

Magnetic Resonance in Solids, 2017, vol.19, N1

EPR study of hydrocarbon generation potential of organic-rich domanik rocks

Khasanova N., Gabdrakhmanov D., Kayukova G., Mikhaylova A., Morozov V.
Kazan Federal University, 420008, Kremlevskaya 18, Kazan, Russia

Abstract

© Kazan Federal University (KFU). The objects of investigation were samples of domanik formation rocks of Berezhovskaya area of Romashkinskoye oil field. Content of Mn²⁺, SO₃²⁻, SO₂²⁻ ions, vanadyl-ions and free radicals has been estimated with the X-band (9.43 GHz) electron paramagnetic resonance (EPR) spectroscopy. Composition of rock and extracted from it bitumen has been studied with methods of thermal analysis, X-ray-structural analysis and gas chromatography. Significant differences in mineralogical composition and content of organic matter were revealed in samples taken from adjacent intervals. Pyrolytic experiments have been conducted to simulate kerogen maturation and petroleum generation. The increasing number of free radicals was registered in all samples after pyrolysis in a hydrogen atmosphere at 350°C. A new organic free radical C350 was registered after pyrolysis. It is suggested that domanik source rocks have not fully realized their hydrocarbon generation potential.

Keywords

Domanik rocks, EPR spectroscopy, Generation potential, Kerogen, Pyrolysis

References

- [1] Speight J.G. Deep Shale Oil and Gas, Gulf Professional Publishing, Cambridge (2017)
- [2] Gordon D. Understanding Unconventional Oil (Carnegie's Energy and Climate Program), Carnegie Endowment for International Peace, Washington, D.C. (2012)
- [3] Muslimov R.K., Plotnikova I.N. Neftyanoe Khozyaistvo [Oil Industry] 1, 12 (2014) (in Russian)
- [4] Muslimov R.K., Plotnikova I.N. Evaluation of the Resource Potential of Shale Hydrocarbons on the Territory Tatarstan Republic (Volga-Ural Oil and Gas Province), EGU General Assembly: Geophysical Research Abstracts, Vienna, (2015)
- [5] Khusainov R.F., Nazimov N.A., Gumarov N.F., Ganiev B.G., Shvydenko M.V., Absalyamov R.S. Georesursy [Georesources] No. 4(63), Vol. 2, 14 (2015) (in Russian)
- [6] Ulmishek G.F., Klemme H.D. Depositional Control, Distribution and Effectiveness of World's Petroleum Source Rocks, U.S. Government Printing Office, Denver, (1990)
- [7] Ostrouhov S.B., Plotnikova I.N., Nosova F.F., Pronin N.V. Georesursy [Georesources] No. 3(62), Vol. 1, 42 (2015) (in Russian)
- [8] Maksimova S.V. Ecological and Facial Features and Forming Conditions of Domanik Sediments, Nauka, Moscow (1970) (in Russian)
- [9] McMillan N.J., Embry A.F., Glass D.J. (eds.) Devonian of the World, Volume I-Regional Syntheses, Calgary, Canadian Society Of Petroleum Geologists (1988)
- [10] Fadeeva N.P., Kozlova E.V., Poludetkina E.N., Shardanova T.A., Pronina N.V., Stupakova A.V., Kalmykov G.A., Khomyak A.N. Moscow University Geology Bulletin 71, 41 (2016)

- [11] Michele L.W. Tuttle, Paul G.L., Jerry L.C. Molecular Stratigraphy of the Devonian Domanik Formation, Timan-Pechora Basin, Russia, Geological Survey Open-File Report 99-379 (1999)
- [12] Fadeeva N.P., Shardanova T.A., Smirnov M.B., Poludetkina E.N., Molenkova A.A. Peculiarities of Domanik Formation Organic Matter within the South-Tatar Arch, 27th International Meeting on Organic Geochemistry: Book of Abstracts, Prague (2015)
- [13] Burov B.V. Tatarstan Geology: Stratigraphy and Tectonics, GEOS, Moscow (2003) (in Russian)
- [14] Gottih R.P., Pisockiy B.I. Georesursy [Georesources] 4, 6 (2006) (in Russian)
- [15] MacLeod N. Russian Geology and Geophysics 9, 979 (2005)
- [16] MacLeod N. The Great Extinction: What Causes Them and How They Shape Life, The Natural History Museum, London (2013)
- [17] Neruchev S.G. Uranium and Life in Earth History, Nedra, Saint-Petersburg (1982) (in Russian)
- [18] Afanasieva M.S., Mikhailova M.V. Stratigraphy and Geological Correlation 9 (5), 419 (2001)
- [19] Lindquist S.J. The Timan-Pechora Basin Province of Northwest Arctic Russia: Domanik-Paleozoic Total Petroleum System, U.S. Geological Survey Open-File Report 99-50-G, (1999)
- [20] Zaidelson M.I., Surovnikov E.Y., Kazmin L.L., Vaynbaum, S.Y., Semenova, E.G. Geologiya Nefti i Gaza [Oil and Gas Geology] 6, 2 (1990) (in Russian)
- [21] Anan'ev V.V., Smelkov V.M., Pronin N.V. Geologiya Nefti i Gaza [Oil and Gas Geology] 1, 32 (2007) (in Russian)
- [22] Vandenbroucke M. Oil & Gas Science and Technology-Revue de l'Institut de Français du Pétrole 58, 243 (2003)
- [23] Tissot B.P., Welte D.H. Petroleum Formation and Occurrence: A New Approach to Oil and Gas Exploration, Springer-Verlag, Berlin (1978)
- [24] McCarthy K., Rojas K., Niemann M., Palmowski D., Peters K., Stankiewicz A. Oilfield Review 23, 32 (2011)
- [25] Solli H., Bjoroy M., Leplat P., Hall K. Journal of Analytical and Applied Pyrolysis 7, 101 (1984)
- [26] Behar F., Vandenbroucke M. Organic Geochemistry 13, 927 (1988)
- [27] Kayukova G.P., Kiyamova A.M., Mikhailova A.N., Kosachev I.P., Petrov S.M., Romanov G.V., Sitdikova L.M., Plotnikova I.N., Vakhin A.V. Chemistry and Technology of Fuels and Oils 52, 149 (2016)
- [28] Tagiev M.F., Zeinalov G.A. Trudy NIPI «Neftegaz» SOCAR [NIPI «Neftegaz» SOCAR works] 2, 16 (2010) (in Russian)
- [29] Kök M.V., Şengüler I. Journal of Thermal Analysis and Calorimetry 116, 367 (2014)
- [30] Bulka G.R., Nizamutdinov N.M., Mukhutdinova N.G., Khasanova N.M., Galeev A.A., Vinokurov V.M. Applied Magnetic Resonance 2, 107 (1991)
- [31] Eaton G.R., Eaton S.S., Salikhov K.M. Foundations of Modern EPR, World Scientific Publishing (1998)
- [32] Gilinskaya L.G. Journal of Structural Chemistry 49, 245 (2008)
- [33] Kai A., Miki T. International Journal of Radiation Applications and Instrumentation. Part C. Radiation Physics and Chemistry 40, 469 (1992)
- [34] Barabas M. International Journal of Radiation Applications and Instrumentation. Part D. Nuclear Tracks and Radiation Measurements 20, 453 (1992)
- [35] Bushnev D.A., Burdel'naya N.S. Petroleum Chemistry 53, 145 (2013)
- [36] Burdel'naya N.S., Bushnev D.A., Mokeev M.V. Vestnik IG Komi NC UrO RAN 6, 33 (2015) (in Russian)
- [37] Kök M.V. Journal of Thermal Analysis and Calorimetry 91, 763 (2008)
- [38] Labus M. Journal of Thermal Analysis and Calorimetry (2017) DOI: 10.1007/s10973-017-6259-7
- [39] Vakhin A.V., Morozov V.P., Sitnov S.A., Eskin A.A., Petrovina M.S., Nurgaliev D.K., Kayukova G.P., Romanov G.V., Yusupova T.N. Chemistry and Technology of Fuels and Oils 50, 569 (2015)
- [40] Peters K.E., Walters C.C., Moldowan J.M. The Biomarker Guide: Volume 2, Biomarkers and Isotopes in Petroleum Systems and Earth History, Cambridge University Press (2007)
- [41] Nosova F.F., Pronin N.V. Organic Geochemical Study of Domanik Deposits, Tatarstan Republic, EGU General Assembly: Geophysical Research Abstracts, Vienna (2010)
- [42] Babakhani A., Yang X. EPR Systems for Flow Assurance and Logging, United States patent application 2016/0223478
- [43] Díaz M., Aldana M., Jiménez S.M., Sequera P., Costanzo-Álvarez V. Revista Mexicana de Física 52 (3), 65 (2006)
- [44] Chilingarian G.V., Buryakovskiy L.A., Eremenko N.A., Gorfunkel M.V. Geology and Geochemistry of Oil and Gas, Elsevier (2005)
- [45] Bakr M.Y., Akiyama M., Sanada Y. Organic Geochemistry 15 (6), 595 (1990)
- [46] Bakr M., Akiyama M., Sanada Y., Yokono T. Organic Geochemistry 12 (1), 29 (1988)