MESOZOIC STRATIGRAPHY OF THE JEANNE D'ARC BASIN

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FOREWORD

This file contains reproductions of the text and figures from a poster displayed at Forum '89, Geological Survey of Canada, Oil and Gas Activities in Canada. The forum was held at the Calgary Convention Centre, February 27-28, 1989.

Errata - Five of the depths shown on Figure 9 are incorrect: in Ben Nevis I-45 well, 2712 m should read 2755 m; in Hebron I-13 well, 1850 m and 4397 m should read 1860 m and 4423 m; in Hibernia K-18 well, 2278 m and 2255 m should read 2184 m and 2274 m.

INTRODUCTION

The Grand Banks of Newfoundland (Fig. 1) is a submerged promontory of continental crust at the eastern edge of North America. The climax of twenty years of petroleum exploration and research activity in this vast offshore area was the discovery of the giant Hibernia oil field in 1979. This discovery initiated a decade of intense petroleum exploration activity in the Jeanne d'Arc Basin (Fig. 2) that has resulted in many more oil discoveries.

The Grand Banks region is underlain by Paleozoic and Precambrian rocks of the Appalachian Orogen that were rifted, eroded and buried during Mesozoic and Cenozoic tectonic episodes related to formation of the North Atlantic Ocean and the Labrador Sea. The most prominent subsurface geologic features are a peneplain (the Avalon Unconformity) beneath relatively undisturbed Upper Cretaceous and Tertiary strata and a series of structured Mesozoic basins beneath this peneplain.

The Jeanne d'Arc Basin preserves the thickest (in excess of 22 kms), most complete and best known Mesozoic-Cenozoic stratigraphic record of the Grand Banks geologic history. Nevertheless, the lithostratigraphic nomenclature for this basin has not yet been standardized. This has led to a plethora of lithostratigraphies used by various industry groups, government agencies and academia (Fig. 3). Here we display details of a new lithostratigraphic framework for the Jeanne d'Arc Basin (McAlpine, in press).

METHODOLOGY

AN INTEGRATED APPROACH

The proposed lithostratigraphy is the product of an integrated approach to basin analysis. We have recognized several seismic sequences that can be correlated regionally; these seismic sequences have been combined with extensive litho- and biostratigraphic data bases compiled and developed from well data. This approach enabled the identification of six main depositional sequences that can be interpreted in terms of plate tectonic events associated with the sequential opening of the North Atlantic Ocean and the Labrador Sea. Detailed synthesis and correlation between the data bases has allowed the subdivision of each sequence within this gross framework into a number of distinctive and mappable rock stratigraphic units.

REGIONAL SEISMIC CORRELATION

Figures 4 and 5 are examples of regional seismic lines (line locations in Fig. 2). Compare the seismic sequences 1 through 6 with equivalent depositional sequences in figure 9.

LITHOSTRATIGRAPHIC CORRELATION

Figure 6 is constructed from some key wells and indicates the results of detailed correlation of borehole data using well logs (Gamma Ray and Acoustic) and lithologic data from well cuttings and rotary cores (well locations in figure 2).

DETAILED SEISMIC CORRELATION

Figure 7 is an example of the method we use to integrate well and seismic data. The synthetic seismograms are computer generated at AGC from digital acoustic log data. This method allows precise ties between lithologic boundaries that produce a seismic response and events observed at the well. In this example, seismic data processing parameters are such that a positive reflection coefficient, i.e. a downward increase in velocity, will produce a peak (black). The point of reflection is the centre of the wavelet.

BIOSTRATIGRAPHIC CORRELATION

Figure 8 shows the results of a very detailed biostratigraphic zonation of the Hibernia oil field; 14 zones and 34 subzones are indicated. This zonation is based on the study of spores, pollen and marine dinoflagellates. Lithostratigraphic units are shown to indicate some of the correlation crossovers that occur before all data bases are synthesized.

CONCLUSIONS

A new lithostratigraphic framework has been erected for the Jeanne d'Arc Basin. The proposed lithostratigraphy is summarized in figure 10; it is the product of an integrated approach to basin analysis. In figure 9, we display a time stratigraphic section constructed by an interpretive integration of our seismo-, litho-, and biostratigraphic data bases. This approach has enabled the identification of six depositional sequences that can be interpreted in terms of plate tectonic events associated with the sequential separation of Africa and Europe from the Grand Banks. Our regional work, offshore Newfoundland, indicates that these results may have widespread application for the other basins of the Grand Banks.

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