North Dakota Geological Survey

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June 10, 2011

Mr. James R. Deutsch
Director, Reclamation Division
North Dakota Public Service Commission
Bismarck, North Dakota 58505

RE: Review of South Heart Coal, LLC's Mining Permit SHSH-1001

Dear Mr. Deutsch:

I recently completed my review of South Heart Coal, LLC's application for a surface coal mining permit in western Stark County (SHSH-1001). I reviewed the geology section (chapter 2.3) and to a much lesser degree the groundwater hydrology section (chapter 2.5) focusing primarily on uranium. The company has amassed and presented quite a bit of data on the proposed site. Most of my time was spent placing the geophysical logs and groundwater uranium analyses presented by the company into a regional context. I also created geologic cross-sections across the proposed mine site so I could plot the stratigraphic position of spikes from the gamma ray logs and the uranium concentrations above the MCL.

I have not had time to evaluate the whole rock acid digestion data that the company submitted with the mine permit application and then supplemented with additional data on May 23. I may have difficulty placing this information into context with data outside of the area. I am not aware of a whole rock database for the Fort Union Group that I can compare it to. The NURE samples were derived from stream sediment and other surface samples and may not offer a good comparison. Rather than delay this review, I am submitting it now and will submit any comments that I might have regarding the whole rock analysis at a later date.

Please contact me if you have any comments regarding the attached review.

Sincerely,

Edward C. Murphy
State Geologist

Encl.

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Review of South Heart Coal, LLC's Mining Permit SHSH-1001

Edward C. Murphy
North Dakota Geological Survey

Introduction

Uranium deposits are known to exist in the vicinity of the proposed coal mine in southwestern North Dakota. However, prior to the vast amount of data generated by Great Northern Project Development L.P., the information available for the proposed site did not include indicators for uranium. Three gamma ray logs and ten groundwater analyses from within the proposed mine boundaries, generated during the 1970s, did not indicate localized concentrations of uranium.

Gamma Ray Logs

Over the last ten years, the Geological Survey has studied thousands of gamma ray logs from oil wells and mineral exploration test holes in southwestern North Dakota. Logs that had increased gamma counts (or spikes) that might be attributable to the presence of uranium were plotted and published on a series of 1:100,000 (100k) scale maps. One of these maps, the Belfield 100K sheet, contains the proposed South Heart coal mine. One of the primary reasons these maps were published was to provide mineral companies with potential areas upon which to focus uranium exploration.

For this permit application review, 442 gamma ray logs within a 13-18 miles radius of the proposed site were reviewed and the values of the gamma spikes were recorded. In addition, the 124 gamma ray logs that were generated by Great Northern Properties within the proposed mine site during the coal exploration phase were also studied and the value of those gamma spikes were also noted. Employing the same methodologies used when generating the 100K uranium maps, I determined that roughly 10% (12 of 124) of the Great Northern gamma ray logs contain spikes that may be attributable to uranium (Table 1 and North Dakota Geological Survey Geologic Investigations No. 138). The scales for the Great Northern gamma ray logs are in American Petroleum Institute (API) units, while the vast majority of the coal and mineral exploration holes in the Geological Survey database are scaled in gamma counts per second (cps). It can be difficult enough quantitatively comparing one cps logging program to another cps program due to differences in gamma tools, calibration, etc, it is even more of a problem when some are in cps and others in API units. For that reason, I asked Great Northern Project Development L.P. to contact the logging company (Century Geophysical) and request the conversion information from API to cps. I received a table of conversion formulas from the company on May 23, 2011. Conversion formulas were not available for the wells logged by Braun Intertec; that is, those logs with a SHMW-__HTB hole number. At that time, I also

Table 1. Spikes on gamma ray logs that may indicate the presence of uranium.

Hole Number	Depth Interval (ft)	Lithology	API Units From Log	API to cps conversion factor	cps
SHMW – 2C	29 - 30	mudstone	180	1 CPS = 3.25 API	57
	41 - 42	siltstone	195	1 CPS = 3.25 API	60
SHMW – 3HTB	2 -- 3	siltstone	> 150	?	
	5 -- 22	sandstone	> 150	?	
SHMW-3D	2 -- 3	siltstone	no reading	1 CPS = 3.25 API	
SHMW-3D	5 -- 22	sandstone	**135**	1 CPS = 3.25 API	42
SHMW – 5D	16-18	claystone	200	1 CPS = 3.25 API	62
SHMW-- 8HTB	19-20	mudstone	> 150	?	
SHMW-- 8D	18-20	mudstone	**218**	1 CPS = 3.25 API	67
SHMW – 10D	7 -- 9	mudstone	200	1 CPS = 3.25 API	62
SHMW-- 12D	10 -- 12	mudstone	190	1 CPS = 3.25 API	58
	14-15	sandstone	194	1 CPS = 3.25 API	60
	24-25	siltstone	188	1 CPS = 3.25 API	58
SHMW – 13C	44-45	siltstone	**235**	1 CPS = 3.25 API	72
	45.5-46	siltstone	190	1 CPS = 3.25 API	58
	46.5-47	siltstone	**222**	1 CPS = 3.25 API	68
SH02 -- 22	37.5-40.5	claystone	185	1 CPS = 0.70 API	264
SH02 -- 23	49.5—54	claystone	260	1 CPS = 0.70 API	371
SHOB – 30C	10 -- 11	claystone	170	1 CPS = 0.97 API	175
SHOB – 41	13-14	claystone	200	1 CPS = 0.97 API	206
	20.5-22	coal	100	1 CPS = 0.97 API	103
	23-24	coal	150	1 CPS = 0.97 API	155
SHOB – 127	65.5-66.5	sandstone	**567**	1 CPS = 1.05 to 1.09 API	530
API units in bold were obtained from a digital file of the log.					

received digital files for two of the four gamma ray logs I had requested where the gamma trace had gone off-scale. I received digital files of SHMW-13C, SHOB-127, SHMW-3D, and SHMW-8D. The latter two digital files were replacements for SHMW-3HTB and SHMW-8HTB which were unavailable.

As previously noted, caution should be taken when comparing gamma ray logs from different logging programs because of different logging tools, calibration differences, different scales, etc. They cannot be compared on a one-to-one basis. However, the conversion of the Great Northern gamma ray log spikes to cps enables some generalizations to be made and allows for general trends to be observed (G.I. 138). Of the 20 gamma spikes that were identified on the 12 Great Northern gamma ray logs, three spikes were off-scale and could not be found digitally, ten were less than 100 cps (when converted), three were between 100 and 200 cps, and four had values greater than 200 cps (Table 1). Of these dozen Great Northern gamma ray logs, three were located outside of the proposed mine boundary, five were located at the boundary, and four were located within the mine (G.I. 138).

SHMW – 3

The gamma ray log for SHMW-3HTB is off-scale (> 150 API units) at depths of 2-3 feet and 5-22 feet. These intervals are primarily siltstone and sandstone and should have API values closer to 50-75. Unfortunately, the digital file was not available for this log, so the API value could not be determined. The gamma log for an adjacent hole (SHMW-3D) contained similar lithologies, but did not contain gamma spikes within these intervals, suggesting the source of the gamma spike (likely uranium) was localized.

SHMW-8

The gamma ray log for SHMW-8HTB is off-scale (> 150 API units) at a depth of 19-20 feet. This interval is primarily mudstone and should have API values closer to 120. Unfortunately, the digital file was not available for this log to determine the API value. The gamma log for an adjacent hole (SHMW-8D) also contained mudstone at this depth and had a digital API reading of 218.

SHMW-13C

The gamma ray log for SHMW-13C is off-scale (>200 API units) at depths of 44-45 and 46.5-47 feet. The intervals are siltstone and should have API readings of approximately 120. The digital log file for these intervals has values of 235 and 222 API units at these respective intervals.

SHOB-127

The gamma ray log for SHOB-127 is off-scale (>200 API units) at depths of 65.5-66.5 feet. This interval is sandstone and should have an API reading of approximately 70. The digital log file for this interval was 567 API units, by far the largest value encountered during the various logging programs.

To better evaluate the spikes on the gamma ray logs and the groundwater chemistry, a series of five east-west geologic cross-sections were constructed across the proposed mine site. The vertical scales on these sections are exaggerated and there is no true horizontal scale. The wells were generally spaced equidistant from each other. These cross sections were constructed to intercept all of the exploration holes with logs containing gamma spikes, except for SHMW-13C, which is located one mile south of the proposed mine site (Figure 1). All but one of these

gamma spikes occurs in the overburden above the "D" coal (Figures 2-6). That gamma spike (530 cps in log number SHOB-127) occurs approximately 15 feet below the base of the "D" coal and, therefore, would not be disturbed by mining (Figure 4). The Sentinel Butte Formation sandstone that contains this gamma spike appears to be directly overlain, at least in some places, by an alluvial deposit of the South Branch of the Heart River. This alluvium is potentially the source of the uranium. The majority of the other gamma spikes occurred within 50 feet of the surface or what would be the upper part of the overburden if this area is mined (Figures 2-6).

All five of the geologic cross-sections depict areas where the "D" coal is directly overlain by sandstone. Throughout southwestern North Dakota, the highest cps gamma spikes generally occur along sandstone/coal contacts (ie., where the coal is directly overlain by sandstone), at the base of sandstones where underlain by other lithologies, or in organic lenses within sandstones. The only gamma spike observed in close proximity to the "D" coal was in SHMW-02, where a small spike was observed near the base of a siltstone that was separated from the underlying "D" coal by a two-foot-thick claystone (Figure 2). There were no indications on the gamma ray logs of increased gamma counts within the "D" coal.

There are several areas within this portion of southwestern North Dakota that contain high gamma readings on gamma ray logs. The proposed South Heart coal mine is located two miles north of the South Heart Badlands (or the Little Badlands) that contains spikes on gamma ray logs up to 2,400 cps. Nine miles to the northwest, cps values of gamma spikes are up to 3,700 cps along a 12-mile-long northerly-trend that encompasses more than a half dozen old uranium mines. Thirteen miles to the southwest is another area of gamma spikes and old uranium mines with cps values up to 450 (G.I. 138). The Chalky Buttes, 32 miles to the southwest, contain readings on gamma ray logs over 5,000 cps.

Groundwater Analyses

Great Northern Project Development L.P. installed 32 monitoring wells in and around the proposed mine site and tested for a number of major ions and metals including uranium. The maximum contaminant level (MCL) for uranium in drinking water is 30 micrograms per liter (ug/l). The uranium concentrations in the Great Northern water samples were reported in milligrams per liter, but were converted to micrograms per liter for Table 2 and North Dakota Geological Survey Geologic Investigations No. 139. While groundwater within the majority of the Great Northern monitoring wells contained less than 1 ug/l of uranium, five monitoring wells contained at least one water sample that exceeded the MCL for uranium (Table 2). Four of those monitoring wells are very shallow, less than 25 feet deep. Of the five wells, one is located more than one mile northeast of the proposed mine boundary (SHMW-15A1) and two others are on the southwestern edge of the proposed mine boundary (SHMW-08 and SHMW-11A2) (Figure 1). The average uranium concentrations (obtained after discarding the high and low analysis) exceeded the MCL in two of these monitoring wells (SHMW-09A2 and SHMW-08S) and were just below the MCL in a third well (SHMW-14A1). The maximum uranium concentrations in these wells ranged from 44-93 ug/l. Monitoring wells SHMW-09A2 and SHMW-14A1 are in alluvium in areas where the "D" coal has been removed by erosion, so those areas would not be mined (Figures 4 and 5).

Table 2. Monitoring wells that exceeded the MCL for uranium.

Monitoring Well	Location	Screen Interval (ft)	Screen Lithology	Average U (ug/l)	Max U (ug/l)
SHMW-08S	western edge	80-100	primarily ss, some clyst, thin coal	53	59
SHMW-09A2	within boundary	21-24	primarily mudstone, some ss	67	93
SHMW-11A1	southwestern edge	13-18	mudstone	19	40
SHMW-14A1	within boundary	12 - 17.0	silt and clay	28	82
SHMW-15A1	one mile northeast	9 - 14.0	sandstone	23	44

The average uranium concentrations from Great Northern Properties 32 monitoring wells (collected from 2006-2009) were compared with uranium concentrations that had been determined for more than 800 private wells in the area during the 1970s. The Bauer & Land Company sampled 3,500 domestic and stock wells for uranium in southwestern North Dakota from 1976-1978 and the U.S. Department of Energy sampled 514 domestic wells in this area during the summer of 1979 under the National Uranium Resource Evaluation (NURE) program. As previously noted, Great Northern Properties reported their findings in milligrams per liter which was converted to micrograms per liter (ug/l). Both Bauer & Land and the NURE project reported their uranium concentrations in parts per billion. Concentrations in parts per billion (ppb) are generally accepted as roughly equivalent to micrograms per liter (ug/l). As a result of these three projects, water samples were collected from 874 private wells or monitoring wells within the attached South Heart map. The uranium concentration exceeded the MCL in 142 (16%) of these wells with the maximum concentration recorded at 1,300 ppb in a well approximately six miles north of Belfield. Sixty-eight percent of these wells (97 wells) were within 50 feet of the surface, 28% (40 wells) were 50 to 100 feet deep, and only 3% (5 wells) were 100 to 200 feet deep. Only 10% of the wells tested (88 of the 874) were more than 200 feet deep and none of those exceeded the MCL for uranium.

The screen intervals for monitoring wells SHMW-08s, SHMW-09A2, and SHMW-14A1 were plotted on the geologic cross-sections (Figures 4 and 5). Monitoring wells SHMW-11A1 and SHMW-15A1 plotted outside of the cross-section areas (Figure 1). Monitoring well SHMW-09A2 contained an average uranium concentration of 67 ug/l, SHMW-14A1 an average of 28 ug/l, and SHMW-11 an average uranium concentration of 19 ug/l (Table 2). Wells SHMW-09A2 and SHMW-14A1, and possibly SHMW-11, appear to have been screened in alluvium (Figures 4 and 5). Of the five monitoring wells that contained uranium values in excess of the MCL, mining is only likely to occur in the vicinity of SHMW-08 (Figures 1 and 4). That monitoring well, screened at the base of a sandstone approximately 16 feet above the "D" coal, contained an average of 53 ug/l of uranium (Figure 4).

Summary

Some of the gamma ray logs within the proposed mine site contain spikes that may be attributable to the presence of uranium (Table 1). Gamma spikes within sandstones or coals in logs SHMW–3HTB, SHMW--12D, SHOB–41, and SHOB–127 appear to be stronger indicators of uranium than the others. There are no indications that economic uranium deposits exist within the proposed mine site. Values on gamma ray logs in excess of 1,000 cps are generally viewed as indicators of economic uranium deposits. The gamma spikes noted on the logs within the proposed coal mine were far below those levels.

There is no evidence (neither gamma ray logs nor groundwater chemistry) of widespread increases in uranium in the "D" coal that is proposed to be mined at this site.

Groundwater analyses obtained by Great Northern confirm the presence of uranium in concentrations that exceed the MCL, at least in localized areas. It may be worth noting that a detailed subsurface analysis of much of southwestern North Dakota would likely yield similar results.

Four of the five Great Northern monitoring wells that contained groundwater samples in excess of the MCL for uranium were within 25 feet of the surface. The screen interval for the fifth monitoring well was 80-100 feet deep. It appears that only this latter well would be disturbed by mining, as the other four wells are either outside of the mine boundary or within alluvium and would not be disturbed by mining.

Similar gamma ray log spikes or elevated uranium in groundwater do not occur in the vicinity of the four major coal mines currently operating in North Dakota; the Falkirk, Center, Beulah, or Freedom mines. However, similar potential indicators of uranium (gamma spikes on logs) as well as elevated uranium concentrations in groundwater are present in the vicinity of the old Gascoyne mine and elevated uranium occurs in groundwater near the old JK Ranch mine. The Gascoyne coal mine operated up until 1995 and the JK Ranch coal mine operated for a few years in the 1990s (see attached maps).

Geophysical logs and groundwater chemistry suggest there are isolated deposits of increased uranium within the proposed mine area. Most of these indicators occur at or near the proposed mine boundaries. These occurrences may well be too localized and/or too low in concentration to be detected during the mining process. However, if a mining permit is issued for this site, it may be prudent to monitor radon levels in the pit and to routinely monitor dust generated during the mining process for radioactivity to determine if permit modifications are necessary or until such time as it is determined that no environmental impacts are being detected. In addition, uranium should be a required constituent of the groundwater monitoring program both during and after mining has occurred.

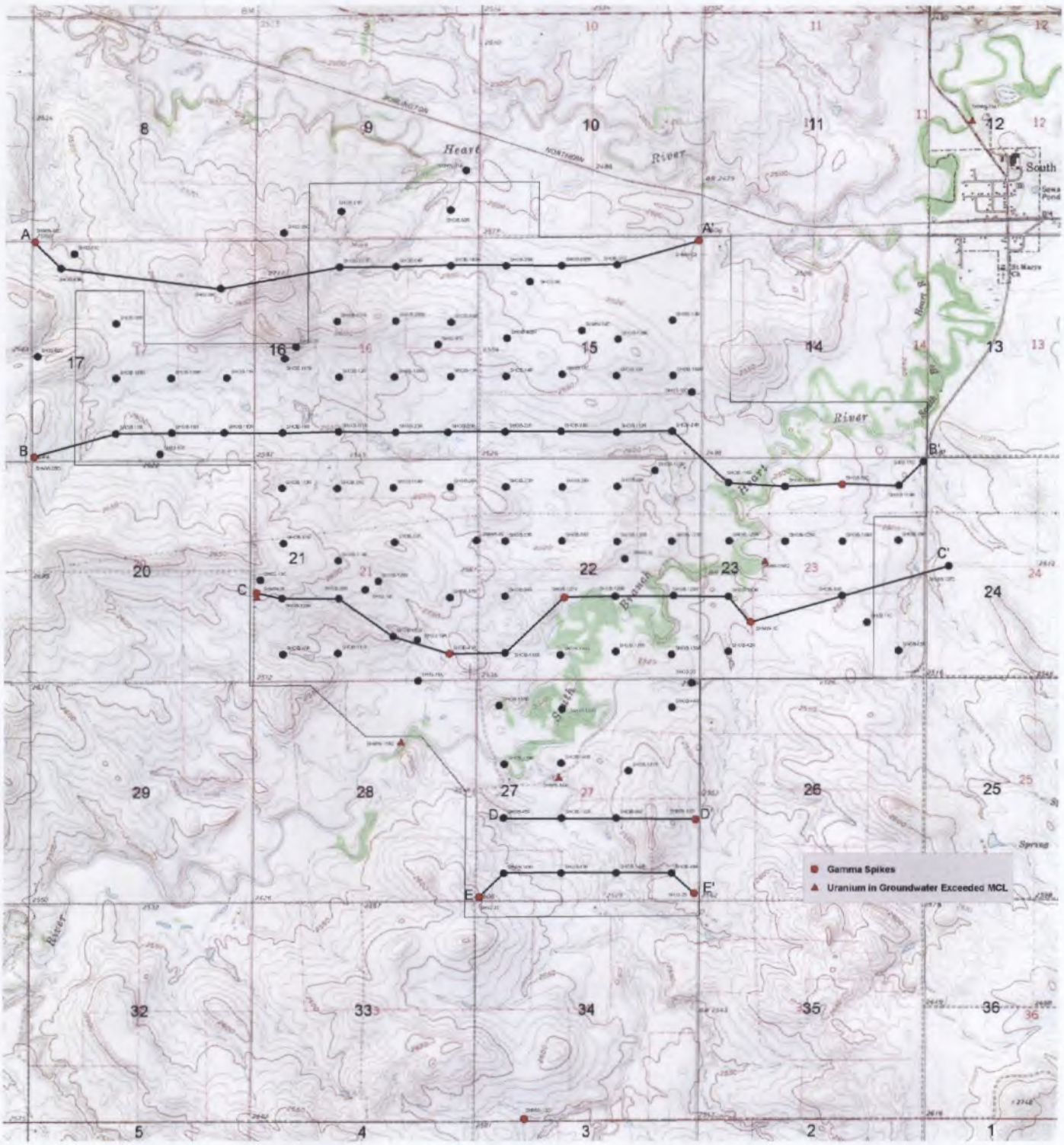

Figure 1. Traces of the five geologic cross-sections constructed across the proposed South Heart coal mine.

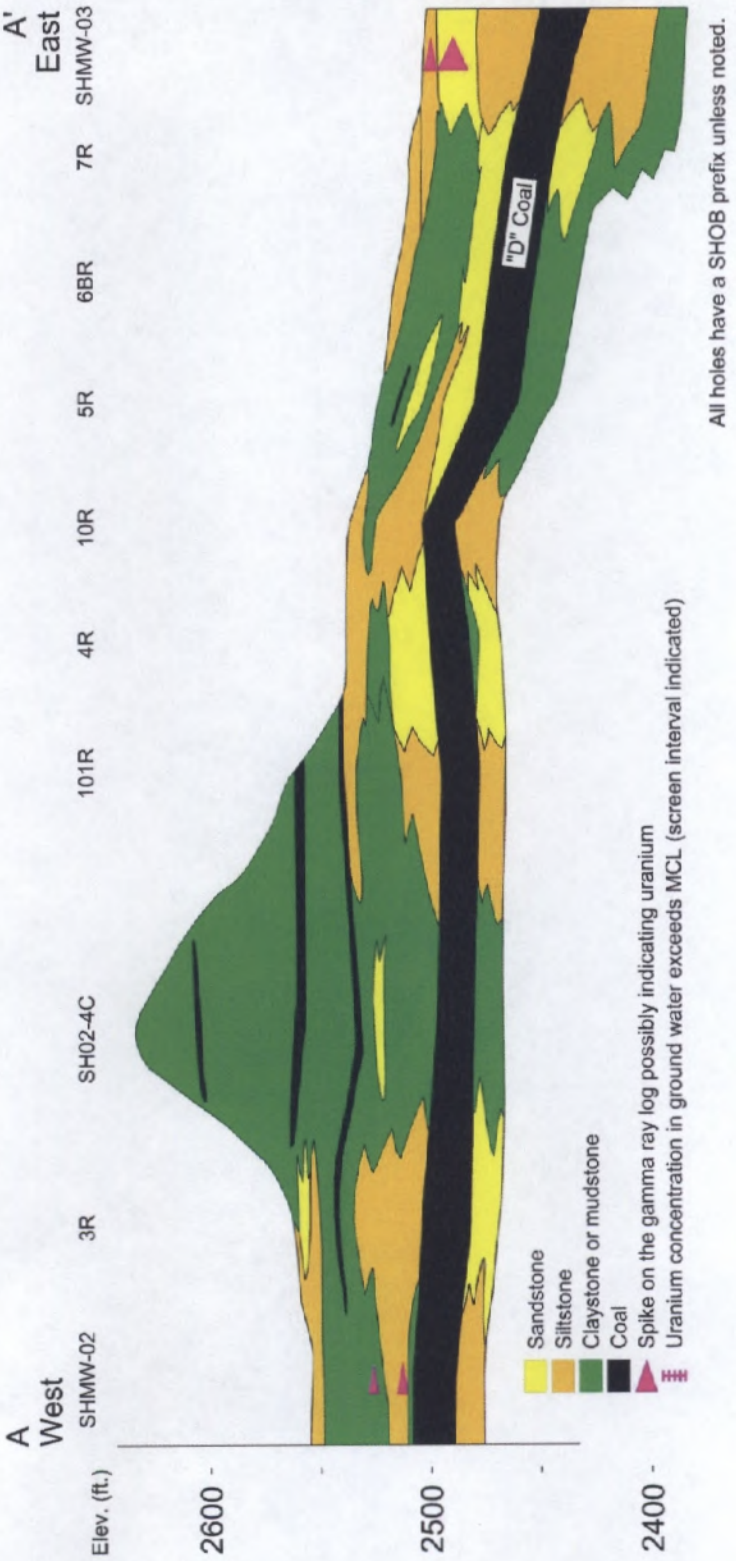

Figure 2. Geologic cross-section A-A' across the northern-most portion of the proposed South Heart coal mine.

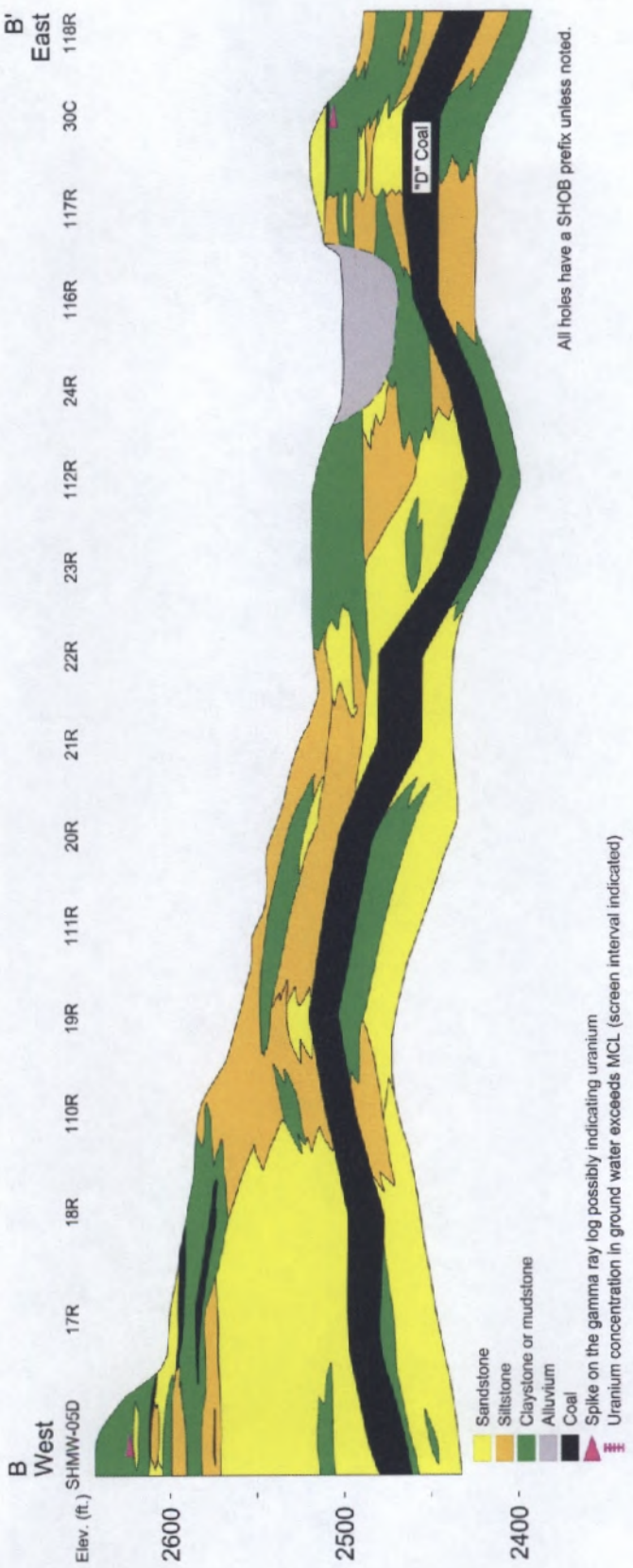

Figure 3. Geologic cross-section B-B' across the proposed South Heart coal mine.

Figure 4. Geologic cross-section C-C' across the midpoint of the proposed South Heart coal mine.

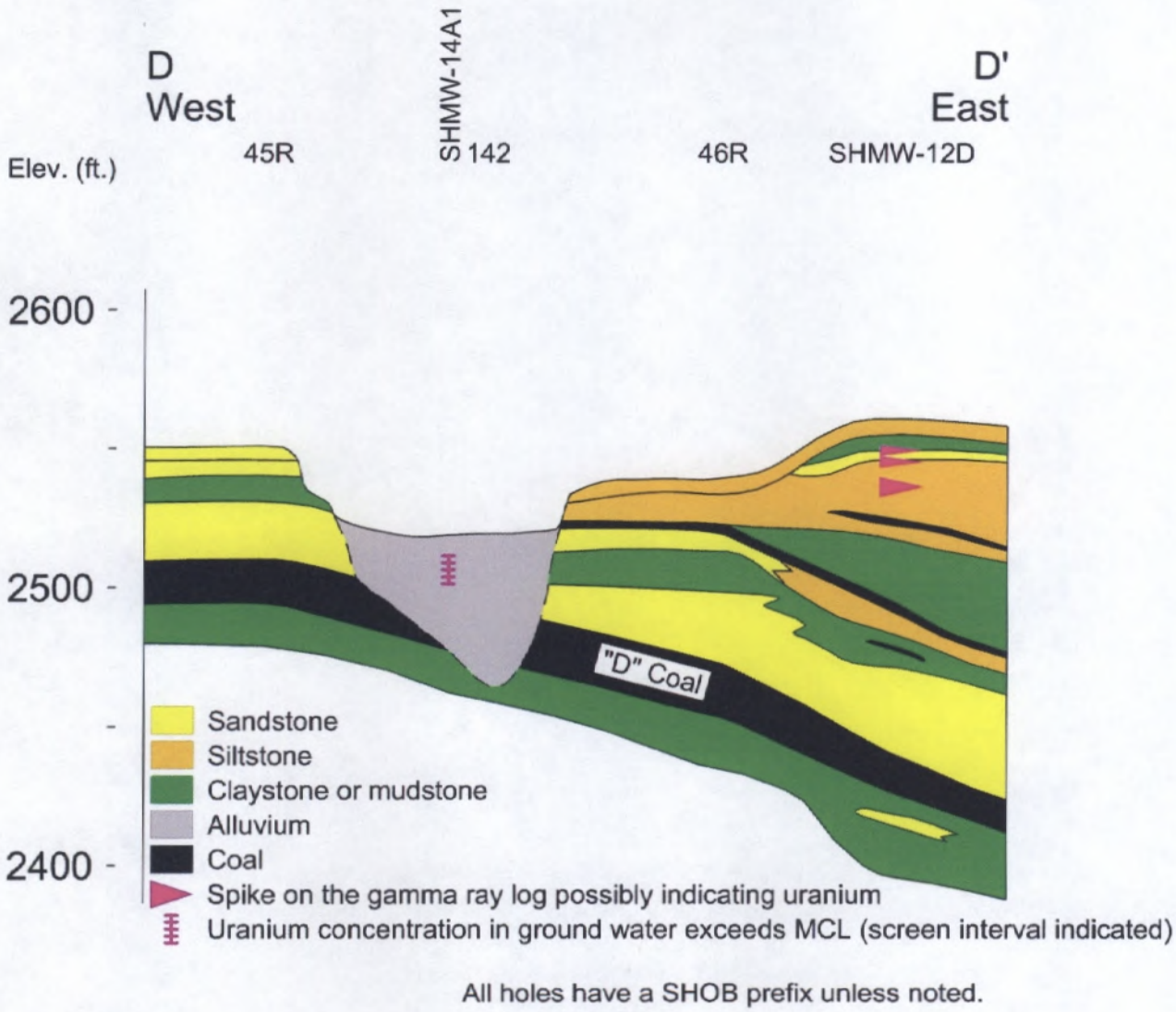

Figure 5. Geologic cross-section D-D' across the proposed South Heart coal mine.

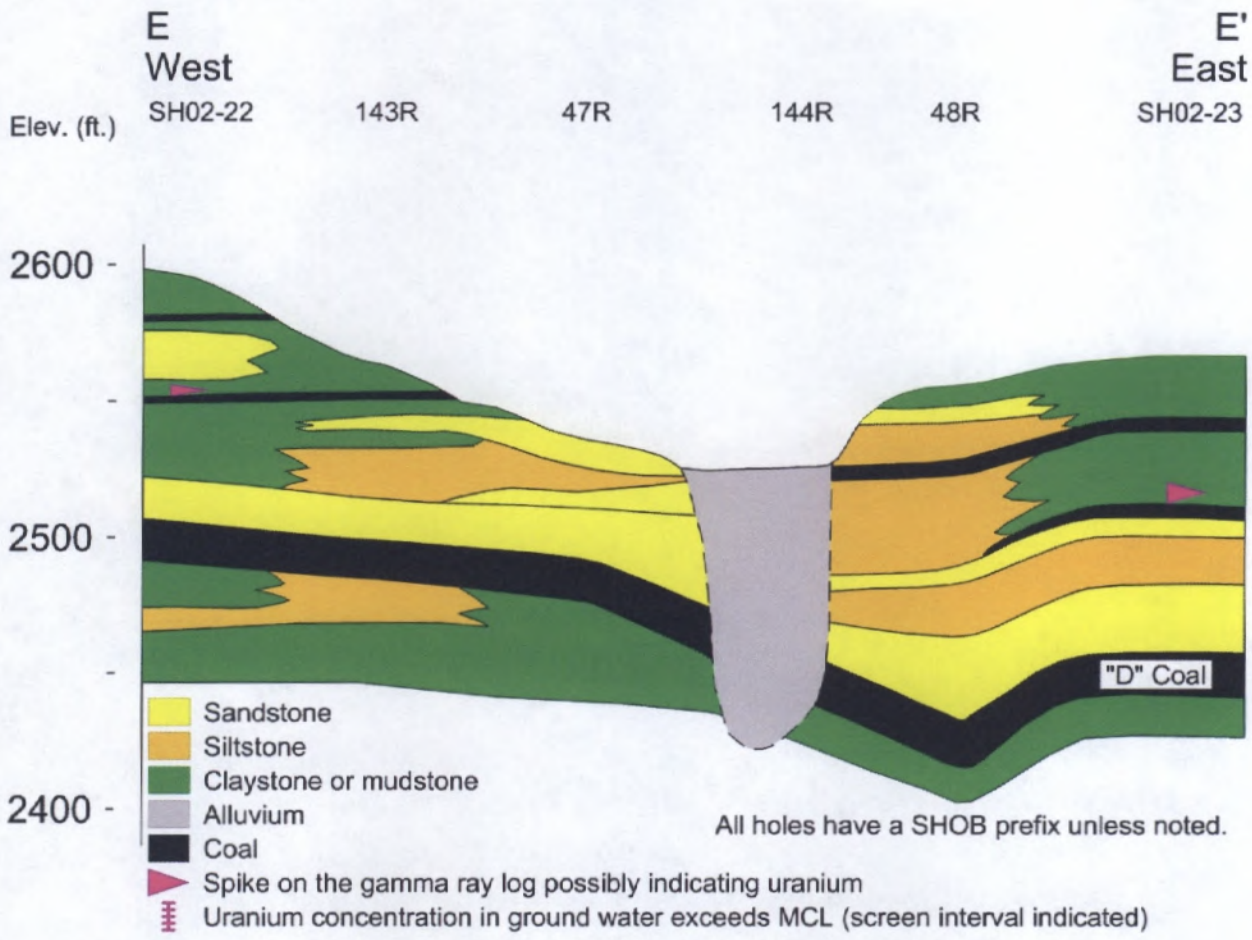

Figure 6. Geologic cross-section E-E' across the southern edge of the proposed South Heart coal mine.