GEOL. CROAT.	49/2	259 - 263	3 Figs.	1 Tab.		ZAGREB 1996

Scientific note

How a Better Knowledge of the Basins Can Reduce the Risk of Exploration: Input of Basin Modelling

Alan **MASCLE**[1] and Bernard **DURAND**[2]

Key words: Western Alps, Basin modelling, Risk of exploration.

Abstract

Basin modelling software has been widely developed in the 80's and is still the subject of active Research and Development in the oil companies, contractors and consultant agencies, and also in the universities. A complete range of software applicable to the basin level are now available to explorationists, including 1-D, 2-D and soon 3-D tools. Most of them are devoted to the validation of structural hypotheses, to the prediction of source rock maturities, or to a reconstruction of petroleum formation and migration in basins. Another class of software, mostly developed in the universities, attempts to describe the thermomechanical behaviour of the lithosphere during basin formation and subsequent inversion (DURAND et al., 1997).

The question now is: how can these tools help explorationists in reducing the risks (and as a consequence the costs) of exploration?

In order to discuss and answer this question, we will present a case study in which IFP software has been used to reassess the petroleum potential of the Southeast Basin and Gulf of Lyon in SE France. These two areas have been the locus of active exploration from the 60's to the early 80's, without commercial results. The analysis and appraisal of failures have already been done and the different potential petroleum systems recognized. Then 1-D and 2-D modelling was performed in order to select within this 50,000 km^2 area the few places where further exploration can be conducted with a minimum of technical and economic hazards.

1. REGIONAL SETTING

The Southeast Basin is the thickest onshore French sedimentary basin where up to 10 km of Mesozoic-Cenozoic sediments can be found locally (Fig. 1). Basin development occurred in several stages between late Carboniferous and late Cretaceous times. Partial tectonic inversion took place during two compressive events, in early and late Tertiary times. They were separated by an intervening stretching event of Oligocene age, which led further south, to the opening up of the western Mediterranean margins and ocean in Burdigalian times (including the Gulf of Lyon located immediately south of the Southeast Basin). In Neogene times the Palaeozoic basement of the Massif Central was uplifted to about 2000 m as the result of an ascending asthenospheric plume.

2. METHODOLOGY

A large oil seep has been exploited since at least 1608 in the vicinity of what will later become the tiny Gabian oil field. Most of the exploration undertaken from 1955 (onshore) and 1975 (offshore) to the present has been disappointing as no significant oil or gas field has ever been discovered, although about 150 wells have been drilled. A reassessment of the remaining potential of the Southeast Basin and Gulf of Lyon basin has been undertaken by IFP since 1991. The main objective was to select the few areas where potential plays have not yet been tested, and where further exploration could be undertaken with a minimum of risks. The agenda of works has been as followed:

a) synthesis of all available geological data;

b) elaboration of the geochemical and geophysical data base;

c) analysis of failures in previous exploration wells;

d) appraisal of the different petroleum systems;

e) 1-D and 2-D numerical modelling of selected sites or transects.

Items a-d are classic works for any basin evaluation. However, their importance should not be underestimated as the quality and the confidence in the modelling will directly be linked to the quality of the input data. The selection of the modelling tools will also be dependent on the availability of quality data. 1-D modelling is easy to operate and the results are very rapidly obtained. Numerous hypotheses can thus be tested for a low cost, and these tools will be used when only a limited amount of data is available. Conversely, 2-D modelling tools are more difficult to operate and are time consuming (for both people and computers). Only a few geological hypotheses can be tested, and the use of such tools should be restricted to areas where a complete set of good quality data can be obtained.

[1] Institut Français du Pétrole, BP 311, 92506-Rueil Malmaison, France.

[2] Ecole Nationale Supérieure du Pétrole et des Moteurs, BP 311, 92506-Rueil Malmaison, France.

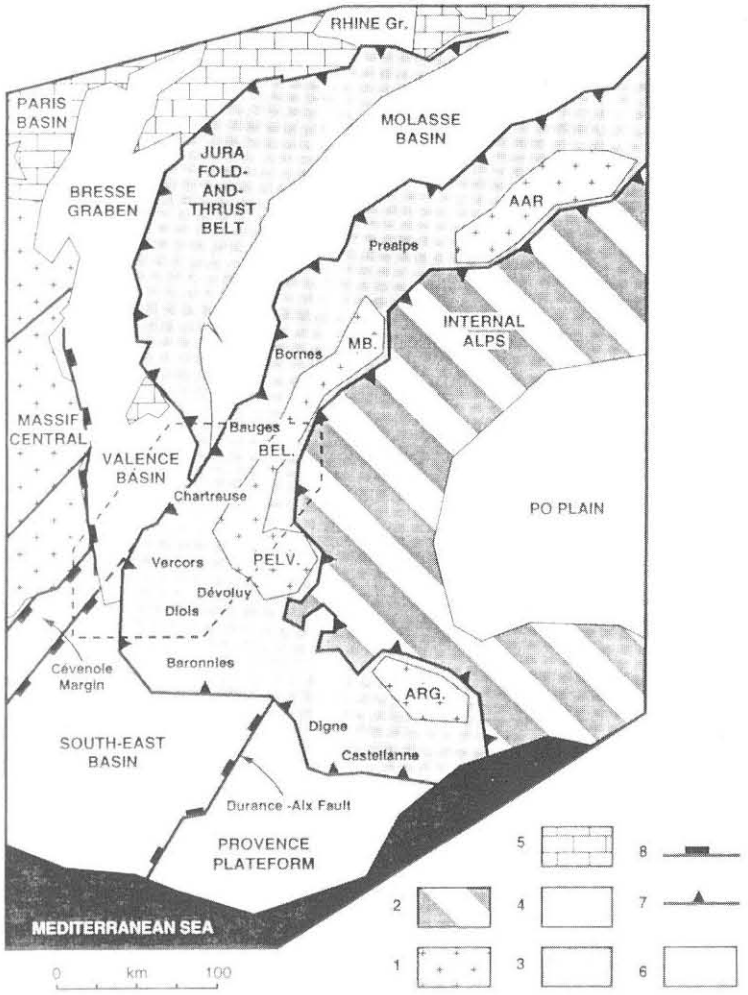

Fig. 1 Structural map of the Southeast Basin, Western Alps. Legend: 1) Palaeozoic basement; 2) internal Alps; 3) external Alps and Jura Thrust belt; 4) Western Alps foreland: Southeast Basin, Provence Platform; 5) stable European craton; 6) Tertiary Basins: Po Plain, Molasse and Valence Basin, Bresse and Rhine Graben; 7) main alpine thrust fronts; 8) main Early Mesozoic normal faults.

3. AVAILABLE BASIN MODELLING SOFTWARE

Software developed at IFP cover a wide range of geological processes. 1-D software such as "Genex" will be used to model the subsidence, thermal and source rock maturity histories of selected sites in sedimentary basins (see one application in the Gulf of Lyon; Fig. 2). Such processes within basins can also be investigated with 2-D software such as "Themispack" or "Themiscomp", with the benefit that fluid pressures and flows can also be investigated. We are now developing a similar tool, "Thrustpack", devoted to the study of thrust belts and their foreland; an application on the Chartreuse Massif of the western Alps, once part of the Southeast Basin, before tectonic inversion in Tertiary times (ZIEGLER & HORVÁTH, 1997), is shown on Fig. 3. Of equal importance, the variety of data needed for proper use of the software is listed in Table 1.

4. CONCLUDING REMARKS

1-D and 2-D modelling have been performed across a continental margin (the Gulf of Lyon) and the foothills of a thrust belt (the western Alps), i.e. in areas where exploration is expensive. The benefit of such modelling work is three fold:

a) to unite the work of a multidisciplinary team and to make an attempt to quantify geological data;

b) as some important input data are often not available (the thermal history for instance) it is possible to test several geological hypotheses (either structural, geochemical, thermal, ...) and to appreciate the range of uncertainties resulting from this lack of data;

c) to promote the most appropriate studies to gather the geological data that appear to be of crucial importance for the petroleum evaluation of the object area.

Acknowledgements

Some of this work was supported by the IBS project (Integrated Basin Studies), part of the Joule Research Programme funded by the Commission of the European Communities (contract nº JOU2-CT-92-0110).

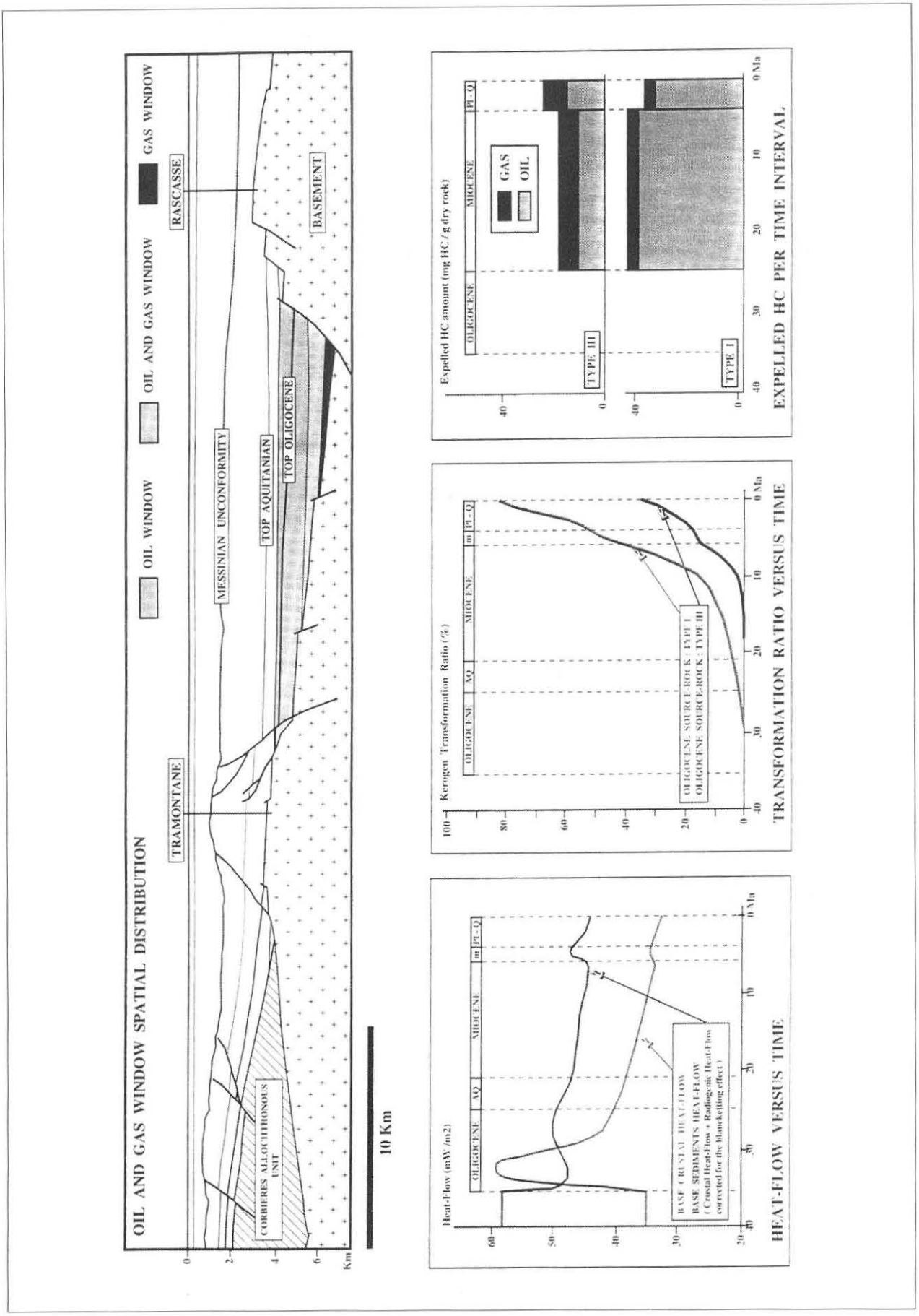

Fig. 2 Gulf of Lyon continental margin (Western Mediterranean); "Genex" modelling of the maturity history of potential source rocks (from VIALLY & TREMOLIERES, in: ZIEGLER & HORVÁTH, 1997). 1-D Genex modelling has been performed in the Oligocene-Miocene graben located between the Rascasse and Tramontane wells. The results have then been graphically extended to the 2-D section.

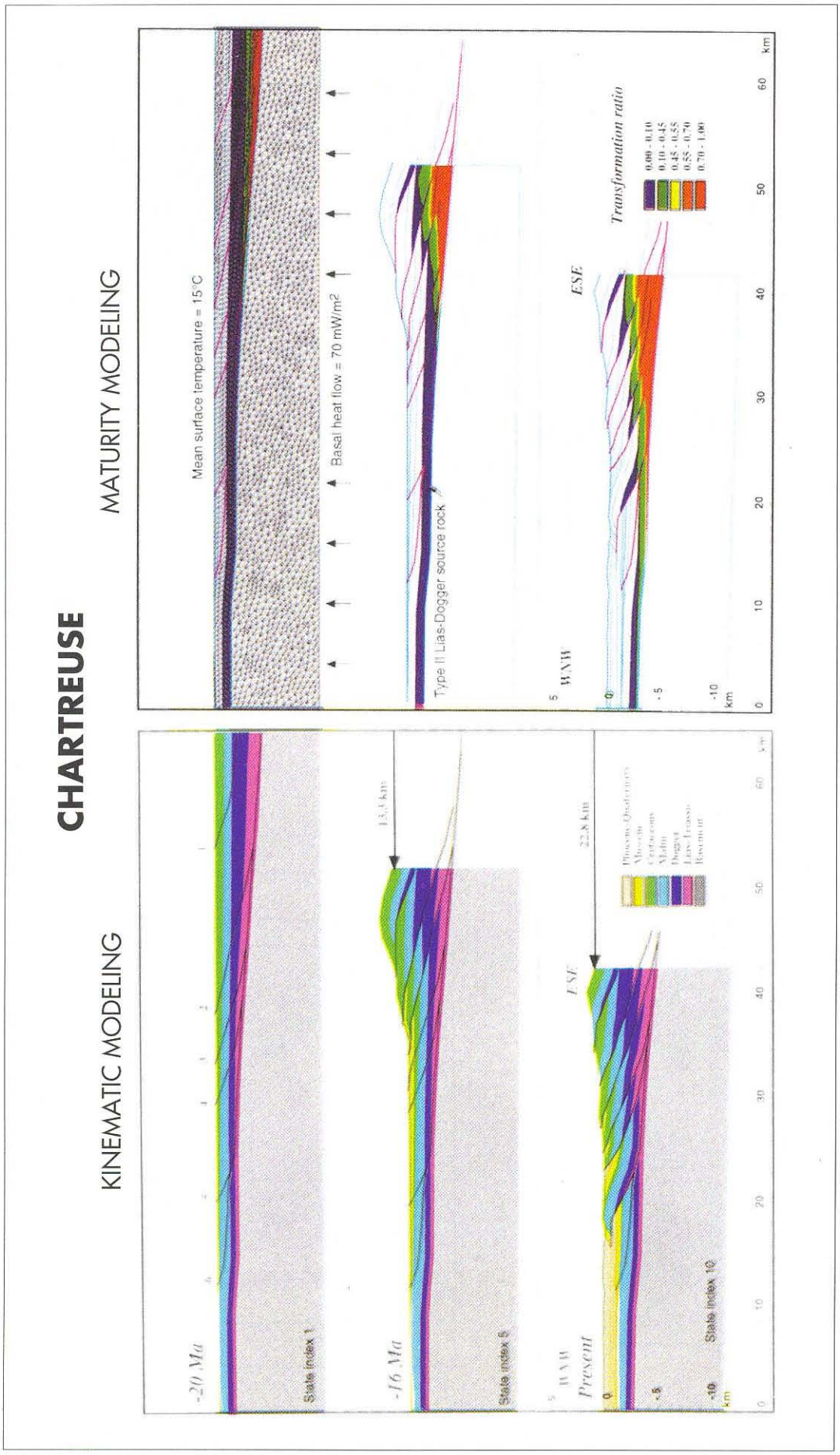

Fig. 3 Chartreuse Massif (Western Alps), "Thrustpack" modelling of the tectonic and source rocks' maturity histories.

1. GEOLOGIC DATA

a. Stratigraphic data: well constrained lithologies and well dated formations (especially syntectonic deposits).
b. Structural data: well balanced cross-section with the restoration before deformation.
c. Kinematics data: timing of deformation and displacement rates on faults.
d. Vertical displacements: erosion and subsidence history.

2. THERMAL DATA

a. Heat flow history (may be estimated from geochemical data).
b. Density, thermal conductivity, heat capacity, radiogenic heat and specific area of sediments (available standard default values vs. lithologies).

3. GEOCHEMICAL DATA

a. Local calibration of source rocks maturity.
b. Kinetic parameters of source rocks (available standard default values for 4 types of source rocks).

Table 1 Required data for "Thrustpack" modelling.

5. REFERENCES

DURAND, B. et al. (eds.) (1997): Extension-in-collision basins.- Geological Society special publication, in preparation.

ZIEGLER, P.A. & HORVÁTH, F. (eds.) (1997): Structure and Prospects of the Alpine Basins and Foreland.- Peri-Tethys Memoir, 2, in press.