanian microfauna is present, and in the lower part a Cenomanian microflora appears.

3.2 - Lower Cenomanian - Albian 1731 - 1896 m

1731 - 1772 m : argillaceous white, green, red, mottled limestones with grey marls interbeds.

1772 - 1896 m : dark grey-black silty and micaceous shales with thin glauconitic and shaly sandstone stringers.

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Foraminifera and ostracods associations indicate an Albian - Lower Cenomanian age for the upper term of this unit, and an Albian age for the lower.

By palynological studies this section has been assigned to Cenomanian down to 1772 m, and to Albian below that depth.

3.3 - Aptian 1896 - 1986 m

This unit consists of interbedded shaly, brick-red, green and grey limestones and black silty shales.

Microfossils contained in this formation are characteristic of Aptian.

3.4 - Barremian - Neocomian 1986 - 2019 m

Dark grey silty shale followed in the lower ten meters by light grey, pyritic, spotted shaly limestones.

A Barremian-Neocomian age is given to this interval on micropaleontological and palynological grounds. (Lower Barremian, Hauterivian, Valanginian).

4 - Jurassic shale : 2019 - 2050,5 m

This unit consists of very radio-active, black, fissile, carbonaceous and pyritic shale with fish remnants.

An upper Jurassic, anteportlandian age is indicated by the microflora of this section. No characteristic microfauna was encountered.

5 - Basement-wash sand

This is a white medium to coarse (250-600) sandstone with grains commonly angular to subangular, abundant flakes of biotite, muscovite and chlorite and some igneous-rock fragments.

The upper two feet have undergone a silica cementation while the remaining sand is friable and has good reservoir properties.

6 - Caledonian basement complex

6.1 - Albitic-porphyry : 2055 - 2060,5 m

Grey, with white and green spots, Orthose, Albite and rhyolitic quartz crystals up to 3 mm, are included in a finely lamellar albitic, chloritic, and quartz matrix. Some chloritic pseudomorphs occur.

This porphyry has been dated Gothlandian by K/Ar and Sr/Rb methods.

6.2 - Metamorphic-schist : 2060,5 - 2060,8 m

Coarse grained, with biotite, muscovite and chlorite, quartz and, accessory, feldspars (oligoclase and orthose) dated Aremig (Sr/Rb).

Therefore, the basement encountered in the well can be interpreted as metamorphics, dating back to the lower Ordovician and later injected by porphyry dikes in Gothlandian times.

III - PETROLEUM GEOLOGY

1 - Shows

Gas shows (C1) were observed with a GAL 21 type chromatograph while drilling the Tertiary series, mainly in the upper part with a maximum of 12 % at 630 m, decreasing to 2-3 % below 790 m.

In Cretaceous, no gas was seen and only a very small show (0.2 %) was recorded at the top of Jurassic shale.

2 - Reservoirs

2.1 - In the lower part of Miocene, three sand beds are present :

upper : 17,5 m
middle : 2 m
lower : 8,5 m

they have a fairly high porosity (≥ 32 %) but are unfortunately water-wet (ca 60.000 ppm NaCl).

2.2 - Overlying directly the basement, 4,5 m of sand were found. The lower 4 m possess a very high porosity (≥ 32 %) but are also water saturated (ca 70.000 ppm NaCl).

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IV - CONCLUSIONS

Exploration well ODIN 1, investigated the sedimentary column down to the Caledonian basement but no hydrocarbons accumulations were found, despite a huge structuration.

Permian and Triassic objectives are lacking due to the basement horst but may exist on the flanks with truncations and/or fault closures.

- the sand overlying the basement complex is very thin and water-wet.
- Miocene sands are good reservoirs but, unfortunately, 100 % water saturated and probably lying at too shallow a depth to have a sufficient cover and a proper source-bed alimentation.

From a stratigraphic point of view, the distinguished feature of the well section, is the thickness of Aptian and Albian units and their calcareous nature.

SUMMARY OF LOGGING

SCHLUMBERGER TOOLS	RUN	INTERVAL	SCALES	DATES
I.E.S.	1	340 - 1.363	1/500 1/200	30.11.1967
	2	2.060,5 - 1.351,5	1/500 1/200	3.01.1968
ML.C	1	600 - 1.362 (340 CAL)	1/500 1/200	29.11.1967
SL BHC-GR	1	340 - 1.362 (200 - 1.362 GR)	1/500 1/200	29.11.1967
	2*	1.351,5 - 2.059,5		5.01.1968
FDL-C	1	1.351,5 - 2.059,5	1/500 1/200	5.01.1968
CDM	1	1.351,5 - 2.057,5	1/500 1/ 40	5.01.1968
CST		see description		
CBL Th	1	140 - 1.351,5	1/500 1/200	5.01.1968
	1	70 - 1.325	1/500	2.12.1967

* Caliper

A seismic well shooting survey was conducted before abandonment.

SIDEWALL SAMPLES DESCRIPTION

1	2053	<u>Sand</u> : friable, medium to fine grained, angular, some chlorite flakes and volcanic rock grains. Very high apparent porosity.
2	2052	<u>Sand</u> : "
3	2050	<u>Shale</u> : black, silty and micaceous, slightly calcareous, high organic content.
4	2039	<u>Shale</u> : "
5	2035	<u>Shale</u> : " less calcareous
6	2027	<u>Shale</u> : "
7	2016	<u>Limestone</u> : microxln, marly, light grey with pyritic spots.
8	2010	<u>Limestone</u> : light grey, white microxln, marly, very pyritic.
9	1992	LOST
10	1980	<u>Marl</u> : red brown
11	1953	<u>Marly Limestone</u> : red brown (poor sample)
12	1936	<u>Limestone</u> : microxln, marly, greenish-grey, brown ironstone partings.
13	1909	<u>Marl</u> : black soft
14	1903	<u>Marl</u> : brick-red, silty and micaceous, very calcareous.
15	1896	<u>Marl</u> : black, very micaceous
16	1875,5	<u>Marl</u> : "
17	1852	LOST

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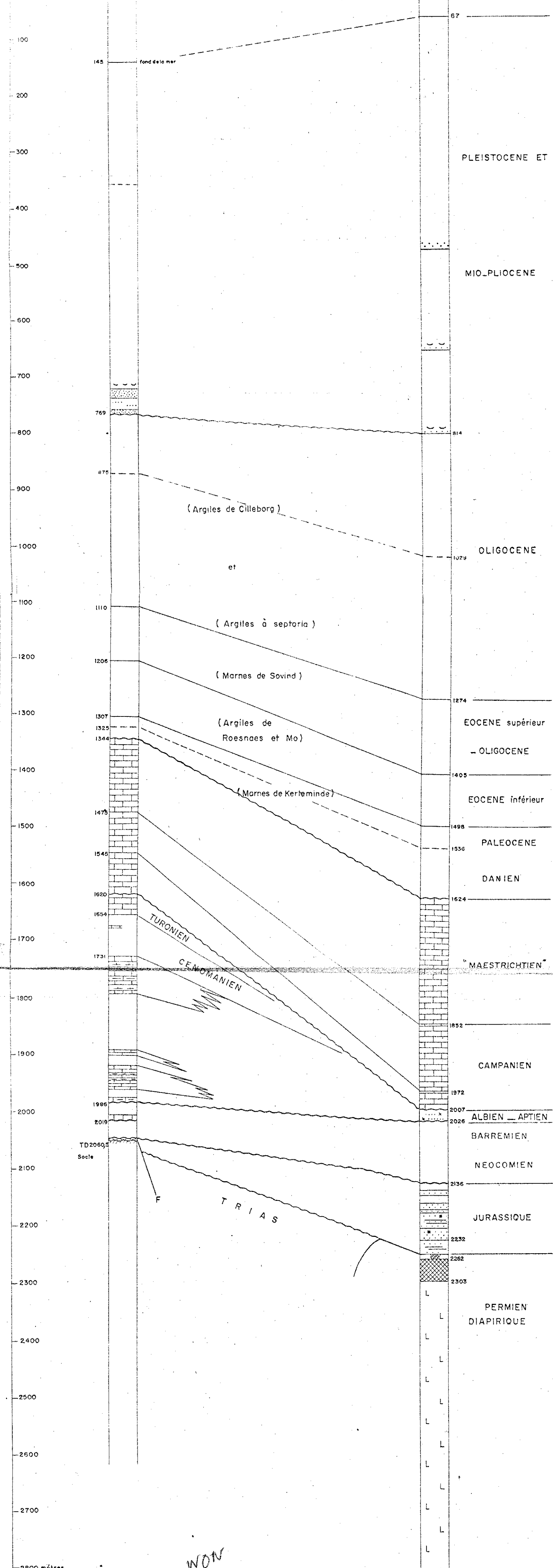
18	1835	<u>Marl</u> : dark, greenish-grey, very silty and micaceous.
19	1810	<u>Marl</u> : " " tr glauconite.
20	1789	<u>Marl</u> : medium grey, silty and micaceous.
21	1769	<u>Limestone</u> : mottled white and red, marly, glauconitic (poor sample).
22	1750	LOST
23	1738	<u>Marl</u> : greenish-grey to brown. Finely micaceous.
24	1715	<u>Marl</u> : dark, grey, micaceous
25	1693,5	<u>Limestone</u> : shaly medium-grey glauconitic and micaceous.
26 26 bis	1676	<u>Limestone</u> : greenish-grey, finely sandy, glauconitic and micaceous.
27	1652	<u>Limestone</u> : chalky, white-grey, microxln, glauconitic with some quartz grains, dissolution partings (poor sample).
28 28 bis	1649	<u>Chalk</u> : white-grey, slightly shaly, some mica and glauconite grains.
29 29 bis	1640	<u>Chalk</u> : " "
30	1631	<u>Chalk</u> : " "
31	1623	LOST

Table de rotation
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ODIN
16.6.1

AMBERJACK
16.11.1

m. s. l.



WON

PETRONORD	Secteur	NORVEGE
	Operateur	ELF NORGE
CORRELATIONS ENTRE ODIN 1 ET AMBERJACK 1		Perforé ou Complété
ENTREPRISE DE RECHERCHES ET D'ACTIVITES PETROLIERES DIRECTION EXPLOITATION		PL2
DIVISION II		Date 26.9.68 Auteur BERTHON N° classé 19027

S. I. D.
LOGS - SONDAGES

Echelle verticale : 1/5000

TD 3049

Length : 3,50 m
 Recovery : 100%

SOCIETE : ELE - NORGE
 WELL : QOIN 1 (16/6-1)
 CORE : N° 1

Date : 3-1-1968
 DEPTHS : 2057-2060, 50 m
 (Driller)

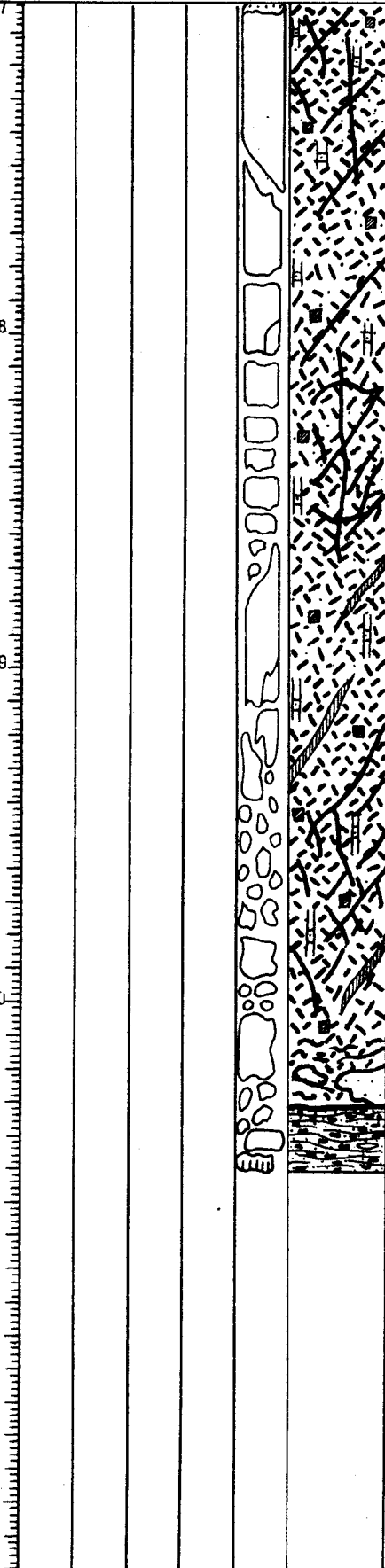
DEPTHS	CaCO ₃	PERM	POROS	SHOWS	DIPS	COUPE	LITHOLOGY
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2057

2058

2059

2060



BASEMENT

Porphyry : grey to green, spotted - chloritic and pyritic
 numerous open fractures, some with calcitic infill

Dike-quartz, nodules

Gneiss : Laminated, with biotite and chlorite micas, quartz and pyrite inclusions.