

TECHNICAL REVIEWERS' RATING SUMMARY

G015-B

Surface Microseismic Study of a Bakken Simultaneous Fracture Stimulation

Submitted by Marathon Oil Company

Principal Investigators: Ken Dunek, Chuck Meeder, Reagan Daniels, David Brimberry

Request for \$207,550; Total Project Costs \$415,100

Rating <u>Category</u>	Weighting <u>Factor</u>	Technical Reviewer		Average Weighted <u>Score</u>
		<u>15B-01</u>	<u>15B-02</u>	
		Rating		
Objective	9	3	4	31.5
Availability	9	4	3	31.5
Methodology	7	3	4	24.5
Contribution	7	3	5	28.0
Awareness	5	4	3	17.5
Background	5	4	4	20.0
Project Management	2	3	4	7.0
Equipment Purchase	2	5	5	10.0
Facilities	2	3	4	7.0
Budget	2	3	5	8.0
Average Weighted Score		173	197	185.0
Maximum Weighted Score				250
<u>OVERALL RECOMMENDATION</u>				
FUND		X	X	
<u>FUNDING TO BE CONSIDERED</u>				
DO NOT FUND				

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1. The objectives or goals of the proposed project with respect to clarity and consistency with North Dakota Industrial Commission/Oil and Gas Research Council goals are: 1 – very unclear; 2 – unclear; 3 – clear; 4 – very clear; or 5 – exceptionally clear.

Reviewer 015B-01 (Rating: 3)

The goal of attempting a treatment method that has found some support and success in the Barnett Shale as a fracture stimulation technique is clearly stated. What is less clear is why this method of stimulation should work in the Bakken. The proposal states that evidence of both transverse and longitudinal fractures and isotopic stress distribution exists for both formations.

Numerous micro-seismic and tilt-meter monitored treatments have been performed in the Barnett that support this position. The same cannot be said for the Bakken formation. While the previously mentioned similarities may be true, there are also significant differences in lithology, pore pressure, horizontal stress magnitude, reservoir thickness, etc., that will impact a fracturing treatment in the Bakken.

The fracturing treatment will be performed regardless of the funding for the surface micro-seismic according to the proposal. As such, the surface micro-seismic monitoring is an opportunity to both determine if the simultaneous fracturing process is effective in the Bakken and at the same time acquire additional fracture geometry data useful regardless of the fracture stimulation technique.

Reviewer 015B-02 (Rating: 4)

The objective of the proposal is clear and consistent with NDIC Oil and Gas Research Council. However, the project could benefit from considering other objectives such as studying natural fracture system response to stimulation.

2. With the approach suggested and time and budget available, the objectives are: 1 – not achievable; 2 – possibly achievable; 3 – likely achievable; 4 – most likely achievable; or 5 – certainly achievable.

Reviewer 015B-01 (Rating: 4)

The operator has already performed surface micro-seismic monitoring in North Dakota on a Bakken horizontal well. A proposal to perform a second fracturing treatment monitored by the same technology indicates a prior knowledge of the potentially successful acquisition of useful data. It is unfortunate the results of the previous surface micro-seismic monitoring project are not yet available for public review.

Reviewer 015B-02 (Rating: 3)

The proposed stimulation design seems to be promising and validation of its efficiency is certainly desirable. However, some concerns were addressed in literature regarding using surface microseismic data. Thus, the project would benefit from including justification of applicability of this technique to the proposed study.

3. The quality of the methodology displayed in the proposal is: 1 – well below average; 2 – below average; 3 – average; 4 – above average; or 5 – well above average.

Reviewer 015B-01 (Rating: 3)

The operator is using existing fracturing techniques from the Barnett shale of northeast Texas as a model for a similar stimulation attempt in the Bakken formation of North Dakota. As stated before, there may be a few similarities between the formations associated with the two unconventional resource plays, but there are likely far more differences, some significant. Some uncertainty is likely even within the assumed common traits of the Barnett and Bakken like the presence of both transverse and longitudinal fractures and an isotropic stress distribution. The results of the proposed micro-seismic monitoring will actually be needed to determine if they are factual in part or whole. Some of these obvious differences between the two formations are likely to impact the proposed fracturing techniques and the induced fracturing field like the pay thickness, pore pressure and fracture pressure contrasts, and lithology changes.

Reviewer 015B-02 (Rating: 4)

As was mentioned before stimulation design looks very promising, but some concerns regarding the monitoring technique exist.

4. The scientific and/or technical contribution of the proposed work to specifically address North Dakota Industrial Commission/Oil and Gas Research Council goals will likely be: 1 – extremely small; 2 – small; 3 – significant; 4 – very significant; or 5 – extremely significant.

Reviewer 015B-01 (Rating: 3)

The contribution of this proposal to the knowledge of fracture geometry in the Bakken formation of North Dakota should be substantial if successful. While the proof of simultaneous fracturing as a useful technique in Bakken stimulation may not be a result of this experiment, it is likely the basic fracturing geometry data, particularly fracture orientation and lateral coverage will be more universally applicable. However, in that arena, the results of this surface micro-seismic monitoring operation may be upstaged by the previous application results.

A downside of surface micro-seismic monitoring is a lower sensitivity to the vertical fracture geometry. This opens up the possibility that micro-seismic events appearing as adjacent to the horizontal laterals may actually be occurring in other formations above or below the deep and relatively thin Bakken formation. This lack of vertical resolution is less problematic when the surface micro-seismic monitoring technique is applied to the shallower and more massive Barnett shale formation.

Reviewer 015B-02 (Rating: 5)

The project intends to assess efficiency of the stimulation design which was not utilized in Bakken Development in ND yet. If proven to be efficient the technique can be applied in other locations, which would benefit oil field operators and the State of North Dakota.

5. The principal investigator's awareness of current research activity and published literature as evidenced by literature referenced and its interpretation and by the reference to unpublished research related to the proposal is: 1 – very limited; 2 – limited; 3 – adequate; 4 – better than average; or 5 – exceptional.

Reviewer 015B-01 (Rating: 4)

There is a limited amount of technical data available regarding both surface micro-seismic monitoring and simultaneous fracturing. Most data on the micro-seismic technology is vendor related although the proposal does contain an SPE paper on the subject. Simultaneous fracturing is a sufficiently recent technology application and most new publications on the subject have just been presented in recent meetings or the treatment results are still confidential.

Reviewer 015B-02 (Rating: 3)

It is indicated in the proposal that Marathon and the PI have experiences both with microseismic monitoring and with operating Bakken Formation reservoirs. More expertise in microseismic data utilization is desirable.

6. The background of the investigator(s) as related to the proposed work is: 1 – very limited; 2 – limited; 3 – adequate; 4 – better than average; or 5 – exceptional.

Reviewer 015B-01 (Rating: 4)

Resume details on the primary project leaders indicate a satisfactory to above average understanding of the Bakken formation, fracturing, and micro-seismic monitoring technologies.

Reviewer 015B-02 (Rating: 4)

It is indicated in the proposal that Marathon and the PI have experiences both with microseismic monitoring and with operating Bakken Formation reservoirs. More expertise in microseismic data utilization is desirable.

7. The project management plan, including a well-defined milestone chart, schedule, financial plan, and plan for communications among the investigators and subcontractors, if any, is: 1 – very inadequate; 2 – inadequate; 3 – adequate; 4 – very good; or 5 – exceptionally good.

Reviewer 015B-01 (Rating: 3)

The proposal contains a fairly complete list of critical milestones and timetable for completion. The time allotments seem reasonable based on current drilling and completion technology and service and product availability. No obvious communication issues are addressed in the proposal. The fracturing process involving two simultaneous fracturing operations is likely to be the most intensive part of the project. The operator and micro-seismic monitoring communication will likely benefit from their prior experience and association.

The cost estimate provided for the surface micro-seismic service indicates a very large portion of the cost is allocated to the mobilization and demobilization of equipment.

Reviewer 015B-02 (Rating: 4)

The project management plan is well thought over and seems to be reasonable.

8. The proposed purchase of equipment is: 1 – extremely poorly justified; 2 – poorly justified; 3 – justified; 4 – well justified; or 5 – extremely well justified. (Circle 5 if no equipment is to be purchased.)

Reviewer 015B-01 (Rating: 5)

No equipment purchase is necessary.

Reviewer 015B-02 (Rating: 5)

No equipment to be purchased.

9. The facilities and equipment available and to be purchased for the proposed research are: 1 – very inadequate; 2 – inadequate; 3 – adequate; 4 – notably good; or 5 – exceptionally good.

Reviewer 015B-01 (Rating: 3)

It is apparent from the cost estimate included in the proposal that this service is currently not readily available in or near North Dakota or is in high demand. While the proposed equipment mobilization and demobilization, installation, acquisition, and analysis of the data appears normal, the cost seems quite high, particularly the mobilization and demobilization charges. It would seem that a fracture monitoring technology that costs as much as some fracturing treatments would have limited long-term marketability to the majority of North Dakota operators. On the other hand, it is much less expensive than drilling a dedicated observation well or perhaps several.

Reviewer 015B-02 (Rating: 4)

Geophones installed on the surface can register noises what will decrease the efficiency of monitoring.

10. The proposed budget “value”¹ relative to the outlined work and the financial commitment from other sources is of: 1 – very low value; 2 – low value; 3 – average value; 4 – high value; or 5 – very high value. (See below)

Reviewer 015B-01 (Rating: 3)

The cost of the acquired data versus the value of the data if acquired in a research facility is not comparable. This type of experiment cannot be performed in any laboratory other than the real world of two working horizontal wells undergoing simultaneous hydraulic fracturing. The result of the experiment in terms of general fracturing geometry and lateral coverage will be useful and quite valuable to other operators once the data becomes public. The simultaneous fracturing technique results will also be useful to some operators depending on their development plans.

The value of the surface micro-seismic data would be greater if this data could be made available at the same time as the equivalent data from the operator’s prior monitoring experiment. Confirmation of results by both treatments would greatly increase the confidence in this and the prior data for other operators.

Reviewer 015B-02 (Rating: 5)

The majority of the costs involved in the project completion is paid by Marathon. The grant is required only for more thorough validation of the design efficiency, what seem to benefit not only Marathon but the state of North Dakota.

Section C. Overall Comments and Recommendations:

Please comment in a general way about the merits and flaws of the proposed project and make a recommendation whether or not to fund.

Reviewer 015B-01 (FUND)

The proposal is generally sound and worthwhile to fund. As previously mentioned, the value of the surface micro-seismic data related to fracture geometry and horizontal lateral coverage would be more valuable if the results of this experiment could be simultaneously released with their prior surface micro-seismic monitoring. A true experiment result must be verified by repetition before the results can become fact.

Reviewer 015B-02 (FUND)

The proposed approach to stimulation is very interesting and is successfully utilized in Barnett Shale, TX. Similarities in geological settings and stress regime allow for suggestion that the application of the approach to Bakken Shale will be successful. Validation of the stimulation design efficiency is certainly desirable. Thus, I recommend to fund the project.

¹ “Value” – The value of the projected work and technical outcome for the budgeted amount of the project, based on your estimate of what the work might cost in research settings with which you are familiar.

Financial commitment from other sources – A minimum of 50% of the total project must come from other sources to meet the program guidelines. Support less than 50% from Industrial Commission sources should be evaluated as favorable to the application.