Use of *DionisosFlow* for Reservoir Quality Prediction: Application to the Central Scotian Margin

SUMMARY REPORT

Submitted to:

Offshore Energy Research Association of Nova Scotia (OERA)

to fulfill the requirements of the Student Research Travel Program

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December 6, 2016

TABLE OF CONTENTS

INTRODUCTION

One of the major issues facing oil and gas companies interested in the Scotian Basin are the uncertainties involved in the exploration process. To counteract these uncertainties stratigraphic models are sometimes used, their predictive analysis allows for de-risking of exploration and may lead to the discovery of plays in previously unexplored areas. Beicip-Franlab is a multinational geoscience consulting firm and software company based in France which developed a modeling software with the intent of lessening these uncertainties. To achieve this, Beicip-Franlab has worked closely with IFP Energies Nouvelles to produce *DionisosFlow*, a forward stratigraphic 4D modeling software capable of recreating the formation of geological units over time. This travel is a unique opportunity to receive hands on training using *DionisosFlow* software from experienced oil and gas industry consultants and software developers at their headquarters in Rueil-Malmaison, Paris, France.

TRIP DETAILS & BACKGROUND INFORMATION

The trip took place over the months of July and August, and is the first of two visits to the Beicip-Franlab headquarters. During my time in Paris I stayed at an offsite residence provided by Beicip-Franlab, located a short distance from their offices. The majority of my time at Beicip-Franlab was spent working with Dr. Nicolas Hawie, a member of my supervisor committee as well as an expert in the use of *DionisosFlow*. Over the course of two months I was instructed in the proper operation of the software as well as well as how to use the model to achieve the most accurate results. As part of my research I took part in bi-weekly meetings with members of my committee as well as monthly intern meetings, in which all the interns and students at Beicip-Franlab would present the work which they had accomplished since the previous meeting, as well as plans for upcoming projects. These meetings served to keep the members of my supervisor committee aware of my progress as well as to prepare me for the regular progress meetings, which are common place in the professional community.

The modeling software which I am using for my project is *DionisosFlow*, a deterministic 4D multi-lithology forward stratigraphic modeling software which simulates basin infilling over geological time scales. It uses a sediment diffusion principle in which particles with differing diffusion coefficients (which are affected by grain properties such as grain size and density) are tracked during the evolution of the basin.

The generation of predictive models requires knowledge about the history of the basin and its associated hinterland, particularly tectonic evolution and changes in the source rivers of the basin. *DionisosFlow* uses information about sediment sources, including the size of sediment supplying rivers, the sediment loads of these rivers as they reach our study area, the grainsize proportions in these sediments, and the tectonic evolution of the basin to generate stratigraphic models. Existing knowledge of inferred drainage basins and paleoclimates have been used to propose realistic sediment inputs from rivers into the Scotian Basin. These inputs are then calibrated against depositional formation thickness within the *DionisosFlow* model. The final results will be compared to available data from known reservoir sandstones to determine the most important factors in their

formation (e.g. source, mineralogy, paleoclimate, etc.). This will allow us to infer the locations of potential reservoir sandstones by looking for the identified factors elsewhere in the basin.

BENEFITS OF TRAVEL

Basin modeling is a complex and involved process which requires the integration of multiple disciplines as well as knowledge regarding the operation and limitations the modeling software. In order to produce accurate models, training by an expert is a necessity.

Beicip-Franlab has an abundance of trained and dedicated multidisciplinary geoscientists who specialize in software related to basin modeling and petroleum exploration. Beicip-Franlab is also affiliated with IFP Energies Nouvelles, an independent research and development center in the oil and gas sector, responsible for the development of the *DionisosFlow* modeling software. This along with years of experience in a wide variety of basins and plays types, promotes the refinement of models and methodologies employed by the company and keeps them on the cutting edge of geological modeling software. As a result, Beicip-Franlab is the ideal candidate for provide training in the use of their modeling software.

Travel to Beicip-Franlab headquaters will allow for hands on training by professionals with a high level of experience using *DionisosFlow* at a commercial level. This trip will be considered an internship by Beicip-Franlab, and as such has given me an opportunity to experience a professional environment in a foreign country and acquire marketable skills from industry professionals.

OUTCOMES OF TRAVEL

Over the course of the two months that I spent at Beicip-Franlab two major objectives of the project were accomplished:

1. Completion of training in the use of *DionisosFlow*, which will allow me to continue modeling over the coming months in Halifax.

2. A reference case model for the study interval was produced. This is an initial, simplified version of the final model designed for simple calibrations using existing well data. Despite the basic state of this model it captures the general tendencies displayed in the reference wells and previous interpretations of structures in the basin such as the distribution of turbidite deposits, salt diapires, and sand rich intervals. This model will be improved upon over the coming months as more research is conducted to better refine the calibration parameters.

Having completed these initial objectives the next steps of the project can be planned, areas which require additional data were identified as well as deciding what other parameters can be included in the model. The work conducted over the summer will be the foundation for the remainder of the project, with this stage completed we are in a position to guide the project towards a predictive and detailed 4D model of the Central Scotian Basin.

SIGNIFICANCE TO NOVA SCOTIA

This project will add to our understanding of the formation and distribution of reservoir sandstones in the Scotian Basin. The production of a 4D stratigraphic model will contribute to the Nova Scotia energy sector directly by reducing the risks associated with reservoir quality and exploration in offshore sandstone reservoirs. OERA Geoscience Research Priorities considers "Reservoir Quality" to be its third ranked priority, with particular emphasis on the Sable and North Eastern regions of the Scotian Basin, which are contained within our study area. There is limited experience with reservoir quality in these deep-water wells, and as a result of this lack of experience the predictive modeling approach employed by this project will be an invaluable technique to reduce risks during exploration in the Scotian Basin.

ACKNOWLEDGEMENTS

I would like to thank my supervisors here in Canada, Dr. Georgia Pe-Piper and Dr. David Piper, for giving me this amazing opportunity to grow as a researcher and a human being. Without them I would not have been able to have this opportunity. I would also like to thank the team at Beicip-Franlab for everything that they did for me during my time there, they were welcoming and helpful, and they really made me feel like part of the team there. In particular I would like to thank Dr. Nicolas Hawie for the countless hours that we spent working on this model, and for teaching me everything that I know about *DionisosFlow*. I would also like to thank Dr. Francky Saint-Ange for all of his help with the geology, interpretation, and everything to do with presentation preparations. I could not have done this without the help of everyone involved. Finally, thanks to OERA for funding my trip to Paris, without them I would not have been able to take part in this trip.