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January 31, 2017

Joseph M. Dlugolenski
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Re: Additional comments on DEC Application ID#0-9999-00075/00001 (Cargill Mine Shaft #4)

Dear Mr. Dlugolenski:

These comments, which supplement my comments dated December 9, 2016, indicate that additional investigation is needed to determine – or rule out – whether a fault intersects Cargill's Corehole 18 and produces a repeated section on the gamma log for Corehole 18. The presence or absence of such a fault would affect both Mine Shaft #4 and northward expansion of subsurface mining, thus adding to the logic that Shaft #4 and additional mining need to be treated as a single SEQRA review rather than two separate or segmented reviews.

The evidence for a repeated section and intersecting fault in Corehole 18 is the unexplained gamma spike which rises from about 20 API units to about 200 API units in the depth interval from about 1510 to 1555 feet on the gamma log for Corehole 18 (API well no. 31-109-26509). See Figs. 1-2 (attached), and see also p. 23 and Appendix C of the November 2013 report by RESPEC, *Cargill Deicing Technology Lansing Mine, Corehole #18 Stratigraphic Test Hole, Installation and Data Collection*, Topical Report RSI-2381.

To the best of my knowledge, this is new information that has not previously been raised in the context of Shaft #4.

The interval in question (from about 1510 to 1555 feet depth) appears to be a repeated section of overlying strata which would indicate that a fault intersects the well bore.

Alternatively, RESPEC interprets this interval as part of the Helderberg Group, including the Deansboro Member of the Coeymans Formation. See Fig. 1 (attached) and RESPEC, op. cit, 16-25. This interpretation is stratigraphically plausible and does not involve any repeated section or fault. The problem with this interpretation is that a strong gamma spike is not characteristic of the Deansboro Member and/or the Coeymans Formation. These units are limestones, as indicated, for example, by J.N. Berdan, *The Helderberg Group and the Position of the Silurian-Devonian Boundary in North America*, USGS Bulletin 1180-B (1964), Fig. 2. Strong gamma spikes are typically associated with black shales but not with limestones.

Comparisons can also be made to other wells that penetrate the Coeymans Formation. Such comparisons do not show a strong gamma spike at or near the interval where the Coeymans is present. Logs for two such wells are shown in Fig. 1. Both wells are known to penetrate the Coeymans Fm.: see January 2005 report by New York State Museum, *Systematic Technical Innovations Initiative, Brine Disposal in the Northeast*, DE-FC26-01NT41298, Fig. 13b (and note that Table 3 of Appendix A could provide other examples, and see also Fig. 9 for another well that penetrates undifferentiated Helderberg strata). Comparisons cannot be made to other, closer wells around Borehole 18 because the Coeymans Fm. is absent in these wells (e.g., 31-109-26039 in Lansing, 31-011-26027 in Ledyard, 31-011-23840 in Genoa, and 31-109-22867 in Dryden).

An unexplained gamma spike may seem a small matter – but wireline logging of oil and gas wells is a mature technology, and an unexplained gamma spike of this magnitude cannot simply be dismissed. Without a good explanation of this gamma spike, *further investigation is needed to characterize or rule out the repeated section and fault implied by the gamma spike*. The issue is complicated by the location of the casing shoe at about 1553' depth in Corehole 18, but a gamma spike of this magnitude is generally not associated with casing. Residual drilling mud may also affect gamma readings (for example, see http://petrowiki.org/Gamma_ray_logs), but even if mud were used in drilling/coring the different stages of this hole, is not clear how this could affect the gamma counts over tens of feet of vertical distance in the well. As noted, the gamma spike gradually rises from about 20 API units to about 200 API units in the depth interval from about 1510 to 1555 feet.

If further investigation shows an old and apparently inactive fault intersecting Corehole 18 or in close proximity to the wellbore, would it matter? In general, such a fault might be a zone of weakness or a pathway for fluid flow, but even if these were ruled out there would be a site-specific question of fault reactivation due to ongoing settling and subsidence (and especially differential settling/subsidence) that occurs in the overlying bedrock as the mine slowly closes. One consequence could be sporadic slippage along the fault, producing microseismic events such as those shown in Fig. 3.2-81 of Volume II of Spectra's 2000 Expanded Environmental Assessment, but more substantial reactivation of an inactive fault may also be triggered by the ongoing deformation of bedrock above a continually closing mine.

Faults already documented or proposed in the general vicinity of the mine include the Cayuga Lake Fault (a tear fault or right-lateral strike-slip fault) shown in Fig. 3 of P.J. Murphy, "Detachment structures in south-central New York," *Northeastern Geology* **3**, 105-115 (1981). See also R.D. Jacobi, "Basement faults and seismicity in the Appalachian Basin of New York State," *Tectonophysics* **353**, 75-113 (2002). Note that a tear fault would generally not produce a repeated section if the fault is configured as a clean, planar vertical surface but may do so if configured as a series of en-echelon shears and associated thrusts.

In summary, further investigation is needed to characterize or rule out the repeated section and fault implied by the strong gamma spike seen on the Corehole 18 logs.

Thank you for considering comments on this matter.

Sincerely,

Raymond C. Vaughan, Ph.D.
Geologist/Environmental Scientist

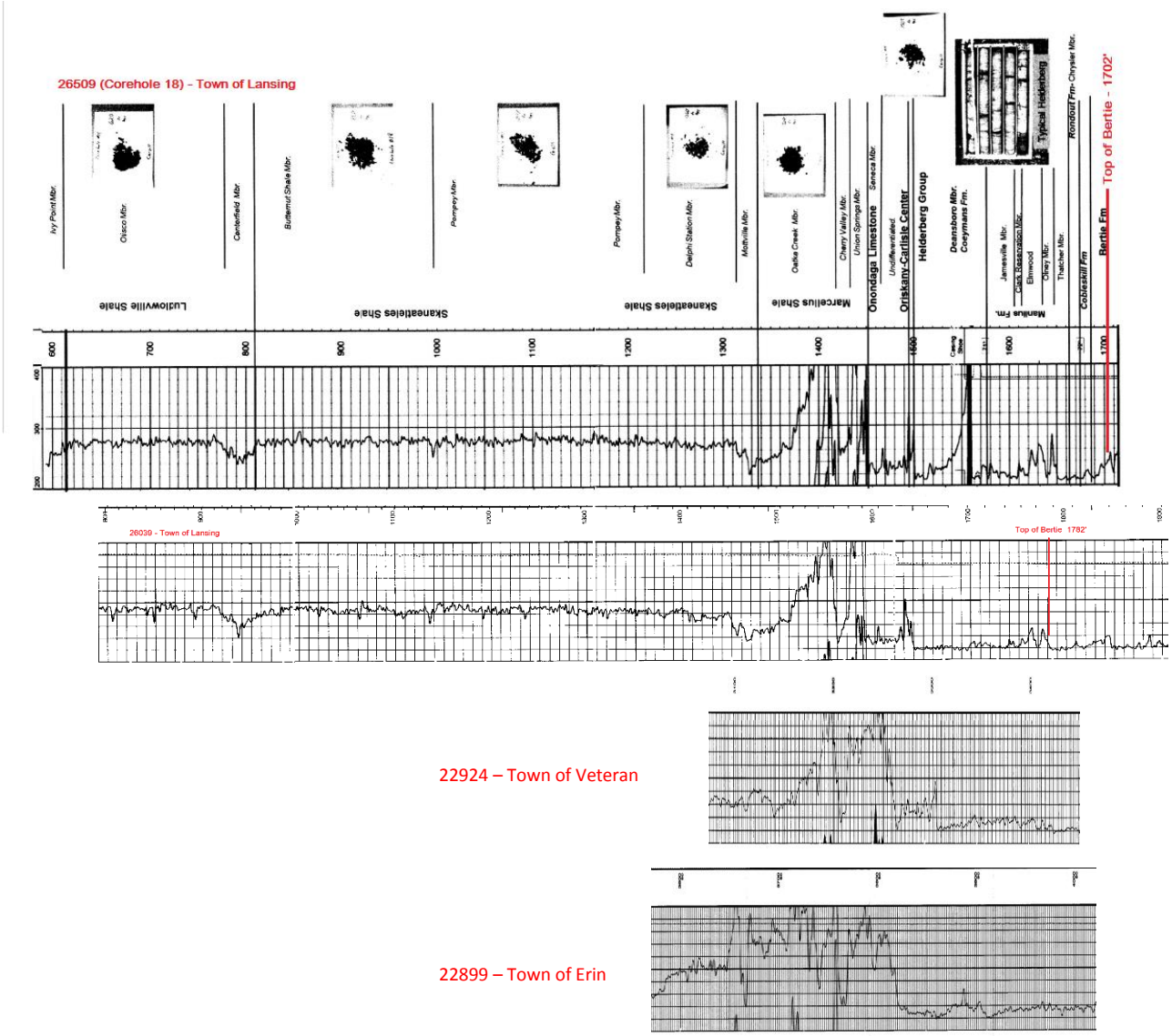

Fig. 1: Gamma log comparison of Corehole 18 (well 31-109-26509) to nearby gas well 31-109-26039 in which Coeymans Fm. is absent; also to more distant wells 31-015-22924 and 31-015-22899 (in Towns of Veteran and Erin in Chemung County), in both of which Coeymans Fm. is present. Wells are aligned here on Cherry Valley Member; depths to top of Bertie Fm. are picks by driller. Note that well 31-109-26039 is about a mile from Corehole 18, and thus provides a good basis for comparison. *Comparison of these two wells shows that the Bertie to Onondaga interval is about 55' thicker in Corehole 18 than in 31-109-26039. Is this difference due to a repeated section in Corehole 18, indicative of a fault that intersects the hole at a depth of roughly 1500'? Or is it simply a difference in stratigraphy that can be explained by Helderberg strata (Coeymans Fm., etc.) having been present in Corehole 18 but having been erosionally removed from 31-109-26039 prior to deposition of overlying sediments? RESPEC and Cargill accept the latter interpretation, apparently supported by RESPEC's examination of chip samples from Corehole 18, including the interval said to be Coeymans Fm. However, the gamma spike extending from about 1500' depth to the casing shoe in Corehole 18 is not characteristic of the Coeymans Fm. No such spike is seen, for example, in the Coeymans interval in the two Chemung County wells. Without a good explanation of this gamma spike, further investigation is needed to characterize/rule out a repeated section and fault.*

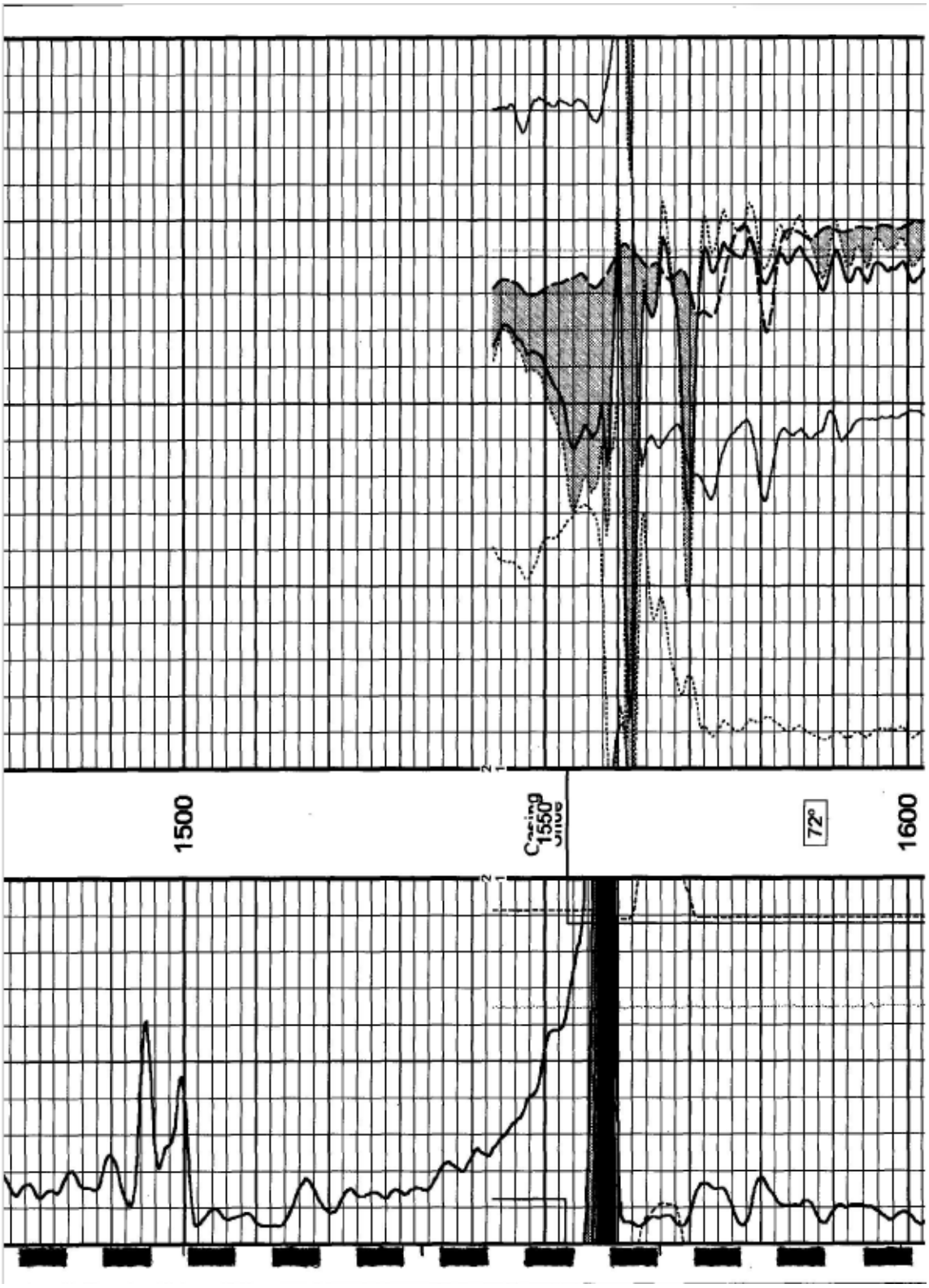

Fig. 2: Relevant interval of Corehole 18 log, from Weatherford Photo Density/Compensated Neutron/ Gamma Ray log, August 20, 2013, 5-inch main log.