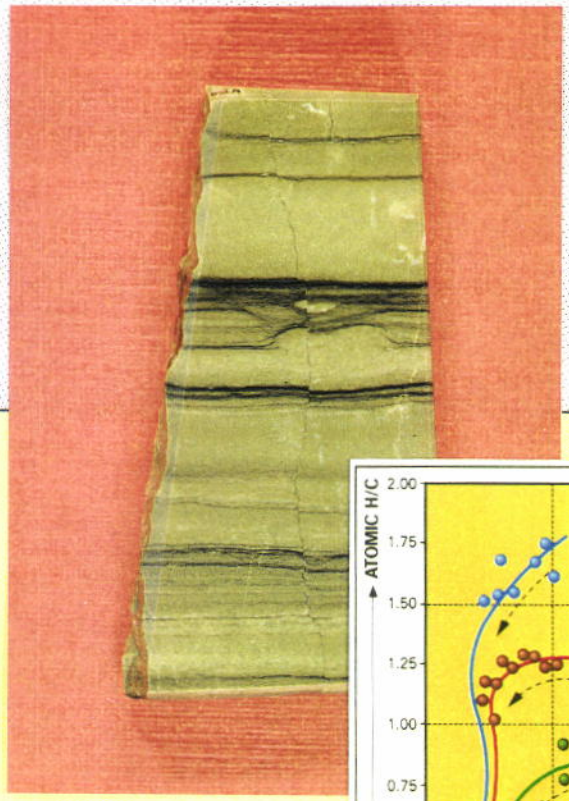
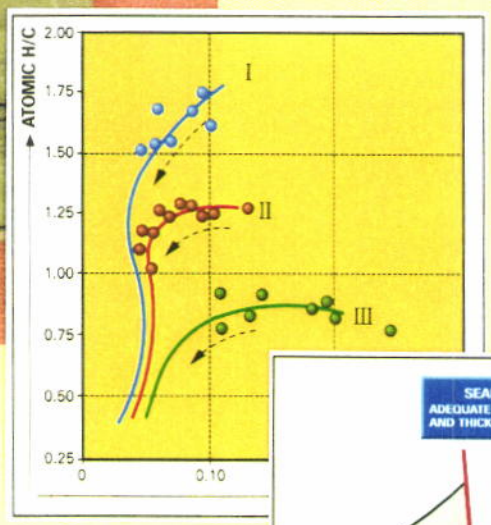
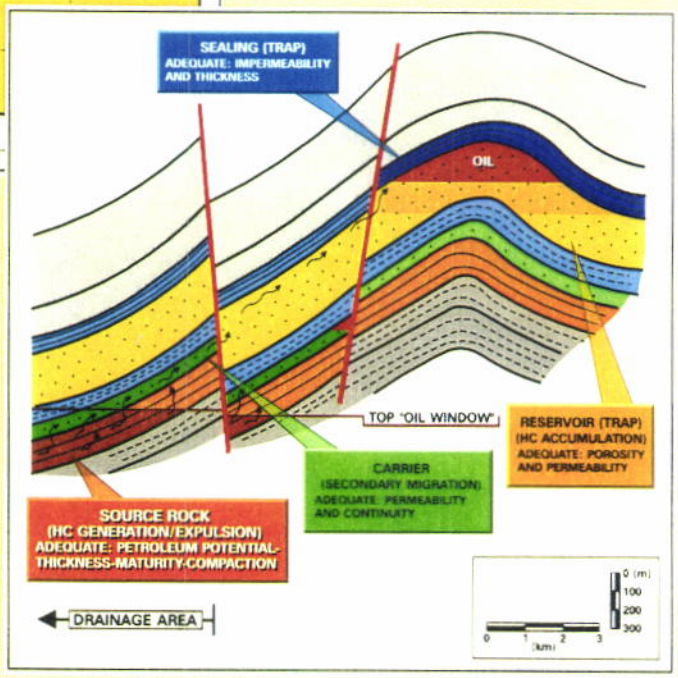
Eni Agip E&P Division



THE SOURCE ROCK: a key point for Hydrocarbon Exploration





Quaderno Tecnico n° 8

What does "Source Rock" mean?

The intervals of sedimentary rocks having the potential capability to generate and expel hydrocarbons in important quantities, from the economic viewpoint, are defined ***source rocks****.*

They are therefore sediments containing significant quantities of ***organic matter*** (mainly of vegetable origin) preserved against degradation phenomena and deposited in non-oxidizing environments. In extreme anoxia conditions (severely reducing environment) the maximum preservation degree is reached, and the whole organic potential, mainly consisting of carbon-hydrogen compounds, is trapped in the sediment.

In the starting phases of sediment burial, the organic matter sustains transformations with the re-organization of carbon-hydrogen bonds, with formation of an organic compound (a large macromolecule) called ***"kerogen"***.

The progressive burial of the potential source rock will determine (due to the geothermal gradient) a temperature increase, thus starting the transformation reactions of the kerogen into hydrocarbons (phenomenon briefly defined ***"kerogen thermal degradation"***).

To obtain the extent of said transformation different experimental parameters are measured in the source rock; they are called ***maturity*** parameters.

The content of *organic matter (o.m.)* in a sediment is usually measured as quantity of ***organic carbon*** (***T.O.C.*** = *Total Organic Carbon*) expressed as percentage by weight of the rock sample.

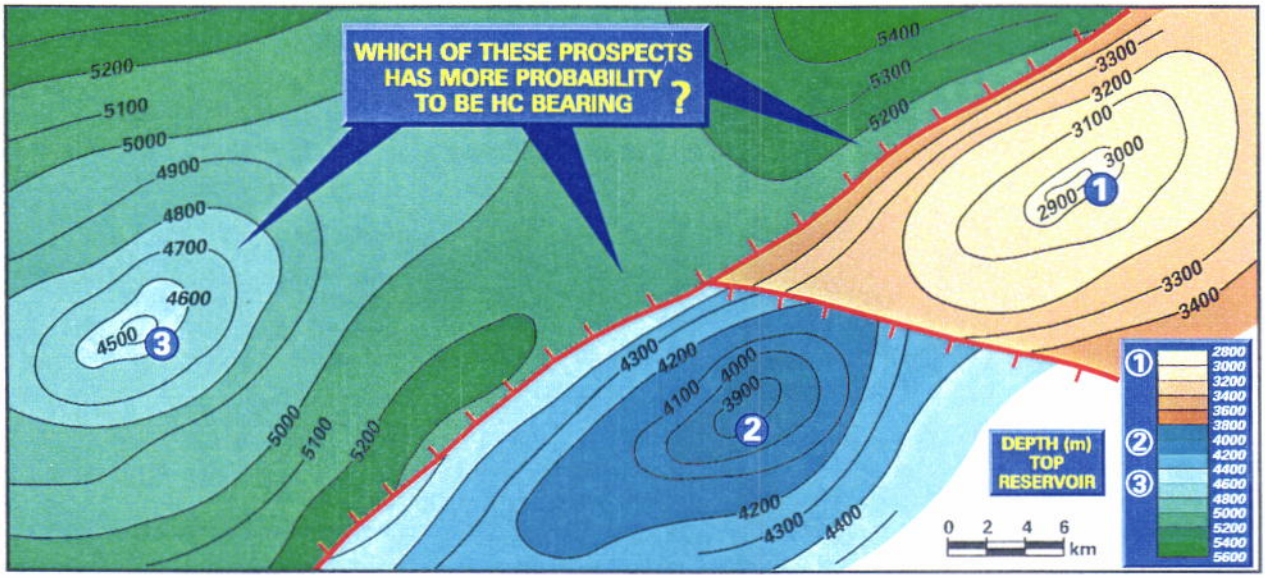
At equal T.O.C., according to the quality of the original organic matter and to its preservation degree, the kerogen can be more or less rich in hydrogen; the higher is the hydrogen content, the higher shall be the quantity of hydrocarbons that can be produced.

The higher are the above-mentioned parameters (T.O.C., o.m. quality and preservation degree), the higher shall be the quantity of hydrocarbons the source rock can generate.

Said quantity, expressed in *Kg of hydrocarbons which can be generated per ton of rock*, is defined ***Petroleum Potential.*** An interval of sedimentary rock can be defined *source rock* if the original ***Petroleum Potential is higher than 1 Kg HC/t rock.***

Why is the study of source rocks important?

> *"Although every petroleum pool occurs in a trap, it does not follow that every trap contains a pool." (Levorsen, 1954)*



For an effective oil exploration in a given sedimentary basin it is necessary the study of all the phenomena concurring to the genesis of hydrocarbon accumulations.

The sole identification of traps or structures is a necessary condition, but of course not sufficient, to foresee the existence of an hydrocarbon accumulations. A prospect becomes a real industrial target when it is verified that there are good possibilities for being filled with hydrocarbons.

In fact, many factors concur to represent the *"risk in exploration"*, which can be summarized as follows:

. trap risk (actual geometrical closing of the structure and suitable size);

. reservoir risk (adequate porosity and permeability);

. sealing risk (existence of a efficient seal);

. hydrocarbon charge risk.

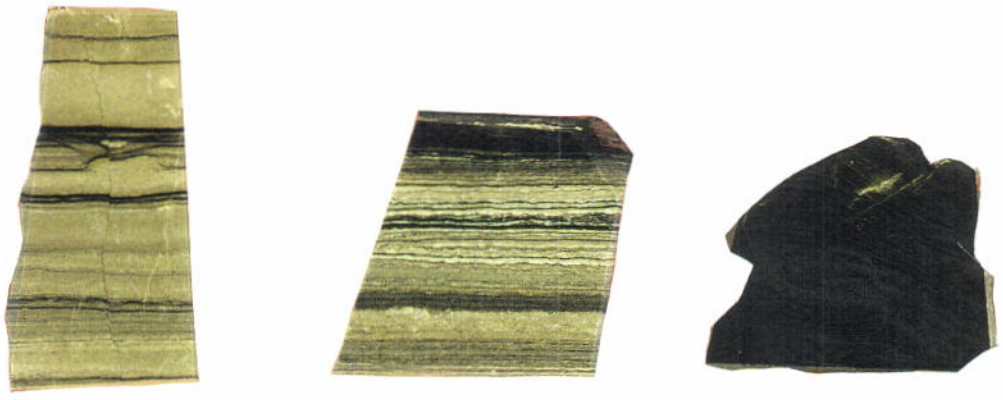
To contribute to the evaluation of the *"hydrocarbon charge risk"* it is necessary to conduct *a deeper study in the sedimentary basin* and therefore: ***to identify*** the potential source rocks; ***to characterize*** them by using a large number of samples and appropriate techniques; to consider their ***maturity*** level and to evaluate the relevant ***Hydrocarbon Potential.***

We recall that *"kerogen or organic matter maturity"* means the extent of the kerogen thermal degradation process to give hydrocarbons; said extent can be expressed as a ratio: the ***"Transformation Ratio (TR)"*** (TR= generated Hydrocarbons / initial Hydrocarbon potential of the considered source).

Identification of source rocks

The identification of potential source rocks should not derive from geochemical analysis carried out in a systematic way on all the sediments of a sedimentary basin , but it shall be restricted to a selection of the formations having peculiar characteristics in terms of ***lithofacies*** (mineralogical composition, texture, sedimentary structures, colour), reflecting therefore *particular sedimentation environments where the organic matter had the possibility to be sedimented, concentrated and preserved* (key factors are: the sedimentation rate, the chemical – physical conditions at the time of sedimentation and type and provenience of organic matter).

Fig. 2*. The three following samples belong to the "Unità a Laminiti Organiche di Rio Resartico" (Late Triassic age, outcropping in the Carnia Region). The first two samples represent dolomitic lithofacies having different lamination frequency, the third one results being dolomitic marl densely laminated and having high dark pigmentation. The T.O.C. result being higher as the lamination frequency and clay content increase.*



Clays & Mica =	*2 %*	*4 %*	*30 %*
T.O.C. *=*	*1.0 %*	*1.4 %*	*12.7 %*