Big Basin, Kansas: Impact Crater or Sinkhole?

Richard R. Donofrio, EDGE Research Associate, June 2002

Additional well information was recently released from the first exploration well drilled in Big Basin, Clark County, Kansas. This approximately one-mile diameter circular depression has been proposed to be either a sinkhole or a meteorite-impact crater. The Big Basin # 1 well (BB-1) was drilled in March 2001 to a total depth of 5,630 ft and completed as a gas discovery with perforations at 5,532–5,550 ft. The well tested at 230 Mcfd of gas and 40 b/d of fluid with 20% oil. The pay zone is a marine oolitic shoal deposit, which is stratigraphically trapped in the basal part of the Chester limestone. The reservoir is independent of the surface Big Basin feature. Prior to BB-1 available records indicated that the deepest penetration in Big Basin was a water well to 140 ft.

The primary exploration method at Big Basin was Relucent imagery. Relucent surveys detect surface micro seepage of pressured hydrocarbons, which can indicate oil and gas reservoirs. They do not distinguish hydrocarbon depth(s) but can be an effective tool, especially when used in conjunction with other available geological and geophysical data. Texaco has a similar (though airborne) imaging spectrometer system called Teems.

The Relucent surveys for Big Basin used a ground-based rotating microwave radar unit to image the area. The Relucent principal holds that some of the pulse transmissions from the rotating transmitter become absorbed by hydrocarbons, the electrons of which become excited and move to higher energy levels. During the lapse between microwave pulses the energy levels return to their normal state and simultaneously emit the absorbed energy as radiation at differing frequencies. Color is arbitrarily assigned for intensity. Big Basin shows an interesting arced Relucent pattern that follows parts of the rim. This is shown among the figures below. The Relucent arc is discontinuous and suggests that most hydrocarbons will be found in the west half of the feature.

Geochemical analysis of the oil from BB-1 was done at the University of Oklahoma by Paul Philp. The gas chromatography (GC) indicated that the Mississippian Chester oil contained oils of Ordovician age. David Newell and Joseph Hatch at the Kansas Geological Survey compared the GC data with other Ordovician oils in their Kansas database and confirmed the findings. This suggests that the oil originated in part from the deeper Viola formation and migrated upward along fractures/faults into the Mississippian reservoir. This has implications for additional exploration objectives.

To review the main finding to date, if Big Basin is an impact crater, disruption of rocks to as deep as 1,500 ft would be expected for a structure of this size. This would be evident in the well logs when compared to rocks outside of the crater. But this was not the case. No disruptions of beds, typical of impact craters, were evident during drilling or in the well logs. BB-1 was correlated with the two nearest wells outside of the depression, the H.R. Duvall # 1 about 1.6 miles southeast and the Berns # 1-21 about 2 miles west. In BB-1 the gamma ray log was run from 5,630 ft to surface; in the Duvall #1 from 7,000 to 650 ft; in the Berns #1 from 6,050 to 970 ft. The gamma ray logs of these wells readily correlate over the logged intervals, show no disruption of beds or loss of interval thickness, and follow the regional dip.

The shallowest point logged in the nearby wells was in the Duvall, which correlated to 700-710 ft drill depth in BB-1. Thus, the process that formed Big Basin can be no deeper and is readily explained not by meteorite impact, but by karst in relatively shallow subsurface rocks. Based on lost circulation during the drilling of BB-1, the gamma ray response, and the loss of two additional wells (BB-2 & 2A), the collapse zone is above 450 ft. This depth is also supported by correlation with a more distant well, the 2-16 Mull located about 4 miles to the northeast. The gamma ray log in this well was run from 6,940 to 70 ft and is shown with the BB-1 and Duvall logs below. Log changes above 450 ft are evident. This is within the Permian red beds.

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The Kansas Historical Marker on Highway 160-283 in Big Basin reads, "…*Big Basin was formed thousands of years ago by the dissolving and collapse of massive gypsum and salt formations lying several hundred feet below the surface…"* Judging by the surface instability during the drilling of BB-2 and the cavernous intervals of BB-2A, some areas of the basin floor are undoubtedly still subsiding.

Further information about the exploration efforts at Big Basin, including the seismic program, will be posted at EDGE when data are available.

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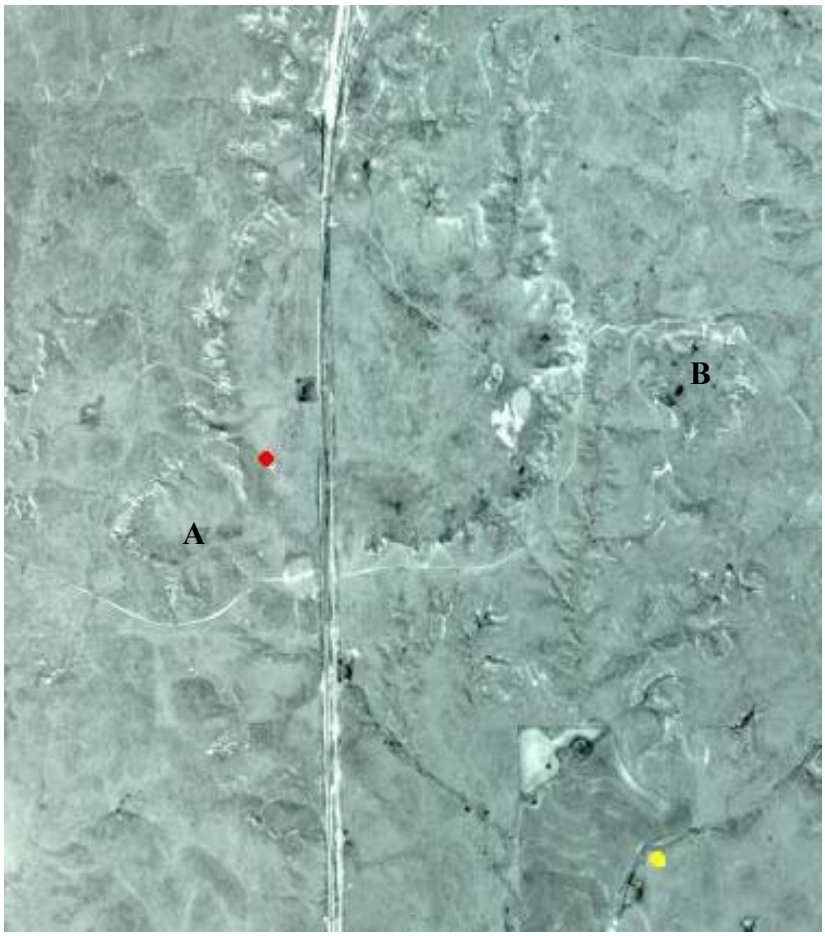
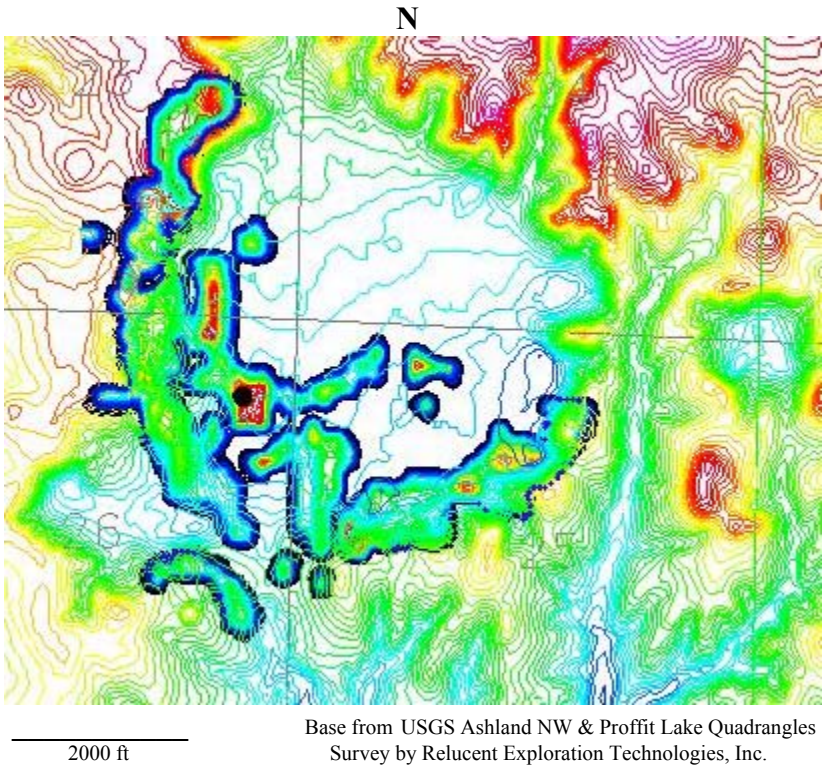


USDA

2000 ft

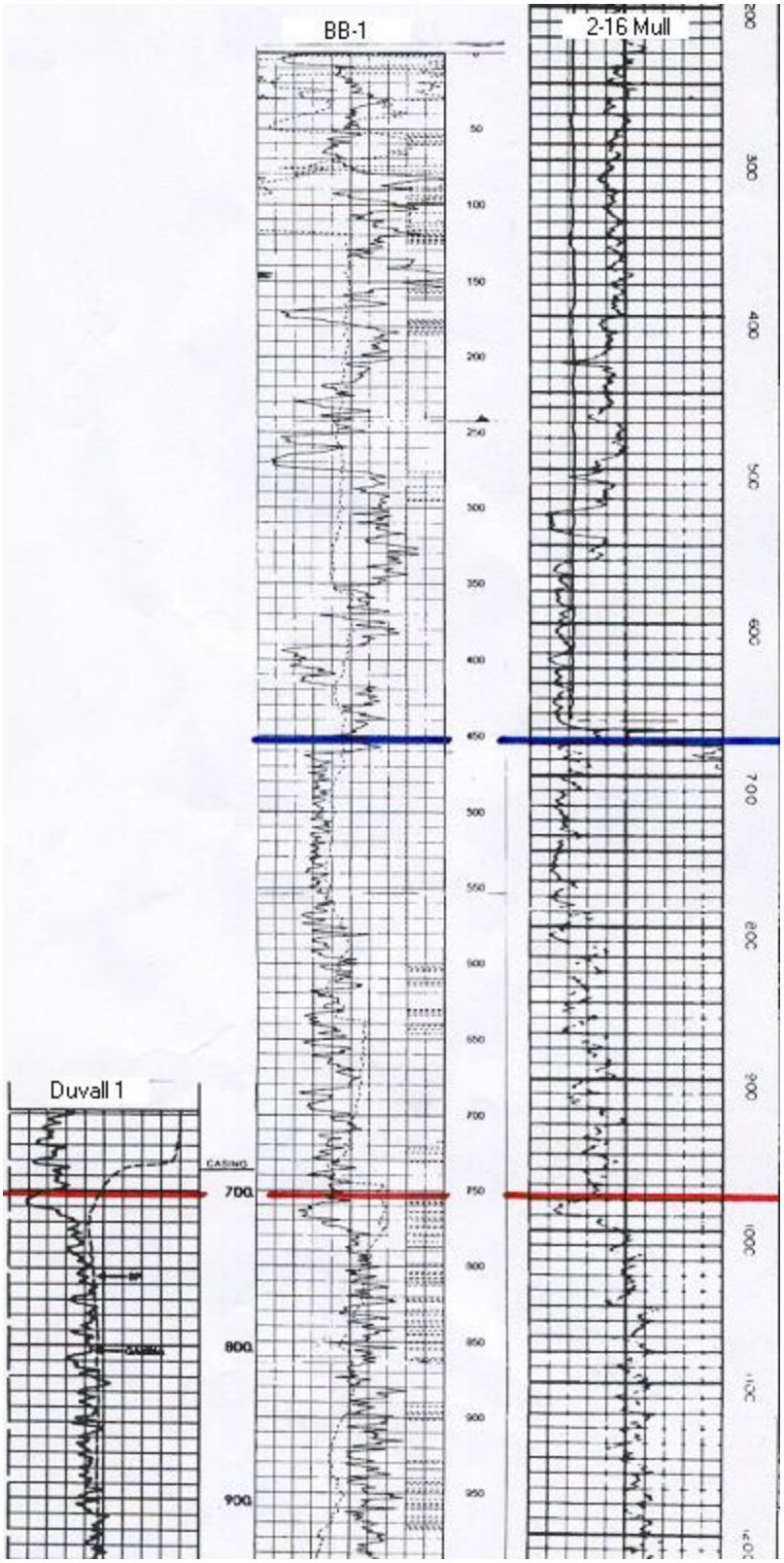
Aerial photograph of Big Basin

Big Basin is located about 25 miles south of Dodge City and has a diameter of about one mile. Red shows location of BB-1 discovery well. Yellow is Duvall # 1, one of the wells used for log correlation. The BB-2 and 2A offset wells were located about 1,100 ft NNW of BB-1. Two smaller sinkholes associated with Big Basin are shown. “A” is referred to here as the “Withers Sink”, and “B” is known as “Little Basin.” The rim of Withers Sink intersects the rim of Big Basin. Highway 160-283 runs N-S through Big Basin and separates private land on left from (State of Kansas) Big Basin Prairie Preserve on right.



Relucent imagery superimposed on surface contours

The Relucent pattern curiously suggests that hydrocarbon seepage is following the surface rim structure. A possible explanation for the pattern is that hydrocarbon seepage from the known pay zone at depth is being funneled or concentrated into an arc pattern because of the arc shape of the fractured and porous surface rocks. Big Basin dynamics did not create the producing reservoir at 5,532 ft, and no evidence of shallower pay zones was found. The black dot (NE/4 S26-T32S-R25W) shows the location of the BB-1 discovery well, which was drilled in one of the Relucent areas of high intensity.



Correlation of Duvall, Big Basin, and Mull gamma ray logs.
The blue and red lines show selected marker beds. Note how the logs match to about 450 ft from the surface. The solution collapse forming Big Basin occurred within the evaporites above the blue line.

Rim rocks in Prairie Preserve on east side of Big Basin
Looking south.

Fractured rim rocks in Prairie Preserve
The dark area of the large vertical fracture is about 2 ft long. The floor of the depression and west rim can be seen in the the background. Looking southwest.

Little Basin

This isolated depression on the east side of Big Basin is about 1,700 ft in diameter and 80 ft in depth. It contains the St. Jacobs well, which is a spring. Looking southeast

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Withers Sink

This depression is adjacent to Big Basin on the southwest. It has sagged about 60 ft and has a diameter of about 2,000 ft. Looking southwest.

Rim rocks on west side of Big Basin
Note the absence of rim height above the encompassing terrain. The floor of the Big Basin depression is about 100 ft lower than the surrounding rocks. No shatter cones or other bona fide impact rocks were found anywhere in or beyond the feature. Looking north.

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Drilling Big Basin #1 on the floor of the depression buttressing the western rim flank, March 2001. The well was positioned primarily by Relucent imagery prior to the seismic survey. The operator is Parwest Land Exploration, Inc., Oklahoma City. Looking northwest.

Related Links

Impact crater proposal: http://www.kgs.ukans.edu/midcont99/cannon1.html

Gravity investigation: http://www.lpi.usra.edu/meetings/lpsc2001/pdf/1087.pdf

Historical Marker: http://skyways.lib.ks.us/history/bigbasin.html

Red Hills: http://www.kgs.ukans.edu/Extension/redhills/RH_factsheet1.pdf

Maps and directions: http://www.naturalkansas.org/bigbasin.htm

Evaporite karst: http://www.kgs.ukans.edu/midcont99/johnson1.html