

An Interpretation of Gas Shows
in the
Donnelly Dome No. 1 (Keys 1-28) Well

A Report to
Steele Energy Corporation
by Lanny H. Fisk, PhD and Craig A. Sandefur, Well-Site Geologists
9 December 1984

Introduction

Interpretations of gas shows while drilling and mud-logging are difficult and fraught with uncertainties until wireline logs and formation testing are completed. The primary reason for this uncertainty is that safe drilling procedures require drilling fluid or mud column pressure to be greater than formation pressures thus preventing the escape of gas to the surface causing a potentially disastrous blowout. Gas shows then are purposely small and return to the surface dissolved in the drilling fluid. However small, gas shows indicate that gas in larger (commercial) quantities may be present in the penetrated formations but are kept from coming into the well bore and to the surface by drilling fluid pressure.

As uncertain as they are, tentative and preliminary interpretations of gas shows should be done to assess as early as possible the economic potential of the well and to evaluate whether or not completion of the well and formation testing are justified. The true commerciality of the well can only be known when during formation testing gas in commercial quantities (probably in excess of 500 mcf/gpd) comes to the surface in a sustained flow.

Gas shows while drilling and mud-logging can result from any of four sources:

- 1) dissolved gases released from formation waters when these waters are circulated to lower pressures at the surface,
- 2) trapped gases from kerogenous source rocks liberated by the grinding action of the bit,
- 3) isolated pockets of trapped gas in small, noncommercial quantities such as in impermeable rocks or left behind during migration of gas elsewhere, and
- 4) trapped accumulations of gas in reservoir quality rocks.

Each of these gas sources has markedly different implications as to the potential commerciality of the well. Under most circumstances only gas shows resulting from source #4 above are an indication of commercial productivity. In some instances gas shows from source rocks such as coal or black shale are commercial if successful fracturing results in a sustained gas flow and a ready market is available close by the field. The Pacific Northwest is an excellent gas market but the distance from the Keys 1-28 well to a gas pipeline (approximately 50 miles)

is probably too far to warrant production of the relatively small amount of gas typically produced from this source. (However, consideration should be given to compressing the gas on site and trucking liquid gas to a nearby large industrial user such as the North American Gypsum Corporation plywood and pressboard plant in Pilot Rock.)

Source differentiation is the first step in gas show interpretation. The second step is to assess whether the gas can be produced to the borehole in economic quantities and at sustained rates -- a difficult, if not impossible, task prior to drill-stem testing. The third and final step in the interpretation of shows in a wildcat well is to extrapolate the significance of the gas shows beyond the single well bore to answer the obvious question: If this wildcat is a commercial producer, what is the extent of the newly discovered field?

In the following sections of this report we will take the first step in interpreting gas shows from the Donnelly Dome well and, based on our preliminary interpretations, make recommendations on further testing the commercial potential of the well.

Source Differentiation

Some highly significant gas shows have been observed from several zones in the first 5000' of the Donnelly Dome No. 1 well. We have attempted to interpret the source and thereby the potential commerciality of each show below.

<u>No.</u>	<u>Depth Interval</u>	<u>Maximum Gas Units</u>	<u>Chromatigraphic Analysis</u>
1	1190'-1370'	22 units	100% methane

Interpretation:

The source of methane from this interval is either dissolved gases from formation water or a trapped accumulation in poor quality reservoir rocks (fractured andesite flows and tuffs). We interpret shows from this zone to be noncommercial, high-pressure, low-volume gas associated with a persistent water flow. Sustained flow of both water and gas from this zone resulting in connection gases as high as 91 units and wipe-hole gases as high as 208 units, indicate significant fracture permeability. Thus, formation testing may be warranted, particularly if gas from this interval could be co-produced with that from other intervals. If wireline logs indicate significant gas saturation (greater than 35%), we recommend that the entire 180-foot interval be perforated and tested.

<u>No.</u>	<u>Depth Interval</u>	<u>Maximum Gas Units</u>	<u>Chromatigraphic Analysis</u>
2	1985'-2050'	45 units	98% methane, 2% ethane

Interpretation:

This show represents coal gas coming from dirty coals and carbonaceous tuffs. Even if "fracked", it is very doubtful if this 65-foot interval could by itself yield commercial quantities of gas.

<u>No.</u>	<u>Depth Interval</u>	<u>Maximum Gas Units</u>	<u>Chromatigraphic Analysis</u>
3	2306'-2323'	34 units	100% methane

Interpretation:

The show from this 17-foot interval is again coal gas and quite clearly non-commercial.

<u>No.</u>	<u>Depth Interval</u>	<u>Maximum Gas Units</u>	<u>Chromatigraphic Analysis</u>
4	3280'-3365'	15 units	97% methane, 3% ethane to 96% methane, 4% propane

Interpretation:

The source for this noncommercial gas show is carbonaceous siltstone and claystone. The relatively high percentage of ethane and propane demonstrate that these source rocks are thermally mature.

<u>No.</u>	<u>Depth Interval</u>	<u>Maximum Gas Units</u>	<u>Chromatigraphic Analysis</u>
5	3990'-5000'	14 units	99.5% methane, 0.5% ethane to 100% methane

Interpretation:

Gas shows from this thick interval, although small, may be significant because they do, in our opinion, clearly represent trapped accumulations of gas in reservoir quality rocks. This interval thus could conceivably contain commercial quantities of low-pressure, high-volume gas. If wireline logs demonstrate gas saturation greater than 35%, two or more intervals in this thick section of porous and permeable sand should be "perfed" and tested. We suggest testing a 210-foot interval at the top of the sequence and possibly also a 115-foot interval from 4385' to 4500'. The invasion of drilling fluid into this interval evidenced by continuous and periodically severe lost circulation problems could have permanently damaged the formation. However, very low formation pressures would seem to indicate that only marginally commercial production could have been expected anyway.

Conclusions and Recommendations

The gas shows thus far encountered in the Donnelly Dome No. 1 well are, to say the least, encouraging. Rocks stratigraphically above productive oil or gas fields typically contain such gas shows while those associated with dry holes do not. Thus, the gas shows already encountered in this well could be an indication that larger, commercial quantities of hydrocarbons may be discovered with continued drilling. In addition, the presence of substantial percentages of ethane, propane, and trace quantities of higher hydrocarbons in these shows indicate that, besides gas, oil production is a distinct possibility. Wet gases containing ethane and propane in such high percentages as observed in these shows are indicative of a potential for the production of petroleum liquids (oil or condensate), while dry gas (essentially all methane) indicates a potential for only gas production. The presence of a significant ethane-plus fraction in these gas shows also conclusively demonstrates the thermal maturation of petroleum source rocks; these gases cannot be the product of solely biogenic processes.

There is at present, insufficient evidence from the gas shows encountered in this well to demonstrate that the Donnelly Dome wildcat will be either a "producer" or "duster." However, as a result of these highly encouraging shows, we recommend the following:

- 1) The well should be drilled to at least its projected and permitted depth of 8000 feet.
- 2) At or near this depth serious consideration should be given to deepening the well to 9000 feet or deeper if drilling problems are not encountered, significant hydrocarbon shows are continuing, and obvious commercial production has not yet been established. (A well drilled to depths below 8726 feet will set a new drilling record for north-central Oregon. At 4251 feet, we have already set a drilling record for Wheeler County.)
- 3) Any potentially commercial reservoir rocks encountered in the sedimentary-rock section of the well should be cored to better evaluate the quantity of hydrocarbons present and the reservoir quality (porosity and permeability).
- 4) Drill-stem testing should be attempted on any future potentially productive reservoirs encountered.
- 5) At total depth, wireline logs should be run to assess the porosity, permeability, and hydrocarbon saturation of potential reservoir rocks. A competent and experienced consultant should be asked to interpret the logs and advise on potentially commercial zones deserving formation testing.
- 6) The well should be completed with a 7" production tubing set to just below the last significant show so that reliable, straddle-packer, drill-stem testing can be done.
- 7) If the results of formation testing indicate that the Donnelly Dome wildcat is commercially producible, then development wells should be planned and a marketing contract negotiated (e.g. with Northwest Natural Gas or Cascade Natural Gas).

Postscript

Regardless of the results from further drilling and testing of the Donnelly Dome No. 1 well and even if the well is later evaluated as noncommercial, the gas shows already encountered make it highly significant and successful in demonstrating that north-central Oregon is a hydrocarbon habitat. The Donnelly Dome No. 1 has already proven (1) that this area has all the ingredients to be a petroleum producing basin, and (2) that it has the potential to produce petroleum liquids (oil or condensate) as well as thermogenic gas. Certainly, the Donnelly Dome No. 1 has also already demonstrated that the area is worthy of further exploration and wildcat drilling.