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P. QUATTRONE, S. ROGLEDI and R. LONGONI*

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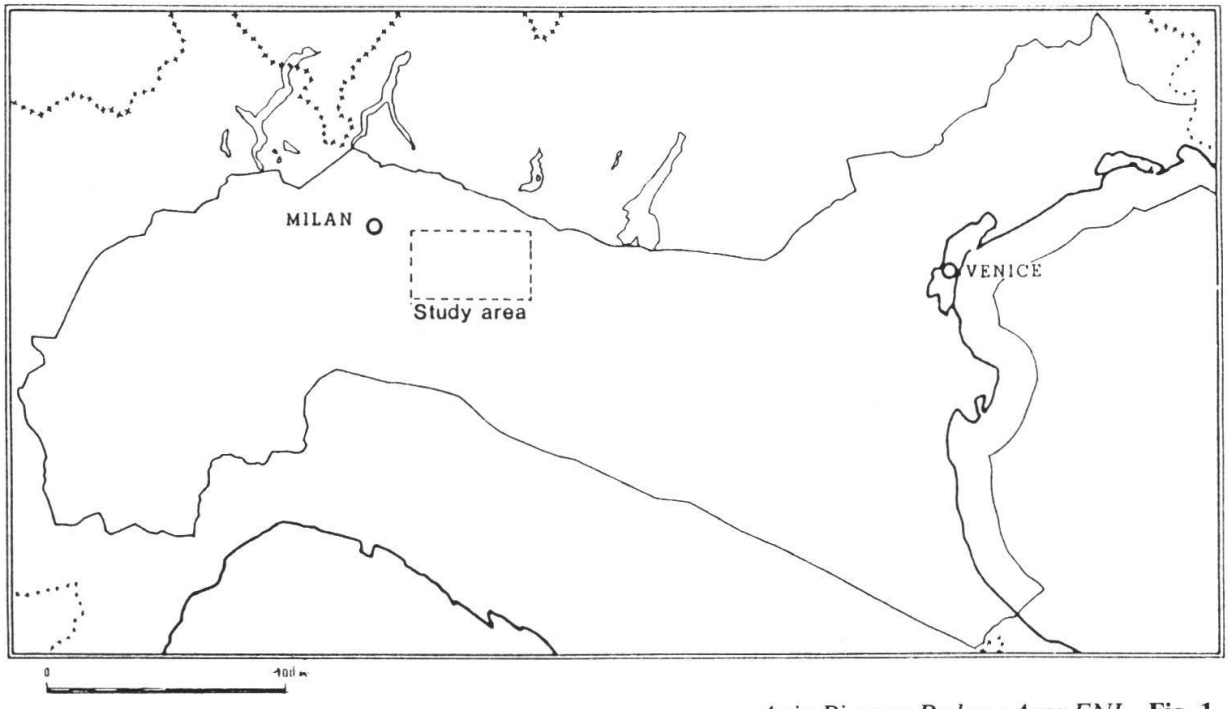
Introduction

The hydrocarbon exploration in the Po Valley pursues two different objectives: oil in the Mesozoic carbonates and gas in the Tertiary/Quaternary clastic sequences.

The aim of the present work is to illustrate, through a few examples, the main gas occurrences in the clastic series of the Upper Lombardian Valley (fig. 1).



Agip Pianura Padana-Area ENI **Fig. 1**

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History of gas exploration in the Tertiary of the Po Valley

Two main phases are recorded in the gas exploration of the Po Valley.

The first stretches from 1940-1971; the second from 1971 to present.

During the first phase the main tectonic features and the principal structural traps were outlined and in the meantime stratigraphic traps, related to the Messinian paleomorphologies, were delineated and the larger fields detected.

In the second phase the geophysical interpretation benefits of the advantages of digital seismic acqusition; therefore the exploration of the structural traps was better refined and completed while new discoveries in stratigraphic traps not previously detectable were made.

Structural and stratigraphic setting of the Upper Lombardian Valley

Two main sedimentary cycles are recognizable in the clastic series of the Upper Lombardian Valley: the Eocene-mid-Tortonian one and the Messinian-Pleistocene one (fig. 2).

The sediments related to the Eocene-mid-Tortonian cycle have been deformed during the late Miocene (Tortonian/Messinian); only a few times (ex. Ripalta Structure) it is possible to recognize further tectonic activity in the Pliocene.

The area belongs to the frontal part of the South Alpine thrust belts (fig. 3 - seismic section «A») and the tectonic style is caracterized by imbricated south-vergent thrusts, with the main detachment level located between the Mesozoic carbonates and the Tertiary clastic sequences.

The overlying cycle (Messinian-Pleistocene) is made up of a thick sequence of clastic deposits that are the marginal part of the Appennine foredeep.

The geometry of the sedimentary clastic sequence in the area shows a tilting in the frontal thrust-belt system towards the Appennine belts, that is very active during the Messinian/Pliocene phase.

The post-tectonic sediments (Messinian-Pliocene) are of great interest for the gas exploration in the study area.

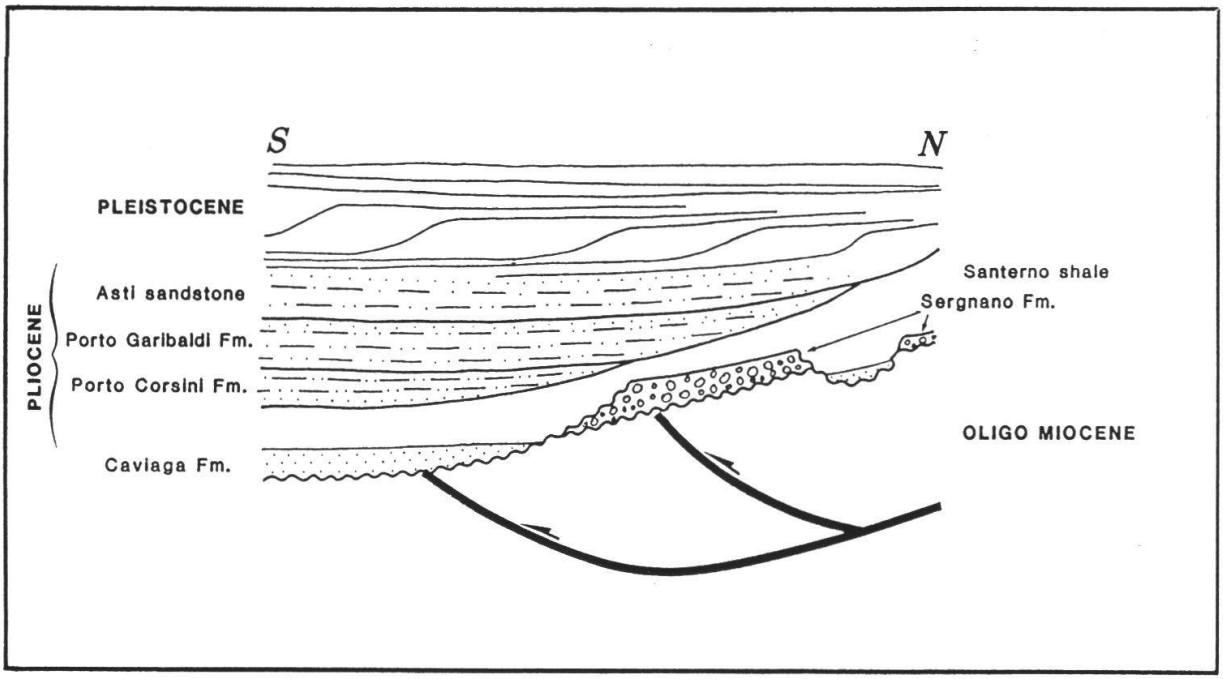
A synthetic description of the main sedimentary sequences related to the Messinian and Pliocene is here below reported.

Messinian (fig. 2-3-4)

Two main sedimentary sequences are recorded during the Messinian period.

— The lower one presents coarse facies, with prevailing gravel and sand of fluvio-deltaic origin (Sergnano Fm.); these sediments are the products of the erosion, due to the up-lifting, of the Alpine thrust belts at that time.

— The upper one presents very thin sediments of turbiditic origin (Caviaga Fm.) which are the marginal part of the Appennine foredeep wedge, well developed in the southern part of the study area (Appennine zone).



Stratigraphic Sketch **Fig. 2**

Pliocene (fig. 2-3-4)

The Pliocene series are mainly represented by a regressive cycle where the sediments deposited range from basinal plain, slope, platform s.s. to continental facies.

The early Pliocene is transgressive over the late Messinian sand (Caviaga Fm.) with shales (Santerno Fm.) of slope facies. The remaining part of the Pliocene can be subdivided in three main sedimentary sequences of turbiditic origin that can be related to: Upper part of Lower Pliocene, Middle Pliocene and Upper Pliocene.

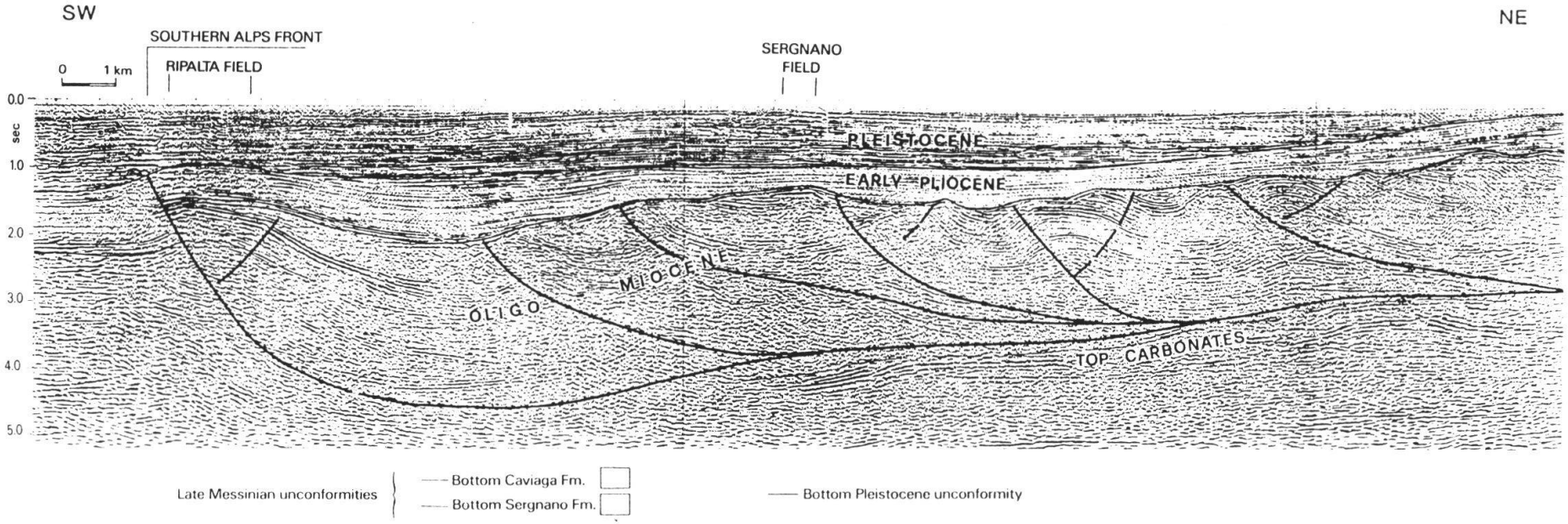
The three cycles are represented by the following formations: Porto Corsini, Porto Garibaldi, and Asti sandstone.

Examples of Gas-fields in the Upper-Lombardian Valley

The aim of the gas field examples is to describe the different types of traps in which gas accumulations occured in the Upper Lombardian Valley (fig. 1).

Ripalta (fig. 3-5)

Discovery year:	1949
Type of trap:	Structural; it is a fold-fault trap with south vergence and with a EW oriented trend.
Deformation time:	Early Tortonian, then Middle Pliocene.
Reservoir depth:	1500 m.
Reservoir:	Caviaga Fm. (alternating beds of sand and shale). Porosity ranges from 20 to 25%.
Cap rock:	Santerno shales.
Gas nature:	Thermogenic-biogenic.
Migration time:	Middle/Upper Pliocene



Seismic Line «A» **Fig. 3**

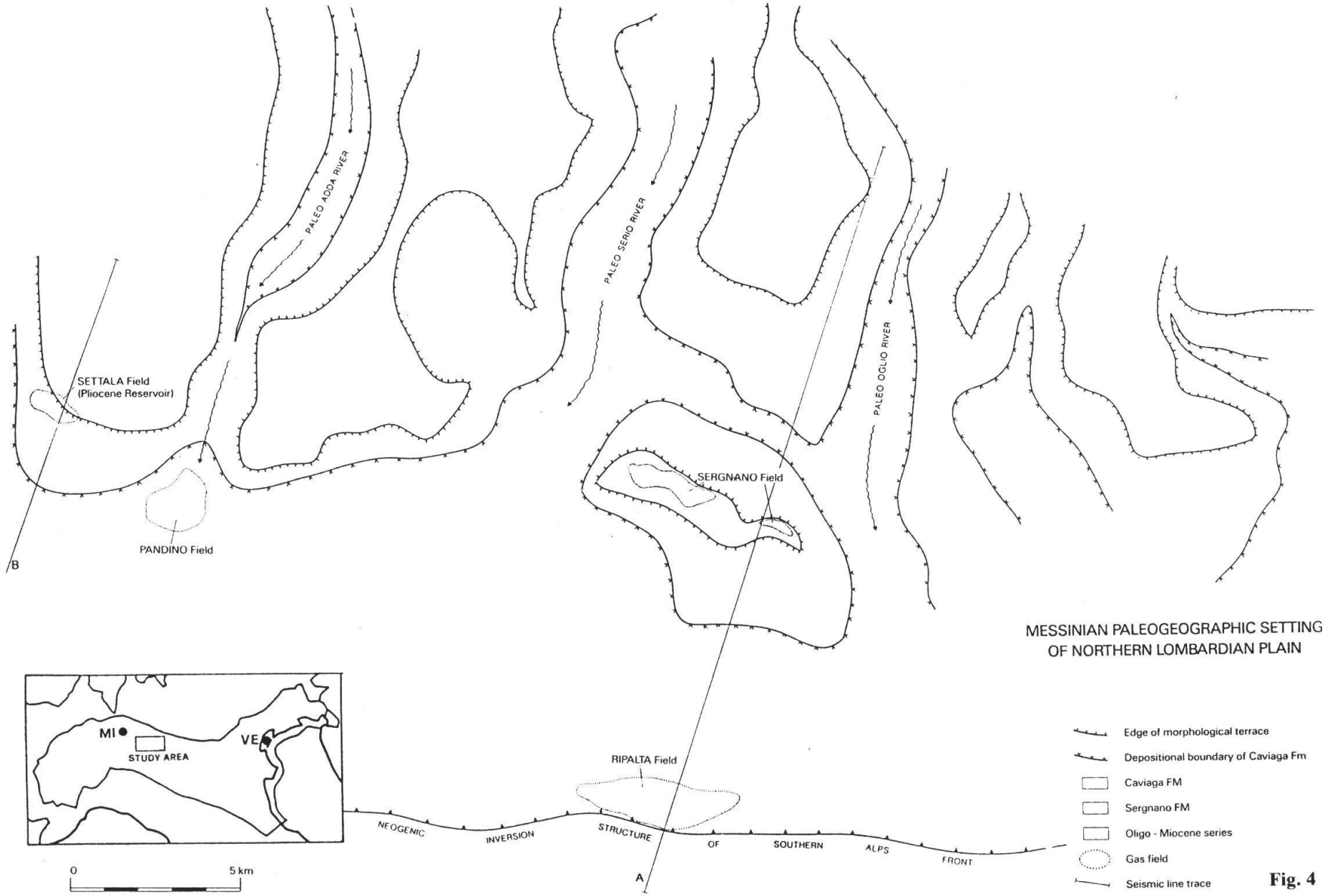
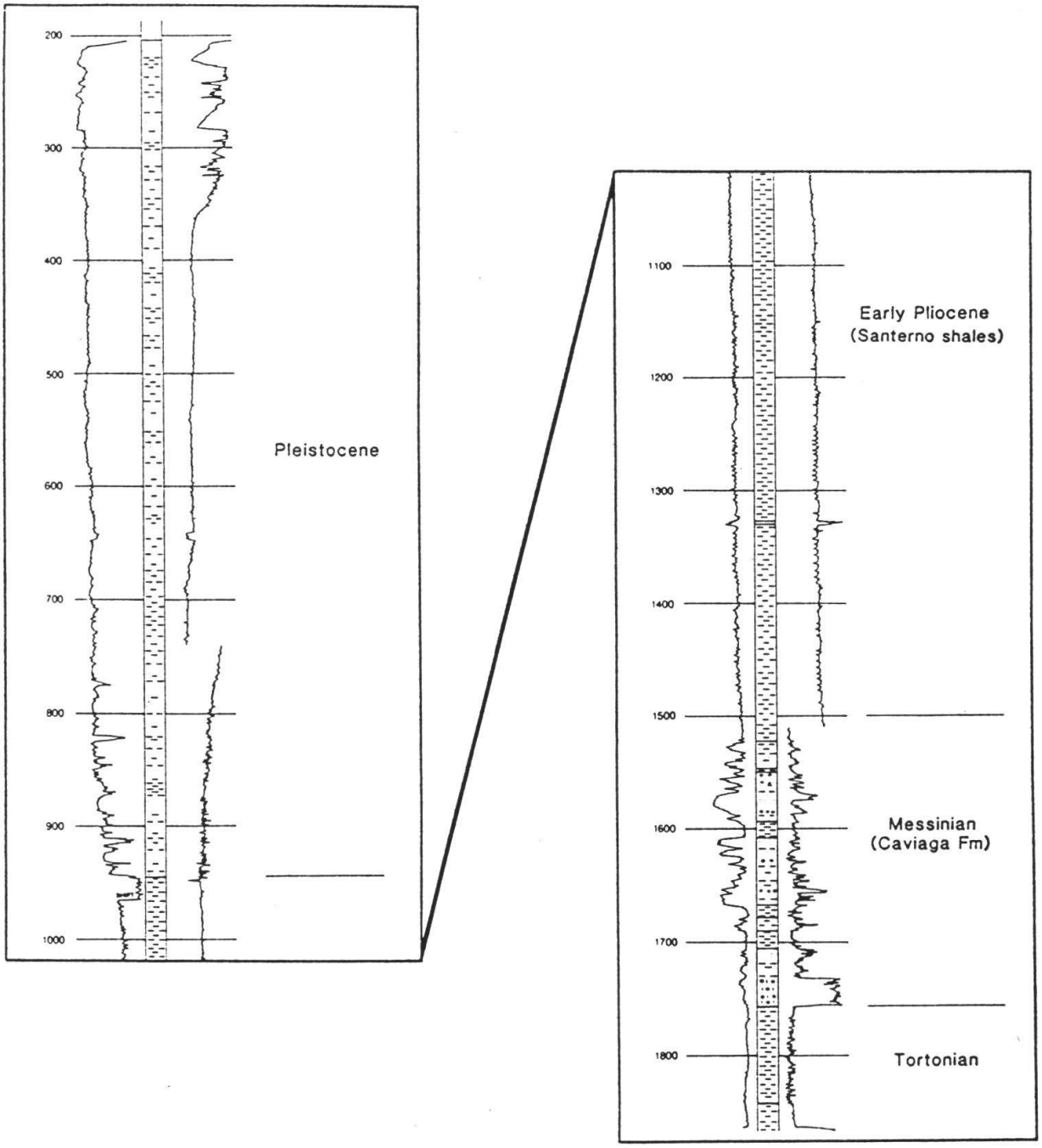
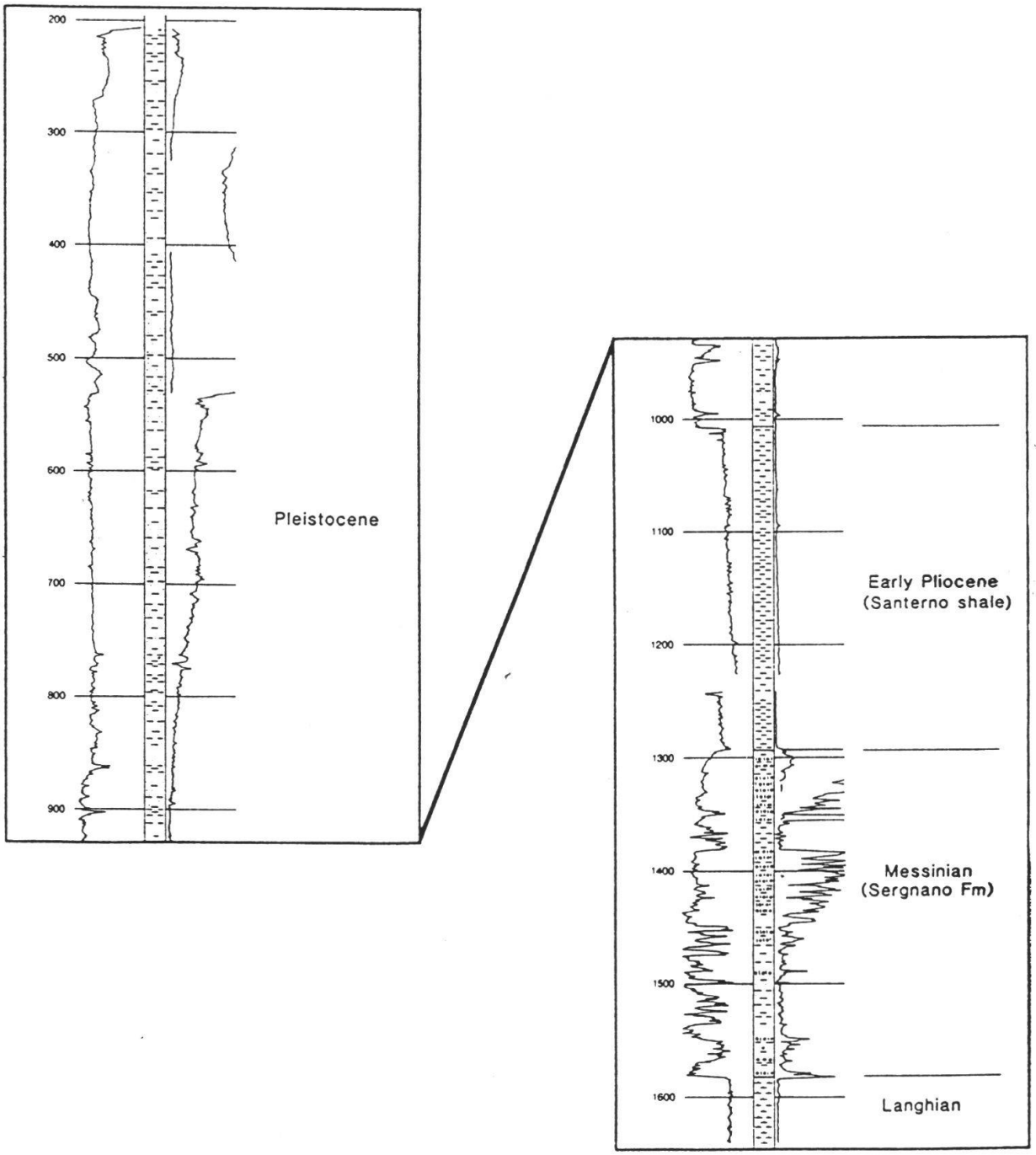

PALEO ADDA RIVER
PALEO SERIO RIVER
PALEO OGLIO RIVER
SETTALA Field
(Pliocene Reservoir)
PANDINO Field
SERGNANO Field
RIPALTA Field
B
A
MI
VE
STUDY AREA
0
5 km
NEOGENIC
INVERSION
STRUCTURE
OF
SOUTHERN
ALPS
FRONT
MESSINIAN PALEOGEOGRAPHIC SETTING
OF NORTHERN LOMBARDIAN PLAIN
Edge of morphological terrace
Depositional boundary of Caviaga Fm
Caviaga FM
Sergnano FM
Oligo - Miocene series
Gas field
Seismic line trace

Fig. 4



Ripalta **Fig. 5**



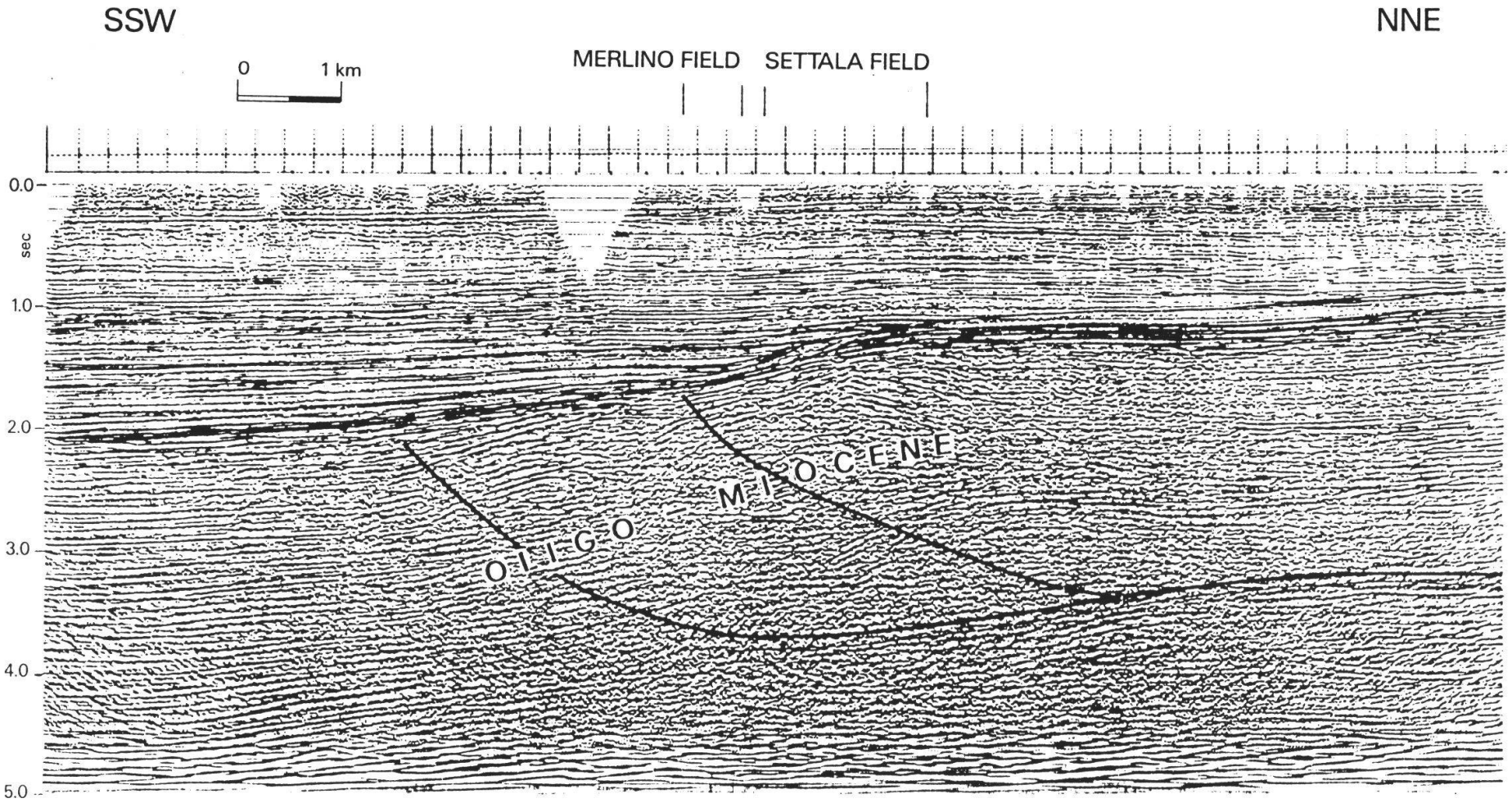
Sergnano **Fig. 6**

Sergnano (fig. 3-6)

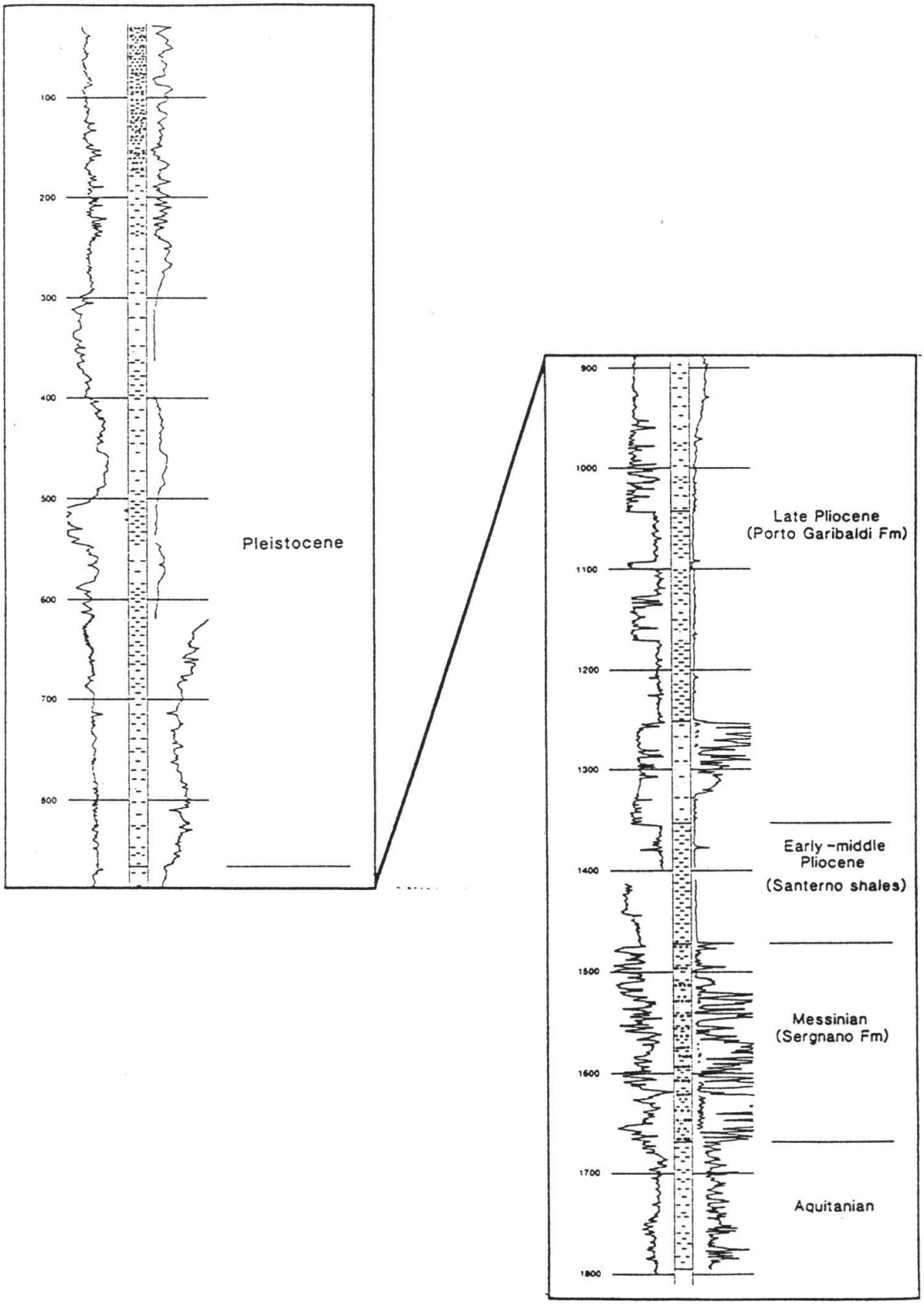
Discovery year:	1954
Tipe of trap:	Stratigraphic; it forms a lens shaped body of fluvio-deltaic conglomerates (Sergnano Fm.) eroded on the top before the Caviaga Fm. deposition.
Resevoir depth:	About 1300 m.
Reservoir:	Sergnano Fm. (prevailing pebbles, sands and shales inter-bedded). Porosoty is about 25%
Cap rock:	Santerno shales (Early Pliocene).
Source rock:	Santerno shales (Early Pliocene).
Gas nature:	Biogenic.
Migration time:	Middle/Late Pliocene.

Settala-Merlino (fig. 7a-b-c)

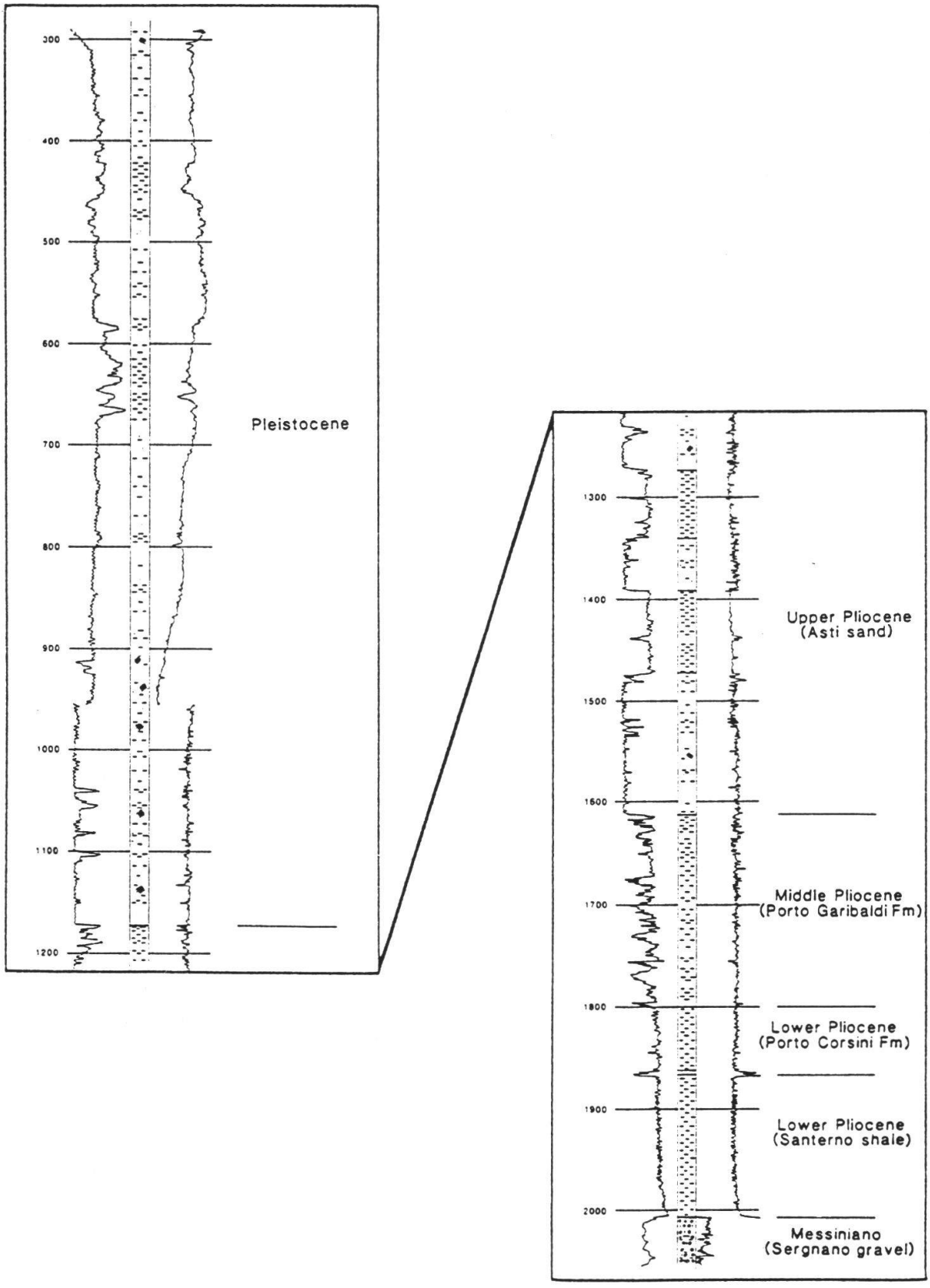
Discovery year:	1977
Type of trap:	Stratigraphic, turbiditic layers of lower Pliocene (Merlino) and Upper Pliocene (Settala) that terminate in onlap upon the underlying sequence (Caviaga + Santerno shales).
Reservoir depth:	1300 m (Settala); 1800 m (Merlino).
Reservoir:	Porto Corsini Fm and Porto Garibaldi Fm. (sand beds more or less thick with shale intercalations). Sand porosity is nearly 27%.
Cap rock:	Shale intercalations in Porto Corsini and Porto Garibaldi Fm.
Source rock:	Santerno Shales.
Gas nature:	Biogenic.
Migration time:	Probably Middle Pliocene-Pleistocene.



Seismic Line «B» **Fig. 7 A**



Settala **Fig. 7 B**



Merlino **Fig. 7 C**

Conclusion (fig. 4)

From the analysis of the data, available in the area, we come across a variety of depositional facies in space and time.

This is mainly due to the fact that the study area encompasses the frontal zone of two thrust-fold belts with opposite vergences: the South Alpine and the North Appenine belts. Therefore this fact concurs to the tectonic control of the sedimentary cycles.

During the Messinian and Pliocene time the space available to the clastic deposits is given by the tilting southward of the Upper Lombardian Valley under the load of the Appennine thrust. The sediments are provided by erosion of the Alpine belts subjected to strong uplift; a further complication can be related to the eustatic cycles very important during Messinian times.

Therefore all the fields described in this area record the complexity and variability of the geological setting.

Buchbesprechungen

Die Ostalpen in den Eiszeiten (1987)

von D. VAN HUSEN

24 S., mit 23 Abb. und einer Karte 1:500000: «Die Ostalpen und ihr Vorland in der letzten Eiszeit (Würm)»; Ö.S. 80.—
Geologische Bundesanstalt Wien

Broschüre und Karte behandeln den Alpenraum und sein unmittelbares Vorland von der oesterreichischen Ostgrenze bis nach Chur und von Regensburg bis nach Udine. Das zur Reihe «populärwissenschaftliche Publikationen» gehörende Werklein beschreibt auf anschauliche Weise die Gletscher mit ihrem Einfluss auf den Untergrund und die erzeugten Produkte. Der Bezug zu heutigen, erforschten Gletschergebieten wird klar dargestellt und die Frage nach den Gründen der Entstehung von Eiszeiten wird in einigen Sätzen zu erklären versucht. Meines Wissens sind wir in der Schweiz im Hinblick auf populärwissenschaftliche Publikationen noch etwas unterentwickelt. Hier wären wohl die naturwissenschaftlichen Museen zu grösserer Aktivität zu ermuntern.

GABRIEL WIENER

Water Shall Flow fron the Rock (1989)

Hydrogeology and Climate in the Lands of the Bible

by A.S. ISSAR

213 p. 51 figs, Softcover DM 48.—
Springer, Heidelberg, Berlin, New York, London, Paris, Tokyo, Hong Kong

Hier liegt ein Werk über die Hydrogeologie der Ländes des nahen Ostens (im englischen Sprachgebrauch «Middle East») vor, welches gegenseitige Beziehungen zur Bibel aufzeigt. Die Verflechtung der Geschichte des oberen Quartärs und seiner Klimaentwicklung in dieser Region ist besonders von der Tatsache geprägt, dass im Quartär Pluvialzeiten existierten, welche auch die Menschengeschichte nachhaltig beeinflussten. Neuere Naturforschung, Archäologie und Frühgeschichte lassen ein interessantes Bild entstehen, welches die erstaunlich «wahren» Grundlagen der mehere Religionen prägenden «biblischen Geschichten» in neuem Licht erschienen lassen. Ein anregendes Buch eines Hydrogeologen.

GABRIEL WIENER