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TO: Carmon D. Bonanno
Blackstone Exploration
FROM: S. J. Mazzullo, PhD
SUBJ: Proposed seismic acquisition in Lead Areas 1 and 2 in Holbrook Basin, AZ
DATE: October 13, 2016

Carmon;

I want to explain my protocol and its rationale for seismic acquisition in Lead Areas 1 and 2 in the Holbrook Basin, Arizona. There are several geologically different types of traps for hydrocarbons and helium, including purely structural traps, purely stratigraphic traps, and purely paleogeomorphic (subunconformity) traps. Each of these includes several variations (trap sub-types), and furthermore, each can be combined with another to create combination types of traps (for example, combination structural-stratigraphic or combination structural-paleogeomorphic traps). Hence, the exploration for hydrocarbons or helium in a given area requires a geological model that addresses the question: for which type of trap or traps as listed above are we searching? That model is provided by identifying the types of traps that are present in producing fields in a given exploration area. These fields then serve as analogs (models) that geologists use to explore for hydrocarbons or helium. Commonly, however, more than one type of trap is present in a given area, and the different types of traps that may be present are controlled by the specific geology of an area. Accordingly, an exploration geologist should not only explore for specific trap types that are present in already-producing fields in an area, but he/she must also anticipate what other trap types might also be present in an area based on its geology.

The problem is that we have no geological model or models of trap types in the Holbrook Basin because producing hydrocarbon or helium fields have yet to be discovered here. Hence, as an exploration geologist I have no recourse other than to initially explore for the most readily identifiable traps that may be present, which are different varieties of structural traps. Such traps include those on subsurface structural highs and those adjoining subsurface faults. I have identified the possible presence of numerous subsurface structural highs and faults in Lead Areas 1 and 2 based solely on subsurface well log-based mapping. I have suggested that these areas may hold commercial traps for hydrocarbons and/or helium because of nearby shows of these substances in previously-drilled wells. The best way to confirm the presence and precise locations of these structural features is via acquisition of seismic data across them. There are two different types of seismic data that are routinely acquired during exploration, that

is, 2-D and 3-D seismic. All seismic acquisition involves laying out specific lines along which various *shot-points* and *receivers* (systematically arranged at specific locations along the lines) are located. The shot-points are the nodes at which energy is transmitted into ground via thumper trucks or dynamite, and that energy is transmitted into the ground and reflected back to the surface receivers. Computers are then used to create seismic sections. 3-D seismic utilizes a fairly dense grid of such lines, and the data from them create (via computer) a three-dimensional seismic representation of the subsurface.

Both types of seismic enable the geologist to determine not only the precise locations of subsurface structural highs and faults suggested by subsurface well log-based mapping, but also the presence of other types of potential traps as listed above. Furthermore, such seismic is readily correlated to some wells logs to enable the exploration geologist to identify the presence or absence of specific reservoir and non-reservoir rocks in an area of interest. Such information is critical in mapping the likely extent of potential reservoirs in the subsurface. Armed with such subsurface data the exploration geologist stands on a firmer foundation of model-driven exploration. The seismic data plus subsurface maps and lithologic determinations made by the exploration geologist allow him/her to identify specific locations for exploratory drilling. 2-D seismic normally is acquired in areas of relatively little well control (so-called *wildcat areas*) such as the Holbrook Basin because large areas can be evaluated relatively quickly and at lower cost than 3-D seismic. In contrast, if resource production is established in a given area, then I might suggest the acquisition of a limited amount of 3-D seismic to determine the lateral extent of a potential hydrocarbon or helium field.

I hope this information helps you understand my rationale of acquiring seismic in Lead Areas 1 and 2 in the Holbrook Basin.

Respectfully submitted,

S. J. Mazzullo, PhD

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LEAD AREA 1

Blackstone leases

proposed 2-D seismic lines

wells deeper than Supai Fm

wells in Supai Fm or shallower

0 — 5

scale in miles

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CI = 20 m

34°30'

110°30'

110°15'

15N-18E

15N-19E

15N-20E

14N-17E

14N-18E

14N-19E

14N-20E

13N-17E

13N-18E

13N-19E

13N-20E

U D

Winslow #1 State

Union-Cont'l #1 Aztec

Holbrook #1 Govt

Hopi #1

Union-Cont'l #1 NMA

Adamana #1 Govt

Webb Res. #8-1 NMAL

Blackstone #4 St. Az

Calif. Oil #1-A State 2519

Calif. Oil #1 State 2519

Blackstone RCR #2

Blackstone RCR #3

Blackstone RCR #4

Webb Res. #29-1 RCR

Johnson #1 Aztec

Johnson #2 Aztec

TD 610'

Lockhart #1 Aztec

Taubert-Steed #1 Babbitt Fee

Blackstone #1 RCR

Lynch #1 Aztec test

Martin #8 Martin

377

Navajo County, AZ

LEAD AREA 2

Blackstone leases

proposed 2-D seismic lines

wells deeper than Supai Fm

wells in Supai Fm or shallower

0 — 5

scale in miles

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CI = 20 m

111°00'

100°45'

100°30'

35°00'

34°45'

19N-12E | 19N-12 1/2E | 19N-13E | 19N-14E | 19N-15E | 19N-16E | 19N-17E

18N-12E | 18N-12 1/2E | 18N-13E | 18N-14E | 18N-15E | 18N-16E | 18N-17E

17N-12E | 17N-12 1/2E | 17N-13E | 17N-14E | 17N-15E | 17N-16E | 17N-17E

16N-12E | 16N-13E | 16N-14E | 16N-15E | 16N-16E | 16N-17E

15N-12E | 15N-13E | 15N-14E | 15N-15E | 15N-16E | 15N-17E

U D

U D

U D

D U

Winslow

Coconino County

Navajo County

COCONINO NATIONAL FOREST

to Mormon Crossing