Sample of Geophysical Logs from Two Upper Devonian Oil Fields in West Virginia

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Introduction

A sample of geophysical logs was assembled as the result of a request for a dataset to be used in teaching geostatistics. The original request was answered; meanwhile, I thought the resulting dataset might be useful to others.

The typical suite of geophysical logs for the typical Appalachian basin well includes gamma ray and neutron density logs. These are useful for correlating stratigraphic units, and where cores are available, for mapping lithofacies after matching log signatures to features observed in cores. We often use numerical methods to identify and map electrofacies (Hohn, 2004).

The rest of this document summarizes the history of oil production, stratigraphy, and depositional environments, and lithofacies in two Upper Devonian oil fields that were the subject of recent studies at our survey. These studies were funded by the U.S. Department of Energy through contract numbers DE-AC26-98BC15104 and 2285-WVGS-DOE-1025 (through the Stripper Well Consortium.)

History of Oil Production from Gordon Sandstone Reservoirs

In 1886, oil was discovered in a well on the Gordon farm in southwestern Pennsylvania; at the time, this was the world's deepest well at a total depth of 2,392 feet (Clapp, 1907). By 1890, oil and gas were being produced from Venango reservoirs in northern West Virginia. The Jacksonburg-Stringtown field was one of the earliest, discovered in 1895 (Whieldon and Eckard, 1963). By the time of the First World War, Gordon sandstones were producing oil from 18 fields in West Virginia. The overall trend of Gordon fields (Figure 1) follows that of Gordon interval thickness (Figure 2) drawn by Boswell and others (1996). In many fields, production is limited to the Gordon Stray, an interval of sandstone and conglomerate westward of the thick Gordon trend and shallower stratigraphically.

Gordon sandstones are part of the thick, Upper Devonian sedimentary section. In West Virginia, outcrop equivalents are called the Hampshire Formation. Sediment composition varies considerably between non-marine red shales and fluvial sandstones of the Hampshire Formation in the eastern outcrop belt of West Virginia, Maryland, Virginia, and Pennsylvania, to distal marine shales of the Ohio Shale in the western outcrop belt of Kentucky and Ohio. Intervening sedimentary rocks grade between these two extremes, containing at different locations fluvial, shoreline, or shelf sandstones and shales; the Gordon lies along the shoreline trend of this spectrum. In general, marine content decreases to the east.

Upper Devonian sandstones in West Virginia are commonly known by an informal terminology developed by drillers exploring for oil and gas during the late 1800s. Informal stratigraphic names include “Gantz”, “Bayard”, “Gordon”, and “Fifty-foot”. Productive sandstones in the Jacksonburg-Stringtown and Wileyville oilfields lie within the Gordon interval. Gordon sandstones are stacked in a north-south trend that extends northward into Pennsylvania.

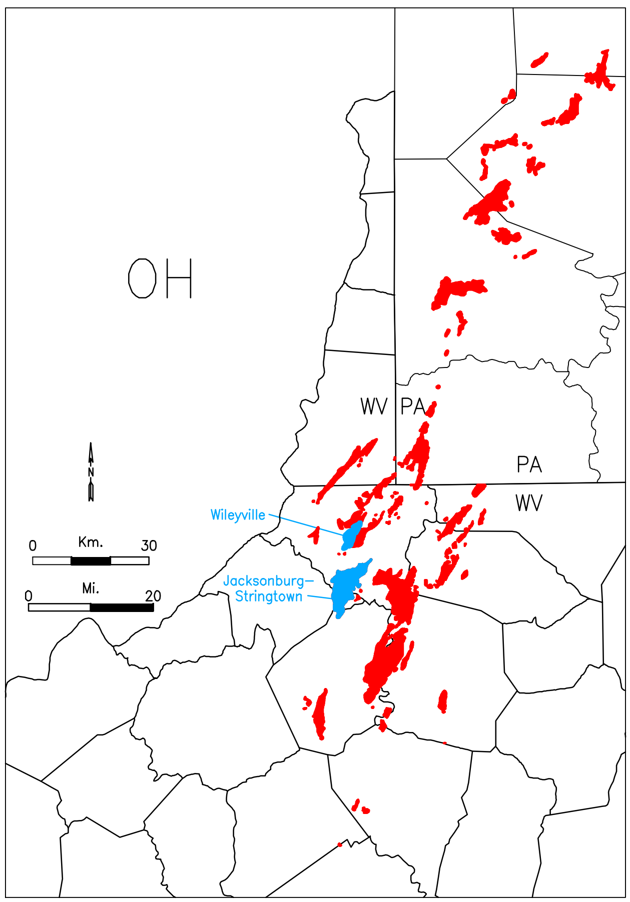

Figure 1. Fields producing from Gordon interval in Pennsylvania and West Virginia, from Whieldon and Eckard (1963) and Harper and Laughrey (1987). Where fields produced from multiple intervals, only parts with Gordon production are shown here.

Depositional Environment

In a study of Upper Devonian sandstones in northern West Virginia, Boswell and Jewell (1988) inferred fluvial, deltaic, shoreline, and shallow shelf environments of deposition from isopach maps of subsurface sandstones and from equivalent outcrops to the east. Shoreline deposits ranged between fluvially dominated, recognized by dip-trending lobes of sandstone, and wave-dominated, recognized by linear, strike-parallel sandstone bodies.

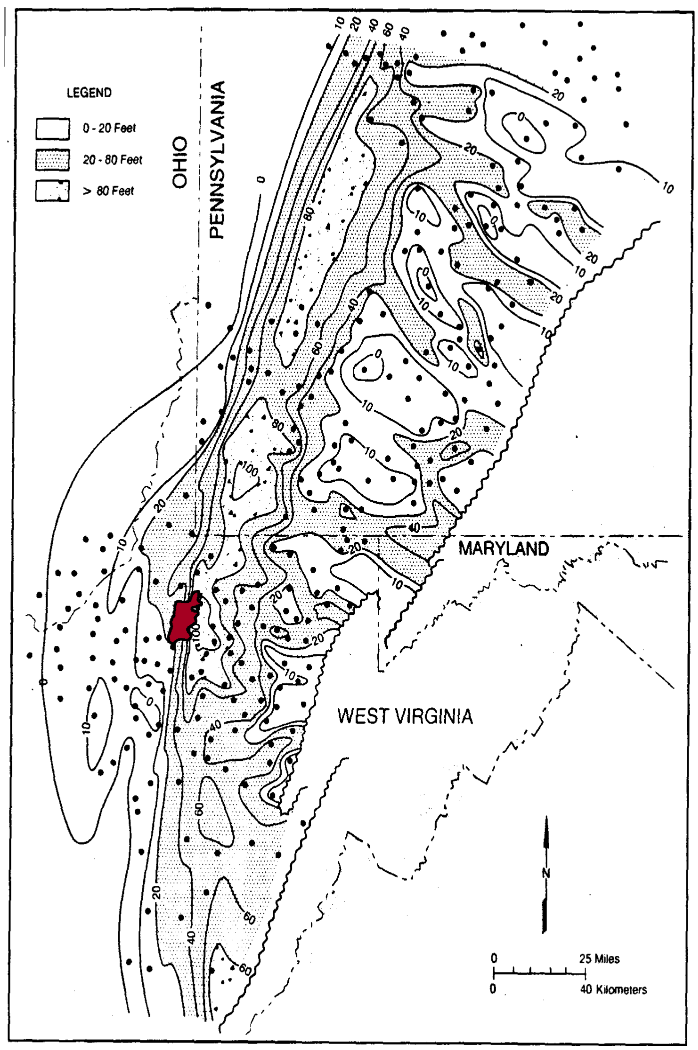

Figure 2. Thickness of Gordon interval (modified from Boswell and others, 1996). Red area shows the location of Jacksonburg-Stringtown field.

Regional isopach maps (Boswell and Jewell, 1988) show a strong north-south trend in thickness of the Gordon interval as a whole, and of individual sandstones, including the Gordon Stray. To the east of the study area, sandstones trend more east-west, possibly representing deposition in river and distributary channels that fed the Gordon shoreline deposits.

Stratigraphy and Lithofacies in Jacksonburg-Stringtown Field

Lithofacies were defined from cores on the basis of grain size, variability of grain size within beds (sorting), presence of laminations, evidence of bioturbation, lithologic texture, and presence of crossbedding. Lithologic units were then compared with geophysical logs to determine log characteristics corresponding to each lithofacies.

Five lithofacies were recognized in this field: featureless sandstone (Fss in Figure 3), Laminated sandstone (lss), Conglomeratic sandstone (css), shale (sh) and heterolithic bioturbated (hb). Each lithofacies is relatively distinctive in core and has a recognizable pattern in geophysical logs. The three sandstone lithofacies (Fss, Lss, and Css) make up most of the Gordon interval. Where present, the shale lithofacies is useful for field-scale correlation. The Hb lithofacies lies above the reservoir and is useful for paleoenvironmental interpretations and correlation.

The primary reservoir in the field comprises three parasequences. Overall, the Gordon and each individual parasequence coarsen upward. Boundaries between parasequences are placed at the top of thin shales interbedded with the sandstone. Additional markers within the Gordon include rocks of the Hb lithofacies and the thin sandstones at the bottom of the section. These three markers help define the Gordon and allow for correlation throughout the field.

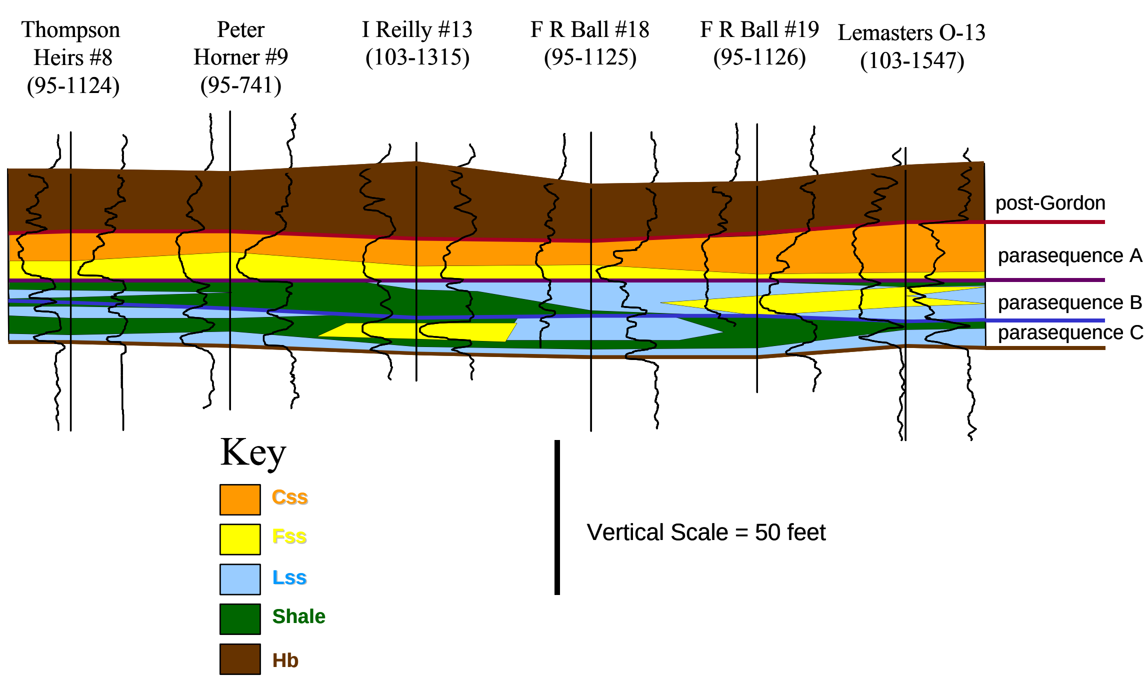

Figure 3. Correlation of wireline logs for cored wells in Jacksonburg-Stringtown oil field. For each well, the gamma ray log is on the left, and the density log on the right. No horizontal scale.

Stratigraphy and Lithofacies in Wileyville Oil Field

Study of cores from the Wileyville oil field showed lithofacies similar to those in the Jacksonburg-Stringtown field. From Jacksonburg-Stringtown field north to Wileyville field, parasequences B and C grade into shale and sandier portions of the lowermost parasequences pinch out. As a consequence, only three parasequences exist in Wileyville field (Figure 4). Only one interval in the Wileyville field—parasequence A—produces oil, whereas the lower two parasequences in Jacksonburg-Stringtown field include intervals of oil pay,

Sample of Wireline Logs

The sample of logs (Table 1) includes wells from the two fields, plus a well in the general vicinity of the fields (Figure 5). Wells representing Jacksonburg –Stringtown field include six having available cores used in correlation (Figure 3). The Gordon interval was cored in two wells in Wileyville oil field: permit numbers 1171 and 1685.

Files are in LAS format, and include gamma ray and density logs. *Caution: the two logs may be in different columns from file to file!*

References

Boswell, Ray M. and Jewell, G.A., 1988. Atlas of Upper Devonian/Lower Mississippian Sandstones of the Subsurface of West Virginia. Circular C-43. West Virginia Geological and Economic Survey. Morgantown WV, 144 p.

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Whieldon, Charles E., Jr., and Eckard, William E., 1963, West Virginia Oil Fields Discovered Before 1940: U.S. Bureau of Mines Bulletin 607, 187 p.

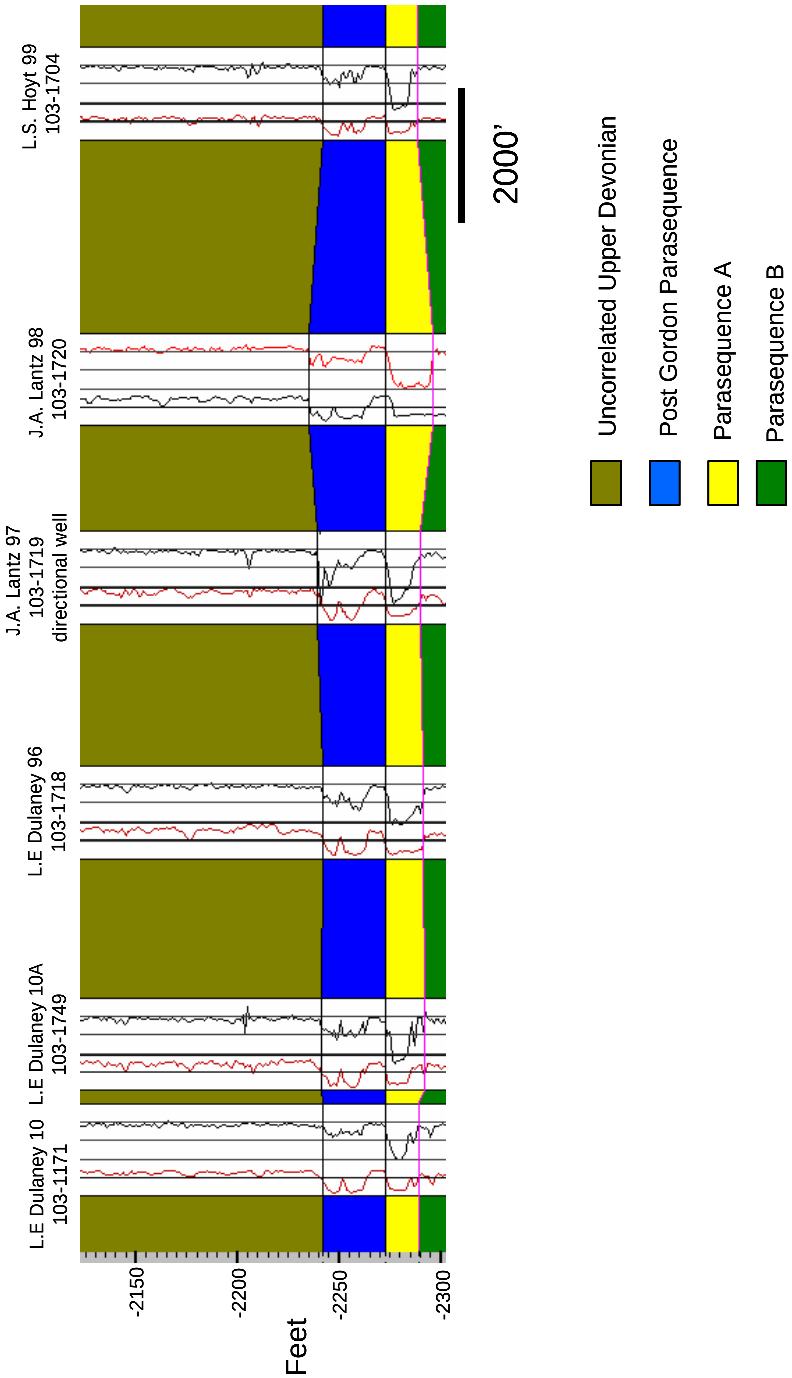

Figure 4. Stratigraphic cross section in southwestern part of Wileyville oil field. Not all of these wells are included in sample dataset.

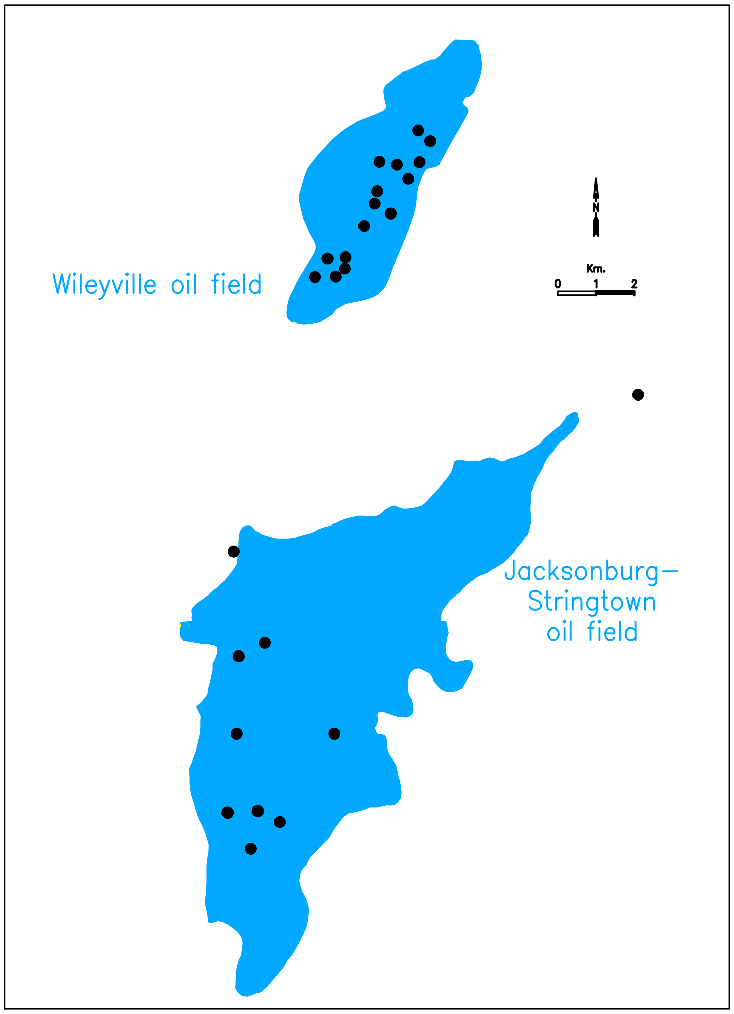

Figure 5. Locations of well logs provided in sample dataset.

Table 1. Stratigraphic Tops of Sample Wells from Jacksonburg-Stringtown and Wileyville Fields. Locations are UTM Coordinates. Location coordinates are in meters; surface elevation and measured depths are in feet.

Easting	Northing	Surface Elevation	Top Post-Gordon	Top A	Top B	Top C	Bottom C	Field
526451.7	4366199.0	1009	2871	2891	2908	2919	2930	Jacksonburg
525842.6	4367138.0	908	2763	2782	2798	2810	2821	Jacksonburg
526630.9	4367183.5	1093	2967	2987	3002	3014	3026	Jacksonburg
527212.2	4366897.0	1196	3070	3087	3103	3114	3128	Jacksonburg
526077.4	4369207.5	1381	3218	3242	3254	3266	3280	Jacksonburg
526132.1	4371237.5	1013	2859	2881	2896	2909	2920	Jacksonburg
528637.4	4369207.5	1138	3007	3025	3045	3059	3068	Jacksonburg
526000.5	4373980.5	974	2750	2778	2797	2812	2815	Jacksonburg
526814.8	4371591.0	1253	3358	3381	3397	3410	3420	Jacksonburg
536600.0	4378088.0	1347	3129	3160	3180	3193	3198	-
528675.6	4381184.7	1010	2822	2853	2870	2890		Wileyville
529421.6	4382510.9	1276	3110	3145	3163	3185		Wileyville
529692.3	4383095.0	1327	3180	3214	3234	3249		Wileyville
529765.4	4383418.5	1408	3265	3300	3317	3344		Wileyville
530281.1	4384118.6	1402	3285	3322	3337	3365		Wileyville
530839.0	4385015.8	1314	3236	3271	3287	3314		Wileyville
528915.1	4381393.0	1198	3016	3047	3065	3084		Wileyville
528935.2	4381692.4	1300	3120	3153	3171	3193		Wileyville
528459.8	4381655.9	1276	3088	3121	3140	3163		Wileyville
531153.6	4384730.8	1410	3329	3362	3388	3431		Wileyville
529822.1	4384195.4	1082	2974	3008	3023	3050		Wileyville
530579.1	4383743.8	1016	2895	2930	2954	3008		Wileyville
530875.6	4384182.4	1406	3307	3341	3361	3412		Wileyville
530116.5	4382835.8	1336	3182	3215	3238	3259		Wileyville
528134.8	4381172.6	1339	3147	3181	3194	3216		Wileyville