

Gamma spectrometry characteristics of the organic-rich Doushantuo shale in the mid-Yangtze area

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Introduction

Gas discovery in the Yangye-1 well in the Sinian Doushantuo Formation (Zhai *et al.*, 2017) brought a new exploration field for the shale gas in the mid-Yangtze area. Lots of previous work has been focused on petrological and geochemical features rather than geophysical characters. This research aims to illustrate some geophysical characteristics of the Doushantuo Formation on gamma spectrometry.

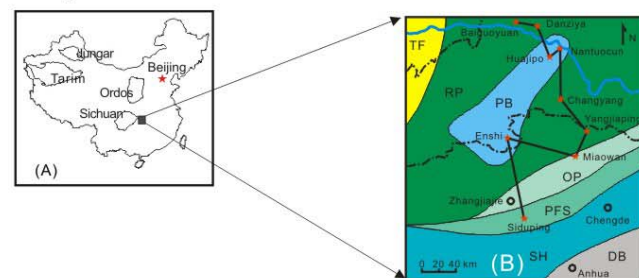


Figure 1. Maps showing (A) the working area in gray in the middle of China and (B) the locations of nine outcrop profiles in red stars on the paleogeography map modified from Li *et al.*, 2014. Facies abbreviations: TF = tidal flat; RP = restricted platform; OP = open platform; PB = inter-platform basin; PFS = platform-front slope; SH = shelf; DB = deep basin.

Materials and methods

The device of RS-230 BGO Super-Spec, produced by Laurel Industrial Company, was employed to assay the total count of radiation and each content of potassium (K), thorium (Th) and uranium (U). We established nine profiles of lithology and gamma spectrometry by outcrop measurement in the western Hubei province and northwestern Hunan province, China.



Figure 2. Photographs showing geological profile measurement at the site of outcrops and portable device for gamma spectrometry assay.

Results

The Doushantuo Formation, deposited after the global glacial ablation, is commonly divided into four members. Outcrop investigation shows that it has lots of lithological types, such as black shale, mudstone, carboniferous shale, dolomite, limestone, chert and many transitional types. Interestingly, phosphorus-bearing rocks occur more in the south than in the north, and chert content increases from north to south.

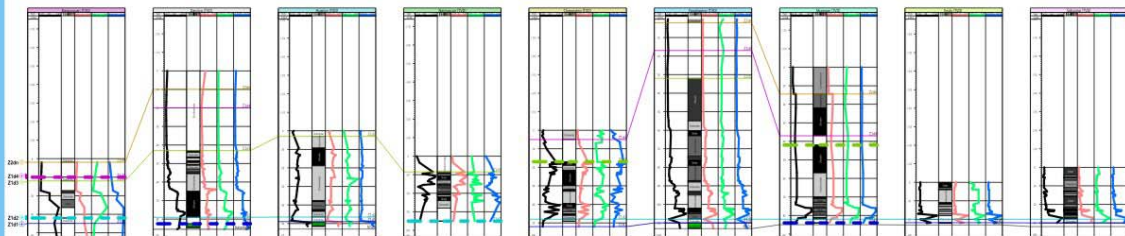


Figure 3. Correlation section showing the Doushantuo Formation ubiquitously deposited in the mid-Yangtze area and has variant thickness from north to south. The result shows that the 2nd member of the Doushantuo Formation (Z_1d^2) is abundant in black shale with high gamma-ray values, especially in the lower part.

The natural radioactivity of the rock is closely related to its lithology. Unlike other rocks, the black shale has obviously higher average values of the natural radioactivity with a quite wide range due to the variant uranium (U) content. The Th/U ratios of Z_1d^2 shows that frequent fluctuation of the Th/U ratios between 0.6 and 11 in the lower part follows a decreasing trend with mostly Th/U ratios lower than 2.

Table 1. Correlation coefficients between the total count of gamma ray and each of potassium (K), thorium (Th) and uranium (U) respectively at different outcrop locations

No.	Location	GR-K	GR-U	GR-Th
1	Danziya	0.94	0.27	0.83
2	Huajipo	0.83	0.27	0.99
3	Nantuocun	0.92	0.17	0.13
4	Changyang	0.96	0.18	0.55
5	Yangjiaping	0.99	0.75	0.95
6	Miaowan	0.91	0.89	0.97
7	Enshi	0.99	0.66	0.97
8	Siduping	0.97	0.96	0.67

Note: Few records (<10) at Baiguoyuan are not taken into account.

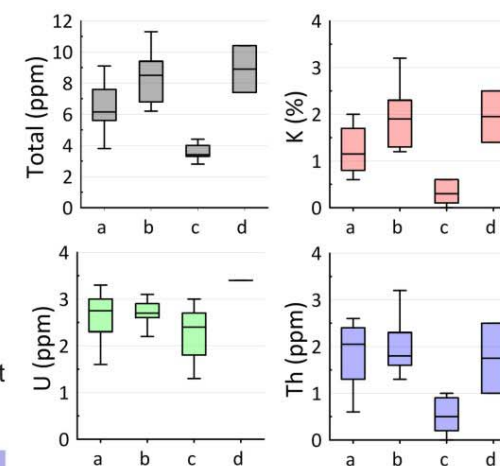


Figure 4. Box-whisker plots showing that different lithological types have distinctive statistical characters of natural radioactivity at Changyang. In the horizontal axis, a stands for dark gray dolomite with shale interlayer, b for black shale, c for gray dolomite and d for dark gray mud shale.

Conclusions

- The turbulent oxidizing-reducing conditions during the deposition of Z_1d^2 is gradually replaced by anaerobic environment.
- Those parameters of natural radioactivity like total values, K, Th and U contents, and Th/U ratios are good measures for availing regional correlation and establishing a megascopic sequence framework.
- As for the organic-rich Doushantuo shale, a further investigation could explore the relation between its geophysical and geochemical characters by performing GCMS tests on rock samples.

Literature cited

- Zhai, G., S. Bao, Y. Wang, et al., 2017. Reservoir accumulation model at the edge of palaeohigh and significant discovery of shale gas in Yichang area, Hubei province (in Chinese): *Acta Geoscientica Sinica*, v. 38, p. 441-447.
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Acknowledgments

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Further information

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