

Naturally-Occurring TPH in Indiana Soils

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Sites impacted by releases from leaking underground storage tanks, pipelines or crude production, require an evaluation of the extent and severity of residual petroleum hydrocarbon concentrations and the need for remedial activities to be completed. Recent data collected from several Indiana locations during subsurface investigations at environmental sites have begun to document the potentially widespread presence of low-level (commonly less than 100 milligrams per kilogram) concentrations of naturally-occurring petroleum hydrocarbons often detected within certain glacial deposits. These natural hydrocarbons, the result of site soils derived from the weathering and incorporation of shale bedrock fragments into their matrix during depositional processes, should be taken into account when assessing whether a site is impacted by historical human activities or the degree of cleanup necessary to protect human health.

Table 1 represents a summary of total petroleum hydrocarbon (TPH) testing using U.S. EPA SW846 Method 8015M on Indiana shales and glacial soils. Two samples of northern Indiana upper Devonian Antrim Shale (provided by the IGS) and one New Albany shale sample from a southern Indiana bedrock outcrop (provided by Andy Gremos) were obtained for TPH analysis. In addition, shale clasts were also detected and removed from three glacial till samples and one outwash sand from Marion County. The results indicate the detection of TPH in the shale samples ranging from 540 to 1100 mg/Kg, with the shale clasts exhibiting TPH levels from 101 to 790 mg/Kg. Testing of over 100 unimpacted glacial soil samples (both till and sands) from sites in central Indiana have shown a TPH concentration range of from less than 20 to 98 mg/Kg, with an average TPH of about 50 mg/Kg.

Table 1.
**Results of Total Petroleum Hydrocarbons Testing
of Indiana Shale Samples and Shale Clasts**

<i>Sample Identification</i>	<i>TPH 8015M, mg/Kg</i>
Antrim Shale Northern Indiana No. 1	540
Antrim Shale Northern Indiana No. 2	1,100
New Albany Shale Southern Indiana Outcrop	557
Marion County Project Sites Sand (SP) Silty Sand (SM) Silty Clay/Clayey Silt (ML/CL) Outwash Sand (SP-SM)	101*, (44)** 481*, (78)** 228*, (34)** 790*
Central Indiana Glacial Soils (100 ⁺ sample locations)	< 20 – 98** (50 avg.)

*Shale clasts taken from sample

**Total soil sample

Knowing the percentage by weight of shale content within the glacial tills and sands, it is possible to predict the variation in the total naturally-occurring TPH concentration within the soils. Based on some published literature (see, for example, Harrison, 1959) and project experience, it is likely that shale content within central Indiana glacial soils ranges between about 3 to 13 percent by weight. Given the results in Table 1, naturally-occurring TPH levels in undisturbed (i.e., not humanly impacted) glacial soils could be expected to be on the order of:

$$\begin{aligned}
 \text{TPH}_{\text{natural}} &= (\text{Shale fraction in Soil})/\text{TPH}_{\text{shale}} \\
 &= (0.03 - 0.13 \text{ kg shale/Kg soil}) (540 - 1100 \text{ mg TPH/Kg shale}) \\
 &= \mathbf{16 - 143 \text{ mg/kg}}
 \end{aligned}$$

This predicted range is in general agreement with the observed data collected at multiple project sites in central Indiana (see Table 1). The ability to distinguish between human-impacted soils and nonhuman-impacted soils can affect the manner in which a ‘nature and extent’ environmental investigation is carried out. An awareness of this phenomenon can also impact the development of recommendations for appropriate remedial alternatives for hydrocarbon sites, especially if site-specific, naturally-occurring TPH levels approach the Indiana Department of Environmental Management’s 100 mg/kg soil cleanup guideline. As such, it is important for Indiana geologists to understand the potential presence of this natural ‘background’ TPH source and its associated impact on environmental decision-making.

Full Reference: Mundell, J. A., 2002, *Evaluating Naturally-occurring Petroleum Hydrocarbon Residuals in Soil*, Proceedings of the Midwestern States Risk Assessment Symposium, Indianapolis, Indiana, July 24-26 (CD).

Additional TPH Data of Interest

The results of glacial soil TPH concentration versus a downhole gamma response for Wisconsin and pre-Wisconsin deposits at a particular site are shown in Figure 1. A moderate linear correlation ($r^2 = 0.51$) between gamma response and TPH exists, indicating that soil units with higher natural shale or clay contents (as indicated by the higher natural gamma response) generally yield higher natural TPH levels. It should be noted that soil samples were TPH tested at 5 ft depth intervals, whereas variations in the gamma response were observed to occur over a much smaller scale length. It is expected that the correlation would improve (i.e., r^2 would increase) as the TPH testing frequency with depth is increased.

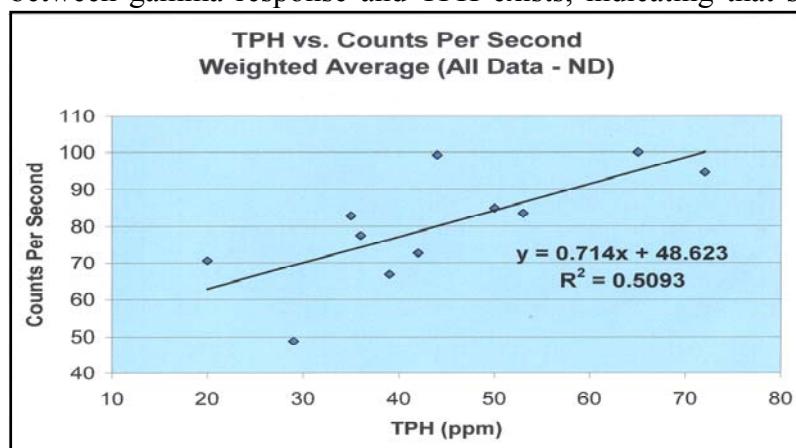


Figure 1. Correlation Between Naturally-occurring TPH and Gamma Counts