# Application of nannofossils (the missing piece of the puzzle) from offshore Newfoundland: Upgrading the regional stratigraphy via an integrated multidisciplinary approach

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The Atlantic margin of Canada has a long, >50-year history of oil and gas exploration that is comparable with the North Sea. The province of Newfoundland and Labrador, whose continental shelf covers more area than the North Sea, has had 529 wells drilled, five that have produced oilfields in the offshore Jeanne d'Arc Basin (Hibernia, Terra Nova, White Rose, North Amethyst, and Hebron). There also have been major discoveries further offshore in the deep-water Flemish Pass Basin that have not yet been developed (e.g., Bay du Nord). In Newfoundland, oil and gas production became a mainstay economic activity during the 1980s, effectively replacing cod fishing after the collapse of the Grand Banks fishery industry. This investment in drilling led to intensive biostratigraphic work, which focused on palynology and foraminifera. There was limited or no use of nannofossils, the study of which was in its relative infancy during the 1980s. In the prolific Jeanne d'Arc Basin, where attention was focused on strata dated to the Early Cretaceous and Late Jurassic, local lithostratigraphic schemes were age calibrated using palynology, which remained the go-to discipline until recently. Key wells were often reanalyzed several times for palynology and foraminifera to resolve anomalies, sometimes by the same contractor. Unfortunately, this resulted in many contradictory interpretations and a large volume of biostratigraphic "baggage" with some age interpretations possibly based on lithostratigraphy alone.

Around 2010, exploration extended into deeper waters, and there was increased emphasis on nannopaleontology. Nannofossils were utilized successfully at wellsites for real-time monitoring of deep-water exploration wells in the Laurentian Basin (Middle Jurassic to Middle Miocene) and Orphan Basin (Late Jurassic to Oligocene). Comparison of these new nannofossil data with historical biostratigraphic data (then publicly available) indicated that there was a substantial need for improving resolution and certainty in wells where nannofossils either had not been used or only a handful of samples were analyzed for nannofossils. This realization spawned a series of non-exclusive studies focusing on the frontier exploration basins where there was a need to maximize information gleaned from limited well penetrations. These studies covered the Orphan Basin (10 wells), Flemish Pass (16 wells), Carson Basin (9 wells), and Southern Flemish Pass into Jeanne d'Arc Basin (16 wells). Other key wells to the south of Newfoundland were examined for research and development. The main goal of these studies was to integrate palynology, micropaleontology, and nannopaleontology data to improve biostratigraphic resolution and its accuracy. New analyses were biased towards nannofossils, the missing piece of the puzzle. This integrated approach helped resolve many ambiguities and restore confidence in biostratigraphy, and it has been applied successfully during recent exploration campaigns.

Here I present a brief overview of available nannofossil data that show the variations in recovery/diversity through time and across the offshore basins, from the onset of normal marine conditions in the Early Jurassic (Pliensbachian) to the Miocene. Historically, the main exploration prospects were Late Jurassic or Early Cretaceous in age, but economic interest has widened to include the Paleogene. All presented information consists of non-proprietary data that were generated during PetroStrat's non-exclusive studies or in-house research.