SEISMIC IMAGING OF THE PROVENCE CONTINENTAL PLATE: OUTCROP-to-MARINE GEOPHYSICS

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ABSTRACT

This study provides a complete investigation of a key structural domain of the Provence continental plate situated between Gulf of Lion and Ligure continental margins. We can recognize the onshore structures in the offshore seismic, realize the continental plate cartography and attempt to reconstruct the evolution of the Cassidaigne submarine canyon since the Messinian salinity crisis.

INTRODUCTION

Though the Provence area has been intensely described by geologists since the end of the 19th century, few studies have focused on the offshore geology, especially the prolongation of the onshore structures [2], [3], [4]. To improve our knowledge of this key structural domain, situated between the Gulf of Lion and Ligure continental margins, it is critical to integrate data from onshore geology and offshore seismic.

DATA AND METHOD

One of the major assets of this study has been the acquisition since 2007 of high resolution offshore seismic lines (MAST5913 and CASSEIS campaigns, “miniGI” and “sparker”; Fig.1, 2, 3) and coring. We also integrated a large amount of published geological and geophysical data collected in the area [2], [4].

PREVIOUS WORK

Few studies focused on this key sector of the continental plate between Marseilles and Toulon. Pioneer works based on offshore seismics [4] described a folded and eroded NE-SW structure in the Planier area, West of Cassidaigne. By integrating cores data in the sector, Froget suggests a Paleogene age for the upper strata of the folds [3]. A metamorphic unit was described in the “Banc des Blauquières” area [2], East of Cassidaigne, in connection to the onshore Sicié cape. This author also interpreted to the North a NE-SW graben with Oligocene infillings.

RESULTS

In this study, we provide a more complete investigation of the domain by calibrating the offshore seismic images with the coastal outcrop structures. Eight types of seismo-facies have been qualitatively interpreted on the basis of stratigraphic and structural characteristics, heterogeneities of the formations and rock properties:

1. The base of Plio-Quaternary reflectors is erosive (Fig.3). The depositional sequence shows a submarine canyon-fill facies with oblique clinoforms prograding to the West [1].
2. The Urgonian formation is characterized by stratigraphic continuity, massive structure highly fractured and karstified. In the seismic profiles, the facies is chaotic, with no evidence of sedimentary strata, but a large heterogeneity due to the karstic and fractured facies (Fig.1 and 2).
3. The Aptian is a marly formation at the outcrop. The seismic profile shows parallel reflectors in conformity above and below, corresponding to the sedimentary strata (Fig.1 and 2).
4. Cenomanian formation presents at the outcrop an alternation of marls and limestones above the Aptian. The seismo-facies is alternatively chaotic and layered, with an angular unconformity at its base (Fig.2).
5. Turonian-Coniacian formations are conformably overlying the Cenomanian. The outcrop reveals strong lateral variation of rock types, from breccias to sandstones. Seismo-facies presents also a lateral variation with layered reflectors in concordance with the base, and more chaotic and discontinuous reflectors above.
6. The thrusted slices of the Bandol unit are showing a North-vergence structure in seismic with high amplitude reflectors limited by faults.
7. The detrital formation of the Permian is chaotic in seismo-facies and in continuity with its onshore unit.
8. The metamorphic unit is chaotic in seismic and its upper boundary is incised by the Messinian unconformity (Fig. 3).

Interpretation of seismo-facies combined with core data allows us to complete the continental plate

cartography. We also give evidences of the Cassidaigne palaeo-canyon which was different during the Messinian than the current canyon (Fig. 4). The palaeo-canyon is draped by the Plio-Quaternary prograding sequence and is E-W in direction. To the West, palaeo and current canyon are connected and are NE-SW in direction, with no more fillings.

CONCLUSION

The seismic imaging of the Provence continental plate and the integration between outcrop knowledge and seismo-facies allows a better understanding of this key structural domain. During the Messinian Salinity Crisis, the Canyon of Cassidaigne had an E-W direction in its upper part, and then a N-S direction in concordance with the current canyon. Direction of progradations in canyon filling evidences a flow from East to West during the Pliocene. Such results imply new considerations not only for the tectonic and stratigraphic framework but also for the geodynamic and hydrographic evolution of the transitional area between the Rhone margin of Gulf of Lion and the Ligure margin.

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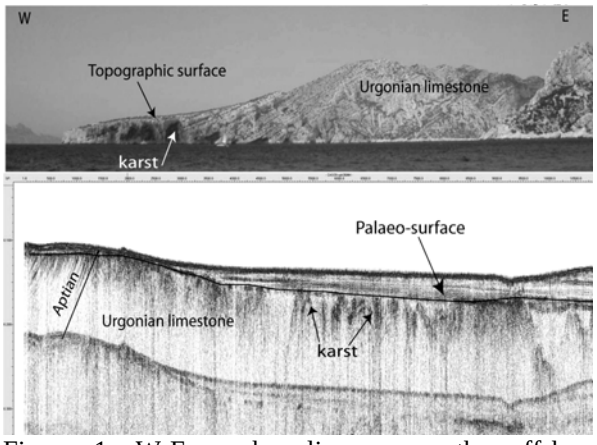

Figure 1: W-E sparker line across the offshore karstified Urgonian formation (bottom) and cape of Morgiou outcrop photography (top) showing the same morphology and structure.

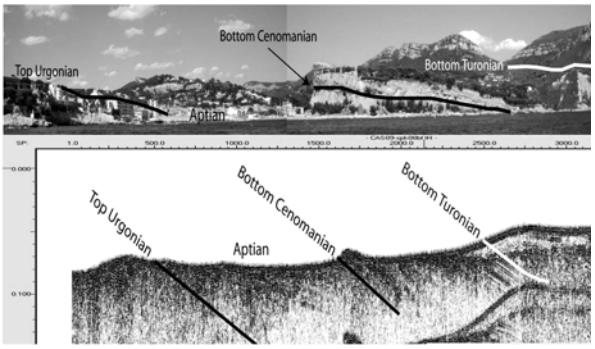

Figure 2: W-E sparker profile along the Cassis bay (bottom) and Cretaceous outcrops forming the Cassis shoreline.

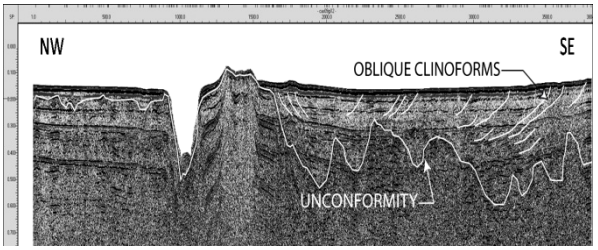

Figure 3: Progradation of a slope system filling the Messinian erosion.

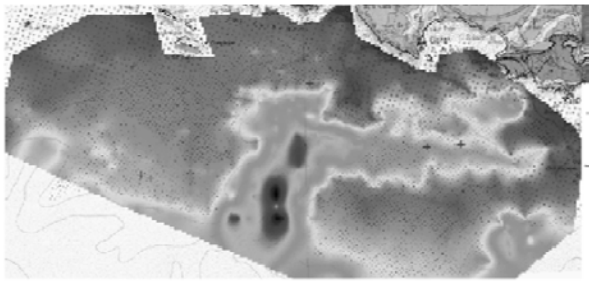

Figure 4: Map of the Messinian incision. The palaeo-canyon of Cassidaigne shows two perpendicular directions.

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