PISTON CORE GEOCHEMISTRY FINAL REPORT

Martin Fowler

APT (Canada) Ltd.

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Executive Summary

The data from the analysis of piston cores and slick samples taken during the 2016 CCGS Hudson offshore Nova Scotia cruise has been interpreted and is provided in the accompanying document that also includes all the project data (previously supplied to OERA) for completeness.

Nova Scotia Department of Energy organized a follow-up piston coring cruise to that which took place in 2015. This occurred June-July 2016, once again using the CCGS Hudson. The equipment malfunctions that plagued the 2015 cruise did not occur in 2016. Hence, the sites previously rated most highly for the occurrence of possible seeps could be sampled this year. Additionally, sites where the 2015 results showed the best evidence for petrogenic hydrocarbons were revisited in 2016. Samples were collected from forty five locations. In addition, four possible oil slick samples were taken during the cruise. A notable observation of the cruise was the occurrence of gas hydrates at three locations.

Site 41, one of the locations where gas hydrates was observed, showed the best evidence to date from the offshore Nova Scotia piston coring program for petrogenic hydrocarbons. The headspace gas from this location has compositional and isotopic characteristics of oil associated gas and extracts have indications of a component of thermogenic hydrocarbons.

The gas at sites 48 and 49, the other two gas hydrate sites, has a biogenic origin. Extracts from these sites show no evidence of a petrogenic origin. However, a slick sample taken during coring at site 49 shows geochemical characteristics suggesting it could be weathered petroleum. Hence there may be a seep in the vicinity of this site.

The analysis of the 2015 site 9 2.00-2.06 m duplicate sample provided some similar and some different results compared to the original 2015 analysis. It did not confirm or disprove the possibility that this core has petrogenic hydrocarbons, as suggested in the 2015 Piston Coring Report. One of the two piston cores obtained in 2016 near 2015 site 9 shows no indications of thermogenic hydrocarbons (site 18). The other location (site 21) shows some similarities to 2015 site 9, with indications of having a component of thermogenic hydrocarbons.

There was no evidence of thermogenic gas at site 32 but all the extracts of sediments from this site have geochemical characteristics that suggest they contain thermogenic hydrocarbons, supporting the possibility of an oil seep at this location.

A headspace gas sample with very dry gas that had a $\delta^{13}C$ methane value suggesting a minor thermogenic component was obtained at site 4. An extract from this site showed no evidence of petrogenic hydrocarbons. Hence, there is the possibility of a gas seep in the area of this site.

Several other sites showed elevated amounts of light hydrocarbons in extracts but no supporting evidence for the presence of petrogenic hydrocarbons and therefore it is doubtful that they are associated with seeps.

Overall, there is good evidence for a working petroleum system in the deep water Scotian Slope, offshore Nova Scotia. The source and nature of the source rock for the petrogenic hydrocarbons present in this area cannot be determined at this time. Saturate and aromatic fraction carbon isotopes imply a source rock older than that for the Scotia Shelf light oils/condensates. However, there is some doubt concerning whether the isotopes are actually indicating the age of the source rock of the petrogenic hydrocarbons, so this is not a definitive conclusion at this time.

Project Introduction and Objectives

The project was a follow-up to that done for the 2015 Nova Scotia Department of Energy Piston Coring Cruise. In 2015 shipboard problems prevented coring of most of the deeper water sites where there was thought to be the best chances of encountering petroleum seeps. In 2016, it was hoped to sample these sites. Geochemical analyses were to be made on piston core samples collected from offshore Nova Scotia to determine if thermogenic hydrocarbons occur on the deep water Scotian Shelf, and in particular, if these hydrocarbons have a Jurassic oil-prone source rock. If possible, the piston core samples were to be supplemented by analyses of surface oil slick samples. The presence of thermogenic hydrocarbons from an oil-prone Jurassic source rock, will offer a huge encouragement to exploration of the deep water portion of the Nova Scotia offshore by lowering one of the largest perceived risks to the presence of economic accumulations of oil in this area.

Project Deliverables

The accompanying report entitled ‘Geochemistry Data Report for 2016 Scotian Slope Piston Coring Program’ contains all the geochemical data obtained from the analysis of piston core headspace gas samples and sediment samples, the AGI report from their analyses on the slick samples and an interpretation of all this data.

Conclusions

The 2016 piston core cruise has produced evidence that indicates the presence of thermogenic hydrocarbons in the deep water Scotian Shelf, thus implying there is working petroleum system in this area. The data does not allow a clear-cut understanding of the nature and age of the

source rock of the thermogenic hydrocarbons. There are some indications from some sites that it could be an oil-prone source that is older than that responsible for the Scotian Shelf light oils/condensates, but this is extremely tentative based on current data.

Recommendations

An inherent nature of piston core geochemical data is that often it is hard to come to a definitive conclusion on the presence of petrogenic hydrocarbons representing petroleum seepage. In the 2015 and 2016 offshore Nova Scotia piston core geochemical data, while there are sites where there it can be said confidently that there is petroleum seepage based on geochemical evidence alone, there are also a number of locations where there are varying degrees of uncertainty using just geochemical evidence to conclude that there is a presence of petrogenic hydrocarbons. Some of this uncertainty would be remove by an ancillary method that also provides indications on the presence of seeps. There would obviously be more confidence if both methods agreed that petroleum seepage was occurring. This was the intention of the microbial work being done at the University of Calgary on the offshore Nova Scotia piston cores. Now that APT and the University of Calgary have data, it is recommended that the two data sets be compared to see if they agree which sites have seeps and, if combined, they provide support for each other for sites where it is hard to come to a definitive conclusion on the presence or absence of a seep based just on one of the methods.

If future piston core cruises are contemplated, and there is sufficient budget, then a Remote Operated Underwater Vehicle (ROV) is recommended. This would allow better visual confirmation of seeps at the sea floor and allow for possible direct sampling.