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Alberto A. Gutiérrez, C.P.G.

May 3, 2019

Phillip Goetze
Engineering Bureau – Oil Conservation Division
New Mexico Energy, Minerals and Natural Resources Dept.
1220 South St. Francis Drive
Santa Fe, NM 87505

RE: NMOCC CASE #20409 – INDUCED SEISMICITY RISK ASSESSMENT FOR PROPOSED 3 BEAR FIELD SERVICES AGI WELLS

Dear Mr. Goetze,

Pursuant to the request made at our meeting on April 4, 2019, Geolex, Inc. has conducted an Induced-Seismicity Risk Assessment covering the general area of the proposed 3Bear Field Services acid gas injection wells in Section 26, T20S, R34E (NMOCC Case #20409). We would like to meet with you next week to go over these reports well in advance of the June 6, 2019 hearing date.

Enclosed you will find two reports, prepared by Geolex, that comprise this risk assessment. The first report present the results and interpretations of Geolex's review of licensed seismic surveys covering the area of the proposed 3Bear wells. Additionally, the second report evaluates the potential for induced seismicity within the area utilizing the Stanford Center for Induced and Triggered Seismicity's Fault Slip Potential model.

Should any additional information be required, or if any questions arise, please contact me or call our office at (505) 842-8000.

Sincerely,
Geolex, Inc.

Alberto A. Gutierrez, RG
President
Consultant to 3Bear Field Services

Enclosures:	Geolex Review of seismic surveys licensed to Chisholm Energy Holdings, LLC 3Bear Field Services – Fault Slip Probability Assessment	
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SEISMIC SURVEY REVIEW

CONDUCTED BY GEOLEX, INC.

Application of 3Bear Field Services, LLC
Case No. 20409
Seismic Survey Review
EXHIBIT #5

EVALUATION OF SEISMIC-EXPRESSED STRUCTURAL FEATURES IN THE SILURO-DEVONIAN SECTION AT THE LIBBY BERRY AGI WELL LOCATION AND VICINITY

Twp. 20S - Rge. 34E, Lea County, NM

Prepared for:

3 Bear Field Services
Denver, Colorado

and

NMOCD
Santa Fe, NM

Prepared by:

Geolex, Inc.
Albuquerque, NM

NMOCC CASE #20409

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SUMMARY OF EVALUATION GOALS AND METHODOLOGY

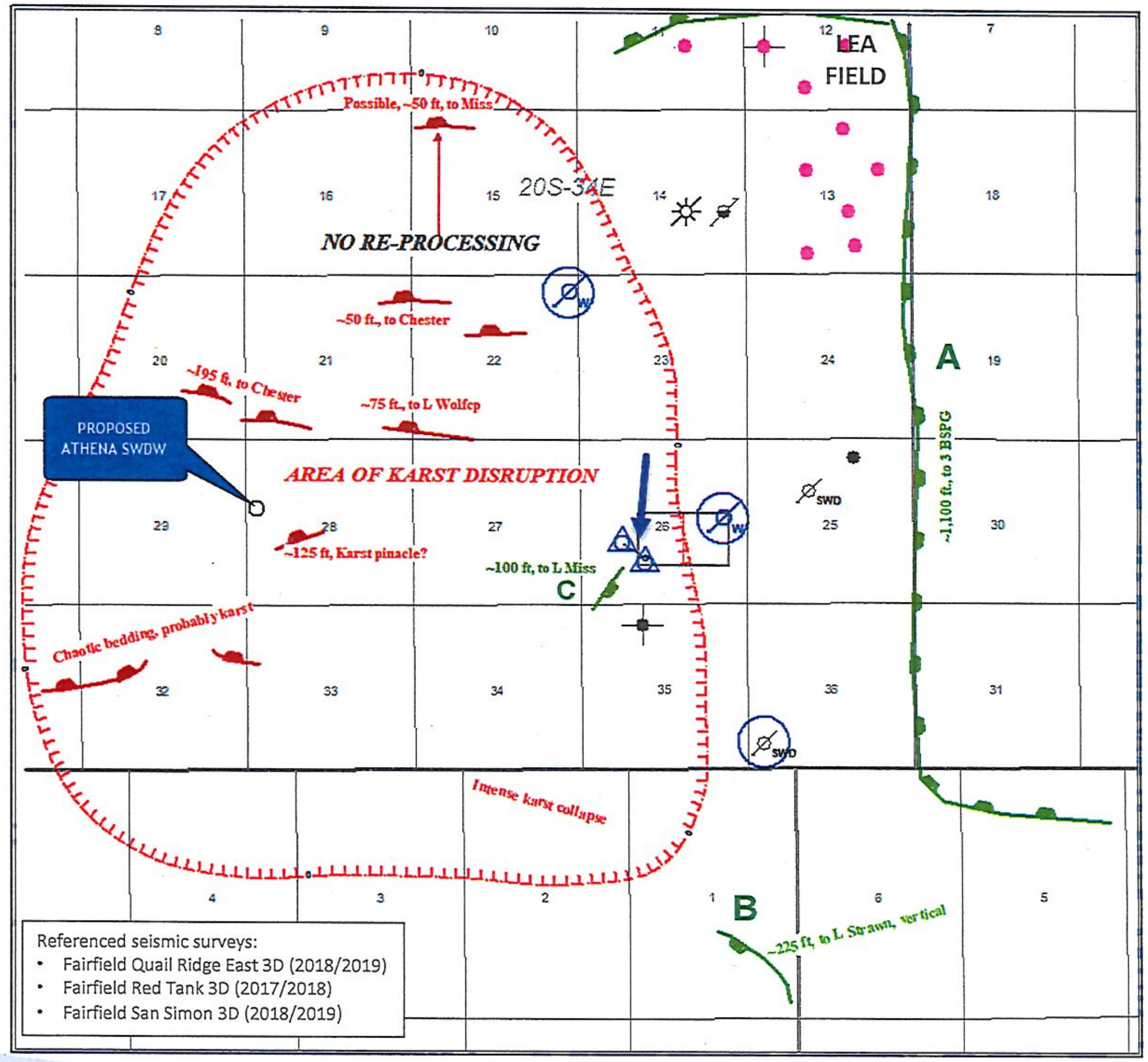
1. 3 Bear and Geolex identified three seismic surveys which cover the study area and are licensed to Chisholm Energy Holdings, LLC (Chisholm). We contacted Steve Poe (chief geophysicist) at Chisholm and were able to arrange to view and analyze the seismic data in their offices in Ft. Worth, TX on April 25, 2019.
2. Lou Mazzullo and David White of Geolex reviewed and analyzed the seismic with Steve Poe of Chisholm and developed this seismic analysis in conjunction with Alberto Gutierrez and James Hunter of Geolex.
3. The separate seismic surveys were reviewed and stacked and numerous cross sections and time slices over the area were constructed to identify and map key structural features.
4. The nature and extent of confirmed and possible faults as well as other structural features (such as Karst collapse features) were identified and evaluated throughout the entire study area.
5. Maps of the features were constructed and displacement (if measurable) was outlined from the seismic analysis as further described in subsequent slides.
6. Seismic interpretation results are presented herein using data evaluated from Chisholm integrated with previous geologic analyses presented by Geolex in 3 Bear's pending AGI wells application (NMOCC Case #20409).
7. The results from this analysis will be incorporated into the induced seismic evaluation and Fault Slip Potential (FSP) modeling which Geolex is developing to address NMOCD concerns with the application.

MAP AND ANALYSIS OF STRUCTURAL FEATURES IDENTIFIED FROM THE CHISHOLM 3D SEISMIC SET

Operating salt water disposal wells (SWDW) completed in the Siluro-Devonian are circled in blue, which include the two Libby Berry SWDWs operated by 3Bear (blue well symbols). The SWDW in section 25 is completed in the Yeso. The location of the proposed Libby Berry AGI well pair is shown by the blue arrow.

Observed faults are shown in green. Only two faults could be traced to the basement (labeled A and B)., The fault closest to the proposed AGI well pair (labeled C), has much less displacement and does not reach the basement. Breaks colored red are localized karst features, which are breaks in strata caused by karst collapse.

Each break is annotated with the approximate "throw" as determined from seismic travel times, and how far up-section it penetrated or influenced overlying strata. In the case of the karst-induced breaks, these annotations refer to how much collapse has occurred within the Devonian section, and how far up-section compaction and subsidence over the breaks has occurred. The area included within the hachured red outline shows a lot of karst-cave development and solution collapse features which are responsible for the stratal breaks observed on the 3D data, but no larger-scale, extensive faults like we see around Lea Field and to its south. All the stratal breaks within this area are oriented east-west, and none extend more than ¼ to ½ mile long, which is not typical of tectonic-induced faulting in this area. The green break closest to the AGI well locations is also likely karst-related but has been shown as a possible fault. (CONTINUED ON NEXT SLIDE)



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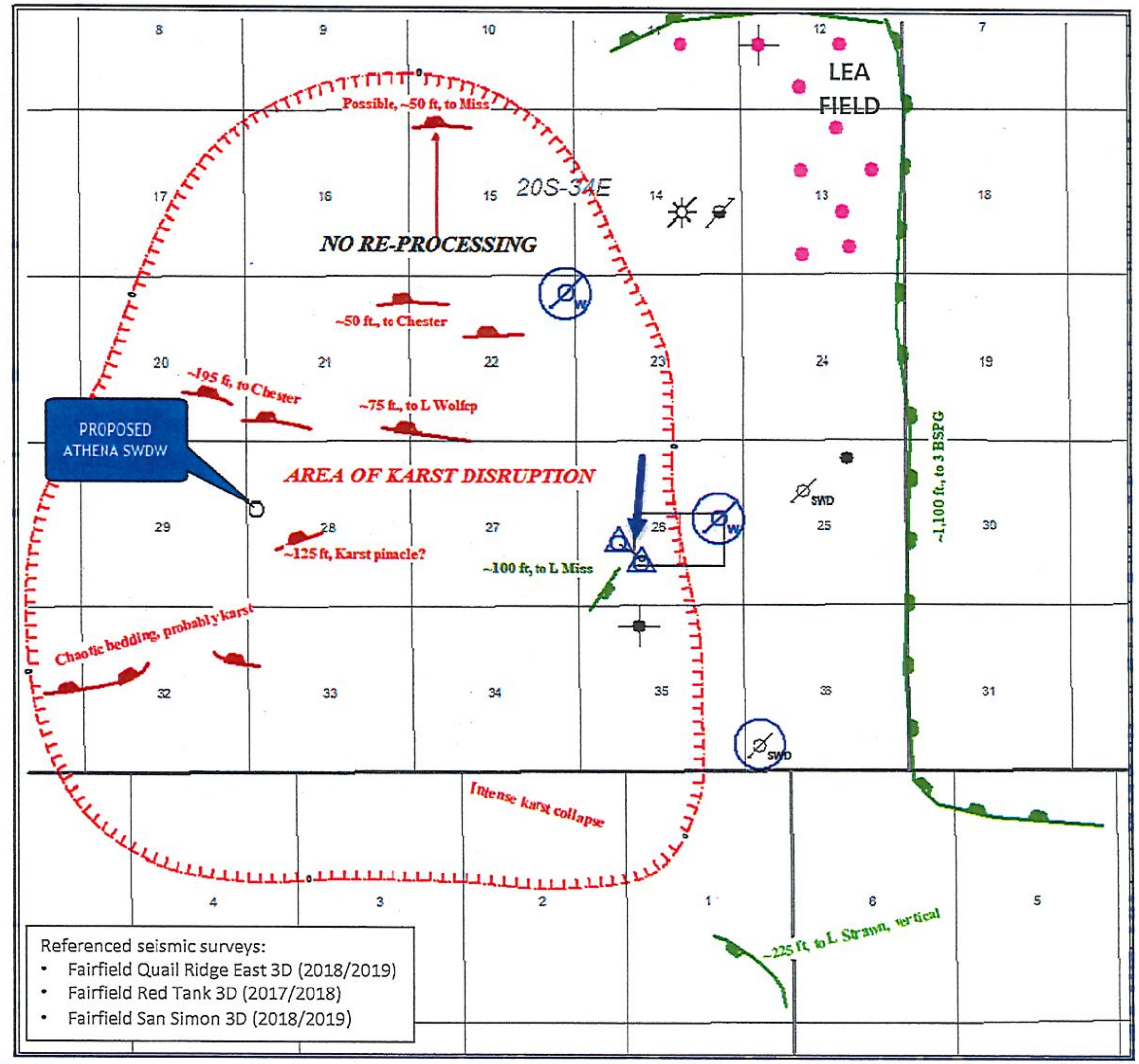
(CONTINUED FROM PREVIOUS SLIDE) Geolex reviewed the seismic data at Chisholm's office in Fort Worth with Steve Poe, their Chief Geophysicist. The data are actually composed of three separate 3D surveys which have yet to be merged, so data quality was variable across the 3 surveys. Re-processing of the original pre-stack data has only been done on one survey, the one which covers the area of the three existing SWDWs. Pre-stack data is fraught with noise, some of which can account for apparent breaks in strata.

Karsting is evident on the re-processed seismic survey, and is pervasive and locally intense, including several identified karst towers. Karsting is known to occur in the Devonian and Silurian section, especially in this part of the Permian Basin. These smaller apparent "fault scarps" are actually localized collapse features. In contrast, major and minor faults in this part of the Permian Basin have more continuity and map extent significantly longer than these observed short segments.

There are only two fault segments that *may be* considered capable of large-enough vertical movement to create induced seismic activity; these are the high-displacement fault (~1,100 foot throw) that frames the Lea Field and trends southward, and a fault with 225 feet of displacement into the basal Strawn (blue arrow) that is a mile south of the Okeanos SWDW in section 36. Lou Mazzullo has done prior coring of the larger fault in the vicinity of the Lea Field in the 1980s. These cores revealed that the fault was sealed by secondary calcite during later-stage diagenesis. The small feature near the proposed AGI well sites is included in the model, but is not considered a true fault but rather a Karst collapse feature.



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SEISMIC DATA ANALOG FOR KARST FEATURES IN THE STUDY AREA FOUND IN SIMILAR ROCKS IN THE DEVONIAN FROM THE WILLISTON BASIN

Illustration of seismic expression of karst disturbances (in this case, localized collapse) from the Devonian of the Williston Basin of Canada. Karstification on this section is not as intense as we observed on the Chisholm 3D, i.e., this is a young karst landscape versus a much more mature karst in Lea County. Note that two small collapse features, each no wider than about ¼ mile, die out well above the base of the Devonian carbonates. The vertical extent of overlying bed subsidence varies from one feature to the other, much like we see in the Lea County surveys.

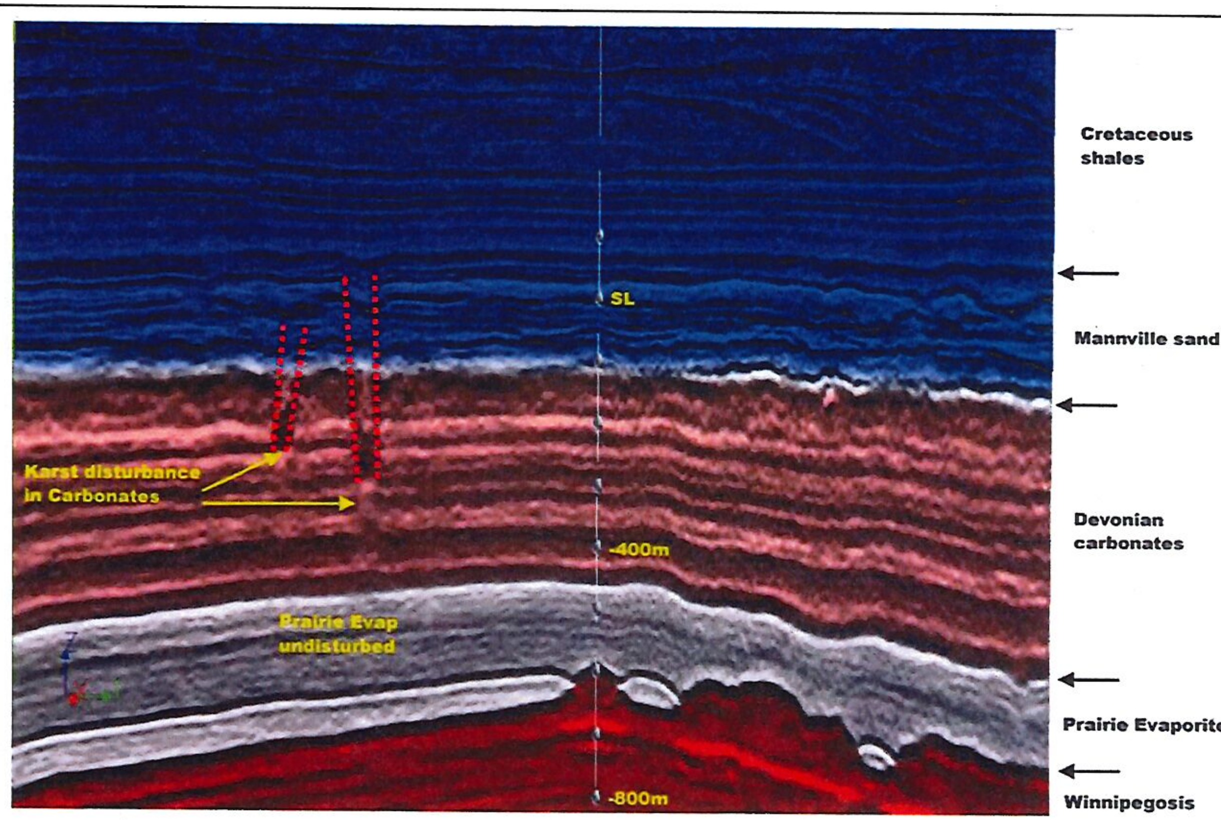
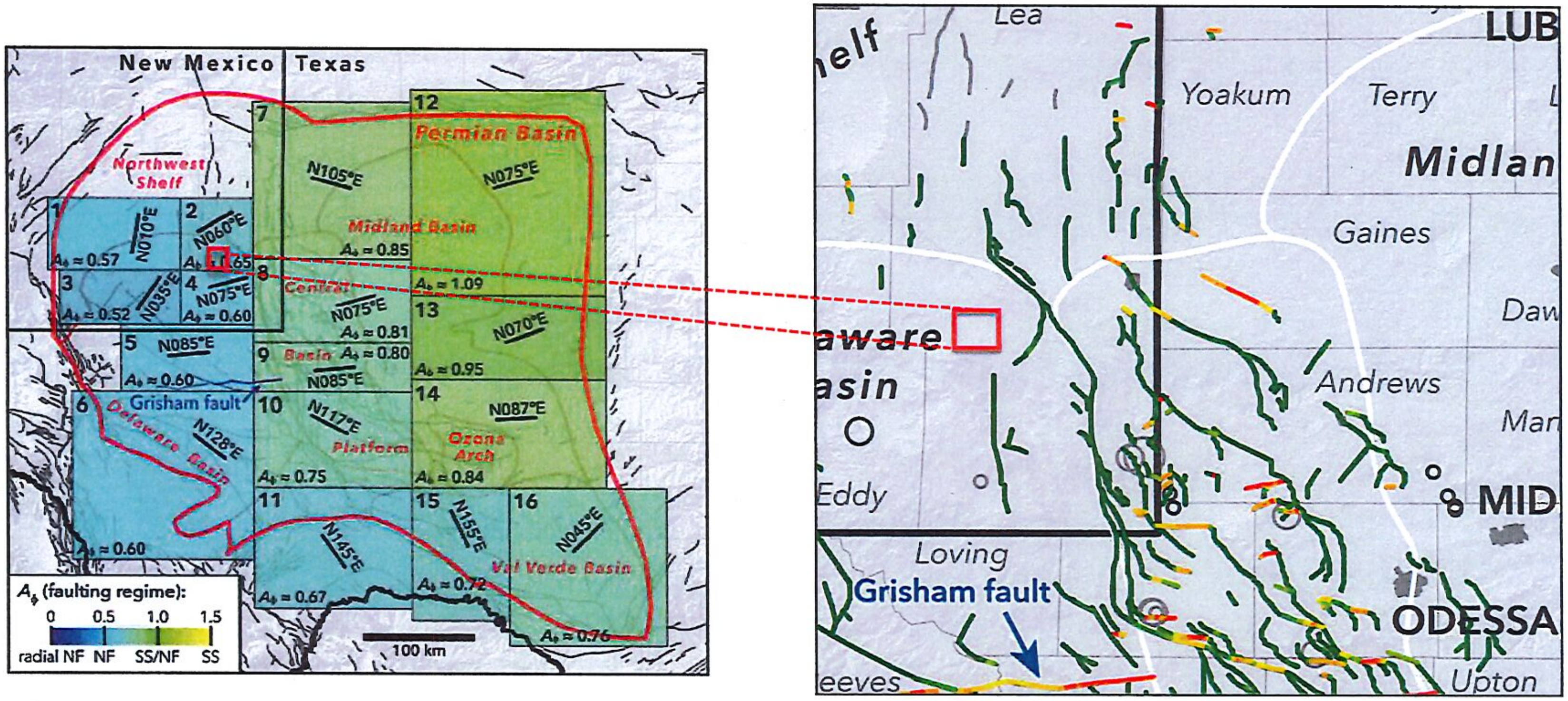


Figure 3: Another fence from the Allan data volume; this section has a 2X vertical exaggeration. Two Karst-type disturbances are marked; these features are about 130 – 150 m wide. (from Gendzwill, D.J 1978, AAPG Bulletin 73-86 "Winnipegosis Mounds and Prairie Evaporite Formation of Saskatchewan – Seismic Study ")



Maps showing principle stress directions (left) and slip potentials of faults (right) in the Permian Basin. The proposed Libby Berry AGI well location and area examined with the Chisholm 3D data is indicated by the red box. It is clear that faulting is oriented primarily north-south in the area of interest, with less frequency as you move west away from the Central Basin Platform margin, and a small chance for slippage (green colors are lower chances, warmer colors more likely to slip). *The small strata breaks we observed on the Chisholm seismic do not conform to regional fault trends, nor do they have the magnitude and lateral extent consistent with regional norms in the area*. The diagenetic sealing of the Lea Field fault would retard any induced slippage, which is consistent with these maps. (from Lund Snee and Zoback, 2018).

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SUMMARY OF OBSERVATIONS AND CONCLUSIONS REGARDING STRUCTURAL FEATURES AND POSSIBLE FAULTING FROM SEISMIC ANALYSIS IN THE AREA OF 3 BEAR'S PROPOSED AGI WELLS

- Many of the apparent, small-displacement features which were identified on the Chisholm seismic data sets do not conform in orientation and extent to the expected trends of faults in this part of the Permian Basin. The seismic expression of these displacements indicates localized collapse breaks that resulted from extensive karst development within the Siluro-Devonian section and subsequent compaction and subsidence over the karsted horizons of the Devonian. The development of these features has been widely observed throughout the Permian Basin in the Devonian and Fusselman section. These smaller features, with one exception (the 225' fault), *cannot be traced to the basement*, but can be detected by reflections as high up as the lower Strawn due to subsequent overburden settling and compaction.

- The Siluro-Devonian section shows a lot of chaotic bedding in places, which is a reflection of cave and karst-fill sedimentation that occurs sporadically throughout the Siluro-Devonian time interval. These karst-cave and collapse features are not capable of slippage or generation of secondary faulting, as they are commonly diagenetically sealed, with little to no porosity with which to transmit fluids. Furthermore the features are highly localized and often not linear

- The only major fault system in the area forms the eastern boundary of the Lea Field. It is the only fault that could be capable of activation, but it is diagenetically sealed, and recognized to be in an area of low slippage potential relative to other areas south in the deeper Delaware Basin. Furthermore, it is over two miles east of our proposed wells.

FAULT SLIP PROBABILITY ASSESSMENT

3Bear Energy

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3BEAR FIELD SERVICES
FAULT-SLIP PROBABILITY ASSESSMENT
T20S, R34E, SECTION 26
LEA COUNTY, NEW MEXICO

May 1, 2019

Pursuant to NMOCD's request at our meeting on April 4, 2019, Geolex, Inc. (Geolex), on behalf of 3Bear Field Services (3Bear), has completed an induced-seismicity risk assessment in the area of the proposed 3Bear acid gas injection (AGI) wells, which are the subject of pending NMOCC Case #20409 currently scheduled for hearing on June 6, 2019. Presented here are the results of that risk assessment, which models the impact of six waste-disposal wells over a 30-year period and estimates the fault-slip probability associated with that injection scenario. The assessment was completed utilizing the Stanford Center for Induced and Triggered Seismicity's (SCITS) Fault Slip Potential (FSP) modeling package. Results of the model simulations presented here predict that operation of the two proposed AGI wells at the designed injection volumes will not contribute significantly to increasing the potential for induced-seismic events.

The two proposed 3Bear AGI wells are located in Lea County, New Mexico (T20S, R34E, Section 26), an area in which four salt-water disposal wells with anticipated injection volumes up to 25,000 barrels per day (bbls/day) are present or proposed (Figure 1, Table 1). To identify subsurface structures within the area of review, Geolex collaborated with Chisholm Energy Holdings, LLC (Chisholm), to evaluate and interpret four seismic surveys licensed to Chisholm by Fairfield Geotechnologies. Based on this assessment, Geolex identified two potential faults and a karst collapse feature modeled as a fault (Fault 1) to be included in the FSP model evaluation (Figure 1). These features were included as they (1) displayed significant vertical displacement or (2) were observed in close proximity to the proposed AGI wells and in alignment with the local stress fields described by Lund Snee & Zoback (2018). The laterally extensive fault occupying the eastern portion of the area of review was subdivided into three fault segments (Faults 3, 4, and 5) in the model simulation to capture the observed variation in strike. Additional features not included in the modeled scenario include karst-cave and collapse features widely observed in this part of the Permian Basin that were deemed not capable of slippage or generating secondary faults.

To estimate the fault-slip potential of the proposed injection scenario, input parameters characterizing the local stress field, reservoir characteristics, subsurface features, and injected fluid are required by the FSP model. Input parameters and their sources for this study are included in Table 2. The location and orientation of potential faults in the area of review were determined through interpretation of the aforementioned seismic survey. In this study, we utilize A_Φ values of Lund Snee & Zoback (2018) to describe the relative stress magnitudes in the proposed Lea County location ($A_\Phi = 0.6$, normal-faulting geologic setting). Lastly, additional stress-field and injection-reservoir model parameters were determined based on the evaluation of nearby wells and similar FSP assessments conducted in the general area.

For this study, limitations of the FSP model required a conservative approach be taken in determining the fault-slip probability of the injection scenario. Specifically, the FSP model is only capable of considering a single set of fluid characteristics and this study aims to model an injection scenario consisting of four SWD and two AGI disposal systems. To ensure a conservative fault-slip probability result, the two proposed AGI were modeled as wastewater injectors. This approach yields a more conservative fault-slip probability prediction as water displays greater density, dynamic viscosity, and is significantly less compressible than acid gas. Table 2 includes the properties of the anticipated acid gas at the modeled reservoir conditions as predicted by AQUAlibrium™ software and reinforces that a water-injection scenario will provide a more conservative fault-slip probability estimate.

Results of the FSP evaluation suggest the area of review includes three potential faults (or fault segments) that display an observable response over the modeled injection period. After 30 years of constant injection, faults 1, 4, and 5 reach maximum Fault Slip Probability values of 0.11, 0.01, and 0.05, respectively (Figure 2). Required pore-pressure increases to induce slip on each fault, as calculated by the FSP model, are shown in Table 3. Each fault in this scenario requires an increase of at least 900 psi or greater to induce slip. As shown in Figure 2, fault-pressure conditions along all model-considered faults remains significantly lower than the predicted pressure thresholds for induced slip (Table 3) throughout the entire 30-year injection period.

Figure 3 (panel A) illustrates the resultant reservoir pressure front upon completion of the modeled scenario. The FSP model predicts the highest pressure conditions (approximately 734 psi) will occur centered on the three SWD injectors with injection volumes of 25,000 bbls/day. Single well radial solutions shown in Figure 3 (panel B) illustrate the two proposed AGI wells (combined injection volume ~3500 bbls/day) contribute significantly less to the observed pressure front, which is predominantly controlled by nearby, high-volume SWD injectors.

Based on the results of the six-well injection simulation, the karst collapse feature modeled as Fault 1 is the most likely subsurface feature to experience the effects of the two proposed 3Bear AGI. However, a subsequent model simulation (Figure 4), in which the two proposed AGI are removed from the injection scenario, shows their model-predicted contribution to pressure change along this fault is minimal (approximately 43 psi). This contribution is significantly less than the model-predicted total increase of 499 psi (Figure 6) and again confirms that high-volume SWD injection wells will have a much greater effect on reservoir pressure over the simulated period. Furthermore, this feature is most likely a small-displacement, local collapse feature and was only modeled as a fault to produce the most conservative risk assessment results.

Faults 4 and 5 are located several kilometers from the proposed AGI sites and, as shown in the single well radial solutions (Figure 3, panel B), would experience minimal pressure effects as a results of the AGI injection operations.

Generally, faults considered in this model simulation do not display significant potential for injection-induced slip and the proposed 3Bear AGI wells are not predicted by the FSP model to contribute significantly to the total anticipated pressure front. Results of the model simulations suggest operation of the four high-volume SWD wells will exhibit the greatest control on pressure conditions. Of the SWD wells included in this model projection, two are operated by 3Bear (Libby Berry Fee SWD #1 and Libby Berry Fee SWD #2). Should additional concerns regarding reservoir pressure conditions arise during operation, injection volumes of 3Bear SWD wells can be adjusted. Additionally, the modeled scenario assumes constant injection rates over the 30-year interval; however, SWD injection volumes tend to decrease through time as production rates decline, significantly reducing the probability of injection-induced seismicity in the area.

In summary, the six-well injection scenario modeled in this study predicts three potential faults (or fault segments) with Fault Slip Potential probability of ≤ 0.11 upon completion of an injection period of 30 years. Model-derived pressure change over the injection period suggests Fault 1 will experience a change in pressure of approximately 499 psi, however, subsequent simulations that exclude injection by the proposed AGI, illustrate their combined contribution to the total pressure front (approximately 43 psi) would be minimal.

Table 1. Location and characteristics of injection wells modeled in FSP assessment.

#	API	Well Name	Latitude	Longitude	Volume (bbls/day)	Start (year)	End (year)
1	TBD	Libby Berry AGI #1	32.541	-103.533	1,750	2020	2050
2	TBD	Libby Berry AGI #2	32.543*	-103.535*	1,750	2020	2050
3	30-025-44288	Libby Berry Fee SWD #1	32.544457	-103.52463	15,000	2018	2050
4	30-025-45344	Libby Berry Fee SWD #2	32.564418	-103.54039	25,000	2020	2050
5	30-025-44189	Okeanos SWD #1	32.524504	-103.52069	25,000	2020	2050
6	30-025-45324	Athena 28 SWD #1	32.545348	-103.57271	25,000	2020	2050

*Denotes bottom-hole location

Table 2. Input parameters and source material for FSP simulations

Modeled Parameter	Input Value	Variability (+/-)	UOM	Source
Stress				
Vertical Stress Gradient	1.05	0.105	psi ft^{-1}	Nearby well estimate
Max Horizontal Stress Direction	N60E	5	Deg.	Lund Snee & Zoback, 2018
Reference Depth	16,400		ft	Nearby well evaluation
Initial Res. Pressure Gradient	0.43	0.043	psi ft^{-1}	Lund Snee & Zoback, 2018
A_Φ Parameter	0.6	0.06	-	Lund Snee & Zoback, 2018
Reference Friction Coefficient (μ)	0.6	0.06	-	Standard Value
Hydrologic				
Aquifer Thickness	1200	10	ft	Nearby well evaluation
Porosity	3.5	0.5	%	Nearby well evaluation
Permeability	20	5	mD	Nearby well evaluation
Material properties				
Density (Water)	1000	50	kg m^{-3}	Standard Value
Dynamic Viscosity (Water)	0.0008	0.0001	Pa.s	Standard Value
Fluid Compressibility (water)	3.6×10^{-10}	0	Pa^{-1}	Standard Value
Rock Compressibility	1.08×10^{-9}	0	Pa^{-1}	Standard Value
Acid gas @ 210 °F, 6,700 psi				
Density	811.00	-	kg m^{-3}	AQUAlibrium™
Dynamic Viscosity	0.0000787	-	Pa.s	AQUAlibrium™

Table 3. Summary of model-simulation results showing the required pressure change to induce fault slip, actual pressure change as predicted by the FSP model, and probability of fault slip at the end of the 30-year injection scenario.

Fault #	Δ Pressure necessary to induce fault slip	Actual Δ Pressure at fault midpoint after 30 years of injection	Fault Slip Potential after 30 years of injection
1	1,086 psi	499 psi	0.11
2	4,643 psi	269 psi	0.00
3	3,328 psi	314 psi	0.00
4	1,758 psi	232 psi	0.01
5	903 psi	205 psi	0.05

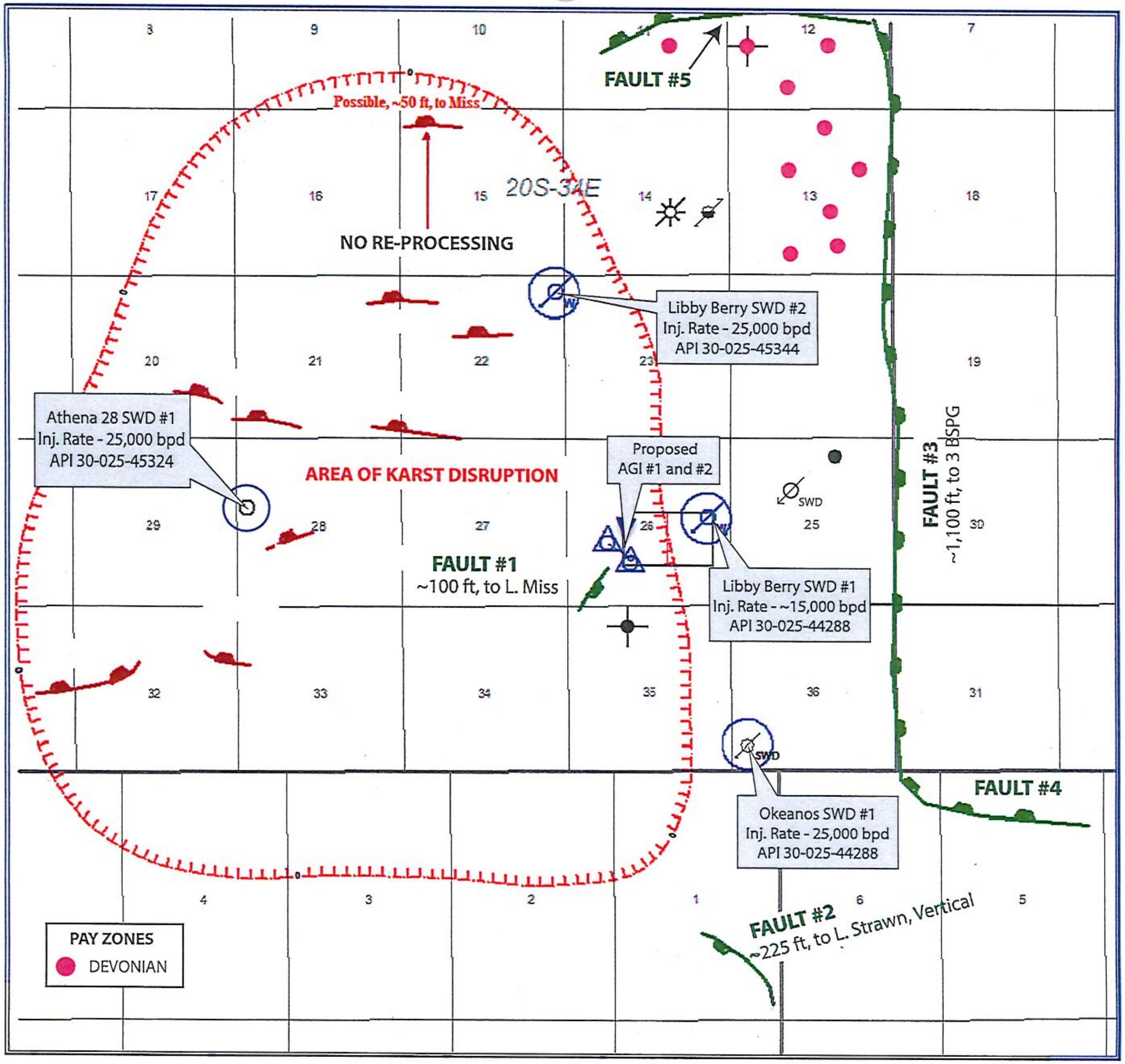

Figure 1 - General location map based on the seismic survey review conducted by Geolex and Chisholm. Injection wells and potential fault features included in model simulations are mapped in blue and green, respectively.

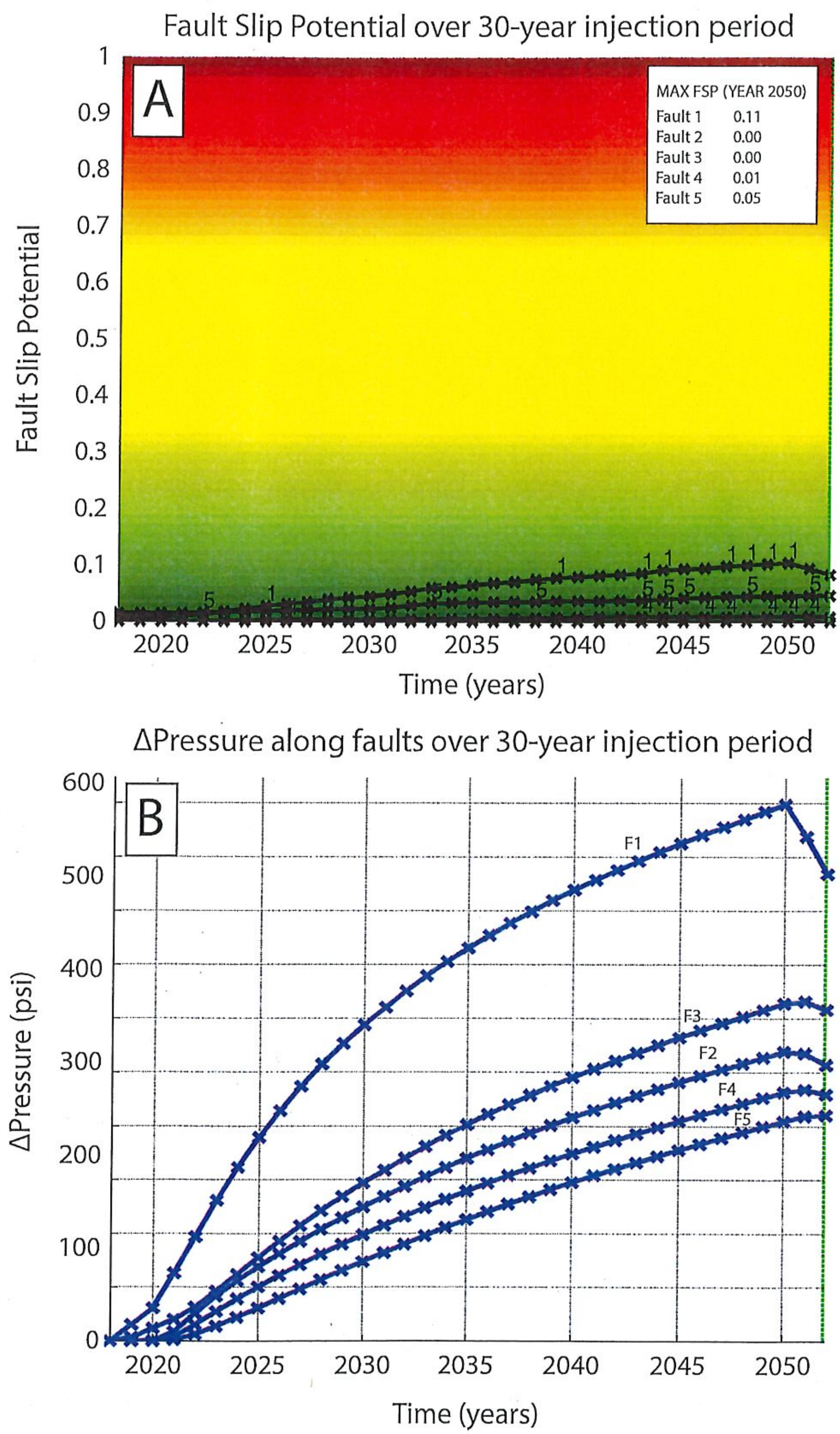

Figure 2 - Fault Slip Potential (panel A) and pressure change along faults (panel B) over the 30-year modeled injection period. Injection rates in this modeled scenario are held constant over the study period resulting in max values occurring during year 2050.

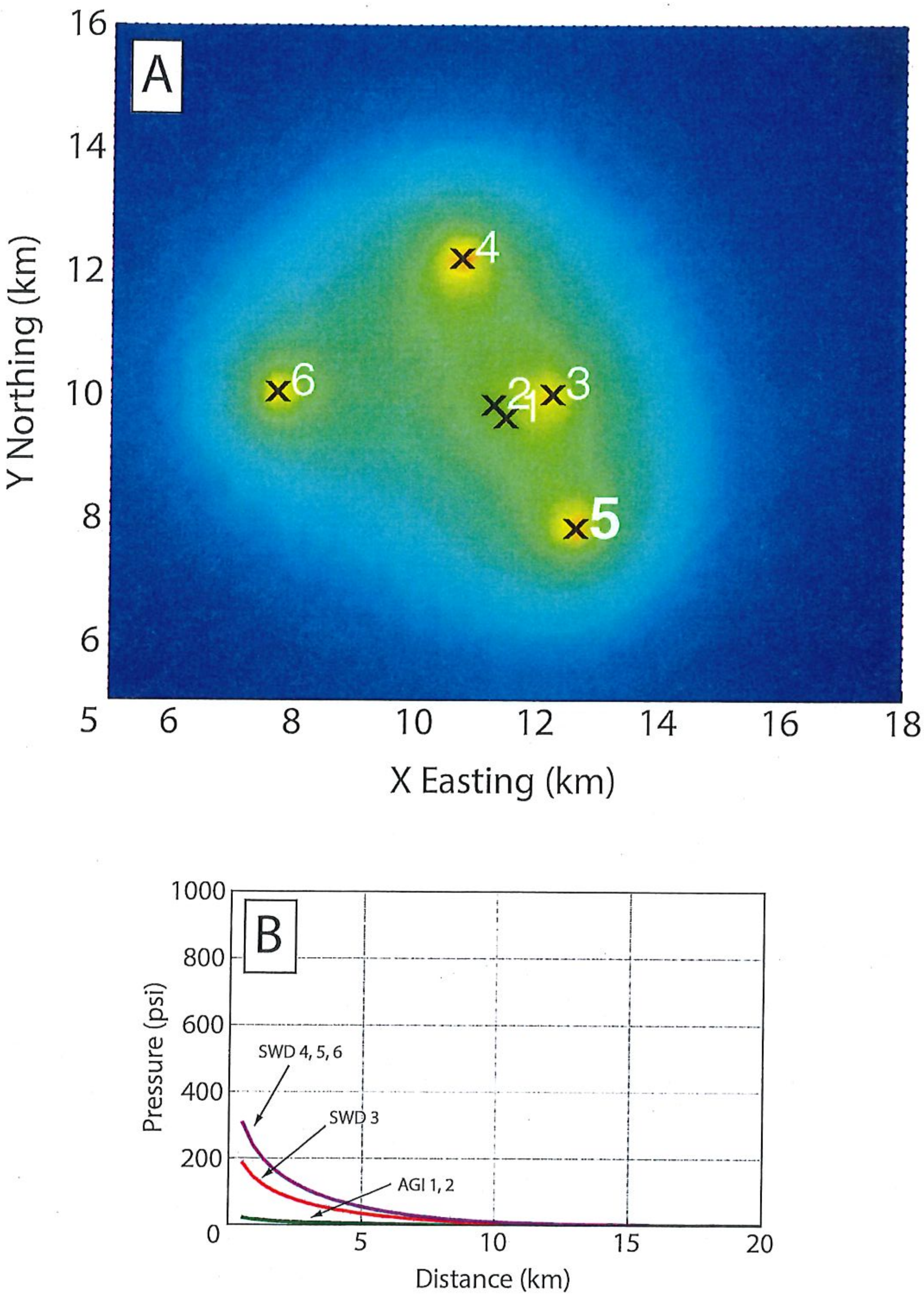

Figure 3 - Resultant pressure front (panel A) and corresponding single well radial pressure solutions at the end of the 30-year injection simulation. Pressures are greatest near high-volume SWD wells and panel B illustrates minimal pressure contribution by the proposed 3 Bear AGI wells.

3Bear Energy

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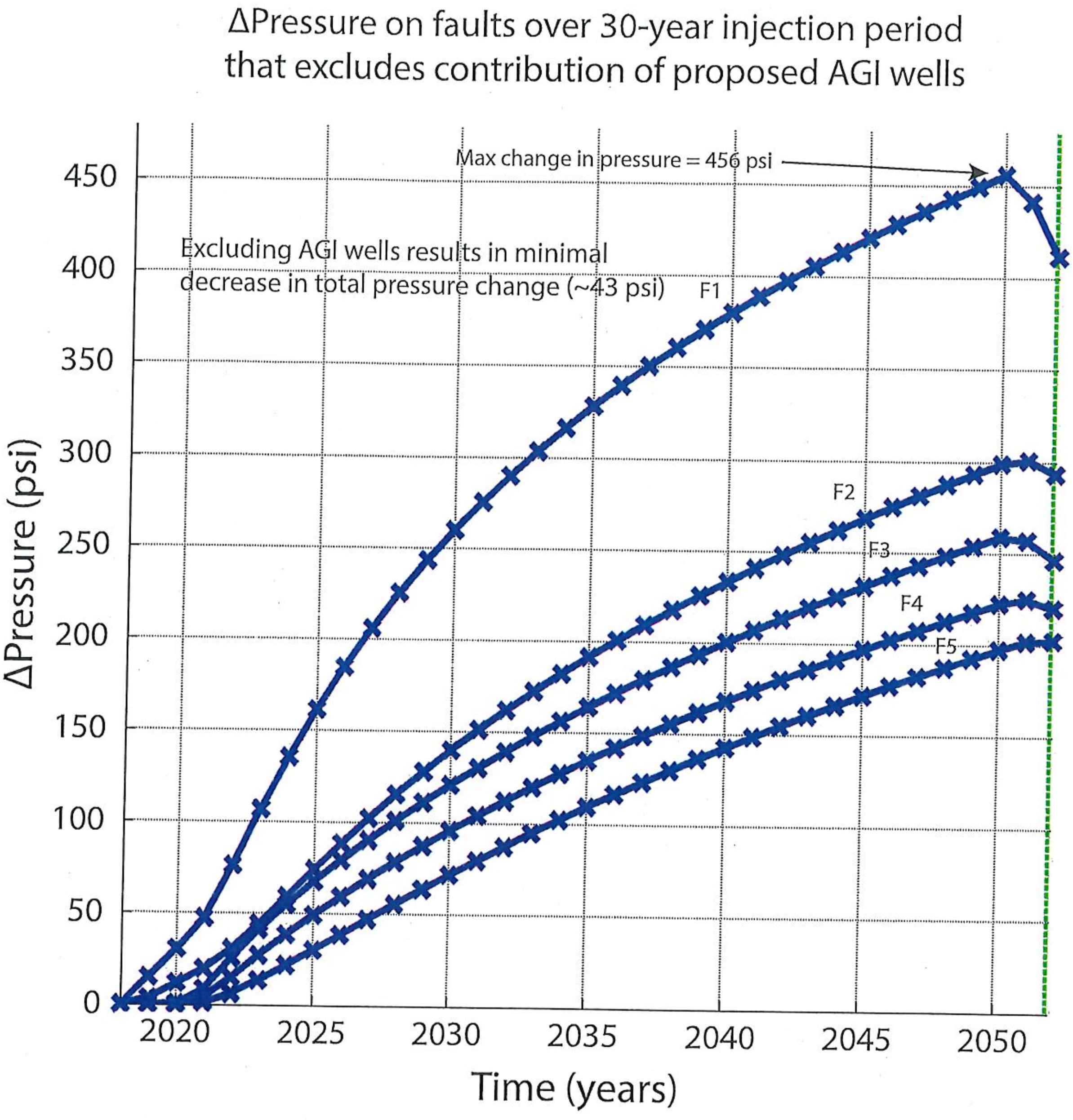

Figure 4 - Modeled change in pressure along faults for an injection scenario that excludes the two proposed AGI wells. Fault #1 reaches a maximum change in pressure of approximately 456 psi. This exercise suggests that operation of the two proposed AGI wells will have minimal influence (~43 psi) on the resultant reservoir pressure conditions in this injection scenario.