P-24 INTEGRATION OF OUTCROP, CORE AND WIRELINE-LOG FACIES ANALYSIS FOR RESERVOIR CHARACTERIZATION

G. BERTOZZI¹, W. PALTRINIERI¹, D. DI BIASE², A. ARTONI² and E. MUTTI²

¹BG Italy, P.zza Cavour 2, 20121 Milan, Italy

²Parma University

Introduction

The Salsomaggiore anticline is located in the foothills of the northern Apennines near Parma. This structure represents a tectonic window in which more than 800 m of Miocene strata crop out beneath allochthonous Cretaceous to Eocene Ligurian units. In its lower part, the Miocene succession consists of Langhian marls which are overlapped by predominantly sandstone and pebbly-sandstone strata of Serravallian age. These strata represent a good analogue of a Miocene gas-bearing reservoir discovered by a Joint Venture group led by British Gas in an area near the Salsomaggiore structure and are generally interpreted as the proximal equivalents of the basinal turbidites forming the upper portion of the Marnoso-arenacea (Langhian to Tortonian), cropping out in the eastern part of the northern Apennines (e.g., Ricci Lucchi, 1981).

To understand the depositional origin of these units and describe the lithologic characteristics of the drilled reservoirs, we integrated outcrop observations and subsurface data as an application of a more general project of collaboration between British Gas and the University of Parma. First, we did a detailed facies analysis using two outcrop sections, 850 m and 100 m thick respectively, in the Salsomaggiore anticline and about 60 m of conventional cores from two wells located in the vicinity of the structure. The results of this study were then compared with high-resolution wireline-log data to extend the analysis over the whole drilled section.

Facies analysis

The sedimentological analysis showed the complexity of the studied units and the similarity of the lithofacies observed in core and outcrop. Basically, the study revealed the following lithofacies: 1) clast-supported conglomerates; 2) pebbly-sandstones with deeply erosional bases and abundant sandstone and mudstone rip-up clasts; 3) massive to crudely graded, very coarse to medium sandstones; 4) parallel to low-angle laminated coarse to medium sandstones; 5) parallel to ripple-cross laminated fine to very fine sandstones; 6) medium to highly bioturbated mudstones. The stacking pattern of both exposed and drilled sections showed an overall thickening- and coarsening-upward trend defined by the predominance of facies 2) and 3) in the upper part of the succession. The occurrence in the studied strata of features such as erosional bases, normal grading and waning-flow current laminations clearly suggests that these sediments are the deposits of high-density and erosive sediment-gravity flows. Based on the occurrence of inverse to normal grading at the base of several sandstone beds, truncated low-angle laminae in the coarse and medium sandstones, combined-flow ripples divisions capping massive sandstone divisions, thick and amalgamated massive sandstone beds, and the lenticular geometry of several sandstone beds, we interpreted these deposits to represent the result of rapid deceleration, in a confined basin, of very

immature bipartite density currents (*sensu* Mutti *et al.*, 1999). Moreover, the occurrence of shell debris associated with locally pervasive bioturbation of both mudstone and sandstone facies, the common presence of coarse-grained deposits whose composition clearly points out a south Alpine derivation, and the overall stacking pattern of the studied successions suggests that these density currents were flowing in a relatively shallow marine environment (outer shelf to upper bathial on the basis of micropaleontological associations) and were directly derived from southward prograding fan-delta systems.

Wireline-log lithofacies analysis

The Miocene gas field occurs in a highly heterogeneous reservoir with abrupt lateral and vertical variations in permeability, therefore, the reservoir modelling required a fine-tuned lithologic characterization. In exploration and development, cores represent the only tool for subsurface lithologic characterization but usually cover only part of the reservoir section. As a result, comparison with wireline-logs recording the entire drilled section is of vital importance. Accordingly, a reconstruction of the lithology from the Gamma Ray, Spontaneous Potential and Electromagnetic Attenuation Transit Time curves of the ETP(EATT) was thus used to infer the lithologic characteristics of the drilled sections. Wireline-log-derived lithologic characteristics were then compared with those observed in cores for calibration purposes and to find out which of the electrical curves represented the most reliable lithology. Facies analysis of the cored interval was then performed on FMI and the analysis extended to the entire drilled section. The facies identification was made by using the Fas Tex processing, a Schlumberger-Agip module for dipmeter texture analysis that makes use of algorithms to create pseudo-dipmeter curves by means of data filtering, background conductivity and heterogeneity analysis. The pseudo-curves revealed the occurrence of: 1) clast- and matrix-supported conglomerates; 2) coarse and medium sandstones; 3) mudstones and interbedded mudstones and sandstones. The lithofacies obtained by Fas Tex were then compared with those observed in cores (Fig.1): based on the results a calibrated facies profile over the whole reservoir interval was thus obtained. (*e.g.*, Bertozzi G., 1999)

Conclusions

Based on the results of the detailed outcrop study and comparison of cores and wireline-logs, it appears that EATT is the most reliable tool to identify lithologic characteristics in the subsurface. Wells correlation by means of the EATT allowed the development of a consistent geological model used as input for reservoir modelling purposes. The Fas Tex processing provided a facies analysis of the whole drilled section. The obtained results along with the study on diagenesis suggested us to associate facies characteristics with porosity and permeability parameters, and thus a better understanding of the strong heterogeneity of the field were achieved.

Fig. 1 - Example of calibration of wireline-logs (conductivity and FMI) based on detailed core analysis.

References

- Bertozzi G., Marza Ph., Pons U. (1999) – *Facies analysis and porosity characterization integrating electrical images with core data*. Geoquest Forum 2000, Paris 1999.
- Mutti E., Tinterri R., Remacha E., Mavilla N., Angella S. and Fava L. (1999) – *An introduction to the Analysis of Ancient Turbidite Basins from and Outcrop Perspective*. A.A.P.G. Continuing Education Course Note Series no. 39, 61pp.
- Ricci Lucchi F. (1981) – *The Miocene Marnoso-arenacea turbidites, Romagna and Umbria Apennines*. In: F. Ricci Lucchi (ed.), Excursion Guidebook, I.A.S. 2nd European Regional Meeting, Bologna, 231-303.
-