APEX

To Whom This May Be Of Interest June 25, 2020

Re: **ADF® - A New Seismic Hydrocarbon Indicator and More**

Commercial hydrocarbon reservoirs all have sufficient source, migration, timing, commercial size, reservoir quality, and seal. Heretofore, despite advances in technology, the industry has not been able to reliably determine reservoir size and quality in the widespread areas where amplitude and AVO are ineffective. Apex's "ADF®" does that.

Starting in 1975, the industry took a wrong turn and incorrectly assumed that all seismic frequencies have the same velocity. Frequency dependent velocity ("dispersion"), was believed to occur, but only at high frequencies, when in fact permeability causes *large* velocity variations with frequency – inside the seismic bandwidth.

After 1975, the O&G industry built various tools based on this "no dispersion" assumption that are routinely used industry wide today and which in some cases even *cause* dry holes. Imaging dispersion with ADF® turns this affliction to large material advantage.

On a particle motion level, fluid moves within the reservoir pore throats when impacted by the seismic wave. More fluid movement causes more dispersion. Intrinsic perm (perm based on the internal shape of the rock), Relative Perm (a reservoir engineering term that describes how typical hydrocarbons move easier than brine through pore throats) and thickness determine the amount of fluid movement and together these define a reservoir's "bulk volume perm".

ADF® *images* bulk volume perm in seismic data without use of well data and displays it in color. Bright ADF® covering a sufficiently large area indicates the likelihood of encountering commercial quality reservoir rock with the drill bit is high.

In many clastic rocks, ADF® also acts as a Direct Hydrocarbon Indicator ("DHI") because typical hydrocarbons have anomalously high Relative Perm. **Hence, in many geologic settings ADF® robustly indicates commercial reservoir quality and areal extent, and hydrocarbon charge.**

In non-clastic carbonate rocks, ADF® indicates the areal extent of commercial level perm but typically does not act as a DHI because changes in intrinsic perm overwhelm Relative Perm. ADF® is nonetheless very helpful in this geologic setting to find perm barriers setting up traps.

In geophysical terms, ADF® is well suited to distal or well consolidated Class III AVO settings, and nearly all Class II and Class I AVO settings. Geologically, ADF® is an effective de-risking tool in the Paleozoic, Mesozoic and in consolidated or distal geology in the Cenozoic.

Sincerely,

Scott W. Peters
President

Apex Spectral Technology, Inc.
Houston, Texas 77042, USA