EXPLORATION OF THE MONTI CIMINI PERMIT (LATIUM - ITALY)

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ABSTRACT - Exploration in the Monti Cimini permit (Latium - Italy) is being carried out by AGIP on behalf of a Joint-venture with ENEL since 1979.
Previous activity in the area by other companies in the 1950's and 70's included drilling of some wells on the Viterbo large structural high on the West side of the permit, site of several warm springs. The Mesozoic limestone reservoir was found at shallow depth, bearing water with a moderate temperature (60°-78°C).
The renewed exploratory effort was based on two ideas:

1. There is no hydraulic connection between the Viterbo high and the downfaulted area to the East which could have a higher temperature because of the influence of recent volcanic activity in the Vico area.
2. The possibility of a deeper reservoir below the shallow one in the Viterbo high should be investigated.

After carrying out a comprehensive set of a geophysical, geochemical and temperature hole drilling, a deep exploratory well was drilled NE of Vico lake (Cimino 1).
It struck the permeable Mesozoic reservoir at 2600 m with a temperature of 220°C, proving that the exploration hypothesis was right. The formation is underpressured and substantial loss of circulation occured; the reservoir could not be adequately tested, even if it produced fresh water intermittently. The area will be further investigated by drilling.
Next year the deeper prospects in the Western area will be tested by a 3500 m wildcat (Vetralla 1).

INTRODUCTION

AGIP, the national oil company and ENEL the national utility of Italy have established a Joint-Venture for the purpose of exploring and producing geothermal fluids. Under such agreement several Italian areas are being explored, one of them being the "Monti Cimini" permit in Latium, north of Rome. The permit, for an area of 97.563 ha, was granted in November 1979 and operations therein are carried out by AGIP on behalf of the Joint-Venture.

GEOLOGICAL SETTING

The Monti Cimini permit lies in the Thyrrenian belt of Italy with an anomalous high heat flow; such belt is the seat of all the known geothermal fields (fig.1). Within the hot Thyrrenian belt the Monti Cimini permit lies in the relatively cooler area between Viterbo and Bracciano lake with temperatures at the top of the reservoir reaching the 200°C in the more favorable area (around the Vico lake) (fig.2).

The main reservoir, which is productive at Latera, Torre Alfina and Marta to the North and in Cesano to the South, consists of limestone and dolomites of Mesozoic age. Cap rock consists of flysch of Tertiary age.

Structurally the area is characterized by complicated tectonics related the build-up of the Appennine range. Volcanic activity was important at the end of such tectonic upheaval.

SURFACE EXPLORATION ACTIVITY

The Monti Cimini permit covers an area where surveys and some deep drilling was carried out between the fifties and the seventies by other companies. Thermal springs and temperature anomalies lead to the drilling of Vico 1 and 2 and Bagnaccio 1 wells in the western and northern parts of the area. The limestone reservoir is very shallow and contains 60-78°C water.

The Monti Cimini permit has been actively explored by AGIP since its granting. Geological (including photointerpretation) and volcanological studies were carried out over all the area.

We were thus able to confirm that two principal volcanic events took place in the area: the earliest stage corresponds to the ignimbritic effusions of Monti Cimini and to the emplacement of riodacitic domes along a fracture elongated for 16 km in a NW-SE (Appenninic) direction, dated 0,9-1,4 million years. The later activity corresponds to the Vico volcano and is dated 0,1-0,4 million years: extensive pyroclastics ignimbritic flows and lavas were emitted. The Vico volcano is placed probably along a regional NE-SW fault trend.

Geochemical surveys consisted in the examination of several hundred samples of water and of many gas shows. Several NH_3 and CO_2 anomalies were mapped. The central area of the permit presents (from the CH_4/H_2 gas ratio) evidences of high temperature (200-300°C) fluid (origina-

ting at an unknown depth). More recently soil sampling for radon gas analysis were carried out.

From the geophysical point of view aeromagnetic, gravity and electrical surveys were carried out over all the permit and enable us to establish the structural framework of the area. The western part of the permit is characterized by an important uplift of the Mesozoic carbonates probably overthrust to the NE. This structural high is flanked by a graben which extends from the Vico lake to Orte where the Soratte Mts ridge borders the west bank of the Tevere river, with a NW-SE direction (fig. 3 and 4).

Other geophysical surveys include some seismic lines and magnetotelluric soundings. To evaluate the underground temperatures several gradient wells were drilled.

GEOTHERMAL TARGETS

Based upon the results of the various surveys and previous drilling, the following geothermal hypotheses were arrived at.

The Viterbo structural high in the Western part of the permit is characterized by a reservoir containing only moderate temperature waters. The same may be said of the eastern part of the permit where the reservoir is shallow and adjoins the structural highs along the Tevere river.

The importance of the limiting faults to the East is such that it is probable that the downthrown central part of the permit is not hydraulically connected to the Viterbo high, thus allowing hope for high temperature fluids to exist therein because of the influence of the recent volcanic activity.

Three areas within the depressed central zone appear more promising: one just North of Mt. Cimino; the second East and South-East of the Vico volcano; the third, between Mt. Cimino and Vico lake. Target depths are between 1500 and 2500 m and possible temperatures in the order of 150-250°C.

Besides the main target consisting of the Mesozoic limestones in the depressed central area, the possibility exists of a high temperature reservoir in the underlying section of the Viterbo uplift (either within the metamorphic basement, on the example of the Amiata area in Tuscany) or in an overthrusted block underlying the first structure and separated from it by a conductive layer (flysch?). The first hypothesis appears more probalbe from seismic data available.

DRILLING ACTIVITY

On the basis of the above hypotheses well Cimino 1 was located between Mt. Cimino and Vico lake in the central downfaulted zone; it was drilled to the depth 3.000 m in 1984. The drilled section is as follows (fig. 5):

0	-	300 m	Volcanics: Quaternary
300	-	1160 m	Clays and sands: Pliocene (middle-lower)
1160	-	2130 m	"Flysch fm." Shales and subordinate sandstones and marly limestones : Oligocene-U. Cretaceous.
2130	-	2586 m	"Scaglia fm." - Marly limestones: M. Eocene - U. Cretaceous
2586	-	2600 m	"Marne a Fucoidi fm." Marly limestones and marls: M. Cretaceous
2600	-	2675 m	"Maiolica fm."-Marly, cherty limestones: L. Cretaceous
2675	-	2750 m	Loss circulation zone: possible marls, marly limestones, siliceous limestones of Jurassic age
2700	-	3000 m	"Calcari a Rhaetavicula contorta fm".-Dolomitic, bituminous limestones with minor marls and shales: U. Triassic.

During drilling severe mud losses (over 10.000 cu.m) were encountered, starting from about 2600 m to total depth. The main fracture appears to be at 2680 m depth. Surveys indicate a temperature of 218°C at 2154 m. The well is underpressured (190 bar at 2670 m).

Several production tests were attempted unsuccesfully. The well produced sporadically fresh water (probably not representative of the formation fluids) and temperature at the fracture did not exceed 150°C (as compared to original estimated temperature of 220°C).

Well Cimino 1 is presently suspended.

Having validated the exploration hypotheses, further programs for the central zone include:

- additional testing in well Cimino 1 and possible side-tracking
- drilling of wildcat well Ronciglione 1 located south of well Cimino 1.

During 1989 it is planned to drill the deep wildcat Vetralla 1 on the Viterbo uplift to check the existence of a possible deeper reservoir; target depth is 3500 m.

Drilling activity in the "M.ti Cimino" area has the support of EC.

AKNOWLEDGEMENT

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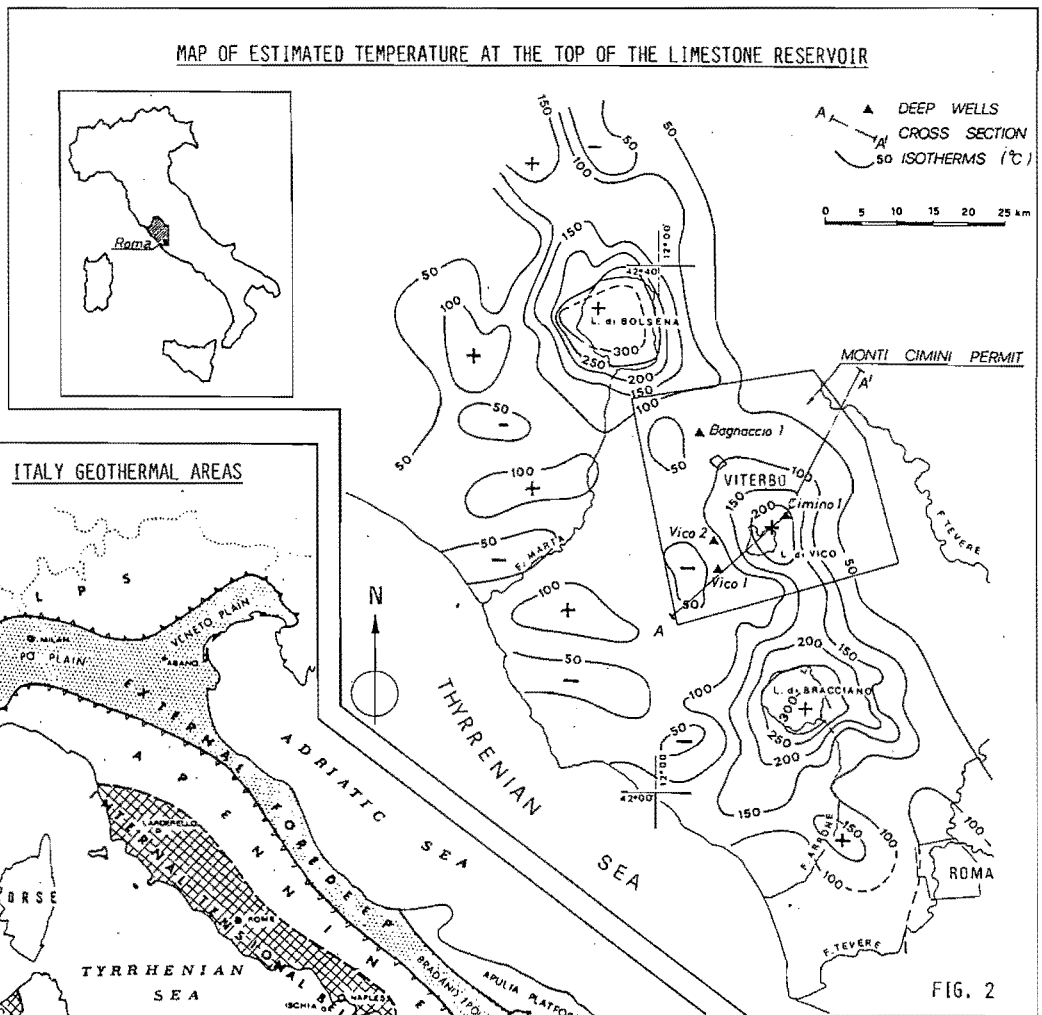
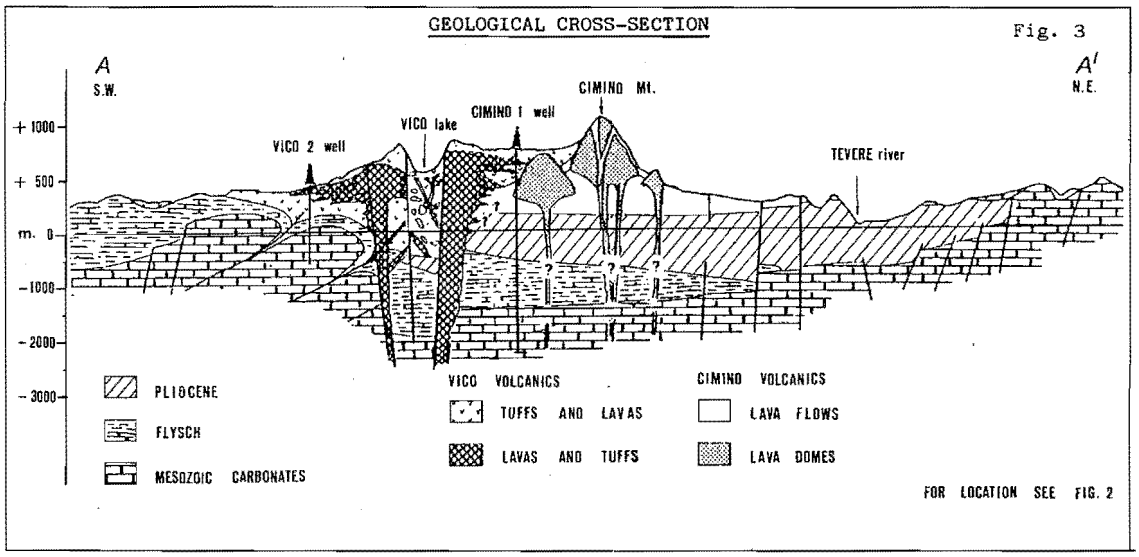



GEOLOGICAL CROSS-SECTION
Fig. 3
A
S.W.
A'
N.E.
CIMINO Mt.
CIMINO 1 well
VICO lake
VICO 2 well
TEVERE river
+ 1000
+ 500
m. 0
-1000
-2000
-3000
PLIOCENE
FLYSCH
MESOZOIC CARBONATES
VICO VOLCANICS
TUFFS AND LAVAS
LAVAS AND TUFFS
CIMINO VOLCANICS
LAVA FLOWS
LAVA DOMES
FOR LOCATION SEE FIG. 2

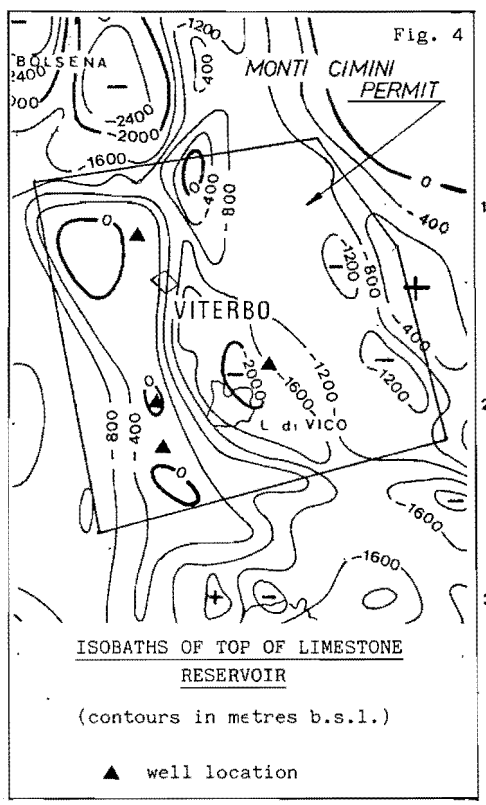
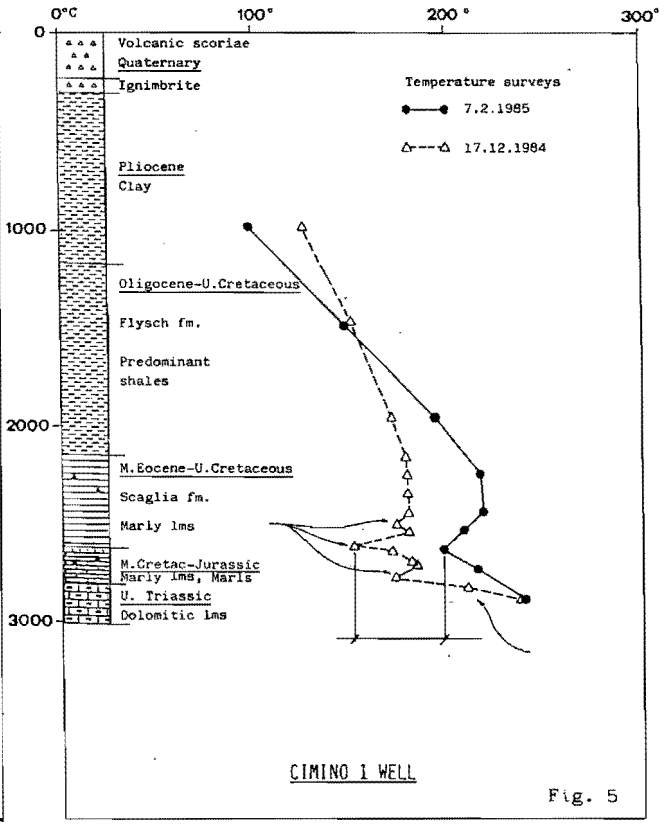


Fig. 4
BOLSENA
MONTI CIMINI
PERMIT
VITERBO
L. di VICO
-2400
-2000
-1600
-1200
-800
-400
0
ISOBATHS OF TOP OF LIMESTONE RESERVOIR
(contours in metres b.s.l.)
well location


0°C
100°
200°
300°
0
1000
2000
3000
Volcanic scoriae
Quaternary
Ignimbrite
Pliocene
Clay
Oligocene-U.Cretaceous
Flysch fm.
Predominant shales
M.Eocene-U.Cretaceous
Scaglia fm.
Marly lms
M.Cretac-Jurassic
Marly lms, Marls
U. Triassic
Dolomitic lms
Temperature surveys
7.2.1985
17.12.1984
CIMINO 1 WELL
Fig. 5