

Granulometric composition of clastic rocks of the Upper Devonian according to natural radioactivity data

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Introduction

Particle size distribution (PSD) is crucial for rock typing, reconstructing depositional environments, and predicting petrophysical properties like porosity and permeability. Traditional lab methods are discrete and limited to core samples. This study explores a continuous solution by correlating granulometric fractions with gamma-ray logs.

Granulometric Fractions

Grains are classified into three main fractions [1]:

- Psammite (Sand): $d > 0.1$ mm

Dominant in sandstones

- Aleurite (Silt): $d = 0.1\text{--}0.01$ mm

Dominant in siltstones

- Pelite (Clay): $d < 0.01$ mm

Dominant in mudstones

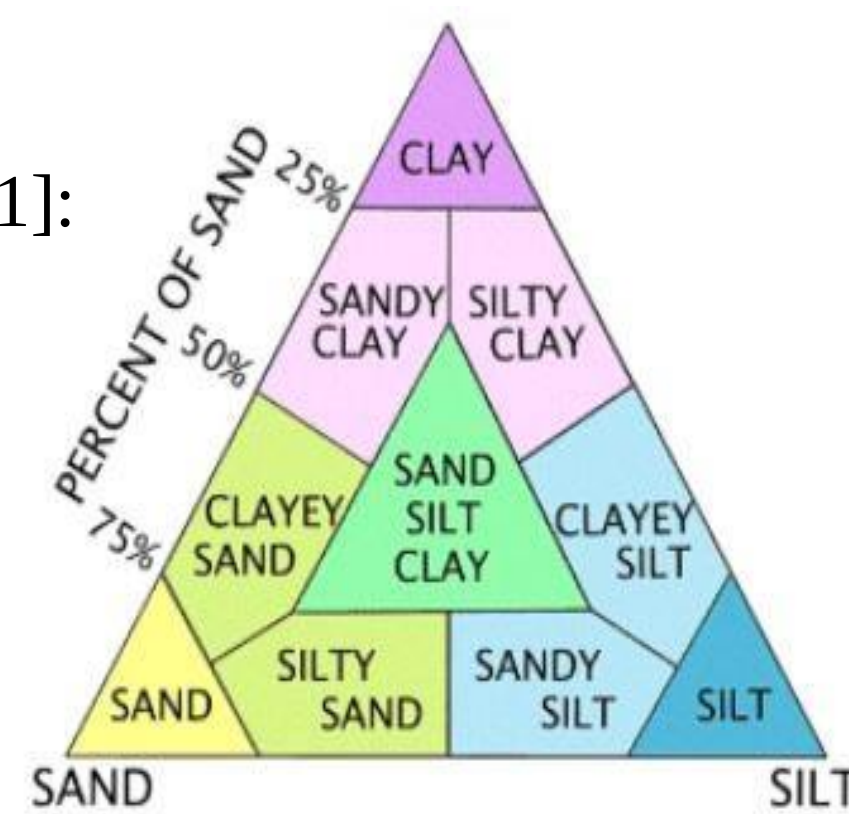


Fig. 1 – Shepard's classification of clastic rocks [2]

Methods

Lab Analysis: Laser diffraction granulometry on core samples.

Well Logging: Downhole gamma-ray log data.

Results

The analysis for two wells revealed **moderate correlations** between the content of each granulometric fraction (psammite, aleurite, pelite) and the processed gamma-ray log signal.

Hypothesis

For the Volga region, clay content (pelitic fraction) shows a direct correlation with natural radioactivity. We hypothesize that a correlation exists between the natural gamma-ray log response and the detailed fractional composition of rocks from granulometric analysis.

Subject of Research

Core samples from the Upper Devonian Pashiysky Horizon at an oil field in the Samara Region, Buzulukskaya Depression.



Fig. 2 – Fragment of the studied core

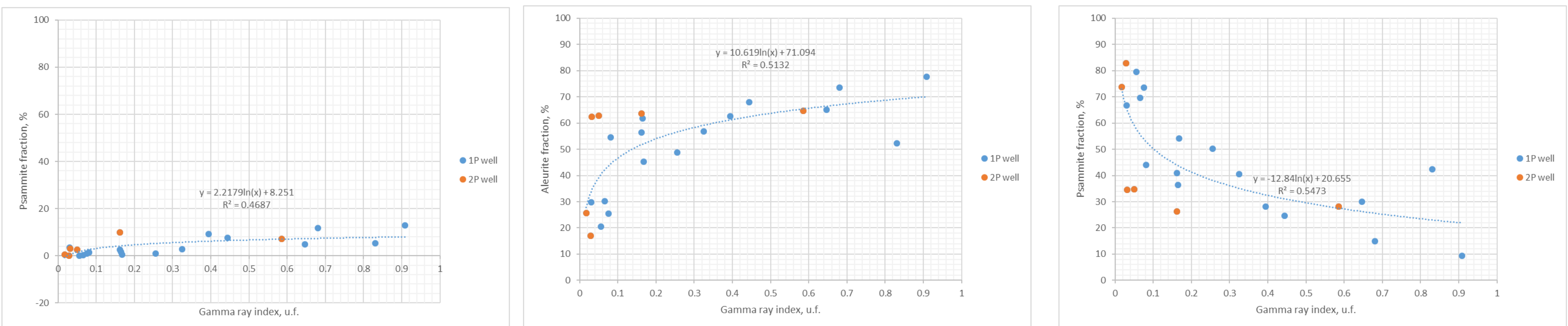


Fig. 3 – Dependencies of the gamma ray index on the content of different granulometric fractions

Discussions

The observed correlations confirm the initial hypothesis that natural gamma-ray activity can serve as a qualitative proxy for grain size distribution in the studied formation. This is consistent with the established practice in the Volga region, where a direct link between clay content (pelitic fraction) and radioactivity is recognized. The ability to also correlate the aleurite and psammite fractions suggests a more complex, yet definable, relationship between the entire PSD and the gamma-ray signal.

The conclusions of the study are based on the analysis of core from two wells. To confirm the robustness and statistical significance of the identified relationships, additional research on a larger dataset, encompassing more wells and intervals of the section, is necessary.

Conclusion

The established correlations demonstrate the potential of using gamma-ray logs as a continuous proxy for estimating granulometric composition along the entire wellbore. This method helps overcome the limitation of discrete core data and can significantly improve well planning and petrophysical studies.

References

1. GOST 12536-2014. (2015). Soils. Methods of laboratory determination of granulometric (grain) and microaggregate distribution. Moscow: Standartinform. (in Russian)
2. Shepard, F. P.: Nomenclature based on sand-silt-clay ratios, J. Sediment. Petrol., 24, 151–158, 1954.